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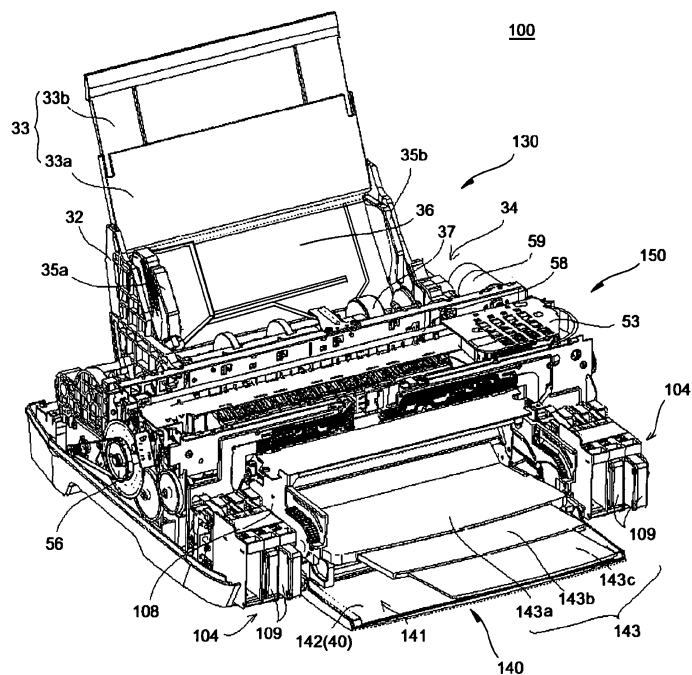
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(54) **Medium feeding device and recording apparatus and liquid ejecting apparatus, having medium feeding device**

(57) A feeder is operable to feed the medium. A separator is provided with an abutment portion on which the

medium fed in a first direction by the feeder is adapted to abut and which projects in a second direction opposed to the first direction.

FIG. 2



Description**BACKGROUND OF THE INVENTION**

5 **[0001]** The present invention relates to a medium feeding device for feeding a medium and a recording apparatus and a liquid ejecting apparatus, having the medium feeding device.

[0002] A printer of an ink jet type which is one of recording apparatuses includes such a type as to feed a paper from a back side and to discharge the paper to a front side and such a type as to feed and discharge the paper on the front side. In the printer of such a type as to feed and discharge the paper on the front side, a paper feed tray is provided in 10 a lower stage of the front surface of the apparatus and a paper discharge stacker is provided in an upper stage. A paper (medium) accommodated in the paper feed tray is started to be fed by a pick-up roller.

[0003] In this case, the papers fed with an overlap are separated into a paper on an uppermost layer and a paper on a lower layer by separator and only the paper on the uppermost layer is further fed by means of a paper feed roller. The paper fed by the paper feed roller is fed to a recorder and is subjected to recording, and the paper is then discharged 15 onto the paper discharge stacker by means of a paper discharge roller. An image forming apparatus comprising a sheet feeder (medium feeder) including such separator has been disclosed in JP A-2000-203738, for example.

[0004] Moreover, JP-A-10-329968 has disclosed that a paper feeding device (a medium feeding device) for separating and feeding a thick paper without a damage comprises separator for causing the paper fed by paper feeding device (medium feeding device) to abut on a friction member supported on an elastic member and separating the papers fed 20 with an overlap.

[0005] A sheet feeding device (medium feeding device) described in JP-A-2000-203738 includes sheet feeder for feeding a sheet (medium) loaded on sheet loader, and separator provided on the downstream side of the sheet feeder and serving to separate the sheet, and the separator includes a guide member for causing the tip portion of the sheet fed by the sheet feeder to abut thereon, thereby curving and separating the sheet, and a separating roller pair for 25 separating a sheet by means of a feed roller provided on the downstream side of the guide member and serving to feed the sheet to the downstream side and a reverse rotating roller capable of delivering the sheet to an upstream side. The sheet feeding device serves to first cause the tip of the fed sheet to abut on the guide member, thereby separating the sheets fed with an overlap.

[0006] Moreover, a paper feeding device (medium feeding device) described in the JP-A-10-329968 includes paper feeder (medium feeder) for feeding an uppermost one of papers stacked on a paper holder, and an elastic member having one end provided with a friction member on which the paper fed by the paper feeder abuts and having a flexible elasticity in the direction of feed of the paper, and serves to separate the paper by causing the paper to abut on the friction member. 30

[0007] Also in the sheet feeding device which have been described in both JP-A-2000-203738 and JP-A-10-329968, a medium to be fed is caused to abut on the separator, thereby carrying out a so-called frictional separation. Another separating configuration utilizing the frictional separation includes a so-called bank separating method. The bank separating method forms a bank with which the tip of a medium collides on a feeding downstream side from medium feeder such as a pick-up roller and causes the tip of a paper pushed out by the medium feeder to abut on the bank, thereby 35 carrying out a frictional separation.

[0008] In separator utilizing the frictional separation, a transport force (propulsive force) received by the medium from the medium feeder, a reaction force (abutment load) received by the medium from the separator which abuts, and a frictional resistance force to act between a medium on an uppermost layer and a medium on a lower layer are taken into consideration to preset the medium feeder and the separator to be suitable ones in order to reliably separate overlapping papers through the frictional separation. However, the reaction force received by the medium from the 40 separator fluctuates depending on the type and strength of the medium, and furthermore, the reaction force received by the medium from the separator fluctuates also in the case in which the medium is fed with an inclination (hereinafter referred to as "skeW"), for example. By the fluctuation in the reaction force, it is hard to separate the medium by the separator or the medium is not fed. Thus, a separating reliability is deteriorated.

[0009] For example, in the case in which weak plain papers are fed with an overlap and abut on the separator in a skewing state, the reaction force acting on the plain paper becomes smaller than an assumed reaction force, resulting in a state in which the plain paper on the lower layer is fed together with the plain paper on the uppermost layer. In the feeding device having the separator of the bank separating type, thus, there is a problem in that the separating reliability is deteriorated when the plain paper is fed in the skewing state. 50

SUMMARY

55 **[0010]** It is therefore an object of the invention to provide a medium feeding device for preventing media from being fed with an overlap while reliably separating the media even if the media are fed in a skewing state, and a recording

apparatus and a liquid ejecting apparatus, having the feeding device.

[0011] In order to achieve the object, according to the invention, there is provided a feeding device, adapted to feed a medium to a downstream section, comprising:

- a feeder, operable to feed the medium; and
- a separator, provided with an abutment portion on which the medium fed in a first direction by the feeder is adapted to abut and which projects in a second direction opposed to the first direction.

[0012] With this configuration, in the state in which the fed medium is set in the skewing condition, the medium abuts on the abutment portion substantially opposed to the feeder. Therefore, the medium can be caused to abut on the separator in a close position to the feeder. As a result, even if the medium is fed in the skewing state, it is possible to prevent the media from being fed with an overlap while reliably separating the media. Thus, it is possible to obtain a high separating reliability.

[0013] The separator may include a center part and opposite end parts in a third direction perpendicular to the first direction, and the opposites end parts may be lower than the center part in a forth direction perpendicular to the first direction and the third direction. In this case, it is possible to effectively prevent the generation of the fold of a medium having a curled side end which might be caused when the medium passes through the separator.

[0014] The abutment portion may include a plurality of projections, and the projections opposed to the feeder may project greater than the other projections. In this case, in the state in which the fed medium is skewed, the medium abuts on the projections opposed to the feeder. Therefore, it is possible to cause the medium to abut on the separator in a close position to the feeder.

[0015] The projections opposed to the feeder may be arranged so as to adapt flexure of the medium. In this case, the abutment load of the weak medium is increased so that the weak medium can reliably be separated and the overlapping feed of the medium can be prevented.

[0016] The projections opposed to the feeder may be arranged at a substantially center of the separator in a third direction perpendicular to the first direction. In this case, it is possible to reliably separate/feed the medium, thereby enhancing the feeding property of the medium.

[0017] The abutment portion may have a curved surface extending in a third direction perpendicular to the first direction, and a portion of the curved surface, opposed to the feeder, may project greater than the other portions of the curved surface. In this case, in the state in which the fed medium is set in the skewing condition, the medium abuts on the portion opposed to the feeder. Consequently, the medium can be caused to abut on the separator in a close position to the feeder.

[0018] According to the invention, there is also provided a recording apparatus incorporating the above feeding device, comprising a recording unit, disposed in the downstream section and operable to record information on the medium fed by the feeding device.

[0019] According to the invention, there is also provided a liquid ejecting apparatus incorporating the above feeding device, comprising a liquid ejecting unit, disposed in the downstream section and operable to eject liquid toward the medium fed by the feeding device. Consequently, it is possible to provide the recording apparatus or the liquid ejecting apparatus, which produces the functions and effects.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

Fig. 1 is a perspective view showing the whole structure of the appearance of a composite machine of an ink jet type to be one of recording apparatus according to an embodiment of the invention,

Fig. 2 is a perspective view showing the internal structure of the composite machine of the ink jet type in Fig. 1,

Fig. 3 is a schematic side view showing the composite machine of the ink jet type in Fig. 1,

Fig. 4 is a side view showing the details of a paper support and a rear ASF in the composite machine of the ink jet type in Fig. 1,

Fig. 5 is a side view showing the details of a front ASF in the composite machine of the ink jet type in Fig. 1,

Fig. 6 is a perspective view showing a bank separating part according to a first embodiment of the composite machine of the ink jet type in Fig. 1,

Fig. 7 is an enlarged plan view showing the vicinity of the central part of the bank separating part in Fig. 6 and a pick-up roller unit,

Fig. 8 is a front view showing the bank separating part in Fig. 6 as seen from a front side (a view seen in the direction of an arrow X in Fig. 6),

Fig. 9 is a perspective view showing the details of the other main parts of the front ASF in Fig. 5 as seen from a

back side,

Fig. 10 is a perspective view showing the details of the other main parts of the front ASF in Fig. 5 as seen from a front side,

Fig. 11 is a conceptual view for explaining a theoretical equation related to the separation of a paper in the bank separating part of Fig. 6,

Fig. 12 is a conceptual view showing a distance between a point on which a load S is applied and a point on which a bank reaction force R is applied in the bank separating part of Fig. 6,

Fig. 13 is a side view showing a state in which a paper on an uppermost layer is fed while going up a bank inclining part in a related bank separating part,

Fig. 14 is a side view showing a state in which a paper on an uppermost layer is fed while going up a bank inclining part in the bank separating part of Fig. 6,

Fig. 15 is a front view showing a bank inclining part in a bank separating part according to a second embodiment as seen from a front side,

Fig. 16 is a perspective view showing a bank separating part according to a third embodiment in the composite machine of the ink jet type in Fig. 1,

Fig. 17 is an enlarged plan view showing the vicinity of the center of the bank separating part in Fig. 16 and a pick-up roller unit, and

Fig. 18 is a front view showing the bank separating part in Fig. 16 as seen from a front side (a view seen in the direction of an arrow X in Fig. 16).

DETAIL DESCRIPTION OF PREFERRED EMBODIMENTS

[0021] As an embodiment of a medium feeding device according to the invention, a medium feeding device to be used in a printer of an ink jet type which is one of recording apparatuses will be described with reference to Figs. 1 to 14. The embodiments which will be described below do not restrict the invention according to claims and all of the combinations of features described in the embodiments are not always essential to the solving means of the invention.

[0022] The composite machine 100 of the ink jet type has a printer function capable of carrying out recording on a cut-form paper or a postcard having a size of L and A6 to A4 according to the JIS standards, a scanner function capable of reading an original having a size which is equal to or smaller than A4 according to the JIS standards and an original which is equal to or smaller than a letter size according to the US standards, and a copy function capable of carrying out copy on a paper having a size of L, 2L, B5, A4, six cut parts or a postcard according to the JIS standards, for example.

[0023] As shown in Fig. 1, the composite machine 100 of the ink jet type is covered with a housing 101 wholly taking the shape of an almost rectangular parallelepiped, and has a printer 110 provided in a lower stage and a scanner 120 provided in an upper stage. A paper feeding/discharging part 140 including a paper feeding device 142 (see Fig. 3) is provided on a front side and a paper feeding part 130 is provided on a back side. A user can select either or both of the paper feeding part 130 on the back side and the paper feeding/discharging part 140 on the front side in the setting direction of the paper before recording. Therefore, it is possible to enhance the degree of freedom of a position in which the composite machine 100 of the ink jet type is provided. Furthermore, the paper subjected to the recording is always discharged from the paper feeding/discharging part 140 on the front side. Therefore, the user can easily take out the paper.

[0024] A scanner cover 102 taking the shape of a rectangular plate shown in Fig. 1 is provided on the upper part of the housing 101. The scanner cover 102 has a pull 103 formed in a front part, and is attached pivotably in the direction of an arrow A in the drawing about a pivoting axis in a rear part. When using the scanner 120, the user can insert fingers into a pull 103, thereby opening and closing the scanner cover 102. Consequently, it is possible to easily put an original in and out.

[0025] Cartridge housing parts 104 for putting a plurality of ink cartridges 109 in and out shown in Fig. 2 are formed on both sides of the front surface of the housing 101. The ink cartridges 109 store inks having respective colors for recording. Each of the cartridge housing parts 104 is covered with a transparent or translucent cartridge cover 105 shown in Fig. 1. The cartridge cover 105 is attached pivotably in the direction of an arrow B in the drawing about a pivoting axis in a lower part thereof. The user can carry out a work for exchanging the ink cartridge 109 by only pushing the cartridge cover 105 lightly to remove an engagement portion and open the cartridge housing part 104 without lifting the whole scanner 120 having a great weight and opening the inner part of the printer 110 as in the related art. Consequently, it is possible to enhance a working efficiency.

[0026] An operating part 106 for giving an instruction for each operation of the printer 110, the scanner 120 and a copy is provided on this side of the scanner cover 102 on the upper surface of the housing 101 as shown in Fig. 1. The operating part 106 includes buttons (not shown) for a power system for turning ON/OFF a power, an operating system for operating to find the top of a paper or to flash ink, and a processing system for carrying out an image processing, and a liquid crystal panel 107 for displaying a state. The user can operate the buttons while seeing and confirming the liquid crystal panel 107.

[0027] As shown in Figs. 2 and 3, the paper feeding/discharging part 140 including the paper feeding device 142, the paper feeding part 130 and a recorder 150 are provided in the housing 101. As shown in Fig. 1, the paper feeding part 130 is provided with a rear paper feeding port 31 which is rectangularly opened upward and a frame 32 along both edges and a rear edge of the rear paper feeding port 31. As shown in Figs. 1 to 3, the frame 32 is provided with a paper support 33 for supporting at least one paper to be fed and a back paper feeding mechanism (hereinafter referred to as a "rear ASF") for automatically feeding the papers supported on the paper support 33 one by one.

[0028] With reference to Figs. 1 to 4, description will be given to the paper feeding part 130. The paper support 33 is almost constituted by a first support 33a and a second support 33b which support the back of the paper, and is linked to a pair of edge guides (a movable edge guide 35a and a fixed edge guide 35b) for regulating the width of the paper on both sides.

[0029] The first support 33a is formed like a plate and is provided to be freely stored in and pulled out of the inside of the rear wall of the frame 32, and the second support 33b is formed like a plate and is provided to be freely stored in and pulled out of the first support 33a. Since the first support 33a and the second support 33b are formed to be, freely expanded and contracted in a paper feeding direction, they can be stored to be compact in non-use, and furthermore, can reliably support papers having various sizes in use.

[0030] The fixed edge guide 35b is formed to take a shape along a right side wall as seen from the front side of the apparatus of the frame 32 and the movable edge guide 35a is formed to take a shape along a left side wall as seen from the front side of the apparatus of the frame 32, and they are attached movably in almost parallel with the rear wall of the frame 32 between the left and right side walls of the frame 32 (see Fig. 2). The movable edge guide 35a and the fixed edge guide 35b can reliably guide both side edges of a paper even if the paper has various sizes. Therefore, it is possible to reliably feed the paper.

[0031] The ASF 34 shown in Fig. 4 includes a hopper 36 for lifting the paper supported on the paper support 33 to be fed, a paper feed roller 37 for taking out the paper lifted by the hopper 36, a rear retard roller 38 for separating the papers fed with an overlap by the paper feed roller 37 one by one, and a paper return unit 39 (see Fig. 4) for returning the residual paper separated from the rear retard roller 38 to the hopper 36.

[0032] The hopper 36 is formed like a plate capable of stacking papers thereon and is provided in almost parallel with the rear wall of the frame 32, and has a lower end positioned in the vicinity of the paper feed roller 37 and has an upper end positioned close to the top part of the rear wall of the frame 32 (see Figs. 2 and 4). One of the ends of a compression spring (not shown) having the other end attached to the rear wall of the frame 32 is fixed to a back on a lower end side in the hopper 36, and the hopper 36 is provided in such a manner that the lower end side is turned around an upper end side by the expansion and contraction of the compression spring.

[0033] The paper feed roller 37 is formed to take the shape of D having a section taken away partially and is provided in the vicinity of the lower end of the hopper 36, and is rotated intermittently to frictionally feed the paper lifted by the hopper 36 (see Fig. 4). The rear retard roller 38 is provided to freely abut on the paper feed roller 37 and serves to frictionally separate only a paper on an uppermost layer from a paper on a lower layer when the papers are fed with an overlap through the paper feed roller 37. The rear paper return unit 39 is formed like a click and is provided in the vicinity of the paper feed roller 37, and the paper on the lower layer which is separated through the rear retard roller 38 is hung on the click and is returned on the hopper 36 (see Fig. 4).

[0034] Next, the paper feeding/discharging part 140 including the paper feeding device 142 according to the invention will be described with reference to Figs. 2 and 3. As shown in Figs. 2 and 3, the paper feeding/discharging part 140 is provided with a front paper feeding/discharging port 141 which is rectangularly opened forward, and the paper feeding device 142 is provided on the inner side of the front paper feeding/discharging port 141. As shown in Fig. 3, the paper feeding device 142 is almost constituted by a paper feed tray 40 to be a medium housing part for accommodating a medium (a paper), a front paper feeding mechanism (hereinafter referred to as a "front ASF") 144 for automatically feeding the papers accommodated in the paper feed tray 40 one by one, and a front paper discharging mechanism (hereinafter referred to as a "front EJ") 145 for automatically discharging a paper to a paper discharge tray 143 provided above the paper feed tray 40.

[0035] As shown in Figs. 2 and 3, the paper feed tray 40 is formed like a plate and a paper to be fed before recording is stacked and accommodated almost horizontally on an upper surface. The paper discharge tray 143 includes a first tray 143a, a second tray 143b and a third tray 143c as shown in Figs. 2 and 3. The first tray 143a is formed like a plate and has a rear part provided pivotably on a body frame 108 in the inner part of the paper feeding/discharging part 140, the second tray 143b is formed like a plate and is provided to be freely stored in and pulled out of the first tray 143a, and the third tray 143c is formed like a plate and is provided to be freely stored in and pulled out of the second tray 143b.

[0036] In the paper discharge tray 143 shown in Fig. 3, a paper to be discharged after the recording is stacked and loaded on an upper surface in a state in which the second tray 143b and the third tray 143c are pulled out. Since the second tray 143b and the third tray 143c are formed to be freely expanded and contracted in a paper discharging direction, they can be stored to be compact in non-use and can reliably stack and load the papers having various sizes to be discharged thereon in use. The paper feeding/discharging part 140 is also formed to manually feed and discharge

a medium such as a thick paper or an optical disk which cannot be bent when the paper is fed and discharged.

[0037] With reference to Figs. 3 and 5, description will be given to the front ASF 144. The front ASF 144 includes a pick-up roller unit for pushing out a paper accommodated in the paper feed tray 40, and a bank separating part (first separator) 42 for causing the tip of the paper pushed out by the pick-up roller unit 41 to abut thereon and separating the papers fed with an overlap. Furthermore, the front ASF 144 according to the embodiment includes a retard separating part 43 to be second separator for separating the overlapping papers which cannot be separated by a bank separating part 42, and an intermediate roller 45 and an assist roller 46 which invert the fed paper to be U-shaped.

[0038] The pick-up roller unit 41 is disposed above the rear part of the paper feed tray 40 and is provided to be pivotable vertically with respect to the paper feed tray 40, and descends to frictionally feed the paper accommodated in the paper feed tray 40. The bank separating part 42 is linked to the inner side of the paper discharge tray 40 and a rear part (an inner part) thereof is formed to be inclined rearward. The tip of the paper pushed out by means of the pick-up roller unit 41 abuts on the inclined rear part. Consequently, the papers are separated while the direction of feed of the paper is changed upward. The details of the bank separating part 42 will be described below with reference to Figs. 6 to 8.

[0039] The retard separating part 43 is almost constituted by a retard roller unit 43a and a front paper return unit 43b for pushing and returning the paper on the lower layer which is separated by the retard roller unit 43a. The retard roller unit 43a is provided to freely abut on the intermediate roller 45, and the overlapping papers which cannot be perfectly separated by the bank separating part 42 are frictionally separated by means of the retard roller unit 43a and the intermediate roller 45. The front paper return unit 43b is formed like a click and is provided in the vicinity of the retard roller unit 43a, and hangs the paper on the lower layer which is separated by the retard roller unit 43a on the click and thus pushes and returns the paper toward the bank separating part 42 side.

[0040] The assist roller 46 is provided on a slightly left position above the intermediate roller 45 so as to always abut on the intermediate roller 45, and interposes, together with the intermediate roller 45, a paper on an uppermost layer which is separated by the retard roller unit 43a, and inverts the paper to be U-shaped and feeds the paper to a platen 55. As shown in Fig. 5, a paper feeding path for delivering the paper includes an inverting section formed along the outer peripheral surface (left half) of the intermediate roller 45 and the assist roller 46 is provided in the middle of the second half of the inverting section.

[0041] On the other hand, the retard roller unit 43a is provided in the middle of the first half of the inverting section of the paper feeding path. More specifically, the retard roller unit 43a is provided to freely abut on the intermediate roller 45 in the middle of the first half of the inverting section of the paper feeding path and the assist roller 46 to always abut on the intermediate roller 45 is provided in the middle of the second half of the inverting section. Consequently, the paper to be inverted and fed along the outer peripheral surface of the intermediate roller 45 is interposed between the intermediate roller 45 and the retard roller unit 43a in the first half of the inverting section and is interposed between the intermediate roller 45 and the assist roller 46 in the second half of the inverting section. Therefore, it is possible to stably feed the paper in the paper feeding path taking an almost U shape.

[0042] The front EJ145 includes a first paper discharge roller 48a, a first spur roller 49a, a second paper discharge roller 48b and a second spur roller 49b as shown in Fig. 3. The first paper discharge roller 48a is provided on the downstream side of the transport of the plate 55 and interposes the paper passing through the platen 55 together with the first spur roller 49a and discharges and feeds the same paper, and furthermore, the second paper discharge roller 48b is provided on the downstream side of the transport of the first paper discharge roller 48a and interposes the paper together with the second spur roller 49b and discharges and feeds the same paper onto the paper discharge tray 143.

[0043] Next, the recorder 150 will be described with reference to Figs. 2 and 3. The recorder 150 is provided with a paper feed roller 51 for feeding a paper in a sub scanning direction synchronously with a recording operation, a driven roller 52, a carriage 53 for moving in a main scanning direction synchronously with the recording operation, a recording head 54 for ejecting an ink synchronously with the recording operation, and the platen 55 for flatly holding the paper during the recording as shown in Fig. 3.

[0044] As shown in Fig. 3, the paper feed roller 51 is provided on the upstream side of the transport of the platen 55 and interposes the paper fed by the paper feeding roller 37 or the paper inverted and fed by the paper feed tray 40 through the intermediate roller 45 together with the driven roller 52 by means of the paper feeding mechanism 56 shown in Fig. 2, and feeds the paper to the platen 55. The carriage 53 is provided through a carriage guide shaft 57 shown in Fig. 3 above the platen 55 and is coupled to a carriage belt 58 (see Fig. 2), and is guided to the carriage guide shaft 57 and is reciprocated together with the motion of the carriage belt 58 when the carriage belt 58 is operated by means of a carriage motor 59 shown in Fig. 2.

[0045] The recording head 54 is mounted on the carriage 53 to form a predetermined interval from the platen 55 as shown in Fig. 3, and includes a recording head for black ink which serves to eject the black ink, and a plurality of recording heads for color inks which serve to eject inks having five colors of yellow, cyan, light cyan, magenta and light magenta respectively, for example. The recording head 54 is provided with a pressure generating chamber and a nozzle opening connected thereto, and the ink is stored in the pressure generating chamber to carry out a pressurization at a predetermined pressure, thereby ejecting an ink droplet having a size controlled from the nozzle opening toward the paper.

[0046] Next, the bank separating part 42 to be a characteristic part of the invention will be described with reference to Figs. 6 to 8.

[0047] As shown in Fig. 6, the bank separating part 42 is almost constituted by a bottom portion 421 linked to the paper feed tray 40, and a bank inclining portion 420 formed on the inner side end of the bottom portion 421 so as to be inclined rearward.

[0048] A plurality of ribs 422 (a first rib 422a, a second rib 422b and a third rib 422c) is formed in the bank inclining portion 420, and the top surface of the rib 422 abuts on the tip of the paper stacked and accommodated on the paper feed tray 40. The inclination angle of the bank inclining portion 420 and the surface condition of the top surface of the rib greatly influence the separation of the papers. Therefore, a suitable condition is set in consideration of the paper (medium) to be fed.

[0049] As shown in Figs. 6 and 8, four ribs provided in the vicinity of the center of the bank inclining portion 420 serve as the first ribs 422a, ribs on an outside provided in the vicinity of both ends of the bank inclining portion 420 serve as the second ribs 422b, and three ribs provided between the first rib 422a and the second rib 422b serve as the third ribs 422c. The first ribs 422a are provided opposite to the pick-up roller unit 41 and is provided on the pick-up roller unit 41 side from the second ribs 422b and the third ribs 422c as shown in Fig. 7.

[0050] More specifically, the top surface of the first rib 422a is provided to be protruded toward the pick-up roller unit 41 side from the top surface of the second rib 422b and that of the third rib 422c. In the embodiment, the (four) top surfaces of the first rib 422a is provided to form an almost identical plane, and the tip of the paper can abut on each of the top surfaces of the four first ribs 422a. Each of the top surfaces of the second rib 422b and the third rib 422c is provided to form an almost identical plane, or each of the top surfaces of the second rib 422b is provided to form an almost identical plane and each of the top surfaces of the third rib 422c is provided to form an almost identical plane.

[0051] As shown in Fig. 8, in the bank separating part 42, the heights of banks on the left and right ends of the bank inclining portion 420 provided with the second ribs 422b are set to be smaller than those of banks in the other portions. The height of the bank implies the height of the bank inclining portion 420 on which the ribs are formed, that is, the height of the bank that the paper to be fed goes up. As shown in Fig. 8, the lengths of the four first ribs 422a and the three third ribs 422c on the left and right are almost equal to each other and the lengths of the second ribs 422b are set to be smaller.

[0052] Thus, the bank separating part 42 is characterized in that the heights of the banks on both left and right ends of the bank inclining portion 420 provided with the second ribs 422b respectively are smaller than the heights of the banks in the other portions. Consequently, it is possible to prevent a paper fold from being generated when a paper having a curled (curved) side end goes up the bank inclining portion 420 and is fed. The generation of the paper fold and the prevention thereof will be described below with reference to Figs. 13 and 14.

[0053] Subsequently, description will be given to the separation of the papers fed with an overlap in the bank separating part 42. As shown in Fig. 3, the paper mounted correctly on the paper feed tray 40 is stacked and accommodated with a tip thereof abutting on the bank inclining portion 420 (each top surface of the first rib 422a). The pick-up roller unit 41 pushes out and feeds a paper on an uppermost layer in a leftward direction in Fig. 3 while pressing the paper on the uppermost layer from above. In this case, a load in a vertically downward direction and a propulsive force in a horizontal direction (a leftward direction in Fig. 3) which are received from the pick-up roller unit 41, a bank reaction force (an abutment load) received from the bank inclining portion 422, and a frictional resistance force with a paper on a lower layer act on the paper on the uppermost layer. The details will be described below with reference to Fig. 11.

[0054] In consideration of the action of various forces applied to the paper on the uppermost layer, the load of the pick-up roller unit 41 and the inclination angle of the bank inclining portion 420 are set into a suitable condition in such a manner that only the paper on the uppermost layer goes up the bank inclining portion 420 and is thus fed. When the pick-up roller unit 41 is driven to start to feed the paper, consequently, the paper feeding direction of only the paper on the uppermost layer is converted into an upward direction in the bank inclining portion 420 and the paper is fed to the retard separating part 43 to be the second separator.

[0055] Fig. 10A shows the state of the retard separating part 43 (the retard roller unit 43a and the front paper return unit 43b) in a standby or recording and Fig. 10B shows a state of the retard separating part 43 in paper feeding. Subsequently, description will be given to the retard separating part 43 (the retard roller unit 43a and the front paper return unit 43b).

[0056] The retard roller unit 43a includes a retard roller 61 for abutting on the intermediate roller 45, and separating the overlapping papers which cannot be perfectly separated in the bank separating part 42 and feeding only the paper on the uppermost layer, and a roller holder 62 for pivotally supporting the retard roller 61 rotatably and causing the retard roller 61 to abut on and separate from the intermediate roller 45. The retard roller 61 is formed cylindrically and a circumferential surface (an outer peripheral surface) is covered with a rubber in order to increase a coefficient of friction, for example. Moreover, the retard roller 61 has no driving source and is rotatable. By the action of a torque limiter which is not shown, however, a predetermined rotating resistance (moment) is generated. The roller holder 62 pivotally supports the retard roller 61 rotatably at one of ends and has the other end supported pivotally on the frame 47, and has one end side which can be turned around the other end side, that is, holds the retard roller 61 to be pivotable.

[0057] The front paper return unit 43b includes a paper return member 71 for abutting on the tip of the paper on the lower layer which is separated by means of the retard roller 61 and pushing back the paper on the lower layer, a paper return shaft 72 for pivoting the paper return member 71 and pivoting the retard roller 61, and a cam floor 73 and a cam clutch 74 (see Fig. 9) which transmit a driving force from a feeding motor (not shown) to the paper return shaft 72. The paper return member 71 takes the shape of a click and is formed integrally with the paper return shaft 72 so as to be protruded from the paper return shaft 72 at both sides of the retard roller 61. The cam floor 73 is formed to be L-shaped and is formed integrally with the paper return shaft 72 so as to be protruded from one of the ends of the paper return shaft 72. The cam clutch 74 is supported rotatably on the frame 47 and is formed to take such a shape as to freely abut on and separate from the cam floor 73 in order to intermittently rotate the paper return shaft 72.

[0058] The paper return shaft 72 is supported rotatably on the frame 47. As described above, the paper return member 71 is positioned on both sides of the retard roller 61. When the paper return shaft 72 is formed to take the shape of a straight bar, therefore, it interferes with the roller holder 62. As shown in Fig. 9, a portion 72a of the paper return shaft 72 which interferes with the roller holder 62 is formed to take the shape of a crank in order to avoid the roller holder 62.

[0059] Furthermore, the paper return shaft 72 has function of pivoting the paper return member 71 and pivoting the retard roller 61. For this reason, as shown in Fig. 14, a cam 75 for pivoting the roller holder 62 is formed integrally with the paper return shaft 72 and a cam receiver 65 for abutting on and separating from the cam 75 is formed integrally with the roller holder 62. The crank 72a in the paper return shaft 72, the paper return member 71 and the cam 75 are formed to regulate a phase. When the paper return shaft 72 is rotated, consequently, the paper return member 71 can be pivoted and the retard roller 61 can be pivoted without an interference with the roller holder 62.

[0060] With such a structure, description will be given to an operation to be carried out in the case in which recording is performed over a paper in the composite machine 100 of the ink jet type. A user accommodates a plurality of papers before recording in the paper feed tray 40 and starts the composite machine 100 of the ink jet type. The papers stacked and accommodated in the paper discharge tray 40 are pushed out by means of the pick-up roller unit 41 and the tips of the papers thus pushed out are frictionally separated while abutting on the bank inclining portion 420, and the paper on an uppermost layer is fed toward the intermediate roller 45 side provided above. In this case, the overlapping papers which cannot be perfectly separated in the bank separating part 42 are separated again by means of the retard roller unit 43a driven by the paper return shaft 72 and the intermediate roller 45, and the paper on an uppermost layer is fed by means of the intermediate roller 45 and the paper on a lower layer which is separated is pushed back toward the paper feed tray 40 side by means of the paper return member 71 driven by the paper return shaft 72. The fed paper is skewed and a top thereof is found, and the same paper is then interposed between the paper feed roller 51 driven by the paper feeding mechanism 56 and the driven roller 52 and is fed to the platen 55.

[0061] The paper fed to the platen 55 is recorded by means of the recording head 54 mounted on the carriage 53 to be scanned by the carriage motor 59 and the carriage belt 58. At this time, the control part of the composite machine 100 of the ink jet type supplies inks having respective colors from ink cartridges having seven colors in total, that is, yellow, magenta, light magenta, cyan, light cyan and black, for example, to the recording head 54 and controls the discharge timing of each of the color inks and the driving operations of the carriage 53 and the paper feed roller 51, thereby executing an ink dot control with high precision and a halftone processing. The paper subjected to the recording is interposed between the first paper discharge roller 48a and the first spur roller 49a and between the second paper discharge roller 48b and the second spur roller 49b which are driven by means of the paper feeding mechanism 56, and is discharged to the paper feeding and discharging portion 140 and is stacked and mounted on the paper discharge tray 143. Next, the invention will be described in detail with reference to Figs. 11 to 14. First of all, description will be given to a theoretical equation related to the separation of a paper in the bank separating part 42.

[0062] P1, P2 and P3 shown in Fig. 11 indicate papers which are stacked and accommodated (a paper on an uppermost layer is indicated as P1, a paper placed under P1 is indicated as P2, and a paper placed under P2 is indicated as P3), and the tip of each of the papers abuts on the bank inclining portion 420. Although a clearance is formed among the papers P1, P2 and P3 in Fig. 11 for convenience of explanation, the papers P1, P2 and P3 are always stacked without the clearance.

[0063] When the paper is started to be fed, subsequently, a load S received from the pick-up roller unit 41 acts on the paper P1 from above. In this case, a frictionally propulsive force F (hereinafter referred to as a "propulsive force F") received by the paper P1 from the pick-up roller unit 41 acts in a rightward direction in Fig. 11 (hereinafter referred to as a "rightward direction in the drawing"). More specifically, although the paper P1 tries to be moved in the rightward direction in the drawing by the propulsive force F, a reaction force R1 (hereinafter referred to as a "bank reaction force R1") in the leftward direction in Fig. 11 (hereinafter referred to as a "leftward direction in the drawing") is received by the bank inclining portion 420 because the tip of the paper P1 abuts on the bank inclining portion 420.

[0064] When a greater propulsive force F than the bank reaction force R1 is applied, the paper P1 starts to go up the bank inclining portion 420. However, the paper P1 is placed in contact with the paper P2 on the lower layer. For this reason, a frictional resistance force f is applied to the paper P1 and the paper P2 (a frictional resistance force in the leftward direction in the drawing which is applied to the paper P1 is represented as f1 and a frictional force in the rightward

direction in the drawing which is applied to the paper P2 is represented as f_2). More specifically, when the propulsive force F is greater than the total of the bank reaction force R_1 and the frictional resistance force f_1 , the paper P1 starts to be moved in the rightward direction in the drawing so that the feeding direction of the paper P1 is changed in the bank inclining portion 420 so that the paper is fed.

[0065] The propulsive force F and the frictional resistance force f (f_1 , f_2) are defined by Equations (1) and (2). A coefficient of friction of the pick-up roller unit 41 and the paper P1 is represented as μ_1 and a coefficient of friction of the paper P1 and the paper P2 is represented as μ_2 .

$$F = \mu_1 \cdot S \quad \dots \text{Equation (1)}$$

$$f = \mu_2 \cdot S \quad \dots \text{Equation (2)}$$

[0066] On the other hand, when the paper P1 is started to be fed (moved), the frictional resistance force f_2 in the rightward direction in the drawing applied to the paper P2. More specifically, the paper P2 is apt to be fed together with the paper P1 (with an overlap).

[0067] Since the tip of the paper P2 abuts on the bank inclining portion 420, however, a bank reaction force R_2 in the leftward direction in the drawing is received by the bank inclining portion 420. In consideration of the coefficients of friction of the papers (media) in such a manner that the bank reaction force R_2 is greater than the frictional resistance force f_2 in the bank inclining portion 420, the inclination angle of the bank inclining portion 420 and the material, size and surface condition of the rib 422 are set into a suitable state. Thus, the bank reaction force R_2 acting on the paper P2 is greater than the frictional resistance force f_2 . Therefore, the paper P2 can be prevented from being fed together with the paper P1. More specifically, the paper P1 on the uppermost layer is fed and the paper P2 on the lower layer is not fed. Consequently, the papers in the bank separating part 42 can be separated.

[0068] On the other hand, in the case in which the media having a remarkably high coefficient of friction between the media are fed (that is, a great increase in the frictional resistance force f_2) or the case in which the bank reaction force R_2 is reduced due to a skew which will be described below, the paper P2 also starts to go up the bank inclining portion 420 together with the paper P1 when the greater frictional resistance force f_2 than the bank reaction force R_2 is applied. The paper P2 is also placed in contact with the paper P3 on the lower layer. Therefore, a frictional resistance force g is applied to the paper P2 and the paper P3 (a frictional resistance force in the leftward direction in the drawing which is applied to the paper P2 is represented as g_2 and a frictional resistance force in the rightward direction in the drawing which is applied to the paper P3 is represented as g_3). If the frictional resistance force f_2 is greater than the total of the bank reaction force R_2 and the frictional resistance force g_2 , therefore, the paper P2 starts to be moved in the rightward direction in the drawing and are fed with an overlap together with the paper P1.

[0069] The frictional resistance force g (g_1 , g_2) is defined by Equation (3) in the same manner as the frictional resistance force f (f_1 , f_2). A coefficient of friction of the paper P1 and the paper P2 is represented as μ_2 . Moreover, the paper P3 is separated or fed (with an overlap) in the same manner as the paper P2.

$$g = \mu_3 \cdot S \quad \dots \text{Equation (3)}$$

[0070] Next, a condition for separating the papers in the bank separating part 42 will be indicated in Equations (4) and (5).

$$F > R_1 + f_1 \quad \dots \text{Equation (4)}$$

$$f_2 < R_2 + g_2 \quad \dots \text{Equation (5)}$$

[0071] More specifically, the Equation (4) represents that the propulsive force F is greater than the total of the bank reaction force R_1 and the frictional resistance force f_1 and implies that the paper P1 goes up the bank separating part 42 and is thus fed as described above. The Equation (5) represents that the frictional resistance force f_2 is smaller than

the total of the bank reaction force R2 and the frictional resistance force g2 and implies that the paper P2 is not fed.

[0072] When the Equations (4) and (5) are transformed, the load S applied from the pick-up roller unit 41 is defined as shown in Equation (6).

$$R2 / (\mu2 - \mu3) < S < R1 / (\mu1 - \mu2) \quad \dots \text{Equation (6)}$$

[0073] Herein, the bank reaction forces R1 and R2 may be equal to each other ($R1 = R2 = R$). Therefore, the load S is defined as in Equation (7).

$$R / (\mu2 - \mu3) < S < R / (\mu1 - \mu2) \quad \dots \text{Equation (7)}$$

[0074] More specifically, the suitable load S for the pick-up roller unit 41 is defined by the bank reaction force R given to the paper by the bank inclining portion 420. Thus, it is important to ascertain the load S of the pick-up roller unit 41 and the bank reaction force R given to the paper by the bank inclining portion 420, and it is preferable that a variation in the bank reaction force R should be suppressed and the bank reaction force R should be equal to or greater than a predetermined reaction force in order to enhance the reliability of the separation of the paper in the bank separating part 42.

[0075] Next, description will be given to the stabilization of the bank reaction force R. The magnitude of the bank reaction force R applied to a weak medium such as a plain paper is generally proportional inversely to the square of a distance between a point on which the load S is applied and a point on which the bank reaction force R is applied. More specifically, the bank reaction force R is reduced when the distance between the point on which the load S is applied and the point on which the bank reaction force R is applied is increased. In order to stabilize the bank reaction force R to be applied to the medium, therefore, it is important to suppress a variation in the distance between the point on which the load S is applied and the point on which the bank reaction force R is applied.

[0076] Figs. 12A and 12B show comparative examples in which a plurality of ribs are formed in a bank inclining portion 520 in such a manner that the top surfaces of the ribs form planes which are almost on the same level with each other, and Fig. 12C shows an example according to the embodiment in which the first rib 422a is provided in an opposed position to the pick-up roller unit 41. Fig. 12C is a conceptual view for explaining a distance between the point on which the load S is applied and the point on which the bank reaction force R is applied according to the embodiment, and the numbers of the first, second and third ribs 422a, 422b and 422c are not coincident with those described above.

[0077] Fig. 12A shows a state in which a paper P11 abuts on a bank inclining portion 520 in a correct paper feeding direction (an orthogonal direction to the bank inclining portion 520) and Fig. 12B shows a state in which a paper P12 abuts on the bank inclining portion 520 in a skewing state. In Fig. 12A, a plurality of ribs formed in the bank inclining portion 520 abuts on the tip of the paper P11 because the tops of the ribs are almost on the same level with each other. In this case, the distance between the point on which the load S is applied and the point on which the bank reaction force R is applied is represented as L1.

[0078] On the other hand, in Fig. 12B, the paper P12 is set in the skewing state. Therefore, the tip of the paper P12 abuts on the rib on a right end and the distance between the point on which the load S is applied and the point on which the bank reaction force R is applied is represented as L2. By skewing the paper P12, the distance between the point on which the load S is applied and the point on which the bank reaction force R is applied is greatly increased from L1 to L2. Consequently, the bank reaction force R received by the paper P12 is decreased to be smaller than the bank reaction force R received by the paper P11.

[0079] More specifically, when a predetermined bank reaction force is not applied to the paper P12, the Equation (5) is not formed so that a paper on a lower layer is fed together with a paper on an uppermost layer. When the ribs formed in the bank inclining portion 520 are provided in such a manner that the top surfaces of the ribs are almost on the same level with each other (a state in which the ribs are arranged in a line), thus, there is a problem in that the reliability of the separation of the paper (the separation of the medium) is remarkably deteriorated if the paper is skewed.

[0080] On the other hand, Fig. 12C shows a state in which a paper P13 abuts on the bank inclining portion 420 in a skewing condition. In Fig. 12C, the tip of the paper P13 abuts on the first rib 422a and the distance between the point on which the load S is applied and the point on which the bank reaction force R is applied is represented as L3. In the case in which the paper P13 abuts on the bank inclining portion 420 in a correct paper feeding direction in the same manner as in Fig. 12A, moreover, the distance between the point on which the load S is applied and the point on which the bank reaction force R is applied is represented as L4. More specifically, while the distance between the point on which the load S is applied and the point on which the bank reaction force R is applied is increased from L4 to L3 by skewing the paper P13, an increase is smaller than the increase from L1 to L2.

[0081] As shown in Fig. 12C, moreover, the pick-up roller unit 41 and the first rib 422a opposed to the pick-up roller unit 41 are provided on almost a center in a transverse direction (a rectangular feeding direction) of the bank inclining portion 420. The pick-up roller unit 41 and the first rib 422a are provided on almost the center in the transverse direction of the bank inclining portion 420. Therefore, the paper P13 can be fed reliably. Also in the case in which the paper P13 is skewed symmetrically with that in Fig. 12C (that is, the case in which the paper P13 is inclined in a clockwise direction), a countermeasure can be taken in the same manner.

[0082] In the invention, thus, the first rib 422a opposed to the pick-up roller unit 41 is provided on the pick-up roller unit 41 side from the second rib 422b and the third rib 422c, that is, the top surface of the first rib 422a is provided to be protruded toward the pick-up roller unit 41 side from the top surfaces of the second and third ribs 422b and 422c. Consequently, the tip of the paper abuts on the top surface of the first rib 422a even if the paper is skewed.

[0083] Furthermore, the pick-up roller unit 41 and the first rib 422a are provided on almost the center in the transverse direction of the bank inclining portion 420 to cause the tip of the paper to abut on the top surface of the first rib 422a even if the paper is skewed in any direction. Also in the case in which the paper is skewed in any direction, consequently, the increase in the distance between the point on which the load S is applied and the point on which the bank reaction force R is applied can be reduced to be small. Consequently, it is possible to suppress a decrease in the bank reaction force R and to enhance the reliability of the separation of the paper in the bank separating part 42. Next, the invention will be described with reference to Figs. 13 and 14.

[0084] The bank inclining portion 620 shown in Fig. 13 has an almost equal bank height in a transverse direction (a perpendicular direction to the paper in Fig. 13) as a comparative example of the bank inclining portion 420 according to the embodiment. The bank inclining portion 420 shown in Fig. 14 is formed in such a manner that the heights of the banks on both side ends are smaller than the heights of the banks in the other portions as described above. The paper P21 shown in Fig. 13 is an uppermost one of papers P which are stacked. Fig. 13 shows one side end of the paper P21 going up the bank inclining portion 620. Referring to the paper P31 on the uppermost layer shown in Fig. 14, similarly, one side end of the paper P31 going up the bank inclining portion 420 (the second rib 422b) is illustrated in Fig. 14.

[0085] Fig. 13A shows a state in which the paper P21 having a downward curved (curled) tip corner is started to be fed, Fig. 13B shows a state in which the paper P21 goes up the bank inclining portion 620, and Fig. 13C shows a state in which the paper P21 completely goes up the bank inclining portion 620. In the bank inclining portion 620 according to the comparative example, there is a possibility that the feed of the paper P21 might be progressed in such a manner that the curved portion is rolled up as shown in Fig. 13B and the corner of the paper P21 might be folded, that is, a paper fold might be caused as shown in Fig. 13C.

[0086] Fig. 14A shows a state in which the paper P31 having a tip corner curved downward is started to be fed, Fig. 14B shows a state in which the paper P31 goes up the bank inclining portion 420 (the second rib 422b), and Fig. 14C shows a state in which the paper P31 completely goes up the bank inclining portion 420 (the second rib 422b). In the bank inclining portion 420 according to the embodiment, as shown in Fig. 14B, the paper P31 is fed in such a manner that a curled portion is rolled up in the same manner as the paper P21. In the bank inclining portion 420, however, the heights of banks on both side ends are formed to be smaller than the heights of banks in the other portions. As shown in Fig. 14C, therefore, it is possible to carry out restoration before the corner of the paper P31 completely going up the bank inclining portion 420 (the second rib 422b) is folded. Consequently, it is possible to prevent the paper from being folded. By setting the heights of the banks on both side ends of the bank inclining portion 420 to be smaller than those of the banks in the other portions, thus, it is possible to effectively prevent the paper from being folded when the paper passes through the bank separating part 42 (the bank inclining portion 420).

[0087] Next, a second embodiment of the bank separating part 42 of the invention will be described with reference to Fig. 15.

[0088] Fig. 15A shows a positional relationship between a plurality of ribs 722 formed in the bank inclining portion 720 and the pick-up roller unit 41, and Fig. 15B shows a state in which a weak paper P41 abuts on the bank inclining portion 720. The bank separating part 42 according to the second embodiment is different from the bank separating part 42 according to the first embodiment in that fourth ribs 722d are further formed between first ribs 722a which are provided opposite to the pick-up roller unit 41, and the other structures are the same as those of the bank separating part 42. More specifically, a second rib 722b (not shown) is provided in the vicinity of both ends of the bank inclining portion 720 and a third rib 722c is provided between the first rib 722a and the second rib 722b. Since the basic structure of the bank separating part 42 according to a second embodiment is the same as that of the bank separating part 42 according to the first embodiment, description thereof will be omitted.

[0089] The fourth ribs 722d are disposed to be retracted from the first ribs 722a in the same manner as the third rib 722c as shown in Fig. 15. More specifically, the top surfaces of the first ribs 722a are provided to be protruded toward the pick-up roller unit 41 side from the top surface of the third rib 722c and that of the fourth rib 722d. An interval between the first ribs 722a provided in opposed positions to the pick-up roller unit 41 is almost equal to the width of a roller in the pick-up roller unit 41. The interval between the first ribs 722a corresponds to a distance at which the flexure of the weak paper P41 such as a plain paper can be accommodated.

[0090] More specifically, the tip of the weak paper P41 is changed as shown in Fig. 15B to cause a parallel flexure with a feeding direction over the paper P41. The weak paper P41 has a small stiffness in the feeding direction. For this reason, it is hard to apply a preset bank reaction force R to the paper P41. As a result, the reliability of the separation of the paper is deteriorated. The fourth ribs 722d are disposed behind the first ribs 722a in order to easily cause a parallel flexure with the feeding direction over the paper P41 by pushing out the pick-up roller unit 41 when the weak paper P41 is to be fed, and furthermore, the first ribs 722a and 722a are disposed in such a manner that the interval between the first ribs 722a is almost equal to the width of the roller of the pick-up roller unit 41.

[0091] The paper P41 generating the parallel flexure with the feeding direction is increased in stiffness in the feeding direction. Therefore, it is possible to reliably receive the bank reaction force R from the bank inclining portion 720. Thus, the interval between the first ribs 722a provided opposite to the pick-up roller unit 41 is caused to correspond to such an interval that the flexure of the medium (paper) can be accommodated. Consequently, the bank reaction force R acting on the weak paper (medium) can be increased and the reliability of the separation of the paper in the bank separating part 42 can be maintained also in the weak paper (medium).

[0092] Next, a third embodiment of the bank separating part 42 will be described with reference to Figs. 16 to 18 corresponding to Figs. 6 to 8. The same structures as those in Figs. 6 to 8 have the same reference numerals and their description will be omitted.

[0093] As shown in Fig. 16, the bank separating part 42 includes a bank inclining portion 820 to be inclined rearward on the inner side end of a bottom portion 421 linked to a paper feed tray 40.

[0094] As shown in Fig. 16, the bank inclining portion 820 is formed like an arcuate tip plate with the bottom portion 421 side taking a convex shape, and a curved surface 822 abuts on the tips of papers stacked and accommodated on the paper feed tray 40. Since the inclination angle of the bank inclining portion 820 and the radius of curvature and surface condition of the curved surface 822 greatly influence the separation of the paper, they are set suitably in consideration of the paper (medium) to be fed.

[0095] As shown in Fig. 17, the bank inclining portion 820 is provided with a central portion 822a of the curved surface 822 opposed to the pick-up roller unit 41 which is formed to be protruded toward the pick-up roller unit 41 side from both side portions 822b of the curved surface 822. According to such a structure, the tip of the paper abuts on the central portion 822a of the curved surface 822 even if the paper is skewed in any direction. Therefore, it is possible to reduce an increase in the distance between the point on which the load S is applied and the point on which the bank reaction force R is applied as shown in Fig. 11. Thus, it is possible to suppress a decrease in the bank reaction force R and to enhance the reliability of the separation of the paper in the bank separating part 42.

[0096] As shown in Fig. 18, furthermore, the bank separating part 42 is formed in such a manner that the heights of the banks in the both side portions 822b of the curved surface 822 are smaller than those of banks in the other portions. The height of the bank implies that of the bank inclining portion 820, that is, the height of the bank that a paper to be fed goes up. According to such a structure, as shown in Figs. 13 and 14, it is possible to prevent a paper having a curled (curved) side end from being folded when the paper goes up the bank inclining portion 820 and is thus fed.

[0097] The first, second and third embodiments according to the invention have been described above. In the embodiments, the bank separating part 42 includes a plurality of ribs 422 and 722 or the curved surface 822 to abut on the paper (medium), and the first ribs 422a and 722a opposed to the pick-up roller unit 41 or the central portion 822a of the curved surface 822 is disposed or formed on the pick-up roller unit 41 side from the other ribs (the second ribs 422b and 722b and the third ribs 422c and 722c) or the both side portions 822b of the curved surface 822. Also in a state in which the fed paper is skewed, consequently, the tip of the paper abuts on the first ribs 422a and 722a or the central portion 822a of the curved surface 822. Therefore, the tip of the paper can be caused to abut on the bank inclining portions 420, 720 and 820 in a close position to the pick-up roller unit 41. As a result, even if the paper is fed in a skewing state, it is possible to prevent the papers from being fed with an overlap while separating the papers reliably. Thus, it is possible to obtain a high separating reliability.

[0098] According to the embodiments, moreover, the heights of the banks on both ends in the transverse direction (the rectangular feeding direction) of the bank separating part 42 (the bank inclining portions 420, 720 and 820) are set to be smaller than those of the banks in the other portions. Consequently, it is possible to effectively prevent the fold of a paper having a curled side end (tip corner) which might be generated when the paper passes through the bank separating part 42.

[0099] According to the embodiments, furthermore, the first ribs 422a and 722a opposed to the pick-up roller unit 41 are provided at such an interval that the flexure of the medium is accommodated. Therefore, it is possible to increase the bank reaction force R (abutment load) of the weak medium, thereby preventing the media from being fed with an overlap while carrying out the separation of the medium reliably.

[0100] According to the embodiments, moreover, the first ribs 422a and 722a opposed to the pick-up roller unit 41 are provided on almost the center in the transverse direction (rectangular feeding direction) of the bank separating part 42 (the bank inclining portions 420 and 720). Therefore; it is possible to reliably separate/feed the medium and to enhance the feeding property of the medium.

[0101] The scope of the invention is not restricted to the embodiments but can be applied to other various embodiments without departing from the description of claims. For example, while the paper feeding device 142 in the paper feeding/ discharging part 140 has been described in the embodiments, the invention can be applied widely to a medium feeding device for feeding a medium. While the description has been given to the ribs 422 and 722 or the curved surface 822 as such a configuration as to abut on the paper, moreover, these are not restricted but it is possible to produce the same advantages by a section taking the shape of a trapezoid or a convex which is protruded toward the pick-up roller unit 41 side, for example.

[0102] The invention can also be applied to a recording apparatus comprising a medium feeding device, for example, a facsimile apparatus or a copying apparatus. In addition to the recording apparatus, moreover, the invention can also be applied to a liquid ejecting apparatus for ejecting liquid corresponding to the uses from a liquid ejecting head onto a medium to be ejected in place of an ink and adhering the liquid to the medium to be ejected, for example, an apparatus comprising a coloring material ejecting head to be used for manufacturing a color filter such as a liquid crystal display, an electrode material (conductive paste) ejecting head to be used for forming an electrode such as an organic EL display or a surface emitting display (FED), a bioorganic ejecting head to be used for manufacturing a biochip or a sample ejecting head to be a precision pipette.

Claims

1. A feeding device, adapted to feed a medium to a downstream section, comprising:
 - a feeder, operable to feed the medium; and
 - a separator, provided with an abutment portion on which the medium fed in a first direction by the feeder is adapted to abut and which projects in a second direction opposed to the first direction.
2. The feeding device according to claim 1, wherein the separator includes a center part and opposite end parts in a third direction perpendicular to the first direction, and the opposites end parts are lower than the center part in a forth direction perpendicular to the first direction and the third direction.
3. The feeding device according to claim 1 or 2, wherein the abutment portion includes a plurality of projections, and the projections opposed to the feeder project greater than the other projections.
4. The feeding device according to claim 3, wherein the projections opposed to the feeder are arranged so as to adapt to flexure of the medium.
5. The feeding device according to claim 3, wherein the projections opposed to the feeder are arranged at a substantially center of the separator in a third direction perpendicular to the first direction.
6. The feeding device according to any of the preceding claims, wherein the abutment portion has a curved surface extending in a third direction perpendicular to the first direction, and a portion of the curved surface, opposed to the feeder, projects greater than the other portions of the curved surface.
7. The recording apparatus incorporation the feeding device according to any of the preceding claims, comprising: a recording unit, disposed in the downstream section and operable to record information on the medium fed by the feeding device.
8. The ejecting apparatus incorporating the feeding device according to any of claims 1 to 6, comprising: a liquid ejecting unit, disposed in the downstream section and operable to eject liquid toward the medium fed by the feeding device

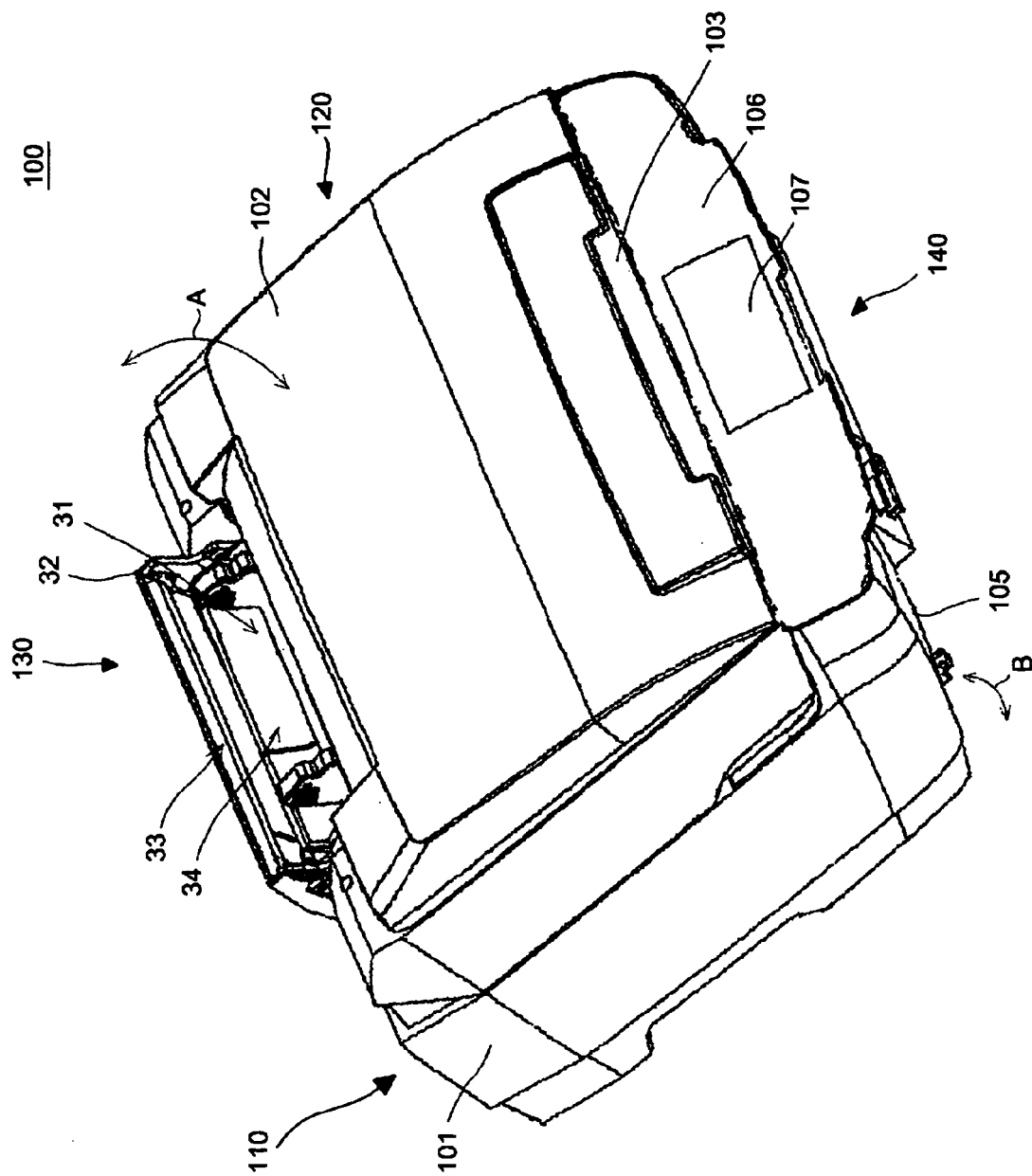


FIG. 1

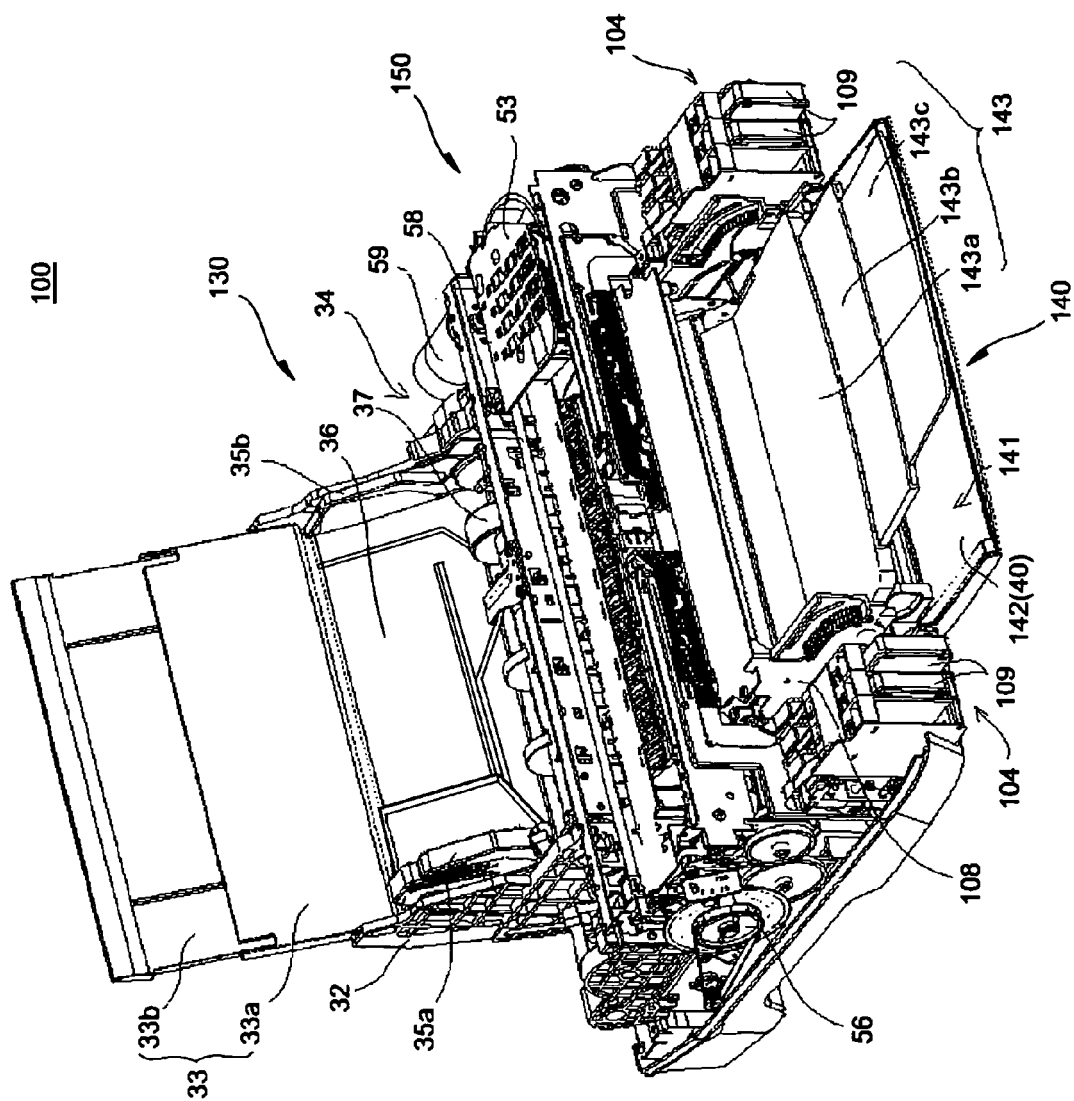


FIG. 2

FIG. 3

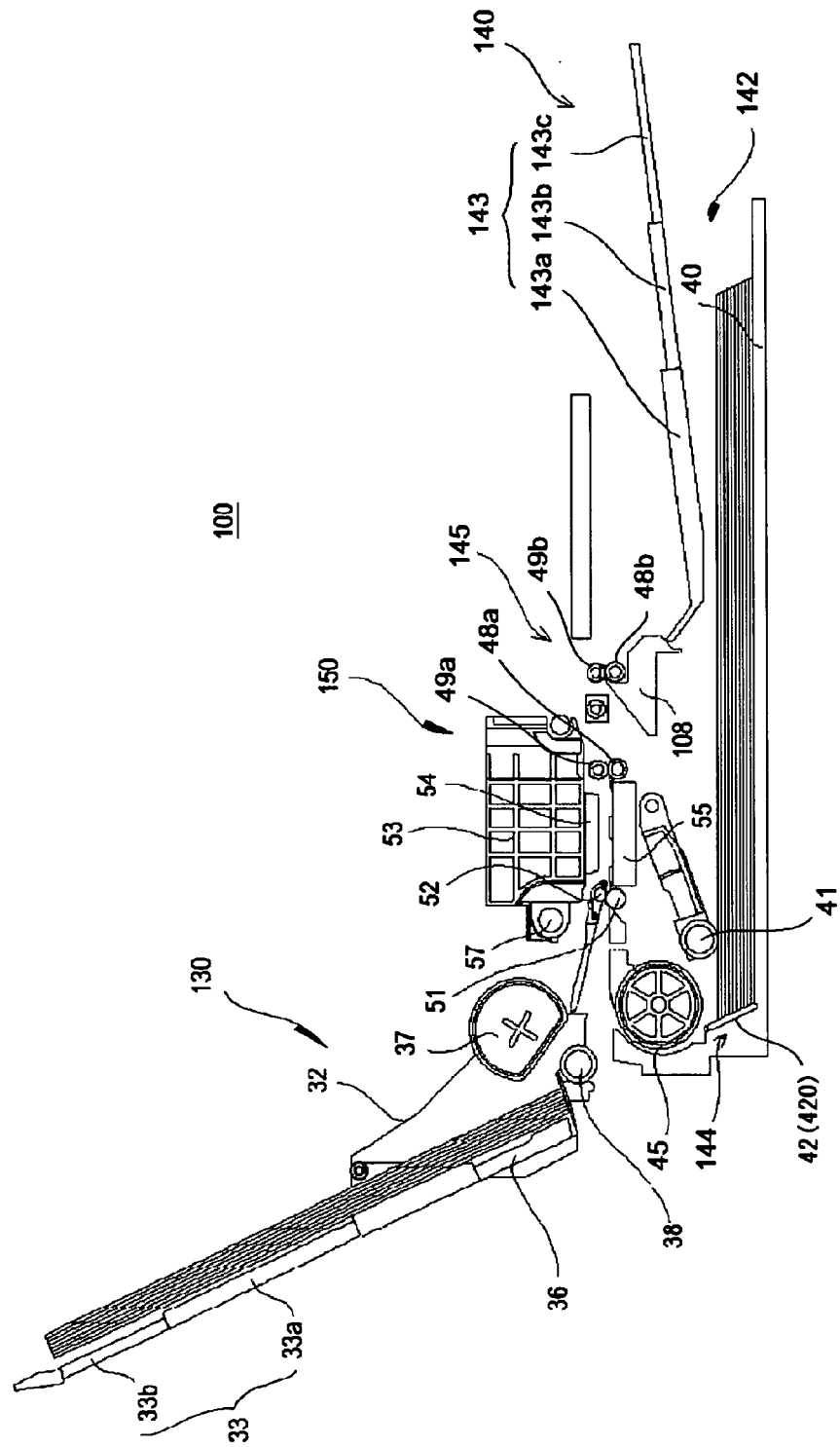


FIG. 4

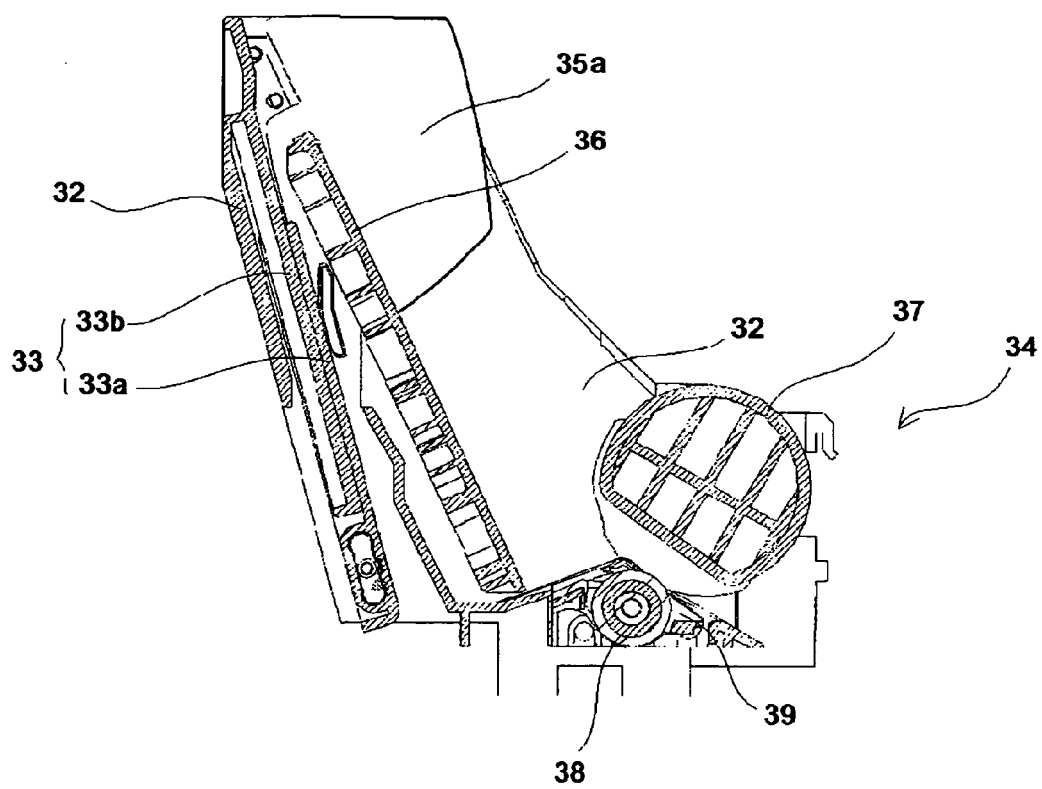


FIG. 5

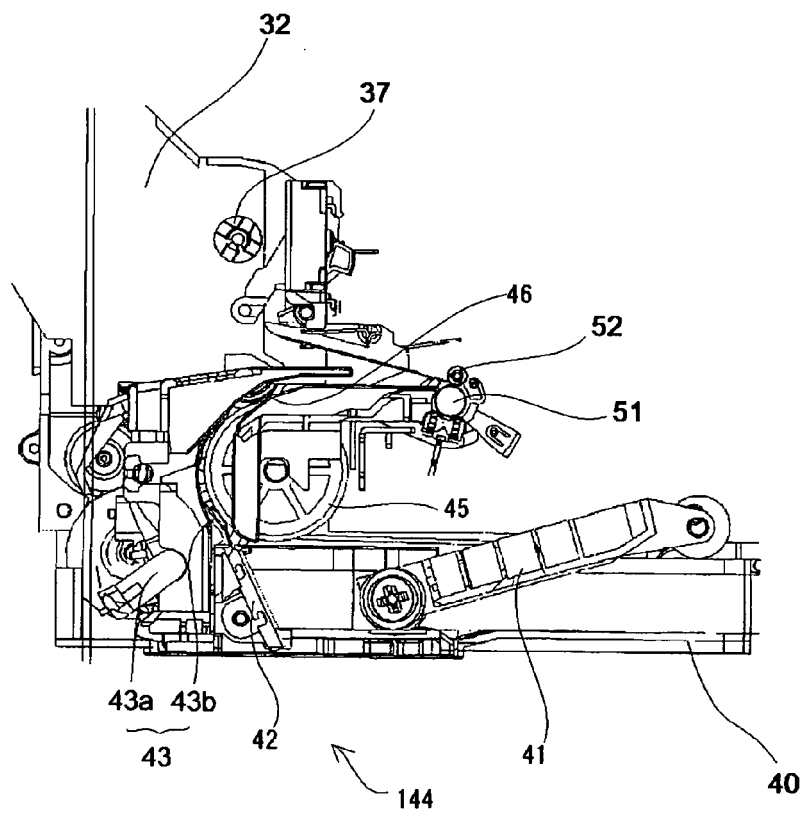


FIG. 6

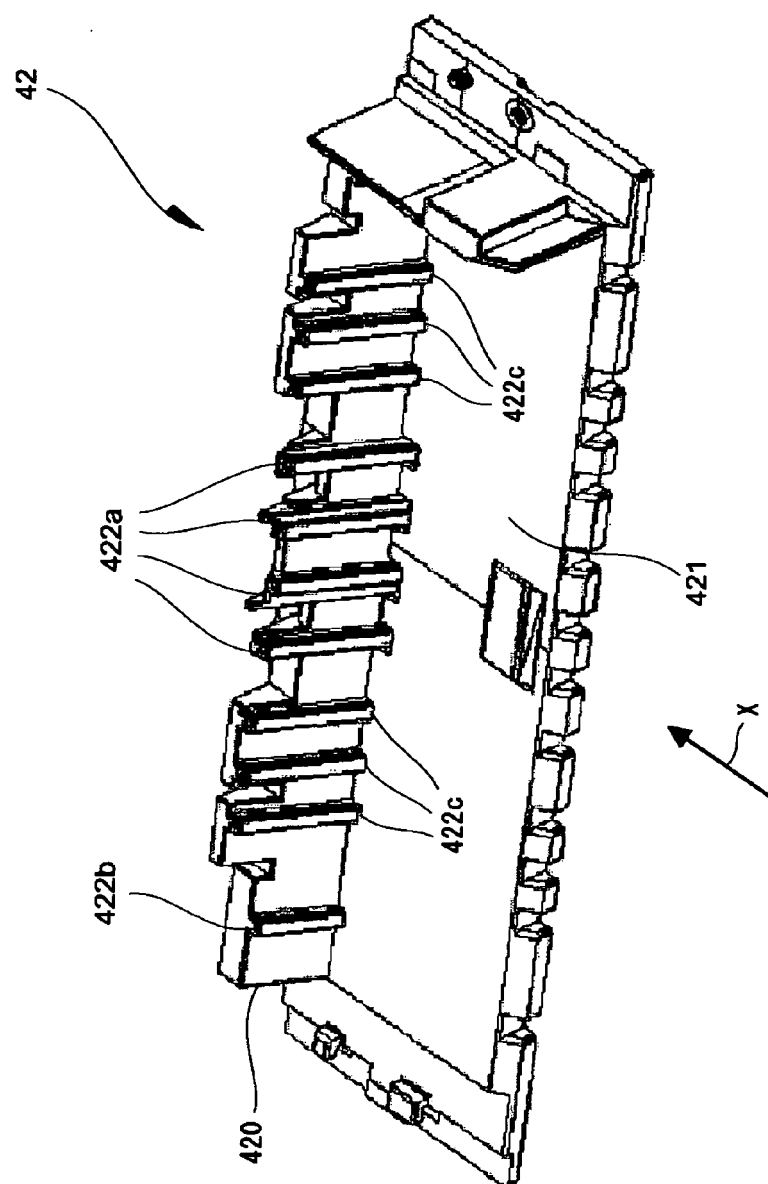


FIG. 7

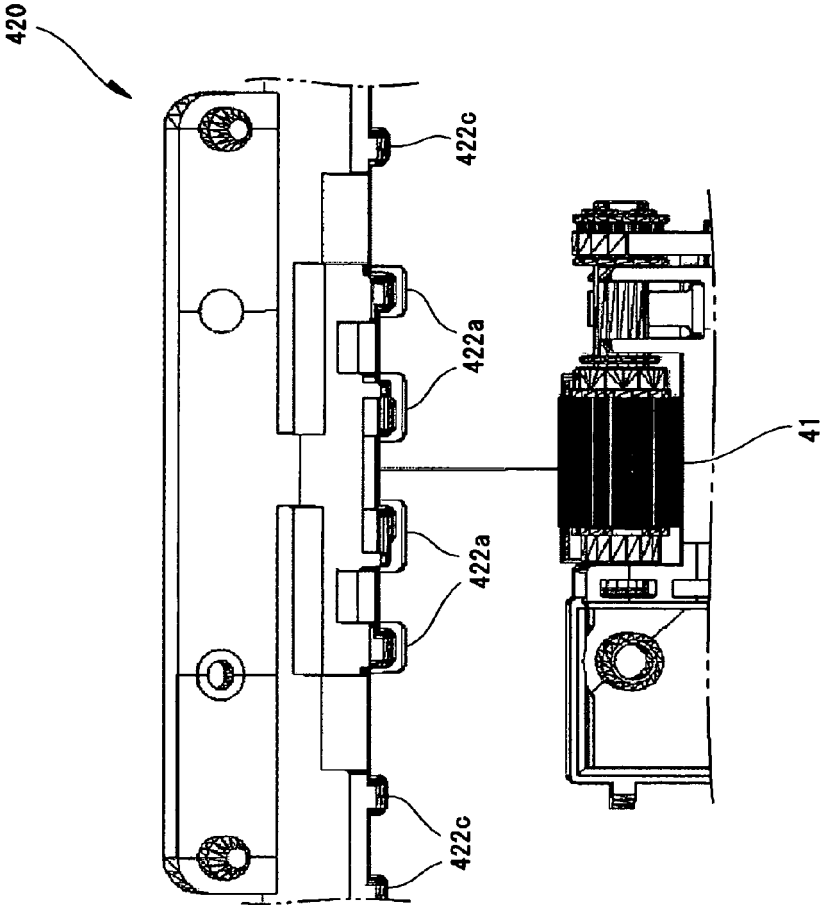


FIG. 8

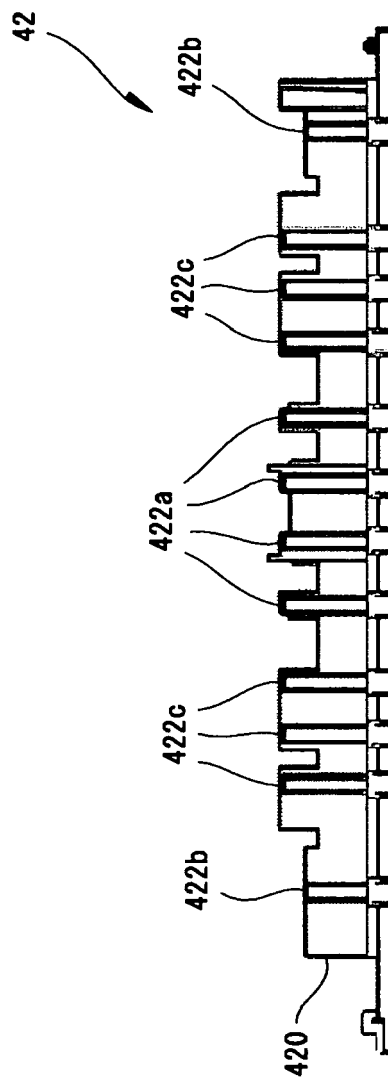


FIG. 9

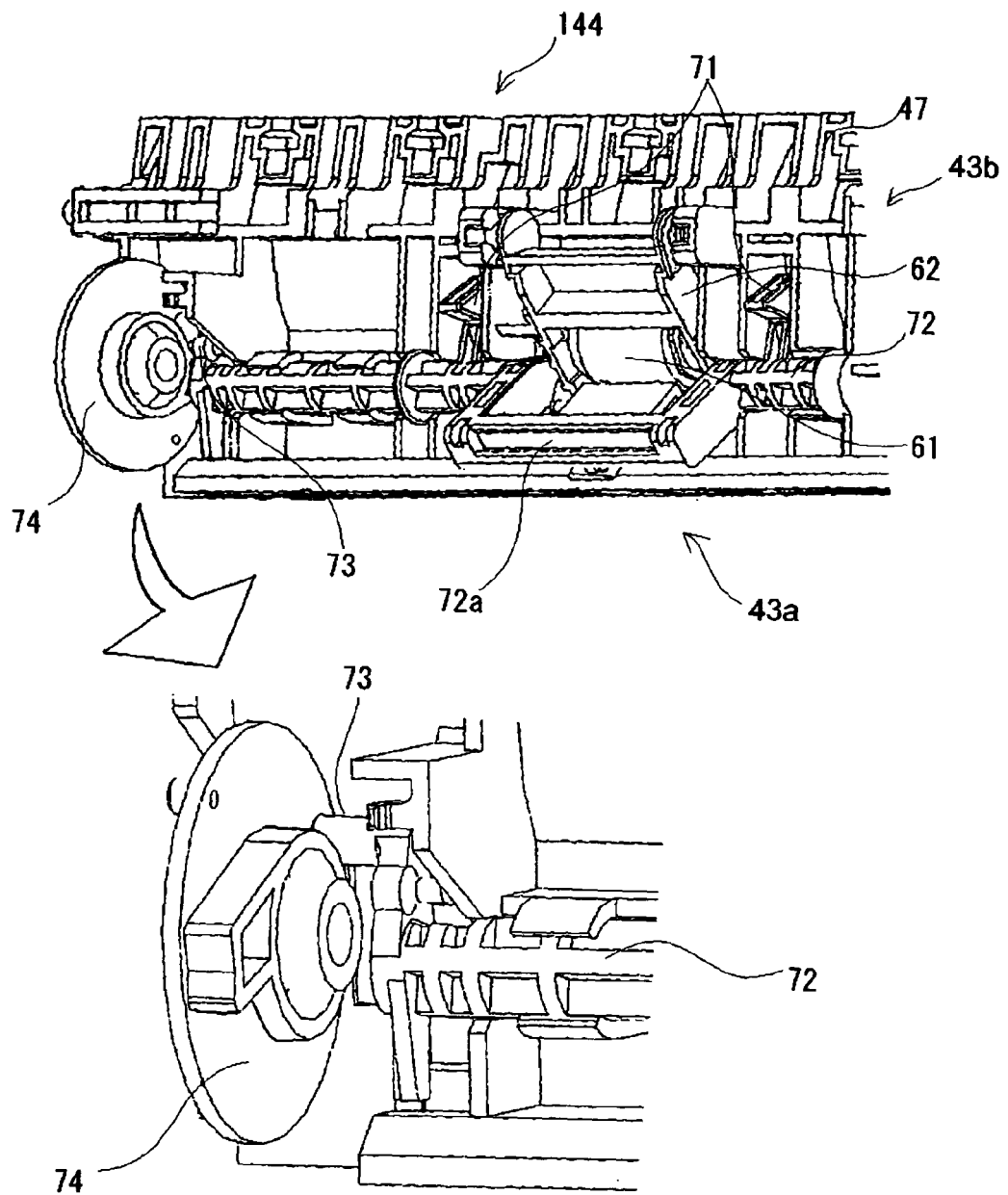


FIG. 10A

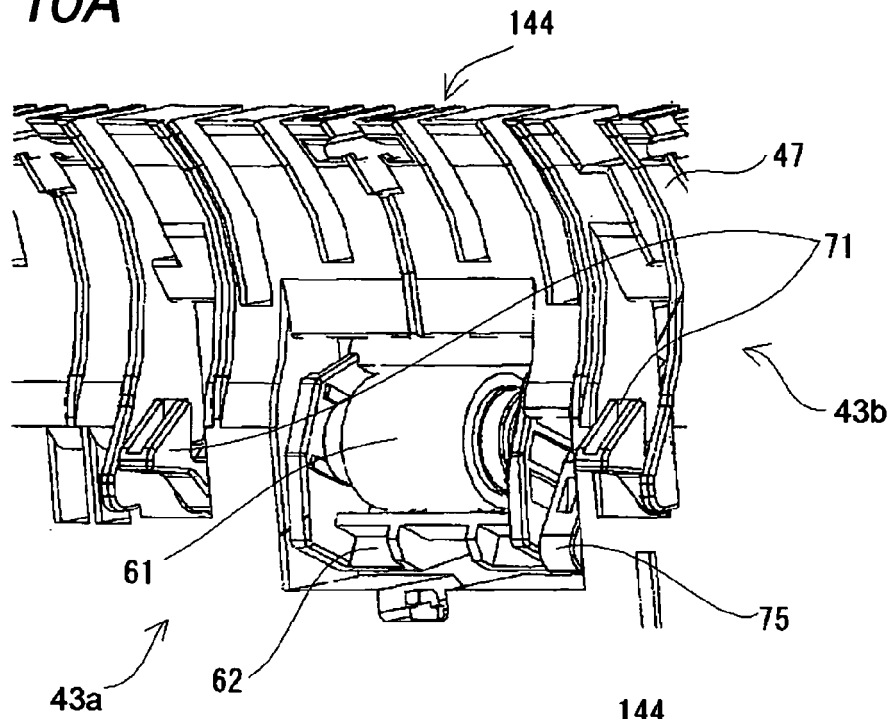


FIG. 10B

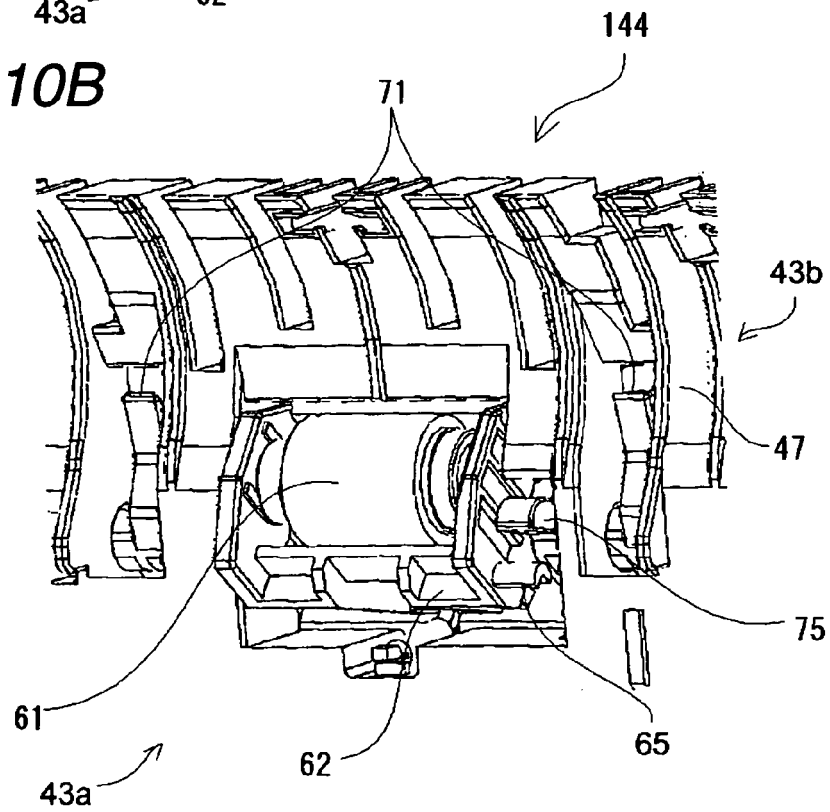


FIG. 11

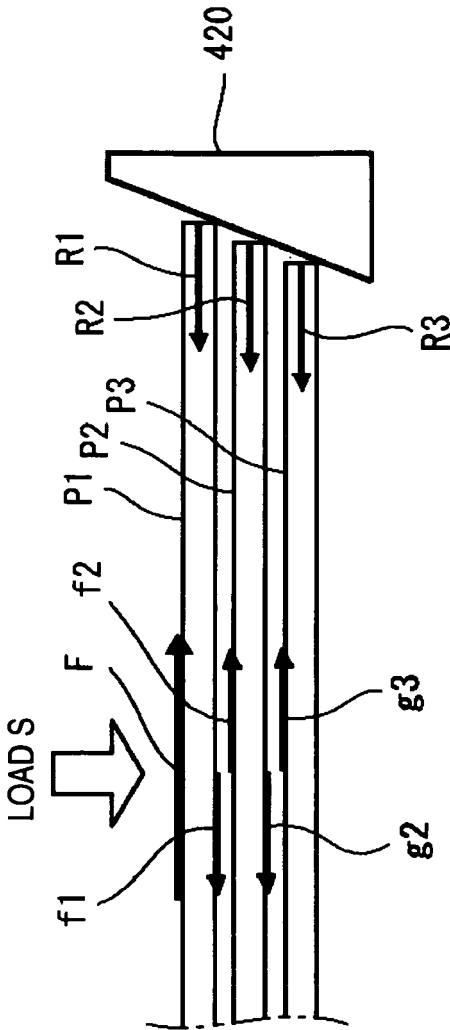


FIG. 12A

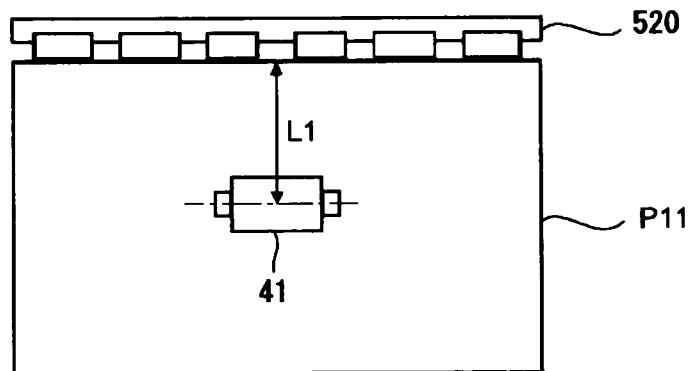


FIG. 12B

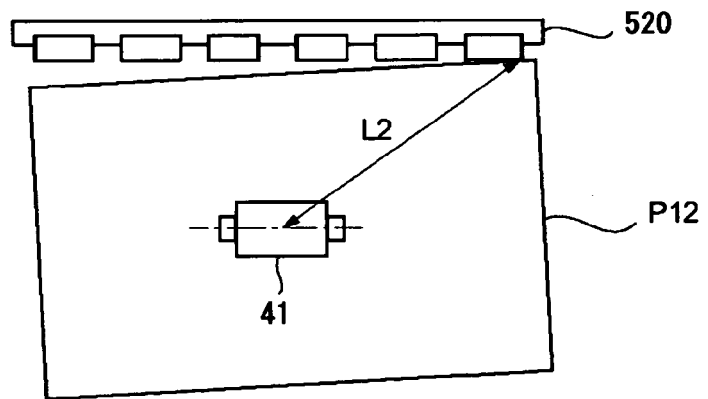


FIG. 12C

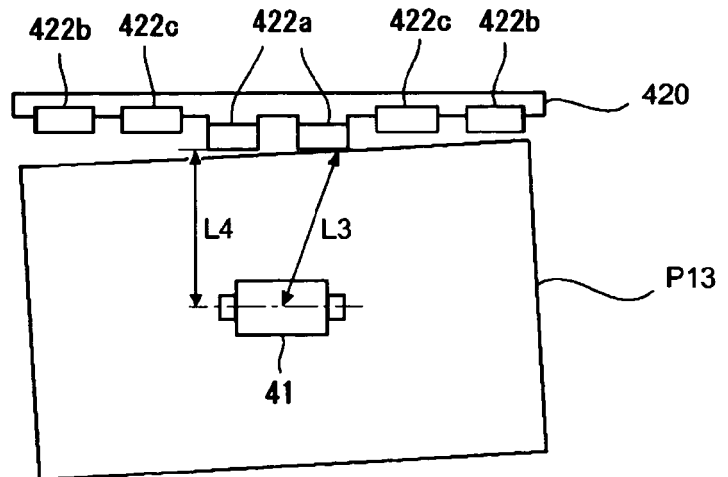


FIG. 13A

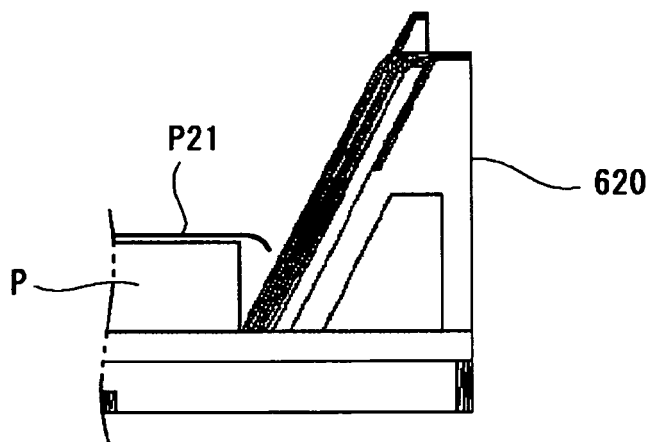


FIG. 13B

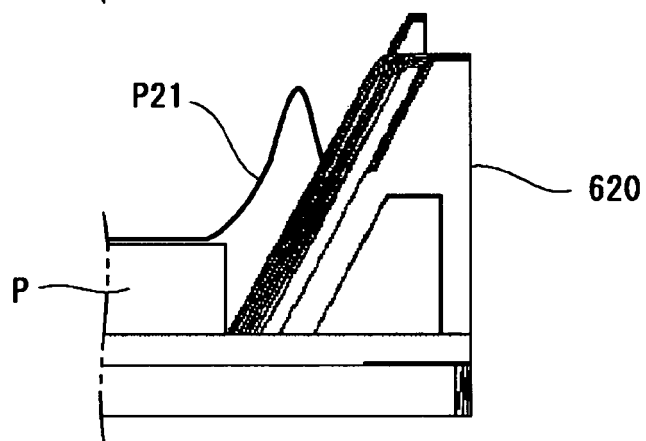


FIG. 13C

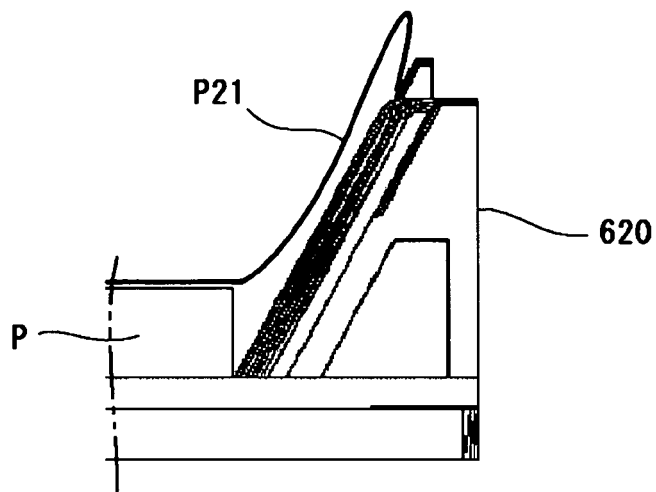


FIG. 14A

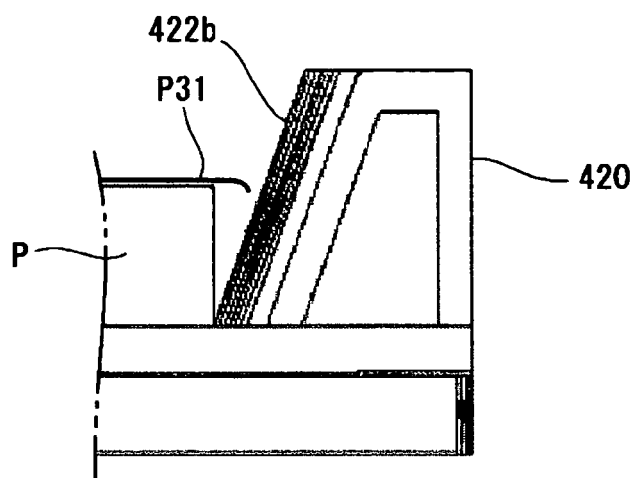


FIG. 14B

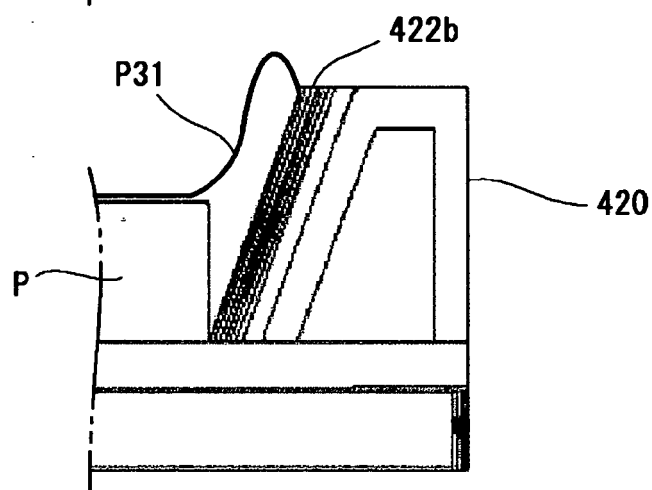


FIG. 14C

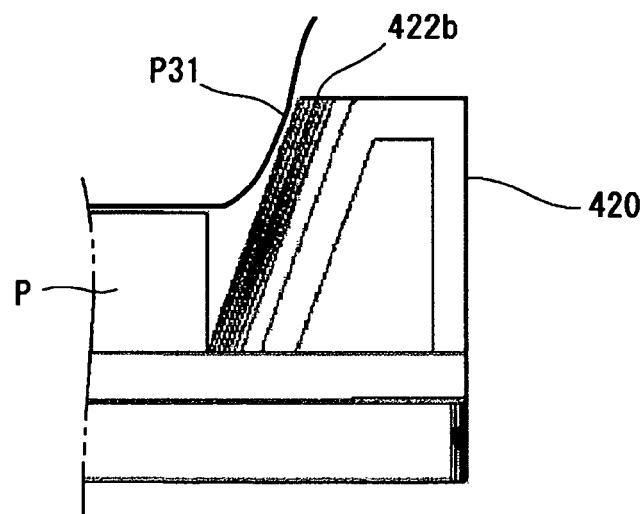


FIG. 15A

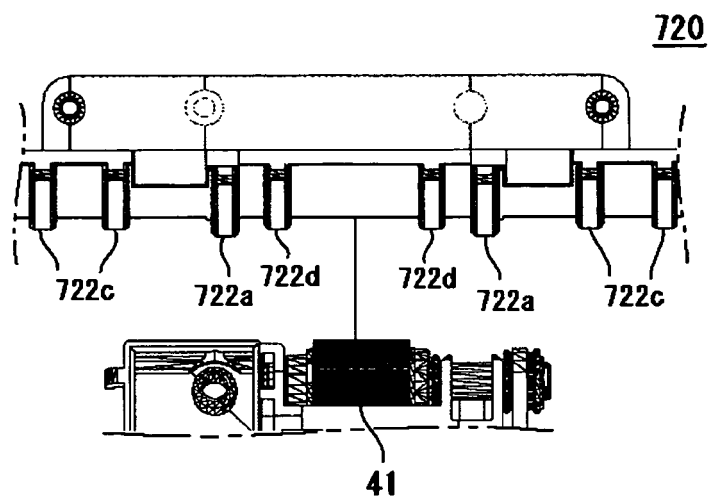


FIG. 15B

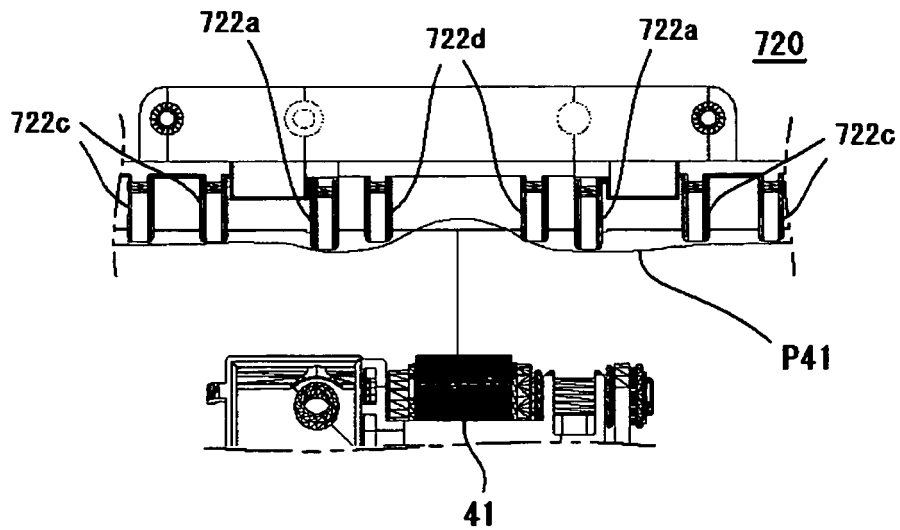


FIG. 16

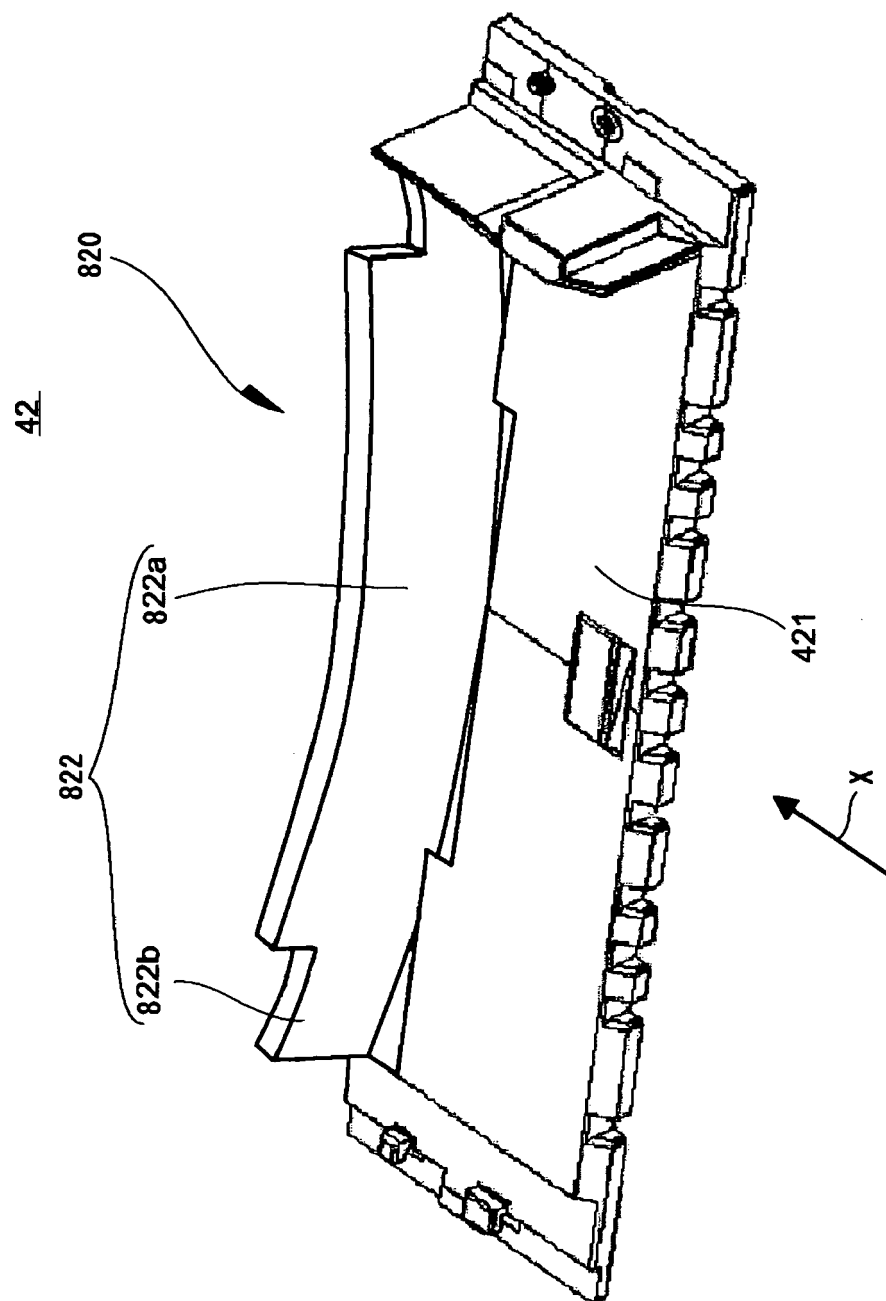


FIG. 17

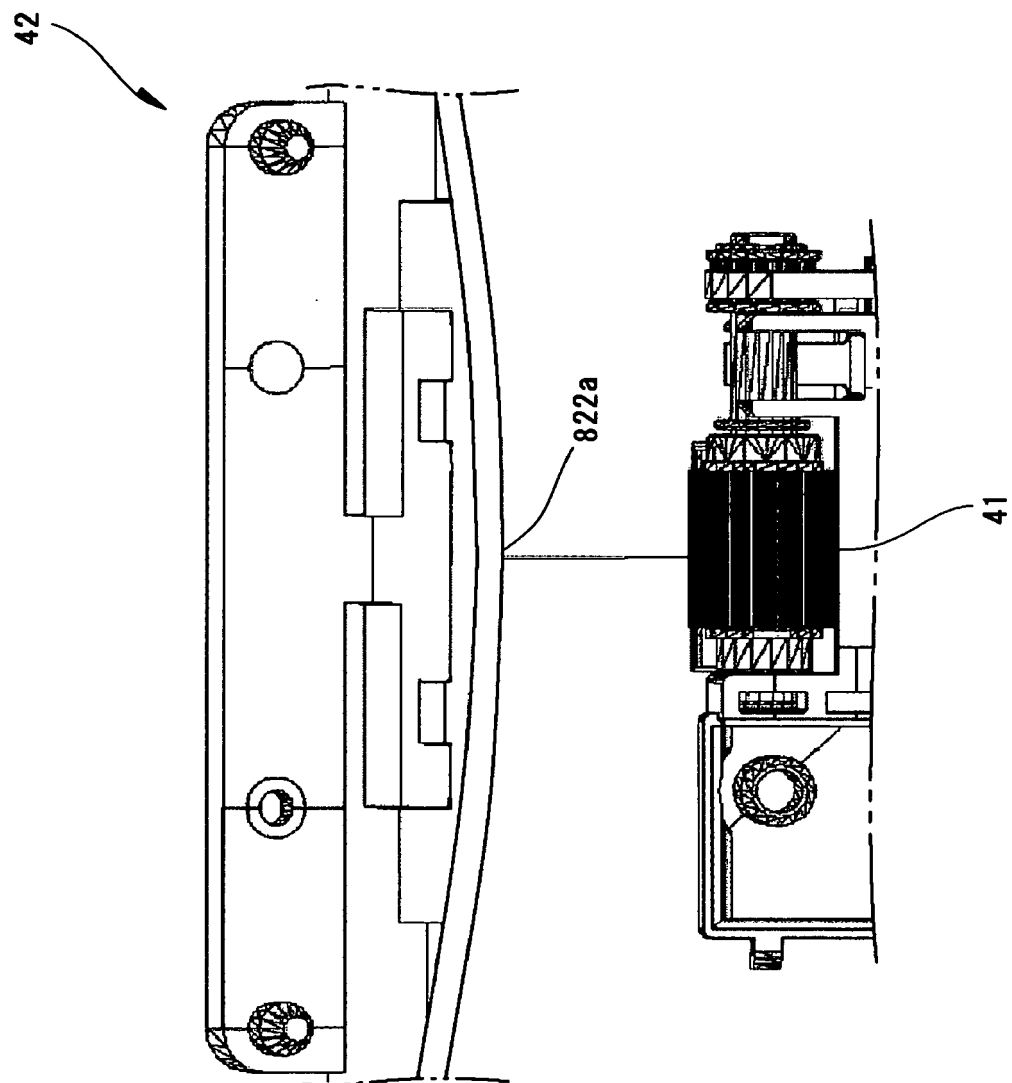


FIG. 18

