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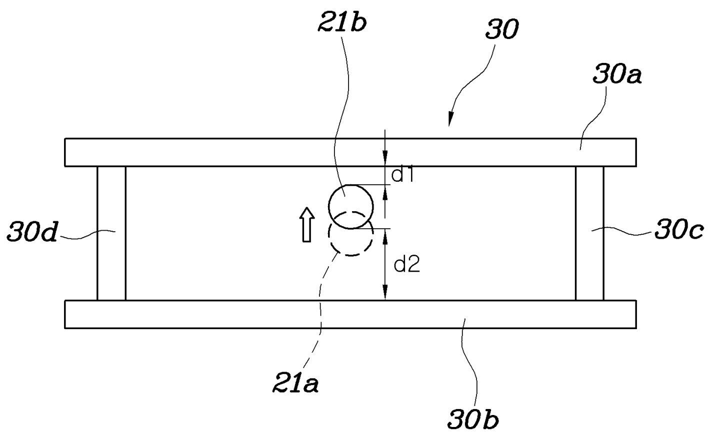
(54) CONTINUOUS SLAB CASTING METHOD

(57) The present invention relates to a continuous casting method for a slab, which controls locations of segregations and shrinkage cavities that are generated within a slab. The continuous casting method for a slab according to an embodiment of the present invention includes: primarily cooling the slab by a mold while the molten steel is injected into an area that is biased from a central portion of an inside of the mold in a thickness direction of the slab; and secondarily cooling the slab by spraying cooling water to a surface of the slab while drawing the slab that is primarily cooled by the mold.

[FIG.3b]



EP 3 354 371 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a continuous casting method for a slab and, more particularly, to a continuous casting method for a slab, which controls locations of segregations and shrinkage cavities that are generated within a slab.

BACKGROUND ART

[0002] In general, in a steel factory, a slab that is a half-finished product is manufactured in a continuous casting process using molten steel that is manufactured via an iron-making process and a steel-making process, and the slab is produced as the coil of a desired thickness by consumers in the rolling process.

[0003] Fig. 1 is a view schematically illustrating a general continuous casting equipment, and Fig. 2 is a schematic view illustrating solidification structures of a slab that is manufactured by the general continuous casting equipment.

[0004] As illustrated in Fig. 1, molten steel 1 that is refined in a steel-making process is accommodated in a ladle 10, is moved to a continuous casting factory, and is then located on a tundish 20. Further, the molten steel that is accommodated in the ladle 10 is injected into the tundish 20 through a shroud nozzle, and the molten steel 1 that has been injected into the tundish 20 is continuously injected into a mold 30 through an submerged nozzle 21. The molten steel 1 that has been supplied to the mold 30 is primarily cooled while passing through the mold 30, is then withdrawn and is mainly cooled by cooling water that is sprayed from spaces between a plurality of segment rolls while being rolled by the rolls, and is thus manufactured into a slab 2.

[0005] The slab 2 that is continuously casted in this way is cut to have a predetermined length by a cutter 50, and is transferred to a rolling process by a transfer roller 60.

[0006] In particular, when the slab 2 is rolled into a thick steel plate, defects of the slab 2 remain after the rolling, and thus, defective products may be caused. Examples of such defects include solidification shrinkage cavities and center segregations that are generated at a center of the slab in a thickness direction thereof, as illustrated in Fig. 2.

[0007] When solute-concentrated residual molten steel is collected in a solidification shrinkage part near a solidification end point in a continuous casting process, this is changed into segregations 4, and when the solidification shrinkage part is not filled and a space remains therein, this is changed into solidification shrinkage cavities 3, that is, center porosities. Such defects remain at the center of the slab even after thick plate rolling.

[0008] Further, while a thick plate rolling/cooling process is undergone, tensile stress is generated at a central portion of the slab in a thickness direction thereof. In the cooling process after rolling, a temperature of a surface of the slab is decreased more rapidly than that of the central portion thereof, and the central portion of the slab in the thickness direction thereof is under a tensile stress due to such a temperature difference. In particular, as the thickness of the slab becomes thicker, the magnitude of the tensile stress that results from such a temperature difference becomes larger, and when such a tensile stress is focused on the segregations 4 and the solidification shrinkage cavities 3, which have been mentioned above, defects of the central portion of the slab 2 are expanded, and thus defective products may be generated.

[0009] A typical technology for reducing defects such as the center segregations 4 and the solidification shrinkage cavities 3 that cause defective products is soft reduction. The soft reduction technology is a technology that applies a roll force to a slab 2 by segment rolls 40 during continuous casting. In the technology, the number of porosities that are generated by solidification shrinkage is minimized by physically compressing solidification shrinkage cavities 3 by rolling the slab at an end of solidification by a solidified and shrunk degree, and at the same time, center segregations 4 are suppressed from being generated in the slab 2 by suppressing molten steel in which solutes that exist between columnar crystals are concentrated from being introduced into the central portion of the slab in the thickness direction thereof. However, in the soft reduction technology, because large-scale rolling equipment should be installed in a continuous casting machine and the rolling is performed at an end of solidification, the segregations 4 and the solidification shrinkage cavities 3 may not be sufficiently removed.

[0010] Further, even though the generation of the center segregations 4 and the solidification shrinkage cavities 3 are suppressed, some of them remain in the central portion of the slab/product in the thickness direction thereof, and a tensile stress that is generated during rolling/cooling is maximized at the central portion in the thickness direction, and thus, defects are generated at the central portion of the slab 2 in the thickness direction thereof. In particular, when the thickness of the slab 2 is large or accelerated cooling should be performed in a rolling process, a temperature difference between the central portion thereof in the thickness direction thereof and a surface thereof becomes much larger, a probability that defective products are caused is further increased.

[0011] Further, technologies for reducing defects such as the center segregations 4 and the solidification shrinkage cavities 3 include an submerged nozzle 21, particularly, improvement of a structure of a discharge hole of the submerged nozzle 21, control of spraying of cooling water in a secondary cooling zone and the like. However, such methods are adapted to suppress the center segregations 4 and the solidification shrinkage cavities 3 from being generated, but have a problem in that the center segregations 4 and the solidification shrinkage cavities 3 cannot be completely removed.

DISCLOSURE

TECHNICAL PROBLEM

[0012] The present invention provides a continuous casting method for a slab, in which a location of an submerged nozzle that supplies molten steel to a mold is changed so that locations of segregations and solidification shrinkage cavities that are generated within the slab are controlled.

TECHNICAL SOLUTION

[0013] A continuous casting method for a slab according to an embodiment of the present invention may include: primarily cooling a slab by a mold while molten steel is injected into an area that is biased from a central portion of an inside of the mold in a thickness direction of the slab; and secondarily cooling the slab by spraying cooling water to a surface of the slab while drawing the slab that is primarily cooled by the mold.

[0014] In the primarily cooling, an submerged nozzle may be input into the mold that includes a pair of long sides that face each other and a pair of short sides that face each other, the molten steel may be injected into the mold, and the submerged nozzle may be biased in a direction of one long side that is selected from the pair of long sides.

[0015] In the secondarily cooling, the slab may be drawn from the mold downward and may be drawn while being forwardly bent, and in the primarily cooling, the direction in which the submerged nozzle is biased may be a direction of a long side that is arranged on a front side with reference to a direction in which the slab is drawn among the pair of long sides.

[0016] In the primarily cooling, a difference between a distance d1 between the submerged nozzle and one long side that is selected from the pair of long sides and a distance d2 between the submerged nozzle and the other long side among the pair of long sides may be 20 mm or longer.

[0017] In the primarily cooling, a distance d1 between the submerged nozzle and one long side that is selected from the pair of long sides and a distance d2 between the submerged nozzle and the other long side among the pair of long sides may be 10 mm or longer.

[0018] In the primarily cooling, a length ratio (d1:d2) of the distance d1 between the submerged nozzle and one long side that is selected from the pair of long sides and the distance d2 between the submerged nozzle and the other long side among the pair of long sides may be 1:3.

[0019] In the secondarily cooling, the slab may be drawn from the mold downward and may be drawn while being forwardly bent, an amount of cooling water that is sprayed from an upper side of the slab may be maintained to be larger than an amount of cooling water that is sprayed from a lower side of the slab until the drawn slab is completely solidified, and the amount of cooling water that is sprayed from the lower side of the slab may be maintained to be larger than the amount of cooling water that is sprayed from the upper portion of the slab after the drawn slab is completely solidified.

ADVANTAGEOUS EFFECTS

[0020] According to an embodiment of the present invention, a location of an submerged nozzle that is placed within a mold is changed and molten steel is injected not into a central portion of the mold but into an area of the mold, which is biased in a thickness direction of a slab, so that locations where segregations and solidification shrinkage cavities are generated may be moved from a central portion to a surface of the slab.

[0021] In this way, as the locations of the segregations and the solidification shrinkage cavities are moved to the surface, the solidification shrinkage cavities are more easily compressed in a rolling process for the slab, and the segregations are not situated at a location where a maximum tensile stress is generated in a cooling process after rolling so that cracks are prevented from being propagated. Accordingly, inner defects of final products may be reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022]

Fig. 1 is a view schematically illustrating a general continuous casting equipment;

Fig. 2 is a schematic view illustrating the solidification structure of a slab that is manufactured by the general continuous casting equipment;

Fig. 3A is a view illustrating the location of an submerged nozzle within a mold in the general continuous casting equipment;

Fig. 3B is a view illustrating the state in which the location of the submerged nozzle within the mold that is applied to a continuous casting method for a slab according to an embodiment of the present invention is changed;

Fig. 4 illustrates the flow and temperature analysis results for molten steel within the mold that is applied to the continuous casting method for a slab according to the embodiment of the present invention;

Fig. 5 is a picture illustrating the slab that is manufactured by the continuous casting method for a slab according to the embodiment of the present invention;

Fig. 6 is a compression simulation result according to locations of solidification shrinkage cavities during rolling; and

Fig. 7 is a schematic view illustrating the remained center segregations in a product and stress distribution.

BEST MODE FOR THE INVENTION

[0023] Hereinafter, embodiments of the present invention will be described in more detail with reference to the accompanying drawings. However, the present invention is not limited to the following embodiments, but will be implemented in various different shapes. Only, the present embodiments make disclosure of the present invention complete, and are provided to completely notify those skilled in the art of the scope of the present invention. The same reference numerals on the drawings refer to the same elements.

[0024] Fig. 3A is a view illustrating the location of an submerged nozzle within a mold in general continuous casting equipment, Fig. 3B is a view illustrating the state in which the location of the submerged nozzle within the mold that is applied to a continuous casting method for a slab according to an embodiment of the present invention is changed, Fig. 4 illustrates the flow and temperature analysis results for molten steel within the mold that is applied to the continuous casting method for a slab according to the embodiment of the present invention, Fig. 5 is a picture illustrating the slab that is manufactured by the continuous casting method for a slab according to the embodiment of the present invention, Fig. 6 is a compression simulation result according to locations of solidification shrinkage cavities during rolling, and Fig. 7 is a schematic view illustrating center segregations that is remained in a product and stress distribution.

[0025] As illustrated in the drawings, the continuous casting method for a slab according to one embodiment of the present invention is implemented using the general continuous casting equipment illustrated in Fig. 1. However, the method is achieved by changing the location where a molten steel 1 accommodated in a tundish 20 is injected into a mold 30 while changing the location of an submerged nozzle 21 through which the molten steel 1 is injected into the mold 30.

[0026] In other words, the continuous casting method for a slab according to one embodiment of the present invention largely includes: performing primary cooling the molten steel 1 using the mold 30 while injecting the molten steel 1 into an inner area of the mold 30 to be biased from the central portion of the mold 30 to a thickness direction thereof, and performing secondary cooling by spraying cooling water to the surface of the slab 2 which is drawn out after being primarily cooled down by the mold 30.

[0027] In the performing of the primary cooling, an submerged nozzle 21a is not arranged at the central portion of the inside of the mold 30 as illustrated in Fig. 3A but an submerged nozzle 21b is arranged on the area thereof to be biased toward the direction widthwise of the slab 2as illustrated in Fig. 3B in order to allow the molten steel 1 to be injected to the direction biased in the widthwise of the slab 2. In detail, the mold 30 is composed of a pair of long sides 30a and 30b that face each other and a pair of short sides 30c and 30d that face each other. Here, the submerged nozzle 21b is arranged to be biased toward the direction of one long side 30a that is selected from the pair of long sides 30a and 30b.

[0028] Thus, a flow strength (flow rate) of the molten steel 1 in the biased area is induced to be greater than that of the other areas. Then, a result as illustrated in Fig. 4A may be obtained. It may be identified in Fig. 4A that an area that has red color (relatively dark part) is an area that has a high flow strength, and flow rates in respective areas on the surface of the molten steel have little difference but a stronger flow field is formed in the areas by 2m under the molten steel surface in the biased direction than at the center. Fig. 4B illustrates a calculated temperature field on this area, and it may be identified that temperatures are different from each other in a thickness direction, which is similar to the result of the flow field. In Fig. 4B, an area having a red color (relatively dark part) is an area having a relatively high temperature and the fact that a temperature difference occurs means that solidification completion is generated not at a central portion of its thickness but at a portion thereof in the biased direction.

[0029] Meanwhile, as illustrated in Fig. 1, in the continuous casting equipment, a plurality of segment rolls 40 that simultaneously compress and draw the slab 2 toward a lower side of the mold 30 are forwardly bent. Here, it is preferred that a direction in which the submerged nozzle 21 is biased is a direction of the long side 30a that is arranged on a front side with reference to a direction in which the slab 2 is drawn among the pair of long sides 30a and 30b. Thus, the direction in which the submerged nozzle 21 is biased is set to be a direction of an upper surface of the drawn slab 2. Accordingly, the point at which the segregations 4 and the solidification shrinkage cavities 3 are generated is biased in a direction of an upper surface of the slab 2 by biasing the point at which solidification is completed in a direction of an upper portion rather than a lower surface portion of the drawn slab 2.

[0030] Next, a degree to which the submerged nozzle 21 is biased will be described.

[0031] As illustrated in Fig. 3B, casting is performed while the submerged nozzle 21 that is generally located at a center of the mold 30 is moved in an arrow direction. Here, "d1" refers to a distance between the submerged nozzle 21 and the long side 30a that is selected from the pair of long sides 30a and 30b, and "d2" refers to a distance between the submerged nozzle 21 and the other long side 30b among the pair of long sides 30a and 30b.

[0032] Thus, the submerged nozzle 21 is arranged such that a length ratio (d2/d1) of d1 and d2 is 1, 3, 4 and 7 and casting is then performed. Here, it may be identified that as a length difference between d1 and d2 becomes larger, a location where solidification is completed is moved not to a central portion of the slab 2 but to a surface thereof. In other words, the solidification shrinkage cavities 3 and the segregations 4 are moved not to the central portion of the slab 2 in the thickness direction but to the surface thereof. However, a difference between d1 and d2 is required to be larger than 20mm. Otherwise, locations where the segregations 4 and the solidification shrinkage cavities 3 are generated do not largely deviate from the central portion of the slab 2 in the thickness direction thereof, and thus, this is not effective in improving qualities of rolled products. Further, when a length of either one of d1 and d2 is smaller than 10mm, solidified layers are re-melted as the discharged molten steel strongly collides with the solidified layers, and thus, an operating accident may occur.

[0033] Thus, as a difference between d1 and d2 becomes larger while being 20mm or more, this is advantageous in moving a solidification completion location. However, it is preferred that the submerged nozzle 21 is arranged such that both d1 and d2 are 10mm or greater respectively. Preferably, it is optimal that a length ratio (d1:d2) of d1 and d2 is 1:3.

[0034] Fig. 5 illustrates a result obtained by performing casting when a length ratio (d1:d2) of d1 and d2 is 1:3, and it may be identified that an area having a red color (area near solidification completion line) indicates an area having a relatively high temperature and a location thereof is biased not to the central portion of the slab 2 in its thickness but to an upper portion thereof. That is, as the location of the submerged nozzle 21 is moved, the flow and temperature fields are changed. Because of this, it may be identified that the location where the solidification is completed may be biased not to the central portion in the thickness direction but to either one surface. Thus, the segregations 4 and the solidification shrinkage cavities 3 are biased not to the central portion of the slab 2 in the thickness direction thereof but to the upper surface thereof by a predetermined interval. However, when d2 is much greater than d1, the segregations 4 and the solidification shrinkage cavities 3 are largely biased to the surface of the slab 2. Thus, the defects are exposed to the surfaces in a rolling process and surface defects may thus be caused. Accordingly, it is preferred that the length ratio (d1:d2) of d1 and d2 is maintained to be 1:3.

[0035] As above, as the molten steel 1 is injected in a state in which the location of the submerged nozzle 21 is biased, the flow and temperature fields of the molten steel 1 are changed, so that the point where the solidification is completed is biased to the upper surface of the slab 2. In this case, bending of the slab 2 is occurred by a residual stress that is caused by a cooling difference that is generated between the upper surface and a lower surface of the slab 2 during the solidification, and thus it may be difficult to transfer the slab 2 using a transfer roller 60.

[0036] To prevent such a problem from being generated, in the present embodiment, an amount of cooling water that is sprayed to an upper side of the slab 2 may be maintained to be greater than an amount of cooling water that is sprayed to a lower side of the slab 2 until the slab 2 that is drawn in the performing of the secondary cooling is completely solidified, and the amount of cooling water that is sprayed to the lower side of the slab 2 may be maintained same as or to be greater than the amount of cooling water that is sprayed to the upper portion of the slab 2 after the drawn slab 2 is completely solidified.

[0037] Next, an effect that may be expected as the segregations 4 and the solidification shrinkage cavities 3 that are generated when the slab 2 is manufactured are changed from the central portion of the slab 2 in the thickness direction thereof to the upper surface thereof will be described.

[0038] First, inner defects of a thick plate product are identified through ultrasonic inspection. At the ultrasonic inspection, defects are detected at central portions of most of thick plate products in thickness directions thereof, and are caused by the solidification shrinkage cavities 3 and the segregations 4 that are generated in the central portion in the thickness direction during the continuous casting. Even though the same amount of the solidification shrinkage cavities 3 and the same amount of the segregations 4 are generated inside the slab 2, the defects are easily detected as the products have a higher strength and a heavier gauge and this is caused by the following reason.

[0039] First, as the products are thickened, a rolling amount of the slab 2 is reduced, and thus compression of the solidification shrinkage cavities 3 becomes more difficult. In particular, because deformation of the central portion of the slab 2 in the thickness direction thereof is less than that of the surface thereof during the rolling, the compression of the solidification shrinkage cavities 3 becomes more and more difficult. Because of this, it may be identified that even though rolling is performed at the same rolling amount, a solidification shrinkage cavity 3b that is located at 1/4 of the thickness is compressed more easily than a solidification shrinkage cavity 3a at the central portion in the thickness direction, as illustrated in Fig. 6. When an extremely thick plate is produced in a state in which the thickness of the slab 2 is determined, a rolling amount is relatively small, and thus, the compression of the solidification shrinkage cavities 3 becomes more difficult.

[0040] However, when the solidification shrinkage cavities 3 are biased not to the central portion of the slab 2 in the thickness direction thereof but to the upper surface thereof, a porosity is compressed more easily, so that defects by the ultrasonic inspection may be reduced.

[0041] In addition, the surface of a product that is produced after the slab 2 is rolled is firstly cooled. That is, the surface of the product is in a low temperature state and an interior thereof is in a relatively high temperature state. Accordingly, a tensile stress is generated at a central portion of the product in a thickness direction thereof. In particular, when a segregation 4 is located at the central portion of the slab 2 in the thickness direction thereof, a crack is easily generated due to stress concentration and propagated, and thus becomes causes of defects at the ultrasonic inspection. In particular, as the thick plate product is highly strengthened and extremely thickened, the tensile stress is more largely increased, and thus a defect incidence is increased.

[0042] Thus, as in the present embodiment, even though the segregation 4 and the solidification shrinkage cavity 3 are not completely removed, locations where the segregation 4 and the solidification shrinkage cavity 3 are generated are moved as illustrated in Fig. 7, the compression is performed more easily in a rolling process. Thereafter, the segregation 4 is not situated at a location where a maximum tensile stress is generated in a cooling process, and thus, the crack is prevented from being propagated, so that defects of a final product may be reduced.

[0043] Although the present invention has been described with reference to the accompanying drawings and the above-described exemplary embodiments, the present invention is not limited thereto, and is limited by the following appended claims. Thus, the present invention may be variously modified and changed by those skilled in the art without departing from the technical spirit that is provided by the following appended claims.

[Descriptions of reference numerals]

[0044]

1: Molten steel	2: Slab
3: Solidification shrinkage cavity	4: Segregation
10: Ladle	11: Shroud nozzle
20: Tundish	21: Submerged nozzle
30: Mold	30a, 30b: Long sides
30c, 30d: Short sides	40: Segment rolls
50: Cutter	60: Transfer roller

Claims

1. A continuous casting method for a slab, in which a slab is continuously casted, the continuous casting method comprising:

   primarily cooling the slab by a mold while the molten steel is injected into an area that is biased from a central portion of an inside of the mold to a thickness direction of the slab; and
   secondarily cooling the slab by spraying cooling water to a surface of the slab while drawing the slab that is primarily cooled by the mold.

2. The continuous casting method of claim 1, wherein in the primarily cooling, an submerged nozzle is input into the mold that includes a pair of long sides that face each other and a pair of short sides that face each other, the molten steel is injected into the mold, and the submerged nozzle is biased in a direction of one long side that is selected from the pair of long sides.

3. The continuous casting method of claim 2, wherein in the secondarily cooling, the slab is drawn from the mold downward and is drawn while being forwardly bent, and
   wherein in the primarily cooling, the direction in which the submerged nozzle is biased is a direction of a long side

that is arranged on a front side with reference to a direction in which the slab is drawn among the pair of long sides.

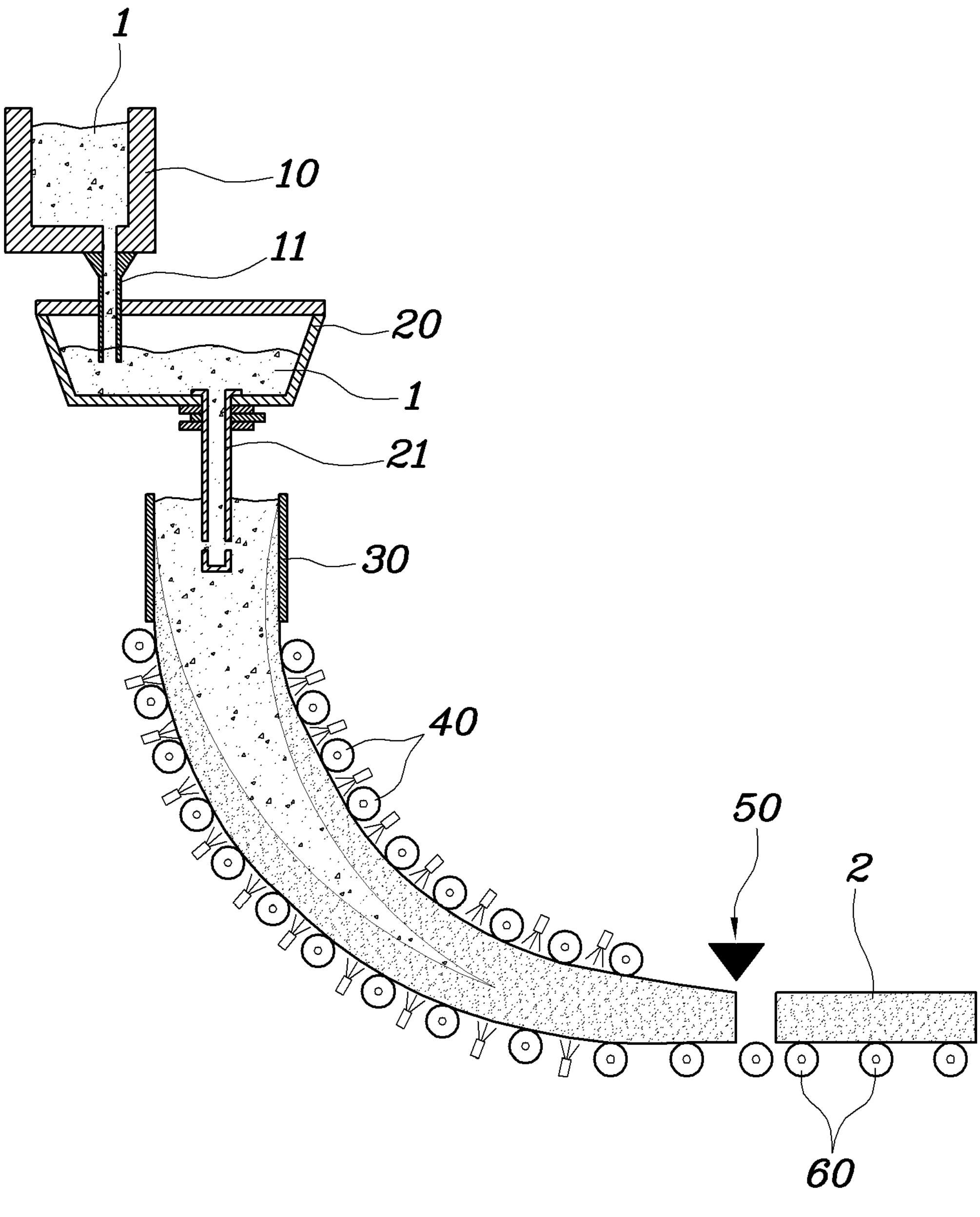
4. The continuous casting method of claim 2, wherein in the primarily cooling, a difference between a distance d1 between the submerged nozzle and one long side that is selected from the pair of long sides and a distance d2 between the submerged nozzle and the other long side among the pair of long sides is 20 mm or longer.

5. The continuous casting method of claim 2, wherein in the primarily cooling, a distance d1 between the submerged nozzle and one long side that is selected from the pair of long sides and a distance d2 between the submerged nozzle and the other long side among the pair of long sides are 10mm or longer respectively.

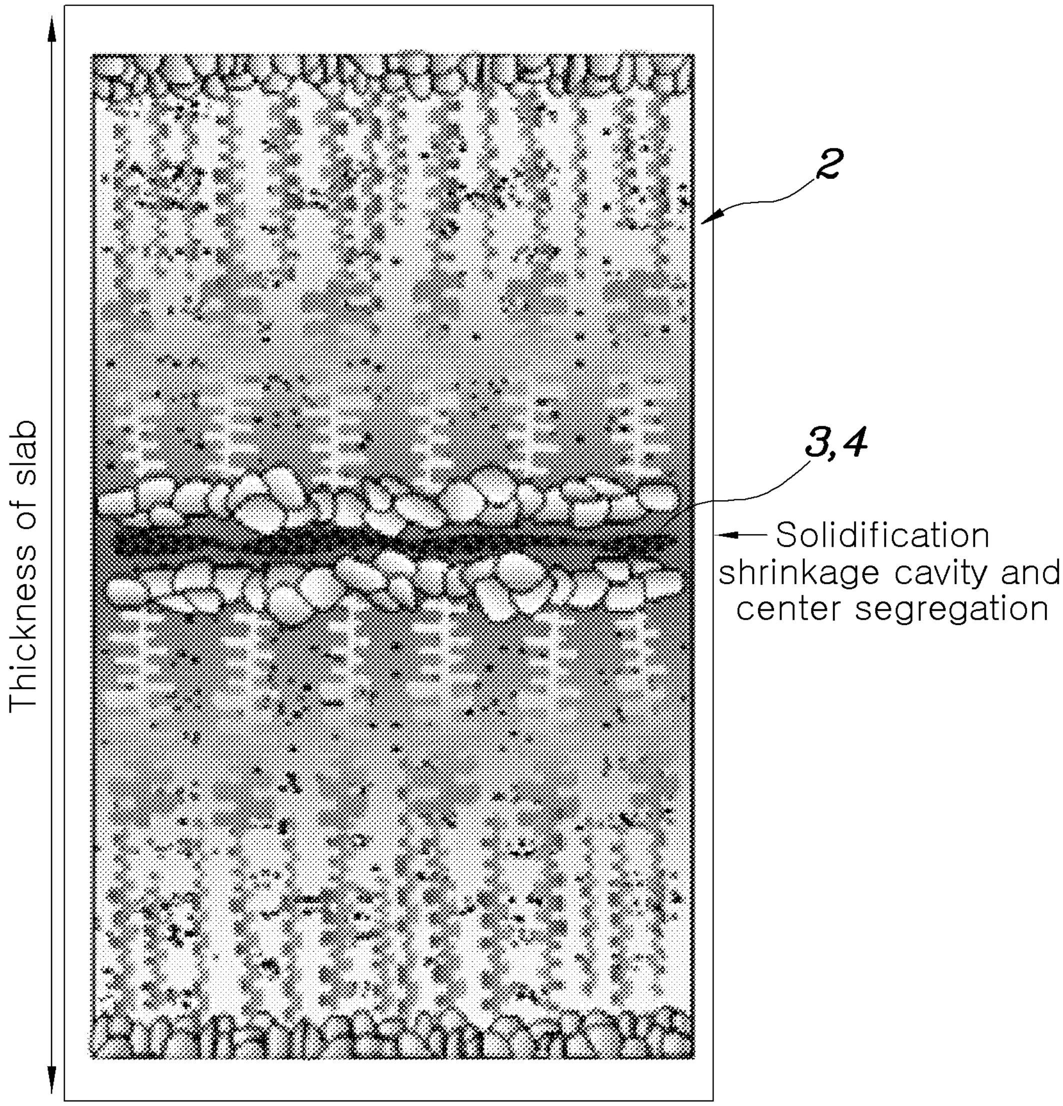
6. The continuous casting method of claim 2, wherein in the primarily cooling, a length ratio (d1:d2) of the distance d1 between the submerged nozzle and one long side that is selected from the pair of long sides and the distance d2 between the submerged nozzle and the other long side among the pair of long sides is 1:3.

7. The continuous casting method of claim 2, wherein in the secondarily cooling, the slab is drawn from the mold downward and is drawn while being forwardly bent,
wherein an amount of cooling water that is sprayed to an upper side of the slab is maintained to be greater than an amount of cooling water that is sprayed to a lower side of the slab until the point that the drawn slab is completely solidified, and
wherein the amount of cooling water that is sprayed to the lower side of the slab is maintained same or to be greater than the amount of cooling water that is sprayed to the upper portion of the slab after the point that the drawn slab is completely solidified.

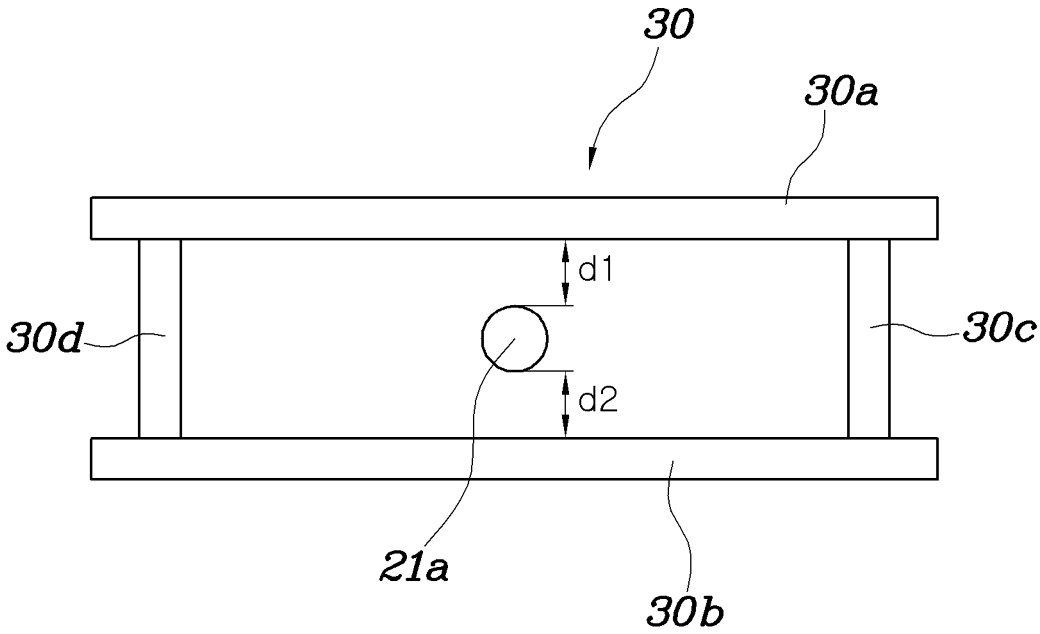
[FIG.1]



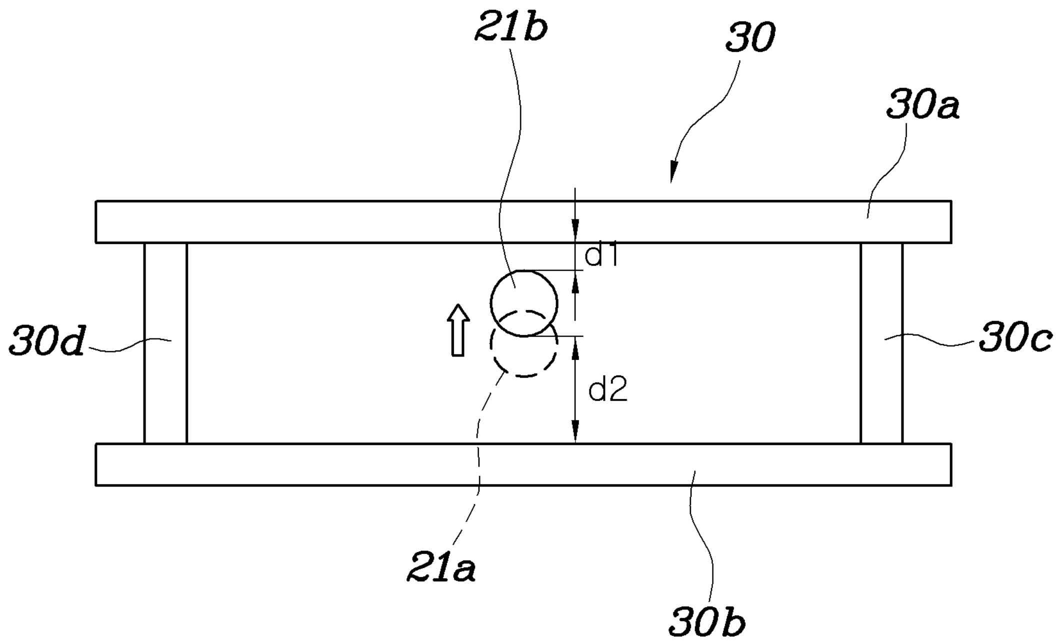
[FIG.2]


2
3,4
Solidification shrinkage cavity and center segregation
Thickness of slab

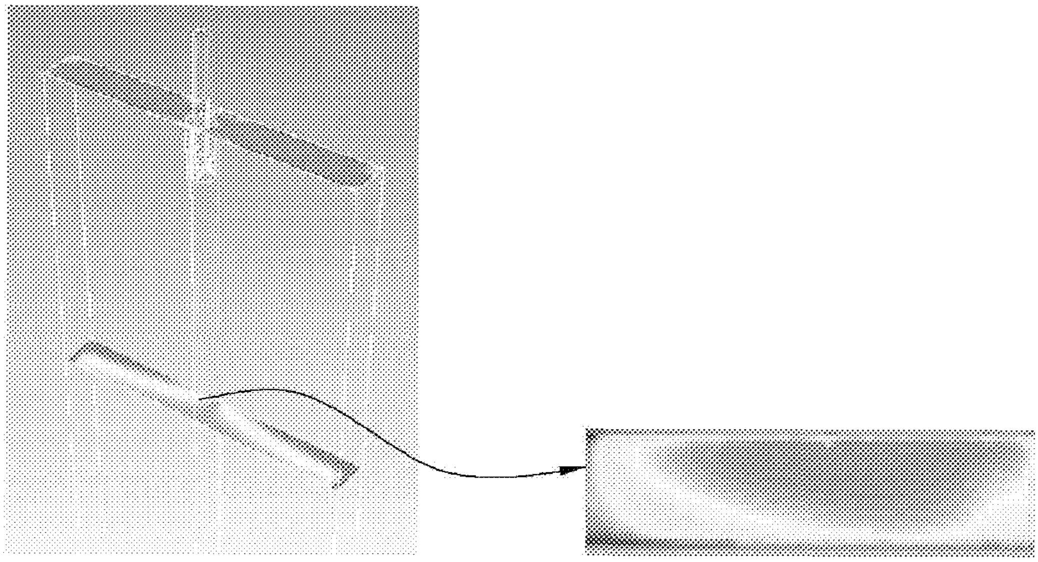
[FIG.3a]



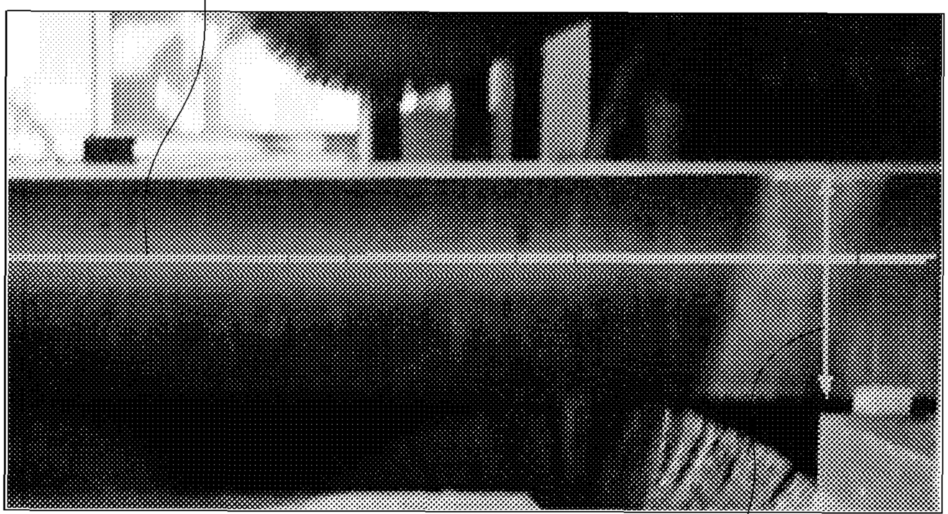
[FIG.3b]



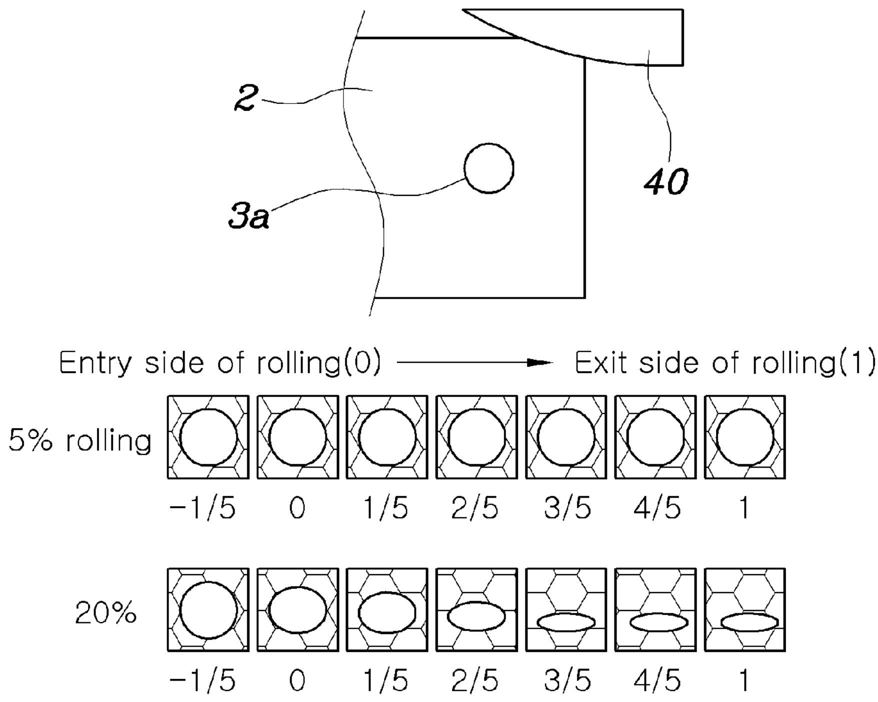
[FIG.4]


(a) Flow analysis result
(b) Temperature analysis result

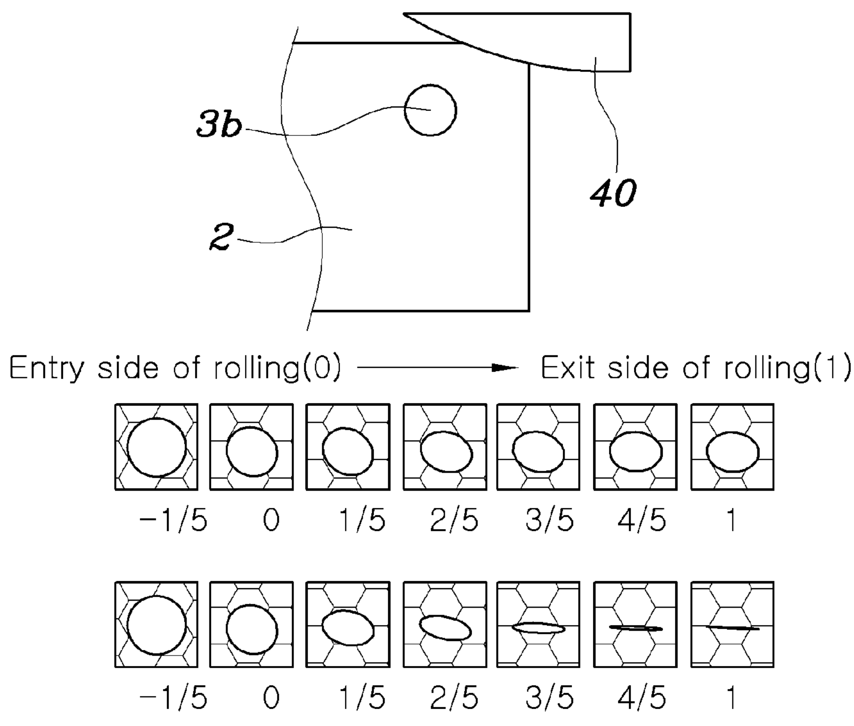
[FIG.5]


Solidification completion line
Thickness of slab

[FIG.6]


2
3a
40
Entry side of rolling(0)
Exit side of rolling(1)
5% rolling
-1/5
0
1/5
2/5
3/5
4/5
1
20%
-1/5
0
1/5
2/5
3/5
4/5
1

(a)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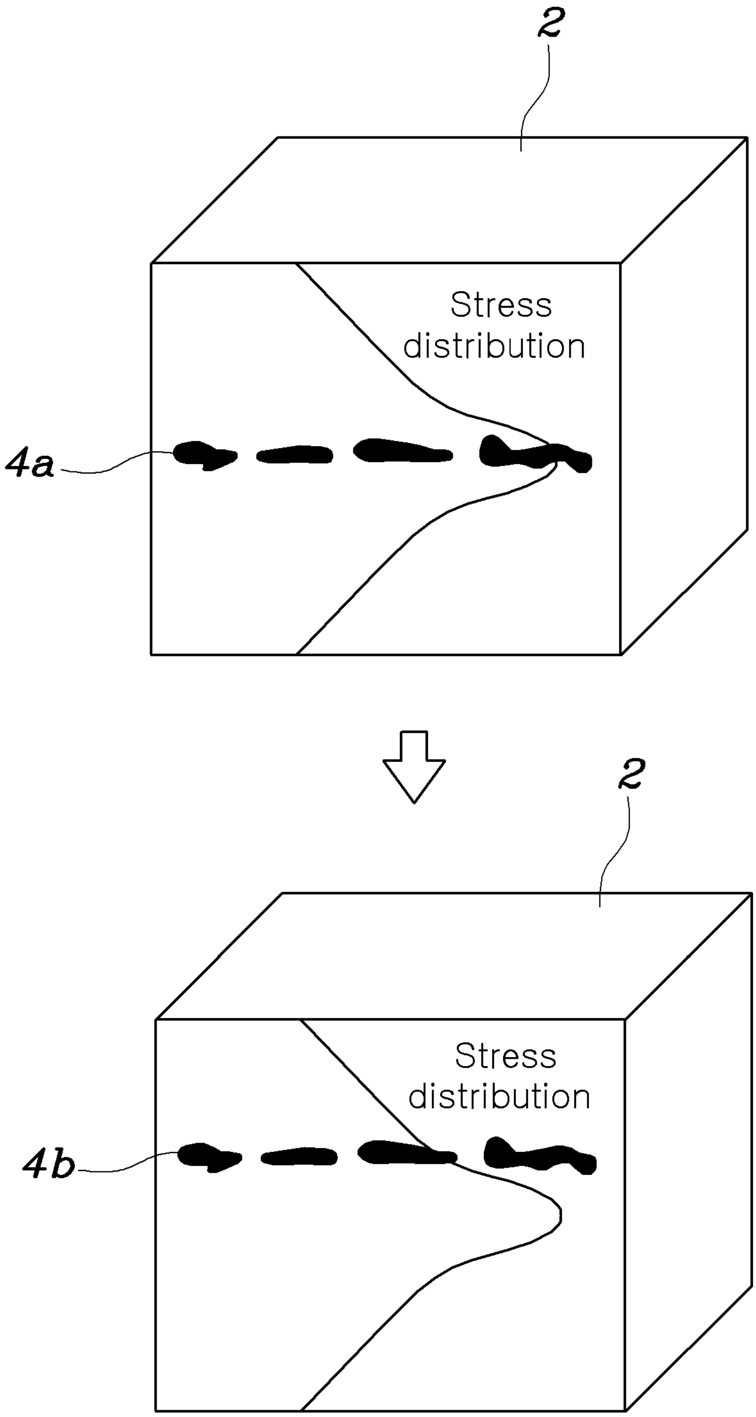
4/5
1

(b)

[FIG.7]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2016/005922

A. CLASSIFICATION OF SUBJECT MATTER

B22D 11/124(2006.01)i, B22D 11/22(2006.01)i, B22D 11/055(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 11/124; B22D 11/04; B22D 11/20; B22D 11/10; B22D 11/108; B22D 11/16; B22D 11/22; B22D 11/055

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: casting, molten steel, submerged nozzle, mold, mold, location control, separation, distance and drawing

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	KR 10-1394441 B1 (POSCO) 13 May 2014 See paragraphs [0003]-[0004], [0029] and figures 1, 3.	1-7
Y	KR 10-2014-0118571 A (POSCO) 08 October 2014 See paragraph [0041] and figure 1.	1-7
A	JP 2011-251308 A (NIPPON STEEL CORP.) 15 December 2011 See paragraphs [0008]-[0011] and figure 8.	1-7
A	KR 10-2011-0046671 A (HYUNDAI STEEL COMPANY) 06 May 2011 See paragraphs [0011]-[0020] and figures 1-2.	1-7
A	KR 10-2011-0034476 A (HYUNDAI STEEL COMPANY) 05 April 2011 See paragraphs [0009]-[0021] and figure 1.	1-7

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

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Date of the actual completion of the international search	Date of mailing of the international search report
30 AUGUST 2016 (30.08.2016)	**01 SEPTEMBER 2016 (01.09.2016)**

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2016/005922

Patent document cited in search report	Publication date	Patent family member	Publication date
KR 10-1394441 B1	13/05/2014	NONE	
KR 10-2014-0118571 A	08/10/2014	NONE	
JP 2011-251308 A	15/12/2011	JP 5387508 B2	15/01/2014
KR 10-2011-0046671 A	06/05/2011	KR 10-1175411 B1	20/08/2012
KR 10-2011-0034476 A	05/04/2011	KR 10-1129982 B1	26/03/2012

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