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(71) Applicant: **Kabushiki Kaisha Toshiba**
Minato-ku,
Tokyo 105-8001 (JP)

(72) Inventors:
- **Asari, Yukio**
  Tokyo 105-8001 (JP)
- **Naruoka, Yoshihiko**
  Tokyo 105-8001 (JP)

(74) Representative: **HOFFMANN EITLE**
Patent- und Rechtsanwälte
Arabellastrasse 4
81925 München (DE)

(54) Sheet takeout device

(57) A sheet takeout mechanism (10) has a takeout roller (2) that rotates in contact with a sheet located at a takeout position, and a motor (5) that intermittently rotates the takeout roller (2). A triangular suction port (3) is formed on a suction surface (2a) of the takeout roller (2) and has a vertex located downstream in a rotation direction (R) of the takeout roller (2). When a negative pressure is exerted on the sheet via the suction port (3), the suction force is weak at the beginning of suction and then increases gradually.

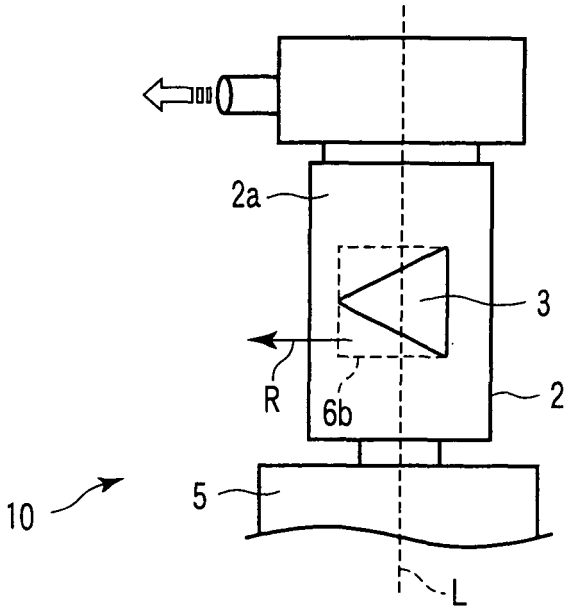

FIG. 2

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Description

[0001] The present invention relates to a sheet takeout device which sucks and contacts a sheet resting at a takeout position and which then rotates to take out the sheet in a surface direction.

[0002] A sheet takeout device is conventionally known which exerts a negative pressure on one of a plurality of sheets located at a takeout position, via a belt hole in an endless takeout belt to suck and contact the sheet and which then allows the takeout belt to travel intermittently in a takeout direction to take out the sheet onto a conveying path (see, for example, Japanese patent No. 3735565).

[0003] In addition to the takeout chamber, this device has a negative pressure chamber located opposite the takeout position across the takeout belt and a chamber mask located between the negative pressure chamber and the takeout belt. Two mask holes separated from each other in a belt traveling direction are formed in the chamber mask. The mask holes allow a negative pressure to be exerted twice on the sheet located at the takeout position, via the belt hole passing intermittently by the takeout position.

[0004] That is, the mask hole located downstream in the takeout direction has a smaller aperture area than the mask hole located upstream in the takeout direction. When an operation of taking out the sheet is started, a relatively high negative pressure is exerted on the sheet. After the taken-out sheet is delivered to a downstream conveying mechanism, the suction force applied to the sheet by the takeout belt is weakened. Thus, a relatively strong conveying force can be applied to the sheet at the beginning of the takeout operation. After the sheet is delivered to the downstream conveying mechanism, the conveyance of the sheet can be prevented from being obstructed.

[0005] However, this conventional device exerts a negative pressure on the sheet resting at the takeout position, via the belt hole in the intermittently driven takeout belt. Thus, when the takeout belt sucks and contacts the sheet, a relatively high negative pressure is rapidly exerted on the sheet. Consequently, the sheet may be skewed or a suction timing may vary. For example, a deviation in sheet suction timing may vary a sheet takeout pitch.

[0006] Furthermore, this device applies a suction force to the sheet with a difference in speed remaining between the sheet resting at the takeout position and the takeout belt. Consequently, friction occurs between the belt and the sheet, which may disadvantageously stain or damage the sheet.

[0007] An object of the present invention is to provide a sheet takeout device which can stabilize an operation of taking out a sheet and which prevents the sheet from being stained or damaged during the takeout operation.

[0008] To accomplish the object, a sheet taking-out device according to an embodiment of the present invention includes a rotating member having a suction surface which travels along a sheet fed to a takeout position and a suction port formed on the suction surface, a rotating mechanism which intermittently rotates the rotating member so as to minimize a rotation speed at a timing when the suction port passes by a suction position where the suction port sucks the sheet located at the takeout position, a suction mechanism which allows the suction surface to generate a negative pressure via the suction port so that the sheet located at the takeout position is sucked by and contacted with the suction surface when the suction port passes by the suction position, and suction force adjusting means which adjusts a suction force applied to the sheet located at the takeout position via the suction port so as to prevent the sheet from being sucked and moved by the suction surface while the suction port is approaching the suction position with the rotation speed of the rotating member reduced.

[0009] According to the present invention, while the suction port is approaching the sheet located at the takeout position with the rotation speed of the rotating member reduced and when there is a relatively significant difference in speed between the suction port and the sheet, the suction force applied to the sheet via the suction port is adjusted so as to prevent the sheet from being sucked and moved by the suction surface. This makes it possible to prevent a suction force strong enough to move the sheet located at the takeout position from being applied to the sheet before the suction port stands opposite the sheet. Furthermore, a sheet suction timing can be fixed to allow a sheet takeout timing to be stabilized.

[0010] Additionally, according to the present invention, the suction force is adjusted so as to prevent a strong suction force from being applied to the sheet via the suction port while a difference in speed remains between the suction port and the sheet. The sheet is thus prevented from being sucked by and contacted with the suction surface of the rotating member being decelerated. This makes it possible to prevent a possible slip between the suction surface and the sheet, which come into contact with each other, and to prevent the sheet from being disadvantageously stained or damaged by friction during the takeout operation.

[0011] The invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a schematic diagram of a sheet takeout device according to a first embodiment of the present invention;

FIG. 2 is an enlarged view showing the appearance of a suction port in a takeout roller incorporated in the takeout device in FIG. 1;

FIG. 3 is a velocity diagram showing a speed at which the takeout roller in FIG. 2 is intermittently rotated;

FIG. 4 is a velocity diagram showing an example in which the takeout roller is rotated at a low speed when the suction port passes by a suction position;

FIG. 5 is a diagram of the appearance of a conventional takeout roller having a rectangular suction port;
FIG. 6 is a diagram illustrating problems with the conventional takeout roller in FIG. 5;
FIG. 7 is a diagram showing the appearance of a first variation of the suction port in the takeout roller in FIG. 2;
FIG. 8 is a diagram showing the appearance of a second variation of the suction port in the takeout roller in FIG. 2;
FIG. 9 is a schematic diagram showing the structure of an essential part of a takeout mechanism according to a second embodiment of the present invention;
FIG. 10 is a velocity diagram of the speed at which a takeout roller in FIG. 9 is intermittently rotated;
FIG. 11 is a schematic diagram showing a variation of the takeout roller in FIG. 9;
FIG. 12 is a schematic diagram showing the structure of an essential part of a takeout mechanism according to a third embodiment of the present invention;
FIG. 13 is a schematic diagram showing a first variation of the takeout roller in FIG. 12;
FIG. 14 is a schematic diagram showing a second variation of the takeout roller in FIG. 12;
FIG. 15 is a schematic diagram of a takeout mechanism according to a fourth embodiment of the present invention;
FIG. 16 is a schematic diagram showing a first variation of a takeout belt in FIG. 15;
FIG. 17 is a schematic diagram showing a second variation of the takeout belt in FIG. 15;
FIG. 18 is a schematic diagram of a takeout mechanism according to a fifth embodiment of the present invention;
FIG. 19 is a schematic diagram showing a variation of a takeout belt in FIG. 18;
FIG. 20 is a schematic diagram of a takeout mechanism according to a sixth embodiment of the present invention; and
FIG. 21 is a schematic diagram showing a variation of a takeout belt in FIG. 20.

[0012] Embodiments of the present invention will be described below in detail with reference to the drawings.

[0013] FIG. 1 shows a schematic plan view of a sheet takeout device 1 according to a first embodiment of the present invention (hereinafter simply referred to as a takeout device 1). FIG. 2 is an enlarged view of a suction port 3 in a takeout roller 2 incorporated in the takeout device 1. FIG. 3 is an example of a velocity diagram showing a speed at which the takeout roller 2 is intermittently rotated.

[0014] As shown in FIG. 1, the takeout device 1 has a loading section 12 on which a plurality of collected sheets P such as mail or bills which are to be processed are loaded in an upright position, a supply mechanism (not shown) which moves the loaded sheets P in a collecting direction (the direction of arrow F in FIG. 1) and which feeds a first sheet P1 located at a moving-direction leading end of the sheets P, to a takeout position, a takeout mechanism 10 that takes out the sheet P1 fed to the takeout position, in a surface direction (the direction of arrow T in FIG. 1), a separating mechanism 16 that applies a separating torque acting in a direction opposite to the takeout direction T, to a second sheet and subsequent sheets P which are carried out with the sheet P1 taken out on a conveying path 14, to separate the second and subsequent sheets P, and a conveying mechanism 18 which receives the sheet P having passed through the separating mechanism 16 and which pulls the sheet P at a speed slightly higher than a takeout speed to convey the sheet P further downstream.

[0015] The takeout mechanism 10 has a substantially cylindrical takeout roller 2 (rotating member) formed of a rigid body such as metal and which rotates in the direction of arrow R in FIG. 1 in contact with the sheet P fed to the takeout position by the supply mechanism (not shown), a pump 4 (suction mechanism) that generates a negative pressure via a suction port 3 formed in an outer peripheral surface 2a (suction surface) of the takeout roller 2 which contacts the sheet P1, and a motor 5 (rotating mechanism) that intermittently rotates the takeout roller 2 in accordance with the velocity diagram illustrated in FIG. 3.

[0016] The takeout roller 2 is annularly and rotatably installed around an outer periphery of a generally cylindrical core member 6 containing a negative pressure chamber 6a connected to a pump 4. The core member 6 is fixedly located such that an opening in the chamber 6a lies opposite the sheet P1 located at the takeout position. As shown by a dashed line in FIG. 2, the opening 6b in the negative chamber 6a is rectangular and has an aperture area sufficient to cover the entire suction port 3 in the takeout roller 2.

[0017] The takeout roller 2 is intermittently rotated in accordance with the velocity diagram in FIG. 3 so as to minimize the rotation speed when the suction port 3 passes by a suction position. In the present embodiment, the takeout roller 2 is rotated such that the suction port 3 is stopped at the suction position. That is, the takeout roller 2 operates such that when the suction port 3 overlaps the opening 6b in the chamber 6a (as shown in FIGS. 1 and 2), the sheet P1 located at the takeout position is sucked by and contacted with the suction surface 2a of the takeout roller 2. The pump 4 always generates a fixed negative pressure in the negative pressure chamber 6a. The sheet P sucked by and contacted with the suction surface 2a of the takeout roller 2 is taken out in the surface direction T by rotation of the takeout roller 2. Thus, when the suction port 3 is located opposite the sheet located at the takeout position, the rotation of the takeout roller 2 is stopped and a sufficient negative pressure is exerted on the sheet P. The sheet P can be reliably sucked by and contacted with the suction surface 2a of the takeout roller 2, allowing the takeout operation to be stabilized.

[0018] In the present embodiment, the one suction port 3 is formed on the suction surface 2a of the takeout roller

2 to allow one sheet P to be taken out every time the takeout roller 2 makes one rotation. However, a plurality of the suction port 3 may be formed in a traveling direction of the suction surface 2a to allow a plurality of the sheets P to be taken out while the takeout roller 2 is making one rotation. In this case, the takeout roller 2 needs to be intermittently rotated so as to temporarily stop the takeout roller 2 every time one of the suction ports 3 stands opposite the sheet P located at the takeout position.

[0019] Furthermore, the velocity diagram in FIG. 3 shows that the rotation speed of the takeout roller 2 is zeroed at a timing when the suction port 3 passes by the suction position, where the suction port sucks and contacts the sheet P1 located at the takeout position. However, for example, as shown in FIG. 4, the takeout roller 2 may be rotated at a low speed (for example, 50 [rad/s]) when the suction port 3 passes by the suction position. In either case, the speed of the takeout roller 2 may be reduced such that the difference in speed between the suction surface 2a of the takeout roller 2 and the sheet P becomes small enough to allow the suction port 3 to reliably suck and contact the sheet P located at the takeout position.

[0020] As shown in FIG. 2, the suction port 3, formed on the suction surface 2a of the takeout roller 2 according to the present embodiment, is formed to be an isosceles triangle having a vertex positioned most downstream in a rotation direction R of the takeout roller 2. The shape of the suction port 3 is not limited to the isosceles triangle but may be such that the downstream aperture area of the suction port 3 is at least smaller than the upstream aperture area of the suction port 3 in the rotation direction of the takeout roller 2.

[0021] The opening 6b in the chamber 6a in the core member 6, which overlaps the suction port 3, is formed to be a rectangle having a rotating-direction width that is at least larger than the height of the isosceles triangle of the suction port 3 and an axial length that is at least larger than the length of the base of the isosceles triangle. Ideally, the opening 6b desirably has a width that is slightly larger than the height of the isosceles triangle and a length that is slightly larger than the length of the base of the isosceles triangle. This prevents the possible loss of the negative pressure and allows the suction hole 3 to efficiently generate a negative pressure. Negative pressure control can thus be performed depending on the shape of the suction hole 3 not relate to the rotating position of the suction hole 3.

[0022] In the present embodiment, the suction port 3 is shaped as described above. Thus, while the suction port 3 is approaching the suction position with the rotation speed of the takeout roller 2 gradually reduced, that is, when the suction port 3 starts to overlap the opening 6b in the negative pressure chamber 6a and it is too early to suck the sheet P, an undesired force applied to the sheet P1 located at the takeout position is weakened via the suction port 3. That is, the shape of the suction port 3 functions as suction force adjusting means according to the present invention.

[0023] Before describing the characteristic configuration (suction port 3) of the present embodiment in detail, description will be given of problems with a conventional takeout roller with a rectangular suction port with reference to FIGS. 5 and 6. The opening in the core member, around which the takeout roller is annularly installed, is also rectangular. In this case, discussion will be given of the case in which with a suction force applied to the sheet P located at the takeout position, via a rectangular suction port 21 shown in FIG. 5(b), the takeout roller 2 is intermittently rotated to take out the sheet P in the surface direction, as shown in FIG. 5(a).

[0024] In this case, when the suction port 21 approaching the suction position with the takeout roller 2 decelerated starts to overlap the opening in the negative pressure chamber 6a, a relatively strong suction force starts to act on the sheet P with a significant difference in speed remaining between the suction port 21 and the sheet P. That is, with the rectangular suction port 21, when the starts to overlap the opening in the negative pressure chamber 6a, a negative pressure acts all over a relatively long area in the axial direction of the takeout roller 2.

[0025] Thus, as shown in the left of FIG. 6(a), an operation of taking out the sheet P sucked by and contacted with the takeout roller 2 is not always started at a timing when the suction port 21 in the takeout roller 2 stands opposite the sheet P located at the takeout position so as to cover the largest area of the sheet P (at this timing, the takeout roller according to the present embodiment is stopped).

[0026] That is, for example, it is assumed that during the deceleration of the takeout roller 2, the sheet P is sucked by and contacted with the suction surface 2a of the takeout roller 2 with a difference in speed remaining between the suction port 21 and the sheet P located at the takeout position, as shown in the left of FIG. 6(b). In this case, before the takeout roller 2 is stopped, the sheet P has been moved slightly in the takeout direction. When the takeout roller 2 is rotated to start the operation of taking out the sheet P in this condition, then as shown in the right of FIGS. 6(a) and 6(b), the takeout-direction leading end of the sheet P taken out on the conveying path 14 is misaligned when the suction port 21 is separated from the sheet P. Furthermore, the opposite is true if the timing for sucking the sheet P is slightly delayed, as shown in FIG. 6(c). Thus, a deviation in the sheet takeout timing may disturb the gaps or pitches between the consecutively taken-out sheets.

[0027] Moreover, as described above, when an attempt is made to allow the suction surface 2a of the takeout roller 2 to suck the sheet P located at the takeout position with a difference in speed remaining between the suction port 21 and the sheet P, slippage may occur between the sheet P and the suction surface 2a to disadvantageously cause the surface of the sheet P to be stained or damaged.

[0028] Thus, in the present embodiment, the suction

port 3 is triangular, as shown in FIG. 2, so as to minimize the overlapping area of the suction port 3 when the suction port 3 starts to overlap the opening in the negative pressure chamber 6a and then to gradually increase the sucking area of the suction port 3. This minimizes the suction force applied to the sheet P located at the takeout position with a difference in speed remaining between the suction port 3 and the sheet P located at the takeout position.

[0029] Specifically, in the vicinity of the end of deceleration of the takeout roller 2 corresponding to each of the shaded portions in the velocity diagram in FIG. 3, a small opening part of the suction port 3 located on the left side of a dashed line L in FIG. 2 lies opposite the sheet P located at the takeout position. After the takeout roller 2 is stopped and when the taking-out of the sheet P is started, a relatively large opening part of the suction port 3 located on the right side of the dashed line L in FIG. 2 lies opposite the sheet P.

[0030] This makes it possible to prevent a strong suction force from being applied via the suction port 3 to the sheet P located at the takeout position, during the deceleration of the takeout roller 2 before stoppage. The suction timing for the sheet P can thus stabilized. That is, all the sheets P can be taken out using a fixed timing, allowing the sheets P to be taken out at a fixed pitch. Furthermore, the present embodiment can minimize the difference in speed between the suction port 3 and the sheet P (according to the present embodiment, the difference is almost zero) when the sheet P located at the takeout position is sucked by the suction surface 2a of the takeout roller 2. This prevents a possible slip between the suction port 3 and the sheet P and thus prevents the sheet from being stained or damaged during the takeout operation.

[0031] Furthermore, the suction port 3 according to the present embodiment makes it possible to inhibit the possible skew of the sheet P during the takeout operation.

[0032] With the conventional rectangular suction port 21, described with reference to FIG. 5, when the suction port 21 starts to overlap the opening in the negative pressure chamber 6a with the takeout roller 2 decelerated, a relatively strong suction force is applied to the sheet P over a relatively wide range in the axial direction of the takeout roller 2. Thus, if the sheet P located at the takeout position is already skewed, the sheet P is likely to be rotated in a direction in which the skew becomes more significant.

[0033] In contrast, with the suction port 3 according to the present embodiment, a weak suction force is first applied through the vertex of the triangle. Thus, even if the sheet is skewed before the takeout operation, the skew is unlikely to be become more significant. Thus, the skew of the taken-out sheet can be easily corrected.

[0034] When a plurality of sheets P in a fixed regular form are to be taken out, the triangle of the suction port 3 is designed such that the vertex of the triangle lies on a line in the takeout direction which passes through the centroid of the sheets P loaded via the loading section 12. This makes it possible to eliminate the skew of the sheet P during the takeout operation. That is, by exerting a negative pressure on an area on a line in the takeout direction which passes through the centroid of the sheet P, it is possible to take out the sheet P with the posture assumed by the sheet P before the takeout operation maintained. Thus, if the sheet P is not skewed before the takeout operation, the sheet P can be taken out in a non-skewed posture.

[0035] In contrast, with the conventional rectangular suction port 21, even if the sheet P is not skewed before the takeout operation, the sheet P may be skewed during the takeout operation. That is, the conventional suction port 21 exerts a negative pressure over a relatively wide range in the axial direction of the takeout roller 2. Consequently, a negative pressure may start to be exerted earlier on areas other than the one on the line in the takeout direction which passes through the centroid of the sheet P. When the negative pressure acts on a position located away from the line of the sheet P, a moment is generated to rotate and skew the sheet P.

[0036] Moreover, the present embodiment allows the pump 4 to be always operated to always draw a vacuum from the negative pressure chamber 6a. The above-described effects inherent in the present invention can be exerted simply by modifying the shape of the suction port 3. That is, the present embodiment allows the suction force to be controlled simply by changing the device configuration and without the need to precisely control the negative pressure.

[0037] FIG. 7 shows a first variation of the suction port 3 in the takeout roller 2 according to the first embodiment. This takeout roller 2' is different from the takeout roller 2 in the first embodiment in that the takeout roller 2' has a plurality of circular suction ports 22 with different aperture areas. The remaining part of the configuration is substantially the same as that of the first embodiment. Thus, components of the first variation which function similarly to those of the first embodiment are denoted by the same reference numerals and will not be described in detail.

[0038] A suction port 22 in the takeout roller 2' has circular holes having a relatively small aperture area and arranged downstream in the rotation direction R of the takeout roller 2' and circular holes having a relatively large aperture area and arranged upstream in the rotation direction R. When the suction port 22 is composed of the circular holes with the plurality of different aperture areas, the downstream aperture area can be set smaller than the upstream area as is the case with the first embodiment, described above. This enables a reduction in the aperture area of the part of the suction port 2 which approaches the sheet P earlier during the deceleration of the takeout roller 2'. As a result, effects similar to those of the first embodiment, described above, can be exerted.

[0039] Furthermore, according to the first variation, the suction port 22 is composed of the combination of the plurality of holes. Thus, compared to the first embodiment, described above, the first variation is expected to

exert an appropriate edge effect between the sheet P sucked by and contacted with the suction surface 2a and the suction port 22. That is, the increased length of the edge of the suction port, which sucks the sheet P, correspondingly increases the length of the edge contacting the sheet P. This allows a stronger conveying force to be applied to the sheet P via the suction surface 2a, making it possible to inhibit a possible slip between the suction surface 2a and the sheet P.

[0040] However, in view of the peel property of the sheet P released from the suction surface 2a after the sheet P has been taken out, the elasticity of the sheet P, and the like, it is necessary to appropriately select the aperture area and shape of the suction port according to the surface condition of the sheets to be processed and the elasticity of the sheets.

[0041] FIG. 8 shows a second variation of the suction port 3 in the takeout roller 2 according to the first embodiment, described above. This takeout roller 2" is different from the takeout roller 2 according to the first embodiment, described above, in that a large number of circular suction ports 23 with the same aperture area are arranged with the arrangement density of the suction ports varied. The remaining part of the configuration is substantially the same as that of the first embodiment. Thus, components of the second variation which function similarly to those of the first embodiment are denoted by the same reference numerals and will not be described in detail.

[0042] The suction ports 23 in the takeout roller 2" are arranged such that the downstream arrangement density is lower (sparser) than the upstream arrangement density in the rotation direction R of the takeout roller 2". When the arrangement density of the large number of suction ports 23 is thus varied, it is possible to reduce the aperture area of the part of the suction port 2 which approaches the sheet P earlier during the deceleration of the takeout roller 2", as is the case with the first embodiment, described above. As a result, effects similar to those of the first embodiment, described above, can be exerted.

[0043] In the embodiment described above, the suction force applied to the sheet P located at the takeout position is adjusted by modifying the shape of the suction port 3, 22, or 23 or the hole arrangement pattern. However, similar effects can be exerted by modifying the shape of the opening in the negative pressure chamber 6a in the core member 6, around which the takeout roller 2 is annularly installed, as described above. For example, similar effects can be exerted by forming the conventional rectangular suction port 21, described with reference to FIG. 5, on the suction surface 2a of the takeout roller 2 and forming the opening in the negative chamber 6a to be triangular. In this case, the opening in the negative pressure chamber 6a may be shaped like a triangle having a vertex located upstream in the rotation direction of the takeout roller 2.

[0044] Now, a takeout mechanism 20 according to a second embodiment will be described with reference to FIGS. 9 and 10. FIG. 9 is an enlarged view of the suction port 21 in the takeout roller 2 according to the present embodiment. FIG. 10 shows a velocity diagram showing the rotation speed of the takeout roller 2. Also in this case, components of the second embodiment which function similarly to those of the first embodiment are denoted by the same reference numerals and will not be described in detail.

[0045] As shown in FIG. 9, the rectangular suction form 21 as described in FIG. 5 is formed on the suction surface 2a of the takeout roller 2 according to the present embodiment. A solenoid valve 25 that turns on and off air suction is attached to the middle of a pipe connecting the negative pressure chamber 6a and the pump 4 together. A controller 27 is connected to the solenoid valve 25 to controllably turn on and off the solenoid valve 25 on the basis of information on the rotational position of the takeout roller 2.

[0046] The takeout roller 2 according to the present embodiment is also rotationally driven in accordance with the velocity diagram in FIG. 10. That is, the takeout roller 2 is intermittently rotated so as to minimize the rotation speed of the takeout roller 2 (in the present embodiment, zero the rotation speed) at the timing when the suction port 21 stands opposite the sheet P located at the takeout position.

[0047] Continuous generation of a negative pressure via the rectangular suction port 21 may result in various problems as in the case of the conventional example, described with reference to FIGS. 5 and 6. Thus, in the present embodiment, the solenoid valve 25 is switched at a specific timing to control the suction force applied during the deceleration of the takeout roller 2. That is, in the present embodiment, the solenoid valve 25 and the controller 27, which switches the solenoid valve 25, function as suction force adjusting means.

[0048] Specifically, in the present embodiment, the controller 27 turns off the solenoid valve at timings shown by shaded portions in FIG. 10 to suspend the suction of air. In other words, the solenoid valve 25 is turned on immediately before the rotation speed of the takeout roller 2 is zeroed, to start the suction of air. Only a low negative pressure is generated in the suction port 21 immediately after the suction of air is started by switching the solenoid valve 25. The suction force increases gradually as the time elapses.

[0049] Thus, switching the solenoid valve 25 at a timing immediately before the stoppage, shown in FIG. 10, enables a gradual increase in the suction force applied to the sheet P via the suction port 21 in the takeout roller 2 being decelerated. This makes it possible to exert effects similar to those of the first embodiment, described above. In particular, in the present embodiment, the switching timing for the solenoid valve 25 is controlled so as to maximize the suction force at the timing when the suction port 21 stands opposite the sheet P located at the takeout position. That is, the present embodiment can prevent the sheet P from being sucked by the suction surface 2a

during the deceleration of the takeout roller 2 and also prevent the sheet P from being stained or damaged as a result of the friction between the suction surface 2a and the sheet P.

[0050] With the solenoid valve 25, the sheet can be reliably sucked by and contacted with the suction surface 2 by stopping the takeout roller 2 with the suction port 21 lying opposite the sheet P located at the takeout position and then turning on the solenoid valve 25. However, to take out the sheets P at a high speed and a short pitch, it is necessary to minimize the time for which the takeout roller 2 is stopped. This requires valve control as performed in the present embodiment.

[0051] FIG. 11 shows a variation of the takeout roller 2 according to the second embodiment, described above. The takeout roller 2 has a suction port 2 composed of a combination of a large number of holes aligned in a matrix. This variation can exert effects similar to those of the takeout roller according to the second embodiment by allowing the controller 27 to control the solenoid valve 25 at the same timings as those in the second embodiment, described above. Furthermore, compared to the second embodiment, the variation can enhance the edge effect owing to the increased length of the edge of the hole. This enables an increase in the conveying force that can be applied to the sheet P.

[0052] FIG. 12 shows the structure of an essential part of a takeout mechanism 30 according to a third embodiment. The takeout mechanism 30 has a structure in which the takeout mechanism 10 according to the first embodiment, described above, is combined with the takeout mechanism 20 according to the second embodiment, described above. That is, the takeout mechanism 30 has the triangular suction port 3 on the suction surface 2a of the takeout roller 2 and the solenoid valve 25 on the pipe between the negative pressure chamber 6 and the pump 4. The solenoid valve 25 is also turned off at the timings shown by the shaded portions in the velocity diagram in FIG. 10. Also in this case, components of this variation which function similarly to those of the above-described embodiments are denoted by the same reference numerals and will not be described in detail.

[0053] Thus, the third embodiment combines the triangular suction port 3 with the solenoid valve 25 to enable an increase in the takeout speed for the sheet P compared to the first and second embodiments. That is, a reduction in the takeout pitch of the sheets P in the takeout mechanism 20 according to the second embodiment, described with reference to FIGS. 9 and 10, reduces the time for which the solenoid valve 25 remains off, that is, the area of the shaded portions in FIG. 10. Consequently, the next suction operation may be started before the negative pressure becomes equal to the atmospheric pressure. In this case, the suction force applied to the sheet P located at the takeout position starts to increase simultaneously with the generation of a negative pressure during the deceleration of the takeout roller 2. This may disadvantageously cause the sheet to be misaligned, stained, or damaged. That is, with the structure of the second embodiment, the takeout speed is limited.

[0054] In contrast, when the suction port 3 is triangular, as is the case with the present embodiment, even if the takeout speed for the sheet P is increased enough to start the next suction before the negative pressure in the negative pressure chamber 6a returns to atmospheric pressure, a strong suction force can be prevented from being applied to the sheet P during the deceleration of the takeout roller 2. This makes it possible to prevent the sheet P from being misaligned, stained, or damaged. Thus, the takeout mechanism 30 according to the present embodiment can increase the takeout speed for the sheet P compared to the takeout mechanisms 10 and 20 according to the first and second embodiments, described above.

[0055] FIG. 13 shows a first variation of the takeout roller according to the third embodiment. FIG. 14 shows a second variation. A large number of holes with different aperture areas are formed on the suction surface 2a of the takeout roller 2 in FIG. 13 as suction ports 32. Suction ports 34 with the same area are arranged on the suction surface 2a of the takeout roller 2 in FIG. 14 with the arrangement density of the suction ports varied. The suction ports 32 and 34 according to the first and second variations can function similarly to the suction ports 3 in the takeout roller 2 according to the third embodiment to exert effects similar to those of the third embodiment.

[0056] When the suction port is formed of the plurality of small holes 32 or 34 as in the case of the first and second variations, an inelastic sheet P can be prevented from being excessively drawn into the holes. In contrast, with the triangular suction port 3, described with reference to FIG. 12, if the suction force of the pump 4 is too strong or the sheet P is inelastic, the sheet P is drawn into the suction port 3 in an undesired manner. In this case, the sheet P may be stained, damaged, or inappropriately peed off. Thus, if an inelastic sheet P is to be processed, the suction port 32 or 34, composed of the combination of the plurality of holes, is desirably used as is the case with the variations shown in FIGS. 13 and 14.

[0057] Additional advantages and modifications will readily occur to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details and representative embodiments shown and described herein.

[0058] Accordingly, various modifications may be made without departing from the spirit or scope of the general inventive concept as defined by the appended claims and their equivalents.

[0059] For example, in the description of the first to third embodiments, the takeout roller 2 is used as a rotating member rotating in contact with the sheet P located at the takeout position. However, the present invention is not limited to this. An endless takeout belt may be used as a rotating member as shown in FIGS. 15 to 21.

[0060] For example, FIG. 15(a) is a schematic plan

view of an essential part of a takeout mechanism 40 according to a fourth embodiment of the present invention corresponding to the takeout mechanism 10 according to the present embodiment, described above, in which the takeout roller 2 is replaced with a takeout belt 42. FIG. 15(b) is a side view of the essential part of the takeout mechanism 40 as viewed from the takeout position. The takeout belt 42 is wound and extended around a plurality of rollers 41 and is allowed to travel endlessly along the sheet P located at the takeout position. A negative pressure chamber 44 is located opposite the sheet P located at the takeout position, across the takeout belt, that is, the negative pressure chamber 44 is located inside the takeout belt 42. The negative pressure chamber 44 is fixedly mounted with an opening 46 facing the takeout position.

[0061] A suction port 48 is formed in the takeout belt 42 and passes by the opening 46 in the negative pressure chamber 44 when the speed is minimized during traveling. The suction port 48 in the takeout belt 42 according to the present embodiment is triangular, as is the case with the first embodiment, described above.

[0062] That is, the present embodiment can control the suction force applied to the sheet P located at the takeout position, when the deceleration of the takeout belt 42 is about to end. This makes it possible to prevent the sheet P from being misaligned, stained, or damaged.

[0063] Likewise, FIG. 16 shows the structure of a first variation of the fourth embodiment, described above. FIG. 17 shows the structure of a second variation. These variations can function similarly to the variations of the first embodiment, described above, and exert effects similar to those of the variations of the first embodiment except that the takeout belt 42 is used in place of the takeout roller 2.

[0064] FIG. 18(a) is a plan view of a takeout mechanism 50 according to a fifth embodiment of the present invention which functions similarly to the takeout mechanism 20 according to the second embodiment, described above. FIG. 18(b) is a side view of the takeout mechanism 50 according to the fifth embodiment. The takeout mechanism 50 has a takeout belt 52 with a rectangular suction port 58, a solenoid valve 55 that turns on and off a negative pressure generated via an opening 56 in a negative pressure chamber 54, and a controller 57. The takeout mechanism 50 can function similarly to the takeout mechanism 20 according to the second embodiment, described above, and exert effects similar to those of the takeout mechanism 20.

[0065] FIG. 19 shows a takeout mechanism 50' according to a variation of the fifth embodiment, described above. A suction port 59 is formed on a takeout belt 52 according to this variation and has a large number of alignigly arranged holes with the same area, as is the case with the variation of the second embodiment, described above. The takeout mechanism 50' can function similarly to the variation of the second embodiment, described with reference to FIG. 11, and exert effects similar to those of the variation of the second embodiment.

[0066] FIG. 20 shows a schematic diagram of a takeout mechanism 60 according to a sixth embodiment of the present invention. The structure of the takeout mechanism 60 corresponds to that of the takeout mechanism 30 according to the third embodiment, described with reference to FIG. 12, in which the takeout roller 2 is replaced with a takeout belt 62. The remaining part of the structure of the takeout mechanism 60 is similar to that of the takeout mechanism 30, and the takeout mechanism 60 functions similarly to the takeout mechanism 30. The takeout mechanism 60 enables an increase in the takeout speed for the sheet P and thus in processing speed compared to the takeout mechanism 40 according to the fourth embodiment, described above, and the takeout mechanism 50 according to the fifth embodiment, described above.

[0067] FIG. 21 shows a variation of the sixth embodiment, described above. This takeout mechanism 60' has a suction port 67 with a large number of holes with different aperture areas instead of the triangular suction port 63 in the takeout mechanism 60, described above. The takeout mechanism 60' can function similarly to the takeout mechanism described with reference to FIG. 13 and exert effects similar to those of the takeout mechanism described with reference to FIG. 13.

[0068] As described above, even if the takeout belt is used as a rotating member that contacts the sheet P located at the takeout position, effects can be exerted which are similar to those exerted when the takeout roller is used. The takeout timing for the sheet P can be prevented from deviating, enabling the pitches or gaps between the sheets P to be stabilized. The sheet P can also be prevented from being stained or damaged as a result of a difference in speed between the belt and the sheet P.

Claims

1. A sheet taking-out device comprising:

a rotating member (2, 42) having a suction surface (2a) which travels along a sheet (P1) fed to a takeout position and a suction port (3, 22, 23) formed on the suction surface;

a rotating mechanism (5) which intermittently rotates the rotating member so as to minimize a rotation speed at a timing when the suction port passes by a suction position where the suction port sucks the sheet located at the takeout position; and

a suction mechanism (4) which allows the suction surface to generate a negative pressure via the suction port so that the sheet located at the takeout position is sucked by and contacted with the suction surface when the suction port passes by the suction position,

characterized by further comprising:

suction force adjusting means (3, 25, 27) which adjusts a suction force applied to the sheet located at the takeout position via the suction port so as to prevent the sheet from being sucked and moved by the suction surface while the suction port is approaching the suction position with the rotation speed of the rotating member reduced.

2. The sheet takeout device according to claim 1, **characterized in that** the suction force adjusting means adjusts the suction force such that the sheet located at the takeout position is sucked by and contacted with the suction surface at a timing when the rotation speed of the rotating member is minimized to locate the suction port opposite the sheet.

3. The sheet takeout device according to claim 2, **characterized in that** the suction force adjusting means adjusts the shape of the suction port (3, 22, 23) such that a downstream aperture area of the suction port is smaller than an upstream aperture area of the suction port in a rotation direction of the rotating member.

4. The sheet takeout device according to claim 3, **characterized in that** the suction port (3) is formed to be a triangle having a vertex located downstream in the rotation direction of the rotating member.

5. The sheet takeout device according to claim 1, **characterized in that** the suction force adjusting means (25, 27) controls the suction mechanism such that as the suction port approaches the suction position, the suction force applied via the suction port to the sheet located at the takeout position increases gradually.

6. The sheet takeout device according to claim 5, **characterized in that** the suction force adjusting means has a valve (25) which turns on and off the negative pressure and a controller (27) which controls a switching timing for the valve so as to maximize the suction force at the timing when the suction port stands opposite the sheet located at the takeout position.

7. The sheet takeout device according to claim 2, **characterized in that** the suction force adjusting means adjusts the shape of the suction port (3, 22, 23) such that the downstream aperture area of the suction port is smaller than the upstream aperture area of the suction port in the rotation direction of the rotating member, and controls the suction mechanism such that as the suction port approaches the suction position, the suction force applied via the suction port to the sheet located at the takeout position increases gradually.

8. The sheet takeout device according to claim 7, **characterized in that** the suction port (3) is formed to be a triangle having a vertex located downstream in the rotation direction of the rotating member.

9. The sheet takeout device according to claim 7, **characterized in that** the suction force adjusting means has a valve (25) which turns on and off the negative pressure and a controller (27) which controls a switching timing for the valve so as to maximize the suction force at the timing when the suction port stands opposite the sheet located at the takeout position.

10. The sheet takeout device according to claim 2, **characterized in that** the rotating member is a substantially cylindrical takeout roller (2) formed of a rigid body such as metal and having the suction surface on an outer periphery.

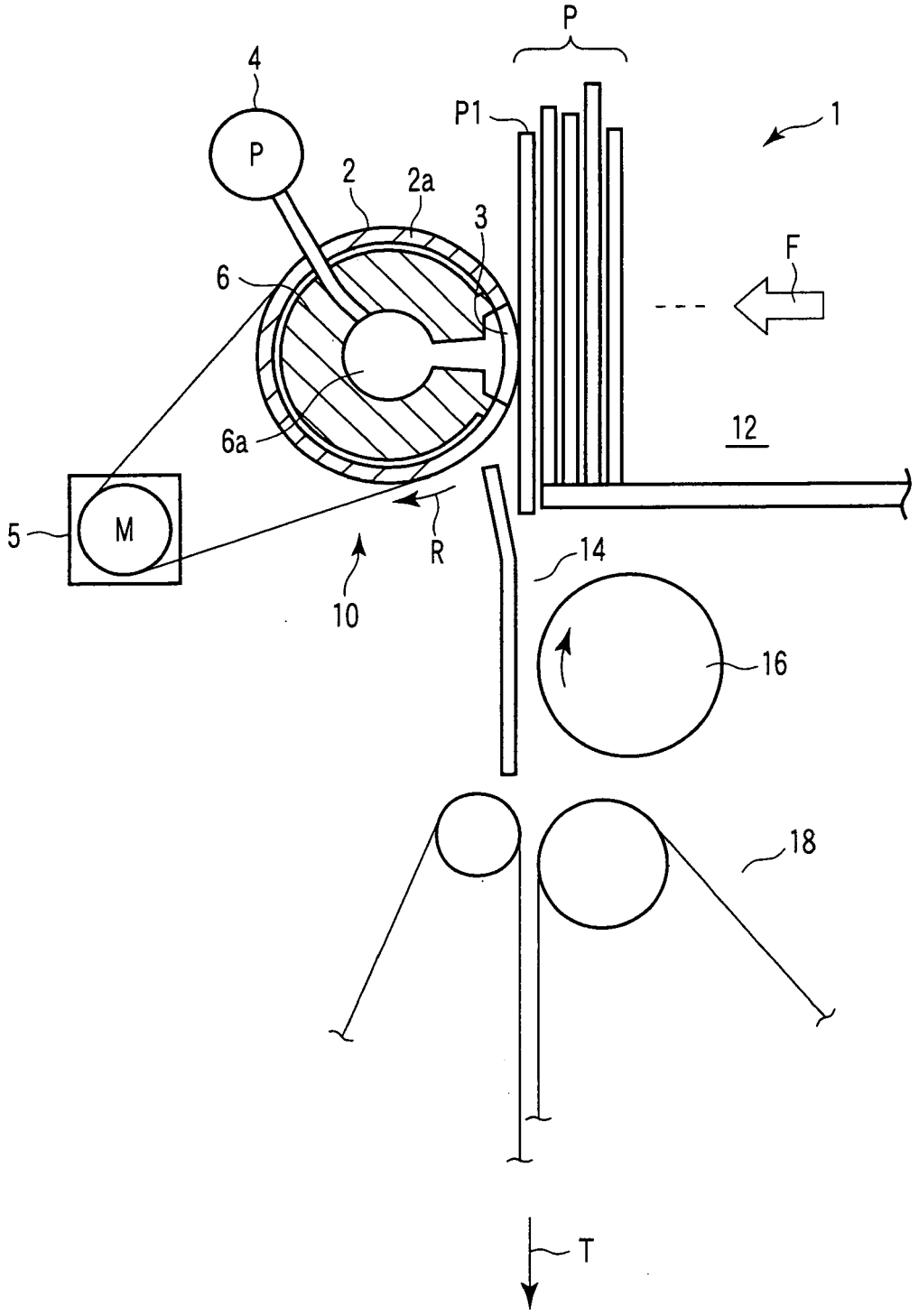

FIG. 1

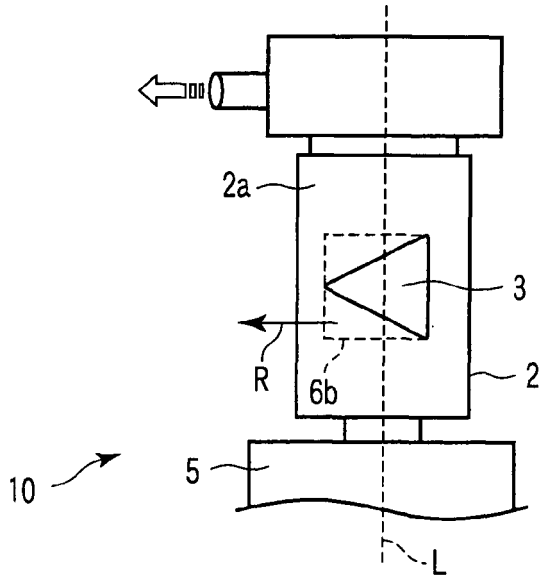
2a
3
R
6b
2
10
5
L

FIG. 2

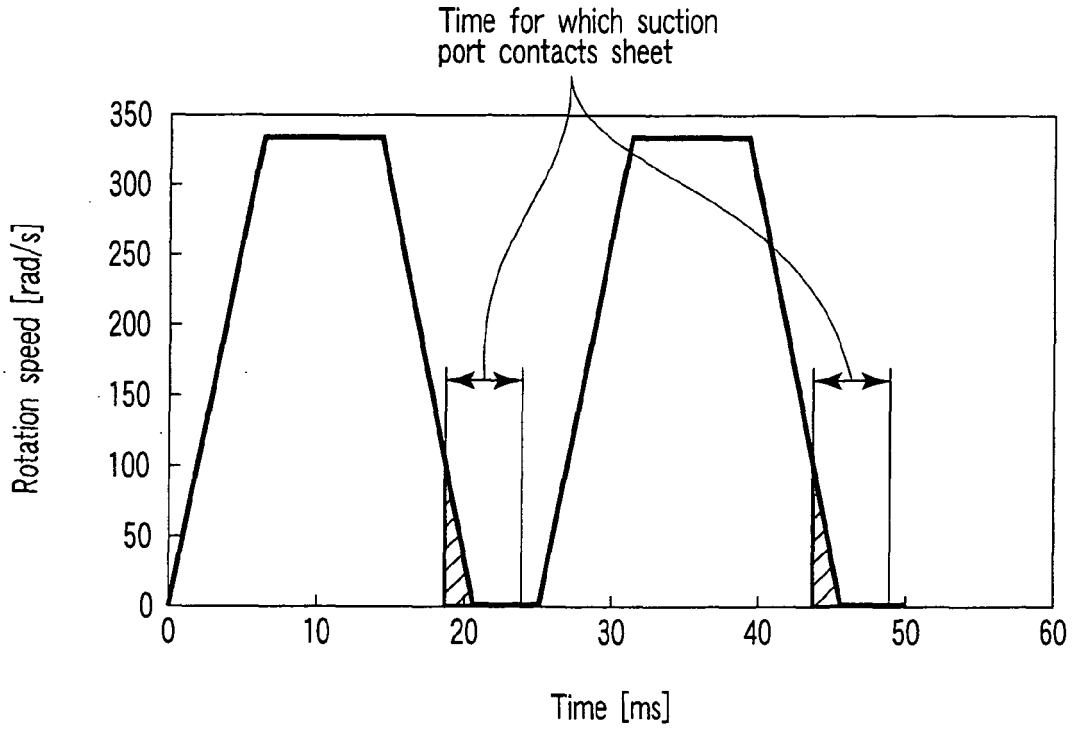
Time for which suction port contacts sheet
Rotation speed [rad/s]
350
300
250
200
150
100
50
0
0
10
20
30
40
50
60
Time [ms]

FIG. 3

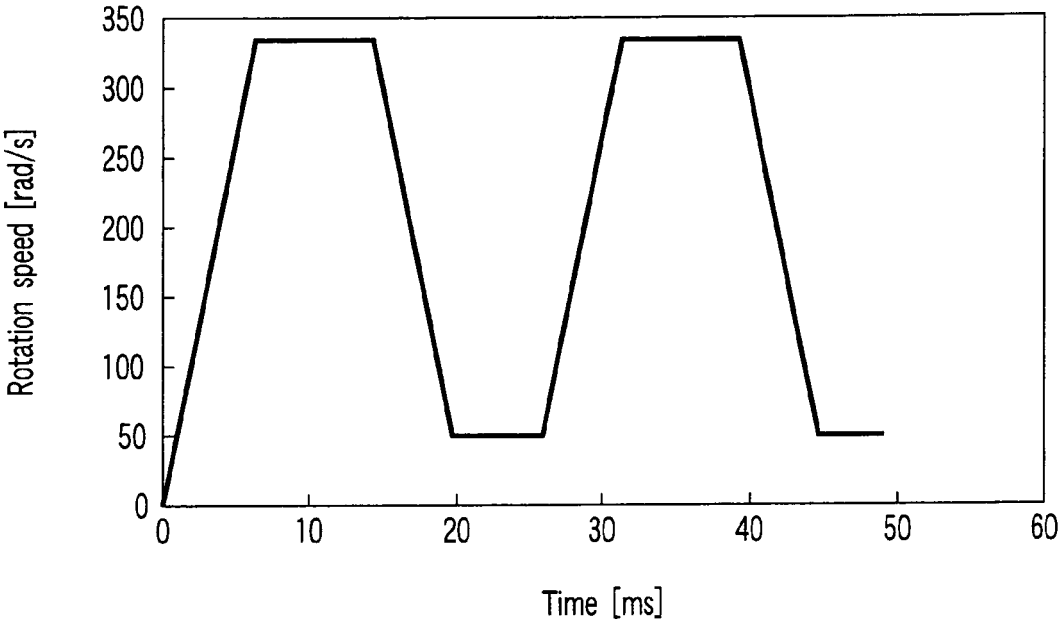
Rotation speed [rad/s]
350
300
250
200
150
100
50
0
0
10
20
30
40
50
60
Time [ms]

FIG. 4

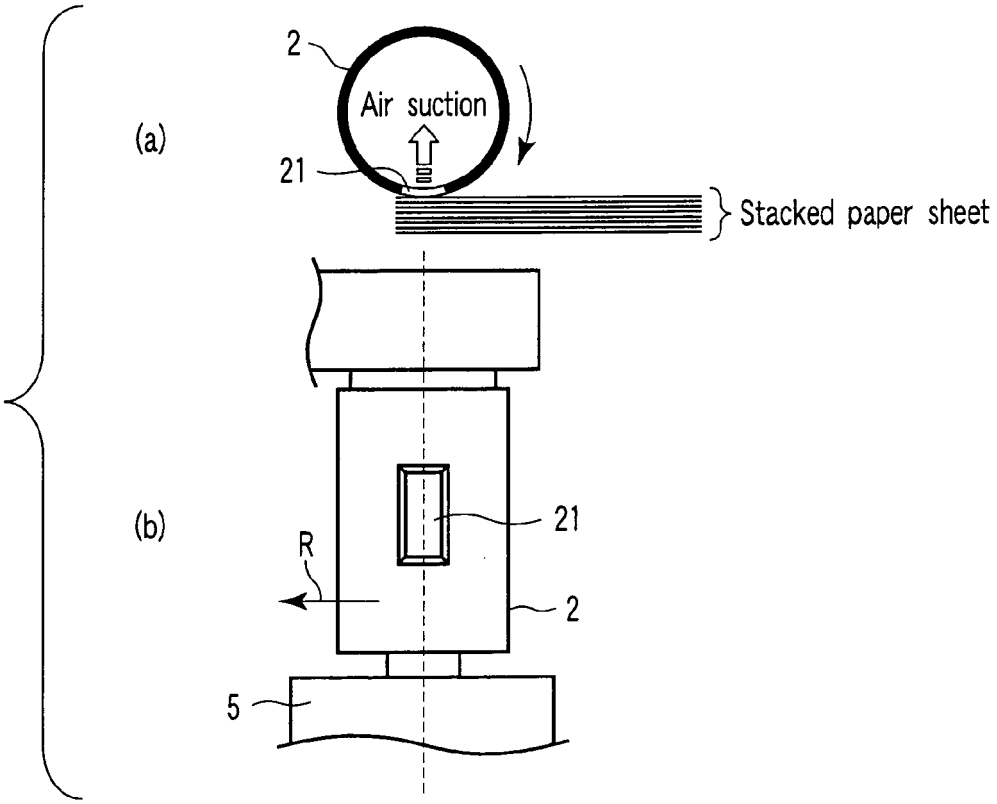
(a)
(b)
2
Air suction
21
Stacked paper sheet
21
R
2
5

FIG. 5

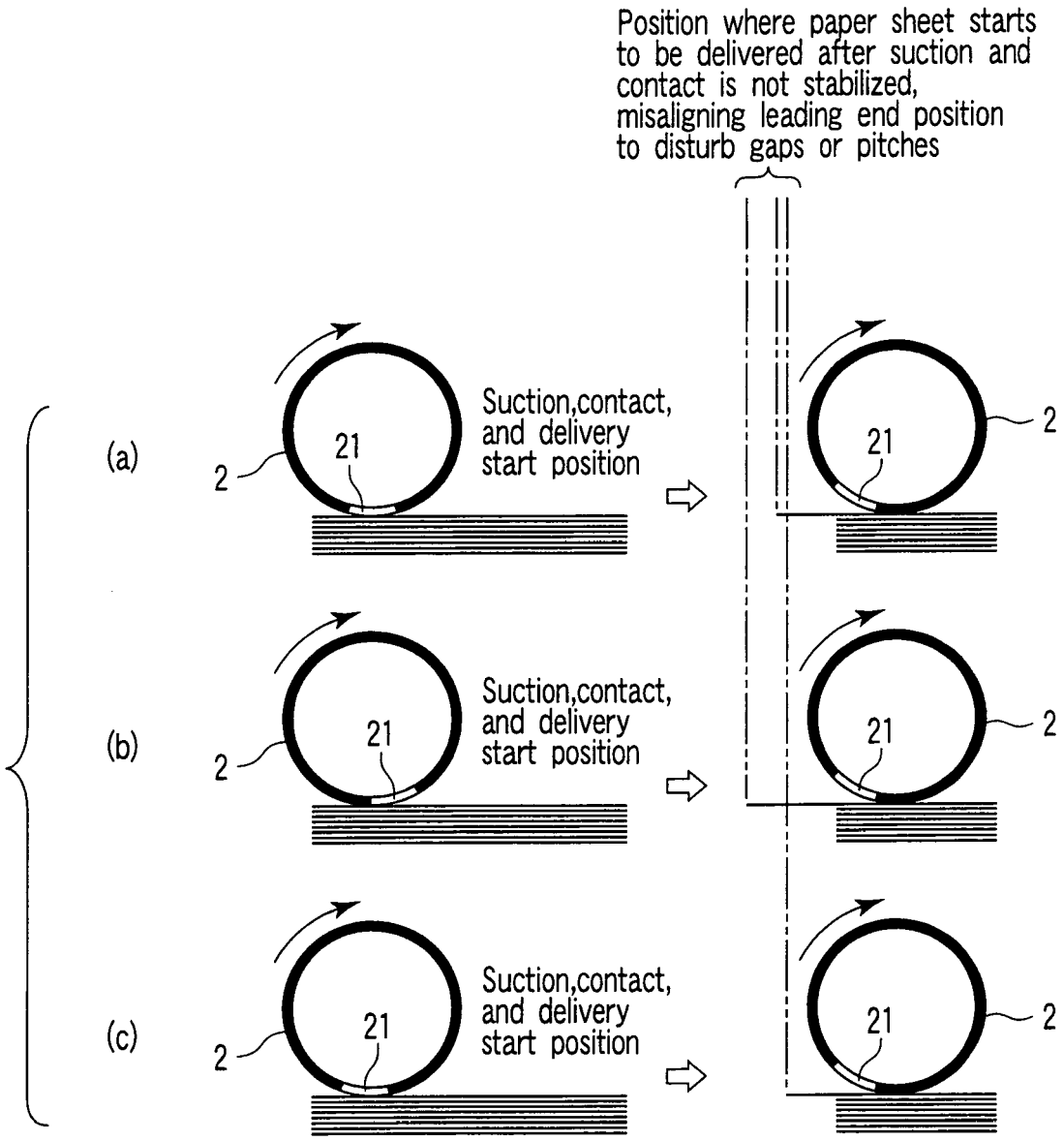
Position where paper sheet starts to be delivered after suction and contact is not stabilized, misaligning leading end position to disturb gaps or pitches
(a)
(b)
(c)
Suction,contact, and delivery start position
Suction,contact, and delivery start position
Suction,contact, and delivery start position
21
2

FIG. 6

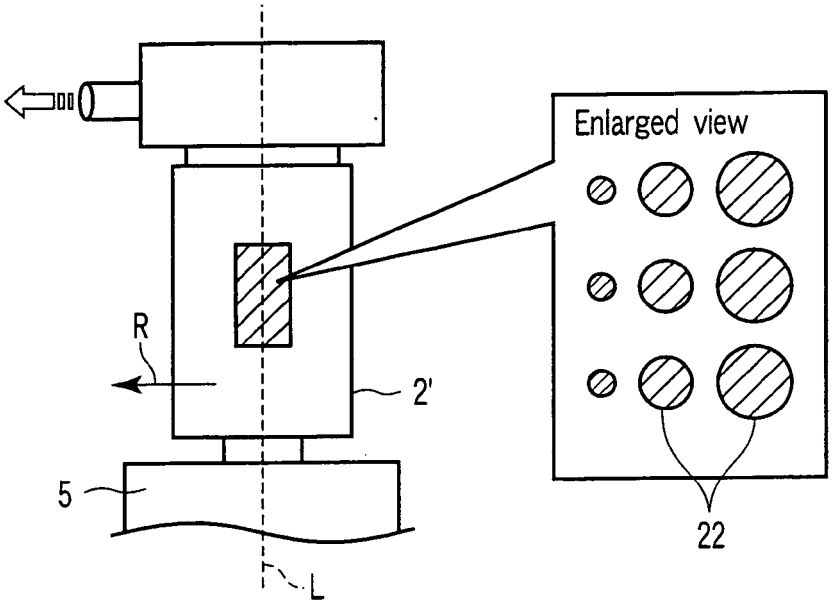

FIG. 7

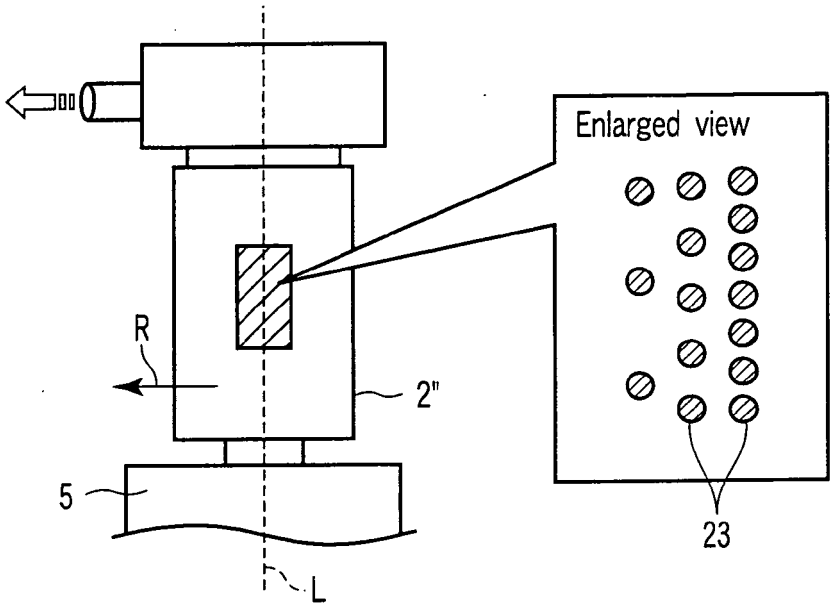

FIG. 8

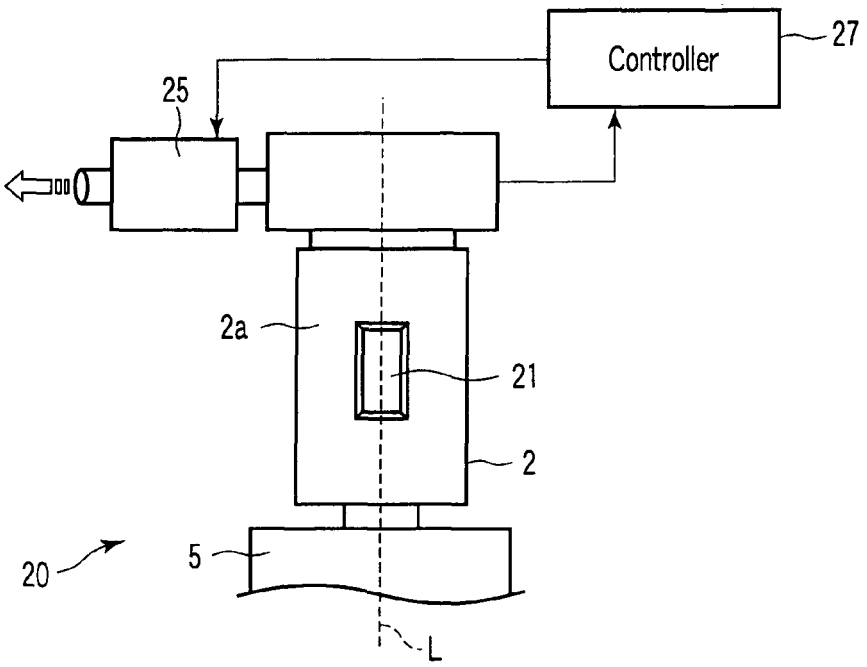
Controller
27
25
2a
21
2
20
5
L

FIG. 9

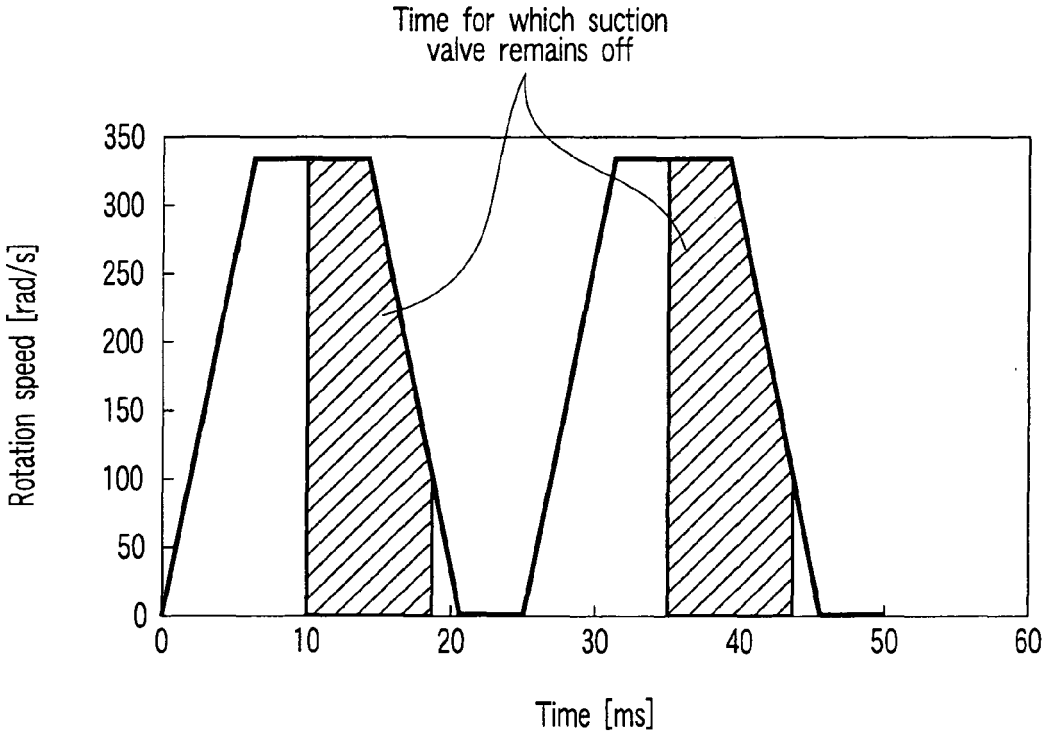
Time for which suction valve remains off
Rotation speed [rad/s]
350
300
250
200
150
100
50
0
0
10
20
30
40
50
60
Time [ms]

FIG. 10

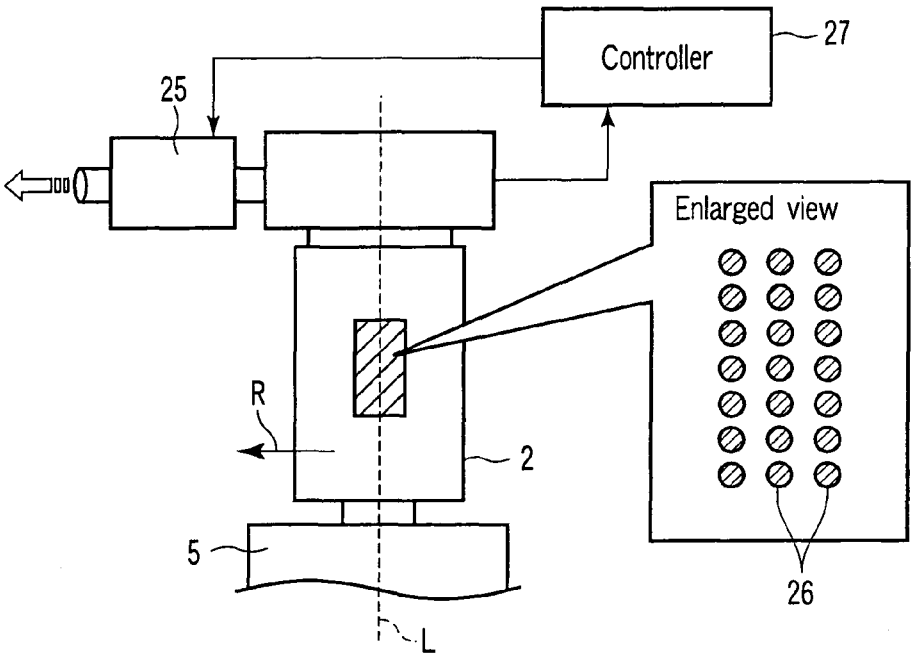
Controller
27
25
Enlarged view
R
2
5
26
L

FIG. 11

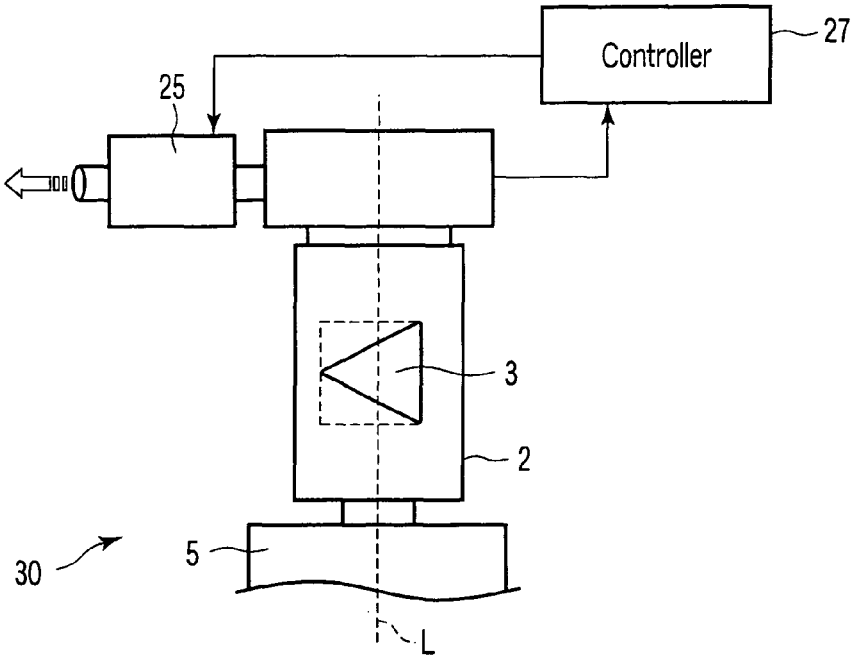
Controller
27
25
3
2
30
5
L

FIG. 12

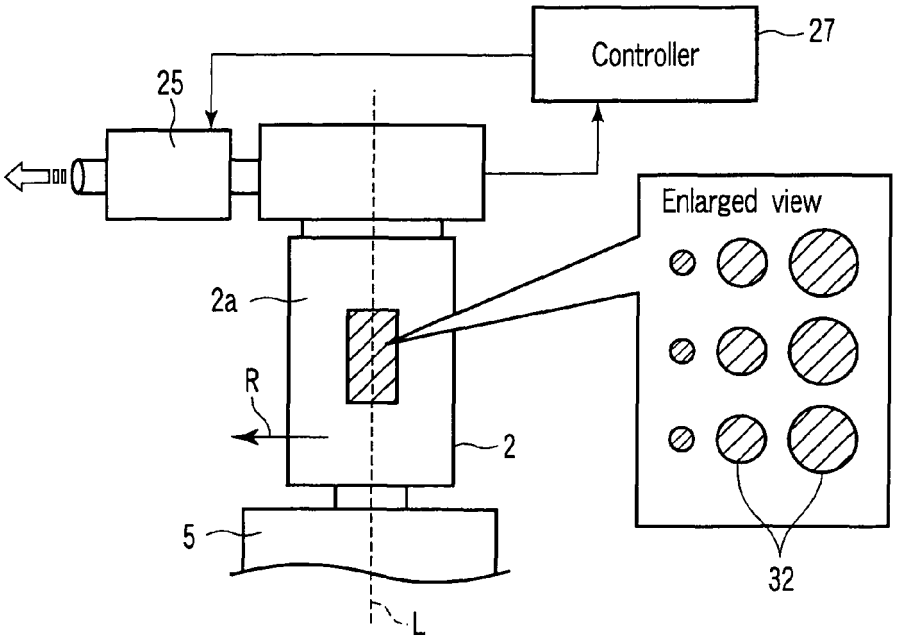
Controller
27
25
Enlarged view
2a
R
2
5
32
L

FIG. 13

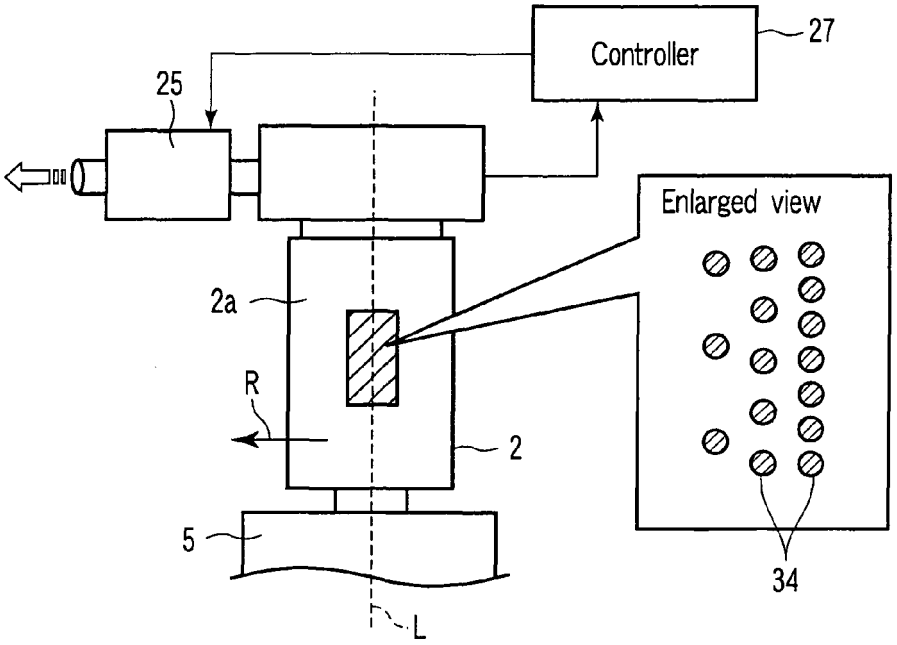
Controller
27
25
Enlarged view
2a
R
2
5
34
L

FIG. 14

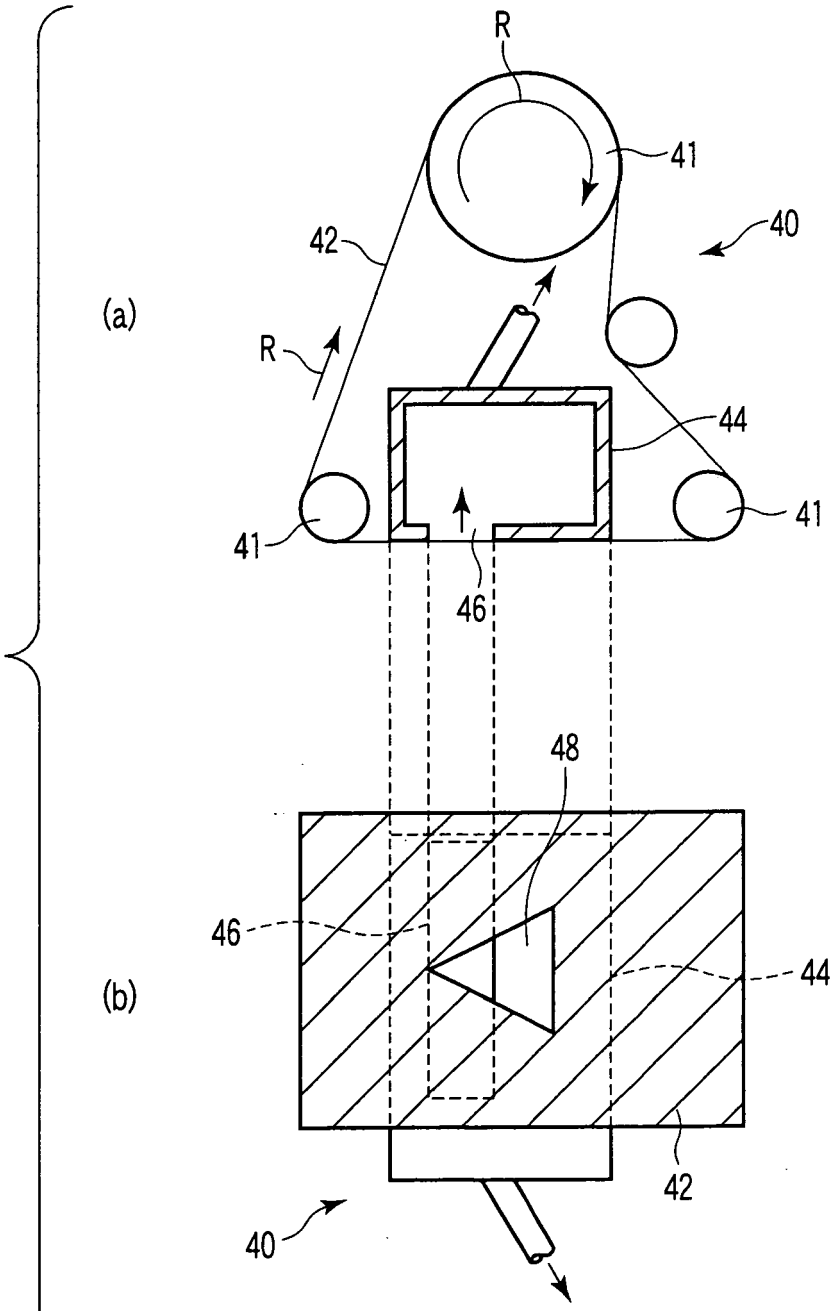

FIG. 15

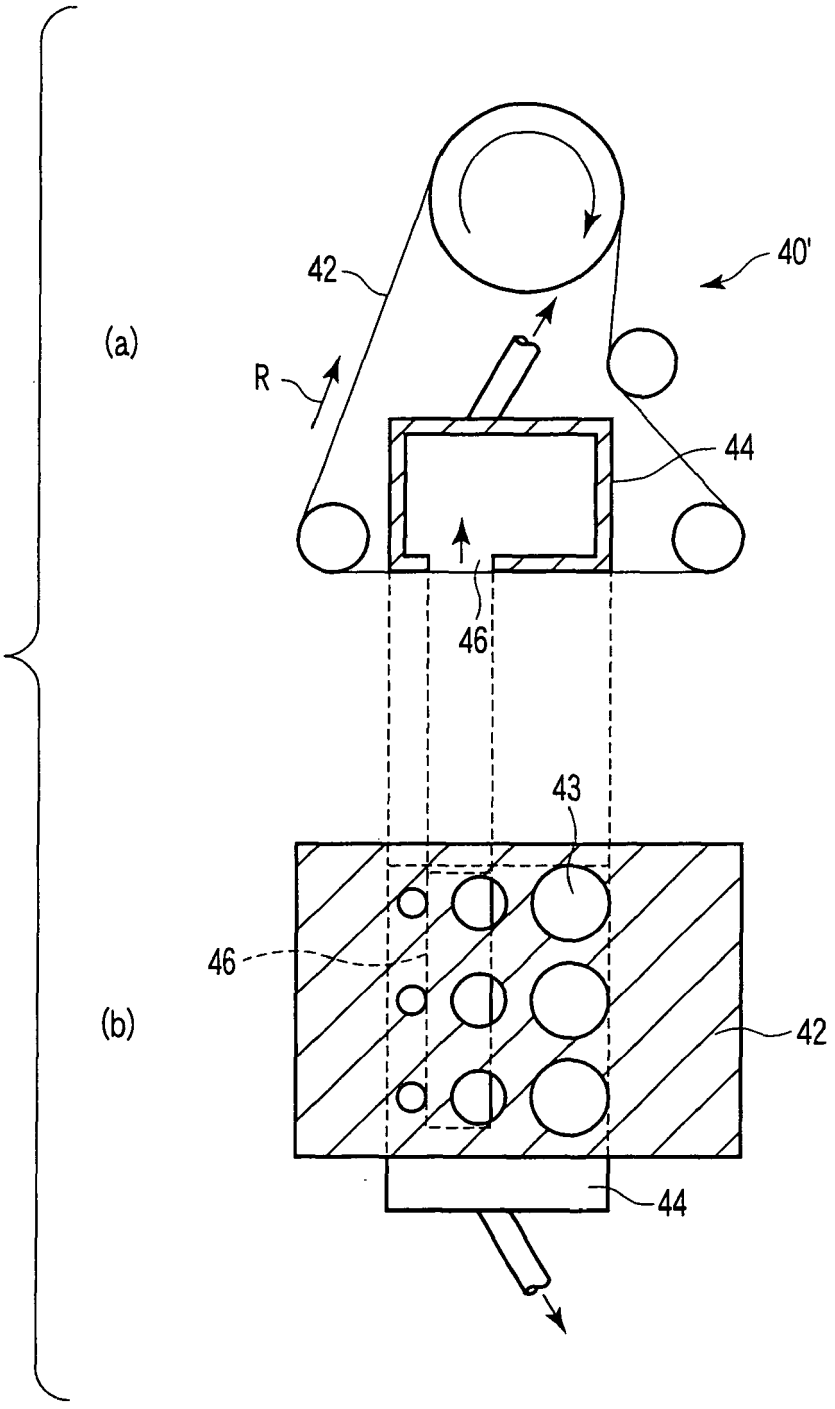

FIG. 16

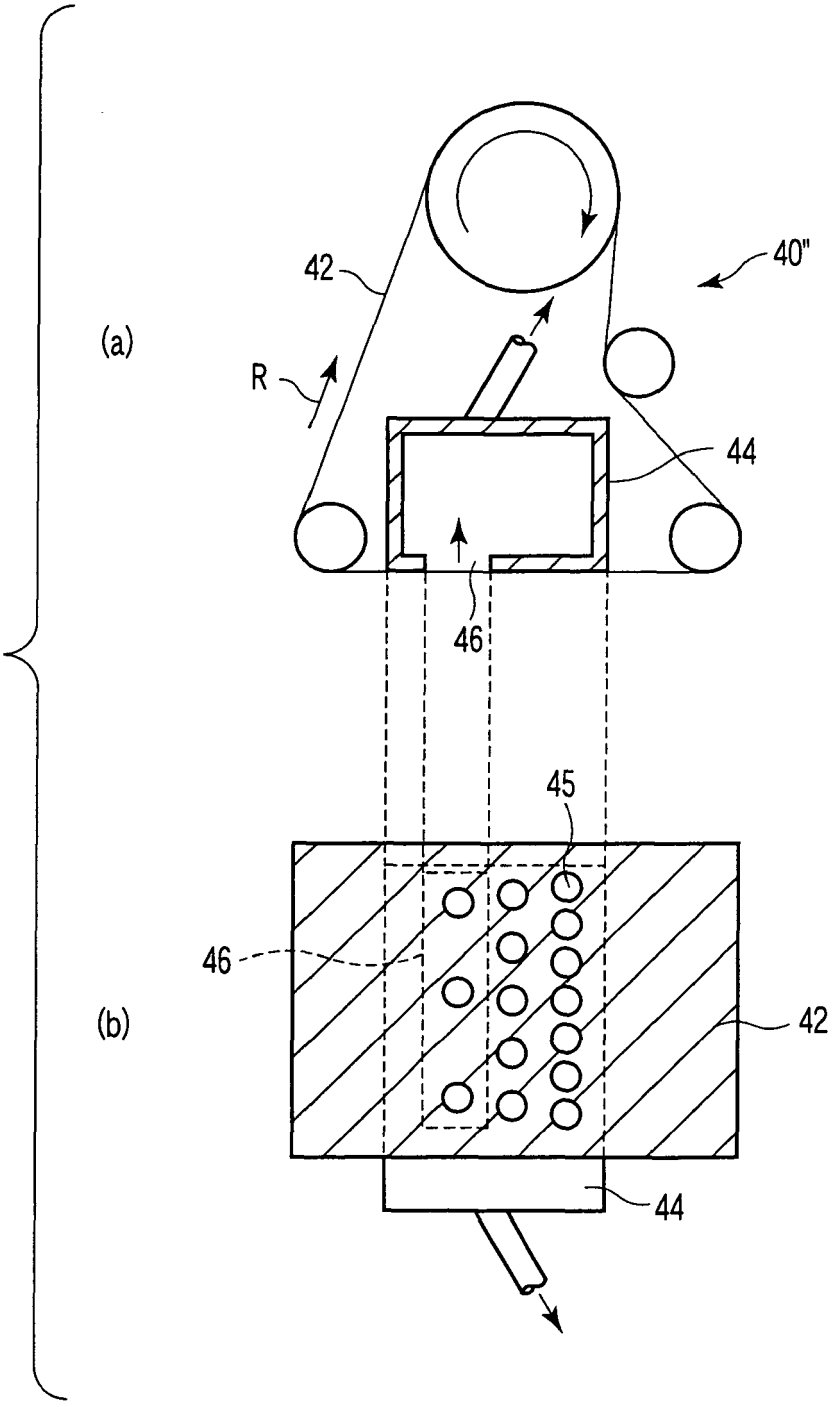

FIG. 17

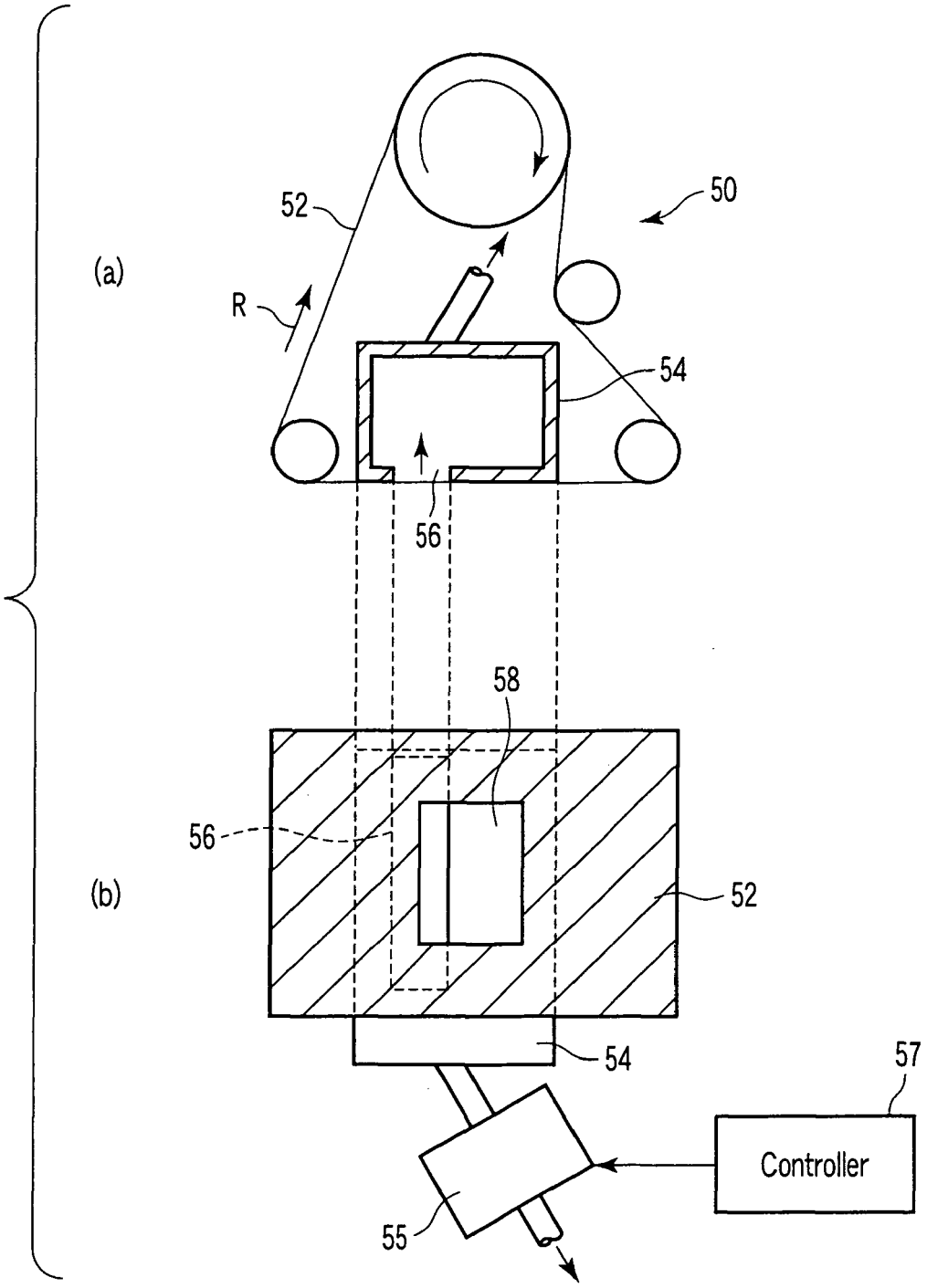

FIG. 18

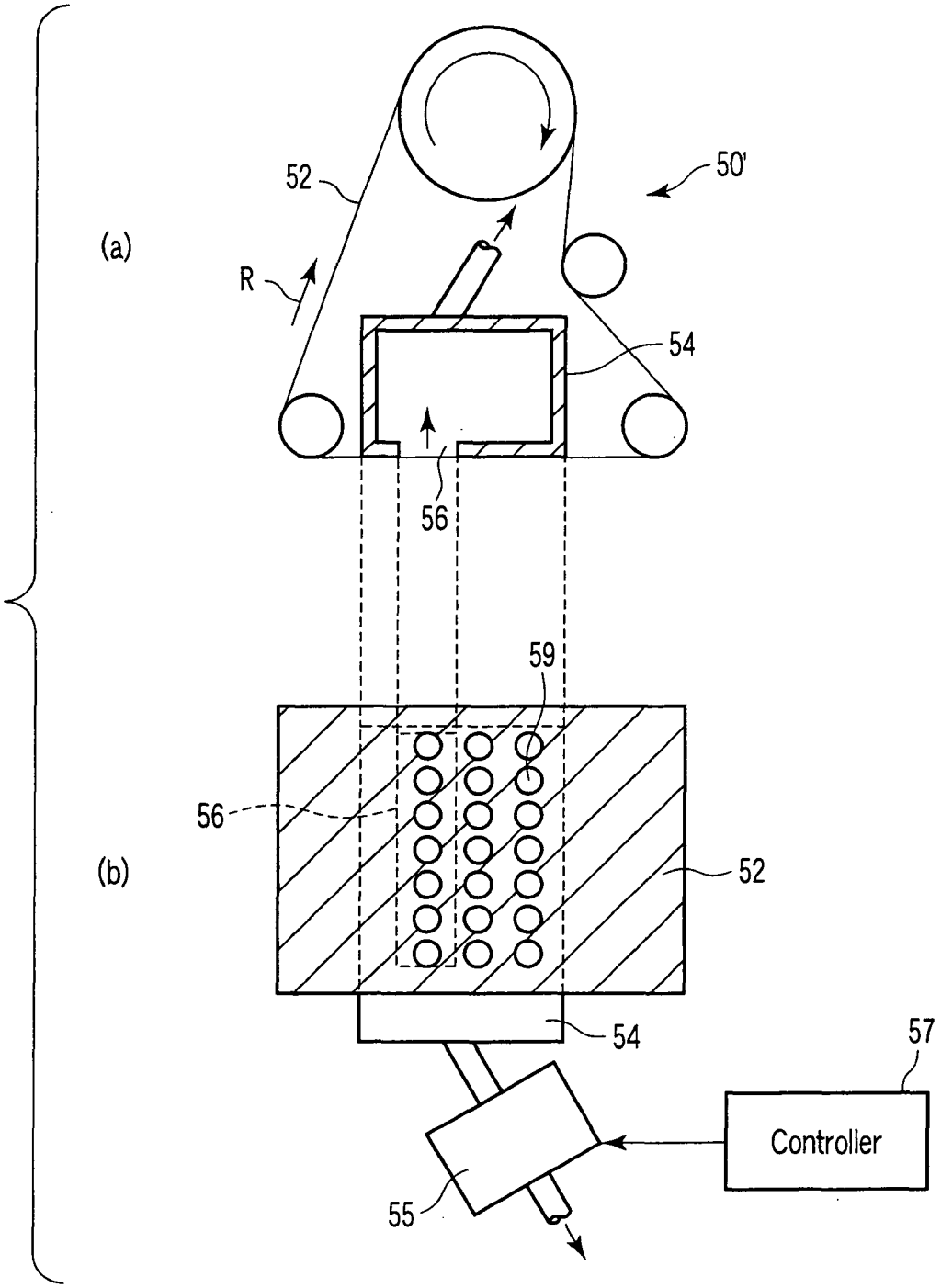

FIG. 19

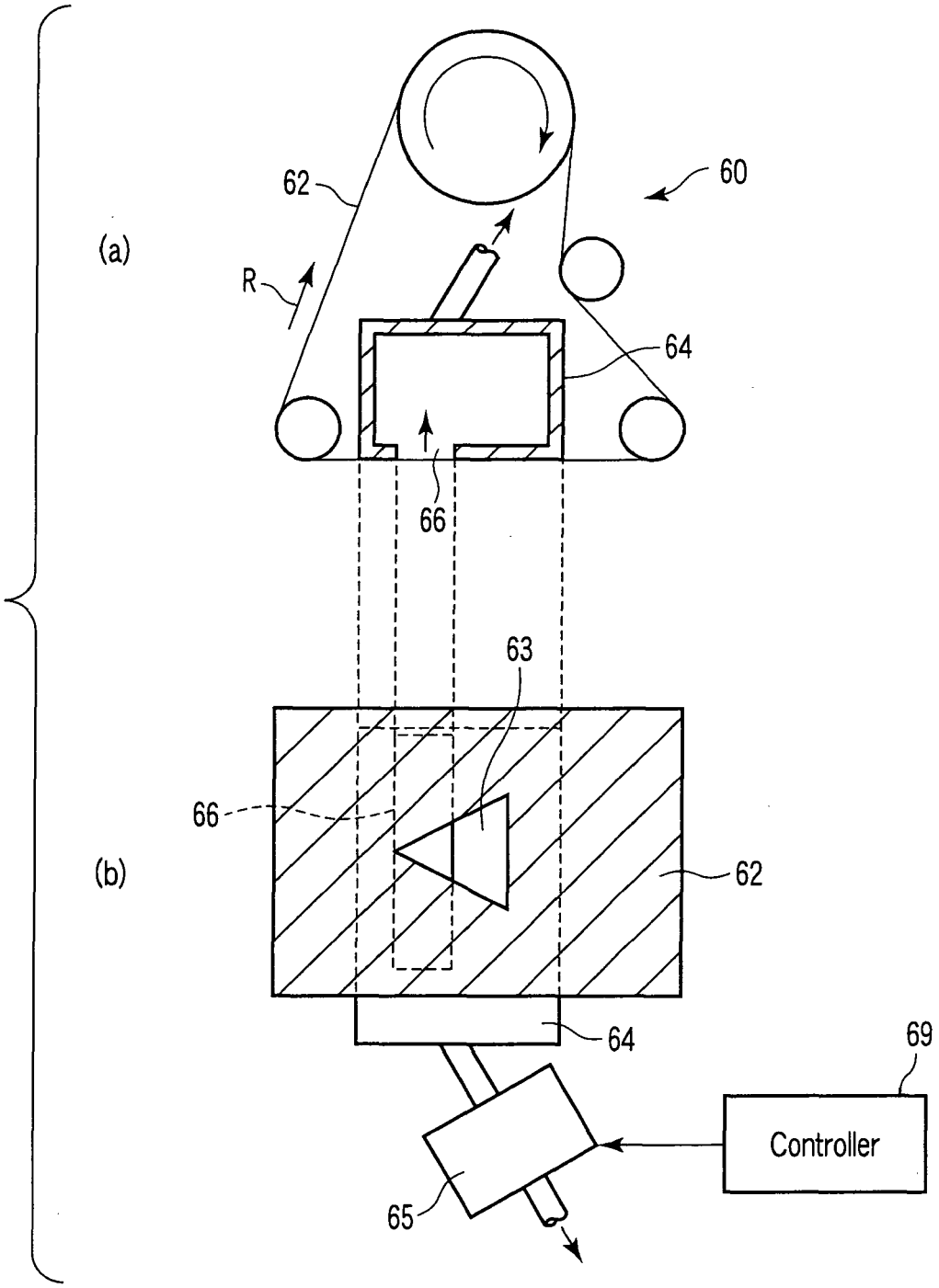

FIG. 20

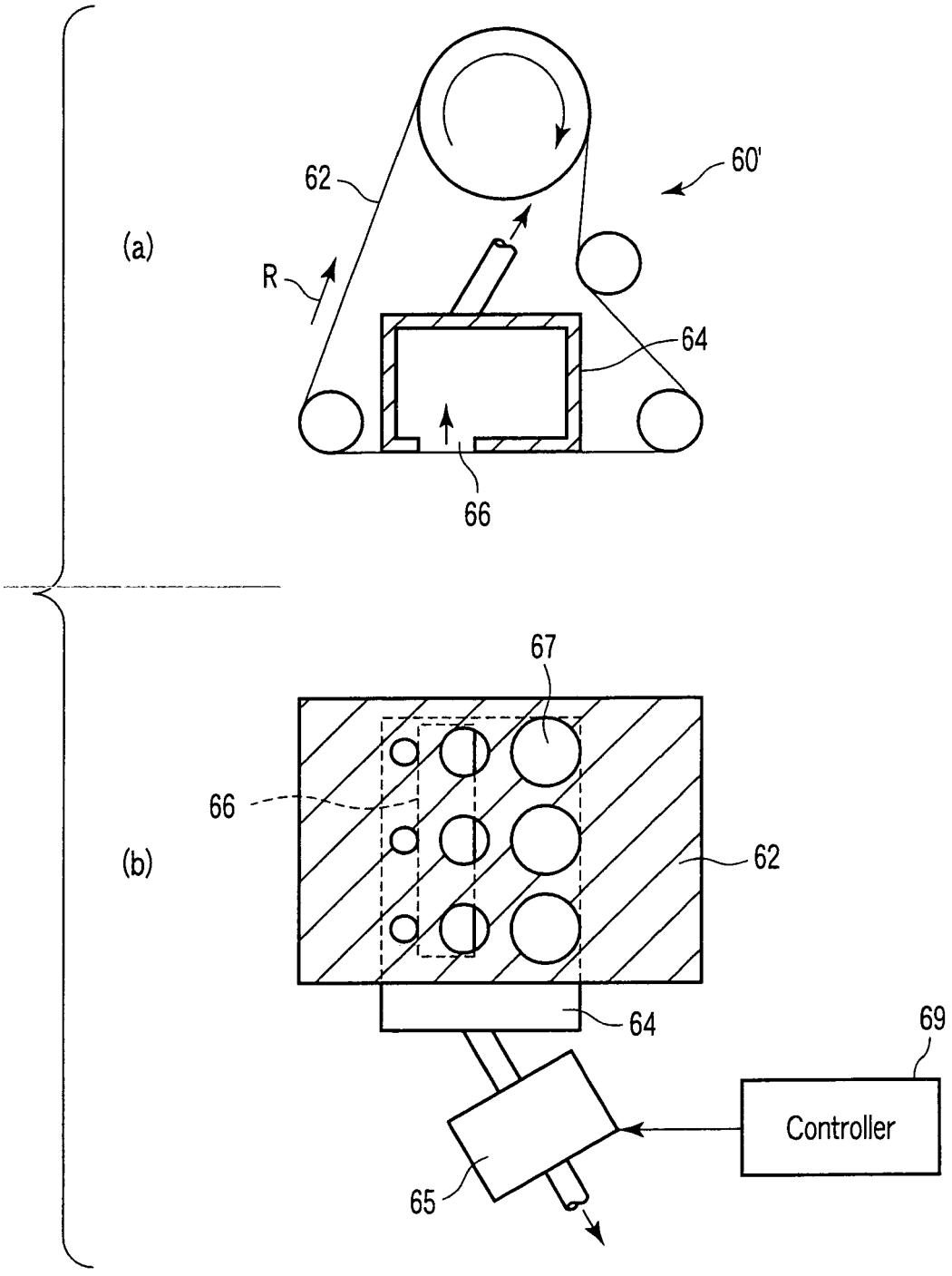

FIG. 21

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 3735565 B **[0002]**