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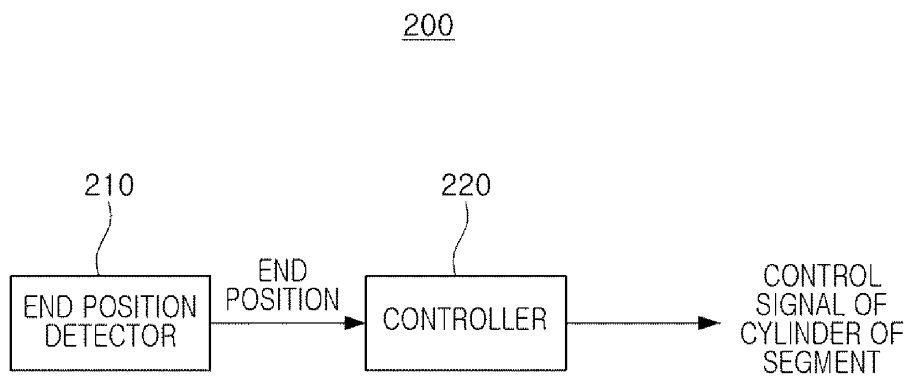
(54) CONTINUOUS CASTING APPARATUS AND METHOD

(57) According to one technical aspect of the present invention, a continuous casting method is performed in a continuous casting apparatus having a plurality of segments continuously provided, so as to continuously cast a slab drawn from a mold, and can comprise the steps of: rough milling the slab by setting a roll gap difference between an input side cylinder and an output side cylinder of an N-th segment as a first roll gap difference when the slab is drawn from the mold; and variably reducing the thickness of the slab by setting the roll gap difference between the input side cylinder and the output side cylinder of the N-th segment as a second roll gap difference smaller than the first roll gap difference, when the slab is not drawn from the mold. The second roll gap difference can change according to a distance between the end of the slab and the N-th segment.

【FIG. 5】



Description

[Technical Field]

[0001] The present disclosure relates to a continuous casting apparatus and a continuous casting method.

[Background Art]

[0002] Continuous casting technology is being developed as a steel manufacturing technique. Such continuous casting technology has advantages of being capable of performing a continuous casting process with a relatively large cross-section, and producing a cast piece several times larger than a conventional casting apparatus.

[0003] Meanwhile, since a cast piece in a continuous casting technology has a relatively large size and a relatively long distance, weight of the cast piece may be relatively heavy to tens of tons. Therefore, influence of the weight and the temperature of the cast piece may affect the manufacturing environment of the cast piece, and such influences may cause an error in the production of the cast piece.

[0004] Such prior art may be easily understood with reference to Korean Patent Publication No. 2015-0073760, Korean Patent Publication No. 2015-0073397, and the like.

(Patent Document 1) Korean Patent Publication No. 2015-0073760

(Patent Document 2) Korean Patent Publication No. 2015-0073397

[Disclosure]

[Technical Problem]

[0005] The present disclosure has been made to solve the problems of the prior art described above. One technical aspect of the present disclosure is to provide a continuous casting apparatus comprising reducing rolling reduction of a roll gap, as a cast piece is drawn and an end portion of the cast piece progresses, which may prevent the occurrence of damage, such as collapse of the cast piece, or the like, even when the cast piece is roughly milled, and may also reduce a difference in thickness of the cast piece to be suitable for tolerance to a rolling operation, and a control method thereof.

[Technical Solution]

[0006] A technical aspect of the present disclosure proposes a continuous casting method. The continuous casting method may include roughly milling the cast piece by setting a roll gap difference between an input side cylinder and an output side cylinder of an N^{th} segment as a first roll gap difference, when the cast piece is drawn from the mold; and variably reducing a thickness of the cast piece by setting a roll gap difference between the input side cylinder and the output side cylinder of the N^{th} segment as a second roll gap difference smaller than the first roll gap difference, when the cast piece is not drawn from the mold. In this case, the second roll gap difference may change in accordance with a distance between an end portion of the cast piece and the N^{th} segment.

[0007] In an embodiment, the second roll gap difference may change in proportion to a distance between the end portion of the cast piece and the N^{th} segment.

[0008] In an embodiment, the roughly milling the cast piece may include setting a roll gap of cylinders of an $(N-1)^{th}$ segment as a roll gap of the input side cylinder of the N^{th} segment.

[0009] In an embodiment, the roughly milling the cast piece may include setting a roll gap of cylinders of an $(N+1)^{th}$ segment as a roll gap of the output side cylinder of the N^{th} segment.

[0010] In an embodiment, the variably reducing the cast piece may include confirming a position of the end portion of the cast piece; and lowering the roll gap difference between the input side cylinder and the output side cylinder of the N^{th} segment on the basis of a predetermined rolling reduction amount, when the end portion of the cast piece proceeds beyond a reference distance.

[0011] In an embodiment, the variably reducing the cast piece may further include adjusting rolling reduction of an input side cylinder of an $(N+1)^{th}$ segment, on the basis of an amount of change of rolling reduction of the output side cylinder of the N^{th} segment.

[0012] A technical aspect of the present disclosure proposes a continuous casting apparatus. The continuous casting apparatus may include a segment portion casting a cast piece, and including a plurality of segments including an input side cylinder and an output side cylinder; an end position detector detecting a position of an end portion of the cast piece; and a controller controlling pressures of cylinders included in the plurality of segments to adjust rolling reduction of the cast piece, in accordance with the position of the end portion of the cast piece. In this case, the controller may set a roll gap difference between an input side cylinder and an output side cylinder of an N^{th} segment as a first roll gap difference, when the end portion of the cast piece is not detected, and may set a roll gap difference between the input side cylinder and the output side cylinder of the N^{th} segment as a second roll gap difference smaller than the first roll gap difference, when the end portion of the cast piece is detected.

[0013] In an embodiment, the controller may lower the roll gap difference between the input side cylinder and the output side cylinder of the N^{th} segment on the basis of a predetermined rolling reduction amount, when the end portion of the cast piece proceeds beyond a reference distance.

[0014] In an embodiment, the controller may adjust rolling reduction of an input side cylinder of an $(N+1)^{th}$ segment, on the basis of an amount of change of rolling reduction of the output side cylinder of the N^{th} segment.

[0015] The means for solving the above-mentioned problems does not list all the features of the present disclosure. Various means for solving the problems of the present disclosure can be understood in detail with reference to specific embodiments of the following detailed description.

[Advantageous Effects]

[0016] According to an aspect of the present disclosure, occurrence of damage, such as collapse of the cast piece, or the like may be prevented, even when the cast piece is roughly milled, by reducing rolling reduction of a roll gap, as a cast piece is drawn and an end portion of the cast piece progresses.

[0017] According to an aspect of the present disclosure, a difference in thickness of the cast piece to be suitable for tolerance to a rolling operation may be reduced, by reducing rolling reduction of a roll gap, as a cast piece is drawn and an end portion of the cast piece progresses.

[Description of Drawings]

[0018]

FIG. 1 is a view illustrating a state of a continuous casting apparatus according to an embodiment of the present disclosure.

FIG. 2 is a view illustrating another state of a continuous casting apparatus according to an embodiment of the present disclosure.

FIG. 3 is a perspective view illustrating an example of a segment of the continuous casting apparatus illustrated in FIG. 1.

FIG. 4 is a cutaway front view illustrating an example of the segment illustrated in FIG. 3.

FIG. 5 is a block diagram illustrating a configuration of a continuous casting apparatus according to an embodiment of the present disclosure.

FIGS. 6A and 6B are views illustrating segments to be controlled differently in accordance with a position of an end portion of a cast piece in a continuous casting apparatus according to an embodiment of the present disclosure.

FIGS. 7A and 7B are views comparing shapes of a cast piece to be controlled differently in accordance with a position of an end portion of a cast piece.

FIG. 8 is a flowchart illustrating a continuous casting method according to an embodiment of the present disclosure.

[Best Mode for Invention]

[0019] Hereinafter, preferred embodiments of the present disclosure will be described with reference to the accompanying drawings.

[0020] However, the embodiments of the present disclosure can be modified into various other forms, and the scope of the present disclosure may be not limited to the embodiments described below. Further, the embodiments of the present disclosure may be provided to more fully explain the present disclosure to those skilled in the art. It should be understood that the various embodiments of the present disclosure may be different, but need not be mutually exclusive.

[0021] Also, "comprising" or "including" an element refers to that it may include other elements, rather than excluding other elements, unless specifically stated otherwise.

[0022] FIG. 1 is a view illustrating a state of a continuous casting apparatus according to an embodiment of the present disclosure.

[0023] The continuous casting will be described with reference to an example illustrated in FIG. 1. Molten steel obtained from a refining process may be injected into a tundish 10 from a ladle (not illustrated), and the molten steel temporarily stored in the tundish 10 may be supplied to a mold 20.

[0024] The molten steel may be subjected to a primary cooling operation in the mold 20, and may be then solidified through a secondary cooling operation in a strand line 21 under the mold, to continuously produce a cast piece (S), such as a billet, a bloom, a slab, or the like.

[0025] The molten steel (M) discharged through the mold 20 may be subjected to a primary cooling operation in the mold 20, and may be conveyed through successive segment(s) (1 to n+1) provided in a continuous casting facility 100 in a state which a surface thereof is somewhat solidified, and may be also compressed.

[0026] For example, each segment 110 may include an upper roller and a lower roller, and may further include a cylinder providing pressure to the upper roller and the lower roller. As illustrated in an example, each of the segments may have an input side cylinder 111 and an output side cylinder 112, which provide pressure to the upper roller and the lower roller, on an input side and an output side, respectively.

[0027] The cast piece (S) may be reduced in a thickness direction using the rollers described above in the segment corresponding to a final point in a solidification operation of the cast piece (S), to improve internal quality of a central portion in a continuous casting process. For example, a segment corresponding to an end point of a solidification operation of the cast piece may be roughly milled and cast under a pressure of about 20 mm, to smoothly coagulate the cast piece (S) and to enhance quality such as flatness of the cast piece.

[0028] For example, when a point of the segment (n) corresponds to the final point in the solidification operation of the cast piece (S), the segment (n) may be cast by roughly milling and casting the cast piece (S) under a pressure of about 20 mm. In this case, a roll separation force in the segment (n) may be set to be higher than a roll separation force in the segment (n-1).

[0029] When a non-coagulated portion of the cast piece (S) is roughly milled to have a roll gap of 20 mm or more, the non-coagulated portion of the cast piece (S) may be collapsed. Therefore, it is important to prevent the non-coagulated portion of the cast piece (S) from collapsing.

[0030] Therefore, a continuous casting apparatus according to the present disclosure may prevent the cast piece (S) from collapsing, and the like, by controlling a roll separation force as the cast piece (S) proceeds, to roughly mill the cast piece stably. In addition, roll separation force may be moderately adjusted to minimize a difference in thickness between a front end portion and a rear end portion of the cast piece, to satisfy a reference value for tolerance to a rolling operation, required in the subsequent process.

[0031] FIG. 2 is a view illustrating another state of a continuous casting apparatus according to an embodiment of the present disclosure. FIG. 2 may be an example in which the situation illustrated in FIG. 1 further proceeds, and an end portion (S_{end}) of the cast piece (S) is then derived.

[0032] When the end portion (S_{end}) of the cast piece (S) is derived in this way, for example, when the cast piece is not drawn from the mold, such as, when a pressure in the segment (n) is roughly milled under a relatively high pressure continuously, the problems such as collapse of the end portion (S_{end}) of the cast piece (S) may occur.

[0033] Therefore, a continuous casting apparatus according to an embodiment of the present disclosure may adjust pressures of cylinders of segments to adjust rolling reduction of the segment, depending on a position of the end portion (S_{end}) of the cast piece (S).

[0034] FIG. 3 is a perspective view illustrating an example of a segment of the continuous casting apparatus illustrated in FIG. 1.

[0035] Referring to FIG. 3, a segment 110 may include an upper roller 32 and a lower roller 34. The upper roller 32 and the lower roller 34 may be provided in forms of a plurality of rollers.

[0036] Molten steel may be cast and rolled between the upper roller 32 and the lower roller 34 of the segment 110, to form a slab.

[0037] Upper and lower frames 36 and 38 on which the upper roller 32 and the lower roller 34 are mounted may be provided with press-down cylinders 40, to pressure the upper roller 32 and the lower roller 34.

[0038] In the illustrated example, four (4) cylinders, present one (1) respectively on the left and the right, may be provided on input and output sides of the segment in total. However, the number of the cylinders is only illustrative, and may be set differently according to an embodiment.

[0039] The cylinders 40 may be fixed by side boxes 42 and 44 on sides of the frame, and may be connected to tie rods 46.

[0040] The upper roller 32 and the lower roller 34 may be assembled by girders 48 and 50 between the frames 36 and 38.

[0041] FIG. 4 is a cutaway front view illustrating an example of the segment illustrated in FIG. 3.

[0042] Referring to FIG. 4, a segment 400 may include upper and lower frames 436 and 438, an input side cylinder 440 and an output side cylinder 430 provided therebetween, and a driving roller 420 disposed between the input side cylinder 440 and the output side cylinder 430.

[0043] The driving roller 420 may be provided to simply transport the cast piece, and may be different from the upper and lower rollers 432 and 434 for rolling the cast piece by the cylinders 430 and 440. Upper and lower portions of the cylinder 440 may be connected to each other by a tie rod 446, and the upper and lower rollers 432 and 434 may apply pressure to the cast piece in accordance with a pressure of the cylinder 440.

[0044] As described above, a continuous casting apparatus according to an embodiment of the present disclosure may control a pressure of a segment in accordance with a position of an end portion of a cast piece, and will be described in more detail with reference to FIGS. 5 to 6.

[0045] FIG. 5 is a block diagram illustrating a configuration of a continuous casting apparatus according to an embodiment of the present disclosure.

[0046] Referring to FIG. 5, a continuous casting apparatus 200 may include a segment portion (not illustrated), an end position detector 210, and a controller 220.

[0047] The segment portion may include a plurality of segments for casting a cast piece, and each of the segments may include an input side cylinder and an output side cylinder, as described above.

[0048] The end position detector 210 may detect a position of an end portion of the cast piece (S_{end}, illustrated in FIG. 2) .

[0049] The end position detector 210 may apply various techniques for detecting an end portion of a cast piece. For example, the end portion of the cast piece may be detected by using an image detector, or the end portion of the cast piece may be detected by using a heat detector. In addition, various means may be applied in the present disclosure, and the end position detector 210 is not limited to any specific means in the present disclosure.

[0050] The controller 220 may control a cylinder of a segment.

[0051] The controller 220 may adjust pressures of cylinders included in the plurality of segments to adjust rolling reduction of the cast piece, in accordance with a position of an end portion of the cast piece.

[0052] For example, the controller 220 may set a roll gap difference between an input side cylinder and an output side cylinder of an N^{th} segment as a first roll gap difference, when the end portion of the cast piece is not detected, for example, when the cast piece continues to be drawn from the mold. Meanwhile, the controller 220 may set a roll gap difference between the input side cylinder and the output side cylinder of the N^{th} segment as a second roll gap difference smaller than the first roll gap difference, when the end portion of the cast piece is detected, for example, when the cast piece is not drawn from the mold.

[0053] In this case, the second roll gap difference may change in accordance with a distance between an end portion of the cast piece and the N^{th} segment. In one example, the second roll gap difference may change in proportion to a distance between the end portion of the cast piece and the N^{th} segment.

[0054] For example, the controller 220 may control to roughly mill the N^{th} segment corresponding to a final point in a solidification operation of the cast piece (S) by a relatively strong pressure, when the cast piece continues to be drawn from the mold, and may control to gradually decrease a pressure of the N^{th} segment in accordance with a position of the end portion of the cast piece, when the cast piece is not drawn from the mold and the end portion of the cast piece is generated.

[0055] The controller 220 may lower the roll gap difference between the input side cylinder and the output side cylinder of the N^{th} segment on the basis of a predetermined rolling reduction amount, when the end portion of the cast piece proceeds beyond a reference distance.

[0056] For example, the controller 220 may periodically monitor a distance that the end portion of the cast piece moves, and when the end portion of the cast piece moves by the reference distance (Li), the roll gap control of the N^{th} segment may be performed by calculating a target roll gap setting value (rolling reduction (PV) - ΔRi), which reduces rolling reduction in the N^{th} segment to be roughly milled by a specific rolling reduction (ΔRi).

[0057] In one embodiment, the controller 220 may adjust rolling reduction of an input side cylinder of an $(N+1)^{th}$ segment, on the basis of an amount of change of rolling reduction of the output side cylinder of the N^{th} segment.

[0058] The controller 220 may be implemented as a controller such as a programmable logic controller (PLC), but is not limited thereto.

[0059] FIGS. 6A and 6B are views illustrating segments to be controlled differently in accordance with a position of an end portion of a cast piece in a continuous casting apparatus according to an embodiment of the present disclosure.

[0060] FIG. 6A illustrates an example in which an end portion of a cast piece has not yet been formed, and FIG. 6B illustrates an example in which an end portion of a cast piece has been formed and rolling reduction thereof is adjusted accordingly.

[0061] First, in the case of FIG. 6A, it can be seen that molten steel 610 inside of a cast piece is roughly milled in a segment (n) corresponding to a non-solidified portion in which the molten steel 610 is less solidified. Therefore, a difference in heights of cast pieces between a previous segment (n-1) and a post segment (n+1) may be set as d1. As a result, since a roll gap difference between an input side cylinder and an output side cylinder of the segment (n) may be set to be equal to or greater than a specific roll gap difference, such a difference in the rolling reduction may be formed.

[0062] Next, in the case of FIG. 6B, it can be seen that rolling reduction of a segment (n) is reduced to d2, as an end portion of a cast piece proceeds. Therefore, rolling reduction may be reduced by reducing a roll gap difference between an input side cylinder and an output side cylinder of the segment (n).

[0063] A rolling reduction of the input side cylinder of the segment (n+1) may change on the basis of an amount of change of rolling reduction of the output side cylinder of the segment (n).

[0064] FIGS. 7A and 7B are views comparing shapes of a cast piece to be controlled differently in accordance with a position of an end portion of a cast piece.

[0065] FIG. 7A illustrates an example in which an end portion of a cast piece has not yet been formed, and FIG. 7B illustrates an example in which an end portion of a cast piece has been formed and rolling reduction thereof is adjusted accordingly.

[0066] FIG. 7A illustrates an example in which a cast piece is roughly milled by setting a roll gap difference between an input side cylinder and an output side cylinder of an N^{th} segment as a first roll gap difference, when the cast piece is drawn from the mold.

[0067] FIG. 7B illustrates an example in which a thickness of the cast piece is variably reduced by setting a roll gap difference between the input side cylinder and the output side cylinder of the N^{th} segment as a second roll gap difference smaller than the first roll gap difference, when the cast piece is not drawn from the mold. As illustrated, the second roll gap difference may vary with a distance between the end portion of the cast piece and the N^{th} segment.

[0068] As the end portion of the cast piece moves by a distance (X1), a section in which rolling reduction of the cast piece varies may also correspond to the distance (X1).

[0069] For example, it can be seen that, in FIG. 7A, a roll gap (Rt) may be formed only by the n^{th} segment; and, in FIG. 7B, a roll gap formed by the n^{th} segment may be only R1, and the rolling amount may be gradually decreased based on the moving distance of the end portion of the cast rolling reduction R2 may be set by the section (X1).

[0070] As a result, as the end portion of the cast piece passes a specific point, rolling reduction of the n^{th} segment may gradually decrease on the basis of movement of the end portion of the cast piece. Therefore, tolerance to a rolling operation may be satisfied, since the end portion of the cast piece may be prevented from collapsing, and the amount of change of the cast piece may be set within a specific amount.

[0071] FIG. 8 is a flowchart illustrating a continuous casting method according to an embodiment of the present disclosure.

[0072] Since a continuous casting method illustrated in FIG. 8 may be performed in a continuous casting apparatus described with reference to FIGS. 1 to 7, it can be easily understood with reference to the contents described with reference to FIGS. 1 to 7.

[0073] In a case in which a cast piece is drawn from a mold (S810, NO), the continuous casting apparatus may roughly mill the cast piece by setting a roll gap difference between an input side cylinder and an output side cylinder of an N^{th} segment as a first roll gap difference.

[0074] In a case in which a casting operation in a mold is completed and a cast piece is drawn from the mold (S810, YES), the continuous casting apparatus may variably reduce a thickness of the cast piece by setting a roll gap difference between the input side cylinder and the output side cylinder of the N^{th} segment as a second roll gap difference smaller than the first roll gap difference. In this case, the second roll gap difference may change in accordance with a distance between an end portion of the cast piece and the N^{th} segment.

[0075] For example, the continuous casting apparatus may calculate a position of an end portion of the cast piece, and may track the position (S820).

[0076] When the position of the end portion of the cast piece is not equal to a predetermined position (PI), the continuous casting apparatus may perform the roughly milling under the same condition as the case in which the cast piece is drawn.

[0077] In one example, the continuous casting apparatus may set a roll gap of cylinders of an $(N-1)^{th}$ segment as a roll gap of the input side cylinder of the N^{th} segment. Alternatively, the continuous casting apparatus may set a roll gap of cylinders of an $(N+1)^{th}$ segment as a roll gap of the output side cylinder of the N^{th} segment.

[0078] When the position of the end portion of the cast piece is equal to a predetermined position (PI), the continuous casting apparatus may perform the variably reducing a thickness of the cast piece (S840 to S880).

[0079] For example, the continuous casting apparatus may calculate a current running distance of the end portion (S840). When the current running distance corresponds to the reference distance (S850), the rolling reduction may be reduced by a predetermined reduction amount, and may be re-adjusted (S860). Further, the continuous casting apparatus may control the roll gap of the segment on the basis of this rolling reduction (S870).

[0080] The continuous casting apparatus may stop the control of the rolling reduction, when the re-adjusted rolling reduction corresponds to the final rolling reduction (S880, YES). The above-described reduction operation of the rolling reduction (S840 to S880) may be repeatedly performed, when the re-adjusted rolling reduction does not correspond to the final rolling reduction (S880, NO).

[0081] While the present disclosure has been particularly illustrated and described with reference to example embodiments thereof, it can be understood that the present disclosure is not limited to the disclosed example embodiments, but, on the contrary, Those skilled in the art will appreciate that various modifications, additions, and substitutions may be possible, without departing from the scope and spirit of the present disclosure as disclosed in the accompanying claims.

[0082] Therefore, the spirit of the present disclosure should not be construed as being limited to the above-described embodiments, and all of the equivalents or equivalents of the claims, as well as the following claims.

Claims

1. A continuous casting method, performed in a continuous casting apparatus having a plurality of segments continuously provided, to continuously cast a cast piece drawn from a mold, comprising:

   roughly milling the cast piece by setting a roll gap difference between an input side cylinder and an output side cylinder of an N^{th} segment as a first roll gap difference, when the cast piece is drawn from the mold; and
   variably reducing a thickness of the cast piece by setting a roll gap difference between the input side cylinder and the output side cylinder of the N^{th} segment as a second roll gap difference smaller than the first roll gap difference, when the cast piece is not drawn from the mold,
   wherein the second roll gap difference changes in accordance with a distance between an end portion of the cast piece and the N^{th} segment.

2. The continuous casting method according to claim 1, wherein the second roll gap difference changes in proportion to a distance between the end portion of the cast piece and the N^{th} segment.

3. The continuous casting method according to claim 1, wherein the roughly milling the cast piece comprises setting a roll gap of cylinders of an $(N-1)^{th}$ segment as a roll gap of the input side cylinder of the N^{th} segment.

4. The continuous casting method according to claim 1, wherein the roughly milling the cast piece comprises setting a roll gap of cylinders of an $(N+1)^{th}$ segment as a roll gap of the output side cylinder of the N^{th} segment.

5. The continuous casting method according to claim 1, wherein the variably reducing the cast piece comprises:

   confirming a position of the end portion of the cast piece; and
   lowering the roll gap difference between the input side cylinder and the output side cylinder of the N^{th} segment on the basis of a predetermined

rolling reduction amount, when the end portion of the cast piece proceeds beyond a reference distance.

6. The continuous casting method according to claim 5, wherein the variably reducing the cast piece further comprises adjusting rolling reduction of an input side cylinder of an $(N+1)^{th}$ segment, on the basis of an amount of change of rolling reduction of the output side cylinder of the N^{th} segment.

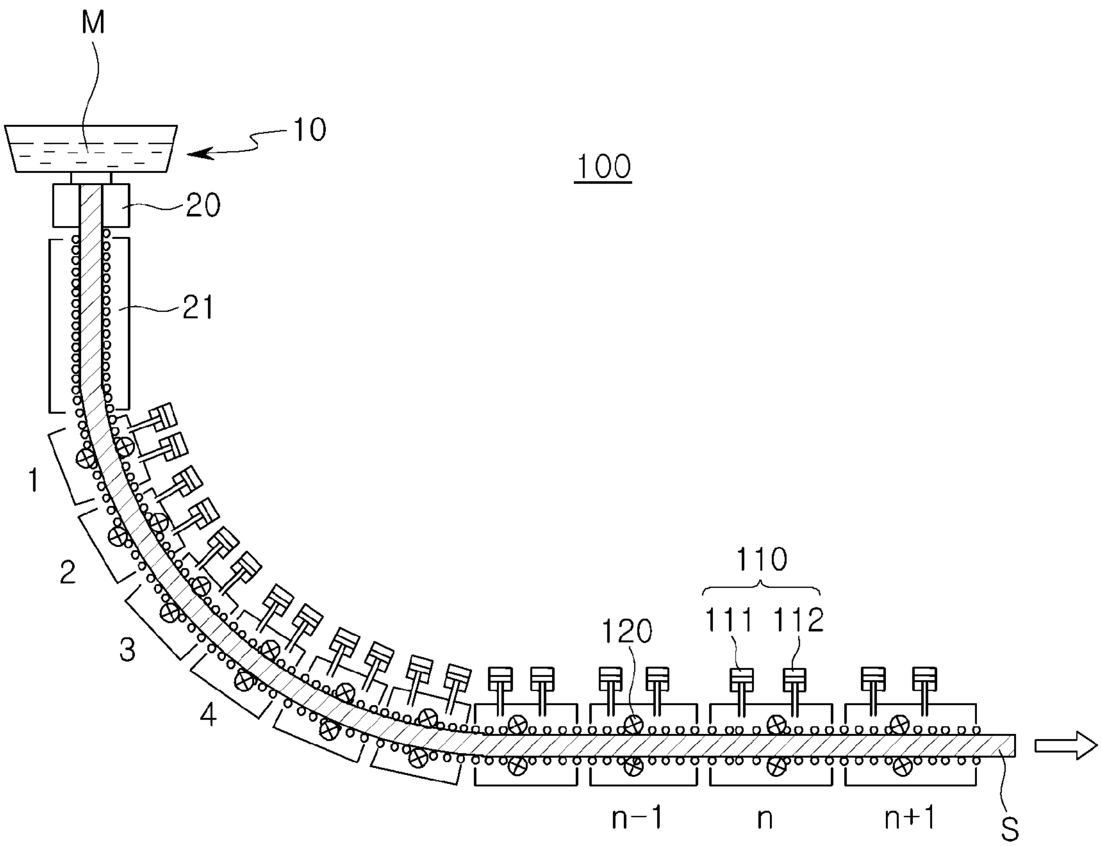
7. A continuous casting apparatus comprising:

a segment portion casting a cast piece, and including a plurality of segments including an input side cylinder and an output side cylinder;
an end position detector detecting a position of an end portion of the cast piece; and
a controller controlling pressures of cylinders included in the plurality of segments to adjust rolling reduction of the cast piece, in accordance with the position of the end portion of the cast piece,
wherein the controller sets a roll gap difference between an input side cylinder and an output side cylinder of an N^{th} segment as a first roll gap difference, when the end portion of the cast piece is not detected, and sets a roll gap difference between the input side cylinder and the output side cylinder of the N^{th} segment as a second roll gap difference smaller than the first roll gap difference, when the end portion of the cast piece is detected.

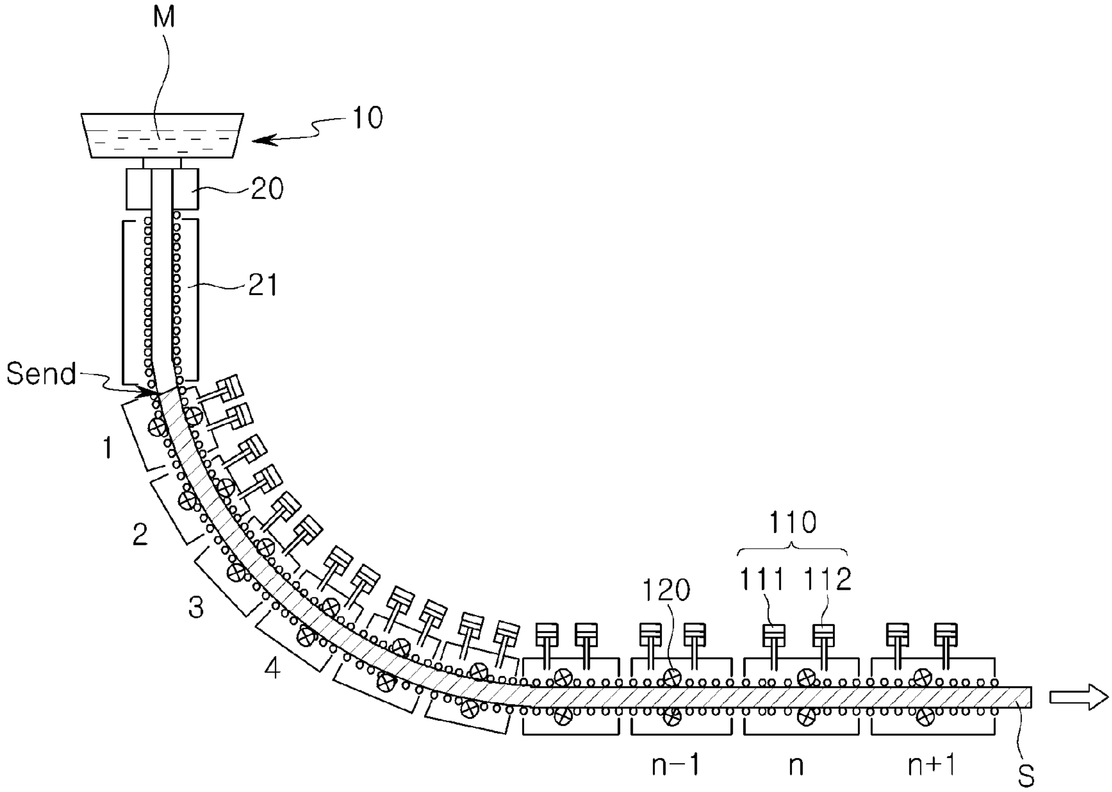
8. The continuous casting apparatus according to claim 7, wherein the controller lowers the roll gap difference between the input side cylinder and the output side cylinder of the N^{th} segment on the basis of a predetermined rolling reduction amount, when the end portion of the cast piece proceeds beyond a reference distance.

9. The continuous casting apparatus according to claim 8, wherein the controller adjusts rolling reduction of an input side cylinder of an $(N+1)^{th}$ segment, on the basis of an amount of change of rolling reduction of the output side cylinder of the N^{th} segment.

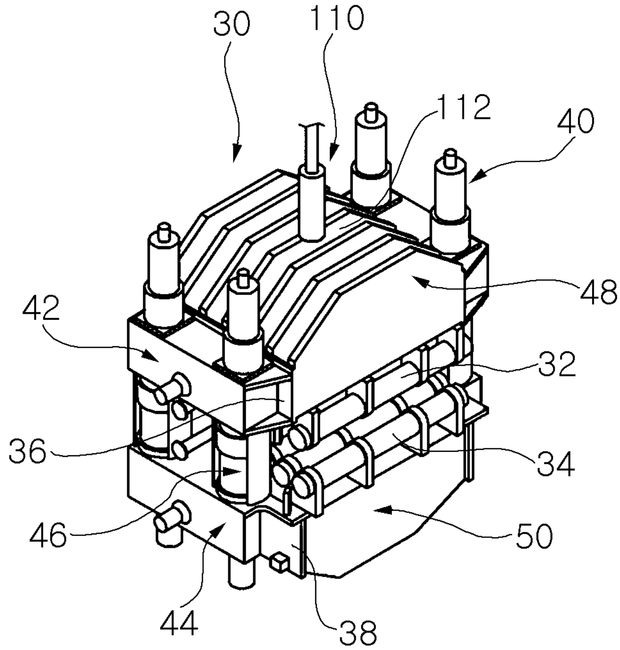
【FIG. 1】



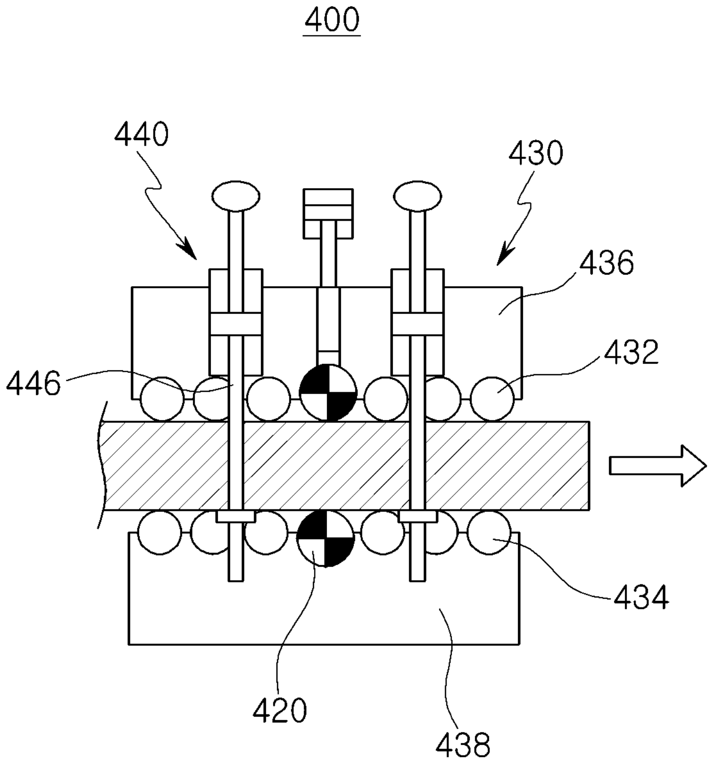
【FIG. 2】



【FIG. 3】



【FIG. 4】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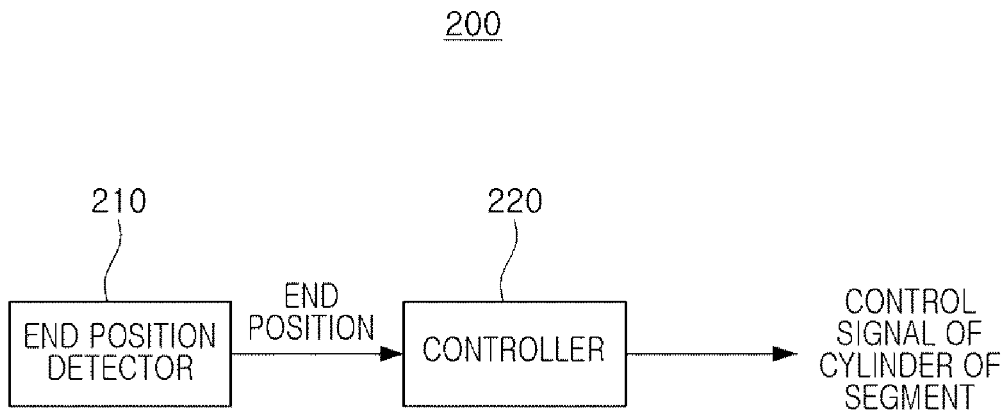
432
446
434
420
438

【FIG. 5】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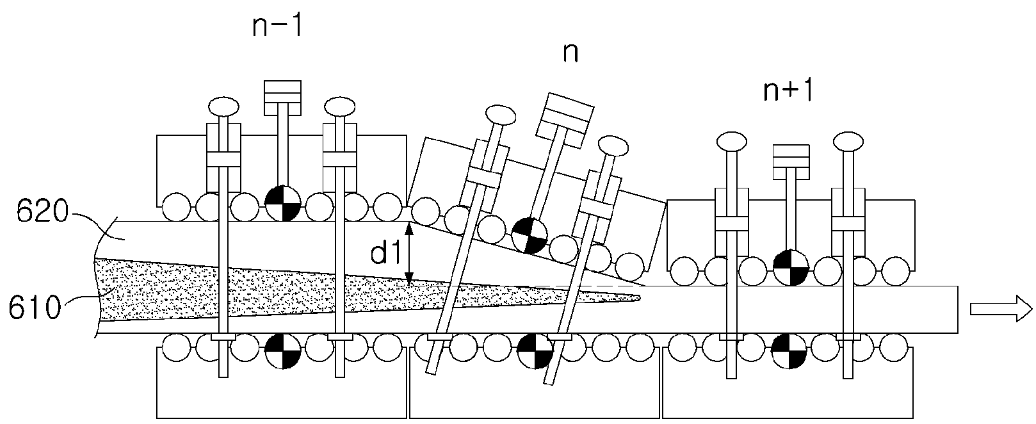
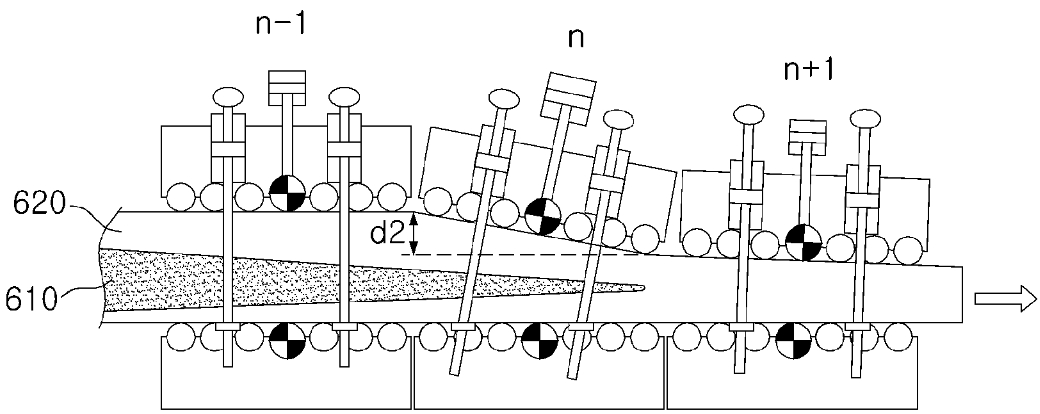
END POSITION
CONTROLLER
CONTROL SIGNAL OF CYLINDER OF SEGMENT

【FIG. 6】

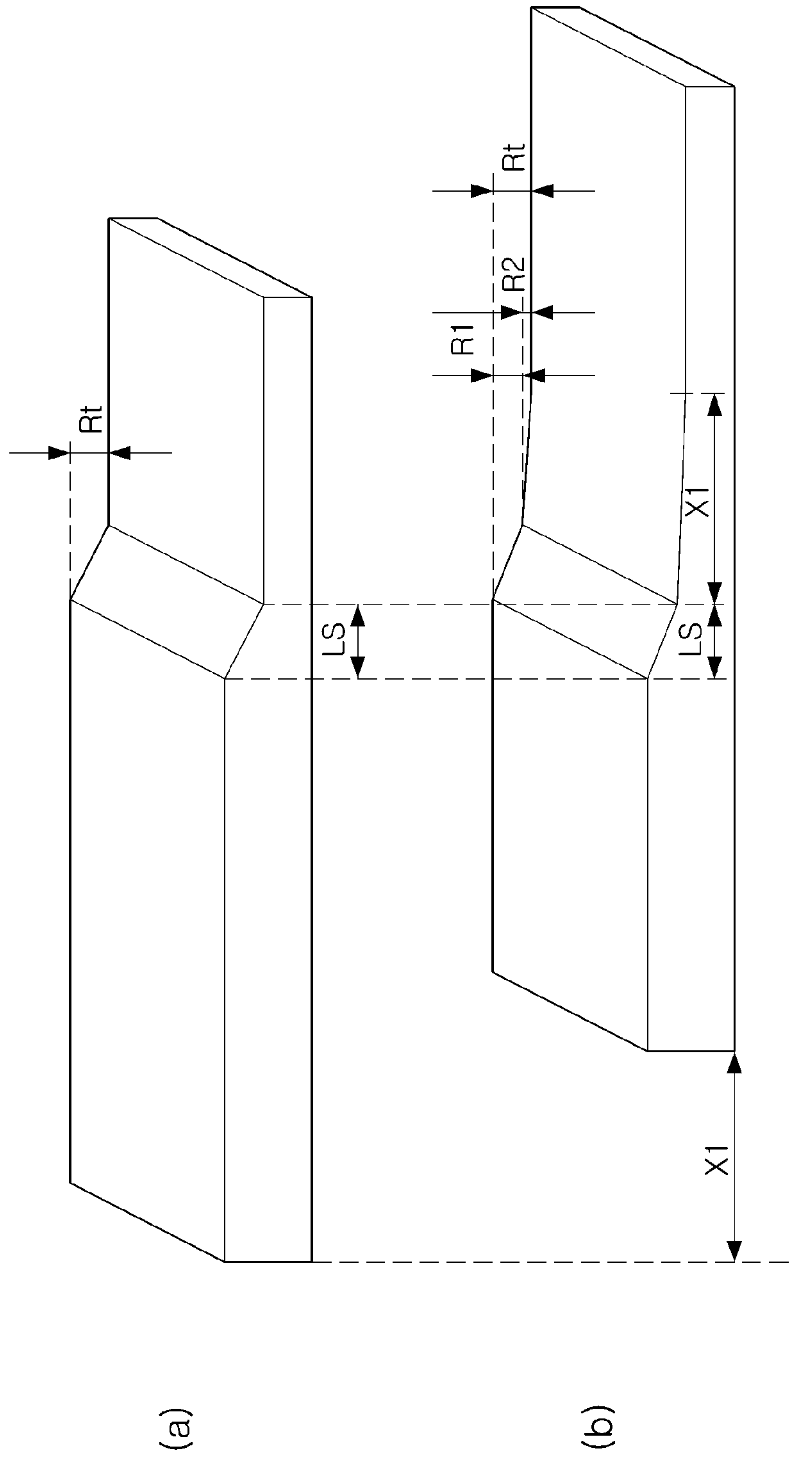
(a)



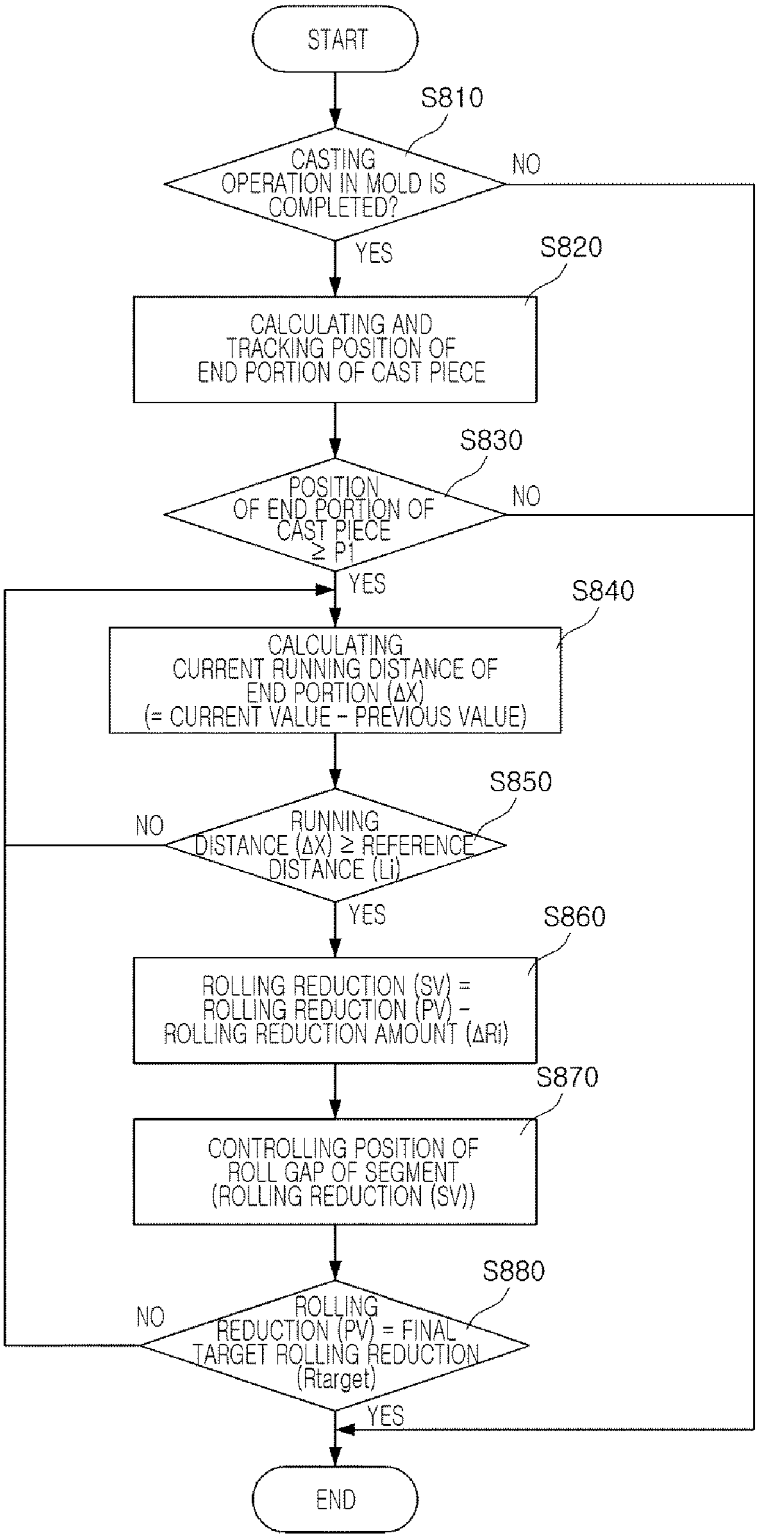
(b)



【FIG. 7】



【FIG. 8】


START
S810
CASTING OPERATION IN MOLD IS COMPLETED?
NO
YES
S820
CALCULATING AND TRACKING POSITION OF END PORTION OF CAST PIECE
S830
POSITION OF END PORTION OF CAST PIECE ≥ P1
NO
YES
S840
CALCULATING CURRENT RUNNING DISTANCE OF END PORTION (ΔX) (= CURRENT VALUE - PREVIOUS VALUE)
S850
RUNNING DISTANCE (ΔX) ≥ REFERENCE DISTANCE (Li)
NO
YES
S860
ROLLING REDUCTION (SV) = ROLLING REDUCTION (PV) - ROLLING REDUCTION AMOUNT (ΔRi)
S870
CONTROLLING POSITION OF ROLL GAP OF SEGMENT (ROLLING REDUCTION (SV))
S880
ROLLING REDUCTION (PV) = FINAL TARGET ROLLING REDUCTION (Rtarget)
NO
YES
END

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2017/015266

A. CLASSIFICATION OF SUBJECT MATTER

B22D 11/20(2006.01)i, B22D 11/128(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 11/20; B22D 11/10; B22D 11/124; B22D 11/16; B22D 11/128

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, castpiece, segment, cylinder, roll gap

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KR 10-2016-0064371 A (POSCO) 08 June 2016 See paragraphs [0002]-[0011] and figure 4.	1-9
A	KR 10-2005-0065730 A (RESEARCH INSTITUTE OF INDUSTRIAL SCIENCE & TECHNOLOGY) 30 June 2005 See paragraphs [0020]-[0044] and figure 1.	1-9
A	KR 10-2001-0021096 A (SMS SCHLOEMANN-SIEMAG AG.) 15 March 2001 See page 2, lines 1-31.	1-9
A	JP 2011-230132 A (NIPPON STEEL ENGINEERING CO., LTD. et al.) 17 November 2011 See paragraphs [0001]-[0011] and figure 1.	1-9
A	JP 2003-290893 A (SUMITOMO HEAVY IND LTD.) 14 October 2003 See paragraphs [0001]-[0008] and figure 1.	1-9

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

* Special categories of cited documents:
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"E" earlier application or patent but published on or after the international filing date
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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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"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	Date of mailing of the international search report
05 APRIL 2018 (05.04.2018)	**06 APRIL 2018 (06.04.2018)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office Government Complex-Daejeon, 189 Seonsa-ro, Daejeon 302-701, Republic of Korea Facsimile No. +82-42-481-8578	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2017/015266

Patent document cited in search report	Publication date	Patent family member	Publication date
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JP 2003-290893 A	14/10/2003	NONE	

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REFERENCES CITED IN THE DESCRIPTION

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