



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
11.04.2018 Bulletin 2018/15

(51) Int Cl.:
B21B 45/02 (2006.01)

(21) Application number: **16799612.3**

(86) International application number:
PCT/JP2016/054779

(22) Date of filing: **19.02.2016**

(87) International publication number:
WO 2016/189903 (01.12.2016 Gazette 2016/48)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(71) Applicant: **Primetals Technologies Japan, Ltd.**
Tokyo 108-0014 (JP)

(72) Inventor: **IKEMOTO, Yuji**
Hiroshima-shi
Hiroshima 733-8553 (JP)

(74) Representative: **Strehl Schübel-Hopf & Partner**
Maximilianstrasse 54
80538 München (DE)

(30) Priority: **26.05.2015 JP 2015106080**

(54) **COOLING DEVICE FOR HOT ROLLED STEEL PLATE AND METHOD FOR ADJUSTING MASK MEMBER POSITION THEREFOR**

(57) A cooling device for a hot rolled steel plate is configured such that: a spray header (2A) is incorporated guide rails (222A_{U,L}) provided on the inside peripheral surface of a main body unit (202A) and extending along the direction of plate width of a hot rolled steel plate (1) and masking units (203A_{L,R}) that move along the guide rails (222A_{U,L}); the masking units (203A_{L,R}) have a support body (231A) provided movably along the guide rails (222A_{U,L}) and a shielding plate (232A) supported by the support body (231A) via an elastic body (235A); the shielding plate (232A) separates from a spray plate (201A) when water pressure does not act thereon; and desired cooling water spray holes are sealed by the shielding plate (232A) being pressed by the spray plate (201A) due to compressive deformation of the elastic body (235A).

Fig. 4(a)

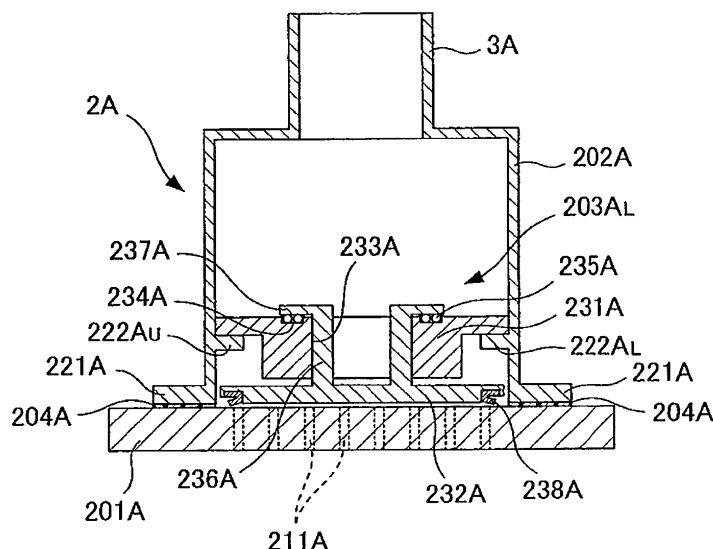


Fig. 4(b)

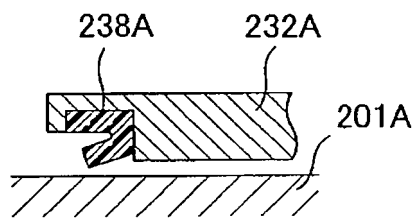
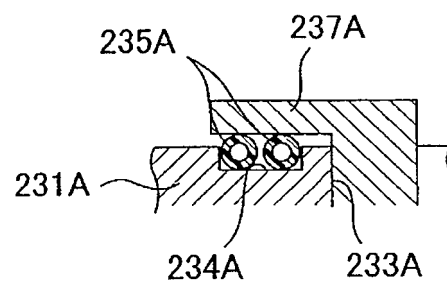


Fig. 4(c)



Description

TECHNICAL FIELD

5 **[0001]** The present invention relates to a cooling device for a hot rolled steel sheet and a method of adjusting positions of mask members in the cooling device.

BACKGROUND ART

10 **[0002]** Among conventional cooling devices which cool a high-temperature hot rolled steel sheet subjected to hot rolling or which cool a hot rolled steel sheet in a step of reheating the hot rolled steel sheet for heat treatment, there is a cooling device for cooling a hot rolled steel sheet which is provided with shield bodies between the hot rolled steel sheet and cooling nozzles attached to a header of the cooling device, to achieve uniform temperature distribution in the width direction of the hot rolled steel sheet. The shield bodies are configured to be movable in the width direction of the hot rolled steel sheet, and block cooling water supplied from the cooling nozzles toward portions near the edges of the hot rolled steel sheet (for example, see Patent Documents 1 to 3).

15 **[0003]** Moreover, there is a cooling device as follows. A header has a double structure including an outer cooling header having cooling water ejection nozzles and an inner cooling header having compressed air ejection nozzles. Mask members which move in a header longitudinal direction and which prevent compressed air from being ejected are fitted in both end portions of the inner cooling header, and the cooling device controls the width of a region in which cooling water is ejected (for example, see Patent Document 4).

PRIOR ART DOCUMENT

25 PATENT DOCUMENT

[0004]

30 Patent Document 1: Japanese Patent Application Publication No. 2009-248177
 Patent Document 2: Japanese Patent Application Publication No. 2004-351501
 Patent Document 3: Japanese Patent Application Publication No. Hei 7-150229
 Patent Document 4: Japanese Patent Application Publication No. Hei 6-246333

SUMMARY OF THE INVENTION

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PROBLEMS TO BE SOLVED BY THE INVENTION

40 **[0005]** In the cooling devices described in Patent Documents 1 to 3 listed above, the shielding bodies are provided between the hot rolled steel sheet and the cooling nozzles. Accordingly, the cooling devices require a structure which can move the shield bodies to fix the shield bodies at set positions and a structure which lets out the cooling water blocked by the shield bodies while withstanding water pressure. Hence, the cooling devices have a problem that the structures around the shield bodies increase in size and complexity. Moreover, disposing the shield bodies between the high-temperature hot rolled steel sheet and the cooling nozzles may cause thermal deformation of the shield bodies. Furthermore, when the shield bodies are installed between the hot rolled steel sheet and cooling nozzles of a lower header configured to cool a lower face of the hot rolled steel sheet, this configuration has a problem that the shield bodies have to be made strong enough to be undamaged even when the shield bodies interfere with the hot rolled steel sheet, and the size increase is inevitable.

45 **[0006]** Moreover, in the cooling device described in Patent Document 4 listed above, the material of the mask members is selected from natural rubber, silicone materials, urethane materials, or the like to maintain air tightness, and the mask members are designed to be movable simultaneously in opposite directions. Accordingly, the cooling device has a problem that, when the mask members are moved, the mask members slide in contact with the inner cooling header and thereby tend to wear and deteriorate.

50 **[0007]** In view of this, an object of the present invention is to provide a cooling device for a hot rolled steel sheet and a method of adjusting the positions of mask members in the cooling device which can make the hot rolled steel sheet have a uniform temperature distribution in a width direction, while suppressing a size increase of the device and extending the life of the mask members.

MEANS FOR SOLVING THE PROBLEMS

[0008] A cooling device for a hot rolled steel sheet in a first aspect of the invention for solving the problems described above is a cooling device for a hot rolled steel sheet in which spray headers are disposed above and below a hot rolled steel sheet moving in a conveyance direction to be opposed to each other, each of the spray headers including a spray plate having a plurality of cooling water ejection holes and a box-shaped main body covering the spray plate, the cooling device configured to cool the hot rolled steel sheet by spraying cooling water from the cooling water ejection holes to the hot rolled steel sheet, the cooling device characterized in that

the spray header internally includes a guide rail provided to an inner peripheral face of the main body and extending in a sheet width direction of the hot rolled steel sheet, and a mask member configured to move along the guide rail, the mask member includes a support body and a shield body, the support body being provided movably in the sheet width direction of the hot rolled steel sheet along the guide rail, the shield body being supported by the support body with an elastic body inserted between the shield body and the support body, the elastic body being elastically deformable in at least an up-down direction, and

when water pressure does not act on the shield body, the shield body is located away from the spray plate and, when water pressure acts on the shield body, compression and deformation of the elastic body causes the shield body to be pressed against the spray plate, and desired ones of cooling liquid ejection holes are thereby closed.

[0009] A cooling device for a hot rolled steel sheet in a second aspect of the invention is the cooling device in the first aspect characterized in that the shield body includes a shield plate formed in a plate shape and opposed to the spray plate and a flat seal formed in a substantially V shape in a cross-sectional view and fixedly attached to an outer peripheral edge of the shield plate such that an open portion of the substantially V shape faces outward.

[0010] A cooling device for a hot rolled steel sheet in a third aspect of the invention is the cooling device in the first aspect characterized in that

the shield body is a masking sheet including a metal thin sheet and an elastic body covering the thin sheet, the masking sheet configured to be capable of being coiled outside the spray header and covering all of the cooling water ejection holes directly under the mask member and in a region on an outer side of the mask member in the sheet width direction of the hot rolled steel sheet,

the masking sheet is inserted in a through hole formed in the spray header with a first seal member formed in an annular shape provided between the masking sheet and the spray header, and

when water pressure does not act on the shield body, the first seal member comes into line contact with the elastic body covering the thin sheet and, when water pressure acts on the shield body, the first seal member presses the elastic body covering the thin sheet.

[0011] A cooling device for a hot rolled steel sheet in a fourth aspect of the invention is the cooling device in any of the first to third aspects characterized in that the shield body has such a shape that a length of the shield body in the sheet width direction of the hot rolled steel sheet varies in the conveyance direction of the hot rolled steel sheet such that a water amount distribution varies with a gradient in the width direction.

[0012] A cooling device for a hot rolled steel sheet in a fifth aspect of the invention is the cooling device in any of the first to fourth aspects characterized in that the cooling device comprises first moving means for moving the mask member in the sheet width direction of the hot rolled steel sheet, the first moving means having a drive source outside the spray header.

[0013] A cooling device for a hot rolled steel sheet in a sixth aspect of the invention is the cooling device in the fifth aspect characterized in that

the first moving means includes a drive roller and a non-drive roller which are installed outside the spray header, respectively on both sides of the spray header in the sheet width direction of the hot rolled steel sheet, and wires which are wound around the drive roller and the non-drive roller and which have both ends fixed to the mask member, the wires are each covered with an elastic body and inserted in a through hole formed in the spray header with a second sealing member formed in an annular shape provided between the wire and the spray header, and

when water pressure does not act on the shield body, the second seal member comes into line contact with the elastic body covering the wire and, when water pressure acts on the shield body, the second seal member presses the elastic body covering the wire and comes into tight contact with the elastic body.

[0014] A cooling device for a hot rolled steel sheet in a seventh aspect of the invention is the cooling device in the sixth aspect characterized in that

the spray header internally includes a plurality of the mask members arranged symmetrically on both sides of a center portion of the hot rolled steel sheet in the sheet width direction, and

the first moving means moves the opposing mask members on both sides of the center portion of the hot rolled steel sheet in the sheet width direction, toward and away from each other in an interlocked manner.

[0015] A cooling device for a hot rolled steel sheet in an eighth aspect of the invention is the cooling device in the sixth or seventh aspect characterized in that the second seal member is made of a high-stiffness material, applies a certain

amount of pressing force to the elastic body covering the wire and comes into tight contact with the elastic body irrespective of action of the water pressure, and is selected depending on the water pressure to be used.

[0016] A cooling device for a hot rolled steel sheet in a ninth aspect of the invention is the cooling device in the seventh or eighth aspect characterized in that the cooling device further comprises:

5 stoppers configured to restrict movement of the mask members in the sheet width direction of the hot rolled steel sheet;
contact detecting means for detecting contact of the mask members with the stoppers;
load measuring means for measuring load acting on the wire wound around the non-drive roller; and
10 second moving means for moving the non-drive roller in the sheet width direction of the hot rolled steel sheet.

[0017] A method of adjusting positions of mask members in a cooling device for a hot rolled steel sheet in a tenth aspect of the invention is a method adjusting the positions of the mask members in the cooling device in the ninth aspect, characterized in that the method comprises:

15 rotating the drive roller to move the opposing mask members on both sides of the center portion of the hot rolled steel sheet in the sheet width direction, in directions away from each other,
upon detecting the contact of at least one of the mask members with the corresponding stopper by using the contact detecting means, moving the non-drive roller in the sheet width direction of the hot rolled steel sheet by using the
20 second moving means until a measurement value of the load measuring means reaches a preset value.

EFFECT OF THE INVENTION

[0018] The cooling device for a hot rolled steel sheet in the present invention described above can make the hot rolled steel sheet have a uniform temperature distribution in the width direction, while suppressing a size increase of the device
25 and extending the life of the mask members. Moreover, the method of adjusting the positions of the mask members in the cooling device for a hot rolled steel sheet in the present invention can adjust the positions of the mask members at high accuracy even when the mask members are internally included in the spray header.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

[Fig. 1] Fig. 1 includes perspective views of a cooling device for a hot rolled steel sheet in Embodiment 1 of the present invention, part (a) illustrates an example in which masking units are located away from each other, and part
35 (b) illustrates an example in which the masking units are located close to each other.

[Fig. 2] Part (a) is a cross-sectional view taken along the line II-II and viewed in the direction of arrows in Fig. 1, part (b) is a detailed view of a portion B in part (a), part (c) is a view in the direction of the arrows C-C in part (a).

[Fig. 3] Fig. 3 is a cross-sectional view taken along the line III-III and viewed in the direction of arrows in Fig. 1.

[Fig. 4] Part (a) is a cross-sectional view in a non-spraying state taken along the line IV-IV and viewed in the direction
40 of arrows in Fig. 1, part (b) is a partially enlarged view of part (a), and part (c) is another partially enlarged view of part (a).

[Fig. 5] Part (a) is a cross-sectional view in a spraying state taken along the line IV-IV and viewed in the direction of arrows in Fig. 1, part (b) is a partially enlarged view of part (a), and part (c) is another partially enlarged view of
45 part (a).

[Fig. 6] Part (a) is an enlarge view of a portion VI in Fig. 2, part (b) is a side view illustrating one portion of part (a) .

[Fig. 7] Part (a) is an enlarged cross-sectional view of a wire seal in the non-spraying state, and part (b) is an enlarged cross-sectional view of the wire seal in the spraying state.

[Fig. 8] Fig. 8 is a schematic view for explaining zero point adjustment of the masking units.

[Fig. 9] Fig. 9 is a schematic view illustrating an example in which only one masking unit is in contact with a positioning
50 stopper.

[Fig. 10] Fig. 10 is a schematic view illustrating an example in which only the other masking unit is in contact with a positioning stopper.

[Fig. 11] Fig. 11 is a schematic view illustrating an example in which both masking units are in contact with the positioning stoppers.

[Fig. 12] Fig. 12 is a schematic view illustrating an example in which the zero point adjustment of the masking units
55 is completed.

[Fig. 13] Fig. 13 is another detailed view of the portion B in part (a) of Fig. 2.

[Fig. 14] Part (a) is an explanatory view illustrating an internal structure of a cooling device for a hot rolled steel

sheet in Embodiment 2 of the present invention, and part (b) is an explanatory view illustrating variation in flow rate of cooling water in a sheet width direction.

[Fig. 15] Part (a) is an explanatory view illustrating an inside of a header structure including a masking sheet which blocks spray in a sheet outer portion of a cooling device for a hot rolled steel sheet in Embodiment 3 of the present invention, part (b) is a partially enlarged view of part (a), and part (c) is a side view illustrating one portion of part (b).

[Fig. 16] Part (a) is an explanatory view illustrating an inside of a header structure including another masking unit in the cooling device for the hot rolled steel sheet in Embodiment 3 of the present invention, part (b) is a partially enlarged view of part (a), and part (c) is a side view illustrating one portion of part (b).

MODE FOR CARRYING OUT THE INVENTION

[0020] A cooling device for a hot rolled steel sheet and a method of adjusting the positions of mask members in the cooling device in the present invention are described below with reference to the drawings.

EMBODIMENT 1

[0021] A cooling device for a hot rolled steel sheet and a method of adjusting the positions of mask members in the cooling device in Embodiment 1 of the present invention are described in detail based on Figs. 1 to 13.

[0022] As illustrated in Fig. 1, the cooling device for the hot rolled steel sheet in the embodiment is equipment which cools the high-temperature hot rolled steel sheet 1 by spraying water from upper and lower spray headers 2A, 2B while continuously conveying the hot rolled steel sheet 1 in a horizontal direction (hereafter, referred to as steel sheet conveyance direction X) indicated by the arrow X in Fig. 1, the upper and lower spray headers 2A, 2B arranged above and below the hot rolled steel sheet 1 to be opposed to each other. Since the upper and lower spray headers 2A, 2B (hereafter, collectively referred to as spray headers 2) have structures which are substantially top-bottom symmetric, description is given below by using the upper spray header 2A as an example.

[0023] As illustrated in Figs. 1 to 3, the upper spray header 2A includes: a plate-shaped spray plate 201A which is disposed such that the width direction and the longitudinal direction thereof are aligned respectively with the steel sheet conveyance direction X and the width direction (hereafter, referred to as steel sheet width direction Y) of the hot rolled steel sheet 1 indicated by the arrow Y in Fig. 1; a substantially-box-shaped spray header main body 202A which covers the spray plate 201A; and two masking units 203A_L, 203A_R which are disposed in a hollow portion formed by the spray plate 201A and the spray header main body 202A and which are disposed to be movable toward and away from each other in the steel sheet width direction Y (hereafter, the masking unit 203A_L located on the left side in a view from the upstream side in the steel sheet conveyance direction X is referred to as "left masking unit 203A_L" while the masking unit 203A_R located on the right side in the view from the upstream side in the steel sheet conveyance direction X is referred to as "right masking unit 203A_R" and the masking units are collectively referred to as "masking units 203A_{L,R}").

[0024] In the spray plate 201A, many cooling water ejection holes 211A (see part (a) of Fig. 2) communicating the inside and the outside of the spray header 2A are arranged at a predetermined pitch over a desired range in the steel sheet conveyance direction X and over a range corresponding to the maximum sheet width of the hot rolled steel sheet 1 in the steel sheet width direction Y. In other words, the cooling device for the hot rolled steel sheet in the embodiment has multi-hole nozzles.

[0025] Moreover, in the spray header main body 202A, a flange 221A is formed in correspondence with an outer periphery of the spray plate 201A and is tightly fixed to the spray plate 201A with an elastic body 204A such as a rubber packing in between. In other words, the spray plate 201A and the spray header main body 202A have a disassemblable structure.

[0026] Furthermore, a cooling water supply pipe 3A is connected to a center portion of a face of the spray header main body 202A opposed to the spray plate 201A. Cooling water is supplied at high pressure from a not-illustrated cooling water supply source to the spray header main body 202A via the cooling water supply pipe 3A.

[0027] As illustrated in Figs. 2 and 3, inside the spray header main body 202A, guide rails 222A_U, 222A_L extending in the steel sheet width direction Y are provided respectively on upstream and downstream faces of the spray header main body 202A in the steel sheet conveyance direction X (hereafter, the guide rail 222A_U located on the upstream side in the steel sheet conveyance direction X is referred to as "upstream guide rail 222A_U" while the guide rail 222A_L located on the downstream side in the steel sheet conveyance direction X is referred to as "downstream guide rail 222A_L" and the guide rails are collectively referred to as "guide rails 222A_{U,L}").

[0028] The masking units 203A_{L,R} are disposed in the hollow portion formed by the spray plate 201A and the spray header main body 202A with the longitudinal direction thereof aligned in the steel sheet conveyance direction X. Specifically, the masking units 203A_{L,R} are each formed to be opposed to the cooling water ejection holes 211 of the spray plate 201 over a predetermined length in the steel sheet width direction Y and over the entire area in the steel sheet conveyance direction X.

[0029] Upstream and downstream portions of each of the masking units 203A_{L,R} in the steel sheet conveyance direction X are supported respectively on the upstream guide rail 222A_U and the downstream guide rail 222A_L, and the masking units 203A_{L,R} are configured to be movable in the steel sheet width direction Y along the guide rails 222A_{U,L}. Moreover, the shape of the spray plate 201A on the spray header main body 202A side is a flat surface with no protrusions interfering with the masking units 203A_{L,R}.

[0030] A positioning stopper 225A_L is attached to the upstream guide rail 222A_U on the side close to a support roller 206A to be described later, and a positioning stopper 225A_R is attached to the downstream guide rail 222A_L on the side close to a drive roller 207A to be described later (hereafter, the positioning stopper 225A_L located on the left side in the view from the upstream side in the steel sheet conveyance direction X is referred to as "left positioning stopper 225A_L" while the positioning stopper 225A_R located on the right side in the view from the upstream side in the steel sheet conveyance direction X is referred to as "right positioning stopper 225A_R" and the stoppers are collectively referred to as "positioning stoppers 225A_{L,R}").

[0031] The positioning stoppers 225A_{L,R} are provided for zero point adjustment of the masking units 203A_{L,R} to be described in detail later and are positioned such that the distance from the center in the steel sheet width direction Y to the left masking unit 203A_L is equal to the distance from the center in the steel sheet width direction Y to the right masking unit 203A_R when the masking units 203A_{L,R} come into contact respectively with the positioning stoppers 225A_{L,R}.

[0032] The movement of the aforementioned masking units 203A_{L,R} in the steel sheet width direction Y is achieved by the support roller 206A and the drive roller 207A which are disposed outside the upper spray header 2A respectively on both sides of the upper spray header 2A in the steel sheet width direction Y and by a wire 205A_L and a wire 205A_R which are wound respectively around the support roller 206A and the drive roller 207A (hereafter, the wire 205A_L wound around the support roller 206A is referred to as "left wire 205A_L" while the wire 205A_R wound around the drive roller 207A is referred to as "right wire 205A_R" and the wires are collectively referred to as "wires 205A_{L,R}").

[0033] One end of the left wire 205A_L penetrates the spray header main body 202A to be fixed to a face of the left masking unit 203A_L on the support roller 206A side, while the other end of the left wire 205A_L penetrates the spray header main body 202A and the left masking unit 203A_L to be fixed to a face of the right masking unit 203A_R on the support roller 206A side.

[0034] One end of the right wire 205A_R penetrates the spray header main body 202A to be fixed to a face of the right masking unit 203A_R on the drive roller 207A side at a position opposed to the other end of left wire 205A_L, while the other end of the right wire 205A_R penetrates the spray header main body 202A and the right masking unit 203A_R to be fixed to a face of the left masking unit 203A_L on the drive roller 207A side at a position opposed to the one end of left wire 205A_L. Note that the right wire 205A_R is wound around a half or more of the drive roller 207A to prevent slipping on the drive roller 207A.

[0035] The masking units 203A_{L,R} can thereby move toward and away from each other along the guide rails 222A_{U,L} with the rotation of the drive roller 207A. In the embodiment, the masking units 203A_{L,R} are moved away from each other when the drive roller 207A is rotated clockwise, and the masking units 203A_{L,R} are moved toward each other when the support roller 206A is rotated counterclockwise.

[0036] Note that, as illustrated in part (b) of Fig. 2, the support roller 206A is supported on a fixed base 261A via a slide base 262A and a roller holder 263A such that the axial direction of the support roller 206A is parallel to the vertical direction.

[0037] The fixed base 261A is fixed to a structure such as a not-illustrated frame supporting the upper spray header 2A. Two bearing boxes 265A, 265A including bearings 264A, 264A are provided on the fixed base 261A at an interval in the steel sheet width direction Y. A screw shaft 266A is turnably supported on the bearings 264A, 264A.

[0038] The slide base 262A is a recess-shaped member having a recess portion 262Aa and protruding portions 262Ab, 262Ac located on both sides of the recess portion 262Aa in the steel sheet width direction Y, and is mounted on the fixed base 261A between the two bearing boxes 265A, 265A.

[0039] The screw shaft 266A penetrates the protruding portions 262Ab, 262Ac. Specifically, a screw hole 262Ad is formed in one (left in part (b) of Fig. 2) protruding portion 262Ab, and the screw shaft 266A is screwed to the screw hole 262Ad. Moreover, a through hole 262Ae is formed in the other (right in part (b) of Fig. 2) protruding portion 262Ac, and the screw shaft 266A is inserted in the through hole 262Ae.

[0040] The roller holder 263A integrally includes support portions 263Aa, 263Ab which support axial ends of the support roller 206A and a projection portion 263Ac which projects downward from the support portion 263Ab. In the roller holder 263A, the support portion 263Ab is supported on the protruding portions 262Ab, 262Ac of the slide base 262A with the projection portion 263Ac inserted in the recess portion 262Aa of the slide base 262A. A gap is provided between a lower face of the projection portion 263Ac and a bottom face of the recess portion 262Aa of the slide base 262A. Moreover, a through hole 263Ad is formed in the projection portion 263Ac and the screw shaft 266A is inserted in the through hole 263Ad.

[0041] Furthermore, a load cell 267A is disposed between the projection portion 263Ac and the other protruding portion 262Ac. The load cell 267A measures the pressure between the projection portion 263Ac and the protruding portion 262Ac.

[0042] Specifically, in the embodiment, rotating the screw shaft 266A causes the slide base 262A to move in the steel sheet width direction Y by the operation of the screw hole 262Ad screwed to the screw shaft 266A and, with this movement, the support roller 206A is moved integrally with the slide base 262A in the steel sheet width direction Y via the roller holder 263A.

[0043] Meanwhile, as illustrated in part (a) of Fig. 2, the drive roller 207A is supported on a roller holder 271A. A motor 208A for turning the drive roller 207A is connected to one axial end of the drive roller 207A.

[0044] Note that the roller holder 271A is fixed to a structure such as the not-illustrated frame supporting the upper spray header 2A, and is set to a state where the axial direction is slightly tilted with respect to the vertical direction (tilt angle θ) as illustrated in part (c) of Fig. 2. The tilt angle θ is set such that the states of upstream and downstream portions of the right wire 205A_R in the steel sheet conveyance direction X are the same when the right wire 205A_R is wound around half or more of the drive roller 207A (the upstream and downstream portions of the right wire 205A_R in the steel sheet conveyance direction X are arranged to be horizontal).

[0045] Note that a member 209A illustrated in Fig. 3 is a tension applying roll provided to be movable between a position where the member 209A presses the right wire 205A_R and a position where the member 209A is located away from the right wire 205A_R.

[0046] Next, the masking units 203A_{L,R} of the upper spray header 2A are described in detail based on Figs. 4 and 5. As illustrated in part (a) of Fig. 4 and part (a) of Fig. 5, the left masking unit 203A_L includes a holder 231A provided to be slidable in the steel sheet width direction Y along the guide rails 222A_{U,L} and a shield plate 232A disposed between the holder 231A and the spray plate 201A and supported by the holder 231A.

[0047] A through hole 233A penetrating the holder 231A in an up-down direction is formed in a center portion of the holder 231A in the steel sheet conveyance direction X. Moreover, recess grooves 234A having a depth of d and extending in the steel sheet width direction Y are formed on an upper face of the holder 231A, upstream and downstream of the through hole 233A in the steel sheet conveyance direction X, respectively. Elastic bodies 235A having a height of D (D>d) and extending in the steel sheet width direction Y are mounted in the recess grooves 234A. The elastic bodies 235A can elastically deform at least in the up-down direction. For example, cylindrical objects with an axis extending in the steel sheet width direction Y, springs, or the like are used as the elastic bodies 235A.

[0048] Moreover, the shield plate 232A is opposed to the cooling water ejection holes 211 over the predetermined length in the steel sheet width direction Y and over the entire area in the steel sheet conveyance direction X. The shield plate 232A is connected to a contact portion 237A via a connection portion 236A inserted in the through hole 233A, the contact portion 237A being in contact with upper portions of the elastic bodies 235A.

[0049] An annular (see Fig. 3) flat seal 238A is disposed along an outer peripheral edge of a face of the shield plate 232A opposed to the spray plate 201A. The flat seal 238A is formed in a substantially V-shape (to be more specific, a folded back shape) in a cross-sectional view, and is attached to the shield plate 232A such that an open portion of the substantially V-shape faces the outside of the shield plate 232A. An upper portion of the flat seal 238A is fixed to the shield plate 232A while a lower portion of the flat seal 238A is a free end.

[0050] Specifically, the left masking unit 203A_L is configured as follows: in a non-spraying state (state where water pressure does not act on the left masking unit 203A_L) as illustrated in Fig. 4, the shield plate 232A is pushed upward by the elastic force of the elastic bodies 235A via the contact portion 237A and the connection portion 236A, and the shield plate 232A and the flat seal 238A are separated from the spray plate 201A; meanwhile, in a spraying state (state where the water pressure acts on the left masking unit 203A_L) as illustrated in Fig. 5, the shield plate 232A is pushed down by the water pressure and the elastic bodies 235A are compressed and deformed. The free end of the flat seal 238A thus comes into contact with the spray plate 201A and is pushed against the spray plate 201A by the water pressure, and the flat seal 238A thus blocks supply of the cooling water to the cooling water ejection holes 211A within a range surrounded by the flat seal 238A. This is the same for right masking unit 203A_R.

[0051] Next, a sealing structure for the wires 205A_{L,R} is described based on Figs. 6 and 7. As illustrated in Fig. 6, the right wire 205A_R is covered with a cover seal 281A made of an elastic material (for example, NBR) and is slidably inserted in a through hole 223A formed in the spray header main body 202A.

[0052] The through hole 223A is formed such that the diameter thereof on the inner side in the steel sheet width direction Y is larger than the diameter thereof on the outer side. A cylindrical wire seal 282A made of a high strength material examples of which including Teflon (registered trademark), a metal such as stainless steel, and the like is fitted into this large diameter portion. The wire seal 282A is fixed by using an annular cover plate 283A covering an outer peripheral portion of a face of the wire seal 282A on the inner side in the steel sheet width direction Y. The cover plate 283A is fixed to the spray header main body 202A by using fixation bolts 209A.

[0053] As illustrated in part (a) of Fig. 7, the wire seal 282A is formed such that the inner diameter of the wire seal 282A on the inner side in the steel sheet width direction Y is substantially the same as the outer diameter of the cover seal 281A and a face of the wire seal 282A opposed to the cover seal 281A has an arch shape in a cross-sectional view. Furthermore, the wire seal 282A has a tapered portion whose inner diameter increases toward the outer side in the steel sheet width direction Y. Accordingly, in the non-spraying state illustrated in part (a) of Fig. 7, the cover seal 281A and

the wire seal 282A are in line contact (point contact in the cross-sectional view) with each other. Meanwhile, in the spraying state illustrated in part (b) of Fig. 7, the tapered portion of the wire seal 282A deforms outward in the steel sheet width direction Y due to the water pressure and an interference with the cover seal 281A is increased.

[0054] Specifically, in the non-spraying state illustrated in part (a) of Fig. 7, friction between the wire seal 282A and the cover seal 281A in the moving of the masking unit 203A_{L,R} can be suppressed to the minimum. Meanwhile, in the spraying state illustrated in part (b) of Fig. 7, the wire seal 282A can secure interference with the cover seal 281A and suppress leakage of the cooling water from the through hole 223A. Moreover, the wire seal 282A is assumed to apply a certain amount of pressing force to the cover seal 281A covering the right wire 205A_R, irrespective of the action of the water pressure and come into tight contact with the cover seal 281A. Furthermore, the material and shape (thickness and the like) of the wire seal 282A are selected depending on the water pressure to be used. The above is the same for the left wire 205A_L.

[0055] Note that, in the cooling device for the hot rolled steel sheet in the embodiment described above, mask members are formed of the masking units 203A_{L,R}, guide rails are formed of the guide rails 222A_{U,L}, a support body is formed of the holder 231A, a shield body is formed of the shield plate 232A and the flat seal 238A, a drive source is formed the motor 208A, a driven roller is formed of the support roller 206A, first moving means is formed of the support roller 206A, the drive roller 207A, the wires 205A_{L,R}, and the cover seal 281A, a second seal member is formed of the wire seal 282A, a load measuring means is formed of the load cell 267A, and second moving means is formed of the slide base 262A and the screw shaft 266A.

[0056] The method of adjusting the positions of the mask members in the cooling device for the hot rolled steel sheet in the embodiment is described below.

[0057] In the cooling device for the hot rolled steel sheet in the embodiment, after the spray header 2 is disassembled for maintenance or the like and assembled again, the position adjustment of the masking units 203A_{L,R} (hereafter, referred to as "zero point adjustment") is performed. Since the masking units 203A_{L,R} are internally included in the upper spray header 2A in the embodiment, the zero point adjustment cannot be performed visually. Accordingly, the zero point adjustment is performed in the following method. Specifically:

[0058]

(1) First, as illustrated in Fig. 8, the tension applying roll 209A is moved away from the wire 205A_R. The tension T_{RU} on the right wire 205A_R thereby becomes zero ($T_{RU}=0$) between the drive roller 207A and the left masking unit 203A_L (between the point Pa and the point Pb in Fig. 8).

[0059] After the tension applying roll 209A is moved away from the right wire 205A_R, the drive roller 207A is rotated by the motor 208A such that the masking units 203A_{L,R} are moved away from each other.

[0060] In this case, the motor 208A is assumed to rotate the drive roller 207A at a certain low torque $2T_0$. When the left masking unit 203A_L comes into contact with the left positioning stopper 225A_L or the right masking unit 203A_R comes into contact with the right positioning stopper 225A_R and a certain tension ($2T_0$ in this case) is applied to the right wire 205A_R, the drive roller 207A stops without rotating further. In the embodiment, this stop is utilized and, when the stop of the rotation of the drive roller 207A is detected by using a torque current or the like of the motor 208A, it is determined that the left masking unit 203A_L is in contact with the left positioning stopper 225A_L or the right masking unit 203A_R is in contact with the right positioning stopper 225A_R.

[0061]

(2) When the rotation stop of the drive roller 207A is detected, which one of the masking units 203A_{L,R} is in contact with a corresponding one of the positioning stoppers 225A_{L,R} is determined based on a measurement value T_L obtained by the load cell 267A.

[0062] Specifically, when the measurement value T_L obtained by the load cell 267A is smaller than $2T_0$ ($T_L < 2T_0$), it is determined that no load is acting on the left wire 205A_L and that, as illustrated in Fig. 9, the distance from the center in the steel sheet width direction Y to the right masking unit 203A_R is longer than the distance from the center in the steel sheet width direction Y to the left masking unit 203A_L, and the right masking unit 203A_R comes into contact with the right positioning stopper 225A_R before the left masking unit 203A_L comes into contact with the left positioning stopper 225A_L. The method then proceeds to processing (3) to be described later.

[0063] In the situation where the right masking unit 203A_R first comes into contact with the right positioning stopper 225A_R and the rotation of the drive roller 207A is stopped, the tension T_{RL} on the right wire 205A_R between the drive roller 207A and the right masking unit 203A_R (between the point Pa and the point Pf in Fig. 9) is $2T_0$ ($T_{RL}=2T_0$). Moreover, the tension T_{RU} on the right wire 205A_R between the drive roller 207A and the left masking unit 203A_L, the tension T_{LU} on the left wire 205A_L between the support roller 206A and the left masking unit 203A_L (between the point Pd and the point Pc in Fig. 9), and the tension T_{LL} on the left wire 205A_L between the support roller 206A and the right masking unit

203A_R (between the point Pd and the point Pe in Fig. 9) are all zero ($T_{RU}=0$, $T_{LU}=0$, $T_{LL}=0$).

[0064] Meanwhile, when the measurement value T_L obtained by the load cell 267A is greater than $2T_0$ ($T_L > 2T_0$), it is determined that load acting on the left wire 205A_L is the same value as the torque of the drive roller 207A and that, as illustrated in Fig. 10, the distance from the center in the steel sheet width direction Y to the left masking unit 203A_L is longer than the distance from the center in the steel sheet width direction Y to the right masking unit 203A_R, and the left masking unit 203A_L comes into contact with the left positioning stopper 225A_L before the right masking unit 203A_R comes into contact with the right positioning stopper 225A_R. The method then proceeds to processing (3') to be described later.

[0065] In the situation where the left masking unit 203A_L first comes into contact with the left positioning stopper 225A_L and the rotation of the drive roller 207A is stopped, the tension T_{RL} on the right wire 205A_R between the drive roller 207A and the right masking unit 203A_R (between the point Pa and the point Pf in Fig. 10) is $2T_0$ ($T_{RL}=0$). Moreover, the tension T_{RU} on the right wire 205A_R between the drive roller 207A and the left masking unit 203A_L remains to be zero ($T_{RU}=0$), the tension T_{LU} on the left wire 205A_L between the support roller 206A and the left masking unit 203A_L (between the point Pd and the point Pc in Fig. 10) is $2T_0$, and the tension T_{LL} on the left wire 205A_L between the support roller 206A and the right masking unit 203A_R (between the point Pd and the point Pe in Fig. 10) is $2T_0$ ($T_{LU}=2T_0$, $T_{LL}=2T_0$). Furthermore, the measurement value T_L obtained by the load cell 267A is $4T_0$ ($T_L=4T_0$).

[0066] Note that, when the measurement value T_L obtained by the load cell 267A is $2T_0$ ($T_L=2T_0$) in the aforementioned processing (2), the masking units 203A_{L,R} can be determined to be in contact with the positioning stoppers 225A_{L,R}, respectively.

[0067]

(3) When it is determined that the right masking unit 203A_R is in contact with the right positioning stopper 225A_R in the processing (2) described above, the screw shaft 266A is rotated and the support roller 206A is thus moved via the slide base 262A and the roller holder 263A in a direction away from the spray header 2 to move the left masking unit 203A_L to such a position that the left masking unit 203A_L comes into contact with the left positioning stopper 225A_L (see Fig. 9). The left masking unit 203A_L is thereby moved in the direction away from the right masking unit 203A_R.

[0068] Thereafter, the support roller 206A is moved until the left masking unit 203A_L comes into contact with the left positioning stopper 225A_L as illustrated in Fig. 11 and the measurement value T_L obtained by the load cell 267A becomes a value equal to half the torque of the drive roller 207A ($T_L=2T_0$). Then, the rotation of the screw shaft 266A is stopped and a removable positioning spacer 268A is attached between the protruding portion 262Ac and the projection portion 263Ac as illustrated in part (b) of Fig. 2 to fix the position of the slide base 262A.

[0069]

(3') When it is determined that the left masking unit 203A_L is in contact with the left positioning stopper 225A_L in the processing (2) described above, the screw shaft 266A is rotated and the slide base 262A is thus moved in a direction toward the spray header 2 to move the right masking unit 203A_R to such a position that the right masking unit 203A_R comes into contact with the right positioning stopper 225A_R (see Fig. 10). The right masking unit 203A_R is thereby moved in the direction away from the left masking unit 203A_L.

[0070] Thereafter, the support roller 206A is moved until the right masking unit 203A_R comes into contact with the right positioning stopper 225A_R as illustrated in Fig. 11 and the measurement value T_L obtained by the load cell 267A becomes the value equal to half the torque of the drive roller 207A ($T_L=2T_0$). Then, the rotation of the screw shaft 266A is stopped and a removable positioning spacer 268A is attached between the protruding portion 262Ac and the projection portion 263Ac as illustrated in part (b) of Fig. 2 to fix the position of the slide base 262A.

[0071] In this case, when the masking units 203A_{L,R} come into contact respectively with the positioning stoppers 225A_{L,R} as illustrated in Fig. 11 by the processing (3) or (3') described above, the tensions T_{RU} , T_{LU} , T_{LL} , and T_{RL} are $T_{RU}=0$, $T_{LU}=T_0$, $T_{LL}=T_0$, and $T_{RL}=2T_0$, respectively.

[0072]

(4) When the masking units 203A_{L,R} come into contact respectively with the positioning stoppers 225A_{L,R} and the measurement value T_L obtained by the load cell 267A becomes the value equal to half the torque of the drive roller 207A ($T_L=2T_0$), lastly, as illustrated in Fig. 12, the tension applying roll 209A is pressed against the right wire 205A_R to apply the tension $T_{RU}=T_0$ to the right wire 205A_R between the drive roller 207A and the left masking unit 203A_L. This sets the tensions T_{RU} , T_{LU} , T_{LL} , and T_{RL} to T_0 ($T_{RU}=T_{LU}=T_{LL}=T_{RL}=T_0$) and the tensions of the wires 205A_{L,R} are set to a balanced state. The zero point adjustment is thereby completed.

[0073] In the aforementioned method of adjusting the positions of the mask members in the cooling apparatus for the

hot rolled steel sheet, the zero point adjustment of the masking units 203A_{L,R} can be performed at high accuracy even when the masking units 203A_{L,R} are internally included in the upper spray header 2A and the positions of the masking units 203A_{L,R} cannot be visually checked.

[0074] Note that the zero point adjustment described above is performed as needed, for example, in cases such as after the disassembly of the upper spray header 2A for maintenance.

[0075] Next, operations and effects of the cooling device for the hot rolled steel sheet in the embodiment are described. The cooling of the hot rolled steel sheet is performed with the positions of the masking units 203A_{L,R} adjusted by the zero point adjustment.

[0076] For example, when excessive cooling is desired to be suppressed in, for example, sheet end portions of the hot rolled steel sheet 1 in the steel sheet width direction Y, the motor 208A is driven in the non-spraying state to rotate the drive roller 207A and move the masking units 203A_{L,R} to positions opposed to the sheet end portions of the hot rolled steel sheet 1.

[0077] Meanwhile, when excessive cooling is desired to be suppressed in a center portion of the hot rolled steel sheet 1 in the steel sheet width direction Y, the motor 208A is driven in the non-spraying state to rotate the drive roller 207A and move the masking units 203A_{L,R} to positions opposed to the center portion of the hot rolled steel sheet 1 in the steel sheet width direction Y.

[0078] In this case, since the shield plate 232A and the flat seal 238A are separated away from the spray plate 201A due to the elastic force of the elastic bodies 235A, the shield plate 232A and the flat seal 238A do not come into contact with the spray plate 201A during the moving of the masking units 203A_{L,R}. This can suppress deterioration of the shield plate 232A and the flat seal 238A and extend the life thereof.

[0079] Moreover, in this case, the cover seal 281A covering the wire 205A is in sliding contact with the wire seal 282A, and the contact between the cover seal 281A and the wire seal 282A is line contact. This can suppress deterioration of the cover seal 281A and the wire seal 282A due to friction and extend the life of the cover seal 281A and the wire seal 282A.

[0080] Then, when the masking units 203A_{L,R} are moved to desired positions, the cooling water is supplied at high pressure from the not-illustrated cooling water supply source into the spray header main body 202A via the cooling water supply pipe 3A.

[0081] In this case, the water pressure moves the flat seal 238A together with the shield plate 232A toward the spray plate 201A against the elastic force of the elastic bodies 235A, and also presses the free end of the flat seal 238A against the spray plate 201A, and the supply of cooling water to the cooling water ejection holes 211A in the range surrounded by the flat seal 238A is blocked.

[0082] Simultaneously, the water pressure causes the tapered portion of the wire seal 282A to deform outward in the steel sheet width direction Y and be pressed against the cover seal 281A, and the contact pressure between the cover seal 281A and the wire seal 282A suppresses leakage of the cooling water from the inside to the outside of the spray header 2A.

[0083] Hence, when excessive cooling is desired to be suppressed in the sheet end portions of the hot rolled steel sheet 1, the cooling device can eject the cooling water in the sheet center portion of the hot rolled steel sheet 1 and prevent the cooling water from being ejected in the sheet end portions of the hot rolled steel sheet 1 as illustrated in part (a) of Fig. 1. Suppressing excessive cooling in the plate end portions can achieve uniform temperature distribution in the width direction of the hot rolled steel sheet 1.

[0084] Meanwhile, when excessive cooling is desired to be suppressed in the center portion of the hot rolled steel sheet 1 in the steel sheet width direction Y, the cooling device can eject the cooling water in the sheet end portions of the hot rolled steel sheet 1 and prevent the cooling water from being ejected in the sheet center portion of the hot rolled steel sheet 1 as illustrated in part (b) of Fig. 1. Suppressing excessive cooling in the sheet center portion can achieve uniform temperature distribution in the width direction of the hot rolled steel sheet 1.

[0085] Moreover, in this case, since the masking units 203A_{L,R} are cooled by the cooling water in the spray header 2A, there is no risk that the masking units 203A_{L,R} thermally deform due to heat of the hot rolled steel sheet 1. In addition, since the masking units 203A_{L,R} can directly close the cooling water ejection holes 211A of the spray plate 201A inside the spray header 201A, the cooling water in the spray header 2A can be uniformly ejected toward the hot rolled steel sheet 1 from the cooling water ejection holes 211A in regions other than the regions covered with the masking units 203A_{L,R}. Hence, water on the hot rolled steel sheet 1 at both ends thereof in the width direction efficiently flows and a drain route of the water can be stabilized.

[0086] Note that, in the embodiment, description is given of the example in which two masking units 203A_{L,R} are provided in one spray header 2A. However, the number of masking units provided in one spray header 2A is not limited to two and may be one or three or more. For example, the masking unit may be a sliding masking unit configured such that the length thereof in the steel sheet width direction Y is changeable.

[0087] Moreover, in the embodiment, the cooling device is configured such that the right wire 205A_R is wound around half or more of the drive roller 207A to prevent the sliding of the right wire 205A_R on the drive roller 207A. However, any method may be used as long as the structure is such that the right wire 205A_R can be pressed against the drive roller

207A even when no tension is applied to the right wire 205A_R.

[0088] Furthermore, in the embodiment, description is given of the example in which the support roller 206A, the drive roller 207A, the wires 205A, and the cover seals 281A are used as the first moving means. However, ropes may be used instead of the wires 205A.

[0089] Moreover, in the embodiment, description is given of the example in which the load cell 267A is used as the load detecting means. However, as illustrated in Fig. 13, a spring 269A may be used instead of the load cell 267A and various changes can be made within a scope not departing from the spirit of the present invention.

[0090] Since the lower spray header 2B is different from the upper spray header 2A only in that, unlike in the masking units 203A_{L,R} of the upper spray header 2A, in the masking units 203B_L, B_R of the lower spray header 2B, positions where recess grooves are formed and elastic bodies are mounted are on faces of holders opposed to shield plates. Accordingly, detailed description of the lower spray header 2B is omitted.

[0091] When the masking units 203B_L, B_R are applied to the lower spray header 2B, the cooling device can block ejection of the cooling water from below which hinders flow of water on the hot rolled steel sheet 1 in the width direction end portions thereof in cooling of the lower face of the hot rolled steel sheet 1, as in the cooling of the upper face of the hot rolled steel sheet 1 by the upper spray header 2A. Accordingly, it is possible to stabilize the drain route of the water on the hot rolled steel sheet 1 and suppress excessive cooling in a desired portion. Hence, uniform temperature distribution in the steel sheet width direction Y can be achieved while a size increase of the device is suppressed.

[0092] The cooling device for the hot rolled steel sheet and the method of adjusting the positions of the mask members in the cooling device in Embodiment 1 of the present invention can make the hot rolled steel sheet have uniform temperature distribution in the width direction while suppressing a size increase of the device and extending the life of the masking units 203A_{L,R}, 203B_{L,R}. In addition, the positions of the masking units 203A_{L,R} can be adjusted at high accuracy even when the masking units 203A_{L,R}, 203B_{L,R} are internally included in the spray headers 2A, 2B.

Embodiment 2

[0093] A cooling device for a hot rolled steel sheet in Embodiment 2 of the present invention is described in detail based on Fig. 14.

[0094] The cooling device for the hot rolled steel sheet in the embodiment is an example in which masking units 503A_L, 503A_R illustrated in Fig. 14 are used instead of the masking units 203A_{L,R} in the cooling device for the hot rolled steel sheet in aforementioned Embodiment 1 illustrated in Figs. 1 to 13. Other configurations of the cooling device in the embodiment are the same as those in Embodiment 1. In the following description, overlapping description is thus omitted by denoting members with the same operations by the same reference numerals, and different points are mainly described.

[0095] As illustrated in part (a) of Fig. 14, in the embodiment, the length of each of the masking units 503A_L, 503A_R in a steel sheet width direction Y varies in a steel sheet conveyance direction X. Specifically, the masking units 503A_L, 503A_R are formed in substantially trapezoid shapes in a top view such that the distance between the masking units 503A_L, 503A_R decreases from the upstream side toward the downstream side in the steel sheet conveyance direction X.

[0096] In the cooling device for the hot rolled steel sheet in the embodiment, as illustrated in part (b) of Fig. 14, it is possible to increase the flow rate of cooling water on the upstream side in the steel sheet conveyance direction X and reduce the flow rate of cooling water on the downstream side in the steel sheet conveyance direction X. Hence, in addition to the effects of Embodiment 1 described above, the controllability of the cooling performance in the steel sheet width direction Y can be further improved. This is the same for the case where this design is applied to the lower spray header 2B.

Embodiment 3

[0097] A cooling device for a hot rolled steel sheet in Embodiment 3 of the present invention is described in detail based on Fig. 15.

[0098] The cooling device for the hot rolled steel sheet in the embodiment is an example in which masking sheets 630A illustrated in Fig. 15 are used instead of the flat seals 238A in the cooling device for the hot rolled steel sheet in aforementioned Embodiment 1 illustrated in Figs. 1 to 13. Other configurations of the cooling device in the embodiment are the same as those in Embodiment 1. In the following description, overlapping description is thus omitted by denoting members with the same operations by the same reference numerals, and different points are mainly described.

[0099] As illustrated in part (a) of Fig. 15, each of the masking sheets 630A is formed in a sheet shape and covers cooling water ejection holes 211A under a corresponding one of the masking units 203A_{L,R} and in an entire area on the outer side of the corresponding masking unit 203A_{L,R} in a steel sheet width direction Y. The masking sheet 630A can be coiled by a coiling unit 701A. Note that, reference numeral 702A in part (a) of Fig. 15 denotes a roller which guides the masking sheet 630A to the coiling unit 701A.

[0100] As illustrated in part (b) of Fig. 15, the masking sheet 630A is formed by covering a sheet body 361A, made of, for example, iron and formed in a thin sheet shape, with a cover seal 632A made of an elastic material. The masking sheet 630A is slidably inserted in a through hole 224A formed in a spray header main body 202A. The through hole 224A is formed such that the diameter on the inner side in the steel sheet width direction Y is larger than the diameter on the outer side, and for example, a tubular flat seal 633A made of Teflon is fitted into this large diameter portion. The flat seal 633A is fixed by using an annular cover plate 634A covering an outer peripheral portion of a face of the flat seal 633A on the inner side in the steel sheet width direction Y. The cover plate 634A is fixed to the spray header main body 202A by using fixation bolts 209A.

[0101] The flat seal 633A is formed such that the inner diameter of the flat seal 633A on the inner side in the steel sheet width direction Y is substantially the same as the outer diameter of the cover seal 632A and a face of the flat seal 633A opposed to the cover seal 632A has an arc shape in a cross-sectional view. Furthermore, the flat seal 633A has a tapered portion whose inner diameter increases toward the outer side in the steel sheet width direction Y. Accordingly, like the aforementioned wire seal 282A illustrated in Fig. 7, in a non-spraying state, the cover seal 632A and the flat seal 633A are in line contact (point contact in the cross-sectional view) with each other. Meanwhile, in a spraying state, the tapered portion of the flat seal 633A deforms outward in the steel sheet width direction Y due to water pressure and is pressed against the cover seal 632A.

[0102] Specifically, in the non-spraying state, a contact state of the flat seal 633A with the cover seal 632A is a point contact in the cross-sectional view, and friction between the flat seal 633A and the cover seal 632A in moving of masking units 203A_{L,R} can be suppressed to the minimum. Meanwhile, in the spraying state, the flat seal 633A can suppress leakage of cooling water from the through hole 223A by being pressed against the cover seal 632A.

[0103] In the cooling device for the hot rolled steel sheet in the embodiment described above, the shield body is formed of the masking sheet 630A and the first seal member is formed of the flat seal 633A.

[0104] The cooling device for the hot rolled steel sheet in the embodiment which is configured as described above has the following advantages in addition to the operations and effects of the cooling device for the hot rolled steel sheet in Embodiment 1 described above. For example, assume a case where a hot rolled steel sheet 1 with a small width is to be cooled and the masking units 203A_{L,R} are moved to be aligned with the positions of edges of the hot rolled steel sheet 1. In this case, when the cooling water ejection holes 211A exist on the outer side of each of the masking units 203A_{L,R} in the steel sheet width direction Y, the masking sheet 630A can close the cooling water ejection holes 211A existing on the outer side of each masking unit 203A_{L,R} in the steel sheet width direction Y. Accordingly, it is possible to save cooling water. Moreover, in this case, when the cooling water is supplied at high pressure from a not-illustrated cooling water supply source into the spray header main body 202A via a cooling water supply pipe 3A, the tapered portion of the flat seal 633A deforms outward in the steel sheet width direction Y due to the water pressure and is pressed against the cover seal 632A. The contact pressure between the cover seal 632A and the flat seal 633A can suppress leakage of the cooling water from the inside to the outside of the upper spray header 2A. This is the same for the case where this design is applied to the lower spray header 2B.

[0105] Note that, in the embodiment, description is given of the example in which a cover plate 283A and the cover plate 634A are separate bodies. However, as illustrated in Fig. 16, the cooling device may be configured such that the through hole 224A in which the masking sheet 630A is slidably inserted and which is formed in the spray header main body 202A is formed near a through hole 223A in which a wire 205A is slidably inserted and which is formed in the spray header main body 202A, and the wire seal 282A and the flat seal 633A are fixed by using one cover plate 635A. Note that, in part (a) of Fig. 16, reference numeral 603A_R denotes the masking unit, 703A denotes a guide block for guiding the masking sheet 630A to the through hole.

INDUSTRIAL APPLICABILITY

[0106] The present invention can be preferably applied to a cooling device for a hot rolled steel sheet and to a method of adjusting the positions of mask members in the cooling device.

EXPLANATION OF THE REFERENCE NUMERALS

[0107]

1	hot rolled steel sheet
2, 2A, 2B	spray header
201A	spray plate
202A	spray header main body
203A _L , 203A _R , 503A _L , 503A _R	masking unit
205A _L , 205A _R	wire

	206A	drive roller
	207A	support roller
	208A	motor
	211A	cooling water ejection holes
5	222A _U , 203A _L	guide rail
	225A _L , 225A _R	positioning stopper
	231A	holder
	232A	shield plate
	235A	elastic body
10	238A	flat seal
	262A	slide base
	266A	screw shaft
	267A	load cell
	282A	wire seal
15	630A	masking sheet
	632A	cover seal
	633A	flat seal

20 Claims

1. A cooling device for a hot rolled steel sheet in which spray headers are disposed above and below a hot rolled steel sheet moving in a conveyance direction to be opposed to each other, each of the spray headers including a spray plate having a plurality of cooling water ejection holes and a box-shaped main body covering the spray plate, the cooling device configured to cool the hot rolled steel sheet by spraying cooling water from the cooling water ejection holes to the hot rolled steel sheet, the cooling device **characterized in that** the spray header internally includes a guide rail provided to an inner peripheral face of the main body and extending in a sheet width direction of the hot rolled steel sheet, and a mask member configured to move along the guide rail, the mask member includes a support body and a shield body, the support body being provided movably in the sheet width direction of the hot rolled steel sheet along the guide rail, the shield body being supported by the support body with an elastic body inserted between the shield body and the support body, the elastic body being elastically deformable in at least an up-down direction, and when water pressure does not act on the shield body, the shield body is located away from the spray plate and, when water pressure acts on the shield body, compression and deformation of the elastic body causes the shield body to be pressed against the spray plate, and desired ones of cooling liquid ejection holes are thereby closed.
2. The cooling device for a hot rolled steel sheet according to claim 1, **characterized in that** the shield body includes a shield plate formed in a plate shape and opposed to the spray plate and a flat seal formed in a substantially V shape in a cross-sectional view and fixedly attached to an outer peripheral edge of the shield plate such that an open portion of the substantially V shape faces outward.
3. The cooling device for a hot rolled steel sheet according to claim 1, **characterized in that** the shield body is a masking sheet including a metal thin sheet and an elastic body covering the thin sheet, the masking sheet configured to be capable of being coiled outside the spray header and covering all of the cooling water ejection holes directly under the mask member and in a region on an outer side of the mask member in the sheet width direction of the hot rolled steel sheet, the masking sheet is inserted in a through hole formed in the spray header with a first seal member formed in an annular shape provided between the masking sheet and the spray header, and when water pressure does not act on the shield body, the first seal member comes into line contact with the elastic body covering the thin sheet and, when water pressure acts on the shield body, the first seal member presses the elastic body covering the thin sheet.
4. The cooling device for a hot rolled steel sheet, according to any one of claims 1 to 3, **characterized in that** the shield body has such a shape that a length of the shield body in the sheet width direction of the hot rolled steel sheet varies in the conveyance direction of the hot rolled steel sheet such that a water amount distribution varies with a gradient in the width direction.
5. The cooling device for a hot rolled steel sheet according to any one of claims 1 to 4, **characterized in that** the

cooling device comprises first moving means for moving the mask member in the sheet width direction of the hot rolled steel sheet, the first moving means having a drive source outside the spray header.

6. The cooling device for a hot rolled steel sheet according to claim 5, **characterized in that**

the first moving means includes a drive roller and a non-drive roller which are installed outside the spray header, respectively on both sides of the spray header in the sheet width direction of the hot rolled steel sheet, and wires which are wound around the drive roller and the non-drive roller and which have both ends fixed to the mask member, the wires are each covered with an elastic body and inserted in a through hole formed in the spray header with a second sealing member formed in an annular shape provided between the wire and the spray header, and when water pressure does not act on the shield body, the second seal member comes into line contact with the elastic body covering the wire and, when water pressure acts on the shield body, the second seal member presses the elastic body covering the wire and comes into tight contact with the elastic body.

7. The cooling apparatus for a hot rolled steel sheet according to claim 5 or 6, **characterized in that**

the spray header internally includes a plurality of the mask members arranged symmetrically on both sides of a center portion of the hot rolled steel sheet in the sheet width direction, and the first moving means moves the opposing mask members on both sides of the center portion of the hot rolled steel sheet in the sheet width direction, toward and away from each other in an interlocked manner.

8. The cooling device for a hot rolled steel sheet according to claim 6 or 7, **characterized in that** the second seal member is made of a high-stiffness material, applies a certain amount of pressing force to the elastic body covering the wire and comes into tight contact with the elastic body irrespective of action of the water pressure, and is selected depending on the water pressure to be used.

9. The cooling device for a hot rolled steel sheet according to claim 7 or 8, **characterized in that** the cooling device further comprises:

stoppers configured to restrict movement of the mask members in the sheet width direction of the hot rolled steel sheet;

contact detecting means for detecting contact of the mask members with the stoppers;

load measuring means for measuring load acting on the wire wound around the non-drive roller; and

second moving means for moving the non-drive roller in the sheet width direction of the hot rolled steel sheet.

10. A method of adjusting positions of the mask members in the cooling device for a hot rolled steel sheet according to claim 9, **characterized in that** the method comprises:

rotating the drive roller to move the opposing mask members on both sides of the center portion of the hot rolled steel sheet in the sheet width direction, in directions away from each other,

upon detecting the contact of at least one of the mask members with the corresponding stopper by using the contact detecting means, moving the non-drive roller in the sheet width direction of the hot rolled steel sheet by using the second moving means until a measurement value of the load measuring means reaches a preset value.

Fig. 1(a)

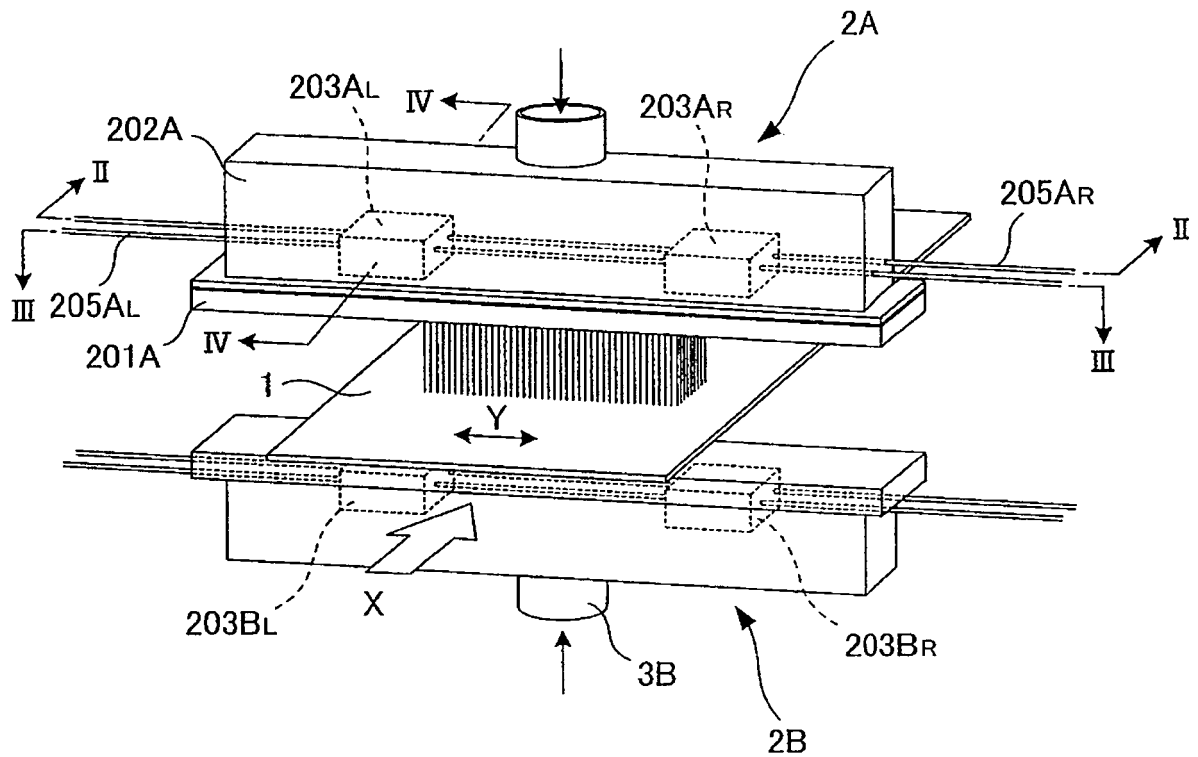
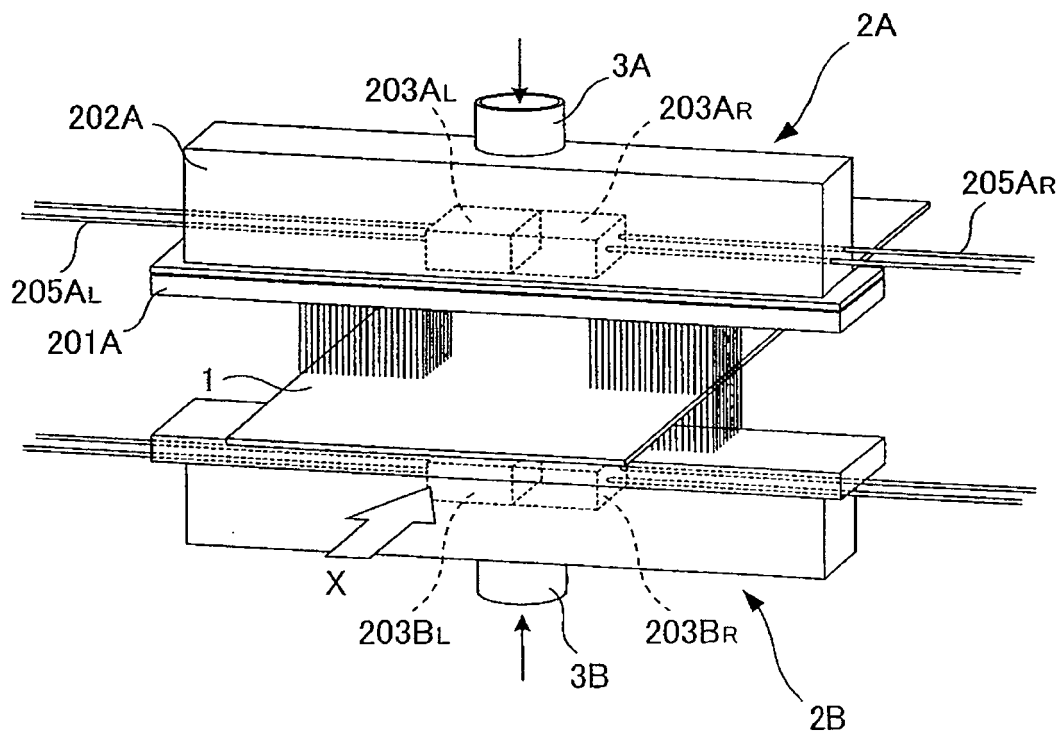


Fig. 1(b)



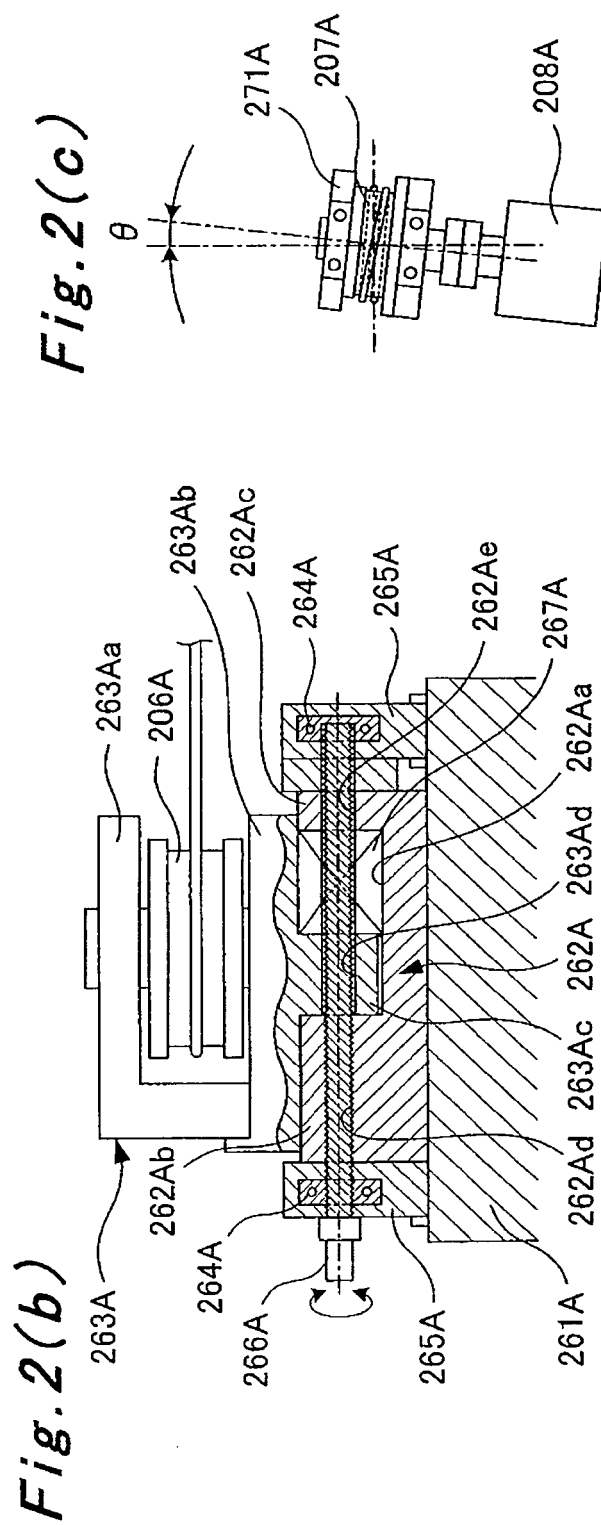
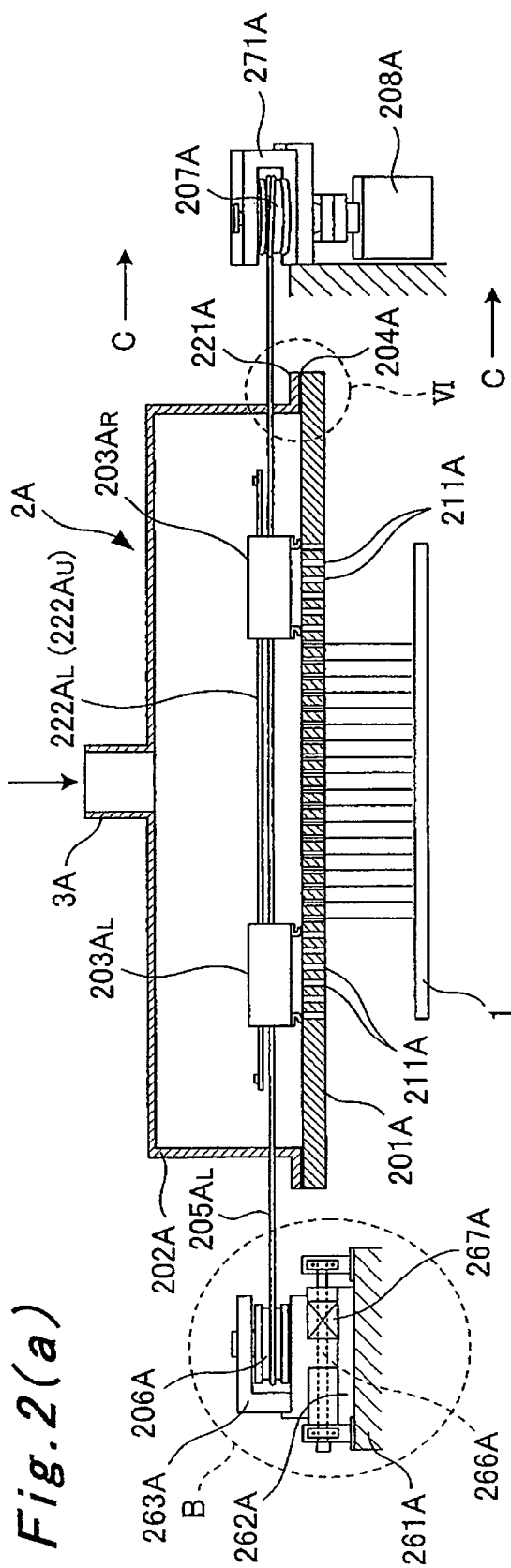


Fig. 3

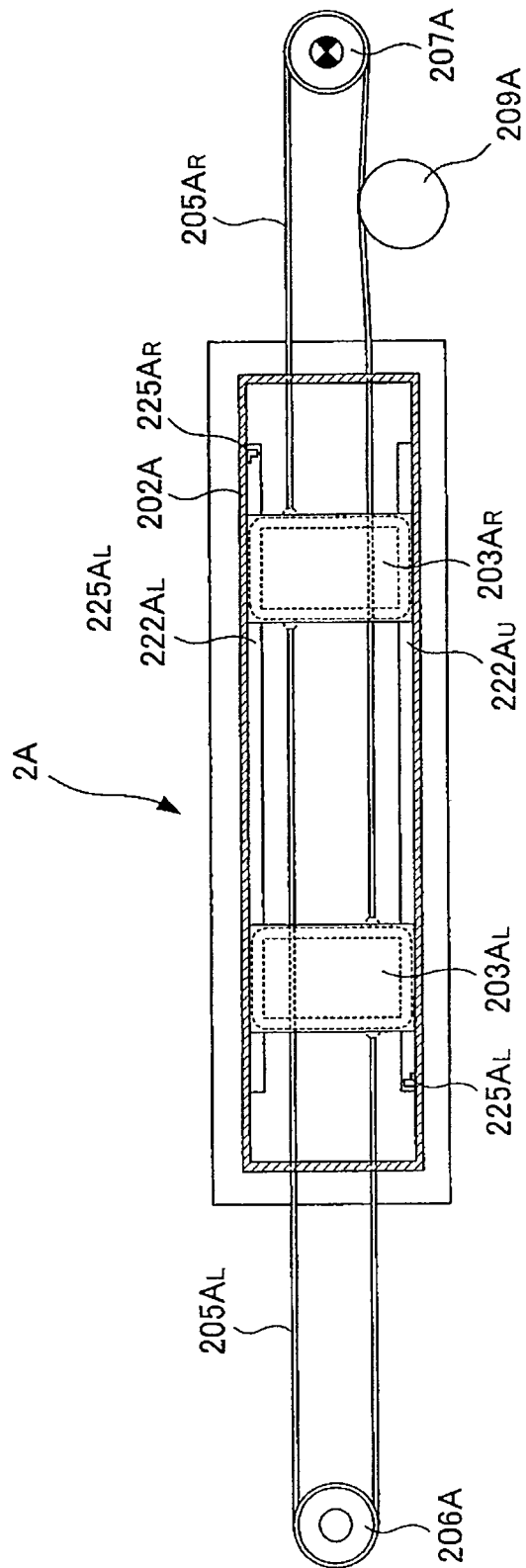


Fig. 4(a)

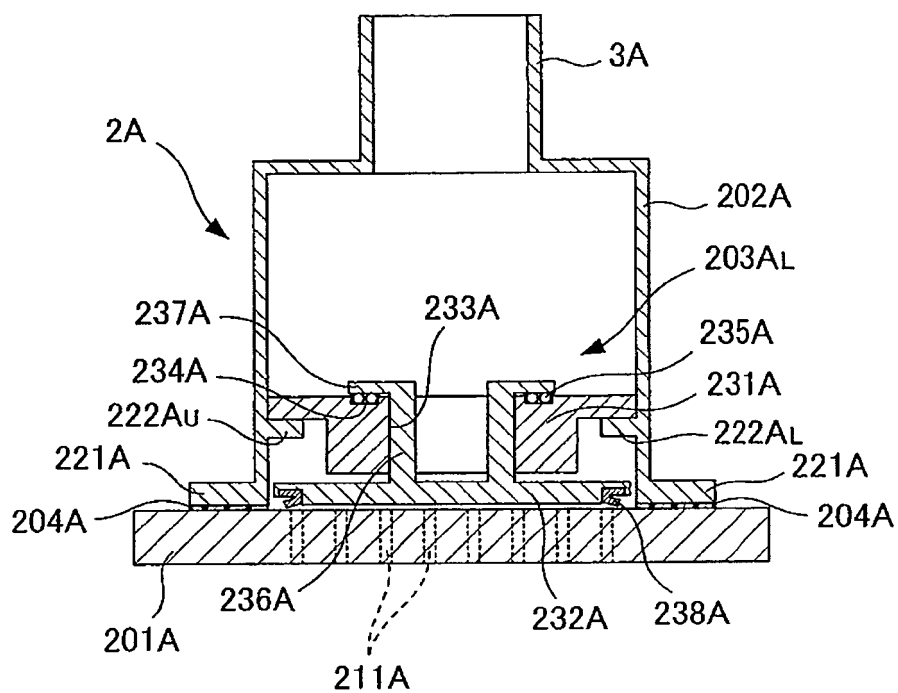


Fig. 4(b)

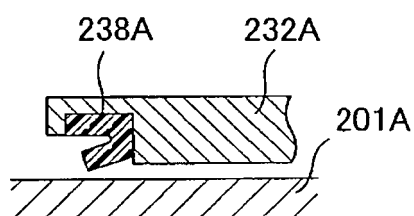


Fig. 4(c)

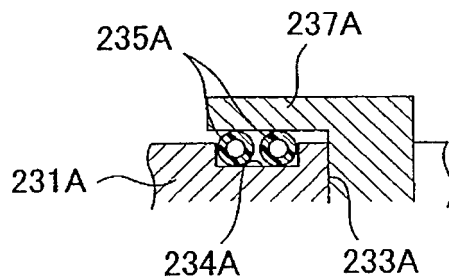


Fig. 5(a)

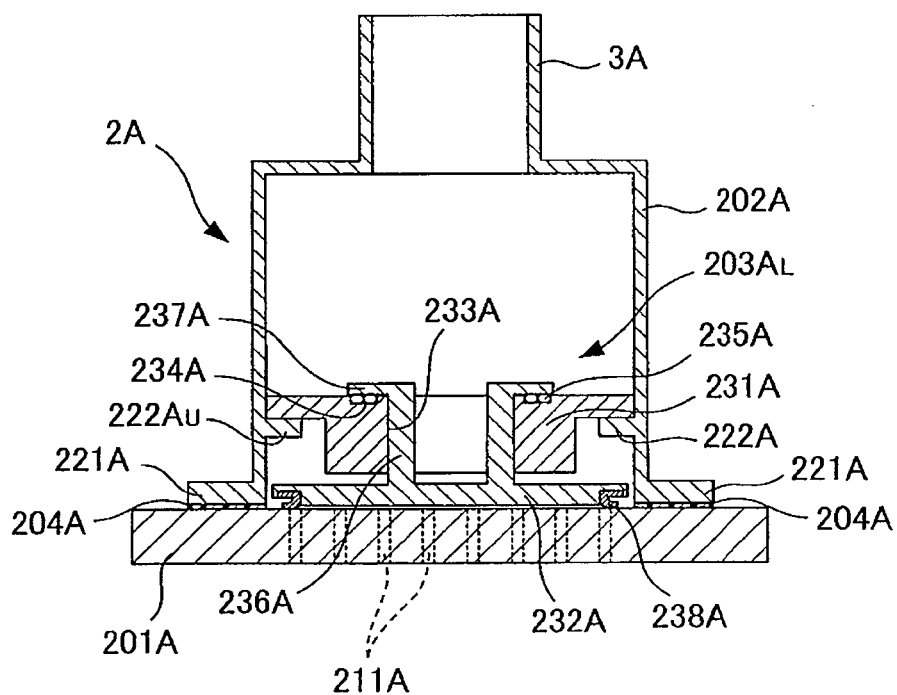


Fig. 5(b)

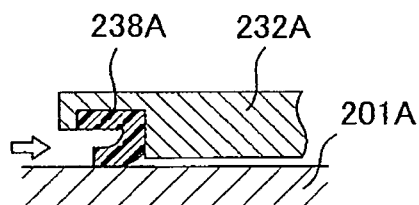


Fig. 5(c)

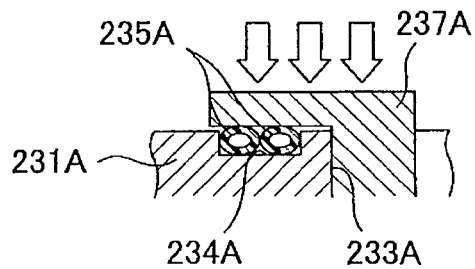


Fig. 6(a)

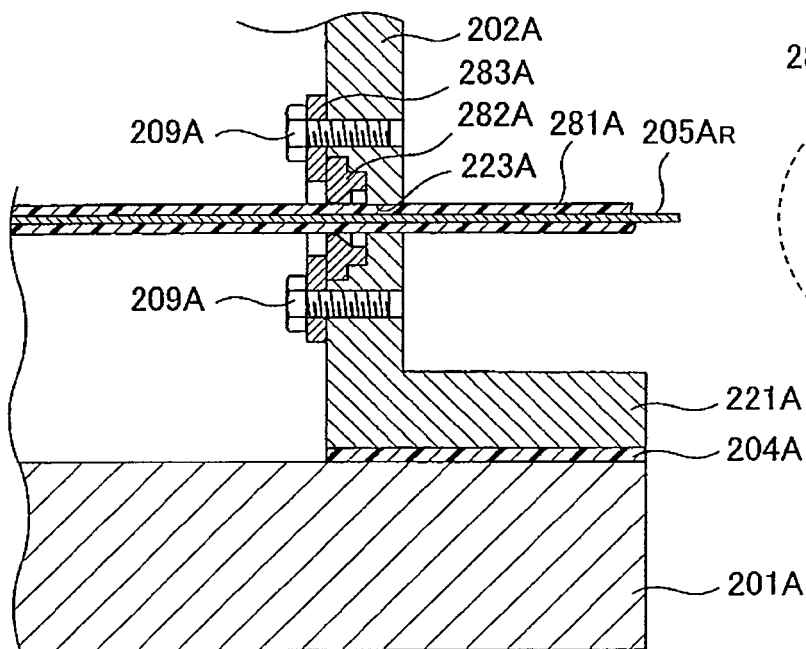


Fig. 6(b)

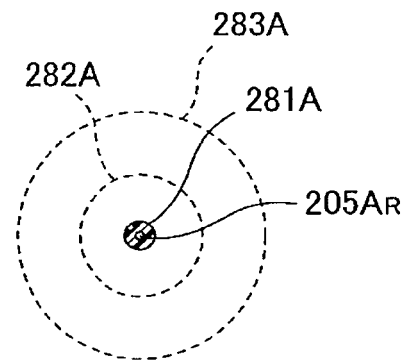


Fig. 7(a)

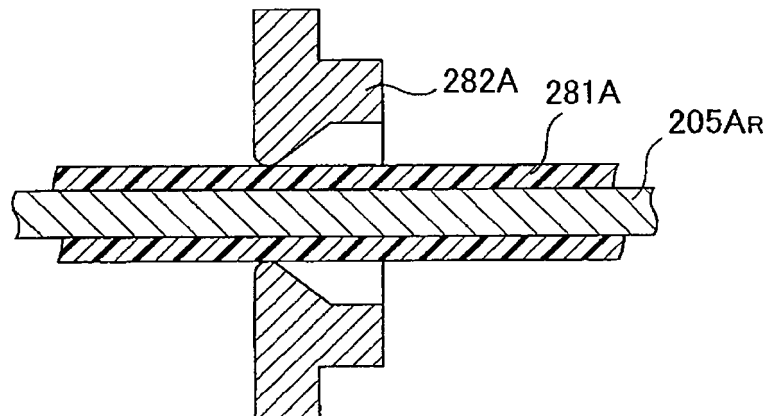


Fig. 7(b)

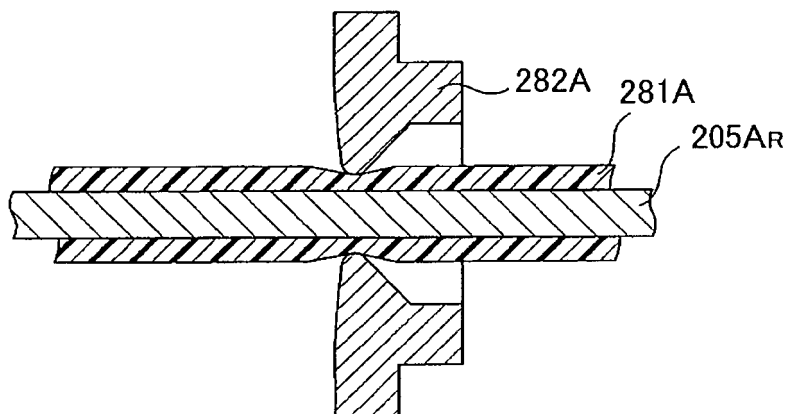


Fig. 8

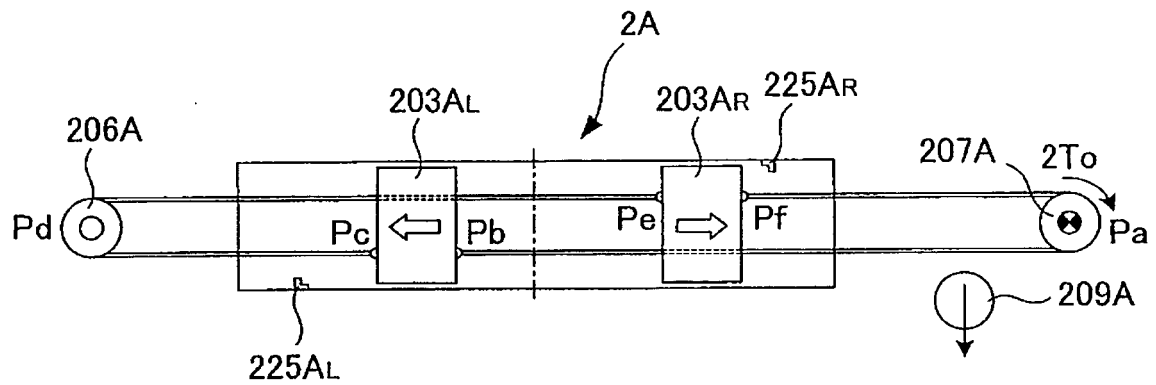


Fig. 9

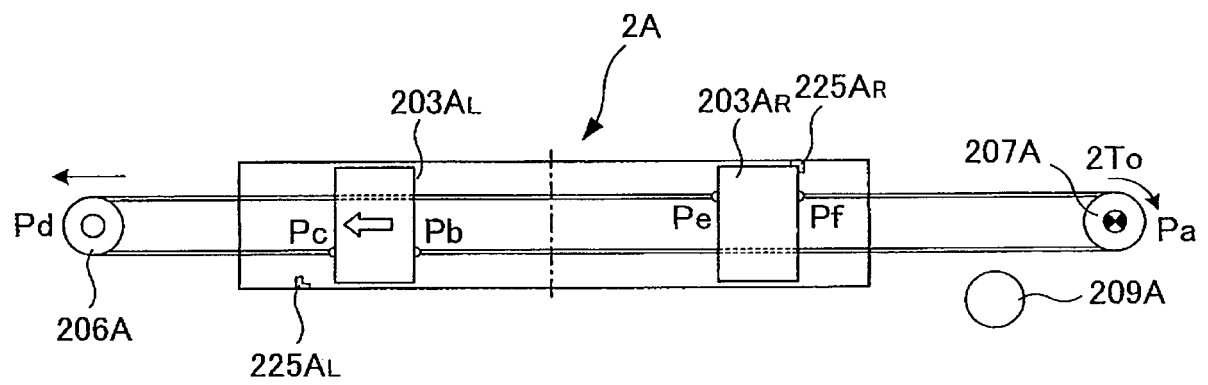


Fig. 10

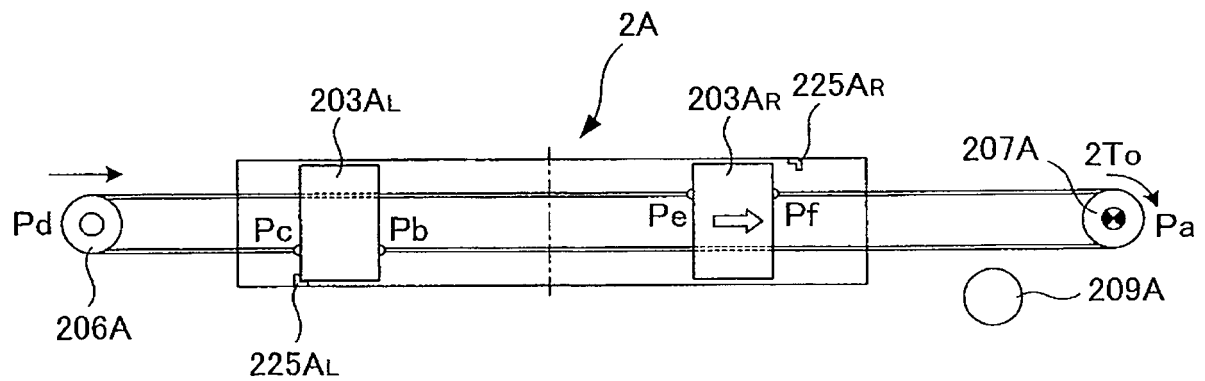


Fig. 11

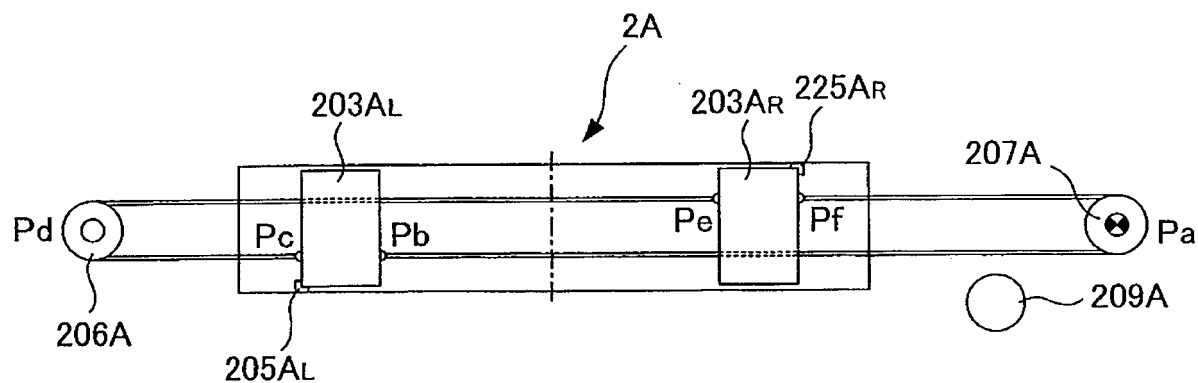


Fig. 12

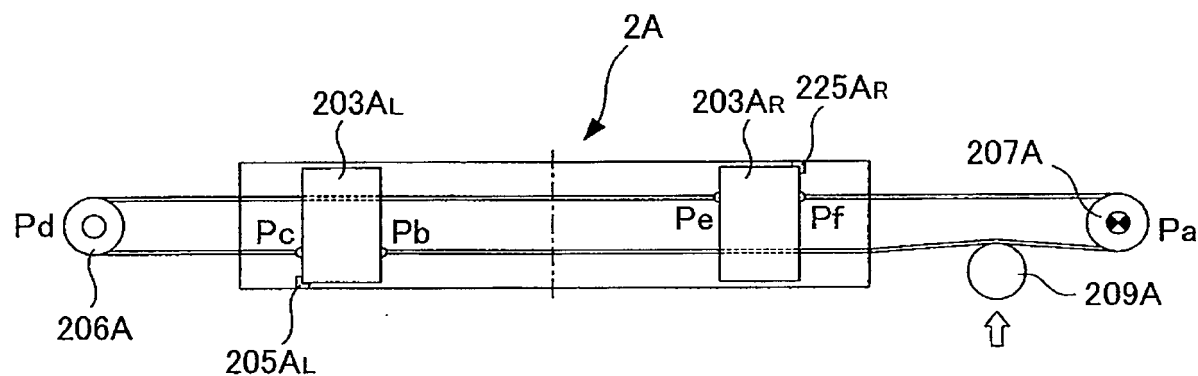


Fig. 13

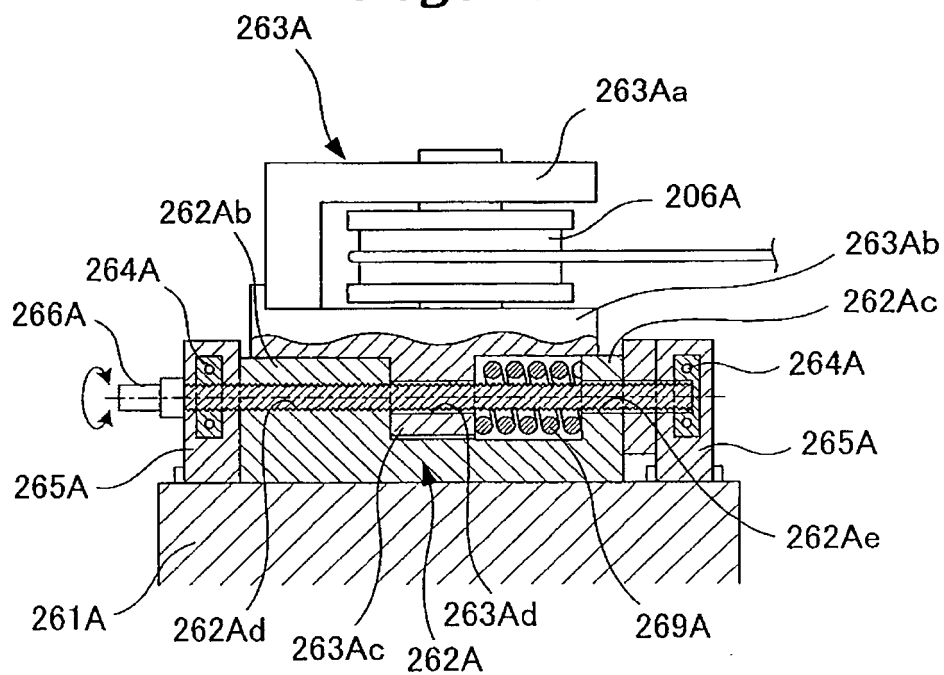


Fig. 14(a)

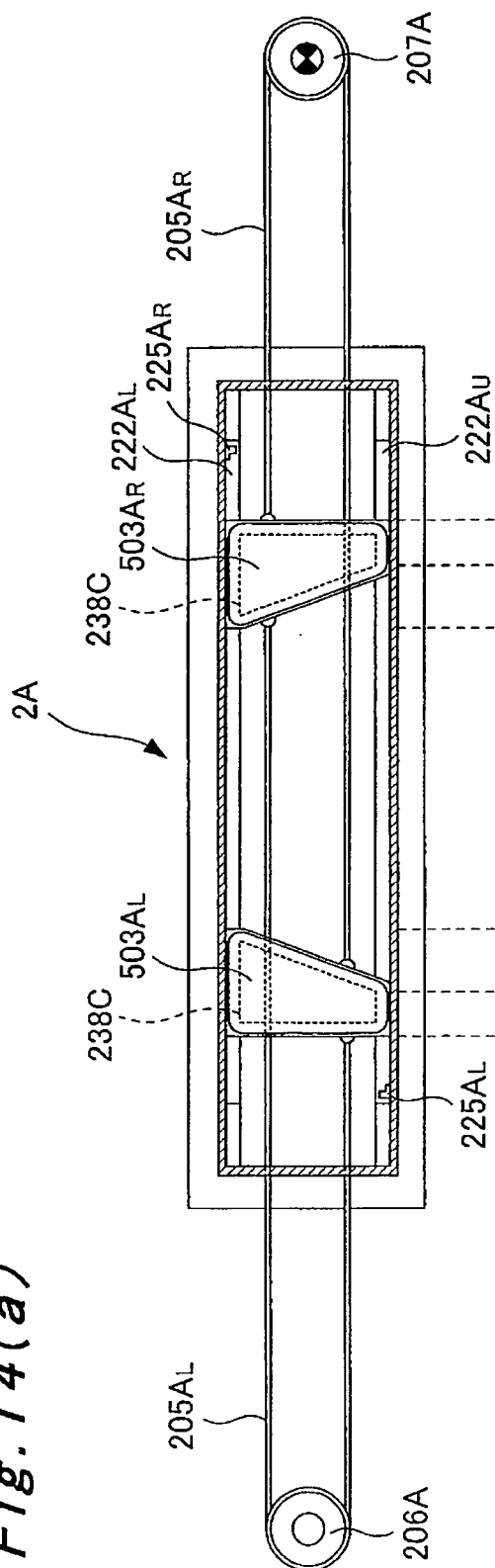


Fig. 14(b)

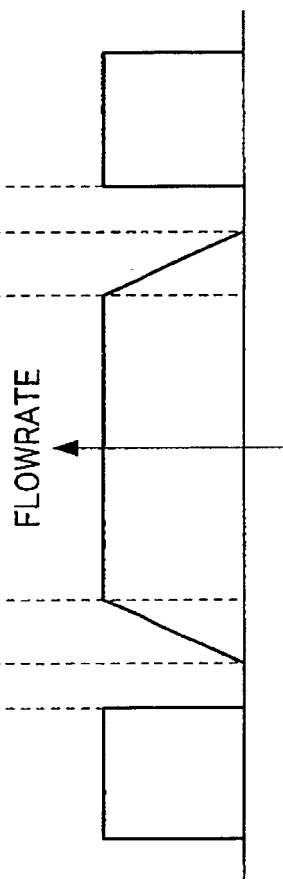


Fig. 15(a)

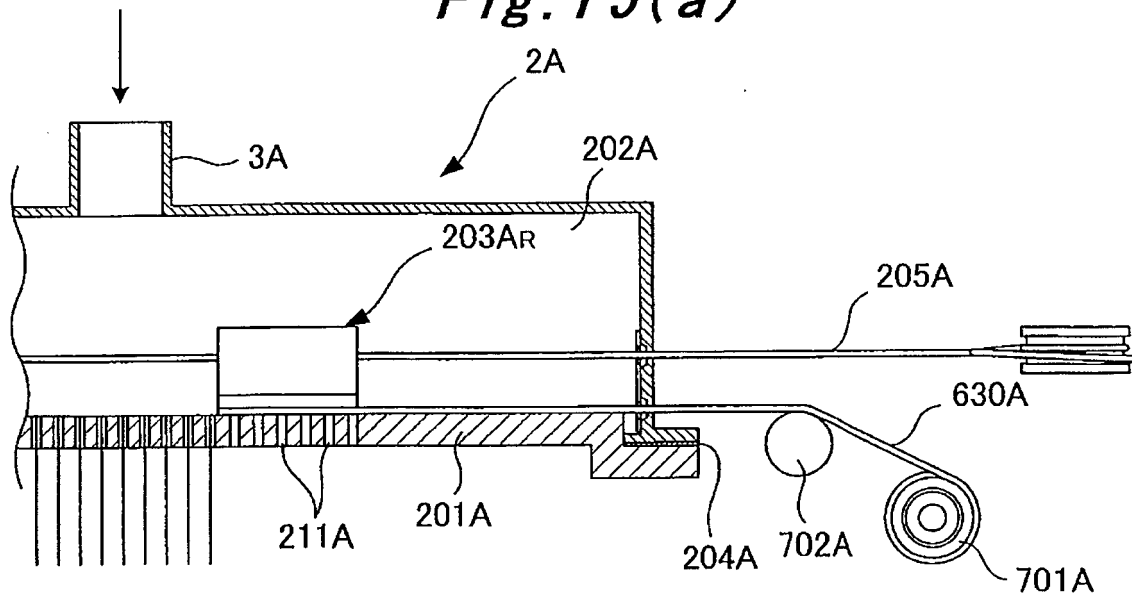


Fig. 15(b)

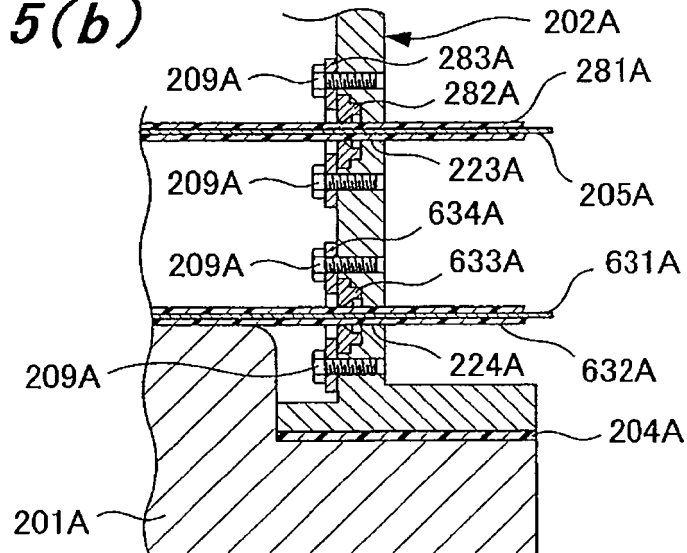


Fig. 15(c)

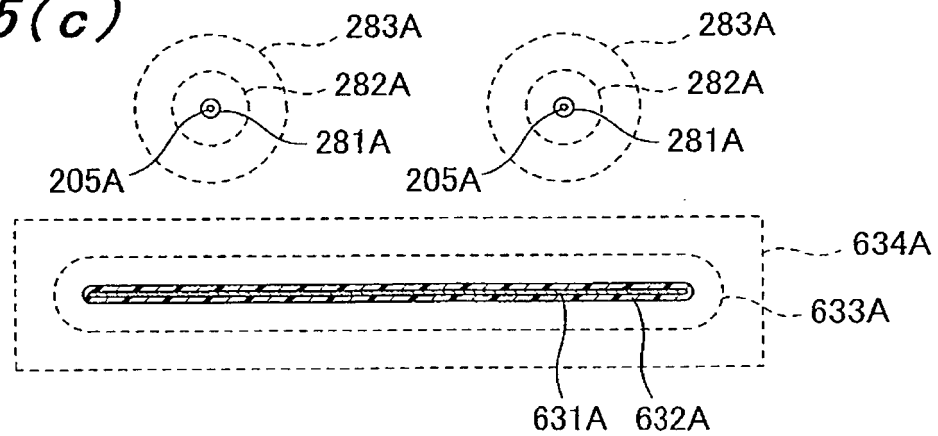


Fig. 16(a)

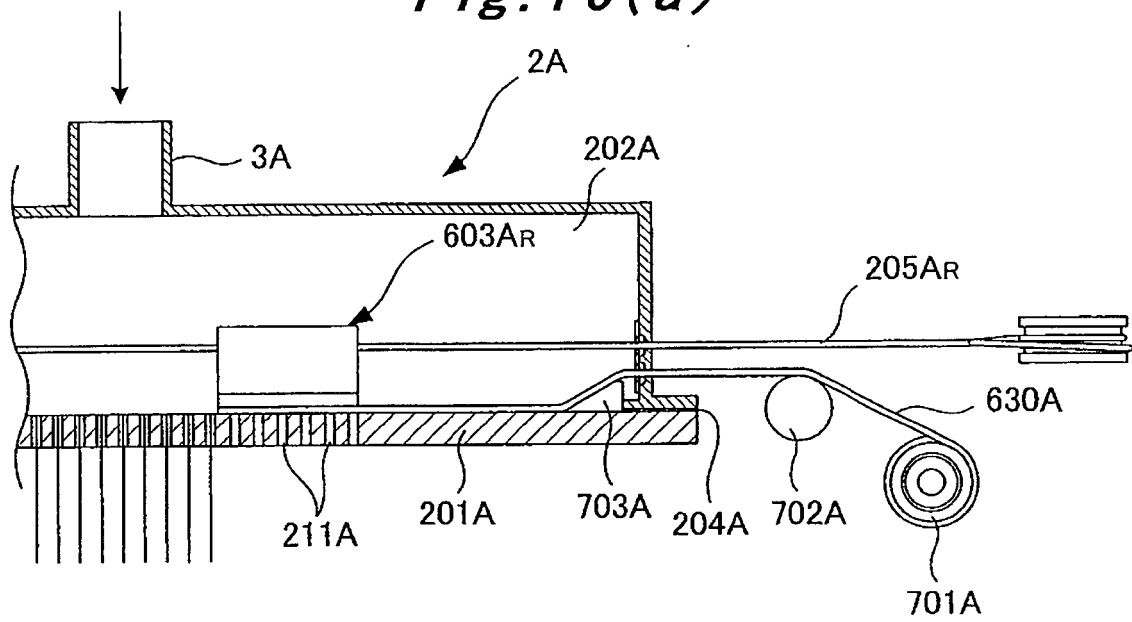


Fig. 16(b)

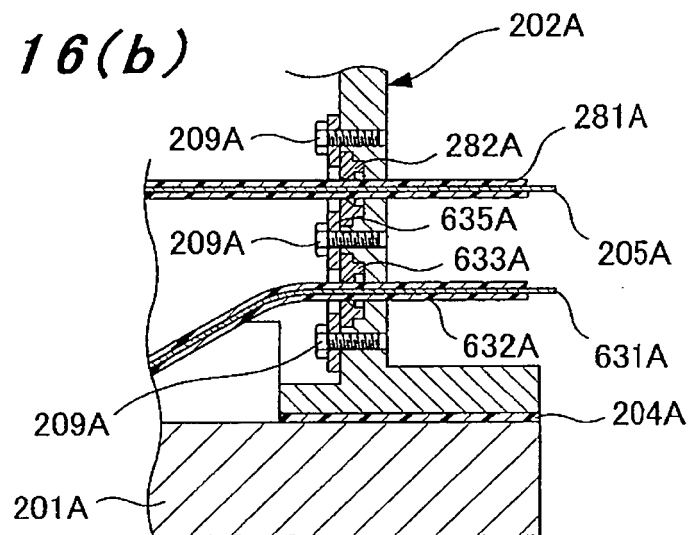
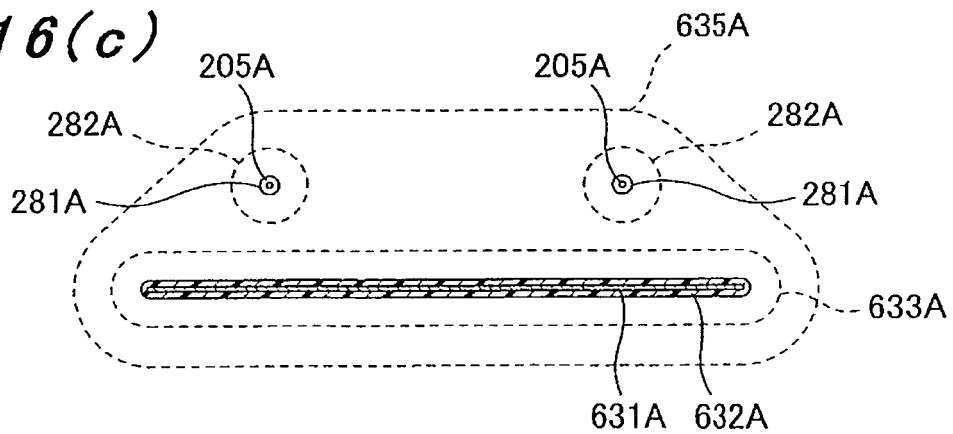


Fig. 16(c)



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/054779

A. CLASSIFICATION OF SUBJECT MATTER

B21B45/02(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)

B21B45/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2016

Kokai Jitsuyo Shinan Koho 1971-2016 Toroku Jitsuyo Shinan Koho 1994-2016

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 6-285531 A (Nippon Steel Corp.), 11 October 1994 (11.10.1994), paragraphs [0013] to [0028]; fig. 1 to 3, 8 to 12 (Family: none)	1-10
A	JP 2007-319928 A (Kobe Steel, Ltd.), 13 December 2007 (13.12.2007), paragraphs [0017] to [0032]; fig. 1, 2 (Family: none)	1-10

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

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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 May 2016 (12.05.16)Date of mailing of the international search report
24 May 2016 (24.05.16)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

REFERENCES CITED IN THE DESCRIPTION

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