



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
29.11.2023 Bulletin 2023/48

(51) International Patent Classification (IPC):
B65H 3/48 ^(2006.01) **B65H 3/08** ^(2006.01)

(21) Application number: **23174420.2**

(52) Cooperative Patent Classification (CPC):
B65H 3/48; B65H 3/0825; B65H 2406/1222;
B65H 2801/21

(22) Date of filing: **22.05.2023**

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

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(30) Priority: **25.05.2022 JP 2022085499**
01.05.2023 JP 2023075650

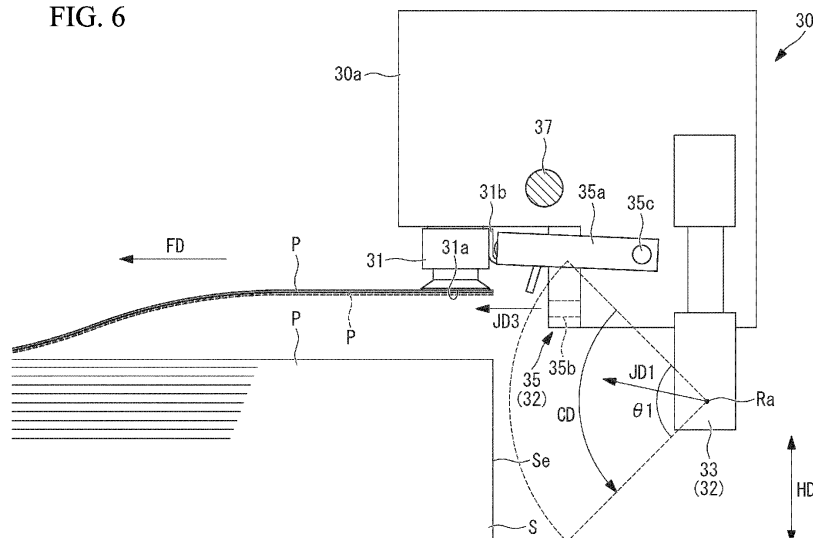
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(54) **SHEET FEEDING APPARATUS AND SHEET SEPARATING APPARATUS**

(57) Provided is a sheet folding apparatus including: a stacking unit configured to be stacked with a paper stack S; a feeding roller configured to come into contact with a surface of the uppermost sheet P of the paper stack 5 and feed sheets in a feeding direction; and a sheet separating mechanism 30 configured to separate the uppermost sheet P of the paper stack 5 from the remaining sheets P. The sheet separating mechanism 30 has a suction unit 31 configured to suck and pull the uppermost sheet P of the paper stack 5 upward in up-

stream in a feeding direction FD and an injection mechanism 32 configured to separate the uppermost sheet P from the remaining sheets P by injecting air toward a predetermined region including an end face Se in upstream in the feeding direction FD of the paper stack 5 including the uppermost sheet P of the paper stack S. The injection mechanism 32 has a rotary injection unit 33 configured to inject air so as to change a first injection direction JD1 oriented to the predetermined region.

FIG. 6



Description

BACKGROUND

1. TECHNICAL FIELD

[0001] The present invention relates to a sheet feeding apparatus and a sheet separating apparatus.

2. DESCRIPTION OF RELATED ART

[0002] Conventionally, an apparatus that injects air toward a sheet bundle stacked on a tray to separate sheets from each other and sucks and transports the uppermost sheet by a suction transport belt is known (see Japanese Patent No. 3521639, for example).

[0003] In Japanese Patent No. 3521639, a pair of air nozzles arranged on the side face side of the sheet bundle inject air to the sheet bundle to facilitate separation between sheets.

[0004] In Japanese Patent No. 3521639, however, it is required to provide a pair of air nozzles for facilitating separation between the sheets of the sheet bundle stacked on the tray. Further, in Japanese Patent No. 3521639, it is required to provide a position detection unit for detecting the position of the uppermost sheet of the sheet bundle and a mechanism for moving the air nozzle in accordance with the detected sheet position to match the position thereof to the position of the uppermost sheet. Thus, in Japanese Patent No. 3521639, a complex mechanism is required for facilitating separation between sheets, and this increases the manufacturing cost.

BRIEF SUMMARY

[0005] The present invention has been made in view of such circumstances and intends to provide a sheet feeding apparatus and a sheet separating apparatus that can prevent an increase in manufacturing cost and reliably separate and feed the uppermost sheet of a paper stack by using a simple mechanism.

[0006] A sheet feeding apparatus according to a first aspect of the present invention includes: a stacking unit configured to be stacked with a paper stack including a plurality of sheets; a feeding unit configured to come into contact with a surface of the uppermost sheet of the paper stack and feed the uppermost sheet in a feeding direction; and a sheet separating mechanism configured to separate the uppermost sheet of the paper stack from the remaining sheets, and the sheet separating mechanism comprises a suction unit configured to suck and pull the uppermost sheet of the paper stack upward in the upstream in the feeding direction, and an injection mechanism configured to inject air toward a predetermined region including an end face in the upstream in the feeding direction of the paper stack including the uppermost sheet of the paper stack to separate the uppermost sheet from the remaining sheets, and the injection mechanism

has a first injection unit configured to inject air so as to change a first injection direction oriented to the predetermined region.

[0007] According to the sheet feeding apparatus of the first aspect of the present invention, the uppermost sheet of the paper stack stacked on the stacking unit is pulled upward by the suction unit in the upstream in the feeding direction of the sheets. The injection mechanism of the sheet separating mechanism then injects air toward a predetermined region including the end face in the upstream in the feeding direction of the paper stack including the uppermost sheet of the paper stack, and thereby the uppermost sheet is separated from the remaining sheets. In such a way, according to the sheet feeding apparatus of the first aspect of the present invention, it is possible to prevent an increase in manufacturing cost and reliably separate and feed the uppermost sheet of a paper stack by using a simple mechanism.

[0008] In a sheet feeding apparatus according to a second aspect of the present invention, in the first aspect, the first injection unit has a nozzle portion that is formed in a cylindrical shape extending along an axis intersecting the height direction of the paper stack and having a closed tip and has an injection hole for injecting air toward the predetermined region formed in a side face of the nozzle portion, and a rotary portion configured to rotate the nozzle portion in a predetermined direction about the axis, and air injected from the injection hole is supplied to an internal space of the nozzle portion.

[0009] According to the sheet feeding apparatus of the second aspect of the present invention, it is possible to periodically change, in the height direction of the paper stack, the first injection direction of air directed to a predetermined region of the end face in the upstream in the feeding direction of the paper stack by using a relatively simple structure in which the rotary portion rotates the nozzle portion in a predetermined direction about the axis intersecting the height direction of the paper stack. Further, according to the sheet feeding apparatus of the second aspect of the present invention, it is possible to facilitate separation between the uppermost sheet and another sheet by blowing air therebetween even when the uppermost sheet is pulled up by the suction unit with another sheet being in contact with the uppermost sheet.

[0010] In a sheet feeding apparatus according to a third aspect of the present invention, in the second aspect, the nozzle portion injects air from the injection hole within an injection region of an angle less than or equal to 180 degrees on the end face side of the paper stack in a circumferential direction about the axis.

[0011] According to the sheet feeding apparatus of the third aspect of the present invention, since air is injected from the injection hole within an injection region of an angle less than or equal to 180 degrees on the end face side of the paper stack, it is possible to suitably prevent air from being injected in a region on the end face side of the paper stack to which no air is injected.

[0012] In a sheet feeding apparatus according to a

fourth aspect of the present invention, in the third aspect, the first injection unit has a body that holds the nozzle portion, the body has an accommodation hole and a supply path, the accommodation hole accommodates the nozzle portion such that a part of the side face in which the injection hole is formed protrudes, and the supply path communicates with the accommodation hole and is externally supplied with air, and in the nozzle portion, an opening communicating between the supply path and the internal space within a region of an angle less than or equal to 180 degrees in the circumferential direction is formed at a position facing the supply path of the side face.

[0013] According to the sheet feeding apparatus of the fourth aspect of the present invention, air is supplied to the internal space of the nozzle portion from the supply path when the opening passes by a position facing the supply path, and the air is injected from the injection hole by supplying air from a supply unit to the supply path. Since the opening is formed in a region of an angle less than or equal to 180 degrees in the circumferential direction on the side face of the nozzle portion at a position facing the supply path, a period in which air is supplied from the supply path to the internal space and a period in which no air is supplied from the supply path to the internal space are periodically repeated in accordance with the rotation of the nozzle portion. Accordingly, it is possible to periodically change the first injection direction of the air directed to the predetermined region.

[0014] In a sheet feeding apparatus according to a fifth aspect of the present invention, in any one of the first aspect to the fourth aspect, the rotary portion generates driving force for rotation about the axis by externally supplied air.

[0015] According to the sheet feeding apparatus of the fifth aspect of the present invention, it is possible to obtain driving force for driving the rotary portion by using the air supplied from the supply unit without using a dedicated device for generating driving force for driving the rotary portion.

[0016] In a sheet feeding apparatus according to a sixth aspect of the present invention, in any one of the first aspect to the fifth aspect, the sheet separating mechanism has a second injection unit configured to fix a second injection direction oriented to the predetermined region and inject air.

[0017] According to the sheet feeding apparatus of the sixth aspect of the present invention, since the sheet feeding apparatus has the second injection unit configured to fix a second injection direction oriented to the predetermined region and injects air, it is possible to facilitate separation between the uppermost sheet and another sheet by the first injection unit and ensure a sufficient volume of air to be blown to the downstream in the feeding direction of the sheets along the second injection direction by the second injection unit and reliably blow the air to a gap formed between the sheets.

[0018] A sheet separating apparatus according to a

seventh aspect of the present invention injects air toward a predetermined region of an end face of a paper stack including a plurality of sheets to separate the sheets from each other and includes a nozzle portion that is formed in a cylindrical shape extending along an axis intersecting the height direction of the paper stack and having a closed tip and has an injection hole for injecting air toward the predetermined region formed in a side face of the nozzle portion; and a rotary portion configured to rotate the nozzle portion in a predetermined direction about the axis, and air injected from the injection hole is supplied to an internal space of the nozzle portion.

[0019] According to the sheet separating apparatus of the seventh aspect of the present invention, it is possible to periodically change, in the height direction of the paper stack, the first injection direction of air directed to a predetermined region of the end face in the upstream in the feeding direction of the paper stack by using a relatively simple structure in which the rotary portion rotates the nozzle portion in a predetermined direction about the axis intersecting the height direction of the paper stack. Further, according to the sheet separating apparatus of the seventh aspect of the present invention, it is possible to facilitate separation between the uppermost sheet and another sheet by blowing air therebetween even when the uppermost sheet is pulled up by the suction unit with another sheet being in contact with the uppermost sheet.

[0020] In a sheet separating apparatus according to an eighth aspect of the present invention, in the seventh aspect, the nozzle portion injects the air from the injection hole within an injection region of an angle less than or equal to 180 degrees on the end face side of the paper stack in a circumferential direction about the axis.

[0021] According to the sheet separating apparatus of the eighth aspect of the present invention, since air is injected from the injection hole within an injection region of an angle less than or equal to 180 degrees on the end face side of the paper stack, it is possible to suitably prevent air from being injected in a region on the end face side of the paper stack to which no air is injected.

[0022] A sheet separating apparatus according to a ninth aspect of the present invention, in the eighth aspect, has a body that holds the nozzle portion, the body has an accommodation hole and a supply path, the accommodation hole accommodates the nozzle portion such that a part of the side face in which the injection hole is formed protrudes, and the supply path communicates with the accommodation hole and is externally supplied with air, and in the nozzle portion, an opening communicating between the supply path and the internal space within a region of an angle less than or equal to 180 degrees in the circumferential direction is formed at a position facing the supply path of the side face.

[0023] According to the sheet separating apparatus of the ninth aspect of the present invention, air is supplied to the internal space of the nozzle portion from the supply path when the opening passes by a position facing the supply path, and the air is injected from the injection hole

by supplying air from a supply unit to the supply path. Since the opening is formed in a region of an angle less than or equal to 180 degrees in the circumferential direction on the side face of the nozzle portion at a position facing the supply path, a period in which air is supplied from the supply path to the internal space and a period in which no air is supplied from the supply path to the internal space are periodically repeated in accordance with the rotation of the nozzle portion. This makes it possible to periodically change the first injection direction of the air directed to the predetermined region.

[0024] A sheet separating apparatus according to a tenth aspect of the present invention, in any one of the seventh aspect to the ninth aspect, the rotary portion generates driving force for rotation about the axis by externally supplied air.

[0025] According to the sheet separating apparatus of the tenth aspect of the present invention, it is possible to obtain driving force for driving the rotary portion by using the air supplied from the supply unit without using a dedicated device for generating driving force for driving the rotary portion.

[0026] According to the present invention, it is possible to provide a sheet feeding apparatus and a sheet separating apparatus that can prevent an increase in manufacturing cost and reliably separate and feed the uppermost sheet of a paper stack by using a simple mechanism.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0027]

Fig. 1 is a front view illustrating a sheet folding apparatus according to a first embodiment of the present invention.

Fig. 2 is a perspective view illustrating a feeding roller and a sheet separating mechanism illustrated in Fig. 1.

Fig. 3 is a diagram of the sheet separating mechanism illustrated in Fig. 1 when viewed from the feeding roller side, which illustrates a state before a suction unit pulls a sheet upwards.

Fig. 4 is a diagram of the sheet separating mechanism illustrated in Fig. 1 when viewed from the feeding roller side, which illustrates a state after the suction unit has pulled the sheet upwards.

Fig. 5 is a sectional view of the sheet separating mechanism illustrated in Fig. 3 when viewed from the arrow direction of the line A-A.

Fig. 6 is a sectional view of the sheet separating mechanism illustrated in Fig. 4 when viewed from the arrow direction of the line B-B.

Fig. 7 is a sectional view of the sheet separating mechanism illustrated in Fig. 4 when viewed from the arrow direction of the line C-C.

Fig. 8 is a perspective view of a rotary injection unit

illustrated in Fig. 3.

Fig. 9 is a partial sectional view of the rotary injection unit illustrated in Fig. 8.

Fig. 10 is a diagram of the rotary injection unit illustrated in Fig. 8 when viewed along an axis of a nozzle portion.

Fig. 11 is a sectional view of the rotary injection unit illustrated in Fig. 9 when viewed from the arrow direction of the line D-D.

Fig. 12 is a perspective view illustrating a feeding roller and a sheet separating mechanism of a sheet folding apparatus according to a second embodiment of the present invention.

Fig. 13 is a diagram of the sheet separating mechanism illustrated in Fig. 12 when viewed from the feeding roller side, which illustrates a state before a suction unit pulls a sheet upwards.

Fig. 14 is a perspective view of a rotary injection unit of a third embodiment of the present invention.

Fig. 15 is a partial sectional view of the rotary injection unit of the third embodiment of the present invention.

DETAILED DESCRIPTION

First Embodiment

[0028] A sheet folding apparatus (sheet feeding apparatus) 100 according to a first embodiment of the present invention will be described with reference to the drawings. Fig. 1 is a front view illustrating the sheet folding apparatus 100 according to one embodiment of the present invention. As illustrated in Fig. 1, the sheet folding apparatus 100 of the present embodiment includes a stacking unit 10, a feeding roller (sheet feeding portion) 20, a sheet separating mechanism (sheet separating apparatus) 30, a conveyor belt 40, a sheet folding unit 50, and a control unit 60.

[0029] While the sheet folding apparatus 100 including the conveyor belt 40 and the sheet folding unit 50 is described in the present embodiment, other sheet feeding apparatuses not having the conveyor belt 40 and the sheet folding unit 50 may be employed. In such a case, the sheet feeding apparatus includes the stacking unit 10, the feeding roller 20, and the sheet separating mechanism 30.

[0030] The stacking unit 10 is a device that is stacked with a paper stack S including a plurality of sheets P. The paper stack S is formed of the plurality of sheets P stacked on a shelf 11 in a height direction HD. The shelf 11 is moved along the height direction HD by a lift mechanism 12 so that the uppermost sheet P of the paper stack S comes close to the feeding roller 20.

[0031] The feeding roller 20 is a device that comes into contact with the surface of the uppermost sheet P of the paper stack S and feeds the sheet P in the feeding direction FD. The feeding roller 20 is rotated in the rotation direction RD about an axis Xf extending in the horizontal

direction, moves the uppermost sheet P of the paper stack S along the feeding direction FD by frictional force, and thereby feeds the sheet P to the conveyor belt 40. Note that a feeding belt that feeds the sheet P by using an endless belt may be employed instead of the feeding roller 20.

[0032] The sheet separating mechanism 30 is an apparatus that separates the uppermost sheet P of the paper stack S from the remaining sheets P. Details of the sheet separating mechanism 30 will be described later.

[0033] The conveyor belt 40 is a device that feeds the sheet P fed from the feeding roller 20 to the sheet folding unit 50. The conveyor belt 40 has a transport belt 41 and a pair of rollers 42 between which the transport belt 41 is stretched. The conveyor belt 40 drives the transport belt 41 through the pair of rollers 42 and transports the sheet P fed to the transport belt 41 to the sheet folding unit 50 along the feeding direction FD. Arrows illustrated on the pair of rollers 42 illustrate the rotation direction of the pair of the roller 42.

[0034] The sheet folding unit 50 is a device that folds, into two, the sheet P fed from the conveyor belt 40. The sheet folding unit 50 has a buckle 51 formed of a pair of rails 51a, 51b, a stopper 52, a pair of intake rollers 53, 54 and a folding roller 55. Arrows illustrated on the pair of intake rollers 53, 54, and the folding roller 55 illustrate rotation directions of respective rollers. The sheet folding unit 50 feeds, by the pair of intake rollers 53, 54, the sheet P fed from the conveyor belt 40 and introduces the sheet P from a slot 51c of the buckle 51 to a clearance 51d between the pair of rails 51a, 51b.

[0035] As illustrated in Fig. 1, when the pair of intake rollers 53, 54 introduces the sheet P to the clearance 51d and feeds the sheet P toward the stopper 52, the leading edge of the sheet P then comes into contact with the stopper 52. When the pair of intake rollers 53, 54 further press the sheet P in the feeding direction FD after the leading edge of the sheet P has come into contact with the stopper 52, the sheet P is folded downstream in the feeding direction FD. The folded sheet P is fed downward by the intake roller 53 and the folding roller 55 with a folded portion Pf being the leading edge.

[0036] The control unit 60 is a device that controls respective units of the sheet folding apparatus 100. The control unit 60 controls respective units of the sheet folding apparatus 100 by reading a control program stored in a storage unit (not illustrated) and executing the control program.

[0037] Next, details of the sheet separating mechanism 30 will be described with reference to the drawings. Fig. 2 is a perspective view illustrating the feeding roller 20 and the sheet separating mechanism 30 illustrated in Fig. 1. Fig. 3 is a diagram of the sheet separating mechanism 30 illustrated in Fig. 1 when viewed from the feeding roller 20 side, which illustrates a state before a suction unit 31 pulls the sheet P upwards. Fig. 4 is a diagram of the sheet separating mechanism 30 illustrated in Fig. 1 when viewed from the feeding roller 20 side, which illus-

trates a state after the suction unit 31 has pulled the sheet P upwards. In Fig. 3 and Fig. 4, illustration of the sheet P is omitted. As illustrated in Fig. 2 to Fig. 4, the sheet separating mechanism 30 has the suction unit 31 and an injection mechanism 32.

[0038] The suction unit 31 is a device that sucks and pulls upward the uppermost sheet P of the paper stack S in the upstream in the feeding direction FD of the paper stack S stacked on the stacking unit 10. The suction unit 31 is connected to a sucking mechanism (not illustrated) and sucks ambient air from a suction face 31a to reduce the pressure of the upper face region of the sheet P in contact with the suction face 31a into a negative pressure state having a lower pressure than the atmospheric pressure.

[0039] The suction unit 31 can be moved along the height direction HD with respect to a body 30a of the sheet separating mechanism 30. Once the upper region of the sheet P is in the negative pressure state and the difference between the negative pressure and the atmospheric pressure exceeds the weight of the suction unit 31, the suction unit 31 sucking the uppermost sheet P is pulled upward from the paper stack S. The suction unit 31 sucks and pulls the uppermost sheet P of the paper stack S upward in such a way and switches the state illustrated in Fig. 3 to the state illustrated in Fig. 4.

[0040] Fig. 5 is a sectional view of the sheet separating mechanism 30 illustrated in Fig. 3 when viewed from the arrow direction of the line A-A. Fig. 6 is a sectional view of the sheet separating mechanism 30 illustrated in Fig. 4 when viewed from the arrow direction of the line B-B. As illustrated in Fig. 5, the suction face 31a of the suction unit 31 is in contact with the uppermost sheet P of the paper stack S in a state before the suction unit 31 pulls the sheet P upward. As illustrated in Fig. 5, in this state, the uppermost sheet P has not yet been pulled up from the paper stack S and is stacked without any gap between the uppermost sheet P and the remaining sheets P.

[0041] As illustrated in Fig. 6, the suction face 31a of the suction unit 31 is in contact with the uppermost sheet P of the paper stack S in a state after the suction unit 31 has pulled the sheet P upward. As illustrated in Fig. 6, in this state, the uppermost sheet P has been pulled up from the paper stack S, and a gap has been provided between the uppermost sheet P and the remaining sheets P stacked on the paper stack S.

[0042] The injection mechanism 32 is a mechanism that injects air toward a predetermined region including an end face Se in the upstream in the feeding direction FD of the paper stack S including the uppermost sheet P of the paper stack S and separates the uppermost sheet P from the remaining sheets P. The injection mechanism 32 separates another sheet P attached to the uppermost sheet P, which is sucked by the suction unit 31, from the uppermost sheet P.

[0043] The suction unit 31 illustrated in Fig. 6 separates the uppermost sheet P from the remaining sheets P stacked on the paper stack S by sucking and pulling up

the uppermost sheet P in the height direction HD. In Fig. 6, however, the sheets P under the uppermost sheet P are not separated from and is attached to the uppermost sheet P. The injection mechanism 32 of the present embodiment guides air to the interface between the uppermost sheet P and another sheet P attached to the underside thereof and thereby separates the uppermost sheet P and another sheet P attached to the underside thereof from each other.

[0044] As illustrated in Fig. 1 to Fig. 4, the injection mechanism 32 has a pair of rotary injection units (first injection units) 33, a pair of fixed injection units (second injection units) 34, a switch injection unit 35, a pair of pressing portions 36, a connection portion 37, and a supply unit 38.

[0045] The rotary injection units 33 are devices that inject air so as to periodically change a first injection direction JD1 oriented to a predetermined region including the end face Se in the upstream in the feeding direction FD of the paper stack S. The pair of rotary injection units 33 are fixed to the body 30a of the sheet separating mechanism 30. As illustrated in Fig. 6, the rotary injection unit 33 injects air in the first injection direction JD1 in a state where the suction unit 31 has pulled the sheet P upward.

[0046] The first injection direction JD1 in which the rotary injection units 33 inject air is changed along the circumferential direction CD illustrated in Fig. 6 and about an axis Ra extending in the horizontal direction. Further, the rotary injection units 33 change the first injection direction JD1 in a region of an angle $\theta 1$ illustrated in Fig. 6. Note that, while Fig. 6 illustrates an example in which the first injection direction JD1 is changed counterclockwise, the first injection direction JD1 may be changed clockwise. The detailed structure of the rotary injection unit 33 will be described later.

[0047] The fixed injection unit 34 is a device that injects air with a second injection direction JD2 being fixed where the second injection direction is a direction oriented to a predetermined region including the end face Se in the upstream in the feeding direction FD of the paper stack S. Fig. 7 is a sectional view of the sheet separating mechanism 30 illustrated in Fig. 4 when viewed from the arrow direction of the line C-C. The fixed injection unit 34 has a nozzle portion 34a that injects the air supplied from the supply unit 38 along the second injection direction JD2 that is the horizontal direction.

[0048] The switch injection unit 35 is a device that injects air along a third injection direction JD3 that is the horizontal direction to a space below the uppermost sheet P pulled up by the suction unit 31 in a state where the suction unit 31 has pulled the sheet P upward. As illustrated in Fig. 5, the switch injection unit 35 has a lid portion 35a that can swing about a swing axis 35c and an injection hole 35b that injects the air supplied from the supply unit 38.

[0049] As illustrated in Fig. 5, in a state before the suction unit 31 pulls the sheet P upward, the switch injection unit 35 seals the injection hole 35b with the lid portion

35a so that no air is injected from the injection hole 35b. On the other hand, as illustrated in Fig. 6, in a state after the suction unit 31 has pulled the sheet P upward, the switch injection unit 35 is switched so that the lid portion 35a swings clockwise about the swing axis 35c and air is injected from the injection hole 35b. The lid portion 35a comes into contact with a protrusion portion 31b fixed to the suction unit 31 and thereby swings clockwise about the swing axis 35c.

[0050] As illustrated in Fig. 2, the pressing portion 36 is a device that presses an end portion in the width direction WD of the uppermost sheet P stacked on the paper stack S so that the end portion is not separated from the paper stack S. The pressing portion 36 can hold the position of the sheet P by pressing the end portion in the width direction WD of the uppermost sheet P onto the paper stack S even in a state where the uppermost sheet P has been pulled upward by the suction unit 31 and blow air into a region below the uppermost sheet P to facilitate separation from the remaining sheets P.

[0051] The connection portion 37 is a device that is formed in a rod shape so as to extend in the horizontal direction and fixes the pair of fixed injection units 34 and the pair of pressing portions 36 with respect to the body 30a of the sheet separating mechanism 30. The connection portion 37 is fixed to the body 30a of the sheet separating mechanism 30. The positions in the width direction WD of the pair of fixed injection units 34 and the pair of pressing portions 36 relative to the connection portion 37 can be adjusted to any positions.

[0052] The supply unit 38 is a device that supplies the air to be injected by the sheet separating mechanism 30. The supply unit 38 supplies the rotary injection unit 33 with the air injected by the rotary injection unit 33 in the first injection direction JD1. Further, the supply unit 38 supplies the fixed injection unit 34 with the air injected by the fixed injection unit 34 in the second injection direction JD2. Further, the supply unit 38 supplies the switch injection unit 35 with the air injected by the switch injection unit 35 in the third injection direction JD3 from the injection hole 35b.

[0053] As illustrated in Fig. 6, the air is injected from the switch injection unit 35 directed between the uppermost sheet P sucked by the suction unit 31 and another sheet P underside thereof in the third injection direction JD3 that is the horizontal direction. Further, by periodically changing the first injection direction JD1 of the air injected from the rotary injection unit 33, the air is guided to the gap between the uppermost sheet P and another sheet P underside thereof. The remaining sheets P are separated from the uppermost sheet P by the air injected in the first injection direction JD1 by the rotary injection unit 33, the air injected in the second injection direction JD2 by the fixed injection unit 34, and the air injected in the third injection direction JD3 from the injection hole 35b by the switch injection unit 35 described above.

[0054] Note that changing the first injection direction JD1 in which the rotary injection unit 33 injects air is par-

ticularly advantageous in separating, from the uppermost sheet P, another sheet P attached to the underside thereof. When adhesion between the uppermost sheet P sucked by the suction unit 31 and another sheet P attached to the underside thereof (sheet P illustrated in a dotted line in Fig. 6) is large, it may not be possible to separate, from the uppermost sheet P, another sheet P attached to the underside thereof by the air injected in the second injection direction JD2 by the fixed injection unit 34 or the air injected in the third injection direction JD3 from the injection hole 35b by the switch injection unit 35. In such a case, it is possible to facilitate separation between the uppermost sheet P and another sheet P attached to the underside thereof by changing the first injection direction JD1 in which the rotary injection unit 33 injects air.

[0055] Next, the detailed structure of the rotary injection unit 33 will be described with reference to Fig. 8 to Fig. 11. Fig. 8 is a perspective view of the rotary injection unit 33 illustrated in Fig. 3. Fig. 9 is a partial sectional view of the rotary injection unit 33 illustrated in Fig. 8. Fig. 10 is a diagram of the rotary injection unit 33 illustrated in Fig. 8 when viewed along an axis Ra of the nozzle portion 33a. Fig. 11 is a sectional view of the rotary injection unit 33 illustrated in Fig. 9 when viewed from the arrow direction of the line D-D.

[0056] As illustrated in Fig. 8 and Fig. 9, the rotary injection unit 33 has the nozzle portion 33a, a rotary portion 33b, a bearing portion 33c, and a body 33d.

[0057] As illustrated in Fig. 8, the nozzle portion 33a is a member formed in a cylindrical shape extending along the axis Ra orthogonal to (intersecting) the height direction HD of the paper stack S and having a closed tip. A plurality of injection holes 33a1 that inject air toward a predetermined region including the end face Se in the upstream in the feeding direction FD of the paper stack S are formed in the side face of the nozzle portion 33a. The plurality of injection holes 33a1 are arranged apart from each other at the same position in the circumferential direction CD about the axis Ra at intervals so as to be aligned along the axis Ra.

[0058] As illustrated in Fig. 9 and Fig. 11, in the nozzle portion 33a, an opening 33a2 communicating between an air supply path 33d2 formed in the body 33d and an internal space IS of the nozzle portion 33a is formed in the region of an angle θ_2 in the circumferential direction CD at a position facing the air supply path 33d2. The angle θ_2 is preferably less than or equal to 180 degrees.

[0059] Air injected from the injection hole 33a1 is supplied to the internal space IS of the nozzle portion 33a when the opening 33a2 passes by the air supply path 33d2. The opening 33a2 is provided only in a range of the angle θ_2 in the circumferential direction CD about the axis Ra. Thus, as illustrated in Fig. 10, the nozzle portion 33a injects air from the injection hole 33a1 within an injection region JA of an angle less than or equal to 180 degrees on the end face Se side of the paper stack S in the circumferential direction CD about the axis Ra. The

angle θ_1 in the circumferential direction CD of the injection region JA matches the angle θ_2 in which the opening 33a2 is formed.

[0060] The nozzle portion 33a is rotated continuously in one direction about the axis Ra, injects air from the injection holes 33a1 when the opening 33a2 passes by the air supply path 33d2 in one turn, and does not inject air from the injection holes 33a1 when the opening 33a2 does not pass by the air supply path 33d2 in one turn. In such a way, the nozzle portion 33a injects air so as to periodically change the first injection direction JD1 oriented to a predetermined region including the end face Se in the upstream in the feeding direction FD of the paper stack S.

[0061] The rotary portion 33b is a device that is connected to the base end portion of the nozzle portion 33a and rotates the nozzle portion 33a in the circumferential direction CD about the axis Ra. A recesses 33b1 are formed in multiple portions in the circumferential direction CD of the rotary portion 33b. Air from the supply unit 38 is supplied to the recesses 33b1 via the air supply path 33d1 formed in the body 33d. The rotary portion 33b generates driving force for rotation about the axis Ra by air supplied from the supply unit 38.

[0062] The bearing portion 33c is a member that is fixed to the body 33d and supports the side face of the nozzle portion 33a rotatably about the axis Ra. A communication hole 33c1 communicating between the air supply path 33d2 and the opening 33a2 is formed in the bearing portion 33c. As illustrated in Fig. 9 and Fig. 11, the communication hole 33c1 is provided at only the position that matches the air supply path 33d2 in the circumferential direction CD about the axis Ra. Thus, the air supply path 33d2 and the opening 33a2 temporarily communicate with each other only when the opening 33a2 passes by the position of the communication hole 33c1.

[0063] As illustrated in Fig. 9, the body 33d is a member that internally holds the nozzle portion 33a, the rotary portion 33b, and the bearing portion 33c. The body 33d has the air supply path 33d1, the air supply path 33d2, and an accommodation hole 33d3. In Fig. 9, arrows illustrated on the air supply path 33d1 and the air supply path 33d2 illustrate the flow direction of air guided from the supply unit 38.

[0064] The air supply path 33d1 is a flow channel through which air supplied from the supply unit 38 is supplied to the rotary portion 33b. The air supply path 33d2 is a flow channel communicating with the accommodation hole 33d3 and supplied with air from the supply unit 38. The air supply path 33d2 guides air supplied from the supply unit 38 to the internal space IS of the nozzle portion 33a. The accommodation hole 33d3 is a hole that accommodates the nozzle portion 33a and the bearing portion 33c such that a part of the side face in which the injection hole 33a1 is formed protrudes.

[0065] Advantages and effects achieved by the sheet folding apparatus 100 of the present embodiment described above will be described.

[0066] According to the sheet folding apparatus of the present embodiment, the uppermost sheet P of the paper stack S stacked on the stacking unit 10 is pulled upward by the suction unit 31 in the upstream in the feeding direction FD of the sheets P. The injection mechanism 32 of the sheet separating mechanism 30 then injects air toward a predetermined region including the end face Se in the upstream in the feeding direction FD of the paper stack S including the uppermost sheet P of the paper stack S, and thereby the uppermost sheet P is separated from the remaining sheets P.

[0067] Further, according to the sheet folding apparatus 100 of the present embodiment, since the rotary injection unit 33 periodically changes the first injection direction JD1 oriented to a predetermined region, it is possible to facilitate separation between the uppermost sheet P and another sheet P by blowing air to the interface between the uppermost sheet P and another sheet P even when the uppermost sheet P is pulled by the suction unit 31 with another sheet P being attached thereto. Since this causes only the uppermost sheet P to be suitably separated from the paper stack S in the upstream in the feeding direction FD of the sheets P, the area in contact with the uppermost sheet P and another sheet P underside thereof is reduced, and this prevents the uppermost sheet P and another sheet P underside thereof from being fed together when the uppermost sheet P is fed by the feeding roller 20. As described above, according to the sheet folding apparatus 100 of the present embodiment, it is possible to prevent an increase in manufacturing cost and reliably separate and feed the uppermost sheet P of the paper stack S by using a simple mechanism.

[0068] Further, according to the sheet folding apparatus 100 of the present embodiment, it is possible to periodically change, in the height direction HD of the paper stack S, the first injection direction JD1 of air directed to a predetermined region of the end face Se in the upstream in the feeding direction FD of the paper stack S by using a relatively simple structure in which the nozzle portion 33a is rotated in a constant direction about the axis Ra orthogonal to (intersecting) the height direction HD of the paper stack S by the rotary portion 33b. Further, according to the sheet folding apparatus 100 of the present embodiment, it is possible to facilitate separation between the uppermost sheet P and another sheet P by blowing air to the interface between the uppermost sheet P and another sheet P even when the uppermost sheet P is pulled by the suction unit 31 with another sheet P being attached to the uppermost sheet P.

[0069] Further, according to the sheet folding apparatus 100 of the present embodiment, since air is injected from the injection hole 33a1 within an injection region JA of an angle less than or equal to 180 degrees on the end face Se side of the paper stack S, it is possible to suitably prevent air from being injected in a region on the end face Se side of the paper stack S to which no air is injected.

[0070] Further, according to the sheet folding apparatus 100 of the present embodiment, air is supplied to the internal space IS of the nozzle portion 33a from the air supply path 33d2 when the opening 33a2 passes by a position facing the air supply path 33d2, and the air is injected from the injection hole 33a1 by supplying air from the supply unit 38 to the air supply path 33d2. Since the opening 33a2 is formed in a region of an angle less than or equal to 180 degrees in the circumferential direction CD on the side face of the nozzle portion 33a at a position facing the air supply path 33d2, a period in which air is supplied from the air supply path 33d2 to the internal space IS and a period in which no air is supplied from the air supply path 33d2 to the internal space IS are periodically repeated in accordance with the rotation of the nozzle portion 33a. This makes it possible to periodically change the first injection direction JD1 of the air directed to the predetermined region.

[0071] Further, according to the sheet folding apparatus 100 of the present embodiment, it is possible to obtain driving force for driving the rotary portion 33b by using the air supplied from the supply unit 38 through the air supply path 33d1 without using a dedicated device for generating driving force for driving the rotary portion 33b.

[0072] Further, according to the sheet folding apparatus 100 of the present embodiment, the sheet folding apparatus 100 has the fixed injection unit 34 configured to fix the second injection direction JD2 oriented to the predetermined region and inject air. Thus, while facilitating separation between the uppermost sheet P and another sheet P by the rotary injection unit 33, it is possible to ensure a sufficient volume of air to be blown to the downstream in the feeding direction FD of the sheets P along the second injection direction JD2 by the fixed injection unit 34 and reliably blow the air to a gap formed between the sheets P.

Second embodiment

[0073] Next, a sheet folding apparatus 100A according to the second embodiment of the present invention will be described with reference to the drawings. The present embodiment is a modified example to the first embodiment, which is assumed to be the same as the first embodiment unless otherwise specified below, and the description thereof will be omitted below. Fig. 12 is a perspective view illustrating a feeding roller 20 and a sheet separating mechanism 30A of the sheet folding apparatus 100A according to the second embodiment of the present invention. Fig. 13 is a diagram of the sheet separating mechanism 30A illustrated in Fig. 12 when viewed from the feeding roller 20 side, which illustrates a state before the suction unit 31 pulls a sheet P upwards.

[0074] As illustrated in Fig. 12 and Fig. 13, in the sheet folding apparatus 100 according to the first embodiment, the pair of rotary injection units 33 of the injection mechanism 32 are fixed to the body 30a of the sheet separating mechanism 30. In contrast, in the sheet folding apparatus

100A according to the present embodiment, the pair of rotary injection units 33 of the injection mechanism 32 are not fixed to the body 30a and arranged at positions separate from the body 30a along the width direction WD by the connection portion 37. The positions in the width direction WD of the pair of rotary injection units 33 relative to the connection portion 37 can be adjusted to any positions.

[0075] Note that, while the injection mechanism 32 of the present embodiment does not have the pair of fixed injection units 34 of the first embodiment as illustrated in Fig. 12 and Fig. 13, other forms may be employed. For example, the fixed injection unit 34 may be installed between the rotary injection units 33 at two positions on the left and right in the width direction WD and the pressing portion 36. Further, for example, the fixed injection unit 34 may be installed between the rotary injection units 33 at two positions on the left and right in the width direction WD and the suction unit 31.

[0076] According to the sheet folding apparatus 100 of the present embodiment, since the pair of rotary injection units 33 of the injection mechanism 32 are not fixed to the body 30a and arranged at positions separate from the body 30a along the width direction WD by the connection portion 37, even if printing on the sheet P or other factors make it difficult to separate the uppermost sheet from other sheet P at the position which is separated along the width direction WD from the body 30a, the uppermost sheet P can be properly separated from other sheet P.

Third Embodiment

[0077] Next, a sheet folding apparatus 100A according to the third embodiment of the present invention will be described with reference to the drawings. The present embodiment is a modified example to the first embodiment, which is assumed to be the same as the first embodiment unless otherwise specified below, and the description thereof will be omitted below. Fig. 14 is a perspective view of a rotary injection unit 33B of the third embodiment of the present invention. Fig. 15 is a partial sectional view of the rotary injection unit 33B of the third embodiment of the present invention.

[0078] The rotary injection unit 33 of the first embodiment rotates the nozzle portion 33a about the axis Ra by supplying air from the supply unit 38 to the rotary portion 33b connected to the nozzle portion 33a. In contrast, the rotary injection unit 33B of the present embodiment rotates the nozzle portion 33a about the axis Ra by driving force of a driving motor 33e.

[0079] The driving motor 33e is connected to the base end portion of the nozzle portion 33a and is a device for rotating the nozzle portion 33a in the circumferential direction CD about the axis Ra. The driving motor 33e generates driving force for rotating the nozzle portion 33a about the axis Ra.

[0080] The nozzle portion 33a is rotated continuously

in one direction about the axis Ra, injects air from the injection holes 33a1 when the opening 33a2 passes by the air supply path 33d2 in one turn, and does not inject air from the injection holes 33a1 when the opening 33a2 does not pass by the air supply path 33d2 in one turn. The nozzle portion 33a injects air so as to periodically change the first injection direction JD1 (see Fig. 10) oriented to a predetermined region including the end face Se in the upstream in the feeding direction FD of the paper stack S.

[0081] According to the rotary injection unit 33B of the present embodiment, it is possible to rotate the nozzle portion 33a about the axis Ra by driving force generated by the driving motor 33e and inject air so as to periodically change the first injection direction JD1 oriented to a predetermined region including the end face Se in the upstream in the feeding direction FD of the paper stack S.

Claims

1. A sheet feeding apparatus (100) comprising:

a stacking unit (10) configured to be stacked with a paper stack (S) including a plurality of sheets; a feeding unit (20) configured to come into contact with a surface of the uppermost sheet of the paper stack (S) and feed the uppermost sheet in a feeding direction; and a sheet separating mechanism (30) configured to separate the uppermost sheet of the paper stack (S) from the remaining sheets, **characterized in that** the sheet separating mechanism (30) comprises a suction unit (31) configured to suck and pull the uppermost sheet of the paper stack (S) upward in upstream in the feeding direction, and an injection mechanism (32) configured to separate the uppermost sheet from the remaining sheets by a first injection unit (33) configured to inject air so as to change a first injection direction oriented to a predetermined region including an end face in upstream in the feeding direction of the paper stack (S) including the uppermost sheet of the paper stack (S).

2. The sheet feeding apparatus (100) according to claim 1,

wherein the first injection unit (33) comprises a nozzle portion (33a) that is formed in a cylindrical shape extending along an axis intersecting the height direction of the paper stack (S) and having a closed tip and has an injection hole (33a1) for injecting air toward the predetermined region formed in a side face of the nozzle portion (33a), and a rotary portion (33b) configured to rotate the

- nozzle portion (33a) in a predetermined direction about the axis, and
wherein air injected from the injection hole (33a1) is supplied to an internal space of the nozzle portion (33a). 5
3. The sheet feeding apparatus (100) according to claim 2, wherein the nozzle portion (33a) injects air from the injection hole (33a1) within an injection region of an angle less than or equal to 180 degrees on the end face side of the paper stack (S) in a circumferential direction about the axis. 10
4. The sheet feeding apparatus (100) according to claim 3, 15
- wherein the first injection unit (33) has a body (33d) that holds the nozzle portion (33a), wherein the body (33d) has an accommodation hole (33d3) and a supply path (33d2), the accommodation hole (33d3) accommodating the nozzle portion (33a) such that a part of the side face in which the injection hole (33a1) is formed protrudes, and the supply path (33d2) communicating with the accommodation hole (33d3) and externally supplied with air, and 20
- wherein in the nozzle portion (33a), an opening (33a2) communicating between the supply path (33d2) and the internal space within a region of an angle less than or equal to 180 degrees in the circumferential direction is formed at a position facing the supply path (33d2) of the side face. 25 30
5. The sheet feeding apparatus (100) according to any one of claims 2 to 4, wherein the rotary portion (33b) generates driving force for rotation about the axis by externally supplied air. 35
6. The sheet feeding apparatus (100) according to any one of claims 1 to 4, wherein the sheet separating mechanism (30) has a second injection unit (34) configured to fix a second injection direction oriented to the predetermined region and inject air. 40
7. A sheet separating apparatus (30) configured to inject air toward a predetermined region of an end face of a paper stack including a plurality of sheets to separate the sheets from each other, the sheet separating apparatus (30) comprising: 45
- a nozzle portion (33a) that is formed in a cylindrical shape extending along an axis intersecting the height direction of the paper stack (S) and having a closed tip and has an injection hole (33a1) for injecting air toward the predetermined region formed in a side face of the nozzle portion (33a); and 50
- a rotary portion (33b) configured to rotate the nozzle portion (33a) in a predetermined direction about the axis, wherein air injected from the injection hole (33a1) is supplied to an internal space of the nozzle portion (33a). 55
8. The sheet separating apparatus (30) according to claim 7, wherein the nozzle portion (33a) injects the air from the injection hole (33a1) within an injection region of an angle less than or equal to 180 degrees on the end face side of the paper stack (S) in a circumferential direction about the axis.
9. The sheet separating apparatus (30) according to claim 8 further comprising a body (33d) that holds the nozzle portion (33a), 10
- wherein the body (33d) has an accommodation hole (33d3) and a supply path (33d2), the accommodation hole (33d3) accommodating the nozzle portion (33a) such that a part of the side face in which the injection hole (33a1) is formed protrudes, and the supply path (33d2) communicating with the accommodation hole (33d3) and externally supplied with air, and 15
- wherein in the nozzle portion (33a), an opening (33a2) communicating between the supply path (33d2) and the internal space within a region of an angle less than or equal to 180 degrees in the circumferential direction is formed at a position facing the supply path (33d2) of the side face. 20
10. The sheet separating apparatus (30) according to any one of claims 7 to 9, wherein the rotary portion (33b) generates driving force for rotation about the axis by externally supplied air. 25

FIG. 1

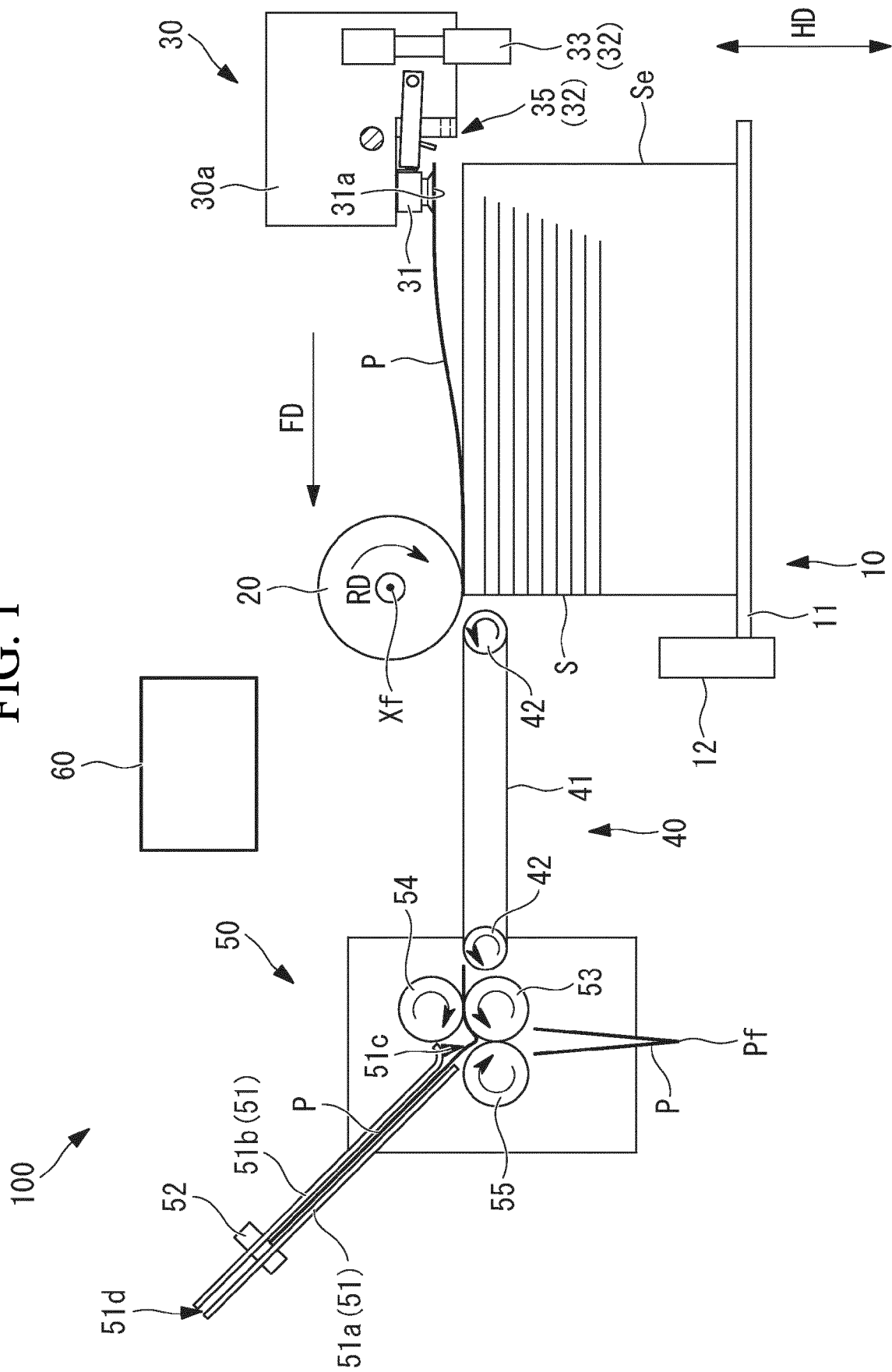


FIG. 2

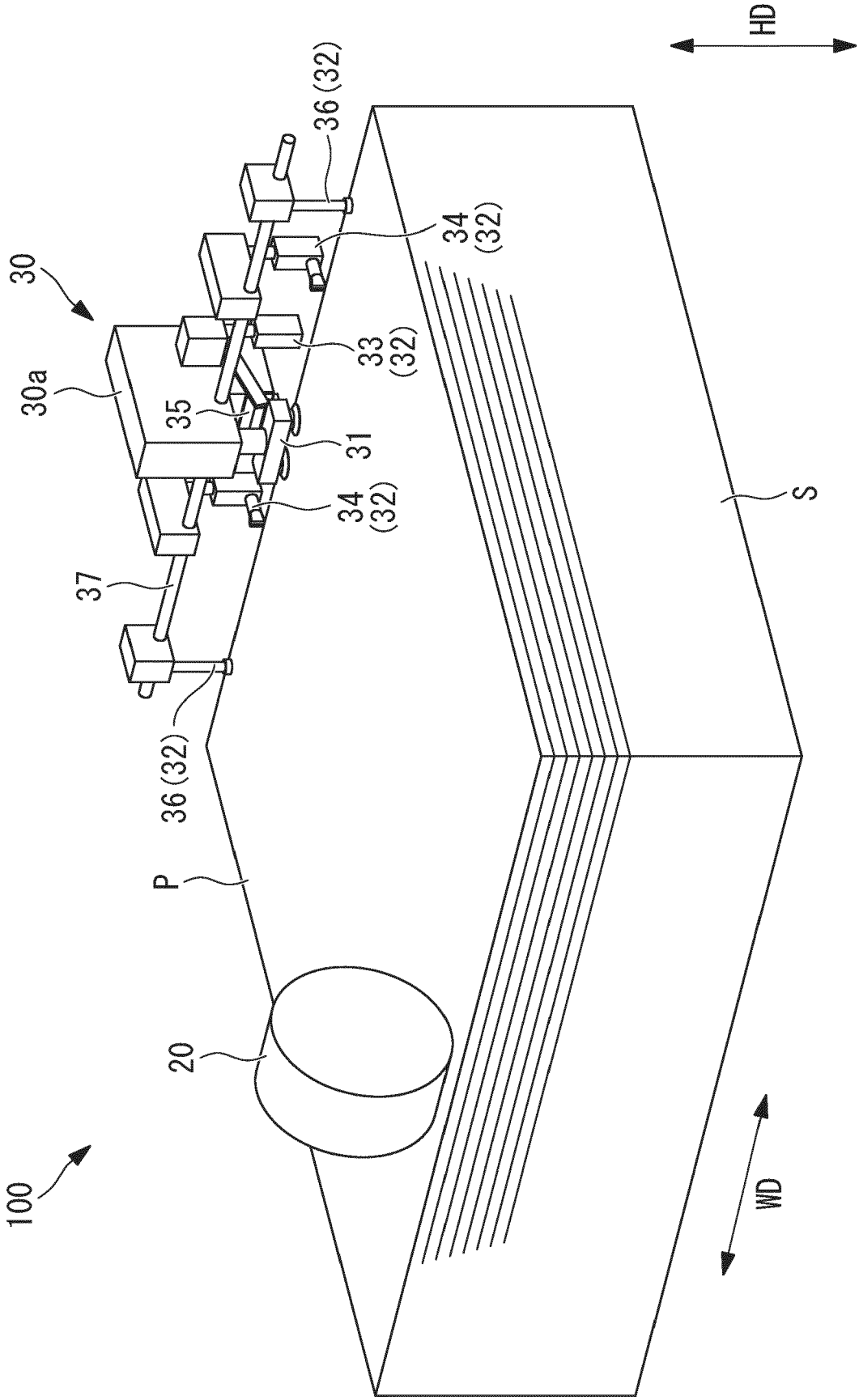


FIG. 3

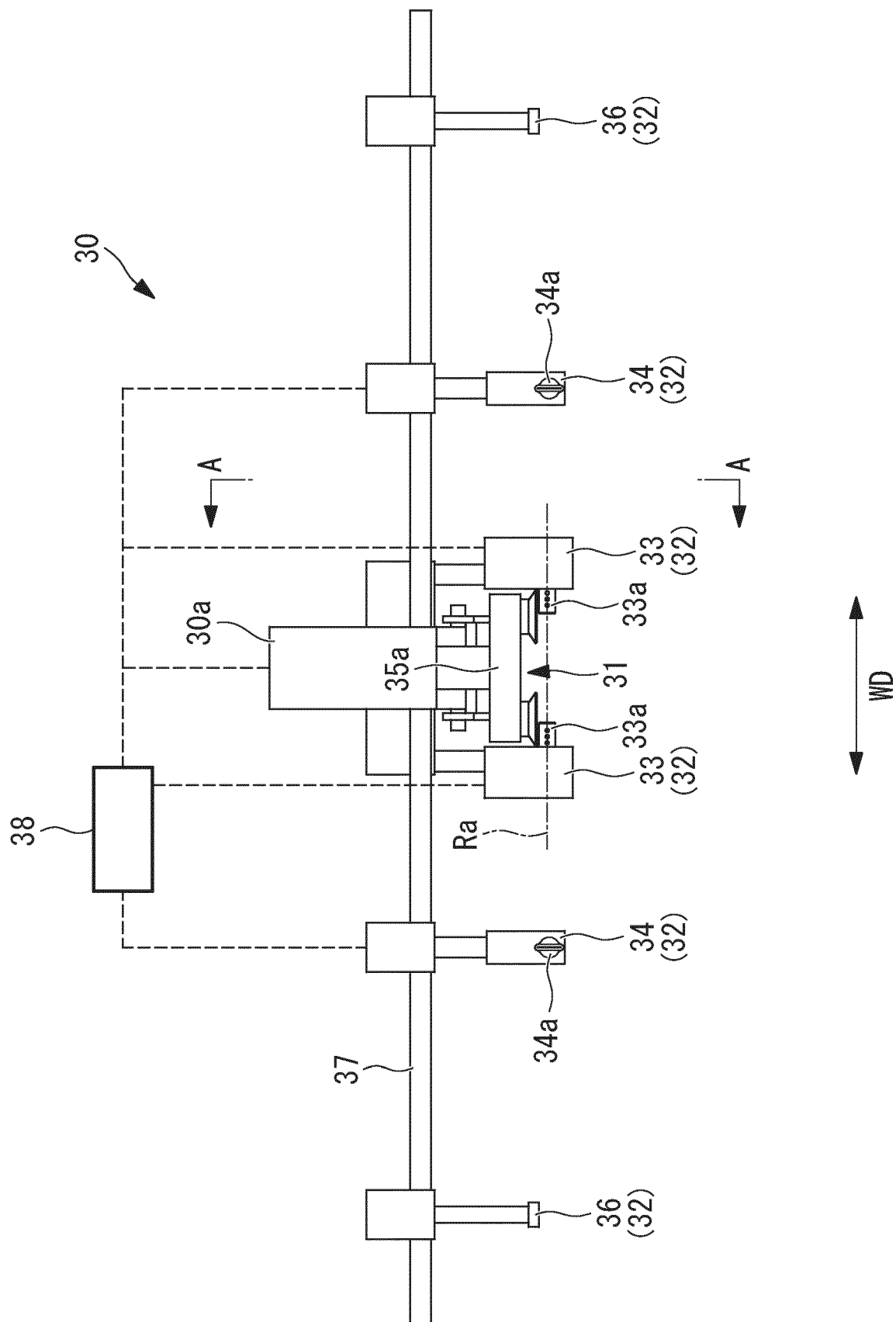


FIG. 4

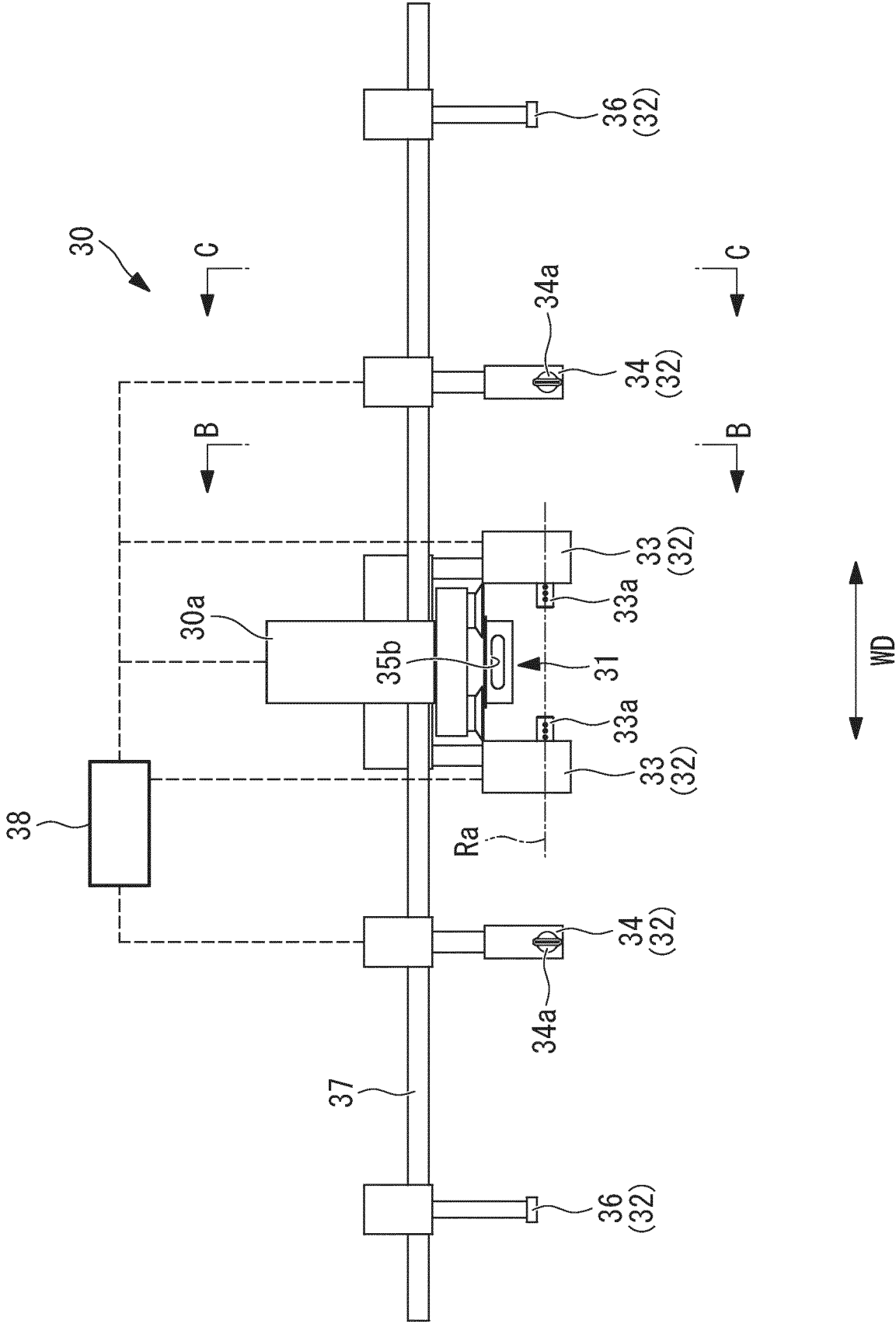


FIG. 5

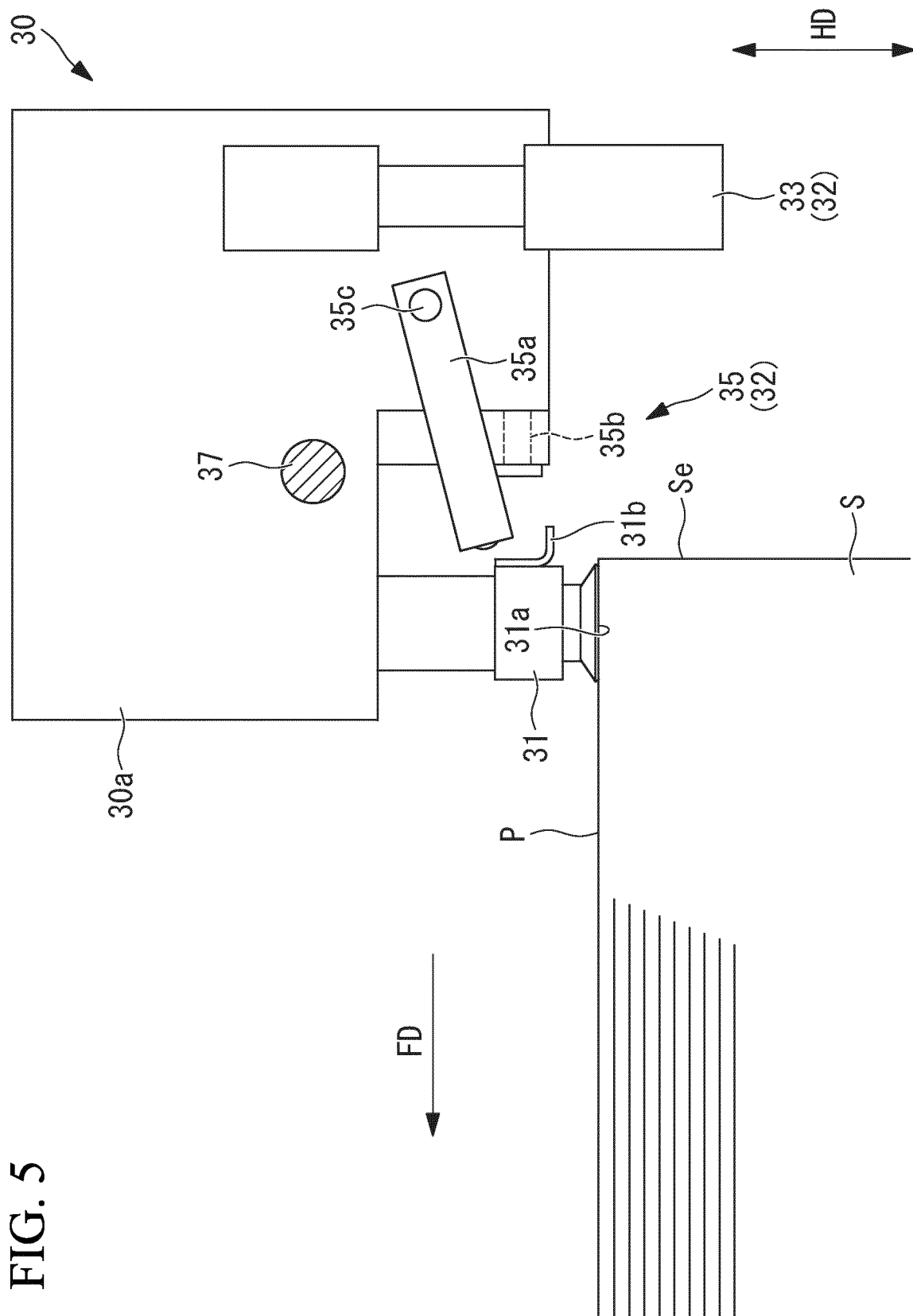


FIG. 6

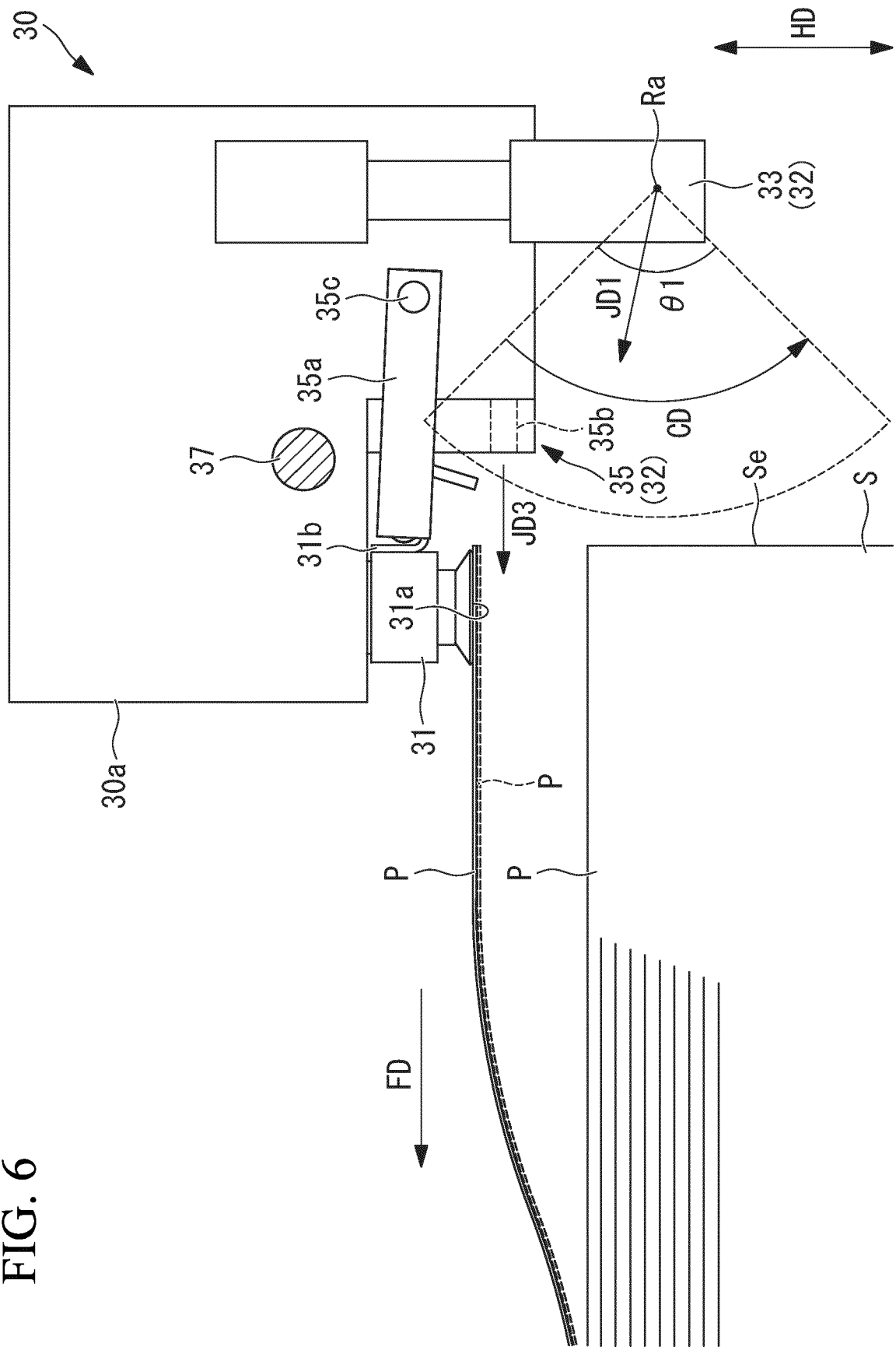


FIG. 7

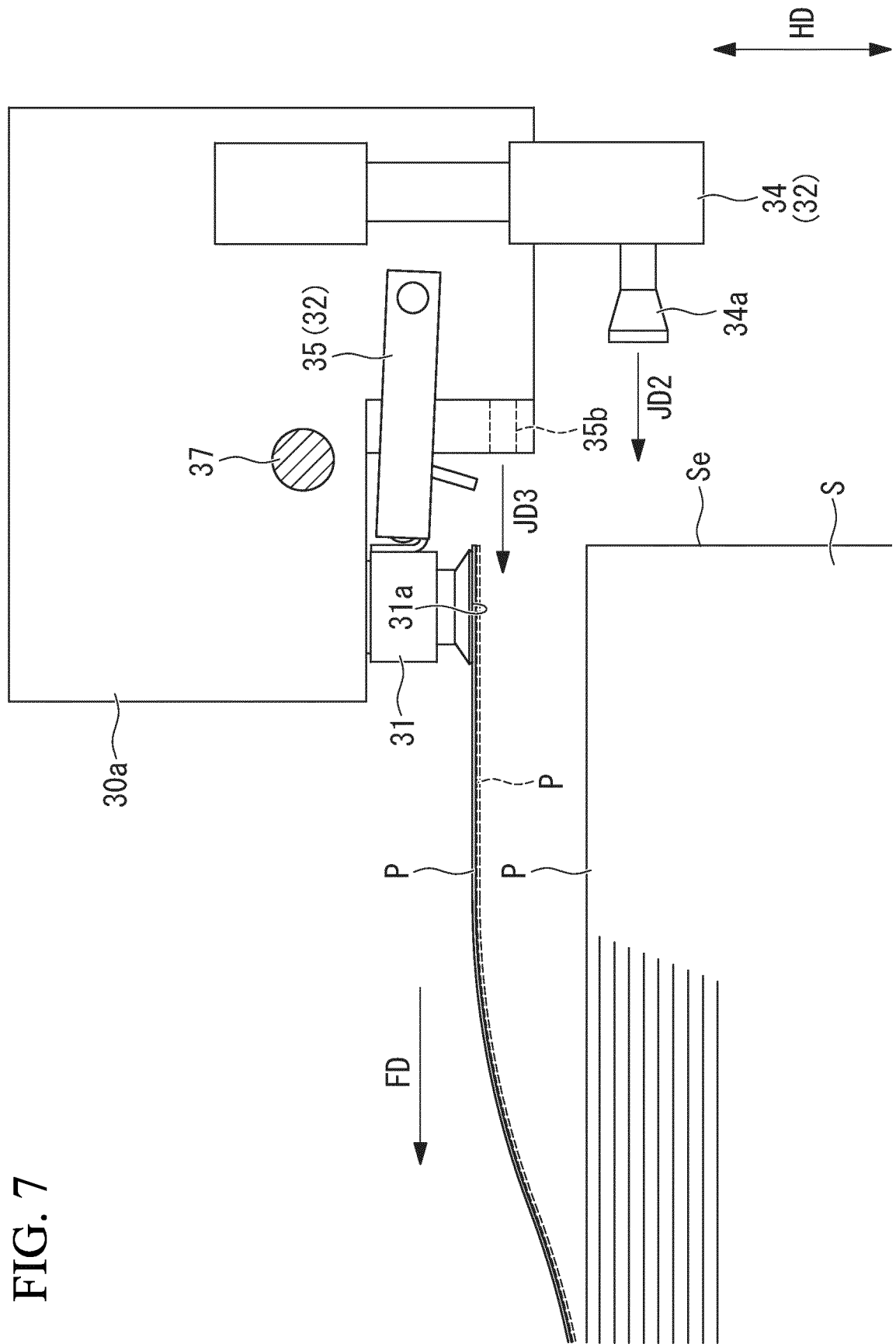


FIG. 8

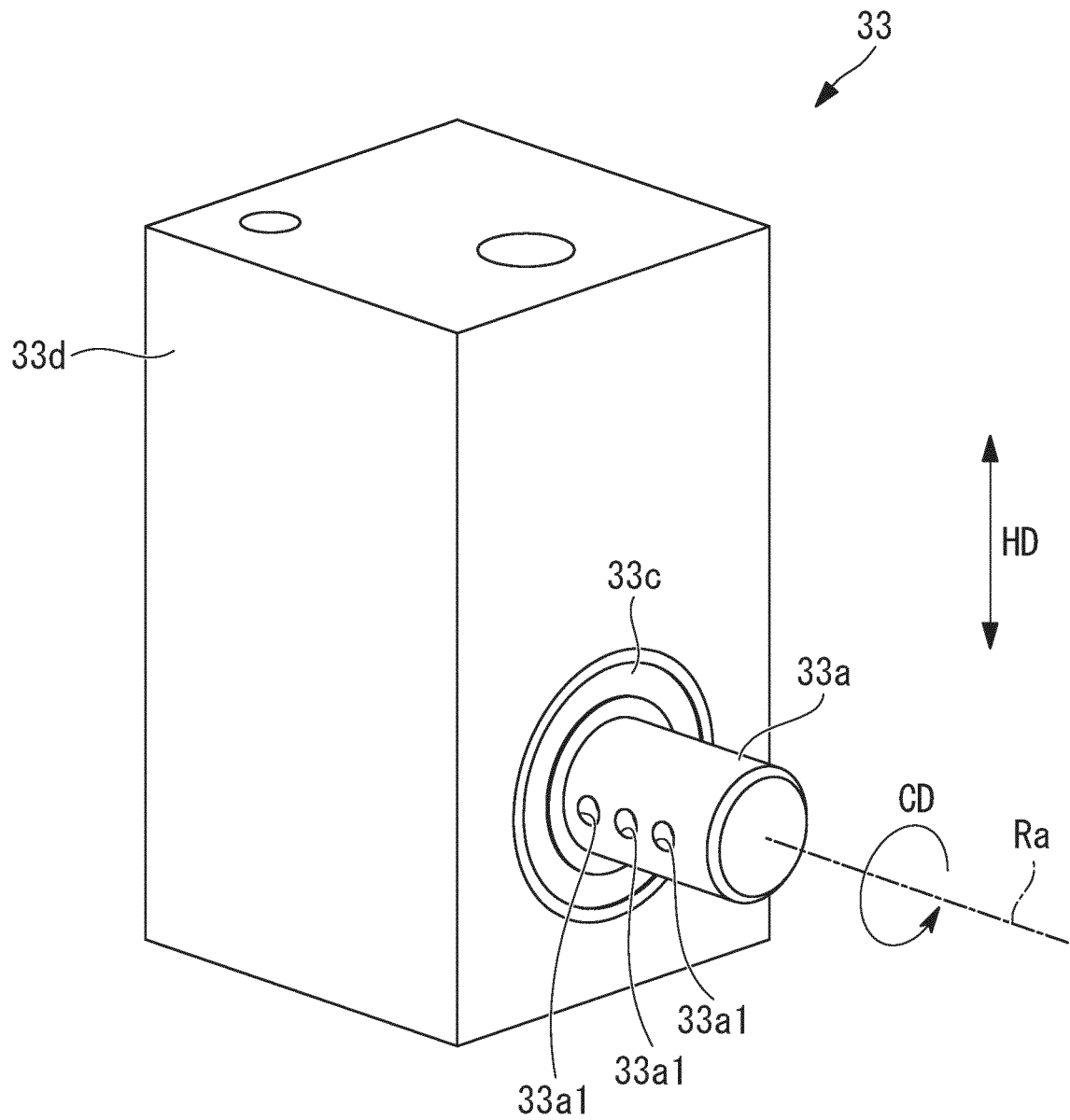


FIG. 9

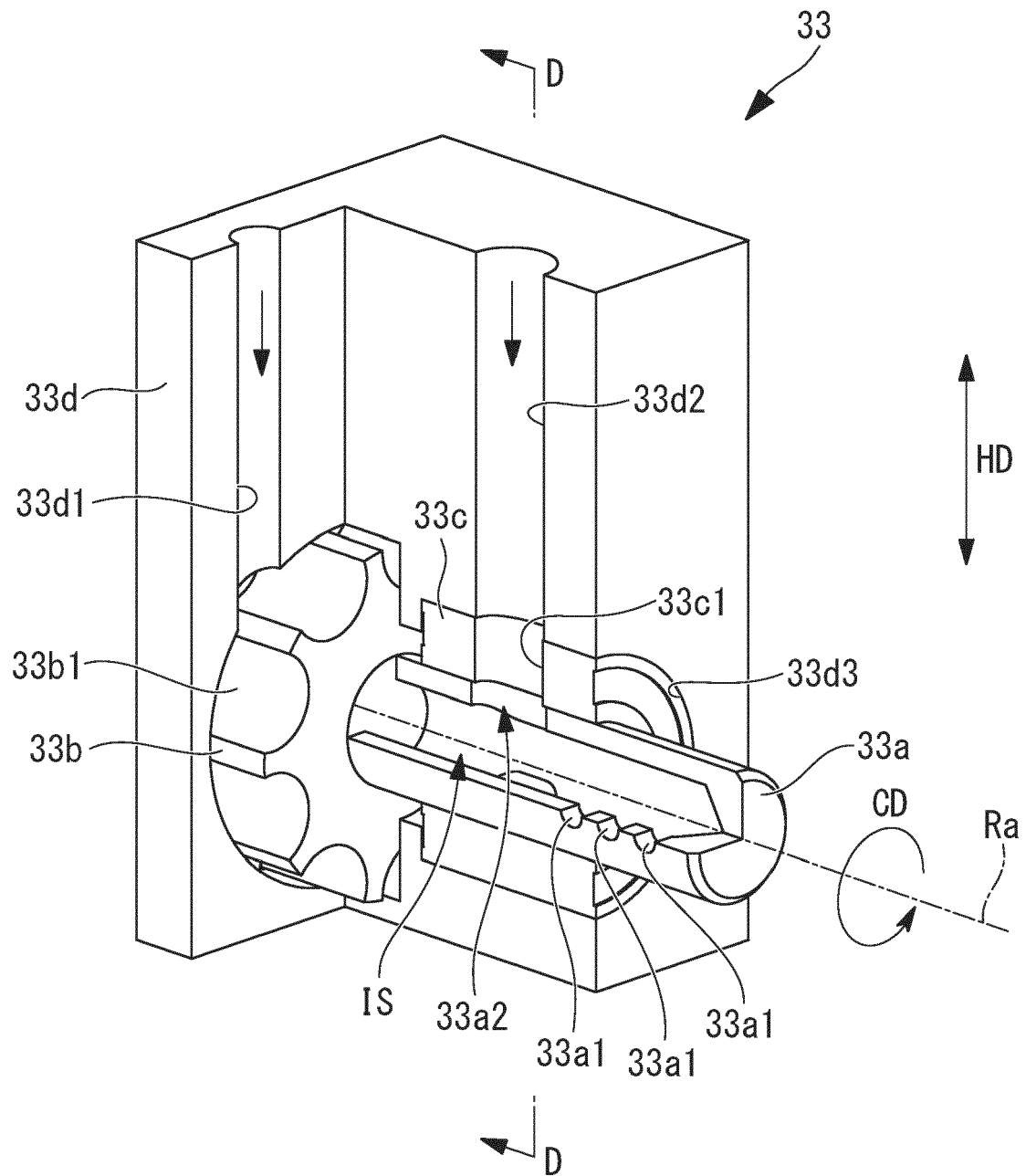


FIG. 10

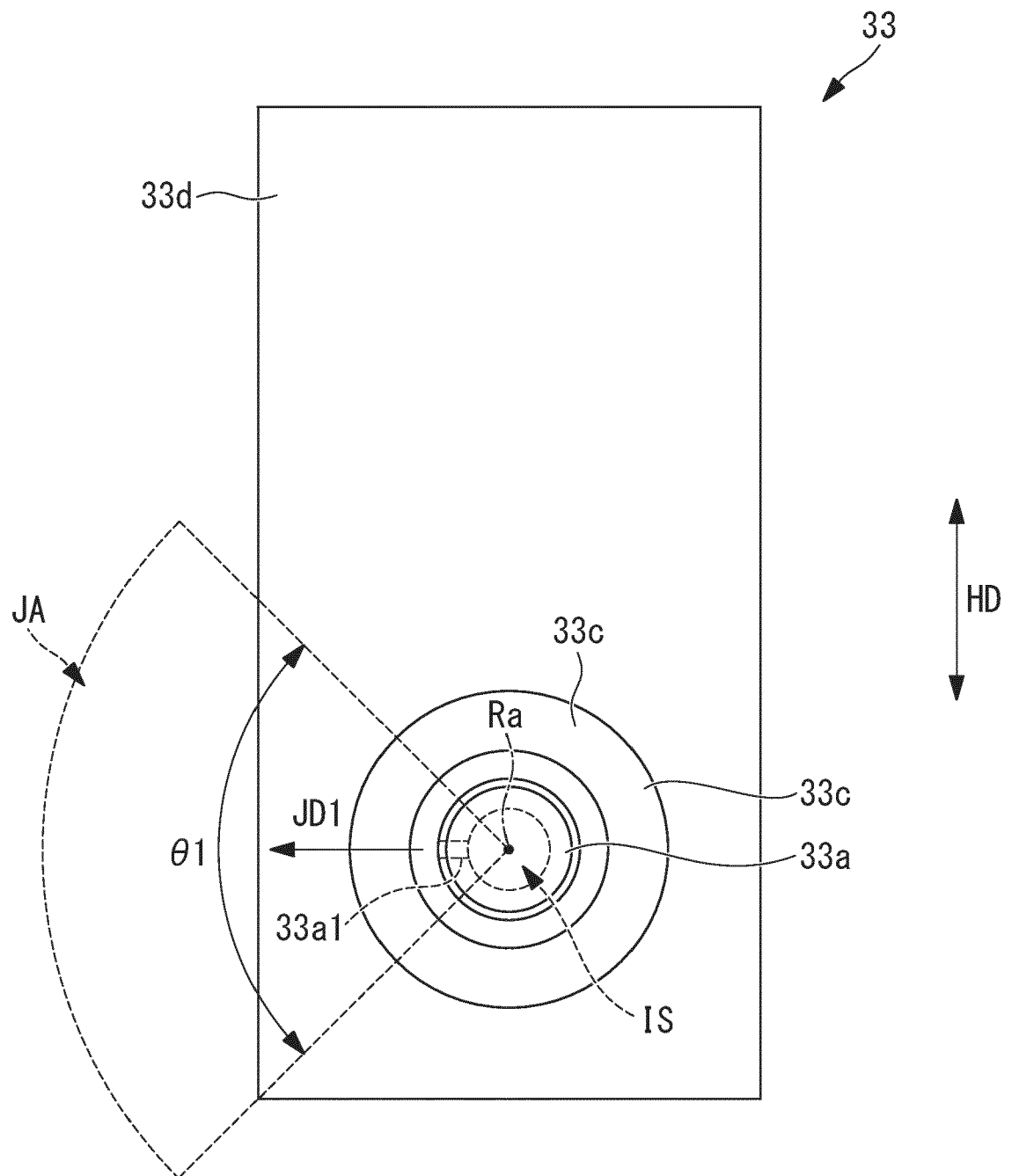


FIG. 11

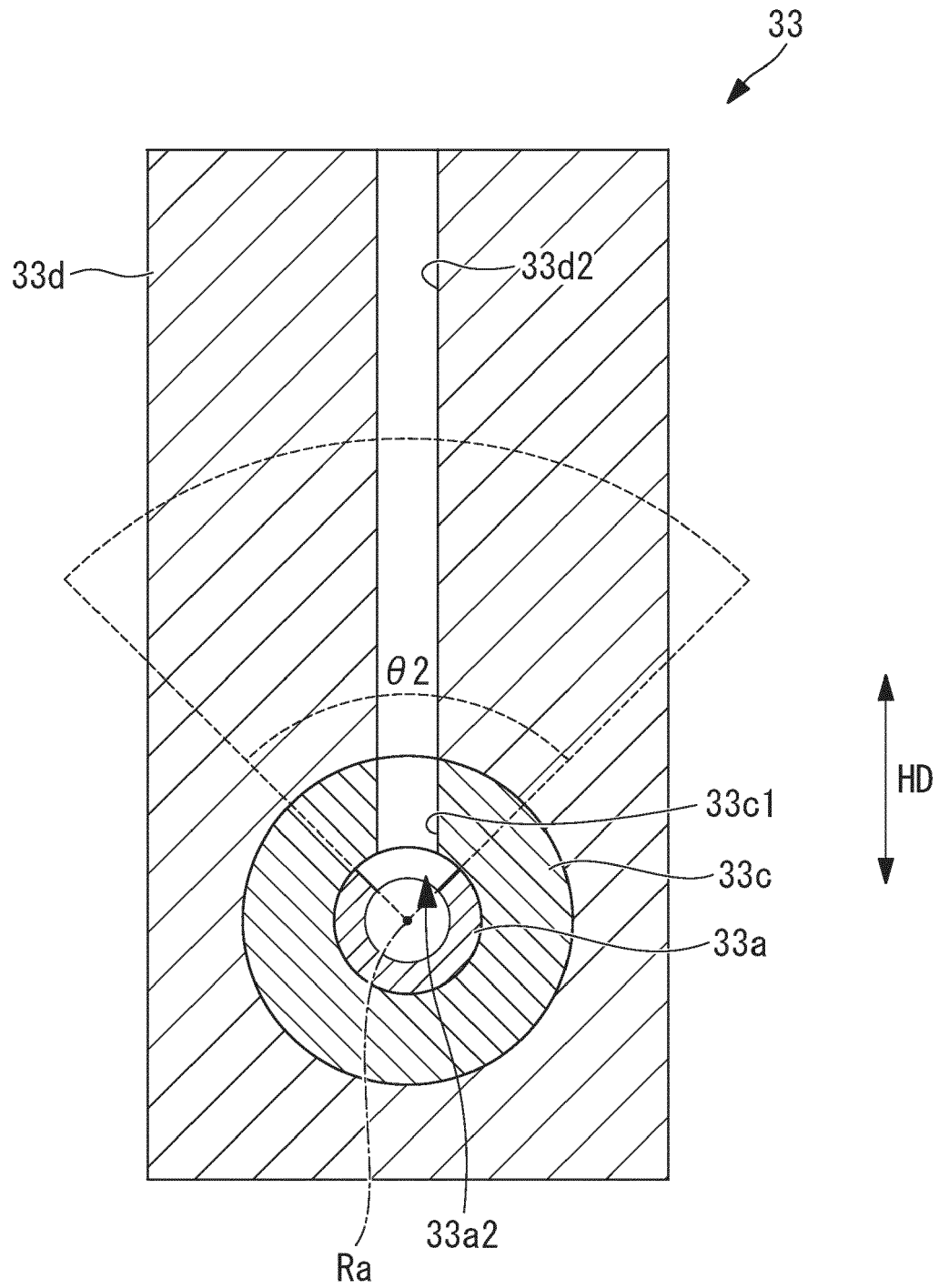


FIG. 12

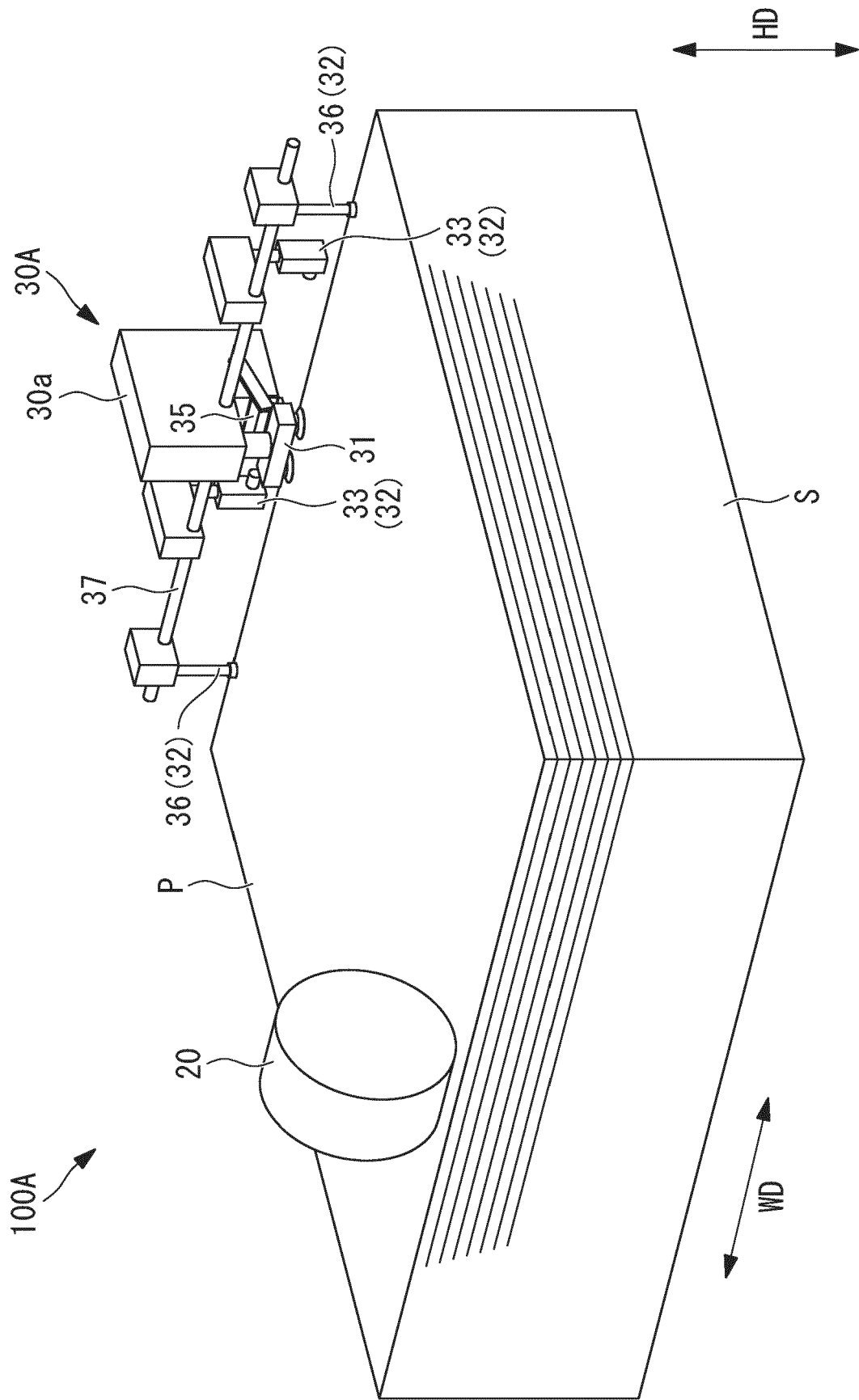


FIG. 13

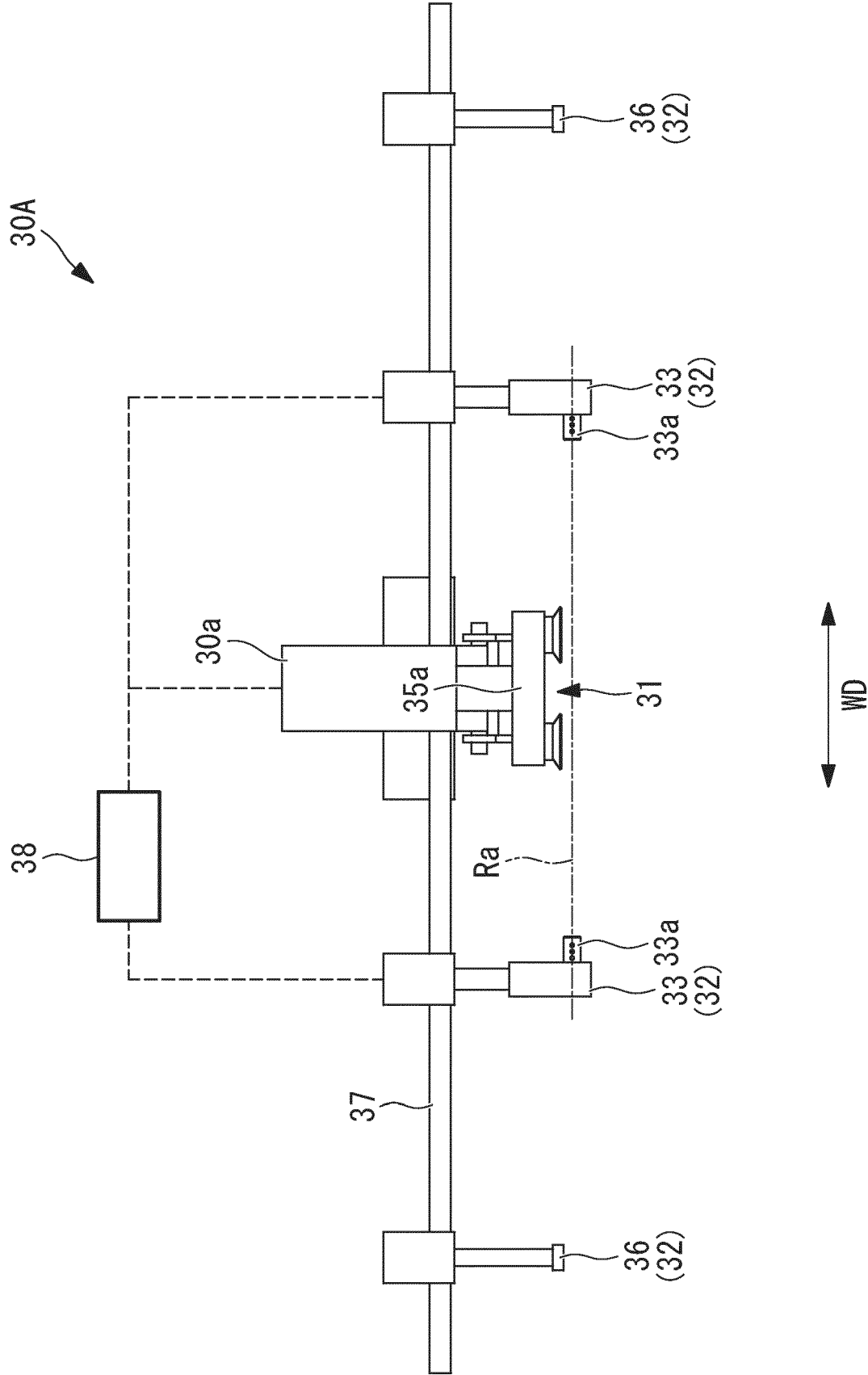


FIG. 14

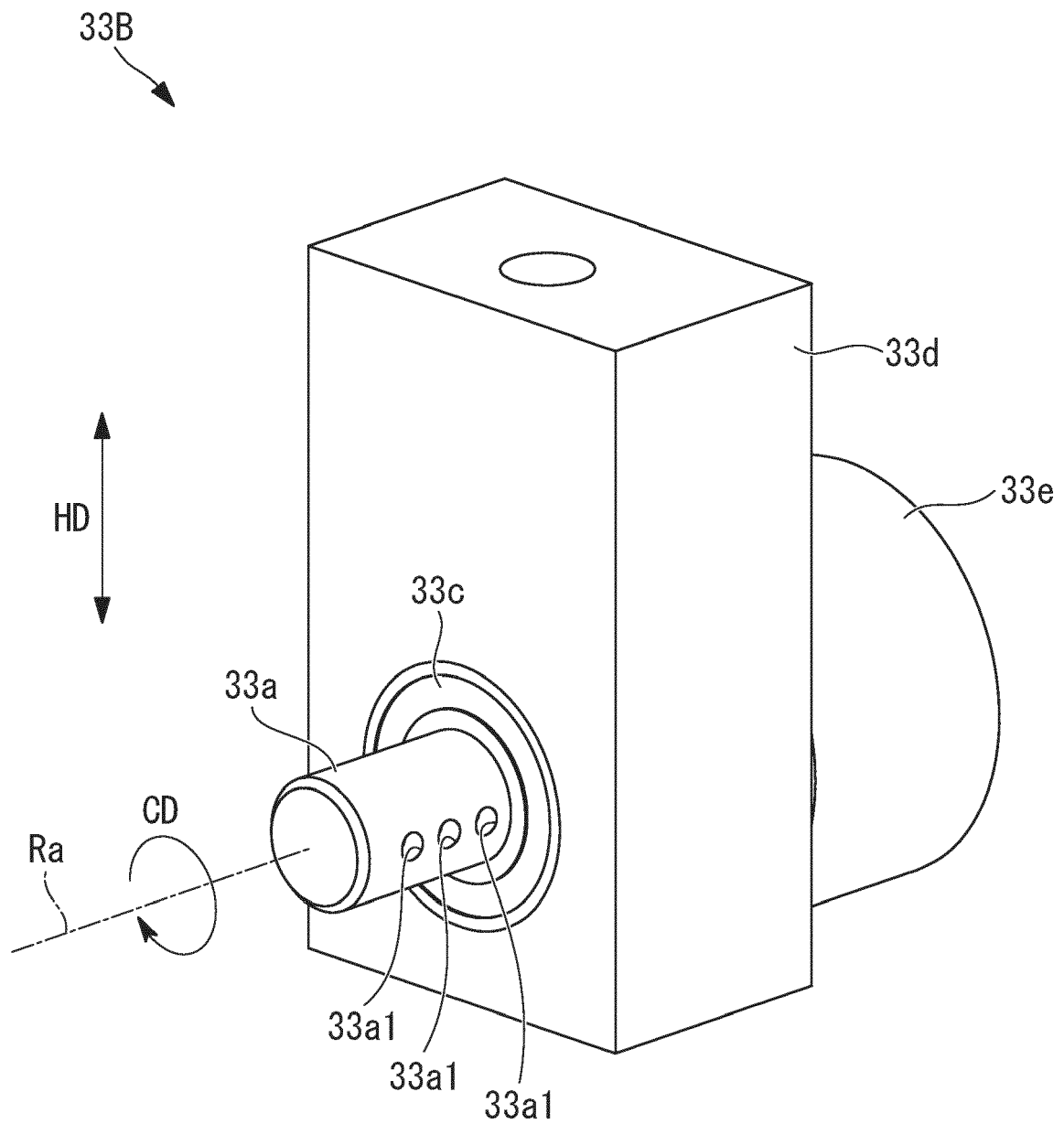
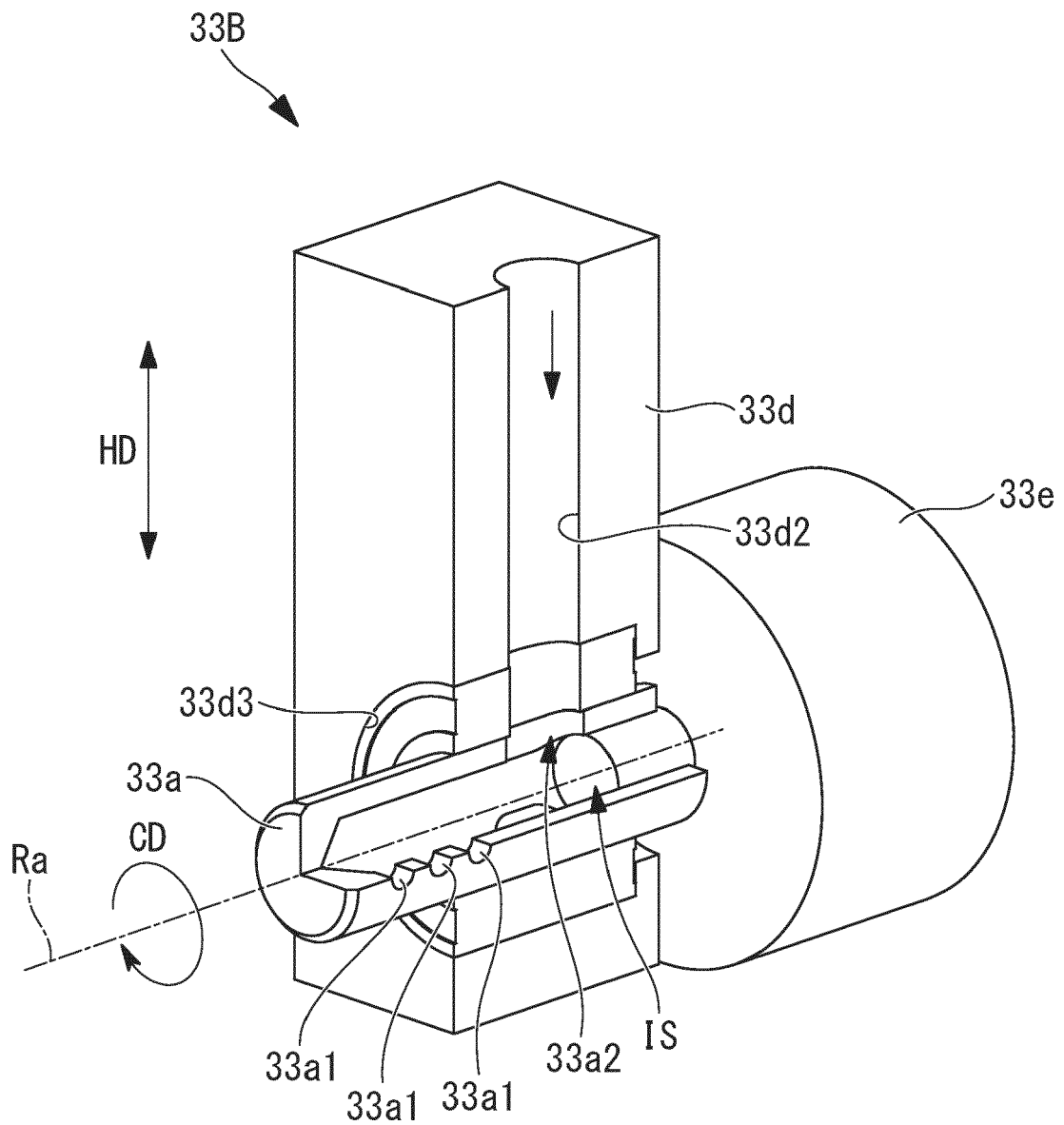


FIG. 15





EUROPEAN SEARCH REPORT

Application Number

EP 23 17 4420

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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X	DE 10 2018 207148 A1 (HOSTERT PRO GMBH [DE]) 14 November 2019 (2019-11-14) * the whole document *	7-9	
X	JP 2021 178692 A (RICOH CO LTD) 18 November 2021 (2021-11-18) * the whole document *	7-9	
			TECHNICAL FIELDS SEARCHED (IPC)
			B65H
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		13 October 2023	Athanasiadis, A
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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13-10-2023

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