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(54) **Sheet handling apparatus**

(57) According to one embodiment, a pickup device includes a separation mechanism (5') for applying, to a to-be-subsequently-fed mail item picked up from accumulated mail items, a separation force exerting in a direction opposite to a mail item pickup direction. The separation mechanism comprises: an outer drum (66) with suction holes (65) that face the to-be-subsequently-fed mail item during rotation; an inner drum (64) provided inside and concentric with the outer drum and having air holes (63) that overlap with the suction holes during rotation; a pump (37) for drawing air through the suction holes facing the to-be-subsequently-fed mail item and the air holes overlapping with them to attach the to-be-subsequently-fed mail item to the outer peripheral surface of the outer drum. A controller (76) rotates the inner and outer drums in association with each other to apply a sufficient separation force to the to-be-subsequently-fed mail item.

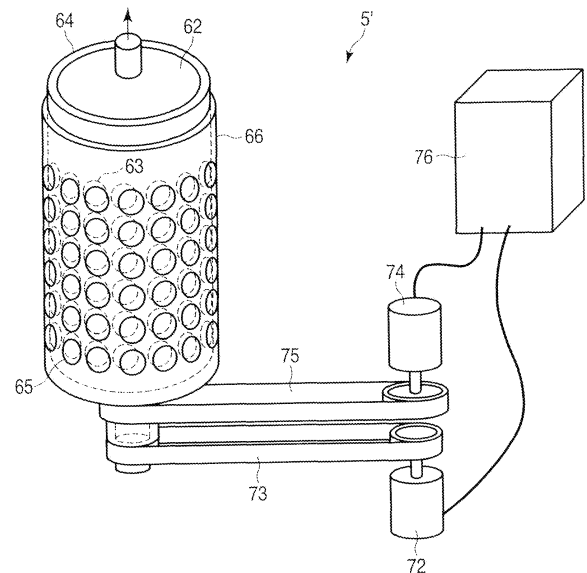


FIG. 12

Description

FIELD

[0001] Embodiments described herein relate generally to a sheet handling apparatus for picking up, one by one, accumulated sheets of, for example, paper.

BACKGROUND

[0002] A sheet handling apparatus is known which comprises a pickup device for sequentially picking up accumulated sheets of, for example, paper, beginning with the outermost one. The pickup device has a picking roller to be brought into contact with the outermost sheet. The picking roller has a plurality of suction holes. The outermost sheet is attached to the outer surface of the picking roller when air is drawn through the suction holes of the picking roller, and is picked up in accordance with the rotation of the picking roller.

[0003] When the picking roller is brought into contact with the outermost sheet to pick up the same, it may unintentionally simultaneously pick up the second sheet. In general, to avoid such "unintentional simultaneous pickup of two or more sheets," a separation unit for separating the simultaneously picked sheets is provided downstream of the pickup device in the conveying direction of sheets.

[0004] The separation unit has a separation roller to which a force of rotation opposite to the pickup rotation is imparted. The separation roller is provided on the opposite side of the pickup device, with a conveyor line for conveying the sheets interposed therebetween. The separation roller has a plurality of suction holes, through which air is drawn. When air is drawn through the holes, each sheet is attached to the outer surface of the separation roller. Thus, when simultaneously picked sheets pass through the separation unit, the sheet (to-be-subsequently-fed sheet) put into contact with the separation roller is backwardly moved and hence separated from the other sheet (to-be-firstly-fed sheet).

[0005] However, since the suction holes of the separation roller are arranged at regular intervals in the direction of rotation, the sheet passing through the separation unit may not be supplied with a sufficient separation force.

[0006] There is a demand for development of a sheet handling apparatus that comprises a separation unit capable of reliably separating simultaneously picked sheets.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007]

FIG. 1 is a block diagram illustrating a mail handling apparatus according to the present invention;
FIG. 2 is a plan view illustrating a pickup device incorporated in the handling apparatus of FIG. 1;

FIG. 3 is an enlarged perspective view illustrating the essential part of the pickup mechanism of the pickup device shown in FIG. 2;

FIG. 4 is an enlarged perspective view illustrating the state in which a pickup belt is removed from the structure of FIG. 3;

FIG. 5 is an enlarged perspective view illustrating the essential part of a suction mechanism incorporated in the pickup device shown in FIG. 2;

FIG. 6 is an enlarged sectional view illustrating the essential part of a separation mechanism incorporated in the pickup device shown in FIG. 2;

FIG. 7 is an enlarged sectional view taken along two-dot break line VII-VII of FIG. 6;

FIG. 8 is an enlarged sectional view useful in explaining behaviors of a separation roller and a mail item assumed when the mail item is conveyed via a conveyor line;

FIG. 9 is an enlarged sectional view useful in explaining other behaviors of the separation roller and the mail item assumed when the mail item is conveyed via the conveyor line;

FIG. 10 is a plan view illustrating a pickup device obtained by adding a suction chamber opposed to the separation roller;

FIG. 11 is an enlarged sectional view useful in explaining behaviors of the separation roller and two mail items assumed when the mail items are simultaneously conveyed via the conveyor line;

FIG. 12 is a schematic perspective view illustrating a separation mechanism according to a first embodiment;

(a) of FIG. 13 is a perspective view illustrating a state in which the air holes of an inner drum and outer drum incorporated in the separation roller shown in FIG. 12 are superposed, and (b) of FIG. 13 is a sectional view illustrating the state; (a) of FIG. 14 is a perspective view illustrating a state in which the air holes of the inner drum and outer drum shown in FIG. 13 are slightly rotated relative to each other, and (b) of FIG. 14 is a sectional view illustrating the state;

FIG. 15 is a view useful in explaining the operation of the separation mechanism shown in FIG. 12, and illustrating states in which the inner and outer drums incorporated in the separation mechanism are developed and superposed on each other;

FIG. 16 is a graph illustrating changes with time in the speeds of the inner and outer drums assumed in the states shown in FIG. 15;

(a) of FIG. 17 is a perspective view illustrating a state in which the separation force of the separation roller is adjusted by the separation mechanism of FIG. 12, (b) of FIG. 17 is a sectional view illustrating the state;

(a) of FIG. 18 is a perspective view illustrating a state in which the air holes of the inner drum and outer drum shown in FIG. 17 are slightly rotated relative to each other, (b) of FIG. 18 being a sectional view illustrating the state;

FIG. 19 is a view useful in explaining the operation of the separation mechanism of FIG. 12, and illustrating states in which the inner and outer drums shown incorporated in the separation mechanism are developed and superposed on each other; FIG. 20 is a graph illustrating changes with time in the speeds of the inner and outer drums assumed in the states shown in FIG. 19;

(a) of FIG. 21 is a perspective view illustrating the essential part of a separation mechanism according to a second embodiment, and (b) is a sectional view of the essential part;

(a) of FIG. 22 is a perspective view illustrating a state in which the air holes of the inner drum and outer drum shown in FIG. 21 are slightly rotated relative to each other, (b) of FIG. 22 is a sectional view illustrating the state;

FIG. 23 is a view useful in explaining the operation of the separation mechanism shown in FIG. 21, and illustrating states in which the inner and outer drums incorporated in the separation mechanism are developed and superposed on each other; and FIG. 24 is a graph illustrating changes with time in the speeds of the inner and outer drums assumed in the states shown in FIG. 23.

DETAILED DESCRIPTION

[0008] According to one embodiment, a pickup device includes a separation mechanism for applying, to a to-be-subsequently-fed mail item picked up from accumulated mail items, a separation force exerting in a direction opposite to a mail item pickup direction. This separation mechanism comprises: an outer drum with suction holes that face the to-be-subsequently-fed mail item during rotation; an inner drum provided inside and concentric with the outer drum and having air holes that overlap with the suction holes during rotation; a pump for drawing air through the suction holes facing the to-be-subsequently-fed mail item and the air holes overlapping with them to attach the to-be-subsequently-fed mail item to the outer peripheral surface of the outer drum. A controller rotates the inner and outer drums in association with each other to apply a sufficient separation force to the to-be-subsequently-fed mail item.

[0009] Various Embodiments will be described hereinafter with reference to the accompanying drawings.

[0010] FIG. 1 is a schematic block diagram illustrating a mail handling apparatus 100 (hereinafter referred to simply as "the handling apparatus 100") according to the

invention. The handling apparatus 100 comprises a pick-up device 1 functioning as a sheet processing device. In addition to the pickup device 1, the handling apparatus 100 comprises a determination unit 102, a rejection unit 104, a switchback unit 106 and an accumulation unit 108. Although in the embodiments, the handling apparatus 100 handles mail items, the to-be-handled medium (in the form of sheets) is not limited to mail matter.

[0011] Mail items are accumulated upright in the pick-up device 1, picked up one by one, and fed to a conveyor line 101 when the pickup device 1 is operated as described later. Along the conveyor line 101, pairs of endless conveyor belts (not shown) are located with the conveyor line 101 interposed therebetween, and are used to hold mail items therebetween to convey them.

[0012] Each mail item fed to the conveyor line 101 is passed through the determination unit 102, where information is read therefrom. Based on the read information, the determination unit 102 determines the conveying attitude and conveying destination of each mail item. More specifically, the determination unit 102 reads, from each mail item, destination information such as the postal code or address, thereby determining the destination.

[0013] The mail item passing through the determination unit 102 is sorted via a gate G1. Namely, if the determination unit 102 determines that the mail item is to be rejected, the mail item is conveyed to the rejection unit 104 via the gate G1, whereas if the mail item is determined not to be rejected, it is conveyed to the accumulation unit 108 via the gate G1.

[0014] If the determination unit 102 determines that it is necessary to reverse the conveying direction of the mail item, the mail item is fed to the switchback unit 106 via a gate G2, where its conveying direction is reversed.

The mail item, the conveying direction of which does not need be reversed, is made to bypass the switchback unit 106 via the gate G2 and is guided to the accumulation unit 108.

[0015] The mail item fed into the accumulation unit 108 through the conveyor line 101 is accumulated in a classification pocket (not shown) in accordance with the determination result of the determination unit 102. In classification pockets, mail items are accumulated with their heads and tails aligned.

[0016] FIG. 2 illustrates the pickup device 1 when viewed from above.

[0017] The pickup device 1 comprises a receiving unit 2 for receiving a plurality of mail items P accumulated upright, a supply mechanism, described later, for forwardly moving the received mail items P toward a pickup position 20 and positioning the leading one of the mail items P at the pickup position 20, a pickup mechanism 3 for picking up the mail item P at the pickup position 20, a suction mechanism 4 for producing the flow of air to draw air so as to move the leading mail item P to the pickup position 20, a separation mechanism 5 for separating, from the leading mail item P, second and seq. mail items P simultaneously picked up along with the former,

an auxiliary mechanism 6 located upstream of the suction mechanism 4 (downward in FIG. 2) in the pickup direction of the sheets positioned at the pickup position 20, and a conveyor mechanism 7 for pulling out each mail item P, passing through the separation mechanism 5, at a speed slightly higher than a pickup speed, and conveying it downstream.

[0018] The pickup device 1 also comprises two sensors 11a and 11b for detecting passing of the mail item P picked up from the pickup position 20 to a conveyor line 10, and a plurality of conveyor guides 12 to 18. The sensors 21 to 26 each include an emission section and a light receiving section, which oppose each other with the conveyor line 10 interposed therebetween, and detect passing of the mail item P when their optical axes are crossed by the mail item. The conveyor guides 12 to 18 are brought into contact with the edges or surfaces of the mail items P to guide them.

[0019] The receiving unit 2 simultaneously receives a plurality of mail items P accumulated upright. On the bottom of the receiving unit 2, two floor belts 8a and 8b are provided, which are to be brought into contact with the lower ends of mail items P to move the mail items P in the direction indicated by arrow F in FIG. 2. A backup plate 9 is provided at a position at which it is brought into contact with the surface of the rearmost one of the accumulated mail items P to supply the leading mail item P to the pickup position 20 along with the floor belt 8b. To this end, the backup plate 9 is connected to the floor belt 8b in a simple way, and is moved in the direction F when the floor belt 8b is driven. These two floor belts 8a and 8b and the backup plate 9 function as a supply mechanism.

[0020] The conveyor guide 18 extends parallel to the direction F to define one side of the receiving unit 2, and is used to guide the front end of each mail item P. The conveyor guides 12, 13 and 14 are arranged along the pickup position 20, and function to stop, at the pickup position 20, the leading mail item P moved in the direction F, and to guide the mail item P picked up from the pickup position 20, kept in contact with one surface of the mail item P.

[0021] The pickup mechanism 3 comprises a chamber 21, a guide 14 and a vacuum pump 22 (or an equivalent). The pickup mechanism 3 also comprises an endless pickup belt 23 which runs in the direction indicated by arrow T_1 (mail item P pickup direction) at least along the pickup position 20, a motor 24 for driving the pickup belt 23. The pickup belt 23 is stretched between a plurality of rollers 25 so that it runs in the direction T_1 at least along the pickup position 20 and the conveyor line 10 (101) continuously extending from the pickup position 20.

[0022] The guide 14 is inside the pickup belt 23 and opposes the pickup position 20 with the pickup belt 23 interposed therebetween. The chamber 21 opposes the rear side of the guide 14. Namely, the chamber 21 opposes the pickup position 20 with the pickup belt 23 and the guide 14 interposed therebetween. As shown in the

enlarged view of FIG. 3, the pickup belt 23 has a large number of suction holes 23a. As shown in FIG. 4, the guide 14 has a plurality of slits 14a extending along the line of the running direction T_1 of the pickup belt 23 (i.e., the pickup direction of each mail item P).

[0023] In this structure, when the vacuum pump 22 is operated to draw the air from the chamber 21, negative pressure (indicated by arrow S1) is exerted on a mail item P at the pickup position 20 via the opening (not shown) of the chamber 21 facing the guide 14, the slits 14a of the guide 14 and the suction holes 23a of the pickup belt 23, whereby the mail item P is drawn to the surface of the pickup belt 23, and fed from the pickup position 20 to a conveyor path 10 in accordance with the running of the pickup belt 23.

[0024] At this time, the suction force produced by the vacuum pump 22 in the direction indicated by arrow S1 is set to a value that enables the frictional force exerted between the pickup belt 23 and the mail item P drawn thereon to be at least greater than that exerted between the belt 23 and the subsequent mail item P, if these mail items P are simultaneously drawn. Basically, the pickup mechanism 3 feeds, to the conveyor path 10 one by one, the mail items P positioned at the pickup position 20. However, if a plurality of mail items P are simultaneously fed to the conveyor path 10, they are separated from each other by a separation mechanism 5 described later.

[0025] The suction mechanism 4 comprises a chamber 26 located behind a conveyor guide 13 with respect to the pickup position 20, and a blower 27 (or an equivalent) for drawing air from the chamber 26. The chamber 26 is located adjacent to the pickup position 20, with its opening (not shown) opposed to the backside of the guide 13. Further, the guide 13 has a plurality of holes 13a aligned with the opening of the chamber 26, as is evident from the partially enlarged view of FIG. 5.

[0026] In this structure, when the blower 27 is operated to draw air from the chamber 26, a flow of air occurs in the direction indicated by arrow B1 via the holes 13a of the guide 13, one of the mail items P received in the receiving unit 2 and closest to the pickup position 20 is drawn to the pickup position 20. After the mail item P positioned at the pickup position is fed to the convey path, the subsequent mail item P is drawn to the pickup position 20.

[0027] Namely, the suction mechanism 4 can quickly feed the subsequent mail item P to the pickup position 20, and therefore, even when the feeding force F of the supply mechanisms 8 and 9 is weak, the to-be-firstly-fed mail item P can be always reliably and quickly fed to the pickup position 20. This enhances the mail item pickup operation of the pickup mechanism 3.

[0028] The separation mechanism 5 is provided on the opposite side of the pickup mechanism 3 with respect to the conveyor path 10 that extends downstream of the pickup position 20 (i.e., downward in FIG. 2). The separation mechanism 5 applies separation torque, exerted in the direction opposite to the pickup direction, to each

mail item P conveyed through the conveyor path 10, while applying negative pressure thereto from the opposite side of the pickup mechanism 3. Namely, by operating the separation mechanism 5, if two or more mail items P are simultaneously picked up from the pickup position 20, the above-mentioned negative pressure and separation torque stop the feeding of the mail items P other than the to-be-firstly-fed one, or return them, whereby the to-be-firstly-fed mail item P is separated from the others.

[0029] More specifically, as shown in the partially enlarged view of FIG. 6, the separation mechanism 5 comprises a separation drum 31 rotatable along the conveyor path 10 in opposite directions. The separation drum of the embodiment has a double structure, as will be described later. A description will now be given of a structure example having a single separation drum 31.

[0030] As shown in FIG. 7, the separation drum 31 is rotatably attached to a rotary shaft fixed to the conveyor path 10, namely, rotatably attached via a bearing 34 to a cylinder 32 having a chamber 33, described later, and has a large number of suction holes 31a formed through the cylinder. The separation drum 31 has a substantially cylindrical rigid body made of, for example, a metal, and has its outer peripheral surface positioned near and opposed to the conveyor path 10.

[0031] The cylinder 32 as the rotary shaft has a chamber 33 for producing negative pressure, and the opening 33a of the chamber 33 is fixed in position so that it faces the conveyor path 10. FIG. 7 is a cross section taken along broken line VII-VII of FIG. 6.

[0032] Further, as shown in FIG. 2, the separation mechanism 5 comprises an AC servo motor 35 for rotating the separation drum 31 in opposite directions with desired torque, and an endless timing belt 36 for transferring the driving force of the motor 35 to the separation drum 31. The timing belt 36 is stretched between a pulley 35a fixed to the rotary shaft of the motor 35 and a pulley (not shown) fixed to the rotary shaft 31b (see FIG. 7) of the separation drum 31. The separation mechanism 5 further comprises a vacuum pump 37 (or an equivalent), which is one example of a suction unit, connected via a pipe 38 to the chamber 33 of the cylinder 32 with the separation drum rotatably attached thereto.

[0033] In this structure, when the vacuum pump 37 is operated to draw air from the chamber 33, negative pressure (indicated by arrow S2 in FIG. 7) is applied to the surface of the mail item P, conveyed by the conveyor path 10, via the opening 33a of the chamber 33, and a particular suction hole 310 included in the suction holes 31a of the separation drum 31 and opposing the opening 33a, whereby the mail item P is drawn onto the outer peripheral surface of the separation drum 31. At this time, when the separation drum 31 rotates, the separation force corresponding to the rotational force of the separation drum 31 is exerted on the mail item P attached to the outer peripheral surface of the drum 31. The area, in which negative pressure is applied to the mail item P via

the suction hole 310 of the separation drum 31, will hereinafter be referred to as "the separation area As."

[0034] The AC servo motor 35 basically controls the separation drum 31 so that it always applies, to the separation drum 31, constant separation torque exerted in a direction (indicated by arrow T2) opposite to the pickup direction. The separation torque is set to a value that enables the separation drum 31 to rotate so as to feed a single mail item P in the pickup direction when the single mail item P is conveyed on the conveyor path 10, and also enables the separation drum 31 to stop or return a mail item or mail items P closer to the drum than another mail item P to thereby separate the first-mentioned one (or ones) from said another one when a plurality of mail items P are simultaneously fed to the conveyor path 10.

[0035] More specifically, when a single mail item P is normally picked up from the pickup position 20 as shown in FIG. 8, the forward feeding force F1 (indicated by arrow T1) applied to the mail item P by the pickup mechanism 3 is greater than the backward separation force F2 applied to the same by the separation drum 31 that is driven by the backward separation torque (indicated by arrow T2). As a result, the mail item P is conveyed in the forward direction T1, and the separation drum 31 rotates to feed the mail item P in the forward direction, or stops, or idles in the direction opposite to the pickup direction.

[0036] When the separation drum 31 idles in the opposite direction, if constant separation torque is continuously applied to the separation drum 31, the rotational speed of the drum 31 is gradually increased, which may adversely affect the pickup operation of mail items P. To avoid this, in this example, an upper limit is set for the backward rotational speed of the separation drum 31. More specifically, the upper limit is set to a value lower in absolute value than the pickup velocity.

[0037] In the first embodiment, since the separation area As facing the separation drum 31 is set at the position at which the mail item P is drawn onto the pickup belt 23, i.e., at a position downstream (with respect to the pickup direction T1) of the position at which the chamber 21 faces the pickup position 20, it is strongly possible that even if the negative pressure S1 produced by the chamber 21 is made sufficiently lower than the negative pressure S2 produced by the separation drum 31, a single mail item P may be drawn to the separation drum 31.

[0038] If the single mail item P is a relatively thin fragile mail item, the returning force of the separation drum 31 may well bend it as shown in FIG. 9. To avoid this, it is desirable to additionally provide a chamber 41 inside the pickup belt 23 at the position facing the separation drum 31 (separation area As), and a vacuum pump 42 for drawing air from the chamber 41, as is shown in FIG. 10. If negative pressure is exerted at the position facing the separation area As in the direction indicated by arrow S3, the above-mentioned bending problem shown in FIG. 9 can be overcome.

[0039] On the other hand, when two mail items P are simultaneously fed from the pickup position 20 to the con-

veyor path 10 as shown in FIG. 11, the to-be-firstly-fed mail item P1 close to the pickup belt 23 receives the aforementioned feeding force F1 from the pickup mechanism 3 and is conveyed in the forward direction T1, while the to-be-subsequently-fed mail item P2 close to the separation drum 31 receives, from the separation drum 31, the aforementioned separation force F2 exerting in the backward direction T2. At this time, frictional forces F3 and F4 exerting in opposite directions occur between the mail items P1 and P2. These frictional forces F3 and F4 occur when the mail items P1 and P2 contact each other. However, they do not occur when the mail items P1 and P2 are separate from each other.

[0040] In any case, since the feeding forces F1 and F2 are set to values sufficiently higher than the maximum values of the frictional forces F3 and F4, the to-be-subsequently-fed mail item P2, to which the backward separation force F2 is imparted, is returned in the direction T2 opposite to the pickup direction T1, and hence separated from the to-be-firstly-fed mail item P1.

[0041] As described above, since in the first embodiment, the separation drum 31 is made of a metal and configured to apply separation torque to each mail item P fed to the conveyor path 10, and also to apply negative pressure thereto, the life of duration of the separation drum (roller) can be significantly increased, the separation performance of the drum can be maintained in good conditions for a long time, the processing speed of each mail item P can be increased, and the throughput of processing can be enhanced, compared to conventional separation rollers made of rubber. Note that when only a single mail item P is picked up, it is strongly possible that the separation drum 21 will perform idling, and therefore in this case, no separation torque may be applied to the separation drum 31.

[0042] Returning to FIG. 2, the auxiliary mechanism 6 located above the suction mechanism 4, i.e., located upstream of the pickup mechanism 3 in the pickup direction T1, has substantially the same structure as the above-described separation mechanism 5. Specifically, the auxiliary mechanism 6 comprises an auxiliary roller 51 located along the conveyor path 10 and configured to be rotatable in opposite directions.

[0043] The auxiliary roller 51 is rotatably attached to a fixed rotary shaft facing the pickup position 20, i.e., rotatably attached to a cylinder 53 having a chamber (not shown) therein, and has a large number of holes 52 formed through its cylindrical body. Further, the auxiliary roller 51 is formed by a substantially cylindrical rigid member made of, for example, a metal, and has its outer peripheral surface opposed to the pickup position 20. The cylinder 53 as a rotary shaft has a chamber formed therein for producing negative pressure, and is fixed in position such that the opening (not shown) of the chamber faces the pickup position 20.

[0044] The auxiliary mechanism 6 comprises an AC servo motor 65 for rotating the auxiliary roller 51 in opposite directions with desired torque, and an endless tim-

ing belt 56 for transferring the driving force of the motor 65 to the auxiliary roller 51. The timing belt 56 is stretched between a pulley 55a fixed to the rotary shaft of the motor 55 and a pulley (not shown) fixed to the auxiliary roller 51 (not shown). The auxiliary mechanism 6 further comprises a vacuum pump 57 (or an equivalent) connected via a pipe 58 to the chamber of the cylinder 53 with the auxiliary roller 51 rotatably attached thereto. An electromagnetic valve 59 is provided across the pipe 58 for turning on and off the negative pressure.

[0045] With this structure, the auxiliary mechanism 6 supports the mail item pickup and separation operations basically by rotating the auxiliary roller 51 at a desired speed in opposite directions and stopping the same, and turning on and off the vacuum pump 57.

[0046] For instance, when the pickup mechanism 3 picks up a mail item P positioned at the pickup position 20, the auxiliary mechanism 6 produces negative pressure at the rear end of the mail item P to draw the same to the outer peripheral surface of the auxiliary roller 51, and rotates the auxiliary roller 51 to feed the mail item P in the forward direction T1. As a result, when a relative heavy mail item P of a large size is picked up, it receives a greater feeding force than normal mail items P in a reliable manner, whereby the pickup operation of mail items P is stabilized.

[0047] Further, when a to-be-firstly-fed mail item P is picked up and its rear end reaches a position at which it is not interfered by the auxiliary roller 51, the auxiliary mechanism 6 can draw, to the auxiliary roller 51, the rear end of another mail item P to be subsequently fed to the pickup position 20, and apply backward-directional torque to the auxiliary roller 51 to brake the same. Thus, the auxiliary mechanism 6 cooperates with the separation mechanism 5 to prevent simultaneous feeding of two or more mail items P. In this case, by controlling the backward-directional torque applied to the auxiliary roller 51 and also controlling the time period of braking, the pitch of mail items P to be fed from the pickup position 20 to the conveyor path 10 can be controlled.

[0048] In the above-described pickup device 1, to reliably pick up mail items P one by one, the separation mechanism 5 must continuously and reliably apply a separation force to a to-be-subsequently-fed mail item P picked up simultaneously along with a to-be-firstly-fed mail item P. However, when using the separation drum 31 shown as an example in FIG. 6, a sufficient separation force may not be applied, depending upon the angular position of the drum.

[0049] Namely, when the separation drum 31 slightly rotates in the backward direction T2 from the angular position shown in FIG. 6, at which the particular suction hole 310 of the separation drum 31 connects the separation area As to the chamber 33, another suction hole 311 comes to face the opening 33a of the chamber 33, whereby air flows into the chamber 33 via the suction hole 311. At this time, the mail item P as a separation target is already attached to the outer peripheral surface

of the separation drum 31 via the particular suction hole 310. Namely, the air flowing into the chamber 33 increases the internal pressure in the chamber 33 and accordingly weakens the suction force, i.e., the mail item attaching force.

[0050] If the suction force of the separation drum 31 is thus weakened, a sufficient separation force cannot continuously be applied to the mail item P as the separation target, which may result in insufficient separation. In particular, when a relatively heavy mail item P is separated, such disadvantage will be conspicuous. Further, such disadvantage will more easily occur, as the space between adjacent suction holes 31a along the circumference of the separation drum 31 is narrower.

[0051] In view of this, in the first embodiment, the separation drum 31 of the separation mechanism 5 is formed to have a double structure to prevent undesired air inflow. Referring now to FIGS. 12 to 14, a modification 5' of the separation mechanism 5 of the first embodiment, which incorporates a separation drum of the double structure, will be described.

[0052] As shown in FIG. 12, the separation mechanism 5' comprises a cylinder 62 having a chamber 61 (see FIGS. 13b and 14b) defined therein, an inner drum 64 (inner rotary body or rotation body) concentrically provided around the cylinder, and an outer drum 66 (outer rotary body or rotation body) concentrically provided around the cylinder. The inner and outer drums 64 and 66 cooperate with each other to function like the separation drum 31.

[0053] The inner drum 64 has an inner diameter slightly larger than the outer diameter of the cylinder 62 so that it can rotate about the cylinder 62. The outer drum 66 has an inner diameter slightly larger than the outer diameter of the inner drum 64 so that it can independently rotate about the inner drum 64.

[0054] The chamber 61 of the cylinder 62 is connected to the vacuum pump 37 via the pipe 38 so that the air therein can be drawn by the vacuum pump 37. The cylinder 62 is fixed in position near the conveyor path 10 with the opening 61a (see FIGS. 13 and 14) of the chamber 61 opposed to the separation area As.

[0055] The inner drum 64 has a plurality of air holes 63, and the outer drum 66 has a plurality of suction holes 65. The air holes 63 are arranged in rows and columns over the entire periphery of the inner drum 64. Similarly, the suction holes 65 are arranged in rows and columns over the entire periphery of the outer drum 66. In the first embodiment, the number of the air holes 63 is equal to that of the suction holes 65. In other words, when the drums 64 and 66 are rotated to their respective positions shown in FIG. 12, all air holes 63 are superposed on all suction holes 65. Namely, the pitch of the suction holes 65 of the outer drum 66 in the direction of rotation is slightly greater than that of the air holes 63 of the inner drum 64 in the direction of rotation.

[0056] The separation mechanism 5' further comprises a driving motor 72 for rotating the inner drum 64 in opposite directions at desired speed, a driving motor 74

for rotating the outer drum 66 in opposite directions at desired speed independent of the inner drum 64, and a control unit 76 for controlling the two driving motors 72 and 74. The driving motor 72 is connected to the inner drum 64 via an endless driving belt 73, and the driving motor 74 is connected to the outer drum 66 via an endless driving belt 75. The driving motors 72 and 74 are AC servo motors, the angular positions of which can be accurately controlled by the controller 76 to rotate the drums 64 and 66 to desired angular positions at desired speeds.

[0057] In this structure, when the air in the chamber 61 is drawn by the vacuum pump 37 to rotate the inner and outer drums 64 and 65 to their respective positions shown in (a) and (b) of FIG. 13, particular air holes 630 and particular suction holes 650 overlap with the opening 61a of the chamber 61, and the air near the separation area As is drawn into the chamber 61 via the holes 650 and 630 and the opening 61a. In this state, a relatively strong suction force is applied to a mail item P positioned as a separation target in the separation area As, whereby the mail item P is attached to the outer drum 66 with a relatively strong force. At this time, if the outer drum 66 is rotated in the backward direction T2, a sufficient separation force is applied to the mail item P.

[0058] When the outer drum 66 is slightly rotated in the backward direction T2 to start to slightly return the mail item P as the separation target from the angular position shown in (a) and (b) of FIG. 13, the inner drum 64 is rotated in the backward direction T2, slightly retarded in angular position relative to the outer drum 66 (i.e., decelerated) as shown in (b) of FIG. 14. This prevents the subsequent column of suction holes 651 subsequently made to face the separation area As by the backward rotation of the outer drum 66 from communicating with the opening 61a of the chamber 61 to guide air into the chamber 61 via the suction holes 651. Namely, by rotating the inner drum 64 with its relative angular position retarded, a disadvantage that the pressure in the chamber 61 is increased can be avoided, and a sufficient separation force can be continuously applied to the mail item P.

[0059] In contrast, if the inner drum 64 is rotated with the same rotation angle as the outer drum 66, the suction holes 651 communicate with the chamber 61 via another column of air holes 631, as in the case of the separation drum 31 described above as a reference example. To prevent the suction holes 651 from communicating with the chamber 61, in the first embodiment, the rotational speed of the inner drum 64 is made different from that of the outer drum 66.

[0060] Referring now to FIGS. 15 and 16, a more detailed description will be given of the control operation of the inner drum 64. In the first embodiment, as shown in FIG. 16, the outer drum 66 is rotated at a constant speed, while the inner drum 64 is accelerated and decelerated. Namely, in this case, only the inner drum 64 is a control target. (a) to (e) of FIG. 15 are development views useful in explaining the operations of the inner and outer drums

64 and 66. FIG. 16 is a graph indicating changes with time in the rotational speed of the inner drum 64 corresponding to the states shown in FIG. 15.

(a) of FIG. 15 shows the moment the particular air holes 630 of the inner drum 64 completely overlap with the opening 61a of the chamber 61, and the particular suction holes 650 of the outer drum 66 completely overlap with the opening 61a of the chamber 61. The rotational speed of the inner drum 64 at this moment is identical to that of the outer drum 66 as indicated by symbol a in FIG. 16.

[0061] When the mail item P as the separation target is returned backward and the outer drum 66 is slightly rotated in the backward direction T2 after the above moment, another column of suction holes 651 slightly overlap with the opening 61a as shown in (b) of FIG. 15. At this time (i.e., when the state shown in (a) of FIG. 15 shifts to that shown in (b) of FIG. 15), the controller 76 reverses the rotation direction of the inner drum 64 with the relative angular position thereof retarded (decelerated). Accordingly, at the time shown in (b) of FIG. 15, the subsequent column of air holes 631 do not overlap with the opening 61a. Namely, in the state shown in (b) of FIG. 15, there is no increase in the internal pressure of the chamber 61.

[0062] When the outer drum 66 is further rotated at a constant speed in the backward direction, the inner drum 64 is accelerated in the backward direction so as to advance its retarded relative angular position and shift to the state shown in (d) of FIG. 15 via the state shown in (c) of FIG. 15. As a result, the angular position of the inner drum 64 advances relative to that of the outer drum 66. Namely, from the state shown in (b) of FIG. 15 to the state shown in (d) of FIG. 15, the inner drum 64 is accelerated in the backward direction. In the state shown in (d) of FIG. 15, the rotational speed of the inner drum 64 is higher than that of the outer drum 66.

[0063] Further, in the state shown in (c) of FIG. 15, since both the particular air holes 630 and the particular suction holes 650 partially overlap with the opening 61a, and the subsequent column of air holes 631 of the inner drum 64 do not overlap with the opening 61a, the pressure in the chamber 61 is not yet increased. In contrast, in the state shown in (d) of FIG. 15, since both the subsequent column of air holes 631 and the subsequent column of suction holes 651 partially overlap with the opening 61a, and the particular holes 630 of the inner drum 64 do not overlap with the opening 61a, a sufficient separation force is applied to the mail item P as the separation target via the subsequent column of air holes 631 and the subsequent column of suction holes 651.

[0064] In other words, in the rotation control employed in the first embodiment, air is introduced into the chamber 61 to increase the internal pressure thereof only for the time period ranging from the state shown in (c) of FIG. 15 to the state shown in (d) of FIG. 15. However, this

time period is just a moment, and therefore the internal pressure of the chamber 61 does not significantly vary.

[0065] In contrast, if the rotational speed of the inner drum 64 is made constant in accordance with that of the outer drum 66, the internal pressure of the chamber 61 already starts to increase in the state shown in (b) of FIG. 15, and still continues to increase in the state shown in (d) of FIG. 15. From this, it is evident that the internal pressure of the chamber 61 can be continuously kept negative by appropriately changing the rotational speed of the inner drum 64.

[0066] As described above, the modification of the first embodiment provides a separation mechanism 5' capable of maintaining a relatively strong suction force for a relatively long time, thereby capable of applying a sufficient and reliable separation force to each mail item P as a separation target. As a result, "simultaneous feeding" of two or more mail items P can be minimized to enhance the processing performance of the whole processing apparatus.

[0067] Referring then to FIGS. 17 to 20, a description will be given of a control method example of adjusting, to a desired value, a separation force to be applied to the mail item P as the separation target, using the separation mechanism 5' of the first embodiment. The separation force to the mail item P is produced by backwardly rotating the outer drum 66, and is substantially proportional to the suction force for attaching the mail item P to the outer peripheral surface of the outer drum 66. Namely, to control the separation force, it is sufficient if the flow of air drawn into the chamber 61 is controlled.

[0068] When applying a maximum suction force to the mail item P as the separation target, the inner and outer drums 64 and 66 are rotated to their respective positions shown in FIG. 13 to completely overlap the particular air holes 630 and suction holes 650 with the opening 61a of the chamber 61. In this state, a great amount of air can be introduced into the chamber 61 via the particular air holes 630 and suction holes 650, thereby applying a maximum separation force to the mail item P as the separation target.

[0069] However, if the maximum separation force is applied to the mail item P as the separation target, and if the mail item P is a thin light one such as a post card, the separation force is too strong and may well cause a disadvantage such as a bending of the mail item P. In particular, if the separation target is not a mail item P, but a much thinner one such as a bill, it may well be broken. Because of this, it is desirable that the separation force of the separation mechanism 5' be set in accordance with the type of the separation target.

[0070] When the separation mechanism 5' of the first embodiment controls the suction force applied to the mail item P as the separation target to control the separation force applied thereto, a method may be employed in which the particular air holes 630 of the inner drum 64 is deviated from the opening 61a of the chamber 61 as shown in FIG. 17. Alternatively, the angular position of

the outer drum 66 is adjusted, instead of adjusting the angular position of the inner drum 64, to deviate the particular suction holes 650. This enables the amount of air introduced into the chamber 61 via the particular air holes 630 and suction holes 650 to be adjusted, whereby the suction force and hence the separation force can be adjusted to a desired value.

[0071] Also in this case, in order to keep, as long as possible, the separation force adjusted to the desired value as mentioned above, when the inner and outer drums 64 and 66 are rotated from their respective angular positions shown in (b) of FIG. 17, the angular position of the inner drum 64 relative to the outer drum 66 is controlled as shown in (b) of FIG. 18. Namely, also in this case, the rotational speed of the inner drum 64 is controlled so that the subsequent column of suction holes 651 do not communicate with the opening 61a of the chamber 61 when the mail item P as the separation target is drawn through the particular suction holes 650.

[0072] Specifically, the inner drum 64 is controlled as shown in, for example, FIGS. 19 and 20. (a) to (g) of FIG. 19 are views useful in explaining the operations of the inner and outer drums 64 and 66, and FIG. 20 is a graph indicating changes with time in the rotational speed of the inner drum 64 corresponding to the states shown in FIG. 19. Also in this case, only the inner drum 64 is a control target, since the outer drum 66 is rotated at a constant speed.

(a) of FIG. 19 shows the moment the particular suction holes 650 of the outer drum 66 completely overlap with the opening 61a of the chamber 61, and the particular air holes 630 of the inner drum 64 partially overlap with the opening 61a of the chamber 61. The rotational speed of the inner drum 64 at this moment is identical to that of the outer drum 66 as indicated by symbol a in FIG. 16. Further, at this moment, the inner drum 64 is rotated with its angular position slightly retarded relative to the outer drum 66.

[0073] Namely, in the state shown in (a) of FIG. 19, since the particular air holes 630 of the inner drum 64 partially overlap with the opening 61a, deviated from the particular suction holes 650 of the outer drum 66, the amount of air drawn into the chamber 61 is less than in the case shown in (a) of FIG. 15. Therefore, in this state, if the outer drum 66 (and the inner drum 64) is rotated in the backward direction, a separation force slightly weaker than that in the first embodiment is applied to the mail item P.

[0074] It is apparent from this that by adjusting the degree of overlap between the particular air holes 630 of the inner drum 64 and the particular suction holes 650 of the outer drum 66, the amount of air flowing into the chamber can be controlled and hence the separation force applied to the mail item P can be controlled.

[0075] When a mail item P as a separation target is attached to the outer peripheral surface of the outer drum

66, and the outer drum 66 slightly rotates at a constant speed from the angular position shown in (a) of FIG. 19 in the backward direction T2, the inner drum 64 also rotates at the same speed in the backward direction as shown in (b) of FIG. 19 and indicated by symbol a in FIG. 20. Namely, during the time period when the state shifts from a to b, the inner drum 64 is rotated in the backward direction at the same speed as the outer drum 66. During this period, the degree of overlap between the particular suction holes 650 and the particular air holes 630 is also maintained, the suction force applied to the mail item P, i.e., the separation force applied thereto, is maintained at a desired value.

[0076] After that, the rotation of the inner drum 64 is accelerated in the backward direction as indicated by symbols b and c in FIG. 20, whereby the rotational speed of the inner drum 64 substantially reaches that of the outer drum 66 as shown in (c) of FIG. 19. At this time, although the subsequent column of suction holes 651 of the outer drum 66 already partially overlap with the opening 61a of the chamber 61, the subsequent column of air holes 631 of the inner drum 64 do not yet overlap with the opening 61a. In other words, in the states up to that shown in (c) of FIG. 19, the internal pressure of the chamber 61 is not increased, and hence the separation force is kept at substantially the same value.

[0077] If, in (c) of FIG. 19, the subsequent column of suction holes 651 of the outer drum 66 completely overlap with the subsequent column of air holes 631 of the inner drum 64, air may flow into the chamber 61 via the subsequent columns of suction holes 651 and air holes 631, as in the above-described case of using the separation drum 31 as the reference example, thereby increasing the internal pressure of the chamber 61. Namely, also in this case, air leakage is prevented by causing the angular position of the inner drum 64 to deviate from that of the outer drum 66.

[0078] When the outer drum 66 is further rotated from the angular position shown in (c) of FIG. 19 at a constant speed in the backward direction, the inner drum 64 is decelerated to a rotational speed lower than the outer drum 66 to reach the state shown in (f) of FIG. 19, after assuming the states shown in (d) and (e) of FIG. 19. The state shown in (f) of FIG. 19 is substantially the same as the state shown in (a) of FIG. 19, except that the opening 61a of the chamber 61 faces the subsequent column of suction holes 651 and the subsequent column of air holes 631. Further, the state shown in (g) of FIG. 19 corresponds to the state shown in (b) of FIG. 19.

[0079] Thus, the above-described control method can adjust, to a desired value, the separation force applied to the mail item P as the separation target, with the result that the separation force can be kept at the desired value for a relatively long time.

[0080] As described above, the first embodiment provides the separation mechanism 5' capable of applying an appropriate separation force in accordance with the type of a medium as a separation target, thereby reducing

the degree of occurrence of "simultaneous feeding" in which a plurality of mail items P stacked on each other are simultaneously fed, and hence enhancing the processing capacity of the entire processing apparatus.

[0081] FIGS. 21 and 22 illustrate the essential structure of a separation mechanism 5" according to a second embodiment. More specifically, (a) of FIG. 21 is a perspective view illustrating a structure in which the outer drum 66 incorporates a plurality of suction holes (650, 651) arranged in a zigzag manner so that the holes are positioned as close as to each other in the direction of rotation. (b) of FIG. 21 is a sectional view of the structure shown in (a) of FIG. 21. (a) and (b) of FIG. 22 show a state in which the inner and outer drums 64 and 66 are slightly rotated in the backward direction from their angular positions shown in (a) and (b) of FIG. 21.

[0082] The separation mechanism 5" of the second embodiment is similar to the separation mechanism 5' of the first embodiment except that in the former, the suction holes (650, 651) of the outer drum 66 are arranged in a zigzag manner to increase the number of the holes, and the air holes (630, 631) of the inner drum 64 are also arranged in a zigzag manner in accordance with the suction holes of the outer drum 66. Accordingly, in the second embodiment, elements similar to those of the first embodiment are denoted by corresponding reference numbers, and no detailed description will be given thereof.

[0083] As shown in FIGS. 21 and 22, where the suction holes (and the air holes) are arranged in a zigzag manner, the pitch of the suction holes (and the air holes) in the direction of rotation is narrower than in the first embodiment. Therefore, the internal pressure of the chamber 61 can be more easily increased than in the separation mechanism 5' of the first embodiment. Namely, in the second embodiment, air can be more easily introduced into the chamber 61 than in the first embodiment, since the subsequent column of suction holes 651 and the subsequent column of air holes 631 can be opposed to the opening 61a of the chamber 61 by more slightly reversing the drums 64 and 66 than in the first embodiment.

[0084] However, also in this case, a disadvantage that the internal pressure of the chamber 61 is increased can be minimized by shortening the periods of accelerating and decelerating the inner drum 64. Further, even if the period in which air is introduced into the chamber 61 becomes slightly longer because of the zigzag arrangement of the holes 630, 631, 650 and 651, the separation force can be more instantly applied to the mail item P through the subsequent holes 631 and 651, since the pitch of these holes is made narrower in the rotation direction of the drums 64 and 66. As a result, the negative pressure does not significantly vary.

[0085] In contrast, if the pitch of the holes 630, 631, 650 and 651 is increased in the rotation direction of the drums 64 and 66, a phenomenon can be eliminated, in which when the mail item P is drawn via the particular holes 630 and 650, the subsequent columns of holes 631 and 651 face the opening 61a of the chamber 61.

[0086] While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel embodiments described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the methods described herein may be made without departing from the scope of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope of the inventions.

[0087] For instance, although in the above-described embodiments, the outer drum 66 is rotated at a constant speed, and the inner drum 64 is accelerated and decelerated, the invention is not limited to this. Instead, the inner drum 64 may be rotated at a constant speed, and the outer drum 66 be accelerated and decelerated. Yet alternatively, both the rotational speeds of the inner and outer drums 64 and 66 may be varied.

Claims

1. A sheet handling apparatus comprising:

a pickup mechanism (3) which can be brought into contact with an outermost sheet of a plurality of accumulated sheets, and rotate to pick up the outermost sheet in a direction parallel to a surface of the outermost sheet;

a separation mechanism (5') which is adapted to apply a separation force to a sheet to be subsequently fed that is included in the accumulated sheets and simultaneously picked up by the pickup mechanism with the outermost sheet, the separation force being exerted in a direction opposite to the direction of pickup of the outermost sheet;

the separation mechanism (5') being **characterized by** comprising:

an outer rotation body (66) including at least one suction hole (65) temporarily facing the sheet to be subsequently fed when the outer rotation body rotates in the opposite direction;

an inner rotation body (64) rotatably provided inside and concentric with the outer rotation body, the inner rotation body including at least one air hole (63) that at least partially overlaps with the at least one suction hole when the inner rotation body rotates;

a suction unit (37) which is adapted to draw air through the at least one suction hole and through the at least one air hole, the at least one air hole at least partially overlapping with the at least one suction hole when the

- at least one suction hole faces the sheet to be subsequently fed, thereby attaching the sheet to be subsequently fed to an outer peripheral surface of the outer rotation body; and
 a control unit (76) which is adapted to rotate the outer and inner rotation bodies to adjust a degree of overlap between the at least one suction hole and the at least one air hole.
2. The sheet handling apparatus according to claim 1, wherein the outer rotation body (66) includes a plurality of columns of suction holes (65), the columns of suction holes sequentially facing the sheet to be subsequently fed when the outer rotation body rotates in the opposite direction; the inner rotation body includes a plurality of columns of air holes (63), the columns of air holes overlapping with the respective columns of suction holes when the inner rotation body rotates; and the suction unit (37) is adapted to draw air through at least one column of suction holes included in the columns of suction holes and through at least one column of air holes included in the columns of air holes and overlapping with the at least one column of suction holes, when the at least one column of suction holes faces the sheet to be subsequently fed, thereby attaching the sheet to be subsequently fed to an outer peripheral surface of the outer rotation body.
 3. The sheet handling apparatus according to claim 2, **characterized in that** the control unit (76) is adapted to rotate the inner rotation body (64) with a relative angular position thereof deviated from a relative angular position of the outer rotation body (66) to prevent the drawn air from leaking through a subsequent column of suction holes which are included in the columns of suction holes and subsequently face the sheet to be subsequently fed in accordance with the rotation of the outer rotation body (66) in the opposite direction.
 4. The sheet handling apparatus according to claim 2 or 3, **characterized in that** the control unit (76) is adapted to rotate the outer rotation body (66) at a constant speed in the opposite direction, and to accelerate and decelerate the inner rotation body (64).
 5. The sheet handling apparatus according to any of claims 2 to 4, **characterized in that** the control unit (76) is adapted to rotate the outer rotation body (66) and the inner rotation body (64) to adjust a degree of overlap between the at least one column of suction holes facing the sheet to be subsequently fed and the at least one column of air holes, thereby adjusting the separation force applied to the sheet to be subsequently fed.
 6. The sheet handling apparatus according to any of claims 2 to 5, further comprising:
 a chamber (61) defined in the inner rotation body and communicating with an outside of the outer rotation body through the columns of suction holes and the respective columns of air holes overlapping therewith;
 wherein the suction unit (37) is adapted to draw air from the chamber through at least one column of suction holes included in the columns of suction holes and through at least one column of air holes included in the columns of air holes and overlapping with the at least one column of suction holes, when the at least one column of suction holes face the sheet to be subsequently fed, thereby attaching the sheet to be subsequently fed to an outer peripheral surface of the outer rotation body.
 7. The sheet handling apparatus according to claim 6, **characterized in that** when the sheet to be subsequently fed is attached to an outer peripheral surface of the outer rotation body (66), the control unit (76) rotates the inner rotation body (64) with a relative angular position thereof deviated from a relative angular position of the outer rotation body (66) to prevent the chamber (61) from communicating with a subsequent column of suction holes which are included in the columns of suction holes and subsequently face the sheet to be subsequently fed in accordance with the rotation of the outer rotation body (66) in the opposite direction.
 8. The sheet handling apparatus according to any of claims 1 to 7, **characterized in that** the control unit (76) is adapted to rotate the outer rotation body (66) at a constant speed in the opposite direction, and to accelerate and decelerate the inner rotation body (64) in the opposite direction.
 9. The sheet handling apparatus according to any of claims 2 to 8, **characterized in that** the control unit (76) is adapted to rotate the outer rotation body (66) and the inner rotation body (64) to adjust a degree of overlap between the at least one column of suction holes facing the sheet to be subsequently fed and the at least one column of air holes, thereby to adjust the separation force applied to the sheet to be subsequently fed.

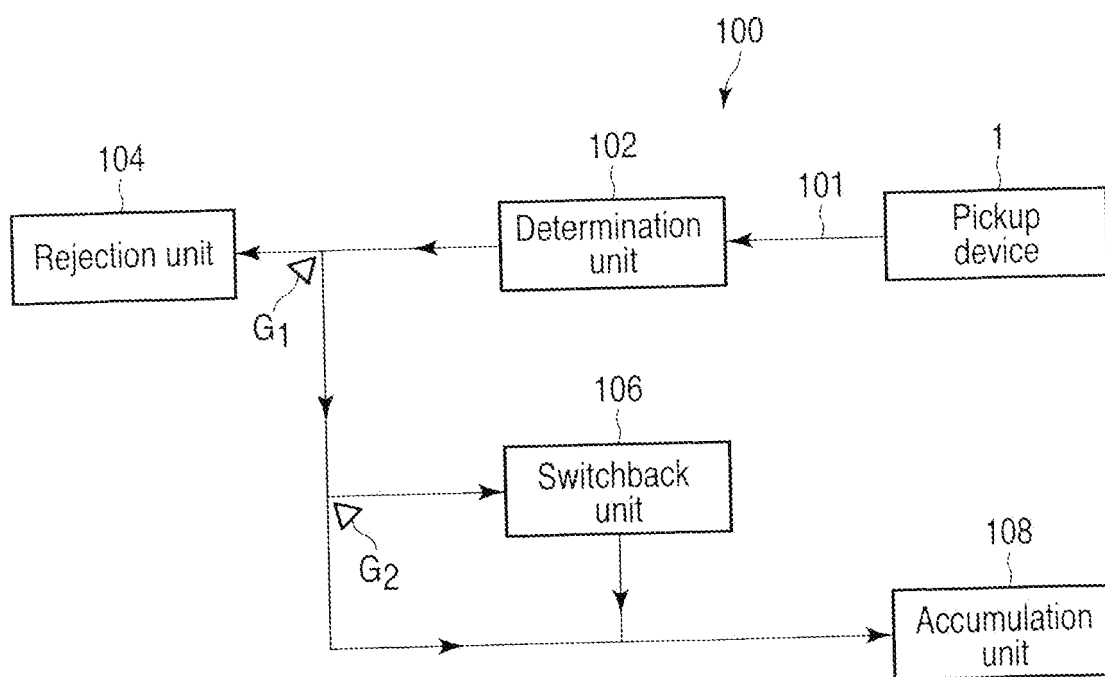


FIG. 1

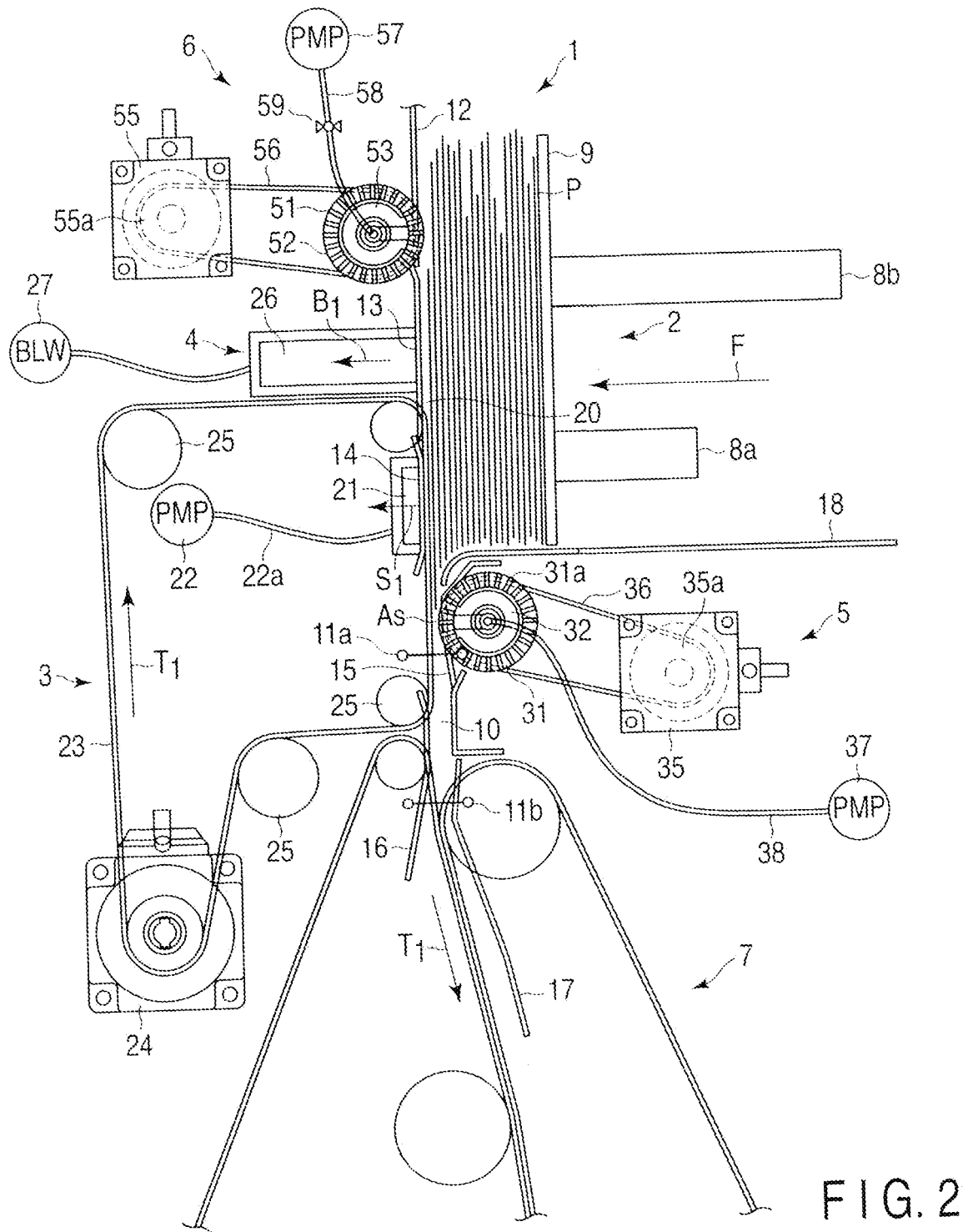


FIG. 2

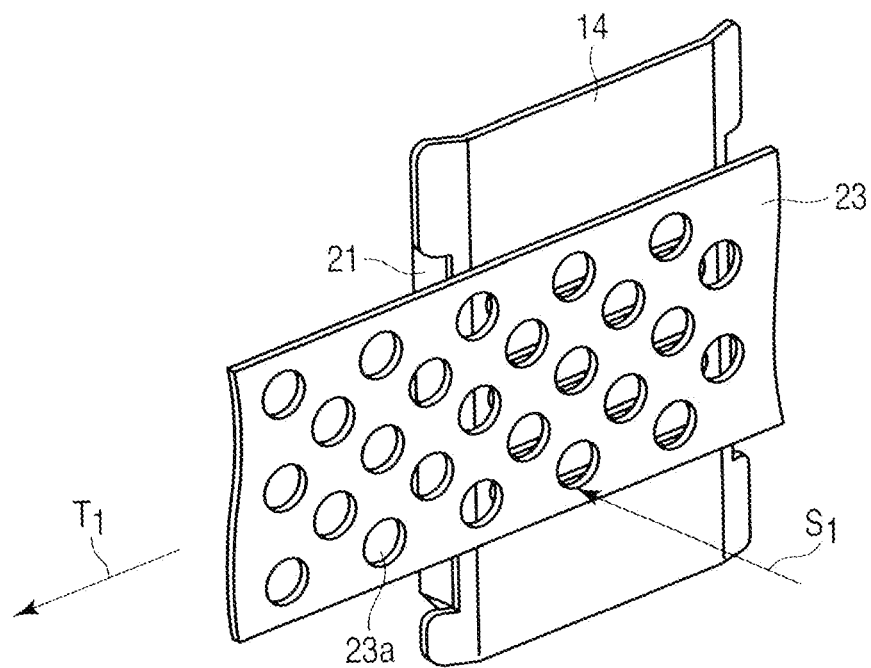


FIG. 3

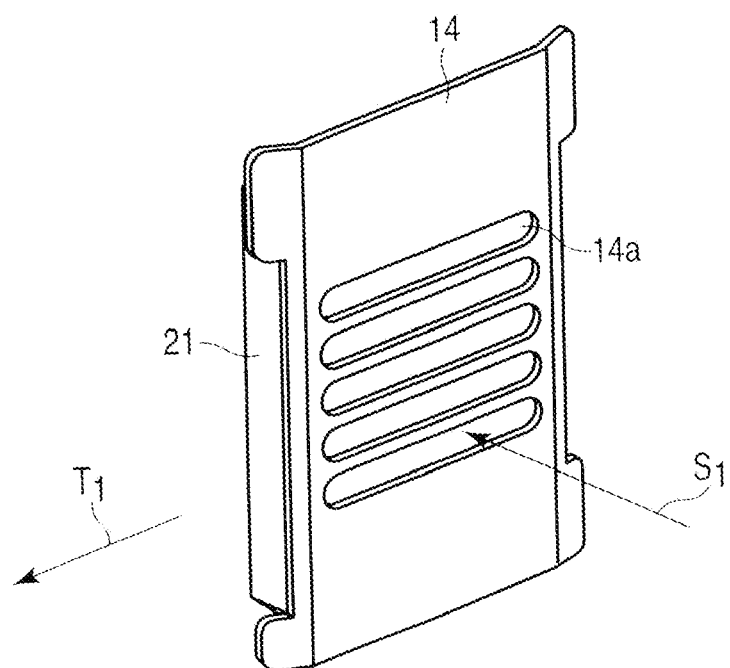


FIG. 4

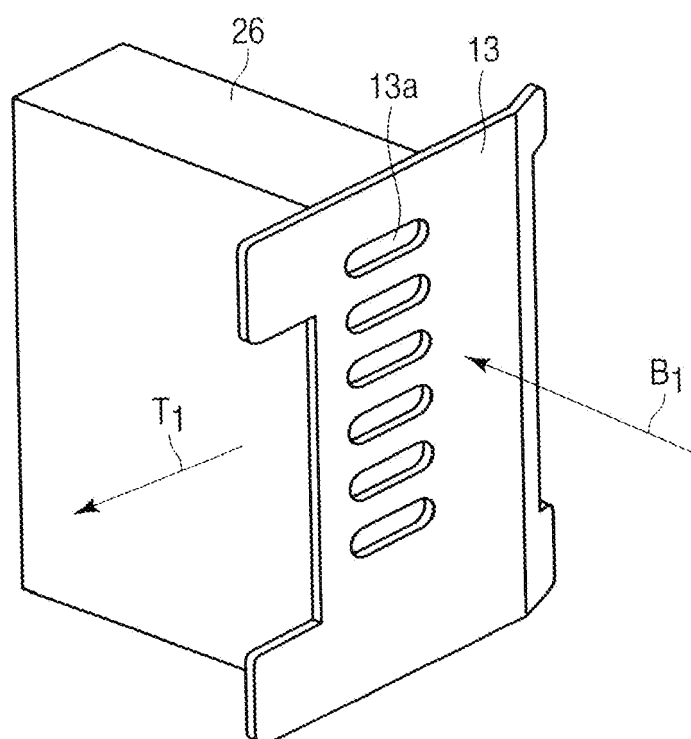


FIG. 5

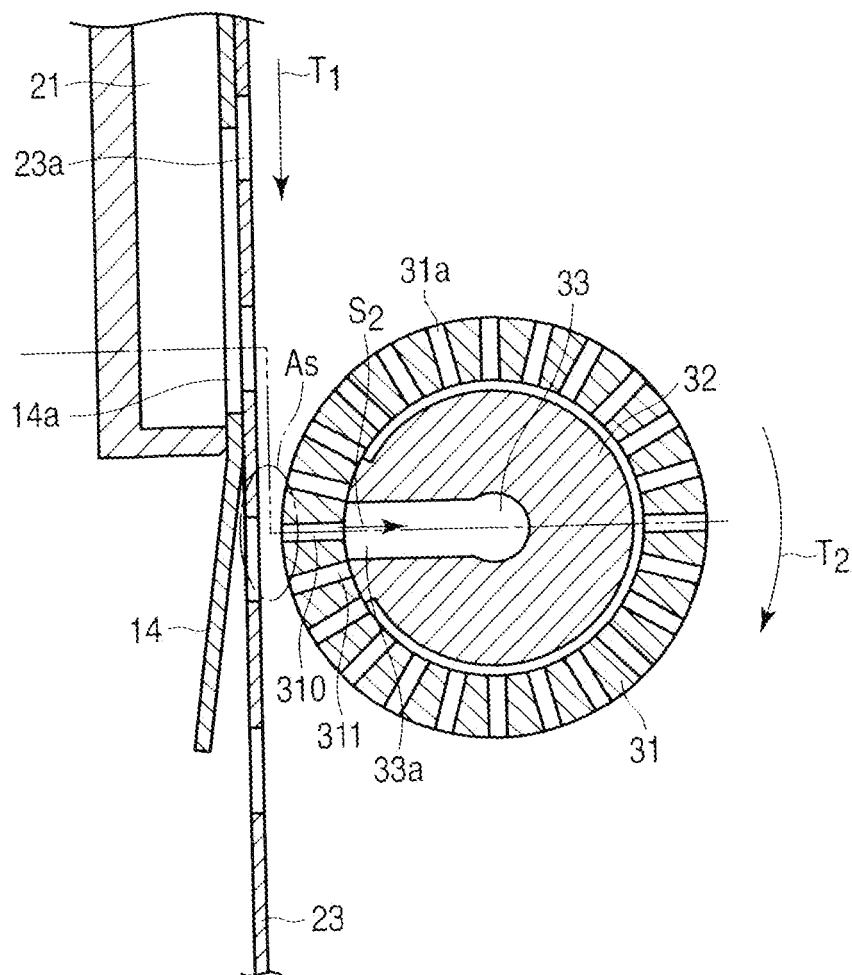


FIG. 6

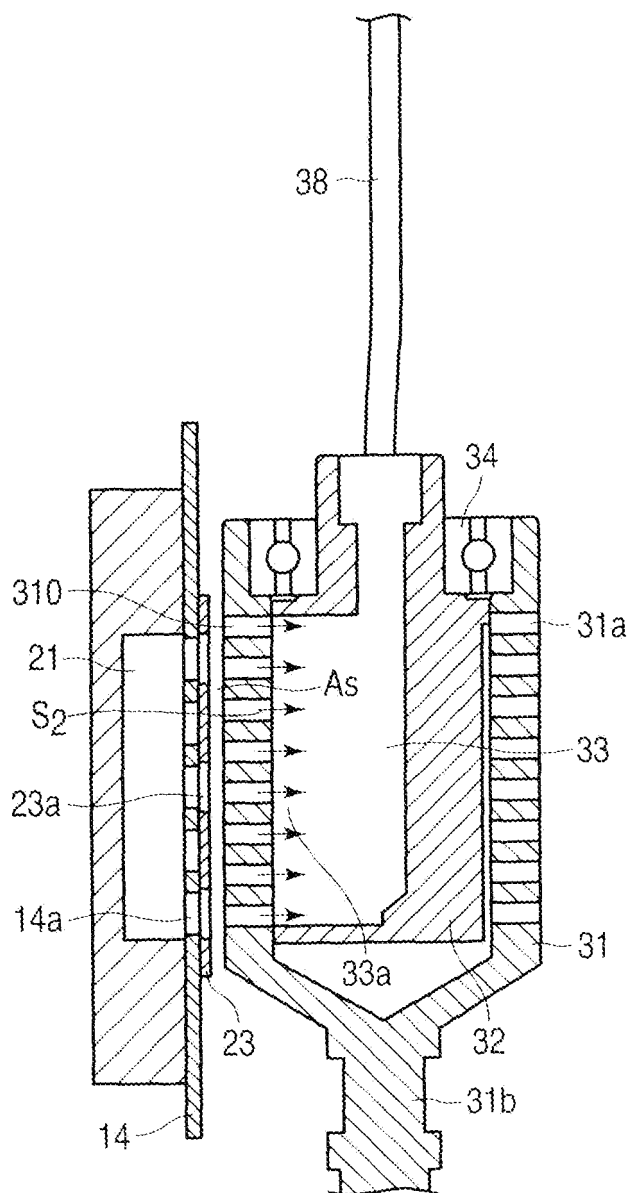


FIG. 7

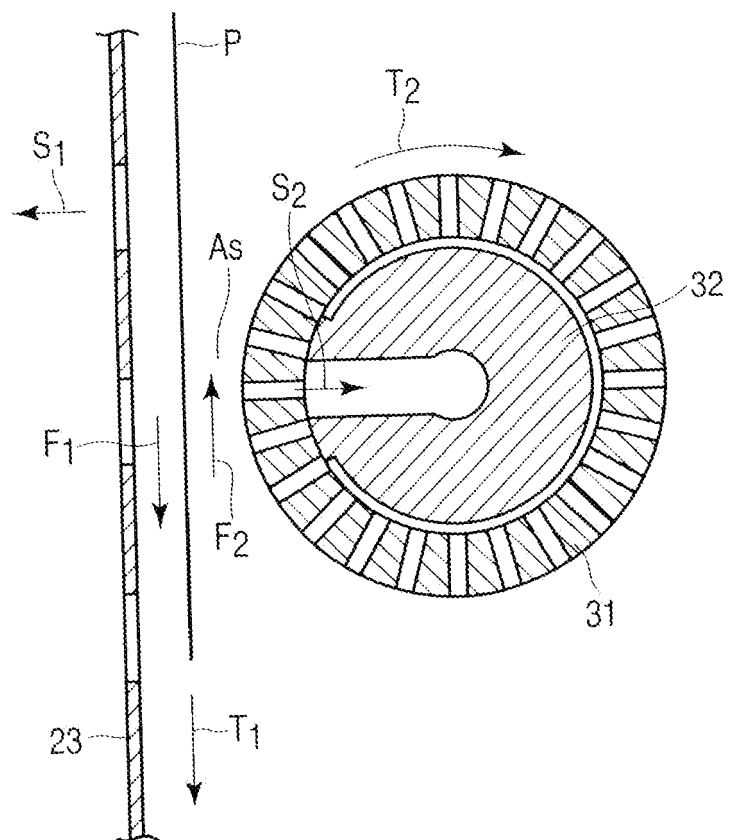


FIG. 8

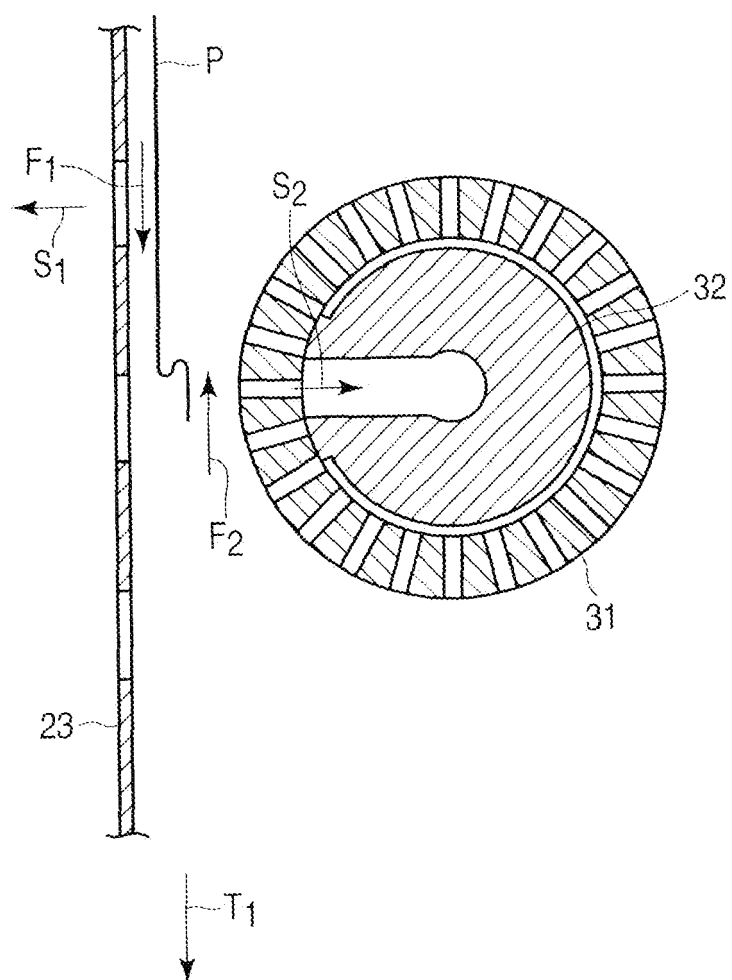


FIG. 9

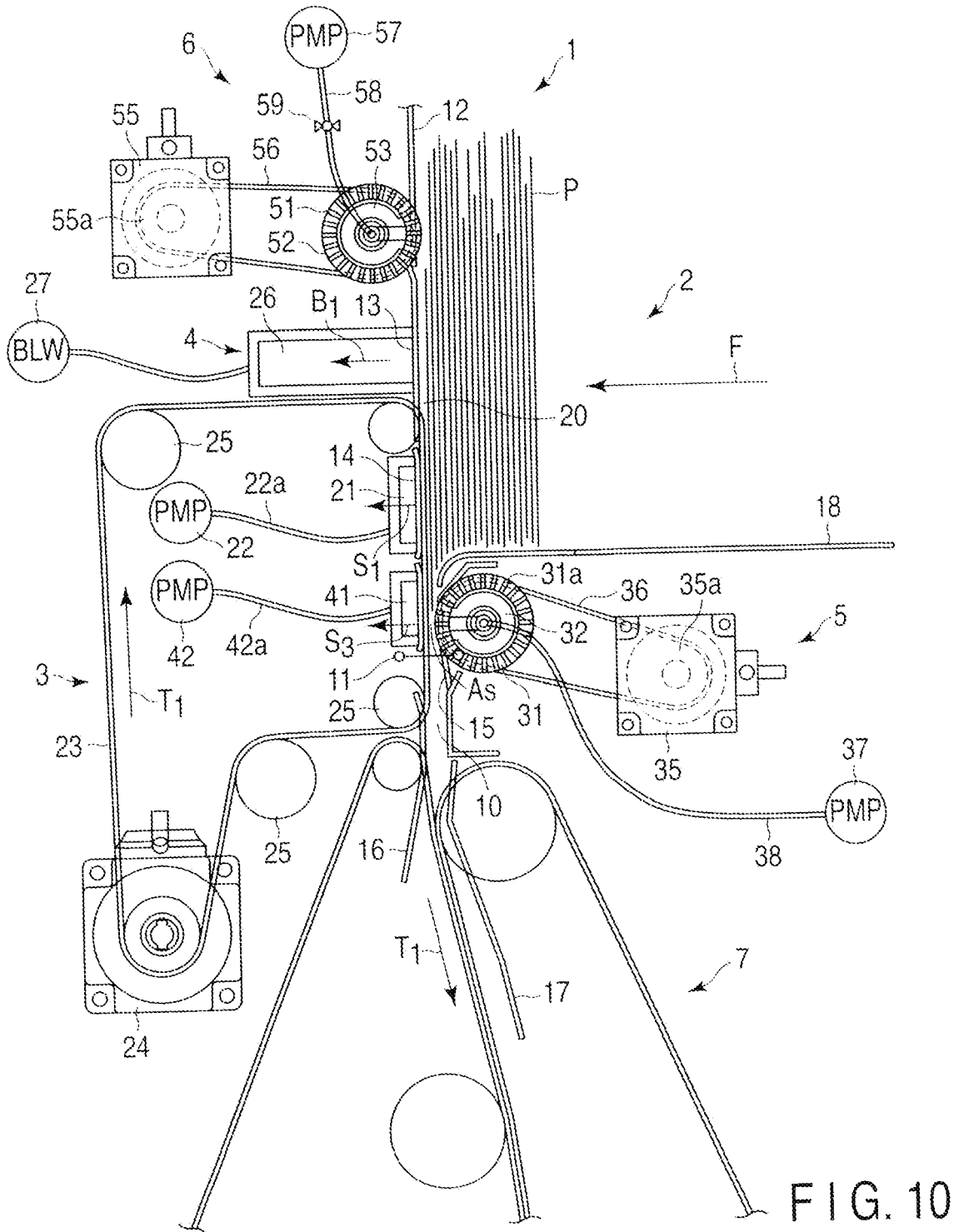


FIG. 10

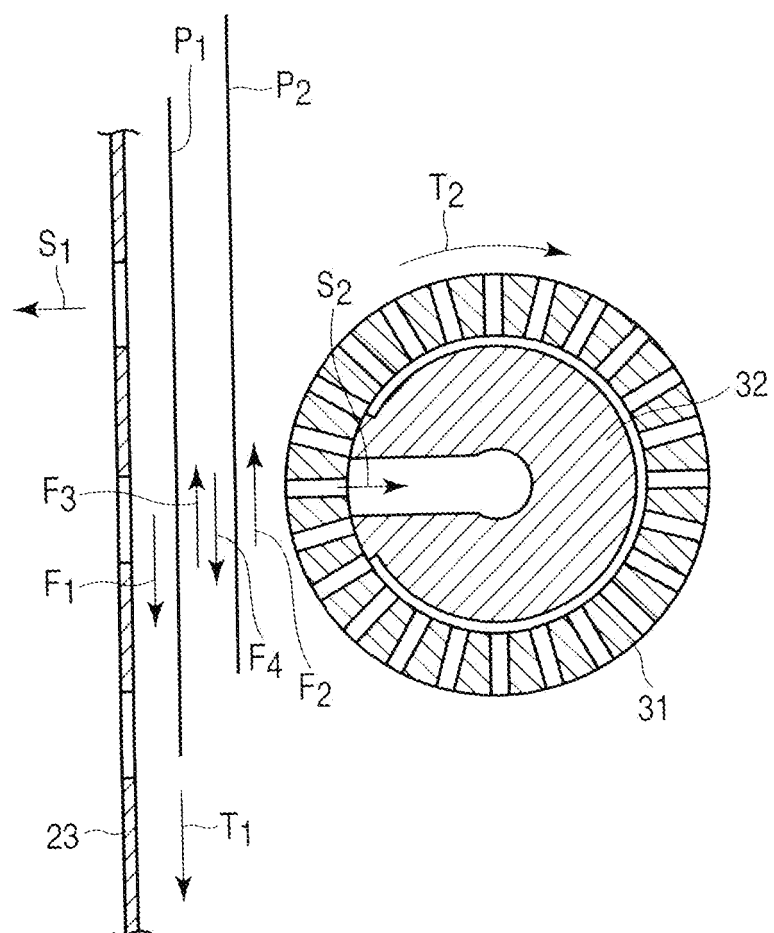


FIG. 11

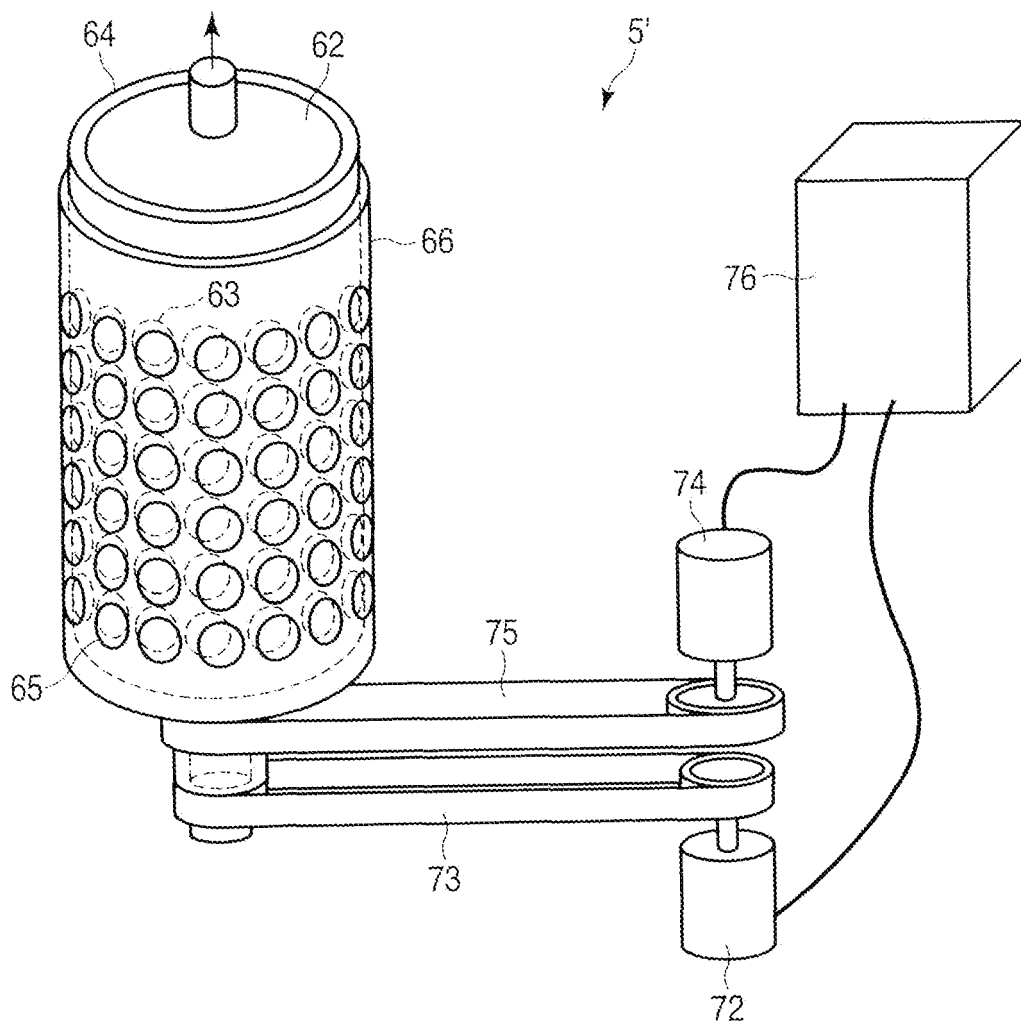
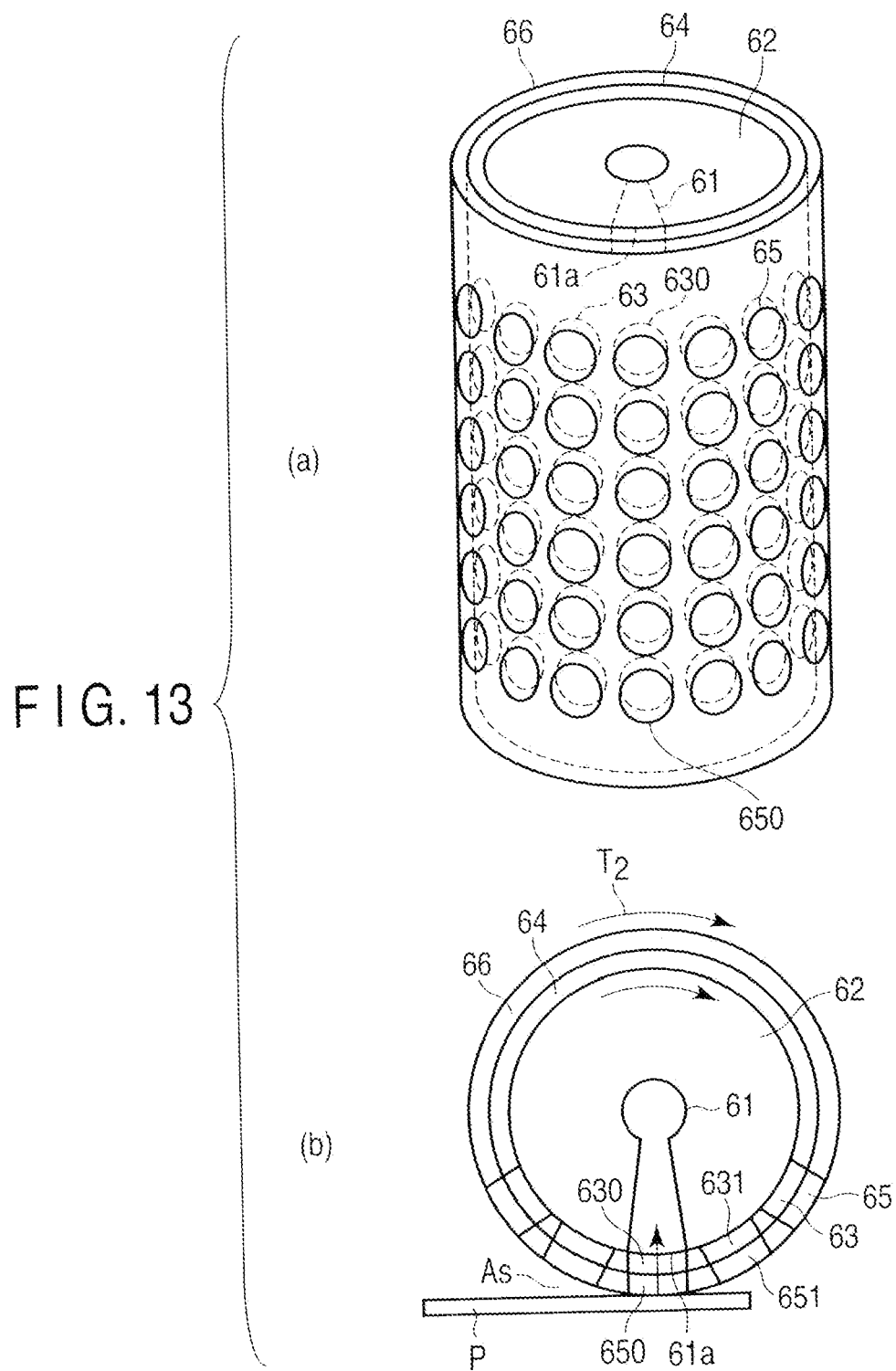
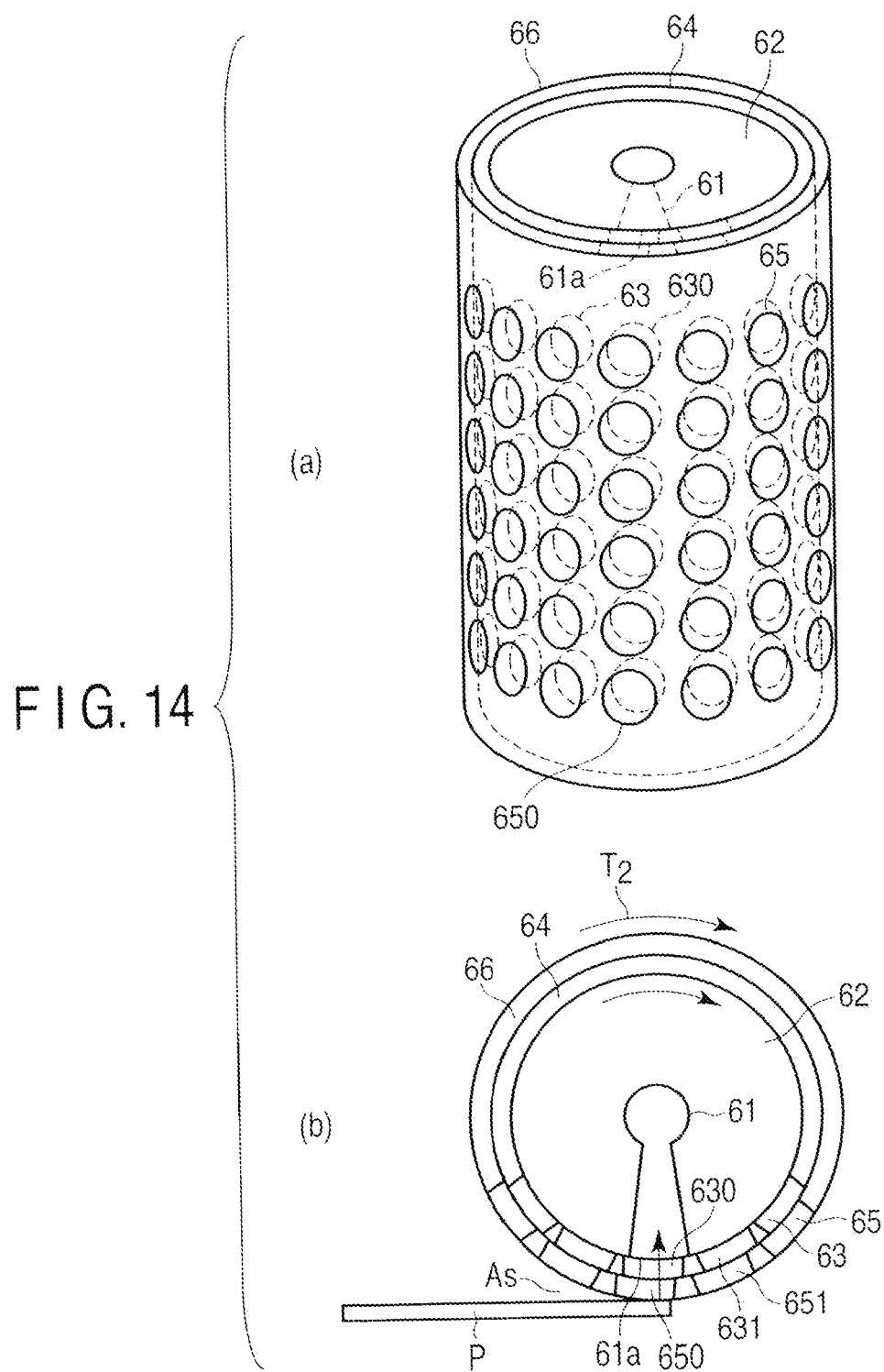


FIG. 12





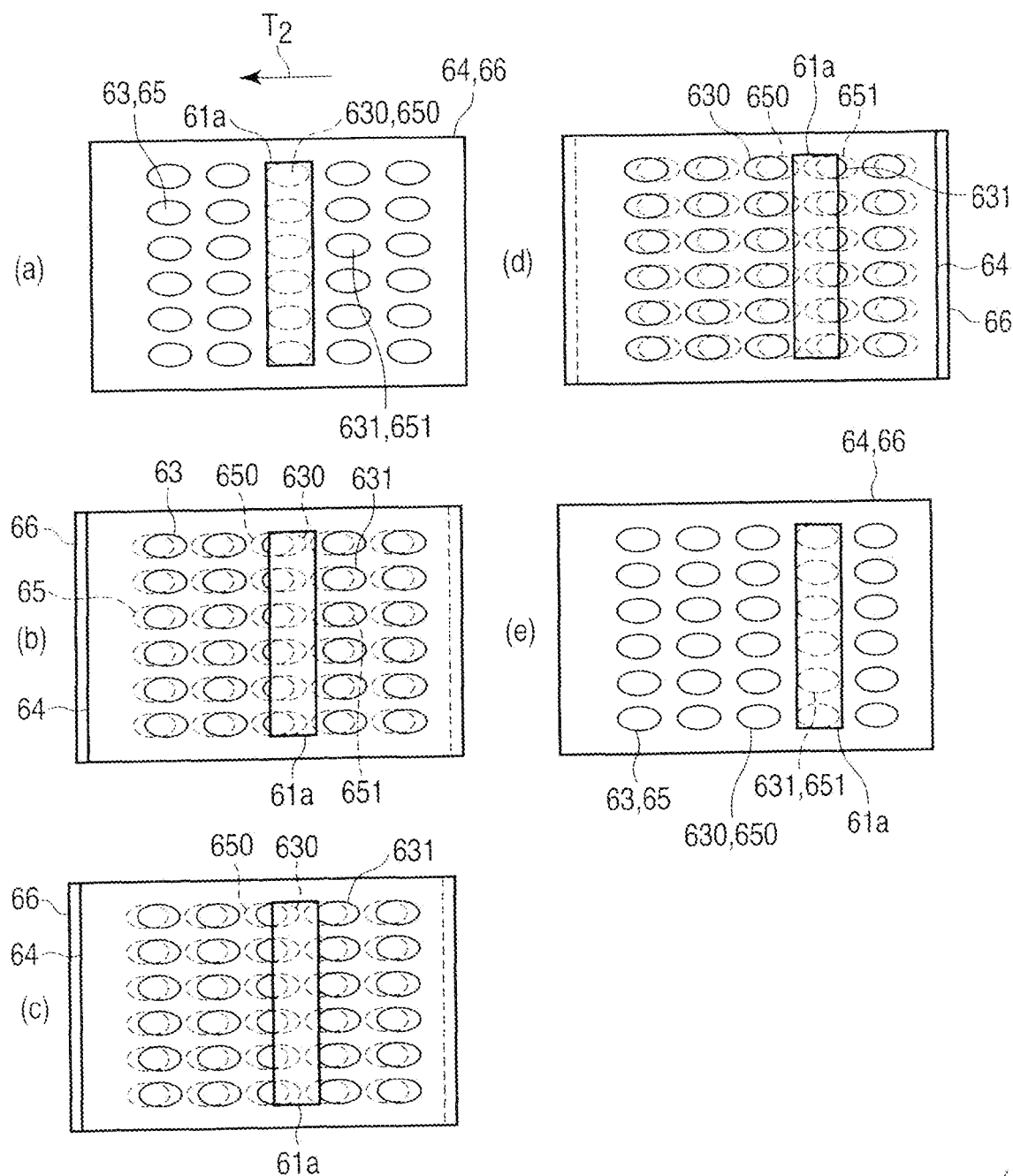


FIG. 15

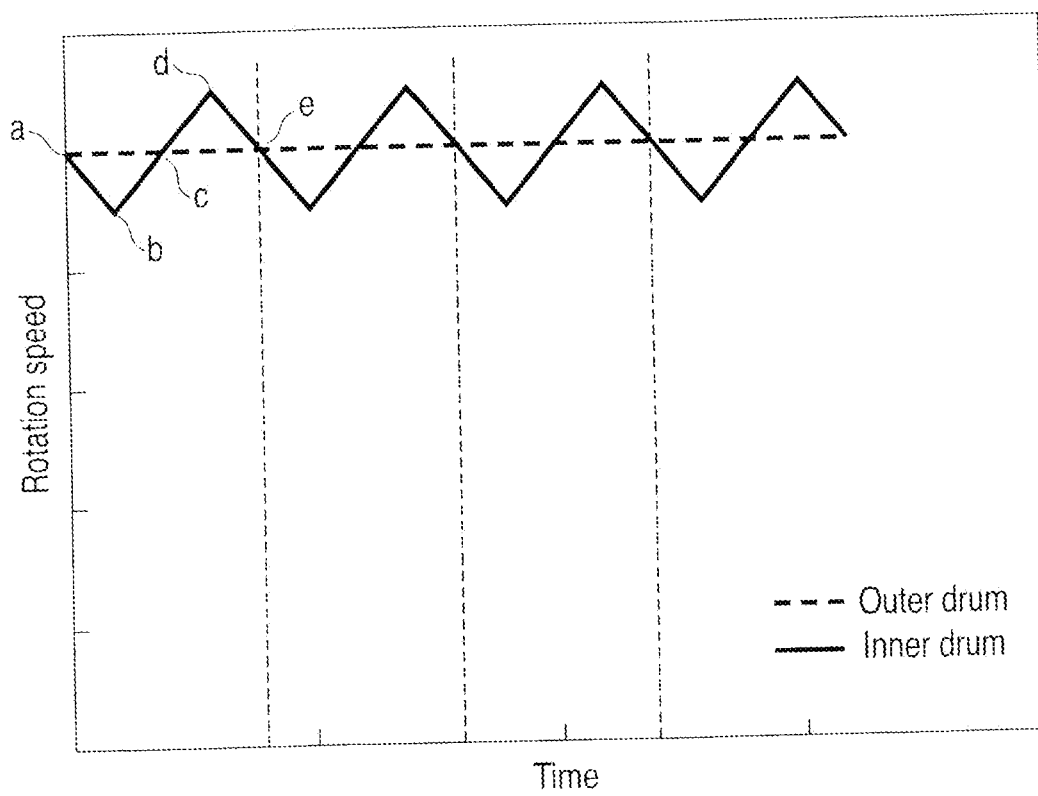
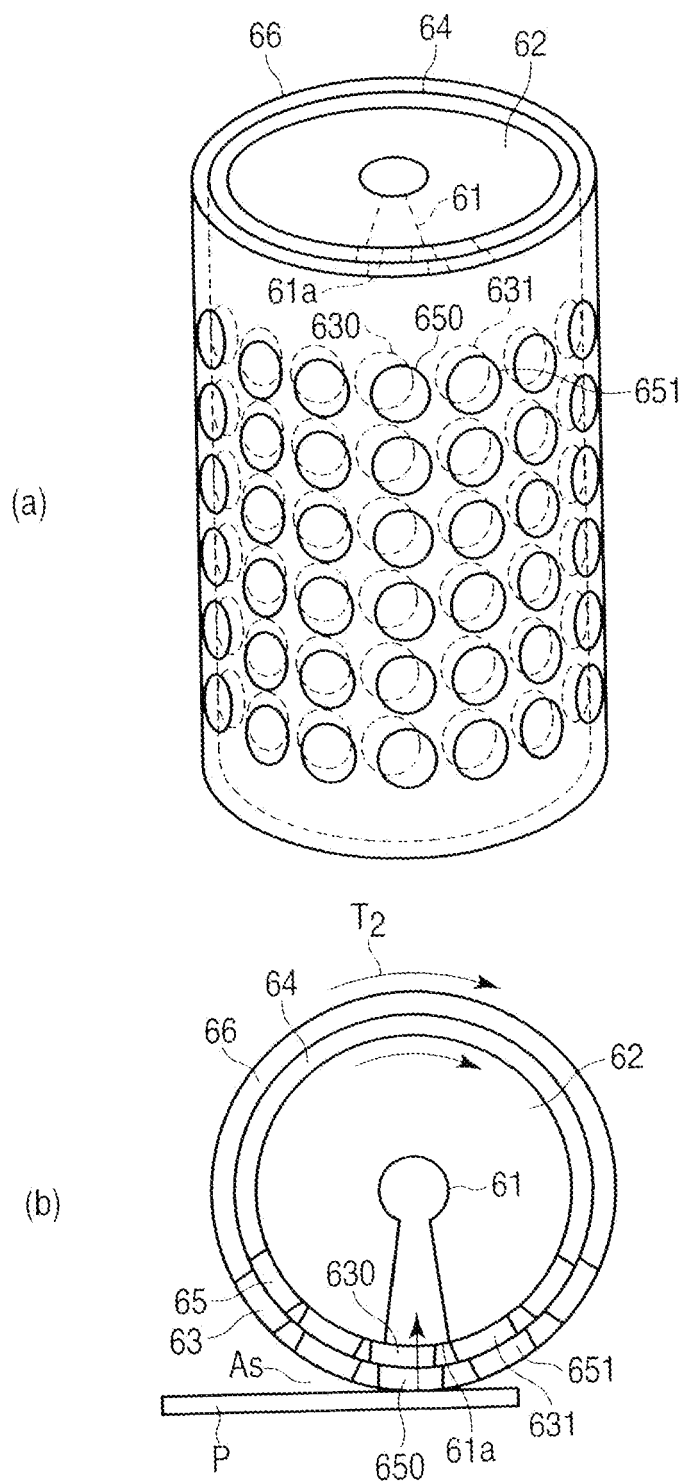
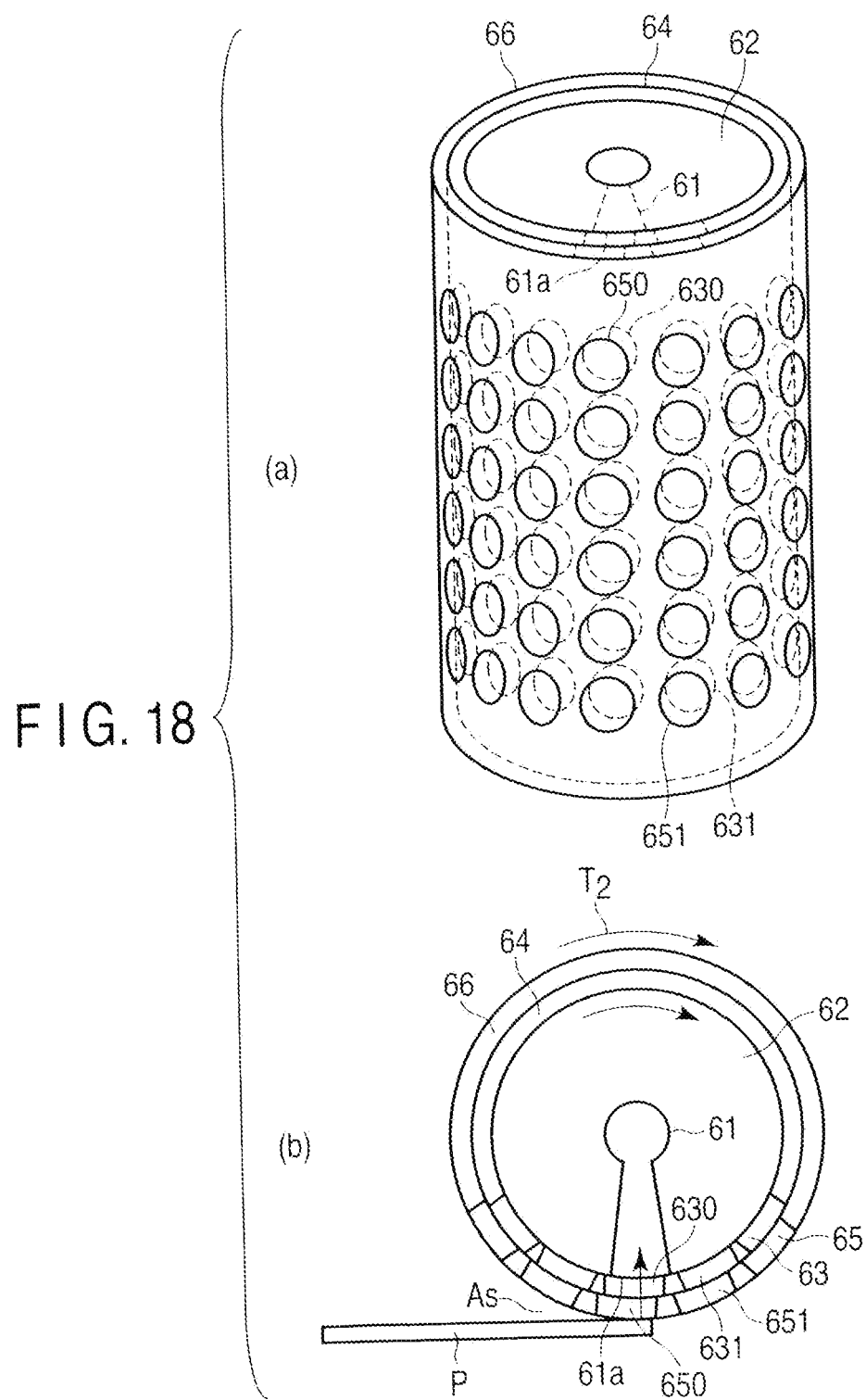


FIG. 16

FIG. 17





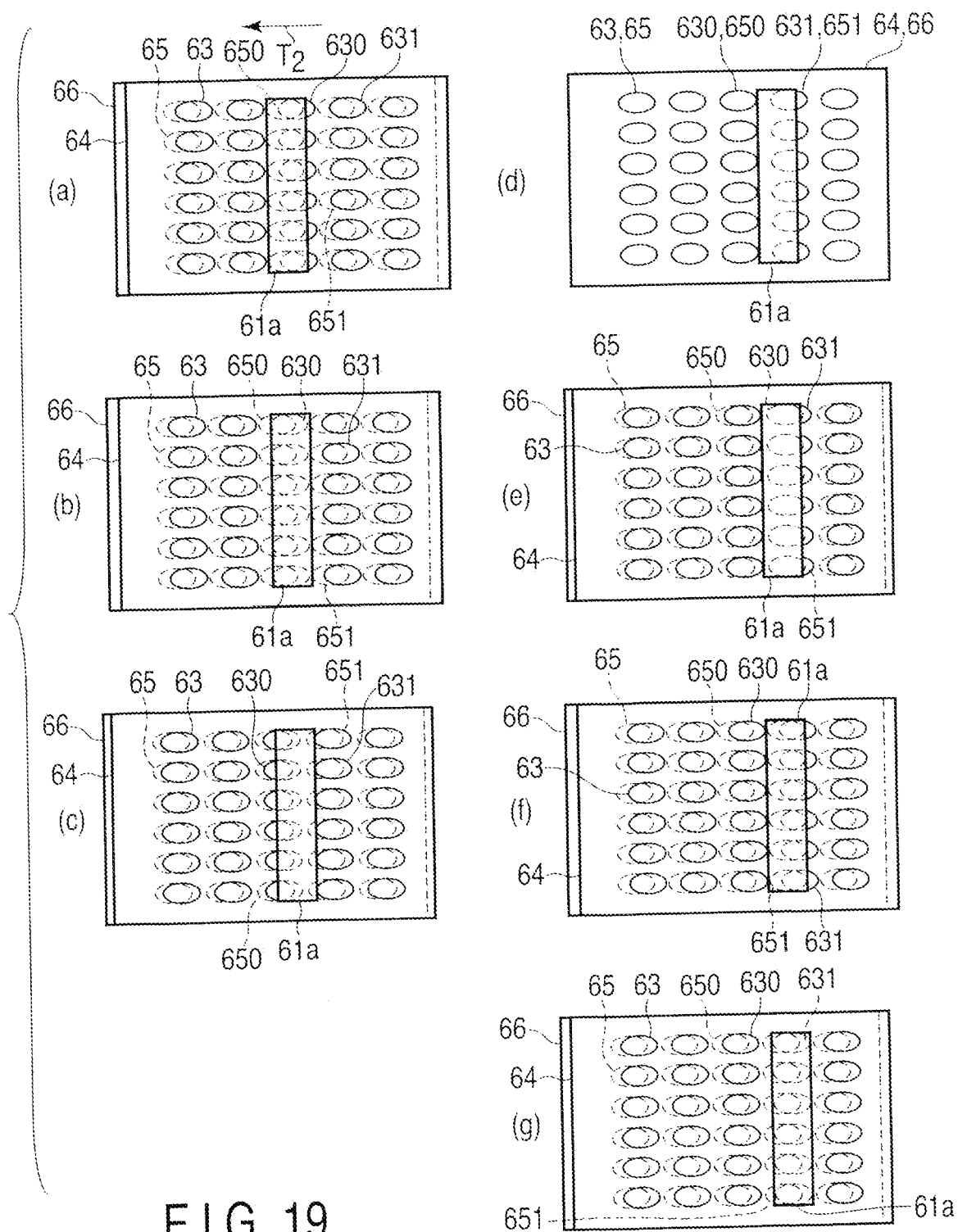


FIG. 19

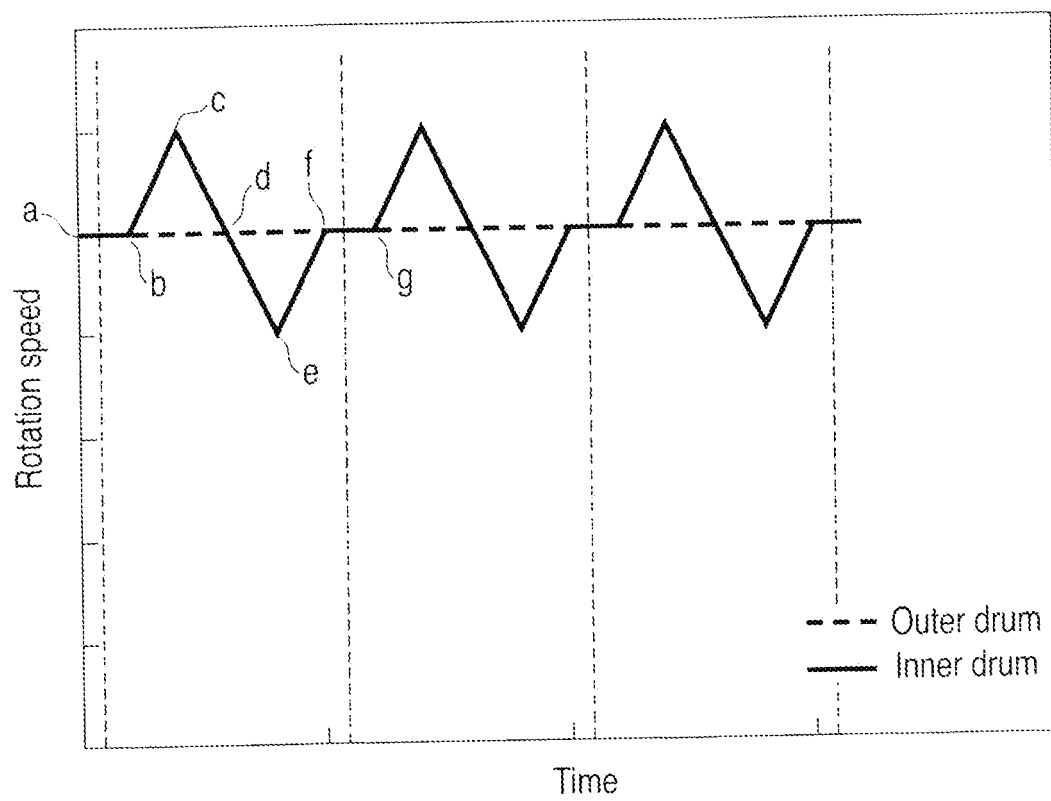


FIG. 20

FIG. 21

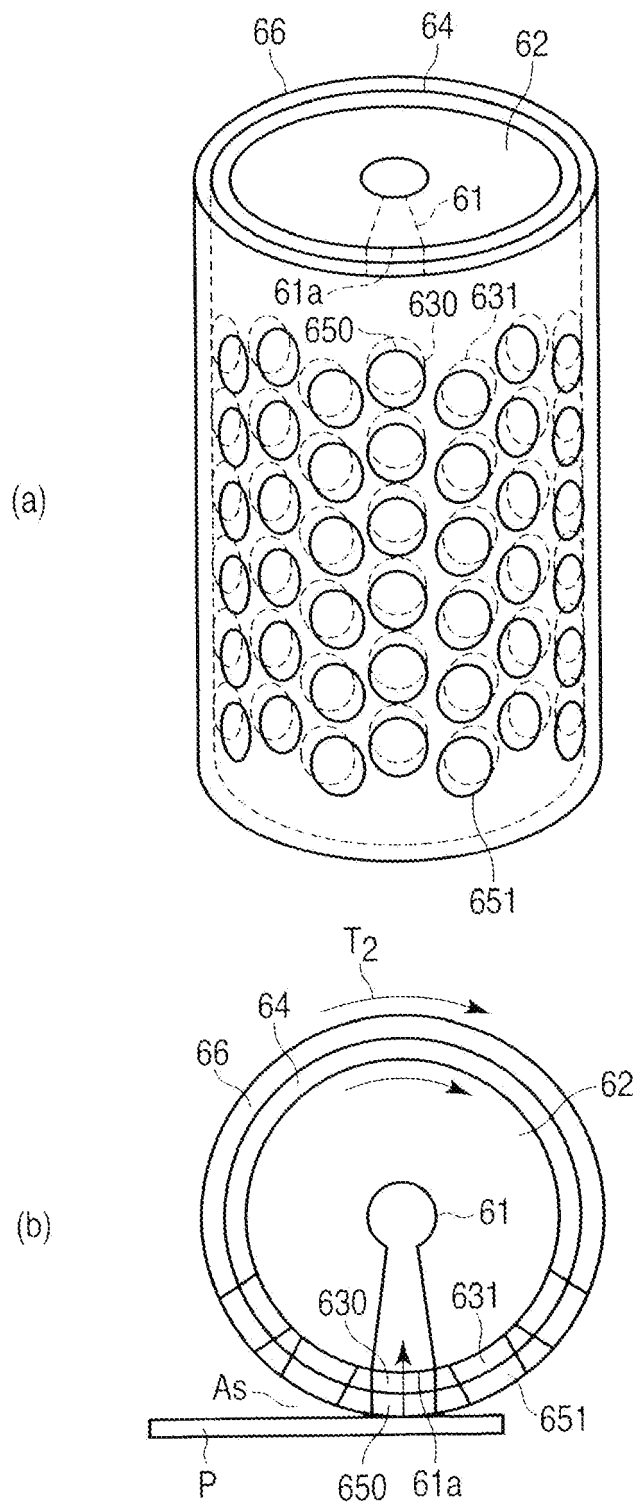
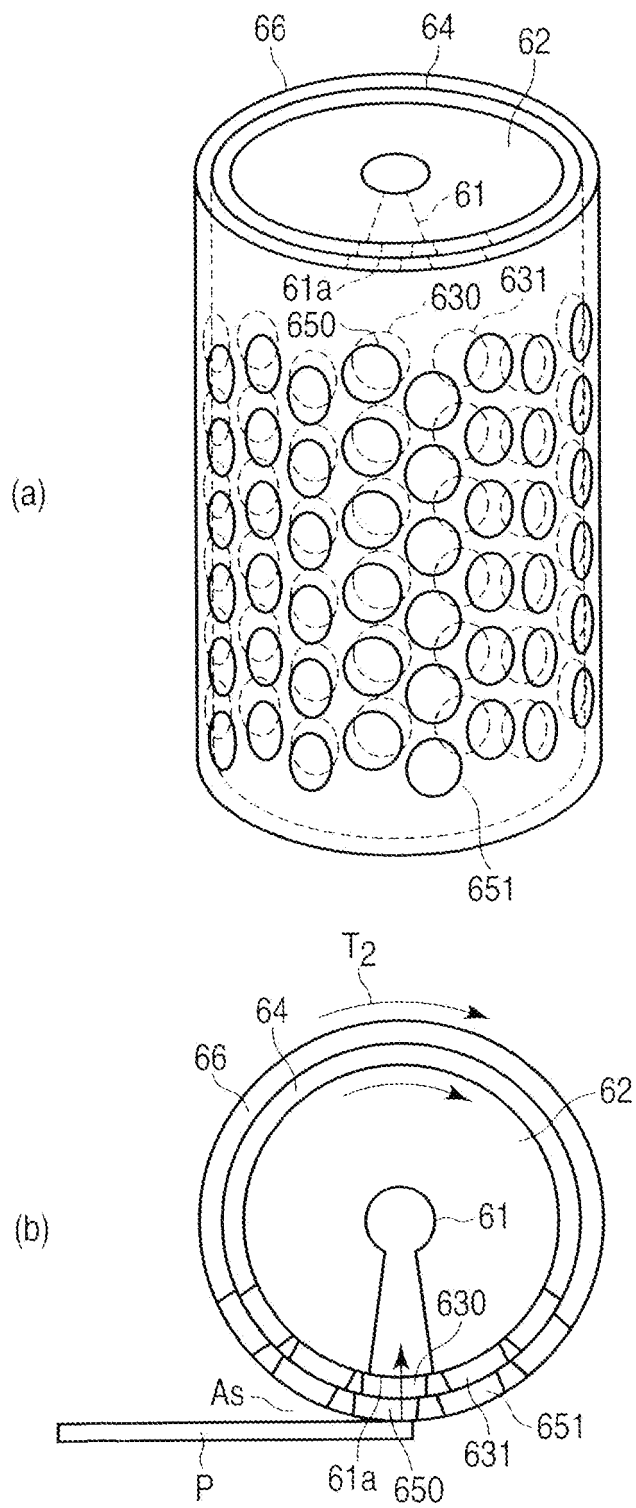


FIG. 22



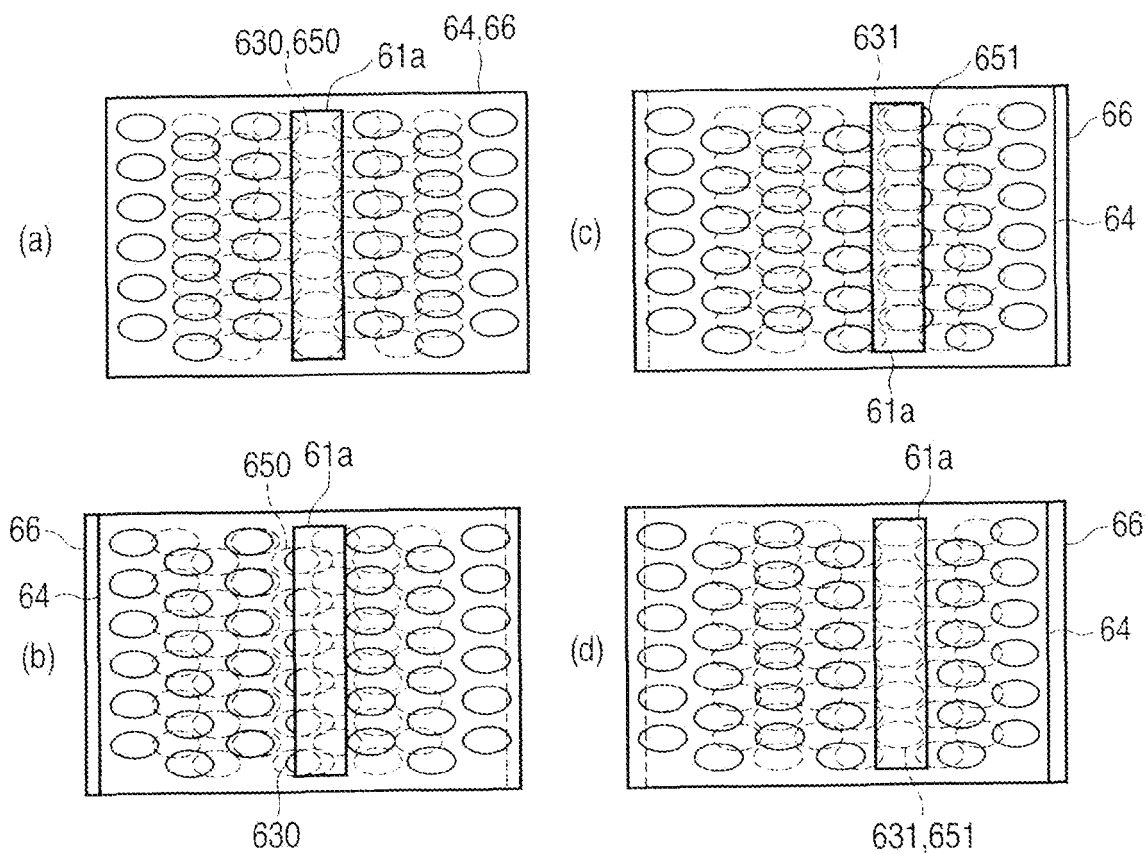


FIG. 23

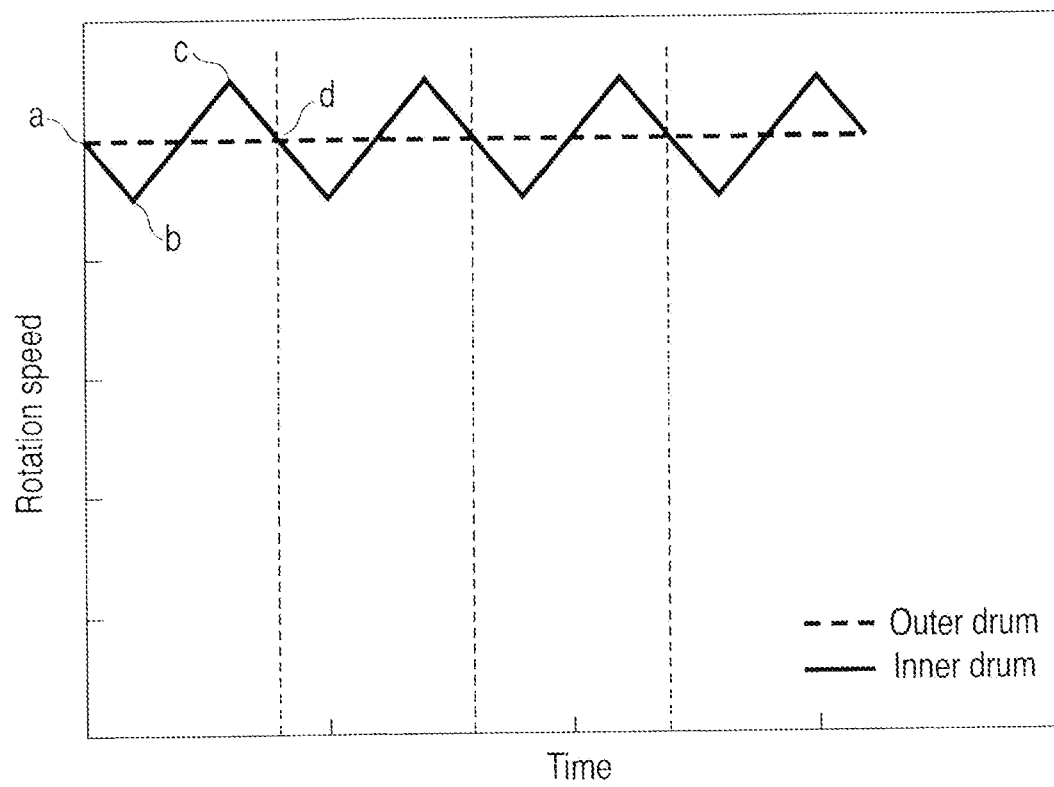


FIG. 24