(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 564 291 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
27.11.1996 Bulletin 1996/48

(51) Int. Cl.[6]: **B41J 13/00**, B65H 29/58, B65H 29/60, G03G 15/00

(21) Application number: **93302589.2**

(22) Date of filing: **01.04.1993**

(54) Sheet transport path switching device for an image forming apparatus

Umschaltvorrichtung für den Blattransportweg in einem Bilderzeugungsgerät

Dispositif d'aiguillage d'un chemin de transport de feuille pour un appareil de formation d'images

(84) Designated Contracting States:
DE ES FR GB IT

(30) Priority: **01.04.1992 JP 79630/92**
08.05.1992 JP 116130/92
28.01.1993 JP 12431/93

(43) Date of publication of application:
06.10.1993 Bulletin 1993/40

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Description

BACKGROUND OF THE INVENTION

The present invention relates to a device incorporated in a printer, copier, facsimile apparatus or similar image forming apparatus for switching the path for transporting sheets.

Today, the processing rate of an image forming apparatus of the kind described is increasing A current trend in the imaging art is toward two-sided or duplex printing which forms an image on both sides of a sheet and, therefore, saves limited resources. Duplex printing is not practicable unless a sheet carrying an image on one side thereof is turned over and then refed to an image forming station. An image forming apparatus, therefore, has to be provided with a sheet transport path switching device on a sheet transport route thereof. Even in the event of simplex printing which forms an image on only one side of a sheet, the switching device is indispensable in, for example, sorting the resulting one-sided sheets.

In the light of the above, it has been customary with an image forming apparatus to switch a pair of rotatable pawls to a particular position by a solenoid or similar drive means. Then, the pawls steer sheets to a desired transport path. Alternatively, the transport path may be switched over by a suction system, as disclosed in Japanese Patent Laid-Open Publication No. 52455/1985.

Modern office automation equipment including printers and copiers have sorting, stacking and other advanced functions. While such advanced functions complicate the sheet transport route, there is an increasing demand for reducing the interval between consecutive sheets to produce a greater number of printings without changing the process speed.

The conventional switching device implemented with the pawls cannot switch over the path at a speed high enough to meet the above demand since the switching speed is determined by the response of the pawls. Further, even when fast path switchover is not necessary, the pawls generally exert a load on a sheet and, therefore, often damages it or causes it to jam the path. On the other hand, the switching device using a suction system implements high speed path switchover. However, the suction system makes the switching device bulky and expensive and, in addition, produces noise.

EP-A-407 151 discloses a transport device which uses a roller as a switching device. The disclosed arrangement only feeds two paths.

SUMMARY OF THE INVENTION

It is, therefore, an object of the present invention to provide a sheet transport path switching device for an image forming apparatus which surely steers sheets to any desired paths even when the sheets are continuously fed at an extremely short interval for high speed image formation.

It is another object of the present invention to provide a simple and compact sheet transport path switching device for an image forming apparatus.

It is another object of the present invention to provide a sheet transport path switching device for an image forming apparatus which steers a sheet to a desired path without rubbing an image carried on the sheet or causing the sheet to bend.

It is another object of the present invention to provide a sheet transport path switching device for an image forming apparatus which is capable of steering sheets to three or more paths and, when sheets should be discharged to a tray, surely directing them to the tray.

It is another object of the present invention to provide a transport path switching device for an image forming apparatus which stably and surely switches the path without exerting a load on sheets or damaging them.

According to a first aspect of the invention, there is provided a sheet transport path switching device for an image forming apparatus, comprising:

an inlet roller pair for transporting a sheet; and
either of a reversibly rotatable switch roller and a reversibly rotatable switch belt located on a line extending through a nip portion of said inlet roller pair in an intended direction of sheet transport;

wherein a direction of rotation of said switch roller or switch belt is changed to change a direction in which the sheet transported by said inlet roller pair advances;

characterised in that the device comprises switch section retracting means for retracting said switch roller or said switch belt from a steering position where said switch roller or said sheet belt is capable of changing the direction of transport; and

a transport path along which the sheet being driven by said inlet roller pair is linearly transported when said switch section retracting means retracts said switch roller or said switch belt to a retracted position.

According to a second aspect of the invention there is provided a sheet transport path switching device for selectively steering a sheet being transported along a transport path to any one of a plurality of transport paths, said device comprising:

sheet guide means located in the vicinity of a position where said plurality of transport paths branch off said transport path; and
drive means for bodily rotating said sheet guide means in a forward and a reverse direction about a shaft substantially parallel to a sheet transport plane and perpendicular to an intended direction of sheet transport;

the sheet being steered in any one of a first direction in which said sheet guide means is bodily rotated in the forward direction for guiding said sheet with a forward rotation periphery thereof, and a second direction in which said sheet guide means is bodily rotated in the reverse direction to guide said sheet with a reverse rotation periphery thereof; characterised in that the device is also arranged to steer the sheet in a third direction.

Preferred features of the invention are set out in Claims 2 to 3 and 5 to 7.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages of the present invention will become more apparent from the following detailed description taken with the accompanying drawings in which:

FIG. 1 is a section showing a sheet transport path switching device embodying the present invention together with an image forming section;
FIG. 2 is a section of a laser printer implemented with the embodiment;
FIGS. 3A-3D are sections demonstrating a specific procedure in which the embodiment steers incoming sheets to two transport paths alternately;
FIGS. 4A-4D are sections showing a procedure to follow the procedure of FIGS. 3A-3D;
FIG. 5 shows a positional relation between an inlet roller pair and transport roller pairs which allows only a small area of a sheet adjoining the leading edge to contact a switch roller;
FIG. 6 is a view similar to FIG. 5, showing a positional relation which causes an intermediate portion of a sheet to contact the switch roller;
FIGS. 7A-7D are sections showing an alternative embodiment of the present invention;
FIGS. 8A and 8B are sections representative of a procedure to follow the procedure of FIGS. 7A-7D;
FIGS. 9A-9D are sections showing another alternative embodiment of the present invention;
FIGS. 10A-10D are sections associated with FIGS. 9A-9D;
FIG. 11 is a section indicative of a positional relation between an inlet roller pair and a transport roller pair which prevents a switch belt from rubbing itself against the intermediate portion of a sheet;
FIGS. 12A-12D are sections showing another alternative embodiment of the present invention;
FIGS. 13A and 13B are sections associated with FIGS. 12A-12D;
FIGS. 14A-14D are sections showing another alternative embodiment of the present invention;
FIGS. 15A-15D are sections associated with FIGS. 14A-14D;
FIGS. 16A-16D are sections showing another alternative embodiment of the present invention;
FIGS. 17A-17D are sections associated with FIGS. 16A-16D;
FIG. 18 is a view indicative of a drawback to occur when the peripheral speed of a switch roller is lower than the transport speed of an inlet roller pair;
FIG. 19 is a view similar to FIG. 18 showing how the drawback of FIG. 18 is eliminated;
FIG. 20 shows a specific configuration of a switch roller;
FIG. 21 shows a specific configuration of a switch belt;
FIG. 22 is a section showing a sheet being transported from an inlet roller toward a switch roller and bent at the leading edge thereof;
FIG. 23 is a section showing the sheet of FIG. 22 which is bent on abutting against the switch roller;
FIG. 24 is a section showing the sheet having the bent leading edge and approached a switch roller formed with grooves by knurling;
FIG. 25 is a section showing the sheet which is not bent even on abutting against the switch roller;
FIGS. 26, 27 and 28A-28D are views showing another alternative embodiment of the present invention;
FIGS. 29 and 30 are sections showing another alternative embodiment of the present invention;
FIGS. 31 and 32 are sections showing another alternative embodiment of the present invention;
FIGS. 33, 34, 35, 36 and 37 are sections showing another alternative embodiment of the present invention;
FIGS. 38 and 39 are perspective views each showing another specific configuration of the switch roller;
FIGS. 40, 41 and 42 are sections showing another alternative embodiment of the present invention;
FIG. 43 is a timing chart representative of another alternative embodiment of the present invention;
FIG. 44 is a timing chart representative of another alternative embodiment of the present invention;
FIGS. 45, 46, 47 and 48 are views showing another alternative embodiment of the present invention;
FIGS. 49 and 50 are view showing another alternative embodiment of the present invention;
FIG. 51 is a section showing another alternative embodiment of the present invention;
FIG. 52 is a perspective view showing still another alternative embodiment of the present invention;
FIGS. 53A-53E are sections showing a further alternative embodiment of the present invention; and
FIGS. 54A-54C are sections demonstrating the operation of a conventional switching device using pawls.

In the figures, the same or similar constituent parts are designated by the same reference numerals, and a detailed description will not be made to avoid redundancy.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

To better understand the present invention, a brief reference will be made to a conventional sheet transport path switching device implemented with pawls, shown in FIGS. 54A-54C. As shown, the switching device has a pair of rotatable pawls 72 and 73. When the pawls 72 and 73 assume a position shown in FIG. 54A, they steer a sheet P being driven by a transport roller pair 76 as indicated by an arrow straight to a path where a transport roller pair 75 is located. When the pawl 72 is shifted to a position shown in FIG. 54B a solenoid or similar drive means, the sheet P is steered to a path where a transport roller pair 74 is located. Further, when the pawl 74 is shifted to a position shown in FIG. 54C, the sheet P is steered to a path where a transport roller pair 77 is located.

However, the switching device relying on the pawls 72 and 73 cannot switch over the path at a high speed since the switching rate is determined by the response of the pawls 72 and 73. Further, even when fast path switchover is not necessary, the pawls 72 and 73 generally exert a load on the sheet P and, therefore, often damages it or causes it to jam the path, as discussed earlier.

Referring to FIG. 1 of the drawings, a sheet transport path switching device embodying the present invention is shown together with a section which forms an image on a sheet. A laser printer implemented with the embodiment is shown in FIG. 2.

As shown in FIG. 2, the laser printer has a printer body 1, a table 5 accommodating a two-side print or duplex unit 2 and a sheet feed unit 3 therein, and a sheet discharge unit 4 mounted on the top of the body 1.

A photoconductive drum 8 is disposed in the printer body 1 and, as an image forming process begins, rotated in a direction indicated by an arrow in the figure by a motor, not shown. A main charger 9 uniformly charges the surface of the drum 8 being rotated. An optical writing unit 10 emits a laser beam having been modulated by image data. The laser beam scans the charged surface of the drum 8 in the axial direction of the drum 8, i.e., the main scanning direction, thereby electrostatically forming a latent image thereon. A developing unit 11 deposits a toner on the latent image to produce a corresponding toner image.

An upper and a lower sheet tray 6 and 7 are mounted on the printer body 1 and provided with pick-up rollers 15a and 15b, respectively. Likewise, the sheet feed unit 3 is provided with a pick-up roller 15c. A sheet, not shown, is fed from any one of the sheet trays 6 and 7 and sheet feed unit 3 by the associated pick-up roller 15a, 15b or 15. The sheet is once brought to a stop on abutting against a register roller pair 16 which adjoins the drum 8. The register roller pair 16 starts rotating in synchronism with the movement of the toner image formed on the drum 8 which is in rotation. As a result, the sheet is driven toward a position where the drum 8 and an image transfer an sheet separation unit 17 disposed below the drum 8 face each other. Then, the unit 17 transfers the toner image from the drum 8 to the sheet by a transfer charger and separates the sheet carrying the toner image from the drum 8. A transport belt 18 conveys the sheet with the toner image to a fixing unit 19. The fixing unit 19 fixes the toner image on the sheet by heat.

The sheet coming out of the fixing unit 19 is selectively steered toward an openable stacker 22 provided on the rear of the printer body 1, the sheet discharge unit 4 or the duplex unit 2, depending on the direction of rotation of a switch roller 21 included in a sheet transport path switching device 20 which will be described. A transport roller pair 23 is disposed in the printer body 1 while transport roller pairs 24 is disposed in the sheet discharge unit 4. The sheet discharge unit 4 includes a lower and an upper tray 4a and 4b. Discharge roller pairs 25a and 25b each discharges the sheet to the associated tray 4a or 4b. A register sensor RS is located just in front of the register roller pair 16 to sense the sheet. A cleaning unit 14 removes the toner remaining on the drum 8 after the image transfer. Further, a discharge lamp 26 dissipates the charge also remaining on the drum 8 after the image transfer. As a result, the drum 8 is initialized to prepare for the next image forming process.

Also accommodated in the printer body 1 are control boards 27 for controlling the entire printer and processing print data, an engine driver 28 for controlling a printer engine constituting the image forming section, a power source unit 29, etc.

As shown in FIG. 1, the sheet transport path switching device 20 has an inlet roller pair 31 for transporting a sheet P in addition to the previously mentioned switch roller 21. The switch roller 21 is a reversible roller and located on a line L extending through the nip portion Np of the inlet roller pair 31 in the direction of sheet transport. As the direction in which the switch roller 21 rotates is changed, either of a path 33 terminating at the sheet discharge unit 4 and a path 34 terminating at the duplex unit 2 is selected. The switch roller 21 is reversibly driven by a motor, not shown, independent of the main motor for driving the various portions of the image forming system. A transport roller pair 35 is provided on the path 34 for transporting the sheet P and corresponds to the transport roller pair 23. Guide plates 36, 37 and 38 each guides the sheet P along the associated path 33 or 34. A sensor 12 is positioned at the inlet of the fixing unit 19.

A reference will be made to FIGS. 3A-3D and 4A-4D for describing the operation of the switching device 20. Assume that the device 20 steers sheets coming in one after another to the paths 33 and 34 alternately by way of example. In the figures, arrows indicate the directions in which the associated rollers rotate.

FIG. 3A shows a condition wherein the inlet roller pair 31 has driven the first sheet P1 to a position where the leading edge of the sheet P1 slightly protrudes from

the roller pair 31 on a line extending through the nip portion of the roller pair 31 in the direction of sheet feed (see the line L). At this instant, the switch roller 21 is rotating counterclockwise to steer the sheet P1 toward the path 33. As shown in FIG. 3B, as the leading edge Pa of the sheet P1 abuts against the switch roller 21, it is directed toward the path 33 by the rotation of the switch roller 21. Then, as shown in FIG. 3C, the sheet P1 is nipped and driven by the roller pair 23 to move the path 33 upward along the guide plates 36 and 37. As soon as the trailing edge Pb of the sheet P1 moves away from the switch roller 21, the roller 21 is caused to rotate clockwise, as shown in FIG. 3D.

The second sheet P2 arrives at the switch roller 21 immediately after the first sheet P1. As shown in FIG. 4A, when the leading edge Pa of the second sheet P2 abuts against the switch roller 21, the roller 21 steers it into the path 34. Consequently, the sheet P2 moves the path 34 downward along the guide plates 36 and 38 by being nipped by the roller pair 35. As shown in FIG. 4C, when the trailing edge Pb of the sheet P2 moves away from the switch roller 21, the roller 21 is again rotated counterclockwise. Subsequently, as the leading edge of the third sheet P3 abuts against the switch roller 21, it is steered in the direction in which the roller 21 is rotating, as shown in FIG. 4D. Repeating such an operating, the device 20 can steer sheets to the paths 33 and 34 alternately with high efficiency, despite that the sheets are continuously fed into the device 20.

As shown in FIG. 5, in the event when the sheet P having been guided by the switch roller 21 is nipped and driven by the roller pair 23 or 35, the sheet P does not contact the roller 21 except for a small area adjoining the leading edge thereof. Specifically, in the illustrative embodiment, the sheet P having been guided by the switch roller 21 is spaced apart from the roller 21 when nipped and driven by the roller pair 23 or 35. For this purpose, as shown in FIG. 5, the switch roller 21 and the roller pairs 23, 31 and 35 are positioned such that the periphery 21a of the roller 21 does not overlap a line L1 connecting the nip portions of the roller pairs 31 and 23 or a line L2 connecting the nip portions of the roller pairs 31 and 35.

FIG. 6 shows a roller arrangement which does not satisfy the above-stated condition. In this arrangement, when the sheet P is nipped and conveyed by the roller pairs 23 and 31, the intermediate portion Pc of the sheet P contacts the periphery 21a of the switch roller 21. As a result, when the switch roller 21 is rotating in a direction different from the transport direction of the sheet P, it rubs itself against the side of the sheet P facing the roller 21 and thereby degrades an image which may exist there. The embodiment prevents the switch roller 21 from contacting the intermediate portion Pc of the sheet P, as stated above.

To be more exact, the above-mentioned line L1 is a line tangential to the periphery of the upper roller of the roller pair 31 and the periphery of the right roller of the roller pair 23 on the switch roller 21 side, as viewed in FIG. 5. Likewise, the line L2 is a line tangential to the lower roller of the roller pair 31 and the right roller of the roller pair 35 on the switch roller 21 side, as viewed in FIG. 5.

Referring to FIGS. 7A-7D, 8A and 8B, an alternative embodiment of the present invention will be described which changes the direction of rotation of the switch roller 21 before the trailing edge Pb of the sheet P1 is spaced apart from the roller 21. The operation of this embodiment will also be described on the assumption that sheets P sequentially coming in the switching device are steered to the paths 33 and 34 alternately.

FIG. 7A shows a condition wherein the inlet roller pair 31 has driven the first sheet P1 to a position where the leading edge of the sheet P1 slightly protrudes from the nip portion of the roller pair 31. At this instant, the switch roller 21 is rotating counterclockwise to steer the sheet P1 toward the path 33. As shown in FIG. 7B, as the leading edge Pa of the sheet P1 abuts against the switch roller 21, it is directed toward the path 33 by the rotation of the switch roller 21. Then, as shown in FIG. 7C, the sheet P1 is nipped and driven by the roller pair 23 to begin to move the path 33 upward along the guide plates 36 and 37. Then, the switch roller 21 is reversed to rotate clockwise to prepare for the second sheet P2. As the leading edge Pa of the second sheet P2 abuts against the switch roller 21, the roller 21 steers it into the path 34, as shown in FIG. 7D.

As shown in FIG. 8A, as the sheet P2 is nipped by the roller pair 35 to begin to move the path 34 downward, the switch roller 21 is again reversed to rotate counterclockwise to prepare for the third sheet P3. As shown in FIG. 8B, when the leading edge Pa of the third sheet P3 abuts against the switch roller 21, the roller 21 guides it into the path 33.

As stated above, this embodiment changes, while a sheet is passing the switch roller 21, the rotating direction of the switch roller 21 to steer the next sheet. This insures efficient and exact switchover of the sheet transport path even when the interval between consecutive sheets is reduced substantially to zero.

FIGS. 9A-9D and 10A-10D show another alternative embodiment of the present invention which uses an endless reversible belt 41 in place of the switch roller 21. As shown, the belt or switch belt 41 is located on a line extending through the nip portion of the roller pair 31 in the direction of sheet feed. The embodiment changes the direction for transporting the sheet P by changing the rotating direction of the switch belt 41. The operation will be described on the assumption that sheets sequentially coming in the switching device are steered to the paths 33 and 34 alternately.

FIG. 9A shows a condition wherein the inlet roller pair 31 has driven the first sheet P1 to a position where the leading edge of the sheet P1 slightly protrudes from the nip portion of the roller pair 31. At this instant, the switch belt 41 is rotating counterclockwise to steer the sheet P1 toward the path 33. As shown in FIG. 9B, as the leading edge Pa of the sheet P1 abuts against the

switch belt 41, it is directed toward the path 33 by the rotation of the switch belt 41. Then, as shown in FIG. 9C, the sheet P1 is nipped and driven by the roller pair 23 to move the path 33 upward along the guide plates 36 and 37. As soon as the trailing edge Pb of the sheet P1 moves away from the switch belt 41, the belt 41 is caused to rotate clockwise, as shown in FIG. 9D. The belt 41 is, therefore, prepared to receive the second sheet P2 which will arrive in a short interval.

As shown in FIG. 10A, when the leading edge Pa of the second sheet P2 abuts against the switch belt 41, the belt 41 steers it into the path 34. Consequently, the sheet P2 moves the path 34 downward along the guide plates 36 and 38 by being nipped by the roller pair 35, as shown in FIG. 10B. As shown in FIG. 10C, when the trailing edge Pb of the sheet P2 moves away from the switch belt 41, the belt 41 is again rotated counterclockwise. Subsequently, as the leading edge of the third sheet P3 abuts against the switch belt 41, it is steered in the direction in which the belt 41 is rotating, as shown in FIG. 10D. Repeating such an operation, the device can steer sheets to the paths 33 and 34 alternately with high efficiency, despite that the sheets are continuously fed into the device.

The switch belt 41 enhances the free layout of the switching device for implementing various kinds of transport paths, compared to the switch roller 21. In addition, the switch belt 41 will be advantageous over the switch roller 21 when a longer distance is desired between the transport roller located at the inlet of the switching device and the transport roller located downstream of such a roller pair.

As shown in FIG. 11, this embodiment, like the embodiment of FIGS. 5 and 6, locates the switch belt 41 such that the surface 41a of the belt 41 does not overlap a line L3 connecting the nip portions of the roller pairs 31 and 23 or a line connecting the nip portions of the roller pairs 31 and 35. This is also successful in preventing the switch belt 41 from rubbing itself against the intermediate portion of the sheet P.

Referring to FIGS. 12A-12D, 13A and 13B, an alternative embodiment of the present invention will be described which changes the direction of rotation of the switch belt 41 before the trailing edge Pb of the sheet P1 is brought out of contact with the belt 41. The operation of this embodiment will also be described on the assumption that sheets P sequentially coming in the switching device are steered to the paths 33 and 34 alternately.

As shown in FIG. 12A, when the leading edge Pa of the first sheet P1 has left the nip portion of the roller pair 31, the switch belt 41 has already started rotating counterclockwise. As shown in FIG. 12B, as the leading edge Pa of the sheet P1 abuts against the switch belt 41, it is directed toward the path 33 by the rotation of the switch belt 41. Then, as shown in FIG. 12C, the sheet P1 is nipped and driven by the roller pair 23 to begin to move the path 33 upward along the guide plates 36 and 37. Then, the switch belt 41 is reversed to rotate clockwise to prepare for the second sheet P2. As the leading edge Pa of the second sheet P2 abuts against the switch belt 41, the belt 41 steers the sheet P2 into the path 34, as shown in FIG. 12D.

As shown in FIG. 13A, as the sheet P2 is nipped by the roller pair 35 to begin to move the path 34 downward, the switch belt 41 is again reversed to rotate counterclockwise to prepare for the third sheet P3. As shown in FIG. 13B, when the leading edge Pa of the third sheet P3 abuts against the switch belt 41, the belt 41 guides it into the path 33.

As stated above, this embodiment changes, while a sheet is passing the switch belt 41, the direction of rotation of the belt 41 to steer the next sheet. This insures efficient and exact switchover of the sheet transport path even when the interval between consecutive sheets is reduced substantially to zero.

FIGS. 14A-14D and 15A- 15D show another alternative embodiment of the present invention. As shown, a first and a second driven roller 43 and 44 are held in contact with the switch roller 21, and each is rotatable in one of opposite directions for transporting the sheet P. The switch roller 21, therefore, exerts a transporting force on the sheet P while steering it. The operation of this embodiment will be described on the assumption that sheets P sequentially coming in the switching device are steered to the paths 33 and 34 alternately.

As shown in FIG. 14A, when the leading edge of the first sheet P1 has moved away from the nip portion of the roller pair 31, the switch roller 21 has already been rotated counterclockwise. The switch roller 21 in turn rotates the driven rollers 43 and 44 in directions indicated by arrows in the figure. As shown in FIG. 14B, as the leading edge of the sheet P1 abuts against the switch roller 21, the former is steered toward the path 33 by the latter, i.e., toward the nip portion of the switch roller 21 and the driven roller 43. Since the nip portion of the switch roller 21 and driven roller 43 cooperate to convey a sheet toward the path 33, it cooperates with the nip portion of the inlet roller pair 31 to move the sheet P1 upward on the path 33 along the guide plates 36 and 37, as shown in FIG. 14C. Subsequently, as shown in FIG. 14D, when the trailing edge Pb of the sheet P1 leaves the nip portion of the switch roller 21 and driven roller 43, the roller 21 is reversed to rotate clockwise to prepare for the second sheet P2. At the same time, the driven rollers 43 and 44 are reversed by the switch roller 21.

As shown in FIG. 15A, when the leading edge Pa of the second sheet P2 abuts against the switch roller 21, the roller 21 steers it toward the nip portion of the roller 21 and driven roller 44. Since the nip portion of the rollers 21 and 44 also cooperate to convey a sheet toward the path 34, the sheet P2 is moved downward on the path 34 along the guide plates 36 and 38, as shown in FIG. 15B. As shown in FIG. 15C, as soon as the trailing edge Pb of the sheet P2 leaves the nip portion of the rollers 21 and 44, the roller 21 is reversed to rotate counterclockwise while causing the driven rollers 43

and 44 to rotate clockwise. Thereafter, as shown in FIG. 15D, when the leading edge of the third sheet P3 abuts against the switch roller 21, the roller 21 steers it toward the nip portion of the roller 21 and driven roller 43 which is associated with the path 33.

By repeating the above operation, the switching device steers consecutive sheets to the paths 33 and 34 alternately. In the illustrative embodiment, the driven rollers 43 and 44 each cooperates with the switch roller 21 to convey the sheet P having been directed toward the associated path. Hence, it is needless to locate transport roller pairs downstream of and in close proximity to the switch roller 21. As a result, the number of required parts is reduced to implement a compact design.

FIGS. 16A-16D and 17A-17D show another alternative embodiment of the present invention which is essentially similar to the embodiment of FIGS. 14A-14D except that the switch roller 21 is replaced with the switch belt 41. The operation will be described on the assumption that sheets sequentially coming in the switching device are steered to the paths 33 and 34 alternately.

As shown in FIG. 16A, when the leading edge of the first sheet P1 has moved away from the nip portion of the inlet roller pair 31, the switch belt 41 has already been rotated counterclockwise. The first and second driven rollers 43 and 44 are pressed against the switch belt 41 and rotated by the latter in directions indicated by arrows in the figure. As shown in FIG. 16B, as the leading edge Pa of the first sheet P1 abuts against the switch belt 41, the belt 41 steers it toward the path 33, i.e., toward the nip portion of the belt 41 and driven roller 43. Since the nip portion of the switch belt 41 and driven roller 43 function to convey a sheet toward the the path 33, it cooperates with the nip portion of the inlet roller pair 31 to move the sheet P1 upward along the path 33, as shown in FIG. 16C. As shown in FIG. 16D, when the trailing edge Pb of the sheet P1 moves away from the nip portion of the switch belt 41 and driven roller 43, the belt 41 is reversed to rotate clockwise and awaits the second sheet P2. At the same time, the driven rollers 43 and 44 are rotated counterclockwise by the switch belt 41.

As shown in FIG. 17A, when the leading edge Pa of the second sheet P2 abuts against the switch belt 41, the belt 41 steers it toward the nip portion of the belt 41 and driven roller 44. Since the nip portion of the switch belt 41 and driven roller 44 also functions to convey a sheet toward the path 34, the sheet P2 is transported on the path 34 along the guide plates 36 and 38, as shown in FIG. 17B. Subsequently, as shown in FIG. 17C, as the trailing edge Pb of the sheet P2 leaves the nip portion of the switch belt 41 and driven roller 44, the belt 41 is reversed to rotate counterclockwise and awaits the third sheet P3. At the same time, the driven rollers 43 and 44 are rotated clockwise by the switch belt 41. As shown in FIG. 17D, when the trailing edge Pa of the third sheet P3 abuts against the switch belt 41, the belt 41 steers it toward the nip portion of the belt 41 and driven roller 43 which is associated with the path 33.

By repeating the above operation, the switching device steers consecutive sheets to the paths 33 and 34 alternately.

In the embodiments shown in FIGS. 1-8B, 14A-14B and 15A-15D, it is preferable to rotate the switch roller 21 at a peripheral speed equal to or higher than the transport speed of the inlet roller pair 31. Specifically, assume that the peripheral speed (transport speed) of the inlet roller pair 31 is V1, that the peripheral speed of the switch roller 21 is V2, and that the speed V2 is lower than the speed V1. Then, when the leading edge Pa of the sheet P abuts against the switch roller 21 to be steered in the rotating direction of the roller 21, the sheet P is apt to bend, as shown in FIG. 18. If V2 is equal to or higher than V1, the sheet P is prevented from bending after it has abutted against the switch roller 21, as shown in FIG. 19. This is also true with the embodiments shown in FIGS. 9A-13B and 16A-17D. Specifically, it is preferable that the switch belt 41 be rotated at a peripheral speed V3 equal to or higher than the transport speed V1 of the roller pair 31.

FIG. 20 shows a specific configuration of the switch roller 21. As shown, the periphery 21a of the switch roller 21 is knurled to form a number of grooves 21b in a direction perpendicular to the direction of rotation of the roller 21. As shown in FIG. 21, the switch belt 41 may also be knurled to form a number of grooves 41b in a direction perpendicular to the direction of rotation of the belt 41. The grooves 21b or 41b will allow the roller 21 or the belt 41 to steer sheets more accurately.

Specifically, FIGS. 22 and 23 are indicative of a drawback particular to the switch roller 21 lacking the grooves 21b. As shown in FIG. 22, assume that the leading edge Pa of the sheet P coming out of the inlet roller pair 31 has been bent. Then, when the leading edge Pa of the sheet P abuts against the switch roller 21, the roller 21 is apt to fail to retain the edge Pa and, therefore, to steer it in the rotating direction thereof (upward in this case), as shown in FIG. 23. In such a condition, it is likely that sheets P sequentially arriving at the switching device jam the path preceding the switch roller 21. By contrast, as shown in FIG. 25, the switch roller 21 with the grooves 21b is capable of surely retaining and steering the leading edge Pa of the sheet P which has been bent as shown in FIG. 24. This prevents sheets from jamming the path preceding the switch roller 21. This is also true with the switch belt 41 having the grooves 41b.

Referring to FIGS. 26 and 27, another alternative embodiment of the present invention will be described. As shown, the driven rollers 43 and 44, FIGS. 14A-14D, are pressed against the switch roller 21 and selectively moved out of contact with the roller 21 by retracting means 50A and 50B, respectively. Briefly, the driven roller 43 or 44 is brought out of contact with the switch roller 21 by the retracting means 50A or 50B when the

leading edge Pa of the sheet P has moved away from the roller 43 or 44.

The retracting means 50A has a lever 51 supporting the driven roller 43 at one end in a rotatable manner, a spring 52 constantly biasing the lever 51 upward as viewed in FIG. 26, a pin 53 about which the lever 51 is rotatable, and a solenoid 54A for rotating the lever 51 against the action of the spring 52. When the solenoid 54A is not energized, the lever 51 is biased by the spring 52 to a position where the driven roller 43 is pressed against the switch roller 21 by a predetermined pressure. As shown in FIG. 27, when the solenoid 54A is energized, the lever 51 is rotated against the action of the spring 52 to move the driven roller 43 away from the switch roller 21. The retracting means 50B is identical in construction with the retracting means 50A. Specifically, when a solenoid 54B included in the retracting means 50B is not energized, the driven roller 44 remains in contact with the switch roller 21; when it is energized, the driven roller 44 is moved away from the switch roller 21. The operation of this embodiment will be described on the assumption that sheets sequentially coming in the switching device are steered to the paths 33 and 34 alternately.

As shown in FIG. 28A, when the leading edge of the first sheet P1 abuts against the switch roller 21, it is steered in the direction of rotation of the roller 21, i.e., toward the nip portion of the roller 21 and driven roller 43. As shown in FIG. 28B, as soon as the leading edge of the sheet P1 moves away from the nip portions of the rollers 21 and 43, the solenoid 54A of the retracting means 50A is turned off to retract the driven roller 43 away from the switch roller 21. At the same time, the switch roller 21 is caused to rotate clockwise and awaits the second sheet P2. At this instant, despite that the driven roller 43 is spaced apart from the switch roller 21, the first sheet P1 is continuously transported on the path 33 along the guide plates 36 and 37 due to the force of the inlet roller pair 31. As shown in FIG. 28C, when the leading edge of the second sheet P2 abuts against the switch roller 21, it is steered in the rotating direction of the switch roller 21, i.e., toward the nip portion of the roller 21 and driven roller 44. As shown in FIG. 28D, when the leading edge of the sheet P2 moves away from the nip portion of the rollers 21 and 44, the solenoid 54B of the retracting means 50B is energized to retract the driven roller 44 away from the switch roller 21. At the same time, the switch roller 21 is reversed to rotate counterclockwise to prepare for the third sheet P3 which should be guided into the path 33. At this instant, despite that the driven roller 44 is spaced apart from the switch roller 21, the sheet P2 is continuously transported on the path 34 along the guide plates 36 and 38 due to the force of the inlet roller pair 31.

As stated above, after the leading edge of the sheet P has moved away from the driven roller 43 or 44 located on the path selected for the sheet P, the roller 43 or 44 of interest is retracted from the switch roller 21. Then, the switch roller 21 does not exert any transporting force and, therefore, does not obstruct the sheet transport despite that it is reversed. This allows the switch roller 21 to prepare for the next sheet rapidly. It follows that sheets can be surely steered by the switch roller 21 even when they are continuously fed at an extremely short interval which is almost zero.

Although not shown, the switching device using a switch belt as shown in, for example, FIGS. 9A-9D may also be provided with retracting means for selectively retracting the driven rollers away from the belt. Then, the driven roller located on the path selected for a sheet will be brought out of contact with the switch belt after the leading edge of the sheet has moved away from the driven roller.

Referring to FIGS. 29 and 30, another alternative embodiment of the present invention is shown which includes means for retracting the switch roller 21 and a linear third sheet transport path. As shown in FIG. 29, the switching device has retracting means 60 for retracting the switch roller 21 from an operative or steering position to an inoperative or retracted position shown in FIG. 30. When the switch roller 21 is brought to the inoperative position by the retracting means 60, the sheet P coming out of the inlet roller pair 31 is transported along a linear path 61. The retracting means 60 retracts the switch roller 21 to below the path 61. At such a retracted position, the switch roller 21 contacts the lower surface of the sheet P being driven by the roller pair 31 and rotates in a direction indicated by an arrow in FIG. 30 to exert an auxiliary transporting force on the sheet P.

The retracting means 60 includes a lever 63 rotatably supported by a pin 62 at substantially the center thereof. The switch roller 21 is mounted on one end of the lever 63 and reversibly rotated by a motor, not shown. A solenoid 64 has a plunger thereof connected to the other end of the lever 63. When the solenoid 64 is not energized, the lever 63 is biased by a spring 65 in a direction indicated by an arrow in FIG. 29. A stop, not shown, stops the lever 63 at the position shown in FIG. 29 where it can steer sheets. When the solenoid 64 is turned on, it rotates the lever 63 about the pin 62 in a direction opposite to the direction A against the action of the spring 65. On reaching the inoperative position shown in FIG. 30, the lever 63 is stopped by a stop, not shown. A sheet discharge tray 66 is openable to stack sheets sequentially coming out of the linear path 61. The retracting means 60 selectively turns on or turns off the solenoid 64 in association with the opening or closing of the tray 66, thereby bringing the switch roller 21 to the inoperative position or the operative position.

A switch 67 is mounted on the left side of the printer body 1, as viewed in FIG. 29. In response to an ON/OFF signal from the switch 67, a controller, not shown, turns on or turns off the solenoid 64. The switch 67 turns on or turns off when the tray 66 located at the outlet of the path 61 is opened or closed. Specifically, as shown in FIG. 29, when the tray 66 is closed, the switch 67 and, therefore, the solenoid 64 is turned off to maintain the

switch roller 21 in the operative or steering position. As shown in FIG. 30, when the tray 66 is opened, the switch 67 and, therefore, the solenoid 64 is turned off to move the switch roller 21 to the inoperative or retracted position. In this position, the switch roller 21 contacts the lower surface of the sheet P being transported by the inlet roller pair 31 along the linear path 61, exerting an auxiliary transporting force.

As stated above, the switch roller 21 is automatically moved to a particular position in association with the position of the tray 66, insuring accurate transport and discharge of sheets. Should the position of the switch roller 21 be switched over by an operation independent of the opening/closing of the tray 66, sheets might accidentally be steered to the linear path 61 having been closed by the tray 66. The three transport paths, including the linear path 61, available with the embodiment are useful in practice. Further, when retracted to below the path 61, the switch roller 21 contacts the lower surface of the sheet P being transported by the roller pair 31 along the path 61, thereby enhancing smooth sheet transport.

FIGS. 31 and 32 show another alternative embodiment of the present invention similar to the embodiment of FIGS. 29 and 30 except that the switch roller 21 is replaced with the switch belt 41. As shown in FIG. 31, the switch belt 41 is movable between an operative or steering position indicated by a phantom line and an inoperative or retracted position indicated by a solid line. To move the switch belt 41 between such two positions, use may be made of retracting means similar to the retracting means 60 shown in FIG. 29. This embodiment is also successful in steering sheets P into the linear path 61, as desired. As shown in FIG. 32, when the switch belt 41 is brought to the retracted position, it contacts the lower surface of the sheet P being transported by the inlet roller pair 31 and rotates in a direction indicated by an arrow, thereby promoting smooth sheet transport.

FIG. 33 shows another alternative embodiment of the present invention which includes a switch roller in the form of a brush roller 71. The switch roller 71 is provided with a configuration shown in FIG. 34 and is located at the junction of the paths 33 and 34, as shown in FIG. 33. As shown in FIG. 35, to steer the sheet P coming out of the fixing unit 19, FIG. 2, to the path 33, the switch roller 71 is rotated counterclockwise to beat the leading edge of the sheet P toward the path 33. As shown in FIG. 36, while the first sheet P1 is still in contact with the switch roller 71, the roller 71 is reversed to rotated clockwise. The reverse rotation of the switch roller 71 does not obstruct the transport of the sheet P1 since the sheet P1 has already been nipped and driven upward by the roller pair 23. As the leading edge of the second sheet P2 abuts against the switch roller 71, the switch roller 71 beats it toward the path 34. As shown in FIG. 37, when the leading edge of the third sheet P3 abuts against the switch roller 71, the switch roller 71 again rotating counterclockwise steers it to the path 33.

The brush-like switch roller 71 is capable of steering sheets smoothly without damaging them. If desired, as shown in FIG. 38, the switch roller 71 may be replaced with a switch roller 81 made of foam rubber or sponge of low hardness. The switch roller 81 exerts greater friction than the switch roller 71 and, therefore, enhances sharp switchover. Alternatively, as shown in FIG. 39, use may be made of a switch roller 91 having blades thereon. The blades of the switch roller 91 generate a stream of air with the result that the sheet coming out of the fixing unit is cooled off. This promotes the fixation of the toner image on the sheet and, therefore, prevents the roller pairs downstream of the switch roller 91 from rubbing the toner image.

FIG. 40 shows another alternative embodiment of the present invention capable of steering sheets to any one of three transport paths, as in the embodiment of FIG. 33. As shown, two (three or more, if desired) switch rollers 71A and 71B are provided for steering sheets P being driven by the inlet roller pair 31 to any one of the paths 33, 34 and 61, as needed. Although the switch rollers 71A and 71B are shown as comprising brush rollers, they may, of course, be implemented as any other type of rollers. To drive the sheet P into the linear path 61, the switch rollers 71A and 71B are rotated as indicated by arrows in FIG. 40. To steer the sheet P to the path 33, the switch rollers 71A and 71B are rotated as indicated by arrows in FIG. 41. To select the path 34, the switch rollers 71A and 71B are rotated as indicated by arrows in FIG. 42.

In the embodiments using switch rollers 21, 71, 81 and 91, it is preferable to rotate the switch roller only for a period of time sufficient to guide the leading edge of the sheet P being transported by the inlet roller pair 31 in a desired direction. In such a case, the switch roller will also be driven by a motor independent of the main motor.

FIG. 43 is representative of a specific procedure which causes the switch roller to stop rotating at the time of switchover of the rotation direction. As shown, as the sensor 12, FIG. 1, located at the inlet of the fixing unit 19 senses the leading edge and then the trailing edge of a sheet, the motor for driving the switch roller is reversed and rotated for a predetermined period of time T. Specifically, when the sensor 12 senses the leading edge of the first sheet P1 to output a signal (ON), the motor is rotated clockwise (CW) for the period of time T to rotate the switch roller in the corresponding direction and then stopped. As the sensor 12 senses the trailing edge of the sheet P1 to stop outputting the signal (OFF), the motor is rotated counterclockwise (CCW) for the period of time T to reverse the rotation of the switch roller. Hence, the rotation of the motor is stabilized before the leading edge of the second sheet P2 arrives at the switch roller, insuring accurate switchover of the path even when the interval between consecutive sheets is extremely short.

At the time when the motor having rotated clockwise (CW) for the period of time T and then brought to a

stop is caused to rotate counterclockwise (CCW), the first sheet P1 is conveyed with the leading edge thereof firmly retained by the roller pair 23 on the path 33, FIG. 1, (or the roller pair 35 on the path 34). Therefore, the motor simply idles when reversed as stated above, so that the sheet P1 is surely driven along the path selected. Moreover, since the motor is deenergized for a period of time Ts, FIG. 43, between consecutive rotations, noise and power consumption ascribable to the motor are reduced. While the motor is deenergized, the intermediate portion of the sheet passes the switch roller 21.

FIG. 44 is representative of another specific procedure using a motor capable of selectively rotating at a normal speed or a high speed. As shown, the switch roller (see roller 21, FIG. 1) is rotated at a peripheral speed Vf (high speed) higher than the linear velocity Vs (normal speed) of the sheet P being transported by the roller pair (see roller pair 31, FIG. 1) for a period of time necessary for the leading edge of the sheet P to be guided to a particular path. During the other periods, the switch roller is rotated at a peripheral speed equal to the linear velocity Vs of the sheet P. Specifically, assume that the switch roller is rotated counterclockwise (CCW) after clockwise rotation (CW). Then, as the sensor 12 senses the leading edge of the first sheet P1 to output a signal, the motor is rotated clockwise at the high speed (Vf) to in turn rotate the switch roller at a high speed. On the elapse of a predetermined period of time T, the motor and, therefore, the switch roller is rotated at the normal speed (Vs). When the sensor 21 senses the trailing edge of the sheet P1 to stop outputting the signal, the motor is driven counterclockwise (CCW) at the high speed (Vf) for the predetermined period of time T. In this manner, the sheet transport direction can be surely switched even if the switch roller is not brought to a stop.

Usually, a one-sided image form mode or simplex mode and a two-sided image form mode or duplex mode are available with a printer or similar image forming apparatus. Therefore, it is necessary to control the sheet transport path switching device in a particular manner in each of the simple and duplex modes. In the simplex mode, the switch roller should only be rotated in one direction. However, in an apparatus of the type turning over a sheet by use of a duplex unit, the switching device has to be operated by taking account of the number of sheets to be continuously fed to the duplex at the beginning of sheet feed in relation to the number of sheets to enter a transport path which terminates at the sheet inlet of the printer body. Assume that sheets carrying images on one side thereof (for duplex printing) and sheets newly fed from a tray (for simplex printing) are driven into an image forming section alternately. Then, the switching device will also selects particular paths alternately. It follows that in the event of duplex printing the switching device can be efficiently controlled only if the control over the front/rear printing of sheets is directly applied.

FIG. 45 shows another alternative embodiment of the present invention which includes a switch roller pair 84 for selecting one of three different transport paths. FIG. 46 shows this embodiment in a perspective view. As shown in FIG. 45, a sheet P advancing a path 80 in a direction K is steered to one of three paths 131, 132 and 133 by the switch roller pair 84, i.e., switch rollers 85 and 86. First drive means 90, FIG. 46, rotates each of the rollers 85 and 86 in a direction indicated by an arrow, so that the rollers 85 and 86 may nip and transport the sheet P. Second drive means 100, FIG. 46, rotates the entire switch roller pair 84 about a second drive axis 101 parallel to the roller axis L of the roller pair 84 in a forward direction or a reverse direction, as needed. The switch roller pair 84 nips and conveys the sheet P in a direction B shown in FIG. 45, guides the sheet P in a direction C with the periphery 84a thereof when bodily rotated in a direction E or forward direction, or guides the sheet P in a direction D with the periphery 84b thereof (identical with the periphery 84a) when bodily rotated in the other direction.

A transport roller pair 87 is located at a position where the paths 132-133 branches off the path 80. Transport rollers 88 and 89 are respectively located on the path 132 downstream of the switch roller pair 84 and on the path 133 downstream of the switch roller pair 84. As shown in FIG. 46, the rollers 85 and 86 of the switch roller pair 84 are respectively mounted on shafts 104 and 92 which are integrally and rotatably supported by opposite support plates 93 and 94 via bearings, not shown. A gear 95 is mounted on one end of the shaft 104 while a drive gear 97 is mounted on the drive shaft 96 and capable of meshing with the gear 95. As shown in FIG. 47, the drive shaft 96 is held by a support member, not shown, in such a manner as to be slidable in a direction indicated by an arrow F. Specifically, the drive shaft 96 is driven by, for example, a solenoid to move between a position where the drive gear 97 meshes with the gear 95 (FIG. 46) and a position where the former does not mesh with the latter (FIG. 47). The drive shaft 96 with the drive gear 97 is affixed to the output shaft of a drive motor 98, FIG. 46. When the drive motor 98 is energized, it causes the roller 85 to rotate in a direction G with the result that the roller 86 is driven by the roller 85 in a direction J.

The gear 95, drive gear 97 capable of meshing with the gear 95, drive shaft 96 and motor 98 constitute the first drive means 90. When the drive gear 97 meshes with the gear 95, the drive means 90 causes the rollers 85 and 86 of the switch roller pair 84 to nip the sheet P coming out of the path 80, FIG. 45, and transport it in the direction B.

As shown in FIG. 46, a second drive shaft 101 extends outward from the center of the support plate 93. Likewise, a drive shaft 102 extends out from the center of the other support plate 94 in alignment with the drive shaft 101. The drive shafts 101 and 102 are journalled to the framework of the device. A reversible drive motor 103 has the output shaft thereof connected to the drive

shaft 101. When the drive motor 103 rotates the entire switch roller pair 84 in the direction E, FIG. 45, via the drive shaft 101 and support plate 93, the roller pair 84 guides the sheet P in the second direction C with the periphery 84a thereof, i.e., the locus of the outermost portions of the rollers 85 and 86. When the motor 103 rotates the switch roller pair 84 in the other direction, the roller pair 84 guides the sheet P in the direction D with the periphery 84b thereof (identical with the periphery 84a).

As stated above, the drive motor 103, second drive shaft 101, shaft 102 and opposite support plates 93 and 94 constitute the second drive means 100. The second drive means 100 causes the switch roller pair 84 to bodily rotate for guiding the sheet P to either of the directions C and D, as needed. In the illustrative embodiment, the drive motor 103 is implemented by a stepping motor so as to locate the switch roller pair 84 at the home position of FIGS. 45 and 46 with ease.

A home position sensor implemented as a transmission type photosensor or similar sensor, not shown, senses the drive gear 97 brought to a home position thereof where it meshes with the gear 95. This allows the drive gear 97 to surely mesh with the gear 95 at an accurate position. Alternatively, to locate the drive gear 97 at the home position, a mechanical stop for restricting the sliding movement of the drive gear 97 may be used.

In operation, to steer the sheet P coming out of the path 80 to the path 131, the entire switch roller pair 84 is held in the position shown in FIG. 48. As shown in FIG. 46, the drive gear 97 is brought to the home position where it meshes with the gear 95. Then, the drive motor 98 is energized to rotate the rollers 85 and 86 in directions indicated by arrows in FIG. 48. As a result, the rollers 85 and 86 nip and transport the sheet P to the path 131.

As shown in FIG. 47, to steer the sheet P to the path 132, the drive gear 97 is moved away from the gear 95 to make the rollers 85 and 86 free. The drive motor 103 of the second drive means 100 is rotated in the forward direction to rotate the entire switch roller pair 84 in the direction E, FIG. 45. Consequently, the switch roller pair 84 guides the sheet P to the path 132 by beating it upward, as viewed in the figure, with the periphery 84a thereof.

Further, to transport the sheet P to the path 133, the drive gear 97 is also brought out of mesh with the gear 95. Then, the drive motor 103 is rotated in the reverse direction to rotate the entire switch roller pair 84 in the direction opposite to the direction E. This causes the switch roller pair 84 to beat the sheet P downward with the periphery 84b thereof, thereby guiding it to the path 133.

In the illustrative embodiment, the rollers constituting the switch roller pair 84 guide the sheet P to desired one of the paths 131-133 stably without damaging it. Regarding the gears 95 and 97, it is preferable that the drive gear 97 is brought to the position shown in FIG. 46 or 47 in interlocked relation to the start or stop of rotation of the drive gear 96.

FIG. 49 shows another alternative embodiment of the present invention which uses a sheet guide member 114 in place of the switch roller pair 84. As shown, the sheet guide member 114 is located in the vicinity of a position where the paths 131-133 branch off the path 80 and is made up of an upper and a lower guide plate 115 and 116. Drive means 110 causes the sheet guide member 114 to bodily rotate in either direction about the shaft 102 and a shaft 111, FIG. 50, which is substantially parallel to a sheet transport plane and perpendicular to the direction K. The shafts 102 and 111 are aligned with each other. When the sheet guide member 114 is held in a predetermined stop position shown in FIG. 49, it guides the sheet P in the direction B. When the sheet guide member 114 is bodily rotated in the direction E or forward direction, it guides the sheet P in the direction C with the periphery 114a thereof. When the sheet guide member 114 is bodily rotated in the direction opposite to the direction E, it guides the sheet P in the direction D with the periphery 114b thereof (identical with the periphery 114a).

In this embodiment, the peripheries 114a and 114b associated with the forward and reverse rotations, respectively, are defined by the locuses of the front edge 115a and rear edge 115b of the guide plate 115 and the front edge 116a and rear edge 116b of the guide plate 116 with respect to the sheet feed direction. The drive shaft 111 and shaft 102, FIG. 50, are positioned at the intermediate between the guide plates 115 and 116 in the vertical direction, so that such locuses substantially coincide with each other. The drive means 110 for reversibly rotating the entire sheet guide member 114 is constituted by retainer plates 117 and 118 supporting opposite ends of the guide plates 115 and 116 as well as by the shafts 111 and 102 and motor 103. The shaft 111 is affixed to the retainer plate 117 at the outside of the center of the plate 117 while the shaft 102 is affixed to the retainer plate 118 at the outside of the center of the plate 118.

In operation, to steer the sheet P coming out of the path 80 to the path 131, the entire sheet guide member 114 is held in the stop position shown in FIG. 49. As shown in FIG. 49, to steer the sheet P to the path 132, the drive motor 103 of the drive means 110 is rotated in the forward direction to rotate the entire sheet guide member 114 in the direction E, FIG. 49. Consequently, the sheet guide member 114 guides the sheet P to the path 132 by beating it upward, as viewed in the figure, with the periphery 114a thereof. Further, to transport the sheet P to the path 133, the drive gear 97 is also brought out of mesh with the gear 95. Then, the drive motor 103 is rotated in the reverse direction to rotate the entire sheet guide member 114 84 in the direction opposite to the direction E. This causes the sheet guide member to beat the sheet P downward with the periphery 114b thereof, thereby guiding it to the path 133.

To restore the sheet guide member 114 to the position of FIG. 49, a home position sensor or similar implementation may be used to determine the angular position of the member 114 and stop the drive motor 103 at the illustrated position. Alternatively, a mechanical stop mechanism may be used to forcibly stop the sheet guide member 114 at the illustrated position and then deenergize the motor 103.

As shown in FIG. 51, the sheet guide member may be constituted by a single guide plate 116 (or 115) located slightly below (or slightly above in the case of the guide plate 115) a line La on which the sheet P is transported. This single guide plate scheme is comparable with the above-stated double guide plate scheme in respect of advantages.

FIG. 52 shows another alternative embodiment of the present invention similar to the embodiment of FIGS. 49 and 50 except that the sheet guide member 114 is replaced with a sheet guide member 124 in the form of two parallel spaced rollers 125 and 126. As shown, the rollers 125 and 126 are rotatably mounted on shafts 127 and 128, respectively. The shafts 127 and 128 are affixed to support plates 121 and 122 at opposite ends thereof. The drive shaft 111 and the shaft 102 extend outward from the centers of the support plates 121 and 122, respectively. The drive shaft 111 is reversibly rotated by the motor 103 to rotate the entire sheet guide member 124 in the direction E or the other direction, as needed.

In this embodiment, when the sheet guide member 124 guides the sheet in the second direction C, FIG. 49, or the third direction P, FIG. 49, with the periphery 124a or 124b thereof, it is prevented from damaging the sheet more surely than in the embodiment of FIG. 49.

Referring to FIGS. 53A-53E, another alternative embodiment of the present invention is shown which is capable of selecting a particular path for sheets which are transported at high speed. Briefly, this embodiment performs patch switchover for the sheet P2 following the sheet P1 before the trailing edge Pb of the sheet P1 moves away from the switch roller pair 84. This will be described specifically on the assumption that after the sheet P1 has been steered to the path 131, FIG. 45, the next sheet P2 is steered to the path 132, FIG. 45.

As shown in FIG. 53A, the transport roller pair 87 moves the sheet P1 in the direction K. The rollers 85 and 86 of the switch roller pair 84 nip the sheet P1 and drive it to the path 131 (see FIG. 45). Before the trailing edge Pb of the sheet P1 moves away from the switch roller pair 84, the switch roller pair 84 is bodily rotated in the direction E, as shown in FIG. 53B. At this instant, the rollers 85 and 86 are free to rotate since the drive gear 97, FIG. 47, has already been brought out of mesh with the gear 95, FIG. 47. Hence, as shown in FIG. 53C, despite that the switch roller pair 84 is bodily rotated in the direction E or forward direction in the above condition, the rollers 85 and 86 freely rotate. As a result, the trailing edge Pb of the sheet P1 readily leaves the rollers 85 and 85 and smoothly reaches the path 131. As shown in FIG. 53D, as the leading edge Pa of the next sheet P2 reaches the switch roller pair 84, the roller pair 84 beats it upward, as viewed in the figures, with the periphery 84a thereof, FIG. 45, thereby guiding the sheet P2 in the direction C. Consequently, the sheet P2 is transported by the transport roller pair 88 located on the path 132, as shown in FIG. 53E.

As stated above, the embodiment switches over the path for the succeeding sheet P2 before the trailing edge of the preceding sheet P1 moves away from the switch roller pair 84. The embodiment can, therefore, surely guide sheets to desired paths even when the interval between the consecutive sheets is extremely short due to high speed transport. It has been customary to replace a transport path by changing the positions of, for example, pawls when the interval between consecutive sheets arrives at the branching point. With this conventional scheme, it is impossible to switch over the path when sheets are continuously fed at an extremely short internal for efficient image formation.

The particular timing for switching the sheet transport path described above with reference to FIGS. 53A-53E is also practicable with the embodiments shown in FIGS. 49, 51 and 52. In such a case, the path for the succeeding sheet will be selected before the leading edge of the preceding sheet moves away from the sheet guide member 114, 116 or 124.

In summary, it will be seen that the present invention provides a sheet transport path switching device having various unprecedented advantages, as enumerated below.

(1) When the leading edge of a sheet being driven by an inlet roller pair abuts against a switch roller, the switch roller guides it to a particular path on the basis of the direction of rotation thereof. This allows sheets to be surely steered to desired paths even if they are fed at an extremely short interval.

(2) The switch roller may be replaced with a switch belt. The switch belt enhances free layout matching various kinds of transport paths. Particularly, the switch belt will be advantageous when a long distance is desired between the inlet roller pair and a transport roller pair located downstream of the path switching position.

(3) The direction of rotation of the switch roller or that of the switch belt is changed before the trailing edge of a sheet is brought out of contact with the roller or the belt. Hence, the path is efficiently switched over when sheets are continuously fed at an extremely short interval close to zero..

(4) A first and a second driven roller are pressed against the switch roller or the switch belt to provide the roller or the belt with a transporting force. This eliminates the need for transport rollers otherwise located downstream of and in close proximity to the switch roller or the switch belt for nipping and driving a sheet. As a result, the number of required

parts is reduced, and the entire device is provided with a simple and compact arrangement.

(5) When a transport roller pair is located on each path downstream of the switch roller or the switch belt, a sheet is brought out of contact with the roller or the belt when such a transport roller pair nips and drives the sheet guided by the roller or the belt. Hence, the sheet contacts the roller or the belt only at a small portion adjoining the leading edge thereof. It follows that when an image is present on the surface of the sheet, the roller or the belt is prevented from rubbing it and degrading the image quality.

(6) The switch roller or the switch belt is driven at a peripheral speed equal to or higher than the transport speed of the inlet roller pair. This is successful in preventing a sheet from bending on abutting against the roller or the belt.

(7) Retracting means is provided for moving the first and second driven rollers away from the switch roller or the switch belt. After the trailing edge of a sheet has moved away from one of the driven rollers located on a path selected, the retracting means brings the driven roller out of contact with the roller or the belt. Then, even when the switch roller or the switch belt is reversed to steer the next sheet while the preceding sheet is passing the roller or the belt, the roller or the belt does not obstruct the sheet transport since the driven roller of interest has already been brought out of contact therewith. Therefore, the path can be surely switched even when the interval between consecutive sheets is extremely short.

(8) Retracting means for retracting the switch roller or the switch belt and a third transport path are provided. When the roller or the belt is retracted by the retracting means, a sheet being driven by the inlet roller pair can be linearly steered to the third transport path. This provides the device with a further advanced function.

(9) The retracting means retracts the switch roller of the switch belt to below the third transport path. At the retracted position, the roller or the belt is rotated in contact with a sheet and in a direction for exerting an auxiliary transporting force. Hence, the roller or the belt can function more effectively when it steers a sheet to the third transport path.

(10) The retracting means is so constructed as to move the switch roller or the switch belt to the retracted position or a steering position in association with the opening or closing of a tray at which the third transport path terminates. When the tray is opened, the roller or the belt is automatically brought to the retracted position, insuring accurate path switchover.

(11) The switch roller is implemented as a brush roller for effecting rapid and smooth path switchover. Alternatively, the switch roller may be made of foam rubber or sponge of low hardness to increase the surface friction and, therefore, to promote sure path switchover. Further, the switch roller may be provided with blades on the periphery thereof. The blades will generate a stream of air for cooling off a toner fixed on a sheet, thereby further promoting fixation. Therefore, the toner is prevented from being rubbed on the path downstream of the switch roller.

(12) A plurality of switch rollers or a plurality of switch belts are provided to steer a sheet to any one of three or more different directions. Then, sheets can be selectively steered to paths which are greater in number than the rollers or the belts by one.

(13) The switch roller is rotated only for a predetermined period of tine necessary for the leading edge of a sheet being driven by the inlet roller pair to be guided in a desired direction. This allows the switch roller and, therefore, a motor or similar drive source to be stopped between consecutive rotations, reducing noise and power consumption.

(14) The switch roller is rotated at a peripheral speed higher than the linear velocity of a sheet only for a period of time necessary for the leading edge of the sheet to be guided in a desired direction. During the other periods, the switch roller is driven at a peripheral speed equal to the linear velocity of the sheet. This is also successful in surely steering the sheet to a desired path.

(15) A switch roller pair is located in the vicinity of the junction of transport paths. First drive means rotates the rollers of the roller pair in a direction for causing them to nip and drive a sheet. Second drive means reversibly rotates the entire roller pair about a shaft parallel to the roller axis of the roller pair. The roller pair nips and transports a sheet when held in a predetermined position. When bodily rotated in the forward or reverse direction, the roller pair guides a sheet with the periphery thereof. Hence, the device is capable of surely guiding a sheet in one of three different paths in a short period of time.

(16) The device does not exert a load on a sheet or damage it, compared to the conventional pawl scheme. In addition, the device does not need an expensive and bulky suction unit particular to a suction type switching device. The device is, therefore, low cost, miniature and free from noise.

(17) When a sheet guide member is substituted for the switch roller pair and reversibly rotated by drive means, it steers a sheet in one of three different directions in a short period of time. This surely guides the sheet despite the simple arrangement.

(18) The sheet guide member is implemented as a pair of parallel spaced rollers. The rollers allow a sheet to pass therethrough or guide it in the second or third direction with the periphery thereof when bodily rotated in the forward or reverse direction. This can be done without damaging the sheet.

(19) The path switching operation for the next sheet is effected before the trailing edge of the preceding sheet moves away from the switch roller pair or the sheet guide member. This allows a particular path to be selected without waiting until the preceding sheet moves away from the switch roller pair of the sheet guide member. Hence, a particular path for the next sheet can be rapidly selected even when the interval between the consecutive sheets is extremely short.

Claims

1. A sheet transport path switching device for an image forming apparatus (1), comprising:

   an inlet roller pair (31) for transporting a sheet (P); and
   either of a reversibly rotatable switch roller (21) and a reversibly rotatable switch belt (41) located on a line extending through a nip portion of said inlet roller pair (31) in an intended direction of sheet transport;

   wherein a direction of rotation of said switch roller (21) or switch belt (41) is changed to change a direction in which the sheet (P) transported by said inlet roller pair (31) advances;

   characterised in that the device comprises switch section retracting means (60) for retracting said switch roller (21) or said switch belt (41) from a steering position where said switch roller (21) or said sheet belt (41) is capable of changing the direction of transport; and

   a transport path (61) along which the sheet (P) being driven by said inlet roller pair (31) is linearly transported when said switch section retracting means (60) retracts said switch roller (21) or said switch belt (41) to a retracted position.

2. A device as claimed in Claim 1, wherein said switch section retracting means (60) retracts said switch roller (21) or said switch belt (41) to below said transport path, said switch roller (21) or said switch belt (41) in said retracted position being rotated in a direction for exerting an auxiliary transporting force on the sheet (P) being driven by said inlet roller pair (31) in contact with said sheet.

3. A device as claimed in Claim 1 or 2, wherein said switch section retracting means moves (60) said switch roller (21) or said switch belt (41) to either of said retracted position and said steering position in association with opening or closing of a tray for stacking sheets sequentially coming out of said transport path.

4. A sheet transport path switching device for selectively steering a sheet (P) being transported along a transport path to any one of a plurality of transport paths, said device comprising:

   sheet guide means (71A,71B; 115,116) located in the vicinity of a position where said plurality of transport paths branch off said transport path; and
   drive means for bodily rotating said sheet guide means (71A,71B; 115,116) in a forward and a reverse direction about a shaft substantially parallel to a sheet transport plane and perpendicular to an intended direction of sheet transport;
   the sheet (P) being steered in any one of a first direction in which said sheet guide means is bodily rotated in the forward direction for guiding said sheet with a forward rotation periphery thereof, and a second direction in which said sheet guide means is bodily rotated in the reverse direction to guide said sheet with a reverse rotation periphery thereof; characterised in that the device is also arranged to steer the sheet in a third direction.

5. A device as claimed in Claim 4, wherein said sheet guide means comprises a pair of parallel spaced plates (115,116).

6. A device according to Claim 4, wherein the said sheet guide means comprises a pair of switch rollers (71A,71B); the drive means comprises first drive means for rotating rollers of said switch roller pair in a direction for transporting a sheet being transported along said transport path while nipping said sheet and second drive means for bodily rotating said switch roller pair in a forward and a reverse direction about a shaft parallel to a roller axis of said switch roller pair; the sheet being steered in the third direction when the switch roller pair (71A,71B) nips and transports the sheet.

7. A device as claimed in Claim 4, 5 or 6, wherein before the trailing edge of the sheet moves away from the said sheet guide means, an operation for selecting one of said first, second and third directions is performed for the next sheet.

Patentansprüche

1. Umschaltvorrichtung für den Blatttransportweg in einem Bilderzeugungsgerät (1), die aufweist:

   ein Eintrittswalzenpaar (31) für das Transportieren eines Blattes (P); und
   entweder eine umschaltbar drehbare Schaltwalze (21) oder ein umschaltbar drehbares Schaltförderband (41), die sich auf einer Linie befinden, die sich durch einen Klemmabschnitt

des Eintrittswalzenpaares (31) in der beabsichtigten Richtung des Blatttransportes erstreckt;

worin die Drehungsrichtung der Schaltwalze (21) oder des Schaltförderbandes (41) verändert wird, um die Richtung zu ändern, in der das Blatt (P), das durch das Eintrittswalzenpaar (31) transportiert wird, befördert wird;

dadurch gekennzeichnet, daß die Vorrichtung aufweist: eine Rückstelleinrichtung (60) für den Schaltabschnitt, um die Schaltwalze (21) oder das Schaltförderband (41) aus der Steuerposition zurückzuziehen, wo die Schaltwalze (21) oder das Schaltförderband (41) in der Lage ist, die Richtung des Transportes zu verändern; und

einen Transportweg (61), auf dem das Blatt (P), das durch das Eintrittswalzenpaar (31) angetrieben wird, linear transportiert wird, wenn die Rückstelleinrichtung (60) für den Schaltabschnitt die Schaltwalze (21) oder das Schaltförderband (41) in die zurückgezogene Position zurückzieht.

2. Vorrichtung nach Anspruch 1, bei der die Rückstelleinrichtung (60) für den Schaltabschnitt die Schaltwalze (21) oder das Schaltförderband (41) bis unterhalb des Transportweges zurückzieht, wobei die Schaltwalze (21) oder das Schaltförderband (41) in der zurückgezogenen Position in einer Richtung für das Ausüben einer Hilfstransportkraft auf das Blatt (P) gedreht wird, das durch das Eintrittswalzenpaar (31) in Berührung mit dem Blatt angetrieben wird.

3. Vorrichtung nach Anspruch 1 oder 2, bei dem die Rückstelleinrichtung (60) für den Schaltabschnitt die Schaltwalze (21) oder das Schaltförderband (41) in die zurückgezogene Position oder in die Steuerposition in Verbindung mit einem Öffnen oder Schließen eines Behälters für das Stapeln der Blätter, die aufeinanderfolgend aus dem Transportweg herauskommen, bewegt.

4. Umschaltvorrichtung für den Blatttransportweg für das selektive Steuern eines Blattes (P), das längs eines Transportweges transportiert wird, zu irgendeinem von einer Vielzahl von Transportwegen, wobei die Vorrichtung aufweist:

eine Blattführungseinrichtung (71A, 71B; 115, 116), die in der Nähe einer Position angeordnet ist, wo die Vielzahl der Transportwege vom Transportweg abzweigt; und
eine Antriebseinrichtung für das Drehen der Blattführungseinrichtung (71A, 71B; 115, 116) als Ganze in der Vorwärts- und Rückwärtsrichtung um eine Welle im wesentlichen parallel zur Ebene des Blatttransportes und senkrecht zur beabsichtigten Richtung des Blatttransportes;

wobei das Blatt (P) in einer ersten Richtung gesteuert wird, in der die Blattführungseinrichtung als Ganze in der Vorwärtsrichtung für das Führen des Blattes mittels deren Umfang bei der Vorwärtsdrehung, und in einer zweiten Richtung, in der die Blattführungseinrichtung als Ganze in der Rückwärtsrichtung gedreht wird, um das Blatt mittels deren Umfang bei der Rückwärtsdrehung zu führen;

dadurch gekennzeichnet, daß die Vorrichtung ebenfalls so angeordnet ist, daß das Blatt in einer dritten Richtung gesteuert wird.

5. Vorrichtung nach Anspruch 4, bei der die Blattführungseinrichtung ein Paar parallele, einen Abstand aufweisende Platten (115, 116) aufweist.

6. Vorrichtung nach Anspruch 4, bei der die Blattführungseinrichtung ein Paar Schaltwalzen (71A, 71B) aufweist; und bei der die Antriebseinrichtung aufweist: eine erste Antriebseinrichtung für das Drehen der Walzen des Schaltwalzenpaares in einer Richtung für den Transport eines Blattes, das längs des Transportweges transportiert wird, während das Blatt festgeklemmt wird, und eine zweite Antriebseinrichtung für das Drehen des Schaltwalzenpaares als Ganzes in der Vorwärts- und in der Rückwärtsrichtung um eine Welle parallel zur Walzenachse des Schaltwalzenpaares; wobei das Blatt in der dritten Richtung gesteuert wird, wenn das Schaltwalzenpaar (71A, 71B) das Blatt festklemmt und transportiert.

7. Vorrichtung nach Anspruch 4, 5 oder 6, bei der vor dem Wegbewegen der hinteren Kante des Blattes von der Blattführungseinrichtung ein Arbeitsgang für das Auswählen einer Richtung von der ersten, zweiten und dritten Richtung für das nächste Blatt durchgeführt wird.

Revendications

1. Dispositif de commutation du passage de transport d'une feuille pour un appareil de formation d'image (1), comprenant:

une paire de rouleaux d'entrée (31) pour transporter une feuille (P); et
ou bien un rouleau de commutation à rotation réversible (21) ou bien une courroie de commutation à rotation réversible (41) agencés sur une ligne s'étendant à travers une partie de serrage de ladite paire de rouleaux d'entrée (31) dans une direction voulue du transport de la feuille;

une direction de rotation dudit rouleau de commutation (21) ou de ladite courroie de commutation (41) étant changée pour changer une direc-

tion de transport vers l'avant de la feuille (P) par ladite paire de rouleaux d'entrée (31);

caractérisé en ce que le dispositif comprend un moyen de rétraction de la section de commutation (60), pour rétracter ledit rouleau de commutation (21) ou ladite courroie de commutation (41) d'une position de direction dans laquelle ledit rouleau de commutation (21) ou ladite courroie de commutation (41) sont capables de changer la direction du transport; et

un passage de transport (61) le long duquel la feuille (P), entraînée par ladite paire de rouleaux d'entrée (31), est transportée linéairement lorsque ledit moyen de rétraction de la section de commutation (60) rétracte ledit rouleau de commutation (21) ou ladite courroie de commutation (41) vers une position rétractée.

2. Dispositif selon la revendication 1, dans lequel ledit moyen de rétraction de la section de commutation (60) rétracte ledit rouleau de commutation (21) ou ladite courroie de commutation (41) jusqu'au-dessous dudit passage de transport, ledit rouleau de commutation (21) ou ladite courroie de commutation (41) étant tournés dans ladite position rétractée dans une direction destinée à exercer une force de transport auxiliaire sur la feuille (P) entraînée par ladite paire de rouleaux d'entrée (31), contactant ladite feuille.

3. Dispositif selon les revendications 1 ou 2, dans lequel ledit moyen de rétraction de la section de commutation (60) déplace ledit rouleau de commutation (21) ou ladite courroie de commutation (41) vers l'une quelconque de ladite position rétractée et de ladite position de direction en association avec l'ouverture ou la fermeture d'un bac destiné à l'empilage des feuilles sortant séquentiellement dudit passage de transport.

4. Dispositif de commutation du passage de transport d'une feuille pour la direction sélective d'une feuille (P) transportée le long d'un passage de transport vers l'un quelconque de plusieurs passages de transport, ledit dispositif comprenant:

un moyen de guidage de la feuille (71A, 71B; 115, 116) agencé au voisinage d'une position où lesdits plusieurs passages de transport dévient dudit passage de transport; et
un moyen d'entraînement pour faire tourner complètement ledit moyen de guidage de la feuille (71A, 71B; 115, 116) dans une direction vers l'avant et vers l'arrière autour d'une arbre pratiquement parallèle à un plan de transport de la feuille et perpendiculaire à une direction voulue du transport de la feuille;
la feuille (P) étant dirigée dans l'une quelconque d'une première direction dans laquelle ledit moyen de guidage de la feuille est complètement tourné dans la direction vers l'avant, pour guider ladite feuille avec une périphérie de rotation avant correspondante, et une deuxième direction dans laquelle ledit moyen de guidage de la feuille est complètement tourné dans la direction opposée, pour guider ladite feuille avec une périphérie de rotation inversée correspondante, caractérisé en ce que le dispositif sert aussi à diriger la feuille dans une troisième direction.

5. Dispositif selon la revendication 4, dans lequel ledit moyen de guidage de la feuille comprend une paire de plaques parallèles espacées (115, 116).

6. Dispositif selon la revendication 4, dans lequel ledit moyen de guidage de la feuille comprend une paire de rouleaux de commutation (71A, 71B); le moyen d'entraînement comprenant un premier moyen d'entraînement pour faire tourner les rouleaux de ladite paire de rouleaux de commutation dans une direction pour transporter une feuille transportée le long dudit passage de transport tout en serrant ladite feuille, et un deuxième moyen d'entraînement pour faire tourner complètement ladite paire de rouleaux de commutation dans une direction vers l'avant et une direction vers l'arrière autour d'un arbre parallèle à un axe des rouleaux de ladite paire de rouleaux de commutation; la feuille étant dirigée dans la troisième direction lorsque la paire de rouleaux de commutation (71A, 71B) serre et transporte la feuille.

7. Dispositif selon les revendications 4, 5 ou 6, dans lequel une opération de sélection de l'une desdites première deuxième et troisième directions est effectuée pour la feuille suivante avant que le bord arrière de la feuille s'écarte dudit moyen de guidage de la feuille.

Fig. 1

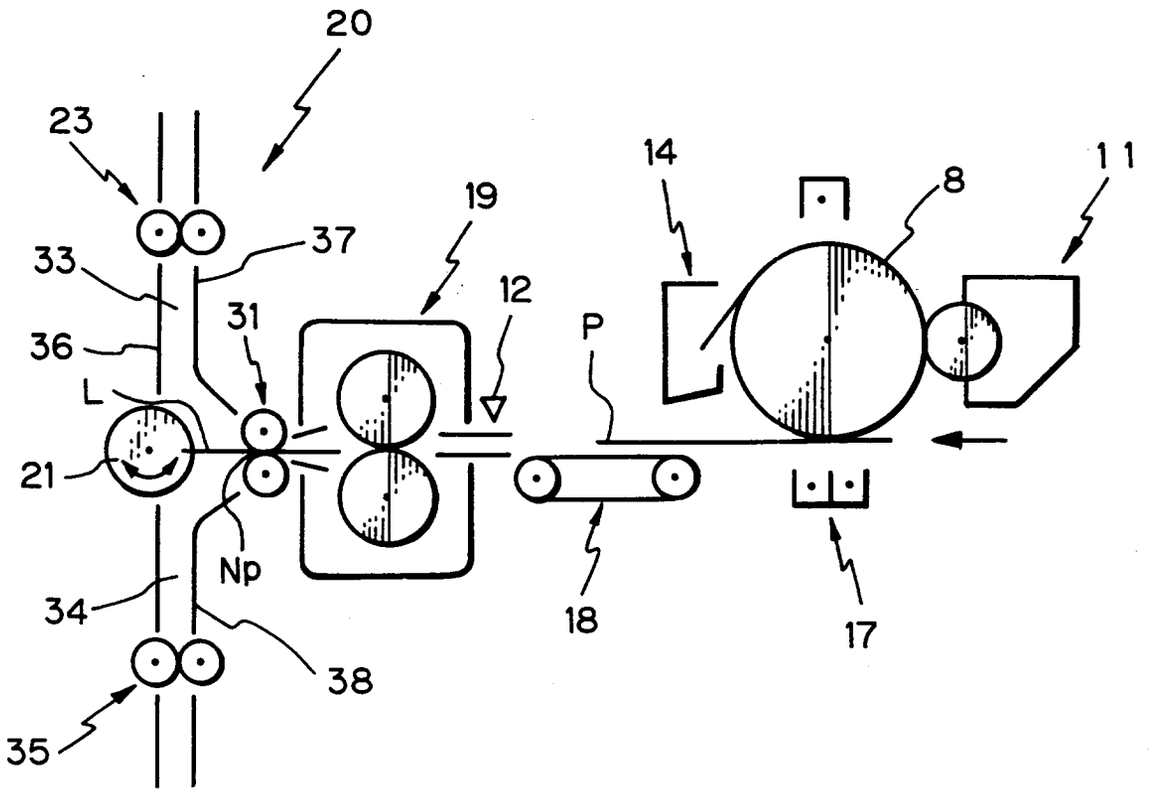

Fig. 2

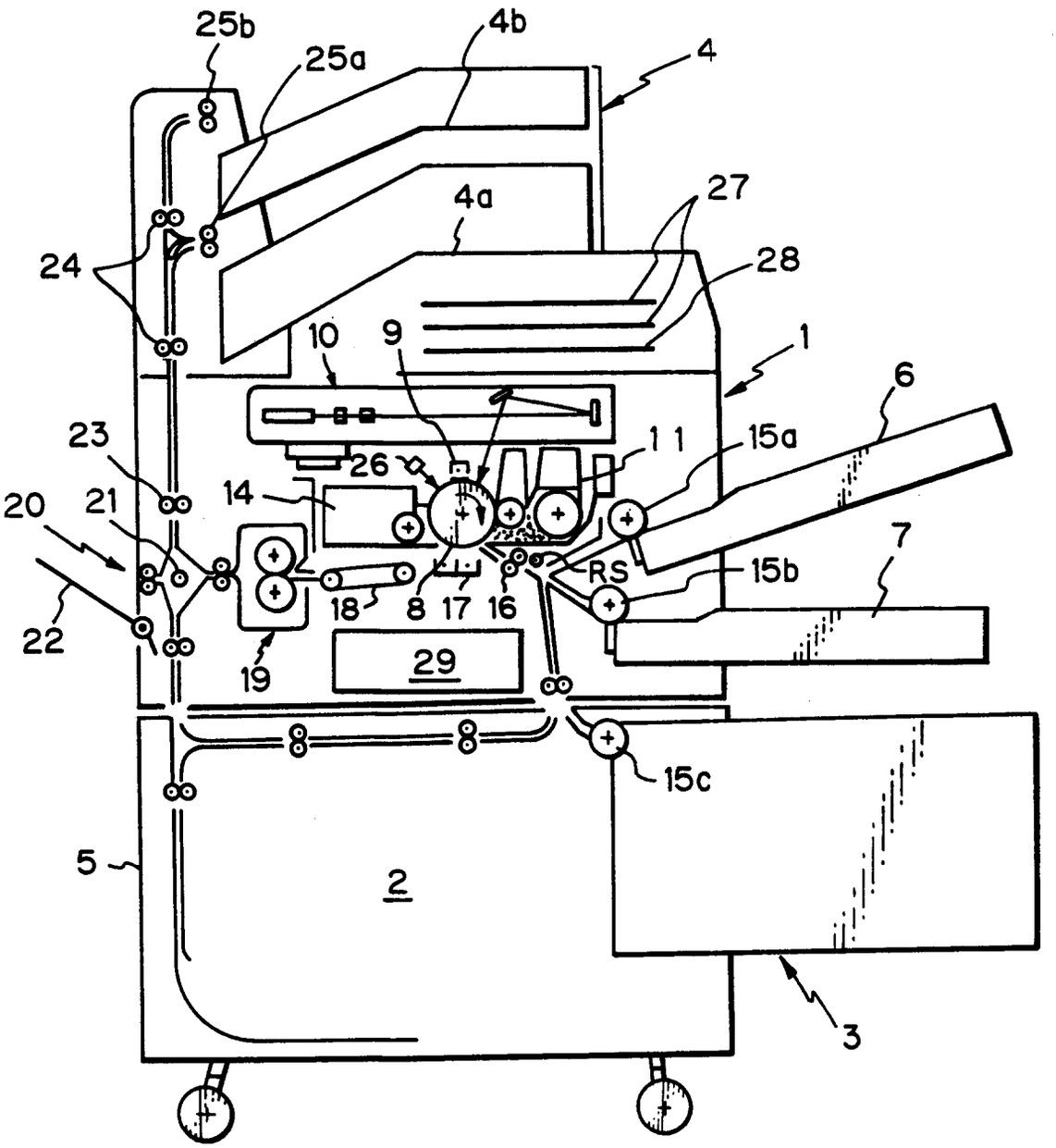
25b
25a
4b
4
4a
27
28
24
10
9
1
6
23
26
11
15a
20
21
14
7
RS
15b
18
8
17
16
22
19
29
15c
5
2
3

Fig. 3A

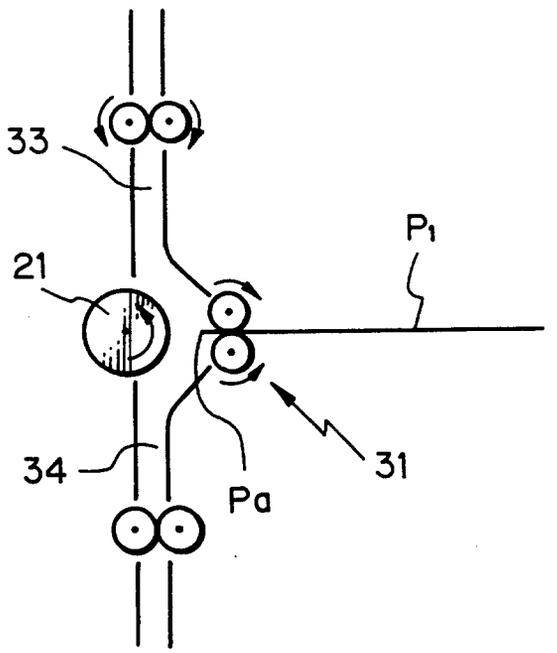

Fig. 3B

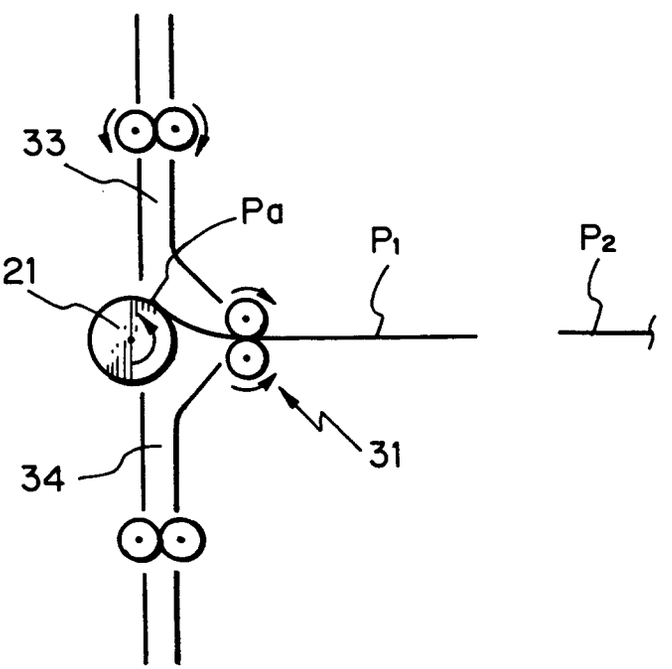

Fig. 3C

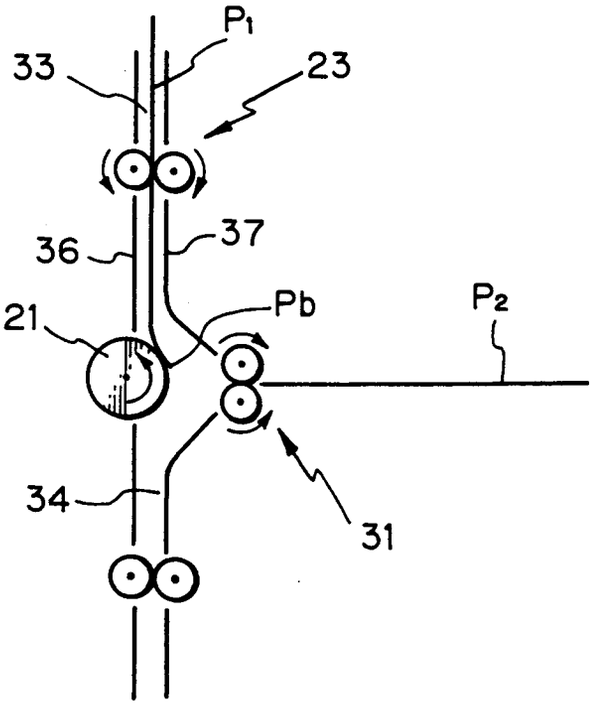

Fig. 3D

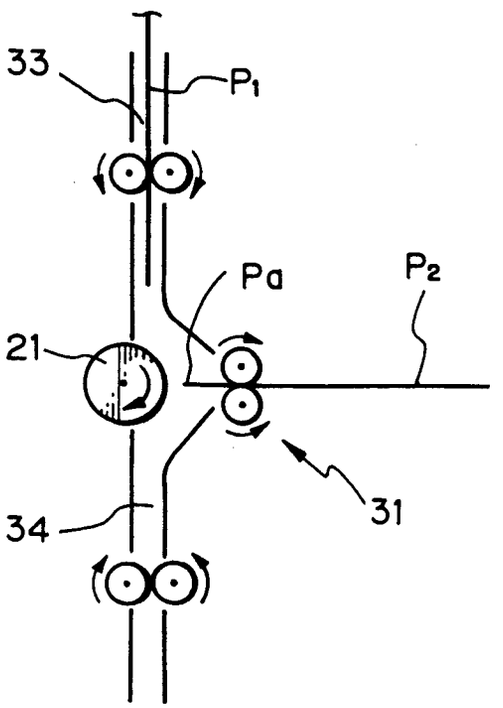

Fig. 4A

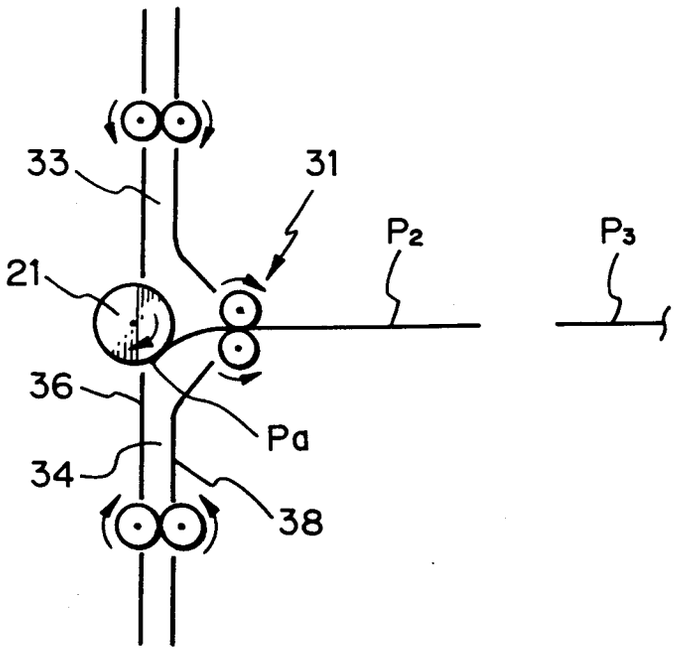

Fig. 4B

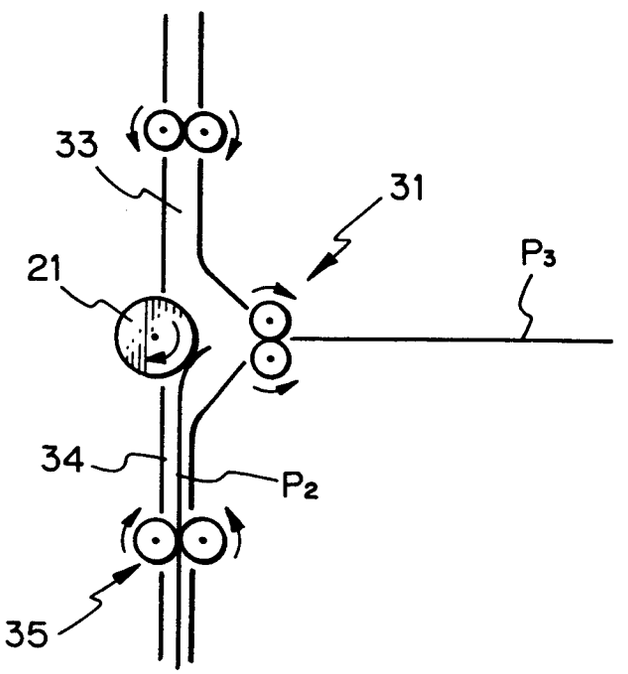

Fig. 4C

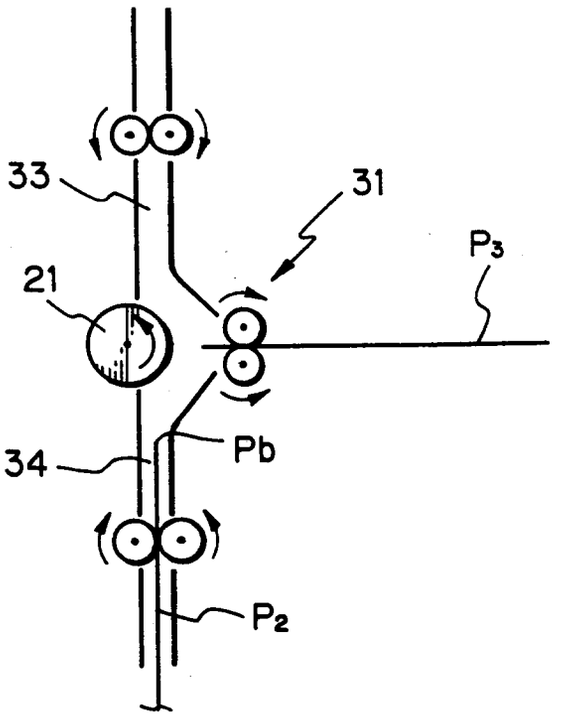

Fig. 4D

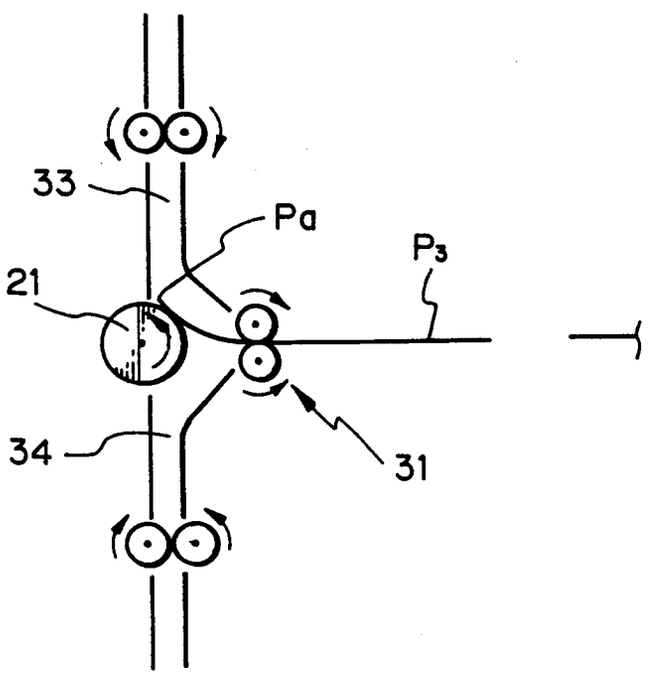

Fig. 5

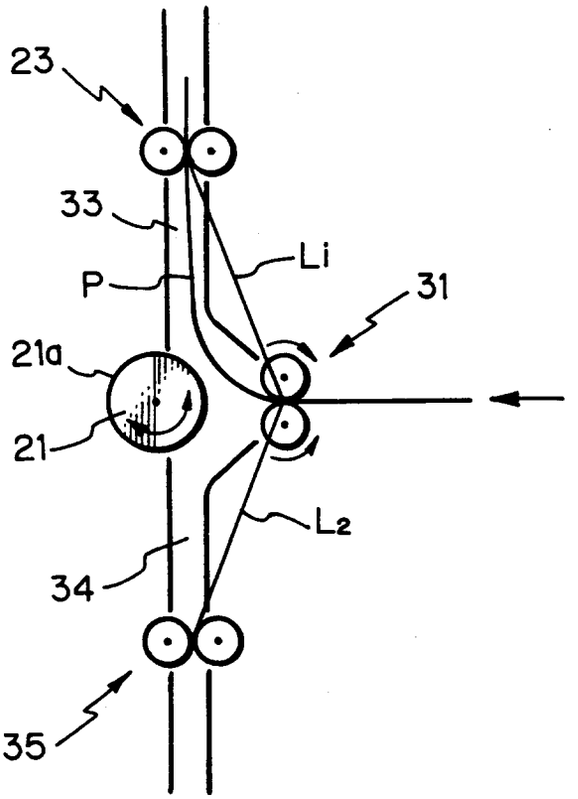

Fig. 6

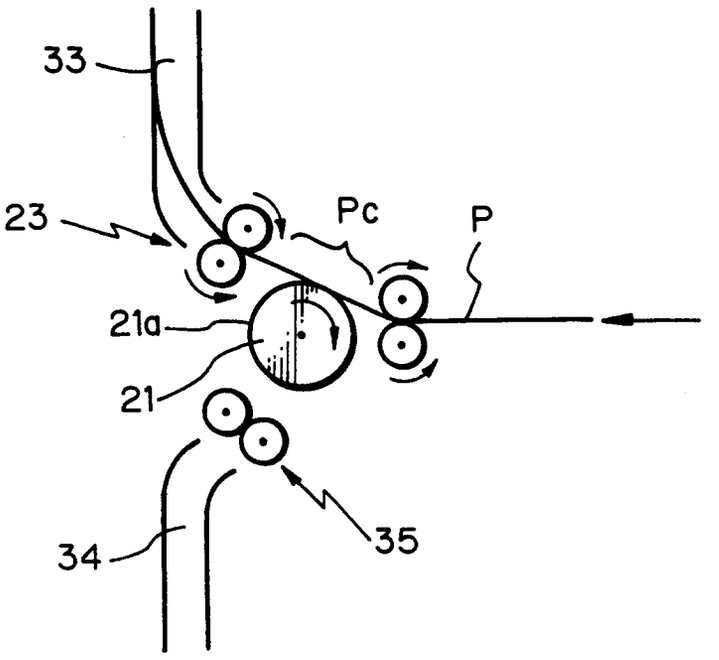

Fig. 7A

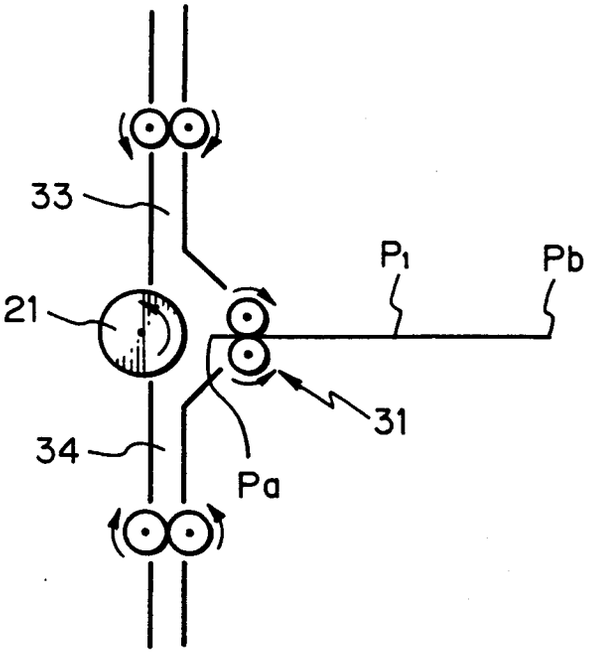

Fig. 7B

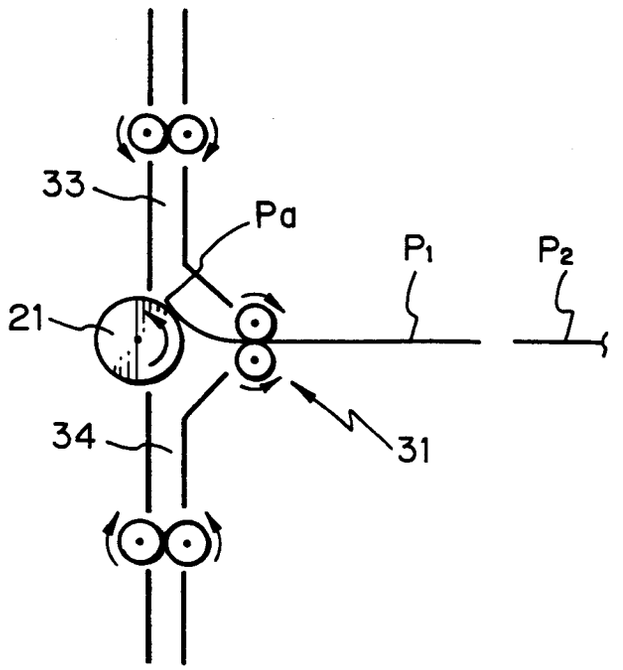

Fig. 7C

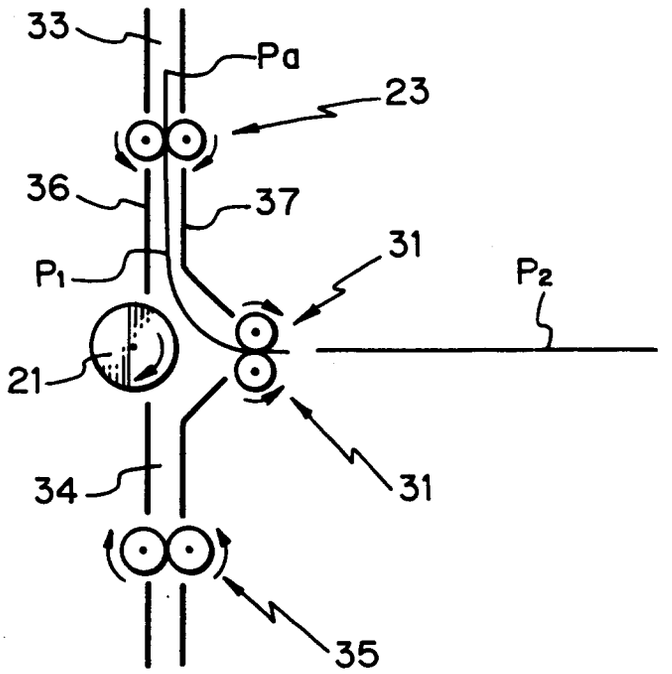

Fig. 7D

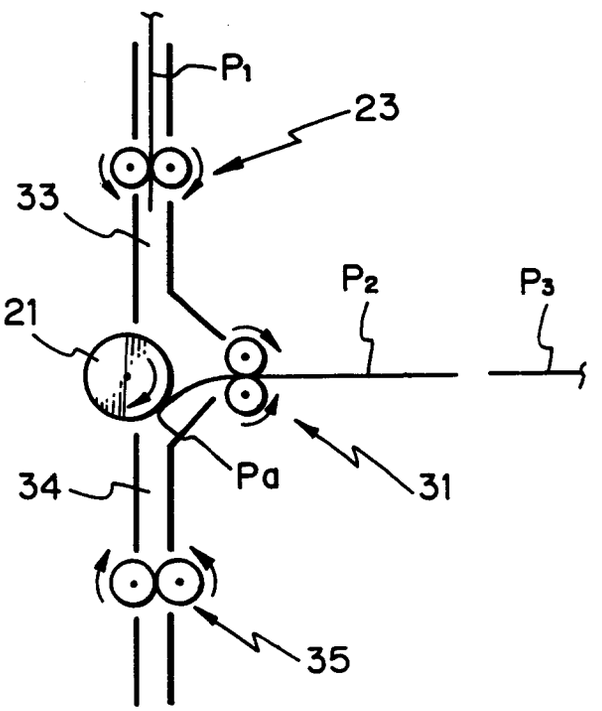

Fig. 8A

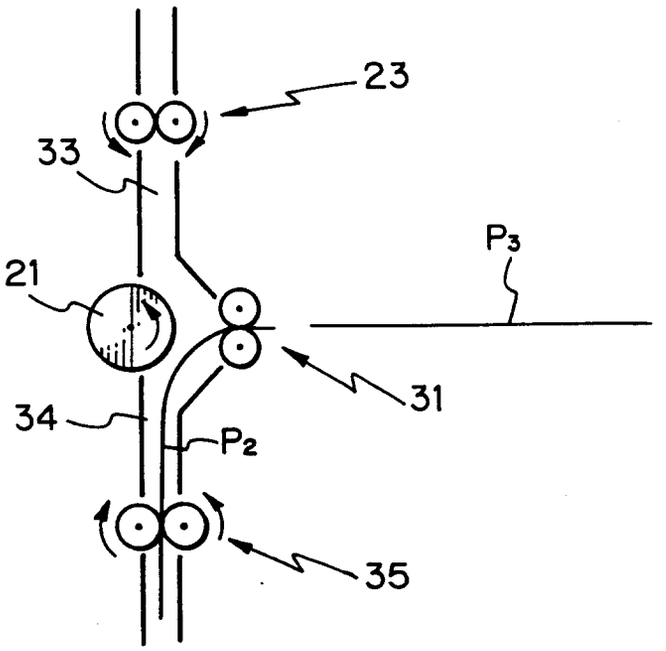

Fig. 8B

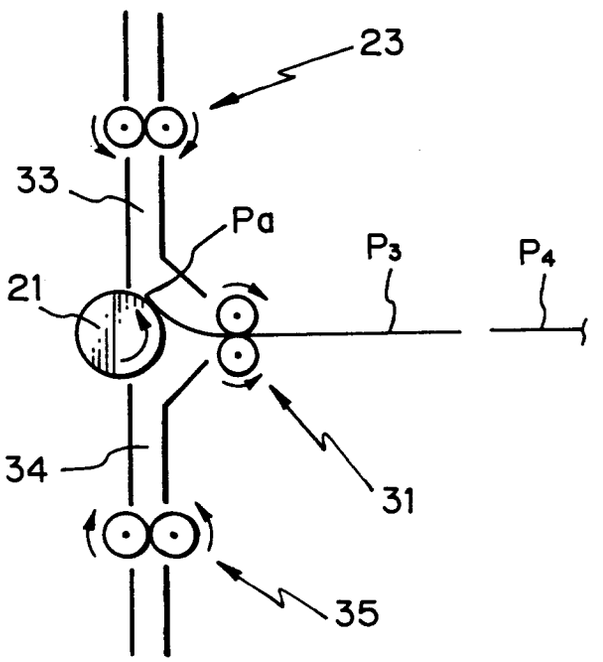

Fig. 9A

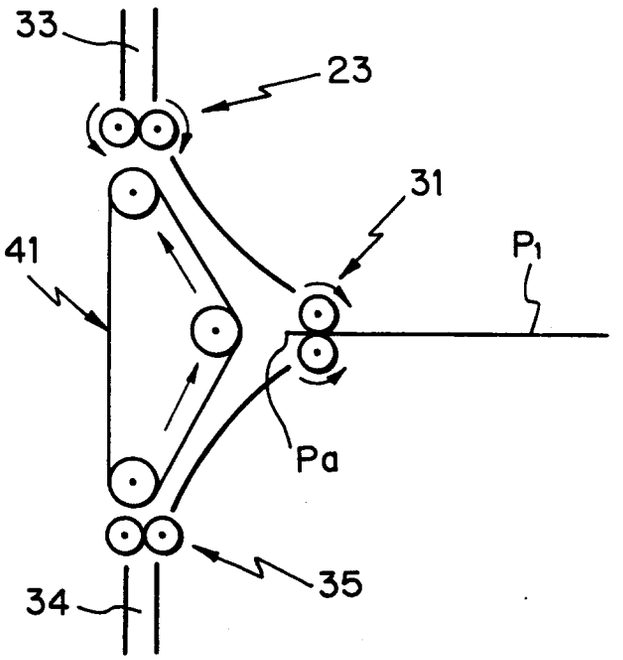

Fig. 9B

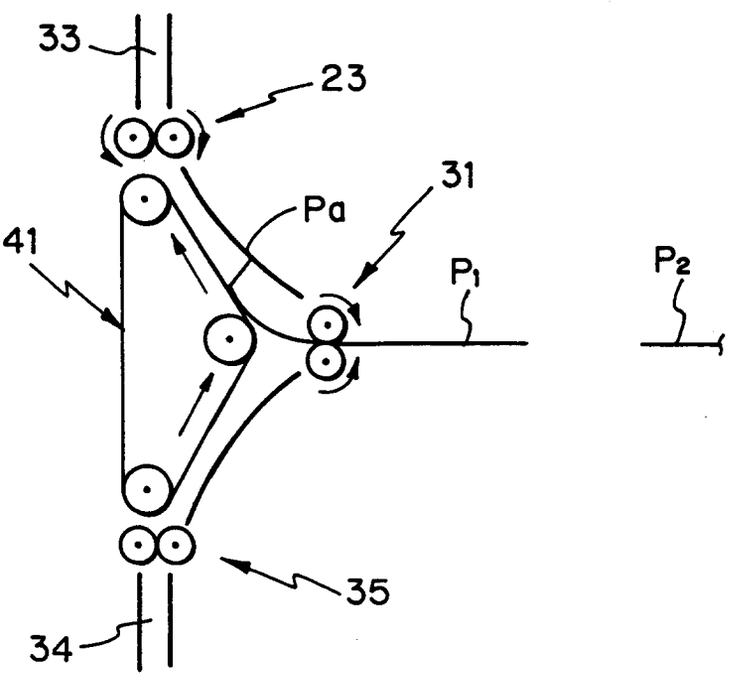

Fig. 9C

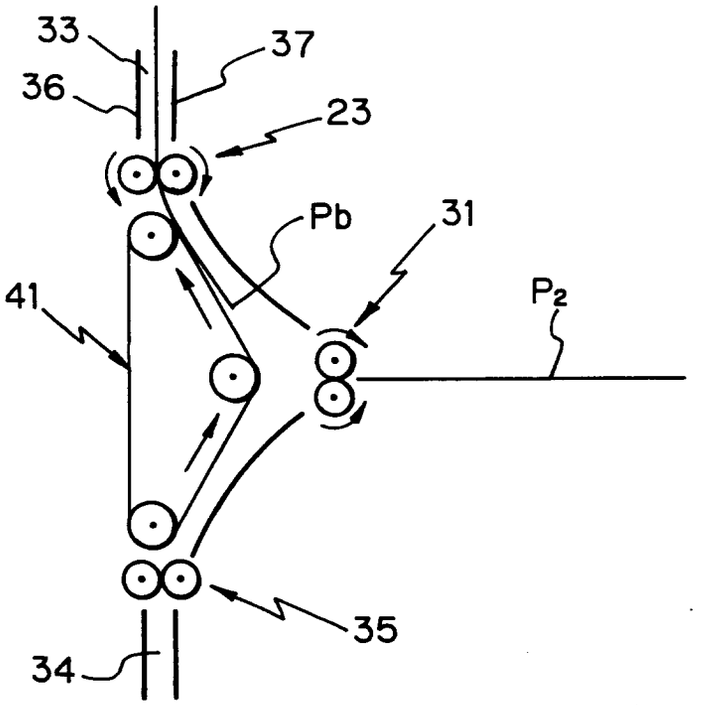

Fig. 9D

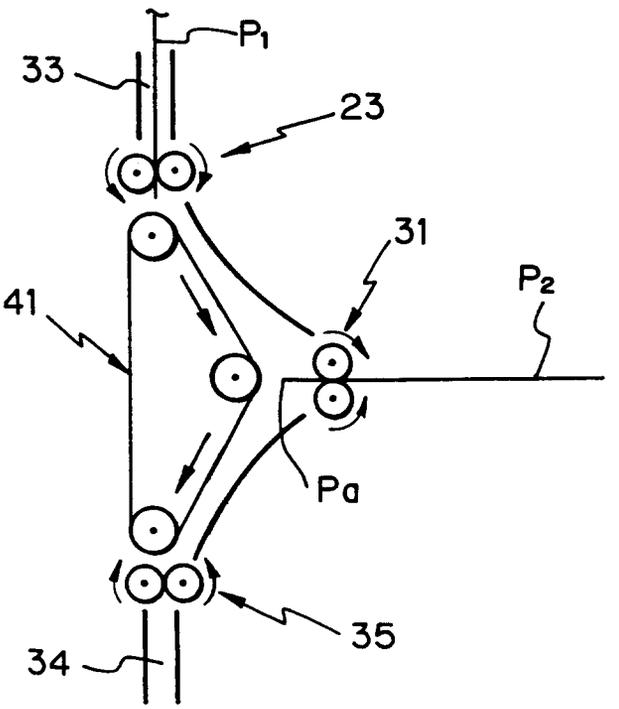

Fig. 10A

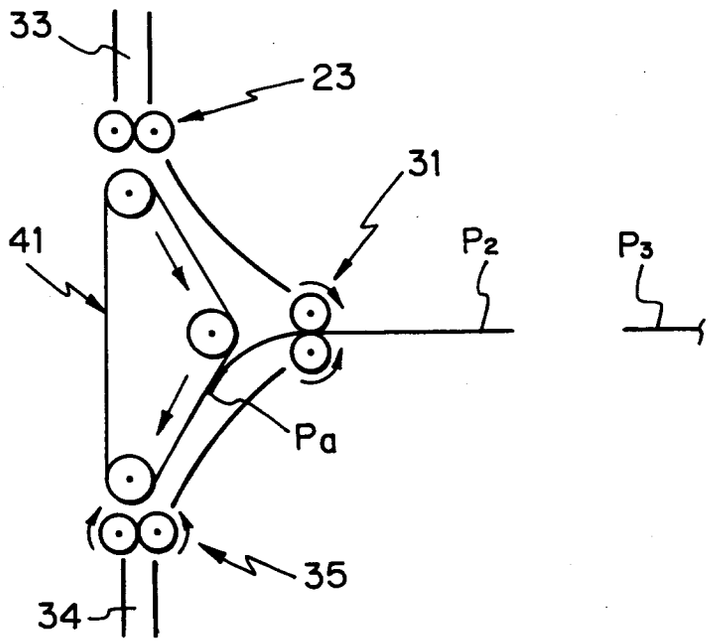

Fig. 10B

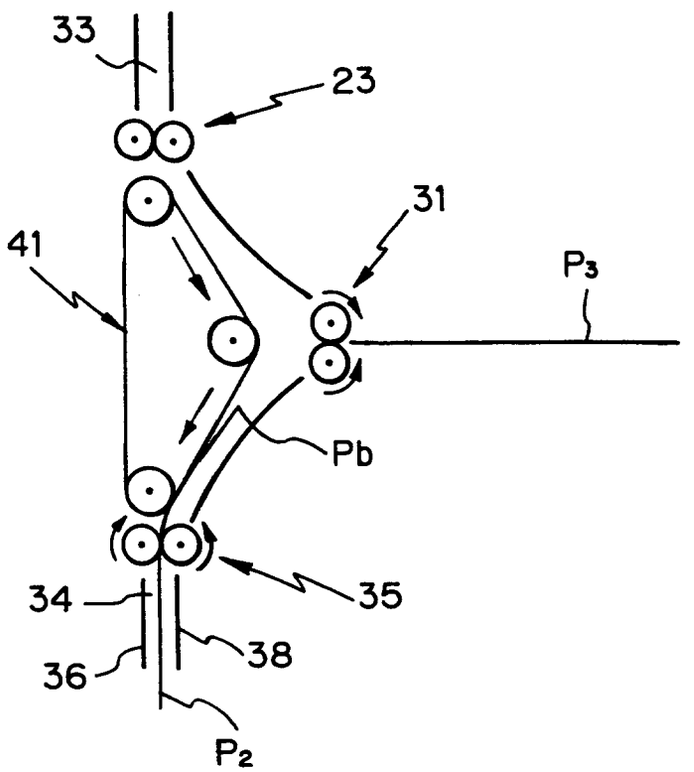

Fig. 10C

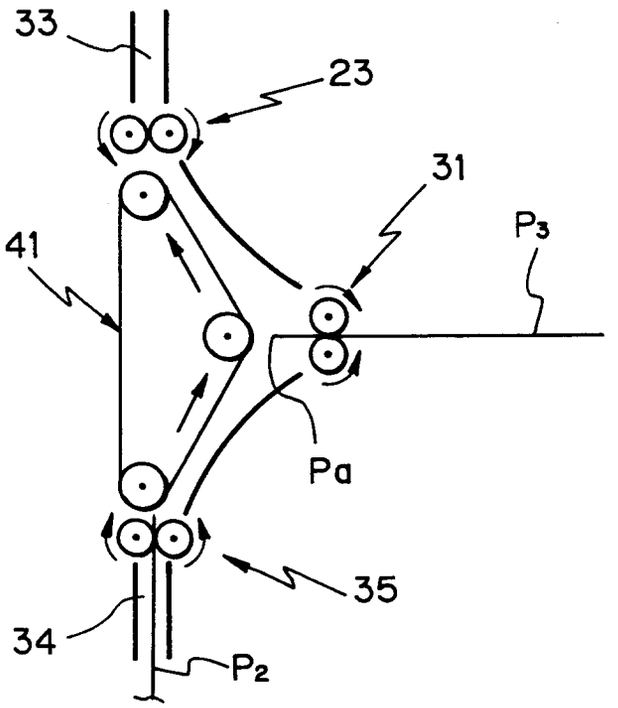

Fig. 10D

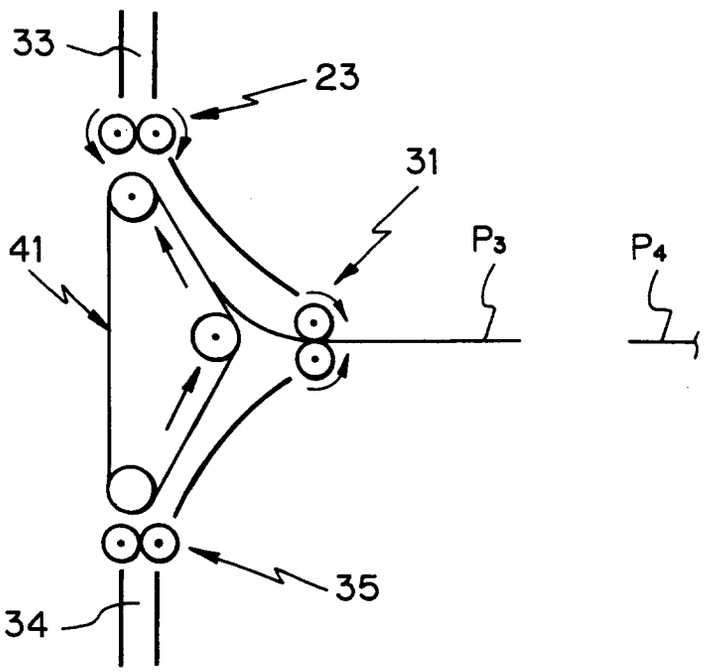

Fig. 11

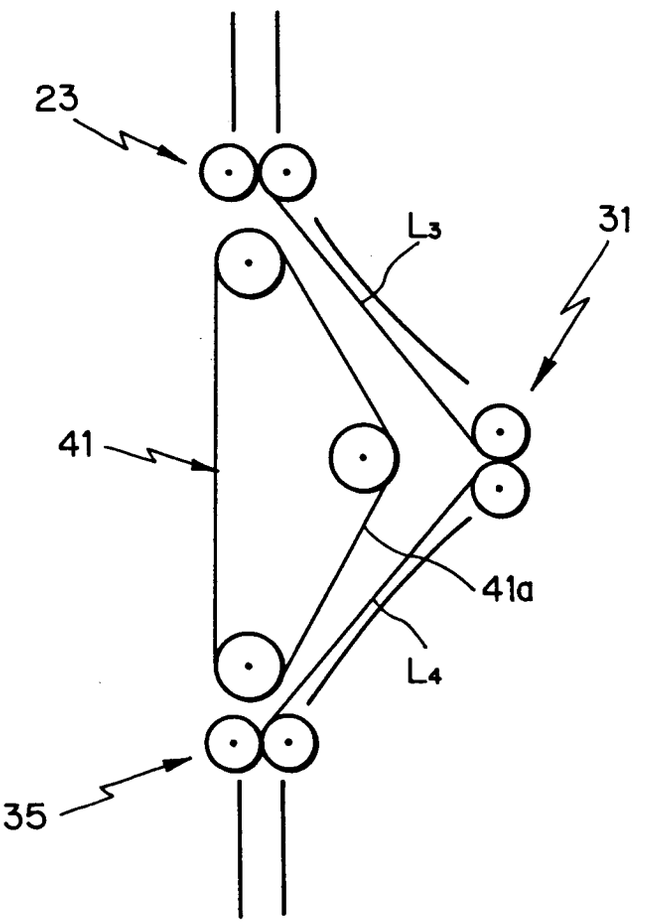

Fig. 12A

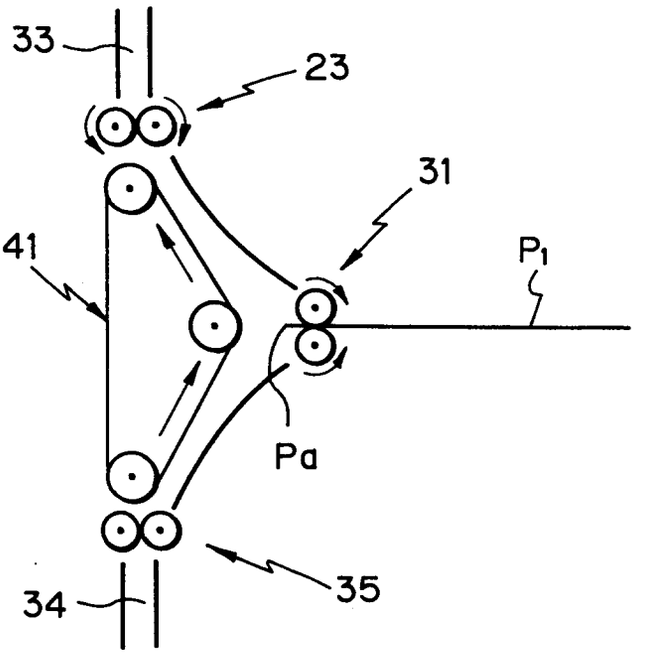

Fig. 12B

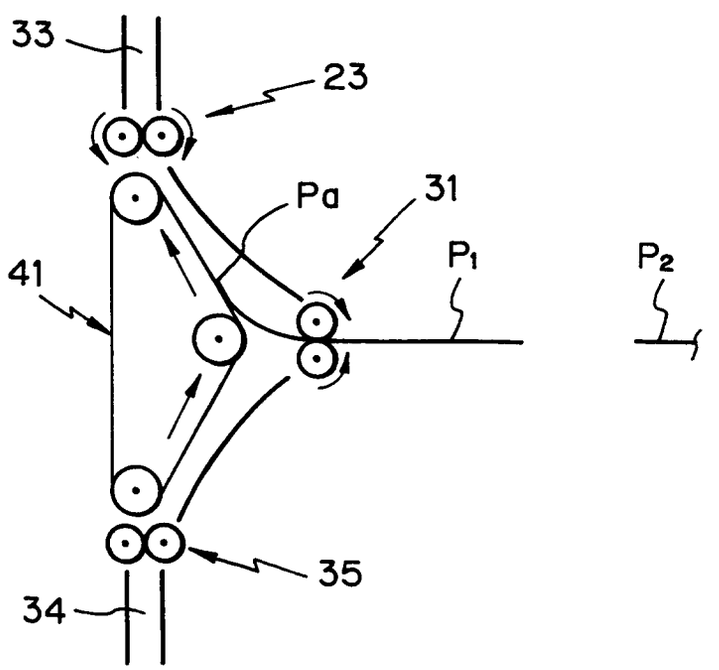

Fig. 12C

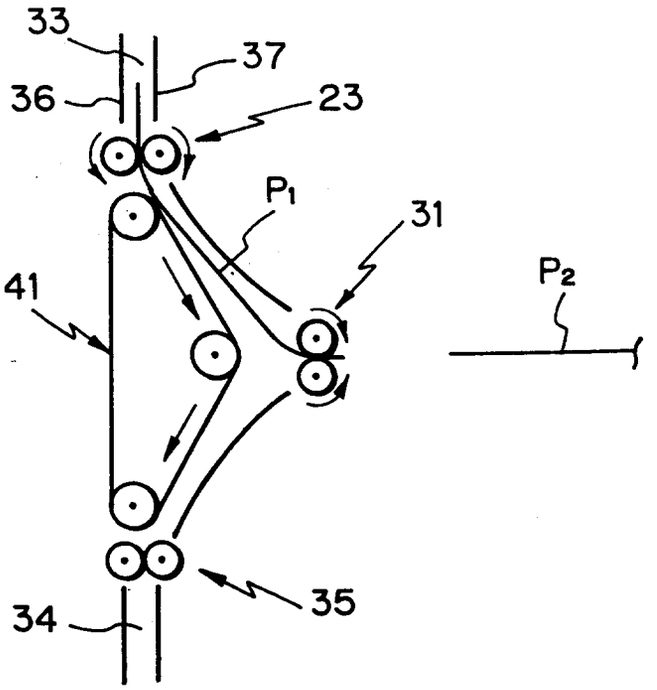

Fig. 12D

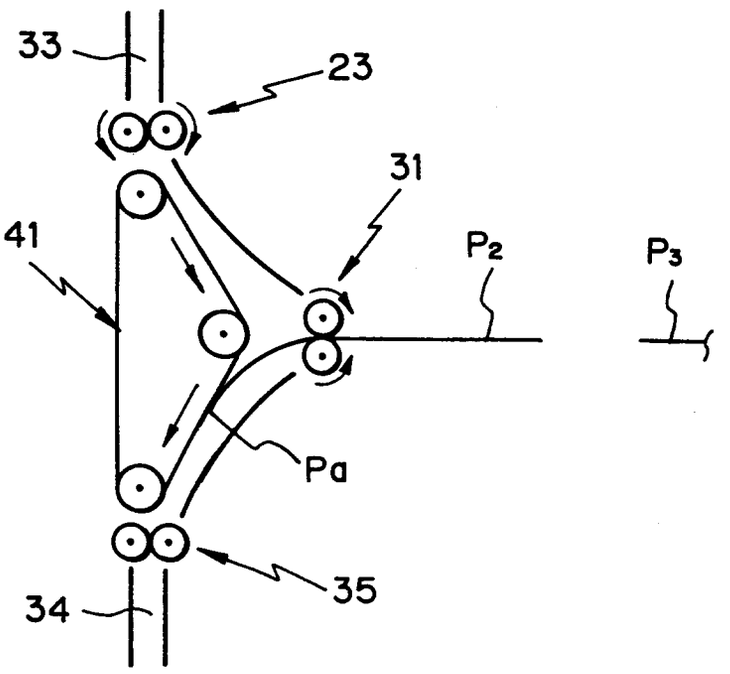

Fig. 13A

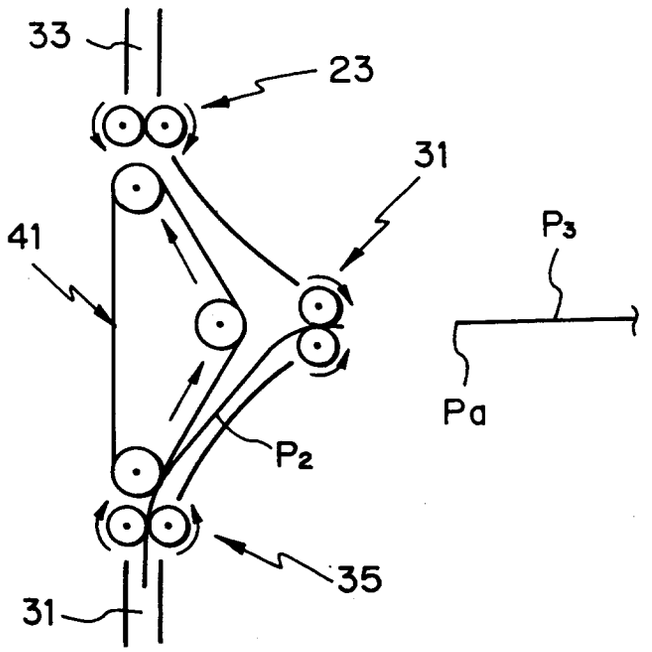

Fig. 13B

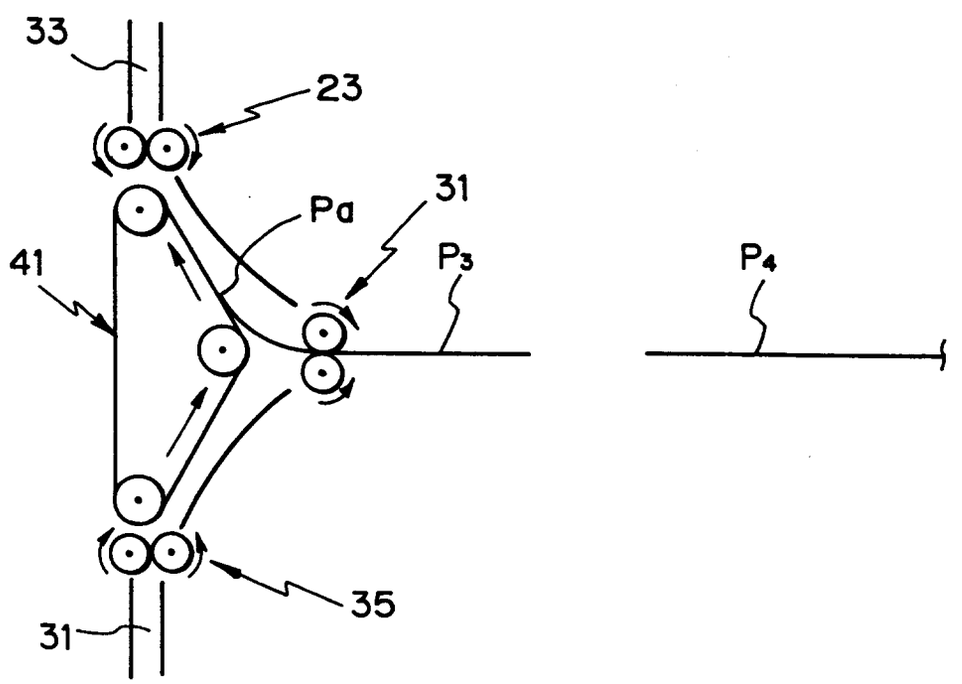

Fig. 14A

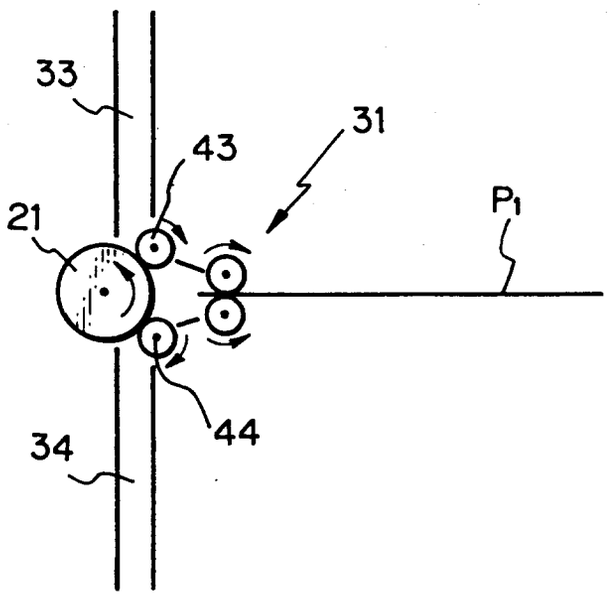

Fig. 14B

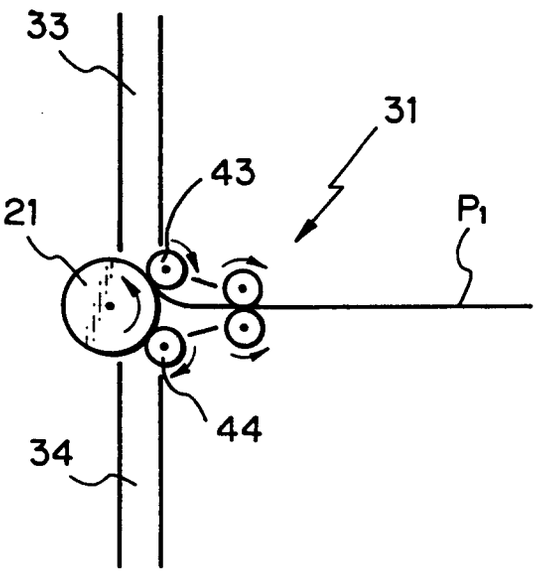

Fig. 14C

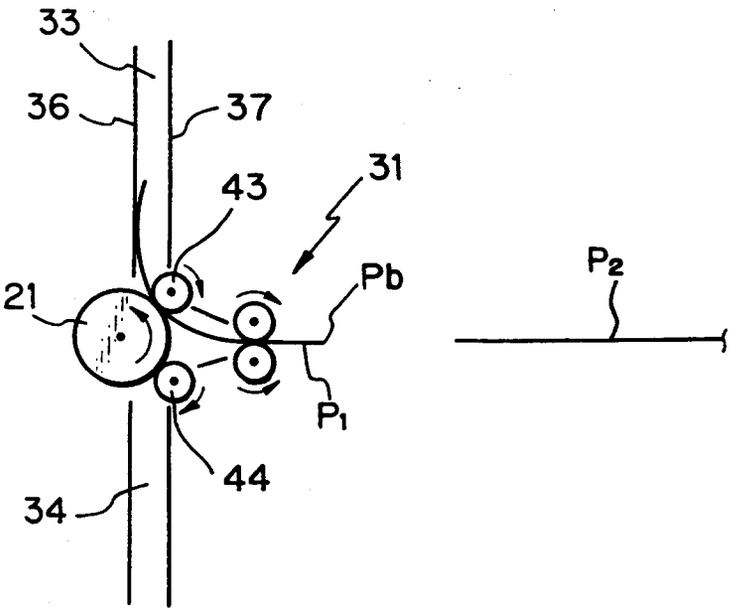

Fig. 14D

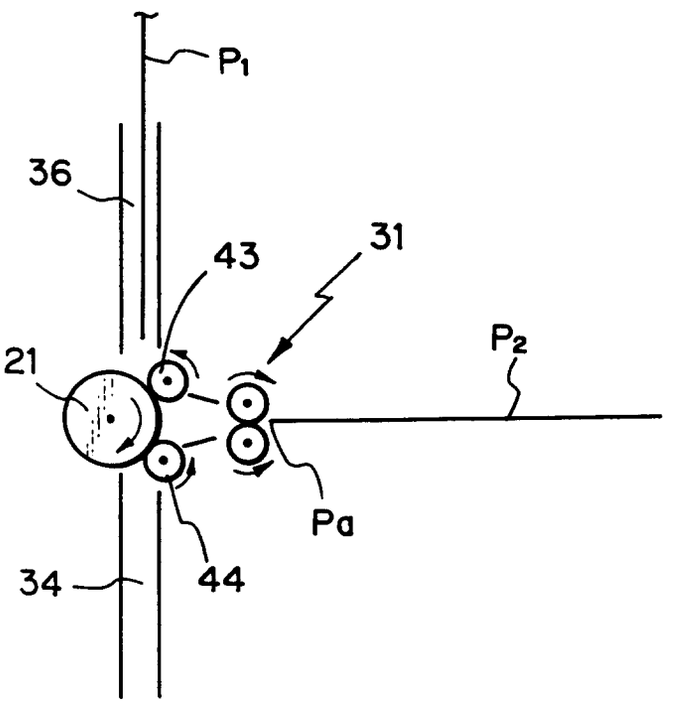

Fig. 15A

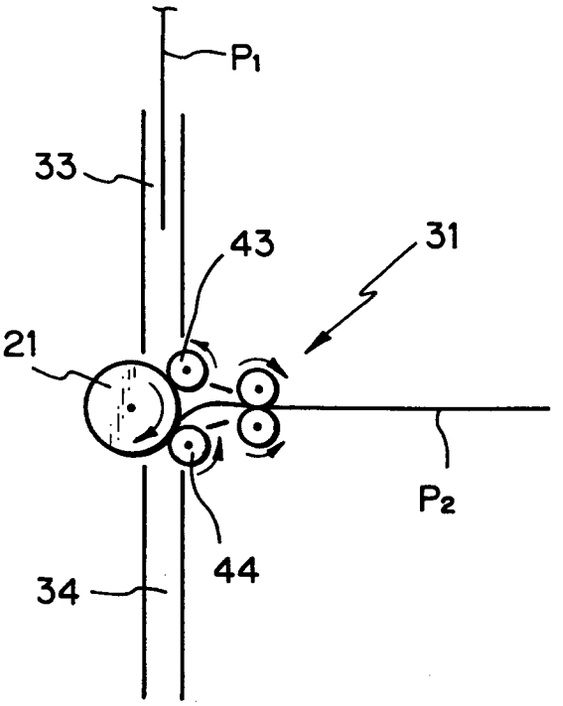

Fig. 15B

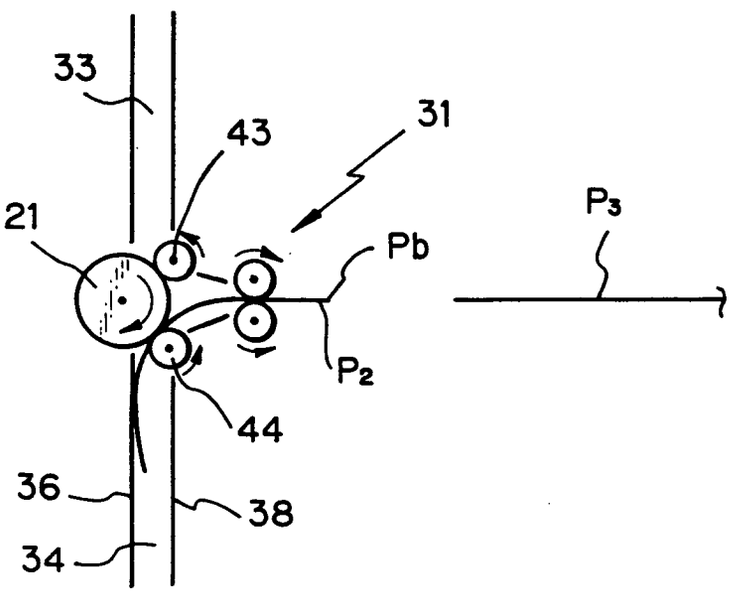

Fig. 15C

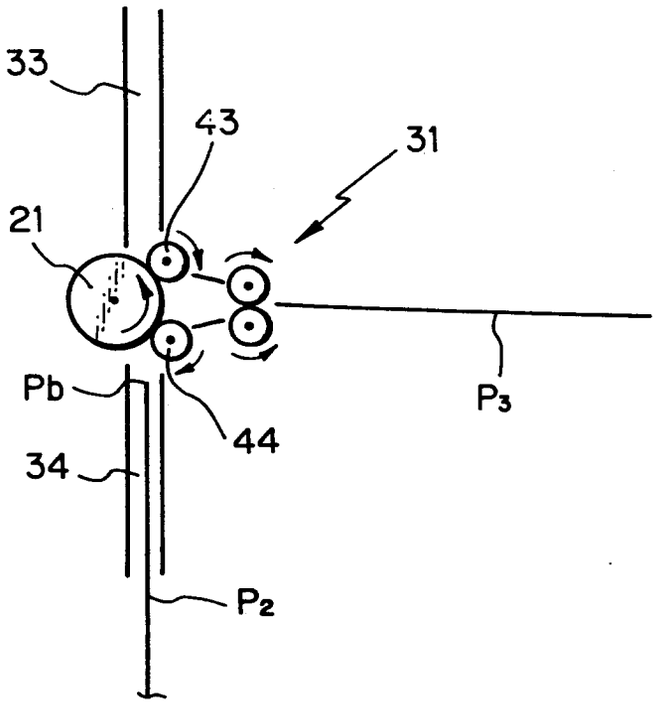

Fig. 15D

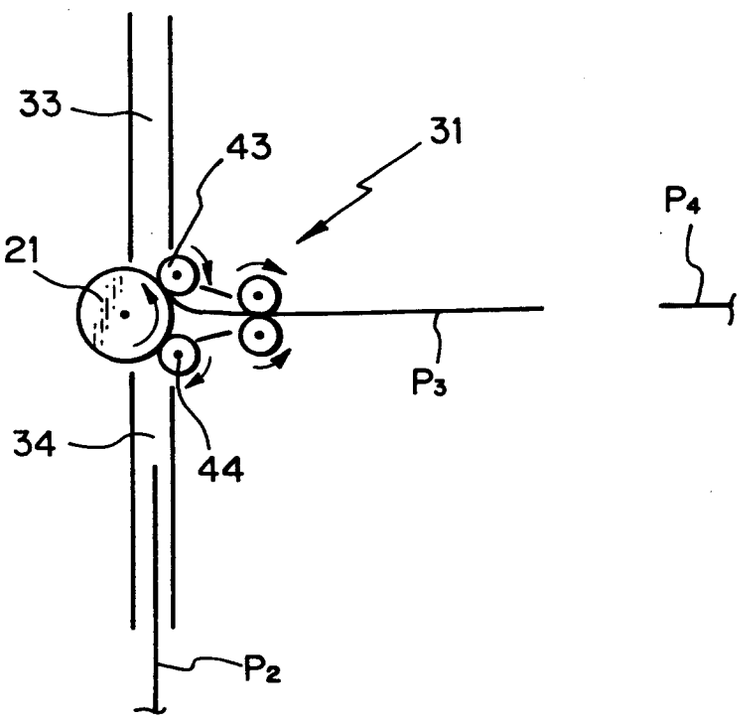

Fig. 16A

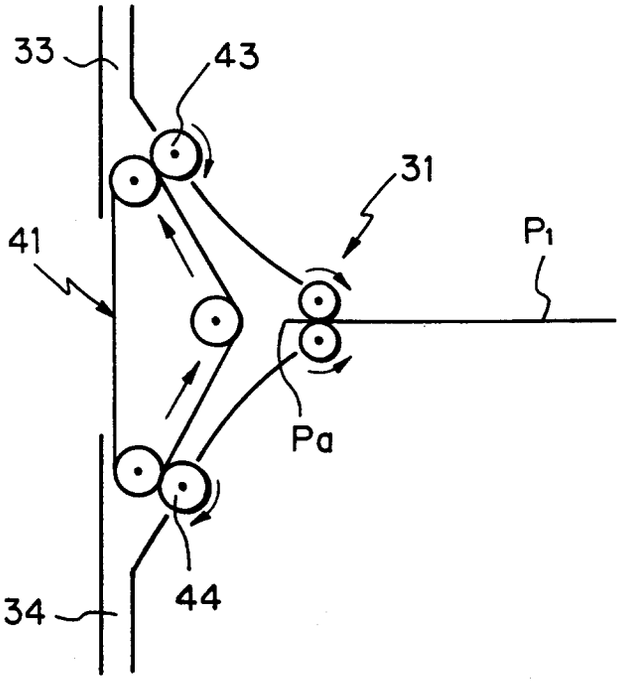

Fig. 16B

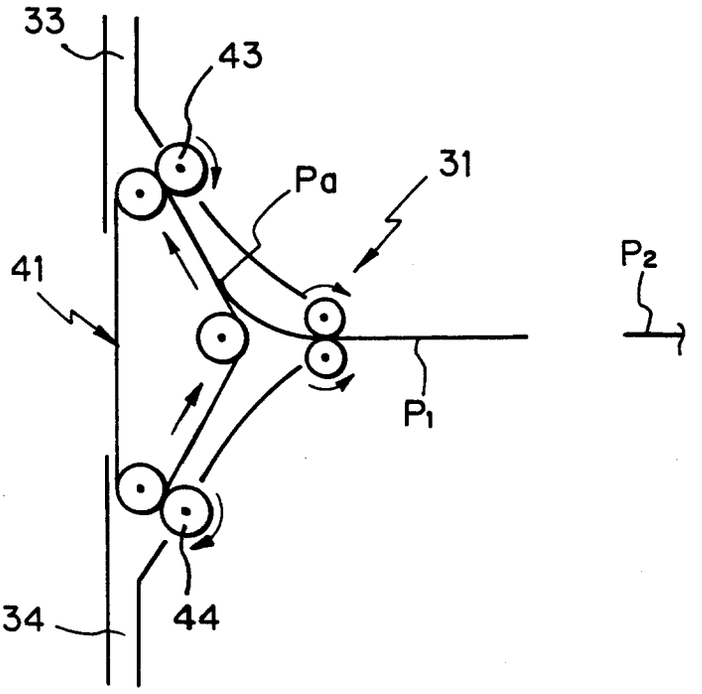

Fig. 16C

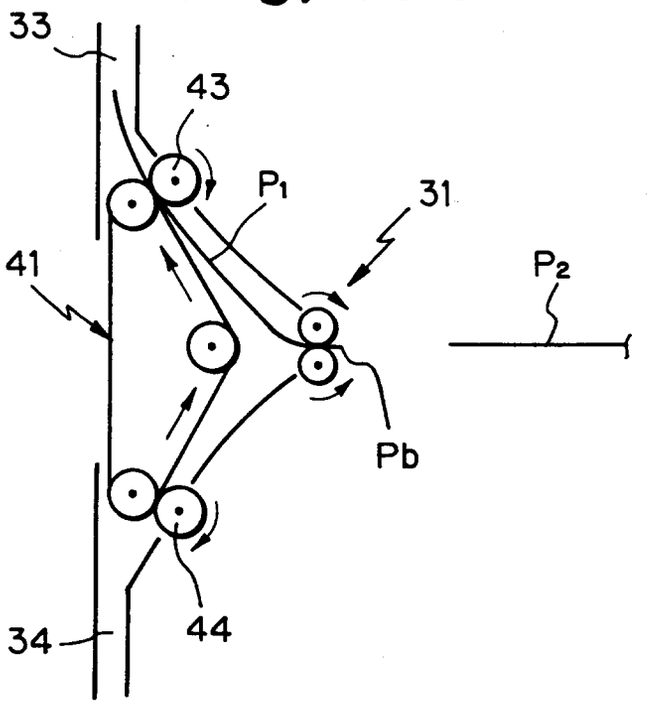

Fig. 16D

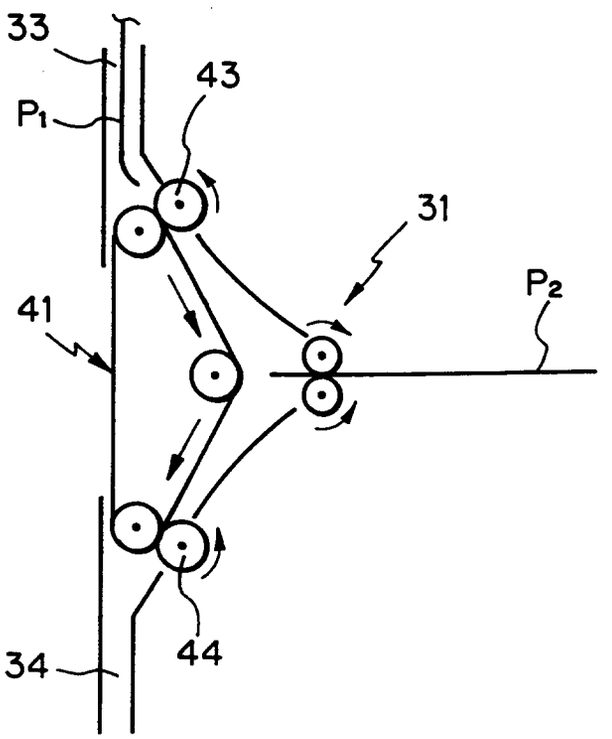

Fig. 17A

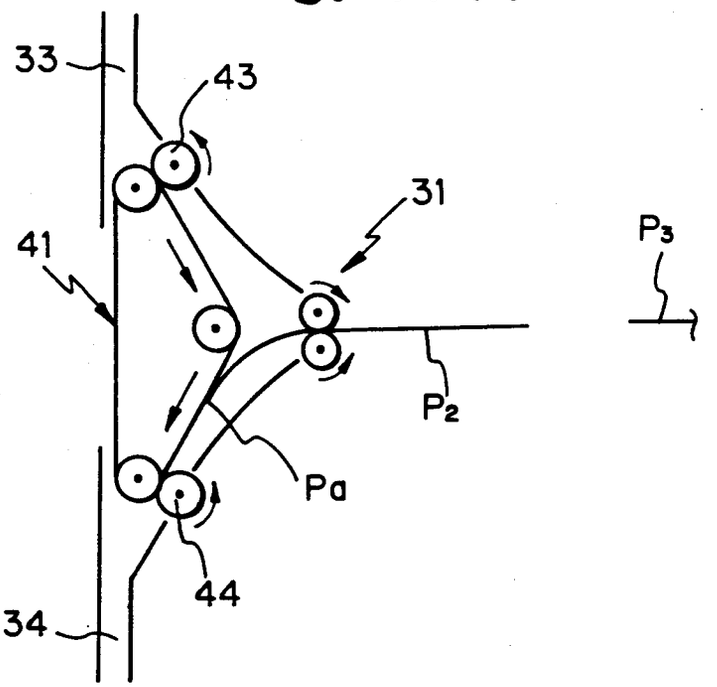

Fig. 17B

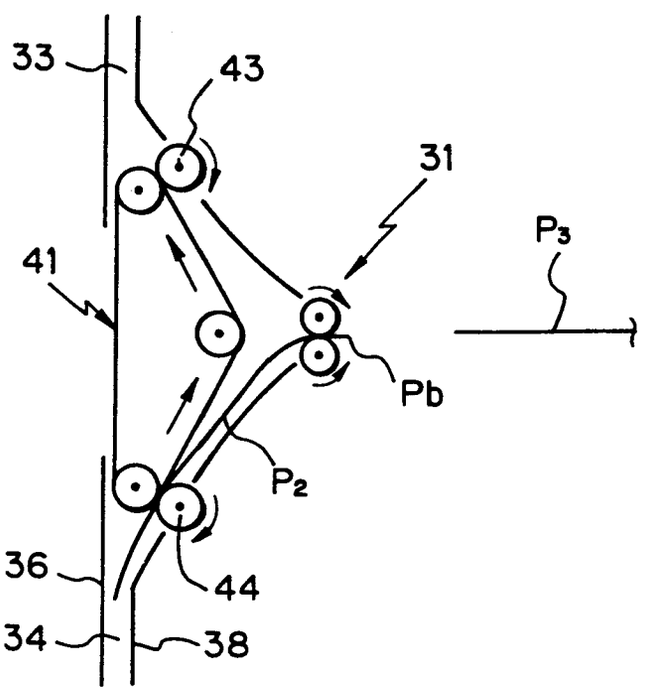

Fig. 17C

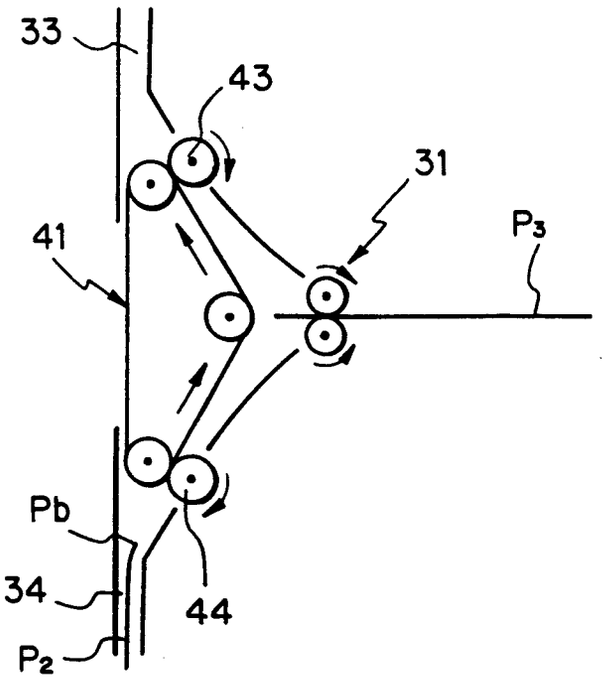

Fig. 17D

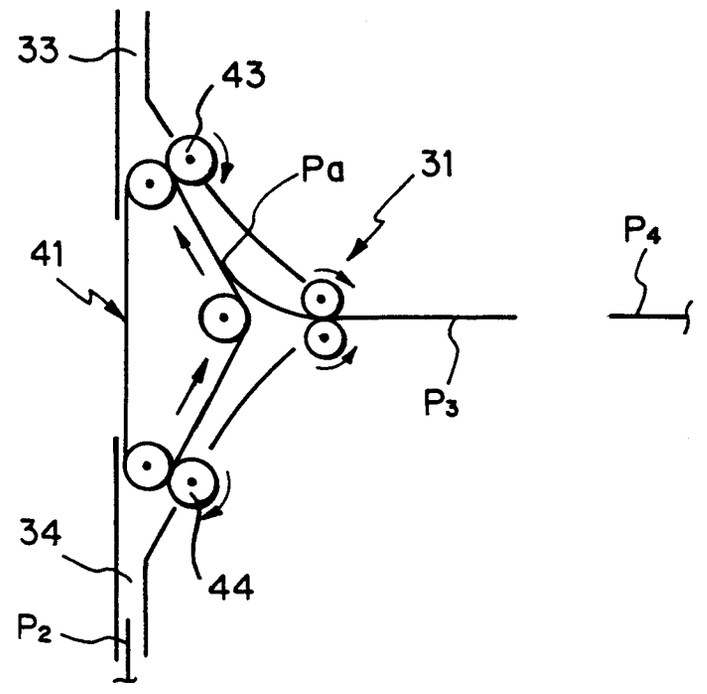

Fig. 18

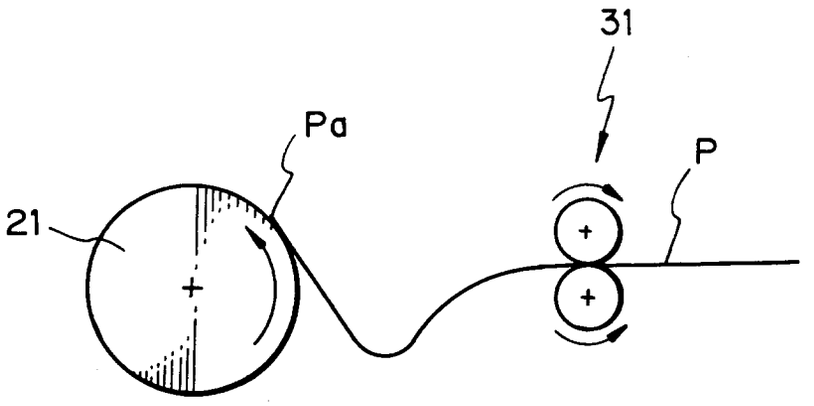

Fig. 19

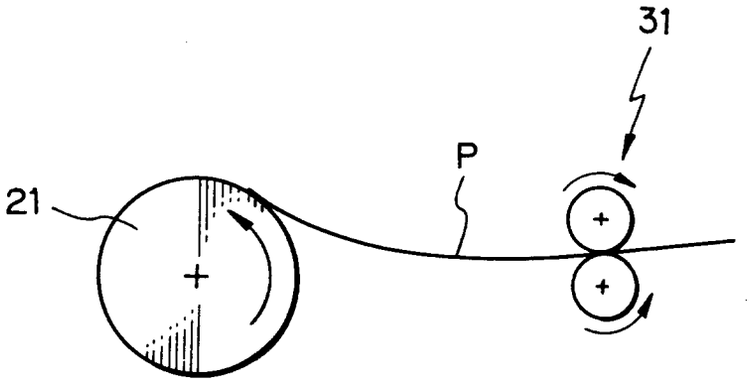

Fig. 20

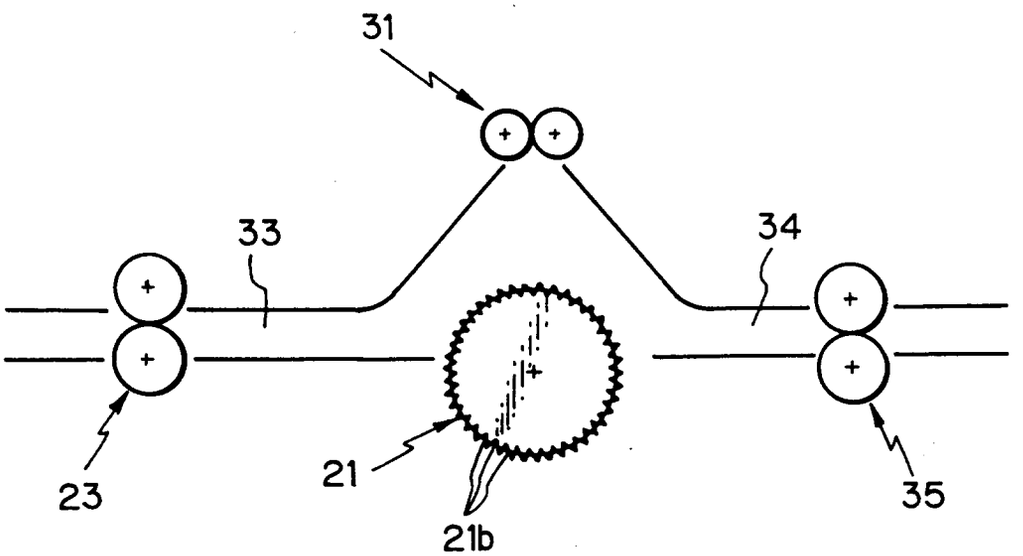

Fig. 21

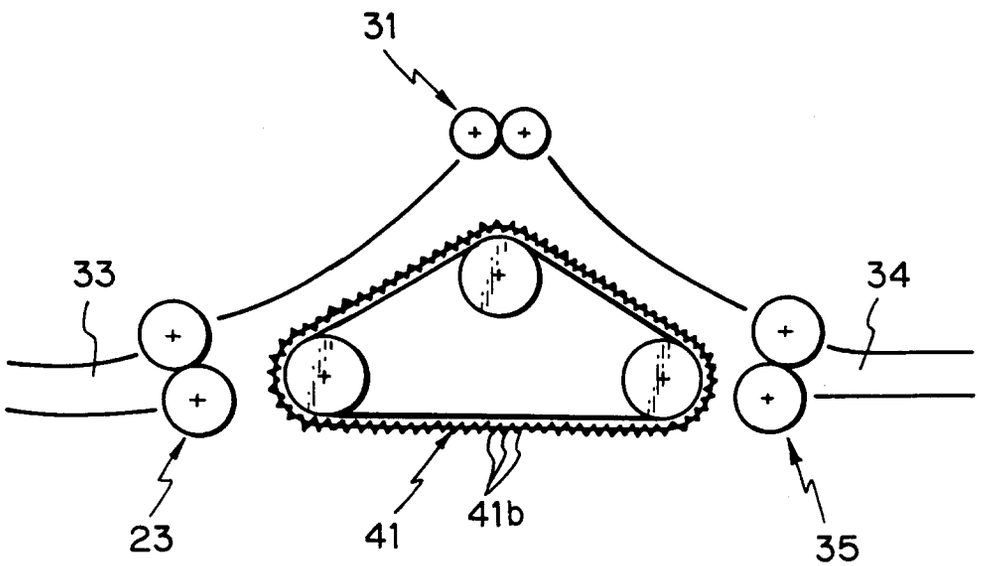

Fig. 22

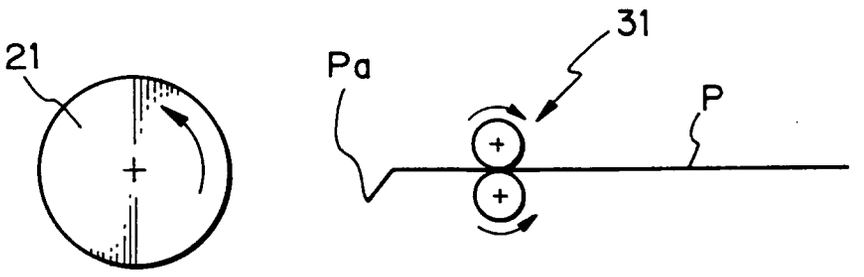

Fig. 23

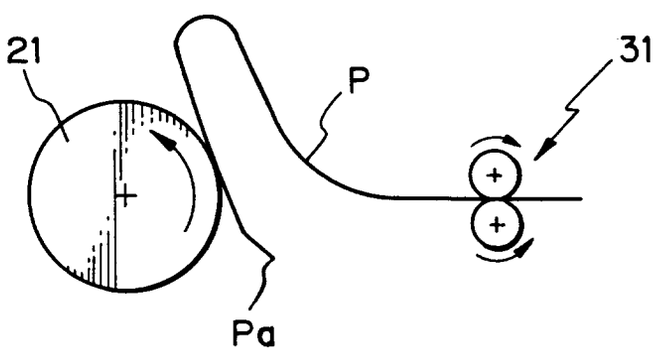

Fig. 24

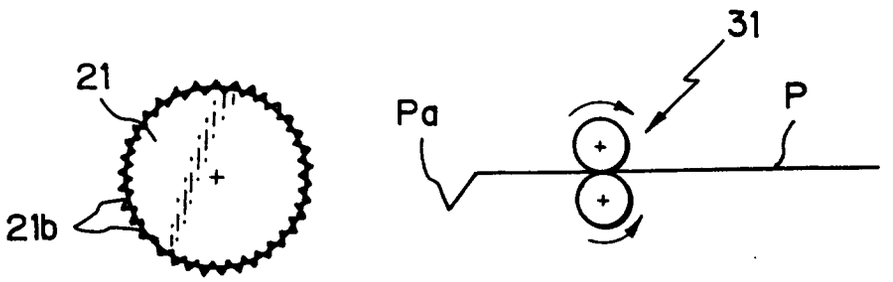

Fig. 25

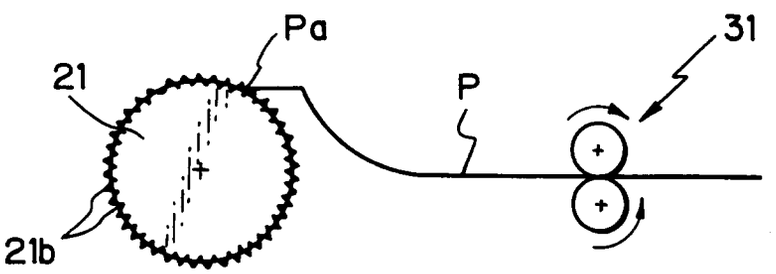

Fig. 26

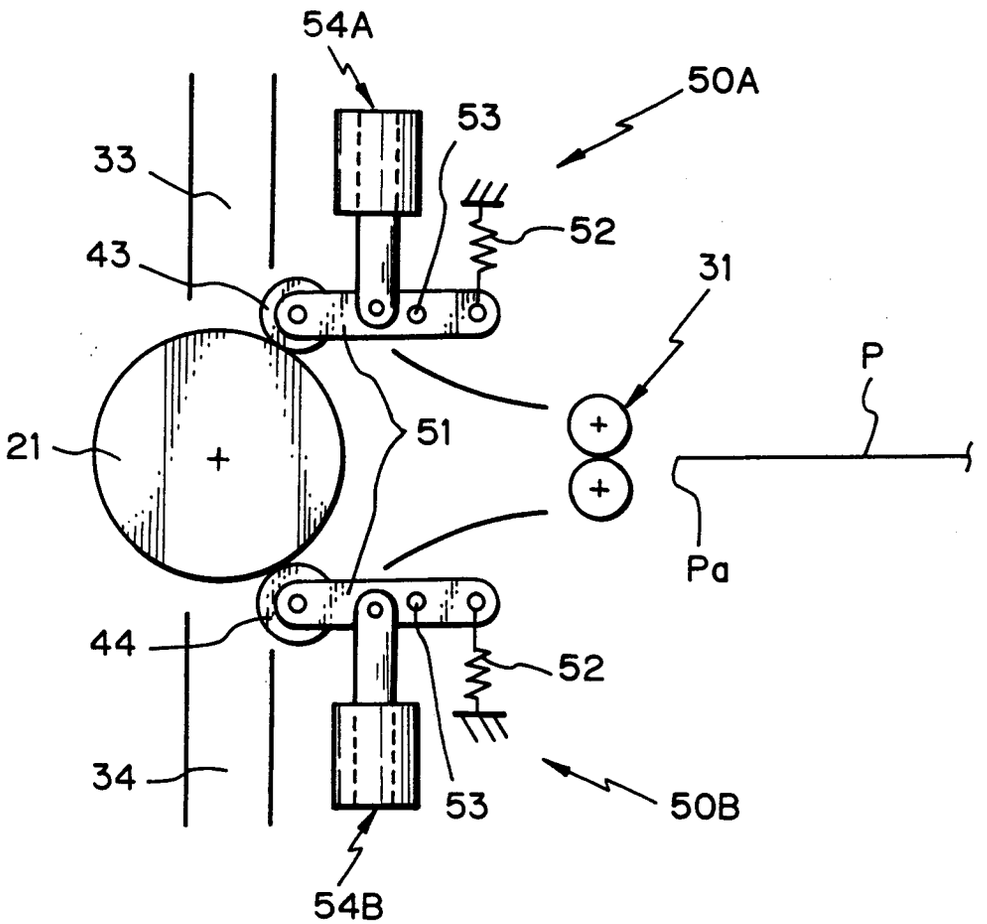

Fig. 27

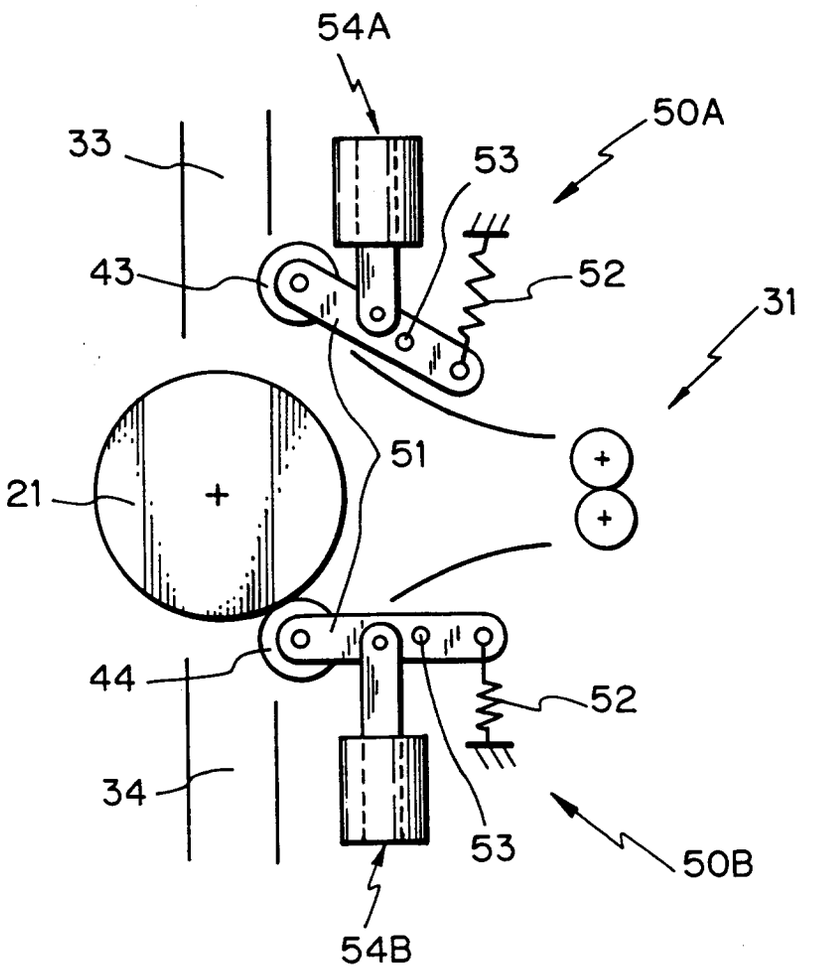

Fig. 28A

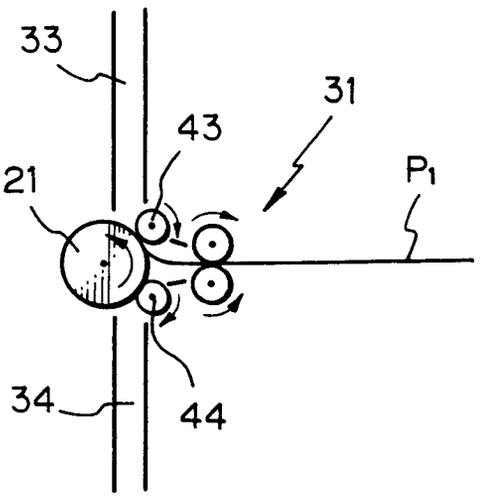

Fig. 28B

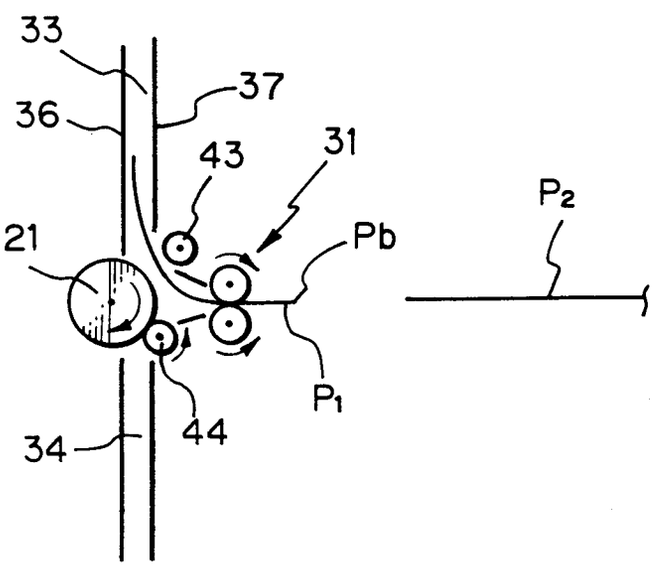

Fig. 28C

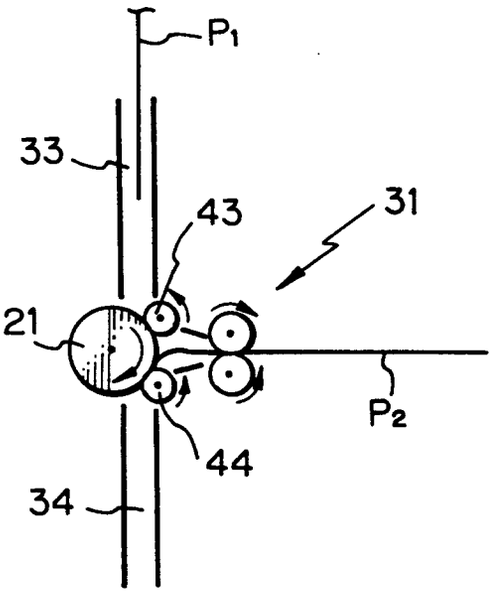

Fig. 28D

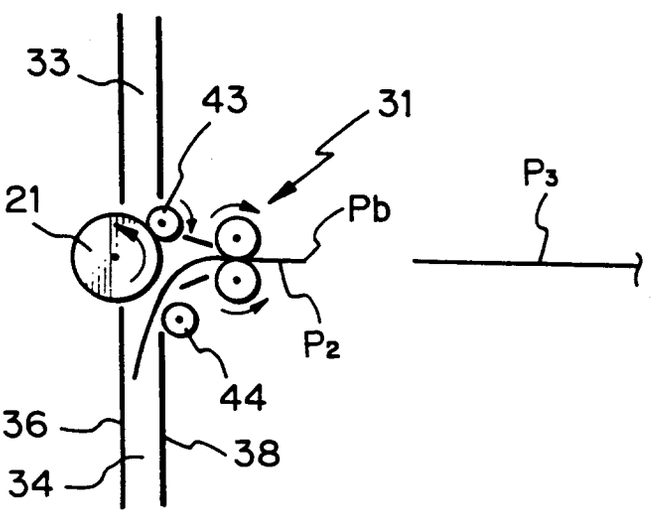

Fig. 29

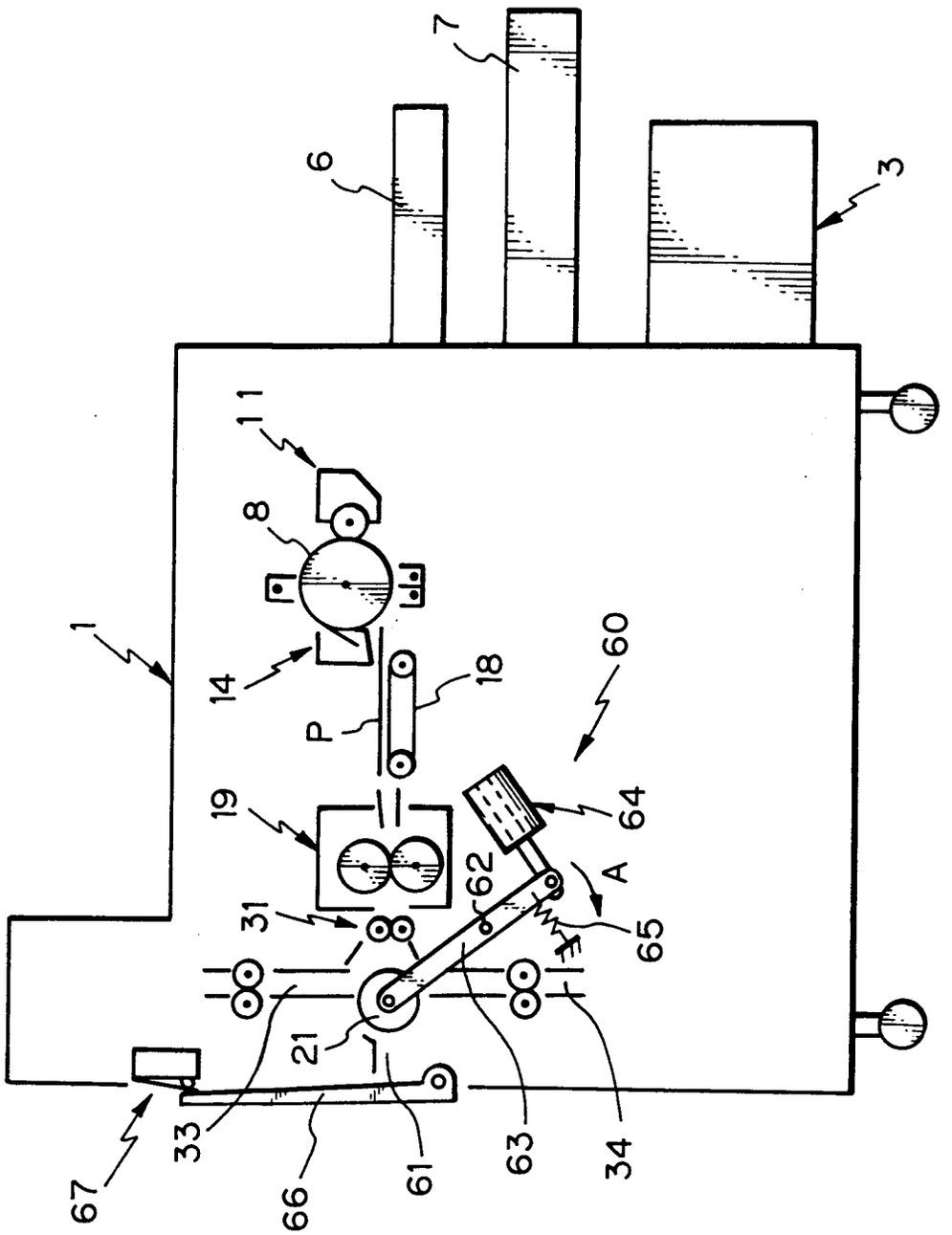

Fig. 30

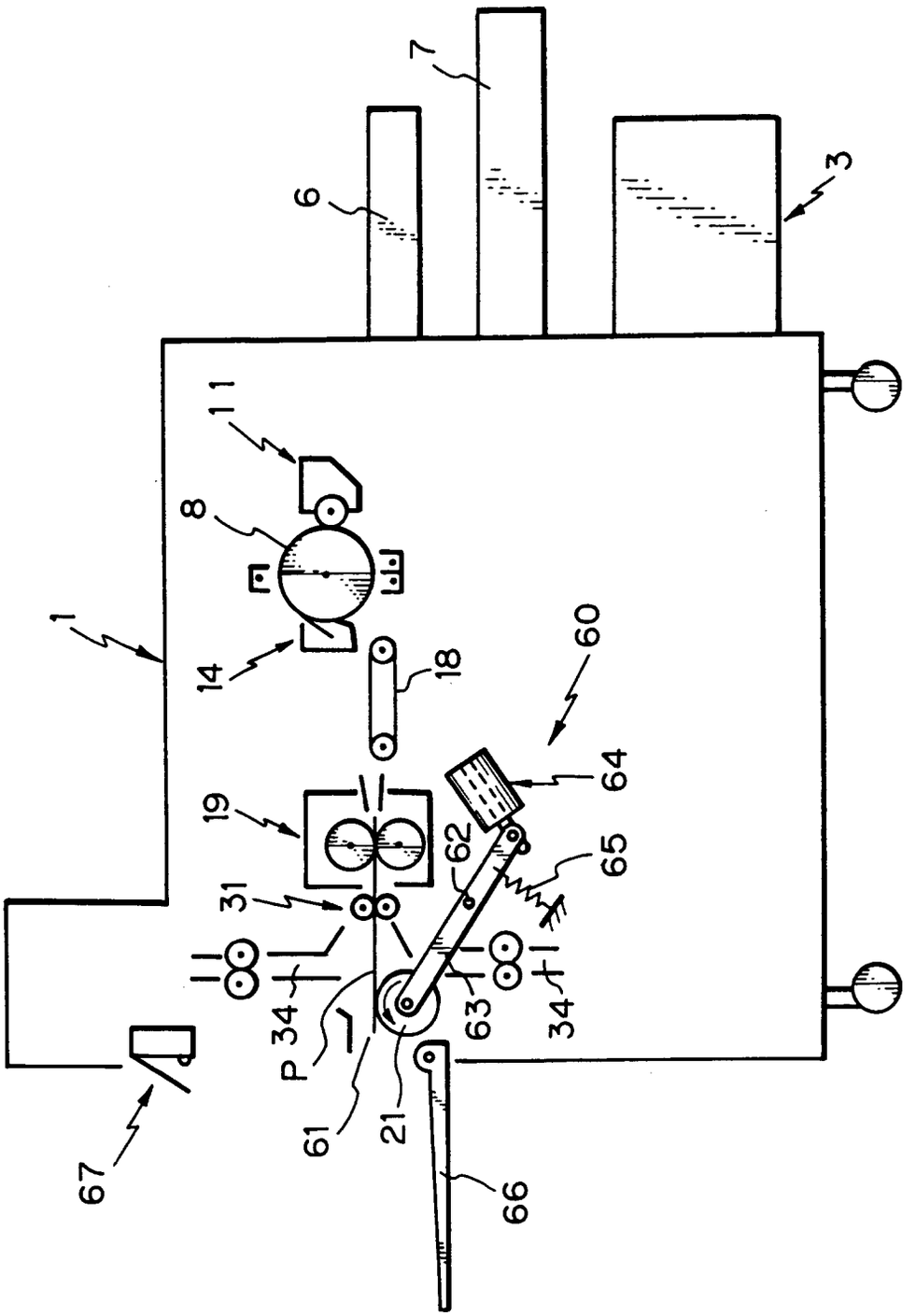

Fig. 31

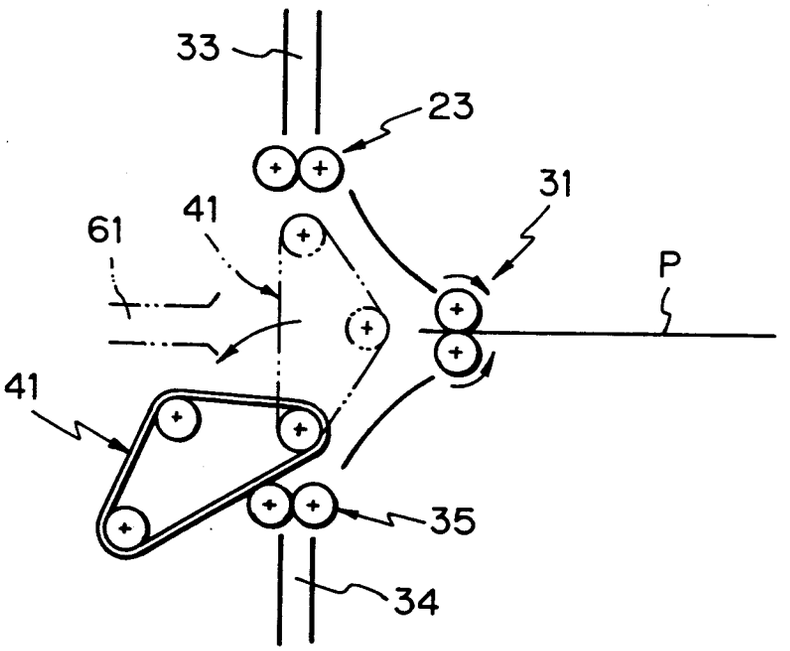

Fig. 32

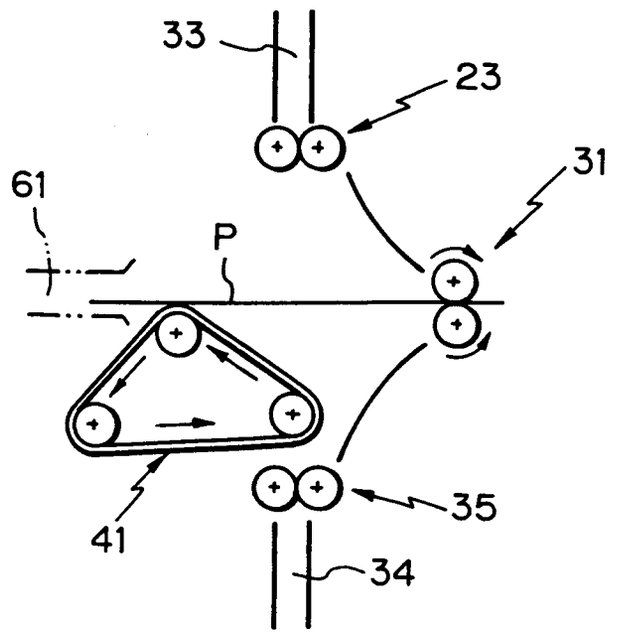

Fig. 33

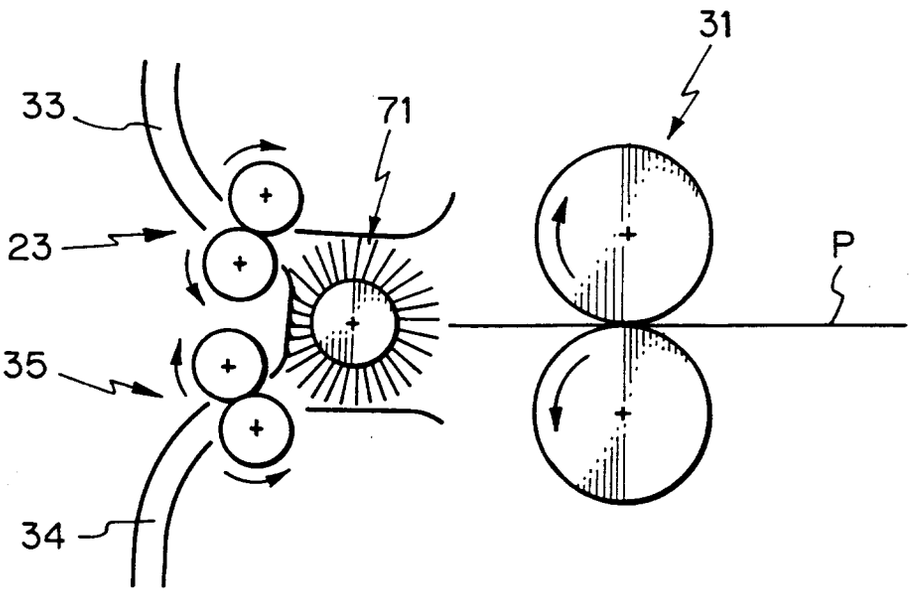

Fig. 34

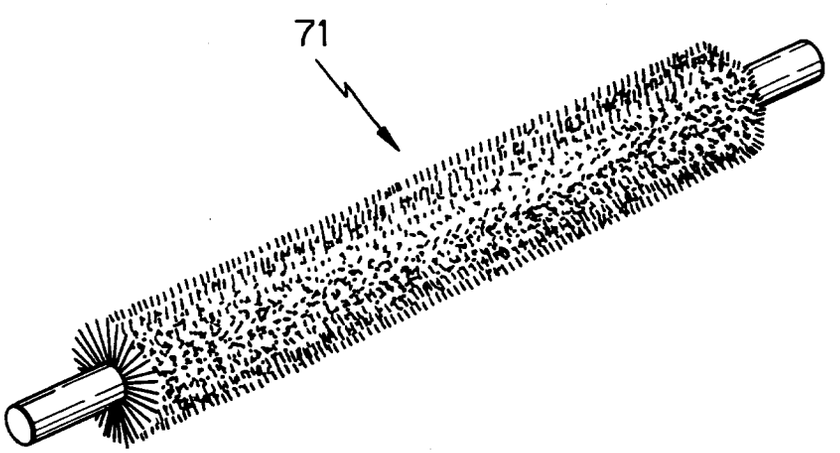

Fig. 35

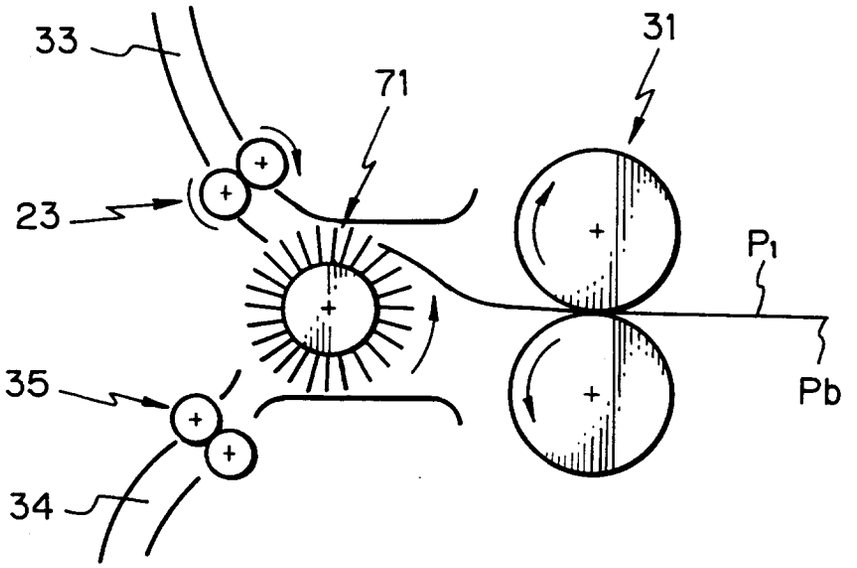

Fig. 36

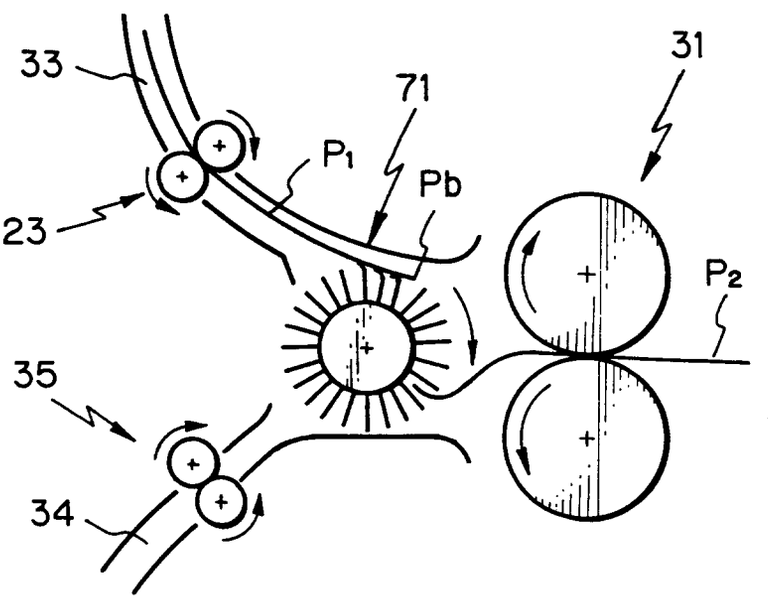

Fig. 37

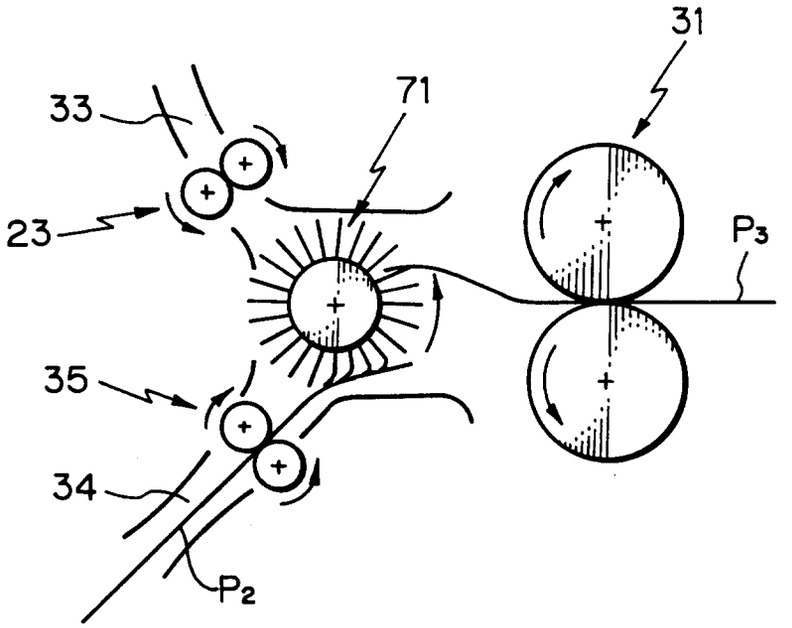

Fig. 38

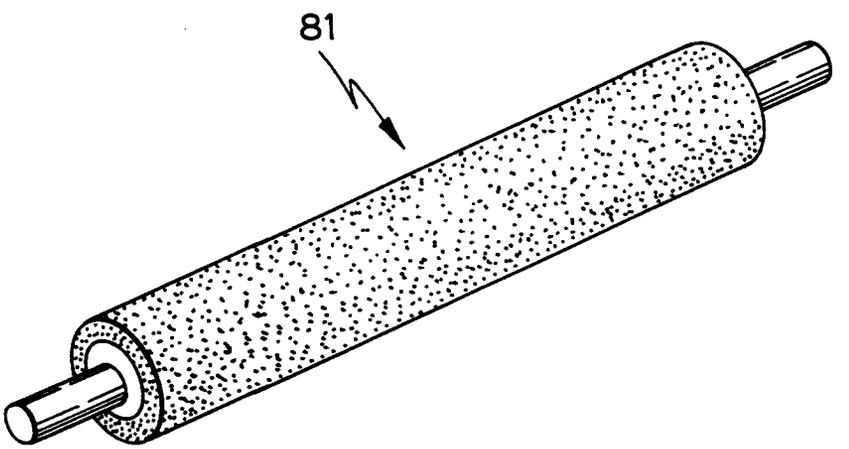

Fig. 39

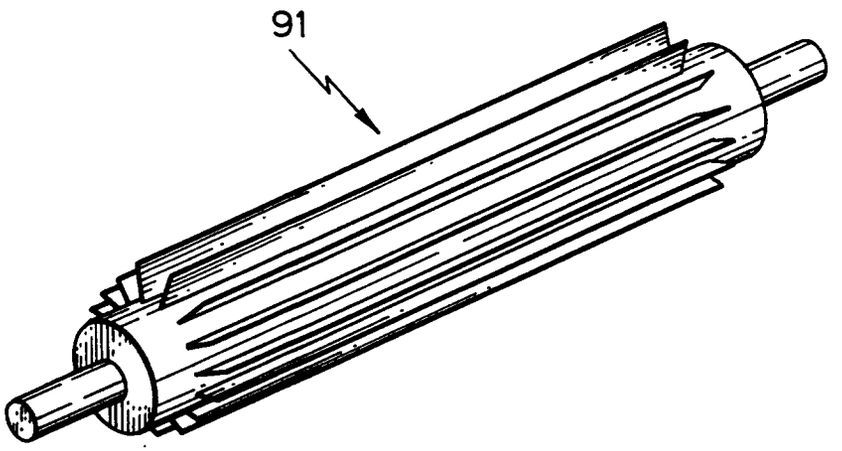

Fig. 40

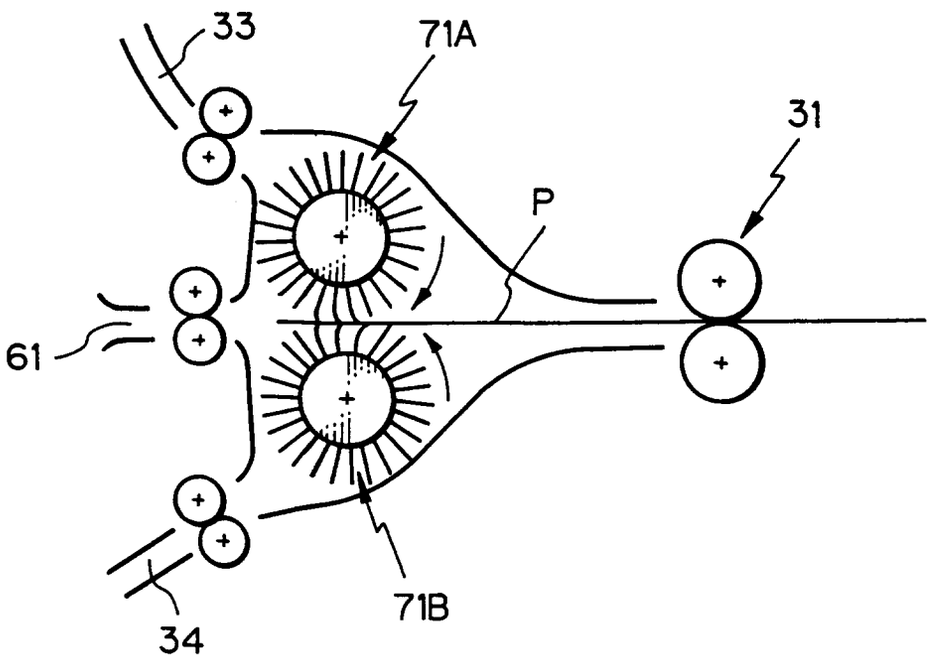

Fig. 41

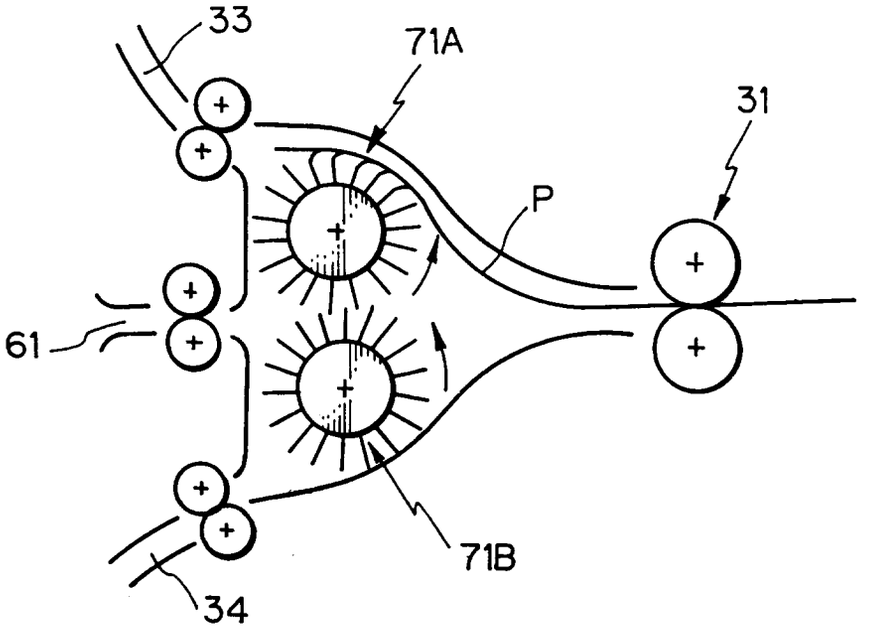

Fig. 42

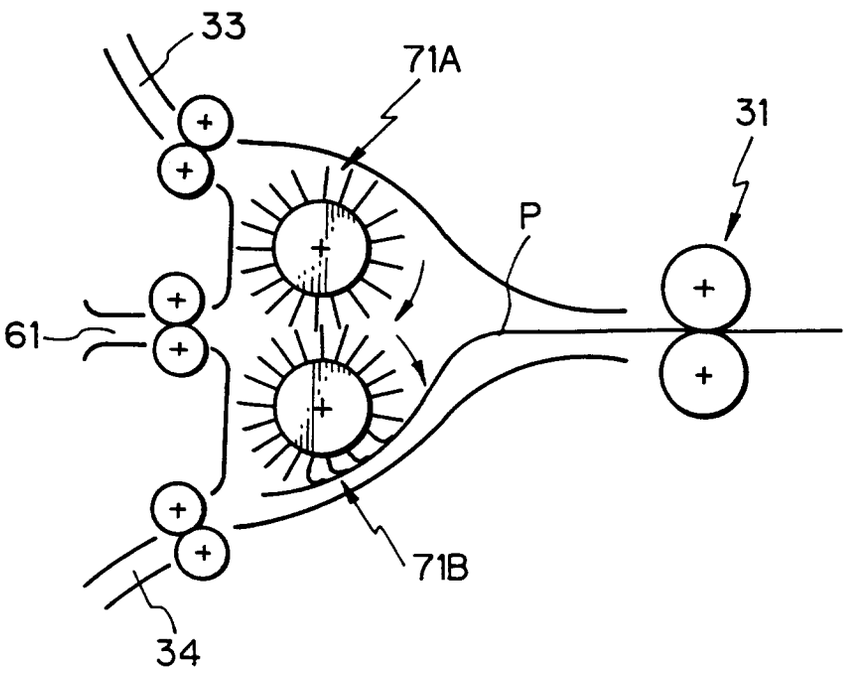

Fig. 43

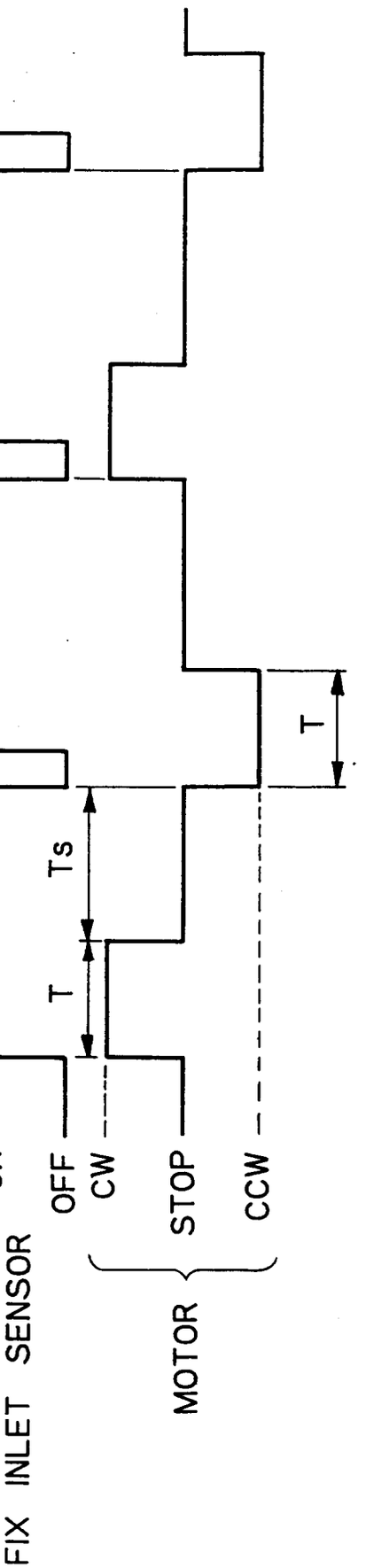

Fig. 44

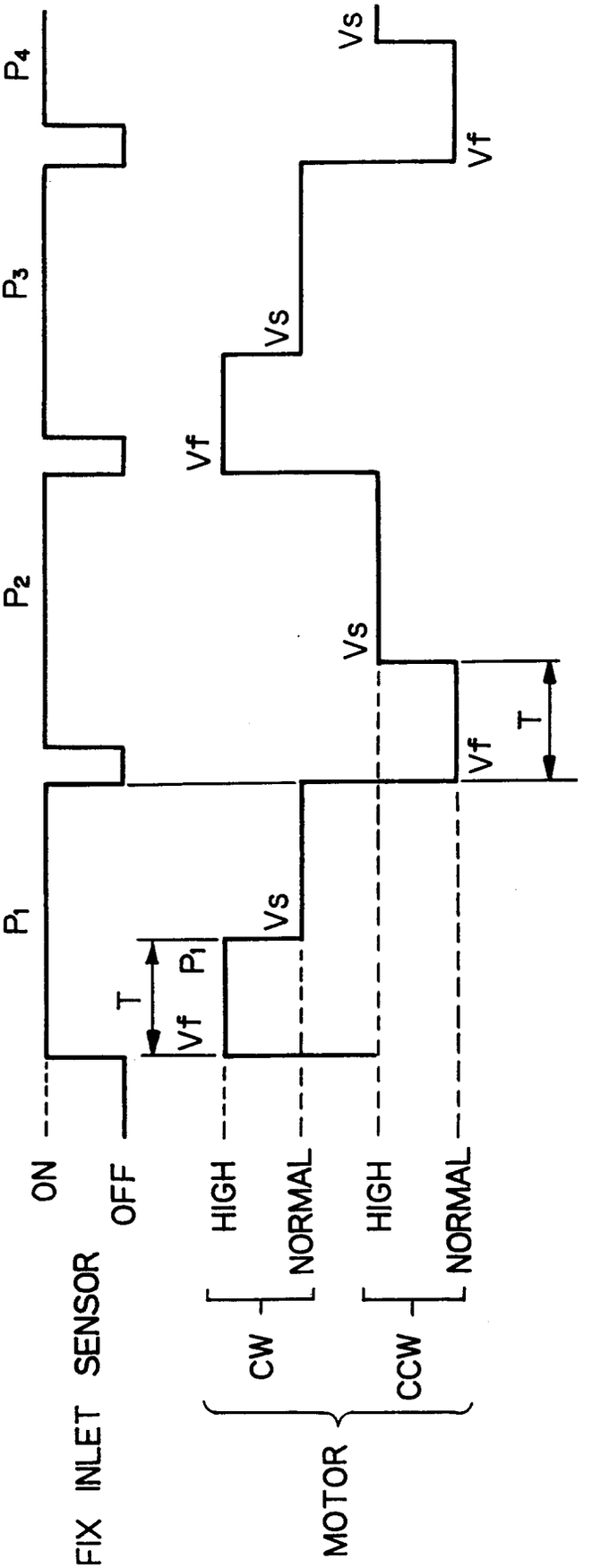
P4
P3
P2
P1
Vs
Vf
T
Vf
P1
FIX INLET SENSOR
ON
OFF
HIGH
NORMAL
HIGH
NORMAL
MOTOR
CW
CCW

Fig. 45

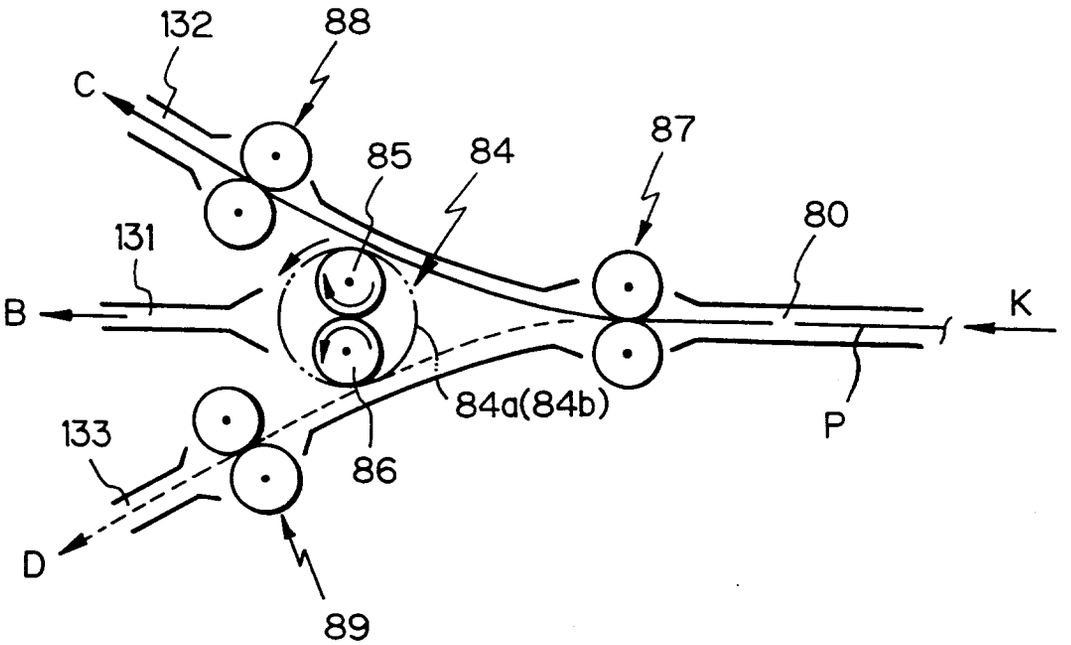
132
88
C
87
85
84
80
131
B
K
84a(84b)
P
133
86
D
89

Fig. 46

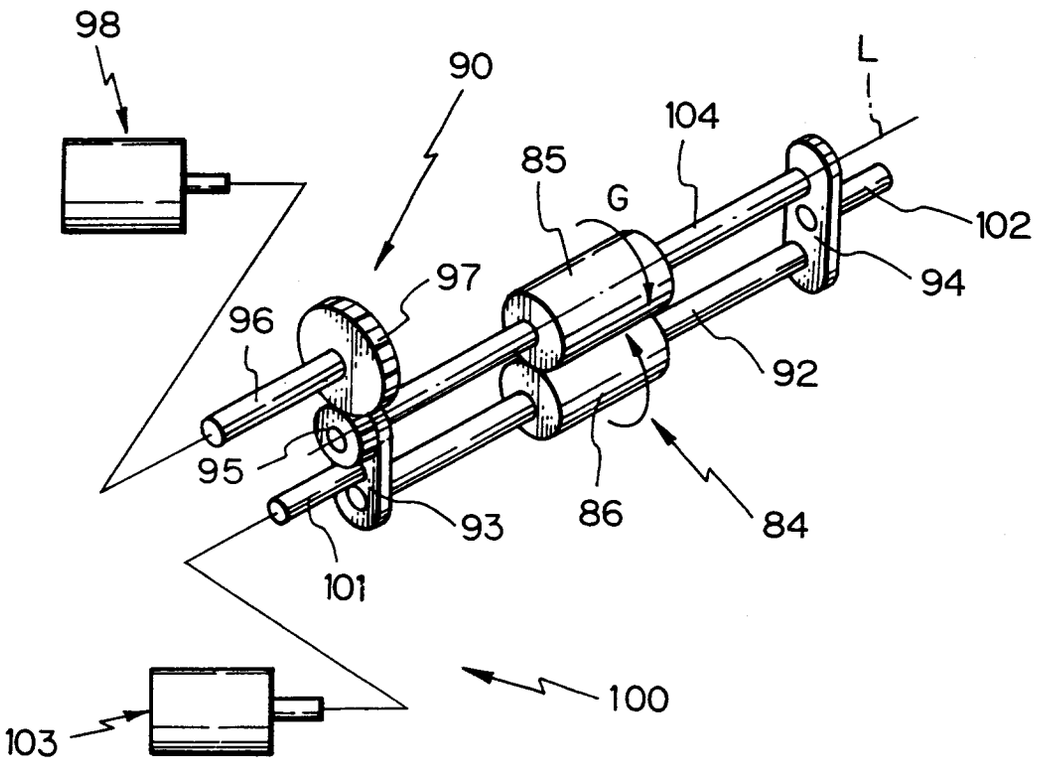
98
90
L
104
85
G
102
97
94
96
92
95
86
84
93
101
100
103

Fig. 47

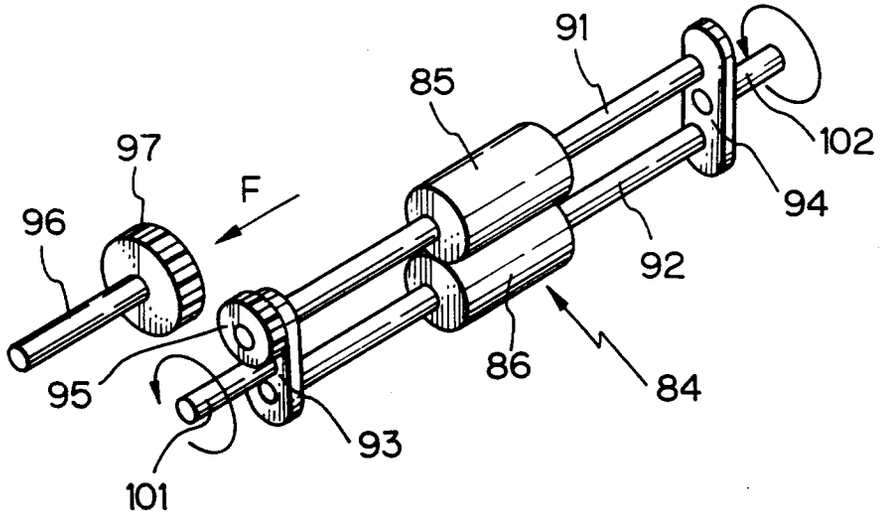

Fig. 48

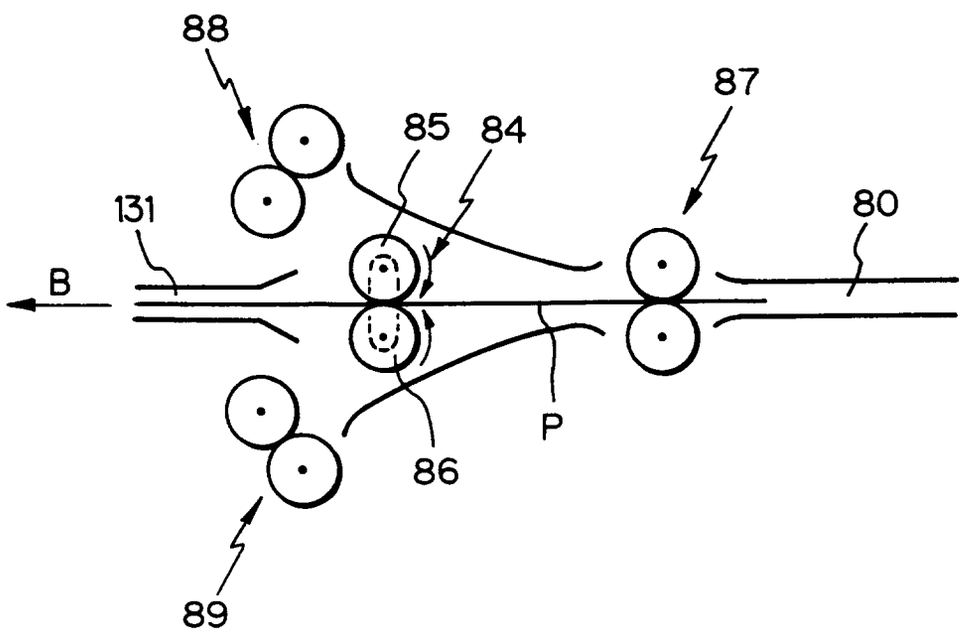

Fig. 49

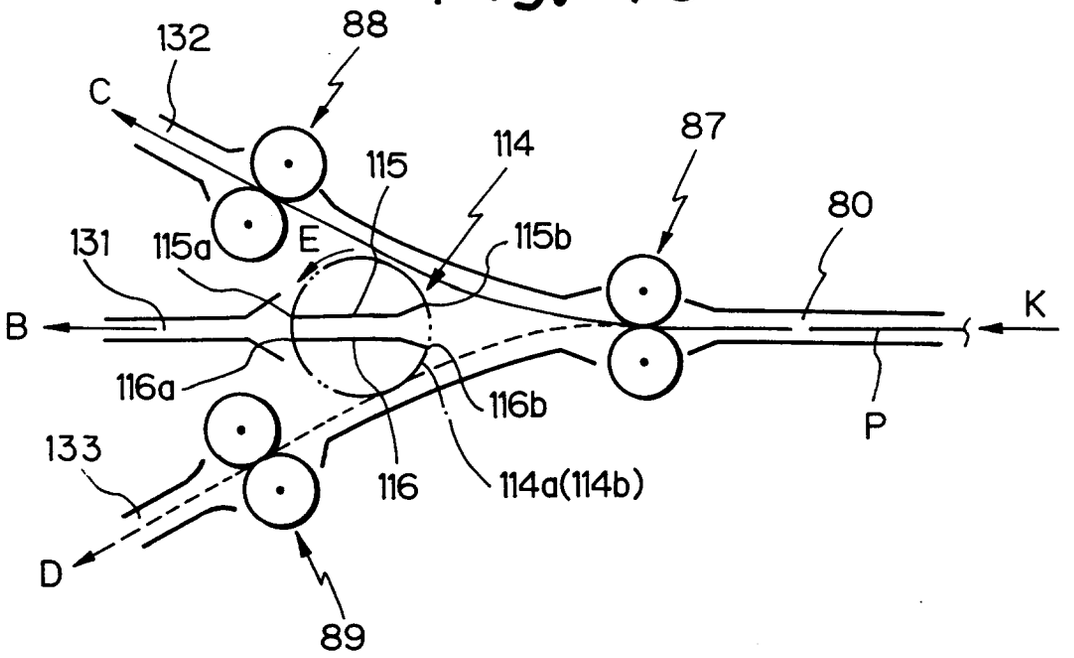
132
88
C
87
114
115
80
131
115a
E
115b
B
K
116a
116b
P
133
116
114a(114b)
D
89

Fig. 50

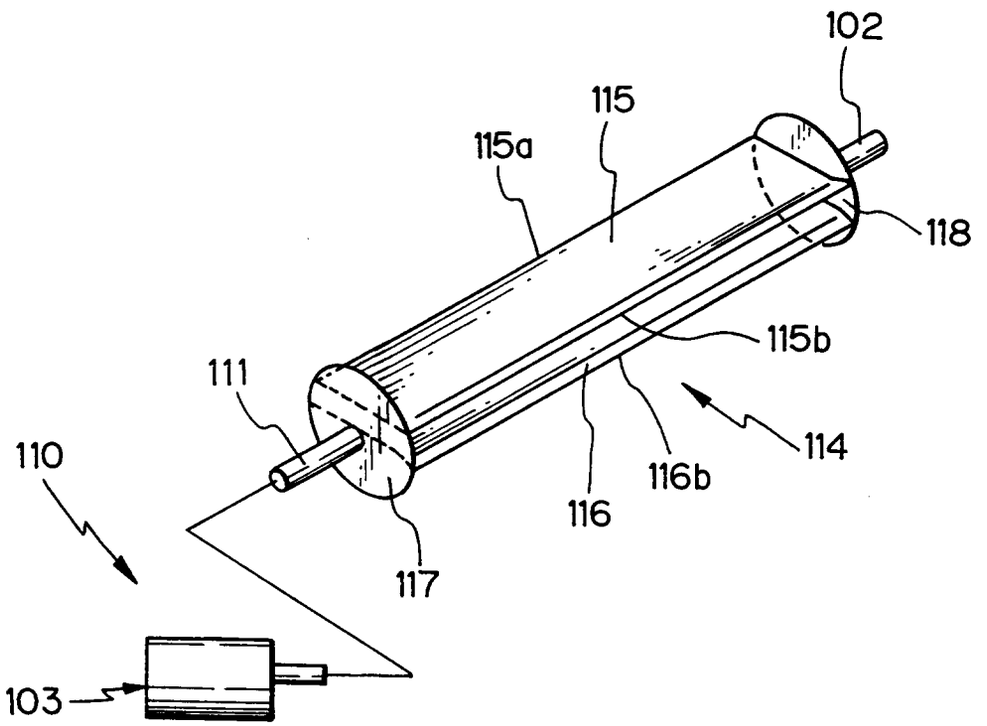
102
115
115a
118
115b
111
114
110
116b
116
117
103

Fig. 51

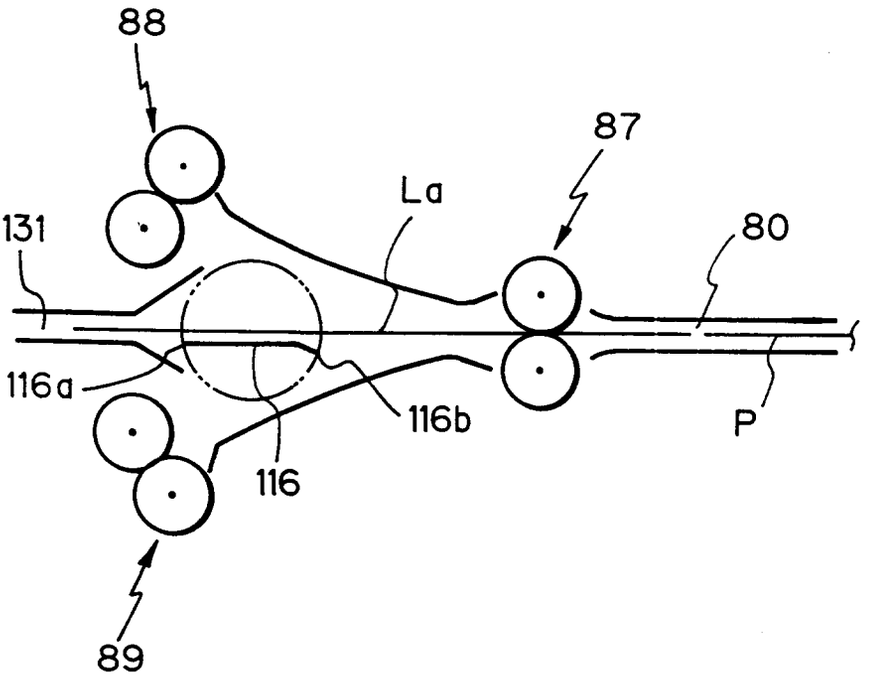
88
87
La
131
80
116a
116b
P
116
89

Fig. 52

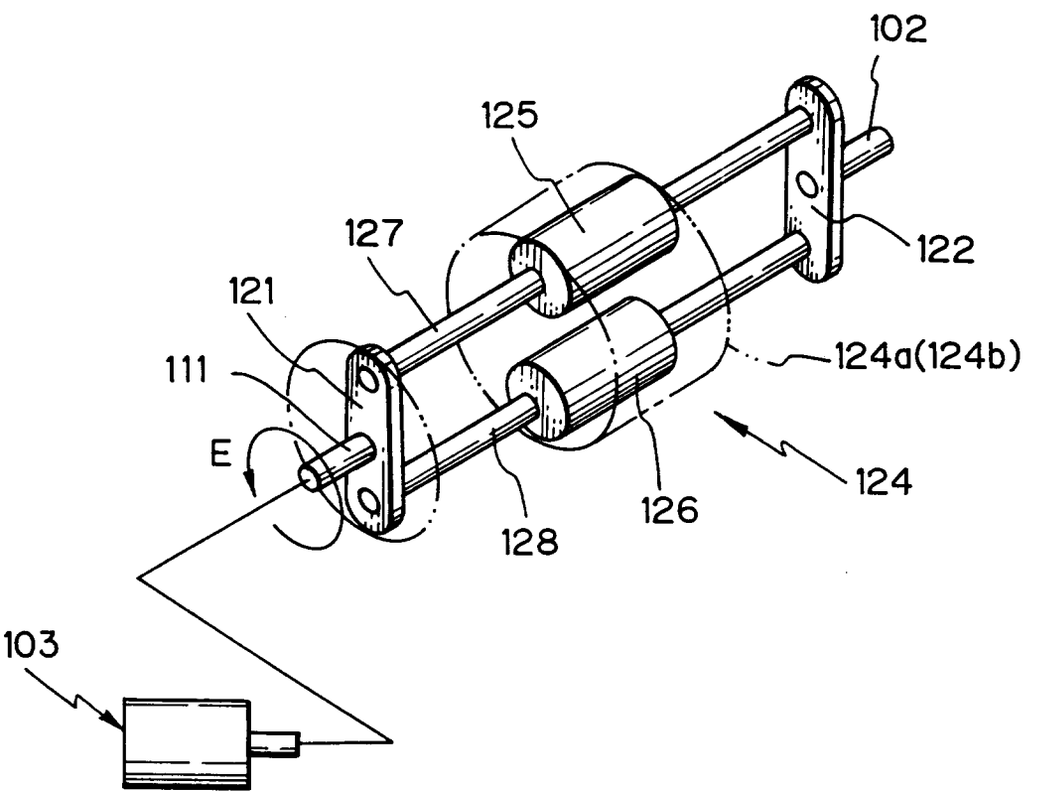
102
125
127
122
121
124a(124b)
111
E
124
126
128
103

Fig. 53A

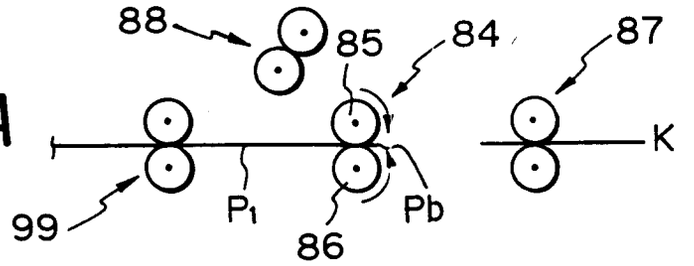

Fig. 53B

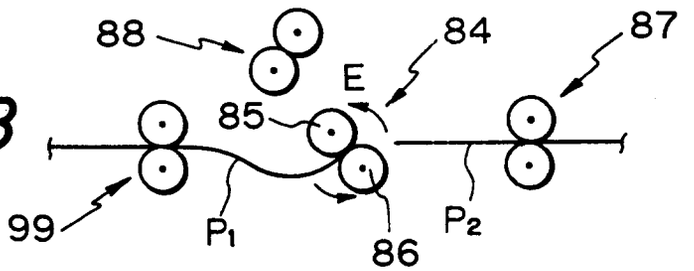

Fig. 53C

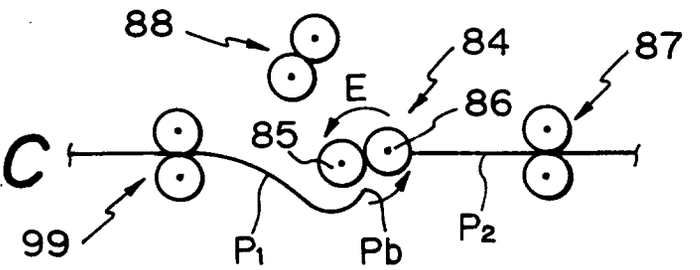

Fig. 53D

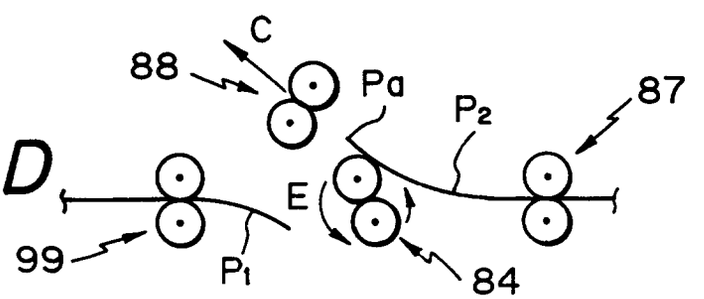

Fig. 53E

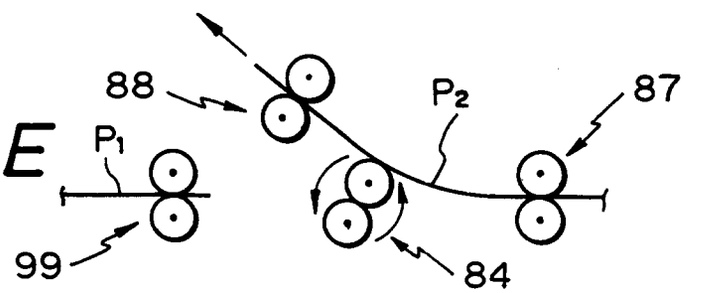

Fig. 54A

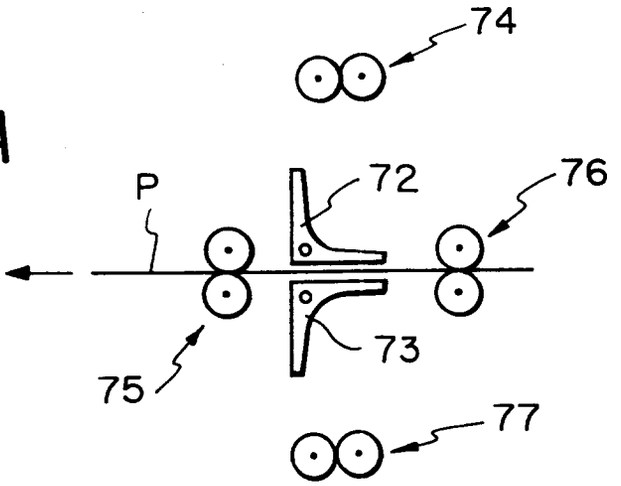

Fig. 54B

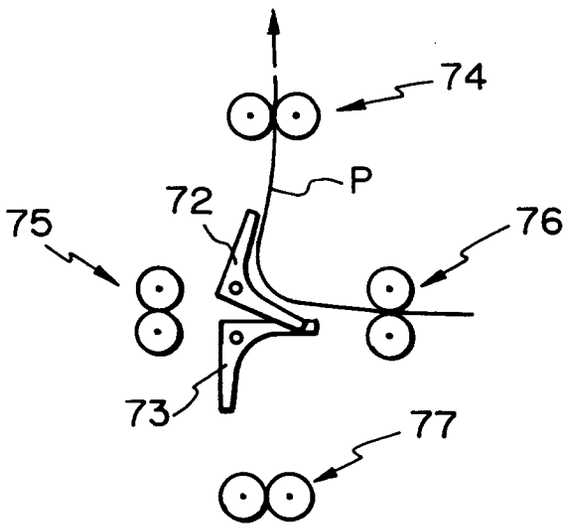

Fig. 54C