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(54) APPARATUS AND METHOD FOR CONTROLLING WIDTH OF DIRECT ENDLESS HOT ROLLING LINE BETWEEN CONTINUOUS CASTING AND HOT ROLLING

(57) Disclosed are an apparatus and a method for controlling a width in a direct endless hot rolling line between continuous casting and hot rolling. The apparatus for controlling a width according to one embodiment of the present invention is an apparatus for controlling a width in a direct endless hot rolling line between continuous casting and hot rolling of a mini mill including a continuous casting machine, a roughing mill, a heating device, and a finishing mill, comprising: a tension control unit for controlling the tension between the roughing mill and the finishing mill so as to obtain a target tension value; a width measurement unit for measuring an output side width of the finishing mill; and a width control unit for controlling the tension control unit so as to change the target tension value when the measured output side width of the finishing mill is different from the target width.

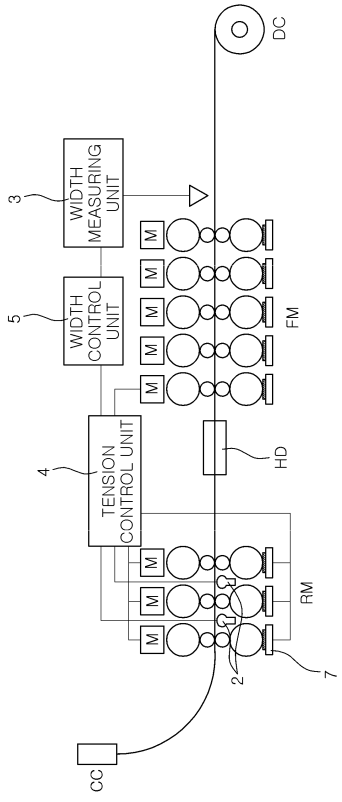

Fig. 2

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Description

[Technical Field]

[0001] Aspects of embodiments relate to a width control apparatus and method for the use thereof in a single continuous rolling process line between continuous casting and hot rolling, and more particularly, to a technology for controlling product width at an exit section of a finishing mill to have a predetermined target width without using an edger, a width varying device.

[Background Art]

[0002] Mini-mills are mills performing a process of melting scraps using an electrical furnace and then producing steel using continuous casting-rolling equipment.

[0003] FIG. 1 illustrates a mini-mill including a continuous caster CC, a roughing mill RM, a heating device HD, a finishing mill FM, and a down coiler DC. In such a mini-mill, continuous rolling is performed between continuous casting and hot rolling without ceasing. Here, width control is performed using a method provided by installing an edger, a width varying device, at a rear end of the continuous caster CC or a front end of the finishing mill FM, a method in which rolling is performed by allowing a width of an exit section of the continuous caster CC to be maintained constantly without a width variation, a method performed by varying a continuous casting mold width, or the like.

[0004] However, in the case of the method using an edger, when a mini-mill process illustrated with reference to FIG. 1 is performed, since a thickness of a slab of the continuous caster and a bar thickness of an exit section of the roughing mill RM are relatively thin, a buckling problem may occur. Further, since difficulties in adding an edger due to a spatial restriction in an installation thereof may be present, there may also be difficulties in the commercialization thereof.

[0005] Accordingly, the method of performing rolling by constantly maintaining a width of an exit section of the continuous caster CC without a width variation and the method of varying a width by varying a continuous casting mold width may be used.

[0006] However, in the case of constantly maintaining a width of an exit side of the continuous caster, it may be difficult to variously cope with requirements for products having various widths.

[0007] In addition, in a case in which only a continuous casting mold width is varied and thus width spread or shrinkage thereof occurs during passing through a liquid core reduction (LCR) in a continuous caster, a roughing mill and a finishing mill, compensation therefore may be difficult to be carried out and it may thus be difficult to obtain a uniform width.

[Related Art Document]

[0008] As the related art document, Korean Patent Registration Publication No. 10-0957707 (Published May 4, 2010) may be provided.

[Disclosure]

[Technical Problem]

[0009] An aspect of an embodiment may provide a high precision on-line width control apparatus capable of rapidly coping with the orders of various widths by users.

[0010] An aspect of an embodiment may provide a method of controlling a width.

[Technical Solution]

[0011] According to an aspect of the inventive concept, there is provided a width control apparatus for the use thereof in a single continuous rolling process line between continuous casting and hot rolling performed in a mini mill including a continuous caster, a roughing mill, a heating device and a finishing mill, the width control apparatus including: a tension control unit controlling tension applied to a strip between the roughing mill and the finishing mill to have a target tension value; a width measuring unit measuring a width of an exit section of the finishing mill; and a width control unit performing control so as to change the target tension value when the measured width of the exit section of the finishing mill differs from a target width.

[0012] The tension control unit may include a tension measuring portion measuring the tension applied to the strip between the roughing mill and the finishing mill.

[0013] The tension control unit may estimate the tension applied to the strip between the roughing mill and the finishing mill using a rolling load of the roughing mill, motor torque, or a measurement value of tension applied to the strip between stands.

[0014] When a measured width of the exit section of the finishing mill is smaller than the target width, the width control unit may control the tension control unit so as to lower the target tension value in proportion to a difference between the measured width of the exit section of the finishing mill and the target width.

[0015] When the measured width of the exit section of the finishing mill is greater than the target width, the width control unit may control the tension control unit so as to increase the target tension value in proportion to a difference between the measured width of the exit section of the finishing mill and the target width.

[0016] According to an aspect of the inventive concept, there is provided a width control method for the use thereof in a single continuous rolling process line between continuous casting and hot rolling in a mini-mill including a continuous caster, a roughing mill, a heating device and a finishing mill, the method including: measuring or

estimating tension applied to a strip between a roughing mill and a finishing mill; and performing controlling such that the measured or estimated tension has a target tension value.

[0017] The width control method may further include measuring a width of an exit section of the finishing mill; and changing the target tension value when the measured width of the exit section of the finishing mill differs from a target width.

[0018] The measuring or estimating of the tension applied to the strip between the roughing mill and the finishing mill may be performed by estimating the tension applied to the strip between the roughing mill and the finishing mill by using a rolling load of the roughing mill, motor torque, or a measured value of tension applied to a strip between stands.

[0019] The changing of the target tension value performed when the measured width of the exit section of the finishing mill differs from the target width may be performed by lowering the target tension value in proportion to a difference between the measured width of the exit section of the finishing mill and the target width when the measured width of the exit section of the finishing mill is smaller than the target width.

[0020] The changing of the target tension value performed when the measured width of the exit section of the finishing mill differs from the target width may be performed by increasing the target tension value in proportion to a difference between the measured width of the exit section of the finishing mill and the target width when the measured width of the exit section of the finishing mill is greater than the target width.

[Advantageous Effects]

[0021] According to exemplary embodiments of the present disclosure, product width at an exit section of a finishing mill may be controlled to have a predetermined target width without using an edger, a width varying device.

[Description of Drawings]

[0022]

FIG. 1 illustrates a process in which a single continuous rolling process between continuous casting and hot rolling is performed in a mini-mill according to the related art; and

FIG. 2 illustrates a process in which a single continuous rolling process between continuous casting and hot rolling is performed in a mini-mill according to an embodiment.

[Best Mode]

[0023] Embodiments will now be described in detail with reference to the accompanying drawings.

[0024] Embodiments may, however, be embodied in many different forms and should not be construed as being limited to embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the inventive concept to those skilled in the art.

[0025] FIG. 2 illustrates a process in which a single continuous rolling process between continuous casting and hot rolling is performed in a mini-mill process according to an embodiment.

[0026] With reference to FIG. 2, a width control apparatus according to an embodiment may be an apparatus for width control in a single continuous rolling process line between continuous casting and hot rolling, in a mini-mill including a continuous caster CC, a roughing mill RM, a heating device HD and a finishing mill FM. In addition, the width control apparatus includes a width measuring unit 3, a tension control unit 4 and a width control unit 5.

[0027] The tension control unit 4 may perform control such that tension applied to a strip between the roughing mill RM and the finishing mill FM may have a target tension value. In this case, the tension applied to a strip between the roughing mill RM and the finishing mill FM may be directly measured through the tension measuring portion 2 or may be estimated using a rolling load of the roughing mill RM, motor torque, or a measured value of tension applied to a strip between stands. The rolling load of the roughing mill RM may be measured by a load measuring device 7. The measurement value of tension applied to a strip between stands may be measured by the tension measuring portion 2.

[0028] The tension control unit 4 may control a speed of a first stand of an entrance section of the finishing mill FM such that tension applied to a strip between the roughing mill RM and the finishing mill FM may have a target tension value. In an embodiment, when the tension applied to a strip between the roughing mill RM and the finishing mill FM is lower than a target tension value, the speed of the first stand may be increased in proportion to a difference value between the tension applied to a strip between the roughing mill RM and the finishing mill FM and the target tension value. On the other hand, when the tension applied to a strip between the roughing mill RM and the finishing mill FM is higher than the target tension value, the speed of the first stand may be delayed in reverse proportion to a difference value between the tension applied to a strip between the roughing mill (RM) and the finishing mill FM and the target tension value.

[0029] Width control may be performed through tension control performed by the tension control unit 4. In addition thereto, more precise control of product width may be performed by measuring a width of an exit section of the finishing mill FM so as to vary a tension target value, a tension control reference value of the tension control unit 4. To this end, a width control apparatus according to an embodiment may further include a width measuring unit 3 and a width control unit 5.

[0030] The width measuring unit 3 may measure a width of an exit section of the finishing mill.

[0031] When a measured width of an exit section of the finishing mill FM differs from a target width, the width control unit 5 may control the tension control unit 4 so as to change the target tension value.

[0032] For example, when a measured width of the exit section of the finishing mill FM is smaller than the target width, the width control unit 5 may control the tension control unit 4 so as to lower the target tension value in proportion to a difference between the measured width of the exit section of the finishing mill FM and the target width. Accordingly, as the tension control unit 4 lowers the target tension value, shrinkage in a width of a strip between the roughing mill RM and the finishing mill FM, occurring due to tension, may be reduced. Therefore, the width of the exit section of the finishing mill FM may be increased so as to reach a target width.

[0033] On the other hand, when the measured width of the exit section of the finishing mill FM is greater than a target width, the width control unit 5 may control the tension control unit 4 so as to increase the target tension value in proportion to a difference between the measured width of the exit section of the finishing mill FM and the target width. As a result, a width of a strip between the roughing mill RM and the finishing mill FM may be shrunk. Accordingly, the width of the exit section of the finishing mill FM may be reduced to reach the target width.

[0034] Accordingly, the width may controlled such that the width of a strip between the roughing mill RM and the finishing mill FM is shrunk or expanded by controlling the tension applied to a strip between the roughing mill RM and the finishing mill FM to be raised or lowered, such that the width of the exit section of the finishing mill FM may have a target width.

[0035] In addition, since the width control through feedback of the width of the exit section of the finishing mill FM is performed using the width measuring unit 3, the width in a direction of the strip length may be constantly controlled.

[0036] The width control in the single continuous rolling process line between continuous casting and hot rolling, using the width control apparatus, may be performed in a sequence in which tension applied to a strip between the roughing mill RM and the finishing mill FM is measured or estimated and the measured or estimated tension is controlled to a target tension value.

[0037] In addition thereto, the width of the exit section of the finishing mill FM may be measured, and when the measured width of the exit section of the finishing mill FM differs from the target width, the target tension value may be changed, such that the width of the exit section of the finishing mill FM may be more accurately controlled.

[0038] Therefore, according to an embodiment of the inventive concept, in a continuous mini-mill process performed between continuous casting and hot rolling, even when a width variation occurs during the continuous rolling process without using an edger, a width thereof may be constantly controlled. For example, the width of a strip between the roughing mill RM and the finishing mill FM may be decreased or increased through tension applied to a strip between the roughing mill RM and the finishing mill RM, and the tension applied to a strip between the roughing mill RM and the finishing mill FM may be continuously increased or decreased so as to obtain a target width of a product by measuring a width of an exit section of the finishing mill FM. As a result, during the continuous rolling process, product width variations and controlling for uniform width may be performed without using an edger, and an excellent width quality as compared to that of a conventional hot rolling process may be provided.

[0039] An implementation embodiment of the inventive concept will be described. Here, it may be assumed that the width of the exit section of the finishing mill FM is greater than the target width, by about 10 to 20mm. In an embodiment, the width of a strip provided between the roughing mill RM and the finishing mill FM may be reduced to be within a range of 10 to 20mm by using a tension control function of the tension control unit 4. In addition thereto, in a case in which a width of an exit section of the finishing mill FM measured through the width measuring unit 3, so as to allow for the width of the exit section of the finishing mill FM to become a target width, differs from the target width, the width control unit 5 may control the tension control unit 4 to perform a process in which the width of a strip provided between the roughing mill RM and the finishing mill FM is further increased or decreased. For example, in order to produce a product having a target margin width of about 7mm, the width of the exit section of the roughing mill may first be reduced by about 3mm by increasing tension of the strip. In this case, when the width of the exit section of the finishing mill measured through the width measuring unit 3 differs from the target width, the width control unit 5 may control the tension control unit 4 such that the width of the strip between the roughing mill RM and the finishing mill FM may be controlled by increasing or decreasing the tension applied to the strip between the roughing mill RM and the finishing mill FM so as to allow for the width of the exit section of the finishing mill FM to reach the target width.

[0040] As set forth above, in a width control apparatus and method for the use thereof in single continuous rolling process line between continuous casting and hot rolling according to an embodiment of the inventive concept, product width at an exit section of a finishing mill may be controlled to have a predetermined target width without using an edger, a width varying device.

[0041] While the inventive concept has been shown and described in connection with embodiments, it will be apparent to those skilled in the art that modifications and variations can be made without departing from the spirit and scope of the present inventive concept as defined by the appended claims.

Claims

1. A width control apparatus for the use thereof in a single continuous rolling process line between continuous casting and hot rolling performed in a mini mill including a continuous caster, a roughing mill, a heating device and a finishing mill, the width control apparatus comprising:

   a tension control unit controlling tension applied to a strip between the roughing mill and the finishing mill to have a target tension value;
   a width measuring unit measuring a width of an exit section of the finishing mill; and
   a width control unit performing control so as to change the target tension value when the measured width of the exit section of the finishing mill differs from a target width.

2. The width control apparatus of claim 1, wherein the tension control unit includes a tension measuring portion measuring the tension applied to the strip between the roughing mill and the finishing mill.

3. The width control apparatus of claim 1, wherein the tension control unit estimates the tension applied to the strip between the roughing mill and the finishing mill using a rolling load of the roughing mill, motor torque, or a measurement value of tension applied to the strip between stands.

4. The width control apparatus of claim 1, wherein when a measured width of the exit section of the finishing mill is smaller than the target width, the width control unit controls the tension control unit so as to lower the target tension value in proportion to a difference between the measured width of the exit section of the finishing mill and the target width.

5. The width control apparatus of claim 1, wherein when the measured width of the exit section of the finishing mill is greater than the target width, the width control unit controls the tension control unit so as to increase the target tension value in proportion to a difference between the measured width of the exit section of the finishing mill and the target width.

6. A width control method for the use thereof in a single continuous rolling process line between continuous casting and hot rolling in a mini-mill including a continuous caster, a roughing mill, a heating device and a finishing mill, the method comprising:

   measuring or estimating tension applied to a strip between a roughing mill and a finishing mill; and
   performing controlling such that the measured or estimated tension has a target tension value.

7. The width control method of claim 6, further comprising:

   measuring a width of an exit section of the finishing mill; and
   changing the target tension value when the measured width of the exit section of the finishing mill differs from a target width.

8. The width control method of claim 6, wherein the measuring or estimating of the tension applied to the strip between the roughing mill and the finishing mill is performed by estimating the tension applied to the strip between the roughing mill and the finishing mill by using a rolling load of the roughing mill, motor torque, or a measured value of tension applied to a strip between stands.

9. The width control method of claim 7, wherein the changing of the target tension value performed when the measured width of the exit section of the finishing mill differs from the target width is performed by lowering the target tension value in proportion to a difference between the measured width of the exit section of the finishing mill and the target width when the measured width of the exit section of the finishing mill is smaller than the target width.

10. The width control method of claim 7, wherein the changing of the target tension value performed when the measured width of the exit section of the finishing mill differs from the target width is performed by increasing the target tension value in proportion to a difference between the measured width of the exit section of the finishing mill and the target width when the measured width of the exit section of the finishing mill is greater than the target width.

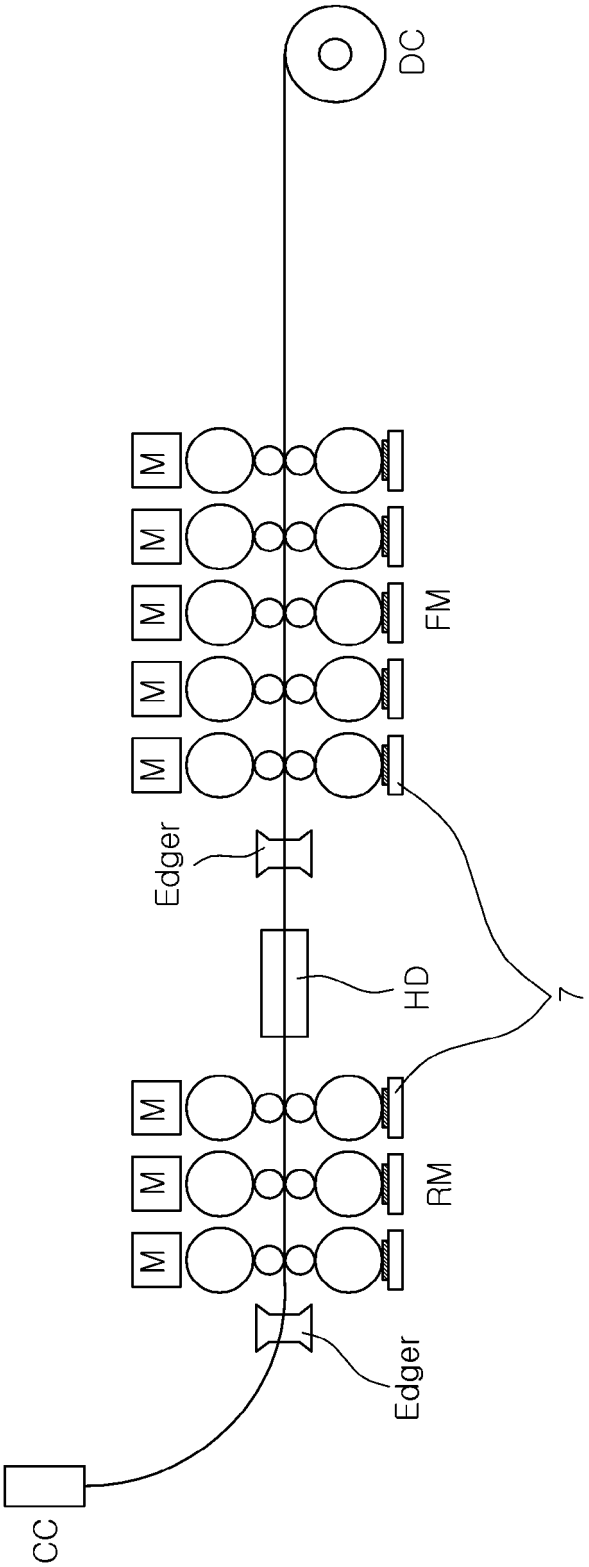

Fig. 1

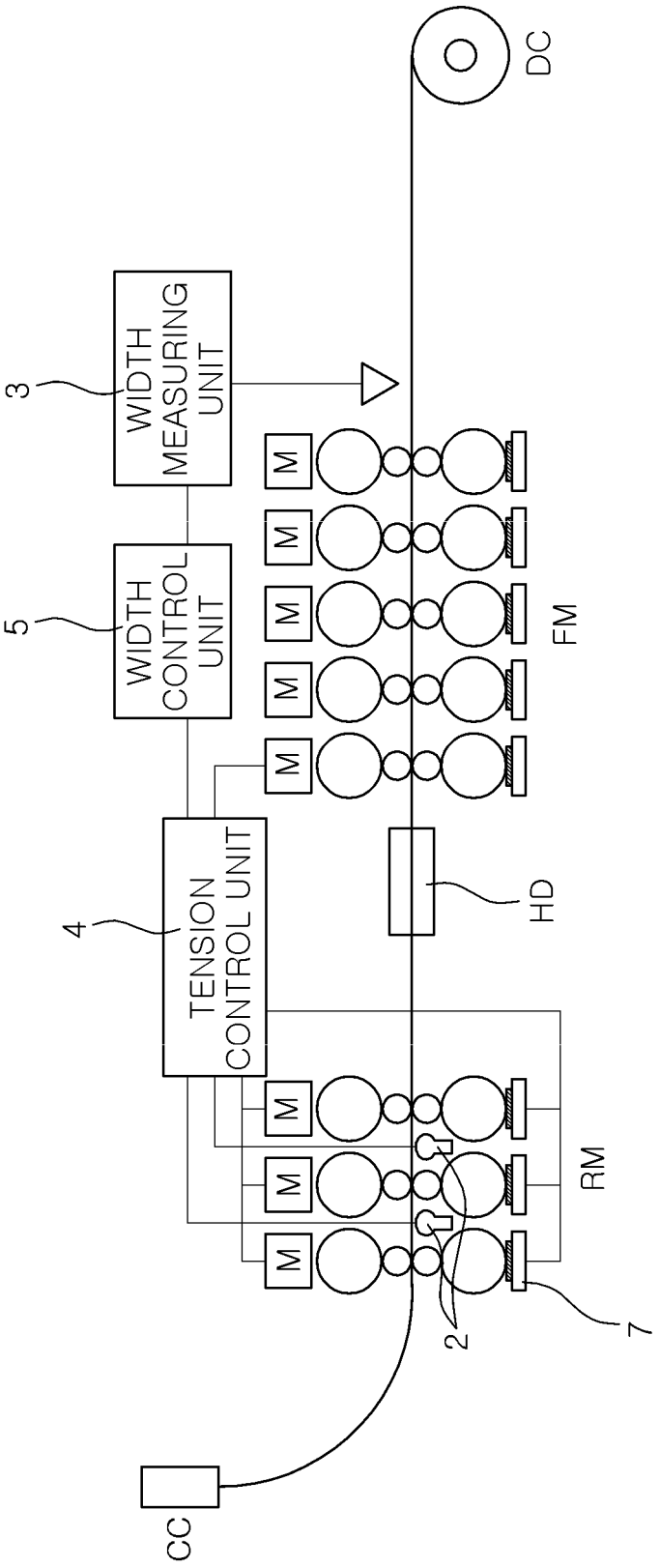
DC
3
WIDTH MEASURING UNIT
5
WIDTH CONTROL UNIT
4
TENSION CONTROL UNIT
M
FM
HD
RM
2
7
CC

Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2013/010692

A. CLASSIFICATION OF SUBJECT MATTER

B21B 37/16(2006.01)i, B21B 37/48(2006.01)i, B21B 38/04(2006.01)i, B21B 38/06(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)

B21B 37/16; B21B 37/22; B21B 37/00; B21B 37/18; B21B 37/48; B21B 38/04; B21B 38/06

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: rolling, width, tension

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2003-305509 A (KOBE STEEL LTD.) 28 October 2003 See abstract; paragraphs 49-53; claim 1; and figure 7.	1,2,4-7,9-10
A	JP 11-342409A (NKK CORP.) 14 December 1999 See abstract; claim 1; and figure 1.	1-10
A	JP 07-100517A (PO HANG IRON & STEEL CO LTD et al.) 18 April 1995 See abstract; claims 1, 17; and figure 1.	1-10

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
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"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	Date of mailing of the international search report
26 FEBRUARY 2014 (26.02.2014)	**26 FEBRUARY 2014 (26.02.2014)**
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. 82-42-472-7140	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2013/010692

Patent document cited in search report	Publication date	Patent family member	Publication date
JP 2003-305509 A	28/10/2003	NONE	
JP 11-342409A	14/12/1999	NONE	
JP 07-100517A	18/04/1995	JP 03-036323 B2	24/04/2000
		KR 10-1995-0013244 B1	26/10/1995
		KR 95-0013244 B1	26/10/1995

Form PCT/ISA/210 (patent family annex) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- KR 100957707 **[0008]**