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(54) DEFLECTOR ROLL AND METHOD FOR MANUFACTURING STEEL SHEET USING SAID DEFLECTOR ROLL

(57) Proposed are a deflector roll on which a metal strip can be threaded without significant meandering and which, moreover, enables efficient production of a steel sheet, and a method of producing a steel sheet including this deflector roll. The deflector roll, which changes a travelling direction of a metal strip being threaded, includes a roll main body that is rotatably supported by a roll frame and a sliding member that is provided on an outer surface of the roll main body. The sliding member is configured to have the metal strip wrapped thereon and to be movable along an axial direction of the roll main body while maintaining that wrapped state.

FIG. 1(a)

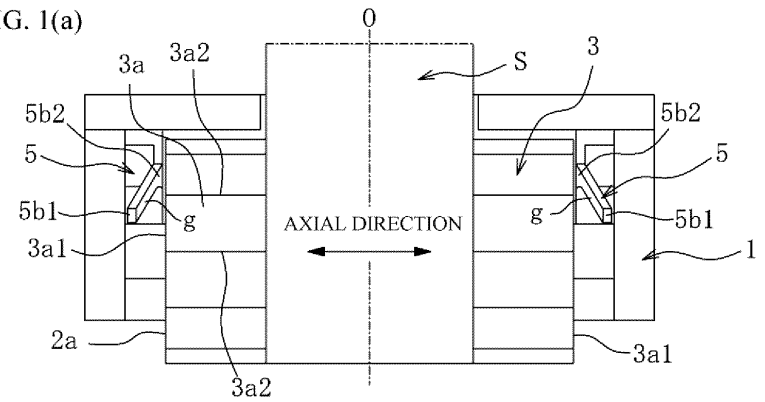

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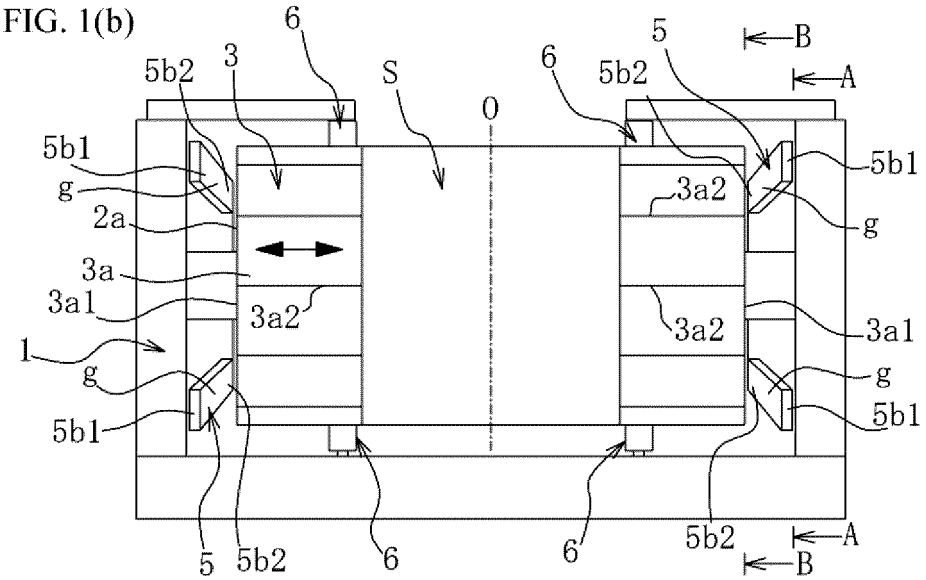
FIG. 1(b)


6
5
B
5b2
3
S
6
5b2
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0
5b1
g
2a
3a
3a1
1
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3a2
3a2
3a2
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3a1
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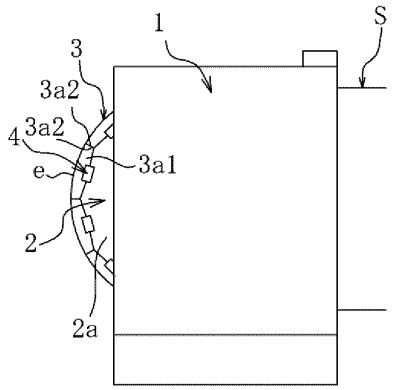
FIG. 1

(c)


1
S
3
3a2
4
3a2
3a1
e
2
2a

Description

Technical Field

[0001] The present invention relates to a deflector roll used to change the travelling direction of a metal strip being threaded by wrapping the metal strip on an outer surface of a roll, and to a method of producing a steel sheet using this deflector roll.

Background Art

[0002] In a steel sheet continuous production facility, a large number of deflector rolls are installed on a threading route for the purpose of changing the travelling direction of a metal strip being threaded. The significance of using deflector rolls lies in making the steel sheet continuous production facility compact and reducing the building cost of the facility. On the other hand, the use of deflector rolls causes an undesirable effect that the metal strip meanders due to a frictional force generated between the metal strip and the deflector rolls.

[0003] To prevent the meandering of a metal strip on a deflector roll, a CPC meandering control device has been hitherto commonly used. However, it has often been impossible to install a CPC meandering control device due to restrictions in terms of the cost, the installation place, etc. For example, in a horizontal looper device, it is difficult to install a CPC meandering control device in a deflector roll that is installed in a moving looper car for cost reasons as well as due to restrictions in terms of the space to dispose electrical components, etc.

[0004] For a large number of deflector rolls in which a CPC meandering control device cannot be installed, a crown roll having a convex roll profile is used. The crown roll can use a frictional force generated between itself and the metal strip as a centering force, and thus, if not as effective as a CPC meandering control device, can hinder the metal strip from meandering to some extent. Moreover, in this case, there is an advantage of being almost free of restrictions in terms of the roll installation place and the cost, as all it takes is to process the deflector roll so as to have a convex roll profile.

[0005] In recent years, as the tensile strength of steel sheets has become higher or magnetic steel sheets have become more upgraded, hot-rolled steel sheets produced in a hot rolling step, which is an upstream step, are becoming more prone to shape defects and camber at a leading end part or a tail end part of a coil. A situation is arising frequently where, when metal strips in which shape defects or camber has occurred are connected to each other and threaded, meandering at the joint cannot be hindered.

[0006] If such meandering cannot be hindered, so-called roll-out in which the metal strip departs from a planned threading route occurs, which can result in a major trouble, such as the metal strip breaking on contact with a peripheral frame, thereby making operation impossible. Also, if a metal strip chipped at the edge is cold-rolled as is, the metal strip breaks during cold rolling and thereby makes operation impossible. Therefore, it is necessary to check the metal strip for chipping of the edge before cold rolling, as well as to reduce the transfer speed of the metal strip, and this also causes reduction in the production efficiency of steel sheets.

[0007] Since it is difficult to newly install a CPC meandering control device in an existing facility, a measure against meandering such as adjusting the convex shape of a crown roll is adopted. However, there are problems including that, if the convex shape is made too high, a contact mark is left as the metal strip and the roll surface cannot be brought into contact over their entire surfaces. Thus, there is a limit to hindering meandering by a crown roll.

[0008] As it is known that meandering of a metal strip is caused by shape defects at the leading end part or the tail end part of the coil, common practice is to remove the affected portions. However, in this case, this is directly linked to lower yield, and so it is of course better not to remove such portions if possible, also for the reduction of CO_2 emissions.

[0009] Another known method for reducing meandering of a metal strip on a deflector roll is to use a guide roll that comes into contact with the edges of the metal strip in the width direction. However, when the metal strip meanders significantly, the guide roll exerts a large colliding force to restrain meandering. This colliding force inevitably causes a defect such as the metal strip becoming chipped at the edge, and thus the method using a guide roll is not perfect.

[0010] The frictional force that amplifies meandering of the metal strip occurs in the axial direction of the deflector roll (thrust direction). Therefore, to reduce meandering of the metal strip, it is effective to use a thrust-free roll that does not generate such a frictional force in the first place. As related arts in this connection, for example, Patent Literature 1 proposes a device in which a belt pulley is movable relative to the thrust direction, and Patent Literature 2 proposes a device in which upper and lower rolls are movable relative to the thrust direction.

[0011] However, in the device of Patent Literature 1, there is a concern that when significant meandering of the belt occurs, movement of the belt pulley may cause an end portion of the belt to collide with a support part that supports the belt pulley. In Patent Literature 2, damper resistance is applied to at least one of the upper roll and the lower roll, which puts a limit on reducing such a frictional force that guides meandering of the steel strip. Thus, neither of these techniques is suitable for application to deflector rolls.

Citation List

Patent Literature

[0012]

Patent Literature 1: Japanese Patent Laid-Open No. 2002-2934
Patent Literature 2: Japanese Patent Laid-Open No. 2010-207867

Summary of Invention

Technical Problem

[0013] An object of the present invention is to propose a deflector roll that enables efficient production of a steel sheet while mitigating meandering of a metal strip due to a frictional force occurring in an axial direction of the roll, without involving structural complication, and a method of producing a steel sheet using this deflector roll.

Solution to Problem

[0014] The present invention is a deflector roll that changes a travelling direction of a metal strip being threaded, characterized in that: the deflector roll comprises a roll main body that is rotatably supported by a roll frame, and a sliding member that is provided so as to be movable relative to an outer surface of the roll main body; and the sliding member is configured to have the metal strip wrapped thereon and to be movable along an axial direction of the roll main body while maintaining that wrapped state.

[0015] In the above-described deflector roll, the following are preferable as specific means for solving the problems:

(1) that the sliding member includes a plurality of plate-shaped bodies, and that the plate-shaped bodies are arrayed over an entire circumference of the roll main body, with end surfaces in a longitudinal direction located on roll end surface sides of the roll main body and end surfaces in a width direction facing one another;
(2) that each of the plate-shaped bodies has an arc surface that forms a part of a wrapping circumferential surface of a circular shape in a state where the plate-shaped bodies are arrayed over the entire circumference of the roll main body;
(3) that the plate-shaped bodies are each separately movable along the axial direction of the roll main body;
(4) that each of the plate-shaped bodies has a cross-sectional profile in which a central part in the longitudinal direction protrudes outward relative to both end portions of the plate-shaped body;
(5) that the roll frame has centering guides that are provided facing the end surfaces of the plate-shaped bodies in the longitudinal direction, in a region of the roll main body except for a wrapping region of the metal strip, and that are hit by the end surfaces in the longitudinal direction of the plate-shaped bodies in a moving state such that the plate-shaped bodies are returned to original positions and centered to a threading center of the metal strip;
(6) that the centering guide includes a base that is held on the roll frame and a guide plate that is supported at one end on the base, and that the guide plate has a guide surface of which a free end is farthest away from the roll end surface of the roll main body and to which a distance from the roll end surface of the roll main body decreases gradually toward a fixed end;
(7) that the roll frame has guide rollers that are respectively located on both end sides of the metal strip in a width direction to prevent the metal strip from rolling out while being threaded; and
(8) that the sliding member has an elastic member that elastically supports the sliding member so as to be movable along the axial direction of the roll main body, and that returns the sliding member to an original position by an urging force.

[0016] Further, the present invention is a method of producing a steel sheet using a deflector roll that produces a steel sheet by transferring a metal strip having undergone an upstream-side production process to a downstream-side production process so as to pass through a looper device in which at least one deflector roll having the above-described configuration is installed. This method is characterized in that, while the metal strip is passing through the looper device, the sliding member of the deflector roll, along with the metal strip wrapped on the deflector roll, is moved along the axial direction of the roll main body using a frictional force attributable to meandering of the metal strip.

Advantageous Effects of Invention

[0017] According to the present invention, since the sliding member provided on the outer surface of the roll main body is movable in the axial direction of the roll main body, generation of such a frictional force as to amplify the meandering of the metal strip is avoided. Moreover, according to the present invention, since the roll main body does not move in the axial direction, a problem such as coming into contact with the roll frame does not occur, either.

[0018] Further, when producing a steel sheet by transferring a metal strip having undergone an upstream-side production process to a downstream-side production process so as to pass through a looper device, it has been hitherto necessary to reduce the transfer speed of the metal strip in a section from near a joint to the downstream-side production process from the viewpoint of avoiding a problem such as breakage of the metal strip. However, according to the present invention, since meandering of the metal strip can be restricted, the section where the transfer speed of the metal strip is reduced can be shortened to thereby achieve improvement in production efficiency.

Brief Description of Drawings

[0019]

FIG. 1 is views schematically showing an embodiment of a deflector roll according to the present invention, with FIG. 1(a) being a plan view, FIG. 1(b) a front view, and FIG. 1(c) a side view.
FIG. 2 is a view showing section A-A of FIG. 1.
FIG. 3 is a view showing section B-B of FIG. 1.
FIG. 4 is views showing a plate-shaped body alone as taken off, with FIG. 4(a) being a plan view, FIG. 4(b) a view of section C-C of FIG. 4(a), and FIG. 4(c) a view showing an end surface in a longitudinal direction.
FIG. 5 is a view showing a side surface of a roll main body.
FIG. 6 is a view schematically showing a horizontal looper device.
FIG. 7 is a graph showing how an amount of meandering of a metal strip changes.
FIG. 8 is a graph showing how the amount of meandering and a camber curvature of the metal strip change.
FIG. 9 is a graph showing how the amount of meandering of the metal strip changes.
FIG. 10 is a graph showing how the amount of meandering and the camber curvature of the metal strip change.
FIG. 11 is a graph showing how a colliding force in guide rollers changes.
FIG. 12 is a graph showing how the amount of meandering of the metal strip changes.
FIG. 13 is a graph showing how the amount of meandering and the camber curvature of the metal strip change.
FIG. 14 is a graph showing how the colliding force in the guide rollers changes.
FIG. 15 is a view schematically showing one example of a steel sheet production facility in which a looper device is installed between a hot rolling step as an upstream-side production process and a cold rolling step as a downstream-side production process.
FIG. 16 is a view showing a facility in which a looper device is installed on an entry side of an annealing treatment step and a delivery side of a pickling treatment step.
FIG. 17 is a view showing another embodiment of the deflector roll according to the present invention in cross-section of a main part.
FIGs. 18(a) and 18(b) are views schematically showing a state where a sliding member is moving in an axial direction of a roll main body in the deflector roll shown in FIG. 17.

Description of Embodiment

[0020] In the following, the present invention will be described more specifically using the drawings.

[0021] FIGs. 1 (a) to 1(c) are views schematically showing an embodiment of a deflector roll according to the present invention, with FIG. 1(a) being a plan view, FIG. 1(b) a front view, and FIG. 1(c) a side view. FIG. 2 is a view showing section A-A of FIG. 1, and FIG. 3 is a view showing section B-B of FIG. 1.

[0022] In FIGs. 1 to 3, reference sign 1 denotes a roll frame; reference sign 2 denotes a roll main body that is rotatably supported by the roll frame 1 through a bearing; and reference sign 3 is a sliding member that is provided on an outer surface of the roll main body 2, and that has a metal strip S wrapped thereon and is movable along an axial direction of the roll main body 2 while maintaining that wrapped state.

[0023] The sliding member 3 can be composed of a plurality of plate-shaped bodies 3a of a rectangular shape that is arrayed over an entire circumference of the roll main body 2, with end surfaces 3a1 in a longitudinal direction located on the sides of roll end surface 2a of the roll main body 2 and end surfaces 3a2 in a width direction facing one another. Between the plate-shaped bodies 3a and the roll main body 2, linear guides 4 each formed by a combination of a plurality of rollers are provided such that the plate-shaped bodies 3a are held on the roll main body 2 so as to be unable to come off and that the plate-shaped bodies 3a are individually movable in the axial direction of the roll main body 2. While the sliding member 3 composed of the plurality of plate-shaped bodies 3a has been shown as an example, the sliding member 3 may be formed by a single member.

[0024] A member preferably used as the plate-shaped body 3a is, for example, a metal member, a wooden member, or a synthetic resin member (including rubber or the like) that has an arc surface e forming a part of a wrapping circumferential surface of a circular shape in a state where the plate-shaped bodies 3a are arrayed over the entire circumference of the roll main body 2, and that has a cross-sectional profile in which a central part 3a3 in the longitudinal direction protrudes outward relative to both end portions as shown in section C-C of FIG. 4 (b).

[0025] Reference sign 5 in the drawings denotes a centering guide that is provided facing the end surfaces 3a1 of the plate-shaped bodies 3a in the longitudinal direction, in a region of the roll main body 2 except for a wrapping region of the metal strip S, and that is hit by the end surfaces 3a1 in the longitudinal direction of the plate-shaped bodies 3a in a moving state such that the plate-shaped bodies 3a are returned to their original positions. The centering guide 5 allows the central parts 3a3 of the plate-shaped bodies 3a in the longitudinal direction to be centered to a threading center O of the metal strip S. In the present invention, when the wrapping region of the metal strip S is denoted by L and the region except for that region L is denoted by L1, the wrapping region L of the metal strip S and the region L1 except for the region L refer to the regions shown in FIG. 5.

[0026] As the centering guide 5, a member including

a base 5a that has a crescent-shaped side surface and is fixed and held on the roll frame 1, and a pair of left and right guide plates 5b that are supported at one end on upper and lower leading end portions of the base 5a can be used.

[0027] The guide plate 5b is provided with a guide surface g of which a free end 5b 1 is farthest away from the roll end surface 2a of the roll main body 2, and to which the distance from the roll end surface 2a of the roll main body 2 decreases gradually toward a fixed end 5b2. In the embodiment of the present invention, the case has been shown as an example in which two pairs of guide plates 5b are provided at the upper and lower leading ends of the base 5a such that the plate-shaped bodies 3a having moved can be reliably centered also when the roll main body 2 rotates in the reverse direction. However, the shape of the side surface and the arrangement of the centering guide 5 can be changed as appropriate and are not limited to those shown in the drawings.

[0028] Further, reference sign 6 in the drawings denotes guide rolls that are provided on the roll frame 1 and respectively located on both sides of the metal strip S to prevent the metal strip S from rolling out while being threaded. As the guide roll 6, a non-driven roller supported at one end that rotates by coming into contact with the metal strip S can be used.

[0029] In the deflector roll configured as described above, when a large frictional force occurs in the axial direction of the roll main body 2, those plate-shaped bodies 3a on which the metal strip S is wrapped (the plate-shaped bodies 3a in the region L) among the plate-shaped bodies 3a composing the sliding member 3 move in the axial direction of the roll main body 2 and thereby reduce the frictional force, so that meandering of the metal strip S attributable to this frictional force is hindered. Meanwhile, in the region L1, the end surfaces 3a1 in the longitudinal direction hit the guide plates 5b of the centering guide 5 and are guided along the guide surfaces g, so that the plate-shaped bodies 3a having moved in the axial direction of the roll main body 2 are returned to their original positions and centered to the threading center O of the metal strip S. In the deflector roll according to the present invention, even when an edge of the metal strip S comes into contact with the guide roll 6, the colliding force is only a colliding force attributable to a shearing force of the metal strip S and therefore its magnitude is significantly reduced.

[0030] Being a passive mechanism, the deflector roll according to the present invention does not require electrical components and control means, and it is relatively easy to replace an existing deflector roll with this deflector roll. Thus, there is an advantage in that the cost of conversion can be reduced.

[0031] The movement of the plate-shaped bodies 3a may be controlled by means of an actuator or the like that uses pneumatic pressure or hydraulic pressure, and in that case, the centering guide 5 is omitted.

[0032] FIG. 6 is a view schematically showing a schematic overall view of a horizontal looper device to which the deflector roll according to the present invention is suitably applied. Here, a looper device is generally a device that functions to temporarily store a metal strip S in the process of being transferred so as to maintain a constant transfer speed of the metal strip S in a downstream-side production process.

[0033] Reference sign 7 in FIG. 6 denotes a deflector roll provided on a most upstream side in a line, and reference signs 8 and 9 denote steering rolls. The steering rolls 8, 9 are rolls that function also as deflectors and are equipped with a CPC meandering control device (the rolls do not move), and can sense the position (an amount of meandering) of the metal strip S relative to the roll and tilt a rotational axis of the roll such that this amount of meandering of the metal strip S becomes zero, i.e., the center of the metal strip S in the width direction passes through the threading center O.

[0034] Reference signs 10 and 11 in FIG. 6 denote looper cars including a deflector roll. The looper cars 10, 11 are moved in the left-right direction of the drawing along a track to thereby change the length of the metal strip S in a threading line as appropriate.

[0035] Reference sign 12 in FIG. 6 denotes support rolls that support the metal strip S at a 2.5 m pitch, for example. Reference sign 13 denotes separator rolls that function to support the metal strip S as well as to open and close when the looper cars 10, 11 pass. The separator rolls 13 are disposed at about 15 m intervals, for example.

[0036] In the horizontal looper device thus configured, it has been hitherto difficult (impossible) to install a CPC meandering control device in the deflector rolls included in the looper cars 10, 11, so that meandering of the metal strip S cannot be hindered by tilting (shifting) the rotational axis of the roll like the steering rolls 8, 9. For this reason, a crown roll is commonly used and the metal strip S is centered using the crown thereof. However, this type of deflector roll cannot be expected to be as effective as the steering roll.

[0037] Regarding a conventional deflector roll adapted as a crown roll, FIG. 7 shows a result of simulating how a metal strip S meanders when threaded under the following conditions: the metal strip S had a sheet width of 1250 mm and a sheet thickness of 2.2 mm; the line speed was 60 mpm; the tensile force was 0.51 kgf/mm^2; the coefficient of friction was 0.3; the length from the steering roll 8 to the looper car 10 and the length from the looper car 10 to the steering roll 9 were both 30 m; and a shape defect portion started to flow 50 seconds after the start of calculation. FIG. 8 is a graph modeling the shape defect of the metal strip S in this simulation by a camber curvature.

[0038] In FIG. 7, the solid line represents the amount of meandering of the metal strip S on the steering roll 8; the dotted line represents the amount of meandering of the metal strip S on the deflector roll of the looper car 10; and the dashed-dotted line represents the amount of me-

andering of the metal strip S on the steering roll 9.

[0039] It is clear from FIG. 7 that, in the steering rolls 8, 9, meandering of the metal strip S can be hindered to some extent by CPC meandering control, whereas in the conventional deflector roll included in the looper car 10, despite the roll being crowned, the metal strip S meanders significantly and rolls out beyond an allowable range of ±0.175 m for the amount of meandering. This demonstrates that simply adapting the deflector roll as a crown roll cannot hinder the metal strip S from meandering.

[0040] FIG. 9 is a graph showing a result of simulating an amount of meandering of a metal strip S on the steering rolls 8, 9 and the looper car 10 in a case where the guide rolls 6 were installed in the support rolls 12 and the separator rolls 13 to hinder roll-out of the metal strip S due to meandering. FIG. 10 is a graph modeling the shape defect of the metal strip S in this simulation by a camber curvature.

[0041] In FIG. 9, the solid line represents the amount of meandering of the metal strip S on the steering roll 8; the dotted line represents the amount of meandering of the metal strip S on the looper car 10; and the dashed-dotted line represents the amount of meandering of the metal strip S on the steering roll 9.

[0042] According to FIG. 9, in the steering rolls 8, 9, meandering of the metal strip S is hindered to some extent by CPC meandering control, and also in the deflector roll 7 included in the looper car 10, the amount of meandering of the metal strip S can be almost kept within the allowable range. However, as shown in FIG. 11, a colliding force occurs between an edge of the metal strip S and the guide rolls 6, which raises a concern that the edge of the metal strip S may become chipped or deformed.

[0043] FIG. 12 is a graph showing a result of simulating an amount of meandering of a metal strip S in a case where the metal strip S was threaded with the deflector roll installed in the looper car 10 changed to the deflector roll according to the present invention. FIG. 13 is a graph modeling the shape defect of the metal strip S in this simulation by a camber curvature. Further, FIG. 14 is a graph showing a colliding force occurring between the metal strip S and the guide rolls 6.

[0044] In FIG. 12, the solid line represents the amount of meandering of the metal strip S on the steering roll 8; the dotted line represents the amount of meandering of the metal strip S on the looper car 10; and the dashed-dotted line represents the amount of meandering of the metal strip S on the steering roll 9.

[0045] As shown in FIG. 12, in the looper car 10 including the deflector roll according to the present invention, meandering of the metal strip S on the looper car 10 is about 0.15 m, which is far below the allowable range of ±0.175 m. Moreover, as shown in FIG. 14, it is clear that the colliding force occurring between the metal strip S and the guide rolls 6 is also substantially reduced compared with that in the conventional deflector roll.

[0046] In a steel sheet production facility as shown in FIG. 15, for example, in which a looper device is installed between a hot rolling step as an upstream-side production process and a cold rolling step as a downstream-side production process, there is a concern that when a metal strip S having been hot-rolled is passed as is through the looper device, as the metal strip S has a shape defect remaining therein, meandering may be facilitated and the metal strip S may become chipped at the edge by colliding with the guide rolls 6. When cold rolling is performed in the state where the metal strip S is chipped, the metal strip S is highly likely to break and make operation impossible. To avoid this, it is necessary to set the transfer speed of the metal strip to 50 mpm or lower in the section of about 30 to 100 m from near the joint between the metal strips S to the entry side of a cold rolling machine. This has been a cause of reduced production efficiency of steel sheets.

[0047] When the deflector roll according to the present invention is installed in a looper device, the metal strip S is restricted from meandering significantly, so that the section where the transfer speed of the metal strip S is set to 50 mpm or lower can be shortened to about 30 m at the longest. As a result, efficient production of steel sheets becomes possible.

[0048] FIG. 16 is a view showing a facility in which a looper device is installed on each of an entry side of an annealing treatment step and a delivery side of a pickling treatment step. Such a facility is sometimes provided between the hot rolling step and the cold rolling step of the steel sheet production facility shown in FIG. 15 described above, and the deflector roll according to the present invention is also applicable to the looper device shown in FIG. 16.

[0049] FIG. 17 is a view showing further another embodiment of the deflector roll according to the present invention in cross-section of a main part. In this embodiment, the plate-shaped bodies 3a of the sliding member 3 are each composed of an outer member 3b having an arc surface e and an inner member 3c placed on a lower surface of the outer member 3b so as to define and form an installation space of an elastic member 14 between the outer member 3b and the inner member 3c. One end of the elastic member 14 disposed inside the installation space is coupled to an inner end of the outer member 3b, while the other end of the elastic member 14 is coupled to a protruding portion 2b provided at a body central part of the roll main body 2, such that the plate-shaped body 3a is elastically supported by the elastic member 14 so as to be movable along the axial direction of the roll main body 2 within the range of a notch 3d formed in the inner member 3c.

[0050] Just like the deflector rolls shown in FIGs. 1 to 3 described above, this deflector roll is provided with the linear guide 4 formed by a combination of a plurality of rollers between the inner member 3c of the plate-shaped body 3a and the roll main body 2. (In FIG. 17, the linear guide 4 is not shown.) Using a frictional force attributable

to meandering of the metal strip S, the plate-shaped bodies 3a can be moved along the axial direction of the roll main body 2 as shown in FIGs. 18 (a) and 18(b) to thereby restrict the metal strip S from meandering more significantly. In a case where the metal strip S has separated from the plate-shaped bodies 3a or in a transfer state where the metal strip S is not meandering, the plate-shaped bodies 3a are returned to their original positions and centered by the urging force of the elastic member 14 such that the central parts 3a3 of the plate-shaped bodies 3a in the longitudinal direction and the threading center O of the metal strip S coincide with each other. Such a deflector roll has the advantage of having a simple structure.

Example

[0051] Operation of an actual facility in which the metal strip S was threaded under the same conditions as those used for the above-described simulations was conducted in two cases: in one case, a horizontal looper device in which a conventional deflector roll was disposed in each of the looper cars 10, 11 and guide rolls were installed in the support rolls 12 and the separator rolls 13 (conventional device) was used; and in the other case, a horizontal looper device in which the deflector roll according to the present invention was disposed in the looper car 10 (conforming device) was used.

[0052] As a result, in the conventional device, the metal strip S meandered between the looper car 10 and the steering roll 8 and came into contact with the guide rolls, but the metal strip S did not become chipped at the edge therebetween. However, when the metal strip S meandered significantly on the looper car 10, the guide rolls directly upstream of the looper car 10 collided hard with the metal strip S, causing a problem of the metal strip S becoming chipped at the edge.

[0053] By contrast, in the device including the deflector roll according to the present invention, even when the metal strip S meandered significantly on the looper car 10 and the edge of the metal strip S came into contact with the guide rolls, a problem such as the metal strip S becoming chipped at the edge did not occur, and it was confirmed that the colliding force in this case was at a level equivalent to that of a colliding force that does not cause chipping of the edge of the metal strip S.

[0054] Using the production facility shown in FIG. 15 described above in which the looper device adopting the deflector roll according to the present invention was disposed between a hot rolling step as an upstream-side production process and a cold rolling step as a downstream-side production process, or a production facility combining the production facility shown in FIG. 15 described above additionally with the facility shown in FIG. 16 described above as appropriate, a non-oriented magnetic steel sheet was produced by performing hot rolling of rolling a 215 mm-thick slab to a finished sheet thickness of 2 mm and a finished sheet width of 1289 mm, and cold rolling of threading the sheet with a sheet thickness of 2 mm and a sheet width of 1280 mm through the looper device and further rolling the sheet to an entry-side sheet thickness of 2 mm, a finished sheet thickness of 0.245 mm, and a finished sheet width of 1289 mm. The obtained non-oriented magnetic steel sheet was examined as to the state of occurrence of chipping of the edge. As a result, it was confirmed that there was no chipping of the edge of the obtained non-oriented magnetic steel sheet, and that the section where the transfer speed was set to 50 mpm or lower on the entry side of the cold rolling step could be shortened to about 30 m to allow efficient production of a non-oriented magnetic steel sheet.

Industrial Applicability

[0055] The present invention can provide a deflector roll on which a metal strip can be threaded without significant meandering and which enables efficient production of a steel sheet, and a method of producing a steel sheet using this deflector roll.

Reference Signs List

[0056]

1	Roll frame
2	Roll main body
2a	Roll end surface
2b	Protruding portion
3	Sliding member
3a	Plate-shaped body
3a1	End surface in longitudinal direction
3a2	End surface in width direction
3a3	Central part in longitudinal direction
3b	Outer member
3c	Inner member
3d	Notch
4	Linear guide
5	Centering guide
5a	Base
5b	Guide plate
5b 1	Free end
5b2	Fixed end
6	Guide roll
7	Deflector roll
8, 9	Steering roll
10, 11	Looper car
12	Support roll
13	Separator roll
14	Elastic member
S	Metal strip
e	Arc surface
O	Threading center
g	Guide surface

Claims

1. A deflector roll that changes a travelling direction of a metal strip being threaded, **characterized in that**:

   the deflector roll comprises a roll main body that is rotatably supported by a roll frame, and a sliding member that is provided so as to be movable relative to an outer surface of the roll main body; and
   the sliding member is configured to have the metal strip wrapped thereon and to be movable along an axial direction of the roll main body while maintaining that wrapped state.

2. The deflector roll according to claim 1, wherein the sliding member includes a plurality of plate-shaped bodies, and the plate-shaped bodies are arrayed over an entire circumference of the roll main body, with end surfaces in a longitudinal direction located on roll end surface sides of the roll main body and end surfaces in a width direction facing one another.

3. The deflector roll according to claim 1, wherein each of the plate-shaped bodies has an arc surface that forms a part of a wrapping circumferential surface of a circular shape in a state where the plate-shaped bodies are arrayed over the entire circumference of the roll main body.

4. The deflector roll according to claim 2 or 3, wherein the plate-shaped bodies are each separately movable along the axial direction of the roll main body.

5. The deflector roll according to any one of claims 2 to 4, wherein each of the plate-shaped bodies has a cross-sectional profile in which a central part in the longitudinal direction protrudes outward relative to both end portions of the plate-shaped body.

6. The deflector roll according to any one of claims 2 to 5, wherein the roll frame has centering guides that are provided facing the end surfaces of the plate-shaped bodies in the longitudinal direction, in a region of the roll main body except for a wrapping region of the metal strip, and that are hit by the end surfaces in the longitudinal direction of the plate-shaped bodies in a moving state such that the plate-shaped bodies are returned to original positions and centered to a threading center of the metal strip.

7. The deflector roll according to claim 6, wherein:

   the centering guide includes a base that is held on the roll frame and a guide plate that is supported at one end on the base; and
   the guide plate has a guide surface of which a free end is farthest away from a roll end surface of the roll main body and to which a distance from the roll end surface of the roll main body decreases gradually toward a fixed end.

8. The deflector roll according to any one of claims 1 to 7, wherein the roll frame has guide rollers that are respectively located on both end sides of the metal strip in a width direction to prevent the metal strip from rolling out while being threaded.

9. The deflector roll according to claim 1, wherein the sliding member has an elastic member that elastically supports the sliding member so as to be movable along the axial direction of the roll main body, and that returns the sliding member to an original position by an urging force.

10. A method of producing a steel sheet using a deflector roll that produces a steel sheet by transferring a metal strip having undergone an upstream-side production process to a downstream-side production process so as to pass through a looper device in which at least one deflector roll according to any one of claims 1 to 9 is installed, **characterized in that**
    while the metal strip is passing through the looper device, the sliding member of the deflector roll, along with the metal strip wrapped on the deflector roll, is moved along the axial direction of the roll main body using a frictional force attributable to meandering of the metal strip.

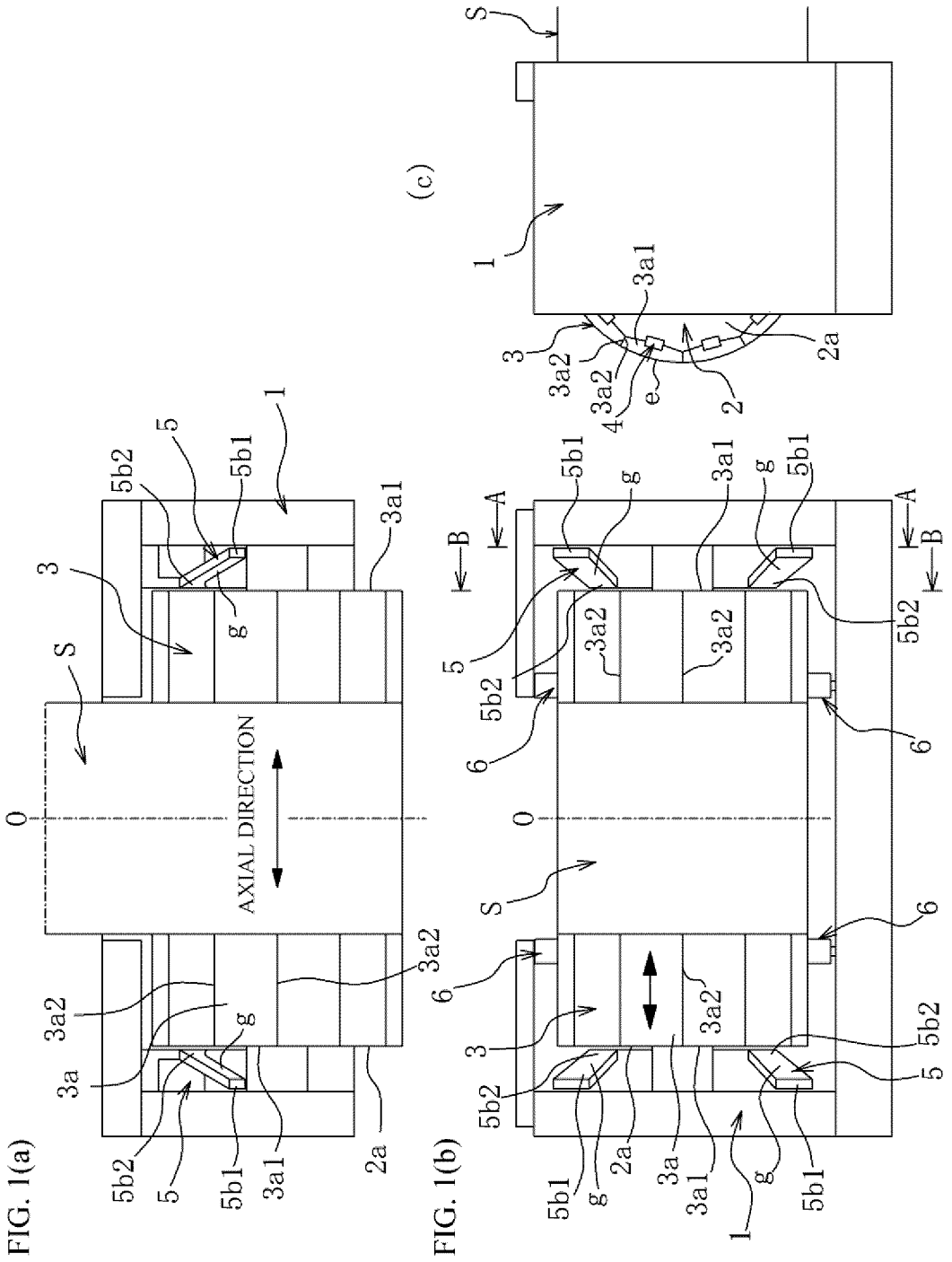


FIG. 1(a)
FIG. 1(b)
(c)
AXIAL DIRECTION
S
0
A
B
1
2
2a
3
3a
3a1
3a2
4
5
5b1
5b2
6
e
g

FIG. 2

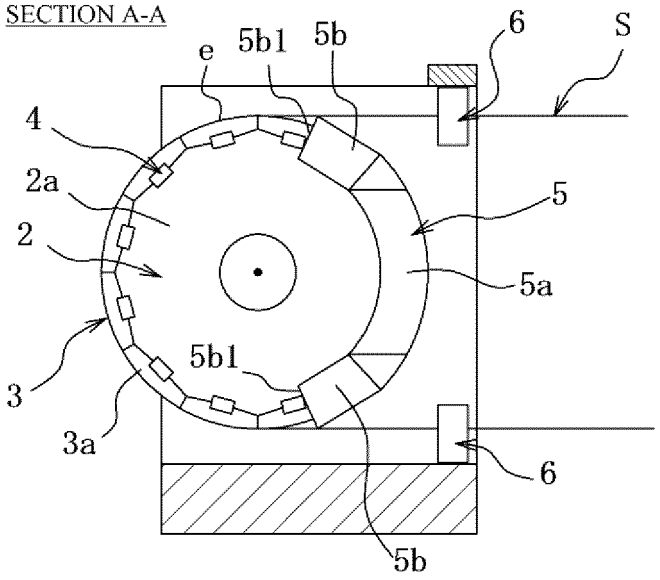

SECTION A-A
e
5b1
5b
6
S
4
2a
2
5
5a
3
5b1
3a
6
5b

FIG. 3

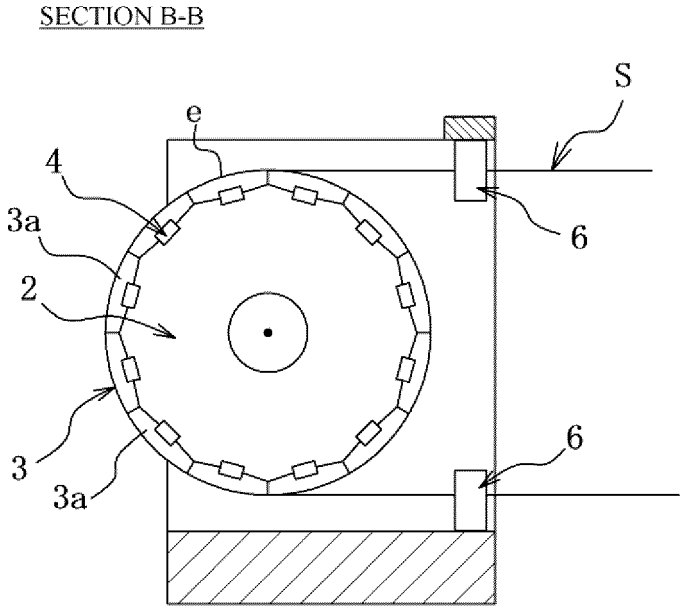

SECTION B-B
S
e
4
3a
2
6
3
3a
6

FIG. 4(a)

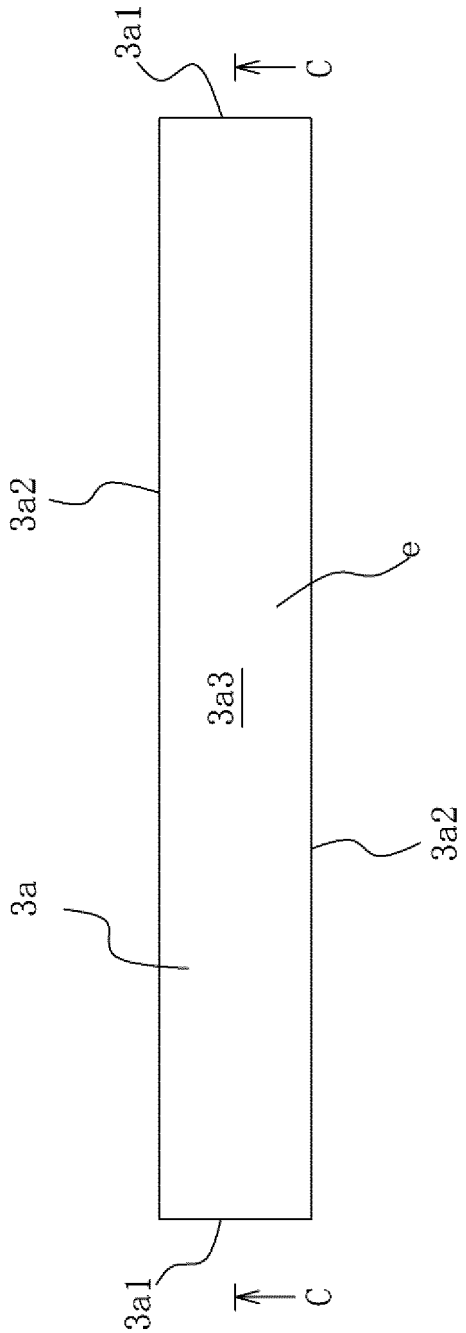


FIG. 4(b)

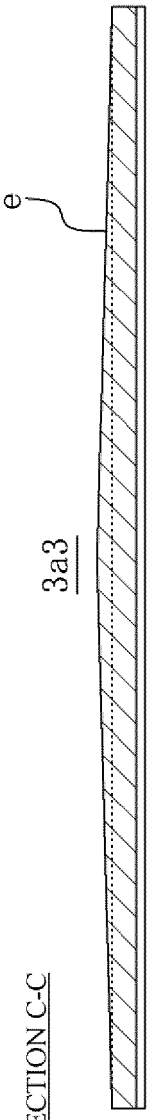


FIG. 4(c)

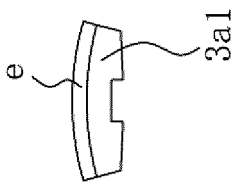
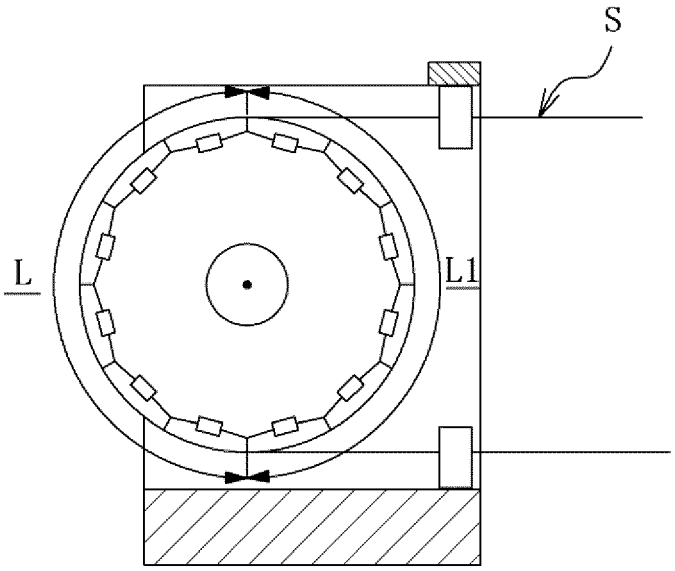


FIG. 5



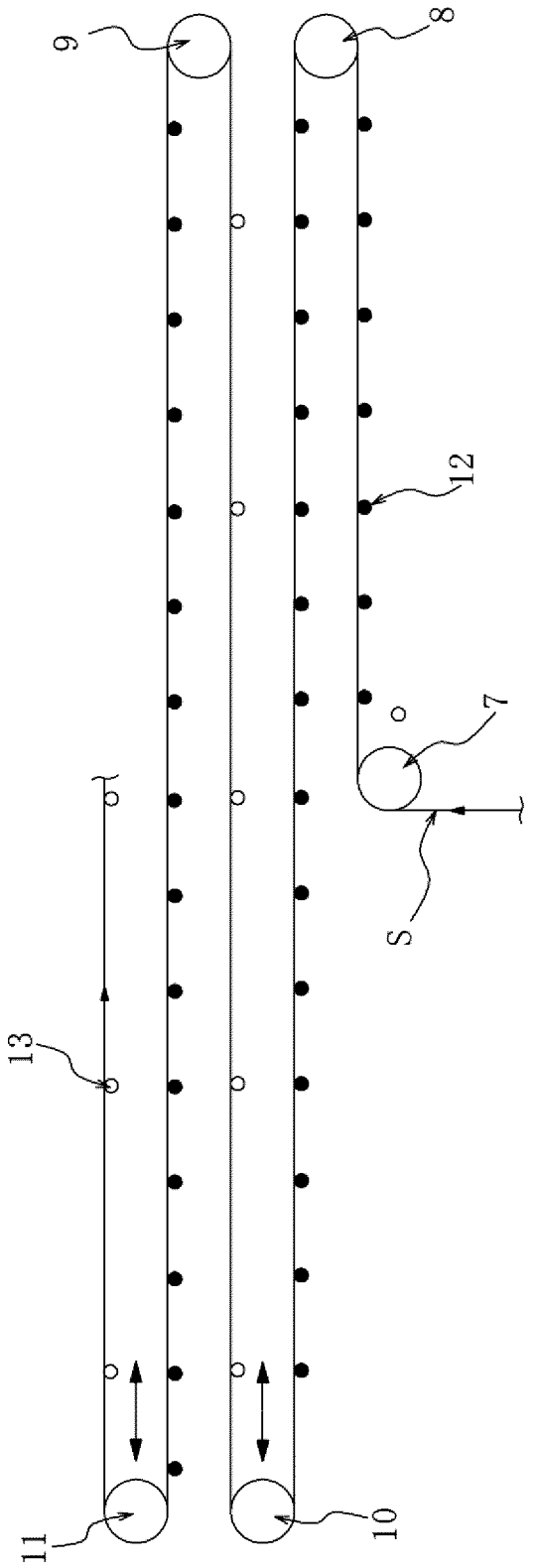


FIG. 6

FIG. 7

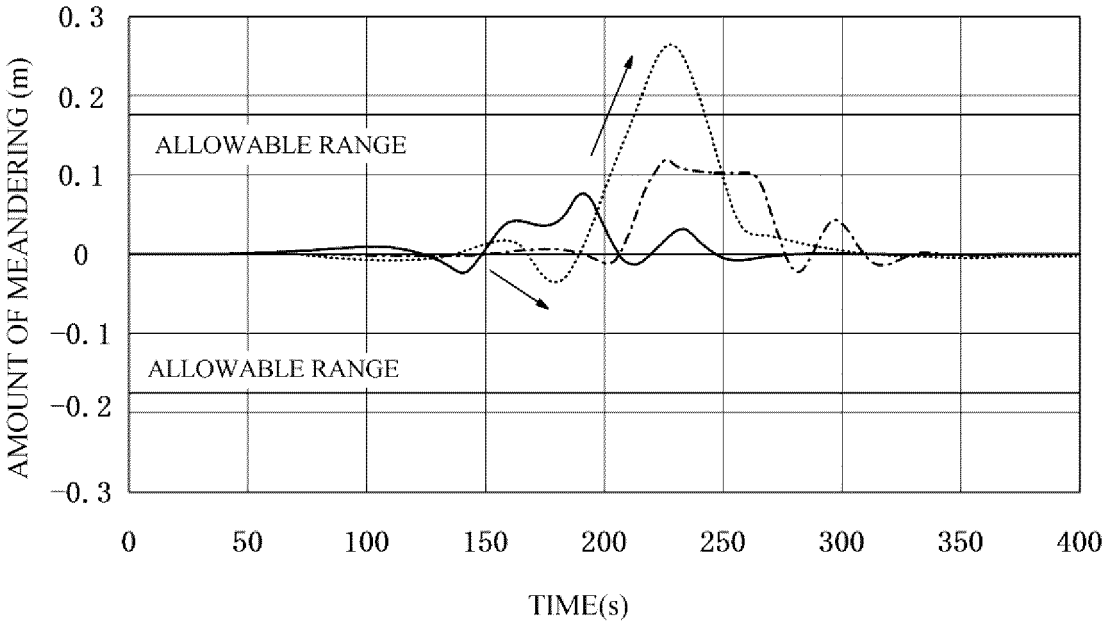

0.3
0.2
0.1
0
−0.1
−0.2
−0.3
AMOUNT OF MEANDERING (m)
ALLOWABLE RANGE
ALLOWABLE RANGE
0
50
100
150
200
250
300
350
400
TIME(s)

FIG. 8

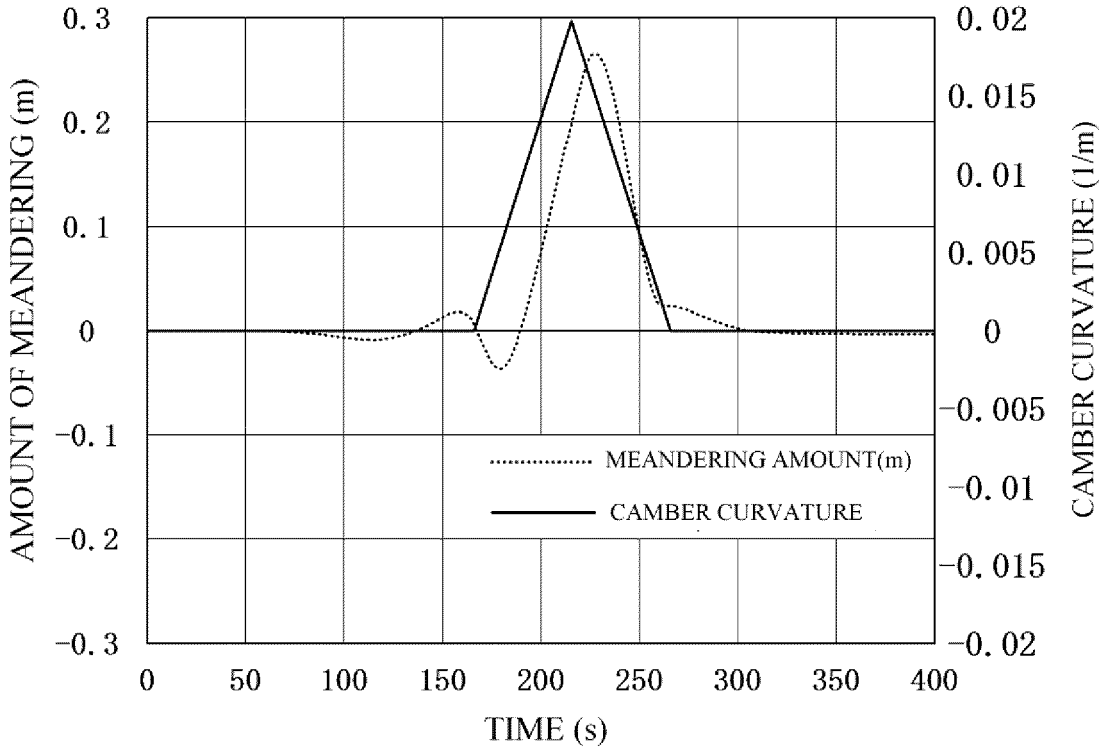

0.3
0.2
0.1
0
−0.1
−0.2
−0.3
AMOUNT OF MEANDERING (m)
0.02
0.015
0.01
0.005
0
−0.005
−0.01
−0.015
−0.02
CAMBER CURVATURE (1/m)
MEANDERING AMOUNT(m)
CAMBER CURVATURE
0
50
100
150
200
250
300
350
400
TIME (s)

FIG. 9

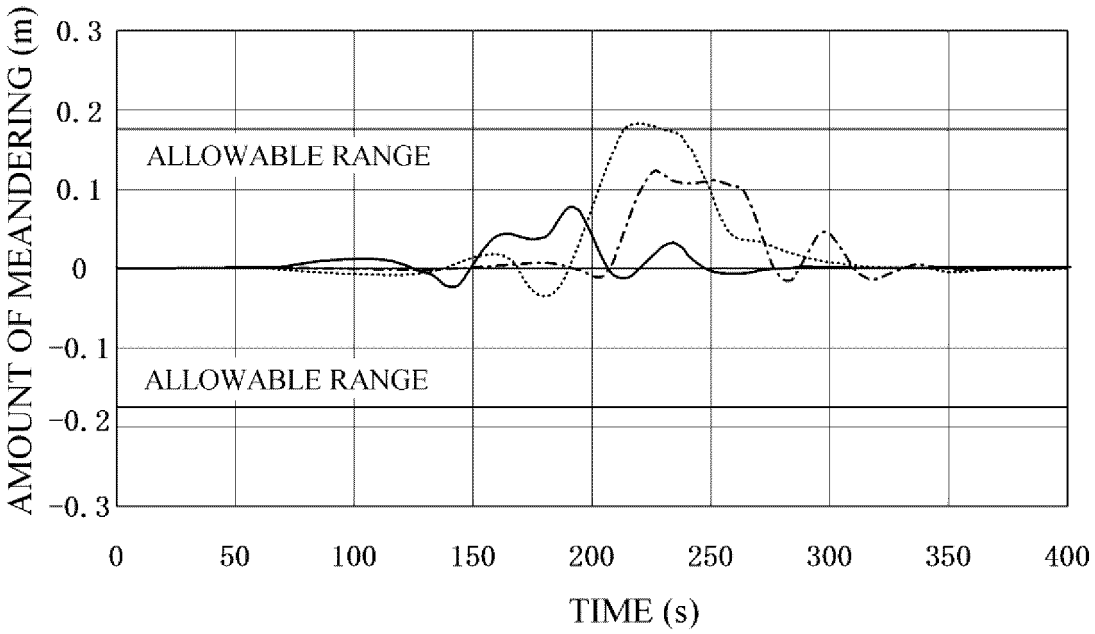

AMOUNT OF MEANDERING (m)
0.3
0.2
0.1
0
−0.1
−0.2
−0.3
ALLOWABLE RANGE
ALLOWABLE RANGE
0
50
100
150
200
250
300
350
400
TIME (s)

FIG. 10

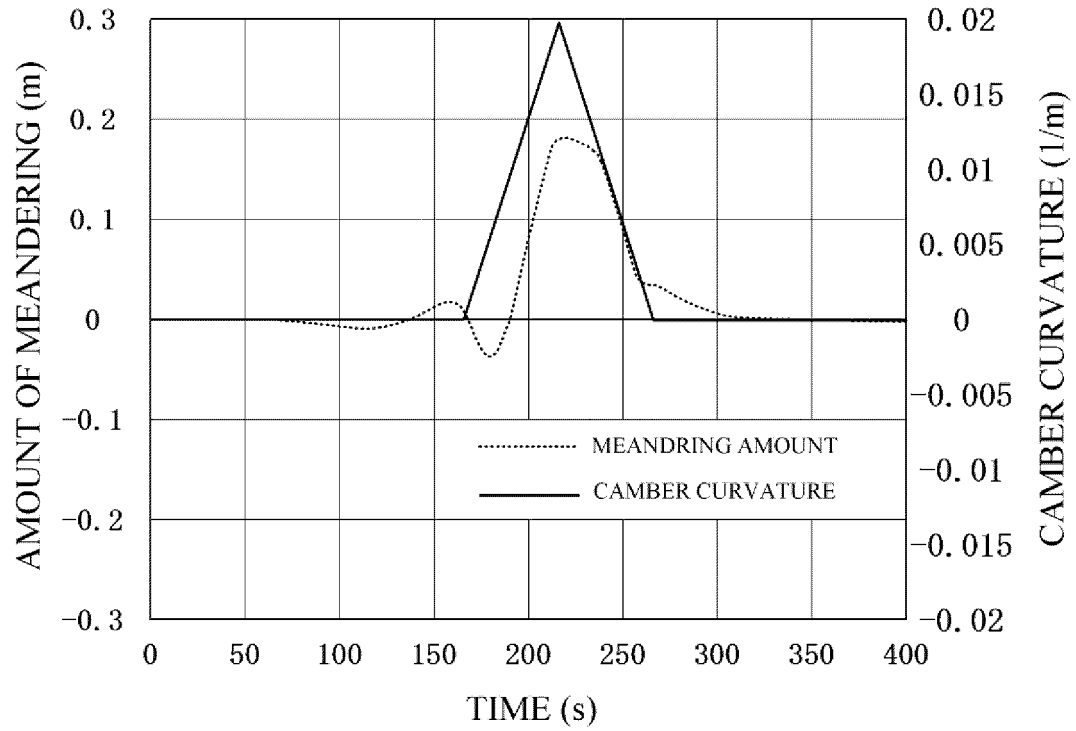

AMOUNT OF MEANDERING (m)
0.3
0.2
0.1
0
−0.1
−0.2
−0.3
0.02
0.015
0.01
0.005
0
−0.005
−0.01
−0.015
−0.02
CAMBER CURVATURE (1/m)
MEANDRING AMOUNT
CAMBER CURVATURE
0
50
100
150
200
250
300
350
400
TIME (s)

FIG. 11

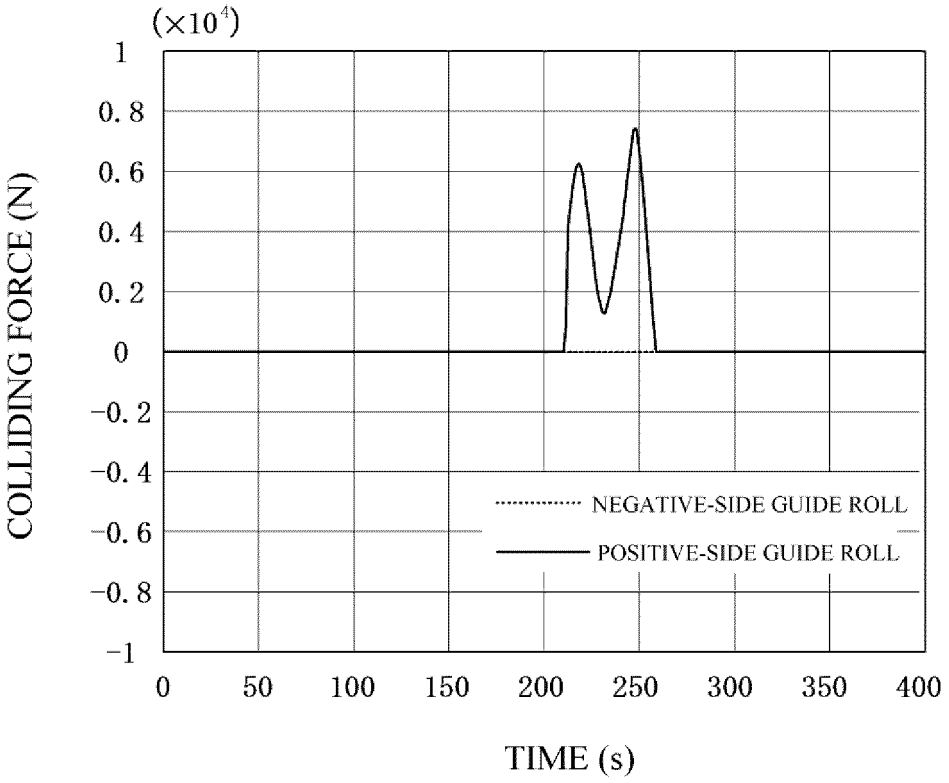

(×10^4)
1
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
−1
COLLIDING FORCE (N)
NEGATIVE-SIDE GUIDE ROLL
POSITIVE-SIDE GUIDE ROLL
0
50
100
150
200
250
300
350
400
TIME (s)

FIG. 12

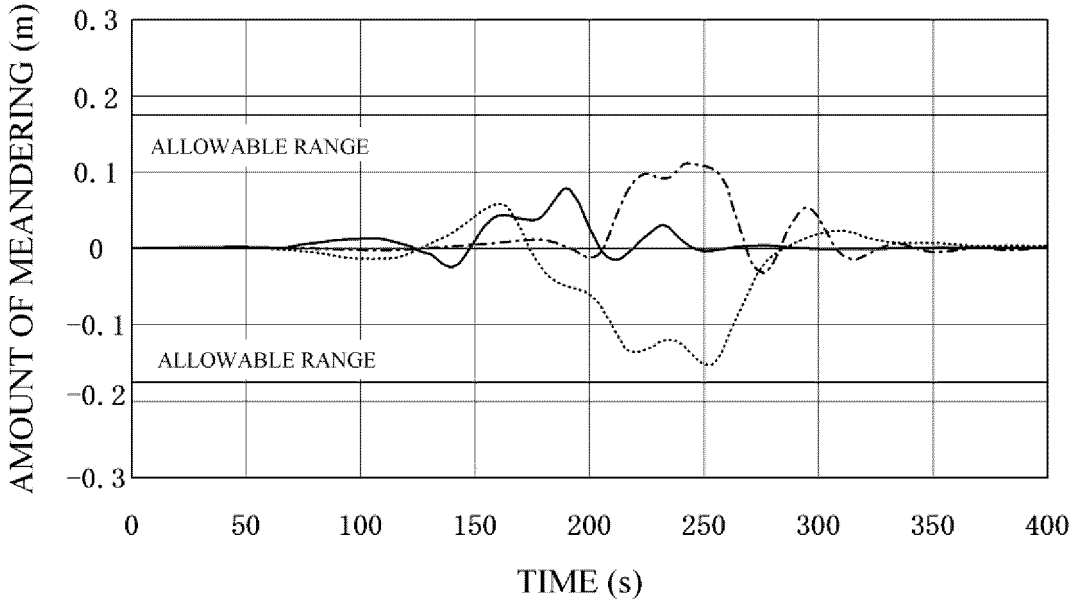

0.3
0.2
0.1
0
−0.1
−0.2
−0.3
AMOUNT OF MEANDERING (m)
ALLOWABLE RANGE
ALLOWABLE RANGE
0
50
100
150
200
250
300
350
400
TIME (s)

FIG. 13

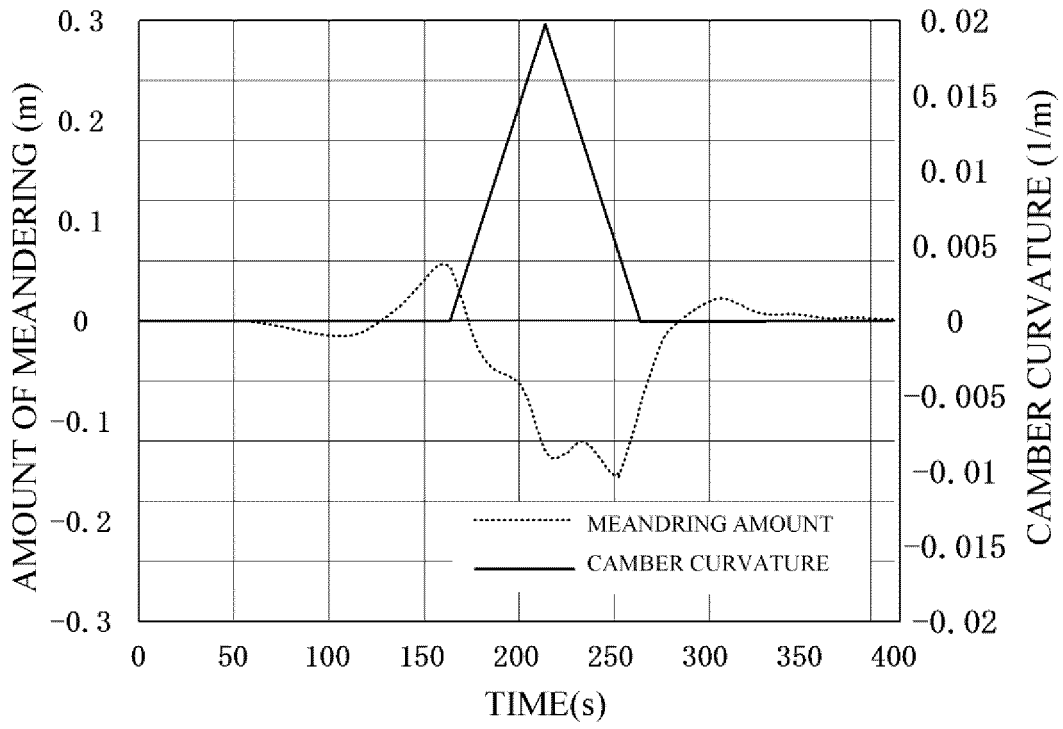

0.3
0.2
0.1
0
−0.1
−0.2
−0.3
AMOUNT OF MEANDERING (m)
0.02
0.015
0.01
0.005
0
−0.005
−0.01
−0.015
−0.02
CAMBER CURVATURE (1/m)
MEANDRING AMOUNT
CAMBER CURVATURE
0
50
100
150
200
250
300
350
400
TIME(s)

FIG. 14

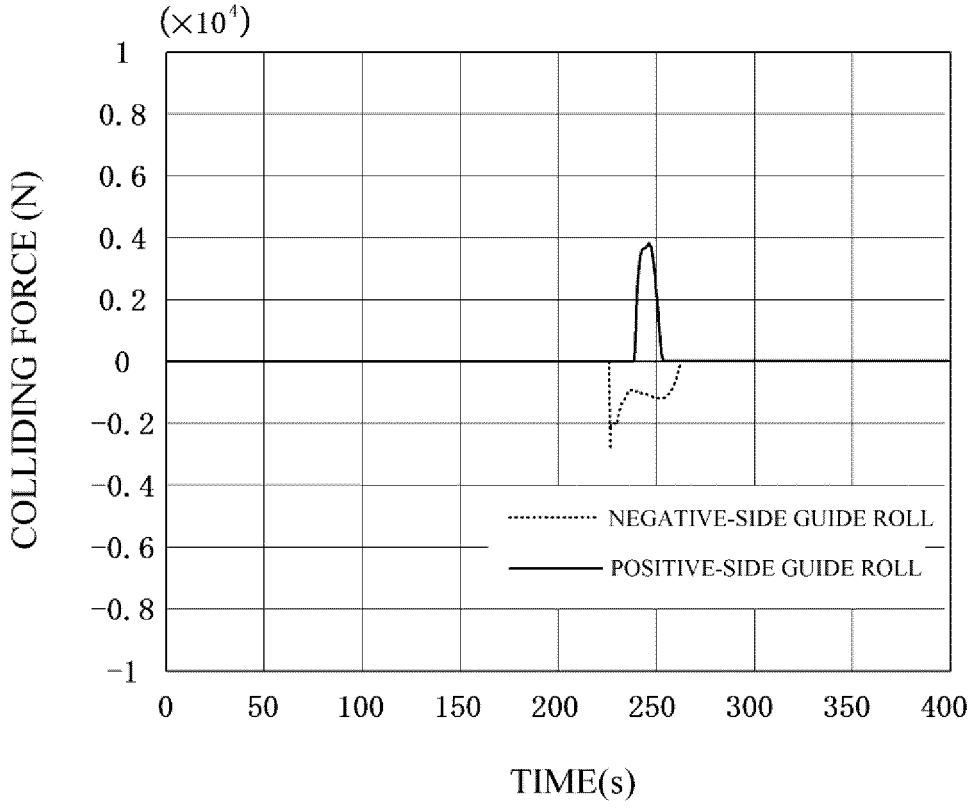

(×10^4)
1
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
−1
COLLIDING FORCE (N)
NEGATIVE-SIDE GUIDE ROLL
POSITIVE-SIDE GUIDE ROLL
0
50
100
150
200
250
300
350
400
TIME(s)

FIG. 15

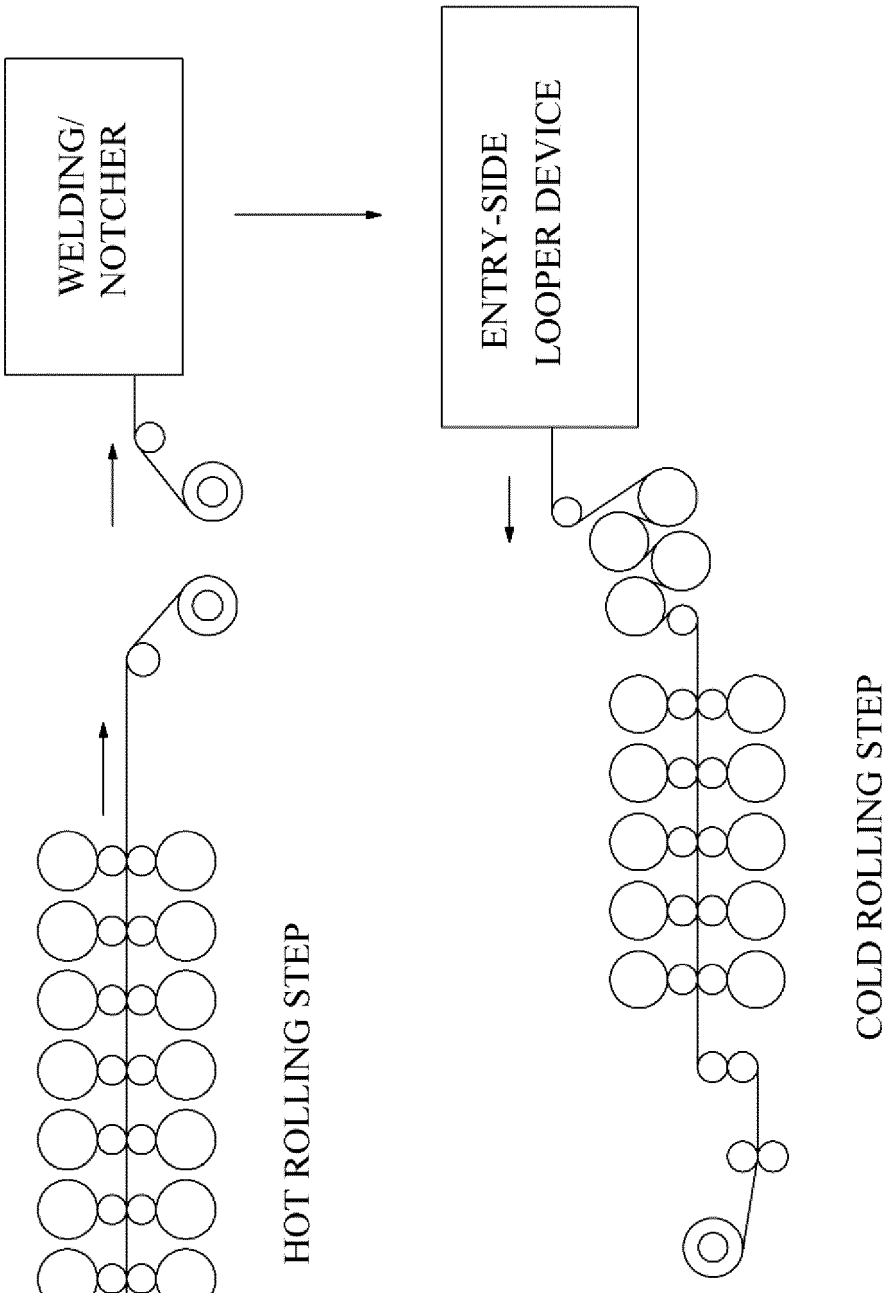

WELDING/
NOTCHER
ENTRY-SIDE
LOOPER DEVICE
HOT ROLLING STEP
COLD ROLLING STEP

FIG. 16

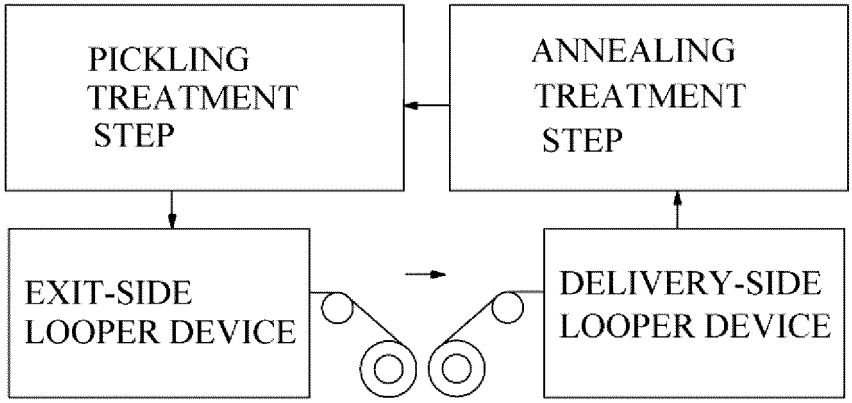

PICKLING TREATMENT STEP
ANNEALING TREATMENT STEP
EXIT-SIDE LOOPER DEVICE
DELIVERY-SIDE LOOPER DEVICE

FIG. 17

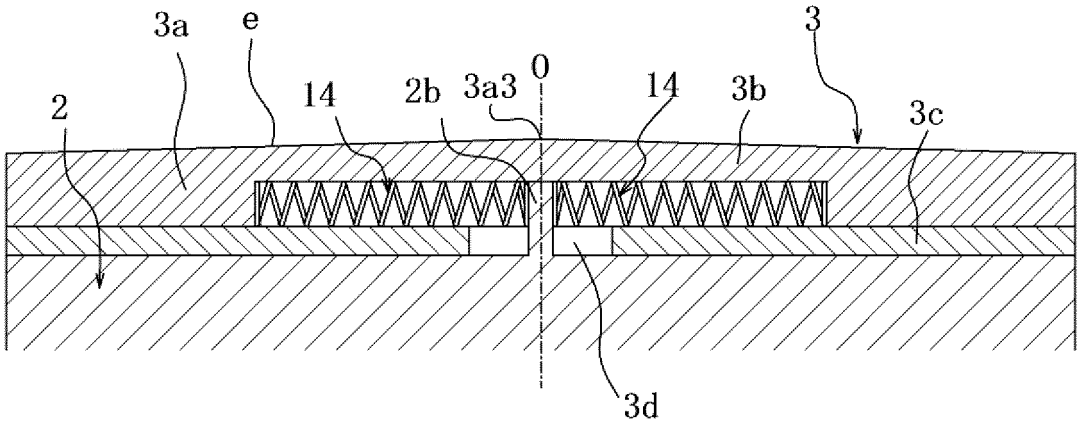

3a
e
3
0
2
14
2b
3a3
14
3b
3c
3d

FIG. 18(a)

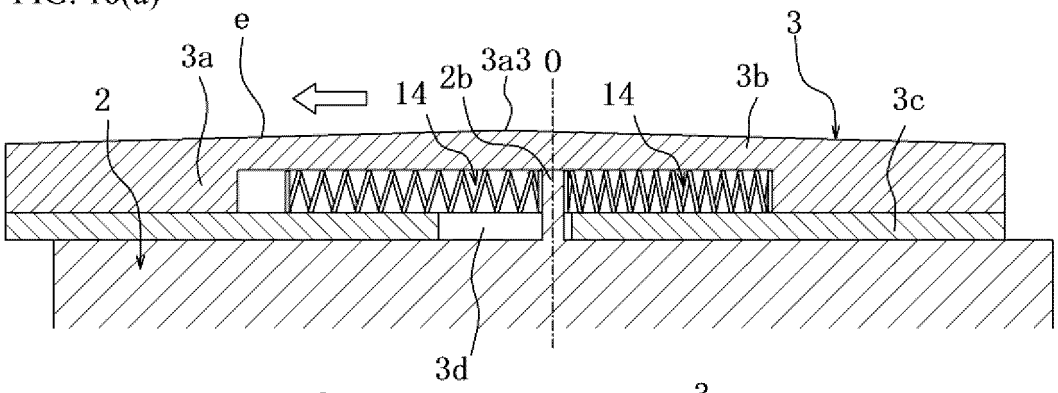
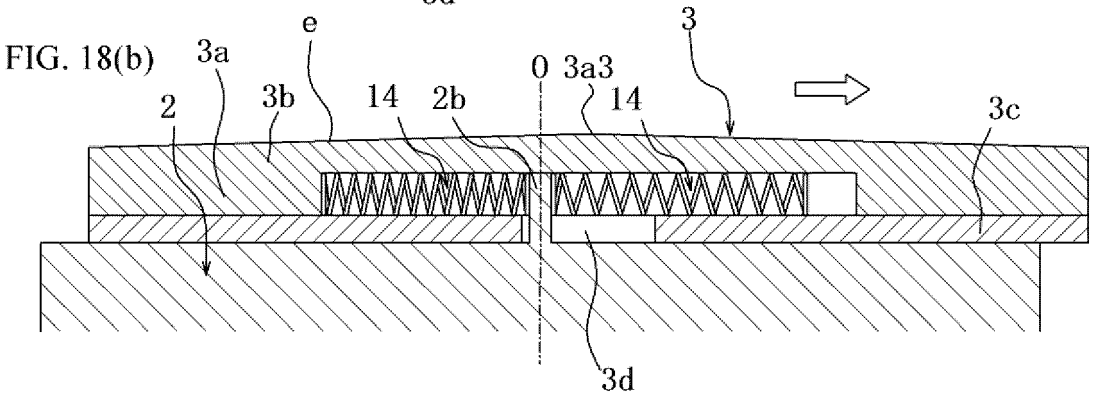


FIG. 18(b)



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2022/022443

A. CLASSIFICATION OF SUBJECT MATTER

B21B 41/10(2006.01)i; ***B21B 39/14***(2006.01)i; ***B65H 23/32***(2006.01)i
FI: B21B41/10; B21B39/14 J; B65H23/32

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)

B21B41/10; B21B39/14; B65H23/32

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

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2022
Registered utility model specifications of Japan 1996-2022
Published registered utility model applications of Japan 1994-2022

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.
X	JP 61-176417 A (MITSUBISHI HEAVY INDUSTRIES, LTD.) 08 August 1986 (1986-08-08) pp. 1-3	1-4, 6-9
Y		1-9
A		10
X	JP 07-227605 A (UBE INDUSTRIES, LTD.) 29 August 1995 (1995-08-29) paragraphs [0001]-[0029], fig. 1-6, 8	1-4, 6-9
Y		1-9
A		10
X	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 033366/1976 (Laid-open No. 125287/1977) (NIPPON STEEL CORP.) 22 September 1977 (1977-09-22), pp. 1-5, fig. 1-3	1-4, 6-9
Y		1-9
A		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
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
01 July 2022	**12 July 2022**

Name and mailing address of the ISA/JP	Authorized officer
Japan Patent Office (ISA/JP) **3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915** **Japan**	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2022/022443

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 039710/1986 (Laid-open No. 153420/1987) (NIPPON STEEL CORP.) 29 September 1987 (1987-09-29), pp. 1-4, fig. 1, 2	1-9

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2022/022443

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 61-176417 A	08 August 1986	(Family: none)	
JP 07-227605 A	29 August 1995	(Family: none)	
JP 52-125287 U1	22 September 1977	(Family: none)	
JP 62-153420 U1	29 September 1987	(Family: none)	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2002002934 A **[0012]**
- JP 2010207867 A **[0012]**