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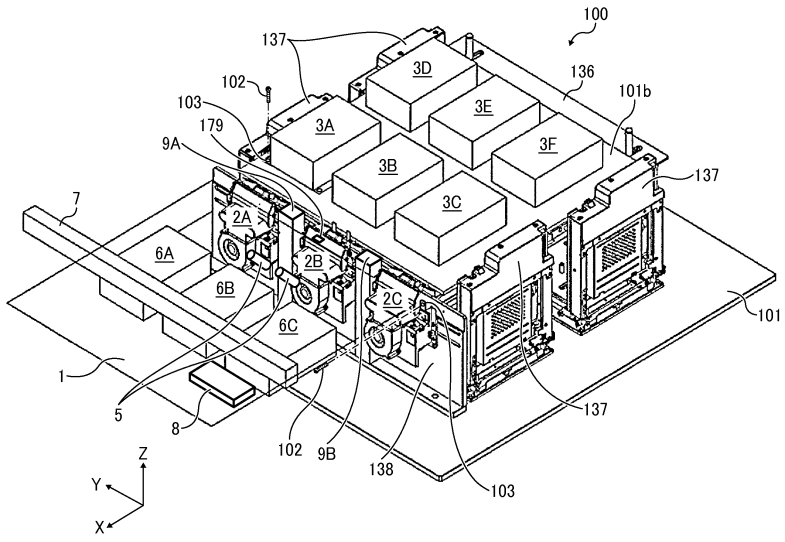
## (54) CONVEYED-MATERIAL SEPARATION DEVICE AND CONVEYED-MATERIAL CONVEYANCE APPARATUS INCLUDING SAME

(57) A conveyed-material separation device (100) includes an air jetting unit (2A to 2C) and a retaining unit (3A to 3F). The air jetting unit jets air to stacked conveyed materials to float an end of a conveyed material. The retaining unit (3A to 3F) retains and separates the conveyed material floated by the air jetting unit (2A to 2C). A position of the retaining unit is changeable according to a width dimension of the conveyed material in a width direction perpendicular to a floating direction of the conveyed material.

FIG. 8A

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## Description

### BACKGROUND

#### Technical Field

**[0001]** The present invention relates to a conveyed-material separation device and a conveyed-material conveyance apparatus including the conveyed-material separation device.

#### Related Art

**[0002]** Devices and methods for separating and conveying prepregs are known (for example, see JP-2003-311769-A). In JP-2003-311769-A, a device and a method for supplying prepreg are disclosed. JP-2003-311769-A describes that an attraction pad rotated by a cylinder or the like is used to attract and raise (upward rotation) an attracting portion or an end portion of the first prepreg of stacked prepregs, and another attraction pad moved up and down by another cylinder is used to attract and raise an end portion of the second prepreg. Then, both of the attraction pads are simultaneously moved horizontally, for example, about 50 mm to separate and convey two prepregs needed.

**[0003]** However, the technique described in JP-2003-311769-A has a problem that separation of prepregs are not easily performed in accordance with the width dimension of the prepregs.

**[0004]** In light of the above-described circumstance, a purpose of the present invention is to provide a conveyed-material separation device to easily separate conveyed materials, such as circuit board sheets or prepregs, in accordance with the width dimension of the conveyed materials.

### SUMMARY

**[0005]** In an aspect of this disclosure, there is provided a conveyed-material separation device that includes an air jetting unit and a retaining unit. The air jetting unit jets air to stacked conveyed materials to float an end of a conveyed material. The retaining unit retains and separates the conveyed material floated by the air jetting unit. A position of the retaining unit is changeable according to a width dimension of the conveyed material in a width direction perpendicular to a floating direction of the conveyed material.

**[0006]** In another aspect of this disclosure, there is provided a conveyed-material separation device that includes an air jetting unit and a plurality of retaining units. The air jetting unit jets air to stacked conveyed materials to float an end of a conveyed material. The plurality of retaining units retains and separates the conveyed material floated by the air jetting unit. The plurality of retaining units is disposed at positions capable of retaining a conveyed material having a maximum size usable in the conveyed-material separation device. The plurality of retaining units is selectively driven and used according to a size of the conveyed material to be used.

**[0007]** In another aspect of this disclosure, there is provided a conveyed-material separation device that includes the conveyed-material separation device and a conveyor to convey the conveyed material retained by conveyed-material separation device.

**[0008]** According to the present invention, a conveyed-material separation device can be provided that easily separates conveyed materials, such as circuit board sheets or prepregs, in accordance with the width dimension of the conveyed materials.

### BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

**[0009]** The aforementioned and other aspects, features, and advantages of the present disclosure would be better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

FIG. 1 is a perspective view of a conveyed-material conveyance apparatus including a conveyed-material separation device according to an embodiment of the present invention;
FIG. 2 is a perspective view of an outer appearance of the conveyed-material conveyance apparatus of FIG. 1;
FIG. 3 is a schematic view of a separation state of conveyed materials in the conveyed-material conveyance apparatus of FIG. 1;
FIG. 4 is a plan view of the conveyed-material conveyance apparatus of FIG. 2;
FIG. 5 is a flowchart of steps executed by the conveyed-material conveyance apparatus of FIG. 1;
FIGS. 6A, 6B, and 6C are illustrations of operational transition states of the conveyed-material conveyance apparatus of FIG. 1;

FIGS. 7A and 7B are illustrations of operational transition states of the conveyed-material conveyance apparatus following the state of FIG. 6C;
FIG. 8A is a perspective view of a conveyed-material conveyance apparatus including a conveyed-material separation device according to Embodiment 1 of the present invention;
FIGS. 8B to 8G are plan views of examples of arrangements of units shown in table 1 according to Embodiment 1 of the present invention;
FIG. 9 is a cross-sectional side view of a portion of a retaining conveyance unit according to Embodiment 1;
FIG. 10 is a perspective view of the retaining conveyance unit of Embodiment 1, seen diagonally from an upper right side thereof;
FIG. 11 is a perspective view of the retaining conveyance unit of Embodiment 1 with a flow of suction air;
FIG. 12 is a partial perspective view of belt retaining areas of a plurality of conveyor belts of the retaining conveyance unit according to Embodiment 1;
FIG. 13 is a back view of an arrangement of return nozzle units according to Embodiment 1;
FIG. 14 is a flowchart of steps executed by the conveyed-material conveyance apparatus of Embodiment 1;
FIG. 15 is a front view of the conveyed-material separation device according to Embodiment 1 in a state in which conveyed materials are isolated and separated with the conveyed-material separation device and attracted and retained by one of a plurality of retaining conveyance units;
FIGS. 16A and 16B are illustrations of action of return air in Embodiment 1;
FIGS. 17 is a front view of a conveyed-material conveyance apparatus including a conveyed-material separation device according to another embodiment of the present invention;
FIG. 18 is a plan view of the conveyed-material conveyance apparatus of FIG. 17;
FIGS. 19A to 19C are schematic views of operational transition states of the conveyed-material conveyance apparatus of FIG. 17; and
FIGS. 20A to 20C are schematic views of operational transition states of the conveyed-material conveyance apparatus, following the transition state of FIG. 19C.

**[0010]** The accompanying drawings are intended to depict embodiments of the present disclosure and should not be interpreted to limit the scope thereof. The accompanying drawings are not to be considered as drawn to scale unless explicitly noted.

## DETAILED DESCRIPTION

**[0011]** In describing embodiments illustrated in the drawings, specific terminology is employed for the sake of clarity. However, the disclosure of this patent specification is not intended to be limited to the specific terminology so selected and it is to be understood that each specific element includes all technical equivalents that operate in a similar manner and achieve similar results.

**[0012]** Although the embodiments are described with technical limitations with reference to the attached drawings, such description is not intended to limit the scope of the disclosure and all of the components or elements described in the embodiments of this disclosure are not necessarily indispensable.

**[0013]** Referring now to the drawings, embodiments of the present disclosure are described below. In the drawings for explaining the following embodiments, the same reference codes are allocated to elements (members or components) having the same function or shape and redundant descriptions thereof are omitted below.

**[0014]** Referring now to the drawings, embodiments of the present invention are described below. In the drawings for explaining the following embodiments and examples, the same reference codes are allocated to elements (members or components) having the same functions or shapes and redundant descriptions thereof are omitted below.

**[0015]** A conveyed-material conveyance apparatus 130 including a conveyed-material separation device according to an embodiment of the present invention is described with reference to FIGS. 1 to 4. FIG. 1 is a perspective view of a conveyed-material conveyance apparatus according to an embodiment of the present invention. FIG. 2 is a perspective view of an outer appearance of the conveyed-material conveyance apparatus of FIG. 1. FIG. 3 is a schematic view of a separation stage of a conveyed material in the conveyed-material conveyance apparatus. FIG. 4 is a plan view of the conveyed-material conveyance apparatus of FIG. 2. In FIGS. 1 to 4, arrows AF indicate directions of air flowing into the devices.

**[0016]** As illustrated in FIGS. 1 and 2, a bundle of conveyed materials (hereinafter, conveyed material bundle) 1 is a plurality of conveyed materials in a stacked state. The conveyed material bundle 1 is mounted and arranged in a stacked stated on a stack table 136 as a bottom plate in a conveyed-material conveyance apparatus 130. The conveyed materials to be separated and conveyed in this embodiment are, for example, thin-plate or sheet materials separatable and conveyable by the conveyed-material conveyance apparatus. Examples of the conveyed materials include resin, front/rear surface protector papers, electronic circuit board materials processed with metal foil, such as copper foil, or

plated and electronic circuit board sheets, such as paper, special film, plastic film, and prepreg. Examples of the prepreg include a sheet-like reinforced plastic molding material made of a fiber reinforcing material, such as carbon fiber or glass cloth. The fiber reinforcing material is impregnated with a thermoplastic resin or the like by mixing additives, such as a curing agent or a coloring agent, in the fiber reinforcing material, and heated or dried to a semi-cured state.

**[0017]** Each of the conveyed-materials to be used has, for example, a width of from about 100 mm to 700 mm and a thickness of from about 0.02 mm to 0.2 mm. The conveyed materials that can be used in this embodiment have, for example, a width dimension of about 210 mm in a width direction of the conveyed materials (conveyed-material width direction) indicated by arrow Y in FIG. 1, and a length of about 297 mm in a conveyance direction indicated by arrow X in FIG. 1. Such relatively small-sized conveyed materials can be separated and conveyed in the structure of the reference example. Note that the above-described width, length, and thickness of the conveyed material are only examples. In some embodiments, widths, lengths, and thicknesses other than the above-described range may be used. Here, the conveyance direction X corresponds to a direction of conveyance of the conveyed material. A vertical direction of the conveyed materials indicated by arrow Z in FIG. 1 corresponds to a direction in which the conveyed materials are stacked one on another. The width direction Y of the conveyed material corresponds to a direction perpendicular to each of the conveyance direction X and the vertical direction Z of the conveyed material.

**[0018]** The stack table 136 may also be referred to as a supply table and functions as a preparation unit to prepare the conveyed materials in the stacked state. The stack table 136 is movable in the vertical direction Z by an elevation assembly as a conveyed-material-stacker driving device. The conveyed-material conveyance apparatus 130 includes a conveyed-material sensor 20 (illustrated in FIG. 3) and a conveyed-material position controller. The conveyed-material sensor 20 as a conveyed-material detector detects a position of the upper surface of the conveyed material bundle 1. The conveyed-material position controller controls the operation of the elevation assembly to adjust the position of the upper surface of the conveyed material bundle 1. When the upper surface of the bundle 1 of the conveyed materials on the stack table 136 comes to a predetermined height position detected by the conveyed-material sensor 20, a conveyed material 1A placed at the uppermost position is separated and conveyed through the movement described later.

**[0019]** The conveyed-material conveyance apparatus 130 includes a pair of side fences 137 as a pair of conveyed-material position regulators, a front end guide plate 138, and end fences 139. The side fences 137 are disposed on both sides of the stack table 136 in the width direction Y of the conveyed materials to position the conveyed material bundle 1 in the width direction Y of the conveyed materials crossing (or perpendicular to) the conveyance direction X of the bundle 1 of the conveyed materials. The front end guide plate 138 positions the front end of the bundle 1 of the conveyed materials in the length direction which is equivalent to the conveyance direction X. The end fences 139 also position the rear end of the bundle 1 of the conveyed materials in the length direction. The side fences 137 are movable in the width direction Y of the conveyed material bundle 1 in accordance with the width of the conveyed materials. The end fences 139 are movable in the conveyance direction X of the conveyed material bundle 1 in accordance with the width of the conveyed materials.

**[0020]** Side air nozzles 370 indicated in broken lines and provided on one side of the side fences 137 (in the far left of FIG. 2), functions as a second air jetting unit being an isolation blower or an air jetting device, to jet and blow side air Ac (see FIG. 4) to the side end of the conveyed material bundle 1. As illustrated in FIG. 4, the side air nozzles 370 are disposed on both the side fences 137 and connected to a side blower 380 as a side air generator or a side air blower to generate side air Ac. A centrifugal blower, such as a sirocco fan, is used as the side blower 380. Alternatively, an axial blower may also be used.

**[0021]** As illustrated in FIGS. 1 to 4, a conveyed-material floating-retaining-conveying device 160 includes a drive roller 162, a driven roller 163, a conveyance belt 161, a negative pressure air chamber 310, and a suction blower 390. As illustrated in FIG. 2, the drive roller 162 is driven to rotate in a direction indicated by arrow R1 in FIG. 2 about a drive shaft 162s that is connected to a drive motor as a belt conveying unit. The driven roller 163 is formed unitarily with a rotatably supported driven shaft, and rotates in a direction indicated by arrow R2 in FIG. 2 according to the rotation and movement of the conveyance belt 161 by the drive roller 162. The conveyance belt 161 is an endless belt member in which many suction holes are formed, with each hole connecting to the negative pressure air chamber 310. The negative pressure air chamber 310 is coupled with an external suction blower 390 via a suction duct, which is described later, and kept at a negative pressure state by suction of air from the external suction blower 390 to suck and attract the uppermost conveyed material 1A via the suction holes of the conveyance belt 161.

**[0022]** The suction blower 390 has a function as a suction air generator to generate suction air Ad. A centrifugal blower, such as the sirocco fan, is used as the suction blower 390, but an axial blower may also be used alternatively. The centrifugal blower (sirocco fan) having a multiblade fan is small and reasonable in cost, and is also advantageous in that a large pressure increase can be achieved easily in a single stage at a lower noise level, when compared to the axial blower. As described above, the conveyance belt 161 of the conveyed-material floating-retaining-conveying device 160 functions as a retaining unit (retaining member) to attract and retain a floated conveyed-material by a negative pressure generated by air suction to separate the floated conveyed-material from other conveyed materials and a conveyor to convey the retained conveyed-material. Note that the size of the conveyed-material floating-retaining-con-

veying device 160 may be increased in accordance with the size of the conveyed material.

**[0023]** An air jetting nozzle device 300 that also functions as an air blower is disposed at a position facing the front end of the mounted bundle 1 of the conveyed materials. The air jetting nozzle device 300 includes an air chamber 320 that stores air fed from an external floating blower in a pressurized manner. As illustrated in FIGS. 3 and 4, the air chamber 320 includes two floating nozzles 322. The floating blower functions as a floating air blower or a floating air generator to generate floating air. For example, a centrifugal blower, such as the sirocco fan, is used as the suction blower. Alternatively, an axial blower may also be used as the floating blower.

**[0024]** As described above, the air jetting nozzle device 300 functions as an air jetting device to blow air to conveyed materials stacked and prepared on the stack table 136 to float an end of the conveyed materials. Examples of air, or gas, include a diselectrified air or other gases used for floating and separating the conveyed materials one after another. In particular, for conveyed materials containing carbon fibers, the conveyed materials in the stacked state are in close contact with each other due to electrostatic action, it is difficult to separate the conveyed materials from each other one by one. It is effective, therefore, to blow the diselectrified air to the bundle 1 of the conveyed materials in the stacked state.

**[0025]** As illustrated in FIG. 3, the floating nozzles 322 blow a floating air Aa toward an end portion on the front (referred to as the front end portion hereinafter) of the bundle 1 of the conveyed materials to float a conveyed material from the bundle 1 of the conveyed materials. The floating nozzles 322 functions as a first air jetting unit to blow air to the conveyed material bundle 1 stacked in a direction opposite to the conveyance direction X to float and separate the conveyed materials. Note that, when warm air is used as the blowing air, an effect of dehumidifying the conveyed materials can be further obtained, thus allowing more effective separation and isolation of the conveyed materials.

**[0026]** FIG. 5 is a flowchart of main steps performed by the conveyed-material conveyance apparatus according to an embodiment of the present invention. FIGS. 6A, 6B, 6C, 7A, and 7B are illustrations of an operational transition by the conveyed-material conveyance apparatus. First, the structure and operation of the conveyed-material conveyance apparatus 130 is further described with reference to FIG. 6A. As illustrated in FIG. 6A, the conveyed-material conveyance apparatus 130 blows floating air Aa from the floating nozzles 322 of the air chamber 320 toward a front end face of the conveyed material bundle 1 stacked on the stack table 136, to float the conveyed material bundle 1 up to the height of the conveyance belt 161 (conveyed-material retainer).

**[0027]** The suction blower 390 is then operated to retain the conveyed material 1A, which is the uppermost sheet of the bundle 1 of the conveyed materials, by the conveyance belt 161. The uppermost conveyed material 1A retained on the conveyance belt 161 is not always separated as a single sheet, but one or more conveyed materials may be in close contact with the conveyed material 1A. Hence, the side air nozzles 370, which are disposed as the isolation blowers on the side fences 137, blow the side air to isolate the conveyed material 1A retained by the conveyance belt 161 from other conveyed materials to be a single sheet. The term "isolation" represents jetting air from the side air nozzles to reduce the attractive force acting between conveyed materials to assist separation. Then, the conveyed material 1A is conveyed to the destination of conveyance by the conveyance belt 161, and subsequent processing is performed.

**[0028]** A conveyed-material stopper 177 is disposed between the air chamber 320 and the bundle 1 of the conveyed materials mounted on the top to prevent conveyance of the conveyed materials other than the uppermost conveyed material 1A. A conveyed-material sensor 20 to detect the height of the conveyed material is provided to keep a fixed distance h between the conveyance belt 161 and the position of the top surface of the conveyed materials, although the distance h tends to decrease due to feeding and sending of the conveyed materials. The conveyed-material sensor 20 is a reflection-type photosensor. The conveyed-material-stacker driving device (elevation assembly) raises and adjusts the stack table 136 in response to detected signals of the conveyed-material sensor 20.

**[0029]** The bundle 1 of the conveyed materials are aligned, with the front end face being a reference surface, to fit the size of the conveyed materials on the stack table 136. A sheet feeding sensor 179 to detect the arrival of the conveyed materials is disposed at a downstream side in the conveyance direction X in the conveyed-material floating-retaining-conveying device 160.

**[0030]** Next, operation and process steps of the conveyed-material conveyance apparatus 130 are described sequentially. (1) A preparation step (step S1 of FIG. 5) for preparing the conveyed materials in a stacked state is performed, for example, in the following manner. Specifically, an operator stacks the bundle 1 of the conveyed materials on the stack table 136. At the same time, the operator hits the front end face of the bundle 1 of the conveyed materials against the front end guide plate 138 to form a reference surface to allow the bundle 1 of the conveyed materials to be set and aligned conforming to the size of the conveyed materials. Further, the side fences 137 and the end fences 139 are manipulated to align the side end faces and the rear end face, respectively, of the bundle 1 of the conveyed materials. In the preparation step, robots or other specialized devices, for example, may perform the stacking or size-alignment operation of the conveyed material bundle 1, as mentioned above, instead of the human operator.

**[0031]** When a conveyed-material feeding instruction is received from the controller of the conveyed-material conveyance apparatus 130 of FIG. 1, as illustrated in FIG. 6B, the air chamber 320 of the air jetting nozzle device 300 and the isolation blower including the side air nozzles 370 operate. Then, the floating step as a first step to blow air to the end portions of the conveyed materials starts (step S11 of FIG. 19). When the floating blower of the air chamber 320 and

the side blower 380 of the side air nozzles 370 operate, floating air Aa is blown from the floating nozzles 322 of the air chamber 320 and side air Ac is blown from the side air nozzles 370. Thus, the contact areas between the uppermost conveyed materials 1A, 1B, and 1C are changed by floating uppermost conveyed materials 1A, 1B, and 1C prepared on the stack table 136.

**[0032]** At the same time, a retaining step (step S3 of FIG. 9) as a second step to retain the floated conveyed materials starts to suction air by the conveyance belt 161. The uppermost conveyed material 1A is floated, attracted, and retained on the conveyance belt 161, as illustrated in FIG. 6B. In FIG. 6B, the term AD parenthesized following the air chamber 320 or the conveyance belt 161 represents that the air chamber 320 is in blowing operation state or the conveyance belt 161 is in sucking operation state. The term ST parenthesized following the conveyance belt 161 represents that the conveyance belt 161 is in stopped state.

**[0033]** The isolation step indicated by step S4 of FIG. 5 is a step of isolating the conveyed materials retained by the conveyance belt 161 and performed by the isolation blower including the side air nozzles 370.

(2) As illustrated in FIG. 6C, the conveyance belt 161 and the conveyance rollers 178 start to operate, and a conveyance step (step S5 of FIG. 5) as a third step to convey the conveyed material 1A retained by the conveyance belt 161 is executed. In FIG. 6C, the term DR parenthesized following the conveyance belt 161 represents that the conveyance belt 161 is in rotational conveyance driving state.

(3) As illustrated in FIG. 7A, the rotational conveyance driving of the conveyance belt 161 is stopped after the conveyed material 1A exits from the conveyance belt 161 after the conveyed material 1A has reached the sheet feeding sensor 179 and a predetermined time has passed. (4) Immediately after the conveyed material 1A has passed through a retaining region retained by the conveyance belt 161, as illustrated in FIG. 7B, the next conveyed material 1A is floated by blowing of the air and retained by the conveyance belt 161.

(5) The operation of the conveyance belt 161 is restarted according to the setting of a conveyed-material feeding interval and the conveyed material 1A is fed. (6) Subsequently, the steps illustrated in FIGS. 6B to 6B are repeated to convey the conveyed materials sequentially.

**[0034]** The floating amount or the isolation state of the conveyed materials differs depending on thickness, weight, or size of the stacked conveyed materials when the air volume is fixed at a certain value. For example, if the floating amount of the conveyed materials is small, no supply (no feed) of the conveyed materials occurs. In contrast, if the conveyed material is floated exceedingly, the conveyed materials come in close contact with each other to cause the multifeed. If the power of the suction blower 390 is small, the conveyed materials cannot be conveyed successfully, and the no-supply also occurs.

**[0035]** To properly execute feeding of the conveyed materials, the air volume is previously fixed according to the stacked conveyed materials, such that the fixed air volume is reached automatically when the user or operator chooses the conveyed material to be fed. The air volume is adjusted according to a duty ratio of the blower.

**[0036]** In the case in which circuit board sheets are used as the conveyed materials, for example, a circuit board produced with a damaged circuit board sheet would have a failure in electrical characteristics (resistance values). Therefore, there is a problem to be solved that the separation of circuit board sheets should be performed while preventing occurrence of a failure in electrical characteristics (resistance values) of separated circuit board sheets. For the problem to be solved, the following effects can be achieved by the following technical configurations of the above-described embodiment.

**[0037]** According to a first technical configuration of the above-described embodiment, a conveyed-material separation method includes the preparation step, such as step S1, to prepare circuit board sheets, such as the conveyed material bundle 1 constituted of circuit board sheet, in the stacked state, a first step as the floating step, such as step S2, to float an end of the circuit board sheets by jetting air from the air jetting device or air jetting unit, such as the air jetting nozzle device 300, and a second step as the retaining step, such as step S3, to retain and separate the floated circuit board sheets by the retainer, such as the conveyance belt 161. According to the first technical configuration of the above-described embodiment, the effect is achieved of providing the conveyed-material separation method capable of easily separating the circuit board sheets without reducing qualities of the circuit board sheets. For example, a circuit board produced with a damaged circuit board sheet would have a failure in electrical characteristics (e.g., resistance values). By contrast, the above-described embodiment provides the conveyed-material separation method capable of easily separating the circuit board sheets without reducing qualities of the circuit board sheets, thus preventing such a failure of the circuit board.

**[0038]** The above-described embodiment also have a technical configuration relating to a conveyed-material separation method employing the air jetting device, such as the air jetting nozzle device 300, to jet air in a direction opposite a conveyance direction, such as the conveyance direction X, of the conveyed materials, the first air blower, and the second air jetting unit, such as the side air nozzles 370, to jet air in a width direction, such as the width direction Y, perpendicular to the conveyance direction.

**[0039]** In the conveyed-material separation method according to the above-described embodiment, the retaining step (the second step) also includes the isolation step, such as step S4, to isolate conveyed materials by the second air jetting unit. The conveyed-material separation method according to the above-described embodiment also has a technical configuration of stopping air jetting from the air jetting unit after the retaining step (the second step) ends.

**[0040]** In the conveyed-material separation method according to the above-described embodiment, the retainer, such as the conveyance belt 161, attracts and retains a floated conveyed material by air suction. The conveyed-material separation method according to the above-described embodiment also has a technical configuration of controlling the stack table, such as the stack table 136, to elevate up and down so that the position of the upper surface of conveyed materials stacked on the stack table that stack the conveyed materials thereon and can elevate up and down in the direction in which the conveyed materials are stacked. According to the above-described embodiment, the effect is achieved of providing the conveyed-material separation method capable of easily and reliably separating conveyed materials without reducing qualities of the conveyed materials.

**[0041]** According to the above-described embodiment, the conveyed-material conveyance method employing the conveyed-material conveyance apparatus has a technical configuration including the third step as the conveyance step, such as step S5, to convey the retained conveyed material. According to the above-described embodiment, the effect is achieved of providing the conveyed-material conveyance method capable of reliably conveying the separated circuit board sheet.

**[0042]** The above-described embodiment has a technical configuration according to the conveyed-material separation device that includes the preparation unit, such as the stack table 136, to prepare conveyed materials, such as the conveyed material bundle 1, the air jetting device, such as the air jetting nozzle device 300, to jet air the conveyed materials prepared and stacked to float an end of the conveyed materials, and the retaining unit and the retainer, such as the conveyed-material conveyance apparatus 130, to retain and separate the floated conveyed materials.

**[0043]** The above-described embodiment has a technical configuration in that the conveyed-material conveyance apparatus includes the conveyed-material separation device according to any one of the above-described technical configurations and the conveyance unit, such as the conveyance belt 161, to convey the retained conveyed materials. According to the above-described embodiment, the effect is achieved of providing the conveyed-material conveyance apparatus capable of reliably conveying the separated conveyed material.

**[0044]** However, if it is desired to increase the supplying speed of the conveyed materials, the air blow needs to be executed before the completion of the conveyance of the first conveyed material 1A. This may lead to the occurrence of the multifeed due the contact caused by the over-floating or behavioral disturbance during the blowing. In addition, the separation may also be difficult when the conveyed materials have large widths. In view of the above, an embodiment which will be described below has created a conveyed-material separation device capable of easily separating the conveyed materials according to the size, such as the widths, of the conveyed materials and a conveyed-material conveyance apparatus including the conveyed-material separation device.

Embodiment 1

**[0045]** Next, the conveyed-material conveyance apparatus including the conveyed-material separation device according to Embodiment 1 of the present invention is described below by focusing on differences from the conveyed-material conveyance apparatus 130 according to the above-described embodiment. FIG. 8A is a perspective view illustrating, in a partly schematic manner, a conveyed-material conveyance apparatus including a conveyed-material separation device according to Embodiment 1 of the present invention. In FIG. 8A, for example, retaining conveyance units 3A to 3F, suction units 6A to 6C, a multifeed detecting sensor 5, an ionizer 7, a laser feed monitor 8 are schematically illustrated. In FIG. 8A, a conveyed material 1 is illustrated intentionally in a transparent manner for easier understanding of front nozzle units 2A, 2B, and 2C, suction units 6A to 6C, and return nozzle units 9A and 9B that are positioned below the conveyed material 1 that is being conveyed.

**[0046]** Embodiment 1 mainly differs from the above-described embodiment illustrated in FIGS. 1 to 7B in that a conveyed-material conveyance apparatus 100 illustrated in FIG. 8A is used instead of the conveyed-material conveyance apparatus 130 illustrated in, for example, FIGS. 1, 2, 4, 6, and 7. The other portions of the structure are similar to those of the above-described embodiment (this also applies to other embodiments described later, such that the notice like this will not be repeated hereinafter). The conveyed-material conveyance apparatus 100 mainly differs from the conveyed-material conveyance apparatus 130 in that the conveyed-material conveyance apparatus 100 includes a configuration described below capable of separating conveyed materials for conveyance according to size, including width, of the conveyed materials. Regarding the size of the conveyed materials, a large size is about 700 mm $\times$ about 700 mm, an intermediate size is about 420 mm $\times$ about 594 mm, and a small size is about 210 mm $\times$ about 297 mm.

**[0047]** First, the conveyed-material conveyance apparatus 100 uses a plurality of (three in Embodiment 1) front nozzle units 2A, 2B, and 2C, which are provided as common air jetting devices and floating units, in place of the single air jetting nozzle device 300. The front nozzle units 2A, 2B, and 2C are detachably attachable relative to the front end guide plate

138 in accordance with the width dimension of the conveyed materials.

**[0048]** Secondly, the conveyed-material conveyance apparatus 100 uses a plurality of (six in Embodiment 1) retaining conveyance units 3A to 3F, which are provided as common retaining units, in place of the single conveyed-material floating-retaining-conveying device 160. The retaining conveyance units 3A to 3F are detachably attachable relative to an upper body frame 101b according to the width dimension of the conveyed materials. The retaining conveyance units 3A to 3F have a unique configuration of attracting and retaining the conveyed materials, compared to the conveyed-material floating-retaining-conveying device 160, which will be further described later.

**[0049]** Thirdly, the conveyed-material conveyance apparatus 100 uses a plurality of (two in Embodiment 1) return nozzle units 9A and 9B that are provided as suction units to suck and attract the floated conveyed materials in a direction opposite to the floating direction, after the conveyed materials are attracted and retained by the retaining conveyance units 3A to 3C. The return nozzle units 9A and 9B will be further described later.

**[0050]** Fourth, the conveyed-material conveyance apparatus 100 differs from the conveyed-material conveyance apparatus 130 in that the two side fences 137 illustrated in, e.g., FIGS. 2 and 4 are disposed at each of an upstream side and a downstream side in the conveyance direction X, that is, the conveyed-material conveyance apparatus 100 includes a total of four side fences 137. In the conveyed-material conveyance apparatus 100, a plurality of (two in Embodiment 1) common side nozzle units 11A and 11B is used in place of the pair of side air nozzles 370 disposed on the pair of left an right side fences 137 illustrated in FIGS. 2 and 4. The side nozzle units 11A and 11B are detachably attached relative to the side fences 137 via a screw as a fastener or an attachment-detachment member according to the width of the conveyed materials. The side nozzle units 11A and 11B function as the second air jetting unit being an isolation blower or an air jetting device to jet and blow side air to a side end of the conveyed material bundle 1. The side nozzle units 11A and 11B include, for example, side air nozzles 370 and a side blower 380 similar to those illustrated in, e.g., FIGS. 4 and 7. The side nozzle unit 11A is detachably attached relative to the left and right side fences 137 at the upstream side in the conveyance direction X in FIG. 8A. The side nozzle unit 11B is detachably attached relative to the left and right side fences 137 at the downstream side in the conveyance direction X in FIG. 8A. Note that the configuration of the side nozzle units 11A and 11B are not limited to the above-described configuration but may be the following configuration. For example, only the side air nozzles 370 are detachably attached relative to the side fences 137 and the side blower 380 is secured to the body frame 101 in an area outside the range of movement of the side fences 137 in the width direction of conveyed materials. The side air nozzles 370 and the side blower 380 may be communicated with each other via a flexible duct being expandable and contractible.

**[0051]** A difference other than the above-described differences is that the suction units 6A to 6C are additionally provided. Another difference is that the multifeed detecting sensor 5, the ionizer 7, and the laser feed monitor 8 are additionally provided. The multifeed detecting sensor 5 is a multifeed detector that detects the presence of multifeed of the conveyed materials being conveyed. A known ultrasonic sensor, for example, using ultrasonic waves may be used as the multifeed detecting sensor 5.

**[0052]** The suction units 6A to 6C are disposed below the conveyed materials being conveyed and arranged similarly to the conveyed-material floating-retaining-conveying device 160 illustrated in FIG. 1, with the conveyed-material retainer facing upward. The suction units 6A to 6C attract and retain a conveyed material, which is conveyed by the retaining conveyance units 3A to 3F, by air suction force and convey the conveyed material to a further downstream side.

**[0053]** Reasons that the suction units 6A to 6C are employed are, for example, as follows. By attracting and conveying the conveyed materials, such as prepregs, by the suction units 6A, 6B, and 6C disposed downstream from the retaining conveyance units 3A, 3B, and 3C, pressed marks or damage are less given to the conveyed materials than a configuration in which the conveyed materials, such as prepregs, are pressed and conveyed by, e.g., a roller. Thus, such a problem of conveyance specific to material sheets used for electronic circuit board materials can be resolved. In a case in which a component, such as glass fiber, is contained in the conveyed materials, the glass fiber may become powdery, and separated and scattered from the end portions (front and rear end portions and lateral end portions) of the conveyed materials. One reason that the suction units 6A to 6C are employed is to prevent powder substances, such as glass fiber, from adhering to a conveyance roller and damaging and degrading a surface of the conveyance roller, for example, in a configuration in which the conveyance roller employs a friction rotation system and is disposed downstream from the retaining conveyance units 3A to 3F to convey the above-described type of conveyed materials. Such a configuration also prevents a conveyed material subsequently conveyed from being damaged by powder substances, such as glass fiber, adhering to and remaining on the surface of the conveyance roller. The ionizer 7 is a unit or a device to diselectrify the conveyed materials being conveyed. The laser feed monitor 8 is a unit or a device to measure skew of the conveyed materials being conveyed.

**[0054]** A configuration of the front nozzle units 2A, 2B, and 2C is similar to the configuration of the air jetting nozzle device 300 according to the above-described embodiment illustrated in FIGS. 1 to 4. Common specifications in, e.g., the shape, attachment dimensions, internal components, and blowers, are employed for the front nozzle units 2A, 2B, and 2C. The front nozzle units 2A, 2B, and 2C are detachably attached relative to the front end guide plate 138 via a screw 102 as a fastener or an attachment-detachment unit, in accordance with the width of the conveyed materials. The

front end guide plate 138 is secured to the body frame 101 with a fastener, such as a screw. The front end guide plate 138 includes a plurality of screw holes 103 as an attachment-detachment unit to attach and detach the front nozzle units 2A, 2B, and 2C in accordance with the width of the conveyed materials. For simplification of illustration, the front nozzle unit 2C is illustrated as an example in which one screw 102 is used and fastened into one screw hole 103. Actually, however, the front nozzle units 2A, 2B, and 2C are fastened with more than one screws at more than one positions, respectively, so as to be reliably secured to the front end guide plate 138. The fastener or the fastening member is not limited to the screw 102, and may be, for example, a clamp member capable of fastening and releasing fastening in one-touch operation.

**[0055]** Common specifications in, e.g., shape, internal components, and blowers, are employed for the six retaining conveyance units 3A to 3F. The six retaining conveyance units 3A to 3F are detachably attached relative to an upper body frame 101b, which is secured to an upper portion of the body frame 101, with the screw 102 in accordance with the width of the conveyed materials. A plurality of screw holes 103 is formed in the upper body frame 101b to attach the retaining conveyance units 3A to 3F, in accordance with the width of the conveyed materials. For simplification of illustration, the retaining conveyance unit 3A is illustrated as an example in which one screw 102 is used and fastened into a single screw hole 103. Actually, the retaining conveyance units 3A to 3F are fastened with more than one screws at more than one positions, so as to be reliably secured to the upper body frame 101b. The fastener or the fastening member is not limited to the screw 102, and may be, for example, a clamp member capable of fastening and releasing fastening in one-touch operation.

**[0056]** The body frame 101 functions as a body of the conveyed-material separation device provided as a structural body. A pair of body side plates as a structural body is disposed on the body frame 101 with the two side fences 137 on each of the right and left sides interposed in between the pair of body side plates. The pair of body side plates is fixedly attached to both sides of the body frame 101 in the conveyance direction X. On the body side plates, the upper body frame 101b is provided as a structural body and fixedly attached. In FIG. 8A, a state is illustrated in which the pair of body side plates are removed. For example, the upper body frame 101b may be prepared in different sizes corresponding to the number of retaining conveyance units 3A to 3F that are detachably attached relative to the upper body frame 101b. In addition, securing positions of the body side plates to be secured on the body frame 101 may be changed. As a result of this, various combinations of the retaining conveyance units are attachable. The attachment of the retaining conveyance units 3A to 3F to the upper body frame 101b is not limited to the above-described configuration. For example, a plurality of screw holes commonly usable for the upper body frame 101b may be formed corresponding to positions at which the retaining conveyance units 3A to 3F are selectively attached.

**[0057]** For example, with the above-described detachably attachable configuration of the front nozzle units 2A, 2B, and 2C and the retaining conveyance units 3A to 3F, the following arrangement and operational use are available in FIG. 8A. For example, when small-sized conveyed materials are used, only the front nozzle unit 2B and the retaining conveyance unit 3B, which are disposed in the center of the conveyed material, are attached and used with other front nozzle units and the retaining conveyance units removed. When large-sized conveyed materials are used, all of three front nozzle units 2A, 2B, and 2C and all of the six retaining conveyance units 3A to 3F are attached and used, as illustrated in FIG. 8A. When medium-sized conveyed materials are used, two adjacent front nozzle units 2A and 2B or two adjacent front nozzle units 2B and 2C, and corresponding adjacent retaining conveyance units 3A, 3B, 3D and 3E or adjacent retaining conveyance units 3B, 3C, 3E, and 3F are attached and used at appropriate positions in the width direction Y of the medium-sized conveyed material. Thus, in the conveyed-material conveyance apparatus 100, the retaining conveyance units 3A to 3F are used as at least one retaining unit or a plurality of retaining units, and the positions of such retaining units can be changed according to the width of the conveyed material in the width direction Y of the conveyed material perpendicular to the floating direction of the conveyed material. With the above-described detachably attachable configuration, the side nozzle units 11A and 11B are also arranged and driven for use, under a technical thought similar to that of the front nozzle units 2A, 2B, and 2C and the retaining conveyance units 3A to 3F.

Example 1

**[0058]** The following table 1 shows a relationship of arrangement of the retaining conveyance units 3A to 3F, the side nozzle units 11A and 11B, and the front nozzle units 2A, 2B, and 2C. FIGS. 8B to 8G are plan views of examples of the arrangement of the units of Embodiment 1 in table 1. In Table 1, the conveyed-material length L represents the length of a conveyed material in the conveyance direction X of the conveyed material (longitudinal dimension). The conveyed-material width W represents the width (lateral dimension) of a conveyed material in the width direction Y of the conveyed material. As illustrated in FIG. 1, the numbers and arrangement of the respective units are associated with each other in accordance with the combination of the range of the conveyed-material length L and the range of the conveyed-material width W. For example, the numbers and arrangement of the respective units are associated with each other as illustrated in FIGS. 8B to 8G with parentheses.

Table 1

| Conveyed-material length L [mm] | Conveyed-material width W [mm] | Number of Retaining conveyance units | Number of Side nozzle units | Number of Front nozzle units | Arrangement of Units |
|---|---|---|---|---|---|
| 250≤L≤350 | 250≤W≤300 | 1 | 2 | 1 | UA (FIG. 8B) |
| 350<L≤650 | | 2 | 4 | 1 | UB (FIG. 8C) |
| 250≤L≤350 | 300≤W≤420 | 2 | 2 | 2 | UC (FIG. 8D) |
| 350≤L≤650 | | 4 | 4 | 2 | UD (FIG. 8E) |
| 250≤L≤350 | 420≤W≤650 | 3 | 2 | 3 | UE (FIG. 8F) |
| 350<L≤650 | | 6 | 4 | 3 | UF (FIG. 8G) |

**[0059]** In Table 1, for example, a conveyance material having a conveyed-material length L of 300 mm and a conveyed-material width W of 300 mm is associated with a unit arrangement of UA (FIG. 8B). In other words, for the unit arrangement of UA, the numbers of the retaining conveyance units, the side nozzle units, the front nozzle units are 1, 2, and 1, respectively.

**[0060]** FIGS. 8B to 8G are examples of the arrangements corresponding to the unit arrangements of UA, UB, UC, UD, UE, and UF shown in table 1. As illustrated in FIGS. 8B to 8G, in accordance with the sizes of the conveyed material (the conveyed-material length L: vertical size, and the conveyed-material width W: horizontal size). Units indicated by shading and broken line In FIGS. 8B to 8G are units to be operated. The retaining conveyance units 3A, 3C, 3D, 3E, and 3F indicated by broken lines in FIG. 8B and the retaining conveyance units indicated by 3A, 3C, 3D, and 3F indicated by broken lines represent the positions and states in which the respective units are removed from the upper body frame 101b. In FIGS. 8D, 8E, and 8F, the retaining conveyance units removed from the upper body frame 101b are omitted for simplicity. Note that the ranges of the conveyed-material length L and the conveyed-material width W, the numbers of units, and the arrangements of the respective units are only examples and are not limited to them.

**[0061]** The retaining conveyance units 3A to 3F are described by focusing on what differs from the conveyed-material floating-retaining-conveying device 160 of the above-described embodiment illustrated in FIG. 1 and so on. Since the retaining conveyance units 3A to 3F have a common configuration, the retaining conveyance unit 3A is described as a representative. FIG. 9 is a cross sectional side view of a portion of the retaining conveyance unit 3A used in Embodiment 1, when seen diagonally from the upper right. FIG.10 is a perspective view of the retaining conveyance unit 3A when seen diagonally from a lower right side thereof. FIG. 11 is a perspective view of the air flow of the suction air of the retaining conveyance unit when seen diagonally from a lower left side thereof. FIG. 12 is a perspective view of areas retained by conveyance belts of the retaining conveyance unit.

**[0062]** The retaining conveyance unit 3A mainly differs from the conveyed-material floating-retaining-conveying device 160 in that a retaining unit 165 including conveyance belts 161a, 161b, and 161c is used in place of the conveyance belt 161, as illustrated in FIGS. 9 to 11. The conveyance belts 161 a, 161b, and 161c are formed by dividing a conveyance belt into three parts to be identical with each other and have the same circumferential length. The conveyance belt 161a and the conveyance belt 161b that form the retaining conveyance unit 3A are arranged on both sides of and across the central conveyance belt 161c in the width direction Y of the conveyed materials. The conveyance belt 161c is stretched over a tension roller 167, a free roller 162c, and a driven roller 163c. The free roller 162c has a diameter smaller than the diameter of a drive roller 162a or a drive roller 162b, and the driven roller 163c has the same diameter as the diameter of a driven roller 163a or a driven roller 163b. The tension roller 167 is disposed further above the upper surfaces of the conveyance belts 161a, 161b at a position closer to the downstream side in the conveyance direction X. The tension roller 167 is supported rotatably to a unit frame via a shaft 167s. The conveyance belt 161a is stretched between the drive roller 162a and the driven roller 163a. The conveyance belt 161b is stretched between the drive roller 162b and the driven roller 163b.

**[0063]** The drive rollers 162a, 162b and the free roller 162c are mounted on the common drive shaft 162s. Only the free roller 162c is guided and supported at a predetermined gap from the drive shaft 162s to allow free rotation. Each of the drive rollers 162a and 162b is integrally molded with the corresponding drive shaft 162s. The driven rollers 163a, 163b, and 163c are integrally molded with and mounted on the common driven shaft 163s. The drive shaft 162s and the driven shaft 163s are supported rotatably to the unit frame 169, which is the unit body of the retaining conveyance unit 3A, via bearings. Thus, as illustrated in FIGS. 9 to 11, there is a difference in height in the vertical direction Z between the belt retaining surfaces of the conveyance belt 161c located in the center of the width direction Y of the conveyed

material and the conveyance belts 161a and 161b located on both sides of the conveyance belt 161c.

**[0064]** The drive shaft 162s is coupled with a drive motor 168, which is a conveyance belt drive unit, via a teethed pulley and a teethed belt, both of which function as rotation transmitters. The drive motor 168 is secured to the unit frame 169 via a motor mount fixed to the unit frame 169, to drive and rotate the conveyance belts 161a and 161b via the drive rollers 162a and 162b. The conveyance belt 161c is driven by the rotational force of the driven roller 163c that is driven to rotate in accordance with the rotation of the conveyance belts 161a, 161b. Thus, the conveyance belts 161a, 161b, and 161c are run to rotate at the same circumferential speed in the same rotational direction indicated by arrows in FIG. 9.

**[0065]** As illustrated in FIGS. 10 to 12, a plurality of suction holes 164 is formed in the conveyance belts 161a, 161b, and 161c to retain the conveyed material. Note that, in FIGS. 10 to 12, the suction holes 164 are illustrated as if the suction holes 164 are formed at a portion of a lower side of the conveyance belts 161 a, 161b, and 161 c. However, in this example, the conveyance belts 161 a, 161b, and 161c are formed over the whole circumference of each of the conveyance belts 161 a, 161b, and 161c c

**[0066]** As illustrated in FIG. 11, the suction blower 390 is driven to generate the air flow of the suction air Ad. Both a suction duct 311 connected to the suction blower 390 and a negative pressure air chamber 310 connected to the suction duct 311 come to a negative pressure state. As a result, the suction air Ad is sucked from the suction holes 164 of the conveyance belts 161 a, 161b, and 161c to attract and retain the conveyed material on the belt retaining surfaces of the conveyance belts 161a, 161b, and 161c. As illustrated in FIG. 12, a retaining area 166, which is illustrated in a transparent manner, for retaining the conveyed material is formed on the retaining conveyance unit 3A in the width direction Y of the conveyed material. The retaining area 166 corresponds to an area where many suction holes 164 are formed in the conveyance belts 161a, 161b, and 161c.

**[0067]** Next, return nozzle units 9A, 9B are described with reference to FIG. 13. FIG. 13 is a back view of an arrangement of the return nozzle units. Note that floating air Aa illustrated in FIG. 13 is generated with a floating blower 330, is stored in the air chamber 320, and is jetted from the two floating nozzles 322. Since the return nozzle units 9A and 9B have a common configuration, the return nozzle unit 9A is described as a representative. The return nozzle unit 9A includes a return nozzle 9b with an opening 9a to suck the return air Ar formed therein and a return air suction blower 9c connected to the return nozzle 9b. The sirocco fan, for example, may be used as the return air suction blower 9c. As illustrated in FIGS. 8A and 13, the return nozzle units 9A and 9B are disposed between two adjacent units of the front nozzle units 2A, 2B, and 2C. Specifically, the return nozzle units 9A and 9B are disposed between the retaining conveyance units 3A and 3B and between the retaining conveyance units 3B and 3C, respectively, in the width direction Y of the conveyed material.

**[0068]** Next, operation of Embodiment 1 is described by referring to FIGS. 8A and 14 to 16. FIG. 14 is an illustration of steps to be executed by the conveyed-material conveyance apparatus of Embodiment 1. Specifically, FIG. 14 is a flowchart of start timing of driving of various types of air. FIG. 15 is a front view of the conveyed-material separation device in a state in which conveyed materials are isolated and separated with the conveyed-material separation device and attracted and retained by one of the plurality of retaining conveyance units. FIG. 16 is a schematic view of action of return air in Embodiment 1. Note that, in the retaining step described later, as illustrated in FIG. 16, the suction blowers 390 of all of the six retaining conveyance units 3A to 3F are operated. However, FIG. 15 shows, as a representative, the state in which the conveyed material 1A is attracted and retained with the retaining conveyance unit 3A.

**[0069]** Next, operation and process steps of the conveyed-material conveyance apparatus 100 are described subsequently, in which similar descriptions already given in connection with the embodiments with reference to FIGS. 1 to 7 are omitted as much as possible. It is assumed that the large-sized conveyed materials are used. (1) A preparation step for preparing the conveyed materials in a stacked state (step S10 of FIG. 14) is similar to step S1 of the above-described embodiment illustrated in FIG. 5. (2) When the conveyed-material feeding instruction is received from the controller of the conveyed-material conveyance apparatus 100 of FIG. 8A, the operation of the isolation blower starts. The isolation blower includes the floating blower 330 and the side blower 380 of each of the front nozzle units 2A, 2B, and 2C. Accordingly, the floating step for blowing the air to the end portions of the conveyed materials starts (step S11 of FIG. 14). When side air Ac is blown from the four side air nozzles 370 while floating air Aa is blown from the floating nozzles 322 of the air chamber 320, the uppermost conveyed materials 1A, 1B, and 1C on the stack table 136 prepared float up. As a result, the contact area is changed between adjacent conveyed materials of the uppermost conveyed materials 1A, 1B, and 1C (see the state in which no return air Ar is blown in FIG. 16A).

(3) At the same time, the retaining step for retaining the floated conveyed materials starts (step S12 of FIG. 14). The suction blowers 390 at all of the six retaining conveyance units 3A to 3F are operated to generate the suction air Ad. Air suction starts by the conveyance belts 161 a, 161b, and 161c (hereinafter simply referred to as the conveyance belts 161) of the retaining conveyance units 3A to 3F. The uppermost conveyed material 1A is floated and, in the state in which the return air Ar has not been blown as illustrated in FIG. 16A, the uppermost conveyed material 1A is attracted and retained by the conveyance belts 161. At this time, the rear end portion of the conveyed material 1A is securely attracted and retained by the conveyance belt 161 of the retaining conveyance units 3D to

3F disposed on the upstream side in the conveyance direction X. As a result of this, the contact area and contact time between the rear end portion of the first conveyed material 1A, which has been attracted and retained by the conveyance belt 161, and the floating second conveyed material 1B can be minimized. As described above, even when the glass or the like become powdery and is separated and flowed from the end portions (the front and rear end portions and the side end portions) of the conveyed materials 1, the contact between the rear end portion of the first conveyed material 1A and the second conveyed material 1B can be avoided as much as possible. Therefore, the damage of the conveyed materials 1A, 1B can be prevented.

As describe above, In Embodiment 1, the floating air Aa from the floating nozzles 322 and the side air Ac from the side air nozzles 370 are blown simultaneously to apply the wind pressure uniformly to the bundle 1 of the conveyed materials. As a result, the overfloat and the behavioral disturbance are suppressed to prevent multifeed at the beginning of the blowing.

(4) Subsequently, after the first conveyed material 1A is attracted and retained by the conveyance belts 161 of the retaining conveyance units 3A to 3F, the return air suction blowers 9c of the return nozzle units 9A and 9B are operated to generate the return air Ar. The return air Ar sucks the floated second and subsequent conveyed materials 1B, 1C at the end portions, which are located on the downstream side of the conveyance direction X, in a direction opposite to the floating direction, to thereby increase the gap between the floated second and subsequent conveyed materials 1B and 1C (see the portions surrounded by broken lines in FIG. 16B). Since the space is formed between the conveyed materials 1B and 1C by increasing the gap between the floated second and subsequent conveyed materials 1B and 1C, the next floating air Aa used for floating, attracting, and retaining of the second conveyed material 1B can easily come into the space between the conveyed materials 1B and 1C. As a result of this, the separating performance of the two and subsequent conveyed materials 1B and 1C can be significantly improved by the return air Ar of the return nozzle units 9A and 9B. Since the return air Ar includes (or sucks), as illustrated in FIG. 16A, circumferential stagnated air, the influence caused by the disturbance of air can be decreased.

Simultaneously, the four side blowers 380 are operated to execute an isolation step (step S13 of FIG. 14) to blow the side air Ac from the four side air nozzles 370 to the side-end portions of the floated second and subsequent conveyed materials 1B, 1C. The first conveyed material 1A retained by the conveyance belts 161 is clearly isolated from the second and subsequent conveyed materials 1B and 1C, to thereby prevent the defect, such as the multifeed or no supply, and perform the separation of the conveyed materials easily and securely.

(5) In FIG. 8A, the conveyance belts 161 and the suction units 6A to 6C start to operate to execute a conveyance step for conveying the conveyed material 1A retained by the conveyance belts 161 (step S14 of FIG. 14). After the conveyed material 1A has reached the sheet feeding sensor 179, the rotational conveyance operation of the conveyance belts 161 is stopped. Below, the operation that are substantially similar to the operation of the above-described embodiment is performed to subsequently convey the conveyed materials.

**[0070]** The floating step described in the above-described (1) and (2) above is additionally described. When floating air Aa is blown from the floating nozzles 322 of the front nozzle units 2A, 2B, and 2C of FIG. 13 and side air is blown from the side air nozzles as described above, the conveyed material 1A, 1B, and 1C float and separate as illustrated in FIG. 15. When the conveyed material 1A, 1B, and 1C float and separate, the above-described retaining step is started. Thus, the suction blowers 390 of all of the six retaining conveyance units 3A to 3F operate and air suction with the conveyance belts 161a, 161b, and 161c of the retaining conveyance units 3A to 3F starts. For example, taking an example of the retaining conveyance unit 3A, the sucked and attracted state of the conveyed material 1A is as follow. For example, as illustrated in FIG. 15, a central leading end portion 1Ac of the conveyed material 1A is deformed in a curved manner to project upward (inverted U-shape) by the suction air Ad from the belt retaining surface of the conveyance belt 161c as a central step portion segmented in the conveyance belt 161.

**[0071]** A central left portion 1Aa and central right portion 1Ab corresponding to the left-side conveyance belt 161a and the right-side conveyance belt 161b, respectively, are retained on the belt retaining surface within the formation range of the belt retaining surface, by suction air Ad blown from the belt retaining surface. A left-side leading end portion 1Aaa and a right-side leading end portion 1Abb (the right side of the conveyed material 1A is cut and omitted in FIG. 15) separated away from the belt retaining surface further hang down toward lateral ends of the conveyed material 1A.

**[0072]** Since the retaining surface of the retaining conveyance unit 3A does not exist in the rear end portion 1Ar of the conveyed material 1A, the first conveyed material 1A is disposed approximately horizontally to the belt retaining surface. The air flow of the side air Ac toward the rear end of the conveyed material 1A keeps the floating state of the conveyed material 1A and bulges the center of the conveyed material 1A, such that the conveyed material 1A comes to an upward arch shape (semi-circular shape) when seen from the rear end portion.

**[0073]** For the subsequent conveyed material 1B and 1C, as illustrated in FIG. 15, a central leading end portion thereof is deformed in a curved manner to project upward (inverted U-shape) by floating air and side air, and floats in such a manner that the leading end thereof further hangs down toward lateral ends thereof by its own weight. The floating and separated state illustrated in FIG. 15 is just an example in which a conveyed material of a type has a thickness of from

0.02 mm to 0.2 mm. Although depending on the material type, for example, as the thickness approaches 0.02 mm and is smaller, the degree of the above-described curve is greater. By contrast, as the thickness approaches 0.2 mm and is greater, the degree of the above-described curve is smaller and the conveyed material floats in a state closer to a horizontal state. When the side air does not act on the second and subsequent conveyed materials 1B and 1C, the conveyed materials 1B and 1C does not float and are retained similarly to the initial stacked state.

**[0074]** In the floating, retaining, and isolation steps described above, a difference in shape between the first conveyed material 1A and the second conveyed material 1B occurs as a separated state, and the conveyed materials deform in the belt retaining direction, thus allowing the conveyed materials to be reliably separated from each other. Accordingly, the multifeed of the conveyed materials can reliably be prevented.

**[0075]** During the conveyance of the first conveyed material 1A, the retained shape of the first conveyed material 1A can be maintained by the retaining force of the belt, while the shape of the first conveyed material 1A changes every moment during the conveyance by receiving stress continuously. Therefore, the separation of the conveyed materials can be facilitated. After floating, the conveyed material is shaped to be away from the conveyed material having the end portions thereof retained in the retaining step or the conveyed materials mounted in the stacked state.

**[0076]** The following effects can be achieved by the technical configurations of Embodiment 1 described above. According to a first technical configuration of Embodiment 1, the conveyed-material separation device includes the air jetting units, such as the front nozzle units 2A, 2B, and 2C, to float an end of stacked conveyed materials, such as the conveyed material bundle 1 stacked, and at least one retaining unit, such as the retaining conveyance unit 3A, 3B, or 3C, to retain and separate the floated conveyed materials. The position of the at least one retaining unit is adjustable according to the width of the conveyed materials in the width direction, such as the width direction Y, perpendicular to the floating direction of the conveyed-materials. According to the first technical configuration of Embodiment 1, the conveyed-material separation device capable of easily separating the conveyed materials according to the width of the conveyed materials is provided without generating a failure, such as multifeed or no feed.

**[0077]** According to a second technical configuration of Embodiment 1, in the conveyed-material separation device according to the first technical configuration, the at least one retaining unit is detachably attachable relative to the body, such as the body frame 101, of the conveyed-material separation device. According to a third technical configuration of Embodiment 1, in the conveyed-material separation device according to the first or second technical configuration, the at least one retaining unit includes a plurality of retaining units, such as the retaining conveyance units 3A, 3B, 3C, 3D, 3E, and 3F, and the retaining units constitute a plurality of common units that are detachably attachable relative to the body of the conveyed-material separation device. According to the third technical configuration, the number of components constituting the units and cost can be reduced.

**[0078]** According to a fourth technical configuration of Embodiment 1, in the conveyed-material separation device according to the third technical configuration, the plurality of common units is disposed at three positions corresponding to a center portion and both end portions of the conveyed material in the width direction on a downstream side in the conveyance direction of the conveyed materials. According to a fifth technical configuration of Embodiment 1, in the conveyed-material separation device according to the fourth technical configuration, the plurality of units is disposed at three positions including the center and both sides of the conveyed material in the width direction on the downstream side of the conveyance direction of the conveyed materials. According to the fifth technical configuration, the conveyed-material separation device capable of easily separating the conveyed materials according to the width (lateral dimension) and the length (longitudinal dimension) of the conveyed materials is provided. In addition, it is possible to prevent damages caused by the rear end portion of the conveyed material, which is retained by the plurality of units disposed on the upstream side of the conveyance direction, by coming into contact with the floated conveyed material or the like.

**[0079]** According to a sixth technical configuration of Embodiment 1, in the conveyed-material separation device according to the fourth or fifth technical configuration, the suction units, such as the return nozzle units 9A and 9B, are included, the suction units sucking the floated conveyed material in a direction opposite to the floating direction after the conveyed material is retained by the plurality of units, the plurality of floating units are disposed corresponding to the plurality of units, and the suction units are disposed between adjacent floating units of the plurality of floating units in the width direction. According to the sixth technical configuration, the influence of disturbance of air is suppressed, and the conveyed materials can be separated easily and securely.

**[0080]** Embodiment 1 may also include the following configuration. For example, the four side fences 137 illustrated in FIG. 8A include the size detectors of the conveyed materials capable of automatically detecting the width of the conveyed material when the side end faces of the conveyed material are positioned. The controller provided in the conveyed-material conveyance apparatus 100 may inform based on the size data of the conveyed material obtained as a result of the positioning of the lateral direction of the conveyed material by the four side fences 137. For example, the following notice or alert may be displayed on a liquid crystal display (LCD) display screen or the like at an input unit, such as an operation panel disposed at the conveyed-material conveyance apparatus 100. That is, for example, a message or alert may be displayed as follow: "The size of the conveyed material is not compatible with the configuration of the apparatus. Therefore, please remove and attach the front nozzle units 2A, 2B, and 2C, the retaining conveyance

units 3A to 3F, or the return nozzle units 9A and 9B of FIG. 8A." Alternatively, the front nozzle units 2A, 2B, 2C, the retaining conveyance units 3A to 3F, or the return nozzle units 9A, 9B of FIG. 8A may be automatically moved rather than being removed and attached by a service operator or a user (such a modification will be included within the concept of the present invention).

Variation 1 of Embodiment 1

**[0081]** Variation 1 differs from the above-described Embodiment 1 as follows. For example, for Variation 1, in a state illustrated in FIG. 8A in which all of the front nozzle units 2A, 2B, and 2C and the six retaining conveyance units 3A to 3F are attached and mounted, the conveyed-material conveyance apparatus 100 can separate and convey a conveyed material of a maximum size usable in the conveyed-material conveyance apparatus 100. The front nozzle units 2A, 2B, and 2C and the six retaining conveyance units 3A to 3F are selectively driven and used according to the size of the conveyed materials to be used.

**[0082]** In the variation 1, when small-sized conveyed materials, for example, are used, only the front nozzle unit 2B disposed in the center of the conveyed material is driven. When large-sized conveyed materials are used, all of the three front nozzle units 2A, 2B, 2C are driven. When intermediate-sized conveyed materials are used, the two adjacent front nozzle units 2A and 2B or the two adjacent front nozzle units 2B and 2C are driven. In addition, when the small-sized conveyed materials are used, only the retaining conveyance unit 3A disposed corresponding to the center of the conveyed material is driven. When the large-sized conveyed materials are used, all of the six retaining conveyance units 3A to 3F are driven. When the intermediate-sized conveyed materials are used, the adjacent retaining conveyance units 3A, 3B, 3D, and 3E or the adjacent retaining conveyance units 3B, 3C, 3E, and 3F are driven. the adjacent retaining conveyance units 3A, 3B, 3D, and 3E or the adjacent retaining conveyance units 3B, 3C, 3E, and 3F are arranged at appropriate positions in the width direction Y of the conveyed material during the conveyance of the intermediate-sized conveyed materials.

**[0083]** In the above-described examples of Embodiment 1 and Variation 1, the plurality of units including the front nozzle units 2A, 2B, and 2C and the six retaining conveyance units 3A to 3F has a common configuration. However, in some embodiments, the plurality of units may not have a common configuration.

**[0084]** According to Variation 1, the effects of Embodiment 1 described above can be obtained with a configuration with a simple structure.

Embodiment 2

**[0085]** Next, a conveyed-material conveyance apparatus according to Embodiment 2 is described below by focusing on differences from the conveyed-material conveyance apparatus 100 according to Embodiment 1. According to Embodiment 2, in the conveyed-material conveyance apparatus 130 of FIG. 8A, the three front nozzle units 2A, 2B, and 2C and the six retaining conveyance units 3A to 3F are not detachably attachable and have the following configuration. For example, according to Embodiment 2, a conveyed-material conveyance apparatus of Embodiment 2 is configured to allow separation and conveyance of a largest size of the conveyed materials usable in the conveyed-material conveyance apparatus. The front nozzle units 2A, 2B, and 2C and the six retaining conveyance units 3A to 3F are selectively driven and used according to the size of the conveyed materials to be used.

**[0086]** With reference to FIG. 8A, for example, with all of the three front nozzle units 2A, 2B, and 2C attached, the front nozzle units 2A, 2B, and 2C may be selectively driven and used according to the size of the conveyed material. For example, when small-sized conveyed materials, for example, are used, only the front nozzle unit 2B disposed in the center of the conveyed material is driven. When large-sized conveyed materials are used, all of the three front nozzle units 2A, 2B, 2C are driven. When intermediate-sized conveyed materials are used, the two adjacent front nozzle units 2A and 2B or the two adjacent front nozzle units 2B and 2C are driven. The two front nozzle units 2A and 2B, or 2B and 2C are arranged at appropriate positions in the width direction Y of the conveyed material during the conveyance of the intermediate-sized conveyed materials.

**[0087]** In addition, with all of the retaining conveyance units 3A to 3F attached, the retaining conveyance units 3A to 3F may be selectively driven and used according to the size of the conveyed material. For example, when the small-sized conveyed materials are used, only the retaining conveyance unit 3A disposed corresponding to the center of the conveyed material is driven. When the large-sized conveyed materials are used, all of the six retaining conveyance units 3A to 3F are driven. When the intermediate-sized conveyed materials are used, the adjacent retaining conveyance units 3A, 3B, 3D, and 3E or the adjacent retaining conveyance units 3B, 3C, 3E, and 3F are driven. Note that the adjacent retaining conveyance units 3A, 3B, 3D, and 3E or the adjacent retaining conveyance units 3B, 3C, 3E, and 3F are arranged at appropriate positions in the width direction Y of the conveyed material during the conveyance of the intermediate-sized conveyed materials.

**[0088]** In the above-described example of Embodiment 2, the plurality of units including the front nozzle units 2A, 2B,

and 2C and the six retaining conveyance units 3A to 3F has a common configuration. However, in some embodiments, the plurality of units may not have a common configuration.

**[0089]** In Embodiment 2, the effects of Embodiment 1 mentioned above can also be achieved with a simpler configuration.

**[0090]** Below, another embodiment differing from the above-described embodiment illustrated in FIGS. 1 to 7 is described with reference to FIGS. 17 to 20. FIG. 17 is a front view of a conveyed-material conveyance apparatus 230 including a conveyed-material floating-retaining-conveying device 260 as the conveyed-material separation device according to another embodiment of the present invention. FIG. 18 is a plan view of the conveyed-material conveyance apparatus 230 of FIG. 17. FIGS. 19A to 19C are schematic views of operational transition states of the conveyed-material conveyance apparatus 130. FIGS. 20A to 20C are schematic views of operational transition states of the conveyed-material conveyance apparatus 130 following the state of FIG. 19C.

**[0091]** The embodiment illustrated in FIGS. 17 and 18 differs from the above-described embodiment illustrated in FIGS. 1 to 4 in that the conveyed-material conveyance apparatus 230 is used in place of the conveyed-material conveyance apparatus 130. The conveyed-material conveyance apparatus 230 includes the conveyed-material sensor 20, the conveyed-material position controller to control driving of the elevation assembly to control the position of the upper surface of the conveyed material bundle 1, and the front end guide plate 138, which are similar to, even if not the same as, those of the conveyed-material conveyance apparatus 130 of FIGS. 1 to 4. The conveyed-material conveyance apparatus 230 includes, for example, the pair of side fences 137, the end fences 139, the side air nozzles 370, and the side blower 380, which are similar to, even if not the same as, those of the conveyed-material conveyance apparatus 130. Likewise, the conveyed-material conveyance apparatus 230 includes the air chamber 320 and the air jetting nozzle device 300 including the floating nozzles 322, which are similar to, even if not the same as, those of the conveyed-material conveyance apparatus 130.

**[0092]** The conveyed-material conveyance apparatus 230 illustrated in FIGS. 17 and 18 differs from the conveyed-material conveyance apparatus 130 in that a conveyed-material floating retaining conveyance device 260 is used in place of the conveyed-material floating-retaining-conveying device 160 illustrated in FIGS. 1 to 4. The conveyed-material floating retaining conveyance device 260 differs from the conveyed-material floating-retaining-conveying device 160 illustrated in FIGS. 1 to 4 in that an attraction roller 261 illustrated in FIGS. 17 and 18 is used in place of the conveyance belt 161. Below, a description is further given of the configuration of the conveyed-material floating retaining conveyance device 260 differing from the conveyed-material floating-retaining-conveying device 160.

**[0093]** As illustrated in FIGS. 17 and 18, the conveyed-material floating-retaining-conveying device 260 includes the attraction roller 261, a negative-pressure air chamber 263, a shutter 270, an air pipe 235 as a suction duct, and a suction fan 280 as a suction air generator to generate suction air. Note that the suction air generator is not limited to the suction fan 280 but may be, for example, an air compressor or any other suitable type of suction air generator. The attraction roller 261 includes a shaft 261s rotatably supported on a body frame. The shaft 261s is coupled with a drive motor 268 as a drive device. The drive motor 268 drives the attraction roller 261 to rotate in a direction to reel out a conveyed material. The shutter 270 is a valve to control on-and-off of the flow of suction air, generated by driving of the suction fan 280, from the negative-pressure air chamber 263 and the attraction roller 261 disposed downstream from the shutter 270.

**[0094]** The attraction roller 261 is an attraction rotator of a roller shape having a plurality of suction holes 264 in an outer circumferential portion thereof. The attraction roller 261 includes the negative-pressure air chamber 263. The negative-pressure air chamber 263 is communicated with the shutter 270 via the air pipe 235 and communicated with and connected to the suction fan 280 via the air pipe 235. In the attraction roller 261, the suction holes 264 are disposed at upper positions opposite a front end portion of the conveyed material bundle 1 stacked on the stack table 136. As described above, the attraction roller 261 is communicated with the shutter 270 and connected to the suction fan 280 via the air pipe 235 connected to the negative-pressure air chamber 263. In the attraction roller 261, air in the negative-pressure air chamber 263 is sucked by the external suction fan 280 and the negative-pressure air chamber 263 is maintained in a state of negative pressure. Accordingly, the uppermost conveyed material 1A is sucked and attracted through the suction holes 264 of the attraction roller 261.

**[0095]** As described above, the attraction roller 261 of the conveyed-material floating-retaining-conveying device 260 functions as a retaining unit (retaining member) to attract and retain a floated conveyed-material by a negative pressure generated by air suction to separate the floated conveyed-material from other conveyed materials and a conveyor to convey the retained conveyed-material. Note that the size of the conveyed-material floating-retaining-conveying device 260 may be increased in accordance with the size of the conveyed material.

**[0096]** Next, an example of operation of the conveyed-material conveyance apparatus 230 including the conveyed-material floating-retaining-conveying device 260 is described with reference to FIGS. 19A t0 19C and 20A to 20C. When a conveyed-material feeding instruction is received from a controller of the conveyed-material conveyance apparatus 230 of FIGS. 19A o 19C, the stack table 136 elevates up as indicated by arrow D1 in FIG. 19A and stops at a predetermined position. The term "predetermined position" used herein represents a position at which the conveyed material 1A at an

uppermost surface of the conveyed material bundle 1 stacked on the stack table 136 floats as described later and is attractable by the attraction roller 261. At this time, the shutter 270 is closed. Next, as illustrated in FIG. 19B, with the shutter 270 closed, floating air Aa is blown from floating nozzles of the air chamber toward a front end face of the conveyed material bundle 1 stacked on the stack table 136, and side air is blown from side air nozzles. Such air floats up the conveyed material 1A, 1B, and 1C at an upper portion of the conveyed material bundle 1 stacked on the stack table 136. Thus, the conveyed material 1A at the uppermost face of the conveyed material bundle 1 floats up to a position close to the height of the attraction roller 261 (the conveyed-material retainer). Accordingly, the contact areas between the uppermost conveyed materials 1A, 1B, and 1C are changed by floating the uppermost conveyed materials 1A, 1B, and 1C prepared on the stack table 136 (floating step).

**[0097]** By activating and operating the suction fan 280 with the shutter 270 closed, suction air is generated, thus generating a negative pressure. Next, as illustrated in FIG. 19C, when the shutter 270 is open, the attraction roller 261 is turned into a state of negative pressure and the conveyed material 1A at the uppermost face is attracted and retained by the attraction roller 261 (retaining step). At this time, the uppermost conveyed material 1A retained on the attraction roller 261 is not always separated as a single sheet, but one or more conveyed materials may be in close contact with the conveyed material 1A. Hence, the side air nozzles, which are disposed as the isolation blowers on the side fences, blow the side air to isolate the conveyed material 1A retained by the attraction roller 261 from other conveyed materials to be a single sheet (isolation step).

**[0098]** Then, as illustrated in FIG. 20A, when the attraction roller 261 is driven to rotate in a direction indicated by arrow D2 in FIG. 20A, the conveyed material 1A attracted and separated is conveyed to a destination of conveyance downstream in the conveyance direction X (conveyance step). A feeding sensor is disposed at a downstream side in the conveyance direction X in the conveyed-material conveyance apparatus 230 to detect the arrival of the conveyed material. When the feeding sensor determines that the conveyed material 1A has arrived the destination of conveyance, as illustrated in FIG. 20B, the shutter 270 is closed to turn the inside of the negative-pressure air chamber 263 into the atmospheric pressure. When the conveyed material 1A passes out from the attraction roller 261 after a predetermined time has passed, the rotational conveyance driving of the attraction roller 261 is stopped (FIG. 20C). Note that, when conveyed materials are continuously conveyed, the operation of FIG. 20A is continuously performed.

**[0099]** The floating amount or the isolation state of the conveyed materials differs depending on thickness, weight, or size of the stacked conveyed materials when the air volume is fixed at a certain value. For example, if the floating amount of the conveyed materials is small, no supply (no feed) of the conveyed materials occurs. In contrast, if the conveyed material is floated exceedingly, the conveyed materials come in close contact with each other to cause the multifeed. If the power of the suction fan 280 is small, the conveyed materials cannot be conveyed successfully, and the no-supply also occurs.

**[0100]** To properly execute feeding of the conveyed materials, the air volume is previously fixed according to the stacked conveyed materials, such that the fixed air volume is reached automatically when the user or operator chooses the conveyed material to be fed. The air volume is adjusted according to a duty ratio of the blower.

**[0101]** As described above, the conveyed-material conveyance apparatus 230 according to this embodiment employing the attraction roller 261 and so on resolves the above-described problem similar to that of the above-described embodiment and obtains the effects equivalent to those of the above-described embodiment.

**[0102]** Similarly with the above-described Embodiments 1 and 2, in the conveyed-material conveyance apparatus 230, the conveyed-material floating-retaining-conveying devices 160 is arranged as a plurality of units in the width direction or the conveyance direction of the conveyed material, in accordance with the size of the conveyed material. The positions of the plurality of units may be configured to be adjustable or detachably attachable, thus obtaining effects equivalent to those of Embodiments 1 and 2. In addition, the plurality of units may be configured to be selectively driven and used. Further, the above-described configurations may be combined.

**[0103]** Although the preferred embodiments of the present invention have been described above, it should be understood that the embodiments of the present invention are not limited to the specific embodiments described above, and various variations and modifications are included within the scope of the appended claims unless otherwise limited in the present invention. For example, the embodiment of the present invention may be provided by appropriately combining technical requirements described in the embodiments, the variation, or the like. The embodiments of the present invention are not limited to a case in which the conveyed material is a prepreg or a circuit board sheet including an electronic circuit board material. The embodiments of the present invention are also applicable to technical fields of a sheet separation device and a sheet conveyance device to separate sheets of paper including very large-sized sheets of paper (e.g., having a width of about 700 mm), special paper, such as coated paper, or films for the overhead projector (OHP) and so on.

**[0104]** The retaining conveyance units are not limited to the retaining conveyance units 3A to 3F of, e.g., Embodiment 1. For example, a plurality of conveyor belts of a common configuration (or different configurations) not forming a step portion may be used in place of the conveyance belts 161 a, 161b, and 161c forming the above-described central step portion. For example, a plurality of (for example, three) conveyance belts, which has the same configuration as the

conveyance belt 161 of the conveyed-material floating-retaining-conveying device 160 used in the above-described embodiment, may be arranged side by side in the width direction of the conveyed material.

**[0105]** The effects and advantages recited in the above-described embodiments and variation of the present invention are only examples of preferable effects and advantages obtained from the present invention. The effects and advantages obtained from the present invention are not limited to those of the above-described embodiments and variations.

## Claims

**1.** A conveyed-material separation device (100, 130, 230) comprising:

an air jetting unit (370, 322) to jet air to stacked conveyed materials (1) to float an end of a conveyed material (1A); and
a retaining unit (3A to 3F) to retain and separate the conveyed material floated by the air jetting unit (370, 322),

wherein a position of the retaining unit is changeable according to a width dimension of the conveyed material in a width direction (Y) perpendicular to a floating direction (D1) of the conveyed material.

**2.** The conveyed-material separation device according to claim 1,
wherein the retaining unit (3A to 3F) is detachably attachable relative to a body (101) of the conveyed-material separation device.

**3.** The conveyed-material separation device according to claim 1 or 2,
wherein the retaining unit (3A to 3F) includes a plurality of retaining units (3A to 3F), and
wherein the plurality of retaining units (3A to 3F) constitutes a plurality of common units detachably attachable relative to the body of the conveyed-material separation device.

**4.** The conveyed-material separation device according to claim 3,
wherein the plurality of common units (3A to 3F) is disposed at three positions including a center portion and both end portions in the width direction (Y) of the conveyed material on a downstream side in a conveyance direction (X) of the conveyed material.

**5.** The conveyed-material separation device according to claim 4,
wherein the plurality of common units (3A to 3F) is further disposed at three positions including a center portion and both end portions in the width direction (Y) of the conveyed material on an upstream side in the conveyance direction (X) of the conveyed material.

**6.** The conveyed-material separation device according to claim 4 or 5, further comprising a suction unit (9A, 9B) to suck the floated conveyed material in a direction opposite to the floating direction (D1) after the conveyed material is retained by the plurality of common units (3A to 3F),
wherein the air jetting unit (370, 322) includes a plurality of air jetting units (370, 322) disposed corresponding to the plurality of common units, and
wherein the suction unit (9A, 9B) is disposed between the plurality of air jetting units in the width direction.

**7.** The conveyed-material separation device according to claim 3,
wherein the plurality of retaining units (3A to 3F) is disposed at positions capable of retaining a conveyed material having a maximum size usable in the conveyed-material separation device, and
wherein the plurality of retaining units is selectively driven and used according to a size of the conveyed material to be used.

**8.** A conveyed-material separation device comprising:

an air jetting unit (370, 322) to jet air to stacked conveyed materials (1) to float an end of a conveyed material (1A); and
a plurality of retaining units (3A to 3F) to retain and separate the conveyed material floated by the air jetting unit (370, 322),
wherein the plurality of retaining units (3A to 3F) is disposed at positions capable of retaining a conveyed material having a maximum size usable in the conveyed-material separation device, and

wherein the plurality of retaining units (3A to 3F) is selectively driven and used according to a size of the conveyed material to be used.

**9.** The conveyed-material separation device according to claim 8, wherein the plurality of retaining units is a plurality of common units.

**10.** A conveyed-material separation device comprising:

the conveyed-material separation device according to any one of claims 1 to 9; and
a conveyor to convey the conveyed material retained by conveyed-material separation device.

FIG. 1

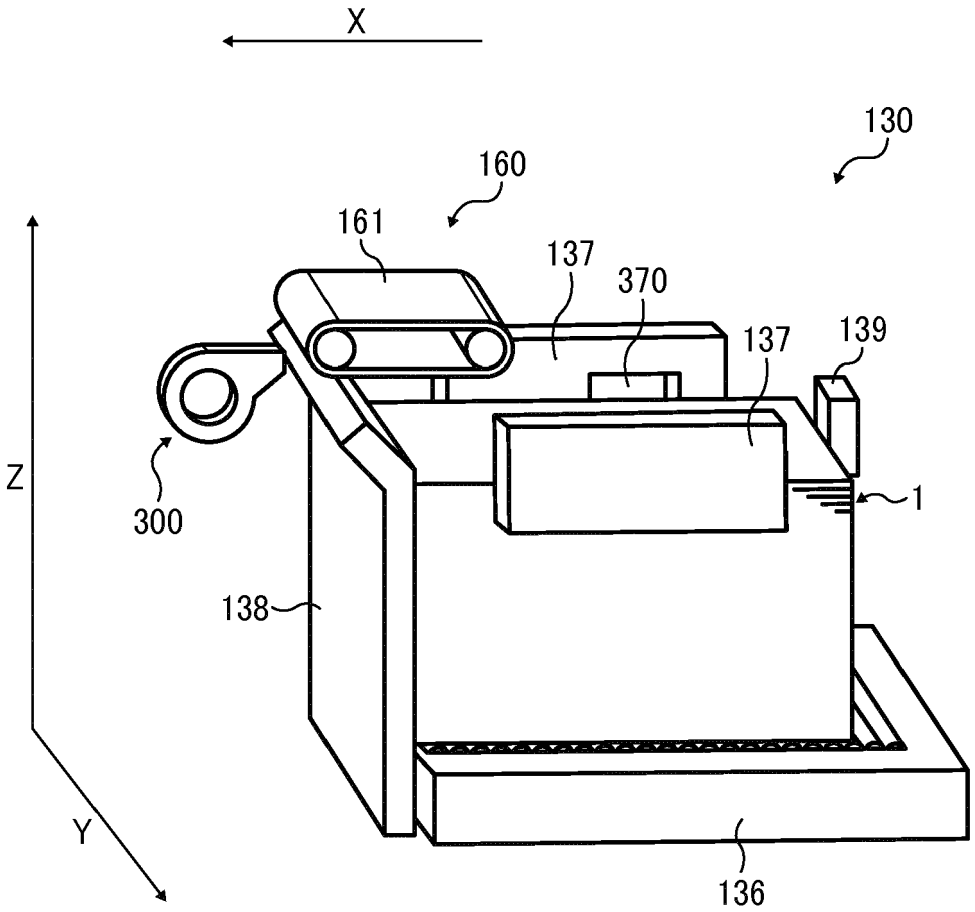


FIG. 2

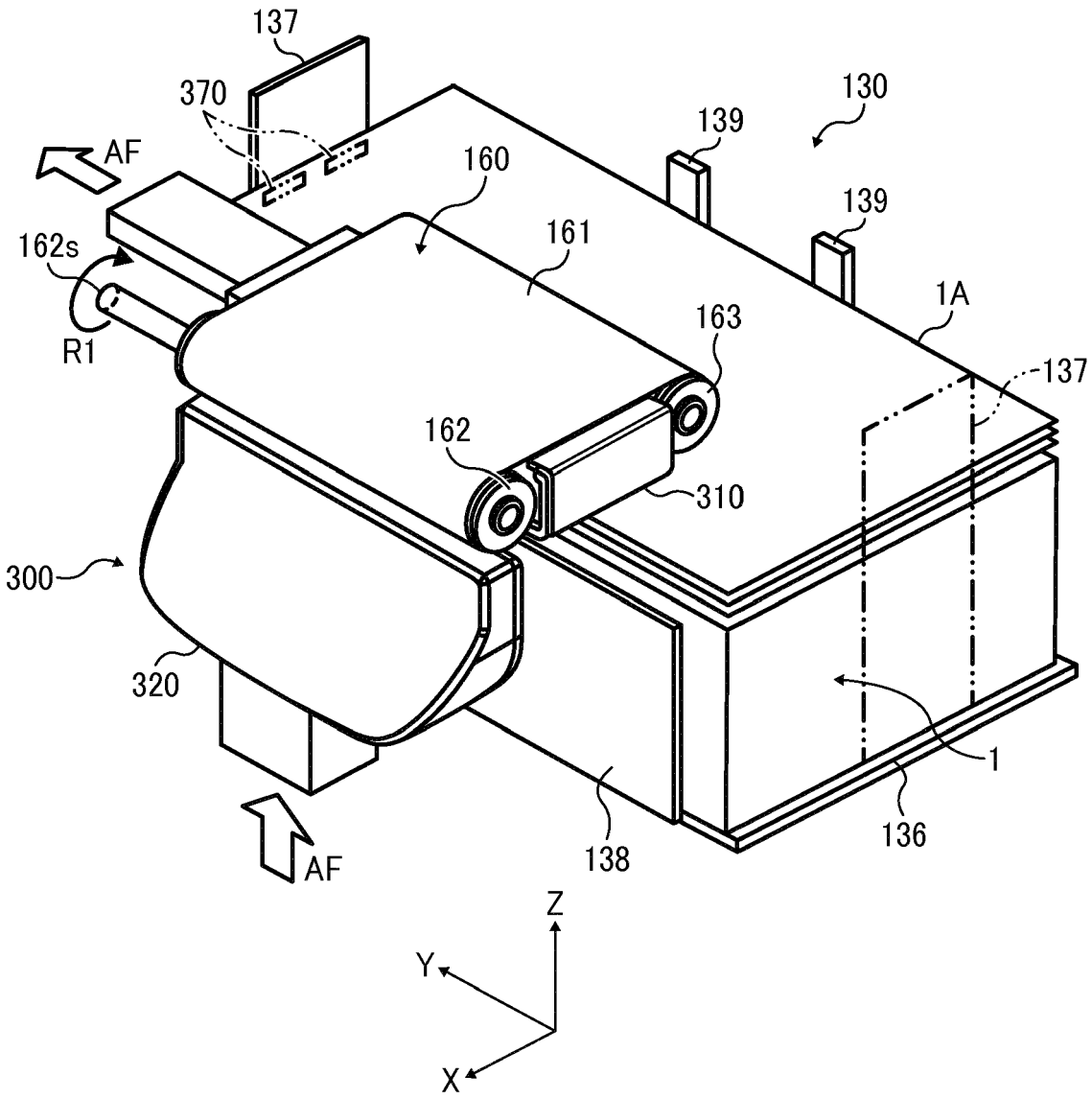

137
370
130
139
AF
160
139
162s
161
1A
163
R1
137
162
310
300
320
1
136
AF
138
Z
Y
X

FIG. 3

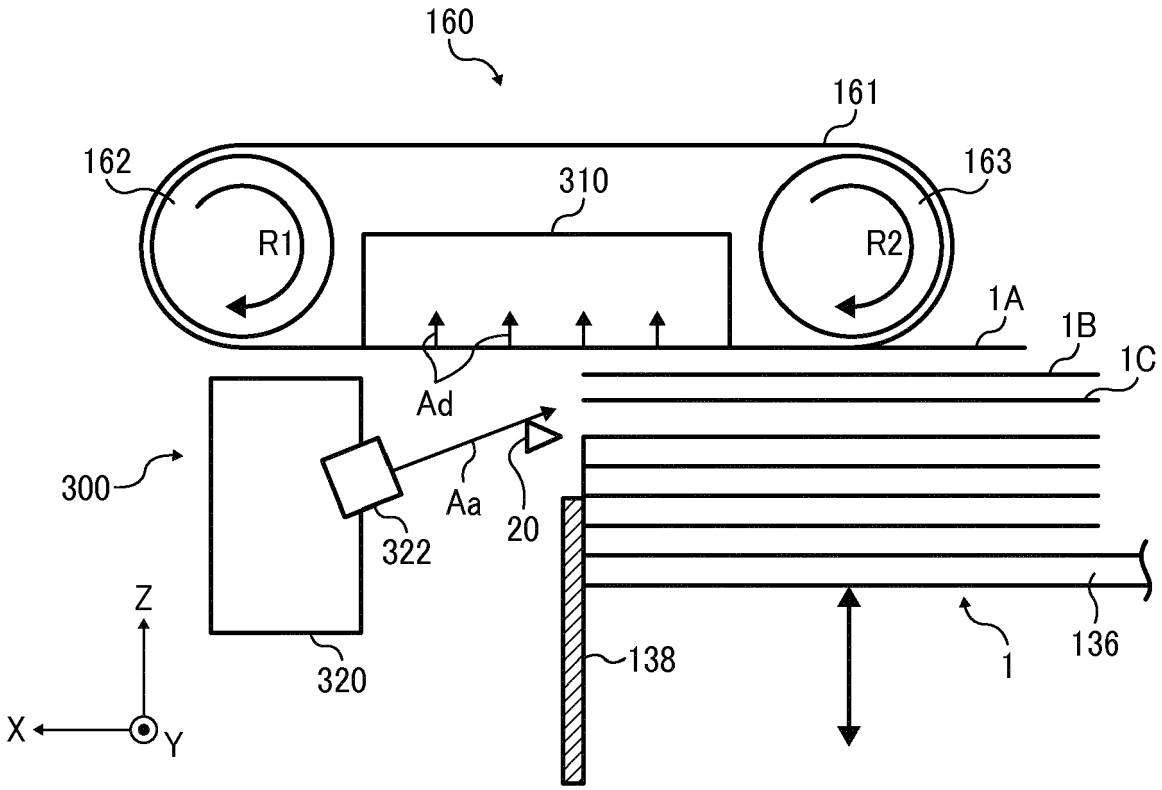

160
161
162
163
310
R1
R2
1A
1B
1C
Ad
300
Aa
20
322
Z
320
138
1
136
X
Y

FIG. 4

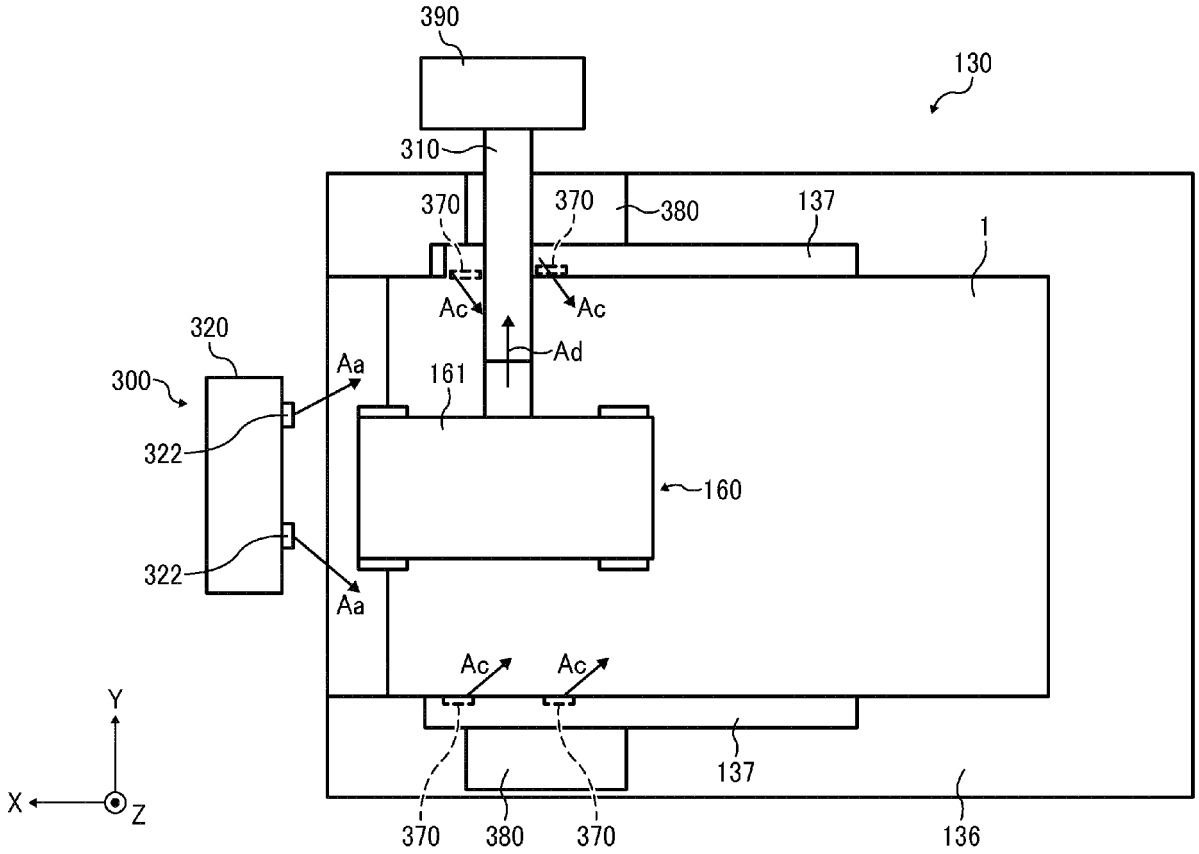

390
130
310
370
370
380
137
1
Ac
Ac
320
Ad
300
Aa
161
322
160
322
Aa
Ac
Ac
Y
X
Z
137
370
380
370
136

FIG. 5

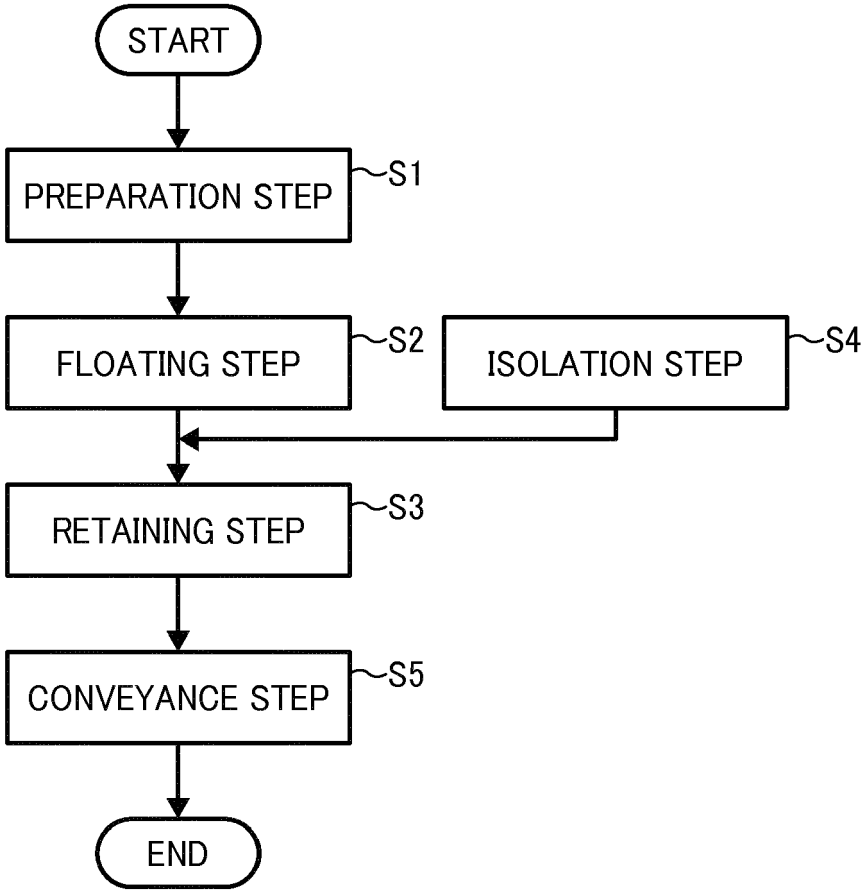

START
PREPARATION STEP
S1
FLOATING STEP
S2
ISOLATION STEP
S4
RETAINING STEP
S3
CONVEYANCE STEP
S5
END

FIG. 6A

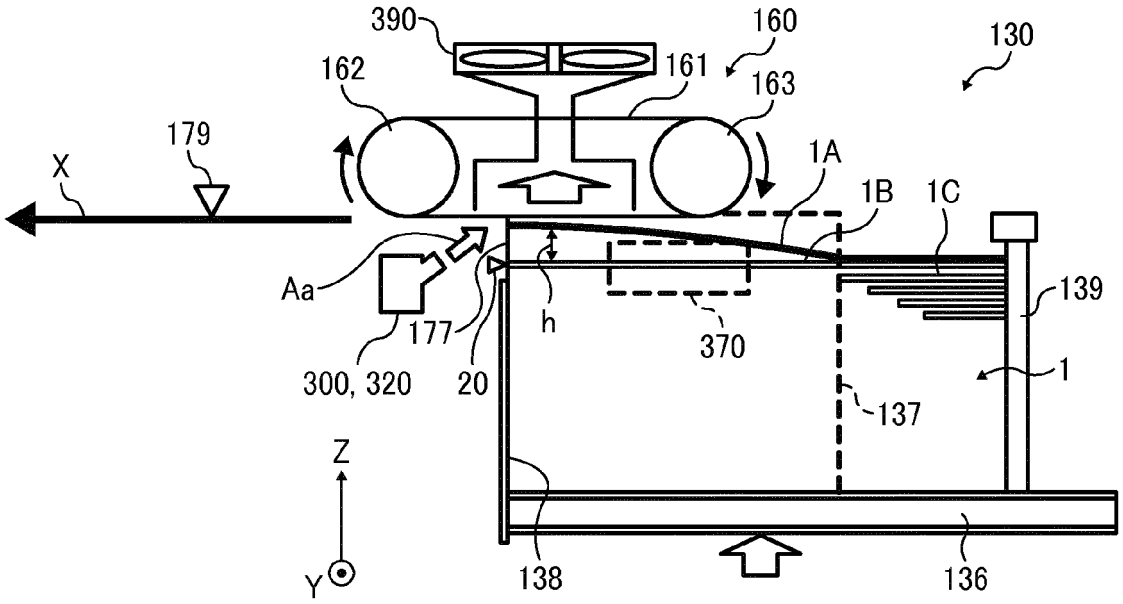

390
160
130
162
161
163
179
X
1A
1B
1C
Aa
177
h
370
139
1
300, 320
20
137
Z
Y
138
136

FIG. 6B

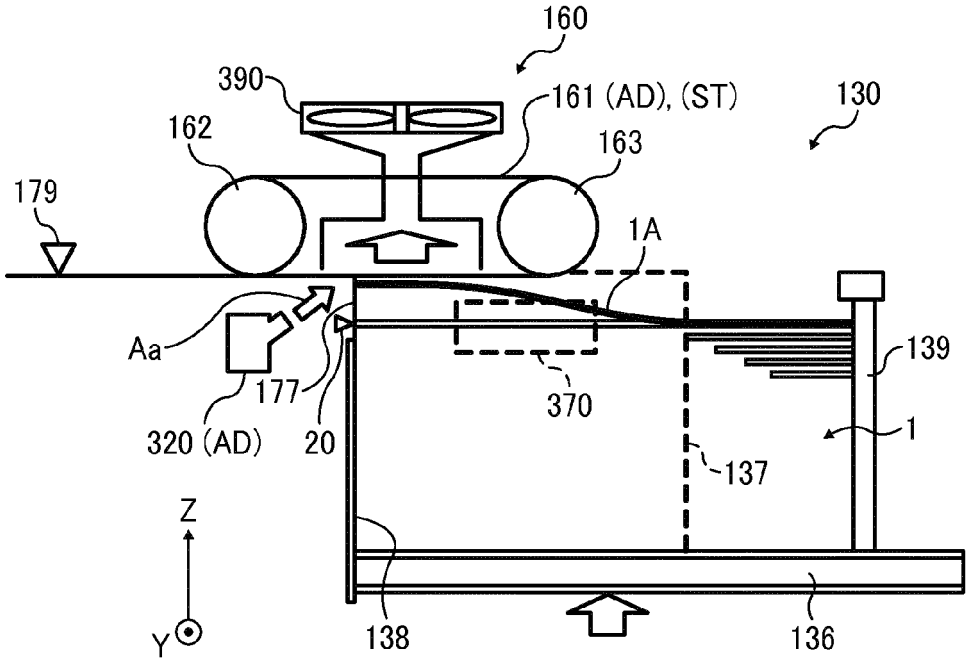

160
390
161 (AD), (ST)
130
162
163
179
1A
Aa
177
370
139
1
320 (AD)
20
137
Z
Y
138
136

FIG. 6C

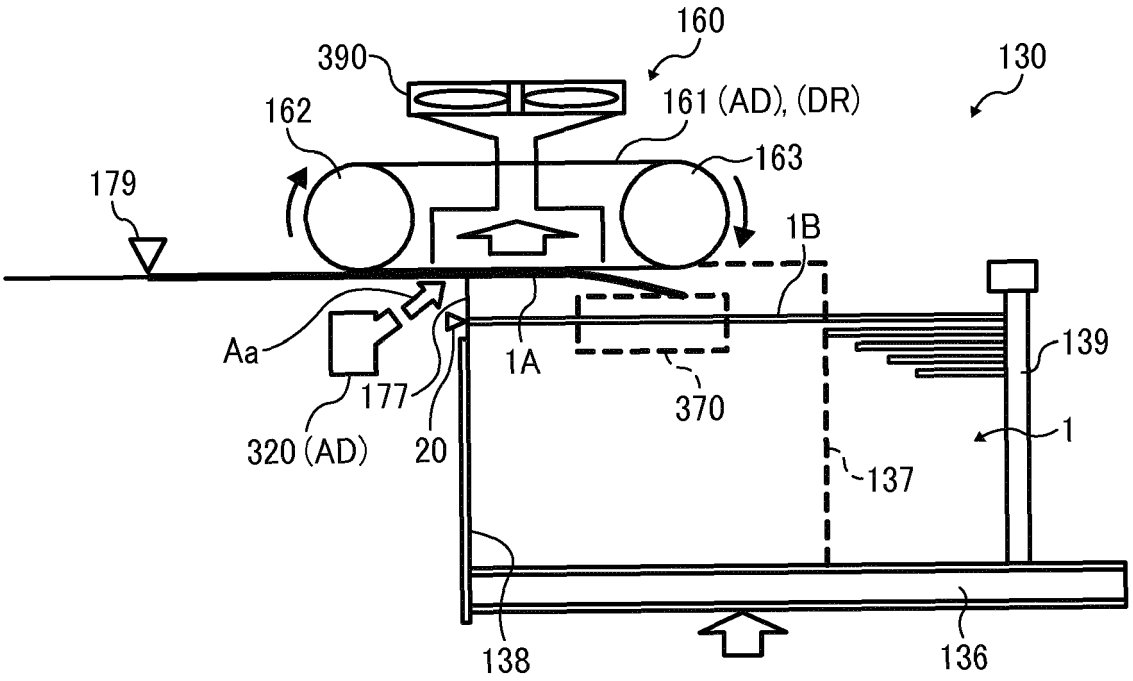

160
390
130
162
161 (AD), (DR)
163
179
1B
Aa
1A
139
177
370
1
320 (AD)
20
137
138
136

FIG. 7A

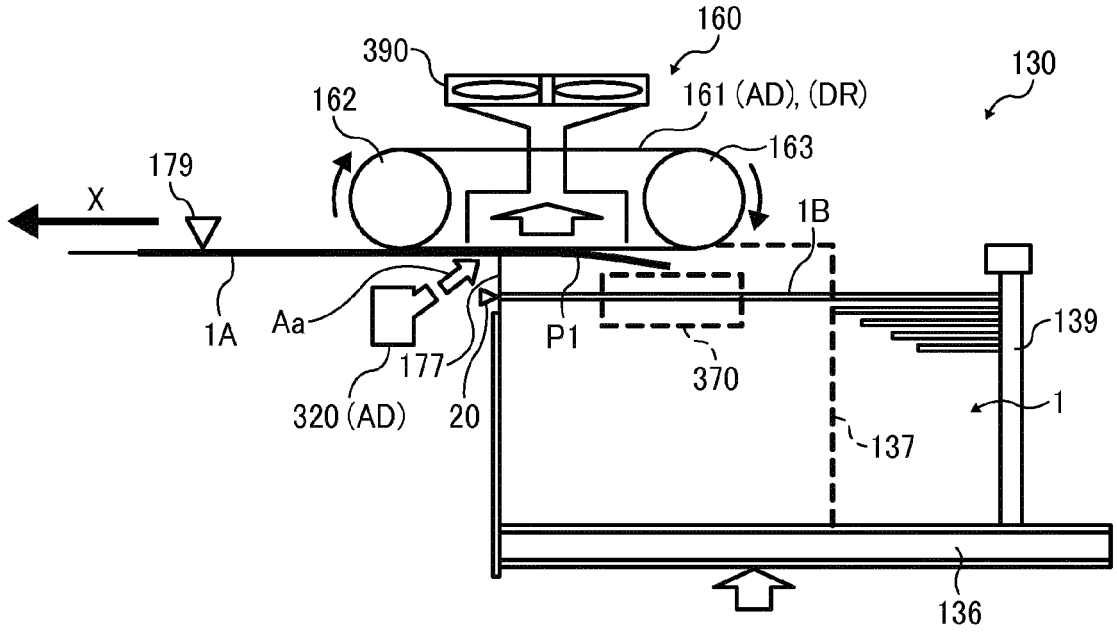

160
390
130
162
161 (AD), (DR)
163
179
X
1B
1A
Aa
P1
139
177
370
320 (AD)
20
1
137
136

FIG. 7B

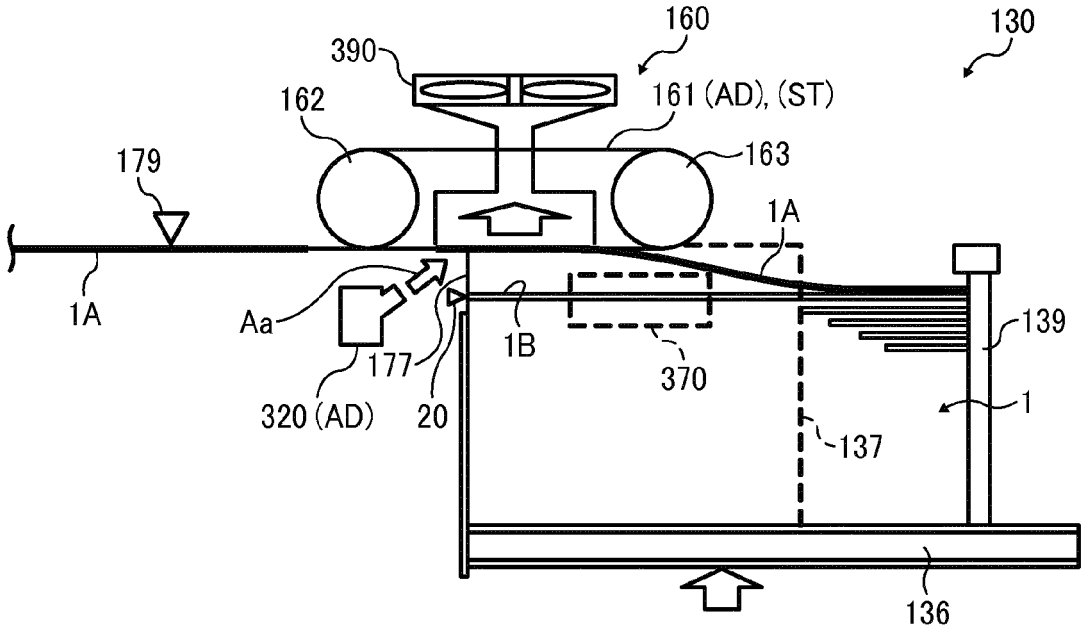

160
390
130
162
161 (AD), (ST)
163
179
1A
1A
Aa
1B
139
177
370
320 (AD)
20
1
137
136

FIG. 8A

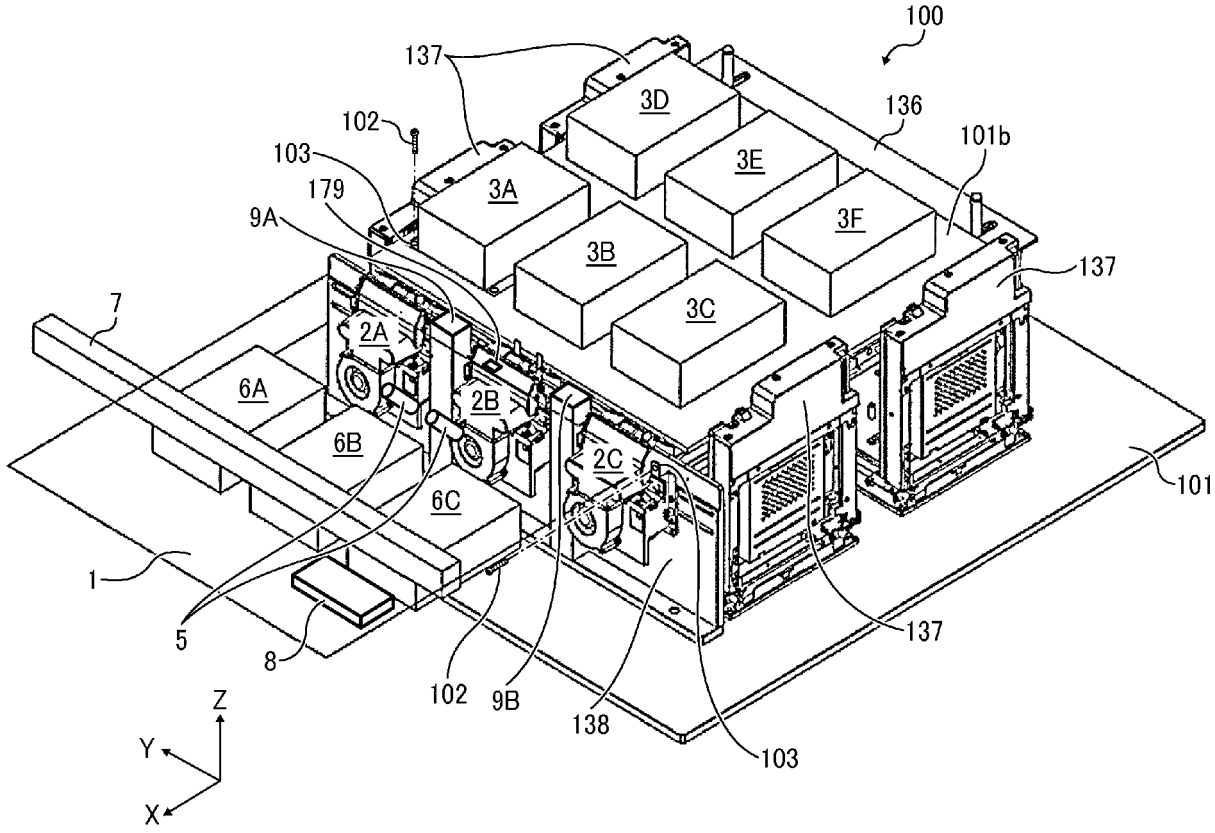

100
137
3D
136
102
101b
103
3E
179
3A
9A
3F
3B
137
7
3C
2A
6A
2B
6B
2C
101
6C
1
137
5
8
102
9B
138
103
Z
Y
X

FIG. 8B

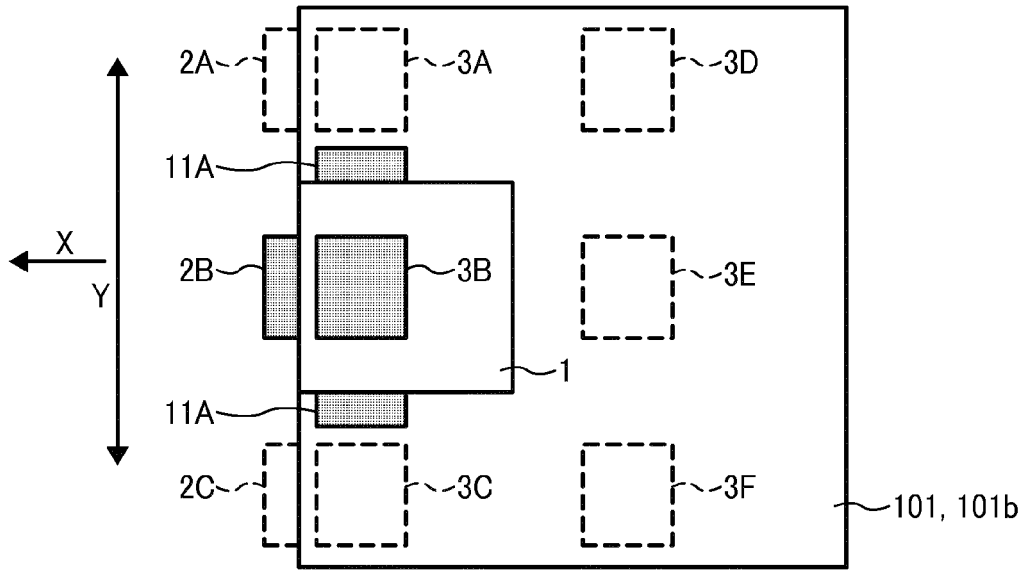

2A
3A
3D
11A
X
Y
2B
3B
3E
1
11A
2C
3C
3F
101, 101b

FIG. 8C

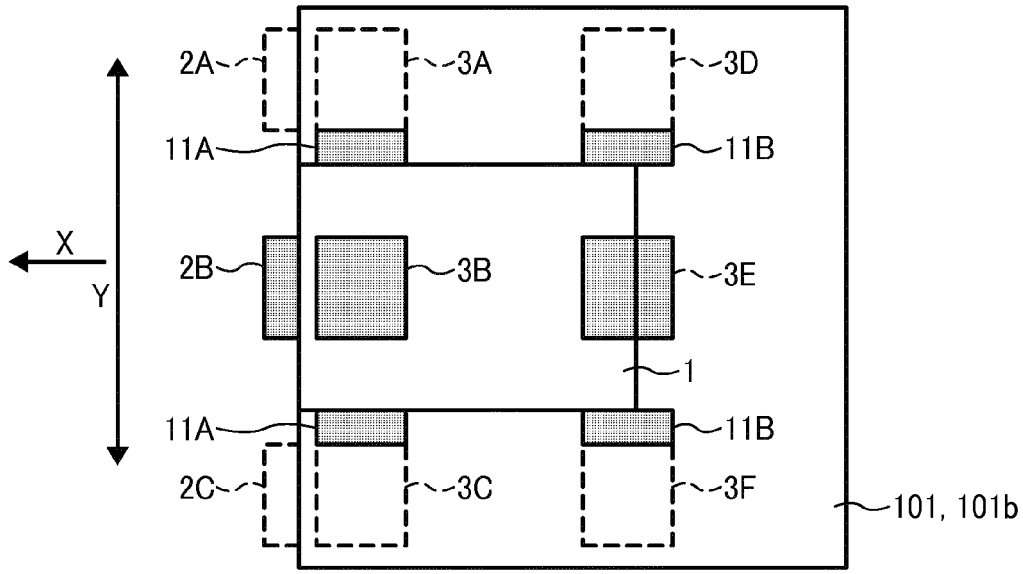

2A
3A
3D
11A
11B
X
Y
2B
3B
3E
1
11A
11B
2C
3C
3F
101, 101b

FIG. 8D

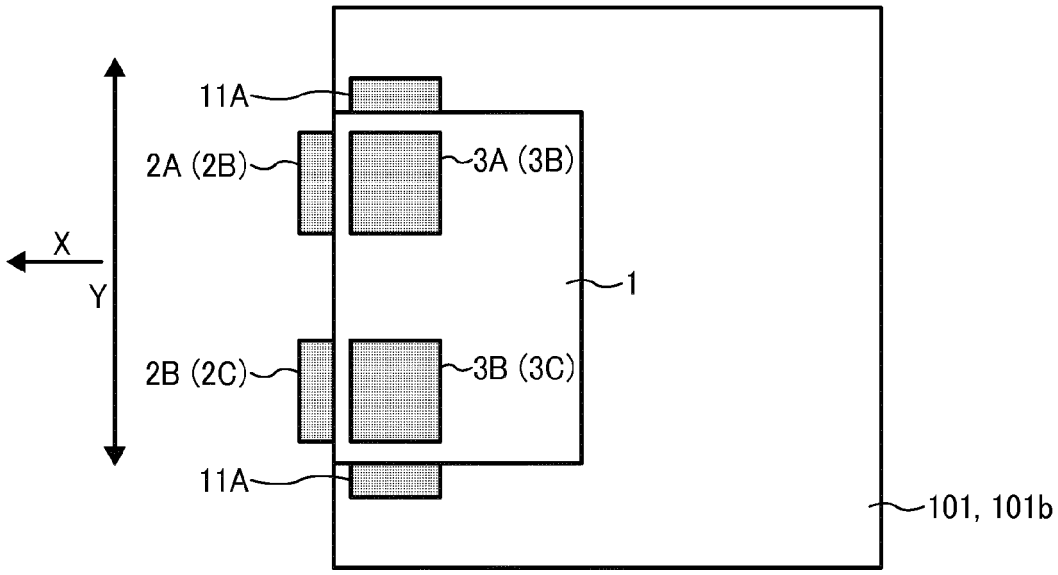

11A
2A (2B)
3A (3B)
X
Y
1
2B (2C)
3B (3C)
11A
101, 101b

FIG. 8E

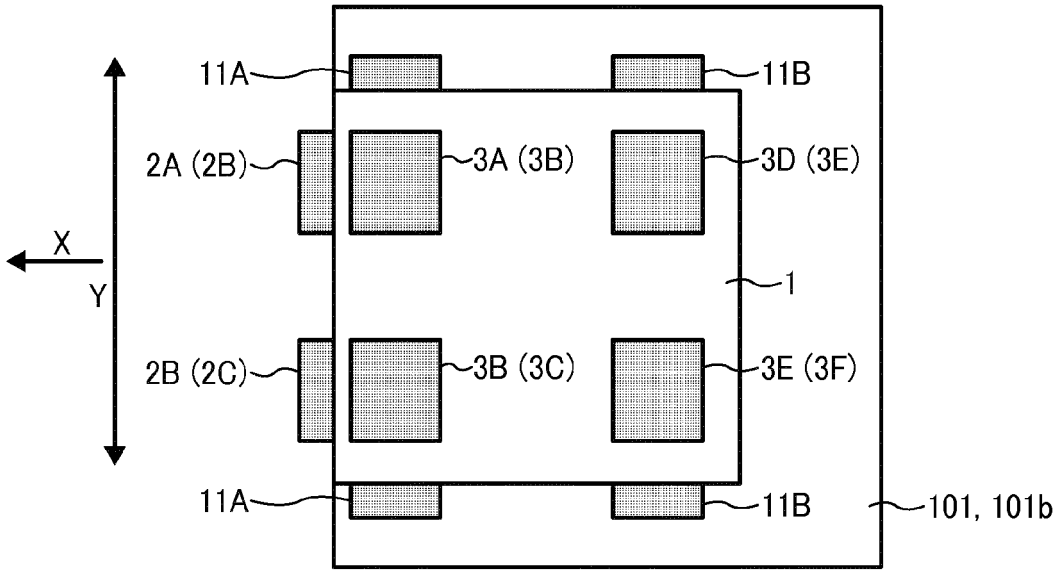

11A
11B
2A (2B)
3A (3B)
3D (3E)
X
Y
1
2B (2C)
3B (3C)
3E (3F)
11A
11B
101, 101b

FIG. 8F

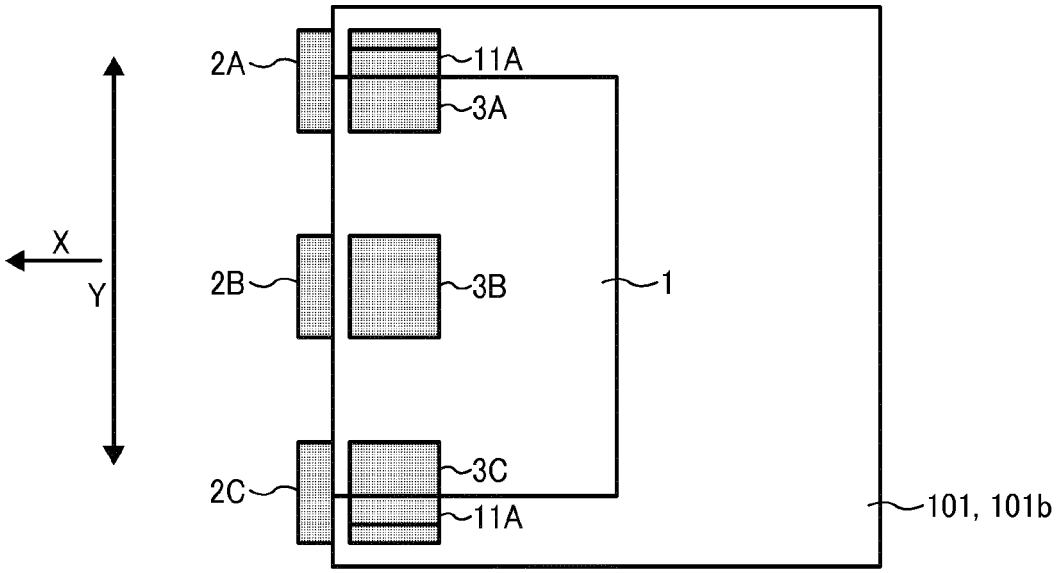

2A
11A
3A
X
Y
2B
3B
1
2C
3C
11A
101, 101b

FIG. 8G

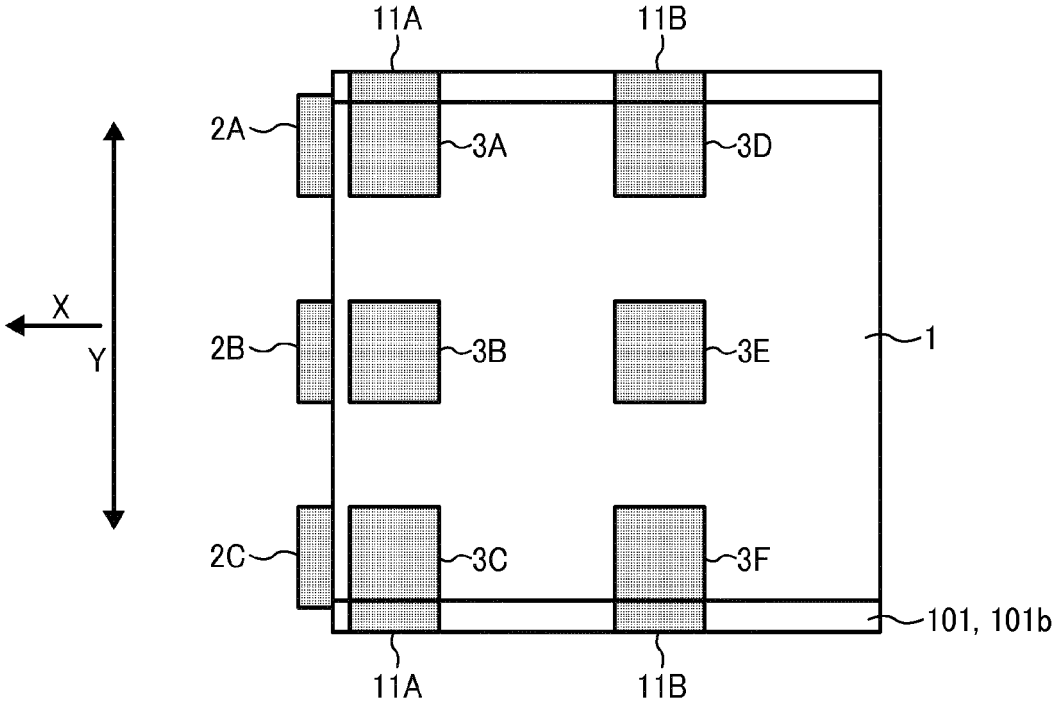

11A
11B
2A
3A
3D
X
Y
2B
3B
3E
1
2C
3C
3F
101, 101b
11A
11B

FIG. 9

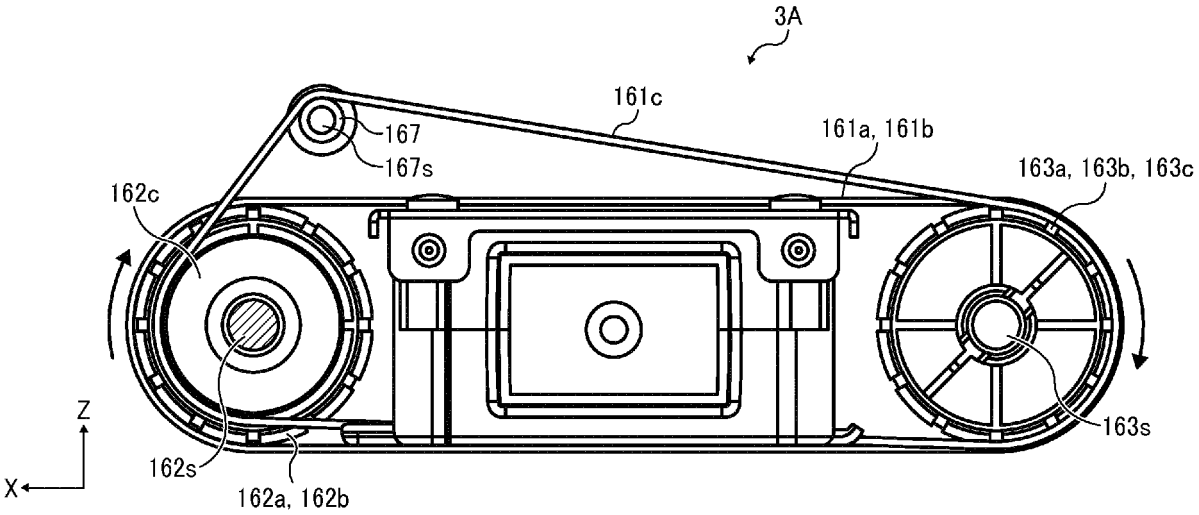

3A
161c
167
167s
161a, 161b
163a, 163b, 163c
162c
Z
X
162s
162a, 162b
163s

FIG. 10

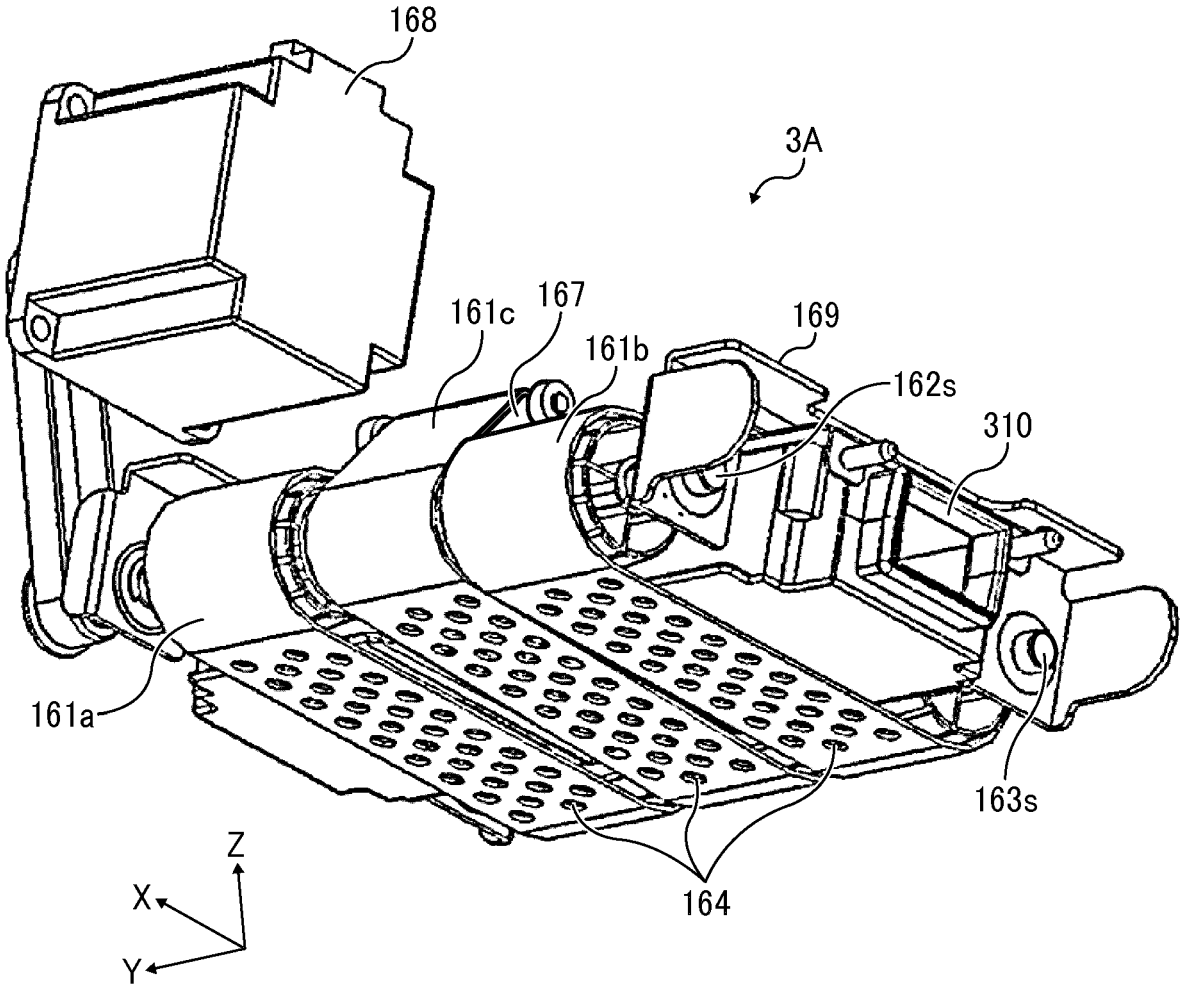


FIG. 11

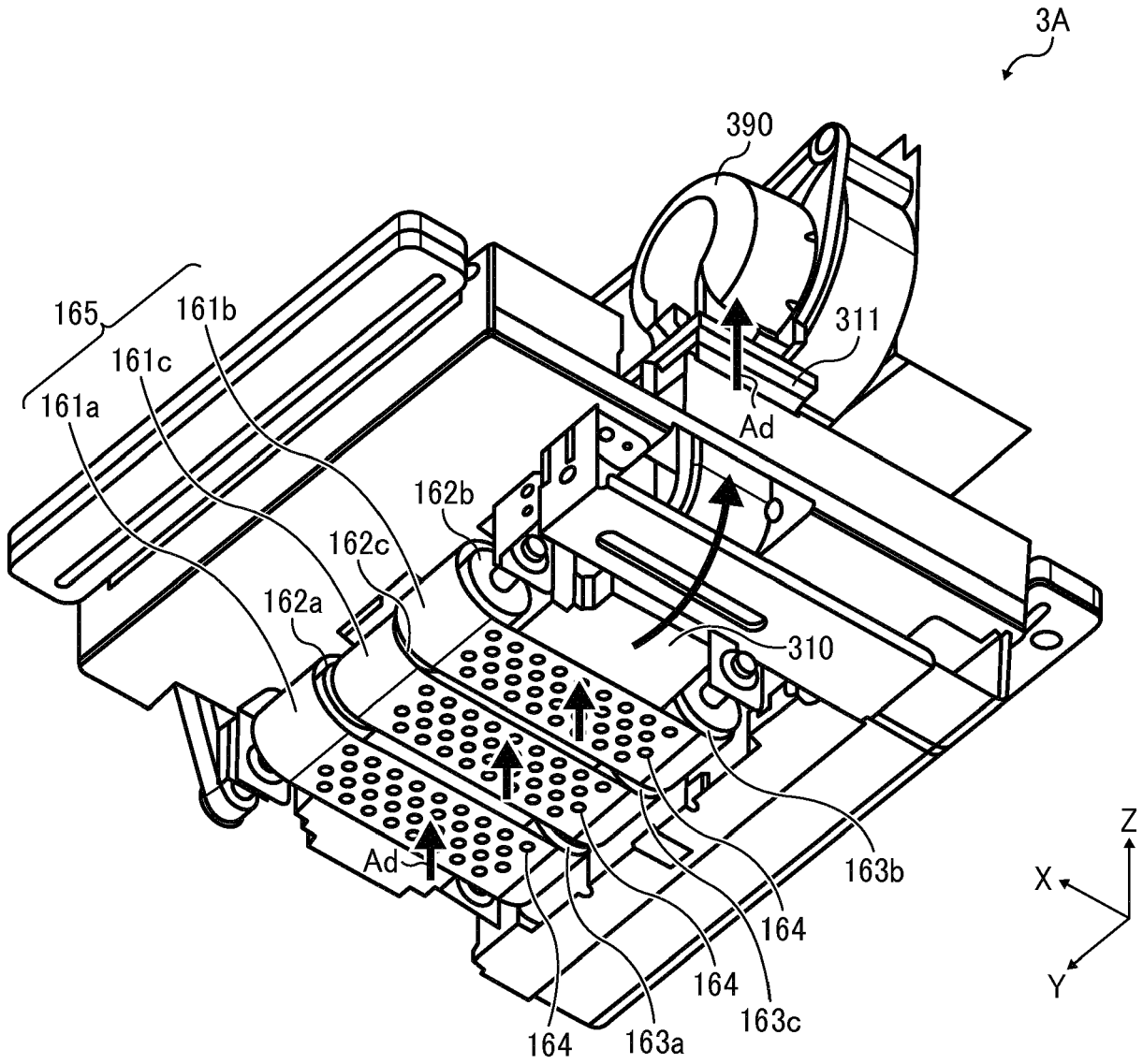

3A
390
165
161b
161c
161a
311
Ad
162b
162c
162a
310
Ad
163b
164
164
163c
164
163a
Z
X
Y

FIG. 12

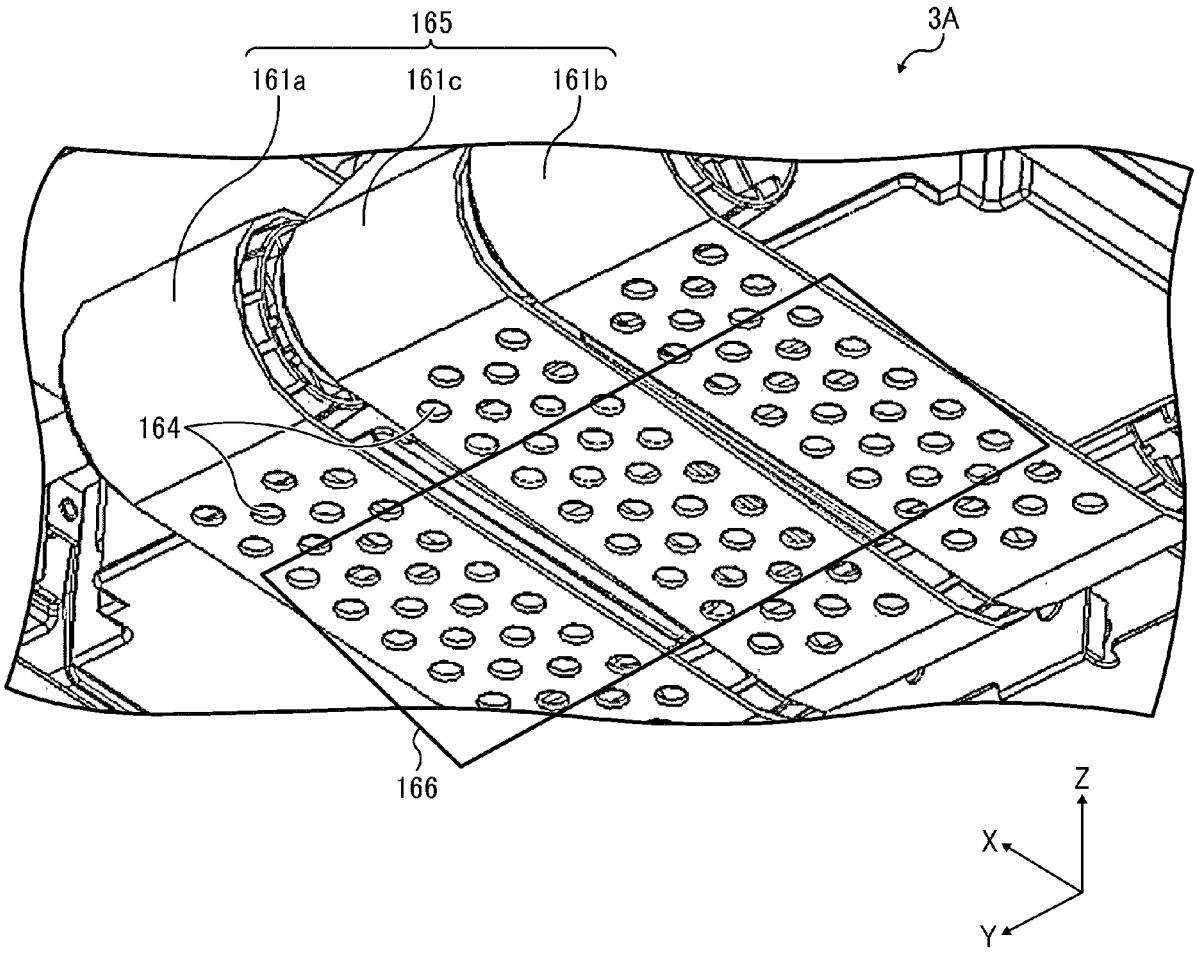


FIG. 13

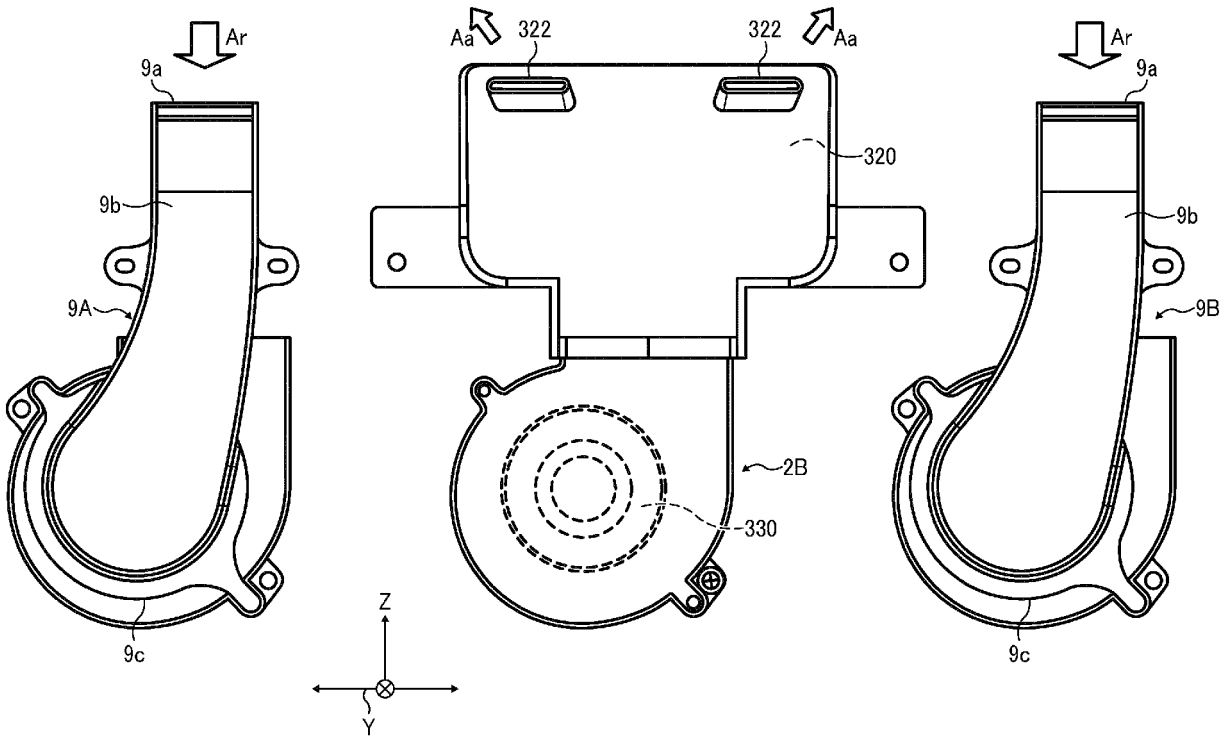


FIG. 14

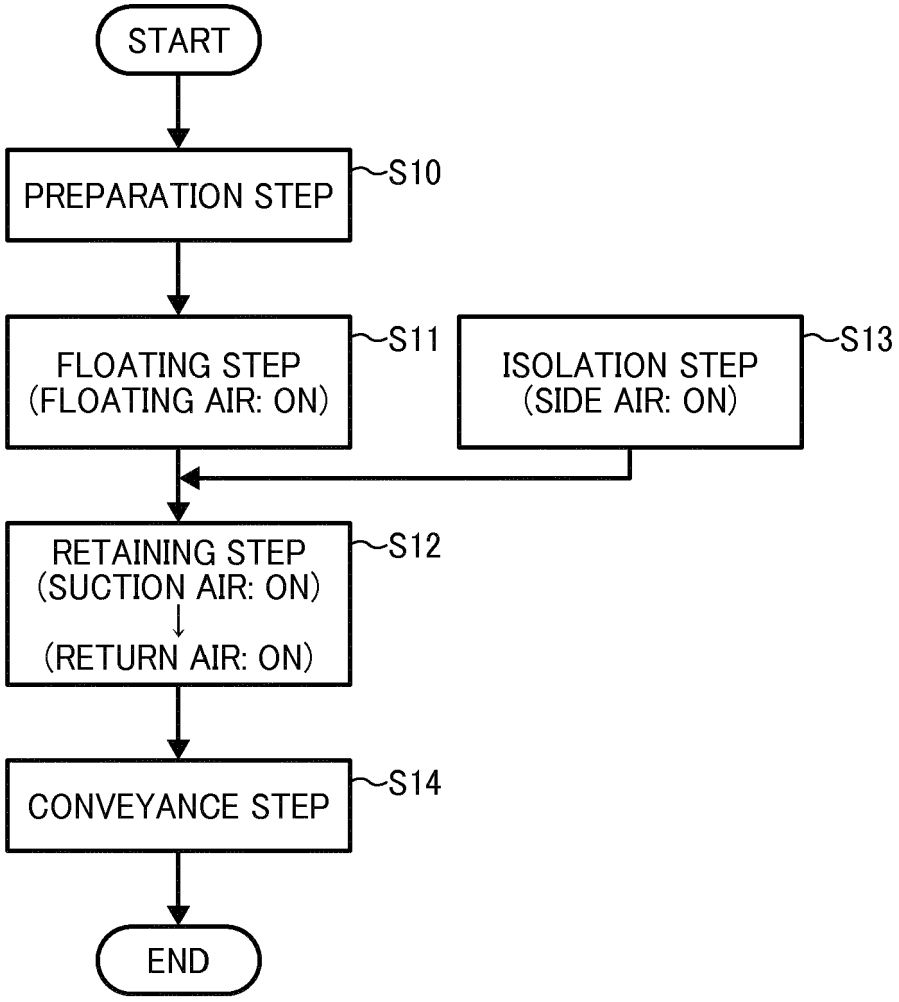

START
PREPARATION STEP
S10
FLOATING STEP
(FLOATING AIR: ON)
S11
ISOLATION STEP
(SIDE AIR: ON)
S13
RETAINING STEP
(SUCTION AIR: ON)
(RETURN AIR: ON)
S12
CONVEYANCE STEP
S14
END

FIG. 15

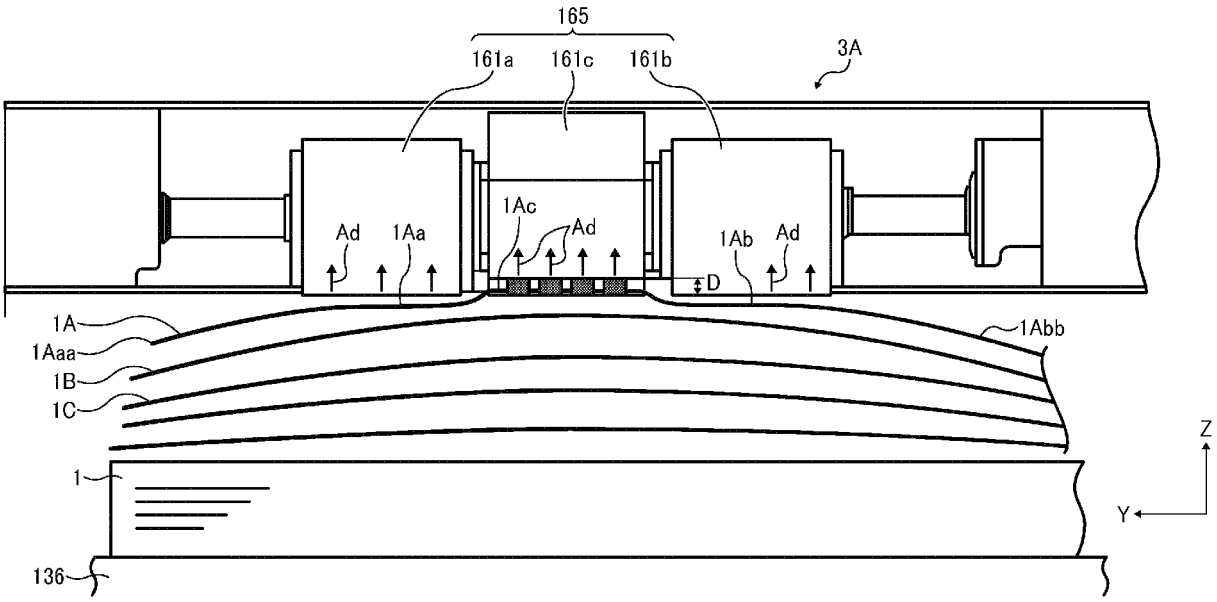

165
161a
161c
161b
3A
Ad
1Aa
1Ac
Ad
1Ab
Ad
D
1A
1Aaa
1B
1C
1Abb
1
136
Z
Y

FIG. 16A

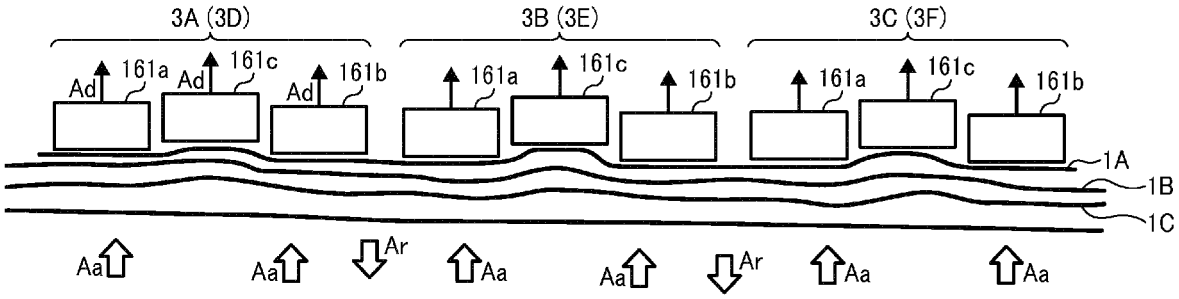



FIG. 16B

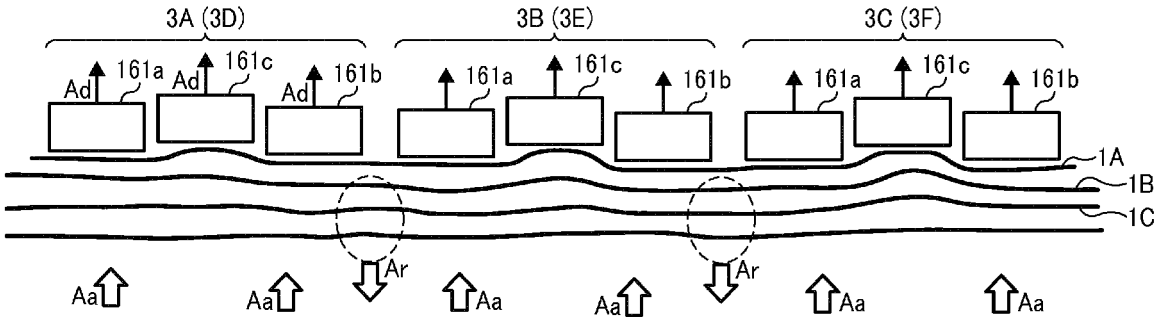


FIG. 17

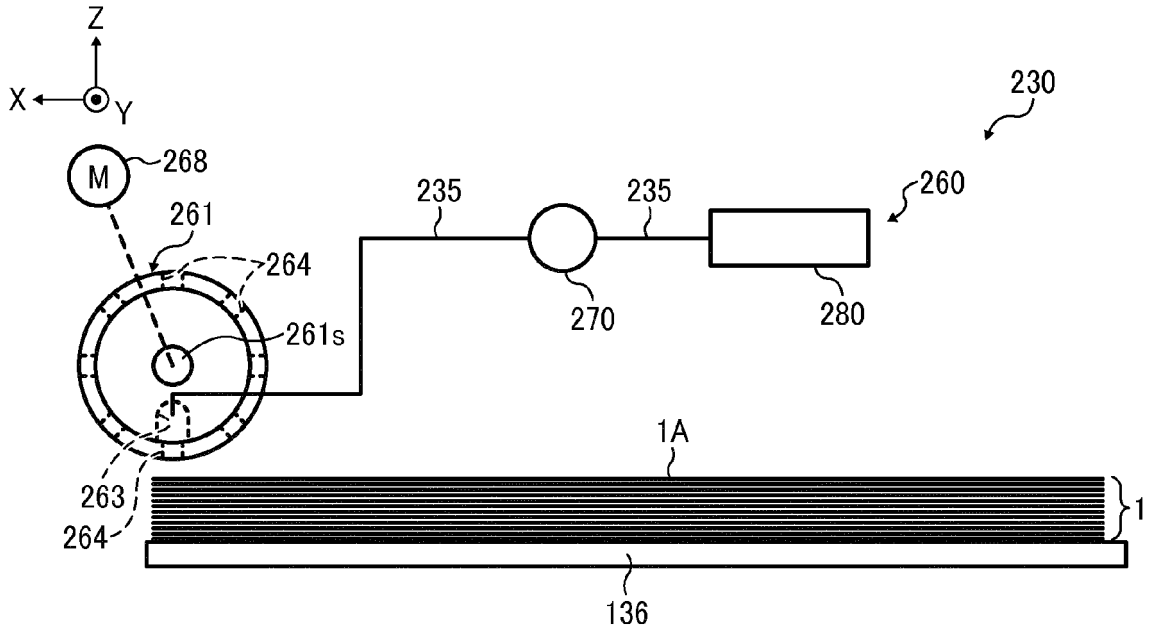

Z
X
Y
230
M
268
261
264
261s
235
235
260
270
280
1A
263
264
1
136

FIG. 18

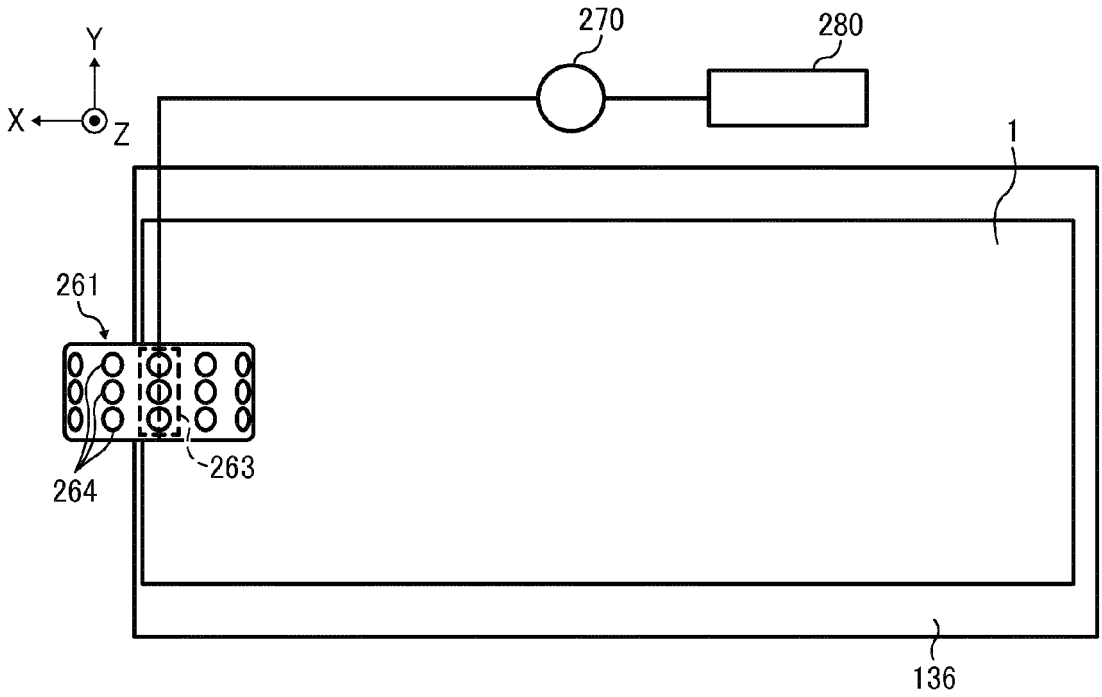

Y
X
Z
270
280
1
261
263
264
136

FIG. 19A

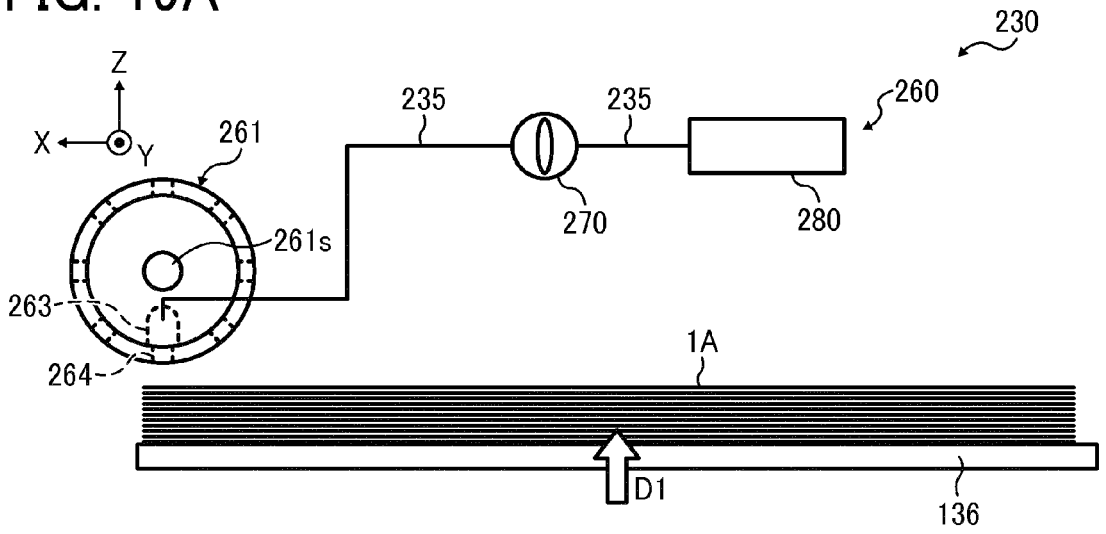



FIG. 19B

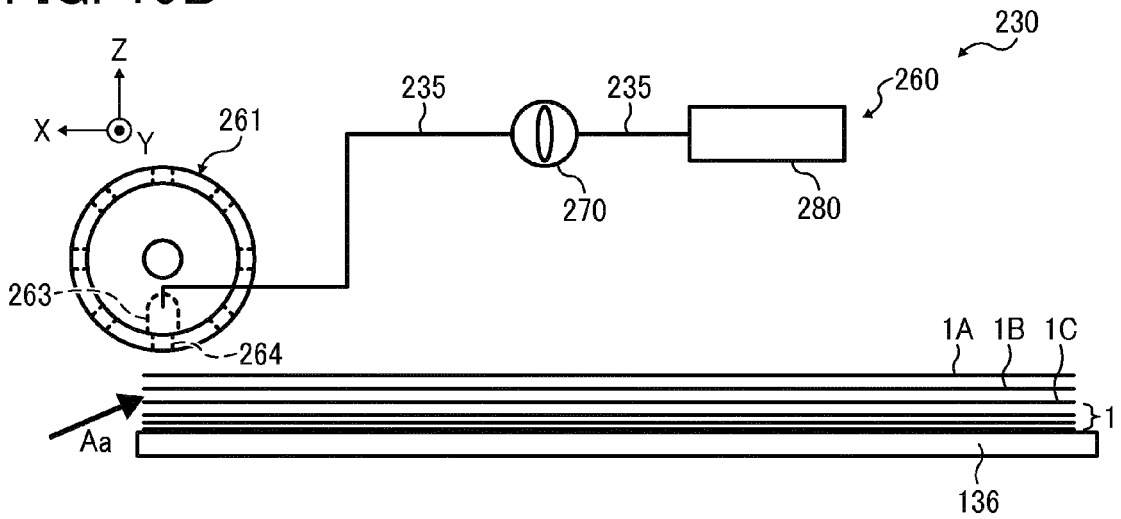



FIG. 19C

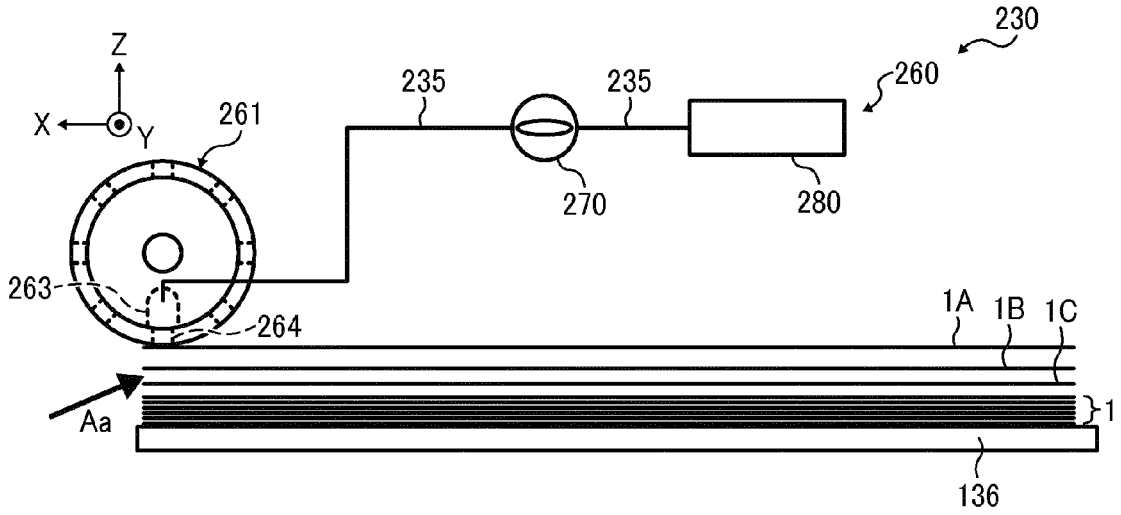


FIG. 20A

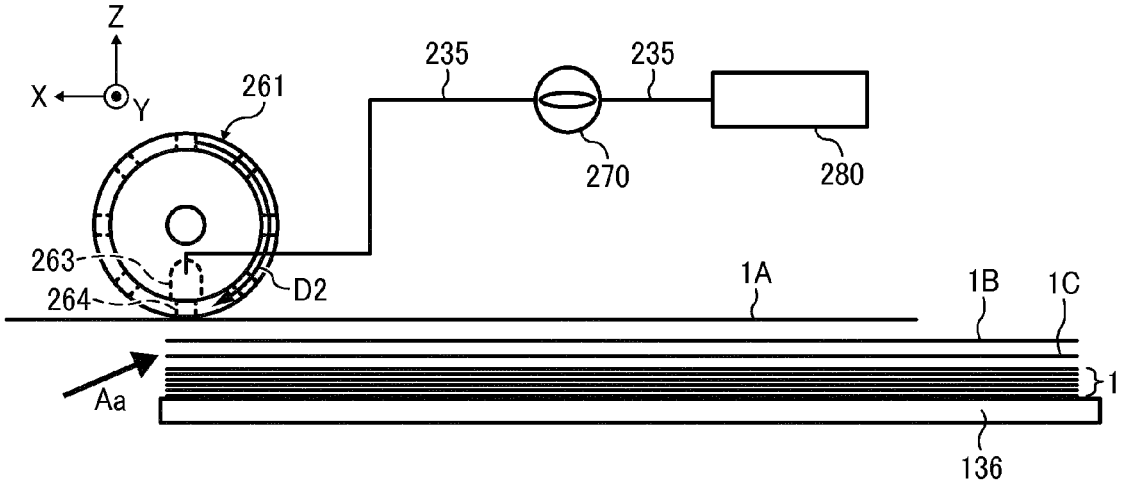



FIG. 20B

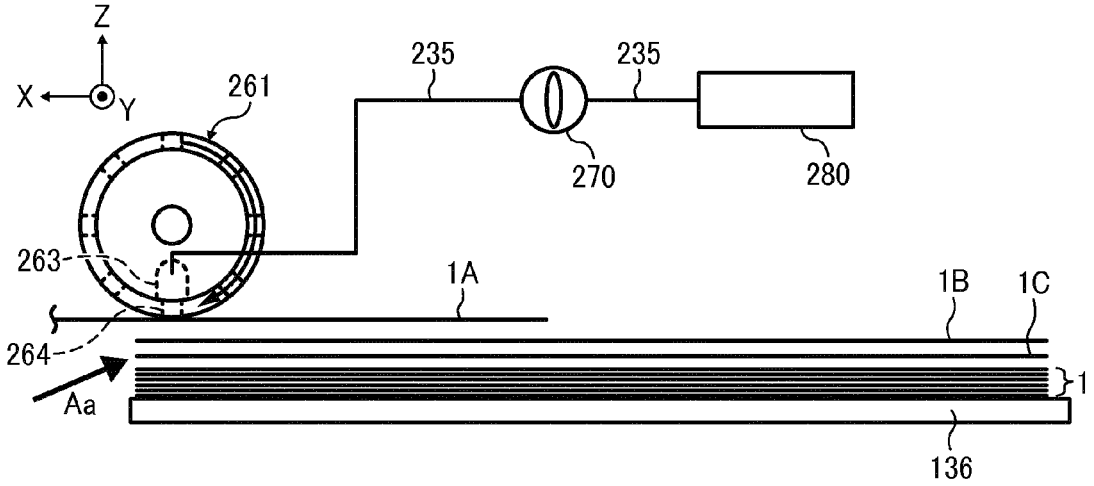
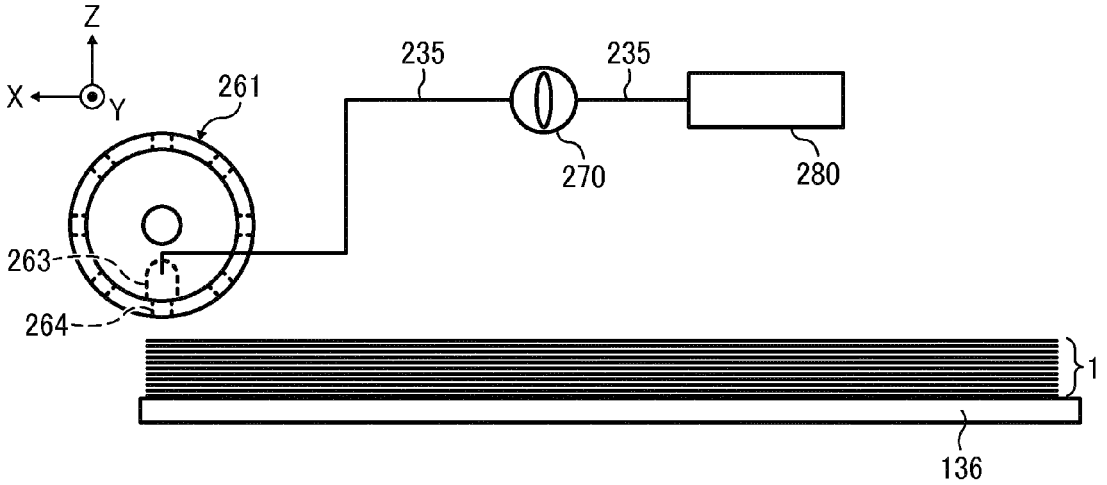



FIG. 20C



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# EUROPEAN SEARCH REPORT

Application Number
EP 16 17 0721

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
|---|---|---|---|
| X<br>Y<br>A | JP 2000 128372 A (MATSUSHITA ELECTRIC WORKS LTD) 9 May 2000 (2000-05-09)<br>* paragraph [0013] - paragraph [0019];<br>figures 1-39 * | 1,10<br>2-5,7<br>6,8,9 | INV.<br>B65H3/12<br>B65H3/48 |
| X | EP 1 466 848 A2 (KOENIG & BAUER AG [DE]) 13 October 2004 (2004-10-13)<br>* paragraph [0009] - paragraph [0024];<br>figures 1-6 * | 1,8,9 | |
| Y<br>A | WO 2009/068016 A1 (BREMER WERK FUER MONTAGESYSTEM [DE]; GEBAUER INGO [DE]; DOERSCH CHRIST) 4 June 2009 (2009-06-04)<br>* page 5, paragraph 1 *<br>* page 8, paragraph 2 - paragraph 4;<br>figures 1-12 * | 2-5,7<br>6 | |
| A | DE 36 12 559 A1 (WINKLER DUENNEBIER KG MASCH [DE]) 22 October 1987 (1987-10-22)<br>* column 2, line 59 - line 64 *<br>* column 5, line 24 - column 6, line 66;<br>figures 1-17 * | 1-10 | |

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 2016 | Henningsen, Ole |

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13-10-2016

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| | | EP 1466848 A2 | 13-10-2004 |
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| | | EP 2217516 A1 | 18-08-2010 |
| | | WO 2009068016 A1 | 04-06-2009 |
| DE 3612559 A1 | 22-10-1987 | NONE | |

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