(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 517 800 A1

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

(43) Date of publication:
31.10.2012 Bulletin 2012/44

(21) Application number: **10839613.6**

(22) Date of filing: **20.12.2010**

(51) Int Cl.:
B21B 39/14 *(2006.01)* ***B21B 39/00*** *(2006.01)*
B21B 39/08 *(2006.01)* ***B21C 47/26*** *(2006.01)*

(86) International application number:
PCT/JP2010/073644

(87) International publication number:
WO 2011/078385 (30.06.2011 Gazette 2011/26)

(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

(30) Priority: **24.12.2009 JP 2009292106**
02.12.2010 JP 2010269375

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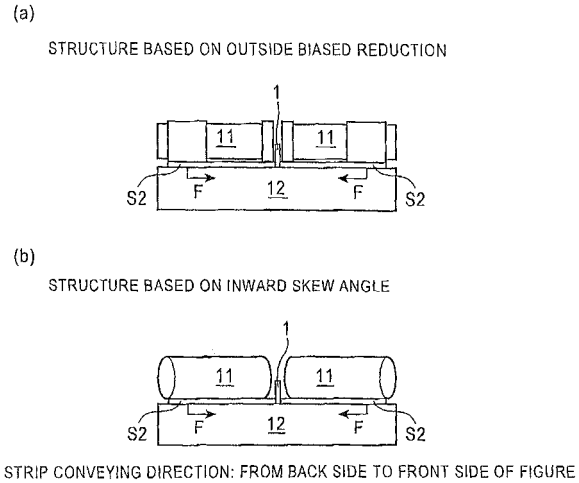
(54) SKEW PREVENTION DEVICE FOR SLIT BAND PLATES

(57) Slit strips can be stabilized at the central area of a conveyance line without damaging the edges of the strips or using a complex control system. In addition, even in an unsteady operation in which, for example, the tail end of the strip after the cutting process is passed, the strip can be passed in a stable state. An apparatus to prevent strip walking passes the slit strips S1 and S2 with a pinch roll. The pinch roll includes the lower roll 12 that supports the bottom surfaces of the slit strips and the upper rolls 11 that are separated from each other in a strip width direction. The upper rolls come into contact with the top surfaces of the slit strips and move the slit strips toward the line center by using the outside biased pinch or the inward skew angle. Portions of the slit strips around the line-center-side edges of the slit strips are nipped by the lower roll and the separated upper rolls or by the lower roll and a center roll 2 provided at a line center area near separation ends of the upper rolls that are separated from each other. The apparatus includes the center guide 1 that guides the line-center-side edges of the slit strips that are restrained by being nipped.

FIG. 1



EP 2 517 800 A1

Description

[Technical Field]

[0001] The present invention relates to apparatuses to prevent strip walking of slit strips (strips that are slit, also called slit materials), and more particularly, to an apparatus to prevent strip walking used to stably pass a strip by suppressing strip walking and stably coil the strip while avoiding formation of a telescoped coiled strip.
The present invention is particularly advantageous when a leading end or a tail end of a strip, at which tension decreases, is passed. The tension decreases in, for example, the following cases. That is, on a conveying table roller between a finishing mill and a coiler in a hot rolling line of a steel strip, the tension is low in periods before the leading end of the steel strip reaches the coiler and after the tail end of the steel strip leaves the finishing mill. In addition, in a cold rolling line or a continuous processing line of a steel strip, the tension decreases when the steel strip is subjected to shear cutting immediately before coiling is finished. The strips to which the present invention may be applied include metal strips, such as steel strips, and sheet-shaped plastic films.

[Background Art]

[0002] In the following description, "nip" means a contact zone in which a conveying roll (including a pinch roll) is in contact with a strip that is being passed. In addition, "skew angle" means a roll skew angle at which rolls are skewed outward or inward with respect to a strip conveying direction. A skew angle at which the rolls are skewed outward is called an outward skew angle, and a skew angle at which the rolls are skewed inward (see Fig. 3) is called an inward skew angle.
In the case where a relatively narrow strip is required, a slitter is arranged at an entrance side of a coiler in a recoiling line, and a rolled strip having a large width is divided into separate strips in a strip width direction. The thus-obtained separate strips are coiled individually. The following are examples of the background art regarding such a slit line:

(1) Apparatus including separator disks (PTL 1)

[0003] In this apparatus, a strip S that has been fed is trimmed by side trimmers at the sides thereof in a strip width direction, and is cut by a slitter at a central position thereof in the strip width direction so that the strip S is divided into two slit materials S1 and S2. The slit materials S1 and S2 are caused to pass a deflector roll and coiled by a single coiler while a slit gap is maintained by separator disks.

(2) Apparatus including guide means

[0004] On a conveying table roller between a finishing mill and a coiler in a hot rolling line, the tension is eliminated after the tail end of the steel strip leaves the finishing mill. Accordingly, an unstable operation may occur in which the tail end of the steel strip undulates or strip walking in the strip width direction occurs. Guide means, such as a side guide, is use to suppress such an operation. Similarly, a method of forcibly restraining a strip with guide means, such as a side guide, is also used in a general operation line to retain the tail end of the strip at a line center position.

(3) Apparatus including edge position control (EPC) device (PTL 1)

[0005] In this apparatus, the two slit materials S1 and S2 are individually coiled by respective coilers. The positions of the sides (edges) of the slit materials S1 and S2 in the strip width direction immediately before the slit materials S1 and S2 are coiled are detected by respective edge sensors. The slit gap is adjusted by moving coiling shafts in the respective coilers in the strip width direction in accordance with the amounts of movement of the edges. Thus, the operation speed of the line can be increased.

(4) Apparatus including skew rolls (PTL 1)

[0006] This apparatus includes a single coiler and left and right skew rolls that are respectively in contact with the two slit materials S1 and S2. The left and right skew rolls are arranged to have the same skew angle, and the skew angle is varied such that a detection value obtained by a slit gap detector approaches a desired value. Thus, the slit gap is adjusted and maintained so as to achieve an excellent coiling appearance that edge becomes complete.

(5) Apparatus including pinch roll capable of performing biased pinch adjustment (PTL 2)

[0007] In this apparatus, each of a plurality of slit materials is provided with a pinch roll that is located between a slitter and a tension reel (coiler) and that is capable of performing a biased pinch adjustment. Owing to the biased pinch adjustment, the slit materials are guided in a direction away from the line center. When biased pinch (partial pinch) is applied to each slit material in an area near the line center, rotation moment is generated in a direction such that the slit gap increases.

[Citation List]

[Patent Literature]

[0008]

[PTL 1] Japanese Unexamined Patent Application Publication No. 3-5017

[PTL 2] Japanese Unexamined Patent Application Publication No. 10-230319

[Summary of Invention]

[Technical Problem]

[0009] According to example (1) of the background art, if the slit gap varies in accordance with the properties of the slit materials S1 and S2, sufficient adjustment cannot be made by the separator disks. As a result, there is a possibility that the slit gap will decrease and strip side portions at both sides of the slit gap will be deformed by being pressed against the separator disks. In addition, there is also a possibility that the slit gap will increase and a coiling failure, a non-uniform edge alignment, etc., will occur. As a result, the line speed cannot be increased and the operation must be performed at a low speed. In addition, at the separator disks, the slit materials are not retained by rolls or the like in the vertical direction. Therefore, if the strip side portions at both sides of the slit gap come into contact with the separator disks, the slit materials will be bent in the vertical direction and the strip side portions will be damaged.

[0010] According to example (2) of the background art, damage on the edge of a strip will occur at a side portion of the strip in a strip width direction when the strip comes into contact with the guide means, such as a side guide. More specifically, as illustrated in Fig. 2(a), a side guide SG is inserted in an area between roll pitches (between nips) of conveying rolls 10. Therefore, the side portion of the strip in the strip width direction is easily damaged in a contact width area in which the strip S is not supported. Therefore, in the case where the strip is restrained by the side guide, accurate position control must be performed in accordance with the strip width. In particular, when the strip thickness is small, accurate pressure control must be performed.

[0011] The method of suppressing the formation of a telescoped coiled strip by performing strip position control in the line width direction as in examples (3) to (5) of the background art have the following problems:

· A displacement occurs between a control target and an actual position in the width direction, owing to a time lag in which the strip travels from an upstream position to a downstream position.
· A complex system is required to perform the control.
· Even when the coiling process can be stabilized in a steady operation, the tension applied to the slit material is eliminated and the behavior of the slit material becomes unstable at the tail end of the slit material after the shear cutting process, the tail end being located at the outermost periphery of a coil after the coiling process. Therefore, there may be a case in which an existing EPC device or skew rolls cannot be used.
· In the case where, for example, a low tension is applied to the tail end after the cutting process, even when a strip edge is detected at an upstream position and the EPC is performed, the following problem occurs. That is, when a tension reel shaft is shifted in a strip width direction, there is a possibility that the tail end of the slit material will move together with the tension reel shaft in the same strip width direction. In such a case, the reel continuously follows the strip edge and divergence occurs within the movement limits of the reel in the width direction. Thus, the coiling process becomes unstable.
· The slit gap control based on the biased pinch is affected by unstable factors of the pinch roll. Therefore, the control cannot be easily performed.

[0012] As described above, according to the background art, the slit strips cannot be stabilized at the central area of a conveyance line without damaging the edges of the strips or using a complex control system. In addition, it is difficult to perform a stable operation in an unsteady operation in which, for example, the tail end of the strip after the cutting process is passed. These problems have not been solved.

[Solution to Problem]

[0013] According to the present invention, to solve the above-described problems, a mechanical mechanism to prevent strip walking that is independent of external control is used. The present invention aims at a mechanical mechanism to prevent strip walking that can be easily adjusted, that can be used for both slit materials and normal strips (strips that are not slit), and in which the two usage patterns can be automatically or easily switched.

[0014] More specifically, the gist of the present invention is as follows.

[1] An apparatus to prevent strip walking which passes at least one slit strip, which is obtained by slitting a single full-width strip into two strips in a conveyance line, with a pinch roll,
wherein the pinch roll includes a lower roll that supports a bottom surface of the slit strip and upper rolls that are separated from each other in a strip width direction, at least one of the upper rolls coming into contact with a top surface of the slit strip and moving the slit strip toward a line center by using outside biased pinch or an inward skew angle,
wherein a portion of the slit strip around a line-center-side edge of the slit strip is nipped by the lower roll and the at least one of the upper rolls that are separated from each other or by the lower roll and a center roll provided at a line center area near separation ends of the upper rolls that are separated from each other, and
wherein the apparatus to prevent strip walking comprises a center guide that guides the line-center-side edge of the slit strip that is restrained by being nipped.
Here, the "outside biased pinch" means pinch (partial pinch, one side pinch, etc.) applied at the outer sides of

the line in the strip width direction.

[0015] [2] The apparatus to prevent strip walking according to above item [1],
wherein the center guide is retractable,
wherein the center guide moves downward to a position of contact with the lower roll to guide the line-center-side edge of the slit strip when the slit strip is passed, and
wherein the center guide is retracted to a top surface of the full-width strip when the full-width strip is passed without being slit.

[0016] [3] The apparatus to prevent strip walking according to above item [2],
wherein a rectangular-rod-shaped guide bar or a disc-shaped guide disc is used as the center guide.

[0017] [4] The apparatus to prevent strip walking according to above item [2],
wherein a disc-shaped large-diameter guide disc having an outer diameter larger than a roll diameter of the upper rolls that are separated from each other or a tiered disc roll in which the large-diameter guide disc and the center roll are integrated together is used as the center guide.

[0018] [5] The apparatus to prevent strip walking according to above item [2],
wherein a movable guide ring that is loosely arranged to be movable in a vertical direction is used as the center guide.

[0019] [6] The apparatus to prevent strip walking according to one of above items [1] to [5],
wherein a guide receiving groove into which the center guide is removably insertable is formed in the lower roll included in the pinch roll provided with the center guide.

[Advantageous Effects of Invention]

[0020] According to the present invention, in the conveyance line of the slit strip, it is not necessary to perform high-response, high-accuracy feedback control for detecting and correcting strip walking, and the slit strip can be stabilized at the central area of the conveyance line with a simple structure. The center guide used in the present invention is a guide disposed at the slit cut side. Therefore, it is also not necessary to perform, for example, position control in accordance with the strip width. In addition, since a portion of the strip edge that is located in and/or near the nip in which the strip is nipped by upper and lower rolls is guided, sufficient strip rigidity can be easily ensured and damage does not easily occur on the edge of the strip. Even in an unsteady operation in which, for example, the tail end of a strip that has been formed by shear cutting is passed and it is difficult to stably pass the strip by the feedback control, the strip can be easily passed in a stable state according to the present invention. In addition, the slit materials and the normal strips can both be passed, and switching between the slit materials and the normal strips can be easily performed.

[Brief Description of Drawings]

[0021]

[Fig. 1] Fig. 1 shows schematic front views of an example of the present invention illustrating the basic concept of the present invention (the conveying direction is from back to front in the direction perpendicular to the figure).
[Fig. 2] Fig. 2 shows schematic perspective views illustrating the operational effects of the present invention as compared with an example of the related art.
[Fig. 3] Fig. 3 is a schematic plan view illustrating the definition of an inward skew angle.
[Fig. 4] Fig. 4 shows schematic front views of another example (example in which a center roll is used) of present invention [1] (the conveying direction is from back to front in the direction perpendicular to the figure).
[Fig. 5] Fig. 5 is a time chart of pinch roll pinch and outputs of strip walking sensors, illustrating an example of data of a strip walking measurement experiment using a model apparatus.
[Fig. 6] Fig. 6 shows schematic perspective views and schematic front views illustrating an embodiment of the present invention in which a guide bar is used as a center guide.
[Fig. 7] Fig. 7 shows schematic perspective views and schematic front views illustrating an embodiment of the present invention in which a guide disc is used as the center guide.
[Fig. 8] Fig. 8 shows schematic perspective views and schematic front views illustrating an embodiment of the present invention in which a large-diameter guide disc or a tiered disc roll is used as the center guide.
[Fig. 9] Fig. 9 shows schematic perspective views and schematic front views illustrating an embodiment of the present invention in which a guide ring is used as the center guide.
[Fig. 10] Fig. 10 shows schematic front views illustrating an embodiment of the present invention in which a lower roll is provided with a guide receiving groove in which the center guide can be removably inserted ((a) illustrates the state in which slit materials are passed, (b) illustrates the state in which a normal strip (strip that is not slit) is passed, and the conveying direction is from back to front in the direction perpendicular to the figure).
[Fig. 11] Fig. 11 shows schematic perspective views of an apparatus to prevent strip walking according to a first example ((a) illustrates the state in which slit materials are passed and (b) illustrates the state in which a normal strip (strip that is not slit) is passed).
[Fig. 12] Fig. 12 shows schematic perspective views of an apparatus to prevent strip walking according to a second example ((a) illustrates the state in which

slit materials are passed and (b) illustrates the state in which a normal strip (strip that is not slit) is passed).

[Fig. 13] Fig. 13 is a schematic front view illustrating a preferred embodiment of an outside biased pinch (the conveying direction is from back to front in the direction perpendicular to the figure).

[Fig. 14] Fig. 14 is a schematic sectional view illustrating a location near a nip.

[Fig. 15] Fig. 15 shows schematic sectional views illustrating an example of a center-guide pressing mechanism.

[Fig. 16] Fig. 16 is a schematic sectional view illustrating a preferred embodiment of a center guide.

[Description of Embodiments]

[0022] The basic concept of the present invention will now be described.

Strip walking of slit materials (slit strips, abbreviated as strips) is not controlled (feedback-controlled). Instead, the slit materials are mechanically moved toward the line center. As a method for mechanically moving the slit materials toward the line center, a method based on an outside biased pinch or a method based on an inward skew angle may be used. In the method based on the outside biased pinch, an upper roll included in a pinch roll is divided into separate rolls in a strip width direction, and a tiered roll, in which an outside pinch width is larger than an inside pinch width, is used as each of the separate rolls. In the method based on the inward skew angle, the separate rolls are skewed inward with respect to a strip conveying direction. According to the outside biased pinch, a frictional force applied between the pinch roll and the strips in the outside pinch areas is larger than that in the inside pinch areas. Therefore, moments that try to rotate the slit materials toward the line center are generated, and the slit materials are mechanically moved toward the line center. According to the inward skew angle, roll circumferential speed components that are oriented inward toward the line center are transmitted to the slit materials. Therefore, the slit materials are mechanically moved toward the line center (in other words, centered).

[0023] If rolls according to the related art are used, strip walking occurs since a stable direction constantly changes in accordance with, for example, an entrance angle of each strip. Therefore, an adjustment is necessary. In contrast, according to the present invention, it is not necessary to perform fine adjustments since the rolls are positively biased in a certain direction.

The positions of the slit materials, which are moved toward the line center, must be stabilized at an area around the line center, and the slit materials must be prevented from overlapping. Accordingly, a center guide for the strips is provided. The center guide is located in and/or near a nip of the pinch roll. Here, a location near the nip corresponds to a range on a strip surface in which an angle of a line of site from the roll center to the strip surface with respect to the normal line in a plane orthogonal to a roll axis is in the range of $\pm 30°$. In other words, referring to Fig. 14, the location near the nip corresponds to a range including upstream and downstream areas in the moving direction of the slit strips S1 and S2, the range corresponding to an angular range of $\pm 30°$ around the roll center. The present invention is characterized in that the center guide is provided to restrain the strip edges that are located in and/or near the nip between the upper and lower rolls and that have an extremely high strip rigidity, so that the strips are prevented from being deformed even when the slit materials that have been moved toward the center guide receive reactive forces from the center guide.

[0024] In other words, according to the present invention, as illustrated in Fig. 1(a) which shows the structure based on the outside biased pinch and Fig. 1(b) which shows the structure based on the inward skew angle, the rolls are positively biased so as to apply external forces F to the slit materials in directions toward the line center. A center guide 1 is provided near the line center so as to generate the reactive forces against the external forces F. Referring to Fig. 3, the inward skew angle for generating the external forces F may be appropriately set in accordance with the roll pinching force, and is preferably set to about 10° to 30°. In the present invention, it is not necessary to use the side guides according to the related art for guiding the edges of the strips at the outer sides of the line.

[0025] Referring to Fig. 2, in the case where, for example, a side guide SG is used as in the related art, there is a risk that the edge of a strip S1 at a side thereof in the width direction will be damaged in an area between a nip and the next nip (Fig. 2(a)). In contrast, according to an example of the present invention, the center guide 1 is provided at the line-center sides of the strip edges that are located in and/or near the nip. The strips S1 and S2 are nipped between upper and lower rolls 11 and 12 in the pinch roll, so that the strips do not shift vertically or yield and have an extremely high strip rigidity. Therefore, the edges of the strips at the sides facing the center guide 1 are not damaged (Fig. 2(b)). From the viewpoint of obtaining a high strip rigidity, of the strip edges that are located in and/or near the nip, the center guide preferably restrains the strip edges that are located in the nip.

[0026] According to the above-described basic concept, in the slit-strip conveyance line (also referred to as a slit line), the slit strips can be stabilized at the central area of the conveyance line without damaging the edges of the strips. In addition, even in an unsteady operation in which, for example, the tail ends of the strips after the cutting process are passed, the strips can be easily passed in a stable state.

An apparatus having the structure illustrated in Fig. 1(a) was produced, and strips were passed along both sides of the center guide and were subjected to pinch by the pinch roll. The behavior of strip walking of the strips was measured with strip walking sensors provided at both

sides of the strips at the exit side of the pinch roll (coiling section). Fig. 5 illustrates an example of the result of the measurement. As is clear from the chart of outputs from the strip walking sensors in the figure, the operation is stabilized at the exit side (coiling section) as a result of the pinch by the pinch roll (PR). In addition, it is clear that the strips are centered as a result of the pinch by the pinch roll.

[0027] According to present invention [1], based on the above-described basic concept, as illustrated in Fig. 1, for example, an apparatus to prevent strip walking passes the slit strips S1 and S2, which are obtained by slitting a single full-width strip into two strips in a conveyance line, with a pinch roll. The pinch roll includes the lower roll 12 that supports the bottom surfaces of the slit strips S1 and S2 and the upper rolls 11 that are separated from each other in a strip width direction. The upper rolls 11 come into contact with the top surfaces of the slit strips S1 and S2 and move the slit strips S1 and S2 toward the line center by using the outside biased pinch (Fig. 1(a)) or the inward skew angle (Fig. 1(b)). Portions of the slit strips S1 and S2 around the line-center-side edges of the slit strips S1 and S2 are nipped by the lower roll 12 and the separated upper rolls 11. The apparatus includes the center guide 1 that guides the line-center-side edges of the slit strips S1 and S2 that are restrained by being nipped.

[0028] In the case where the upper rolls included in the pinch roll are arranged to perform the outside biased pinch, central contact zones for nipping the line-center-side edges of the slit strips S1 and S2 may be provided at the line-center sides of the upper rolls. Unlike the outside biased pinch zones, the central contact zones are required simply to suppress upward warping of the edge portions of the strips. Therefore, the roll outer diameter of the central contact zones may be less than or equal to the roll outer diameter of the outside biased pinch zones. The contact width of the central contact zone is 1/2 or less, preferably 1/4 or less, of the biased pinch contact width of the outside biased pinch zones. Accordingly, the roll pinching force applied in the central contact zone is smaller than that applied in the outside biased pinch zones, so that the slit strips are moved toward the line center.

[0029] The central contact zones of the upper rolls 11 ideally press the strips S1 and S2 over the areas including the line-center-side edges, and preferably press the strips S1 and S2 at positions as close to the edges as possible. However, depending on the installation conditions of the upper rolls 11 and the curvature of edge portions of the central contact zones of the upper rolls 11, there may be a case in which the central contact zones cannot press the areas including the edges. In such a case, portions that are separate from but near the edges are pressed within areas in which the amount of deformation of the strip edges can be maintained within an elastic range. The areas near the edges may be areas between the center-side edges and positions separated from the center-side edges by about 10 mm toward the centers of the slit strips S1 and S2. Thus, the central contact zones of the upper rolls 11 are brought into contact with the slit strips S1 and S2 at positions where the central sides of the central contact zones are separated from the center-side edges of the slit strips S1 and S2 by about 10 mm toward the centers of the slit strips S1 and S2 (see Fig. 13).

[0030] The width of the center guide is set to be less than or equal to a slit gap between the slit materials within a range in which sufficient strength is ensured.

In the case where the upper rolls included in the pinch roll have the inward skew angle, the pinch points between the lower roll and the skewed upper rolls are positioned near the line center on the axial line of the lower roll. Accordingly, similar to the above-described case in which the central contact zones are provided, the line-center-side edges of the slit strips can be nipped.

[0031] According to present invention [1], as illustrated in Fig. 4, for example, an apparatus to prevent strip walking passes the slit strips S1 and S2, which are obtained by slitting a single full-width strip into two strips in a conveyance line, with a pinch roll. The pinch roll includes the lower roll 12 that supports the bottom surfaces of the slit strips S1 and S2 and the upper rolls 11 that are separated from each other in a strip width direction. The upper rolls 11 come into contact with the top surfaces of the slit strips S1 and S2 and move the slit strips S1 and S2 toward the line center by using the outside biased pinch (Fig. 4(a)) or the inward skew angle (Fig. 4(b)). Portions of the slit strips S1 and S2 around the line-center-side edges of the slit strips S1 and S2 are nipped by the lower roll 12 and a center roll 2 provided at a central area of the line near separation ends of the upper rolls 11 that are separated from each other. The apparatus includes the center guide 1 that guides the line-center-side edges of the slit strips S1 and S2 that are restrained by being nipped.

[0032] When the center roll is provided, the line-center-side edges of the slit strips are nipped by using the center roll. Therefore, in the case where the upper rolls included in the pinch roll are arranged to perform the outside biased pinch, it is not necessary that the upper rolls have the central contact zones. In addition, in the case where the upper rolls included in the pinch roll have the inward skew angle, the pinch points between the lower roll and the skewed upper rolls may either be positioned near the line center or the outer sides of the line on the axial line of the lower roll. When the center roll is provided, the line-center-side edges of the slit strips are nipped by the center roll 2 and the lower roll 12. Therefore, the separate upper rolls included in the pinch roll may be designed in consideration of only the function of centering the slit strips toward the line center. The center roll is configured such that the center roll does not hinder the centering force applied by the separate upper rolls. For example, when the center roll has the same contact width as that of the upper rolls, the roll pinching force of the center roll is set to 1/2 or less, preferably 1/4 or less, of the roll

pinching force of the separate upper rolls. When the center roll has the same roll pinching force as that of the upper rolls, the contact width of the center roll is set to 1/2 or less, preferably 1/4 or less, of the contact width of the separate upper rolls. In other words, for each of the slit strips S1 and S2, the contact width and the roll pinching force are adjusted within ranges in which the line-center-side edges of the slit strips to be nipped by the center roll do not rise. The adjustment is made such that outward reactive forces applied in the strip width direction of the center roll is less than or equal to 1/4 of the centering forces F applied by the separate upper rolls. Since the upper rolls included in the pinch roll and the center roll have different roles, the adjustment versatility is increased. Therefore, the upper rolls and the center roll can be appropriately set.

[0033] The two slit strips do not always have the same width. Therefore, the gap between the slit strips is not always positioned at the line center. The position of the gap depends on the position of the slitter in the line width direction. Therefore, the center guide is installed at the same position as the slitter in the line width direction. The upper rolls included in the pinch roll that are separated from each other in the width direction can also be shifted in accordance with the outer edges of the slit strips having different widths. This allows the generation of stable centering forces. Accordingly, two coils of slit strips having different strip widths can be produced simultaneously.

[0034] The pinch roll used in the present invention is not limited to those having the structure in which the two slit strips are passed along both sides of the center guide, and may instead be structured such that only one of the two slit strips is passed along one side of the center guide. More specifically, referring to Fig. 1, for example, the pinch roll may be structured such that only the slit material S1 is passed and the slit material S2 is not passed, and such a pinch roll can also be used in the present invention. Here, it is not necessary to align the side portions of the slit strips with the outer sides of the biased pinch zones of the pinch roll in the width direction as illustrated in Fig. 1.

[0035] There are two types of slit-strip conveyance lines: conveyance lines that pass only slit strips (referred to as type I for convenience) and conveyance lines that alternately pass slit strips and full-width strips (normal strips) that are not slit (referred to as type II for convenience). In the case of type I, the center guide may be installed in a fixed state. However, in the case of type II, the center guide is preferably retractable (of retractable type) instead of being installed in a fixed state. More specifically, when the slit strips are to be passed, the center guide moves downward to a vertical position corresponding to the top end of the lower roll and guides the line-center-side edges of the slit strips. When a normal strip is passed without being slit, the center guide is retracted to the top surface of the normal strip (this structure corresponds to present invention [2]). When the pass line movement, for example, is considered, the bottom end of the center guide is preferably moved downward to the vertical position corresponding to the top end of the lower roll, so that the edges can be reliably guided. However, when the center guide is installed in a line in which the pass line movement is negligibly small, the center guide may be moved downward to a vertical position between the top surfaces of the slit materials and the top end of the roll.

[0036] Examples of the above-described center guide are illustrated in Figs. 6 to 9. In each of the perspective views, the conveying direction of the slit strips (not shown) is the direction from left to right. In addition, in each of the front views, the conveying direction of the slit strips (not shown) is the direction from back to front in the direction perpendicular to the figure.

Fig. 6 illustrates examples in which a rectangular-rod-shaped guide bar 13 is used as the center guide. In these examples, the guide bar 13 is of the retractable type (corresponds to the guide bar in present invention [3]). However, the guide bar 13 may instead be of a fixed type. In Fig. 6, Fig. 6(a) illustrates the structure which is based on the outside biased pinch and in which no center roll that is independent of the pinch roll is provided. Fig. 6(b) illustrates the structure which is based on the inward skew angle and in which no center roll that is independent of the pinch roll is provided. Fig. 6(c) illustrates the structure which is based on the outside biased pinch and which includes the center roll. Fig. 6(d) illustrates the structure which is based on the inward skew angle and which includes the center roll.

[0037] Fig. 7 illustrates examples in which a disc-shaped guide disc 14 is used as the center guide. In these examples, the guide disc 14 is of the retractable type (corresponds to the guide disc in present invention [3]). However, the guide disc 14 may instead be of a fixed type. In Fig. 7, Fig. 7(a) illustrates the structure which is based on the outside biased pinch and in which no center roll that is independent of the pinch roll is provided. Fig. 7(b) illustrates the structure which is based on the inward skew angle and in which no center roll that is independent of the pinch roll is provided. Fig. 7(c) illustrates the structure which is based on the outside biased pinch and which includes the center roll. Fig. 7(d) illustrates the structure which is based on the inward skew angle and which includes the center roll.

[0038] Fig. 8 illustrates examples in which a disc-shaped large-diameter guide disc 15 having an outer diameter larger than a roll diameter of the separate upper rolls 11 or a tiered disc roll 16 in which the large-diameter guide disc 15 and the center roll 2 are integrated together is used as the center guide. In these examples, both the large-diameter guide disc 15 and the tiered disc roll 16 are of the retractable type (correspond to present invention [4]). However, one or both of the large-diameter guide disc 15 and the tiered disc roll 16 may instead be of a fixed type. In Fig. 8, Fig. 8(a) illustrates the structure which is based on the outside biased pinch and in which no center roll that is independent of the pinch roll is pro-

vided. Fig. 8(b) illustrates the structure which is based on the inward skew angle and in which no center roll that is independent of the pinch roll is provided. Fig. 8(c) illustrates the structure which is based on the outside biased pinch and which includes the center roll. Fig. 8(d) illustrates the structure which is based on the inward skew angle and which includes the center roll.

[0039] As a method for moving the center guide downward, the center guide may, for example, be moved downward by its own weight. Alternatively, the center guide 1 may be positively pressed downward from above by a pressing mechanism or the like. For example, as illustrated in Fig. 15, a pressing mechanism may be provided in which a small roll 41 is attached to an end portion of a cylinder 40 and is caused to press an upper portion of a guide ring 17 or the guide disc (not shown in Fig. 15) downward from above. In the pressing mechanism, the pressing force is set such that the top surface of the normal strip is not deformed or damaged when the normal strip S is passed. As illustrated in Fig. 16, for example, an outermost peripheral portion of the center guide 1 is preferably formed of the same material as the material of the upper rolls or an elastic body, such as rubber, since the outermost peripheral portion comes into contact with the normal strip S. In addition, the side surfaces of the center guide 1, which come into contact with the edges of the slit materials S1 and S2, are preferably formed of a high-hardness wear-resistant material.

[0040] The positional relationship between the strip edges and the roll edges is not particularly limited. However, in the case where, for example, the rolls are made of rubber and abrasion of the rubber caused by burrs or the like at the strip edges is to be suppressed, the roll edges are preferably constantly positioned inside the strip edges.

Fig. 9 illustrates examples in which a movable guide ring 17 which is loosely arranged to be movable in the vertical direction (corresponds to present invention [5]) is used as the center guide of the retractable type. A ring-supporting shaft to which the guide ring 17 is loosely fitted may be appropriately provided in the gap between one and the other of the separate upper rolls 11. In Fig. 9, Fig. 9(a) illustrates the structure which is based on the outside biased pinch and in which no center roll that is independent of the pinch roll is provided. Fig. 9(b) illustrates the structure which is based on the inward skew angle and in which no center roll that is independent of the pinch roll is provided. Fig. 9(c) illustrates the structure which is based on the outside biased pinch and which includes the center roll. Fig. 9(d) illustrates the structure which is based on the inward skew angle and which includes the center roll.

[0041] According to the present invention, to more stably guide the line-center-side edges of the slit materials with the center guide, a guide receiving groove into which the center guide is removably insertable may be formed in the lower roll included in the pinch roll that is provided with the center guide (this structure corresponds to present invention [6]). An example, of this structure is illustrated in Fig. 10. In this example, a separate ring 1E having a structure similar to that of the above-described tiered disc roll 16 is used as the center guide. A guide receiving groove 12U receives a lower portion (end portion in a radial direction) of the separate ring 1E, and restrains the separate ring 1E from moving in the line width direction. Therefore, the line-center-side edges of the slit materials can be more stably guided. As long as the side portions of the slit materials are prevented from entering the guide receiving groove 12U, the guide receiving groove 12U may be outwardly tapered or rounded at the entrance corners thereof, so that the center guide, such as the separate ring 1E, can easily enter and the normal strips can be passed without any problem.

[First Example]

[0042] A first example is incorporated in a slit line of cold rolled sheet steel. In this slit line, as illustrated in Fig. 11(a), two slit strips S1 and S2 pass through first and second deflector pinch rolls 21 and 22 in an area downstream of a shear 20. Accordingly, the conveying direction of the slit strips S1 and S2 is changed from the horizontal direction to the downward direction. Then, the two slit strips S1 and S2 are coiled around first and second tension reels 31 and 32, respectively. Although the slit strip S2 passes the first deflector pinch roll 21 in parallel with the slit strip S1 before entering the second deflector pinch roll 22, the conveying direction of the slit strip S2 is not changed from the horizontal direction at the first deflector pinch roll 21. In this slit line, as illustrated in Fig. 11(b), a normal strip S may also be passed. In this case, the operation line including the first deflector pinch roll 21 and the first tension reel 31 and the operation line including the second deflector pinch roll 22 and the second tension reel 32 are alternately used to coil the normal strip S. According to the related art, in each of the first and second deflector pinch rolls 21 and 22, both the upper and lower rolls are flat rolls.

[0043] In the first example, rolls having the structure illustrated in Fig. 9(a) are used as the first and second deflector pinch rolls 21 and 22. More specifically, the upper rolls 11 are separated from each other and configured to be capable of performing centering based on the outside biased pinch. In addition, the movable guide ring 17 which is loosely fitted to the ring-supporting shaft, which is provided in the gap between one and the other of the separate upper rolls 11, such that the guide ring 17 is movable in the vertical direction is used as the center guide. At the first deflector pinch roll 21, both of the slit strips S1 and S2 are moved toward the line center owing to the outside biased pinch, and the strip edges that have been moved toward the line center are guided by the guide ring 17. At the second deflector pinch roll 22, only the slit strip S2, which has become alone after passing the first deflector pinch roll 21 positioned upstream of the second deflector pinch roll 21, is centered owing to the

outside biased pinch. Then, the strip edge that has been moved to the line center is guided by the guide ring 17.

[0044] When the normal strip S is passed, the guide ring 17 is automatically retracted to the top surface of the strip.

Sufficient strip-walking preventing effect can be obtained even when the present invention is applied only to the first deflector pinch roll 21. However, when the present invention is applied also to the second deflector pinch roll 22 as in the first example, the effect can be increased.

[Second Example]

[0045] A second example is incorporated in the same slit line as that of the first example. Fig. 12 illustrates the structure according to the second example. As illustrated, a pinch roll according to the related art is used as a second deflector pinch roll 22. A pinch roll having the structure illustrated in Fig. 9(b) is used as a first deflector pinch roll 21. More specifically, the upper rolls 11 are separated from each other and configured to be capable of performing centering based on the inward skew angle. In addition, the movable guide ring 17 which is loosely fitted to the ring-supporting shaft, which is provided in the gap between one and the other of the separate upper rolls 11, such that the guide ring 17 is movable in the vertical direction is used as the center guide.

[0046] The operational effects obtained by the second example are similar to those obtained when a pinch roll according to the related art is used as the second deflector pinch roll 22 in the first example.

[Reference Signs List]

[0047]

1	center guide
2	center roll
10	conveying roll
11	separate upper rolls
11A	undivided upper roll
12	lower roll
12U	guide receiving groove
13	guide bar
14	guide disc
15	large-diameter guide disc
16	tiered disc roll
17	guide ring
20	shear
21	first deflector pinch roll
22	second deflector pinch roll
31	first tension reel
32	second tension reel
S	strip (full-width strip or normal strip (strip that is not slit))
S1, S2	slit strip
SG	side guide

Claims

1. An apparatus to prevent strip walking which passes at least one slit strip, which is obtained by slitting a single full-width strip into two strips in a conveyance line, with a pinch roll,
wherein the pinch roll includes a lower roll that supports a bottom surface of the slit strip and upper rolls that are separated from each other in a strip width direction, at least one of the upper rolls coming into contact with a top surface of the slit strip and moving the slit strip toward a line center by using outside biased pinch or an inward skew angle,
wherein a portion of the slit strip around a line-center-side edge of the slit strip is nipped by the lower roll and the at least one of the upper rolls that are separated from each other or by the lower roll and a center roll provided at a line center area near separation ends of the upper rolls that are separated from each other, and
wherein the apparatus to prevent strip walking comprises a center guide that guides the line-center-side edge of the slit strip that is restrained by being nipped.

2. The apparatus to prevent strip walking according to Claim 1,
wherein the center guide is retractable,
wherein the center guide moves downward to a position of contact with the lower roll to guide the line-center-side edge of the slit strip when the slit strip is passed, and
wherein the center guide is retracted to a top surface of the full-width strip when the full-width strip is passed without being slit.

3. The apparatus to prevent strip walking according to Claim 2,
wherein a rectangular-rod-shaped guide bar or a disc-shaped guide disc is used as the center guide.

4. The apparatus to prevent strip walking according to Claim 2,
wherein a disc-shaped large-diameter guide disc having an outer diameter larger than a roll diameter of the upper rolls that are separated from each other or a tiered disc roll in which the large-diameter guide disc and the center roll are integrated together is used as the center guide.

5. The apparatus to prevent strip walking according to Claim 2,
wherein a movable guide ring that is loosely arranged to be movable in a vertical direction is used as the center guide.

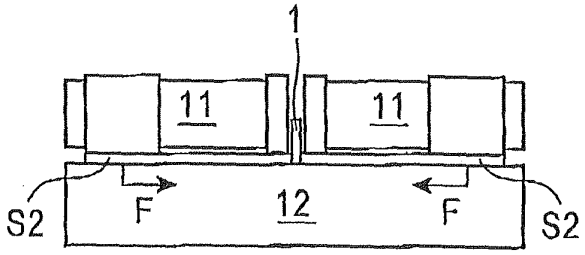
6. The apparatus to prevent strip walking according to one of Claims 1 to 5,

wherein a guide receiving groove into which the center guide is removably insertable is formed in the lower roll included in the pinch roll provided with the center guide.

FIG. 1

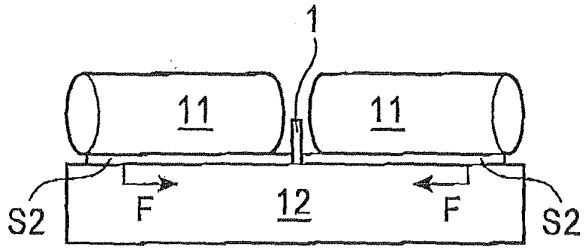
(a)

STRUCTURE BASED ON OUTSIDE BIASED REDUCTION



(b)

STRUCTURE BASED ON INWARD SKEW ANGLE



STRIP CONVEYING DIRECTION: FROM BACK SIDE TO FRONT SIDE OF FIGURE

FIG. 2

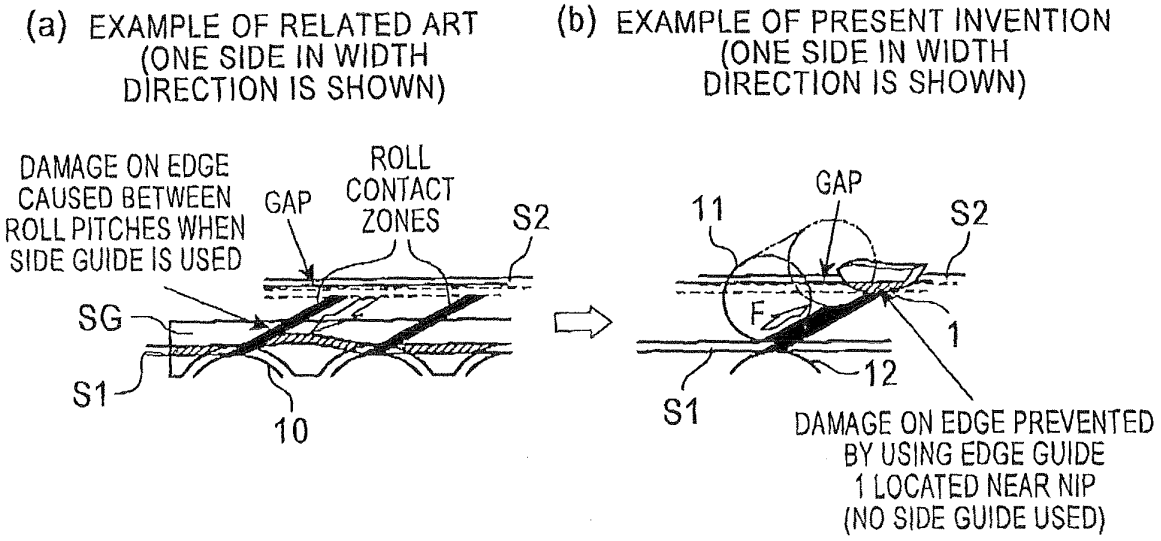
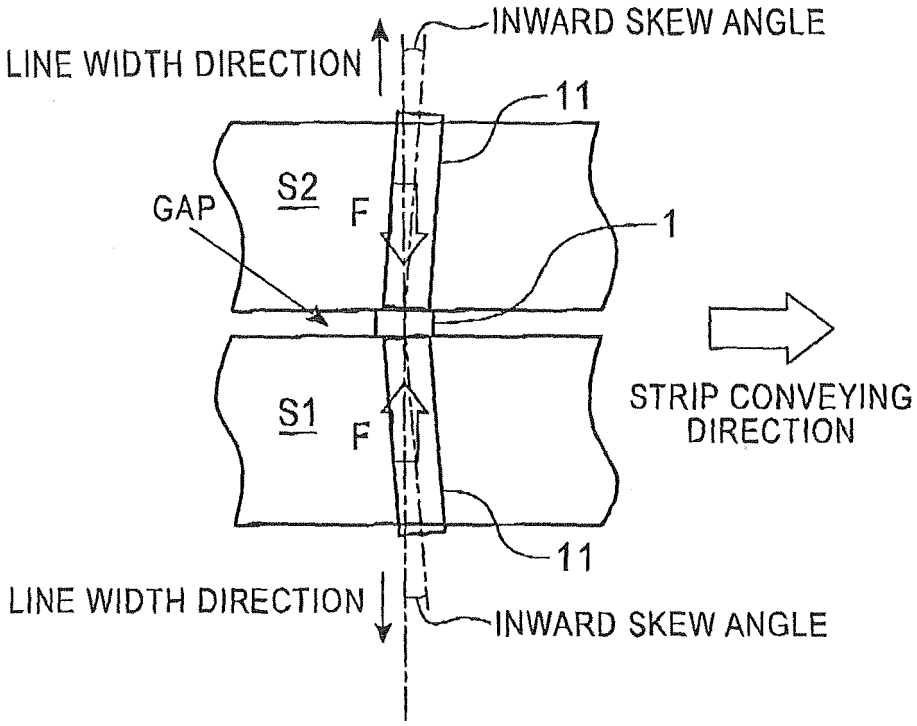


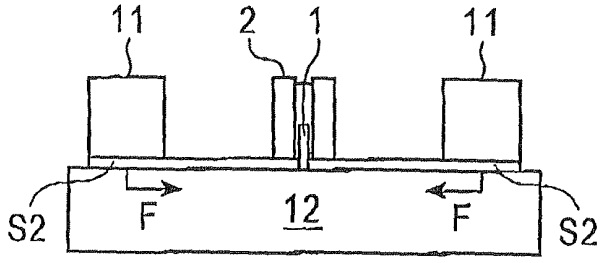
FIG. 3


INWARD SKEW ANGLE
LINE WIDTH DIRECTION
11
S2
F
GAP
1
STRIP CONVEYING DIRECTION
S1
F
11
LINE WIDTH DIRECTION
INWARD SKEW ANGLE

(a)

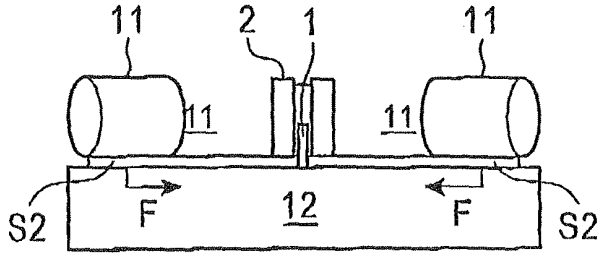
FIG. 4

STRUCTURE BASED ON OUTSIDE BIASED REDUCTION



(b)

STRUCTURE BASED ON INWARD SKEW ANGLE



STRIP CONVEYING DIRECTION: FROM BACK SIDE TO FRONT SIDE OF FIGURE

FIG. 5

CHART WAVEFORM OF STRIP WALKING SENSOR AT EXIT SIDE OF PINCH ROLL

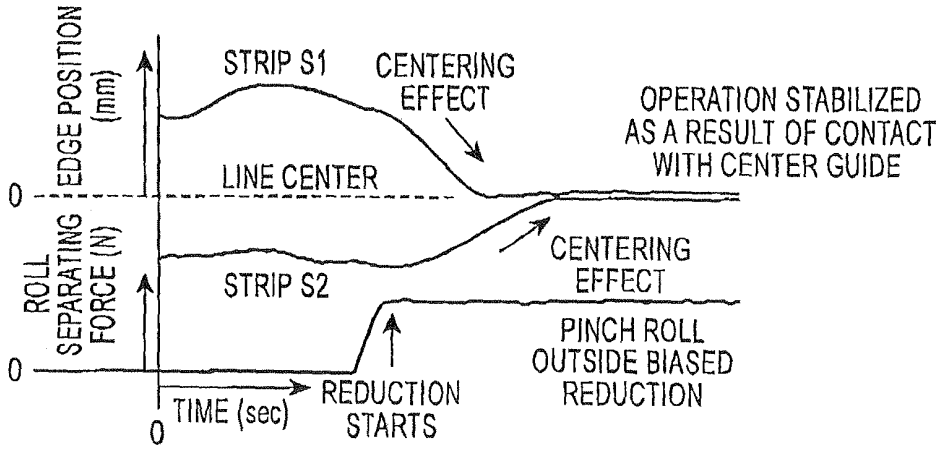
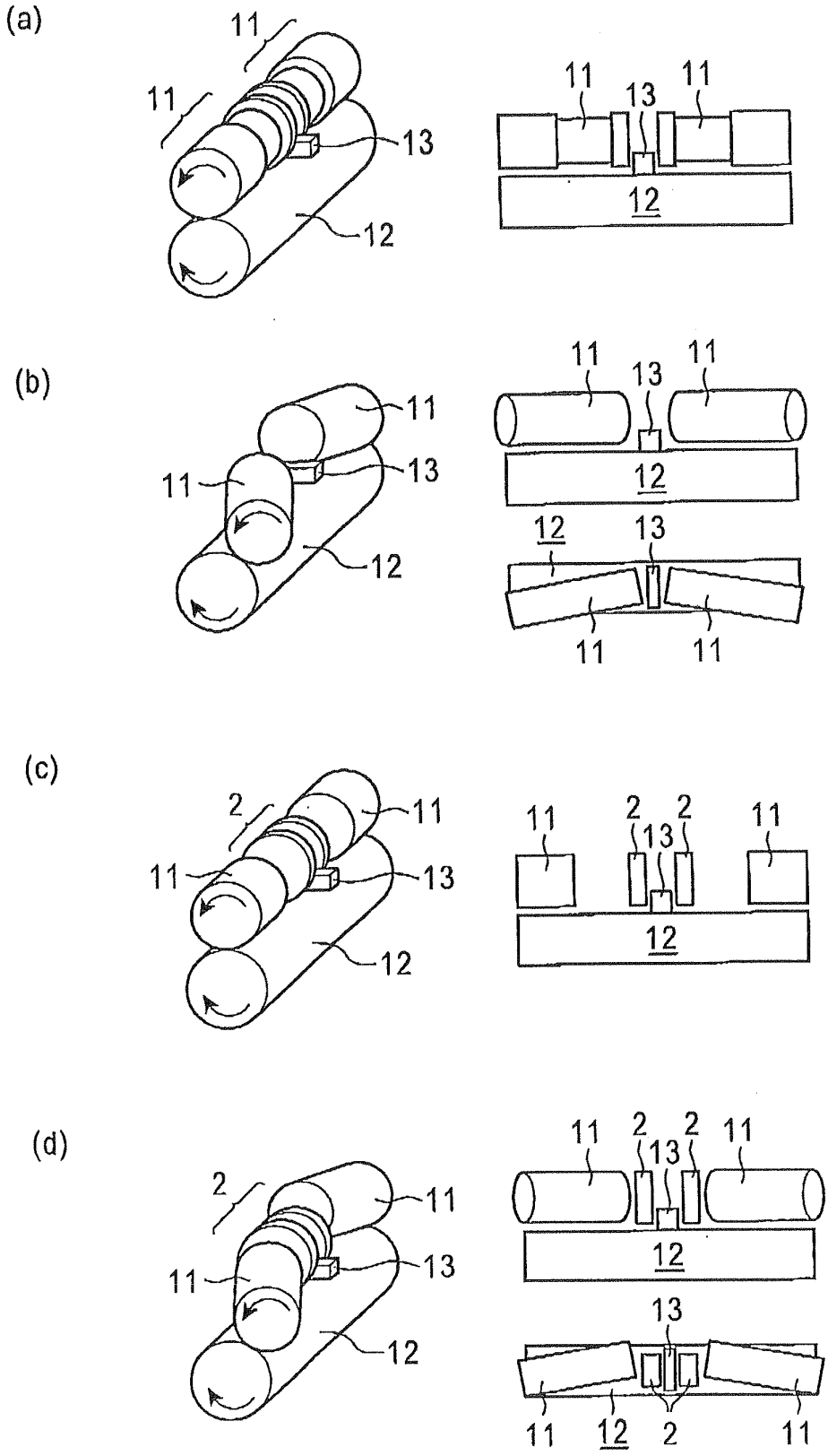


FIG. 6


(a)
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(c)
2
11
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13
12
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13
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(d)
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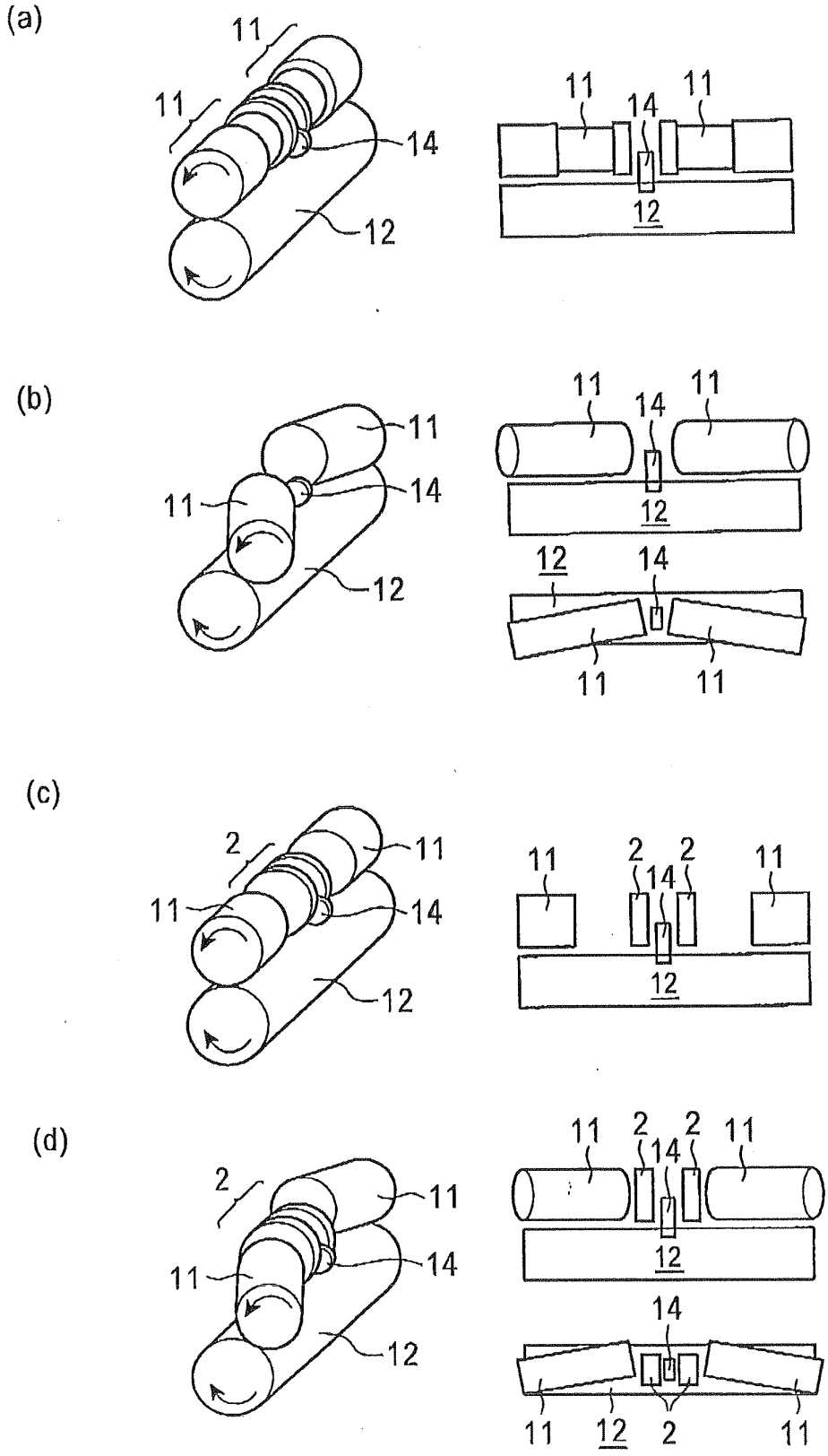
FIG. 7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(b)
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(c)
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14
12
11
2
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14
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(d)
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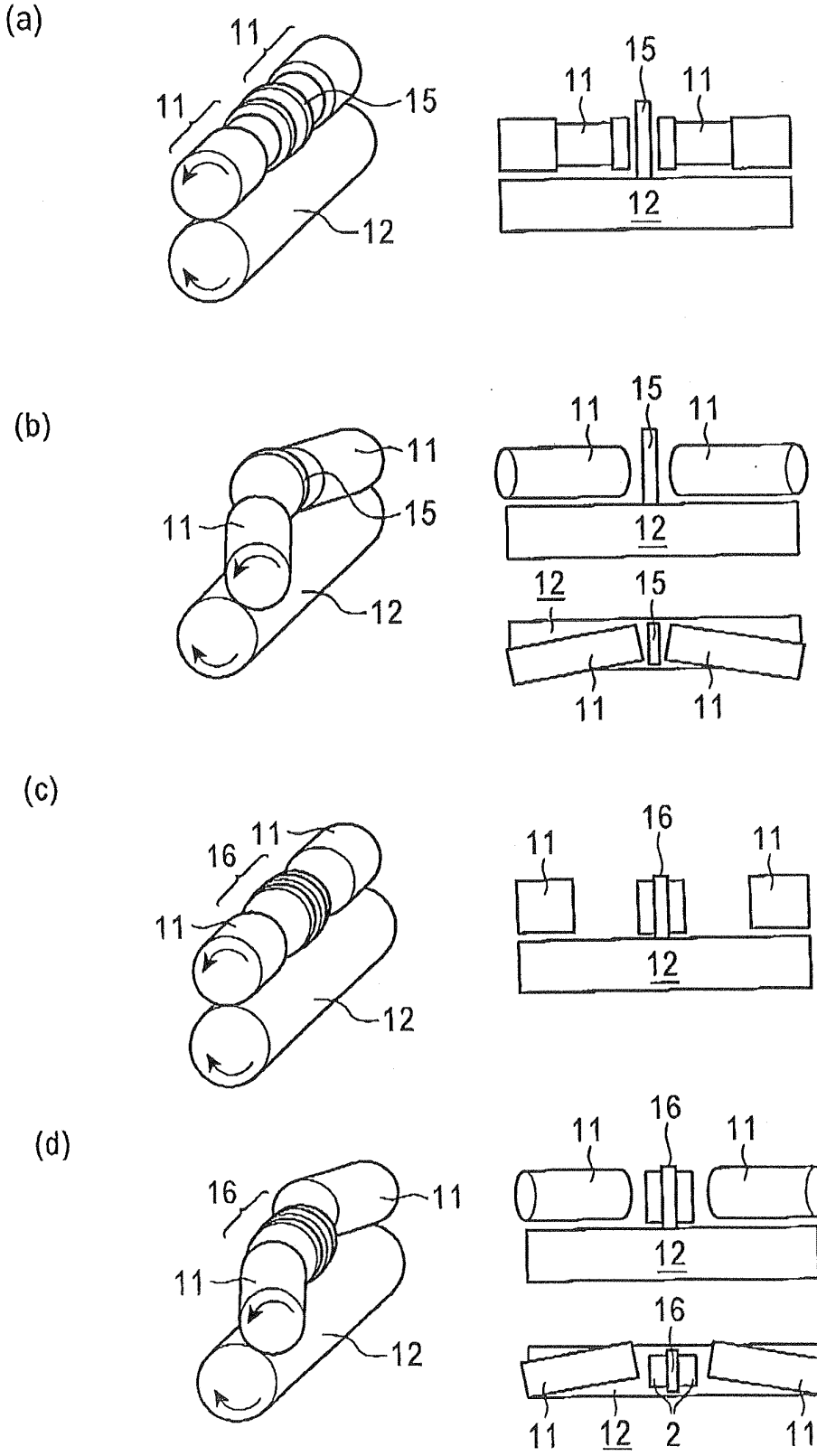
FIG. 8


(a)
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(b)
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(c)
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(d)
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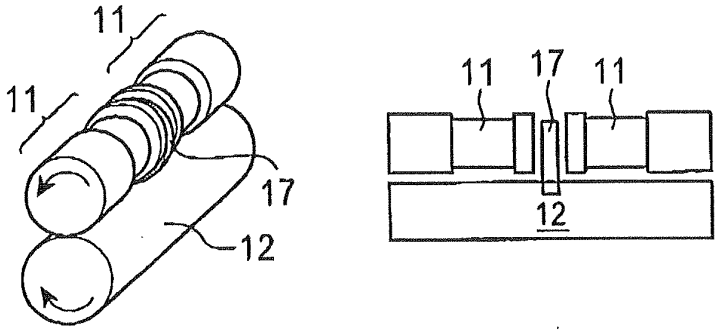
FIG. 9

(a)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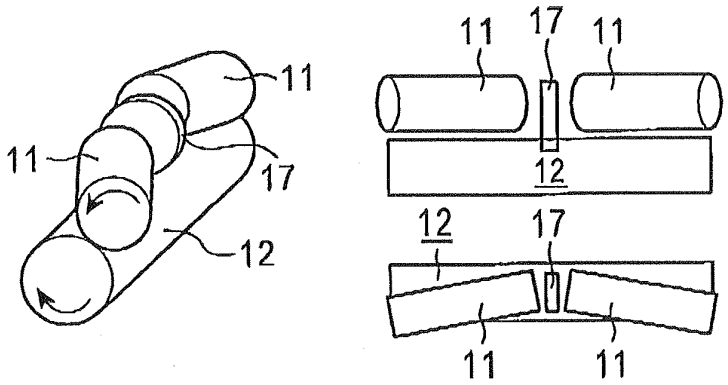
(b)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11
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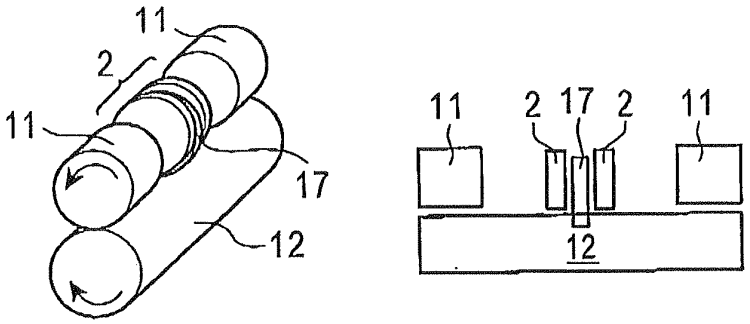
(c)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17
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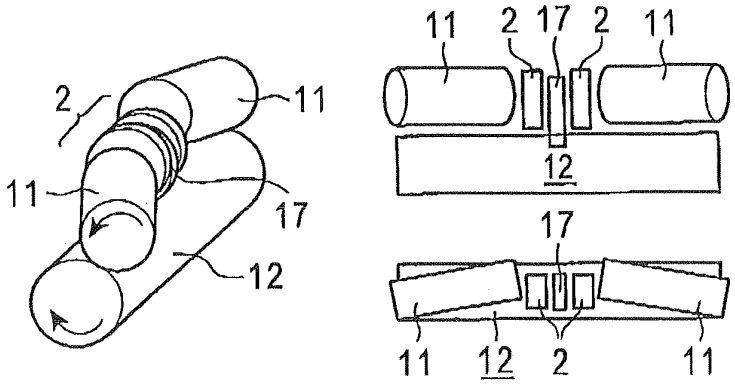
11
12

(d)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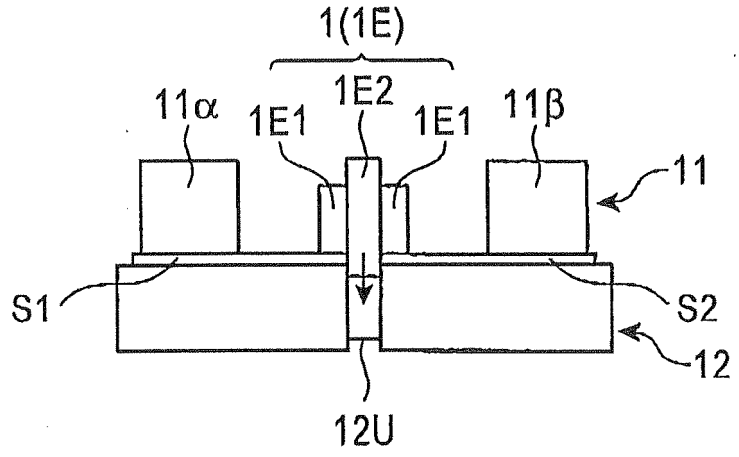
2
11

FIG. 10

(a)



(b)

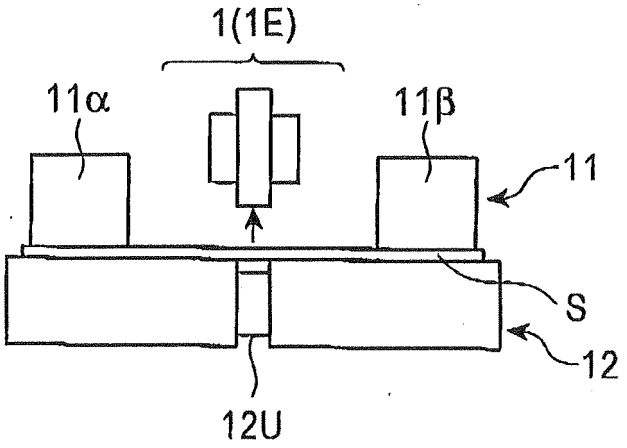


FIG. 11

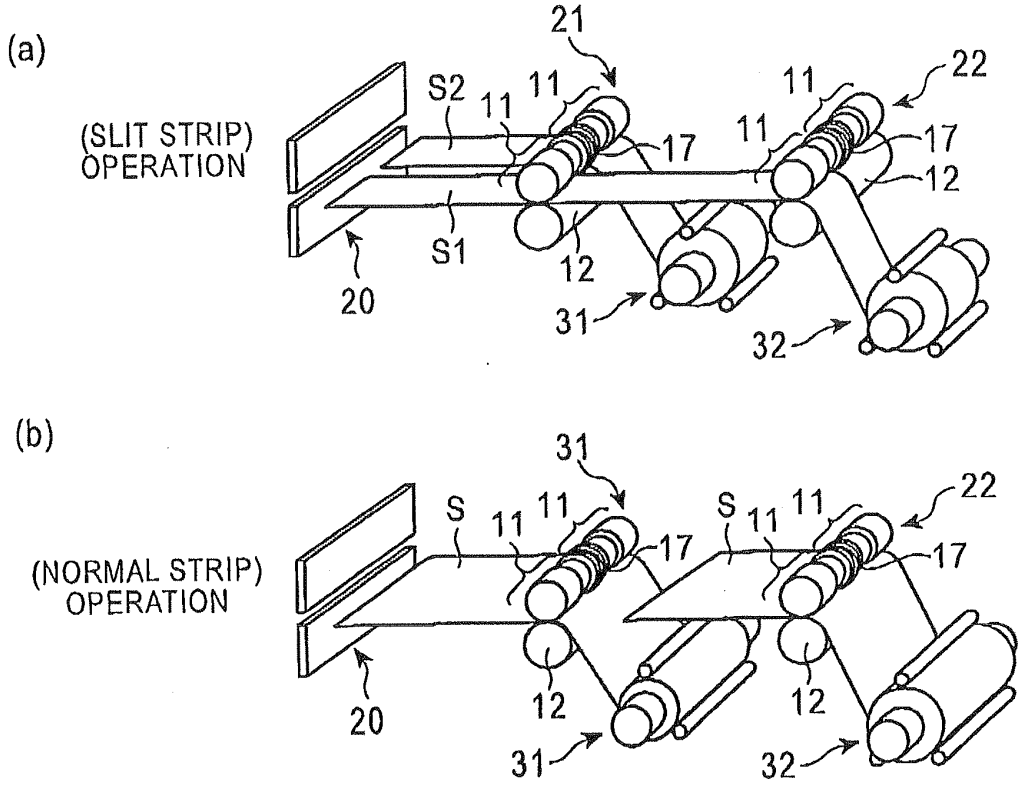
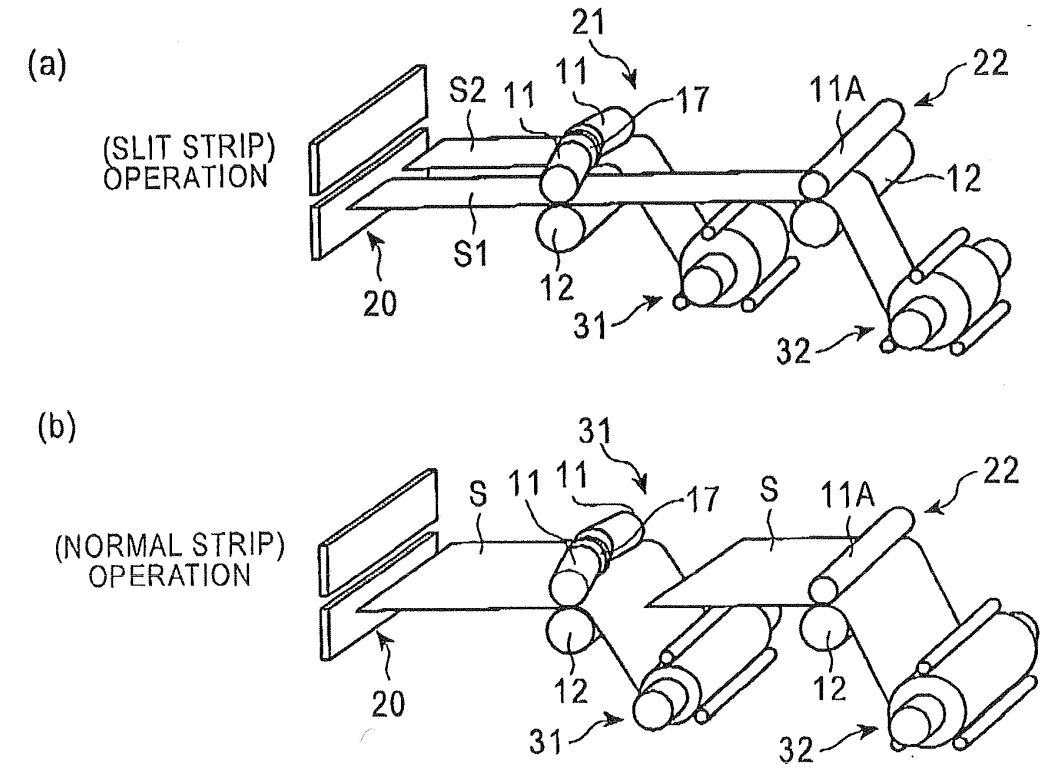

(a)
(SLIT STRIP) OPERATION
21
22
S2
11
17
12
S1
20
31
32
(b)
(NORMAL STRIP) OPERATION
31
S
11
17
12
20
31
32

FIG. 12


(a)
(SLIT STRIP) OPERATION
21
22
S2
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17
11A
12
S1
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(b)
(NORMAL STRIP) OPERATION
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S
11
17
11A
12
20
31
32

FIG. 13

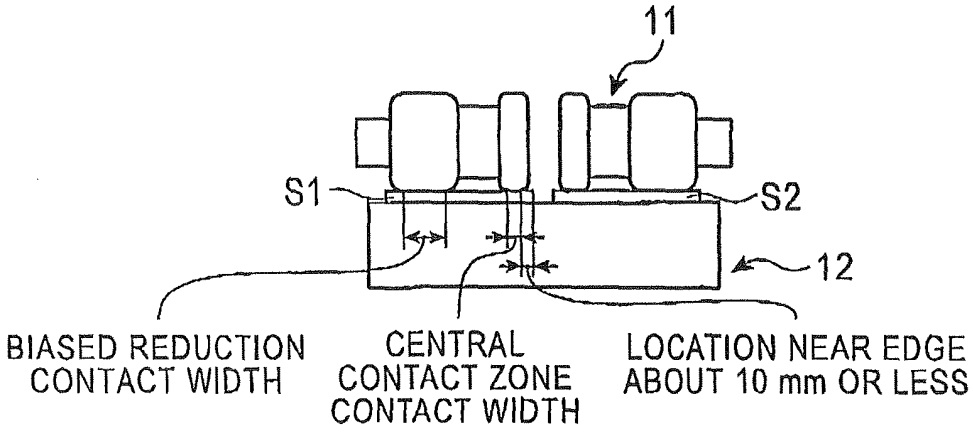


FIG. 14

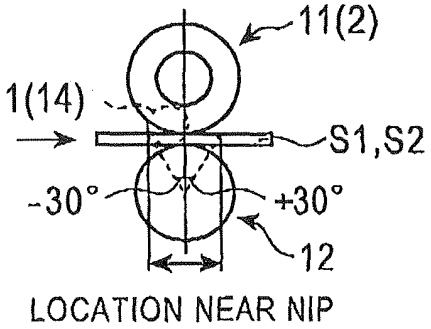


FIG. 15

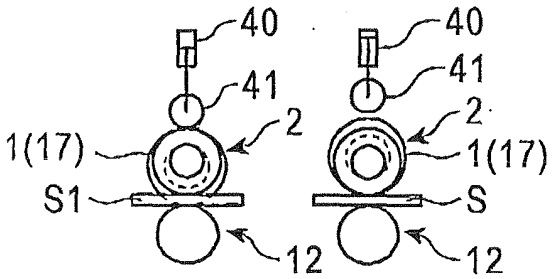
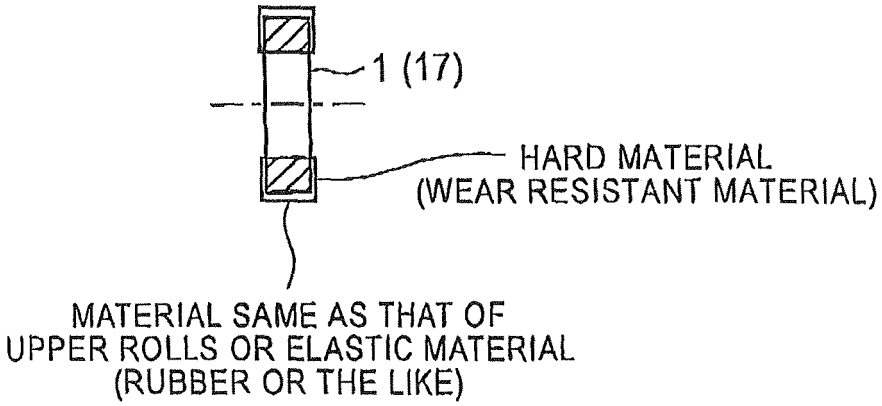


FIG. 16


1 (17)
HARD MATERIAL
(WEAR RESISTANT MATERIAL)
MATERIAL SAME AS THAT OF
UPPER ROLLS OR ELASTIC MATERIAL
(RUBBER OR THE LIKE)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/073644

A. CLASSIFICATION OF SUBJECT MATTER
B21B39/14(2006.01)i, *B21B39/00*(2006.01)i, *B21B39/08*(2006.01)i, *B21C47/26*(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)
B21B39/14, B21B39/00, B21B39/08, B21C47/26

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	1996-2011
Kokai Jitsuyo Shinan Koho	1971-2011	Toroku Jitsuyo Shinan Koho	1994-2011

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 10-230319 A (Nippon Steel Corp.), 02 September 1998 (02.09.1998), claims; fig. 1 (Family: none)	1-6
A	JP 5-338872 A (Kawasaki Steel Corp.), 21 December 1993 (21.12.1993), fig. 5, 6 (Family: none)	1-6

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

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"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 January, 2011 (21.01.11)	01 February, 2011 (01.02.11)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/073644

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 176535/1987(Laid-open No. 80206/1989) (Denkishizai Co., Ltd.), 30 May 1989 (30.05.1989), fig. 1, 2 (Family: none)	1-6

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 3005017 A **[0008]**
- JP 10230319 A **[0008]**