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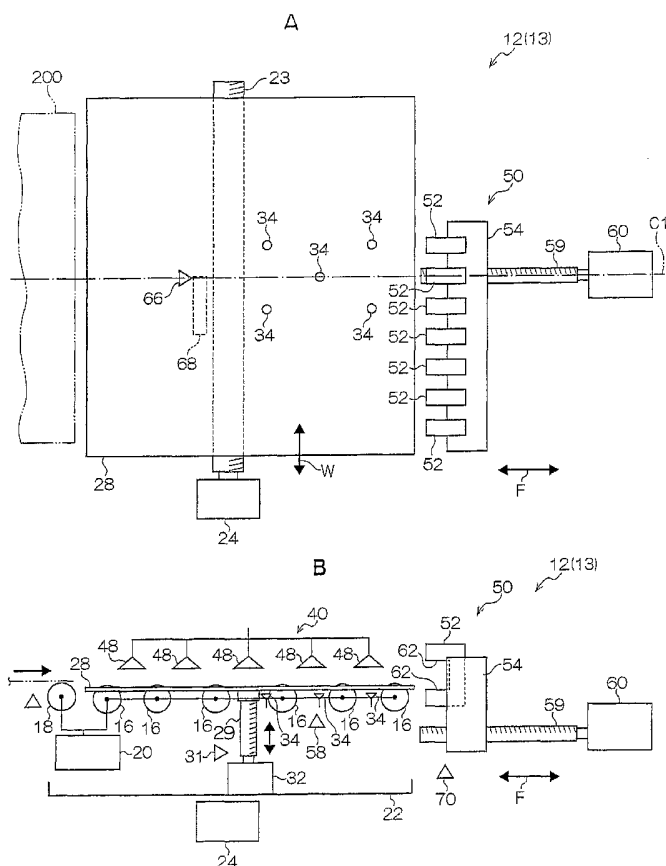
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(54) Title: SUBSTRATE POSITIONING MECHANISM, SUBSTRATE POSITIONING METHOD, SUBSTRATE CONVEYING
DEVICE, AND IMAGE FORMING DEVICE



(57) Abstract: The present invention provides a substrate positioning mechanism and a substrate positioning method, and a substrate conveying device equipped with the substrate positioning mechanism, and an image forming device equipped with the substrate conveying device. A leading end positioning unit, which is disposed at a conveying direction downstream side of conveying/supporting rollers, has a plurality of sensor holders, and a holding block integrally holding the sensor holders. When a substrate material is detected by sensors for positioning which are mounted to the sensor holders, a ball screw is rotated by a leading end positioning motor, and the leading end positioning unit is moved toward a conveying direction downstream side. In this way, contract pressure at a time of contact is mitigated, and deformation and damage of the substrate material are prevented.

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DESCRIPTION

SUBSTRATE POSITIONING MECHANISM, SUBSTRATE POSITIONING METHOD,
SUBSTRATE CONVEYING DEVICE, AND IMAGE FORMING DEVICE*Technical Field*

The present invention relates to a substrate positioning mechanism, a substrate positioning method, a substrate conveying device, and an image forming device, and in particular, to a substrate positioning mechanism and a substrate positioning method which position a substrate such as a printed wiring board or the like at a predetermined position, and to a substrate conveying device provided with the substrate positioning mechanism, and to an image forming device which is provided with the substrate conveying device and which forms an image by exposing an image-drawing region on a printed wiring board or the like by a light beam modulated on the basis of image information.

Background Art

There have conventionally been known laser exposure devices which serve as image forming devices which form a wiring pattern on, for example, a printed wiring board (hereinafter, simply called "substrate" upon occasion) or the like. A stage member is provided at the laser exposure device. A printed wiring board, which is the object of image exposure, is placed (loaded) on the stage member. The stage member is moved along a predetermined conveying path.

The substrate must be supported on the stage in a state in which the substrate is correctly positioned at a predetermined position. Thus, there is known, for example, a preliminary positioning mechanism which controls a moving mechanism section and

carries out preliminary positioning on the basis of a sensing signal from a sensing component and a size information signal which is inputted in advance (refer to Japanese Patent Application Laid-Open (JP-A) No. 2003-229470).

When positioning the substrate, if the substrate is positioned by being made to abut some type of member, positioning can be carried out by a simple structure. However, when the substrate is merely made to abut a member, the substrate may deform or be damaged.

SUMMARY OF THE INVENTION

A first aspect of the present invention has an abutment member abutted by a leading end of a substrate which is conveyed-in along a predetermined conveying-in direction; and a moving component which moves the abutment member in the same direction as the conveying-in of the substrate, at a speed which is slower than a conveying-in speed of the substrate.

In this substrate positioning mechanism, the substrate can be positioned by, for example, a substrate positioning method of a fifth aspect of the present invention.

Namely, the leading end of the substrate, which has been conveyed-in along a predetermined conveying-in direction, abuts the abutment member, while the moving component moves the abutment member in the same direction as the conveying-in of the substrate, at a speed which is slower than the conveying-in speed of the substrate. In this way, as compared with a case in which the abutment member is stationary, the relative speed of the substrate with respect to the abutment member at the time of abutment is low. Therefore, the substrate can be positioned while deformation and damage of the substrate are prevented. Because the abutment member is merely moved by the moving component, the structure is simple.

The invention of the first aspect can be structured, as in a second aspect, so as to

have a driving component which drives the moving component at a timing at which the substrate abuts the abutment member which is moving.

In the substrate positioning mechanism of the second aspect, the substrate can be positioned by, for example, a substrate positioning method of a sixth aspect.

Namely, the driving component stops the movement of the abutment member, after the substrate abuts the abutment member. By stopping the movement of the abutment member in this way, the substrate can be reliably positioned.

In an invention of a third aspect, in the invention of the first aspect or the second aspect, the abutment member can contact a conveying-in direction end side of the substrate at at least two places in a transverse direction of the substrate.

In this substrate positioning mechanism, the substrate can be positioned by, for example, a substrate positioning method of a seventh aspect.

Namely, when the leading end of the substrate abuts the abutment member, the abutment member contacts and abuts the conveying-in direction end side of the substrate at at least two places in a transverse direction of the substrate. The tilting of the substrate can thereby be corrected.

In the substrate positioning method of the seventh aspect, as in an eighth aspect, if, after the abutment member stops, the abutment member is moved a predetermined distance in a direction opposite to the conveying-in of the substrate, the tilting of the substrate can be even more reliably corrected due to this movement of the abutment member in the opposite direction.

In an invention of a fourth aspect, the invention of the third aspect has a detecting component provided at a conveying-in direction upstream side of the abutment member, and detecting the substrate; and a control component controlling the moving component and moving the abutment member, after the substrate is detected by the detecting

component.

In this substrate positioning mechanism, the substrate can be positioned by, for example, a substrate positioning method of a ninth aspect.

Namely, after the existence of the substrate is detected by the detecting component, movement of the abutment member by the moving component is started. If the substrate does not exist, the abutment member is not moved. Therefore, the substrate can be positioned efficiently.

An invention of a tenth aspect has the substrate positioning mechanism of any of the first aspect through the fourth aspect, and a suction unit suctioning the substrate, which is positioned by the substrate positioning mechanism, and conveying the substrate to a stage portion.

Because any of the substrate positioning mechanisms of the first aspect through the fourth aspect is provided, the substrate can be positioned by a simple structure and while preventing deformation and damage of the substrate.

Further, the positioned substrate is suctioned by the suction unit and can be conveyed to the stage portion.

An invention of an eleventh aspect has the substrate conveying device of the tenth aspect, and an exposure device exposing an image-drawing region of the substrate loaded at the stage portion, and forming an image at the image-drawing region.

The substrate conveying device of the tenth aspect, which structures this image forming device, has the substrate positioning mechanism of any of the first aspect through the fourth aspect. Therefore, the substrate can be positioned by a simple structure and while preventing deformation and damage of the substrate.

Then, the exposure device can form a desired image at an image-drawing region of the substrate, which has been positioned and conveyed to the stage portion.

In an invention of a twelfth aspect, the invention of the eleventh aspect has a moving mechanism moving the stage portion along a predetermined conveying path, and the exposure device exposes the image-drawing region of the substrate loaded at the stage portion, by a light beam modulated on the basis of image information, and forms the image at the image-drawing region.

Accordingly, while the stage portion is moved by the moving mechanism, a light beam is illuminated by the exposure device onto the substrate which moves together with the stage portion, and an image can be formed at the image-drawing region.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view showing an image forming device of the present invention.

Fig. 2 is a perspective view showing a state in which an interior of a substrate conveying device is exposed in the image forming device of the present invention.

Fig. 3 is a perspective view showing a state in which an interior of a laser exposure device of the image forming device of the present invention, is exposed.

Fig. 4A is an explanatory diagram showing an exposure region at the laser exposure device of the present invention.

Fig. 4B is a plan view showing an arrangement pattern of the laser exposure device of the present invention.

Figs. 5A and 5B are plan views showing a schematic structure of the substrate conveying device of the present invention.

Fig. 6 is a schematic block diagram showing a substrate half-fixing mechanism of the substrate conveying device of the present invention.

Fig. 7 is a perspective view showing a sensor holder to which are mounted sensors

for positioning of the substrate conveying device of the present invention.

Fig. 8 is an explanatory diagram showing control blocks of the substrate conveying device of the present invention.

Figs. 9A and 9B are flowcharts showing a substrate positioning/conveying sequence in the substrate conveying device of the present invention.

Fig. 10 is a timing chart showing speeds of a substrate and a leading end positioning unit in the substrate conveying device of the present invention.

Figs. 11A and 11B are plan views showing processes of positioning and conveying the substrate in the substrate conveying device of the present invention.

Figs. 12A and 12B are plan views showing processes of positioning and conveying the substrate in the substrate conveying device of the present invention.

Figs. 13A and 13B are plan views showing processes of positioning and conveying the substrate in the substrate conveying device of the present invention.

Figs. 14A and 14B are plan views showing processes of positioning and conveying the substrate in the substrate conveying device of the present invention.

Figs. 15A and 15B are plan views showing processes of positioning and conveying the substrate in the substrate conveying device of the present invention.

Figs. 16A and 16B are plan views showing processes of positioning and conveying the substrate in the substrate conveying device of the present invention.

Figs. 17A and 17B are plan views showing processes of positioning and conveying the substrate in the substrate conveying device of the present invention.

Figs. 18A and 18B are plan views showing processes of positioning and conveying the substrate in the substrate conveying device of the present invention.

Figs. 19A and 19B are plan views showing processes of positioning and conveying the substrate in the substrate conveying device of the present invention.

Figs. 20A and 20B are plan views showing processes of positioning and conveying the substrate in the substrate conveying device of the present invention.

Figs. 21A and 21B are plan views showing processes of positioning and conveying the substrate in the substrate conveying device of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

An image forming device 100 of an embodiment of the present invention is shown in Figs. 1 and 2. The image forming device 100 is structured by a laser exposure device 126 and a substrate conveying device 10. The laser exposure device 126 exposes a substrate material 200, which is shaped as a thin plate and is formed, for example, of a material of a printed wiring board (or may be a substrate for a liquid crystal display or the like), by a laser beam modulated in accordance with image information, so as to form images (latent images) corresponding to a wiring pattern of a printed wiring board on image-drawing regions of the substrate material 200 (see Fig. 3). The substrate conveying device 10 conveys, to the laser exposure device 126, the substrate material 200 which has been conveyed-in from a pre-processing process, and discharges the exposed substrate material 200 out from the laser exposure device 126.

In the present embodiment, the direction of conveying into the substrate conveying device 10 from the pre-processing process, and the conveying direction from the substrate conveying device 10 to the laser exposure device 126, coincide with one another. Hereinafter, these directions will both be called “the conveying direction”, without distinguishing therebetween.

A plurality of image-drawing regions, at which latent images corresponding to a predetermined wiring pattern are formed, are set at an exposure surface (top surface) 202 of the substrate material 200. Plural groups of alignment marks, which correspond

respectively to these plural image-drawing regions, are also formed on the exposure surface 202. Hereinafter, the moving direction of a stage member 110 will be called the subscanning direction (designated by arrow S in Fig. 3), and the direction orthogonal thereto will be called the main scanning direction (designated by arrow M in Fig. 3).

As shown in Fig. 3, a supporting stand 102, which is formed to a predetermined thickness, is provided at the laser exposure device 126. The top surface of the supporting stand 102 is shaped substantially as a rectangle whose longitudinal direction is the subscanning direction of the substrate material 200. The supporting stand 102 is placed horizontally on the floor via vibration proof rubber elements 104 or the like such that vibrations are cut-off.

A pair of guide rails 106 are provided, parallel to the subscanning direction, on the top surface portion of the supporting stand 102. The stage member 110 for substrate placement is movably disposed on the guide rails 106. The top surface of the stage member 110 is shaped substantially as a rectangle whose longitudinal direction is the subscanning direction of the substrate material 200. Guide members 108, which are substantially upside-down U-shaped in sectional view and which extend rectilinearly along the subscanning direction, are mounted to the four corners of the bottom surface of the stage member 110. The guide members 108 are slidably fit-together with the guide rails 106.

A ball screw 112 is provided along the subscanning direction (parallel to the guide rails 106) between the guide rails 106 and via a bearing or the like which is fixed on the supporting stand 102. A driving motor 114, which drives and rotates the ball screw 112, is provided at one end of the ball screw 112. A tube-shaped member, with which the ball screw 112 screws-together, is disposed along the subscanning direction at the center of the bottom surface of the stage member 110. Accordingly, due to the ball screw 112 being rotated in forward and reverse directions by the driving motor 114, the stage member 110

can move, via the tube-shaped member, in directions of advancing and withdrawing (i.e., reciprocatingly) along the pair of guide rails 106.

A supporting gate 116, which is substantially shaped as an upside-down “U” as seen in front view, stands erect at the substantial center, in the subscanning direction, of the supporting stand 102 so as to straddle the stage member 110. A plurality of (e.g., four) CCD cameras 118, which are for reading the plural groups of alignment marks provided on the substrate material 200, are disposed at predetermined positions of the supporting gate 116. Each of the CCD cameras 118 incorporates therein a flash which serves as a light source at the time of image pickup and whose light-emitting time each one time is extremely short. The sensitivity of the CCD camera 118 is adjusted such that image pickup is possible only at the time when the flash thereof emits light.

Accordingly, due the respective CCD cameras 118 causing the flashes to emit light at predetermined timings when the stage member 110 passes by image pickup positions positioned on the optical axes of the CCD cameras 118, image pickup ranges, which include the alignment marks, on the substrate material 200 can be picked-up respectively. Note that the respective CCD cameras 118 are disposed in advance at predetermined positions along the transverse direction of the substrate material 200 (the main scanning direction) such that respectively different regions are the image pickup ranges thereof, in accordance with the positions of the plural groups of alignment marks formed on the substrate material 200 which is the object of image pickup.

An exposure section 124, which supports a plurality of exposure heads 120, is disposed at the downstream side, in the subscanning direction, of the supporting gate 116 to which the CCD cameras 118 are mounted. When the substrate material 200 passes by exposure positions directly beneath the exposure heads 120, the exposure heads 120 irradiate a plurality of laser beams, which are modulated on the basis of image information,

onto the exposure surface 202 of the substrate material 200, so as to form an image (a latent image) corresponding to a wiring pattern of a printed wiring board on the exposure surface 202.

The recording heads 120 are arranged substantially in the form of a matrix of m lines and n columns (e.g., 2 lines and four columns), along the transverse direction of the supporting stand 102 (the main scanning direction). As shown in Fig. 4B, an exposure area 122 of one of the exposure heads 120 is in the shape of a rectangle whose short side is the subscanning direction, and the exposure area 122 is tilted at a predetermined angle of tilting with respect to the subscanning direction.

A light source unit is disposed at the laser exposure device 126 at a place where it does not impede movement of the stage member 110 (e.g., furthest rearward from a door 92 in Fig. 1). The light source unit accommodates a laser generating device. The laser light exiting from the laser generating device is guided via optical fibers to the respective exposure heads 120.

The laser light, which is guided and made incident by the optical fibers, is controlled in units of dots by a digital micromirror device (hereinafter, "DMD") which is a spatial light modulating element, and the exposure heads 120 expose dot patterns on the substrate material 200. The density of one pixel is expressed by using a plurality of dot patterns.

Accordingly, as shown in Fig. 4A, as the stage member 110 moves, a strip-shaped exposed region 204 is formed by each exposure head 120 on the substrate material 200. Due to the two-dimensionally arranged dot pattern being tilted with respect to the subscanning direction, the respective dots which are lined up in the subscanning direction pass through between dots which are lined up in a direction intersecting the subscanning direction. Therefore, the substantial pitch between dots can be narrowed, and higher

resolution can be realized.

Here, operation of the laser exposure device 126 will be described. First, when the substrate material 200 is placed on the stage member 110 which is standing-by at a loading/unloading position, the ball screw 112 rotates due to the driving of the driving motor 114, and the stage member 110 moves in the subscanning direction. Then, the alignment marks are picked-up by the CCD cameras 118. On the basis of the positional information of the picked-up alignment marks, the positions of the plural alignment marks which are provided in correspondence with one image-drawing region are respectively determined. From the positions of the alignment marks, the position of the image-drawing region along the subscanning direction and the main scanning direction (the transverse direction), and the amount of tilting of the image-drawing region with respect to the subscanning direction, are determined.

Then, on the basis of the position of the image-drawing region along the main scanning direction (the transverse direction) and the amount of tilting of the image-drawing region with respect to the subscanning direction at the substrate material 200, conversion processing is carried out on the image information (the wiring pattern), and the image information, which has been subjected to conversion processing, is stored within a frame memory. This image information is data expressing binarily (i.e., by the presence or absence of dot recording) the density of each pixel structuring the image.

The conversion processing includes coordinate conversion processing which rotates the image information around the original of coordinates, rotating processing of the image along the subscanning direction, and coordinate conversion processing which moves in parallel the image information along the coordinate axis corresponding to the main scanning direction (the transverse direction). Further, if needed, a strain correction processing is carried out which extends or contracts the image information in accordance

with the amounts of extension and the amounts of contraction of the image-drawing region along the main scanning direction (the transverse direction) and the subscanning direction.

Thereafter, the stage member 110 moves, and synchronously with the timings at which the leading ends of the image-drawing regions on the substrate material 200 reach the exposure positions directly beneath the exposure heads 120, the image information stored in the frame memory is read-out successively in units of plural lines, and the respective DMDs are controlled on and off on the basis of this image information. Then, when the laser light is illuminated onto the DMD, the laser light reflected when the DMD is in an on state is focused onto the exposure surface 202 of the substrate material 200 by a lens system.

In this way, by turning the laser light, which exits from the light source unit, on and off per pixel, the image-drawing regions of the substrate material 200 are exposed in units of pixels (the exposure area 122) of substantially the same number as the number of pixels used by the DMD. Namely, due to the stage member 110 being moved at a given scanning speed, the substrate material 200 is scanned/exposed by a plurality of laser beams in the direction opposite to the moving direction of the stage member 110, and the strip-shaped exposed region 204 is formed by each of the exposure heads 120 (see Fig. 4A).

Next, description will be given of the substrate conveying device 10 which conveys the substrate material 200 into the above-described laser exposure device 126, and discharges the exposed substrate material 200 out from the laser exposure device 126. As shown in Fig. 2, a conveying-in section 12 and a discharge section 14 are disposed adjacent to one another at the left and right sides of the laser exposure device 126, orthogonal to the subscanning direction along which the stage member 110 moves, at the starting side in the moving direction of the stage member 110 (the loading/unloading position). In Fig. 2, assuming that the substrate material 200 is conveyed-in from the right

(shown by arrow R) and discharged-out from the left (shown by arrow L), the right side is the conveying-in section 12 and the left side is the discharge section 14. The conveying-in section 12 has a substrate positioning mechanism 13 of the present invention (Figs. 5A and 5B), which positions the conveyed-in substrate material 200 and sends it to the stage member 110.

A pair of guide rails span above the conveying-in section 12, the stage member 110 and the discharge section 14, in the direction (the main scanning direction) orthogonal to the moving direction of the stage member 110 (the subscanning direction). One of or a plurality of (two in Fig. 2) traveling bodies 30 are movably supported at the guide rails.

Next to the guide rails 106, the ball screw 112 spans parallel to the guide rails 106, and is screwed-together with screw holes of the traveling bodies 30. Accordingly, due to the ball screw 112 rotating in forward and reverse directions by the driving motor 114, the traveling bodies 30 move reciprocatingly in the main scanning direction along the guide rails 106.

A suction unit 40 is mounted to the traveling body 30 so as to be able to freely be raised and lowered. A plurality of suction cups 48 for conveying are provided at the suction unit 40. A tube for air suction is connected to each of the suction cups 48 for conveying. Due to air being suctioned via these tubes from the distal ends of the suction cups 48 for conveying, the substrate material 200 can be suctioned by the suction cups 48 for conveying.

The suction unit 40 can be raised and lowered by a raising/lowering mechanism 56. Accordingly, changes in the thicknesses of the substrate materials 200 can be handled flexibly.

As shown in Fig. 5B, the conveying-in section 12 (the substrate positioning mechanism 13) has a holder 22 which is positioned lower than the conveying path of the

substrate material 200. A ball screw 23 is screwed-together with the holder 22. The holder 22 moves in the transverse direction of the substrate material 200 (the directions of arrow W) by rotation of the ball screw 23 due to a transverse direction moving motor 24. Due to this movement, as will be described later, the transverse direction center of the substrate material 200 can be made to coincide with a conveying center C1 at the substrate conveying device 10.

As shown in Fig. 5A, the holder 22 has a plurality of conveying/supporting rollers 16 which are disposed so as to be spaced apart at uniform intervals along the conveying-in direction, and a guide-in roller 18 provided at the conveying direction upstream side of the conveying/supporting rollers 16. The conveying/supporting rollers 16 and the guide-in roller 18 have the same diameters and lengths, and rotate by receiving rotational driving force of a conveying motor 20. Accordingly, the substrate material 200 can be conveyed due to the conveying/supporting rollers 16 and the guide-in roller 18 rotating while supporting the substrate material 200.

A substantially flat-plate-shaped ascending/descending stage 28 is disposed at the holder 22 so as to be able to be raised and lowered by a raising/lowering supporting member. A ball screw 29 is screwed-together with the ascending/descending stage 28. Due to the driving of a stage raising/lowering motor 32, the ascending/descending stage 28 is raised and lowered between a proximate position (see Fig. 5B for example) at which the ascending/descending stage 28 is proximate to the substrate material 200 supported by the conveying/supporting rollers 16, and a separated position (see Fig. 14B for example) at which the ascending/descending stage 28 is separated from the substrate material 200. The ascending/descending stage 28 opposes the suction cups 48 for conveying, with the substrate material 200 therebetween. Accordingly, as will be described later, at the proximate position, when the substrate material 200 which is pressed by the suction cups

48 for conveying is flexed, the flexed substrate material 200 contacts the ascending/descending stage 28 and the flexure thereof is restricted. Further, at the separated position, the ascending/descending stage 28 is withdrawn from the conveying path so that there is no obstacle to the conveying of the substrate material 200. The amount of raising and lowering of the ascending/descending stage 28 is detected by a raising/lowering amount sensor 31.

Note that hole portions are formed in the ascending/descending stage 28 so as to not interfere with and so as to avoid the conveying/supporting rollers 16 and suction cups 34 for fixing which will be described later.

The suction cups 34 for fixing, which are positioned between the conveying/supporting rollers 16, are provided at the holder 22. As shown in Fig. 6, a pump 44 and a silencer 46 are selectively connected to the suction cups 34 for fixing via a filter 36 and a valve 42. (A silencer 47 is connected to the pump 44 as well.) If the suction cups 34 for fixing are set in a state of being connected to the pump 44 due to the switching of the valve 42, the interiors of the suction cups 34 for fixing are suctioned, and the substrate material 200, which is supported by the conveying/supporting rollers 16, can be temporarily suctioned and fixed. Further, if the connection with the pump 44 is cancelled, the suctioning/fixing of the substrate material 200 also is cancelled.

An upstream side sensor 58 which senses the presence or absence of a substrate, is provided between the conveying/supporting rollers 16 (in Fig. 5B, between the second conveying/supporting roller 16 and the third conveying/supporting roller 16 from the conveying direction downstream side). The presence or absence of the substrate material 200 can thereby be detected.

A central position sensor 66, which is provided at the holder 22, detects a sensor dog 68 of the ascending/descending stage 28, and can detect the transverse direction

position of the ascending/descending stage 28.

A leading end positioning unit 50 is disposed at the conveying direction downstream side of the conveying/supporting rollers 16. The leading end positioning unit 50 has a plurality of (seven in the present embodiment) sensor holders 52 disposed so as to be spaced apart from one another at uniform intervals in the transverse direction, and a holding block 54 integrally holding these sensor holders 52. The abutment member of the present invention is structured by these plural sensor holders 52 and the holding block 54. A ball screw 59 is screwed-together with a screw hole formed in the holding block 54. Due to the ball screw 59 being rotated by a leading end positioning motor 60, the leading end positioning unit 50 can, as a whole, be moved at a predetermined moving speed toward the downstream side in the conveying direction.

As shown in detail in Fig. 7, the sensor holder 52 is formed in the shape of a sideways "U" which opens toward the ascending/descending stage 28. Sensors 62 for positioning are mounted so as to oppose one another at an upper portion 52A and a lower portion 52C of the sensor holder 52, so as to be able to detect the presence or absence of the substrate material 200.

The aperture of the sensor 62 for positioning is formed in the shape of a circle as seen in a plan view parallel to the substrate material 200 which is being conveyed, and is formed such that no directivity arises in the detecting sensitivity. Accordingly, the presence or absence of the substrate material 200 can be detected with the same sensitivity in, for example, the conveying direction as well as the transverse direction.

The sensor holders 52 are mounted to the holding block 54 with the positions thereof adjusted such that intermediate portions 52B thereof are lined-up rectilinearly along the transverse direction of the substrate material 200. Accordingly, for example, even if the substrate material 200 is tilted with respect to the conveying direction, due to the

leading end side of the substrate material 200 being pressed at plural places (at least two places) by the leading end positioning unit 50, the tilting can be corrected such that there is no tilting in the conveying direction.

A downstream side sensor 70 is disposed beneath the leading end positioning unit 50. The presence or absence of the substrate material 200 and the leading end positioning unit 50 at that position is detected by the downstream side sensor 70. Here, a rectangular jig is used to measure in advance the tilting of the plural sensor holders 52 with respect to the transverse direction (tilting reference values), by the number of pulses from a home position of the substrate material 200, which is detected by the downstream side sensor 70, to the rectangular jig.

Note that, in the present embodiment, among the seven sensor holders 52, one is disposed at the center in the transverse direction, five are disposed at the conveying direction right side (the lower side in the drawing), and the remaining one is positioned at the opposite side. Due to the sensor holders 52, i.e., the sensors 62 for positioning, being disposed in this way, there is no need to provide a larger number of sensors 62 for positioning than needed, and the substrate materials 200 of various widths can be handled, and the presence or absence thereof can be detected.

As shown in Fig. 8, the upstream side sensor 58, the sensors 62 for positioning, the downstream side sensor 70, the conveying motor 20, the stage raising/lowering motor 32, the leading end positioning motor 60, and the suction units 40 are connected to a control device 64. At the control device 64, the conveying motor 20, the stage raising/lowering motor 32, the leading end positioning motor 60, and the suction units 40 are controlled on the basis of the presence/absence information of the substrate material 200 at the upstream side sensor 58 and the sensors 62 for positioning. Further, at the control device 64, the conveying motor 20, the stage raising/lowering motor 32, and the leading end positioning

motor 60 are controlled at desired timings by pulses of uniform intervals.

Next, the processes of positioning and conveying the substrate by the substrate conveying device 10 of the present embodiment will be described with reference to the flowcharts shown in Figs. 9A and 9B. Note that the size of the substrate material 200 which is being conveyed is inputted to the control device 64 in advance by an input operation from an operator, or by detection by a sensor. Further, amounts of offset of the respective sensors 62 for positioning from the conveying center C1 are stored in advance as intrinsic parameters in the control device 64 by, for example, a reference plate or the like.

First, before the substrate material 200 is conveyed into the substrate conveying device 10, in step 302, the ascending/descending stage 28 is lowered to the separated position (refer to Figs. 5A and 5B). Then, in step 304, the leading end positioning unit 50 is moved (advanced) toward the upstream side in the conveying direction.

Next, in step 306, the conveying motor 20 is driven and the conveying/supporting rollers 16 are rotated. The substrate material 200, which has been conveyed-in, is conveyed while being supported by the conveying/supporting rollers 16. Because the ascending/descending stage 28 is at the separated position, the substrate material 200 can be conveyed-in smoothly without inadvertently contacting the ascending/descending stage 28. As shown in Fig. 10, the conveying speed at this time is, for example, 100 mm/sec to 250 mm/sec.

In step 308, it is judged whether the leading end of the substrate material 200 is detected by the upstream side sensor 58. When the leading end is detected (refer to Figs. 11A and 11B), in step 310, the rotating speed of the conveying/supporting rollers 16 is begun to be slowed down, after a predetermined period of time (e.g., a number of pulses) passes from the detection. In this way, the conveying speed of the substrate material 200 as

well is decelerated to, for example, 20 mm/sec to 60 mm/sec.

Next, in step 312, it is judged whether the leading end of the substrate material 200 is detected by any of the sensors 62 for positioning (e.g., the sensor 62 for positioning at the transverse direction center). If the leading end is detected (see Figs. 12A and 12B), in step 314, the leading end positioning motor 60 is driven, and the leading end positioning unit 50 is withdrawn toward the conveying direction downstream side. As shown in Fig. 10, the withdrawing speed is, for example, 10 mm/sec.

Then, after a predetermined period of time (e.g., a number b of pulses) elapses, in step 316, the leading end positioning unit 50 is stopped at a predetermined position. The withdrawing speed of the leading end positioning unit 50 at this time is a speed (e.g., 10 mm/sec) which is slower than the conveying speed of the substrate material 200, and which is such that, during the period of time from the start of withdrawing to the stoppage, the leading end of the substrate material 200 contacts the leading end positioning unit 50 (the holding block 54 or the intermediate portions 52B of the sensor holders 52). Due to the leading end positioning unit 50 contacting the leading end of the substrate material 200 while withdrawing in this way, the relative speed of the substrate material 200 with respect to the leading end positioning unit 50 is low, as compared with a structure in which the leading end positioning unit 50, in a stopped state, contacts the leading end of the substrate material 200. In this way, the contact pressure at the time of contact is mitigated, and deformation and damage of the substrate material 200 are prevented (see Figs. 13A and 13B).

Next, in step 318, after a predetermined period of time (e.g., α seconds) elapses from the stopping of the withdrawing of the leading end positioning unit 50, the conveying motor 20 is stopped, the rotating of the conveying/supporting rollers 16 is stopped, and the conveying of the substrate material 200 as well is stopped.

In step 320, the valve 42 is switched to the pump 44, the pump 44 is driven, and the substrate material 200 is suctioned and fixed by the suction cups 34 for fixing. However, because it suffices to make the substrate material 200 integral with the conveying/supporting rollers 16 and the like, this fixing may be so-called "half-fixing".

In step 322, the stage raising/lowering motor 32 is driven, and the ascending/descending stage 28 is raised (see Figs. 14A and 14B). The top surface of the ascending/descending stage 28 becomes substantially flush with the portions of the outer peripheral surfaces of the plural conveying/supporting rollers 16, which portions are positioned at the top ends. Accordingly, the top surface of the ascending/descending stage 28 either contacts the substrate material 200, or opposes the substrate material 200 with an extremely slight (e.g., about 1 mm) gap therebetween.

Next, in step 324, the leading end positioning motor 60 is driven (rotated forward), and the leading end positioning unit 50 is advanced forward by a predetermined distance toward the conveying direction upstream side (refer to the leading end positioning unit 50 shown by the two-dot chain lines in Figs. 15A and 15B). In this way, the substrate material 200 is pushed toward the conveying direction upstream side in a state in which the leading end side of the substrate material 200 contacts the leading end positioning unit 50 (the holding block 54 or the intermediate portions 52B of the sensor holders 52), and the substrate material 200 is positioned at a predetermined position. Accordingly, at this stage, the registration (position correction) of the substrate material 200 in the conveying direction is completed. Further, if the substrate material 200 is tilted with respect to the conveying direction, the tilting is corrected.

In step 326, the leading end positioning motor 60 is rotated reversely, and the leading end positioning unit 50 is withdrawn by a predetermined distance toward the conveying direction downstream side (refer to the leading end positioning unit 50 shown

by the solid lines in Figs. 15A and 15B). This amount of withdrawing is preferably longer than the amount of advancing of the leading end positioning unit 50 in step 324. In this way, the intermediate portions 52B of the sensor holders 52 separate from the leading end side of the substrate material 200. However, the upper limit of the amount of withdrawing is determined such that, in this state as well, the sensors 62 for positioning can detect the vicinity of the leading end side of the substrate material 200.

Next, in step 328, the transverse direction moving motor 24 is driven, and the ascending/descending stage 28 is moved in the transverse direction (see Figs. 16A and 16B). Because the size of the substrate material 200 is known in advance, this amount of movement is a predetermined amount of movement which is computed from the size information.

In step 330, the transverse direction movement continues until a change in the state of detecting the substrate material 200 is detected at any of the sensors 62 for positioning due to the transverse direction movement. Namely, due to the substrate material 200 moving in the transverse direction, any of the sensors 62 for positioning changes from a state of not detecting the substrate material 200 to a state of detecting the substrate material 200. Therefore, if there is such a change in the detection state, movement in the transverse direction is stopped. The moved distance (an actually measured value) in the transverse direction is known from the moving speed and the time (the number of pulses) required for the movement.

Here, the amounts of offset of the respective sensors 62 for positioning from the conveying center C1 are stored as intrinsic parameters in the control device 64. In step 332, the amount of offset of the ascending/descending stage 28 from its transverse direction home position (detected by the central position sensor 66) is computed on the basis of the width of the substrate material 200 which is known in advance, and the moved distance

(the detected number of pulses) of the substrate material 200 in the transverse direction which was obtained in step 330.

In step 334, on the basis of the computed offset amount, the transverse direction moving motor 24 is driven for a predetermined time, the substrate material 200 is moved by an amount which is $1/2$ of the offset amount, and the transverse direction center thereof is made to coincide with the conveying center C1 (refer to Figs. 17A and 17B).

In step 336, the leading end positioning motor 60 is rotated reversely, and the leading end positioning unit 50 is withdrawn toward the conveying direction downstream side (see Figs. 18A, 18B, 19A and 19B). While the leading end positioning unit 50 is being withdrawn, in step 338, the amount of tilting of the substrate material 200 with respect to the conveying direction is computed. Namely, while the leading end positioning unit 50 is being withdrawn, the states of detection of the substrate material 200 at the sensors 62 for positioning are monitored. Here, for example, in a case in which the substrate material 200 is tilted with respect to the conveying direction, differences arise in the timings at which the states of detection of the substrate material 200 change at the sensors 62 for positioning (i.e., in the numbers of pulses at which the sensors 62 for positioning turn off). Then, the amount of tilting of the substrate material 200 can be known by comparing these time differences with the previously-mentioned tilting reference values which were measured in advance by the rectangular jig.

In step 340, it is determined whether the computed amount of tilting of the substrate material 200 exceeds a critical value. If the amount of tilting exceeds the critical value, in step 342, notice is given of that fact by a notifying component. Note that instead of (or in parallel with) the notification by the notifying component, correcting of the amount of tilting of the substrate material 200 may be retried, or processing may be carried out so as to discharge the substrate material 200 to the exterior of the substrate conveying

device 10.

If the amount of tilting of the substrate material 200 does not exceed the critical value, in step 344, the driving of the leading end positioning motor 60 is stopped, and the withdrawing of the leading end positioning unit 50 is stopped. This amount of withdrawing is an amount of withdrawing at which the substrate material 200 completely comes out from between the upper portions 52A and the lower portions 52C of the sensor holders 52. Accordingly, when the substrate material 200 is raised in a subsequent process, the substrate material 200 does not contact the sensor holders 52.

Then, in step 346, the suction units 40 are driven, and the suction cups 48 for conveying contact and suction the substrate material 200. Simultaneously therewith, the driving of the pump 44 is stopped and the valve 42 is connected to the silencer 46, and the provisional fixing of the substrate material 200 by the suction cups 34 for fixing is cancelled (see Figs. 20A and 20B).

When the suction cups 48 for conveying contact the substrate material 200, the substrate material 200 is locally pressed and attempts to flex. However, the ascending/descending stage 28 is positioned at a position of opposing the suction cups 48 for conveying, with the substrate material 200 disposed therebetween. Therefore, this flexure is restricted, and the substrate material 200 is maintained substantially planar. Thus, the tight contact between the suction cups 48 for conveying and the substrate material 200 is maintained, and the substrate material 200 can be reliably suctioned. In this suctioned state, the suction units 40 move the substrate material 200 from on the ascending/descending stage 28 to onto the stage member 110 (see Figs. 21A and 21B).

In this way, at the substrate conveying device 10 of the present embodiment, the series of processes for positioning and conveying one substrate material 200 are completed.

As can be understood from the above description, in the present embodiment, when the substrate material 200 is conveyed-in and is positioned by the leading end positioning unit 50, the substrate material 200 contacts the leading end positioning unit 50 while the leading end positioning unit 50 is being withdrawn. Therefore, as compared with a structure in which the substrate material 200 is made to contact the leading end positioning unit 50 while the leading end positioning unit 50 is in a stopped state, deformation and damage of the leading end of the substrate material 200 (the portion contacting the leading end positioning unit 50) can be prevented. In particular, even the substrate material 200 which is thin can be positioned while deformation and damage thereof are prevented. Because the leading end positioning unit 50 is merely withdrawn, a simple structure suffices.

Note that, instead of the above-described leading end positioning unit 50, for example, a plurality of abutment pins may be disposed along the transverse direction.

CLAIMS

1. A substrate positioning mechanism comprising:

an abutment member abutted by a leading end of a substrate which is conveyed-in along a predetermined conveying-in direction; and

a moving component which moves the abutment member in the same direction as the conveying-in of the substrate, at a speed which is slower than a conveying-in speed of the substrate.

2. The substrate positioning mechanism of claim 1, further comprising a driving component which drives the moving component at a timing at which the substrate abuts the abutment member which is moving.

3. The substrate positioning mechanism of claim 1, wherein the abutment member can contact a conveying-in direction end side of the substrate at at least two places in a transverse direction of the substrate.

4. The substrate positioning mechanism of claim 1, further comprising:

a detecting component provided at a conveying-in direction upstream side of the abutment member, and detecting the substrate; and

a control component controlling the moving component and moving the abutment member, after the substrate is detected by the detecting component.

5. A substrate positioning method of positioning a substrate at a predetermined position by using a substrate positioning mechanism, wherein the substrate positioning mechanism

includes:

an abutment member abutted by a leading end of a substrate which is conveyed-in along a predetermined conveying-in direction; and

a moving component which moves the abutment member in the same direction as the conveying-in of the substrate, at a speed which is slower than a conveying-in speed of the substrate,

the substrate positioning method comprising:

abutting the leading end of the substrate against the abutment member, while the moving component moves the abutment member in the same direction as the conveying-in of the substrate, at a speed which is slower than the conveying-in speed of the substrate.

6. The substrate positioning method of claim 5, wherein the substrate positioning mechanism further includes a driving component which drives the moving component at a timing at which the substrate abuts the abutment member which is moving, and

the driving component stops movement of the abutment member after the substrate abuts the abutment member.

7. The substrate positioning method of claim 6, wherein the abutment member can contact a conveying-in direction end side of the substrate at at least two places in a transverse direction of the substrate, and

when the leading end of the substrate abuts the abutment member, the conveying-in direction end side of the substrate contacts and abuts the abutment member at at least two places in the transverse direction of the substrate.

8. The substrate positioning method of claim 7, wherein, after stopping of the abutment

member, the abutment member is moved a predetermined distance in a direction opposite to the conveying-in of the substrate.

9. The substrate positioning method of claim 5, wherein the substrate positioning mechanism further includes:

a detecting component provided at a conveying-in direction upstream side of the abutment member, and detecting the substrate; and

a control component controlling the moving component and moving the abutment member, after the substrate is detected by the detecting component, and

after existence of the substrate is detected by the detecting component, movement of the abutment member by the moving component is started.

10. A substrate conveying device comprising:

a substrate positioning mechanism which includes an abutment member abutted by a leading end of a substrate which is conveyed-in along a predetermined conveying-in direction, and a moving component which moves the abutment member in the same direction as the conveying-in of the substrate, at a speed which is slower than a conveying-in speed of the substrate; and

a suction unit suctioning the substrate, which is positioned by the substrate positioning mechanism, and conveying the substrate to a stage portion.

11. An image forming device comprising:

(A) a substrate conveying device, the substrate conveying device including:

(i) a substrate positioning mechanism which includes:

(a) an abutment member abutted by a leading end of a

substrate which is conveyed-in along a predetermined conveying-in direction, and

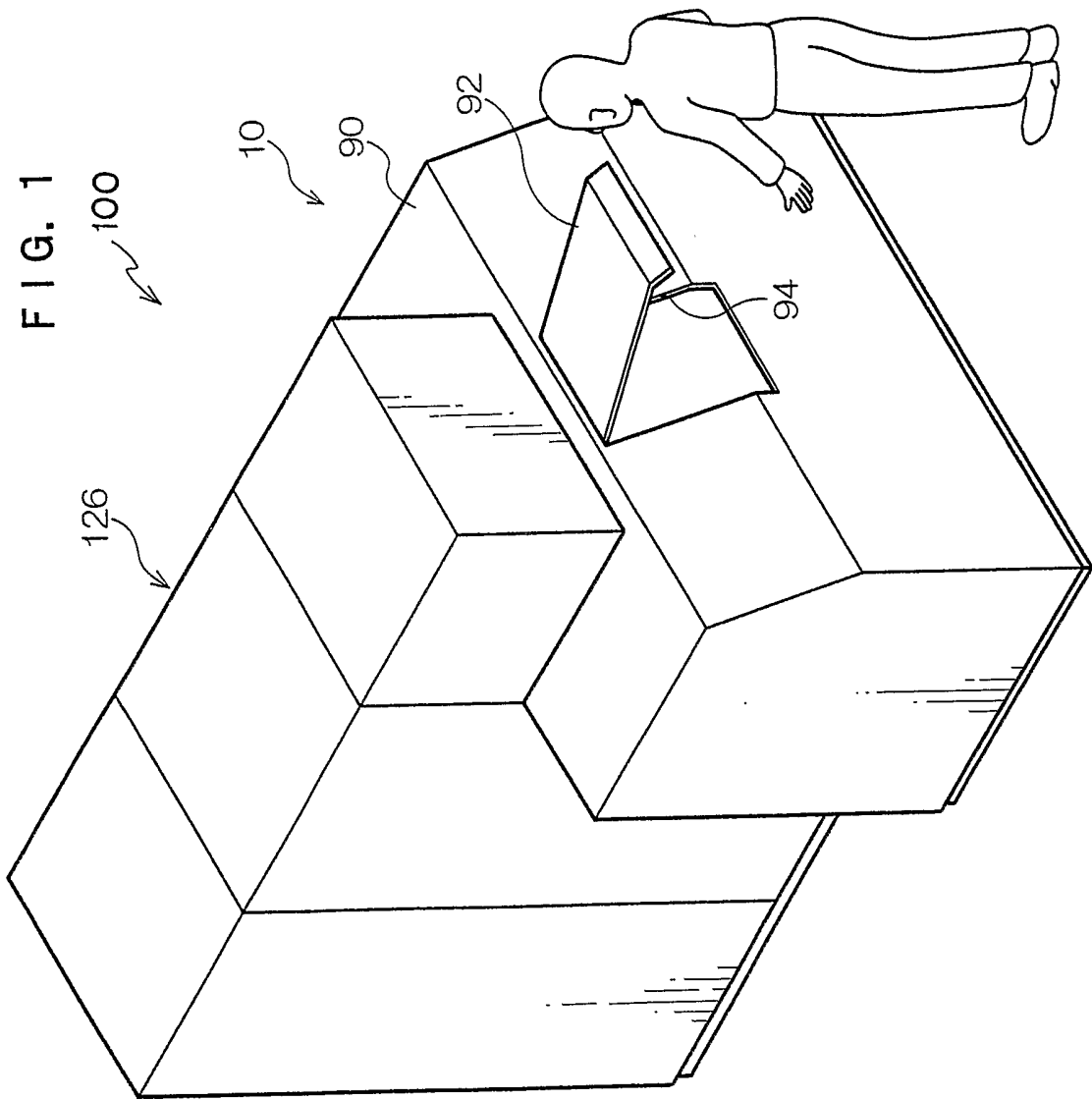
(b) a moving component which moves the abutment member in the same direction as the conveying-in of the substrate, at a speed which is slower than a conveying-in speed of the substrate; and

(ii) a suction unit suctioning the substrate, which is positioned by the substrate positioning mechanism, and conveying the substrate to a stage portion; and

(B) an exposure device exposing an image-drawing region of the substrate loaded at the stage portion, and forming an image at the image-drawing region.

12. The image forming device of claim 11, further comprising a moving mechanism moving the stage portion along a predetermined conveying path, wherein

the exposure device exposes the image-drawing region of the substrate loaded at the stage portion, by a light beam modulated on the basis of image information, and forms the image at the image-drawing region.



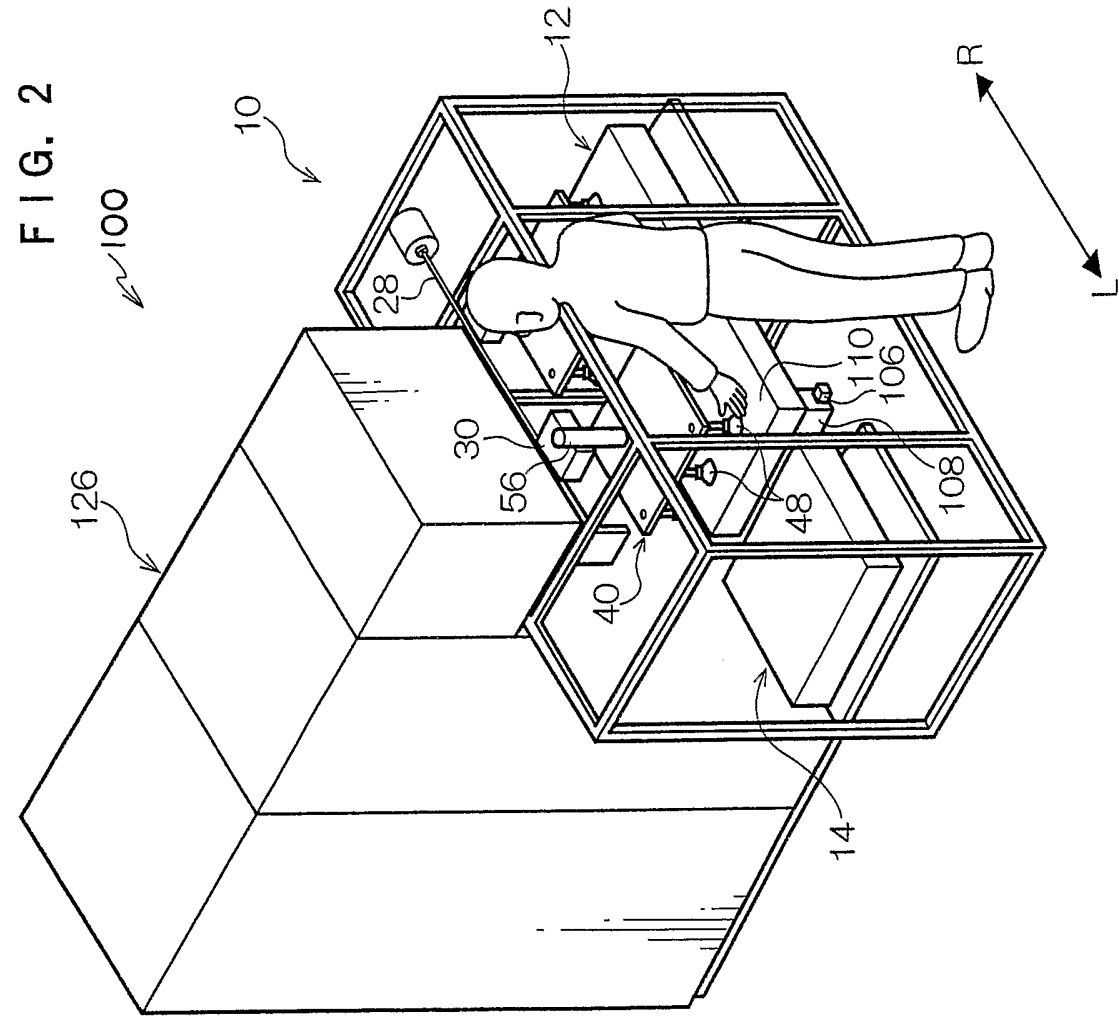


FIG. 3

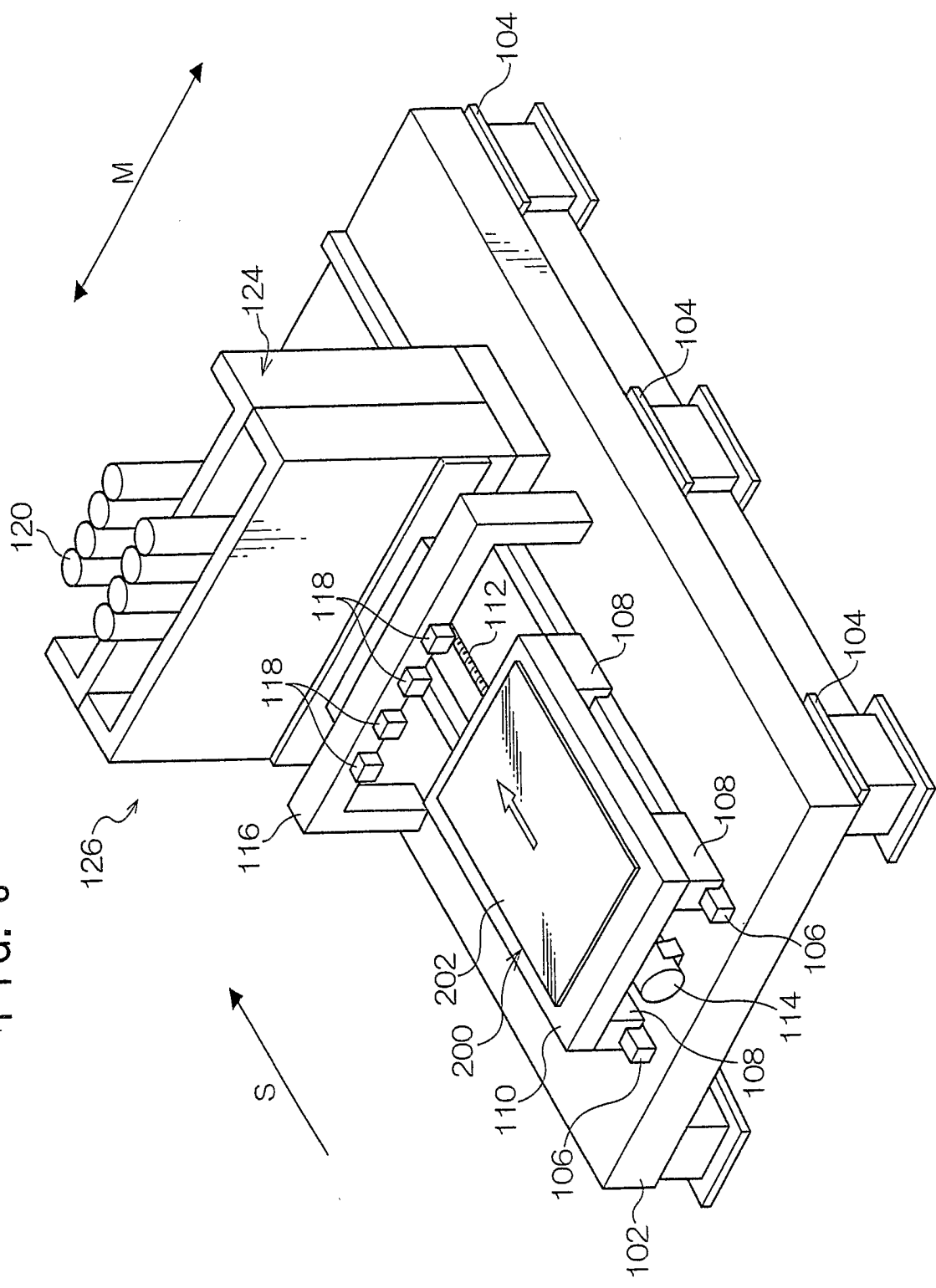


FIG. 4A

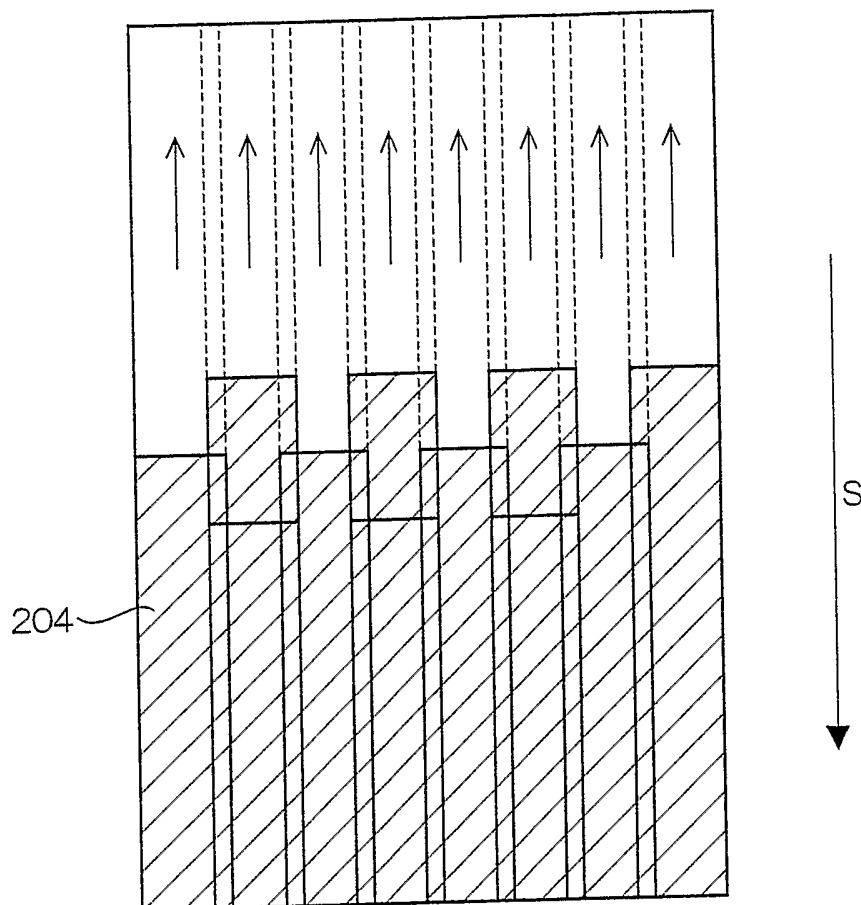


FIG. 4B

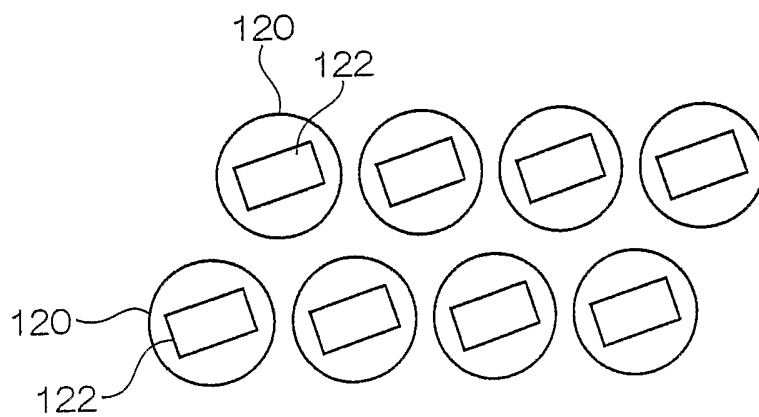


FIG. 5A

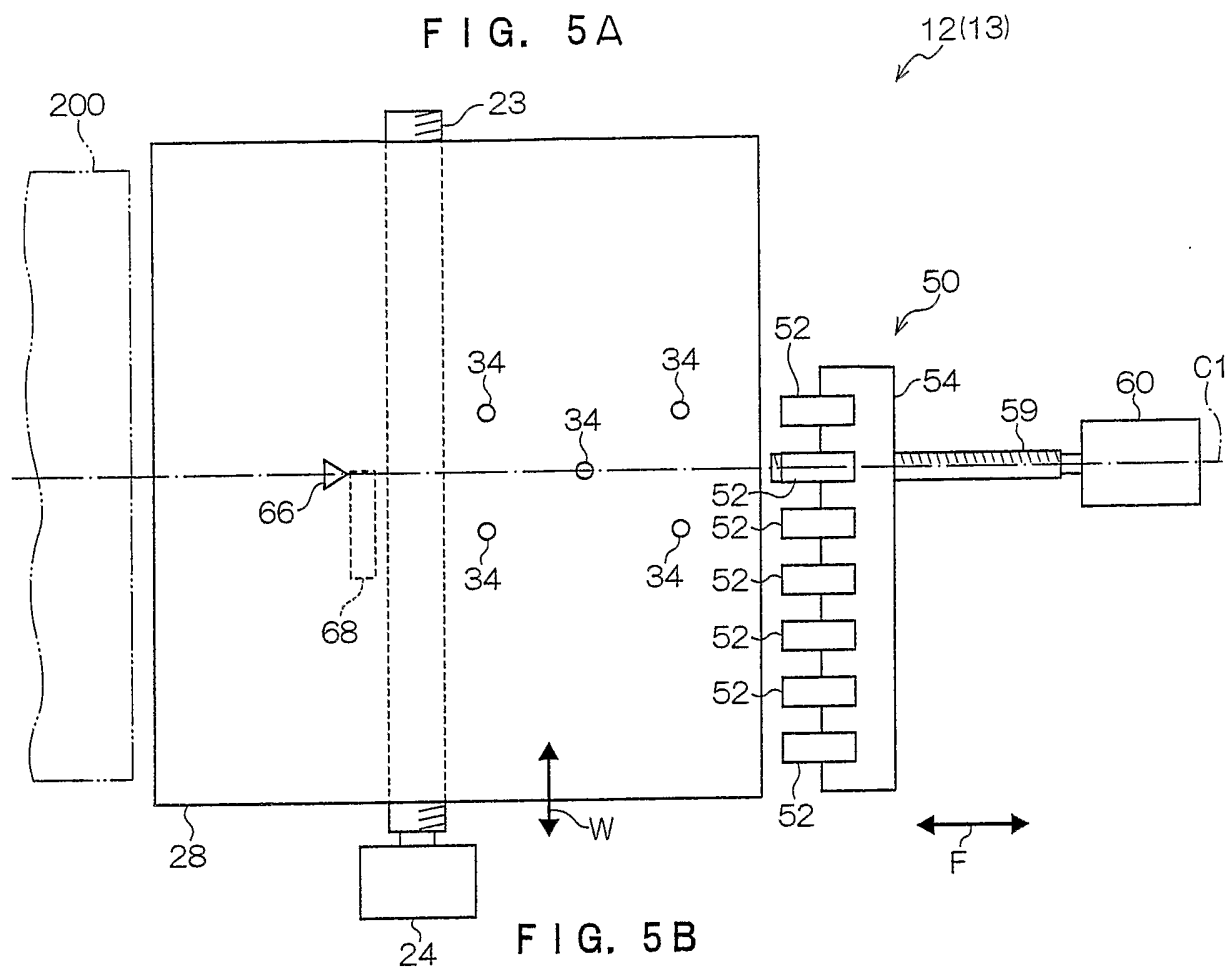


FIG. 5B

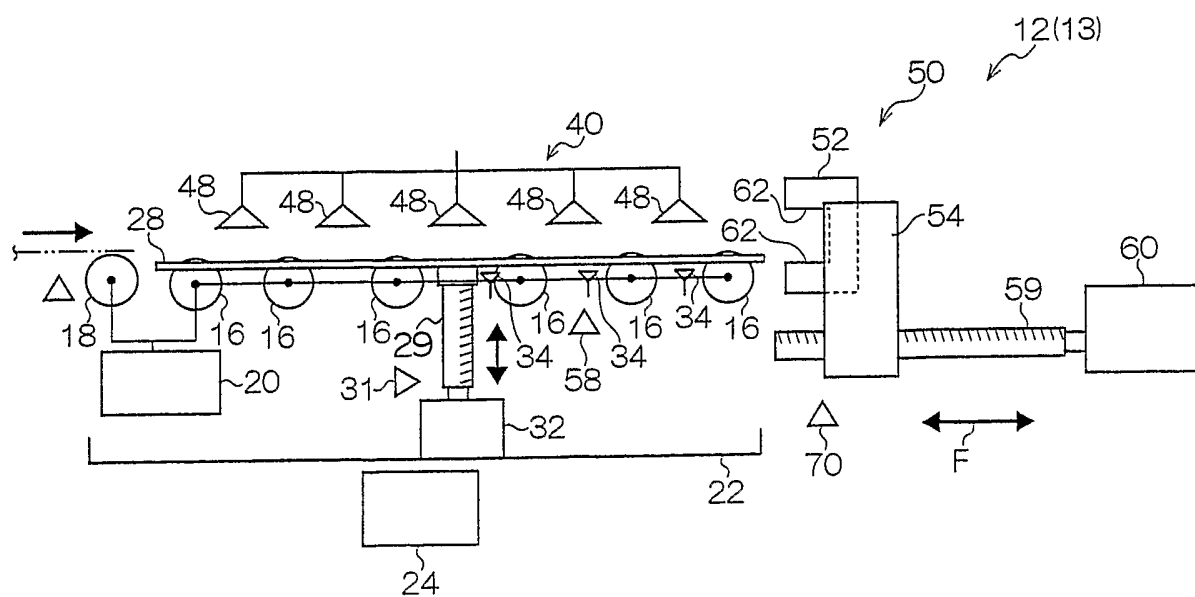


FIG. 6

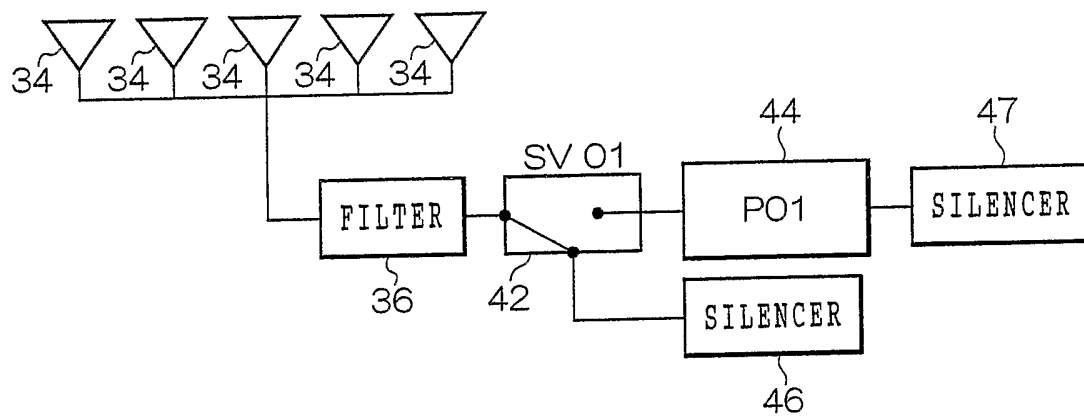
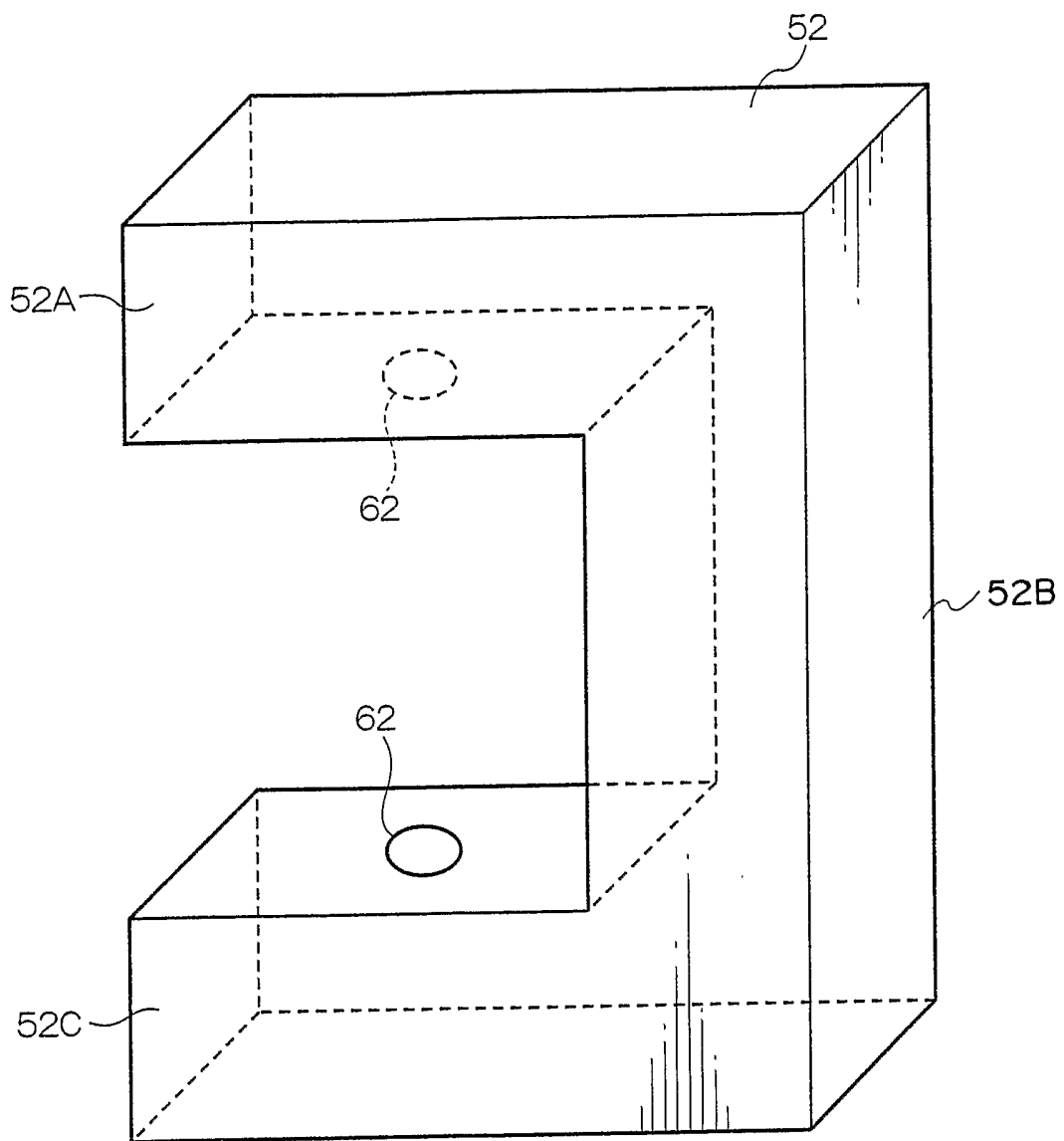


FIG. 7



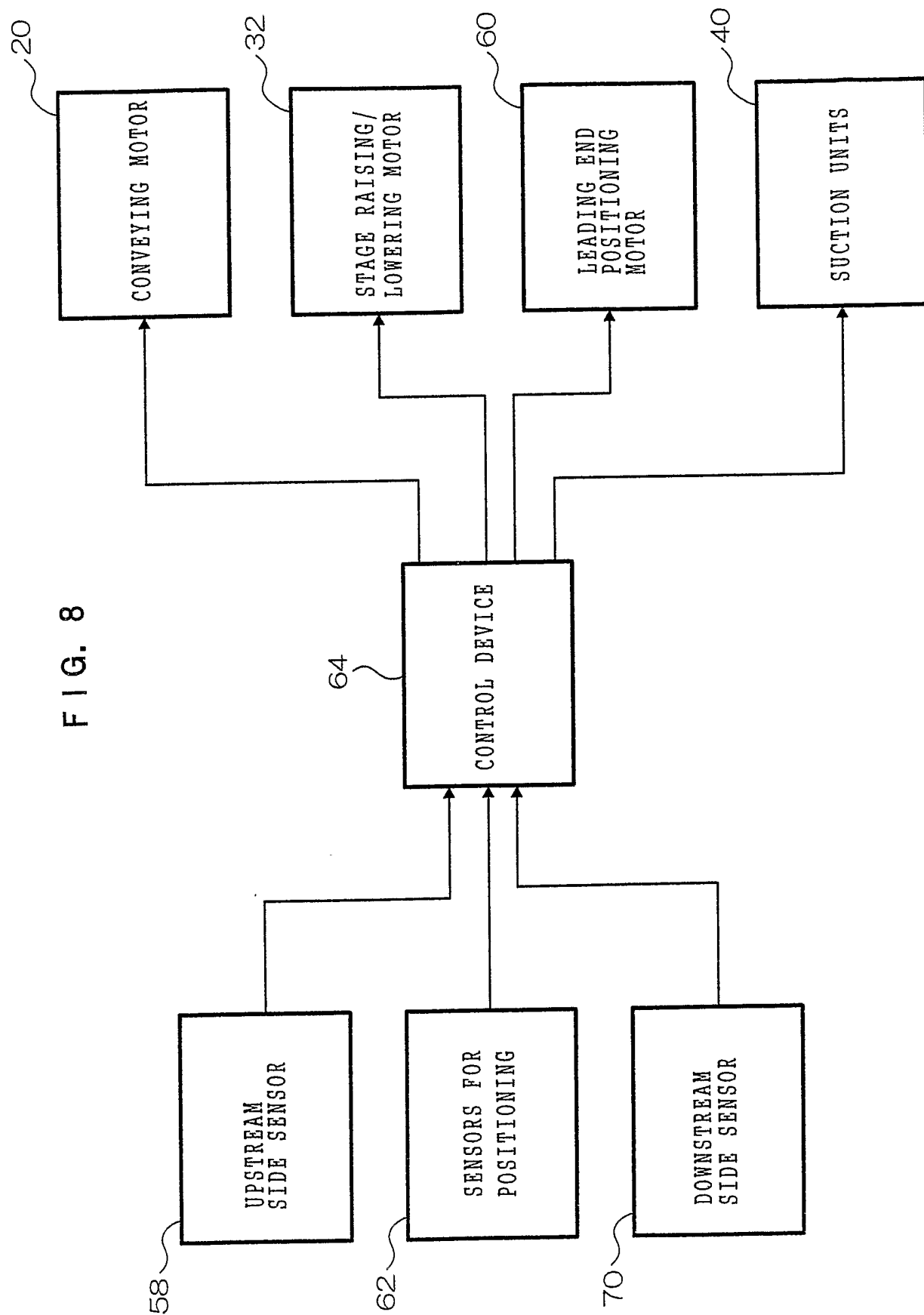


FIG. 9A

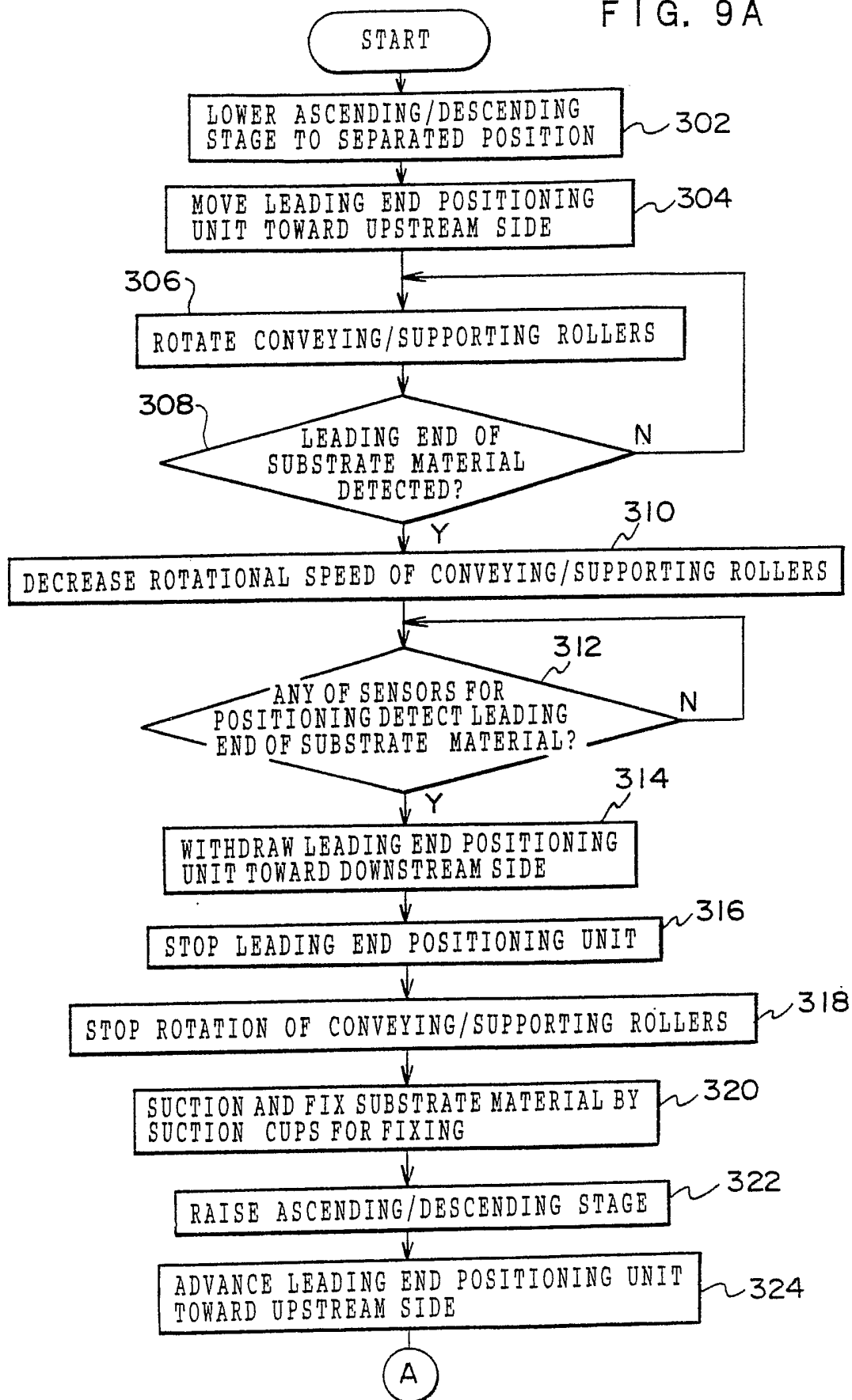


FIG. 9B

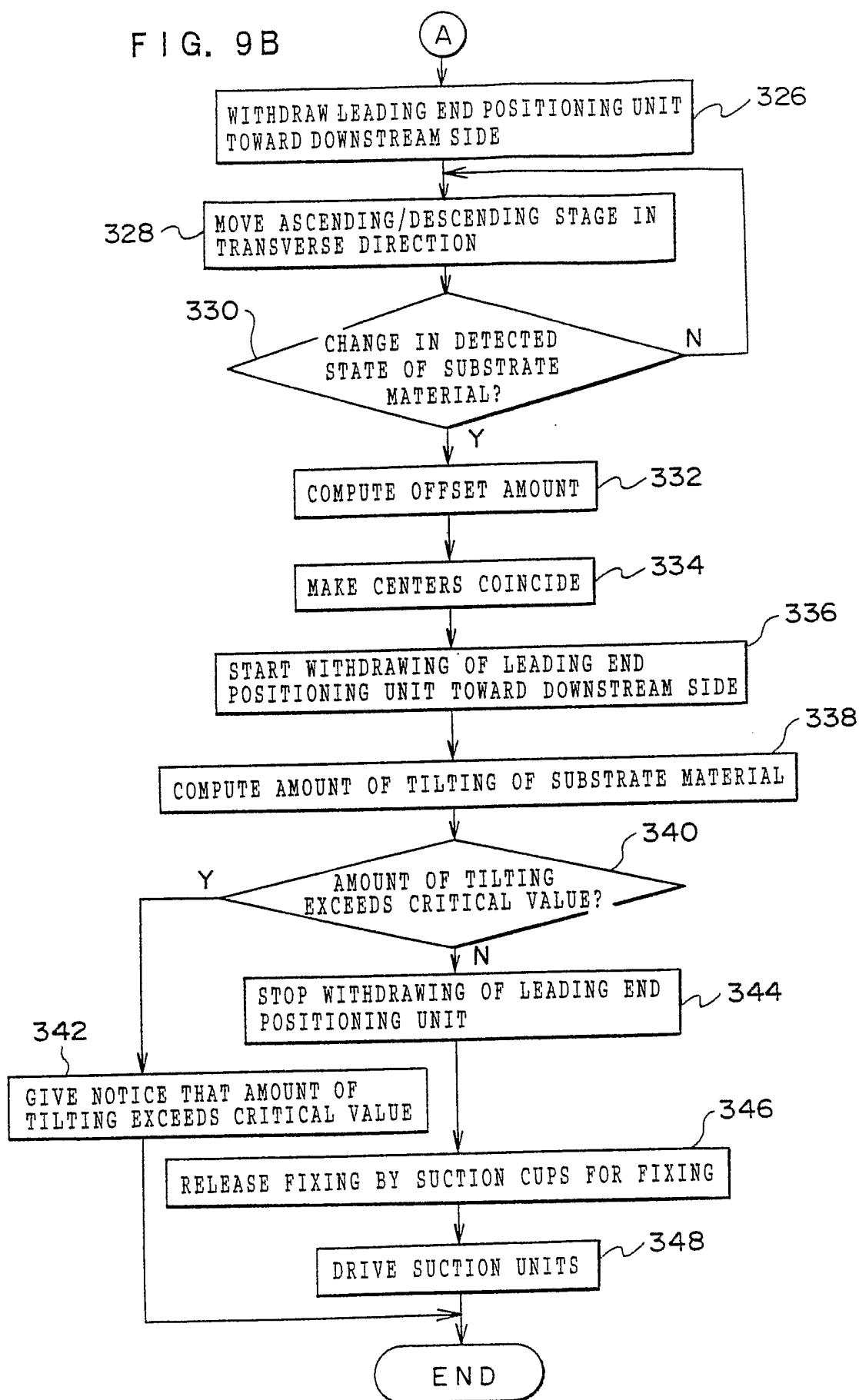


FIG. 10

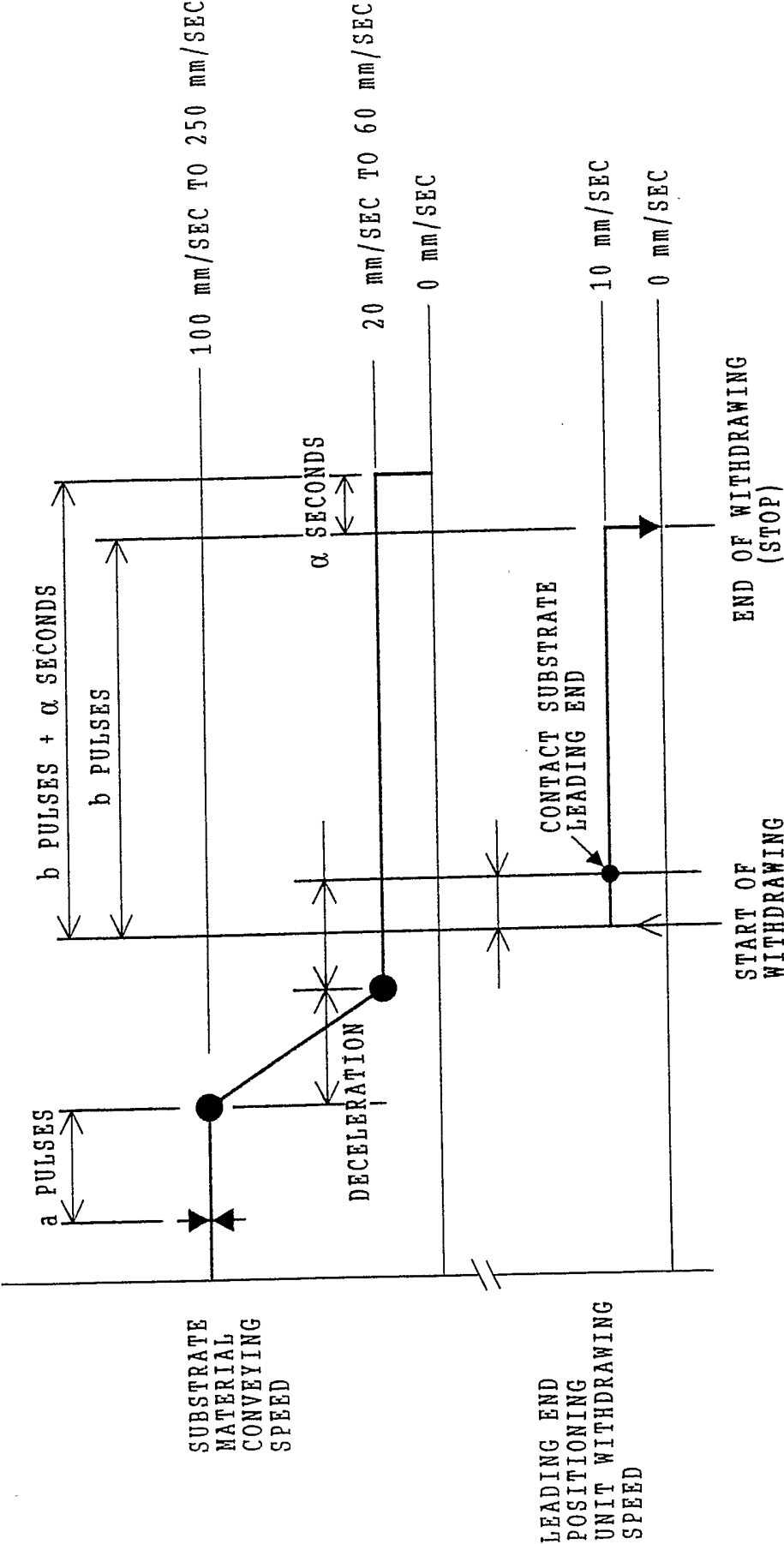


FIG. 11A

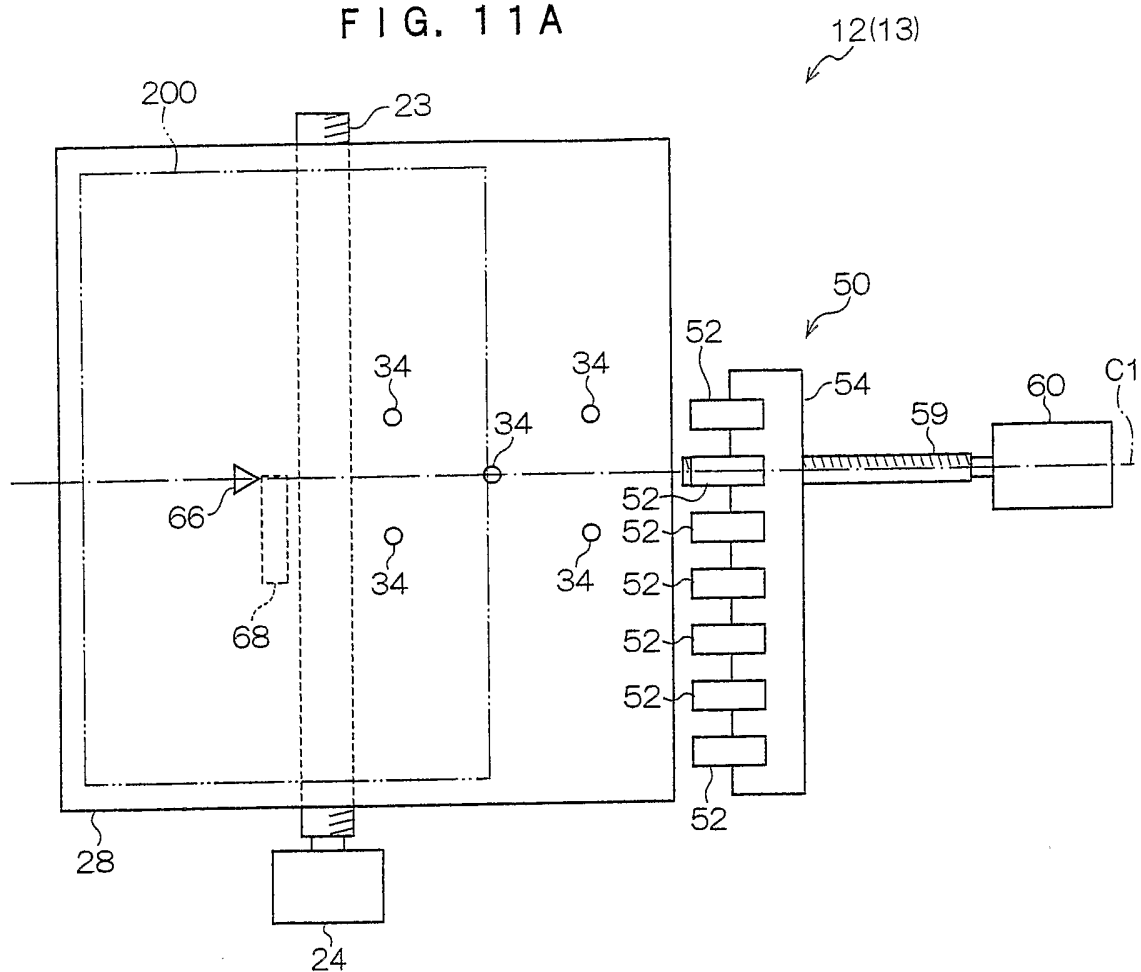


FIG. 11B

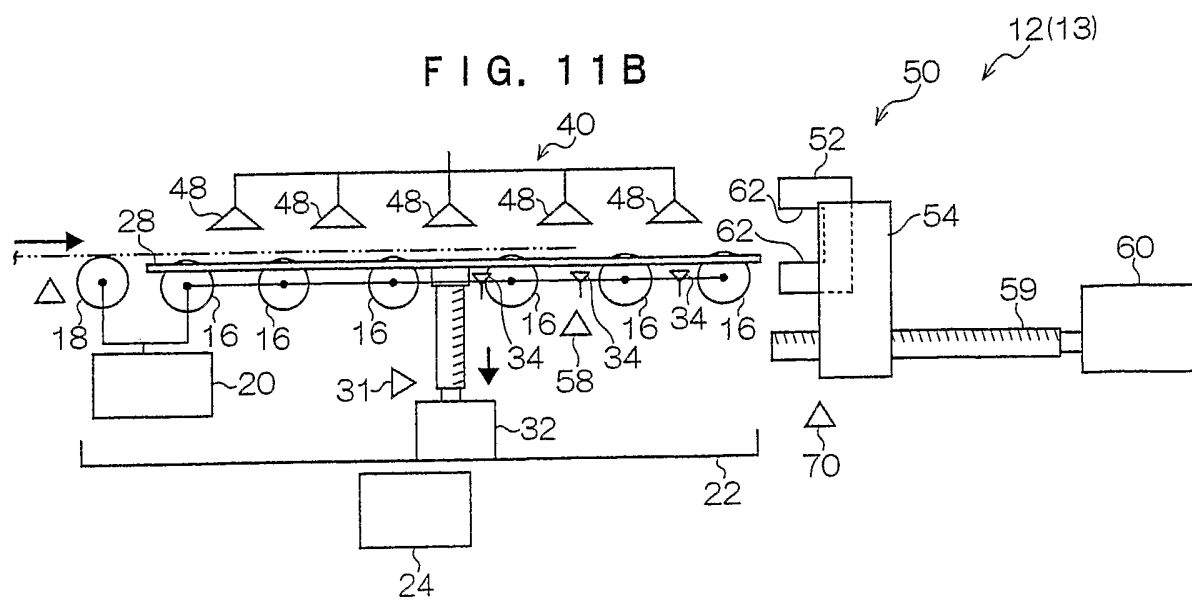


FIG. 12A

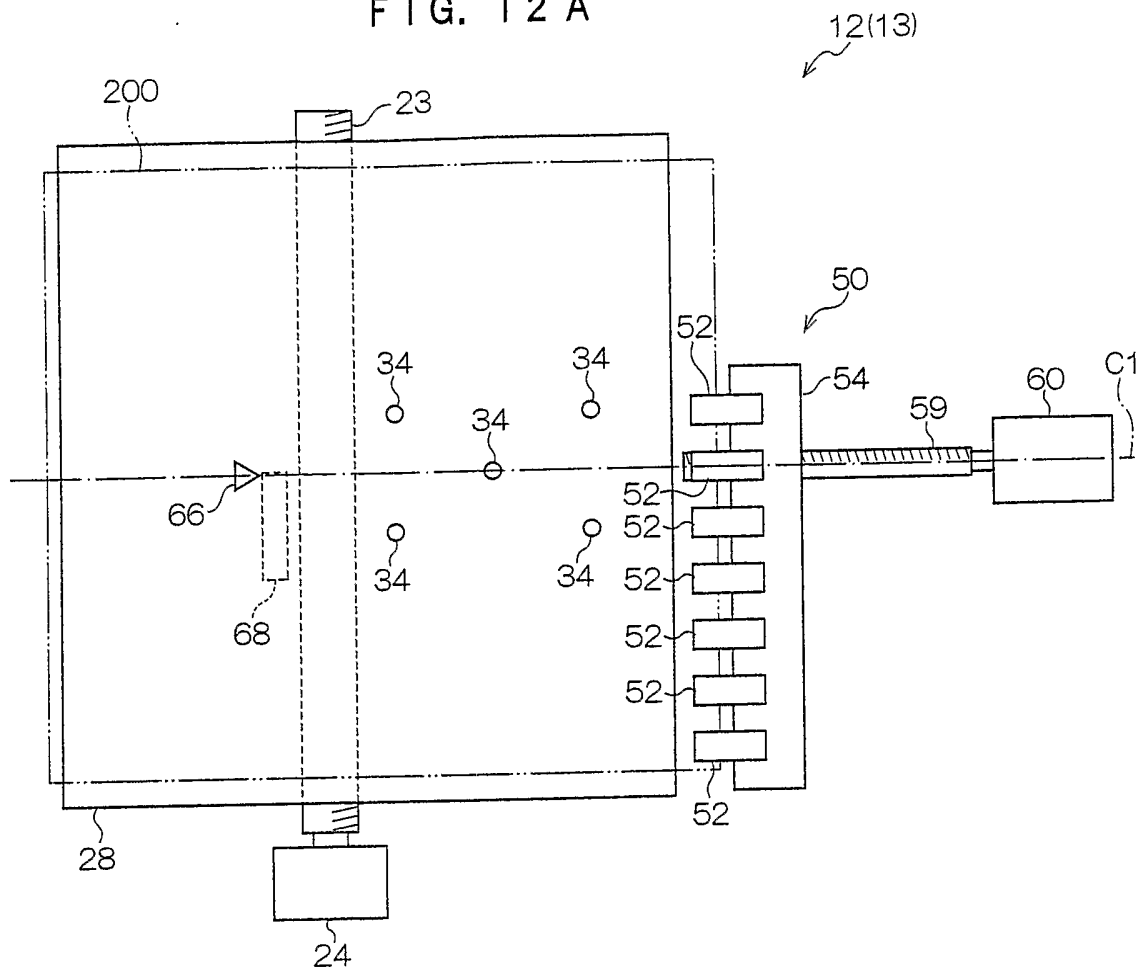


FIG. 12B

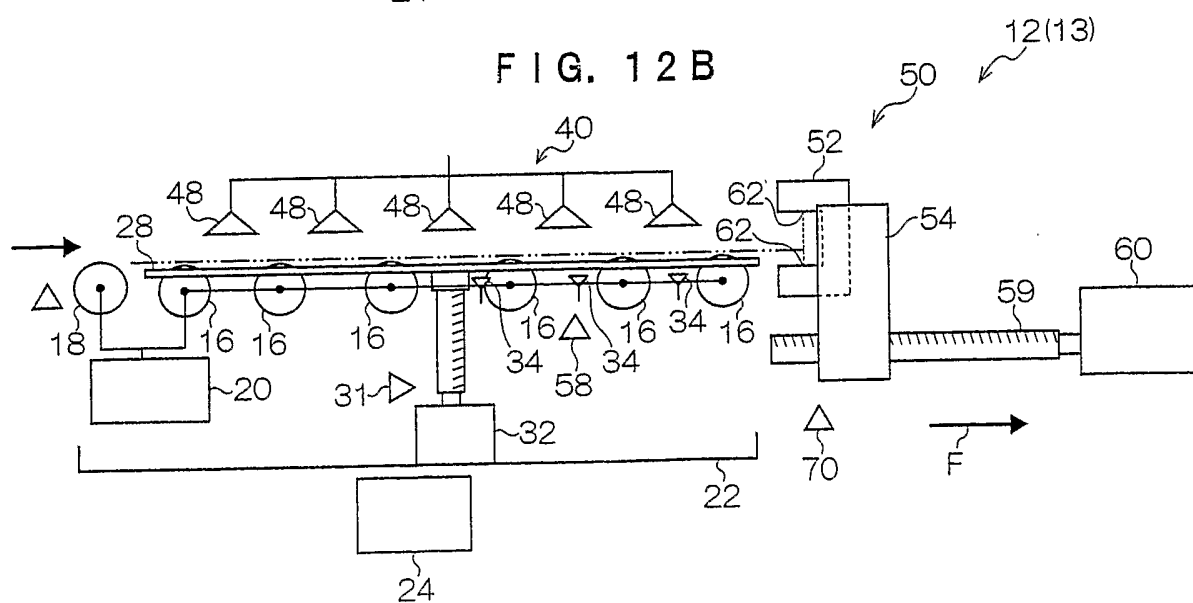


FIG. 13 A

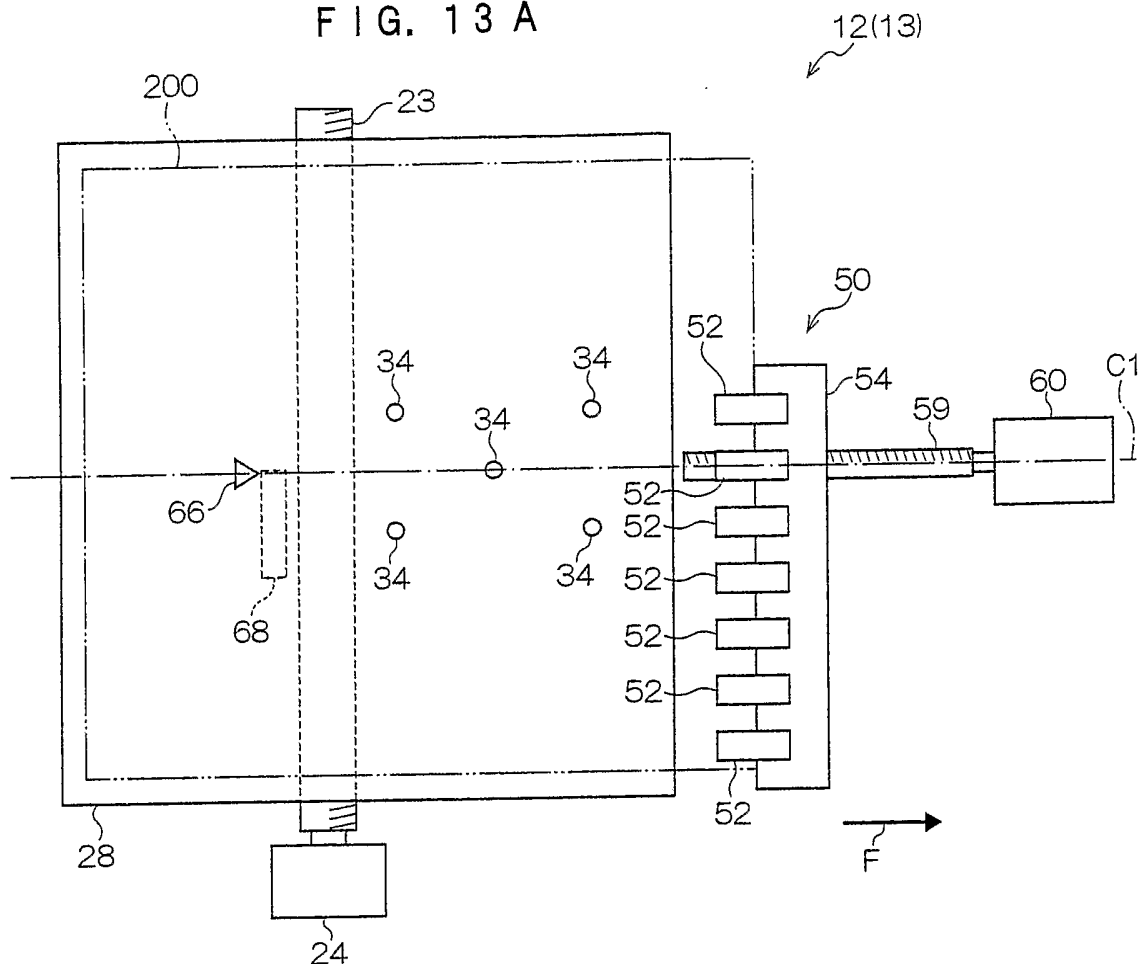


FIG. 13 B

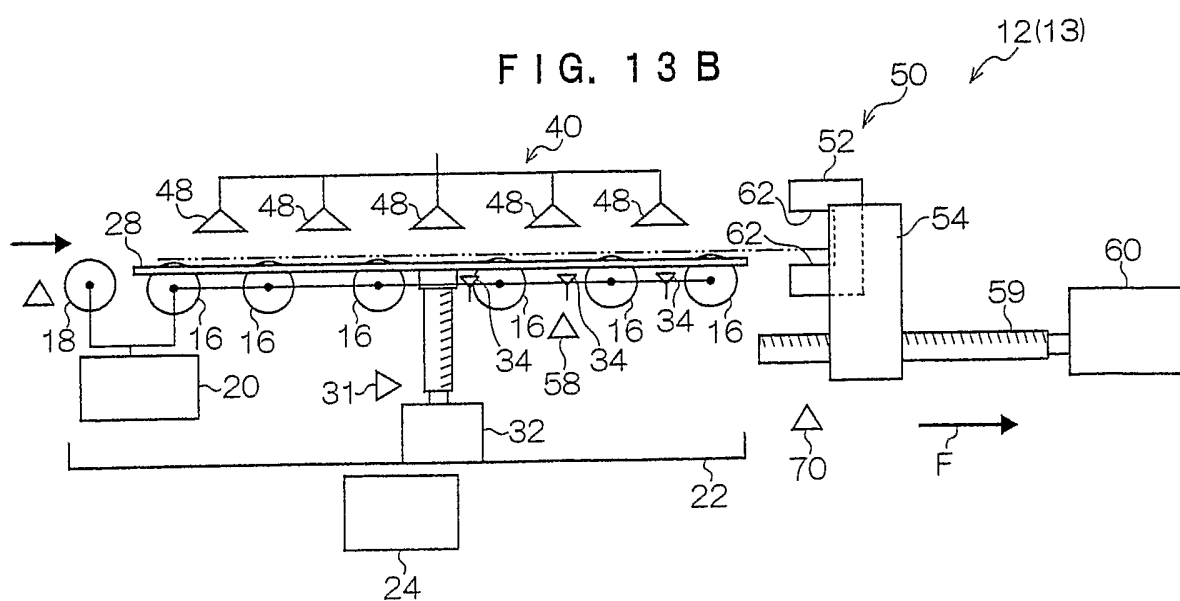


FIG. 14A

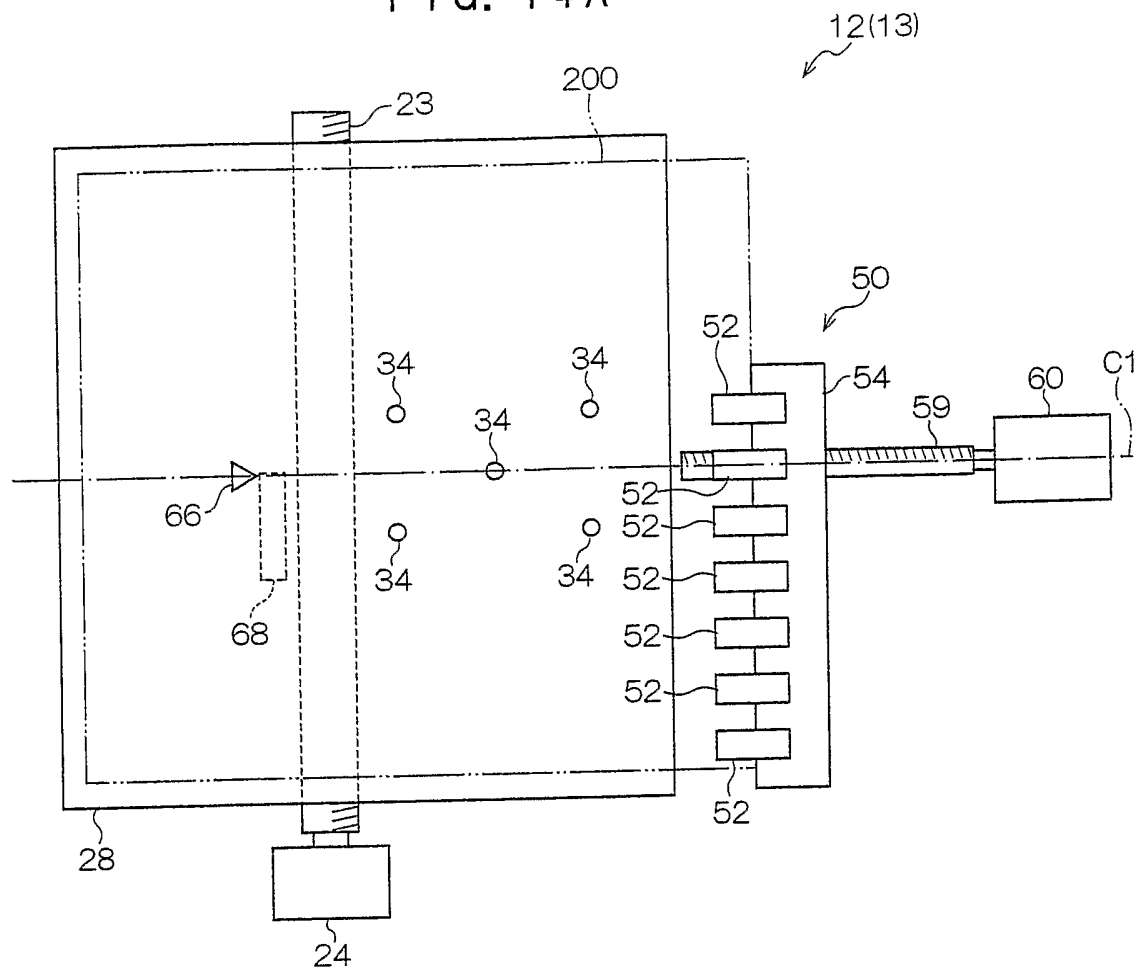


FIG. 14B

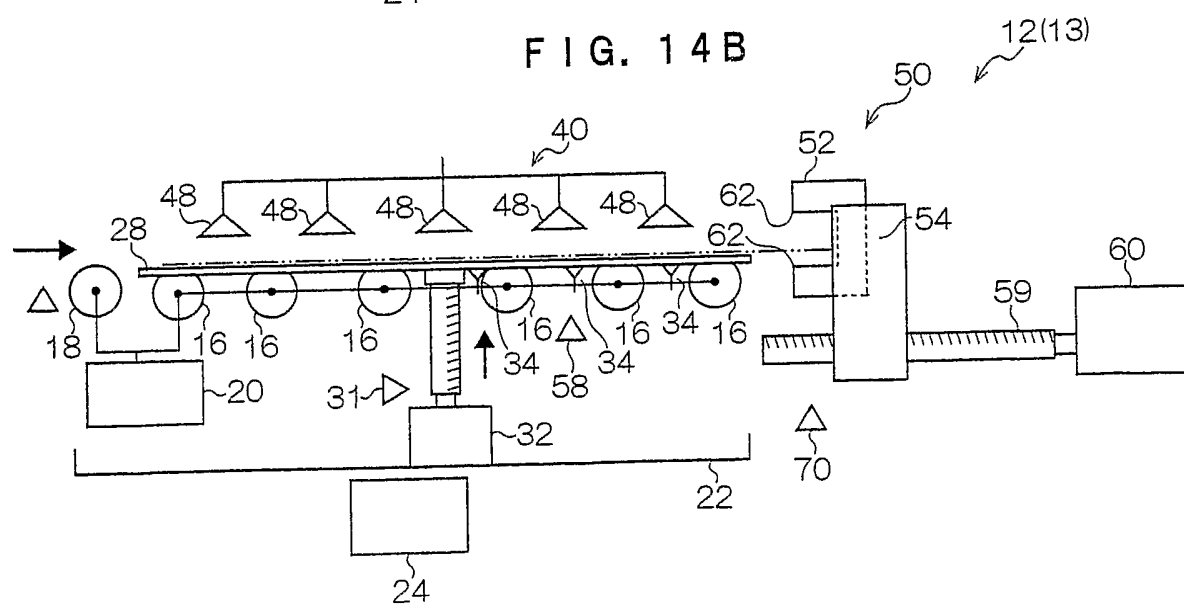


FIG. 15A

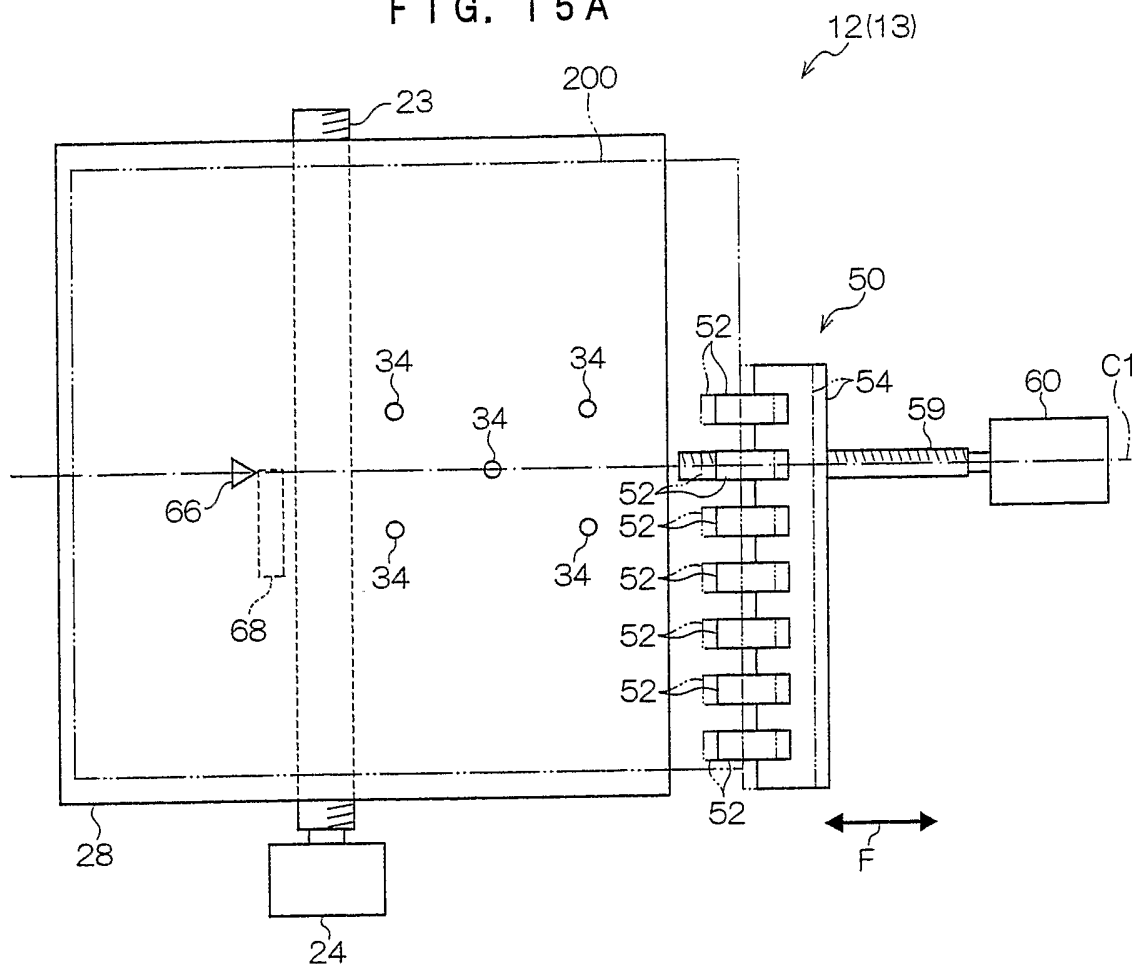


FIG. 15B

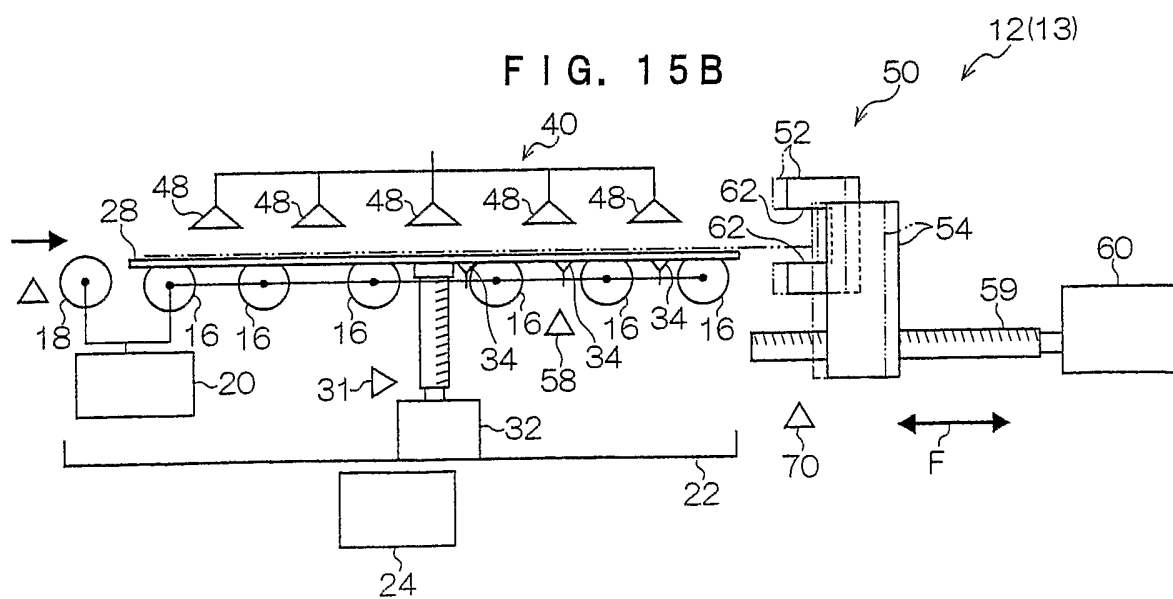


FIG. 16A

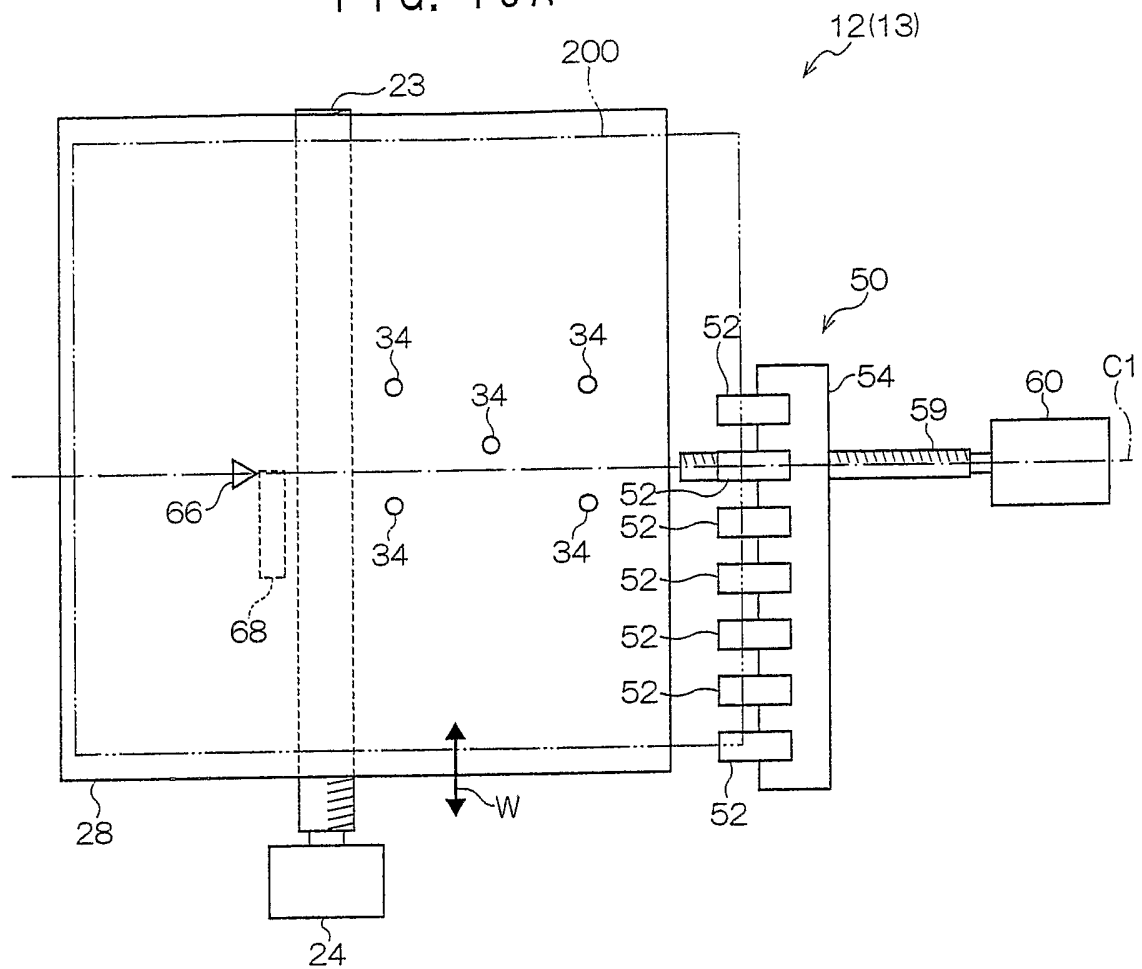


FIG. 16B

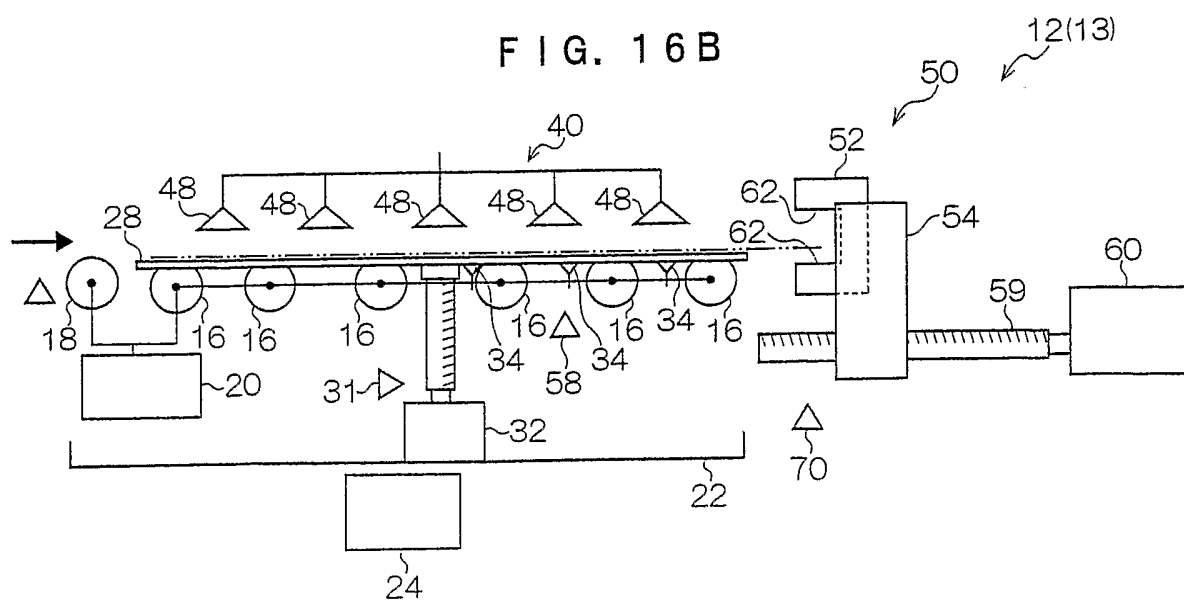


FIG. 17A

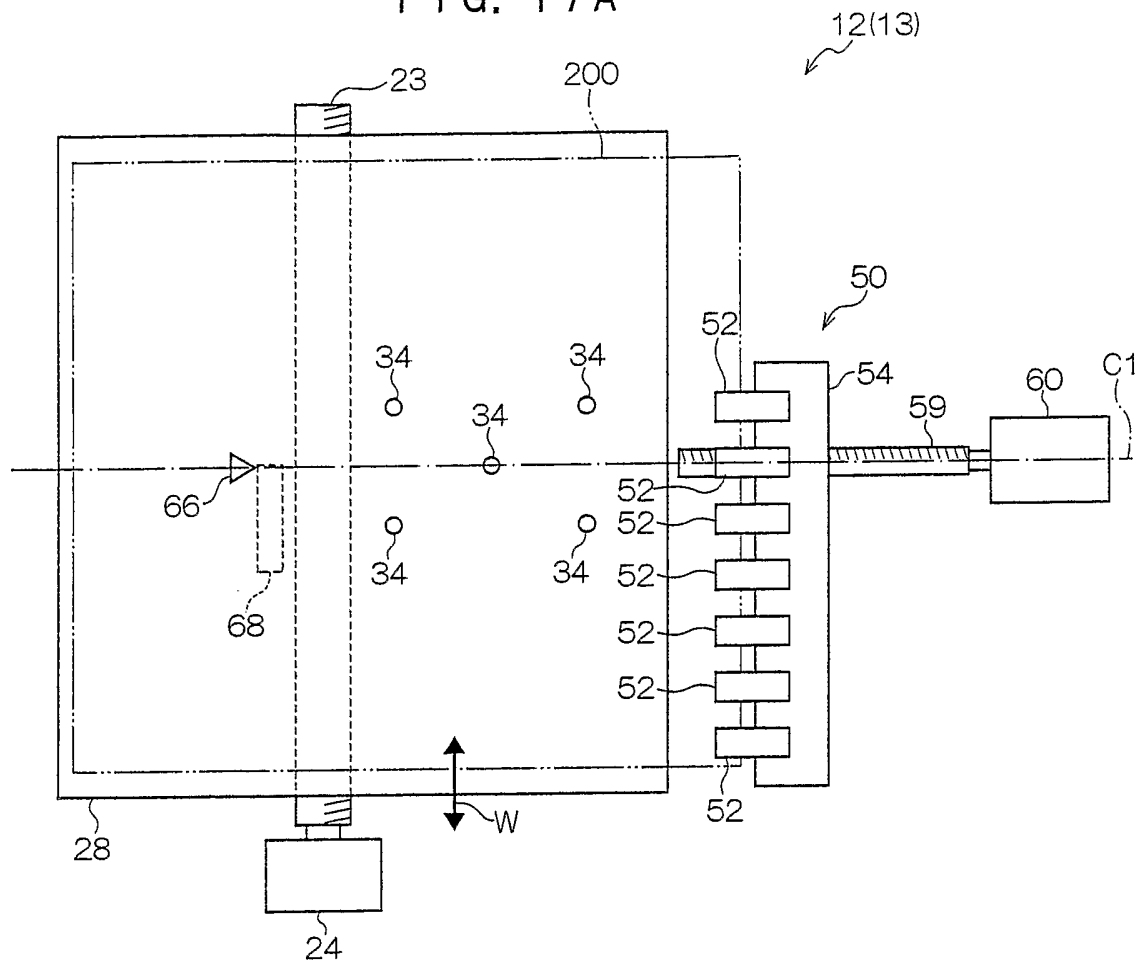


FIG. 17B

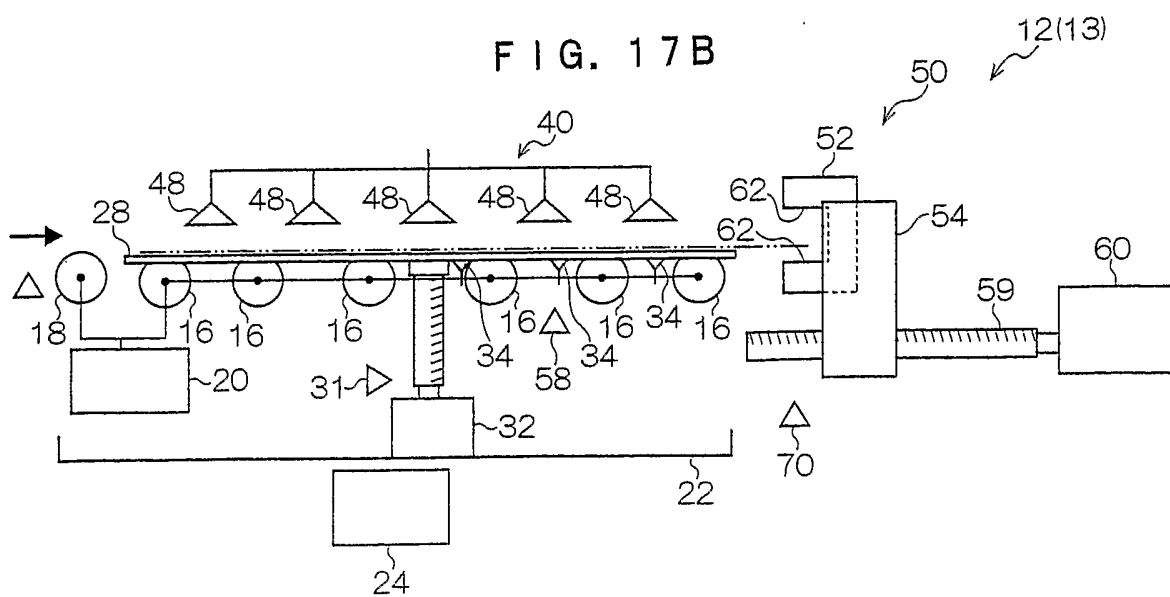


FIG. 18A

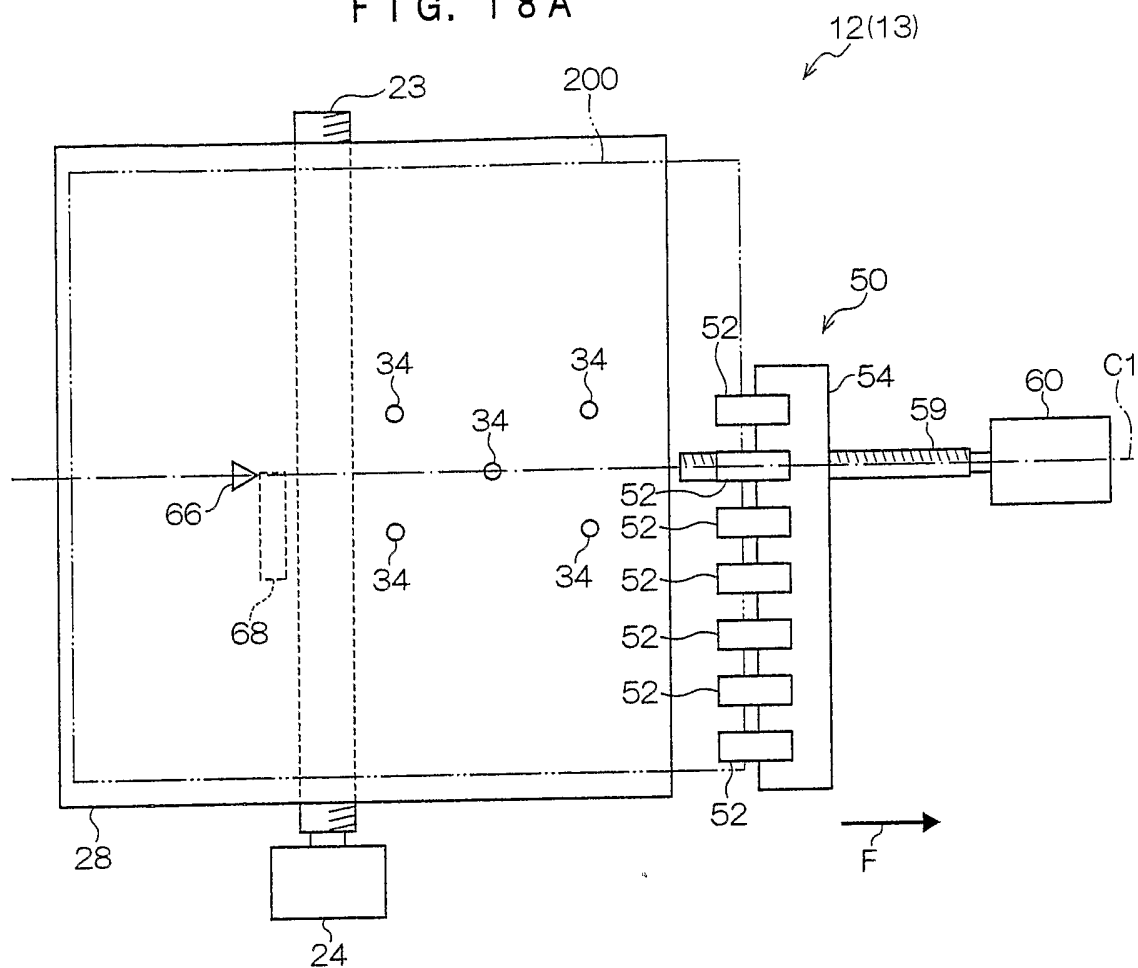


FIG. 18B

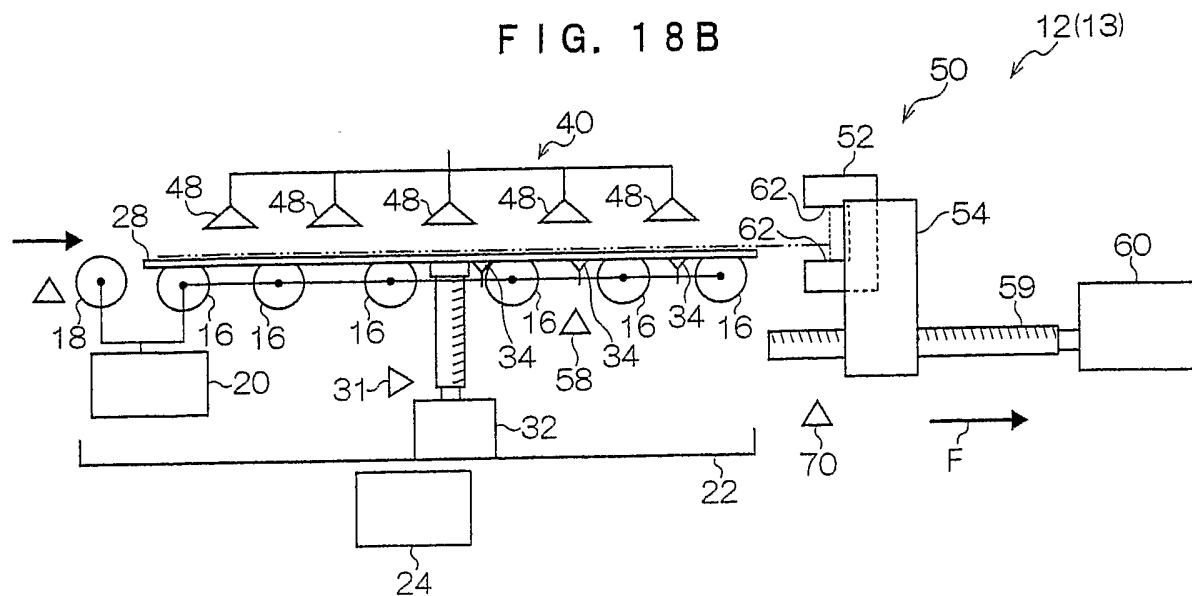


FIG. 19A

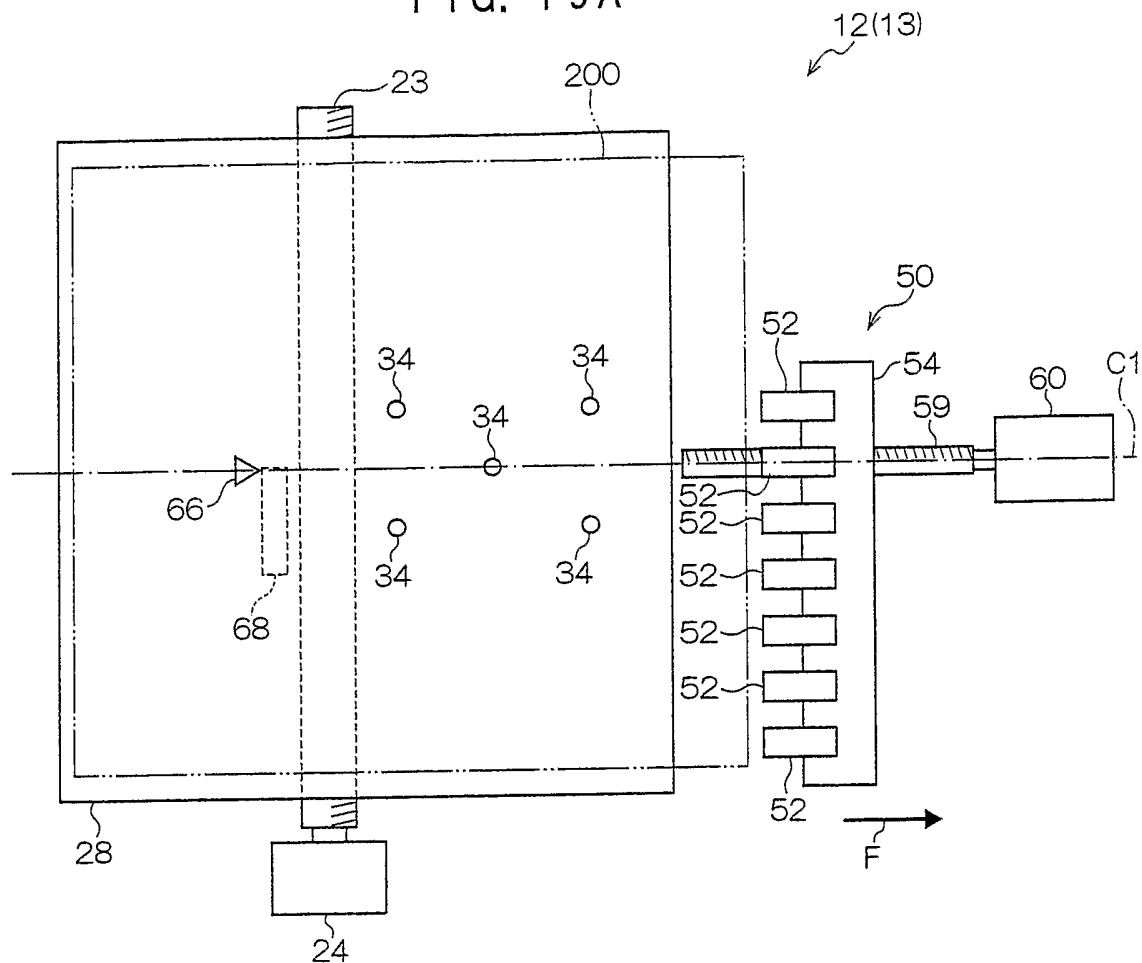


FIG. 19B

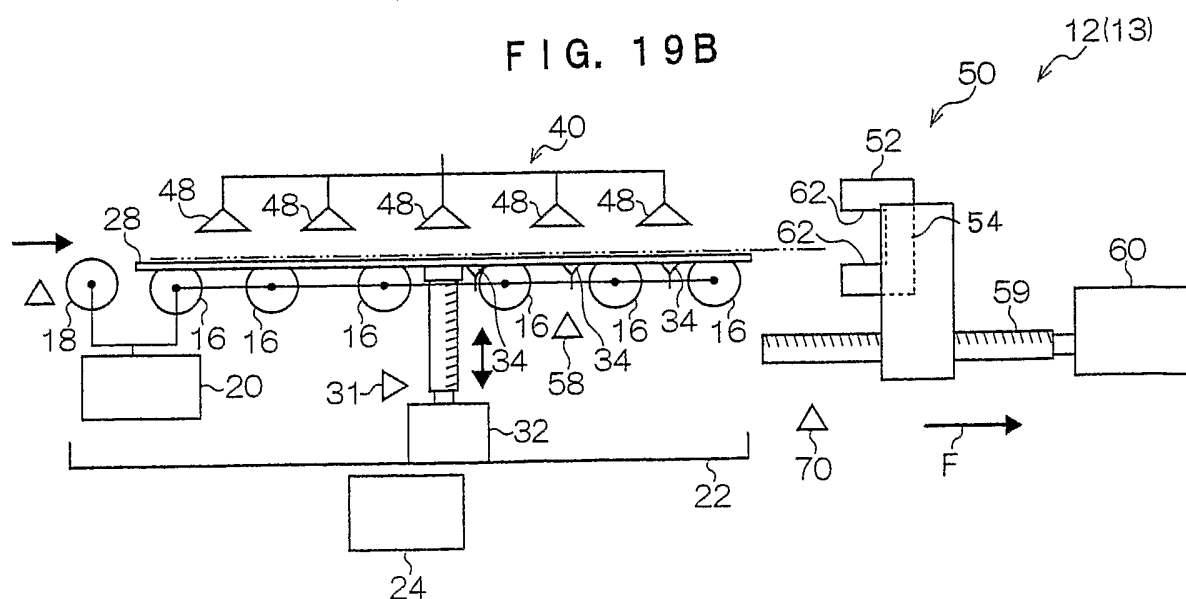


FIG. 20A

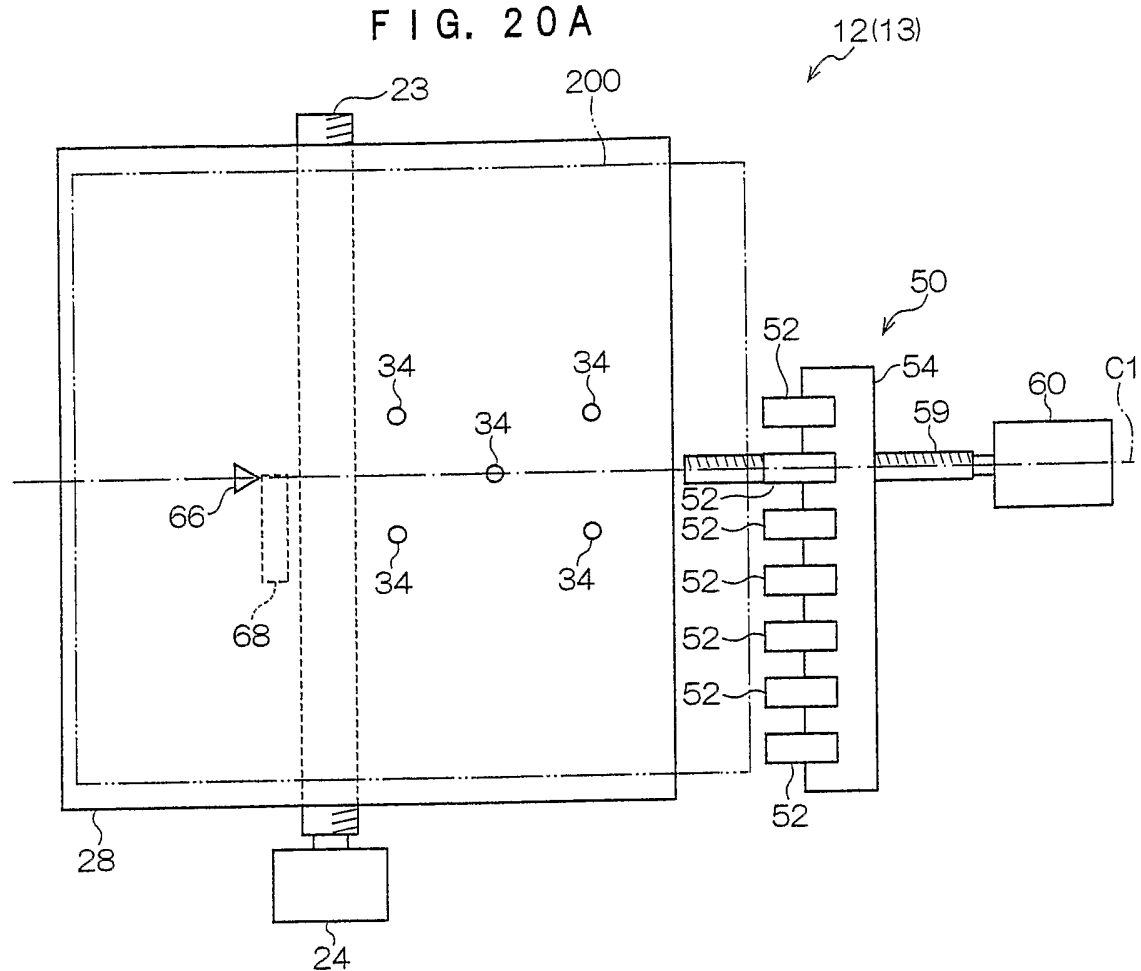


FIG. 20B

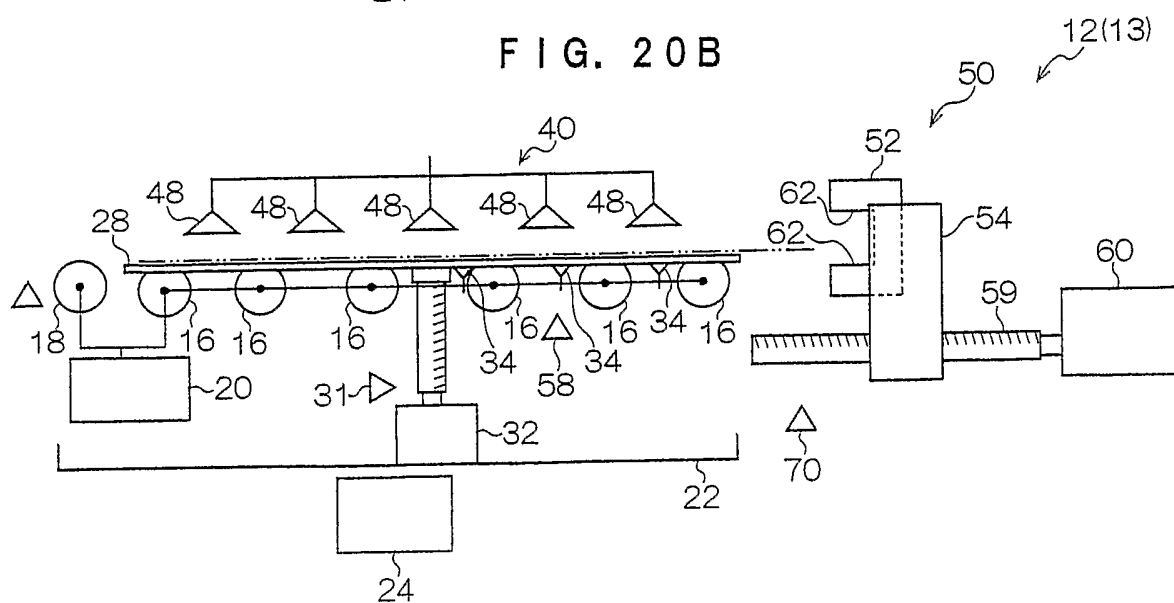


FIG. 21A

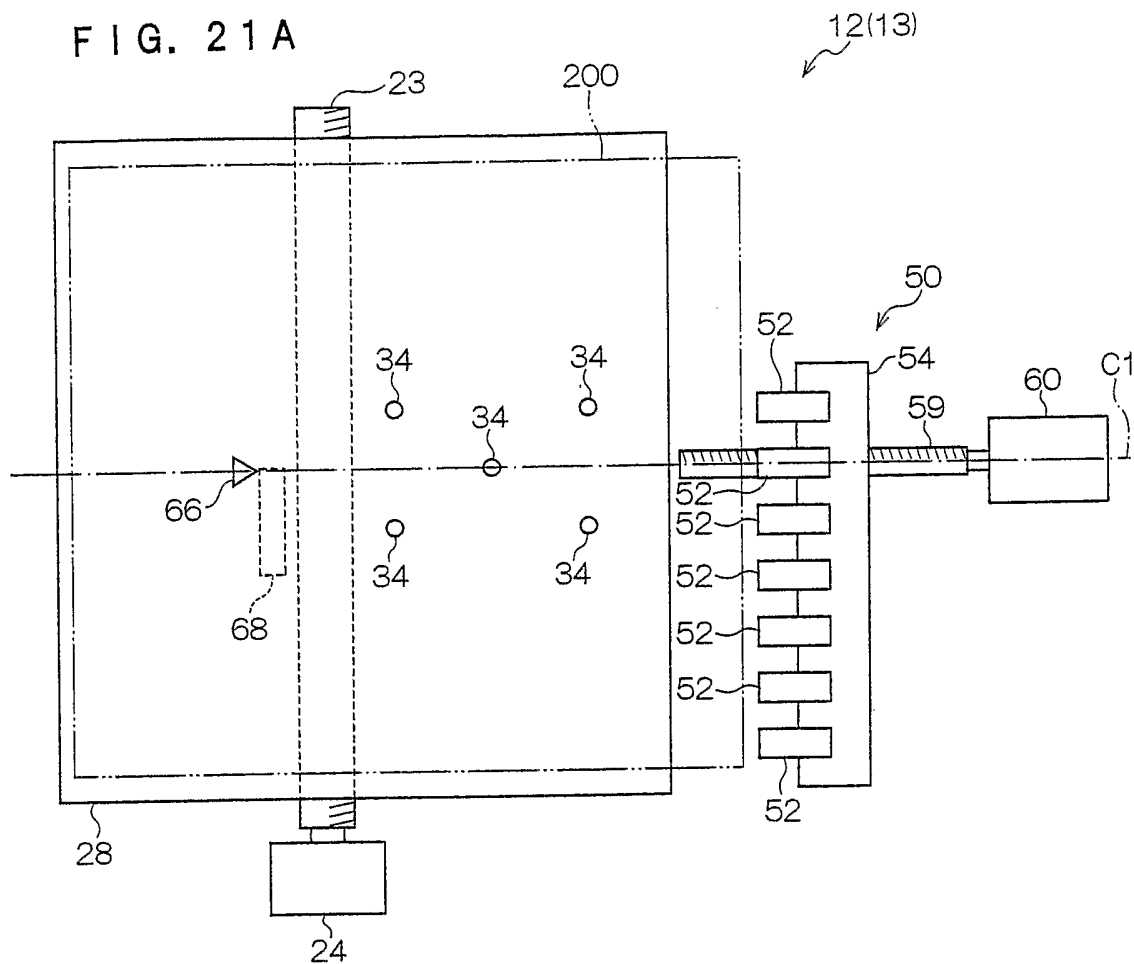


FIG. 21B

