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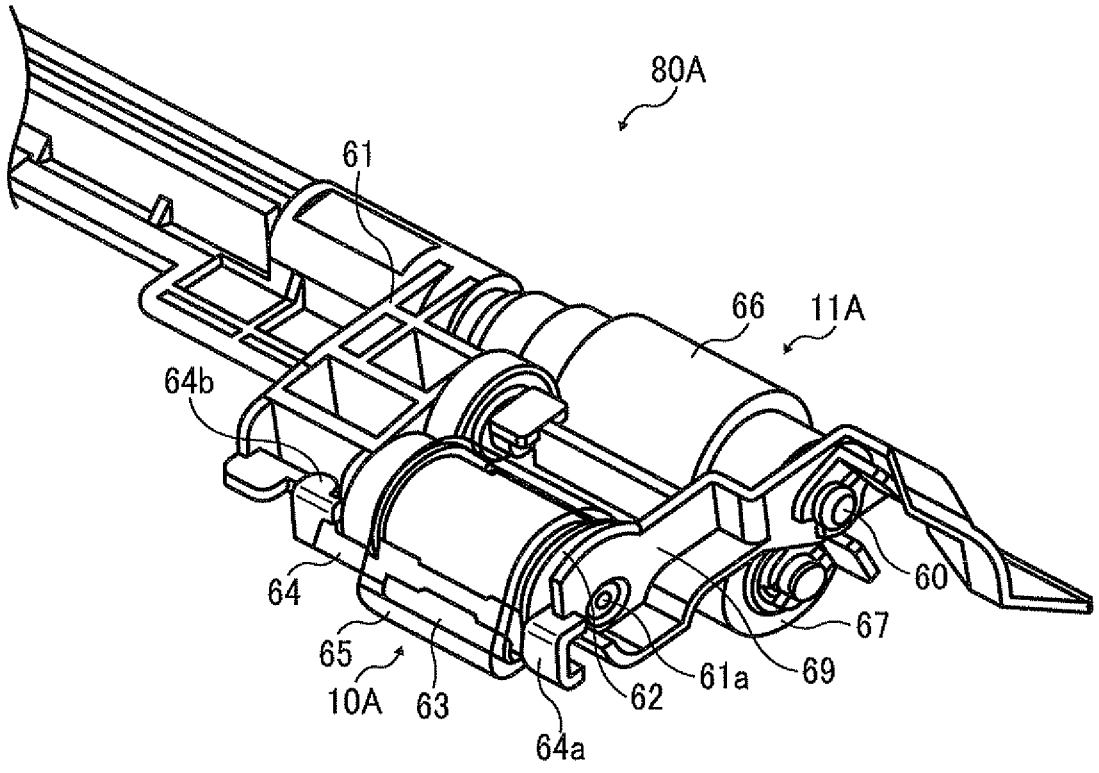
(54) **Feed device, and image reader and image forming apparatus incorporating the same**

(57) A feed device (90A) feeds a sheet of a recording medium, and includes a body, a support shaft (60), and a pickup mechanism (80A). The pickup mechanism (80A) contacts and picks up the sheet, and includes a swingable arm (61) and a pickup unit (10A). The swingably arm (61) is rotatably mounted on a support shaft (60) provided in the body of the feed device (90A) and includes a fulcrum shaft (61a). The pickup unit (10A) is rotatably attached to the fulcrum shaft (61a) of the swingably arm (61), and includes an endless elastic belt (65), a first pulley (62), a supporter (64), and a second pulley (63).

FIG. 3A



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] Example embodiments generally relate to a feed device, and an image reader and an image forming apparatus incorporating the same, for example, in which the feed device can efficiently feed a thick sheet.

Description of the Related Art

[0002] Recently, image forming apparatuses, such as copiers, facsimile machines, printers, and multifunction devices having at least one of copying, printing, scanning, and facsimile functions, increasingly need to form a toner image on a recording medium (e.g., a sheet) having a thickness greater than that of a conventional sheet.

[0003] However, when one sheet is picked up from a stack of sheets, such thick sheets tend to slip so that the sheet cannot be properly conveyed to an image forming part of the apparatus.

[0004] FIG. 1 illustrates a related-art pickup mechanism 80R including a rubber pickup roller 70. When printing on a thick sheet, the pickup roller 70 needs to exert substantial pressure on the sheet in order to convey it properly without slippage. As a result, the pickup roller 70 bears an increased drive load, and therefore, in some cases, the size of a drive motor of the pickup mechanism 80R needs to be increased as does the strength of a member or a housing supporting the pickup roller 70, thereby increasing the size of the pickup mechanism 80R. In addition, the increased pressing force of the pickup roller 70 accelerates wear of the pickup roller 70, thereby shortening the useful life of the pickup roller 70.

[0005] Accordingly, there is a need for a pickup mechanism capable of picking up a thick sheet with increased conveyance force but without increased pressing force.

SUMMARY

[0006] At least one embodiment provides a feed device that includes a body, a support shaft, and a pickup mechanism. The support shaft is provided in the body. The pickup mechanism is configured to contact and pick up a sheet, and includes a swingable arm and a pickup unit. The swingable arm includes a fulcrum shaft, and rotatably mounted on the support shaft provided in a body of the feed device. The pickup unit is rotatably attached to a fulcrum shaft of the swingable arm, and includes an endless elastic belt, a first pulley, a supporter, and a second pulley. The feed device is detachably attachable to the body of the feed device.

[0007] Further, at least one embodiment provides an image reader that includes a feed device. The feed device includes a body, a support shaft, and a pickup mechanism as described above.

[0008] Further, at least one embodiment provides an image forming apparatus that includes a feed device. The feed device includes a body, a support shaft, and a pickup mechanism as described above.

[0009] Additional features and advantages of example embodiments will be more fully apparent from the following detailed description, the accompanying drawings, and the associated claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] A more complete appreciation of example embodiments and the many attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

FIG. 1 is a schematic perspective view of a related-art pickup mechanism;

FIG. 2 is a schematic sectional view of an image forming apparatus according to an example embodiment;

FIG. 3A is a schematic perspective view (according to an example embodiment) of a pickup mechanism included in the image forming apparatus shown in FIG. 2;

FIG. 3B is a schematic sectional view (according to an example embodiment) of the pickup mechanism shown in FIG. 3A;

FIG. 4A is a schematic perspective view (according to an example embodiment) of a pickup unit included in the pickup mechanism shown in FIG. 3B;

FIG. 4B is a schematic exploded perspective view (according to an example embodiment) of the pickup unit shown in FIG. 4A;

FIG. 5 is a schematic perspective view (according to an example embodiment) of a first pulley included in the pickup unit shown in FIG. 4B;

FIG. 6A is a schematic perspective view (according to an example embodiment) of a supporter included in the pickup unit shown in FIG. 4B;

FIG. 6B is a schematic exploded perspective view (according to an example embodiment) of the supporter shown in FIG. 6A;

FIG. 7A is a schematic side view (according to an example embodiment) of the pickup mechanism shown in FIG. 3A;

FIG. 7B is a schematic side view (according to an example embodiment) of the pickup mechanism shown in FIG. 3A;

FIG. 7C is a schematic side view (according to an example embodiment) of the pickup mechanism shown in FIG. 3A;

FIG. 7D is a schematic side view (according to an example embodiment) of the pickup mechanism shown in FIG. 3A;

FIG. 7E is a schematic side view (according to an

example embodiment) of the pickup mechanism shown in FIG. 3A;

FIG. 8 is a schematic sectional view (according to an example embodiment) of the pickup mechanism shown in FIG. 7E;

FIG. 9 is a schematic sectional view (according to an example embodiment) of the pickup mechanism shown in FIG. 8; and

FIG. 10 is a schematic sectional view of a pickup mechanism according to another example embodiment.

[0011] The accompanying drawings are intended to depict example embodiments and should not be interpreted to limit the scope thereof. The accompanying drawings are not to be considered as drawn to scale unless explicitly noted.

DETAILED DESCRIPTION OF EXAMPLE EMBODIMENTS

[0012] It will be understood that if an element or layer is referred to as being "on", "against", "connected to", or "coupled to" another element or layer, then it can be directly on, against, connected or coupled to the other element or layer, or intervening elements or layers may be present. In contrast, if an element is referred to as being "directly on", "directly connected to", or "directly coupled to" another element or layer, then there are no intervening elements or layers present. Like numbers refer to like elements throughout. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

[0013] Spatially relative terms, such as "beneath", "below", "lower", "above", "upper", and the like, may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the figures. It will be understood that the spatially relative terms are intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, elements described as "below" or "beneath" other elements or features would then be oriented "above" the other elements or features. Thus, term such as "below" can encompass both an orientation of above and below. The device may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein are interpreted accordingly.

[0014] Although the terms first, second, etc. may be used herein to describe various elements, components, regions, layers and/or sections, it should be understood that these elements, components, regions, layers and/or sections should not be limited by these terms. These terms are used only to distinguish one element, component, region, layer, or section from another region, layer, or section. Thus, a first element, component, region, layer, or section discussed below could be termed a second element, component, region, layer, or section without departing from the teachings of the present invention.

[0015] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the present invention. As used herein, the singular forms "a", "an", and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "includes" and/or "including", when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[0016] In describing example embodiments illustrated in the drawings, specific terminology is employed for the sake of clarity. However, the disclosure of this specification is not intended to be limited to the specific terminology so selected and it is to be understood that each specific element includes all technical equivalents that operate in a similar manner and achieve a similar result.

[0017] Referring now to the drawings, wherein like reference numerals designate identical or corresponding parts throughout the several views thereof, in particular to FIG. 2, an image forming apparatus 100 according to an example embodiment of the present invention is described.

[0018] FIG. 2 is a schematic sectional view of the image forming apparatus 100, which in this embodiment is a tandem-type full color printer. The image forming apparatus 100 includes image forming devices 1Y, 1C, 1M, and 1K, an exposure device 8, an intermediate transfer unit 6, a toner housing TS, a secondary transfer unit 14, a bypass feeding device 25, a frame F, a rotary shaft Fa, a feed roller 26, a separation member 27, rollers 22, 23, and 24, a fixing device 15, a switching nail G1, a discharge path P3, a pair of discharge rollers 16, an output tray T, pairs of conveyance rollers 12A and 12B, a feed path P1, and a pair of registration rollers 13, a first switching guide G1, a sheet guide 30, a conveyance path P4, conveyance rollers 18a and 18b, an inner tray 31, a switch back path P5, a re-feeding path P6, pairs of conveyance rollers 20 and 14d, and 21 and 14c, feed devices 90A and 90B, and/or an additional feed unit 50 including feed devices 90C and 90D and/or pairs of conveyance rollers 12C and 12D. The toner housing TS includes toner cartridges 40Y, 40C, 40M, and 40K. The secondary transfer unit 14 includes a secondary transfer roller 14a, a power source 14b, a roller 14c, and/or a conveyance path P2.

[0019] The image forming devices 1Y, 1C, 1M, and 1K include photoconductors 2Y, 2C, 2M, and 2K, chargers 4Y, 4C, 4M, and 4K, development devices 5Y, 5C, 5M, and 5K, and/or cleaners 3Y, 3C, 3M, and 3K, respectively. The intermediate transfer unit 6 includes an intermediate transfer belt 6a, a plurality of rollers 6b, 6c, 6d, and 6e, primary transfer rollers 7Y, 7M, 7C, and 7K, a tension roller 6e, a belt cleaner 6h, an inner frame 6f, and/or a

shaft 6g. The fixing device 15 includes rollers 15a and 15b. The feed devices 90A and 90B include paper trays 9A and 9B, and/or pickup mechanisms 80A and 80B including pickup units 10A and 10B and/or separation members 11A and 11B, respectively. The feed devices 90C and 90D of the additional feed unit 50 include paper trays 9C and 9D, and/or pickup mechanisms 80A and 80B including pickup units 10C and 10D and/or separation members 11C and 11D.

[0020] The drum-like photoconductors 2Y, 2C, 2M, and 2K, serving as latent image carries, are provided side by side, equally separated from each other, and form yellow, cyan, magenta, and black toner images, respectively. When the image forming apparatus 100 is in working condition, the photoconductors 2Y, 2C, 2M, and 2K are driven to rotate by a driving source.

[0021] The chargers 4Y, 4C, 4M, and 4K, the development devices 5Y, 5C, 5M, and 5K, and the cleaners 3Y, 3C, 3M, and 3K of the image forming devices 1Y, 1C, 1M, and 1K are provided around the photoconductors 2Y, 2C, 2M, and 2K, and necessary for electrophotographic image formation.

[0022] Each of the image forming devices 1Y, 1C, 1M, and 1K has a same structure. According to this example embodiment, the photoconductors 2Y, 2C, 2M, and 2K have a drum-like shape. Alternatively, the photoconductors 2Y, 2C, 2M, and 2K may have a belt-like shape.

[0023] Referring to FIG. 2, a description is given of a process of image formation performed by the image forming apparatus 100. After the chargers 4Y, 4C, 4M, and 4K uniformly charge respective surfaces of the photoconductors 2Y, 2C, 2M, and 2K, the exposure device 8 provided below the photoconductors 2Y, 2C, 2M, and 2K directs laser beams 8Y, 8C, 8M, and 8K corresponding to image data on respective color toner images onto the respective surfaces of the photoconductors 2Y, 2C, 2M, and 2K to form electrostatic latent images thereon. An elongate gap is formed between each of the chargers 4Y, 4C, 4M, and 4K and each of the development devices 5Y, 5C, 5M, and 5K in a direction of an axis of rotation of each of the photoconductors 2Y, 2C, 2M, and 2K, such that the laser beams 8Y, 8C, 8M, and 8K emitted from the exposure device 8 is directed onto the respective surfaces of the photoconductors 2Y, 2C, 2M, and 2K.

[0024] The exposure device 8 uses a laser scanning method using a laser light source, a polygon mirror, and the like. Four laser diodes emit the laser beams 8Y, 8C, 8M, and 8K modulated according to the image data. The exposure device 8 stores optical components and control components in a metal or resin housing, and includes a translucent dust-proof member provided in an exit on an upper surface thereof. According to this example embodiment, the image forming apparatus 100 includes one exposure device 8. Alternatively, however, the image forming apparatus 100 may include a plurality of exposure devices provided in the respective image forming devices 1Y, 1C, 1M, and 1K. According to this example embodiment, the exposure device 8 uses a laser beam. Alternatively, however, the exposure device 8 may use a known LED (light-emitting diode) array combined with an imaging device.

[0025] When a toner detector detects that the development devices 5Y, 5C, 5M, and 5K consume yellow, cyan, magenta, and black toner, respectively, a toner supplier supplies each of the development devices 5Y, 5C, 5M, and 5K with fresh toner from the toner cartridges 40Y, 40C, 40M, and 40K provided in an upper portion of the image forming apparatus 100 and storing yellow, cyan, magenta, and black toner. In order not to supply different color toner to the development devices 5Y, 5C, 5M, and 5K caused by erroneous attachment of the toner cartridges 40Y, 40C, 40M, and 40K, the housing TS has a shape conforming to each of shapes of the toner cartridges 40Y, 40M, 40C, and 40K.

[0026] The intermediate transfer unit 6 is provided above the photoconductors 2Y, 2C, 2M, and 2K. The intermediate transfer belt 6a, serving as an image carrier, is wrapped around and supported by the plurality of rollers 6b, 6c, 6d, and 6e and moves in a direction of arrow as the roller 6b rotates. After a development process, the intermediate transfer belt 6a contacts one part of each of the photoconductors 2Y, 2C, 2M, and 2K. The primary transfer rollers 7Y, 7M, 7C, and 7K are provided on an inner circumferential surface of the intermediate transfer belt 6a to oppose the photoconductors 2Y, 2C, 2M, and 2K, respectively.

[0027] The belt cleaner 6h is provided on an outer circumferential surface of the intermediate transfer belt 6a to oppose the roller 6e, and removes residual toner or a foreign substance such as paper powder, or the like remaining on the surface of the intermediate transfer belt 6a. The roller 6e opposing the belt cleaner 6h provides tension to the intermediate transfer belt 6a. As the roller 6e moves in order to maintain a proper belt tension, the belt cleaner 6h is movable.

[0028] The secondary transfer roller 14a is provided on the outer circumferential surface of the intermediate transfer belt 6a and in the vicinity of the support roller 6b. As a bias is applied to a sheet S passing between the intermediate transfer belt 6a and the secondary transfer roller 14a, a toner image carried by the intermediate transfer belt 6a is electrostatically transferred to the sheet S.

[0029] A plurality of paper trays, for example, two paper trays 9A and 9B, are provided below the exposure device 8, capable of being pulled out of the image forming apparatus 100. A sheet S stored in the paper trays 9A and 9B is selectively fed due to rotation of the corresponding pickup units 10A and 10B, and conveyed to the conveyance path P1 by the separation members 11A and 11B and the pairs of conveyance rollers 12A and 12B. It is to be noted that the pickup units 10A and 10B are described in detail later.

[0030] The pair of registration rollers 13 is provided in the conveyance path P1, and properly feeds a sheet S to a secondary transfer portion formed between the in-

termediate transfer belt 6a and the secondary transfer roller 14a.

[0031] When not in use, the bypass feeding device 25 rotates and can be stored in the frame F forming a part of a body of the image forming apparatus 100. An uppermost sheet S stored in the bypass feeding device 25 is fed by the feed roller 26, separated from other sheets by the separation member 27, and conveyed toward the pair of registration rollers 13 via the conveyance path P1 by the pair of conveyance rollers 22 and 24.

[0032] The fixing device 15 is provided above the secondary transfer portion formed between the intermediate transfer belt 6a and the secondary transfer roller 14a, and includes heating members, that is, the rollers 15a and 15b incorporating a heater. Alternatively, the heating members may be belts, and may use an IH (induction heating) method, or the like.

[0033] The switching guide G1 is rotatable and guides a sheet S after fixation to the discharge path P3. Then, the pair of discharge rollers 16 discharges the sheet S to the output tray T provided on the image forming apparatus 100.

[0034] In order to automatically form an image on both sides of a sheet S, the image forming apparatus 100 includes a conveyance path or a roller for inverting and re-feeding the sheet S. For example, the switch back path P5 is provided above a discharge device, that is, the output tray T. When a sheet S fed from the feed devices 90A and 90B is conveyed to the fixing device 15 through the secondary transfer portion formed between the intermediate transfer belt 6a and the secondary transfer roller 14a, an image is formed on one side of the sheet S.

[0035] When the first switching guide G1 rotates clockwise, the sheet S passes through the conveyance path P4 partially formed by the left side surface of the sheet guide 30 to the conveyance rollers 18a and 18b rotatable in reverse directions. Then, the conveyance rollers 18a and 18b guide the sheet S to the switch back path P5 formed by the inner tray 31.

[0036] When a trailing edge of the sheet S passes through a top of the sheet guide 30 provided on the downstream side in a direction of conveyance of the sheet S, the conveyance roller 18a rotates counterclockwise to guide the sheet S to the re-feeding path P6. After passing through the pairs of conveyance rollers 20 and 14d, and 21 and 14c provided in the re-feeding path P6, the sheet S is caught by the rollers 22 and 23 contacting each other and rotatable in reverse directions and fed again to the pair of registration rollers 13.

[0037] The driving roller 22 contacts the rollers 23 and 24. In rotating clockwise, the roller 22 together with the roller 24 conveys a sheet S from the bypass feeding device 25. Conversely, in rotating counterclockwise, the roller 22 conveys a sheet S fed from the re-feeding path P6 toward the pair of registration rollers 13.

[0038] The additional feed device 50 is provided below the image forming apparatus 100. According to this example embodiment, two paper trays 9C and 9D are provided. Alternatively, the number of the paper trays may be increased, or the paper trays 9C and 9D may store an increased number of sheets S.

[0039] An operation of single-sided printing forming an image on one side of a sheet S performed by the image forming apparatus 100 is described.

[0040] When the exposure device 8 emits a laser beam 8Y corresponding to image data for yellow toner from a laser diode onto the surface of the photoconductor 2Y uniformly charged by the charger 4Y, an electrostatic latent image is formed thereon.

[0041] After being subjected to a development process performed by the development device 5Y, the electrostatic latent image is made visible and primarily transferred by the primary transfer roller 7Y onto the surface of the intermediate transfer belt 6a moving in association with the photoconductor 2Y. It is to be noted that the photoconductors 2C, 2M, and 2K sequentially perform the same latent image formation, development, and primary transfer processes, respectively.

[0042] As a result, the yellow, cyan, magenta, and black toner images are transferred and superimposed on each other onto the surface of the intermediate transfer belt 6a, and moves in the direction of arrow as the intermediate transfer belt 6a rotates. The cleaners 3Y, 3C, 3M, and 3K remove residual toner or foreign objects remaining on the respective surfaces of the photoconductors 2Y, 2C, 2M, and 2K.

[0043] After the secondary transfer roller 14a transfers the toner images formed on the intermediate transfer belt 6a onto a sheet S conveyed as rotation of the intermediate transfer belt 6a to form a full color toner image, the belt cleaner 6h cleans the surface of the intermediate transfer belt 6a, thereby preparing for subsequent image formation and transfer processing.

[0044] When the fixing device 15 fixes the full color toner image formed on the sheet S, the pair of discharge rollers 16 discharges the sheet S to the output tray T, with an image-bearing surface facing down.

[0045] An operation of duplex printing forming an image on both sides of a sheet S performed by the image forming apparatus 100 is described. As described above, when a sheet S passes through the fixing device 15, with one side of a sheet S bearing an image transferred from the intermediate transfer belt 6a, the first switching guide G1 guides the sheet S to the pair of rollers 18a and 18b. When the pair of rollers 18a and 18b conveys the sheet S to the conveyance path P5, the reversal driving roller 18a rotates counterclockwise when the trailing edge of the sheet S passes the top of the sheet guide 30. Then, the pairs of conveyance rollers 20 and 14d, and 21 and 14c convey the sheet S to the rollers 22 and 23, with the trailing edge of the sheet S changing to the leading edge. When the sheet S reaches the pair of registration rollers 13, the pair of registration rollers 13 properly conveys the single-sided printed sheet S to the secondary transfer portion, so that the secondary transfer roller 14a transfers a toner image formed on the intermediate transfer belt

6a onto another side of the sheet S.

[0046] When the image to be formed on another side of the sheet S is sequentially formed by an imaging process starting when the sheet S is conveyed to a predetermined position. The imaging process is similar to full color toner image formation in single-sided printing using the intermediate transfer belt 6a carrying the full color toner image as described above. However, since the sheet S is reversed when being conveyed through the conveyance path P6, creation of image data transmitted from the exposure device 8 is controlled and executed to order image formation in a direction opposite to the previous image formation. Accordingly, after fixation by the fixing device 15 again, the sheet S bearing the full color toner image on both sides is discharged to the output tray T via the discharge rollers 16.

[0047] In order to improve efficiency of duplex printing, several sheets S can be simultaneously conveyed through the conveyance path P6. A controller controls timing of image formation on both sides of a sheet S. It is to be noted that the above descriptions regarding the single-sided printing and the duplex printing relate to full color image formation. However, in monochrome image formation, the photoconductors 2Y, 2C, and 2M do not need to be used. Therefore, the image forming apparatus 100 has a mechanism of keeping the photoconductors 2Y, 2C, and 2M or the development devices 5Y, 5C, and 5M from working, as well as separating the photoconductors 2Y, 2C, and 2M from the intermediate transfer belt 6a. According to the example embodiment, since the inner frame 6f supporting the roller 6d and the primary transfer rollers 7Y, 7C, and 7M is rotatable around the shaft 6g and moves in a direction (clockwise direction of FIG. 2) of separating from the photoconductors 2Y, 2C, and 2M, the photoconductor 2K contacts the intermediate transfer belt 6a to perform image formation with black toner, thereby forming a monochrome image. Such operation is effective for extending the useful life of the image forming apparatus 100.

[0048] In occurrence of paper jam in a conveyance path, for example, the conveyance path P1, the conveyance path P2, or the like, the frame F is rotatable around the rotary shaft Fa, so that the upper portion of the frame F can open. By operation of a locking lever, most of the conveyance paths P1, P2, P3, P4, P5, and P6 open to be accessible to a user, thereby facilitating treatment of a jammed sheet.

[0049] The secondary transfer unit 14 sandwiched between the conveyance paths P2 and P6 rotates around the roller 23, so that when the frame F opens, the secondary transfer roller 14a separates from the intermediate transfer belt 6a, and the rollers 14c and 14d separate from the rollers 21 and 20, respectively. The power source 14b is provided inside the secondary transfer unit 14. In addition, the secondary transfer unit 14 also has a function of conveying a sheet S.

[0050] Referring to FIGS. 3A, 3B, 4A, and 4B, a description is now given of the pickup mechanism 80A. FIG. 3A is a perspective view of the pickup mechanism 80A. FIG. 3B is a schematic sectional view of the pickup mechanism 80A. FIG. 4A is a perspective view of the pickup unit 10A, and FIG. 4B is an exploded perspective view thereof.

[0051] The pickup mechanism 80A includes the pickup unit 10A and/or the separation member 11A. The pickup unit 10A includes a pickup arm 61, a fulcrum shaft 61a, a first pulley 62, a second pulley 63, a supporter 64, an elastic belt 65, and/or a thrust stopper 69. The supporter 64 includes nails 64a and 64b. The separation member 11A includes a support shaft 60, a feed roller 66, and/or a separation roller 67.

[0052] The pickup unit 10A of the pickup mechanism 80A of the feed device 90A feeding a sheet S from the paper tray 9A to the image forming devices 1Y, 1C, 1M, and 1K contacts an uppermost sheet S stored in the paper tray 9A to pick up the sheet S. The separation member 11A is provided downstream from the pickup unit 10A in a direction of conveyance of the sheet S, and when the pickup unit 10A simultaneously conveys two or more sheets, the separation member 11A separates one sheet from the other sheet(s) and sequentially feeds the sheets to the image forming devices 1Y, 1C, 1M, and 1K.

[0053] The pickup arm 61 rotates around the support shaft 60 supporting the feed roller 66 of the separation member 11A. The first pulley 62 is rotatably attached to the fulcrum shaft 61a fixed to the pickup arm 61. The supporter 64 is slidable along an outer circumferential surface of the first pulley 62 and supports the second pulley 63. The endless elastic belt 65 is wrapped around the first pulley 62 and the second pulley 63 due to its own elastic force.

[0054] Referring to FIGS. 5, 6A, and 6B, a description is now given of a relation between the first pulley 62 and the supporter 64. FIG. 5 is a perspective view of the first pulley 62. The first pulley 62 includes an input gear 62d, sliding portions 62a and 62b, a central outwardly convex portion 62c, and/or ribs 71a and 71b.

[0055] The ribs 71a and 71b, serving as collars, are provided on both lateral ends, or sides, of the first pulley 62. The input gear 62d is provided outside the rib 71a and combined with the rib 71a. The sliding portions 62a and 62b are provided inside the ribs 71a and 71b. The central convex portion 62c is slightly convex outward from surfaces of the sliding portions 62a and 62b. That is, both sides, for example, the sliding portions 62a and 62b, of the first pulley 62 contacting the elastic belt 65 has an outer diameter smaller than that of the central convex portion 62c of the first pulley 62. Lo represents a distance between both the ribs 71a and 71b.

[0056] FIG. 6A is a perspective view of the supporter 64 seen from a side of the supporter 64 contacting the first pulley 62. FIG. 6B is a perspective view of the supporter 64 seen from the opposite side of FIG. 6A. As illustrated in FIG. 6A, the supporter 64 further includes sliding members 64c and 64d.

[0057] The nails 64a and 64b are provided on both

lateral ends of the supporter 64. The sliding members 64c and 64d are provided in a central portion of the supporter 64 to oppose the sliding portions 62a and 62b of the first pulley 62. L1 represents a distance between the sliding members 64c and 64d. The distance L0 between the ribs 71a and 71b and the distance L1 between the sliding members 64c and 64d are such that Lo - L1>0, so that the sliding portions 62a and 62b of the first pulley 62 contact the sliding members 64c and 64d of the supporter 64, respectively. In addition, provision of the ribs 71a and 71b, serving as collars, of the first pulley 62 prevents the supporter 64 from moving in a thrust direction as well as prevents the elastic belt 65 from moving in the thrust direction.

[0058] As illustrated in FIG. 6B, the second pulley 63 fits in a concave portion of the supporter 64. Since the concave portion of the supporter 64 has an appropriate length equal to a length of the second pulley 63, the supporter 64 can properly accommodate the second pulley 63.

[0059] Referring again to FIG. 4A, the elastic belt 65 is wrapped around the first pulley 62 and the second pulley 63 across the supporter 64. An inner circumference of the elastic belt 65 has a length smaller than a circumferential length of the first pulley 62 and the second pulley 63 across the supporter 64. A contractive force of the elastic belt 65 combines the elastic belt 65, the first pulley 62, the second pulley 63, and the supporter 64 into a single unit, that is, the pickup unit 10A.

[0060] Referring to FIGS. 7A, 7B, 7C, 7D, and 7E, a description is now given of operation of the pickup mechanism 80A when the paper tray 9A is installed in the feed device 90A before the sheet feeding operation. It is to be noted that the other feed devices 90B, 90C, and 90D operate like the feed device 90A. As illustrated in FIG. 7C, the thrust stopper 69 includes a stopper 68a provided at a lateral end of the thrust stopper 69. As illustrated in FIG. 7D, the pickup arm 61 includes a stopper 68b provided at a lateral end of the pickup arm 61. The thrust stopper 69 also serves as a subsidiary guide for conveying a sheet S.

[0061] When a sensor detects that the paper tray 9A storing a stack of sheets S is installed in the image forming apparatus 100, a bottom plate of the paper tray 9A is elevated by an elevating motor. When doing so, the pickup arm 61 depicted in FIG. 3A rotates in a direction A as indicated by an arrow in FIG. 7A to be set at a position lower than a predetermined feeding position. The second pulley 63 is positioned substantially parallel to the first pulley 62, with the nails 64a and 64b being prevented from rotating counterclockwise by the stoppers 68a and 68b, respectively, as illustrated in FIGS. 7C and 7D.

[0062] As the stack of sheets S is elevated, the elastic belt 65 contacts an uppermost sheet S on a partial area of the elastic belt 65 supporting the second pulley 63, as illustrated in FIG. 7B. When further elevated, the elastic belt 65 contacts the uppermost sheet S on a larger area of the elastic belt 65 supporting the first pulley 62, as illustrated in FIG. 7C.

[0063] When the stack of sheets S is further elevated, the pickup arm 61 swings and rotates clockwise via the pickup unit 10A. When a sensor moving with the swing of the pickup arm 61 detects that the stack of sheets S reaches a predetermined feeding height, the elevating motor stops driving, thereby obtaining an appropriate feeding height, and the uppermost sheet S contacts the elastic belt 65 on the area of the elastic belt 65 supporting the first pulley 62 and the second pulley 63 as illustrated in FIGS. 7C and 7D.

[0064] Under such conditions, since the supporter 64 depicted in FIG. 6A slightly rotates clockwise, the nails 64a and 64b are separated from the stoppers 68a and 68b by appropriate gaps $\delta 1$ and $\delta 2$, respectively, as illustrated in FIGS. 7C and 7D.

[0065] Although the nails 64a and 64b separate from the stoppers 68a and 68b, the elastic belt 65 contacts the sheet S along a surface of the sheet S, thereby obtaining a relation of $\delta 1 \approx 52$. Any difference between the gaps $\delta 1$ and $\delta 2$ arises from dimensional tolerances of each component defining the gaps $\delta 1$ and $\delta 2$, or an inclination of the surface of the sheet S contacting the elastic belt 65, especially an inclination of the sheet S in a longitudinal direction of the sheet S, or the like. However, when the difference is within a given acceptable range, the pickup mechanism 80A can properly pick up a sheet S and convey the sheet S without any problem. Moreover, since the elastic belt 65 contacts the surface of the sheet S when the sheet S is picked up, the first pulley 62 is kept substantially parallel to the second pulley 63, thereby preventing deviation of the elastic belt 65 from a predetermined position.

[0066] In order to obtain a conveyance force of the pickup unit 10A, a spring presses the pickup arm 61 such that the pickup arm 61 rotates counterclockwise around the support shaft 60 depicted in FIG. 3A. Accordingly, when the uppermost sheet S reaches a feeding height, an appropriate pressure is applied to the elastic belt 65a and the uppermost sheet S.

[0067] Referring to FIG. 8, a description is now given of a sheet feeding operation of the feed device 90A. FIG. 8 is a schematic sectional view of the pickup mechanism 80A.

[0068] When a command to start sheet feeding is issued, the feed roller 66 starts to drive, so that driving force is transmitted to the input gear 62d depicted in FIG. 5 of the first pulley 62, thereby rotating the first pulley 62 in a direction equal to that of the feed roller 66. As the first pulley 62 rotates, the elastic belt 65 rotates in the direction of rotation of the first pulley 62.

[0069] The contraction force of the elastic belt 65 causes the first pulley 62 and the supporter 64 to press against each other, and the second pulley 62 to press against the concave portion of the supporter 64 depicted in FIG. 6B. When the first pulley 62 and the elastic belt 65 rotate, a sliding load is generated on contact surfaces between the first pulley 62 and the supporter 64 and between the

second pulley 63 and the supporter 64, so that the supporter 64 rotates around the fulcrum shaft 61a depicted in FIG. 3A in the same direction as to the direction of rotation of the first pulley 62. Since the feed roller 66 rotates the elastic belt 65 across the first pulley 62, the supporter 64 is caused to rotate counterclockwise (in a direction C of FIG. 8) in the same direction of rotation of the first pulley 62 around the fulcrum shaft 61a.

[0070] As a result, the pickup unit 10A can properly pick up the uppermost sheet S, with the surface of the elastic belt 65 wrapped around the first and the second pulleys 62 and 63 stably contacting the surface of the uppermost sheet S. Then, the uppermost sheet S is conveyed to the separation member 11A.

[0071] The feed roller 66 of the separation member 11A is rotatably attached to the support shaft 60 depicted in FIG. 3A. The separation roller 67 is paired with the feed roller 66. A driving source provides a driving force other than the driving force of the feed roller 66 to drive the separation roller 67, so that the separation roller 67 is rotatable in forward and reverse directions via a torque limiter. More specifically, the separation roller 67 rotates in a direction opposite to the direction of rotation of the feed roller 66.

[0072] When the pickup unit 10A feeds one sheet S, the separation roller 67 rotates together with the feed roller 66 and conveys the sheet to the image forming devices 1Y, 1C, 1M, and 1K. When the pickup unit 10A simultaneously feeds a next sheet together with the uppermost sheet S, the separation roller 67 rotates in a direction B as indicated by a broken line arrow in FIG. 8 to return the next sheet to the upstream side in the direction of conveyance of the sheet S, thereby preventing double feeding.

[0073] When the sheet S is properly fed to the separation member 11A, the pickup mechanism 80A can perform two operations. One is to contact and separate the pickup unit 10A from the surface of the sheet S each time the pickup mechanism 80A feeds one sheet. The other is to constantly keep the pickup unit 10A in contact with the surface of the sheet S. In the latter operation, when a sheet picked up by the pickup unit 10A is conveyed via the separation member 11A to conveyance rollers provided downstream in a direction of conveyance of the sheet S, that is, the conveyance rollers 12A and 12B, the pickup unit 10A stops driving. After the sheet S is fed into the image forming apparatus 100, the pickup unit 10A resumes driving when a next sheet S is fed. During this process, the pickup unit 10A contacts the surface of the sheet S.

[0074] Since no mechanism for contacting and separating the pickup unit 10A from the surface of the sheet S is necessary, the image forming apparatus 100 can be made more compact at low cost.

[0075] Compared to the above-describe method, the contact and separation method focuses on prevention of double-feeding of a sheet. When the pickup arm 61 rotates clockwise to separate from the surface of the sheet S, as illustrated in FIG. 7E, a pressing force of the pickup unit 10A pressing the surface of the sheet S is released, so that the separation roller 67 of the separation member 11A can properly separate an uppermost sheet S from other sheets.

[0076] Even after separating from the surface of the sheet S, the pickup unit 10A keeps rotating in synchronization with rotation of the feed roller 66 of the separation member 11A. When doing so, since the second pulley 63 and the supporter 64 supporting the second pulley 63 rotate counterclockwise due to rotation of the elastic belt 65, the nails 64a and 64b depicted in FIG. 3A attached to front and back of the supporter 64 contact the stoppers 68a and 68b depicted in FIGS. 7C and 7D, so that the supporter 64 stop rotating counterclockwise. Since the stoppers 68a and 68b are positioned such that the first pulley 62 parallels the second pulley 63, the first pulley 62 and the second pulley 63 can be kept parallel to each other, thereby preventing deviation of the elastic belt 65 from a predetermined position in axial directions of the first and the second pulleys 62 and 63.

[0077] If one of the stoppers 68a and 68b is not provided, or if the stoppers 68a and 68b deviate from each other, the supporter 64 inclines, so that the first pulley 63 cannot be kept parallel to the second pulley 63, causing deviation of the elastic belt 65 from a predetermined position across the ribs 71a and 71b depicted in FIG. 5 of the first pulley 62.

[0078] Therefore, even when the pickup unit 10A separates from the surface of the sheet S, the pickup unit 10A can prevent deviation of the elastic belt 65, so that the elastic belt 65 can be properly positioned for stable feeding of the sheet S.

[0079] Referring to FIG. 9, a description is given of a sheet surface raising mechanism. FIG. 9 is a schematic sectional view of the pickup mechanism 80A when a small number of sheets remain in the paper tray 9A of the feed device 90A.

[0080] When the feed device 90A continuously feeds a sheet S, the sensor again works to detect that a feeding height of the sheet S is lowered. Then, when the elevating motor drives, the stack of the sheet S is raised to an appropriate feeding height. Since an appropriate feeding height has a certain range, according to this example embodiment, the pickup unit 10A conforms to the surface of the sheet as the height of the surface of the sheet lowers, and the pickup unit 10A constantly contacts with the surface of the sheet, thereby stably feeding the sheet without causing variation of conveyance performance. Although the height of the stack of the sheet is lowered as the pickup unit 10A sequentially feeds the sheets S, an angle of the surface of the sheet to the elastic belt 65 changes due to a sheet surface raising mechanism.

[0081] In such a case, until the paper tray 9A is out of the sheets S, by positioning the stoppers 68a and 68b so as to generate the gaps $\delta 1$ and $\delta 2$ between the nails 64a and 64b and the stoppers 68a and 68b, respectively, as illustrated in FIGS. 7C and 7D, the surface of the sheet

stably contacts the elastic belt 65, thereby properly conveying the sheet.

[0082] The sheet surface raising mechanism includes a horizontal sheet surface raising mechanism and a gradient type sheet surface raising mechanism. The horizontal sheet surface raising mechanism horizontally raises a bottom plate of the paper tray 9A storing sheets. The gradient type sheet surface raising mechanism raises a leading edge of a bottom plate of the paper tray 9A in a direction of conveyance of the sheet. It is to be noted that the horizontal sheet surface raising mechanism includes raising the sheet with an inclined surface of the sheet being kept at a constant angle.

[0083] Since the horizontal sheet surface raising mechanism horizontally raises the stack of sheets, the angle of the surface of the sheet contacting the pickup unit 10A is kept constant. In this case, even a conventional feed device conveying a sheet using a belt for picking up and feeding the sheet can stably feed the sheet. However, since an appropriate feeding height must be kept within a given range, the conventional feed device cannot uniformly keep a contact area between the pickup unit 10A and the surface of the sheet.

[0084] By contrast, in the gradient type sheet surface raising mechanism, as illustrated in FIG. 9, as the number of the sheets stored in the paper tray 9A decreases, the surface of the stack of sheets inclines, so that the angle of the sheets to the elastic belt 65 gradually steepens. The conventional feed device conveying a sheet using a belt for picking up and feeding the sheet cannot conform to the inclined surface of the sheet, thereby failing to properly convey the sheet.

[0085] For example, another known feed device sequentially feeds a lowermost sheet stored in a paper tray and keeps a uniform feeding height, and an angle of a surface of a sheet does not change regardless of the number of sheets stored in the paper tray. Compared to a typical feed device sequentially feeding an uppermost sheet, application of such feed device is limited. However, the feed device 90A depicted in FIG. 2 is applicable to such feed device.

[0086] Referring to FIG. 10, a description is now given of a pickup mechanism 80B according to another example embodiment. FIG. 10 is a schematic sectional view of the pickup mechanism 80B.

[0087] The pickup mechanism 80B using a feeding method of sequentially conveying an uppermost sheet is generally used for a feed mechanism of feeding a small number of sheets stored in a paper tray. Since the pickup mechanism 80B does not include a sheet surface raising mechanism, a height of the sheet stacked on the paper tray gradually declines as each uppermost sheet is conveyed. However, a pickup unit 10A' can conform to the surface of the stack of sheets according to the height of the sheet stacked on the paper tray. That is, even when the height of the sheet varies, the pickup unit 10A' is swingable due to a pickup arm, so that the pickup unit 10A' can conform to the surface of the sheet.

[0088] According to this example embodiment, the pickup mechanism 808 can significantly improve the function of picking up a sheet. The pickup unit 10A' is swingable so that a contact area between the surface of the sheet and the pickup unit 10A' is kept constant even when the height of the sheet varies or the angle of the surface of the sheet varies. Thus, the pickup mechanism 80B can feed even thick, heavy paper inappropriate for feeding and can be applied to various feed position controlling mechanisms.

[0089] According to the above-described example embodiments, the ability to extend a useful life of the pickup mechanism 80A stems from provision of the elastic belt 65, which increases a contact area between the surface of the sheet and the pickup unit 10A and thus decreases overall pressure on the elastic belt 65, thereby reducing damage to the pickup unit 10A due to wear. In addition, since the outer circumferential length of the elastic belt 65 is greater than that of the pickup roller 70 depicted in FIG. 1 of the pickup mechanism 80R, the elastic belt 65 has a surface area greater than that of the pickup roller 70, thereby preventing a decrease in thickness of the elastic belt 65.

[0090] That is, according to the above-described example embodiments, although the pickup mechanism 80A includes the pickup unit 10A including the elastic belt 65, it is as compact as a conventional pickup mechanism. In addition, the pickup unit 10A can be easily replaced, as well as with a conventional pickup roller. Since the second pulley 63 depicted in FIG. 4A is supported by the supporter 64, the second pulley 63 may be hollow body or solid. When the second pulley 63 is solid, the second pulley 63 can decrease in diameter, as well as a distance between the first pulley 62 and the second pulley 63, thereby making the pickup unit 10A more compact. Moreover, a contractive force of the elastic belt 65 combines the first pulley 62, the second pulley 63, and the supporter 64 into a single unit, that is, the pickup unit 10A, thereby facilitating removal of a used pickup unit 10A and attachment of a new pickup unit 10A in replacement of the pickup unit 10A. In addition, since the support shaft 60 depicted in FIG. 3A supporting the feed roller 66 of the separation member 11A is common to other conveyance device, for example, a pickup roller, the support shaft 60 can be attached to both devices, thereby improving applicability of the pickup mechanism according to a type of a sheet or a thickness of a sheet.

[0091] In order to keep the elastic belt 65 from hitting the paper tray 9A when the paper tray 9A is pulled into the feed device 90A, and in order to improve prevention of double-feeding of the separation member 11A depicted in FIG. 3B, the pickup unit 10A separates from a surface of an uppermost sheet when the pickup unit 10A conveys each sheet. When doing so, the pickup unit 10A runs idle.

[0092] In running idle, as the elastic belt 65 rotates, the supporter 64 rotates in the direction equal to that of the first pulley 62 due to the sliding load of the first pulley

62 around the support shaft 60 as described above. Then, the nails 64a and 64b provided at both lateral ends of the supporter 64 contact the stoppers 68a and 68b depicted in FIGS. 7C and 7D to keep the first pulley 62 parallel to the second pulley 63, thereby preventing the elastic belt 65 from deviating from a predetermined position.

[0093] Both sides of the surface of the first pulley 62 contacting the elastic belt 65 have an outer diameter smaller than that of a central portion thereof, improving prevention of deviation of the elastic belt 65 in the axial direction thereof. In addition, the supporter 64 slides on both sides of the surface of the first pulley 62 contacting the elastic belt 65 with a reduced diameter and a contact angle formed between the first pulley 62 and the second pulley 63 can be increased, thereby improving stability of the supporter 64 as well as keeping the first pulley 62 parallel to the second pulley 63, so that a failure in the feed device 90A due to deviation of the elastic belt 65 can be resolved. Moreover, a relation between an inner width between collars, that is, the distance Lo between the ribs 71a and 71b of the first pulley 62 depicted in FIG. 5 and an outer width of both sliding members of the supporter 64, that is, the distance L1 between the sliding members 64c and 64d of the supporter 64 depicted in FIG. 6A, is appropriately set as described above, thereby controlling axial movement of the supporter 64 and oblique movement of the supporter 64, so that the first pulley 62 can be kept parallel to the second pulley 63, thereby preventing deviation of the elastic belt 65. If the supporter 64 is obliquely positioned, the supporter 64 cannot be kept parallel to the first pulley 62, causing deviation of the elastic belt 65.

[0094] In terms of simplification and cost reduction of components of the feed device 90A, if the second pulley 63 is provided downstream from the first pulley 62, the second pulley 63 separates from a surface of a sheet due to a tendency of the second pulley 63 to rotate by a driving force. Therefore, a spring or the like needs to be provided to press the surface of the sheet so as to maintain the contact area. Therefore, according to the above-described example embodiments, the second pulley 63 is provided upstream from the first pulley 62, so that the elastic belt 65 stably contacts the surface of the sheet. Therefore, the second pulley 62 does not need a spring or an installation member for the spring, thereby reducing components of the feed device 90A as well as reducing cost.

[0095] According to the above-described example embodiments, the image forming apparatus 100 includes the plurality of feed devices 90A, 90B, 90C, and 90D, and at least one of the plurality of feed devices 90A, 90B, 90C, and 90D includes the pickup mechanism 80A as described above. Therefore, the pickup mechanism 80A can be provided in a feed device that needs to convey a comparatively rigid sheet such as a thick sheet of paper or an envelope, or can be replaced with another feed device, thereby providing a convenient and inexpensive feed device.

[0096] According to the above-described example embodiments, provision of an endless belt, that is, the elastic belt 65 depicted in FIG. 3B, can increase size of a surface contacting a recording medium, thereby increasing a conveyance force, so that the feed device 90A can properly feed a recording medium of great thickness.

[0097] The present invention has been described above with reference to specific example embodiments. Nonetheless, the present invention is not limited to the details of example embodiments described above, but various modifications and improvements are possible without departing from the scope of the present invention. The number, position, shape, and the like, of the above-described constituent elements are not limited to the above-described example embodiments, but may be modified to the number, position, shape, and the like, which are appropriate for carrying out the present invention. It is therefore to be understood that, within the scope of the associated claims, the present invention may be practiced otherwise than as specifically described herein. For example, elements and/or features of different illustrative example embodiments may be combined with each other and/or substituted for each other within the scope of the present invention.

[0098] The present patent application claims priority from Japanese Patent Application No. 2008-196268, filed on July 30, 2008 in the Japan Patent Office, the entire contents of which are hereby incorporated herein by reference.

Claims

1. A feed device (90A) for feeding a sheet of recording media comprising:

a body, from which the feed device is detachably attachable;
a support shaft (60) provided in the body; and
a pickup mechanism (80A) to contact and pick up the sheet, the pickup mechanism comprising:

a swingable arm (61) including a fulcrum shaft (61a), rotatably mounted on the support shaft (60) provided in the body of the feed device; and
a pickup unit (10A) rotatably attached to the fulcrum shaft (61a) of the swingable arm, the pickup unit **characterized by** comprising:

an endless elastic belt (65), an outer circumferential surface of which contacts the recording media;
a first pulley (62) rotatably attached to the fulcrum shaft (61a);
a supporter (64) to rotate around the fulcrum shaft (61a) and slidable along

an outer circumference of the first pulley (62); and
a second pulley (63) supported by the supporter (64),
the belt (65) extended around the first pulley (62) and the second pulley (63), and
the belt (65) having an inner circumference smaller than a circumferential length of the first pulley (62), the supporter (64), and the second pulley (63).

2. The feed device (90A) according to claim 1,
wherein the supporter (64) of the pickup unit (10A) comprises nails (64a; 64b) extending from both lateral ends of the supporter (64),
wherein the pickup mechanism (80A) further comprises stoppers (68a; 68b) provided at both lateral ends of the first pulley (62) and the second pulley (63) to oppose the nails (64a; 64b), and
wherein when the nails (64a; 64b) contact the stopper, the first pulley (62) and the second pulley (63) are disposed substantially parallel to each other.

3. The feed device (90A) according to claim 1 or 2,
wherein at least one of the first and the second pulleys comprises a collar (71) provided at both ends of the pulley to prevent deviation of the elastic belt from a predetermined position,
wherein both sides (62a; 62b) of the pulley contacting the elastic belt has an outer diameter smaller than that of a central portion (62c) of the pulley, and
wherein the supporter (64) comprises a sliding surface (64c; 64d) having a width equal to that of the both sides of the pulley.

4. The feed device (90A) according to any one of claims 1 to 3,
wherein the first pulley (62) comprises a drive input gear (62d), and
the second pulley (63) is provided upstream from the first pulley (62) in a direction of conveyance of the recording media.

5. The feed device (90A) according to any one of claims 1 to 4, further comprising a plurality of feeding members,
wherein at least one of the plurality of feeding members comprises the pickup mechanism (80A).

6. An image reader (100) including the feed device according to any one of claims 1 to 6.

7. An image forming apparatus (100) including the feed device according to any one of claims 1 to 4.

8. An image forming apparatus (100) including the image reader according to claim 6.

9. The image forming apparatus (100) according to claim 8,
wherein the image forming apparatus is a multifunction printer having a function of one of a copier, a facsimile machine, a printer, and an inkjet recording device.

10. The image forming apparatus (100) according to claim 8,
wherein the image forming apparatus is a multifunction printer having at least two functions of a copier, a facsimile machine, a printer, and an inkjet recording device.

FIG. 1
RELATED ART

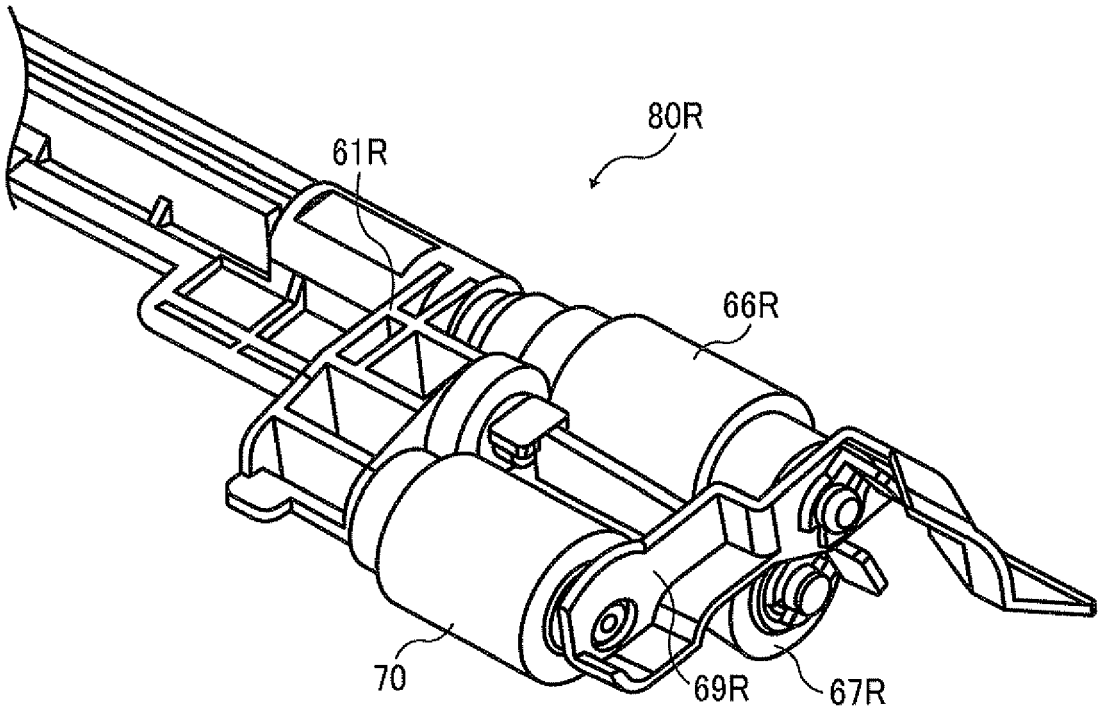
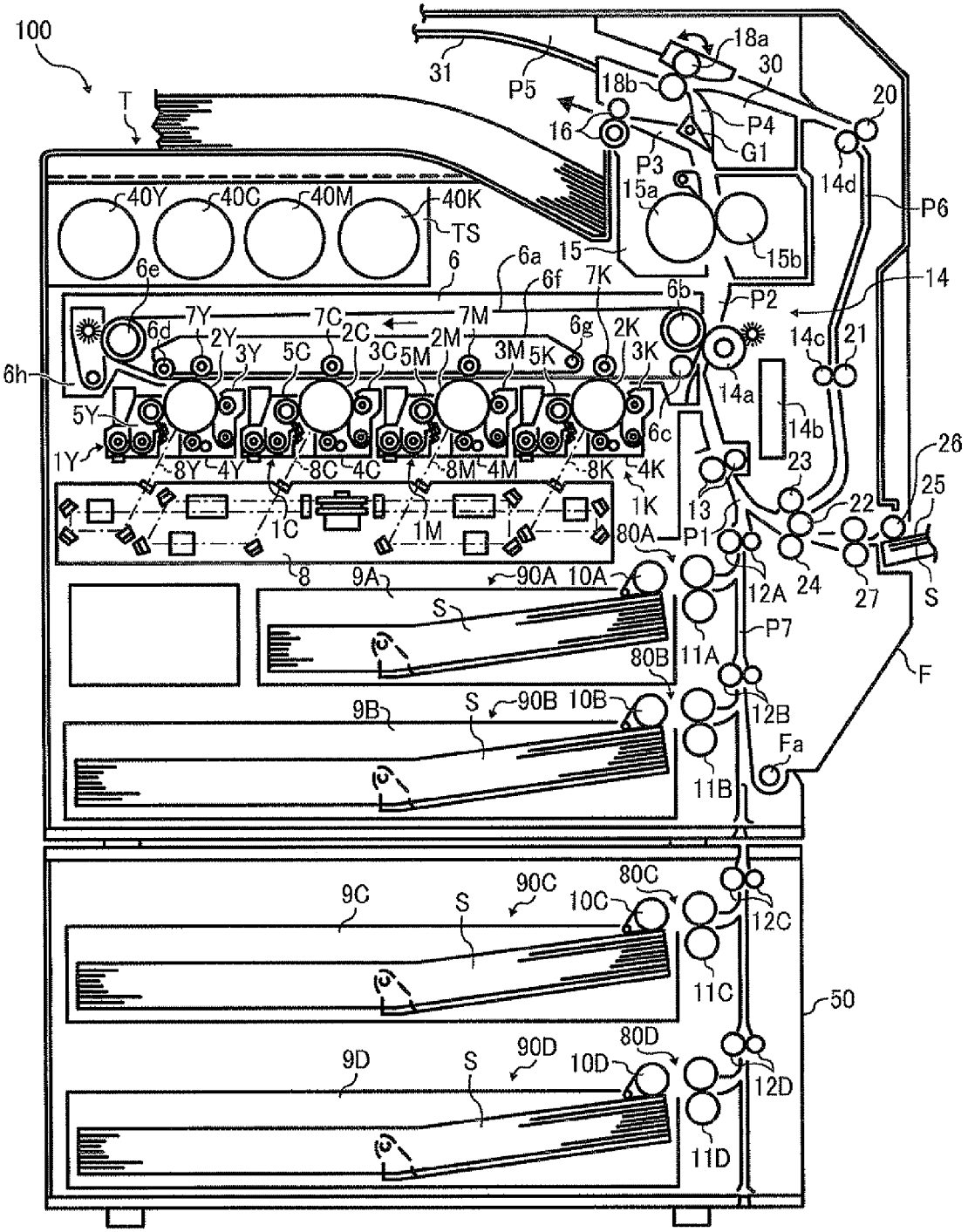


FIG. 2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4M
8K
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11B
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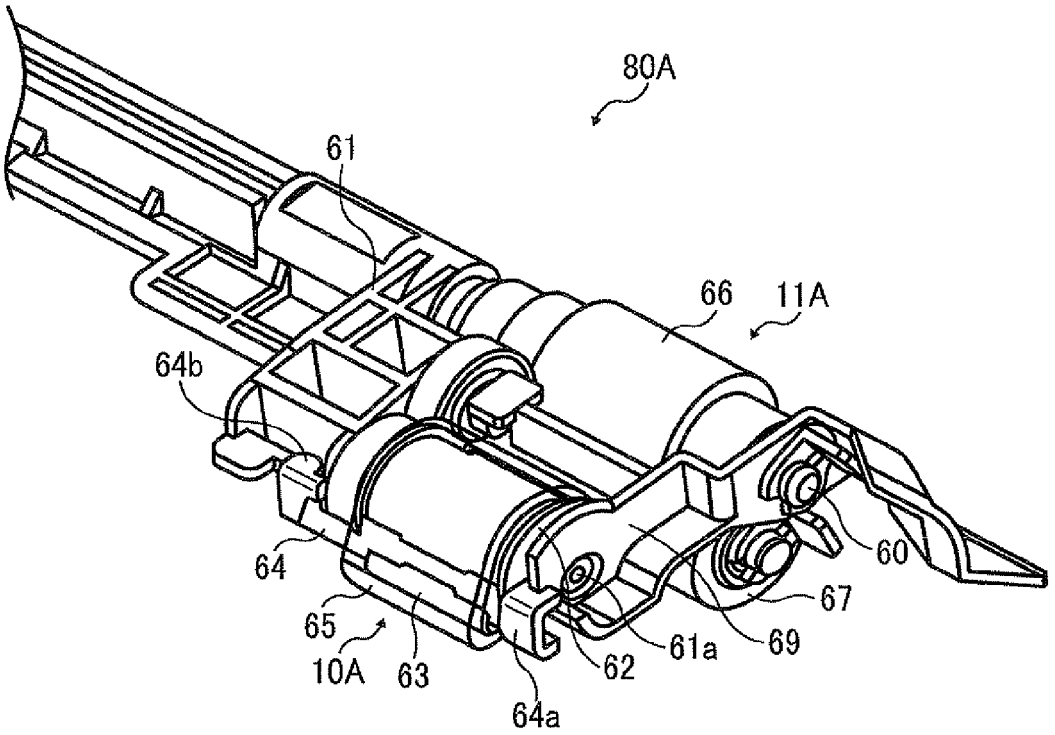
FIG. 3A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65
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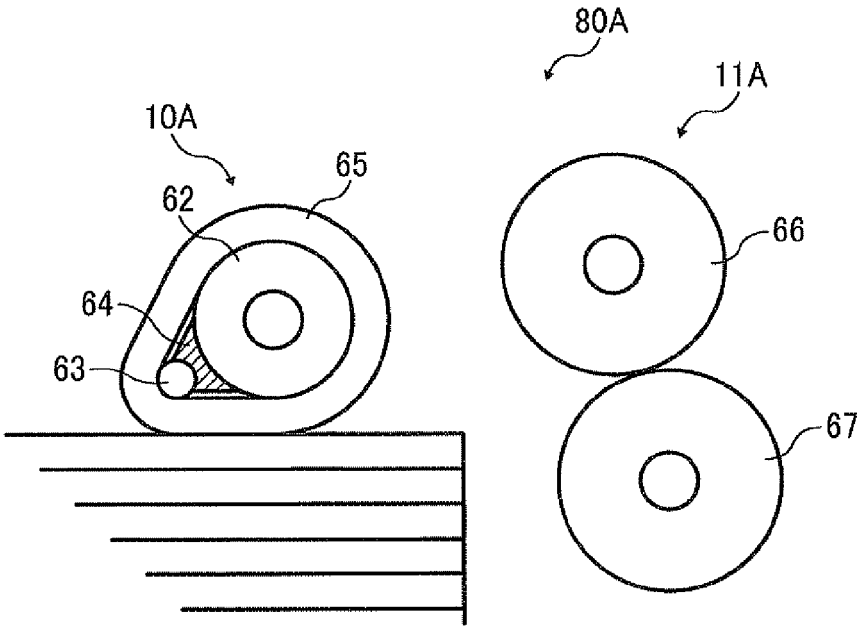
61a
10A
63
62
64a

FIG. 3B


80A
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67

FIG. 4A

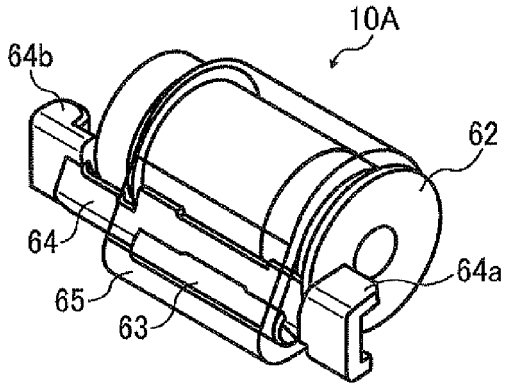


FIG. 4B

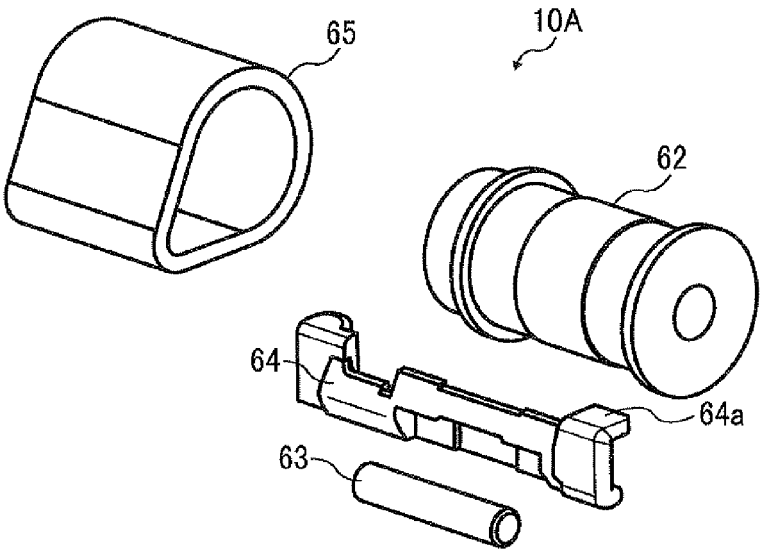


FIG. 5

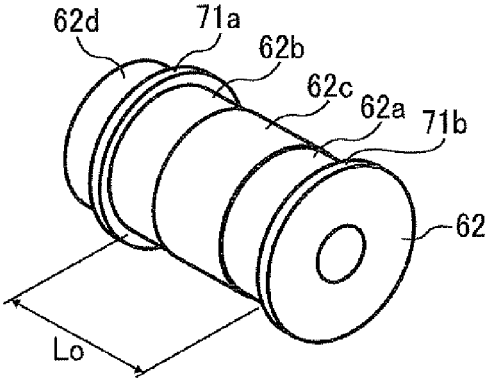


FIG. 6A

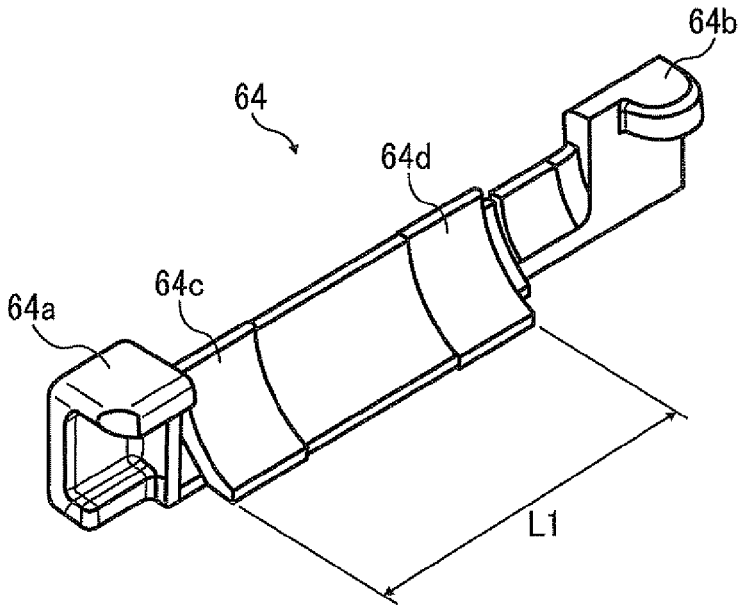


FIG. 6B

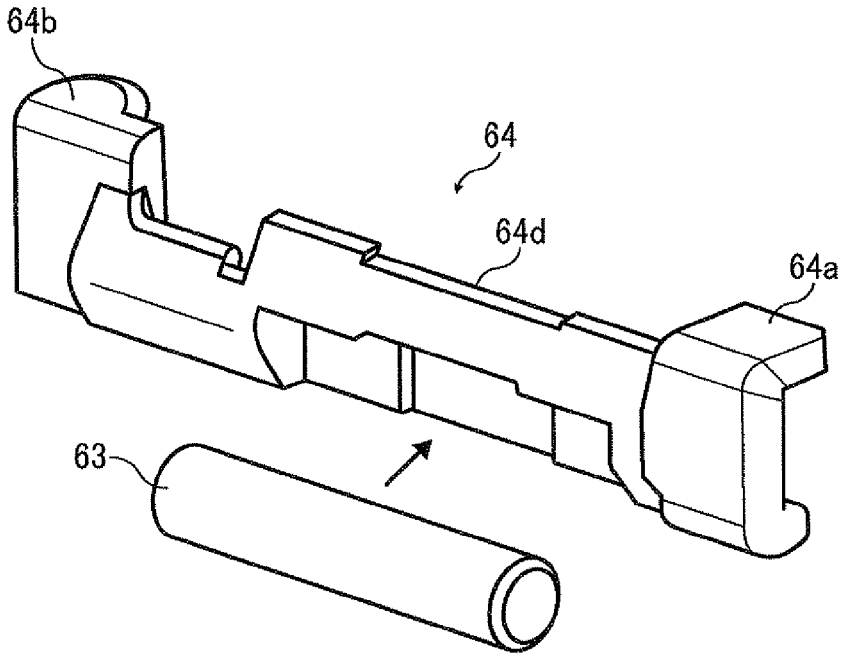


FIG. 7A

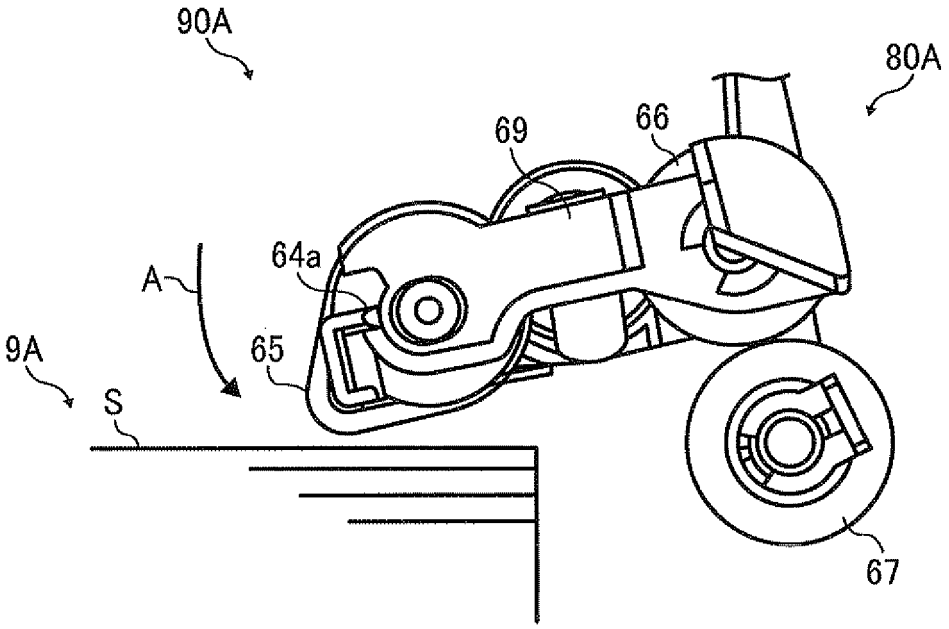


FIG. 7B

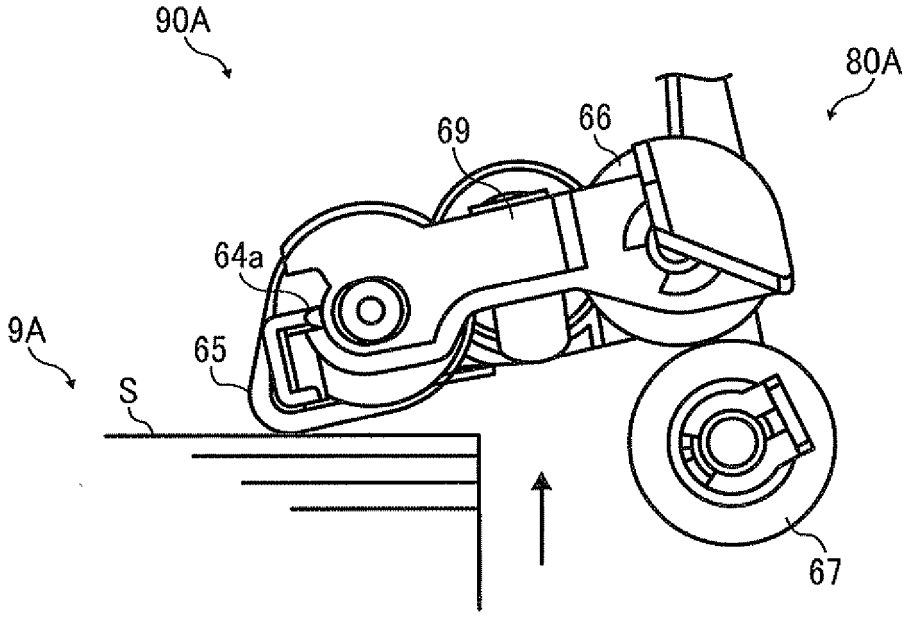


FIG. 7C

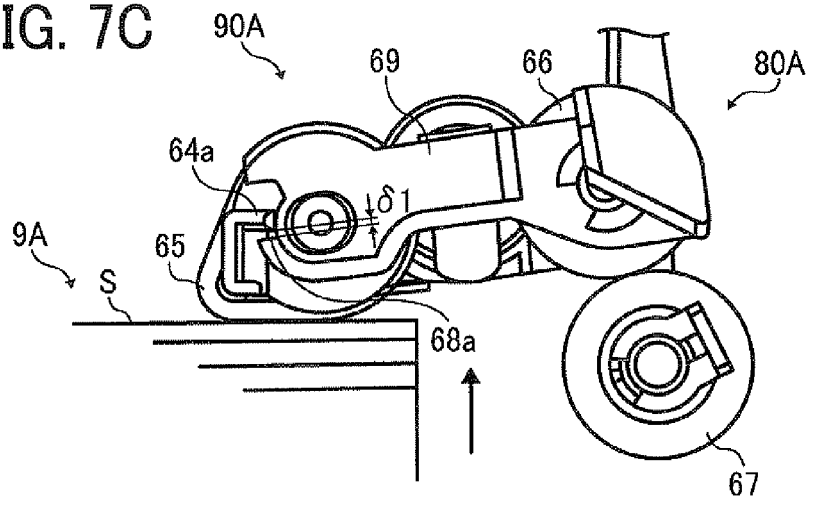


FIG. 7D

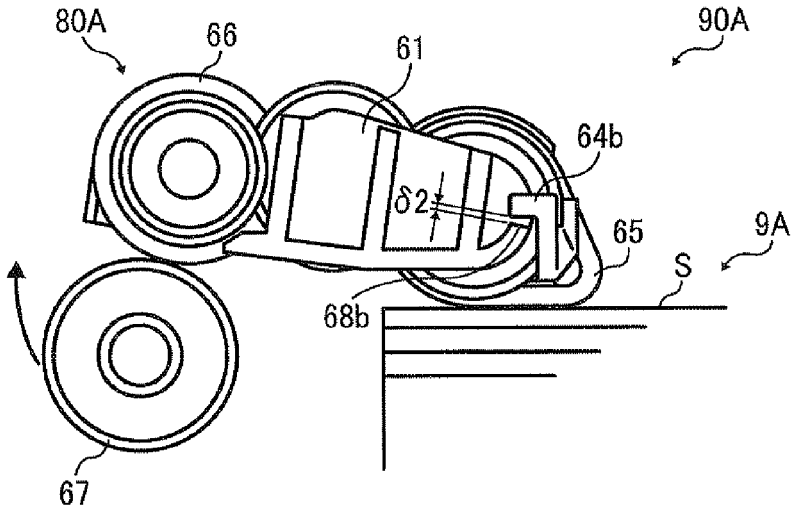


FIG. 7E

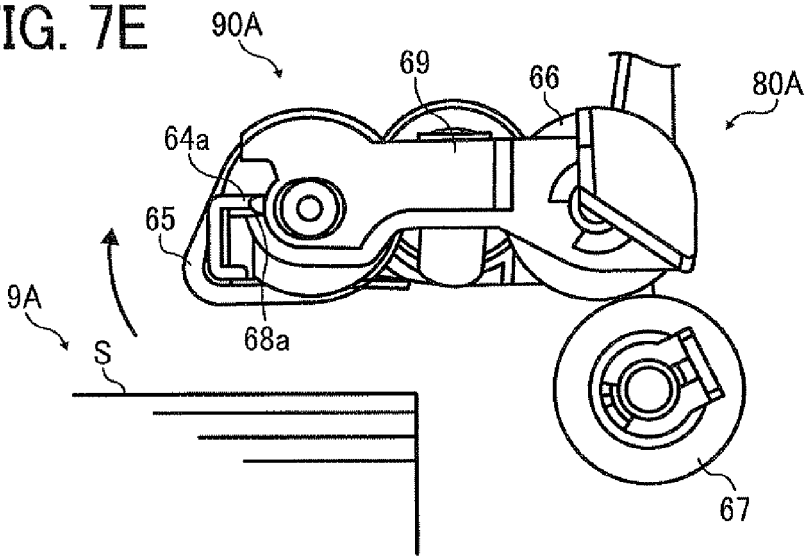


FIG. 8

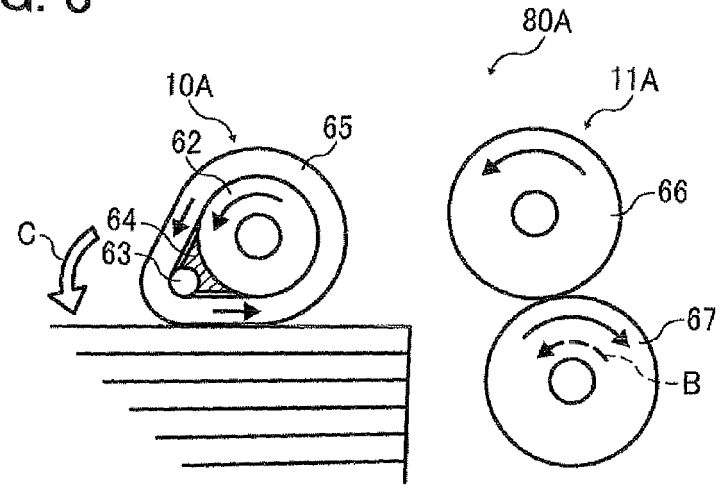


FIG. 9

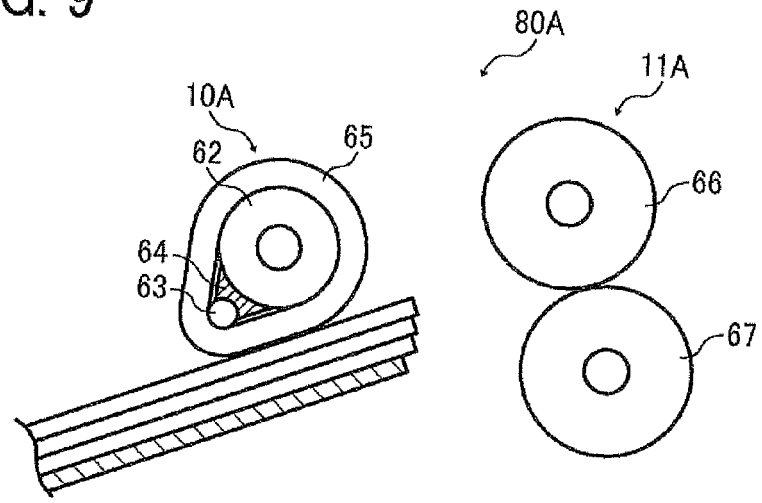
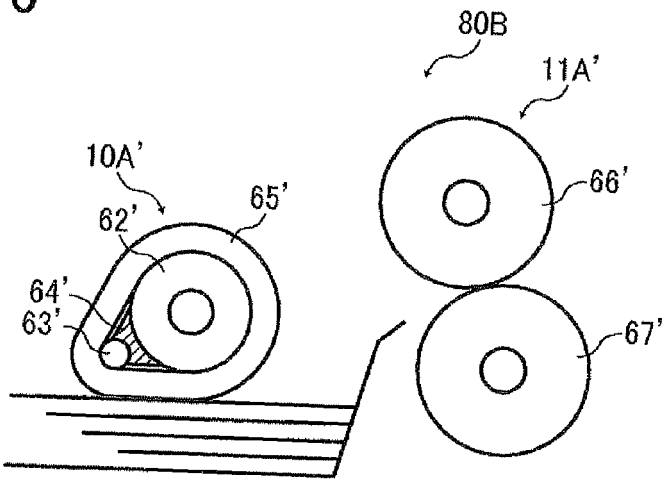


FIG. 10



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Patent documents cited in the description

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