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(72) Inventors:
• **CHOI, Dae-Gon**
Gwangyang-si
Jeollanam-do 57807 (KR)
• **KIM, Yong-Hoon**
Gwangyang-si
Jeollanam-do 57807 (KR)
• **BAE, Jae-Wook**
Gwangyang-si
Jeollanam-do 57807 (KR)

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(71) Applicant: **Posco**
Pohang-si, Gyeongsangbuk-do 37859 (KR)

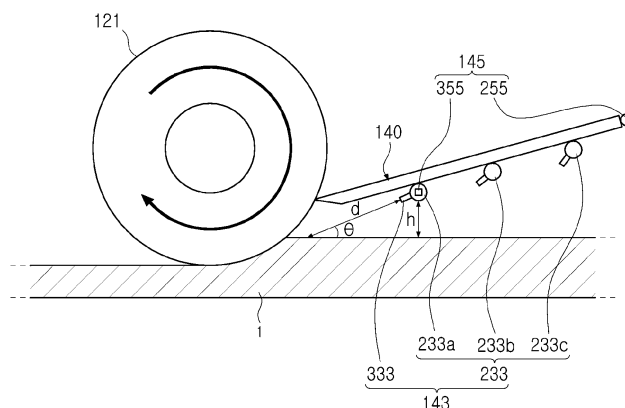
(74) Representative: **Zech, Stefan Markus**
Meissner Bolte Patentanwälte
Rechtsanwälte Partnerschaft mbB
Postfach 86 06 24
81633 München (DE)

(54) **ROLLING FACILITY AND ROLLING METHOD**

(57) The present invention relates to a rolling facility and a rolling method. According to the present invention, the rolling facility comprises: a roughing mill having a roughing mill roll for pressing a material to be transferred; a finishing mill having a finishing mill roll, which is provided on a material transfer path, and pressing the material having passed through the roughing mill; a wiper device provided at a feed-in side of the finishing mill roll,

polishing the surface of the finishing mill roll, and supplying cooling fluid to the material; and a cooling device provided on the material transfer path and cooling the material having passed through the finishing mill, wherein the wiper device can include a plurality of cooling header units for supplying the cooling fluid to the material at different positions.

FIG. 6



Description

[Technical Field]

[0001] The present disclosure relates to a rolling facility and a rolling method.

[Background Art]

[0002] FIG. 1 schematically illustrates a hot rolling process of producing a hot-rolled steel plate. In the hot rolling process, a slab, having passed through a heating furnace 10, is transferred to a roughing mill 20 by a feed roll 5, to be subjected to rough rolling, followed by finish rolling in a finishing mill 30, to be cooled on a run-out table 40, and to then be wound in coil form in a winding device 50.

[0003] In this case, in the roughing mill 20, the slab moved from the heating furnace 10 is first rolled in the form of a steel plate, and in the finishing mill 30, the primary rolled steel plate is rolled to have a final target thickness.

[0004] However, since a work roll used in such a hot rolling process repeatedly contacts a high-temperature hot slab or steel plate, an amount of the heat input to the work roll from a hot slab or steel plate should be considered.

[0005] In a case in which the work roll is exposed to high temperature for an extended period of time, the work roll may be in a thermal fatigue state. On the surface of the steel plate contacting such a work roll, high intensity scale such as hematite and magnetite may be generated, causing a phenomenon in which mill scale of a roll surface is partially or entirely peeled off. As such, when mill scale is peeled off from the surface of the roll, spindle scale and sand scale may occur on the surface of a product, thereby deteriorating the quality of the product.

[0006] Therefore, in a hot rolling process, a thermal fatigue phenomenon of a work roll should be suppressed, and the temperature of the work roll should be properly controlled. To appropriately control the temperature of the work roll, a method of spraying cooling water on a work roll may be used.

[0007] However, since a problem in which a large amount of cooling water is concentrated on a specific area of a work roll may occur, depending on a distance by which a nozzle for spraying cooling water onto the work roll is spaced apart from a roll, the position of spraying the cooling water should be carefully controlled.

[0008] Furthermore, only cooling the work roll repeatedly in contact with a high-temperature steel sheet may cause cooling efficiency to deteriorate.

[Disclosure]

[Technical Problem]

[0009] An aspect of the present disclosure is to provide

a rolling facility and a rolling method, in which damage to a work roll pressing a material in a hot rolling process may be prevented and the quality of a rolled product may be improved.

[0010] An aspect of the present disclosure is to provide a rolling facility and a rolling method, in which a material may be prevented from being rapidly cooled before entering a work roll and cooling efficiency of the work roll and the material may increase.

[0011] An aspect of the present disclosure is to provide a rolling facility and a rolling method, in which efficiency and productivity in a rolling process may increase.

[Technical Solution]

[0012] According to an aspect of the present disclosure, a rolling facility and a rolling method are provided.

[0013] According to an aspect of the present disclosure, a rolling facility includes a roughing mill including a roughing roll pressing a material transferred thereto; a finishing mill including a finishing roll, provided on a material conveying path and pressing the material having passed through the roughing mill; a wiper device provided on an inlet side of the finishing roll, polishing a surface of the finishing roll, and supplying a cooling fluid to the material; and a cooling device provided on the material conveying path and cooling the material having passed through the finishing mill. The wiper device includes a plurality of cooling header units supplying the cooling fluid to the material in different positions.

[0014] In detail, the wiper device may include a device frame disposed after the finishing roll in a material travel direction; a wiper member provided on the device frame; and a cooling header unit provided on the device frame or the wiper member, supplying a largest amount of cooling fluid in a position farthest away from the finishing roll, and supplying a smallest amount of cooling fluid in a position closest to the finishing roll.

[0015] In more detail, the wiper device may further include a cooling header adjusting unit connected to the cooling header unit to adjust at least one of a distance from the cooling header unit to the finishing roll or the material and an angle formed by the cooling header unit with the material, to prevent the cooling fluid supplied to the material from overlapping.

[0016] In more detail, the cooling header adjusting unit may include a distance adjusting unit, connected to the cooling header unit, to move the cooling header unit along the wiper member to vary a distance from the cooling header unit to the finishing roll or the material; and an angle adjusting unit connected to the device frame or the wiper member to rotate the device frame or the wiper member to adjust an angle formed by the cooling header unit with the material.

[0017] In more detail, the cooling header unit may include a plurality of cooling pipes provided on the wiper member to face the material and spaced apart from each other by a predetermined distance; and a cooling nozzle

provided in the plurality of cooling pipes and provided as a plurality of cooling nozzles disposed in a width direction of the material.

[0018] In more detail, the distance adjusting unit may include a moving frame supporting or fixing the plurality of cooling pipes; a moving rail provided on the moving frame and the wiper member; and a power transmission unit connected to the moving frame or the plurality of cooling pipes to move the moving frame or the plurality of cooling pipes along the moving rail.

[0019] In more detail, the power transmission unit may include a screw housing provided on the moving frame; and a screw member connected to a rotary shaft of a motor connected to an encoder, and connected to the screw housing.

[0020] In further detail, the angle adjusting unit may include an angle adjusting motor in which a rotary shaft is connected to the device frame or the wiper member, and may adjust an angle formed by a jet port of the cooling nozzle with the material by rotating the device frame or the wiper member by the angle adjusting motor.

[0021] In further detail, the wiper device may further include a sensing unit provided on at least one of the device frame, the wiper member, and the plurality of cooling pipes, the sensing unit being electrically connected to a control unit.

[0022] In more detail, the sensing unit may include an angle sensor provided on the device frame or the wiper member; and a distance sensor provided on the plurality of cooling pipes.

[0023] In further detail, the rolling facility may further include an outlet-side cooling device provided on an exit side of the finishing roll to supply the cooling fluid to the finishing roll.

[0024] In more detail, the material may be a material comprising at least one of a medium carbon steel having 0.08% to 0.3% by weight of carbon, a high carbon steel having 0.3% or more by weight of carbon, and a niobium (N_b)-added steel.

[0025] According to another aspect of the present disclosure, a method of rolling a material using a rolling facility includes a roughing operation of pressing the material with a roughing mill; an inlet-side cooling operation of supplying a cooling fluid to the material, on an inlet side of a finishing roll of a finishing mill; a finishing operation of pressing the material with the finishing roll after the inlet-side cooling operation or during the inlet-side cooling operation; and an outlet-side cooling operation of supplying the cooling fluid to the finishing roll and the material, on an exit side of the finishing roll, after the finishing operation or during the finishing operation.

[0026] In detail, in the inlet-side cooling operation, the cooling fluid may be supplied to a plurality of cooling pipes spaced apart from each other by different distances from the finishing roll, to supply a greatest amount of cooling fluid at a farthest distance from the finishing roll and supply a smallest amount of cooling fluid at a closest distance from the finishing roll.

[0027] In more detail, the inlet-side cooling operation may include a nozzle adjusting operation of changing a position of a nozzle supplying the cooling fluid or rotating the nozzle.

[0028] In further detail, the nozzle adjusting operation may be performed by changing a distance from the nozzle to the finishing roll or the material or changing an angle formed by the nozzle with respect to the material.

[0029] In more detail, the inlet-side cooling operation may be performed to supply the cooling fluid to the material, such that a temperature of a material, including at least one of a medium carbon steel having 0.08% to 0.3% by weight of carbon, a high carbon steel having 0.3% or more by weight of carbon, and a niobium (N_b)-added steel, is within a range of 850°C to 900°C.

[Advantageous Effects]

[0030] According to an embodiment of the present disclosure, the lifetime of a work roll may be increased and a replacement cycle of the work roll may be extended.

[0031] In addition, the material may be prevented from being rapidly cooled and from deteriorating the quality of a rolled product, and cooling efficiency of the material and the work roll may be increased.

[0032] Further, manufacturing costs may be reduced, and the product quality and productivity may be improved.

[Description of Drawings]

[0033]

FIG. 1 schematically illustrates a rolling process of the related art.

FIG. 2 schematically illustrates a rolling process according to an embodiment of the present disclosure.

FIG. 3 schematically illustrates a rolling facility according to an embodiment of the present disclosure.

FIG. 4 schematically illustrates a cooling pipe according to an embodiment of the present disclosure.

FIG. 5 is a perspective view of a wiper device according to an embodiment of the present disclosure.

FIG. 6 schematically illustrates the arrangement of a cooling pipe according to an embodiment of the present disclosure.

FIG. 7 is a perspective view of a wiper device according to another embodiment of the present disclosure.

FIG. 8 schematically illustrates a rolling method according to an embodiment of the present disclosure.

FIG. 9 illustrates physical properties of a material rolled according to an embodiment of the present disclosure.

[Best Mode]

[0034] In order to facilitate an understanding of the de-

scription of embodiments in the present disclosure, elements denoted by the same reference numerals in the accompanying drawings are the same elements, and among elements performing the same function in respective embodiments, relevant elements are represented by the same or similar reference numerals.

[0035] Further, to clarify the gist of the present disclosure, a description of elements and techniques well known in the related art will be omitted, and embodiments in the present disclosure will be described in detail with reference to the accompanying drawings.

[0036] In addition, the present disclosure is not limited to the embodiments provided herein, but may be suggested by those skilled in the art in other forms in which specific constituent elements are added, changed or deleted, within the scope of the present disclosure.

[0037] Hereinafter, a case in which cooling water is used as a cooling fluid is described as an example, but the cooling fluid type is not necessarily limited by an embodiment in the present disclosure, and may be appropriately changed and applied by those skilled in the art.

[0038] As illustrated in FIG. 2, a rolling facility 100 according to an embodiment in the present disclosure may include a roughing mill 110, having a roughing roll 111 pressing a material 1 to be fed, a finishing mill 120 having finishing rolls 121 provided on a conveying path of the material to press the material having passed through the roughing mill, a wiper device 140, provided on an inlet side of the finishing roll to polish a surface of the finishing roll and supplying a cooling fluid to the material, and a cooling device 130 provided on the conveying path of the material to cool the material having passed through the finishing mill.

[0039] In this case, the cooling device 130 may be a run-out table. Further, the wiper device 140 may be respectively provided on all of the finishing rolls 121 provided on the conveying path of the material 1 or may only be provided on the finishing roll 121 at any position, but the configuration thereof is not limited thereto, and may be appropriately selected and applied by those skilled in the art, depending on rolling conditions or the like.

[0040] In addition, as illustrated in FIG. 3, an inlet-side cooling unit 60 may be provided on an inlet side of the finishing roll 121 to supply cooling water to the finishing roll 121. On an exit side of the finishing roll 121, an outlet-side cooling unit 70 may be provided to supply the cooling water to the finishing roll 121.

[0041] In this case, the wiper device 140 provided below the inlet-side cooling unit 60 is in contact with a surface of the finishing roll 121. For example, in a case in which the surface of the finishing roll is worn or damaged by foreign substances or the like, the wiper device 140 polishes the surface of the finishing roll, thereby increasing process efficiency without separately performing a finishing roll replacement operation.

[0042] A lubricating unit 80, supplying rolling oil and air, may be provided above the wiper device 140. The lubricating unit 80 may include a plurality of supply lines

(not illustrated) connected to a lubricating oil supplier (not illustrated) and an air supplier (not illustrated), respectively, and supply nozzles provided on the supply pipes, respectively.

[0043] In addition, the wiper device 140 includes a plurality of cooling header units 143 supplying a cooling fluid to the material in different positions.

[0044] The cooling header unit may include a cooling pipe 233 connected to a cooling water supply unit (not illustrated) and a cooling nozzle 333 provided on the cooling pipe. The cooling pipe 233 may include a first cooling pipe 233a disposed to be closest to the finishing roll 121, a third cooling pipe 233c spaced farthest from the finishing roll 121, and a second cooling pipe 233b disposed between the first cooling pipe 233a and the third cooling pipe 233c.

[0045] On the other hand, the number of cooling pipes is not necessarily limited by the present disclosure, but may be appropriately selected and applied by those skilled in the art depending on material characteristics and a working environment.

[0046] As illustrated in FIG. 4, for example, FIGS. 4A and 4B, the cooling pipe 233 may be provided with a plurality of cooling nozzles 333 arranged in a width direction of the finishing roll (121 in FIG. 3). The cooling nozzles 333 may be provided to spray cooling water to the material by being spaced apart from the surface of the finishing roll or the surface of the material.

[0047] In this case, since the cooling pipe 233 is spaced apart from the finishing roll or the material by a predetermined distance, the cooling nozzles 333 are present in predetermined positions from the finishing roll or the material, and a distance from the cooling nozzles 333 to the surface of the material is defined as a first spraying distance d_1 , and a distance from the cooling nozzles 333 in another position to the surface of the material is defined as a second spraying distance d_2 .

[0048] In this case, comparing the first and second spraying distances with each other, the first spraying distance d_1 is shorter than the second spraying distance d_2 , and thus, it can be seen that the closer the cooling pipe 233 is disposed to the finishing roll or the material, a spraying distance is reduced.

[0049] It can be seen that the second spraying distance d_2 becomes longer as the cooling pipe 233 is further spaced away from the finishing roll or the material, and in this case, an overlap region R in which cooling water jetted from the cooling nozzles 333 are overlapped occurs.

[0050] If the overlap region R occurs as described above, it may be difficult to uniformly supply cooling water, and a large amount of cooling water is accumulated in a specific region on the material, which lowers cooling efficiency of the finishing roll and the material.

[0051] Accordingly, in the case of an embodiment of the present disclosure, a wiper device, capable of improving cooling efficiency of the material and the finishing roll, while preventing the problem described above and

uniformly supplying cooling water, is provided.

[0052] FIG. 5 illustrates the wiper device 140 according to an embodiment of the present disclosure.

[0053] The wiper device 140 according to an embodiment of the present disclosure includes a device frame 141 disposed behind the finishing roll 121 in a traveling direction of the material 1.

[0054] A thickness of the material before being drawn into the finishing roll 121 is greater than a thickness of the material after having been drawn into the finishing roll 121. A side on which the thickness of the material is relatively great is defined as an inlet side of the finishing roll 121, and a side on which the thickness of the material is less than that on the inlet side is defined as an exit side.

[0055] In this case, the device frame 141 may be disposed on an inlet side of the finishing roll 121.

[0056] A wiper member 142 may be coupled to the device frame 141 by a coupling member (not illustrated). In addition, the wiper member 142 may also be integrally formed with the device frame 141, but an embodiment thereof is not limited thereto. For example, the wiper member 142 may be appropriately modified by those skilled in the art.

[0057] The cooling header unit 143 may be provided with the device frame 141 or the wiper member 142, and the cooling header unit 143 may be configured to supply cooling water to the surface of the material 1. In this case, the cooling header unit 143 may be provided on the device frame 141 or the wiper member 142 as described above. Hereinafter, a case in which the cooling header unit 143 is provided on the wiper member 142 will be described by way of example.

[0058] However, the description below is for the sake of clarity and not for the purpose of limiting the present disclosure, and a position in which the cooling header unit 143 is provided may be appropriately selected by those skilled in the art.

[0059] Further, when the cooling header unit 143 is provided on the device frame 141 or the wiper member 142 on the inlet side of the finishing roll, a rolling mill space may be efficiently utilized. Therefore, according to an embodiment in the present disclosure, not only constructing a cooling header unit applicable in the actual mill space, but also constructing a cooling header unit suitable for the actual mill space may be implemented.

[0060] In addition, according to the cooling header unit 143 in an embodiment of the present disclosure, there is an effect in which cooling of a material surface, based on an actual thickness of the material 1, may be performed, regardless of a reduction rate, a finishing roll gap, a finishing roll diameter, and the like.

[0061] In a hot rolling process, the materials may have different thicknesses depending on physical conditions such as an ambient temperature, a material heating history, or the like, even under the same rolling condition and reduction. Therefore, in a case in which cooling water is supplied, based on data of the material, of which a

thickness is estimated by a rolling condition, a reduction rate, or the like (in this case, since the thickness of the material is determined by an interval of finishing rolls pressing the material, the thickness of the material may be regarded as being the same as an interval of the finishing rolls), cooling work suitable for an actual material thickness may be performed.

[0062] Therefore, in the present disclosure, the cooling header unit 143 supplies the cooling water directly to the surface of the material 1, to cool the surface of the material on the inlet side of the finishing roll, to a temperature of a critical point or lower. Such a method may efficiently cool the surface of the material as compared with a method of supplying cooling water to a finishing roll or a finishing roll gap, and further, has an effect of efficiently cooling up to a finishing roll.

[0063] In addition, there is an effect in which surface defects of the material caused by uneven cooling of the material and the finishing roll may be prevented.

[0064] Further, as described above, a cooling header adjusting unit 144 may be provided to move the cooling header unit 143 on the wiper member 142 to remove the overlap region (see R in FIG. 4) in which cooling water overlaps, and thus, to promote uniform cooling.

[0065] On the other hand, the cooling header unit may be provided as a plurality of cooling header units below the wiper member, and may be configured to supply a largest amount of cooling fluid, in a position farthest away from the finishing roll, and to supply a smallest amount of cooling fluid, in a position closest to the finishing roll.

[0066] By the cooling header unit provided as described above, the temperature of the material 1 may be prevented from suddenly changing before entering the finishing roll 121. For example, a smallest amount of cooling fluid is supplied from the third cooling pipe 233c farthest from the finishing roll 121 to cool the material 1, and an amount of cooling fluid more than that from the third cooling pipe 233c is supplied from the second cooling pipe 233b to cool the material 1, and a greatest amount of cooling fluid is supplied through the first cooling pipe 233a provided immediately before the finishing roll 121, thereby exhibiting an effect of preventing brittleness from occurring due to rapid cooling of the material before being drawn into the finishing roll 121, and thus, contributing to improvement in moldability.

[0067] In detail, when the material 1 is a material containing at least one of medium carbon steel (0.08% to 0.3% of carbon weight), high carbon steel (0.3% or more of carbon weight) and niobium(N_b)-added steel, the effect as described above may be further significantly increased.

[0068] In more detail, the amount of the cooling water supplied to the cooling pipe is controlled such that a material temperature before being drawn into the finishing roll 121 is in the range of 850°C to 900°C, thereby significantly increasing formability of the material 1.

[0069] For example, as illustrated in FIG. 9, in a case in which the material 1 is a material containing at least

one of medium carbon steel (0.08% to 0.3% of carbon weight), high carbon steel (0.3% or more of carbon weight) and niobium (N_b)-added steel, when a material temperature is within a range from 850°C or higher to 900°C or lower, the fraction of hematite (ferrous oxide: Fe_2O_3) and magnetite (ferric oxide: Fe_3O_4), which have hardness greater than that of the finishing roll, is increased, causing that mill scale is peeled off as a surface defect. Thus, a surface temperature of the material may be in the range of 850°C to 900°C, which may be significantly effective to improve the quality.

[0070] To this end, a separate temperature measuring unit (not illustrated) may be provided on the inlet side of the finishing roll 121, but this may also be selected and applied by those skilled in the art.

[0071] As described above, the sudden decrease in the surface temperature of the material causes a decrease in the temperature of the entirety of the material in a thickness direction, adversely affecting plate passing ability. Therefore, cooling the material uniformly, while preventing rapid cooling of the material and formation of an overlap region (see R in FIG. 4) of cooling water, may be significantly important.

[0072] Therefore, the material 1 may be appropriately cooled to be in an optimum state by adjusting a distance and an angle of the cooling pipe 233 by the cooling header adjusting unit 144.

[0073] The cooling header adjusting unit may vary a distance from the cooling nozzle 333 to the material surface by moving the cooling pipe 233 on the wiper member 142 by a distance adjusting unit 343.

[0074] The distance adjusting unit 343 may change the position of the cooling nozzle 333 on the wiper member 142 and thereby change a distance of the spray from the cooling nozzle 333 to the material surface.

[0075] According to the cooling header adjusting unit 144 as described above, the position of the cooling pipe 233 appropriate for rolling conditions may be selected, thereby preventing cooling water supplied from a plurality of the cooling nozzles from overlapping, and there is an effect of removing an overlap region in which cooling water is overlapped.

[0076] As a result, the cooling efficiency of the material and the finishing roll may be improved, and the quality of a rolled product may be improved.

[0077] In detail, the cooling header adjusting unit 144 is configured to rotate the wiper member 142 (by rotating the device frame in a case in which the cooling pipe is installed on the device frame) on which the cooling pipe 233 is installed, by an angle adjusting unit, in such a manner that an angle formed by the cooling nozzle 333 with respect to a surface of the material 1 may also be changed, which will be described later.

[0078] On the other hand, to facilitate movement of the cooling pipe 233 on the wiper member 142, a moving frame 241 is provided between the wiper member 142 and the cooling pipe 233, and a moving rail 242 may be provided between the moving frame 241 and the wiper

member 142.

[0079] In detail, the moving rail 242 may be provided as an LM guide, but the configuration thereof is not limited thereto and may be replaced by other guiding parts.

5 **[0080]** According to the moving frame 241 and the moving rail 242 as described above, a movement path of the cooling pipe 233 may be set in advance on the wiper member 142, and the stable movement of the cooling pipe 233 may be implemented.

10 **[0081]** The distance adjusting unit 343 to move the cooling pipe 233 on the wiper member 142 may include the moving frame 241 supporting or fixing the cooling pipe 233, the moving rail 242 provided on the moving frame and the wiper member 142, and a power transmission unit 243 connected to the moving frame or the cooling pipe to move the moving frame or the cooling pipe along the moving rail.

15 **[0082]** The power transmission unit 243 may include a screw housing 244, an encoder 247, a motor 246, and a screw member 245 that is connected to a rotary shaft of the motor connected to the screw housing and the encoder and is connected to the screw housing to pass through the inside of the screw housing.

20 **[0083]** In detail, a bracket member supporting the screw member 245 may be further provided between the screw member 245 and the screw housing 244, to support the screw member 245. When the bracket member is provided as described above, the screw member 245 may be efficiently supported when a length of the screw member is increased or a moving distance is relatively increased, and the screw member 245 may be prevented from drooping due to the load, or the like.

25 **[0084]** However, this embodiment is not necessarily limited thereto, and may be appropriately selected and applied by those skilled in the art.

30 **[0085]** The screw member 245 may be provided with threads protruding from an outer circumference and the screw housing 244 may be provided with a thread groove that engages with the thread of the screw member 245. In this case, when the screw member 245 is rotated by the motor 246, the screw housing 244 does not rotate but performs a linear motion in such a manner that the moving frame 241 connected to the screw housing 244 is moved linearly along the moving rail 242.

35 **[0086]** In detail, a bearing (not illustrated) may be provided in a region in which the screw housing 244 engages with the screw member 245, to prevent rotation of the screw housing 244 due to rotation of the screw member 245.

40 **[0087]** When the moving frame 241 moves, the cooling pipe 233 moves, and a distance by which the cooling pipe 233 moves may be detected by the encoder 247. The encoder 247 may detect the number of revolutions of the motor 246 to calculate a linear travel distance, which may be performed more efficiently by a control unit (not illustrated) electrically connected to the encoder 247.

45 **[0088]** A distance by which the cooling pipe 233 is separated from the surface of the material 1 may be adjusted

by moving the moving frame 241 through the rotation of the motor 246. Accordingly, as such, by adjusting the position of the cooling pipe 233, a spraying distance of cooling water may be adjusted, and by adopting an appropriate position of the cooling pipe 233 depending on rolling conditions, the overlap region (see R in FIG. 4) in which the cooling water sprayed from the cooling nozzle 333 is superimposed may be prevented from occurring.

[0089] In this case, the cooling pipe 233 may be configured to be separately controlled, but an embodiment thereof is not limited thereto, and may be selectively modified by those skilled in the art.

[0090] On the other hand, in the present disclosure, a sensing unit 145 is provided as illustrated in FIG. 6. The travel distance and position of the cooling pipe 233 may be grasped by a distance sensor 355 provided on the cooling pipe 233. In detail, the distance sensor 355 may also be electrically connected to the control unit (not illustrated).

[0091] In addition, the cooling nozzle 333 of the cooling pipe 233 may adjust an angle θ at which the cooling water is sprayed. The angle θ at which the cooling water is sprayed may be adjusted by rotating the wiper device 140, in detail, the wiper member (see 142 in FIG. 5) or the device frame (see 141 in FIG. 5) by a predetermined angle.

[0092] Further, the angle θ at which the cooling water is sprayed may be sensed by an angle sensor 255 that may be provided on the wiper member.

[0093] On the other hand, when the distance from the cooling pipe to the surface of the material 1 is h , a spraying distance d is as in the following [Equation 1].

[Equation 1]

$$d = \frac{h}{\sin \theta}$$

[0094] A thickness of the material 1 is set before the material 1 is drawn into the finishing roll 121, and a value of the angle θ at which the cooling water is sprayed by the angle sensor 255 may be known. In this case, an optimum spraying distance at which the cooling water overlap region does not occur may have a previously derived value, and the angle θ at which the cooling water is sprayed may be a value that does not change after initial setting in which a diameter of the finishing roll 121 and a target material are determined.

[0095] Therefore, the cooling pipe may be moved to an optimum spraying distance at which the overlap region does not occur, by the distance adjusting unit 343 according to an embodiment, and the device frame or the wiper member may be rotated to form an initially determined angle θ at which the cooling water is sprayed, by an angle adjusting unit (see 350 in FIG. 7).

[0096] For example, when a distance from a current

cooling pipe to a surface of the material 1 is defined as h' , a movement amount d' of the cooling pipe 233 for setting an optimal spraying distance d_{opt} is as in the following Equation 2.

[Equation 2]

$$d' = d_{opt} - \frac{h'}{\sin \theta}$$

[0097] In this case, when respective cooling pipes are configured so that the distance and the angle are collectively changed, the above-mentioned [Equation 1] and [Equation 2] may be calculated on the basis of the first cooling pipe 233a, and when the respective cooling pipes are configured so that the distance and the angle are individually changed, the above-mentioned [Equation 1] and [Equation 2] may be individually applied to the respective cooling pipes, and the spraying distance and the spraying angle may also be separately calculated with respect to the respective cooling pipes.

[0098] Hereinafter, with reference to FIG. 7, a configuration in which the angle θ for spraying the cooling water is adjusted will be described in detail. An angle θ at which the cooling water is sprayed may be adjusted by the angle adjusting unit 350, which is connected to the device frame 141 or the wiper member 142, to rotate the device frame 141 or the wiper member such that an angle formed by the cooling header unit 143 with respect to the surface of the material 1 may be adjusted.

[0099] Hereinafter, a case in which the angle adjusting unit 350 is provided in the device frame 141 will be described as an example, but an embodiment thereof is not limited thereto, and may be appropriately changed by those skilled in the art.

[0100] The angle adjusting unit 350 may include an angle adjusting motor 351 of which a rotational axis is connected to the device frame. In this case, an encoder 352 may also be connected to the angle adjusting motor 351.

[0101] In detail, the device frame 141 may also be provided with an angle sensor 163 to sense a rotational state and angle. The sensors described above may all be configured to be electrically connected to the control unit (not illustrated) so that information thereof may be transferred to an operator.

[0102] For example, when the device frame 141 is rotated by the angle adjusting motor 351 as described above, the wiper member 142 connected to the device frame 141 rotates, and the cooling nozzle 333 may rotate accordingly.

[0103] Accordingly, the operator may adjust the angle θ at which the cooling water is sprayed onto the surface of the material 1 by the cooling nozzle 333, according to this principle. In addition to the distance for spraying the cooling water, when the angle is adjusted together, oc-

currence of an overlap region may be prevented more effectively.

[0104] Hereinafter, a case in which the angle adjusting unit 350 is provided in the device frame 141 will be described as an example, but an embodiment thereof is not limited thereto, and may be appropriately changed by those skilled in the art.

[0105] The angle adjusting unit 350 may include an angle adjusting motor 351 of which a rotational axis is connected to the device frame. In this case, an encoder 352 may also be connected to the angle adjusting motor 351.

[0106] In detail, the device frame 141 may also be provided with an angle sensor 163 to sense a rotational state and angle. The sensors described above may all be configured to be electrically connected to the control unit (not illustrated) so that information thereof may be transferred to an operator.

[0107] For example, when the device frame 141 is rotated by the angle adjusting motor 351 as described above, the wiper member 142 connected to the device frame 141 rotates, and the cooling nozzle 333 may rotate accordingly.

[0108] Accordingly, the operator may adjust the angle θ at which the cooling water is sprayed onto the surface of the material 1 by the cooling nozzle 333, according to this principle. In addition to the distance for spraying the cooling water, when the angle is adjusted together, occurrence of an overlap region may be prevented more effectively.

[0109] On the other hand, as illustrated in FIG. 8, a method of rolling a material using a rolling facility, according to another embodiment of the present disclosure, may include a roughing operation S610 in which the material is pressed by a roughing mill, an inlet-side cooling operation S620 in which cooling water is supplied to the material on an inlet side of a finishing roll of a finishing mill, a finishing operation S630 in which the material is pressed by the finishing roll after the inlet-side cooling operation or during the inlet-side cooling operation, and an outlet-side cooling operation S640 in which the cooling water is supplied to the finishing roll and the material on an exit side of the finishing roll after the finishing operation or during the finishing operation.

[0110] In this case, the inlet-side cooling operation S620 may include a nozzle adjusting operation S621 of changing a position of a nozzle for supplying cooling water or rotating the nozzle, and the nozzle adjusting operation may be performed by adjusting a distance from the nozzle to the finishing roll or the material or changing an angle formed by the nozzle with respect to the material.

[0111] In this case, the outlet-side cooling operation S640 may be performed by supplying cooling water to the finishing roll 121 on an exit side of the finishing roll 121 by the outlet-side cooling unit 70 as illustrated in FIG. 3.

[0112] According to this rolling method, the cooling water may be uniformly sprayed onto the surface of the material,

thereby enabling efficient cooling of the surface of the material. Therefore, a phenomenon in which mill scale of a roll surface is partially or entirely peeled off may be prevented, and the quality of a rolled product may be further improved.

[0113] While embodiments have been illustrated and described above, it will be apparent to those skilled in the art that modifications and variations could be made without departing from the scope of the present disclosure as defined by the appended claims.

Claims

1. A rolling facility comprising:

a roughing mill including a roughing roll pressing a material transferred thereto;
a finishing mill including a finishing roll, provided on a material conveying path and pressing the material having passed through the roughing mill;
a wiper device provided on an inlet side of the finishing roll, polishing a surface of the finishing roll, and supplying a cooling fluid to the material; and
a cooling device provided on the material conveying path and cooling the material having passed through the finishing mill, wherein the wiper device includes a plurality of cooling header units supplying the cooling fluid to the material in different positions.

2. The rolling facility of claim 1, wherein the wiper device comprises:

a device frame disposed after the finishing roll in a material travel direction;
a wiper member provided on the device frame; and
a cooling header unit provided on the device frame or the wiper member, supplying a largest amount of cooling fluid in a position farthest away from the finishing roll, and supplying a smallest amount of cooling fluid in a position closest to the finishing roll.

3. The rolling facility of claim 2, wherein the wiper device further comprises a cooling header adjusting unit connected to the cooling header unit to adjust at least one of a distance from the cooling header unit to the finishing roll or the material and an angle formed by the cooling header unit with the material, to prevent the cooling fluid supplied to the material from overlapping.

4. The rolling facility of claim 3, wherein the cooling header adjusting unit comprises:

- a distance adjusting unit, connected to the cooling header unit, to move the cooling header unit along the wiper member to vary a distance from the cooling header unit to the finishing roll or the material; and
 an angle adjusting unit connected to the device frame or the wiper member to rotate the device frame or the wiper member to adjust an angle formed by the cooling header unit with the material.
5. The rolling facility of claim 4, wherein the cooling header unit comprises:
- a plurality of cooling pipes provided on the wiper member to face the material and spaced apart from each other by a predetermined distance; and
 a cooling nozzle provided in the plurality of cooling pipes and provided as a plurality of cooling nozzles disposed in a width direction of the material.
6. The rolling facility of claim 5, wherein the distance adjusting unit comprises:
- a moving frame supporting or fixing the plurality of cooling pipes;
 a moving rail provided on the moving frame and the wiper member; and
 a power transmission unit connected to the moving frame or the plurality of cooling pipes to move the moving frame or the plurality of cooling pipes along the moving rail.
7. The rolling facility of claim 6, wherein the power transmission unit comprises:
- a screw housing provided on the moving frame; and
 a screw member connected to a rotary shaft of a motor connected to an encoder, and connected to the screw housing.
8. The rolling facility of claim 5, wherein the angle adjusting unit comprises an angle adjusting motor in which a rotary shaft is connected to the device frame or the wiper member, and adjusts an angle formed by a jet port of the cooling nozzle with the material by rotating the device frame or the wiper member by the angle adjusting motor.
9. The rolling facility of claim 8, wherein the wiper device further comprises a sensing unit provided on at least one of the device frame, the wiper member, and the plurality of cooling pipes, the sensing unit being electrically connected to a control unit.
10. The rolling facility of claim 9, wherein the sensing unit comprises:
- an angle sensor provided on the device frame or the wiper member; and
 a distance sensor provided on the plurality of cooling pipes.
11. The rolling facility of any one of claims 1 to 10, further comprising an outlet-side cooling device provided on an exit side of the finishing roll to supply the cooling fluid to the finishing roll.
12. The rolling facility of claim 11, wherein the material is a material comprising at least one of a medium carbon steel having 0.08% to 0.3% by weight of carbon, a high carbon steel having 0.3% or more by weight of carbon, and a niobium (N_b)-added steel.
13. A method of rolling a material using a rolling facility, comprising:
- a roughing operation of pressing the material with a roughing mill;
 an inlet-side cooling operation of supplying a cooling fluid to the material, on an inlet side of a finishing roll of a finishing mill;
 a finishing operation of pressing the material with the finishing roll after the inlet-side cooling operation or during the inlet-side cooling operation; and
 an outlet-side cooling operation of supplying the cooling fluid to the finishing roll and the material, on an exit side of the finishing roll, after the finishing operation or during the finishing operation.
14. The rolling method of claim 13, wherein in the inlet-side cooling operation, the cooling fluid is supplied to a plurality of cooling pipes spaced apart from each other by different distances from the finishing roll, to supply a greatest amount of cooling fluid at a farthest distance from the finishing roll and supply a smallest amount of cooling fluid at a closest distance from the finishing roll.
15. The rolling method of claim 14, wherein the inlet-side cooling operation comprises a nozzle adjusting operation of changing a position of a nozzle supplying the cooling fluid or rotating the nozzle.
16. The rolling method of claim 15, wherein the nozzle adjusting operation is performed by changing a distance from the nozzle to the finishing roll or the material or changing an angle formed by the nozzle with respect to the material.
17. The rolling method of any one of claims 14 to 16,

wherein the inlet-side cooling operation is performed to supply the cooling fluid to the material, such that a temperature of a material, including at least one of a medium carbon steel having 0.08% to 0.3% by weight of carbon, a high carbon steel having 0.3% or more by weight of carbon, and a niobium (Nb)-added steel, is within a range of 850°C to 900°C.

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FIG. 1

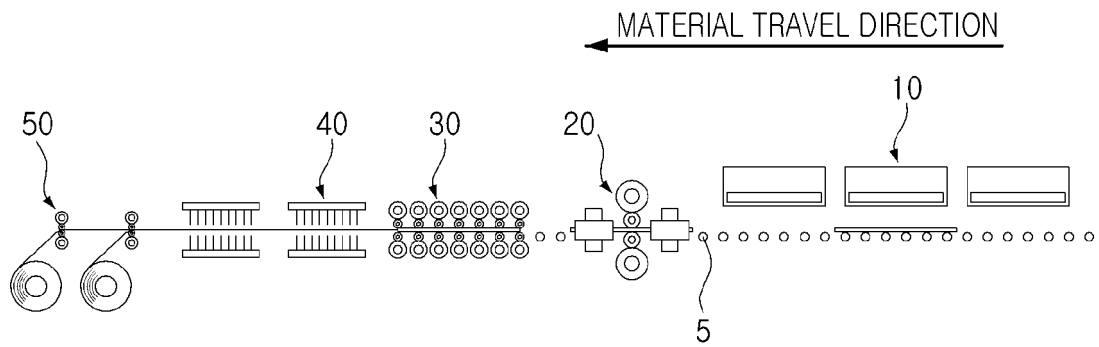


FIG. 2

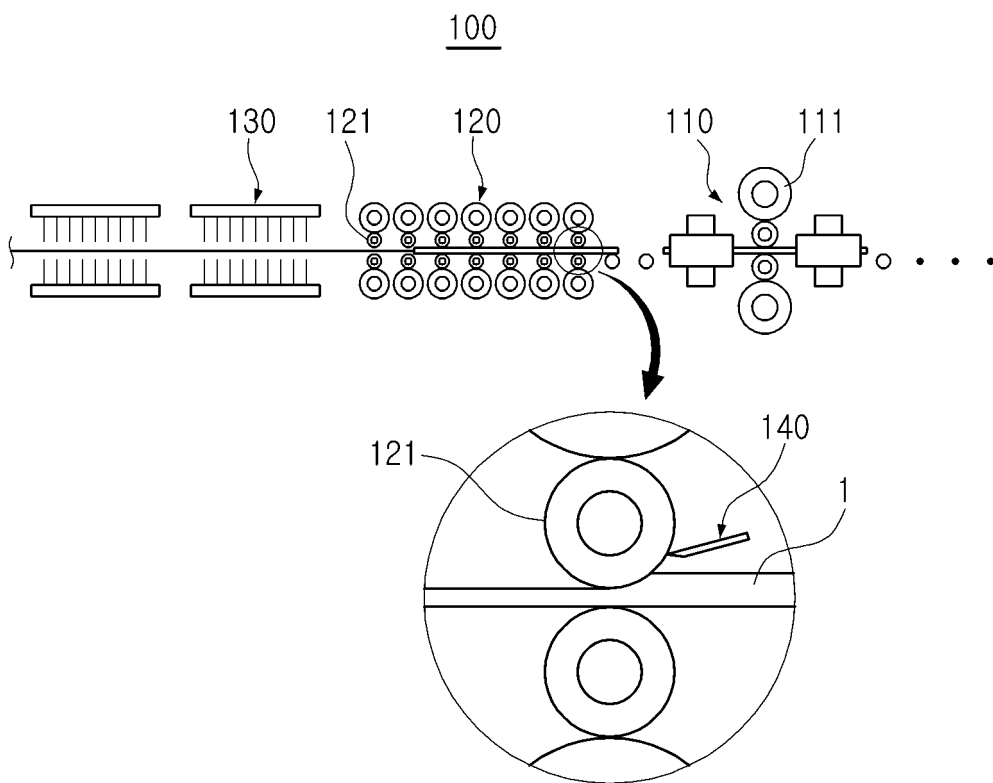


FIG. 3

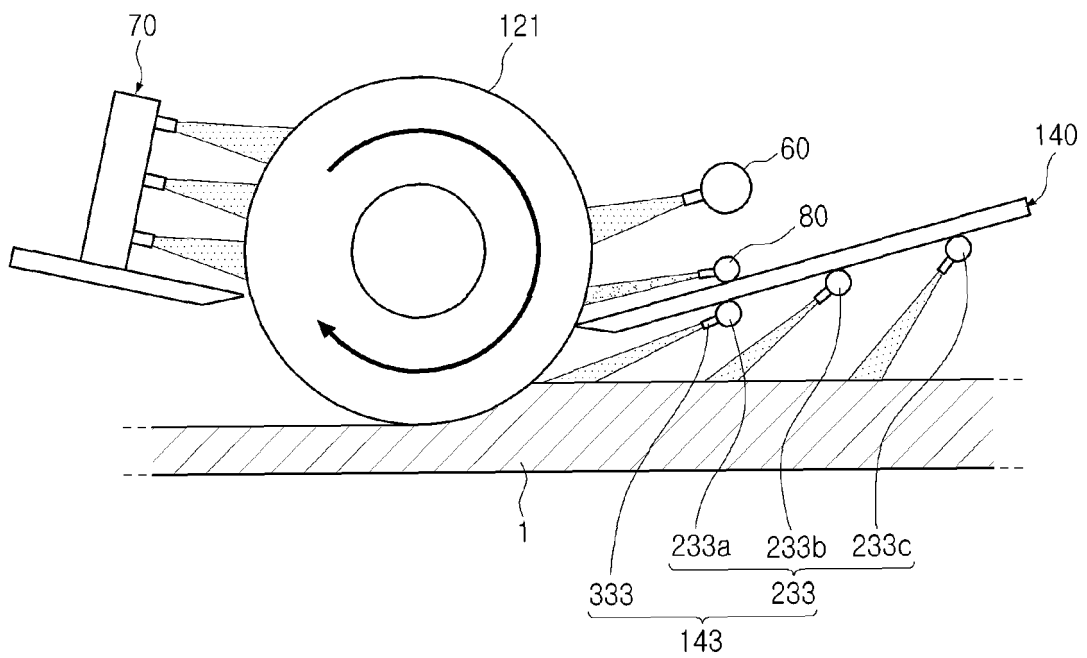
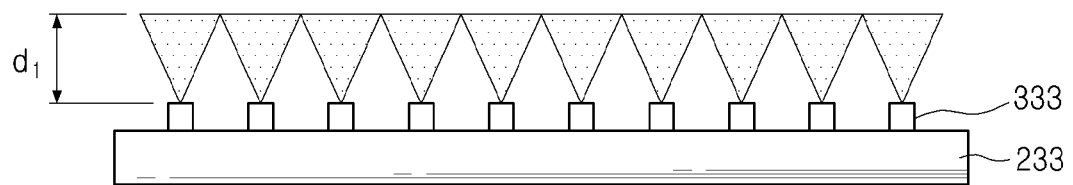


FIG. 4

(a)



(b)

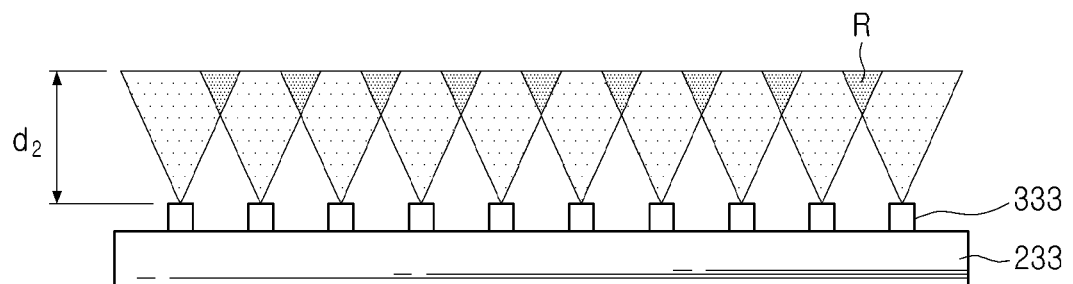


FIG. 5

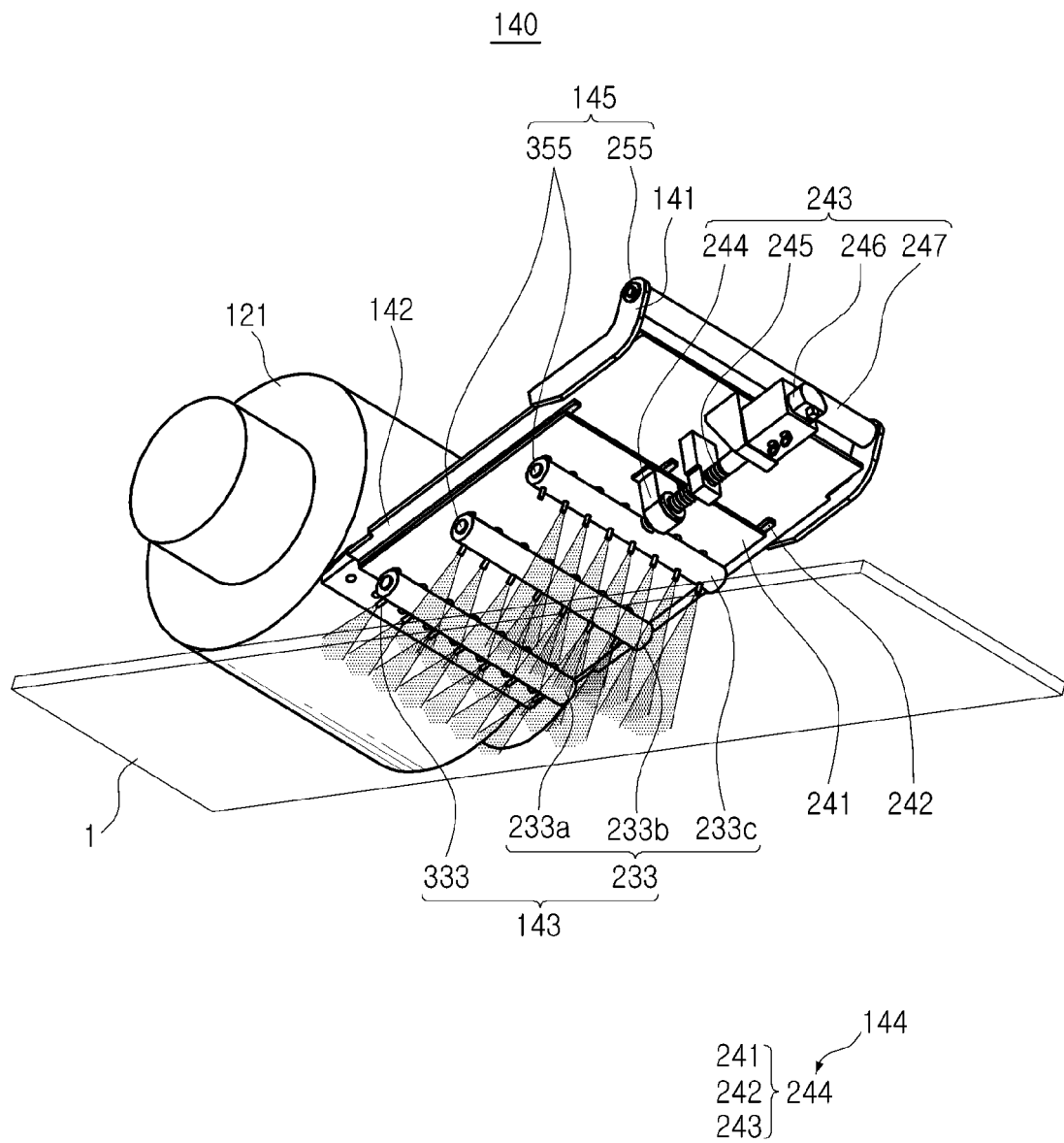


FIG. 6

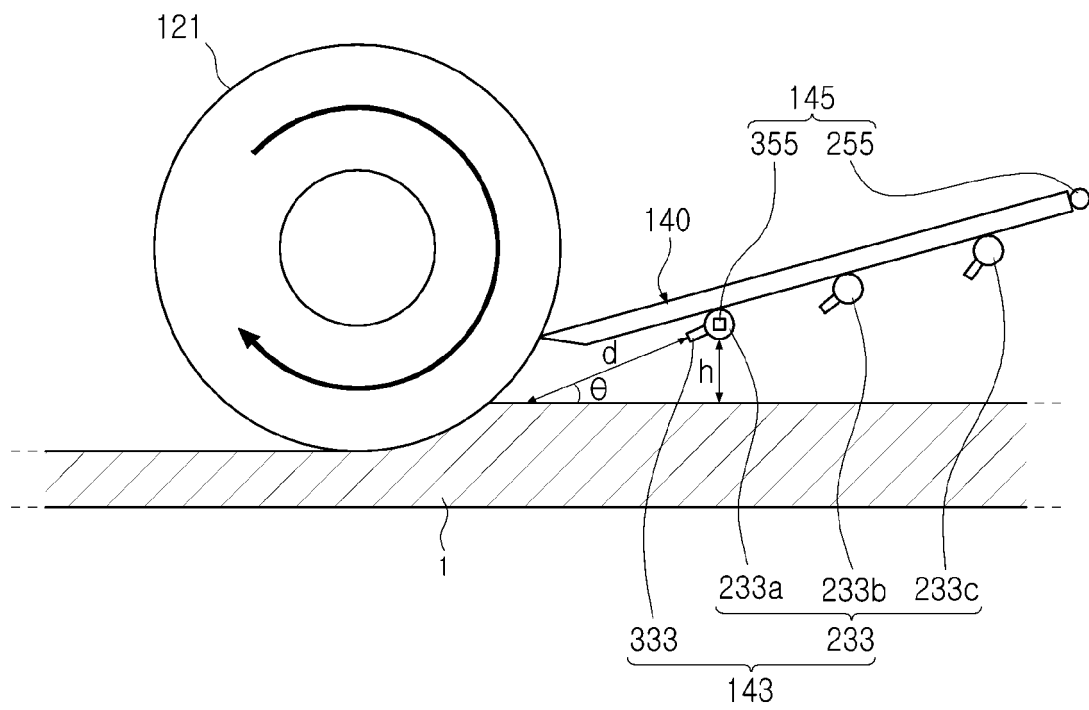


FIG. 7

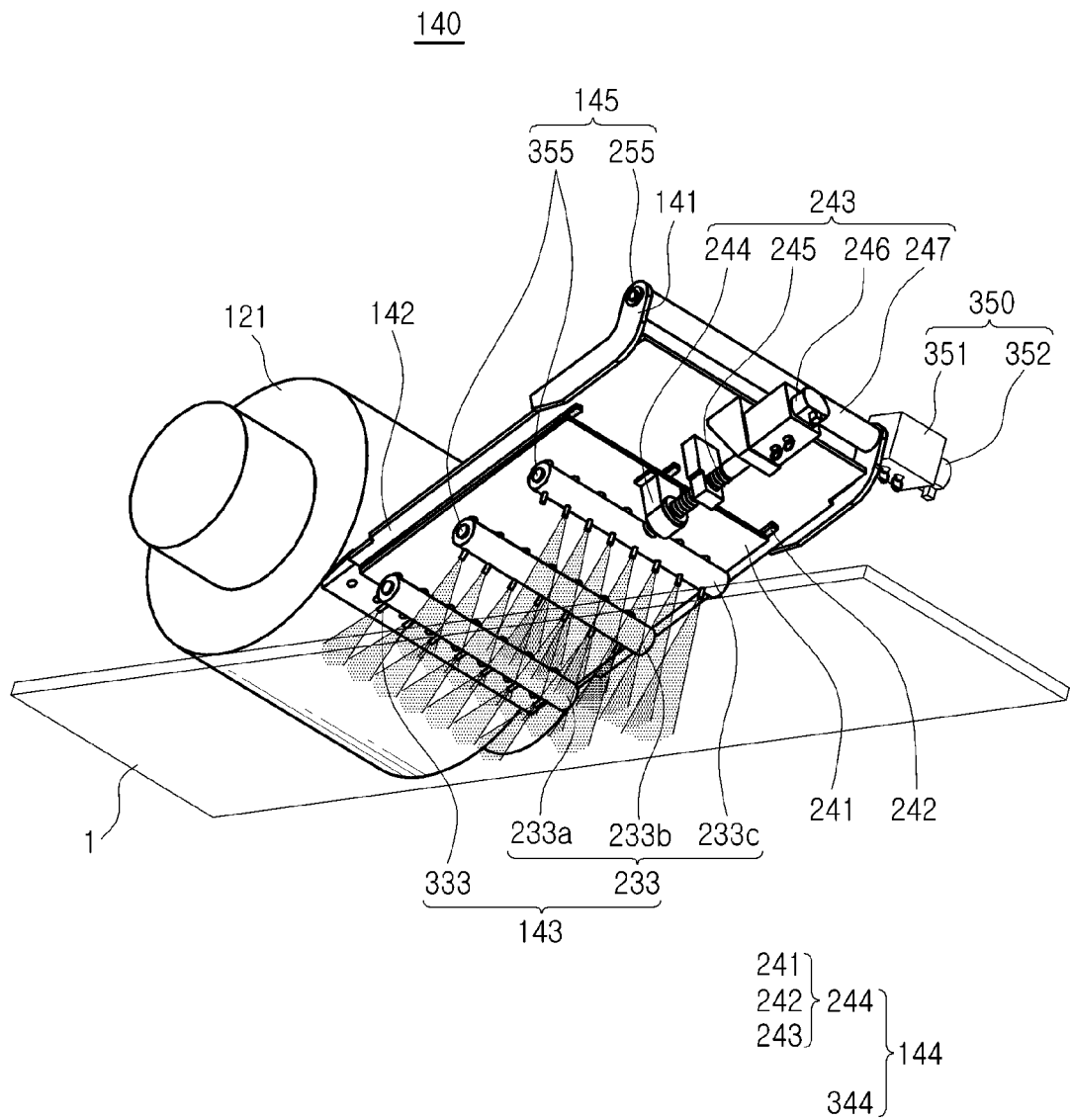


FIG. 8

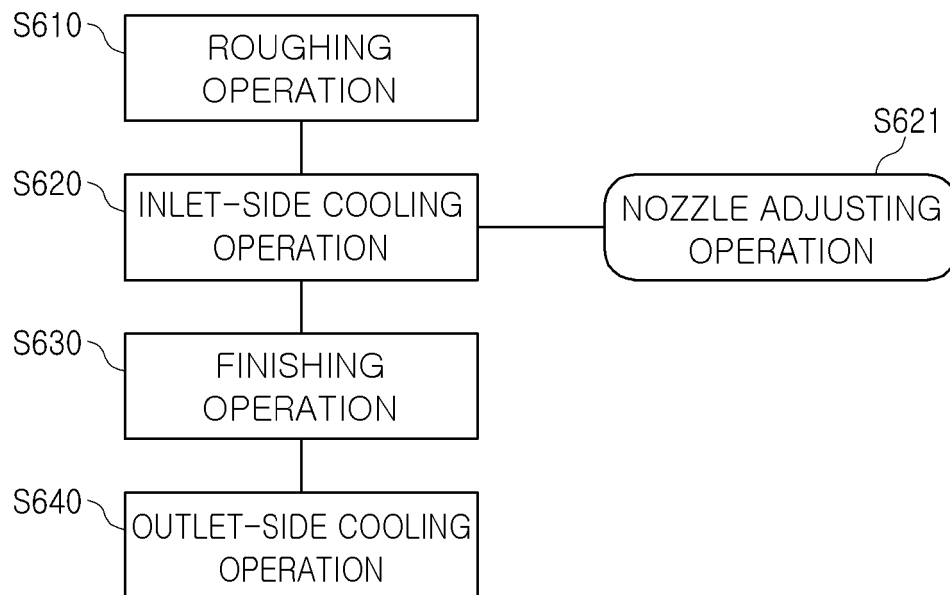
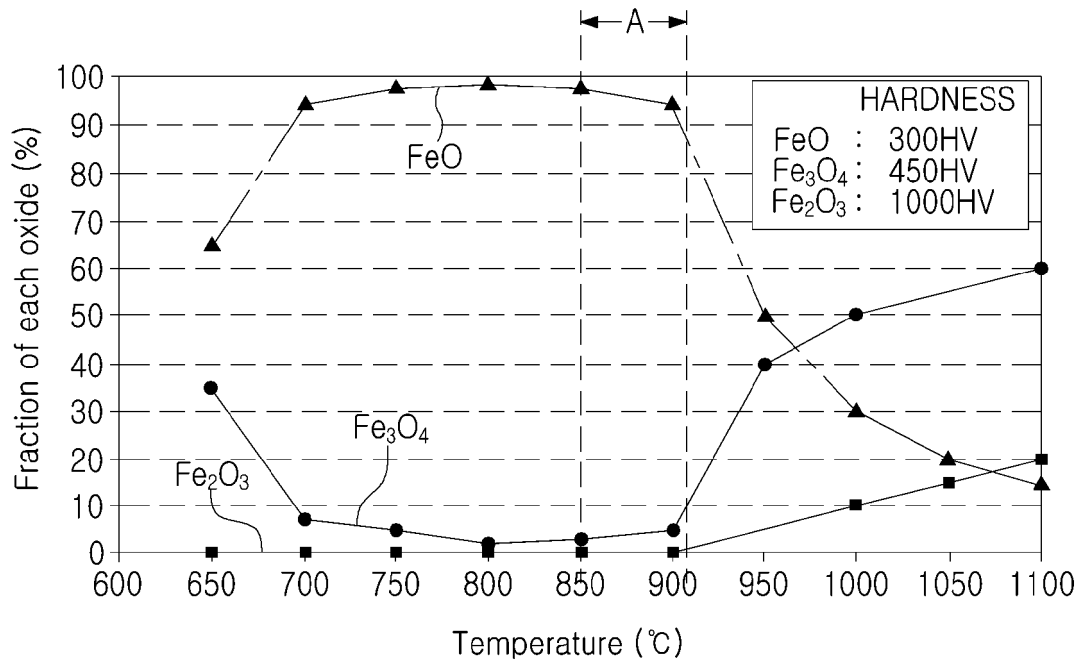


FIG. 9



INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2017/014564

A. CLASSIFICATION OF SUBJECT MATTER

B21B 28/02(2006.01); B21B 45/02(2006.01); B21B 1/24(2006.01);

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 28/02; G01K 13/04; B21B 28/04; B21B 45/02; C22C 38/00; B21B 38/00; C22C 38/04; B21B 1/26; B21B 1/24

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: roughing, finishing, cooling device, wiper device, polishing, cooling header, distance adjustment, angle adjustment

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	KR 10-2005-0068320 A (POSCO) 05 July 2005	1-8
Y	See paragraphs [0024], [0026]-[0038] and figures 1-3.	9-17
Y	KR 10-2011-0047045 A (HYUNDAI STEEL COMPANY) 06 May 2011	9-17
	See paragraphs [0002], [0030]-[0035] and claims 1, 4.	
A	KR 10-0742891 B1 (POSCO) 25 July 2007	1-17
	See paragraphs [0032]-[0037] and claim 1.	
A	JP 2004-314080 A (NIPPON STEEL CORP.) 11 November 2004	1-17
	See paragraphs [0010]-[0011] and claim 1.	
A	KR 10-2001-0059510 A (POHANG IRON & STEEL CO., LTD.) 06 July 2001	1-17
	See abstract and claims 1-3.	

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

* Special categories of cited documents:

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“O” document referring to an oral disclosure, use, exhibition or other means

“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“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

12 MARCH 2018 (12.03.2018)

Date of mailing of the international search report

13 MARCH 2018 (13.03.2018)

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
Government Complex-Daejeon, 189 Seonsa-ro, Daejeon 302-701,
Republic of Korea

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Authorized officer

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2017/014564

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