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(71) Applicant: **Sendzimir Japan, Ltd.**
Tokyo, 104-0033 (JP)

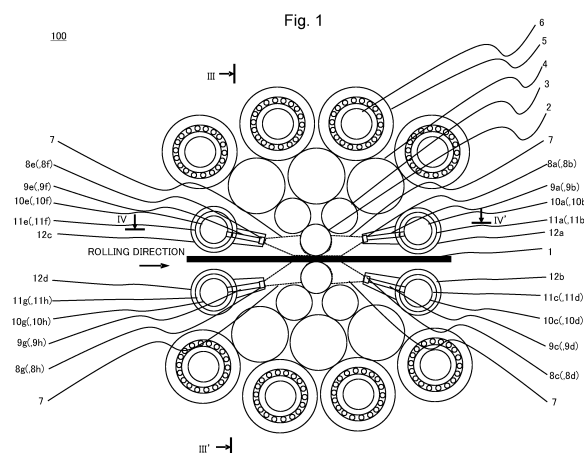
(72) Inventor: **NORIKURA, Takashi**
Tokyo 104-0033 (JP)

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

(54) **ROLLING MILL, TANDEM ROLLING MILL, AND COOLANT SUPPLY MECHANISM FOR ROLLING MILL**

(57) A coolant supply mechanism that jets a coolant to work rolls 2 includes jetting nozzles 8 that jet the coolant, the jetting nozzles 8 being plurally provided so as to form a row in a strip width direction of a metal strip 1, holes 9 that supply the coolant to the respective jetting nozzles 8, a header 12 that houses the plurally provided jetting nozzles 8, a tube 11 that selectively shields or opens the holes 9 within the header 12, and a hydraulic

cylinder 18 that adjusts respective coolant jetting amounts of the plurally provided jetting nozzles 8 by moving the tube 11. Thus, provided are a rolling mill, a tandem rolling mill, and a rolling mill coolant supply mechanism that include coolant sprays capable of selectively jetting a coolant, the coolant sprays being applicable also to a rolling mill that uses small diameter work rolls and has a limited space.



Description

Technical Field

[0001] The present invention relates to a rolling mill, a tandem rolling mill, and a rolling mill coolant supply mechanism suitable for obtaining a metal strip of high product quality such as high strip shape accuracy or the like in the rolling of a soft material such as an ordinary steel strip or an aluminum alloy and, in particular, a hard material such as a stainless steel strip or a copper alloy.

Background Art

[0002] As an example of a device for controlling flatness of a strip in cold rolling, the device being capable of excellently correcting a flatness defect even in a case where a flatness deviation exceeds a threshold value throughout the whole in the width direction of the strip, Patent Document 1 describes a device including: first coolant jetting determining means for detecting a flatness most defective position of the strip on the basis of a deviation between a flatness detected value obtained by a flatness detector and a flatness target value, and generating a first coolant jetting command for the flatness most defective position; second coolant jetting determining means for detecting a flatness local defect position of the strip on the basis of the flatness deviation, and generating a second coolant jetting command for the flatness local defect position; third coolant jetting determining means for generating an opening or closing command for each coolant nozzle header on the basis of the first coolant jetting command and the second coolant jetting command; and means for performing an opening or closing operation of each coolant nozzle header on the basis of a determination result of the third coolant jetting determining means.

[0003] As an example of a rolling mill and a rolling method that can provide excellent strip shape control performance while optimizing equipment specifications of a base coolant and a spot coolant, Patent Document 2 describes a rolling mill for rolling a strip material by a pair of upper and lower work rolls, the rolling mill including: base coolant supply means for jetting the base coolant to the work rolls; and spot coolant supply means for jetting the spot coolant to the work rolls; the base coolant supply means and the spot coolant supply means being configured such that a flow rate ratio between the coolants jetted from the base coolant supply means and the spot coolant supply means is set on the basis of a usage temperature difference between the base coolant and the spot coolant.

Prior Art Document

Patent Documents

[0004]

Patent Document 1: Japanese Patent No. 1933399

Patent Document 2: Japanese Patent No. 3728784

Summary of the Invention

Problems to be Solved by the Invention

[0005] Conventionally, particularly when small diameter work rolls are used in the rolling or the like of a special steel, there is a problem of a local shape defect such as a buckle of a strip width quarter (1/4) part or a swelling of a 1/8 part. These local shape defects are localized shape defects, and a shape control function of a roll bender, a crown adjusting device, or the like in the past has not been effective. The technologies of the foregoing Patent Documents 1 and 2 have been devised as an example of measures to remedy this problem.

[0006] These Patent Documents 1 and 2 provide an example in which when large diameter work rolls are used in ordinary steel rolling or the like, this local shape defect is corrected by providing a plurality of roll jetting nozzles in a strip width direction on an entry side and/or an exit side so as to form a row, selectively opening or closing the roll jetting nozzles by respective solenoid opening and closing valves provided to respective coolant supply lines of the plurally provided jetting nozzles, and thereby turning on or off the jetting of a coolant from the roll jetting nozzles.

[0007] However, these technologies require the respective solenoid opening and closing valves and respective pipes to be provided to the respective coolant supply lines of the plurally provided jetting nozzles, and thus necessitate a space. However, in a case of using the small diameter work rolls, in particular, the space is limited for the provision of the respective solenoid opening and closing valves and the respective pipes to the respective coolant supply lines of the plurally provided jetting nozzles. It is thus difficult to apply these technologies.

[0008] The present invention provides a rolling mill, a tandem rolling mill, and a rolling mill coolant supply mechanism that include coolant sprays capable of selectively jetting a coolant, the coolant sprays being applicable also to a rolling mill that uses small diameter work rolls and has a limited space.

Means for Solving the Problems

[0009] The present invention includes a plurality of means for solving the above-described problems. To cite an example of the means, there is provided a rolling mill including: at least one pair of work rolls that roll a metal strip; and a coolant supply mechanism that jets a coolant to the work rolls at at least one position of an entry side, an exit side, an upper side, and a lower side in a pass direction of the metal strip, the coolant supply mechanism including jetting nozzles that jet the coolant, the jetting nozzles being plurally provided so as to form a row in a

strip width direction of the metal strip, supply lines that supply the coolant to the respective jetting nozzles, a header that houses the plurally provided jetting nozzles, a sliding member that selectively shields or opens the supply lines within the header, and a drive unit that adjusts respective coolant jetting amounts of the plurally provided jetting nozzles by moving the sliding member.

Advantages of the Invention

[0010] According to the present invention, it is possible to perform a selective coolant jetting applicable also to a rolling mill that uses small diameter work rolls and has a limited space. Problems, configurations, and effects other than those described above will be made clear by the following description of embodiments.

Brief Description of the Drawings

[0011]

FIG. 1 is a front view of a 20-high rolling mill according to a first embodiment of the present invention.

FIG. 2 is a view taken in the direction of arrows of a line II-II' in FIG. 4.

FIG. 3 is a sectional view taken in the direction of arrows of a line III-III' in FIG. 1.

FIG. 4 is a sectional view taken in the direction of arrows of a line IV-IV' in FIG. 1.

FIG. 5 is a diagram of assistance in explaining nozzle jetting of all of jetting nozzles in the 20-high rolling mill according to the first embodiment.

FIG. 6 is a diagram of assistance in explaining a partial stopping of the nozzle jetting of the jetting nozzles in the 20-high rolling mill according to the first embodiment.

FIG. 7 is a diagram of assistance in explaining stopping of nozzle jetting of all of the jetting nozzles in the 20-high rolling mill according to the first embodiment.

FIG. 8 is a diagram of assistance in explaining a partial nozzle jetting of the jetting nozzles in the 20-high rolling mill according to the first embodiment.

FIG. 9 is a front view of another configuration of the 20-high rolling mill according to the first embodiment of the present invention.

FIG. 10 is a sectional view taken in the direction of arrows of a line X-X' in FIG. 9.

FIG. 11 is a front view of a 20-high rolling mill according to a second embodiment of the present invention.

FIG. 12 is a sectional view taken in the direction of arrows of a line XII-XII' in FIG. 11.

FIG. 13 is a diagram of assistance in explaining a state of nozzle jetting of all of jetting nozzles in the 20-high rolling mill according to the second embodiment.

FIG. 14 is a diagram of assistance in explaining a

closed state in only a cross section 35b in the 20-high rolling mill according to the second embodiment.

FIG. 15 is a diagram of assistance in explaining a closed state in only a cross section 35c in the 20-high rolling mill according to the second embodiment.

FIG. 16 is a diagram of assistance in explaining a closed state in only a cross section 35d in the 20-high rolling mill according to the second embodiment.

FIG. 17 is a diagram of assistance in explaining a state of nozzle jetting of all of jetting nozzles in a 20-high rolling mill according to another configuration of the second embodiment.

FIG. 18 is a diagram of assistance in explaining an opened state in only a cross section 35b in the 20-high rolling mill according to the other configuration of the second embodiment.

FIG. 19 is a diagram of assistance in explaining an opened state in only a cross section 35c in the 20-high rolling mill according to the other configuration of the second embodiment.

FIG. 20 is a diagram of assistance in explaining an opened state in only a cross section 35d in the 20-high rolling mill according to the other configuration of the second embodiment.

FIG. 21 is a diagram of assistance in explaining a state of nozzle jetting of all of jetting nozzles in a 20-high rolling mill according to yet another configuration of the second embodiment.

FIG. 22 is a diagram of assistance in explaining a closed state in only a cross section 35b in the 20-high rolling mill according to the yet another configuration of the second embodiment.

FIG. 23 is a diagram of assistance in explaining a closed state in only a cross section 35c in the 20-high rolling mill according to the yet another configuration of the second embodiment.

FIG. 24 is a diagram of assistance in explaining a closed state in only a cross section 35d in the 20-high rolling mill according to the yet another configuration of the second embodiment.

FIG. 25 is a front view of a 4-high rolling mill according to a third embodiment of the present invention.

FIG. 26 is a front view of a 6-high rolling mill according to a fourth embodiment of the present invention.

FIG. 27 is a front view of an 18-high rolling mill according to a fifth embodiment of the present invention.

FIG. 28 is a view taken in the direction of arrows of a line V-V in FIG. 27.

FIG. 29 is a front view of a 12-high rolling mill according to a sixth embodiment of the present invention.

FIG. 30 is a front view of a 20-high rolling mill according to a seventh embodiment of the present invention.

FIG. 31 is a front view of a tandem rolling mill according to an eighth embodiment of the present invention.

Modes for Carrying Out the Invention

[0012] Embodiments of a rolling mill, a tandem rolling mill, and a rolling mill coolant supply mechanism according to the present invention will hereinafter be described with reference to the drawings. Incidentally, in the drawings used in the present specification, identical or corresponding constituent elements are identified by identical or similar reference numerals, and repeated description of these constituent elements may be omitted.

<First Embodiment>

[0013] A first embodiment of a rolling mill and a rolling mill coolant supply mechanism according to the present invention will be described with reference to FIGS. 1 to 10.

[0014] First, a general configuration of the rolling mill and a configuration of the coolant supply mechanism will be described with reference to FIGS. 1 to 8. FIG. 1 is a front view of a 20-high rolling mill according to the present first embodiment, and is a sectional view taken in the direction of arrows of a line I-I' in FIG. 4. FIG. 2 is a view taken in the direction of arrows of a line II-II' in FIG. 4. FIG. 3 is a sectional view taken in the direction of arrows of a line III-III' in FIG. 1. FIG. 4 is a sectional view taken in the direction of arrows of a line IV-IV' in FIG. 1. FIG. 5 is a diagram of assistance in explaining nozzle jetting of all of jetting nozzles. FIG. 6 is a diagram of assistance in explaining a partial stopping of the nozzle jetting of the jetting nozzles. FIG. 7 is a diagram of assistance in explaining stopping of the nozzle jetting of all of the jetting nozzles. FIG. 8 is a diagram of assistance in explaining a partial nozzle jetting of the jetting nozzles.

[0015] A rolling mill 100 according to the first embodiment is a 20-high rolling mill as illustrated in FIG. 1 and the like. A metal strip 1 as a metal strip is rolled by a pair of upper and lower work rolls 2.

[0016] The pair of upper and lower work rolls 2 is respectively in contact with and supported by two pairs of upper and lower first intermediate rolls 3. The two pairs of upper and lower first intermediate rolls 3 are respectively in contact with and supported by three pairs of upper and lower second intermediate rolls 4. In addition, the three pairs of upper and lower second intermediate rolls 4 are respectively in contact with and supported by four pairs of upper and lower divided backing bearing shafts (not illustrated) constituted by divided backing bearings 5, shafts 6, and saddles (omitted for the convenience of illustration). Further, the four pairs of upper and lower divided backing bearing shafts are supported by a mill housing (not illustrated) through the saddles.

[0017] The rolling mill 100 according to the first embodiment is provided with a total of four coolant supply

mechanisms that jet a coolant for roll cooling and rolling lubrication to the pair of upper and lower work rolls 2 from an entry side and an exit side in a pass direction of the metal strip 1 and an upward and a downward direction.

A coolant oil is jetted as coolant sprays 7 from the coolant supply mechanisms.

[0018] Parts of the surfaces of the pair of upper and lower work rolls 2, where the coolant sprays 7 at this time hit, are indicated as spray jetting marks 19 in FIG. 3 and FIG. 4.

[0019] Incidentally, while description will be made of a case where the coolant supply mechanisms are provided to all of the entry side, the exit side, the upper side, and the lower side of the pass direction of the metal strip 1, it suffices to provide a coolant supply mechanism to at least one position among these four positions.

[0020] The coolant supply mechanisms respectively include jetting nozzles 8a, 8b, 8c, 8d, 8e, 8f, 8g, and 8h (hereinafter described also as "jetting nozzles 8"), holes 9a, 9b, 9c, 9d, 9e, 9f, 9g, and 9h (hereinafter described also as "holes 9"), headers 12a, 12b, 12c, and 12d (hereinafter described also as "headers 12"), tubes 11, gears 13a, 13b, 13c, 13d, 13e, 13f, 13g, and 13h (hereinafter described also as "gears 13"), sector gears 14a, 14b, 14c, 14d, 14e, 14f, 14g, and 14h (hereinafter described also as "sector gears 14"), second pins 15a, 15b, 15c, 15d, 15e, 15f, 15g, and 15h (hereinafter described also as "second pins 15"), pins 16a, 16b, 16c, 16d, 16e, 16f, 16g, and 16h (hereinafter described also as "pins 16"), fork ends 17a, 17b, 17c, 17d, 17e, 17f, 17g, and 17h (hereinafter described also as "fork ends 17"), and hydraulic cylinders 18a, 18b, 18c, 18d, 18e, 18f, 18g, and 18h (hereinafter described also as "hydraulic cylinders 18").

[0021] Incidentally, suppose that in the cases of those provided with reference characters "a, b, c, d, e, f, g, and h" in FIG. 1 and the like, "a" denotes the work side of the exit side above the metal strip 1, "b" denotes the drive side of the exit side above the metal strip 1, "c" denotes the work side of the exit side below the metal strip 1, "d" denotes the drive side of the exit side below the metal strip 1, "e" denotes the work side of the entry side above the metal strip 1, "f" denotes the drive side of the entry side above the metal strip 1, "g" denotes the work side of the entry side below the metal strip 1, and "h" denotes the drive side of the entry side below the metal strip 1.

[0022] In addition, suppose that in the cases of those provided with reference characters "a, b, c, and d" in FIG. 1 and the like, "a" denotes the exit side above the metal strip 1, "b" denotes the exit side below the metal strip 1, "c" denotes the entry side above the metal strip 1, and "d" denotes the entry side below the metal strip 1.

[0023] Further, suppose that reference numerals parenthesized in FIG. 1 and the like denote those difficult to illustrate due to the same structures present in front. For example, it is denoted that the jetting nozzle 8b in FIG. 1 is present at a position that cannot be illustrated due to the jetting nozzle 8a. The same is true for other

parenthesized reference numerals.

[0024] The jetting nozzles 8 are plurally provided so as to form a row in a strip width direction of the metal strip 1. The jetting nozzles 8 are members for jetting the coolant to the work rolls 2.

[0025] The holes 9 are to supply the coolant to the respective jetting nozzles 8. The holes 9 are respectively provided to the headers 12.

[0026] The headers 12 are members that house the jetting nozzles 8 plurally provided.

[0027] The coolant oil is supplied to coolant flow passages 10a, 10b, 10c, 10d, 10e, 10f, 10g, and 10h (hereinafter described also as "coolant flow passages 10") of the headers 12 via a pump (not illustrated) and a pipe. The coolant sprays 7 are jetted from the jetting nozzles 8 via the tubes 11 and the holes 9.

[0028] The tubes 11 are members that selectively shield or open the holes 9 within the headers 12. The tubes 11 are constituted by a cylinder having a plurality of holes. More specifically, as illustrated in FIG. 5 and FIG. 6, the tubes 11 have a plurality of elongated holes or holes provided to outer circumferential surfaces thereof, and the tubes 11 are attached to the respective headers 12 so as to be rotationally slidable. Incidentally, the holes do not need to be plurally provided, and one hole may suffice.

[0029] In addition, the rolling mill 100 according to the present first embodiment has driving mechanisms for adjusting coolant jetting amounts of the respective plurally provided jetting nozzles 8 by moving the tubes 11.

[0030] The driving mechanisms include the gears 13, the sector gears 14, the second pins 15, the pins 16, the fork ends 17, the hydraulic cylinders 18, and the like. In the driving mechanisms, at the fork ends 17 provided to end portions of the respective hydraulic cylinders 18, the respective sector gears 14 and the respective hydraulic cylinders 18 are connected to each other via the respective pins 16.

[0031] The respective sector gears 14 are configured so as to rotate about the respective second pins 15. The sector gears 14 are respectively in mesh with the gears 13 provided to the tubes 11.

[0032] When a hydraulic cylinder 18 is expanded or contracted, the vertical direction positions of the fork end 17 and the pin 16 vary, and the sector gear 14 rotates about the second pin 15. As the sector gear 14 rotates, the gear 13 provided to the tube 11 also rotates with the rotation of the sector gear 14, and thus the tube 11 rotates.

[0033] As illustrated in FIG. 5 and FIG. 6, the tube 11 is provided with a plurality of holes 11a in the outer circumferential surface thereof. The coolant amounts of the respective jetting nozzles 8 can be adjusted in amount from 0 to a fixed value, or switched and adjusted between 0 and the fixed value by a pattern of the holes 11a and an adjustment of the rotational angle of the tube 11.

[0034] The rotational control of the tube 11 may be performed by a control unit (that is equivalent to a control

unit 57 in a seventh embodiment to be described later, and is not illustrated), or may be performed by operation of an operator.

[0035] As in a developed view of the tube 11 illustrated in FIG. 5 and FIG. 6, for example, supposing that the holes 11a are a plurality of elongated hole patterns, in a case of a rotational angle of zero degrees of the tube 11 in FIG. 5, all of the positions of the holes 11a of the tube 11 and the holes 9 coincide with each other in the strip width direction, and thus the coolant sprays 7 are jetted from all of the jetting nozzles 8. In this state, as illustrated in FIG. 5, a detrimental partial local swelling may occur at a strip width 1/8 part in a strip shape.

[0036] Here, as in FIG. 6, when the tube 11 is rotated to a rotational angle illustrated in the figure, the position of a hole 9 and the position of a hole 11a of the tube 11 coincide with each other at a position 20b. At this position 20b, the jetting nozzle 8 is not shut off, and a coolant spray 7 is jetted from that part.

[0037] Meanwhile, at a position 20a, the position of the hole 9 and the position of the hole 11a of the tube 11 do not coincide with each other. At this position 20a, the jetting nozzle 8 is shut off by the tube 11, and no coolant spray 7 is jetted from that part.

[0038] In the case of FIG. 6, the work roll 2 at a position to which no coolant spray 7 is jetted (part of an area A in FIG. 6) is cooled less than other parts. Thus, only that part thermally expands more than the other parts, and is increased in diameter. As a result, the metal strip 1 is rolled correspondingly more than the other parts, the detrimental local swelling disappears from the strip shape or is reduced, and the strip shape is improved to a gently inclined shape.

[0039] Here, the pattern of the holes of the tube 11 is not limited to the pattern illustrated in FIG. 5 and FIG. 6. As illustrated in FIG. 7 and FIG. 8, when a pattern such as a plurality of short holes 11a1 is formed as in a tube 11A, in a case of a rotational angle of zero degrees of the tube 11A in FIG. 7, the positions of the holes 11a1 of the tube 11A and the positions of the holes 9 do not coincide with each other at all parts in the strip width direction, and no coolant sprays 7 are jetted from the jetting nozzles 8 at all. In this state, as illustrated in FIG. 7, a detrimental partial local buckle may occur in the strip shape as in FIG. 5.

[0040] Here, as illustrated in FIG. 8, when the tube 11A is rotated to a rotational angle illustrated in the figure, the position of a hole 9 and the position of a hole 11a1 of the tube 11A coincide with each other at a position 21b. At this position 21b, the jetting nozzle 8 is not shut off, and a coolant spray 7 is jetted from that part.

[0041] Meanwhile, at a position 21a, the position of the hole 9 and the position of the hole 11a1 of the tube 11A do not coincide with each other. At this position 21a, the jetting nozzle 8 is shut off by the tube 11A, and no coolant spray 7 is jetted from that part.

[0042] In the case of FIG. 8, the work roll 2 at a position to which the coolant spray 7 is jetted (area B in FIG. 8)

is cooled more than other parts. Thus, only that part has a smaller thermal expansion than the other parts, and is decreased in diameter. As a result, rolling becomes correspondingly lighter than the other parts, the detrimental local buckle disappears from the strip shape or is reduced, and the strip shape is improved to a gently inclined shape.

[0043] Thus, when the jetting amount of a jetting nozzle 8 at a same width direction position as a part in which the strip shape is locally swelled is decreased or set at 0, and/or the jetting amounts of jetting nozzles 8 at the other width direction positions are increased, the cooling of that part becomes relatively insufficient, the thermal crown of that part of the work roll 2 grows, and the strip tends to extend only in that part. As a result, the excessive local swelling of the strip shape is alleviated.

[0044] In addition, when the jetting amount of a jetting nozzle 8 at a same width direction position as a part in which the strip shape is locally extended is increased, and/or the jetting amounts of jetting nozzles 8 at the other width direction positions are decreased or set at 0, the cooling of that part is relatively increased, the thermal crown of that part of the work roll 2 is decreased, and only that part tends to swell. As a result, the excessive local buckle of the strip shape is alleviated.

[0045] In the first embodiment, the tube 11 is divided into two parts on the work side and the drive side, and the two parts are rotated independently of each other. Thus, the coolant sprays 7 on the work side and the drive side can also be jetted independently of each other, which is effective in a case where the strip shape is bilaterally asymmetric.

[0046] Incidentally, the work side and the drive side of the tube 11 may be made integral with each other. In this case, when the pattern of the holes 11a of the tube 11 is bilaterally symmetric about a strip width center, the coolant sprays 7 are jetted by bilaterally symmetric coolant jetting with respect to the center in the strip width direction of the metal strip 1. However, there is an advantage in that a drive device is on only one side, that is, the work side or the drive side, and thus has an even simpler structure. Incidentally, the pattern of the holes 11a does not need to be bilaterally symmetric about the strip width center, but can be changed as appropriate.

[0047] Next, a modified configuration of the rolling mill and the rolling mill coolant supply mechanism according to the first embodiment will be described with reference to FIG. 9 and FIG. 10. FIG. 9 is a front view of another configuration of the 20-high rolling mill according to the present first embodiment. FIG. 10 is a sectional view taken in the direction of arrows of a line X-X in FIG. 9.

[0048] A rolling mill 100A illustrated in FIG. 9 and FIG. 10 has the same configuration as the rolling mill 100 illustrated in FIG. 1 and the like except for a different configuration of the driving mechanism for rotating the tube 11 or 11A.

[0049] The driving mechanisms of the rolling mill 100A respectively include rotary cylinders 25a, 25b, 25c, 25d,

25e, 25f, 25g, and 25h (hereinafter described also as "rotary cylinders 25"), sprockets 24a, 24b, 24c, 24d, 24e, 24f, 24g, and 24h (hereinafter described also as "sprockets 24"), chains 23a, 23b, 23c, 23d, 23e, 23f, 23g, and 23h (hereinafter described also as "chains 23"), and sprockets 22a, 22b, 22c, 22d, 22e, 22f, 22g, and 22h (hereinafter described also as "sprockets 22").

[0050] As illustrated in FIG. 9 and FIG. 10, a sprocket 24 is attached to an output shaft of the rotary cylinder 25, and the chain 23 is meshed with the sprocket 24 so as to be drivable. Further, the sprocket 22 is meshed with an opposite side of the chain 23 from a side on which the chain 23 is meshed with the sprocket 24. The sprocket 22 is attached to an end portion of the tube 11 or 11A.

[0051] When the tube 11 or 11A is rotationally driven, the sprocket 24 is driven by the rotational driving of the rotary cylinder 25, and the tube 11 or 11A is rotated via the chain 23 and the sprocket 22.

[0052] Incidentally, a hydraulic motor or an electric motor can be used in place of the rotary cylinder 25. In addition, a timing belt can be used as the chain 23.

[0053] Next, effects of the present embodiment will be described.

[0054] The rolling mill 100 according to the first embodiment of the present invention described above includes: at least a pair of work rolls 2 that roll a metal strip 1; and a coolant supply mechanism that jets a coolant to the work rolls 2 at at least one position of an entry side, an exit side, an upper side, and a lower side in a pass direction of the metal strip 1, the coolant supply mechanism including jetting nozzles 8 that jet the coolant, the jetting nozzles 8 being plurally provided so as to form a row in a strip width direction of the metal strip 1, holes 9 that supply the coolant to the respective jetting nozzles 8, a header 12 that houses the plurally provided jetting nozzles 8, a tube 11 that selectively shields or opens the holes 9 within the header 12, and a hydraulic cylinder 18 that adjusts respective coolant jetting amounts of the plurally provided jetting nozzles 8 by moving the tube 11.

[0055] In a cluster type 12-high rolling mill as in a sixth embodiment to be described later, a 20-high rolling mill as in the present first embodiment, and an 18-high rolling mill as in a fifth embodiment, for example, a space is narrow, and thus it is difficult to provide the respective coolant supply lines of the plurally provided jetting nozzles with respective solenoid opening and closing valves and respective pipes.

[0056] In addition, as for a 4-high rolling mill in a third embodiment and a 6-high rolling mill as in a fourth embodiment, when the respective coolant supply lines of the plurally provided jetting nozzles are provided with the respective solenoid opening and closing valves and the respective pipes, the solenoid opening and closing valves and the pipes are large in number, and thus require cost.

[0057] However, according to the coolant supply mechanism as in the present invention, because of the simple configuration thereof, the solenoid opening and

closing valves and the pipes do not need to be provided, and the coolant supply mechanism can be installed even in a narrow space in a case of small diameter work rolls. In addition, a reduction in cost can also be achieved.

[0058] In addition, according to the strip shape, for example, the coolant amounts of the respective jetting nozzles 8 can be adjusted in amount from 0 to a fixed value, or switched and adjusted between 0 and the fixed value. Hence, the thermal crown amounts of the work rolls are changed to control the strip shape by a difference between degrees of local cooling of the work rolls. Thus, this is effective in remedying a local shape defect.

[0059] Such a rolling mill can be said to be a rolling mill suitable for obtaining a metal strip of high product quality such as high strip shape accuracy or the like in the rolling of a soft material such as an ordinary steel strip or an aluminum alloy and, in particular, a hard material such as a stainless steel strip, a magnetic steel strip, or a copper alloy.

[0060] In addition, the sliding member is constituted by the cylindrical tube 11 or 11A having a plurality of holes. Thus, partial coolant supply can be realized easily by a simple configuration.

[0061] Further, the tube 11 or 11A is divided into two parts on the drive side and the work side. Therefore, even when the surface shape of the metal strip 1 is bilaterally asymmetric, coolant supply control according to the surface shape is possible, so that the metal strip 1 having a surface shape of higher quality can be obtained.

<Second Embodiment>

[0062] A rolling mill and a rolling mill coolant supply mechanism according to a second embodiment of the present invention will be described with reference to FIGS. 11 to 24.

[0063] FIG. 11 is a front view of a 20-high rolling mill according to the present second embodiment. FIG. 12 is a sectional view taken in the direction of arrows of a line XII-XII' in FIG. 11. FIG. 13 is a diagram of assistance in explaining a state of nozzle jetting of all of jetting nozzles. FIG. 14 is a diagram of assistance in explaining a closed state in only a section 35b. FIG. 15 is a diagram of assistance in explaining a closed state in only a section 35c. FIG. 16 is a diagram of assistance in explaining a closed state in only a section 35d.

[0064] A rolling mill 100B according to the present second embodiment illustrated in FIG. 11 is different from the rolling mill 100 according to the first embodiment in terms of the configuration of the sliding member (tube 11 or 11A) that selectively shields or opens the holes 9 within the header 12. The sliding member is constituted by any one of shielding bodies 26 and 37 and a shielding plate 43.

[0065] The shielding bodies 26 and 37 and the shielding plate 43 are constituted by any one of a circular cylinder having one or more projections, a circular cylinder having one or more holes, and a ring-shaped plate mov-

able in the strip width direction. Details thereof will be described in the following.

[0066] In the rolling mill 100B according to the present second embodiment, as illustrated in FIG. 11 and FIG. 12, the coolant oil is supplied to the coolant flow passages 10 of the headers 12 via a pump (not illustrated) and a pipe.

[0067] Further, the coolant sprays 7 are jetted from the jetting nozzles 8 via primary holes 30a, 30b, 30c, 30d, 30e, 30f, 30g, and 30h (hereinafter described also as "primary holes 30"), coolant flow passages 28a, 28b, 28c, 28d, 28e, 28f, 28g, and 28h (hereinafter described also as "coolant flow passages 28"), shielding bodies 26a, 26b, 26c, 26d, 26e, 26f, 26g, and 26h (hereinafter described also as "shielding bodies 26"), and holes 29a, 29b, 29c, 29d, 29e, 29f, 29g, and 29h (hereinafter described also as "holes 29").

[0068] A plurality of projections 27a, 27b, 27c, 27d, 27e, 27f, 27g, and 27h (hereinafter described also as "projections 27") are provided to the respective surfaces of the cylindrical shielding bodies 26, and are attached to the insides of the coolant flow passages 28 so as to be rotationally slidable. Incidentally, notches can be provided in place of or in addition to the projections 27.

[0069] In addition, the driving mechanisms of the shielding bodies 26 include rotary cylinders 34a, 34b, 34c, 34d, 34e, 34f, 34g, and 34h (hereinafter described also as "rotary cylinders 34"), sprockets 33a, 33b, 33c, 33d, 33e, 33f, 33g, and 33h (hereinafter described also as "sprockets 33"), chains 32a, 32b, 32c, 32d, 32e, 32f, 32g, and 32h (hereinafter described also as "chains 32"), and sprockets 31a, 31b, 31c, 31d, 31e, 31f, 31g, and 31h (hereinafter described also as "sprockets 31").

[0070] A sprocket 33 is attached to an output shaft of the rotary cylinder 34a, and the chain 32a is meshed with the sprocket 33 so as to be drivable. In addition, the sprocket 31 is meshed with another side of the chain 32. The sprocket 31 is attached to an end portion of the shielding body 26.

[0071] The sprocket 33 is driven by the rotational driving of the rotary cylinder 34, and the shielding body 26 is rotated via the chain 32 and the sprocket 31.

[0072] Here, a hydraulic motor or an electric motor can be used as the rotary cylinder 34. In addition, the chain 32 may be a timing belt.

[0073] In the rolling mill 100B, each of the holes 29 is opened or closed by a rotational adjustment of the projections 27 of the shielding body 26, and thereby the coolant amounts of the jetting nozzles 8 are adjusted in amount from 0 to a fixed value, or switched and adjusted between 0 and the fixed value.

[0074] Supposing that the pattern of the projections 27 of the shielding body 26 is of a configuration illustrated in FIG. 13 and the like, as illustrated in FIG. 13, in a case of a rotational angle of zero degrees of the shielding body 26, as illustrated in cross sections 35a, 35b, 35c, 35d, and 35e, none of the positions of the projections 27 and the positions of the holes 29 coincide with each other in

the strip width direction, and thus the coolant sprays 7 are jetted from all of the jetting nozzles 8 in the strip width direction. In particular, even when the projections 27 coincide with the positions of the primary holes 30, the coolant can detour through a clearance groove 36e (, 36a, 36b, 36c, 36d), and therefore the coolant sprays 7 are jetted.

[0075] Next, when the rotational angle of the shielding body 26 is 45 degrees as in FIG. 14, at the positions of the cross sections 35a, 35c, 35d, and 35e, the positions of the projections 27 and the positions of the holes 29 do not coincide with each other, and thus the coolant sprays 7 are jetted. Meanwhile, at the position of the cross section 35b, the position of the projection 27 and the position of the hole 29 coincide with each other, and thus the jetting amount of the coolant is decreased or becomes 0.

[0076] Similarly, when the rotational angle of the shielding body 26 is 90 degrees as in FIG. 15, at the positions of the cross sections 35a, 35b, 35d, and 35e, the positions of the projections 27 and the positions of the holes 29 do not coincide with each other, and thus the coolant sprays 7 are jetted. Meanwhile, at the position of the cross section 35c, the position of the projection 27 and the position of the hole 29 coincide with each other, and thus the jetting amount of the coolant is decreased or becomes 0.

[0077] When the rotational angle of the shielding body 26 is 135 degrees as in FIG. 16, at the positions of the cross sections 35a, 35b, 35c, and 35e, the positions of the projections 27 and the positions of the holes 29 do not coincide with each other, and thus the coolant sprays 7 are jetted. Meanwhile, at the position of the cross section 35d, the position of the projection 27 and the position of the hole 29 coincide with each other, and thus the jetting amount of the coolant is decreased or becomes 0.

[0078] Next, a modified configuration of the sliding member will be described with reference to FIGS. 17 to 20. FIG. 17 is a diagram of assistance in explaining a state of nozzle jetting of all of jetting nozzles in a 20-high rolling mill according to another configuration of the second embodiment. FIG. 18 is a diagram of assistance in explaining an opened state in only the cross section 35b. FIG. 19 is a diagram of assistance in explaining an opened state in only the cross section 35c. FIG. 20 is a diagram of assistance in explaining an opened state in only the cross section 35d.

[0079] In this configuration, as illustrated in FIG. 17 and the like, the sliding member is a cylindrical shielding body 37 that internally has one or more flow passage holes 38 in place of the shielding body 26.

[0080] In the shielding body 37, a rotational adjustment of the shielding body 37 is made to open or close each of the holes 29 by movement of the flow passage holes 38, and thereby the coolant amounts of the jetting nozzles 8 are adjusted in amount from 0 to a fixed value, or switched and adjusted between 0 and the fixed value.

[0081] Supposing that the pattern of the flow passage holes 38 of the shielding body 37 is of a configuration

illustrated in FIG. 17 and the like, when the rotational angle of the shielding body 37 is zero degrees as in FIG. 17, as illustrated in the cross sections 35a, 35b, 35c, 35d, and 35e, the positions of the flow passage holes 38 and the positions of the holes 29 all coincide with each other, and thus the coolant sprays 7 are jetted from all of the jetting nozzles 8 in the strip width direction.

[0082] Next, when the rotational angle of the shielding body 37 is 45 degrees as in FIG. 18, at the positions of the cross sections 35a, 35c, 35d, and 35e, the positions of the flow passage holes 38 and the positions of the holes 29 do not coincide with each other, and thus the jetting amounts of the coolant are decreased or become 0. Meanwhile, at the position of the cross section 35b, the position of the flow passage hole 38 and the position of the hole 29 coincide with each other, and thus the coolant spray 7 is jetted.

[0083] Similarly, when the rotational angle of the shielding body 37 is 90 degrees as in FIG. 19, at the positions of the cross sections 35a, 35b, 35d, and 35e, the positions of the flow passage holes 38 and the positions of the holes 29 do not coincide with each other, and thus the jetting amounts of the coolant are decreased or become 0. Meanwhile, at the position of the cross section 35c, the position of the flow passage hole 38 and the position of the hole 29 coincide with each other, and thus the coolant spray 7 is jetted.

[0084] When the rotational angle of the shielding body 37 is 135 degrees as in FIG. 20, at the positions of the cross sections 35a, 35b, 35c, and 35e, the positions of the flow passage holes 38 and the positions of the holes 29 do not coincide with each other, and thus the jetting amounts of the coolant are decreased or become 0. Meanwhile, at the position of the cross section 35d, the position of the flow passage hole 38 and the position of the hole 29 coincide with each other, and thus the coolant spray 7 is jetted.

[0085] Incidentally, as with the tube 11 or 11A, the work side and the drive side of the shielding body 26 or 37 may be integral with each other. In this case, when the pattern of the projections 27 or the flow passage holes 38 is bilaterally symmetric about the strip width center, the coolant sprays 7 are jetted bilaterally symmetrically. However, there is an advantage in that the drive device is on only one side, that is, the work side or the drive side, and thus has a simple structure. Incidentally, the pattern of the projections 27 or the flow passage holes 38 does not need to be bilaterally symmetric about the strip width center, but can be changed as appropriate.

[0086] Next, a further modified configuration of the sliding member will be described with reference to FIGS. 21 to 24. FIG. 21 is a diagram of assistance in explaining a state of nozzle jetting of all of jetting nozzles in a 20-high rolling mill according to yet another configuration of the second embodiment. FIG. 22 is a diagram of assistance in explaining a closed state in only the cross section 35b. FIG. 23 is a diagram of assistance in explaining a closed state in only the cross section 35c. FIG. 24 is a diagram

of assistance in explaining a closed state in only the cross section 35d.

[0087] As illustrated in FIG. 21 and the like, the sliding member can be a shielding plate 43 movable in the strip width direction in place of the shielding bodies 26 and 37.

[0088] The shielding plate 43 is disposed on the outside of a screw shaft 42. When the screw shaft 42 is rotated, the shielding plate 43 is shifted and moved in the axial direction of the screw shaft 42 (that is, the strip width direction) to open or close each of the holes 29 as appropriate. The coolant amounts of the jetting nozzles 8 are thereby adjusted in amount from 0 to a fixed value, or switched and adjusted between 0 and the fixed value.

[0089] Supposing that the position of the shielding plate 43 is a position illustrated in FIG. 21 or the like, when the position of the shielding plate 43 is as in FIG. 21, as illustrated in the cross sections 35a, 35b, 35c, 35d, and 35e, the position of the shielding plate 43 and the positions of the holes 29 do not coincide with each other, and thus the coolant sprays 7 are jetted from all of the jetting nozzles 8 in the strip width direction.

[0090] Next, when the position of the shielding plate 43 is as in FIG. 22, at the positions of the cross sections 35a, 35c, 35d, and 35e, the position of the shielding plate 43 and the positions of the holes 29 do not coincide with each other, and thus the coolant sprays 7 are jetted. Meanwhile, at the position of the cross section 35b, the position of the shielding plate 43 and the position of the hole 29 coincide with each other, and thus the jetting amount of the coolant is decreased or becomes 0.

[0091] Similarly, when the position of the shielding plate 43 is as in FIG. 23, at the positions of the cross sections 35a, 35b, 35d, and 35e, the position of the shielding plate 43 and the positions of the holes 29 do not coincide with each other, and thus the coolant sprays 7 are jetted. Meanwhile, at the position of the cross section 35c, the position of the shielding plate 43 and the position of the hole 29 coincide with each other, and thus the jetting amount of the coolant is decreased or becomes 0.

[0092] When the position of the shielding plate 43 is as in FIG. 24, at the positions of the cross sections 35a, 35b, 35c, and 35e, the position of the shielding plate 43 and the positions of the holes 29 do not coincide with each other, and thus the coolant sprays 7 are jetted. Meanwhile, at the position of the cross section 35d, the position of the shielding plate 43 and the position of the hole 29 coincide with each other, and thus the jetting amount of the coolant is decreased or becomes 0.

[0093] In addition, here, the screw shafts 42 on the work side and the drive side can be made integral with each other, and a right handed screw and a left handed screw can be used as reverse screws on the work side and the drive side. In this case, the shielding plates 43 on the work side and the drive side can be moved symmetrically by only one-side rotational driving on the work side or the drive side. In this case, the coolant sprays 7 are jetted bilaterally symmetrically, but there is an advan-

tage in that the drive device is on only one side, that is, the work side or the drive side, and thus has a simple structure.

[0094] Other configurations and operations are substantially the same configurations and operations as in the first embodiment described above, and details thereof will be omitted.

[0095] The second embodiment of the present invention also provides substantially similar effects to those of the first embodiment described above.

[0096] In addition, partial coolant supply can be realized easily by a simple configuration also when the sliding member is constituted by any one of the cylindrical shielding body 26 having one or more projections, the cylindrical shielding body 37 having one or more holes, and the shielding plate 43 movable in the strip width direction.

<Third Embodiment>

[0097] A rolling mill and a rolling mill coolant supply mechanism according to a third embodiment of the present invention will be described with reference to FIG. 25. FIG. 25 is a front view of a 4-high rolling mill according to the present third embodiment.

[0098] As illustrated in FIG. 25, a rolling mill 100C according to the present third embodiment is a 4-high rolling mill, and a metal strip 1 as a rolled metal strip is rolled by a pair of upper and lower work rolls 2. The pair of upper and lower work rolls 2 is respectively in contact with and supported by a pair of upper and lower back-up rolls 44.

[0099] This rolling mill 100C also has the coolant supply mechanisms described in the foregoing first embodiment or the foregoing second embodiment.

[0100] The 4-high rolling mill 100C as in the present third embodiment has a relatively small number of rolls, and has a surplus space. However, the coolant supply mechanisms described in the foregoing first embodiment or the foregoing second embodiment do not use a large number of solenoid valves and have a simple structure, and therefore the coolant supply mechanisms have an advantage of being inexpensive.

[0101] Other configurations and operations are substantially the same configurations and operations as in the first embodiment or the second embodiment described earlier, and details thereof will be omitted.

<Fourth Embodiment>

[0102] A rolling mill and a rolling mill coolant supply mechanism according to a fourth embodiment of the present invention will be described with reference to FIG. 26. FIG. 26 is a front view of a 6-high rolling mill according to the present fourth embodiment.

[0103] As illustrated in FIG. 26, a rolling mill 100D according to the present fourth embodiment is a 6-high rolling mill, and a metal strip 1 as a metal strip is rolled by a pair of upper and lower work rolls 2. The pair of upper

and lower work rolls 2 is respectively in contact with and supported by a pair of upper and lower intermediate rolls 45. The pair of upper and lower intermediate rolls 45 is respectively in contact with and supported by a pair of upper and lower back-up rolls 46.

[0104] This rolling mill 100D also has the coolant supply mechanisms described in the foregoing first embodiment or the foregoing second embodiment.

[0105] The 6-high rolling mill 100D as in the present fourth embodiment has a relatively small number of rolls, and has a surplus space. However, the coolant supply mechanisms described in the foregoing first embodiment or the foregoing second embodiment do not use a large number of solenoid valves and have a simple structure, and therefore the coolant supply mechanisms have an advantage of being inexpensive.

[0106] Other configurations and operations are substantially the same configurations and operations as in the first embodiment or the second embodiment described earlier, and details thereof will be omitted.

<Fifth Embodiment>

[0107] A rolling mill and a rolling mill coolant supply mechanism according to a fifth embodiment of the present invention will be described with reference to FIG. 27 and FIG. 28. FIG. 27 is a front view of an 18-high rolling mill according to the present fifth embodiment. FIG. 28 is a view taken in the direction of arrows of a line V-V in FIG. 27.

[0108] As illustrated in FIG. 27 and FIG. 28, a rolling mill 100E according to the present fifth embodiment is an 18-high rolling mill, and a metal strip 1 as a metal strip is rolled by a pair of upper and lower work rolls 2. The pair of upper and lower work rolls 2 is respectively in contact with and supported by a pair of upper and lower intermediate rolls 47. The pair of upper and lower intermediate rolls 47 is respectively in contact with and supported by a pair of upper and lower back-up rolls 48. In addition, the work rolls 2 are supported in a horizontal direction by four pairs of supporting rolls 49 and eight pairs of supporting bearings 50 that support the supporting rolls 49. In addition, the supporting bearings 50 are supported by arms 52 via shafts 51, and the arms 52 are supported by side beams 53.

[0109] This rolling mill 100E also has the coolant supply mechanisms described in the foregoing first embodiment or the foregoing second embodiment.

[0110] Here, in the rolling mill 100E, the tubes 11 are included within the side beams 53 so as to be rotatable.

[0111] In the 18-high rolling mill 100E as in the present fifth embodiment, there is no space to spare because of the presence of a support roll group. However, the coolant supply mechanisms described in the foregoing first embodiment or the foregoing second embodiment are compact, and are therefore easily applicable even in the 18-high rolling mill having a limited space.

[0112] Other configurations and operations are sub-

stantially the same configurations and operations as in the first embodiment or the second embodiment described earlier, and details thereof will be omitted.

5 <Sixth Embodiment>

[0113] A rolling mill and a rolling mill coolant supply mechanism according to a sixth embodiment of the present invention will be described with reference to FIG. 29. FIG. 29 is a front view of a 12-high rolling mill according to the present sixth embodiment.

[0114] As illustrated in FIG. 29, a rolling mill 100F according to the sixth embodiment is a 12-high rolling mill, and a metal strip 1 as a metal strip is rolled by a pair of upper and lower work rolls 2. The pair of upper and lower work rolls 2 is respectively in contact with and supported by two pairs of upper and lower intermediate rolls 54. The two pairs of upper and lower intermediate rolls 54 are respectively in contact with and supported by three pairs of upper and lower divided backing bearing shafts 55.

[0115] This rolling mill 100F also has the coolant supply mechanisms described in the foregoing first embodiment or the foregoing second embodiment.

[0116] In the 12-high rolling mill 100F as in the present sixth embodiment, there is no space to spare because of a cluster roll arrangement. However, the coolant supply mechanisms described in the foregoing first embodiment or the foregoing second embodiment are compact, and are therefore easily applicable even in the 12-high rolling mill having a limited space.

[0117] Other configurations and operations are substantially the same configurations and operations as in the first embodiment or the second embodiment described earlier, and details thereof will be omitted.

<Seventh Embodiment>

[0118] A rolling mill and a rolling mill coolant supply mechanism according to a seventh embodiment of the present invention will be described with reference to FIG. 30. FIG. 30 is a front view of a 20-high rolling mill according to the present seventh embodiment.

[0119] As illustrated in FIG. 30, a rolling mill 100G according to the present seventh embodiment is a 20-high rolling mill, and is provided with a shape detecting roller 56 that detects the strip shape of a metal strip 1 on the exit side of the rolling mill 100G.

[0120] In addition, a control unit 57 is provided which controls the operation of the hydraulic cylinders 18 to move the tubes 11 so as to correct a shape defect such as local buckle or swelling on the basis of the strip shape detected by the shape detecting roller 56. This control unit 57 is preferably constituted by a computer or the like provided with a CPU, a storage medium, a display device, and the like.

[0121] The control unit 57 adjusts the coolant amount of each of the jetting nozzles 8 by the pattern of the plu-

rality of elongated holes or holes in the outer circumferential surfaces of the tubes 11 and the adjustment of the rotational angles of the tubes 11. The control unit 57 thereby corrects a local shape defect.

[0122] More specifically, the jetting amount of a jetting nozzle 8 at a same strip width direction position as a part in which the strip shape is locally swelled can be decreased or set at 0, and the jetting amounts of the other jetting nozzles 8 can be increased.

[0123] Alternatively, the jetting amount of a jetting nozzle 8 at a same strip width direction position as a part in which the strip shape is locally buckled can be increased, and the jetting amounts of the other jetting nozzles 8 can be decreased or set at 0.

[0124] Incidentally, while description has been made of a case where the coolant supply mechanisms according to the first embodiment are applied, it is possible to apply the coolant supply mechanisms according to the modification of the first embodiment and the second embodiment.

[0125] Other configurations and operations are substantially the same configurations and operations as in the first embodiment or the second embodiment described earlier, and details thereof will be omitted.

[0126] The seventh embodiment of the present invention also provides substantially similar effects to those of the first embodiment or the second embodiment described earlier.

[0127] In addition, because of the further provision of the shape detecting roller 56 that is disposed on the exit side in the rolling mill, and detects the strip shape of the metal strip 1, and the control unit 57 that controls the operation of the hydraulic cylinders 18 to move the tubes 11 or 11A, the shielding bodies 26 or 37, or the shielding plates 43 so as to correct a shape defect such as local buckle or swelling on the basis of the strip shape detected by the shape detecting roller 56, coolant supply control according to the shape of the metal strip 1 can be performed more easily, and thus a further improvement in the strip shape can be realized more easily.

[0128] Further, the control unit 57 decreases or sets at 0 the jetting amount of a jetting nozzle 8 at a same strip width direction position as a part in which the strip shape is locally swelled, and increases the jetting amounts of the other jetting nozzles 8, or increases the jetting amount of a jetting nozzle 8 at a same strip width direction position as a part in which the strip shape is locally buckled, and decreases or sets at 0 the jetting amounts of the other jetting nozzles 8. An improvement in the strip shape can be thereby achieved more reliably.

<Eighth Embodiment>

[0129] A tandem rolling mill according to an eighth embodiment of the present invention will be described with reference to FIG. 31. FIG. 31 is a front view of the tandem rolling mill according to the present eighth embodiment in which 20-high rolling mills are arranged in a plurality

of rolling mill stands.

[0130] As illustrated in FIG. 31, the present eighth embodiment is a tandem rolling mill 200 in which rolling mills are arranged in a plurality of rolling mill stands. In FIG. 31, the rolling mill 100 described in the foregoing first embodiment is provided in a final rolling mill stand. The rolling mill 100 according to the first embodiment is disposed in the final rolling mill stand, which is effective because a local shape defect of the strip shape can be corrected in a final rolling pass.

[0131] Other configurations and operations of the rolling mill 100 are substantially the same configurations and operations as in the first embodiment described earlier, and details thereof will be omitted.

[0132] The eighth embodiment of the present invention also provides substantially similar effects to those of the first embodiment described above.

[0133] Incidentally, any one of the rolling mills 100A, 100B, 100C, 100D, 100E, 100F, and 100G according to the modification of the first embodiment to the seventh embodiment can be provided in place of the rolling mill 100. In addition, without being limited to the final rolling mill stand, the other rolling mill stands can be provided with one or more of the rolling mills 100, 100A, 100B, 100C, 100D, 100E, 100F, and 100G described in the first to seventh embodiments.

[0134] <Others>

[0135] It is to be noted that the present invention is not limited to the foregoing embodiments, but includes various modifications. The foregoing embodiments are described in detail to describe the present invention in an easily understandable manner, and are not necessarily limited to embodiments including all of the described configurations.

[0136] In addition, a part of a configuration of a certain embodiment can be replaced with a configuration of another embodiment, and a configuration of another embodiment can be added to a configuration of a certain embodiment. In addition, for a part of a configuration of each embodiment, another configuration can be added, deleted, or substituted.

Description of Reference Characters

[0137]

- 1: Metal strip
- 2: Work roll
- 3: First intermediate roll
- 4: Second intermediate roll
- 5: Divided backing bearing
- 6: Shaft
- 7: Coolant spray
- 8, 8a, 8b, 8c, 8d, 8e, 8f, 8g, 8h: Jetting nozzle
- 9, 9a, 9b, 9c, 9d, 9e, 9f, 9g, 9h: Hole (supply line)
- 10, 10a, 10b, 10c, 10d, 10e, 10f, 10g, 10h: Coolant flow passage (supply line)
- 11, 11A: Tube (sliding member)

11a, 11a1: Hole
 12, 12a, 12b, 12c, 12d: Header
 13, 13a, 13b, 13c, 13d, 13e, 13f, 13g, 13h: Gear (drive unit)
 14, 14a, 14b, 14c, 14d, 14e, 14f, 14g, 14h: Sector gear (drive unit)
 15, 15a, 15b, 15c, 15d, 15e, 15f, 15g, 15h: Second pin (drive unit)
 16, 16a, 16b, 16c, 16d, 16e, 16f, 16g, 16h: Pin (drive unit)
 17, 17a, 17b, 17c, 17d, 17e, 17f, 17g, 17h: Fork end (drive unit)
 18, 18a, 18b, 18c, 18d, 18e, 18f, 18g, 18h: Hydraulic cylinder (drive unit)
 19: Spray jetting mark
 20a, 21a: Position (closed)
 20b, 21b: Position (opened)
 22, 22a, 22b, 22c, 22d, 22e, 22f, 22g, 22h: Sprocket (drive unit)
 23, 23a, 23b, 23c, 23d, 23e, 23f, 23g, 23h: Chain (drive unit)
 24, 24a, 24b, 24c, 24d, 24e, 24f, 24g, 24h: Sprocket (drive unit)
 25, 25a, 25b, 25c, 25d, 25e, 25f, 25g, 25h: Rotary cylinder (drive unit)
 26, 26a, 26b, 26c, 26d, 26e, 26f, 26g, 26h: Shielding body (sliding member)
 27, 27a, 27b, 27c, 27d, 27e, 27f, 27g, 27h: Projection
 28, 28a, 28b, 28c, 28d, 28e, 28f, 28g, 28h: Coolant flow passage (supply line)
 29, 29a, 29b, 29c, 29d, 29e, 29f, 29g, 29h: Hole (supply line)
 30, 30a, 30b, 30c, 30d, 30e, 30f, 30g, 30h: Primary hole (supply line)
 31, 31a, 31b, 31c, 31d, 31e, 31f, 31g, 31h: Sprocket (drive unit)
 32, 32a, 32b, 32c, 32d, 32e, 32f, 32g, 32h: Chain (drive unit)
 33, 33a, 33b, 33c, 33d, 33e, 33f, 33g, 33h: Sprocket (drive unit)
 34, 34a, 34b, 34c, 34d, 34e, 34f, 34g, 34h: Rotary cylinder (drive unit)
 35a, 35b, 35c, 35d, 35e: Cross section
 36a, 36b, 36c, 36d, 36e: Clearance groove
 37: Shielding body (sliding member)
 38: Flow passage hole
 42: Screw shaft
 43: Shielding plate (sliding member, ring-shaped plate)
 44, 46, 48: Back-up roll
 45, 47: Intermediate roll
 49: Supporting roll
 50: Supporting bearing
 51: Shaft
 52: Arm
 53: Side beam
 54: Intermediate roll
 55: Divided backing bearing shaft

56: Shape detecting roller (shape detector)
 57: Control unit
 100, 100A, 100B, 100C, 100D, 100E, 100F, 100G: Rolling mill
 200: Tandem rolling mill

Claims

1. A rolling mill comprising:
 - at least one pair of work rolls that roll a metal strip; and
 - a coolant supply mechanism that jets a coolant to the work rolls at at least one position of an entry side, an exit side, an upper side, and a lower side in a pass direction of the metal strip, the coolant supply mechanism including
 - jetting nozzles that jet the coolant, the jetting nozzles being plurally provided so as to form a row in a strip width direction of the metal strip,
 - supply lines that supply the coolant to the respective jetting nozzles,
 - a header that houses the plurally provided jetting nozzles,
 - a sliding member that selectively shields or opens the supply lines within the header, and
 - a drive unit that adjusts respective coolant jetting amounts of the plurally provided jetting nozzles by moving the sliding member.
2. The rolling mill according to claim 1, wherein the sliding member is constituted by any one of a tube having one or more holes, a cylinder having one or more projections, a cylinder having one or more holes, and a ring-shaped plate movable in the strip width direction.
3. The rolling mill according to claim 1 or 2, wherein the sliding member is divided into two parts on a drive side and a work side.
4. The rolling mill according to any one of claims 1 to 3, further comprising:
 - a shape detector that is disposed on the exit side in the rolling mill, and detects a strip shape of the metal strip; and
 - a control unit that controls operation of the drive unit to move the sliding member so as to correct a shape defect of local buckle or swelling, on a basis of the strip shape detected by the shape detector.
5. The rolling mill according to claim 4, wherein

the control unit

decreases or sets at 0 the jetting amount of a jetting nozzle at a same strip width direction position as a part in which the strip shape is locally swelled, and/or increases the jetting amounts of other jetting nozzles, or
increases the jetting amount of a jetting nozzle at a same strip width direction position as a part in which the strip shape is locally buckled, and/or decreases or sets at 0 the jetting amounts of other jetting nozzles.

6. The rolling mill according to any one of claims 1 to 5, wherein
the rolling mill is any one of

a 4-high rolling mill including the pair of work rolls and a pair of back-up rolls that support the work rolls,
a 6-high rolling mill including the pair of work rolls, a pair of intermediate rolls that support the work rolls, and a pair of back-up rolls that support the intermediate rolls,
an 18-high rolling mill including the pair of work rolls, a pair of intermediate rolls that support the work rolls, a pair of back-up rolls that support the intermediate rolls, four pairs of supporting rolls that support the pair of work rolls in a horizontal direction, and eight pairs of supporting bearings that support the four pairs of supporting rolls,
a 12-high rolling mill including the pair of work rolls, two pairs of intermediate rolls that support the work rolls, and three pairs of divided backing bearing shafts that support the intermediate rolls, and
a 20-high rolling mill including the pair of work rolls, two pairs of first intermediate rolls that support the work rolls, three pairs of second intermediate rolls that support the first intermediate rolls, and four pairs of divided backing bearing shafts that support the second intermediate rolls.

7. A tandem rolling mill comprising rolling mills arranged in a plurality of rolling mill stands, wherein the rolling mill according to any one of claims 1 to 6 is provided as at least one rolling mill stand among the plurality of rolling mill stands.
8. A rolling mill coolant supply mechanism for jetting a coolant for cooling work rolls of a rolling mill, the coolant supply mechanism comprising:

jetting nozzles that jet the coolant, the jetting nozzles being plurally provided so as to form a row in a strip width direction of a metal strip;

supply lines that supply the coolant to the respective jetting nozzles;
a header that houses the plurally provided jetting nozzles;
a sliding member that selectively shields or opens the supply lines within the header; and
a drive unit that adjusts respective coolant jetting amounts of the plurally provided jetting nozzles by moving the sliding member.

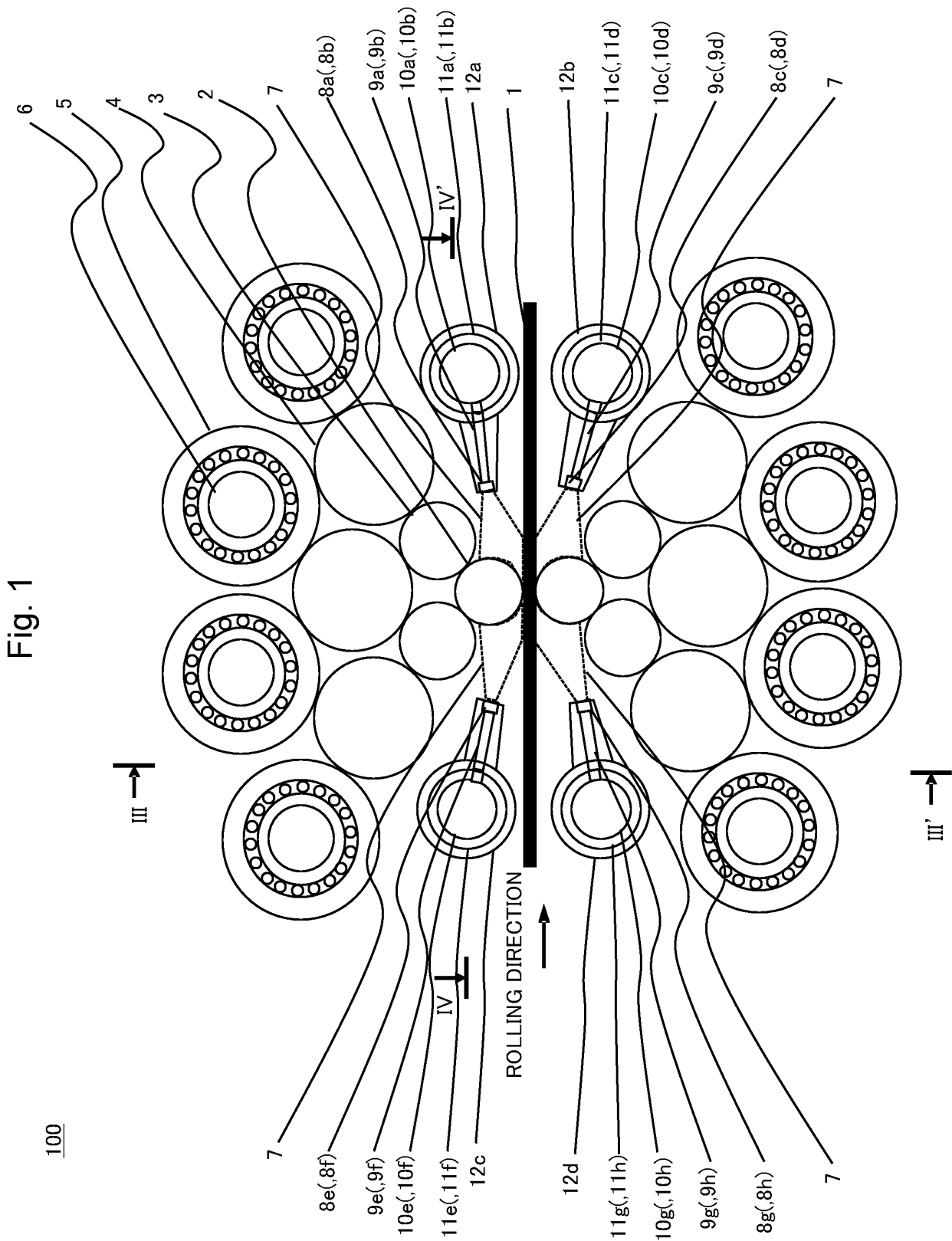


Fig. 2

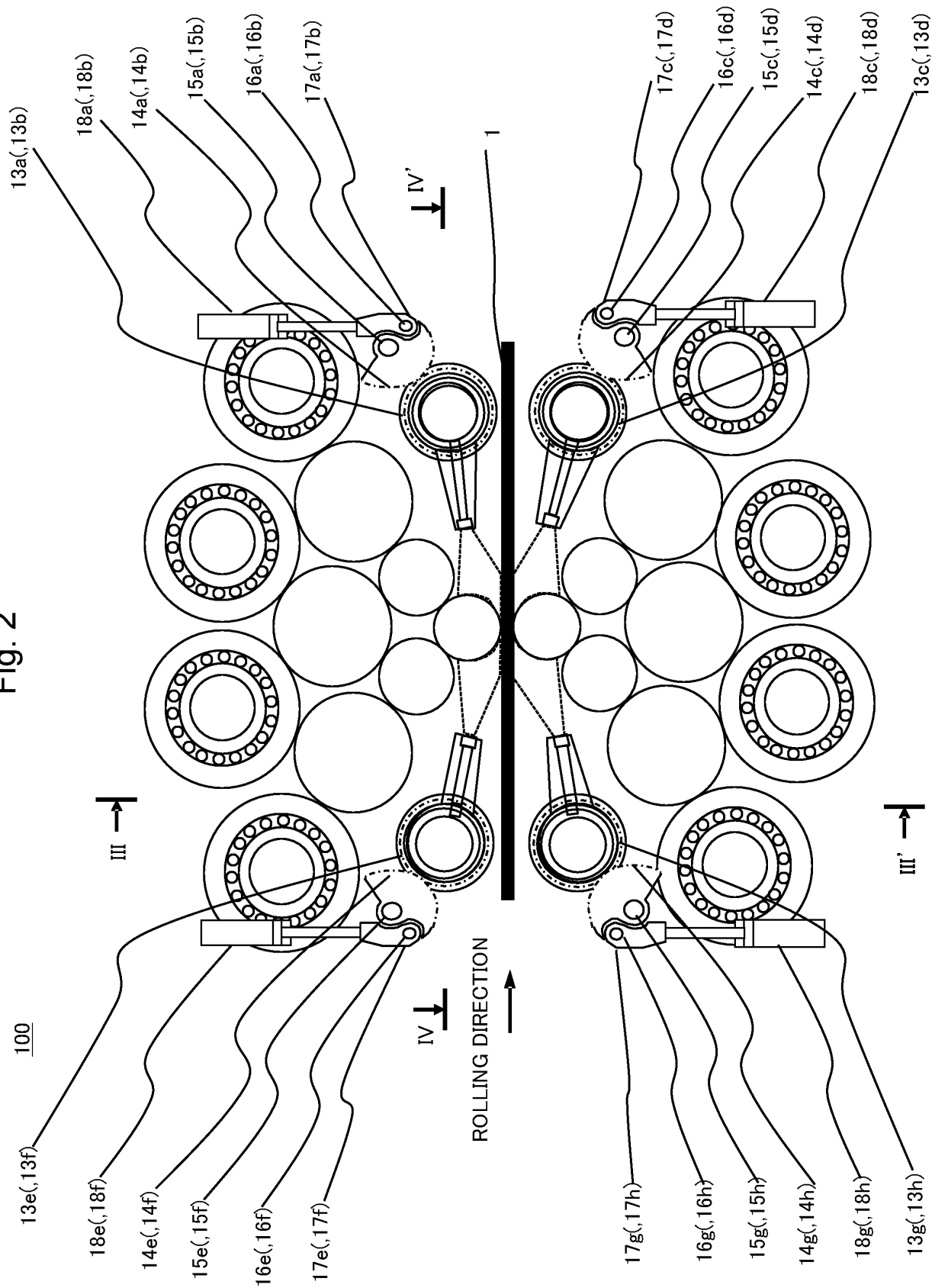


Fig. 3

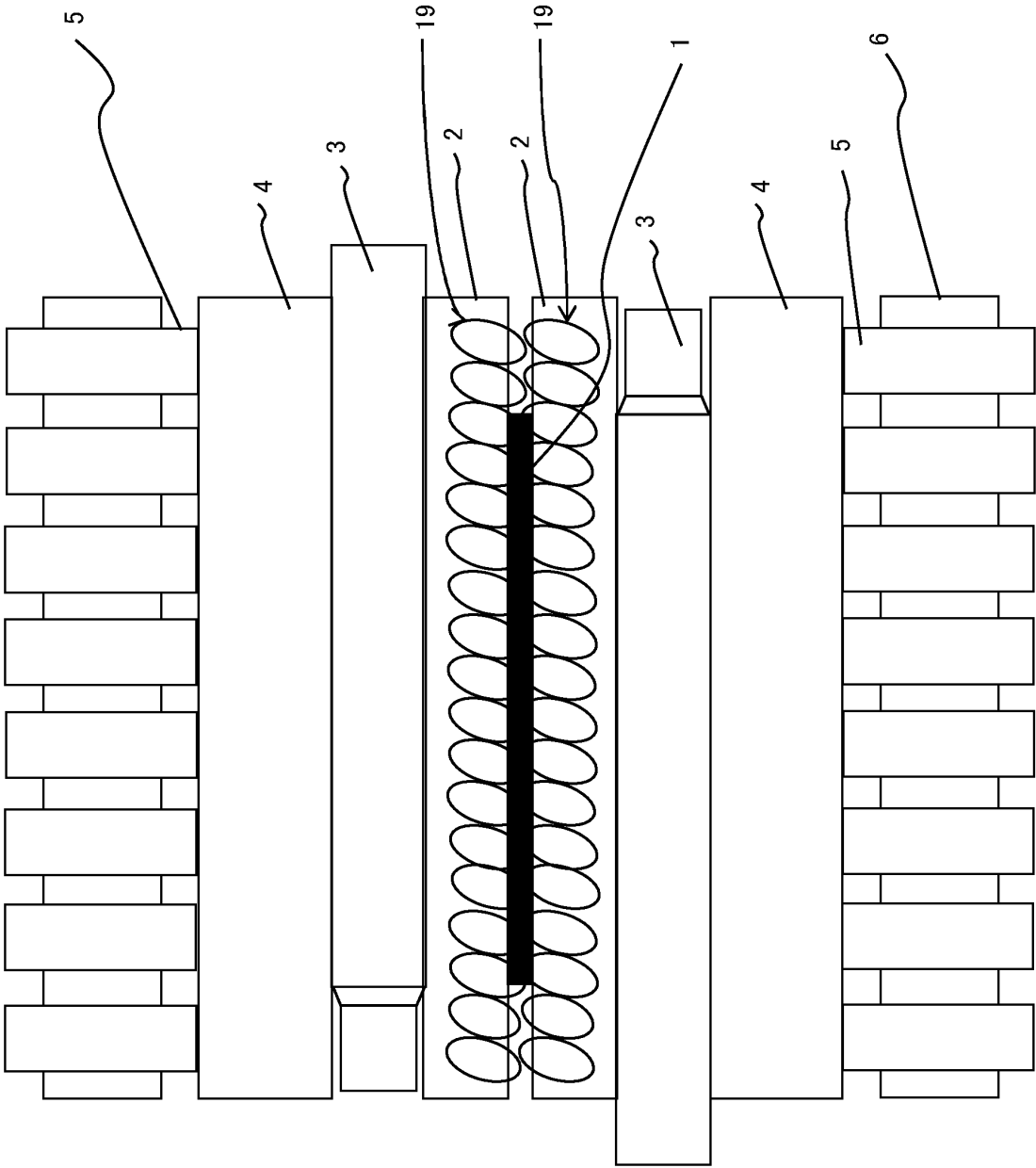
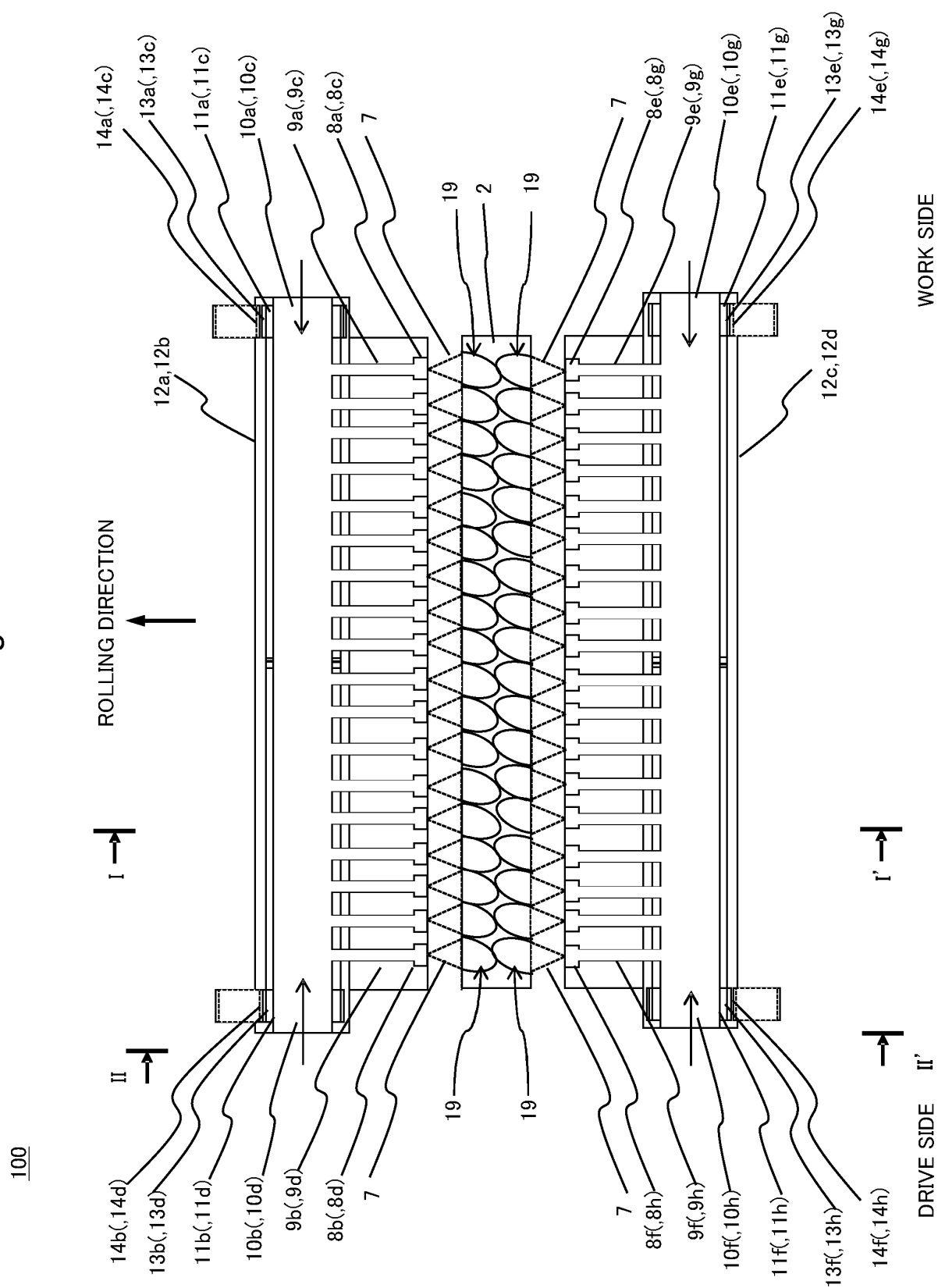


Fig. 4



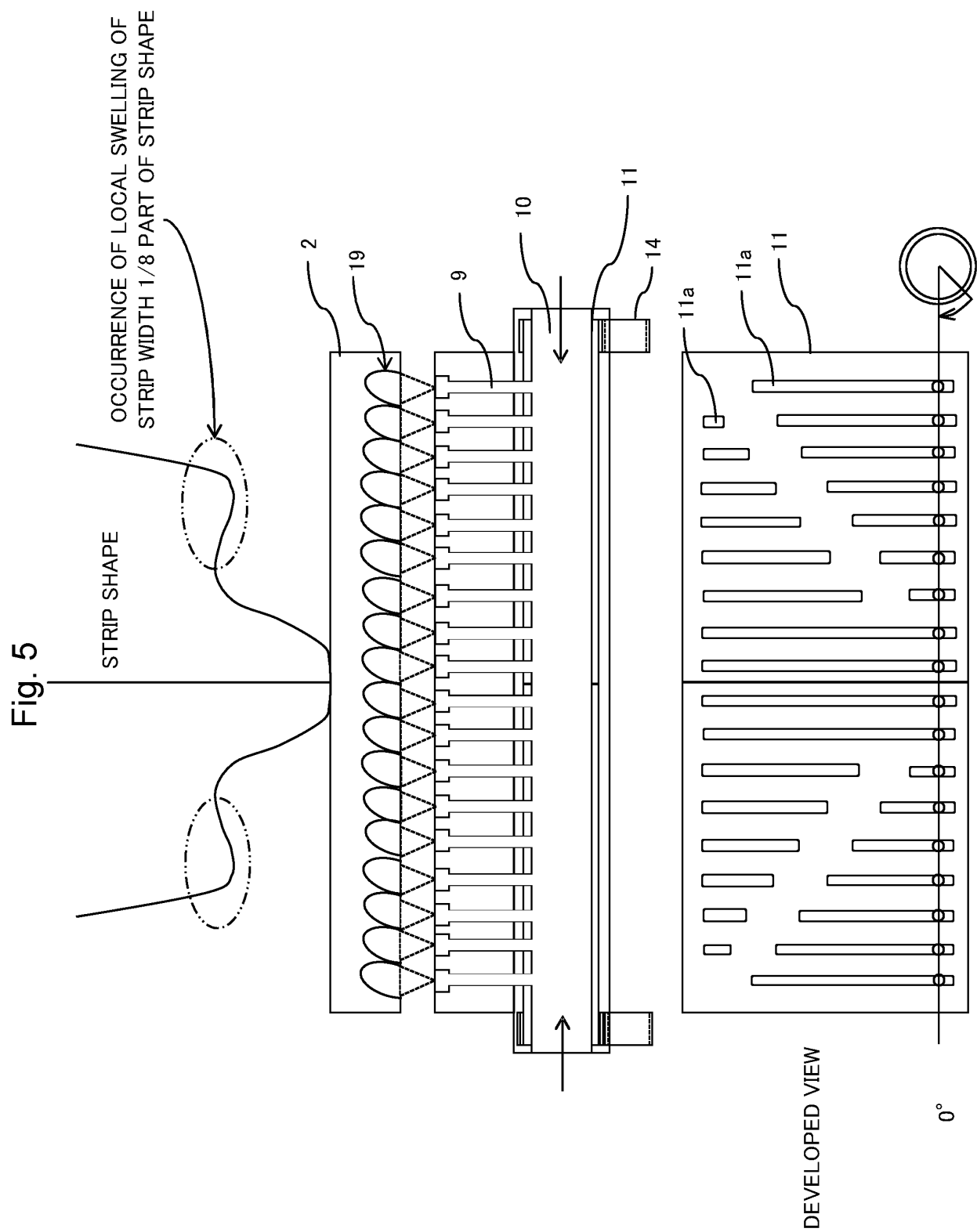


Fig. 6

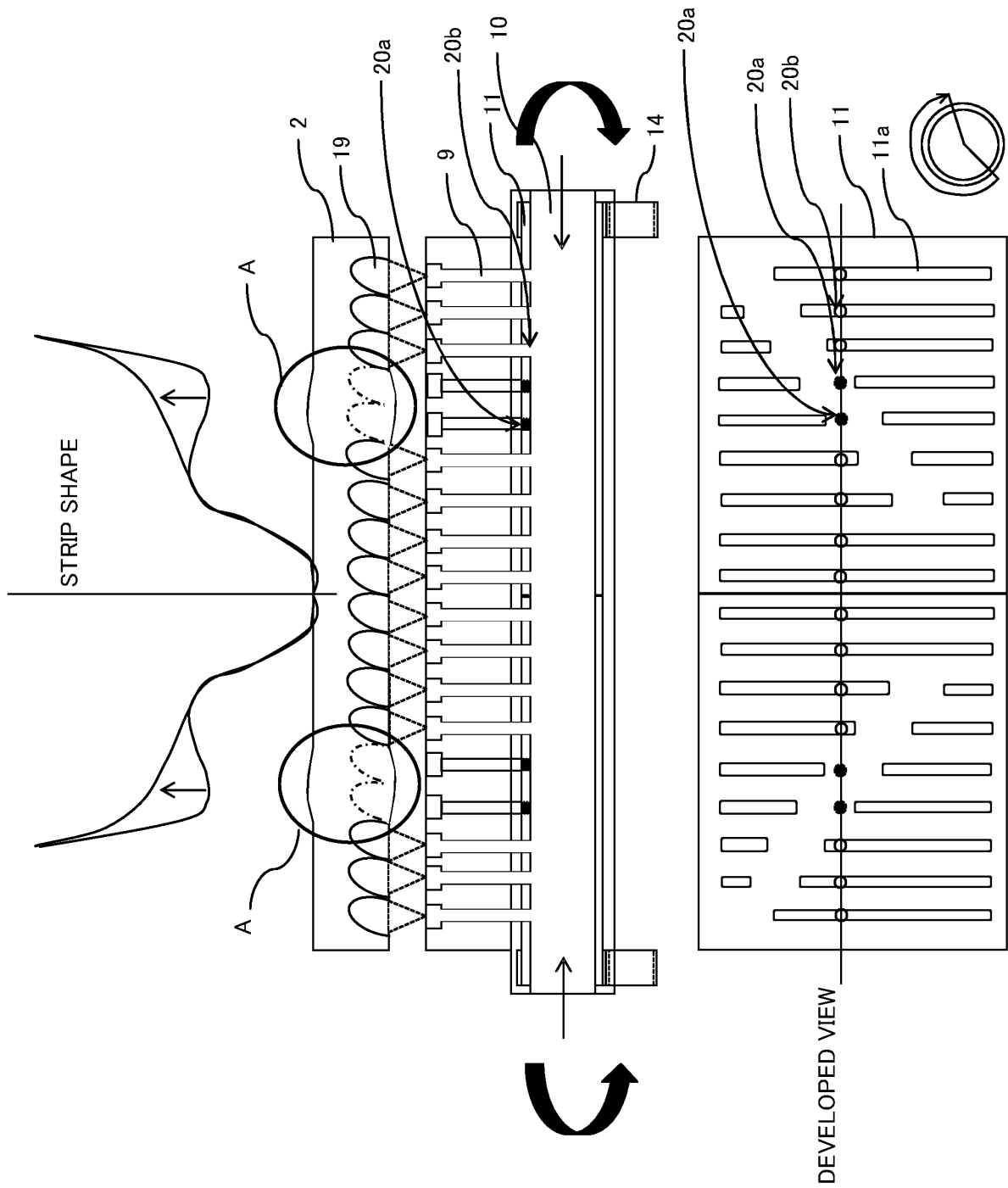


Fig. 7

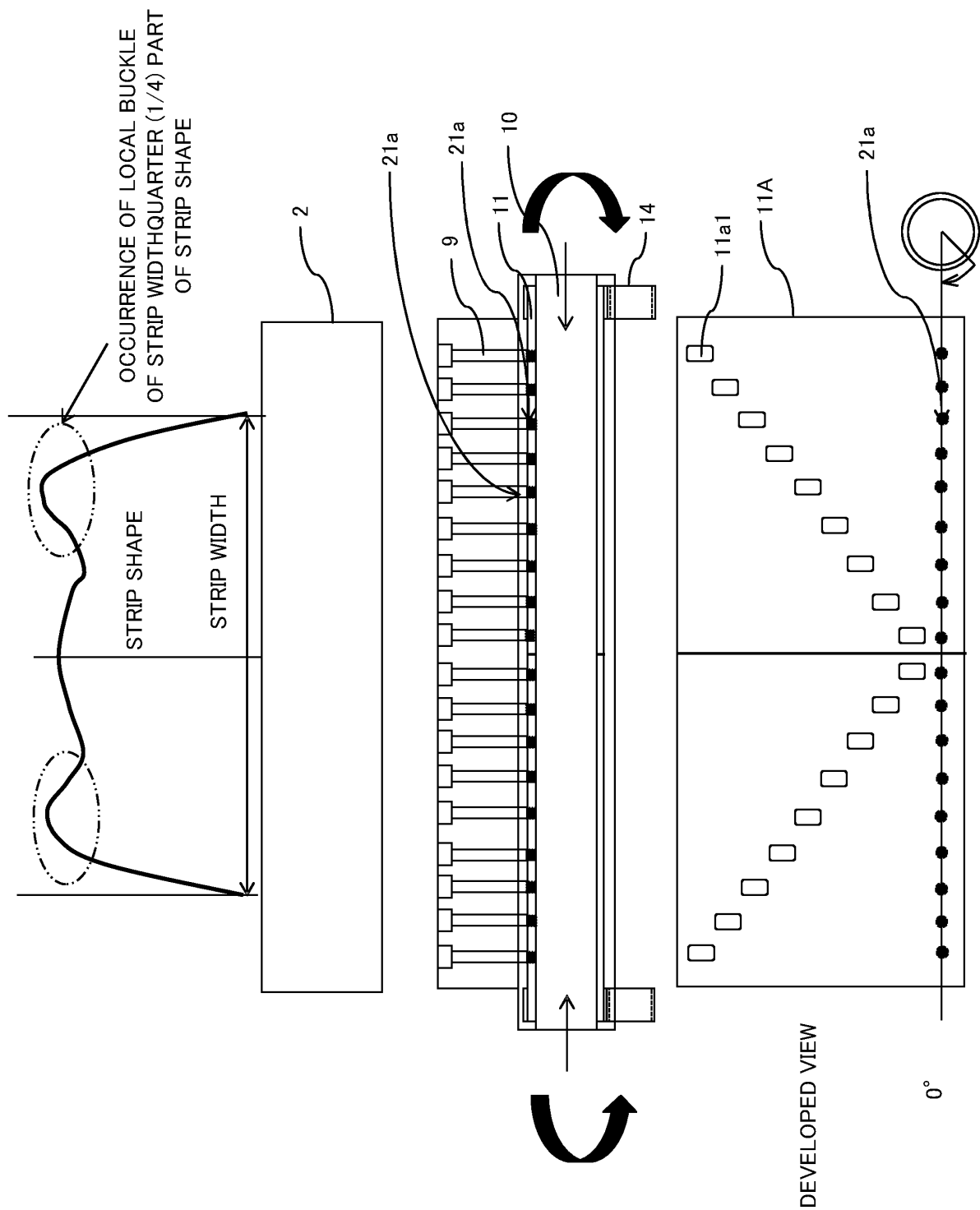


Fig. 8

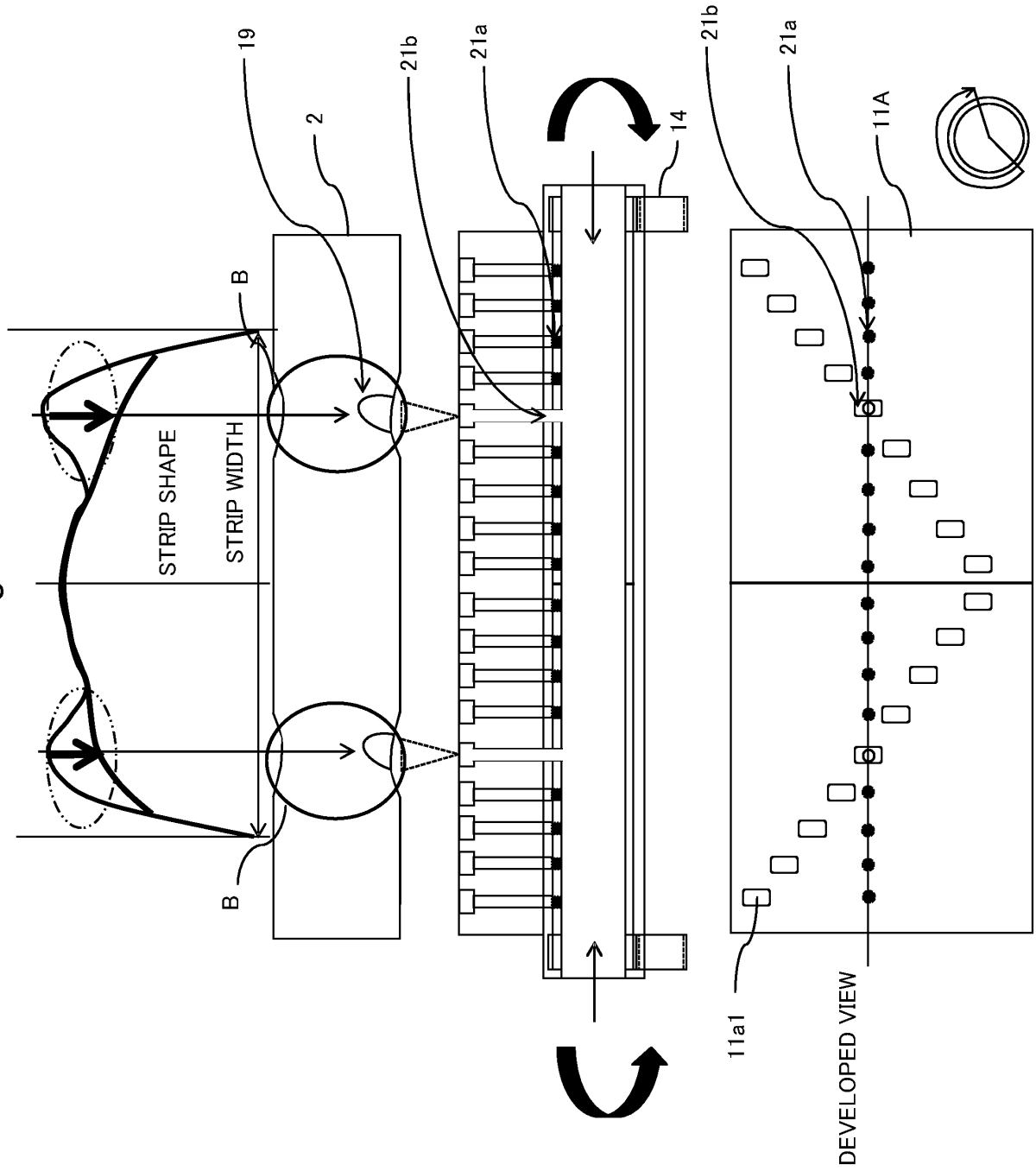


Fig. 9

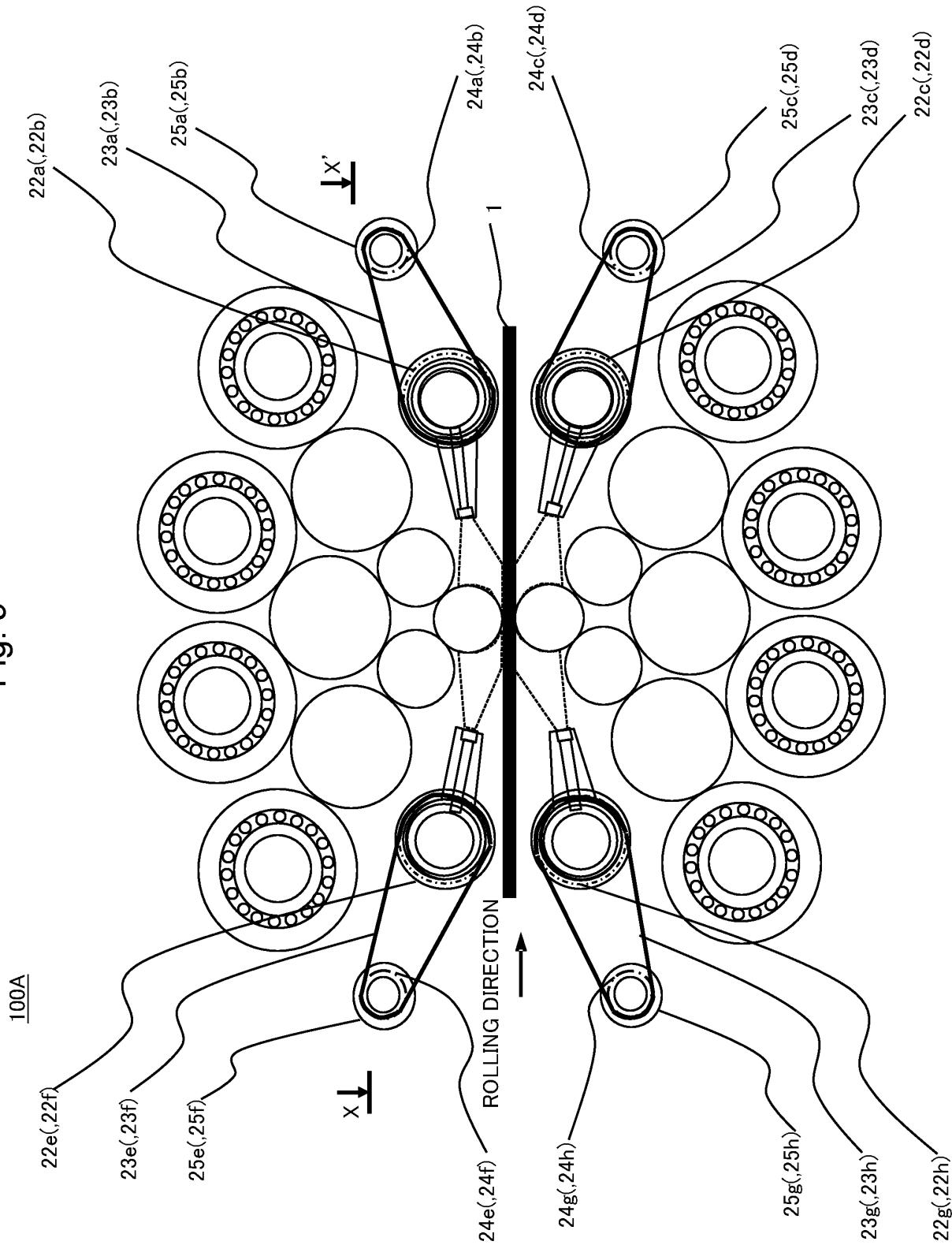


Fig. 10

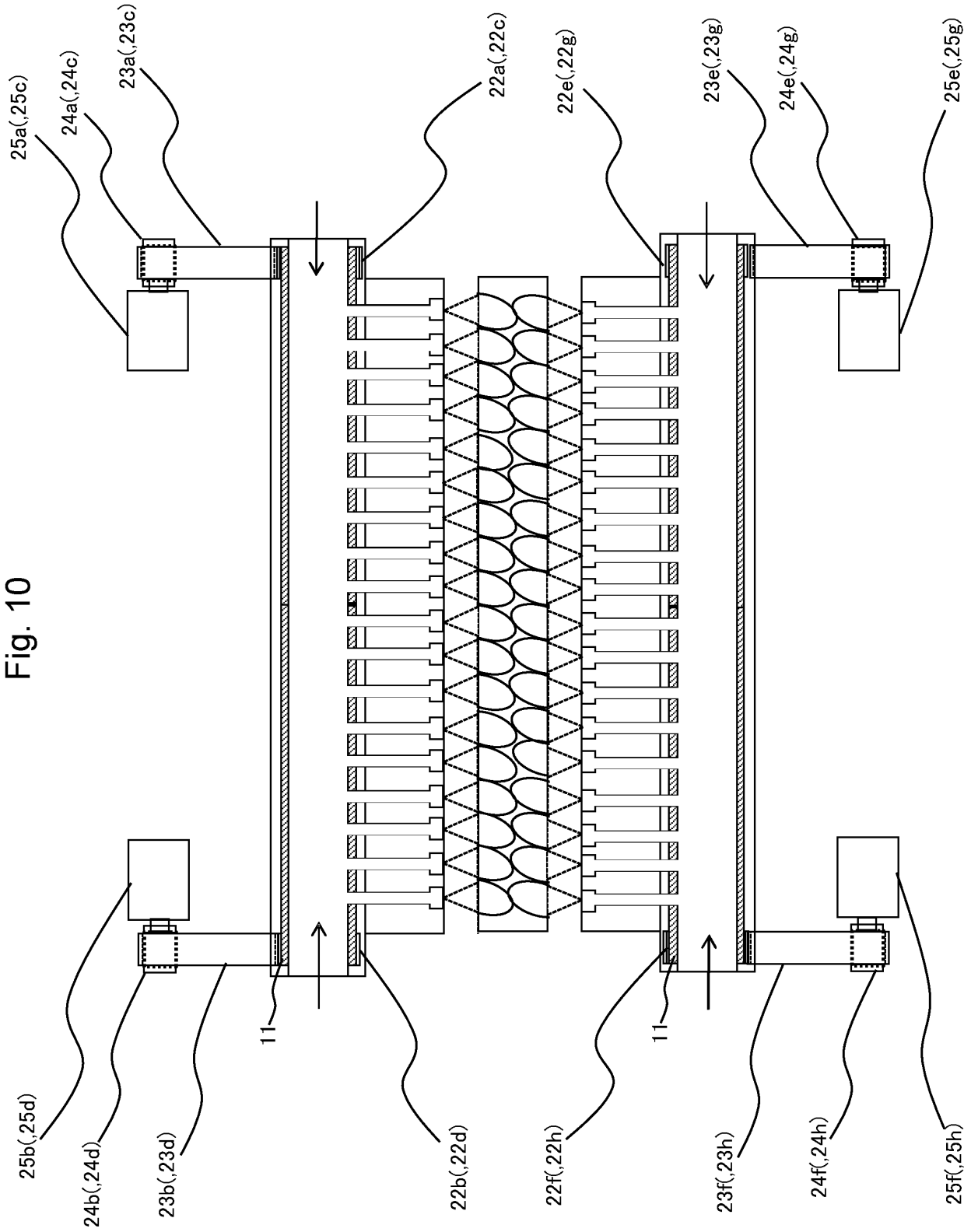


Fig. 11

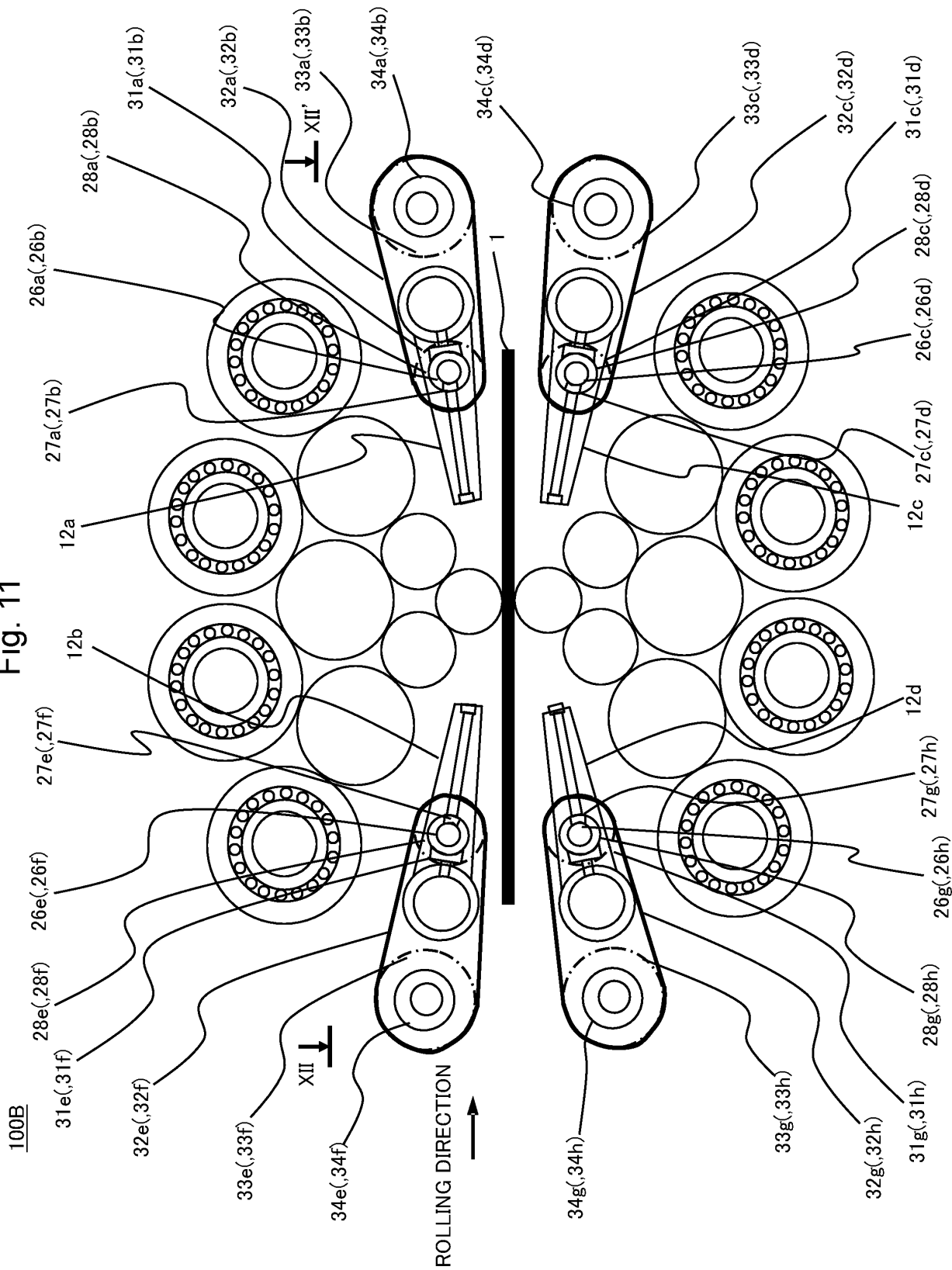


Fig. 12

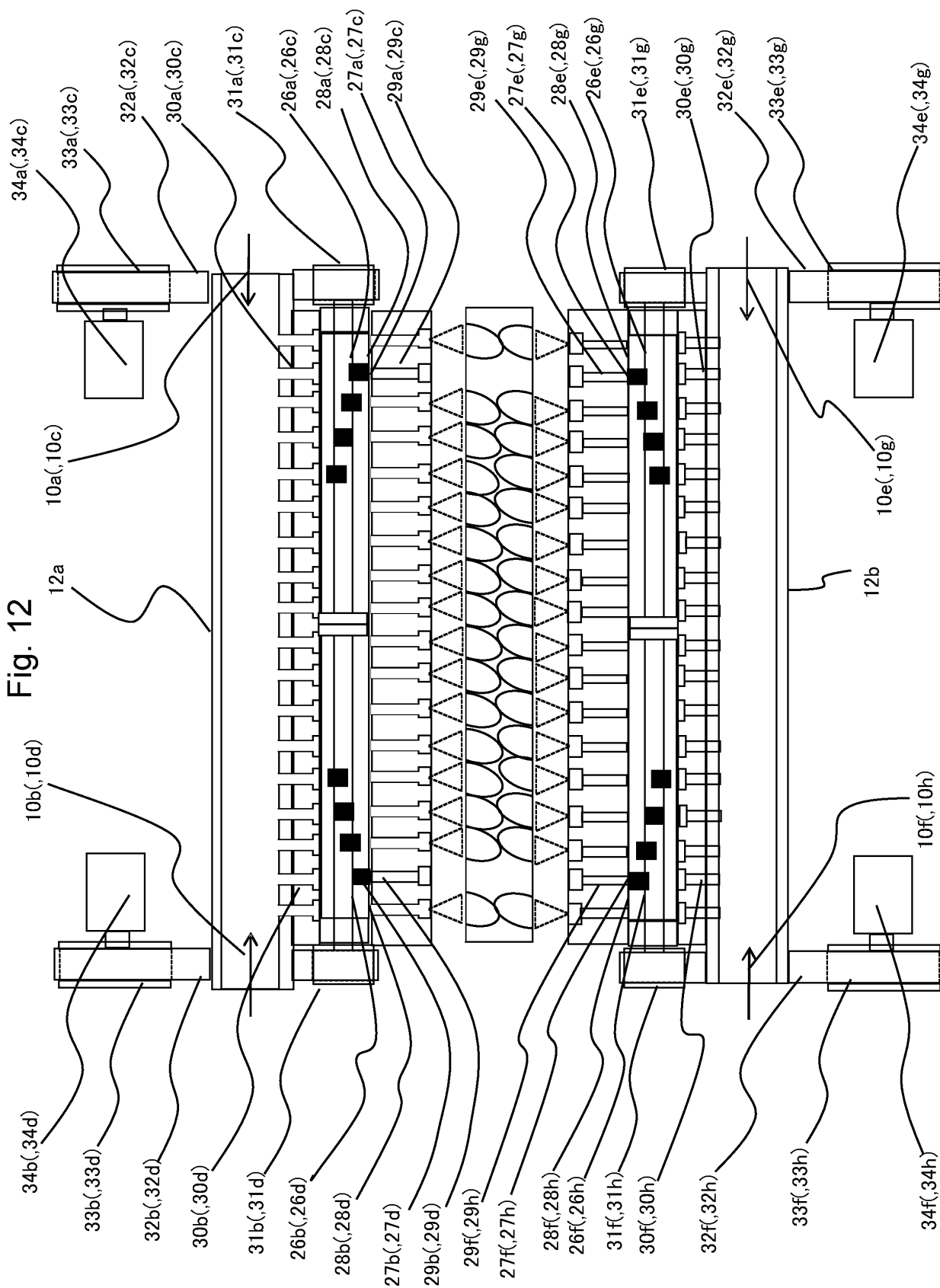


Fig. 13

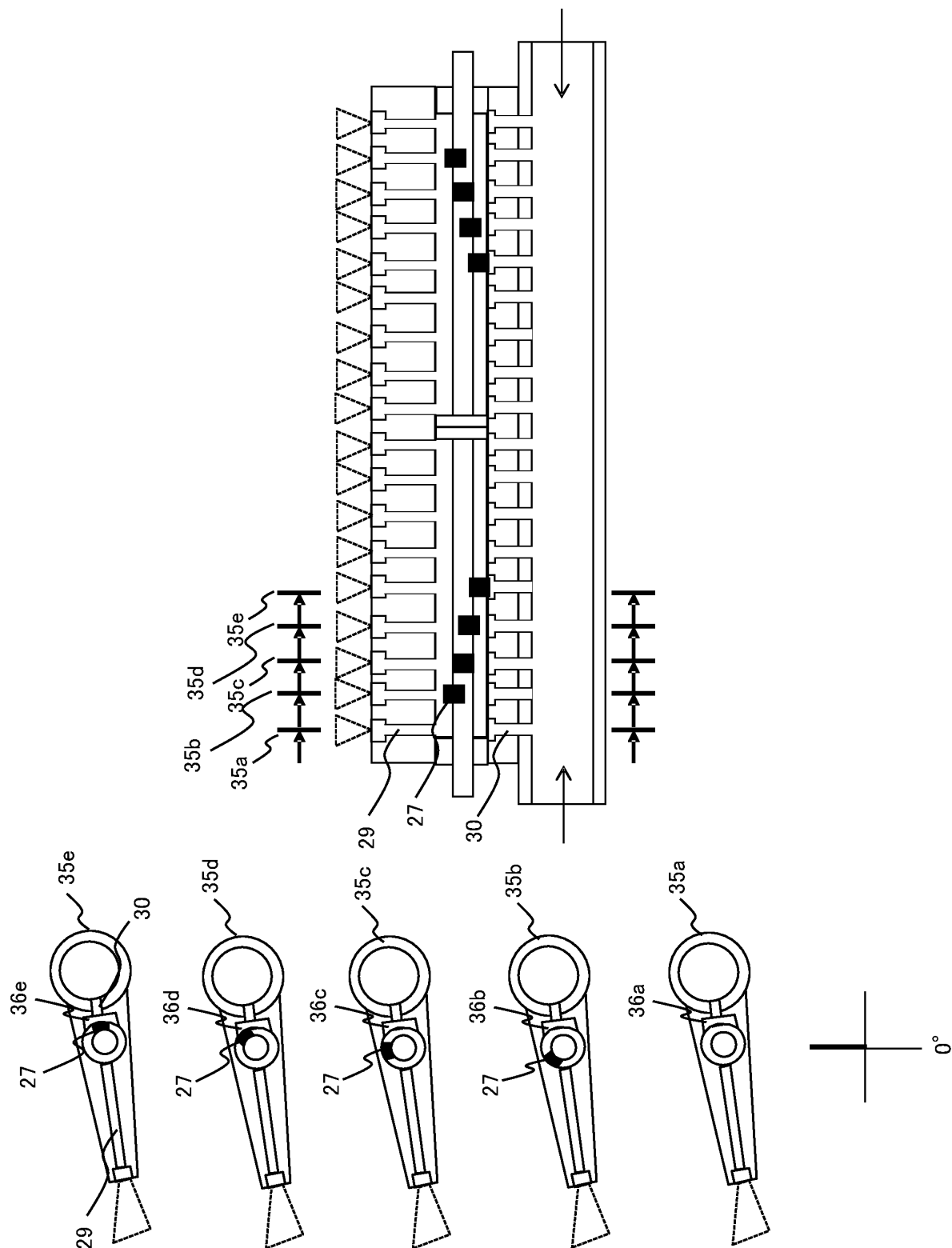


Fig. 14

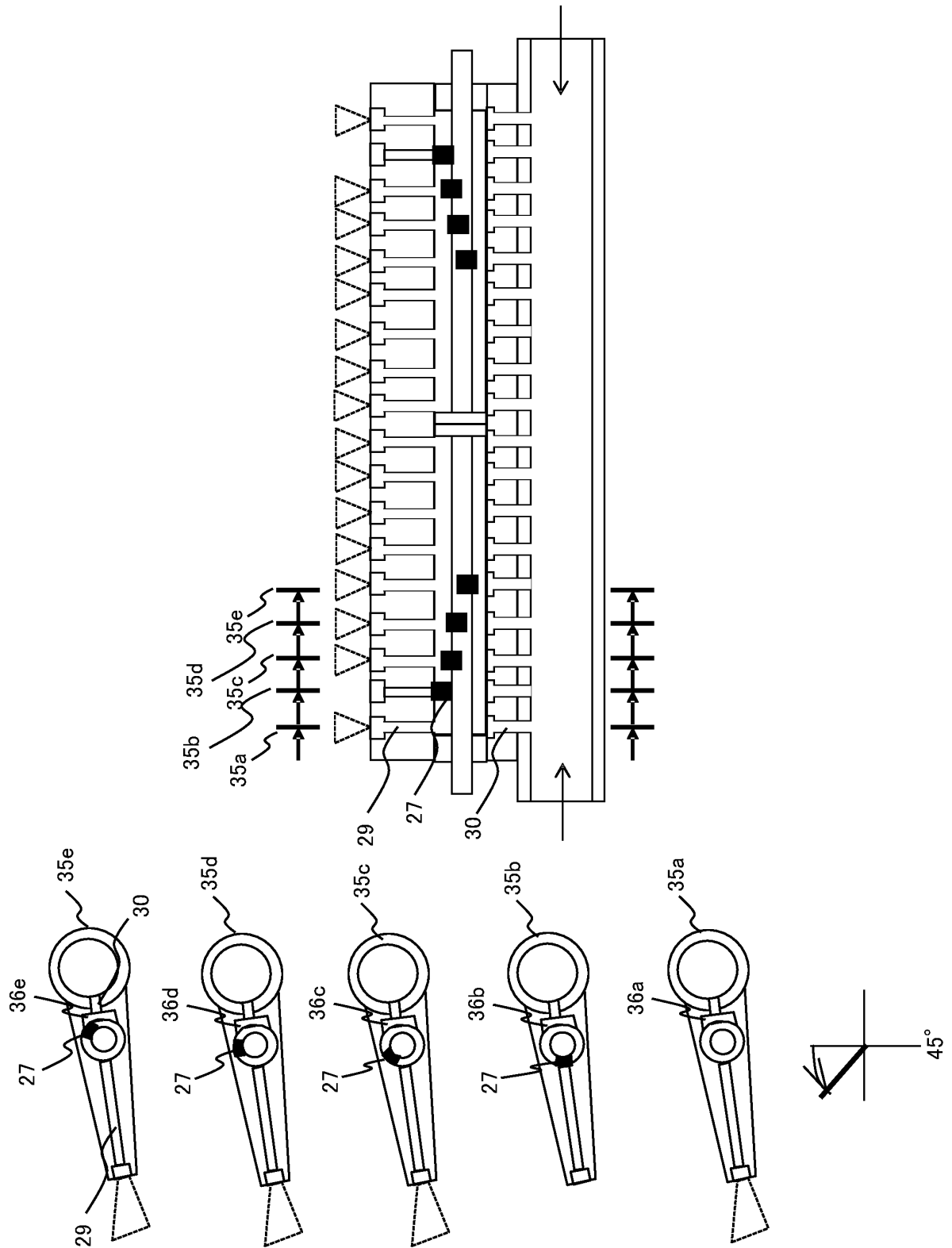


Fig. 15

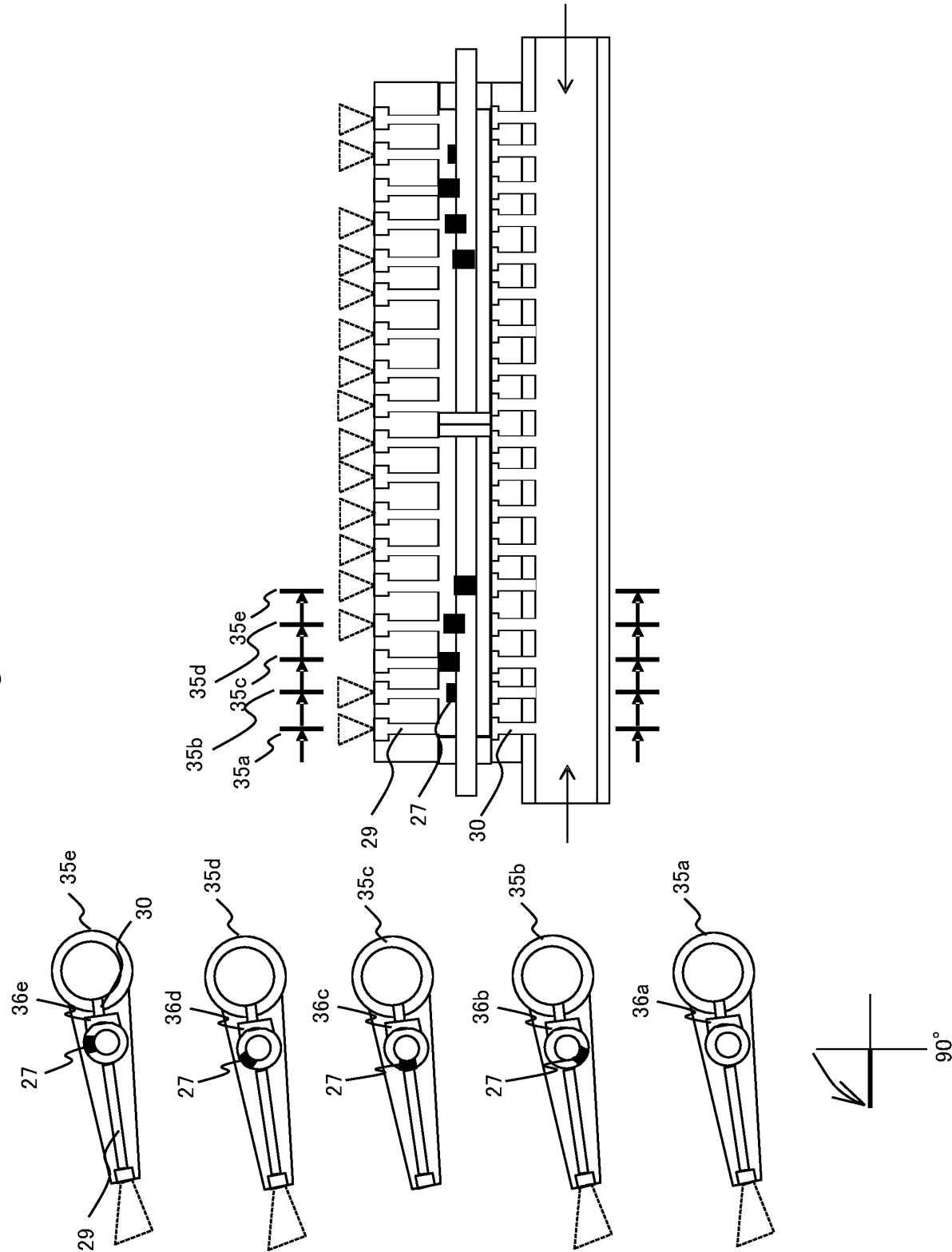


Fig. 16

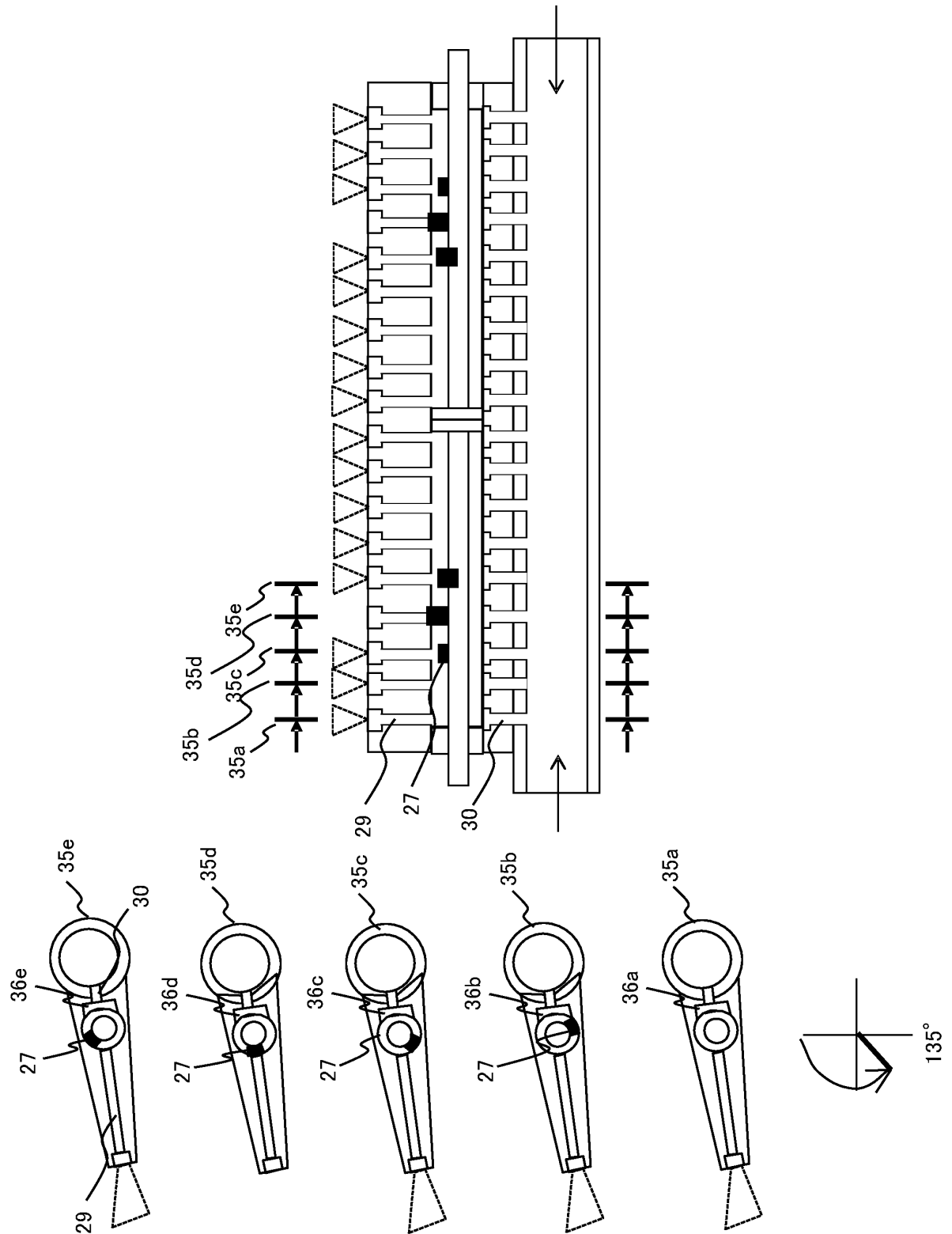


Fig. 17

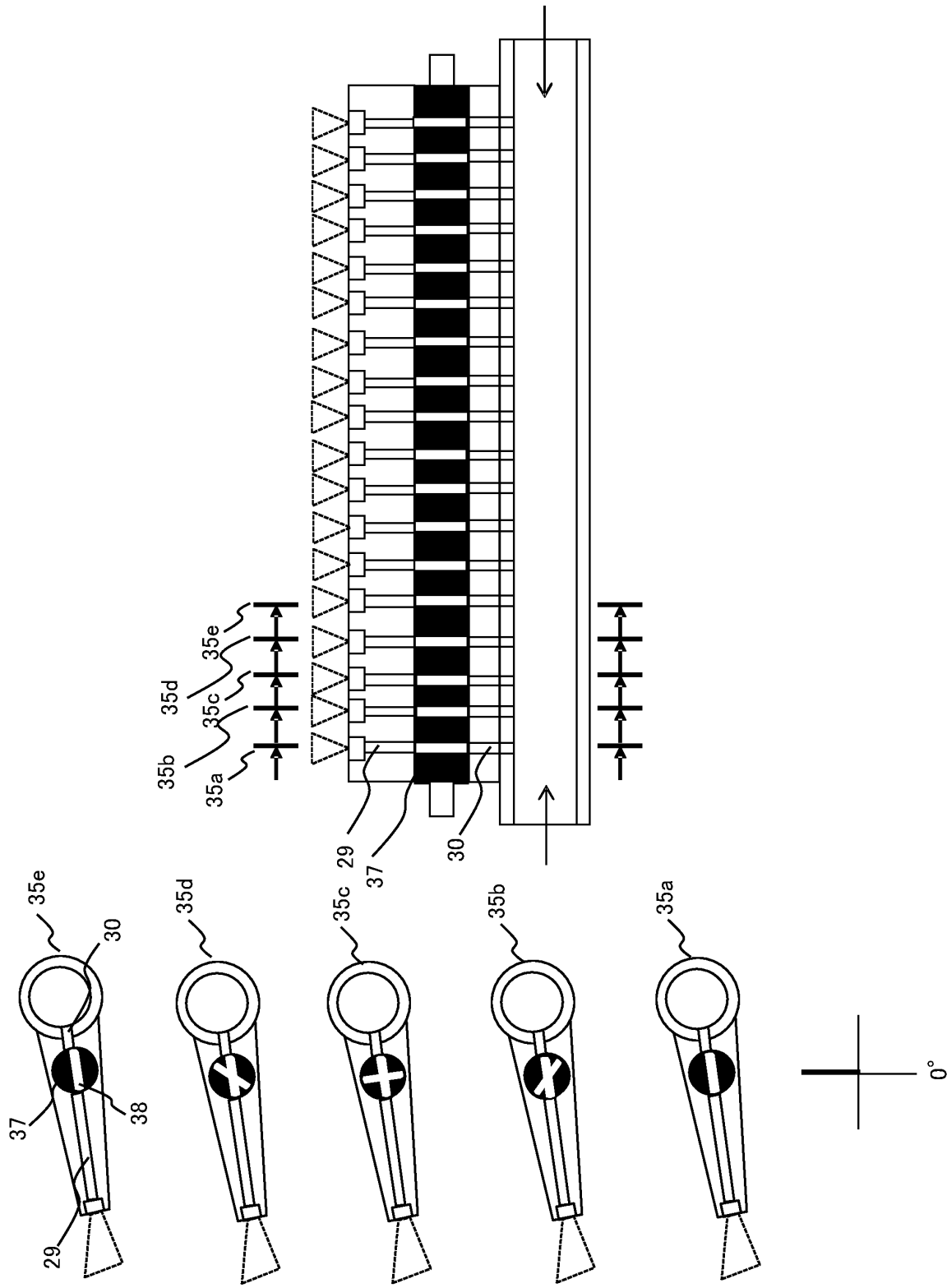


Fig. 18

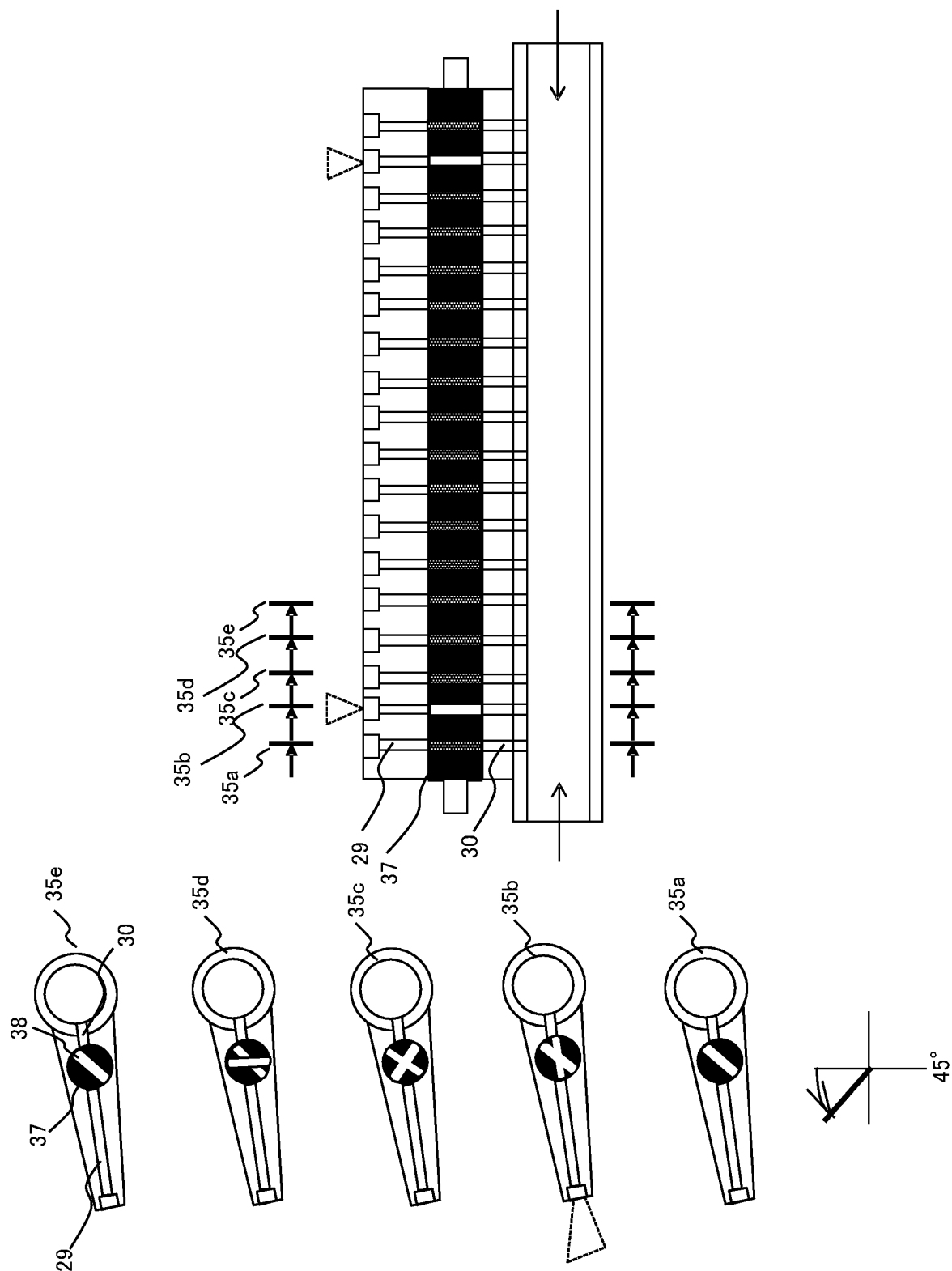


Fig. 19

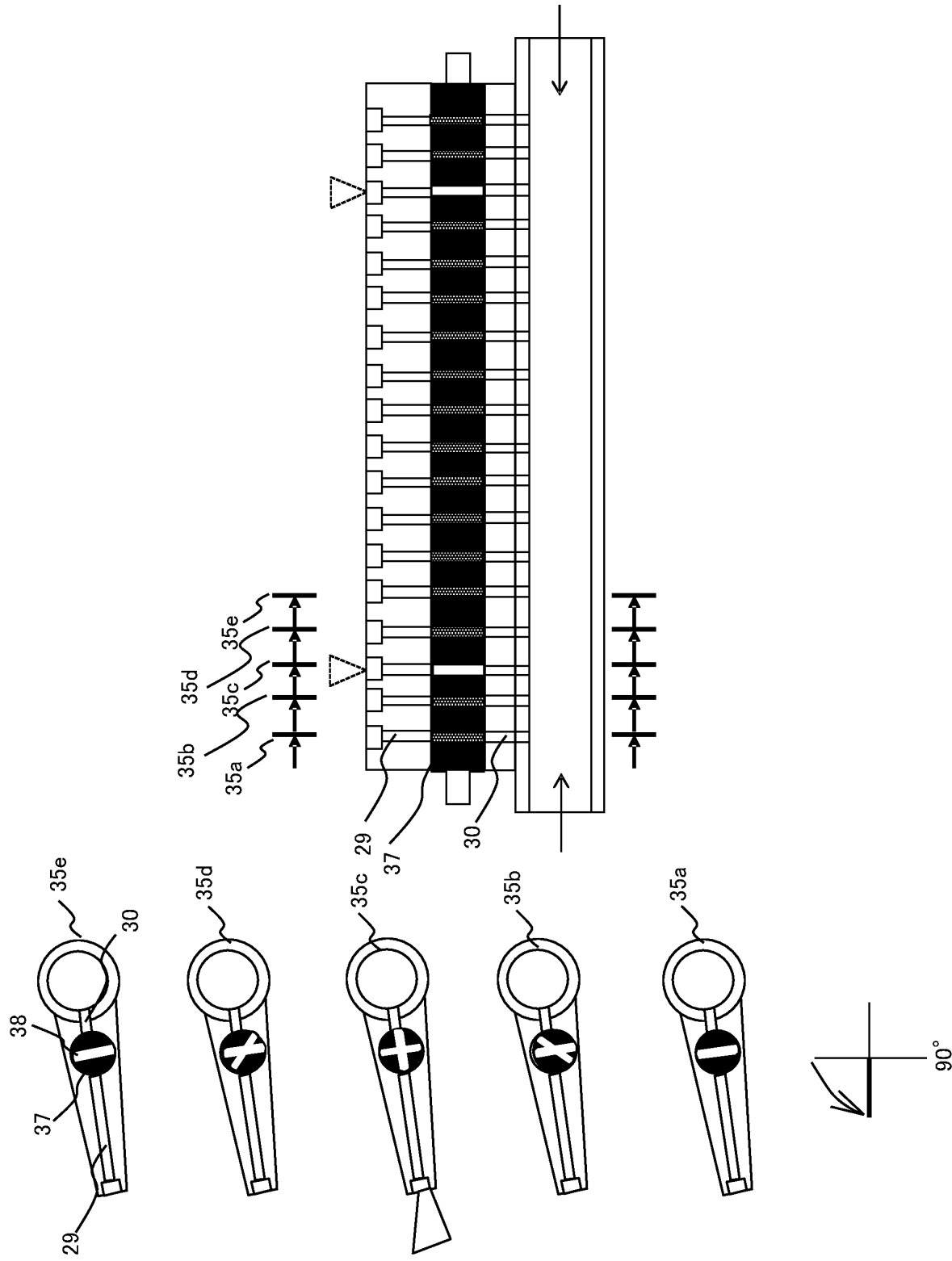


Fig. 20

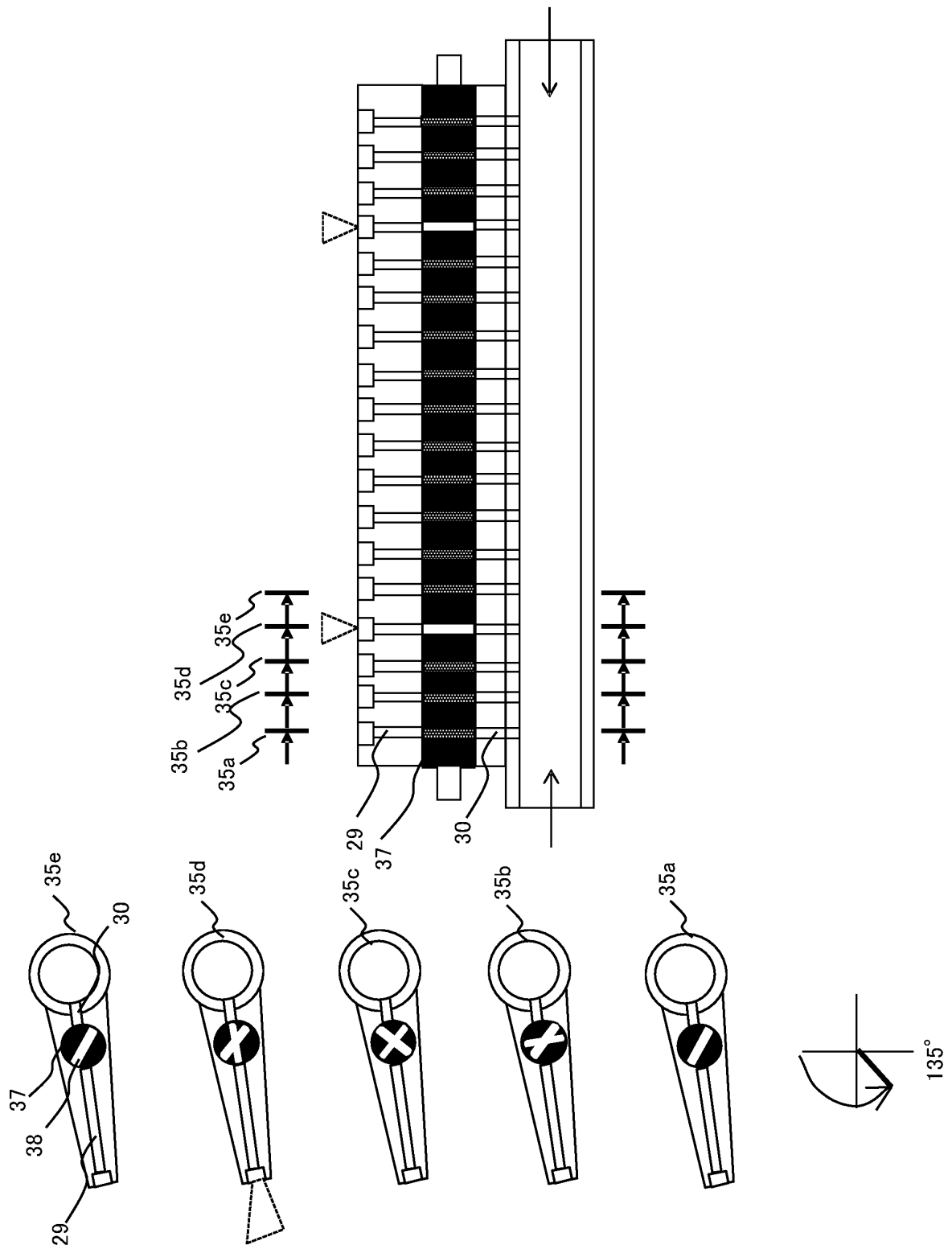


Fig. 21

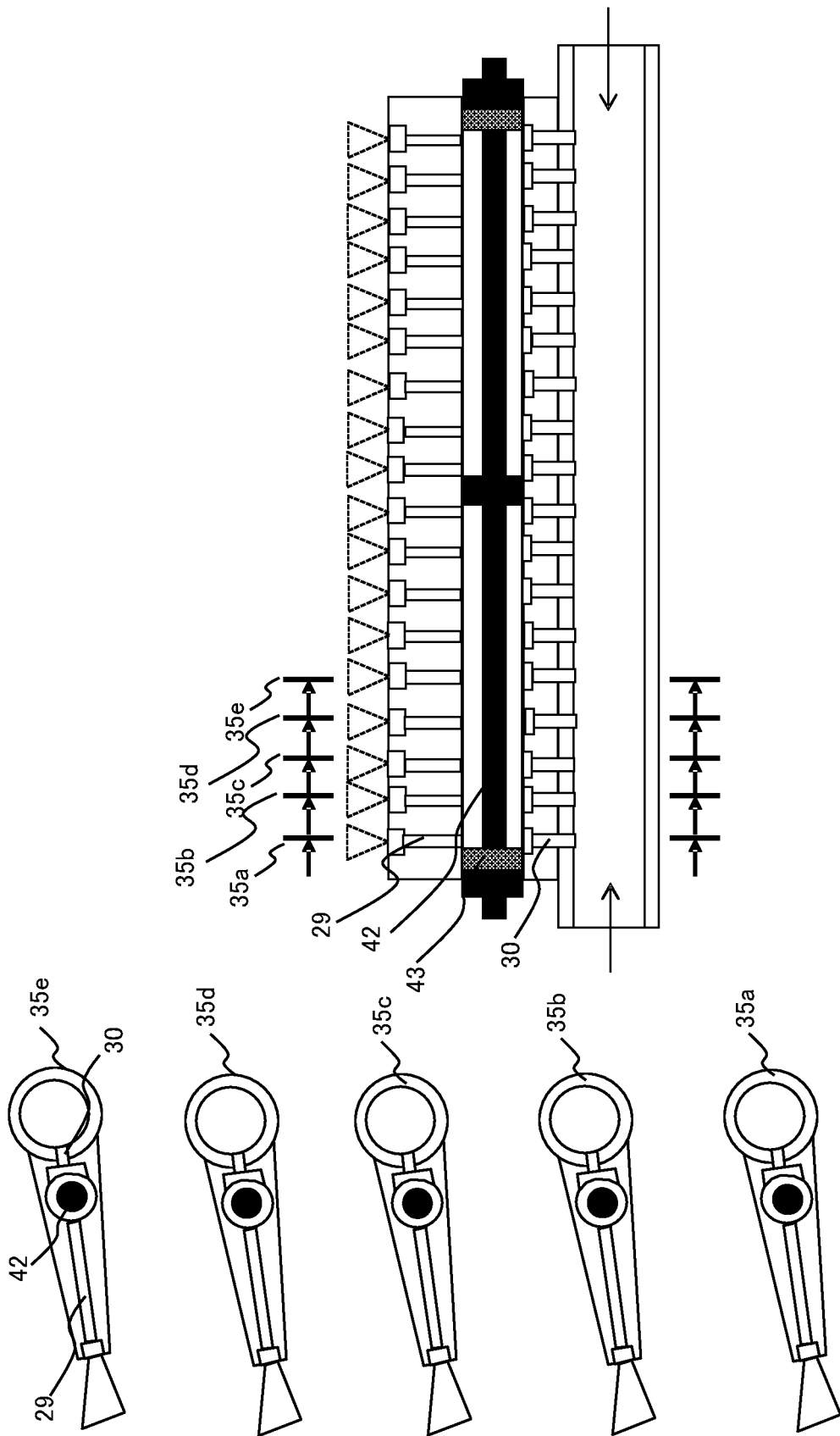


Fig. 22

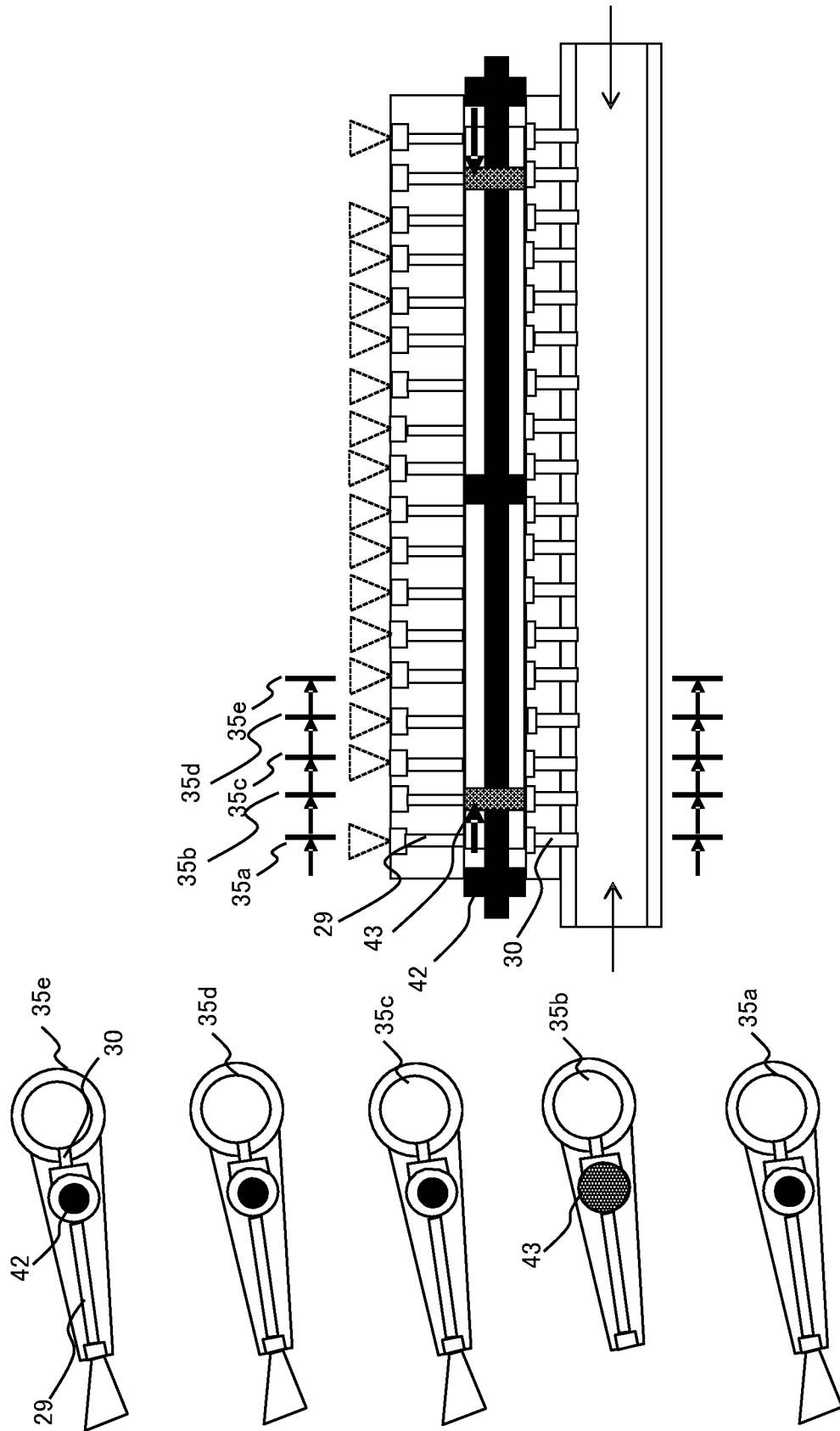


Fig. 23

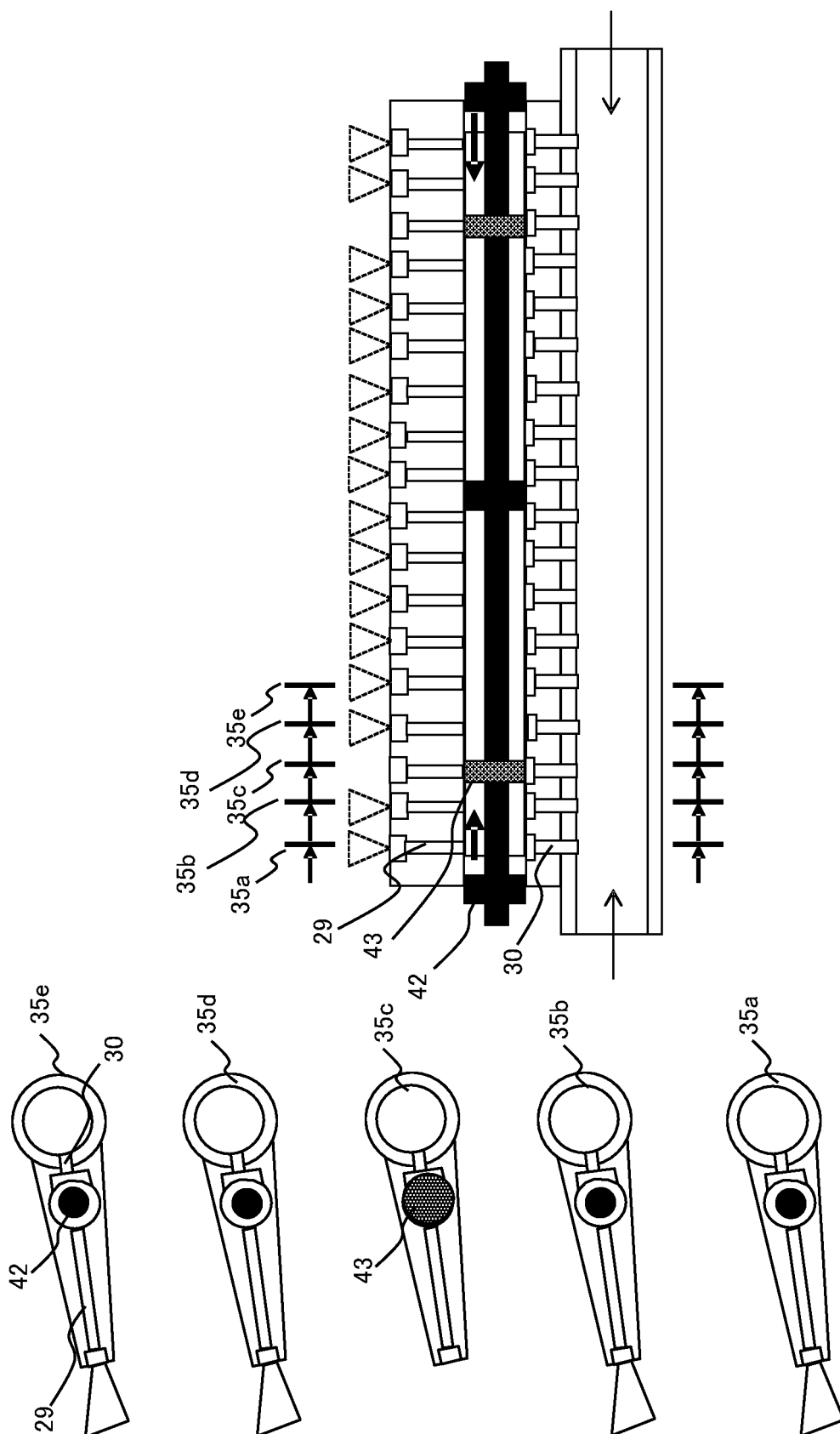


Fig. 24

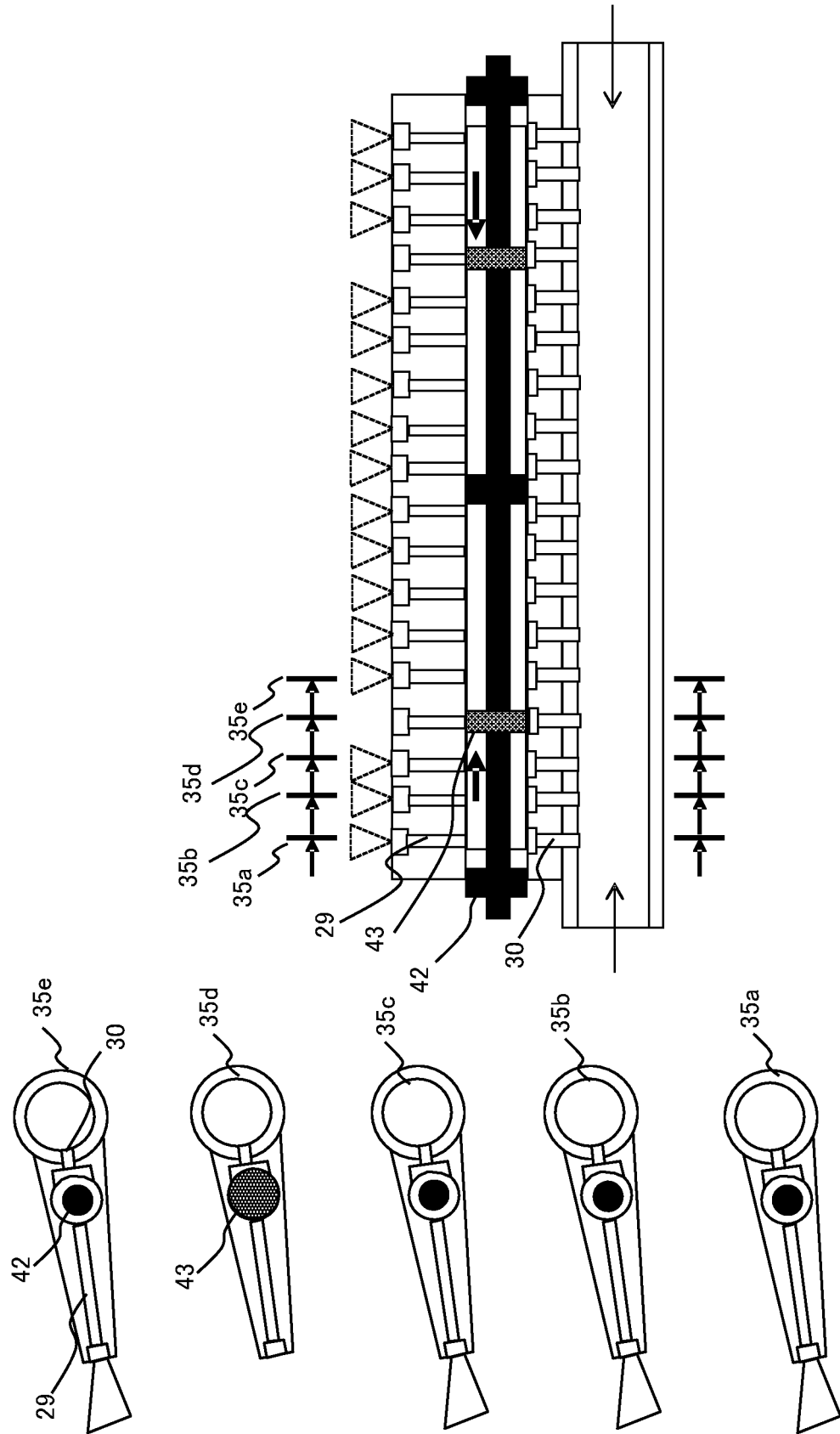


Fig. 25

100C

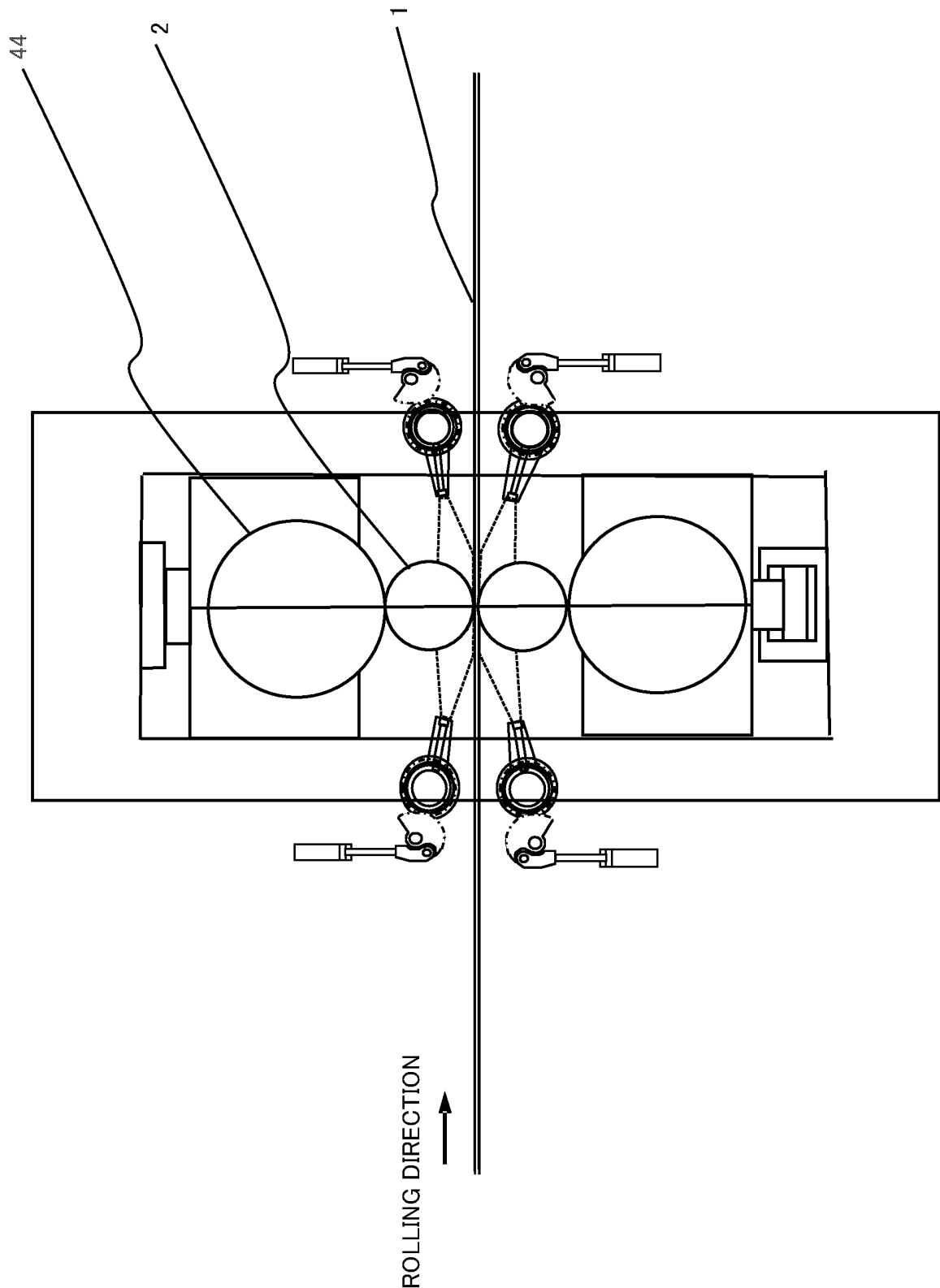
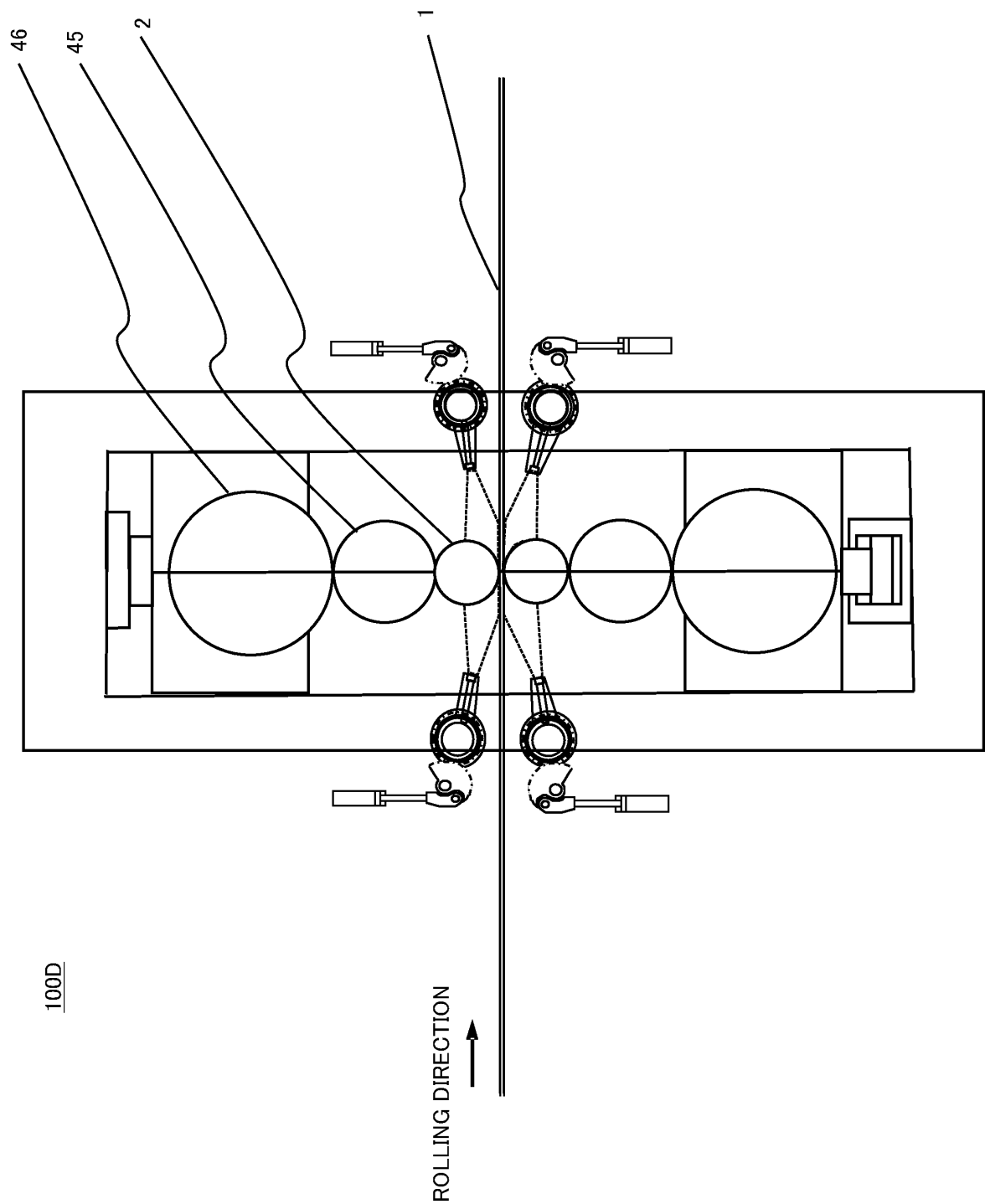
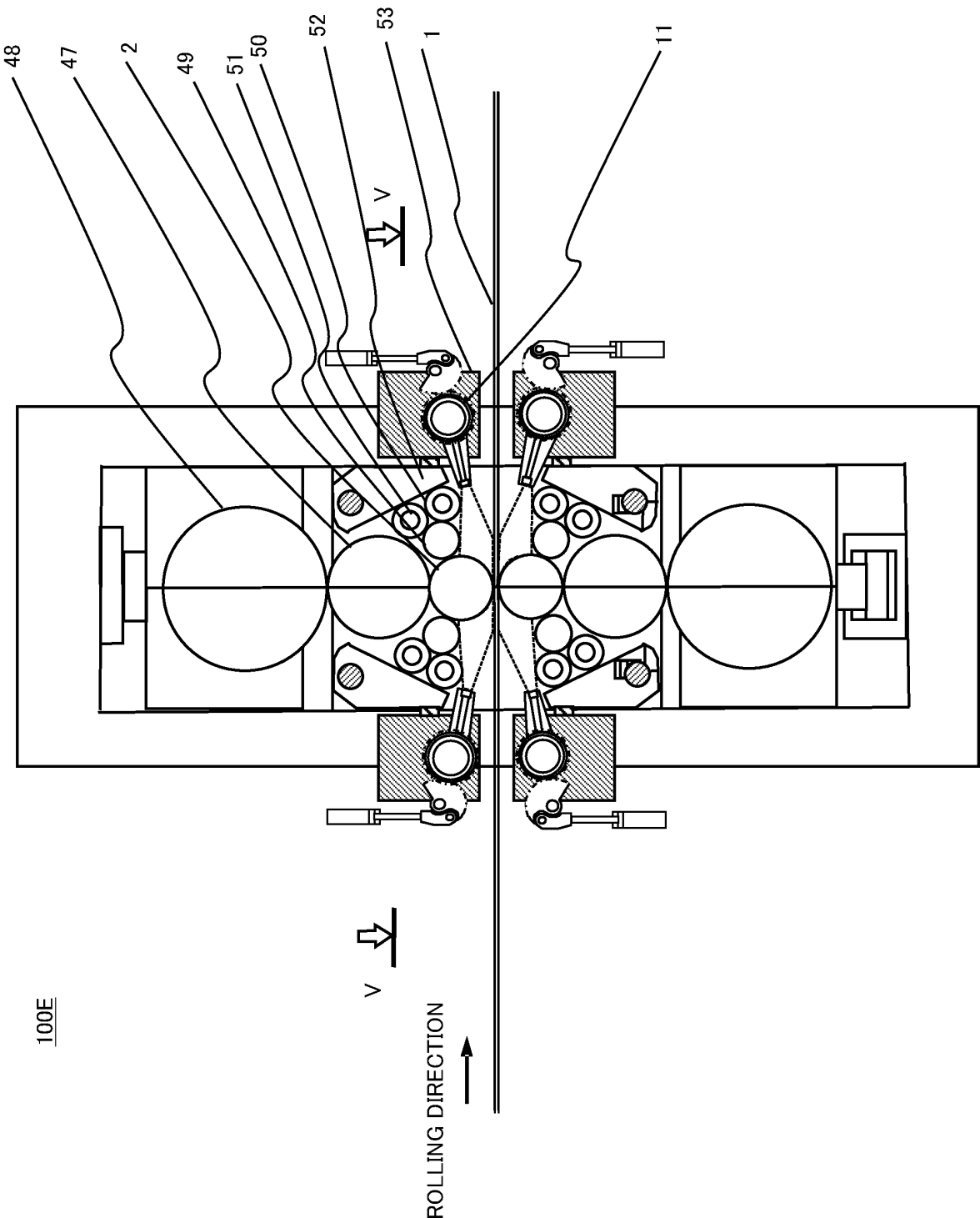


Fig. 26



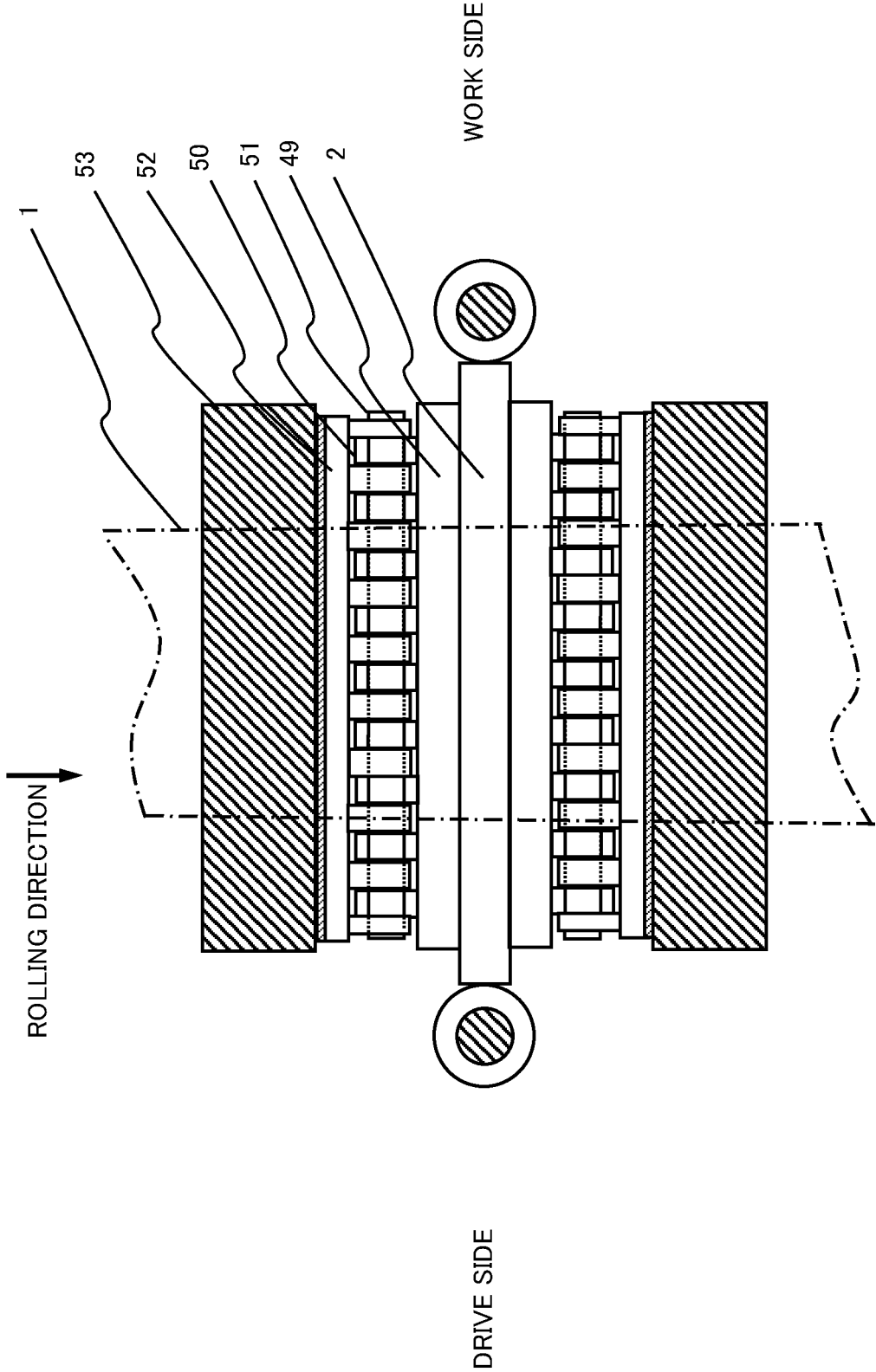
100D

Fig. 27



100E

Fig. 28



$$\frac{100F}{}$$

Fig. 29

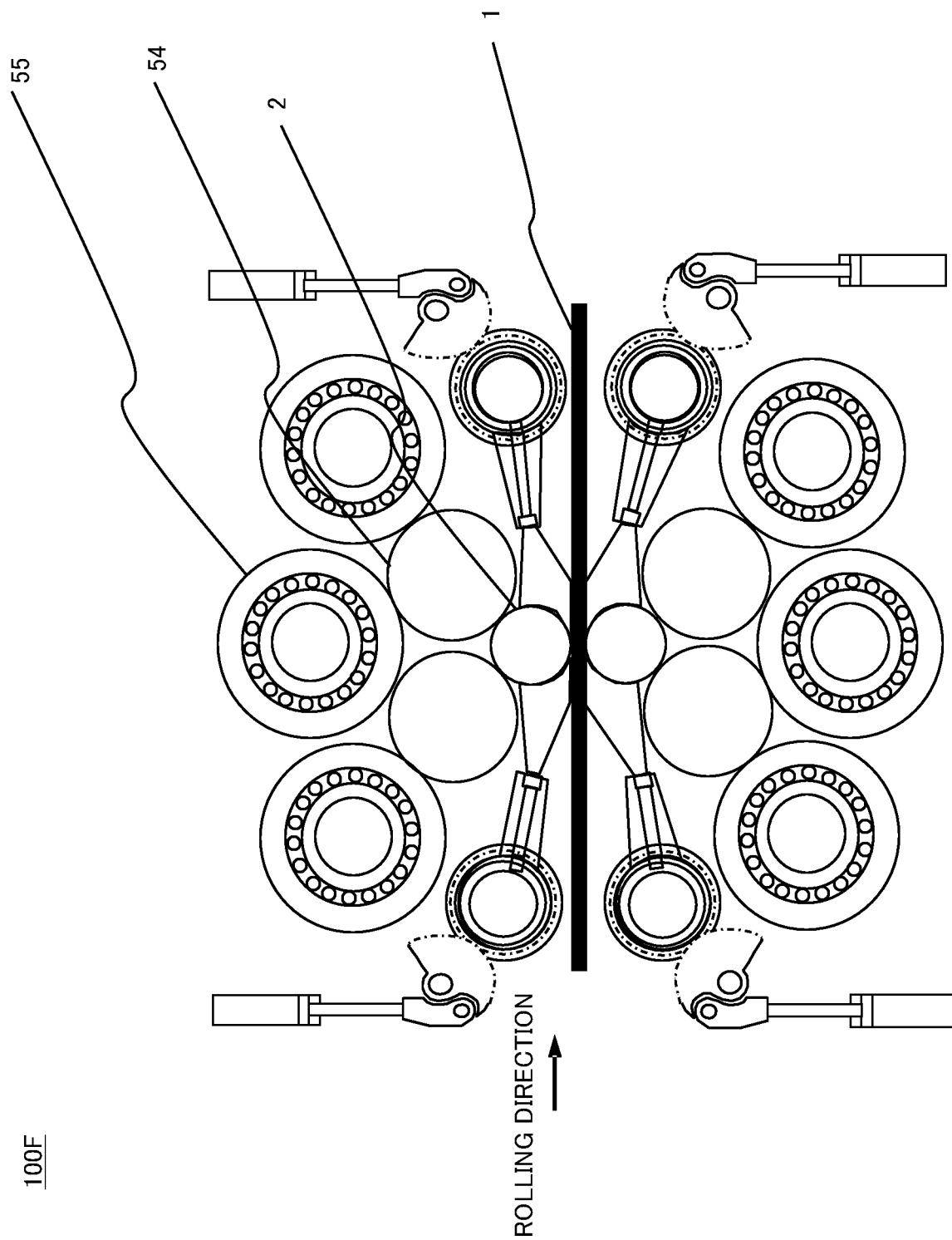


Fig. 30

100G

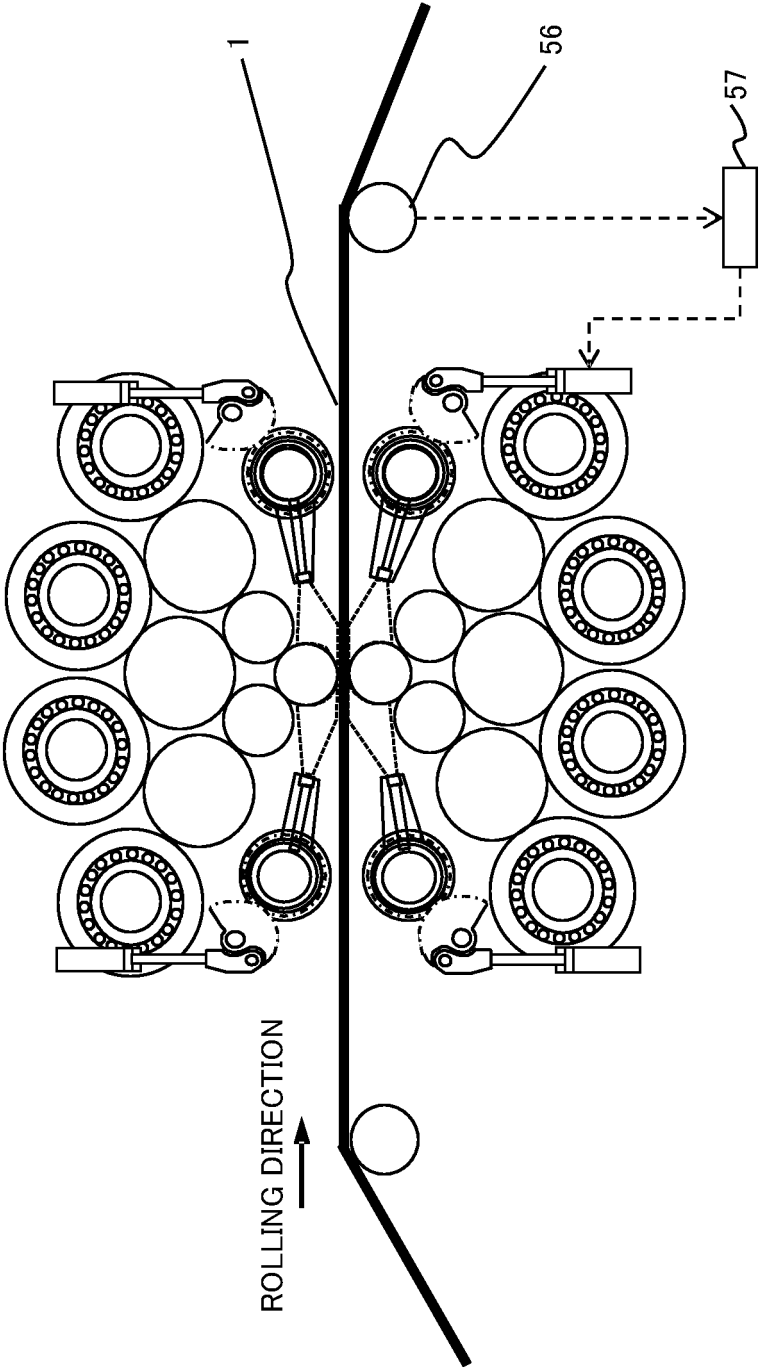
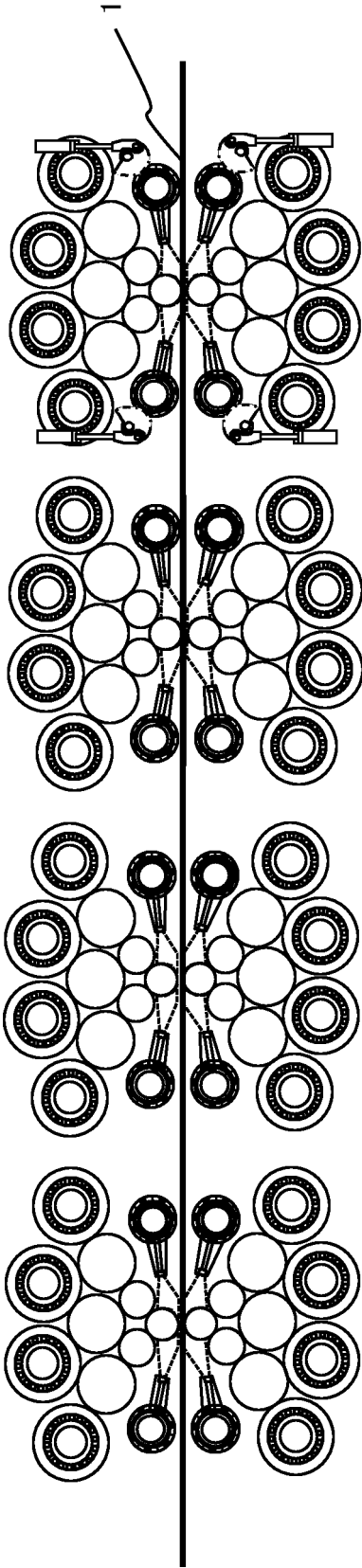


Fig. 31

200

ROLLING DIRECTION
↑



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2022/028140

5	A. CLASSIFICATION OF SUBJECT MATTER <i>B21B 27/10</i> (2006.01)i; <i>B21C 51/00</i> (2006.01)i; <i>B21B 1/28</i> (2006.01)i; <i>B21B 37/32</i> (2006.01)i; <i>B21B 38/02</i> (2006.01)i FI: B21B27/10 C; B21B1/28; B21B27/10 A; B21B37/32 C; B21B38/02; B21C51/00 L According to International Patent Classification (IPC) or to both national classification and IPC		
10	B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) B21B27/10; B21B1/28; B21B37/32; B21B38/02; B21C51/00 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)		
15			
20	C. DOCUMENTS CONSIDERED TO BE RELEVANT		
	Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Y	JP 2006-315084 A (T SENDZIMIR INC) 24 November 2006 (2006-11-24) paragraphs [0019]-[0020], fig. 2-4	1-8
25	Y	JP 4-50965 Y2 (KOBE STEEL, LTD.) 01 December 1992 (1992-12-01) column 4, line 25 to column 5, line 12, fig. 3, 4	1-8
	Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 182037/1980 (Laid-open No. 106509/1982) (SUMITOMO METAL INDUSTRIES, LTD.) 01 July 1982 (1982-07-01), p. 5, line 2 to p. 7, line 18, fig. 1-4	1-8
30			
35			
	☐ Further documents are listed in the continuation of Box C.		
	☒ See patent family annex.		
40	* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "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		
45	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
	Date of the actual completion of the international search		Date of mailing of the international search report
	20 September 2022		04 October 2022
50	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
Information on patent family members

International application No.
PCT/JP2022/028140

5	Patent document cited in search report		Publication date (day/month/year)		Patent family member(s)	Publication date (day/month/year)
	JP	2006-315084	A	24 November 2006	US 2006/0254335 A1 fig. 2, 4, paragraphs [0027]- [0028] EP 1721685 A1	
10	JP	4-50965	Y2	01 December 1992	(Family: none)	
	JP	57-106509	U1	01 July 1982	(Family: none)	
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REFERENCES CITED IN THE DESCRIPTION

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- JP 1933399 A [0004]
- JP 3728784 B [0004]