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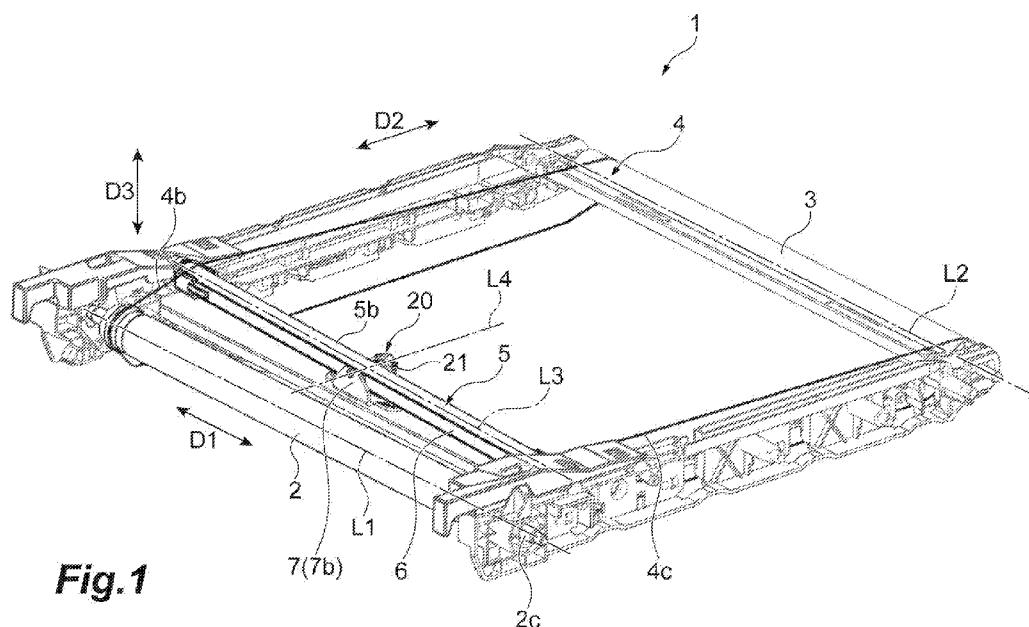


Fig.1

(57) Abstract: An imaging system includes a belt roller, an endless belt, a steering member, a tilting mechanism, and a link mechanism. The endless belt rotates about the first belt roller which extends in a longitudinal direction. The steering member is located inside the endless belt. The tilting mechanism is operably coupled to a center portion of the steering member. The link mechanism is operably coupled to the tilting mechanism and operates the tilting mechanism so that the steering member is tilted in response to a displacement of the endless belt in the longitudinal direction of the first belt roller.

Declarations under Rule 4.17:

- *as to the identity of the inventor (Rule 4.17(i))*
- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

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IMAGING SYSTEM

BACKGROUND

[0001] Some image forming systems include an endless belt as an intermediate transfer belt to transfer toner. The endless belt is stretched over a drive roller and a tension roller, and moves as the drive roller is rotationally driven. Some image forming systems include a steering roller located inside the endless belt. The steering roller is tilted when the endless belt is displaced in the longitudinal direction of the drive roller or the tension roller to correct the displacement of the endless belt.

BRIEF DESCRIPTION OF DRAWINGS

[0002] FIG. 1 is a perspective view of an example belt driving device of an example imaging system.

[0003] FIG. 2 is a perspective view of components of the example belt driving device illustrated in FIG. 1, including a first belt roller, a steering member, a tilting mechanism, and a link mechanism.

[0004] FIG. 3 is a cross-sectional view of a structure in the periphery of an end of the first belt roller illustrated in FIG. 2.

[0005] FIG. 4 is a partial plan view of the first belt roller and the link mechanism illustrated in FIG. 2.

[0006] FIG. 5 is a perspective view of the components illustrated in FIG. 2.

[0007] FIG. 6 is a side view of the components illustrated in FIG. 2.

[0008] FIG. 7 is a partial side view of the tilting mechanism illustrated in FIG. 2.

[0009] FIG. 8 is a side view illustrating an example state in which the steering member is tilted by the tilting mechanism and the link mechanism illustrated in FIG. 2.

[0010] FIG. 9 is a side view illustrating another example state in which the steering member is tilted by the tilting mechanism and the link mechanism

illustrated in FIG. 2.

[0011] FIG. 10 is a side view illustrating an example gear portion of the tilting mechanism illustrated in FIG. 2.

[0012] FIG. 11 is a side view illustrating another example gear portion.

[0013] FIG. 12 is a side view illustrating another example gear portion.

[0014] FIG. 13 is a perspective view of components of an example belt driving device, including a link mechanism, a tilting mechanism, and a steering member.

[0015] FIG. 14 is a perspective view of a spring of the example link mechanism illustrated in FIG. 13.

[0016] FIG. 15 is a perspective view of components of an example belt driving device, including a link mechanism, a tilting mechanism, a first belt roller, and a steering member according to another modified example.

[0017] FIG. 16 is a partial perspective view illustrating an end of the example first belt roller illustrated in FIG. 15.

[0018] FIG. 17 is a partial perspective view illustrating an end portion of the example first belt roller illustrated in FIG. 15.

[0019] FIG. 18 is a schematic diagram of an example imaging system including an example intermediate transfer device.

DETAILED DESCRIPTION

[0020] In the following description, with reference to the drawings, the same reference numbers are assigned to the same components or to similar components having the same function, and overlapping description is omitted.

[0021] An example belt driving device of an imaging system is used as a transfer device which may secondarily transfer a toner image developed by a developing device in an image forming apparatus such as a printer. In some examples, an imaging system may include an imaging apparatus such as a printer. In some examples, an imaging system may include a developing device to be mounted in or to be operable with an imaging apparatus. The example belt driving device may include an endless belt, where the endless belt is an intermediate

transfer belt of the transfer device. The belt driving device may be used in a printing medium conveying device which conveys a printing medium such as a sheet (e.g., paper sheet). In this case, the endless belt of the belt driving device functions as a printing medium conveying belt which conveys a printing medium.

[0022] With reference to FIG. 1, an example belt driving device 1 includes a first belt roller 2, a second belt roller 3, and an endless belt 4 which is stretched over the first belt roller 2 and the second belt roller 3. In the drawings, an inner structure of the endless belt 4 is indicated by solid lines for easier understanding. Each of the first belt roller 2 and the second belt roller 3 may extend in a direction D1. The direction D1 indicates the longitudinal direction of each of the first belt roller 2 and the second belt roller 3 and the width direction of the endless belt 4. The first belt roller 2 and the second belt roller 3 may face each other in a direction D2 intersecting the direction D1.

[0023] The first belt roller 2 may include a drive roller which drives the endless belt 4. The second belt roller 3 is a driven roller which follows the driving of the first belt roller 2. The first belt roller 2 may receive power from an electric motor. In this case, the first belt roller 2 rotates about an axis L1 extending in the direction D1 by the power from the electric motor. The first belt roller 2 may include a columnar shaft portion 2c which includes the axis L1. In some examples, the endless belt 4 is stretched over the first belt roller 2 and the second belt roller 3 and moves in a circulating manner along the outer circumference of the first belt roller 2 and the outer circumference of the second belt roller 3 in the direction D2 as the first belt roller 2 rotates. The second belt roller 3 rotates about an axis L2 as the endless belt 4 moves.

[0024] In some examples, the belt driving device 1 includes a steering member 5 that corrects the displacement of the endless belt 4 in the direction D1. When the steering member 5 contacts the endless belt 4, the displacement of the endless belt 4 is corrected. The example steering member 5 is a steering roller which extends in the direction D1 along with the first belt roller 2 and the second belt roller 3. In some examples, the steering member 5 is a steering roller which is located between the first belt roller 2 and the second belt roller 3 and extends in the direction D1 inside the endless belt 4.

[0025] With reference to FIGS. 1 and 2, the example belt driving device 1 may include a tilting mechanism 20 which is operably connected to a center portion of the steering member 5, and a link mechanism 10 which is operably connected or coupled to the tilting mechanism 20. In the present description, the "center portion of the steering member" indicates a portion including the center of the steering member in the longitudinal direction and includes the intermediate point of the steering member in the longitudinal direction and also the position of the steering member slightly displaced from the intermediate point. For example, a position or regions slightly spaced from the intermediate point of the steering member 5 in the direction D1 is also included in the center portion of the steering member 5. In some examples, the endless belt 4 includes a first edge portion 4b (also referred to herein as first end portion 4b) which is located at one end in the direction D1, and a second edge portion 4c (also referred to herein as second end portion 4c) which is located at the other end in the direction D1. The steering member 5 may be disposed at the upstream side of the first belt roller 2 and the downstream side of the second belt roller 3 in the circumferential movement direction of the endless belt 4. The steering member 5 may be disposed above the circumferential path (e.g, circumferential orbit) of the endless belt 4 so as to contact the inner circumferential surface of the endless belt 4 directed from the second belt roller 3 toward the first belt roller 2. In some examples, the steering member 5 is disposed at a position near the first belt roller 2 in relation to the intermediate point of the first belt roller 2 and the second belt roller 3.

[0026] In some examples, an outer circumferential surface 5b of the steering member 5 contacts the inner circumferential surface of the endless belt 4. In some examples, the steering member 5 rotates about an axis L3 in a driven manner as the endless belt 4 moves in a circulating manner. A first end 5c and a second end 5d respectively provided at both ends of the steering member 5 may be protected by a cap 5f. In some examples, the outer circumferential surface of the cap 5f is formed in a spherical shape. Each of the first end 5c and the second end 5d may be movable in a direction D3 intersecting both of the direction D1 and the direction D2.

[0027] The belt driving device 1 may include a support member 6 that

extends in the direction D1, and a rotation shaft portion 7 which is provided at the center of the support member 6 in the direction D1 to be connected to the support member 6. In some examples, the support member 6 extends in the longitudinal direction of the steering member 5. The support member 6 may be disposed to cover the lower portion of the outer circumferential surface 5b of the steering member 5. The rotation shaft portion 7 may support the support member 6 in a pivotable (e.g., swingable) manner. The rotation shaft portion 7 may include a pair of clamping portions 7b which clamps the support member 6 from both sides of the direction D2. Each of the pair of clamping portions 7b is connected to the support member 6 below the support member 6.

[0028] In some examples, the steering member 5 may be pivotable (or swingable) about an axis L4 which passes through the rotation shaft portion 7 and extends in the direction D2. In this case, each of the first end 5c and the second end 5d of the steering member 5 pivots along the direction D3 as the steering member 5 pivots about the axis L4. In some examples, the steering member 5 is tiltable by using the pair of clamping portions 7b as a fulcrum when one of the first end 5c and the second end 5d is pressed.

[0029] In some examples, the link mechanism 10 may move along the direction D1. The link mechanism 10 may include a slide member 10A that moves in the direction D1 in response to the displacement of the endless belt 4 in the direction D1, and that tilts the steering member 5 when the link mechanism 10 moves in the direction D1. The slide member 10A may extend from one end 2b of the first belt roller 2 in the direction D1 toward the steering member 5. The example slide member 10A may include a first member 11 that is attached to one end 2b of the first belt roller 2 and a second member 15 that is connected to the tilting mechanism 20.

[0030] In some examples, the tilting mechanism 20 may be provided inside the endless belt 4, coupled (e.g., connected) to the clamping portion 7b of the rotation shaft portion 7. In some examples, the tilting mechanism 20 tilts the steering member 5 through the clamping portion 7b. The example tilting mechanism 20 may include a gear portion 21 which is fixed to the steering member 5 and coupled (or connected) to the link mechanism 10. The steering

member 5 may be tilted by the rotation of the gear portion 21.

[0031] FIG. 3 is a cross-sectional view illustrating an example structure in the periphery of an end 2b of the first belt roller 2. FIG. 4 is a plan view illustrating the end 2b of the first belt roller 2 and the slide member 10A. With reference to FIGS. 3 and 4, the end 2b of the first belt roller 2 includes a pulley 8, a spring 9, and a first member 11. In some examples, the pulley 8 includes a tubular portion 8b covered by the endless belt 4, a flange portion 8c which is enlarged at an end portion of the tubular portion 8b in the direction D1, and a small diameter portion 8d which is provided at the side opposite to the tubular portion 8b of the flange portion 8c. In some examples, the pulley 8 includes a through-hole 8f which penetrates the tubular portion 8b, the flange portion 8c, and the small diameter portion 8d in the direction D1. The shaft portion 2c of the first belt roller 2 is inserted through the through-hole 8f.

[0032] The first member 11 may include a first plate-shaped portion 12 and a second plate-shaped portion 13. The first plate-shaped portion 12 has a constant thickness in the direction D1 and extends in the direction D2 from an end portion of the first belt roller 2 in the direction D1 when viewed from the pulley 8. The second plate-shaped portion 13 extends from the first plate-shaped portion 12 along the first belt roller 2. The first plate-shaped portion 12 may include a through-hole 12b which penetrates in the direction D1. The small diameter portion 8d of the pulley 8 and the shaft portion 2c of the first belt roller 2 are inserted into the through-hole 12b in the direction D1.

[0033] In some examples, the first plate-shaped portion 12 includes an annular protrusion 12c which surrounds the through-hole 12b and protrudes toward the pulley 8. The annular protrusion 12c faces the flange portion 8c of the pulley 8. The first plate-shaped portion 12 may include a tubular portion 12d which surrounds the through-hole 12b and protrudes toward the side opposite to the annular protrusion 12c. The spring 9 is wound on the tubular portion 12d. In the link mechanism 10 a portion other than the first plate-shaped portion 12 may be provided inside the endless belt 4.

[0034] In some examples, the spring 9 urges the pulley 8 and the first member 11 of the link mechanism 10 toward the center side of the direction D1

(the left side in FIGS. 3 and 4). In some examples, an end of the spring 9 is wound on the tubular portion 12d of the first plate-shaped portion 12 and the other end of the spring 9 is wound on the tubular portion 1c formed in the frame 1b of the belt driving device 1. The first member 11 may extend from the spring 9 and the pulley 8 toward the steering member 5 in the direction D2.

[0035] In some examples, the second plate-shaped portion 13 is provided inside the endless belt 4. In some examples, the second plate-shaped portion 13 includes a first side 13b, a second side 13d and a third side 13g. The first side 13b extends in the direction D2 intersecting the direction D1. The second side 13d extends from an end portion 13c at the side opposite to the first belt roller 2 of the first side 13b toward the tilting mechanism 20. The third side 13g extends from an end portion 13f at the side of the tilting mechanism 20 of the second side 13d toward the end 2b of the first belt roller 2. In some examples, the first side 13b, the second side 13d, and the third side 13g form a right triangle. The second plate-shaped portion 13 may include a fourth side 13j extending from the third side 13g in the direction D1. For example, the fourth side 13j may be located at an end portion at the side of the end 2b of the third side 13g to extend from the third side 13g in the direction D1.

[0036] In some examples, the second plate-shaped portion 13 includes a first rib 13h which extends in the direction D1, a second rib 13k which extends along the second side 13d, a third rib 13m which extends along the third side 13g, and a fourth rib 13p which extends along the fourth side 13j. In some examples, all of the first rib 13h, the second rib 13k, the fourth side 13j, and the fourth rib 13p protrude in an out-of-plane direction of the second plate-shaped portion 13 (for example, a direction orthogonal to the drawing sheets of FIGS. 3 and 4). A plurality of ribs increases a strength of the second plate-shaped portion 13.

[0037] In some examples, the first member 11 includes a connection portion 14 at an end portion opposite to the first belt roller 2, connected to the second member 15. In some examples, a first connection portion 14 is located at an end portion 12f at the side opposite to the first belt roller 2 of the first plate-shaped portion 12, and a second connection portion 14 is located at the end portion 13f at the side of the tilting mechanism 20 of the second plate-shaped

portion 13. In some examples, the connection portions 14 protrude in the direction D2, respectively, from the first plate-shaped portion 12 and from the second plate-shaped portion 13. The protruding ends of the connection portions 14 are connected to the second member 15 by a pin P. In some examples, a single end of the second member 15 in the direction D1 (e.g., the right end in FIG. 4) is exposed from the endless belt 4. A portion other than the single end of the second member 15 is provided inside the endless belt 4.

[0038] With reference to FIGS. 5 and 6, the slide member 10A may include a guide member 16 that guides the sliding movement of the slide member 10A in the direction D1. In some examples, the guide member 16 covers a part of the first plate-shaped portion 12 and the second plate-shaped portion 13. The guide member 16 may extend in the direction D1 below the steering member 5 and the support member 6. In some examples, the guide member 16 includes a first plate portion 16b which has a rectangular shape with a long side extending in the direction D1 and a short side extending in the direction D2, and a pair of second plate portions 16c which is bent downward from the end portion of the first plate portion 16b in the width direction. The pair of second plate portions 16c may be arranged side by side in the direction D2.

[0039] One of the pair of second plate portions 16c may be provided with a through-hole 16d which extends in the direction D1 and penetrates in the direction D2. The pin P may be inserted through the through-hole 16d. Accordingly, the second member 15 is guided by the guide member 16 and linearly moves in the direction D1. The second member 15 may have a bar shape extending in the direction D1.

[0040] The example second member 15 includes a pair of insertion portions 15b through which the pin P is inserted, a first bar-shaped portion 15c which is located between the pair of insertion portions 15b, and a second bar-shaped portion 15d which is located at the side of the tilting mechanism 20 of the pair of insertion portions 15b. In some examples, the second member 15 linearly extends in the direction D1. The width of each insertion portion 15b in the direction D3 may be wider than the width of the first bar-shaped portion 15c in the direction D3 and the width of the second bar-shaped portion 15d in the direction

D3.

[0041] In some examples, the slide member 10A includes a rack portion 17 which extends in the direction D1. The rack portion 17 is formed on the surface of the second bar-shaped portion 15d of the second member 15. The rack portion 17 includes a plurality of tooth portions which engage with the gear portion 21 of the tilting mechanism 20. The gear portion 21 rotates as the rack portion 17 moves linearly in the direction D1 and the steering member 5 is tilted as the gear portion 21 rotates.

[0042] FIG. 7 is an enlarged side view of the gear portion 21 of the example tilting mechanism 20. The gear portion 21 includes a pinion portion 22 which is connected to the rotation shaft portion 7 located at the center portion of the steering member 5 and engages with the rack portion 17. In some examples, the rack portion 17 of the link mechanism 10 and the pinion portion 22 of the tilting mechanism 20 constitute a rack and pinion mechanism. The gear portion 21 may include a first gear 23 which is the pinion portion 22 and a second gear 24 which is rotatable and connected to the center portion of the steering member 5 to tilt the steering member 5 in accordance with the rotation.

[0043] In some examples, the first gear 23 and the second gear 24 are arranged side by side in the direction D3 and the first gear 23 is disposed at the lower side in relation to the second gear 24. That is, the first gear 23 is disposed between the second gear 24 and the rack portion 17. In some examples, the first gear 23 is rotatably supported by the first shaft portion 7c protruding from the rotation shaft portion 7 in the direction D2 and the second gear 24 is rotatably supported by the second shaft portion 7d protruding from the rotation shaft portion 7 in the direction D2. In some examples, the first gear 23 includes a teeth portion formed on the entire circumference thereof and the second gear 24 includes a teeth portion formed at the lower portion thereof.

[0044] Example operations of the example link mechanism 10 and the example tilting mechanism 20 will be described with reference to FIGS. 8 and 9. FIG. 8 is a side view illustrating an example in which the steering member 5 is tilted so that the first end 5c moves upward and the second end 5d moves downward. FIG. 9 is a side view illustrating an example in which the steering

member 5 is tilted so that the first end 5c moves downward and the second end 5d moves upward.

[0045] With reference to FIG. 9, when the endless belt 4 is displaced toward the link mechanism 10 and the link mechanism 10 may move toward both ends of the direction D1 (e.g., the right side in FIG. 9) against the urging force of the spring 9, the rack portion 17 may move toward both ends in the direction D1 and the pinion portion 22 (e.g., the first gear 23) may rotate in a first direction (e.g., a counter-clockwise rotation direction in FIG. 9). When the pinion portion 22 rotates in one direction, the second gear 24 may rotate in a second direction (e.g., a clockwise rotation direction in FIG. 9) opposite to the first direction and the steering member 5 is tilted so that the second end 5d moves upward and the first end 5c moves downward.

[0046] With reference to FIG. 8, when the link mechanism 10 returns from both ends of the direction D1 by the urging force of the spring 9, the rack portion 17 may move toward the center side of the direction D1 (e.g., the left side in FIG. 8) and the pinion portion 22 (e.g., the first gear 23) may rotate in the above-described opposite direction (e.g., a clockwise rotation direction in FIG. 8). Then, when the pinion portion 22 rotates in the opposite direction, the second gear 24 may rotate in the above-described first direction (e.g., a counter-clockwise rotation direction in FIG. 8) and the steering member 5 may be tilted so that the second end 5d moves downward and the first end 5c moves upward.

[0047] With reference to FIG. 9, in the example imaging system including the belt driving device 1, when the first edge portion 4b of the endless belt 4 moves toward the first end 5c, the link mechanism 10 moves toward the end portion of the direction D1 and the steering member 5 is tilted so that the tilting mechanism 20 raises the second end 5d. When the second end 5d moves upward with respect to the first end 5c, a tension of the endless belt 4 with respect to the second end 5d becomes higher than a tension of the endless belt 4 with respect to the first end 5c. Accordingly, the endless belt 4 moves toward the second end 5d.

[0048] Since the endless belt 4 which is displaced toward the first end 5c of the steering member 5 moves toward the second end 5d by the link mechanism

10, the tilting mechanism 20, and the steering member 5, the displacement of the endless belt 4 toward the first end 5c is corrected. Accordingly, the steering member 5, the link mechanism 10, and the tilting mechanism 20 function as a belt position correction member that corrects the displacement of the endless belt 4.

[0049] With reference to FIG. 2, in the example belt driving device 1, the steering member 5 is located inside the endless belt 4, and the tilting mechanism 20 is operably connected to the center portion of the steering member 5. The tilting mechanism 20 is located inside the endless belt 4, to prevent foreign substances such as toner or paper dust from intruding into the tilting mechanism 20. Accordingly, an increase in sliding load of the tilting mechanism 20 due to the intrusion of foreign substances is inhibited, and the life span of the tilting mechanism 20 may be increased.

[0050] The link mechanism 10 may include the slide member 10A that tilts the steering member 5 when the link mechanism 10 moves in the direction D1 and moves in the longitudinal direction of the first belt roller 2 in response to the movement (displacement) of the endless belt 4. Accordingly, since the steering member 5 can be tilted by the sliding movement of the slide member 10A, a configuration of the link mechanism 10 which is connected to the tilting mechanism 20 tilting the steering member 5 can be simplified.

[0051] The tilting mechanism 20 may include a gear portion 21 which is fixed to the steering member 5 and connected to the link mechanism 10 and may convert a linear motion of the slide member 10A in the direction D1 into a rotational motion of the gear portion 21. Accordingly, the configurations of the link mechanism 10 and the tilting mechanism 20 tilting the steering member 5 can be simplified.

[0052] The slide member 10A may include the rack portion 17 extending in the direction D1, the gear portion 21 may include the pinion portion 22 connected to the rotation shaft portion 7 at the center portion of the steering member 5, and may engage with the rack portion 17. The tilting mechanism 20 may tilt the steering member 5 in accordance with the rotation of the pinion portion 22. Accordingly, since the steering member 5 can be tilted by the rack and pinion mechanism, a smoother tilting of the steering member 5 may be achieved with a

simpler configuration.

[0053] The gear portion 21 may be located inside the endless belt 4, to prevent foreign substances such as toner or paper dust from intruding into the gear portion 21, in order to prevent an increase in rotation load of the gear portion 21. Accordingly, since it is possible to more smoothly tilt the steering member 5 for a long time, it is possible to further increase the life span of the tilting mechanism 20 and the endless belt 4.

[0054] The gear portion 21 may include the first gear 23 which is the pinion portion 22, and the second gear 24 which is rotatable and connected to the center portion of the steering member 5, to tilt the steering member 5 in accordance with the rotation. Since the gear portion 21 can be provided as two gears, the configuration of the tilting mechanism 20 can be simplified.

[0055] With reference to FIGS. 10 to 12, in the example tilting mechanism 20, a gear constituting the gear portion 21 can be changed. FIG. 10 illustrates an example in which the diameter of the first gear 23A is larger than the diameter of the second gear 24A, FIG. 11 illustrates an example in which the diameter of the first gear 23B is the same as the diameter of the second gear 24B, and FIG. 12 illustrates an example in which the diameter of the first gear 23C is shorter than the diameter of the second gear 24C.

[0056] With reference to FIGS. 10 to 12, when the diameter of the first gear 23A is larger than the diameter of the second gear 24A, the rotation amount of the second gear 24A with respect to the movement amount of the rack portion 17 and the rotation amount of the first gear 23A increases. Accordingly, a relatively small movement of the link mechanism 10 may actuate the second gear 24 to rotate in a relatively large increment, in order to tilt the steering member 5 more promptly.

[0057] Meanwhile, when the diameter of the first gear 23C is smaller than the diameter of the second gear 24C, the rotation of the second gear 24C with respect to the movement amount of the rack portion 17 and the rotation amount of the first gear 23C decreases. Accordingly, the rotational motion of the second gear 24 and the tilting motion of the steering member 5 can be decreased even when the link mechanism 10 is moved in a relatively large increment. Accordingly,

the tilting motion of the steering member 5 can be adjusted more finely. As described above, when the gear constituting the gear portion 21 can be changed, the tilting motion of the steering member 5 with respect to the movement amount of the link mechanism 10 can be better adjusted.

[0058] With reference to FIGS. 2 and 4, the slide member 10A may include the first member 11 that is attached to one end 2b of the first belt roller 2, and the second member 15 that is connected to the tilting mechanism 20. When the slide member 10A is formed as two components, the slide member 10A may be more easily assembled by connecting the two components.

[0059] The first member 11 may extend from one end 2b of the first belt roller 2 in the direction D2 intersecting the direction D1 and the second member 15 may extend from the first member 11 in the direction D1, in order to simplify the shapes of the first member 11 and the second member 15.

[0060] The first member 11 may include the first side 13b which extends in the direction D2, the second side 13d which extends from the end portion 13c at the side opposite to the first belt roller 2 of the first side 13b toward the tilting mechanism 20, and the third side 13g which extends from the end portion 13f at the side of the tilting mechanism 20 of the second side 13d toward one end 2b of the first belt roller 2. Accordingly, the shape of the first member 11 can be further simplified. The first side 13b, the second side 13d, and the third side 13g may be shaped in a right triangle, to further simplify the shape of the first member 11.

[0061] The belt driving device 1 may include the spring 9 which urges one end 2b of the first belt roller 2 through the slide member 10A, in order to return the tilting motion of the steering member 5 by the tilting mechanism 20 to an original state, and to better stabilize the tilting motion of the steering member 5.

[0062] With reference to FIGS. 13 and 14, an example belt driving device 31 includes a spring 39 which is provided inside the endless belt 4 instead of the spring 9. In some examples, in the belt driving device 31, the guide member 16 includes a protrusion 16f which protrudes from one first plate portion 16b toward the opposite side of the first belt roller 2 and the protrusion 16f is provided at the distal end of the front end portion 15f of the second member 15.

[0063] The front end portion 15f may be provided between the protrusion

16f and the tilting mechanism 20. In some examples, the front end portion 15f includes a plate-shaped portion 15g, a concave portion 15h, and a protrusion 15j. The plate-shaped portion 15g protrudes from the second bar-shaped portion 15d toward the opposite side of the tilting mechanism 20 and extends in both of the direction D1 and the direction D3. The concave portion 15h is recessed in the plate-shaped portion 15g in the direction D2. The protrusion 15j protrudes from a bottom surface of the concave portion 15h toward the opposite side of the first belt roller 2. In some examples, a first end of the spring 39 is supported by the protrusion 15j of the second member 15 and a second end of the spring 39 is supported by the protrusion 16f of the guide member 16. In some examples, the spring 39 is a tensile coil spring which urges the second member 15 in a pulling direction.

[0064] In some examples, the belt driving device 31 may include the spring 39 which urges the second member 15 of the slide member 10A toward the opposite side of the tilting mechanism 20, in order to return the tilting motion of the steering member 5 to an original state by the spring 39 and to stabilize the tilting motion of the steering member 5. The spring 39 provided inside the endless belt 4 prevents foreign substances such as toner or paper dust from intruding into the spring 39, thereby preventing a state in which the urging of the spring 39 is disturbed by foreign substances, which in turn increases the life of the spring 39.

[0065] FIG. 15 is a perspective view illustrating an example belt driving device 41. FIG. 16 is an enlarged perspective view illustrating an end 2d of an example first belt roller 2 of the belt driving device 41. FIG. 17 is an enlarged perspective view illustrating a second end 2f opposite to the first end 2d of the first belt roller 2 of the belt driving device 41. The belt driving device 41 includes a pulley 8 at both ends in the direction D1. The belt driving device 41 does not include the springs 9 and 39.

[0066] With reference to FIGS. 15 to 17, the example belt driving device 41 includes a link mechanism 50. The link mechanism 50 includes a pair of arm portions 51 which extend from the first end 2d and from the second end 2f, respectively, of the first belt roller 2 in a direction intersecting the direction D1, and a slide portion 55 which connects the pair of arm portions 51. Each arm

portion 51 may be plate-shaped, and have a constant thickness in the direction D1 when viewed from each pulley 8.

[0067] The example arm portion 51 includes a connection portion 52 which is connected to the first belt roller 2 and an extension portion 53 which extends from the connection portion 52 toward the lower side of the steering member 5. In some examples, the connection portion 52 extends from the extension portion 53 into a circular shape. The connection portion 52 may be provided with a through-hole 52b in the direction D1, to insert the small diameter portion 8d of the pulley 8 and the shaft portion 2c of the first belt roller 2, in the direction D1.

[0051] An end portion opposite to the first belt roller 2 of each arm portion 51 may be connected to the slide portion 55 by the pin P. In some examples, opposite ends of the slide portion 55 are exposed beyond the endless belt 4 and the rest of the slide portion 55 is located within the endless belt 4. The slide portion 55 may be bar shaped and extend in the direction D1, from a first end 2f to a second end 2d of the first belt roller 2. Accordingly, the slide portion 55 extends similarly to the second member 15.

[0068] The example slide portion 55 includes a plurality of insertion portions 55b through which the pin P is inserted and a plurality of bar-shaped portions 55c located between two adjacent insertion portions 55b. In some examples, the width of each insertion portion 55b in the direction D3 is wider than the width of each bar-shaped portion 55c in the direction D3. In some examples, the slide portion 55 includes four insertion portions 55b which are arranged side by side in the direction D1 and three bar-shaped portions 55c which are arranged side by side in the direction D1. Among three bar-shaped portions 55c, an upper surface of the bar-shaped portion 55c located at the center of the direction D1 is provided with the rack portion 17.

[0069] As described above, the belt driving device 41 may include the link mechanism 50 including the pair of arm portions 51 and the slide portion 55, in which the upper surface of the bar-shaped portion 55c of the slide portion 55 is provided with the rack portion 17. Accordingly, the gear portion 21 of the tilting mechanism 20 rotates in accordance with the linear motion of the rack portion 17 in the direction D1 and the steering member 5 can be tilted by the rotation of the

gear portion 21.

[0070] The link mechanism 50 may include the pair of arm portions 51, respectively attached to the first end 2f and to the second end 2d of the first belt roller 2 and extending in a direction intersecting the direction D1, and the slide portion 55 provided between the pair of arm portions 51 to extend in the direction D1. Since each end portion of the slide portion 55 in the direction D1 is connected to the first belt roller 2 through the arm portion 51, the springs 9 and 39 are not necessary, which simplifies the link mechanism 50.

[0071] When the endless belt 4 is displaced toward the first end 5c of the steering member 5, the second end 5d of the steering member 5 is actuated to move upward by the linear motion of the link mechanism 50 and the rotational motion of the tilting mechanism 20. Consequently, the endless belt 4 moves toward the second end 5d. When the endless belt 4 is displaced toward the second end 5d of the steering member 5, the first end 5c of the steering member 5 is actuated to move upward by the linear motion of the link mechanism 50 and the rotational motion of the tilting mechanism 20. Consequently, the endless belt 4 moves toward the first end 5c. Accordingly, both of displacements of the endless belt 4, toward the first end 5c and toward the second end 5d, may be corrected by the link mechanism 50 and the tilting mechanism 20.

[0072] With reference to FIG. 18, an example imaging system 61 may include an example belt driving device as described above, as an intermediate transfer device 62. The example imaging system may be a color image forming apparatus which includes the intermediate transfer device 62. For better ease of understanding, the entire imaging system 61 is not illustrated in FIG. 18. The intermediate transfer device 62 may include any one of the belt driving device 1, the belt driving device 31, and the belt driving device 41. The intermediate transfer device 62 includes the first belt roller 2, the second belt roller 3, an intermediate transfer belt 63 which is the endless belt 4, and a secondary transfer roller 64.

[0073] The example imaging system 61 may include process cartridges 66 which include respective photoconductors 65 arranged in the movement direction of the intermediate transfer belt 63, and a cassette 67 which accommodates the

printing medium M of the imaging system 61, in addition to the intermediate transfer device 62. In some examples, the process cartridges 66 collectively include a photoconductor 65, a developing device, a charging device, and a cleaning device.

[0074] In some examples, the imaging system 61 may include a casing 68 onto which a plurality of process cartridges 66 are attached and each process cartridge 66 may be attachable to and detachable from the casing 68 in such a manner that a door of the casing 68 is opened and the process cartridge is inserted into and extracted from the casing 68. In some examples, the cassette 67 is opened and closed to accommodate the printing medium M. The printing medium M accommodated in the cassette 67 may be picked up and conveyed by the medium conveying device 69. The medium conveying device 69 may allow the printing medium M to reach the secondary transfer region R at a timing in which the toner image transferred onto the intermediate transfer belt 63 of the intermediate transfer device 62 reaches the secondary transfer region R.

[0075] In some examples, as described above, the endless belt 4 (the intermediate transfer belt 63) is stretched over the first belt roller 2 and the second belt roller 3. The first belt roller 2, the second belt roller 3, the endless belt 4, the steering member 5, the tilting mechanism 20, and the link mechanisms 10 and 50 form part of the belt driving device 1, 31, and 41. The belt driving device 1, 31, and 41 correspond to the intermediate transfer device 62. The tilting mechanism 20 is provided inside the intermediate transfer belt 63 in the example imaging system 61, to prevent foreign substances such as toner or paper dust from intruding into the tilting mechanism 20, thereby increasing the life span of the tilting mechanism 20 and of the intermediate transfer belt 63 mounted on the imaging system 61.

[0076] It is to be understood that not all aspects, advantages and features described herein may necessarily be achieved by, or included in, any one particular example. Indeed, having described and illustrated various examples herein, it should be apparent that other examples may be modified in arrangement and detail.

[0077] For example, although an example in which the tilting mechanism

20 includes the gear portion 21 and the steering member 5 is tilted by the rack and pinion mechanism has been described, the tilting mechanism may be one that does not include a gear portion and that may tilt the steering member by a mechanism other than the rack and pinion mechanism. In some examples, the imaging system may tilt the steering member via a tilting mechanism which is a link mechanism instead of the gear portion. Accordingly, the configuration of the tilting mechanism may be modified. Further, the configuration of the link mechanism, the configuration of the steering member, the configuration of the belt driving device, or the configuration of the imaging system may also be modified.

CLAIMS

1. An imaging system comprising:
a belt roller extending in a longitudinal direction;
an endless belt to rotate about the belt roller;
a steering member located inside the endless belt;
a tilting mechanism operably coupled to a center portion of the steering member; and

a link mechanism which is operably coupled to the tilting mechanism to pivot the steering member in response to a displacement of the endless belt in the longitudinal direction of the belt roller.

2. The imaging system according to claim 1,
wherein the link mechanism includes a slide member to move in the longitudinal direction of the belt roller in response to a shifting of the endless belt, the slide member to actuate the tilting mechanism to tilt the steering member, when the slide member moves in the longitudinal direction.

3. The imaging system according to claim 2,
wherein the tilting mechanism includes a gear portion operably coupled between the steering member and slide member of the link mechanism, to convert a linear movement of the slide member in the longitudinal direction into a pivotal movement of the steering member.

4. The imaging system according to claim 3,
wherein the slide member includes a rack portion extending in the longitudinal direction,

wherein the gear portion includes a rotatable pinion portion mounted on a rotation shaft located adjacent a center portion of the steering member, the pinion portion to engage with the rack portion, and

wherein the tilting mechanism to tilt the steering member when the pinion portion rotates.

5. The imaging system according to claim 4,
wherein the pinion portion includes a first gear to rotate,
wherein the gear portion includes a second gear rotatably coupled to the first gear, and

wherein the second gear is rigidly fixed to a center portion of the steering member to tilt the steering member in response to a rotation of the first gear.

6. The imaging system according to claim 3,
wherein the gear portion is located inside the endless belt.

7. The imaging system according to claim 3,
comprising a mounting shaft, wherein the gear portion includes a gear removably mounted on the mounting shaft, the mounting shaft to accommodate gears of different sizes.

8. The imaging system according to claim 2,
wherein the slide member includes a first member that is attached to an end of the belt roller and a second member that is connected to the tilting mechanism.

9. The imaging system according to claim 8,
wherein the first member extends from the end of the belt roller in a direction intersecting the longitudinal direction of the belt roller, and
wherein the second member extends from the first member in the longitudinal direction.

10. The imaging system according to claim 8,
wherein the first member has a first side extending in a direction intersecting the longitudinal direction from a first end adjacent the belt roller to a second end opposite the first end, a second side extending from the second end of the first side toward the tilting mechanism, and a third side extending from the

second side opposite the first side, toward an end of the belt roller.

11. The imaging system according to claim 10,
wherein the first side, the second side, and the third side form a right triangle.

12. The imaging system according to claim 8, comprising:
a spring which urges the second member of the slide member toward a side opposite to the tilting mechanism.

13. The imaging system according to claim 2, comprising:
a spring which urges an end of the belt roller via the slide member.

14. The imaging system according to claim 1,
wherein the link mechanism includes a pair of arm portions attached to respective ends of the belt roller and extending in a direction intersecting the longitudinal direction, and a slide portion extending in the longitudinal direction between the pair of arm portions.

15. The imaging system according to claim 1,
wherein the belt roller includes a first belt roller,
wherein the imaging system includes a second belt roller extending in the longitudinal direction,

wherein the endless belt is stretched over the first belt roller and the second belt roller,

wherein the first belt roller, the second belt roller, the endless belt, the steering member, the tilting mechanism, and the link mechanism form a belt driving device, and

wherein the belt driving device is an intermediate transfer device to sequentially transfer toner images carried on respective photoconductors.

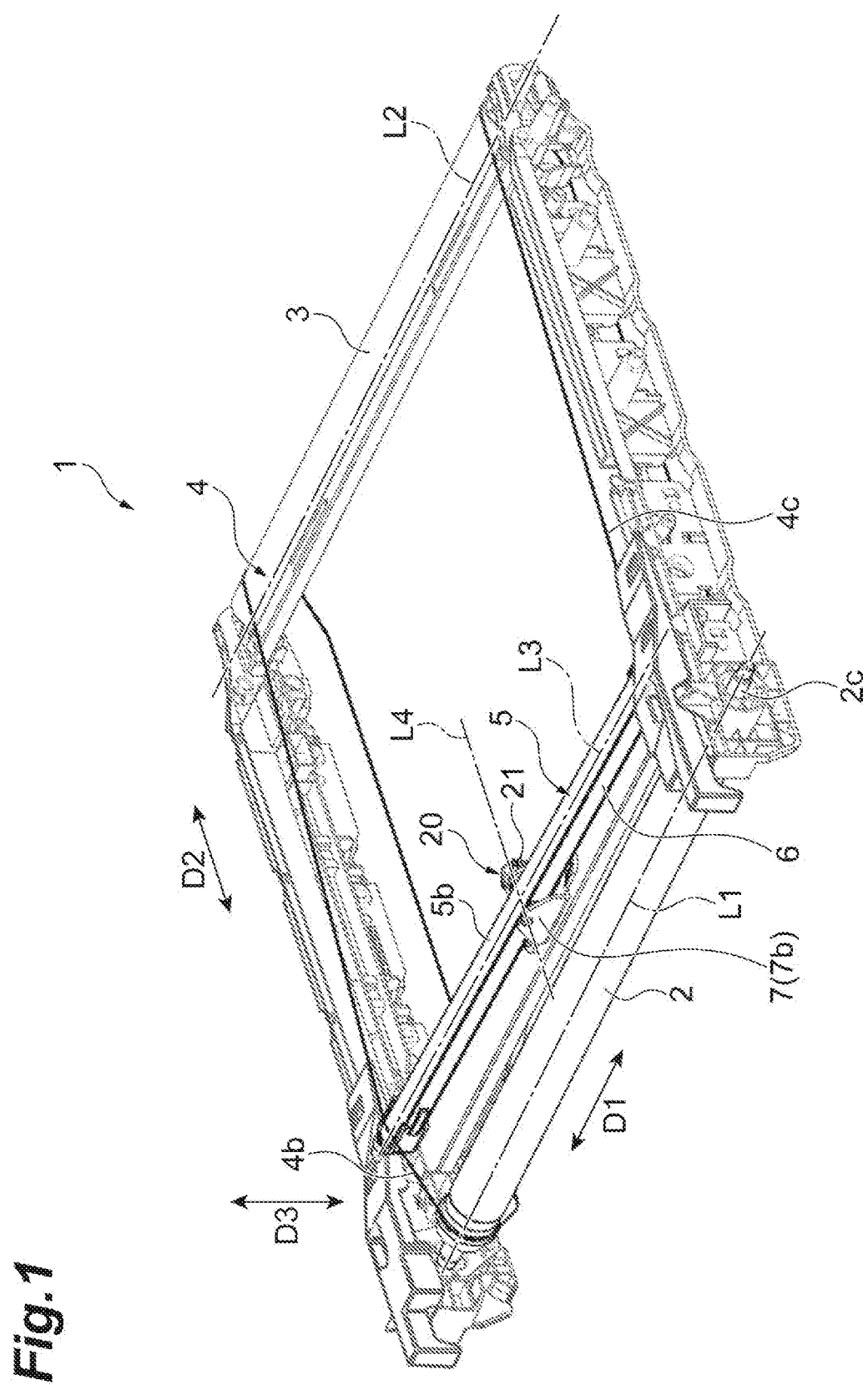
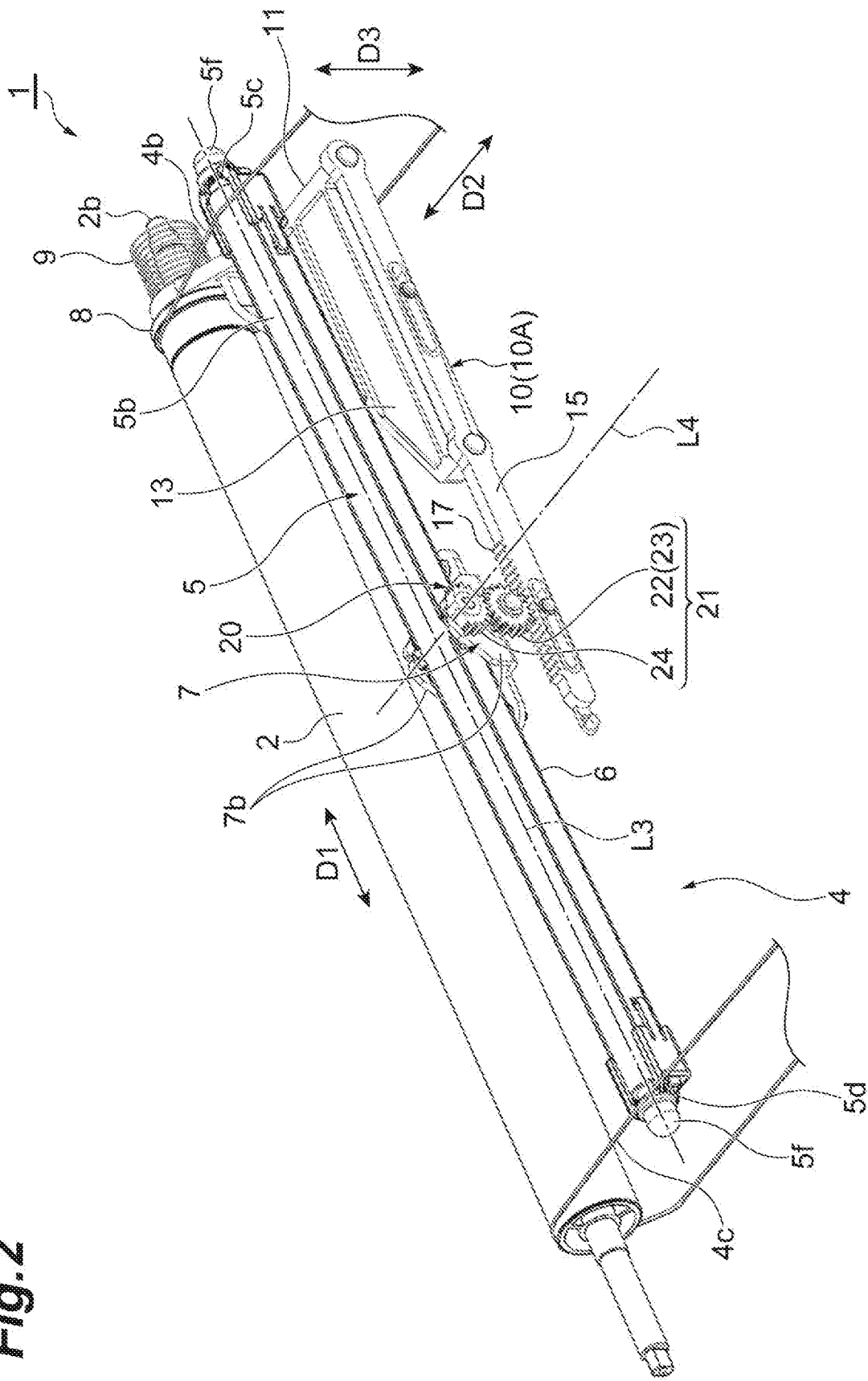


Fig.2



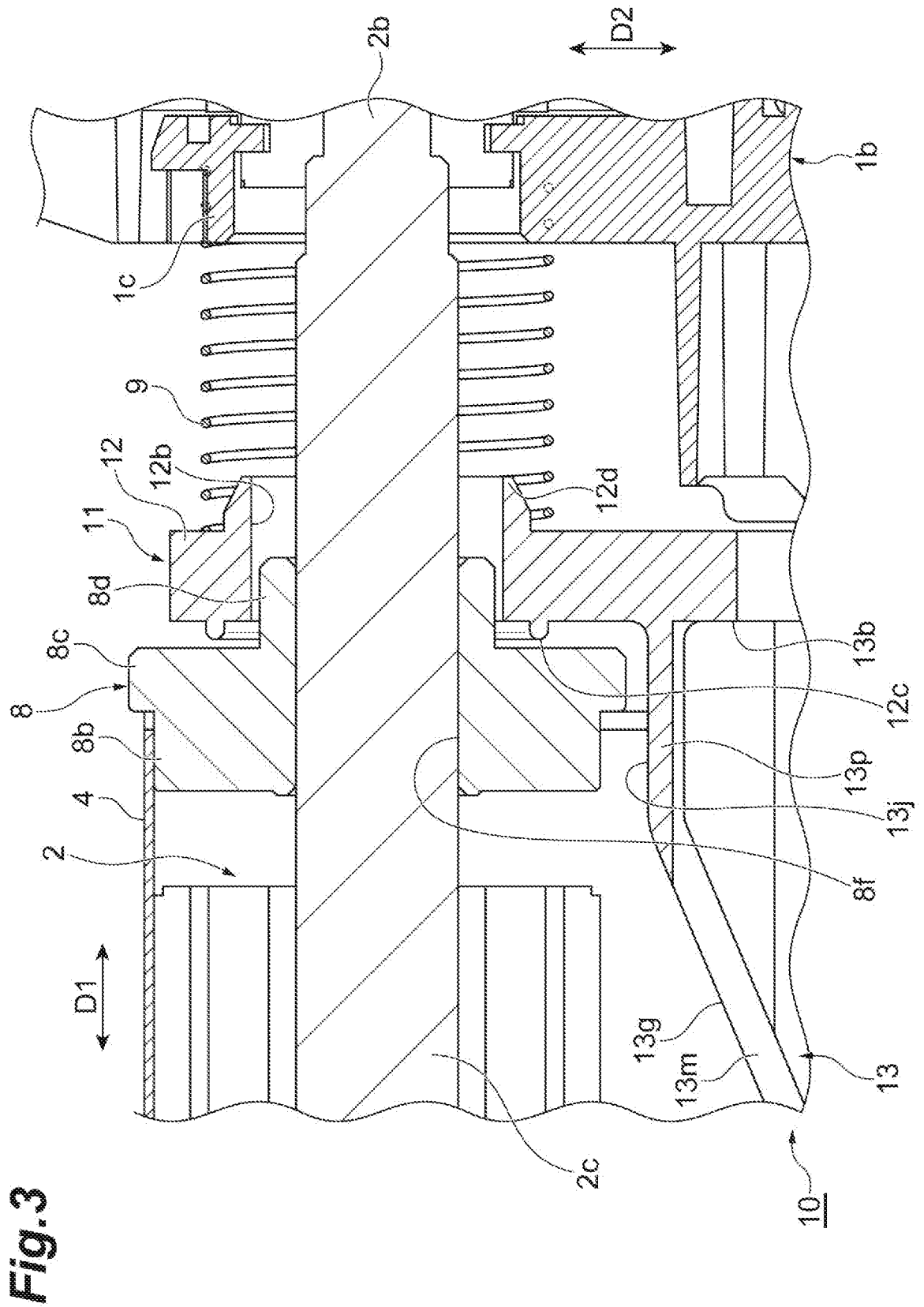


Fig. 4

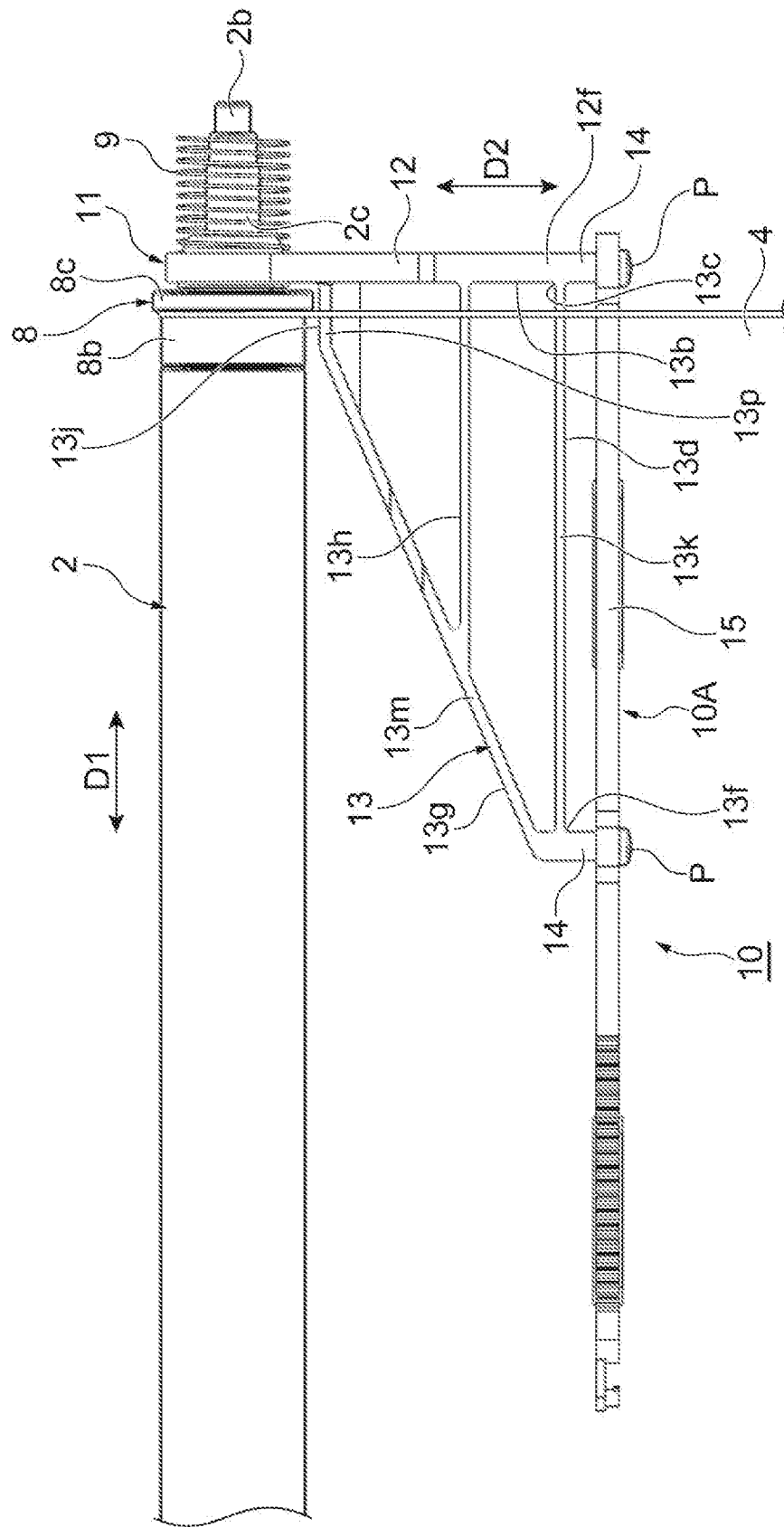


Fig. 5

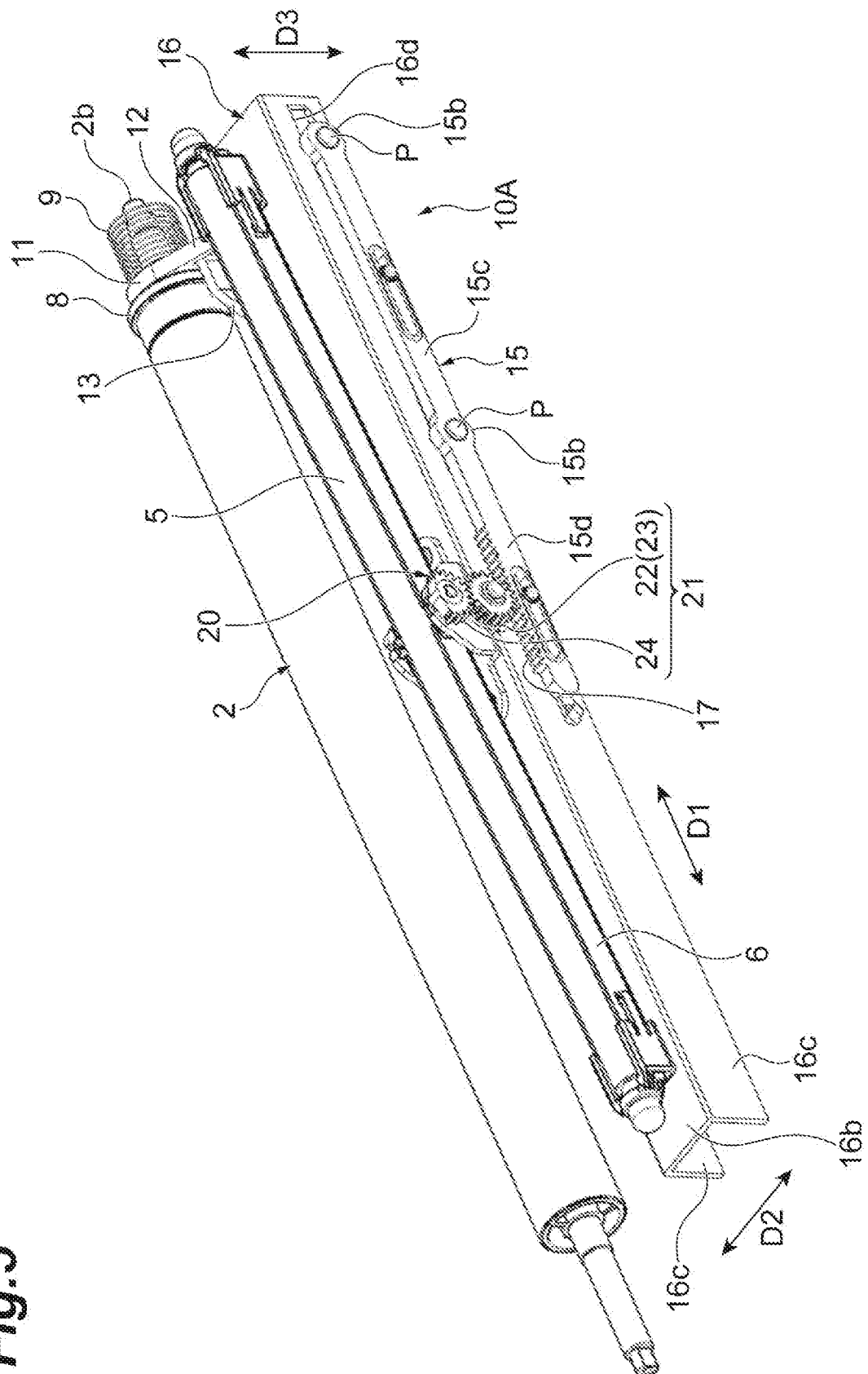


Fig. 6

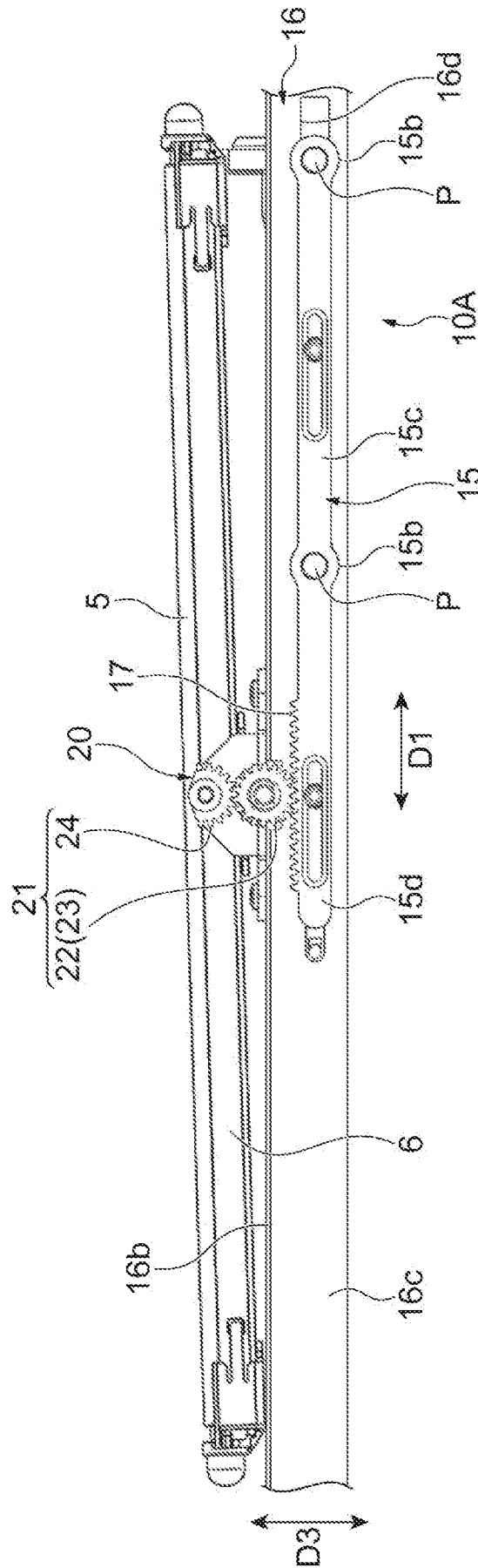


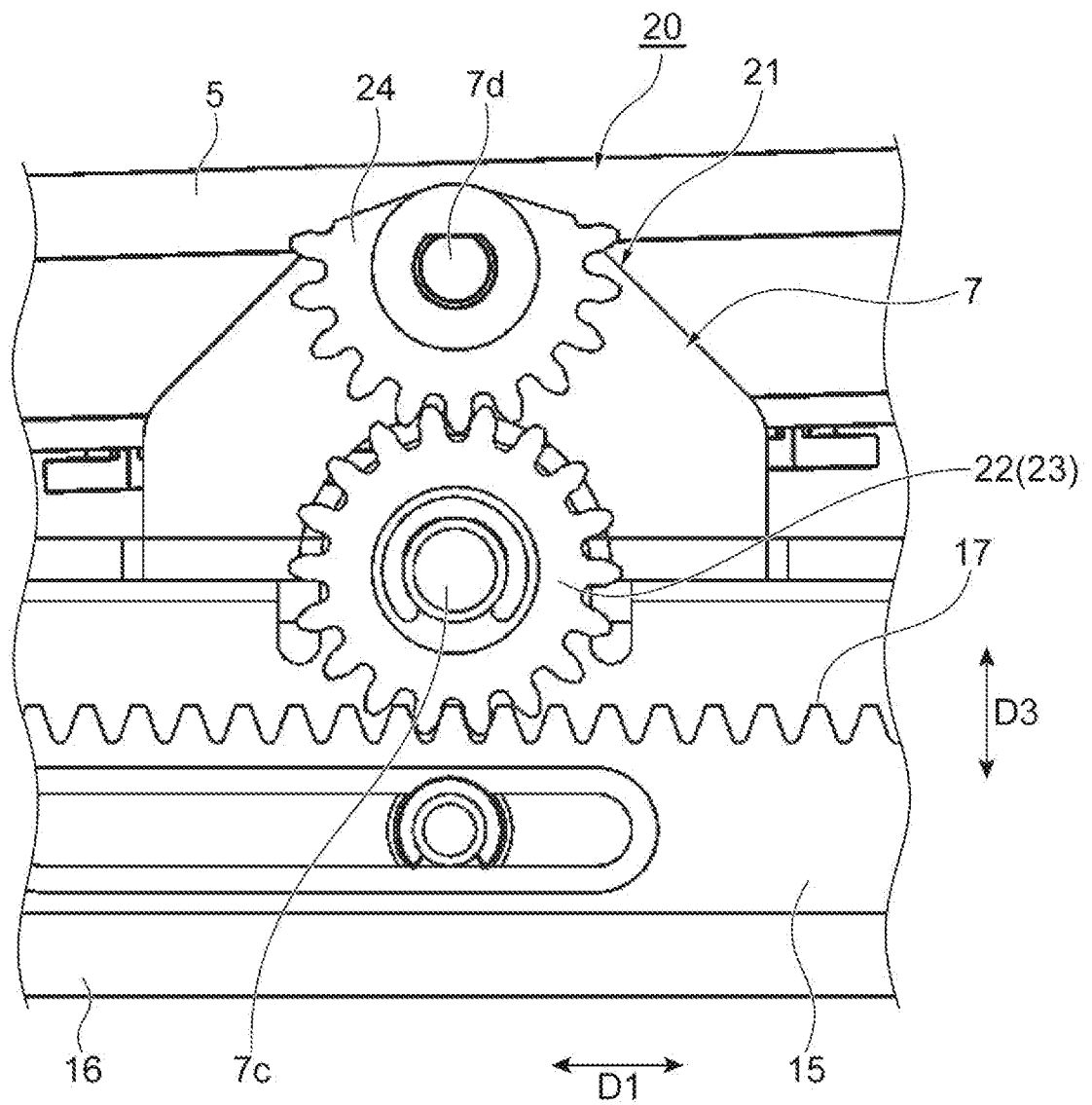
Fig.7

Fig. 8

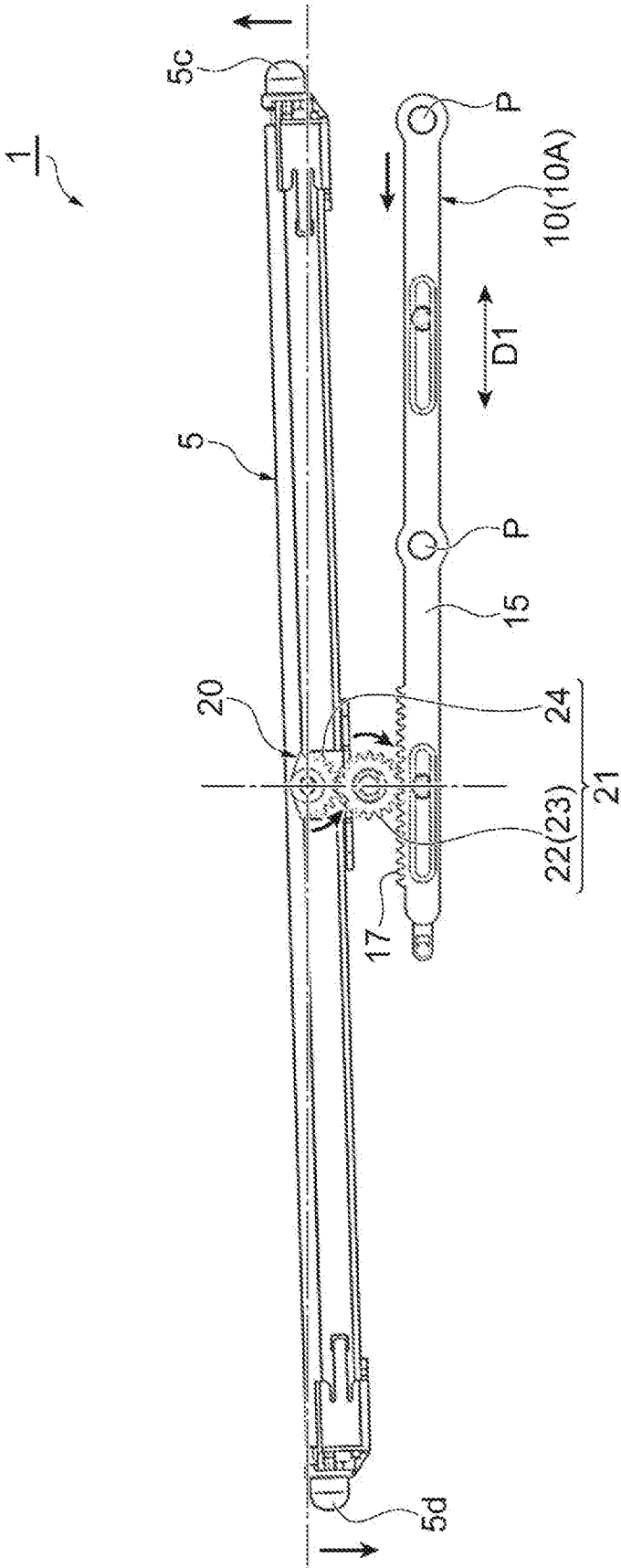


Fig. 9

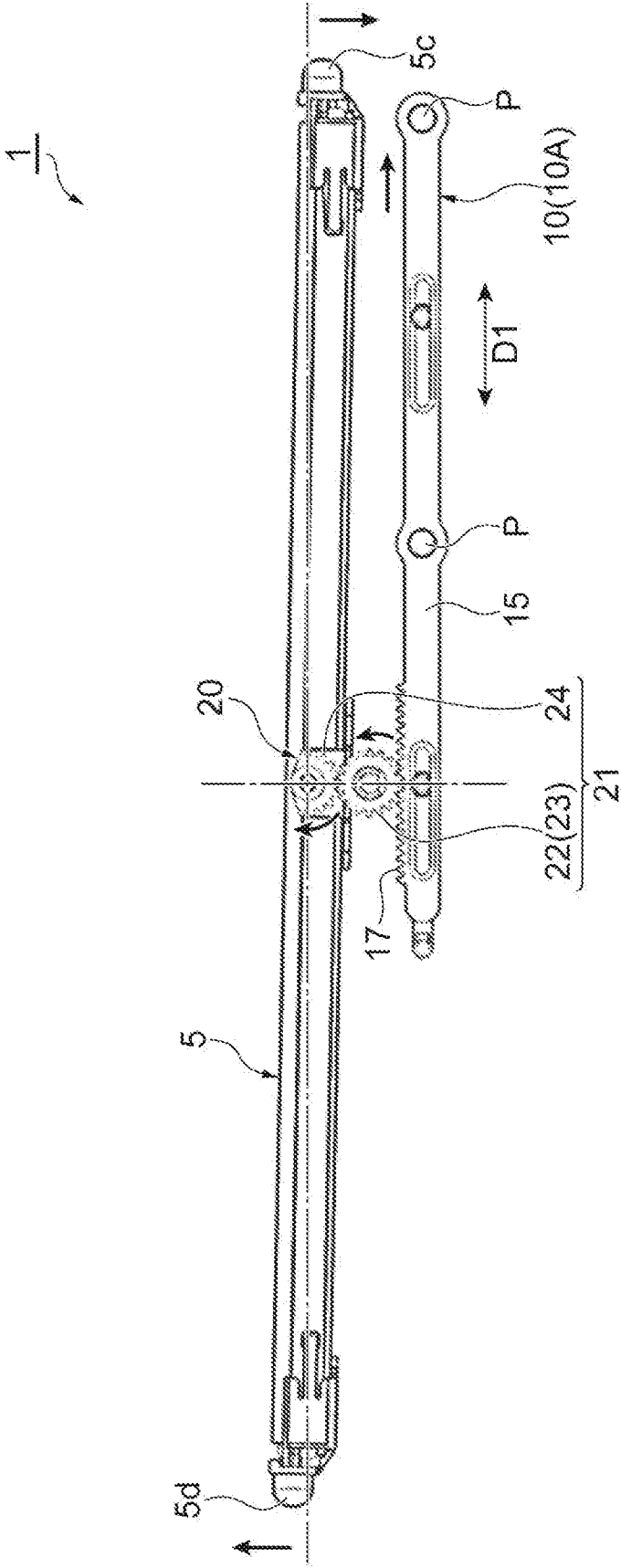


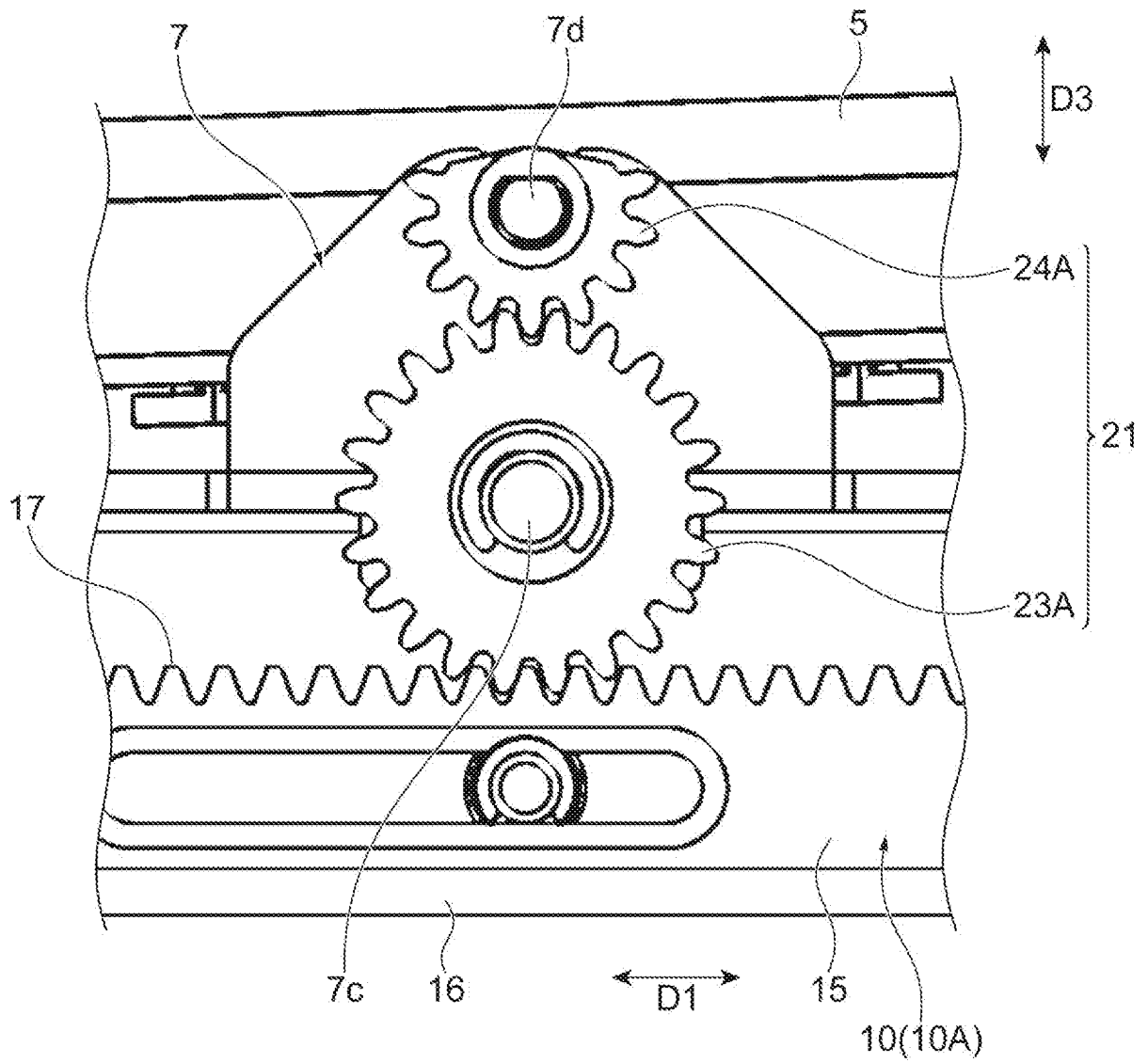
Fig.10

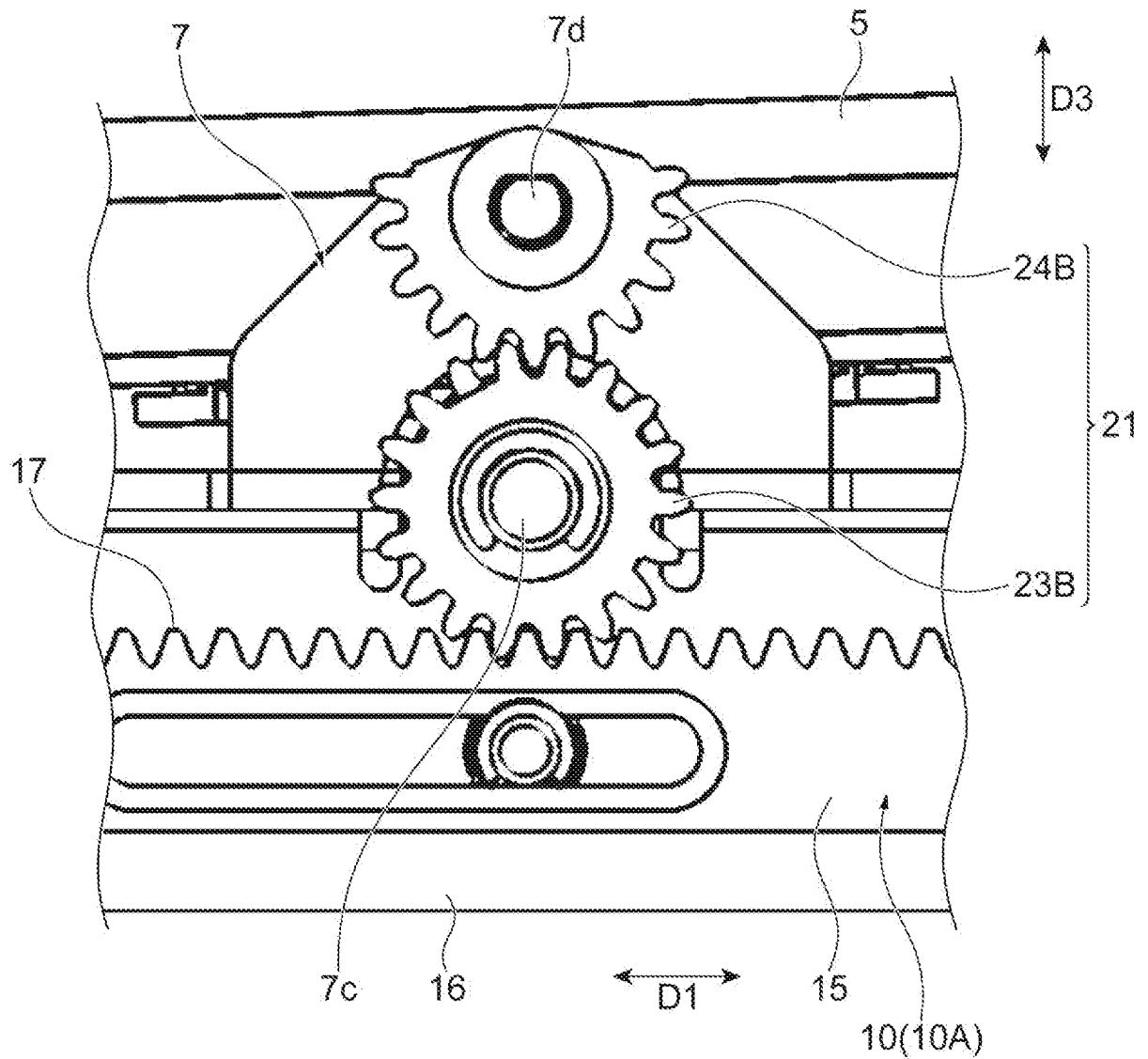
Fig.11

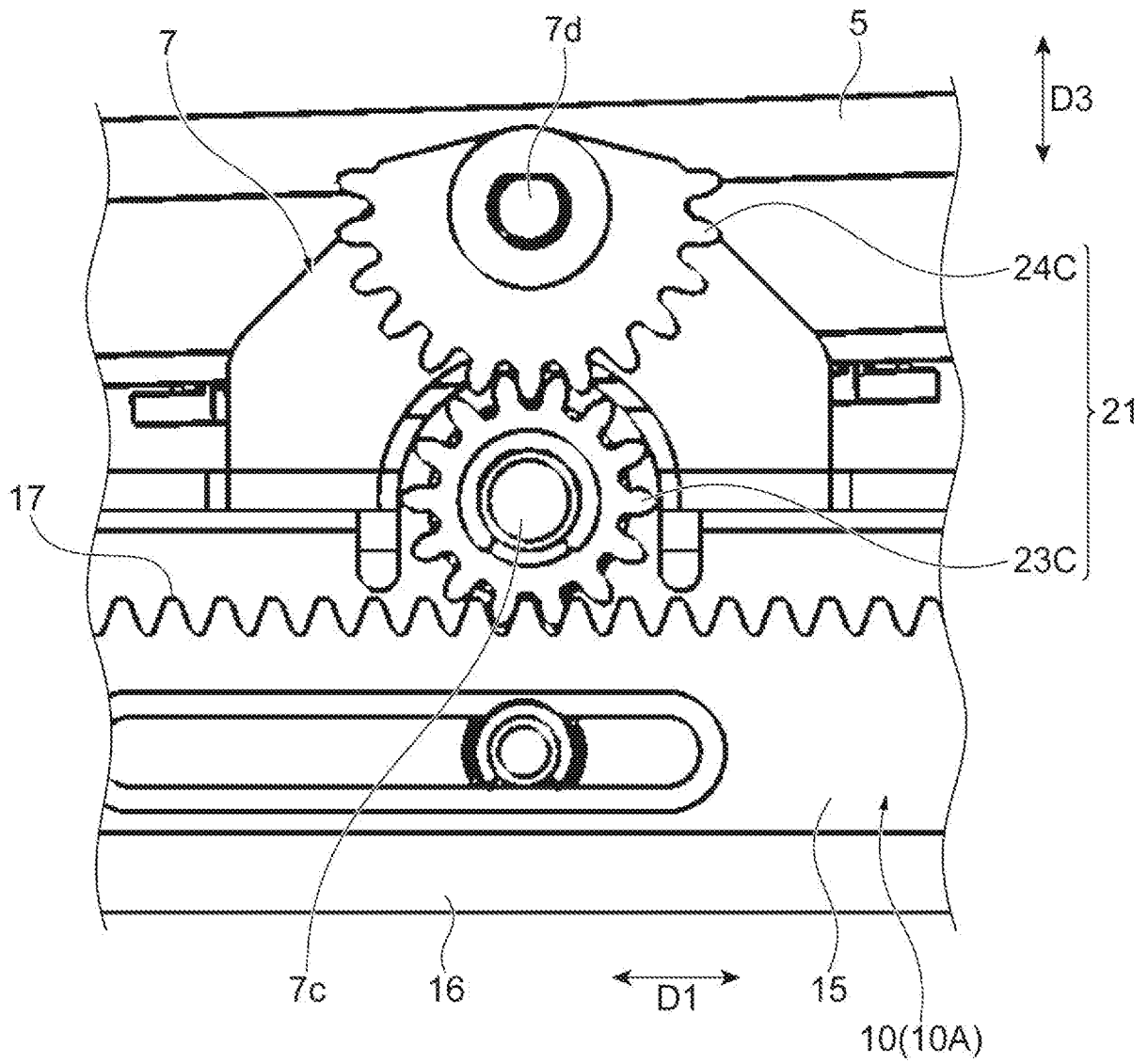
Fig.12

Fig.13

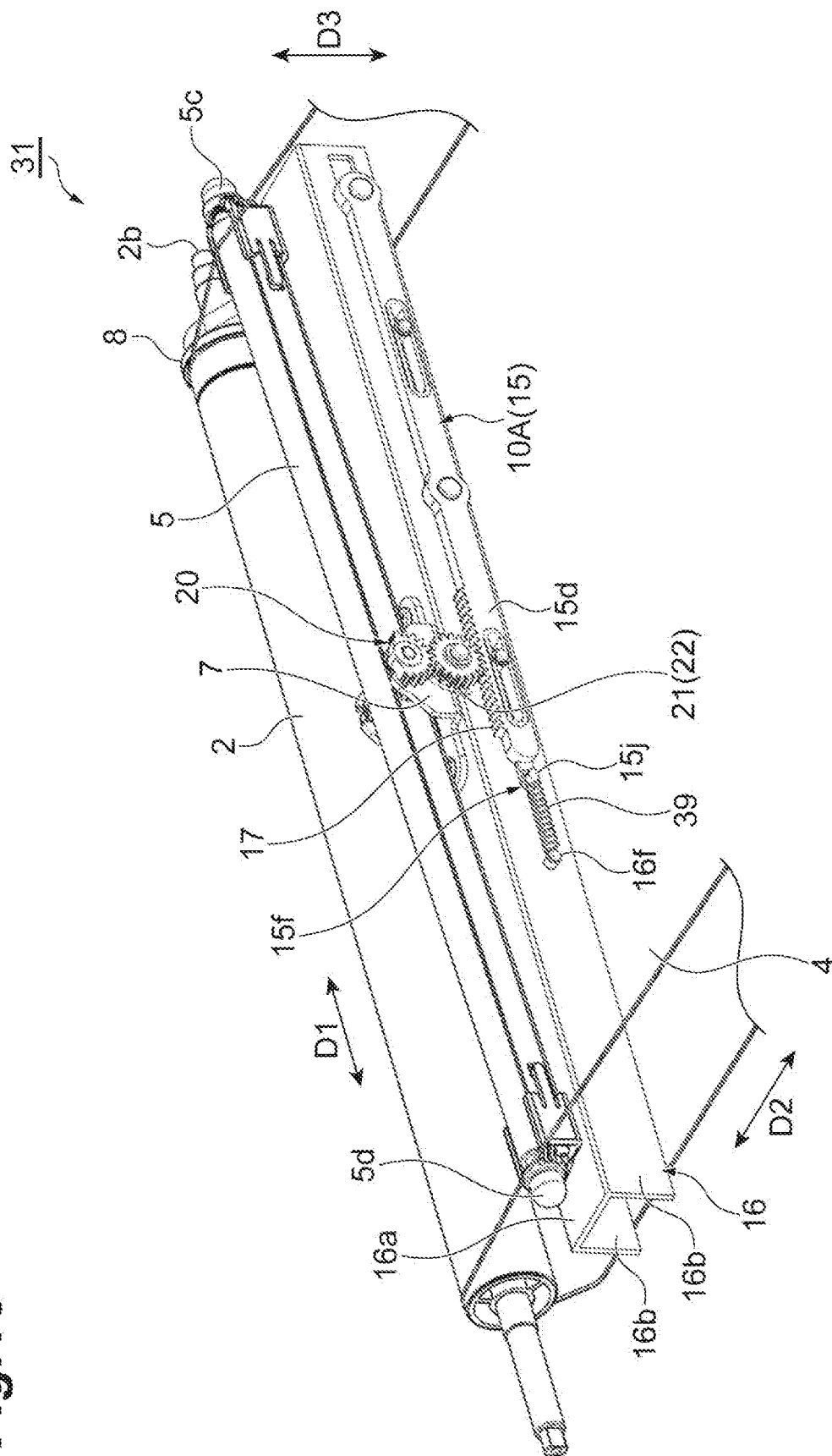


Fig.14

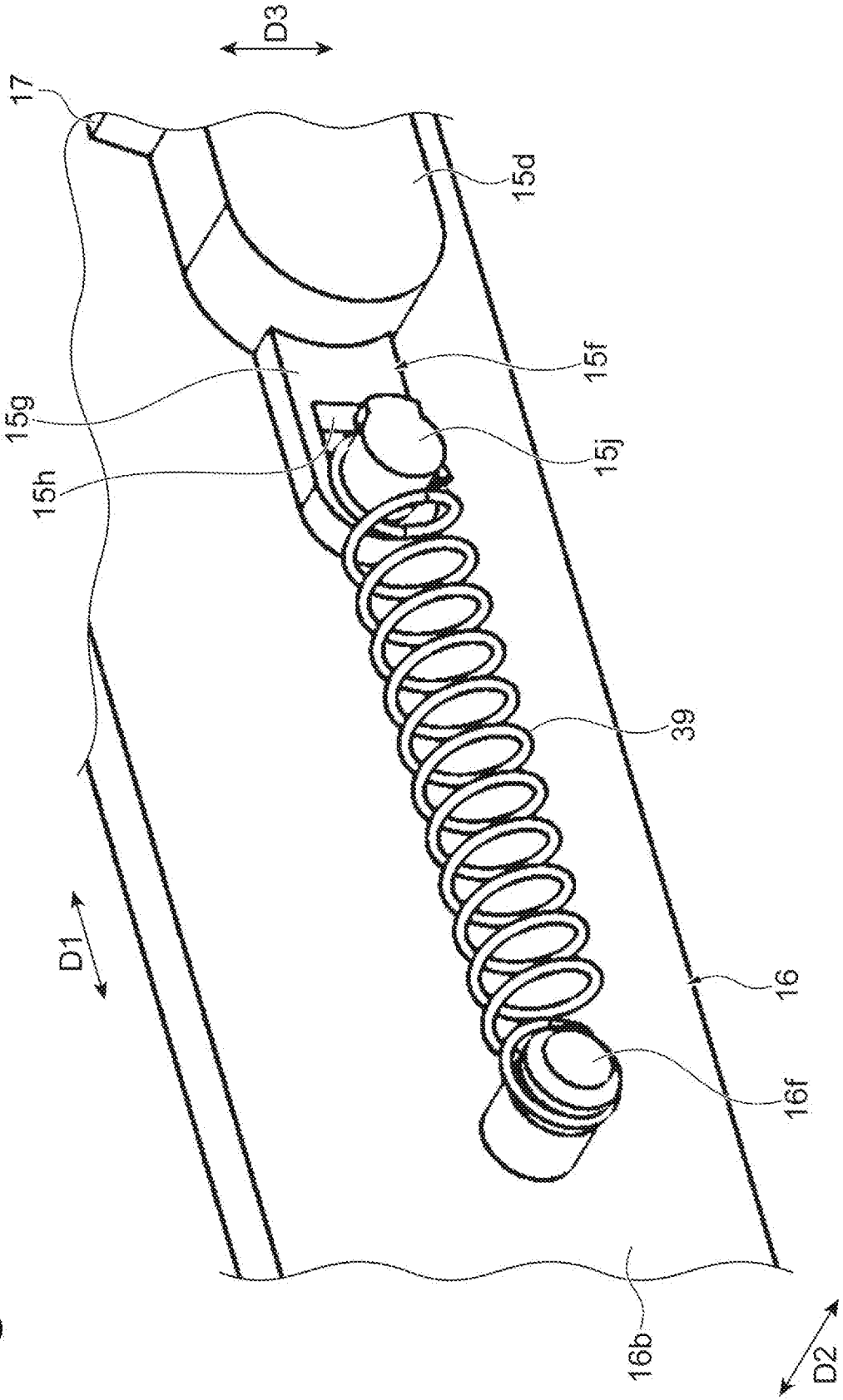


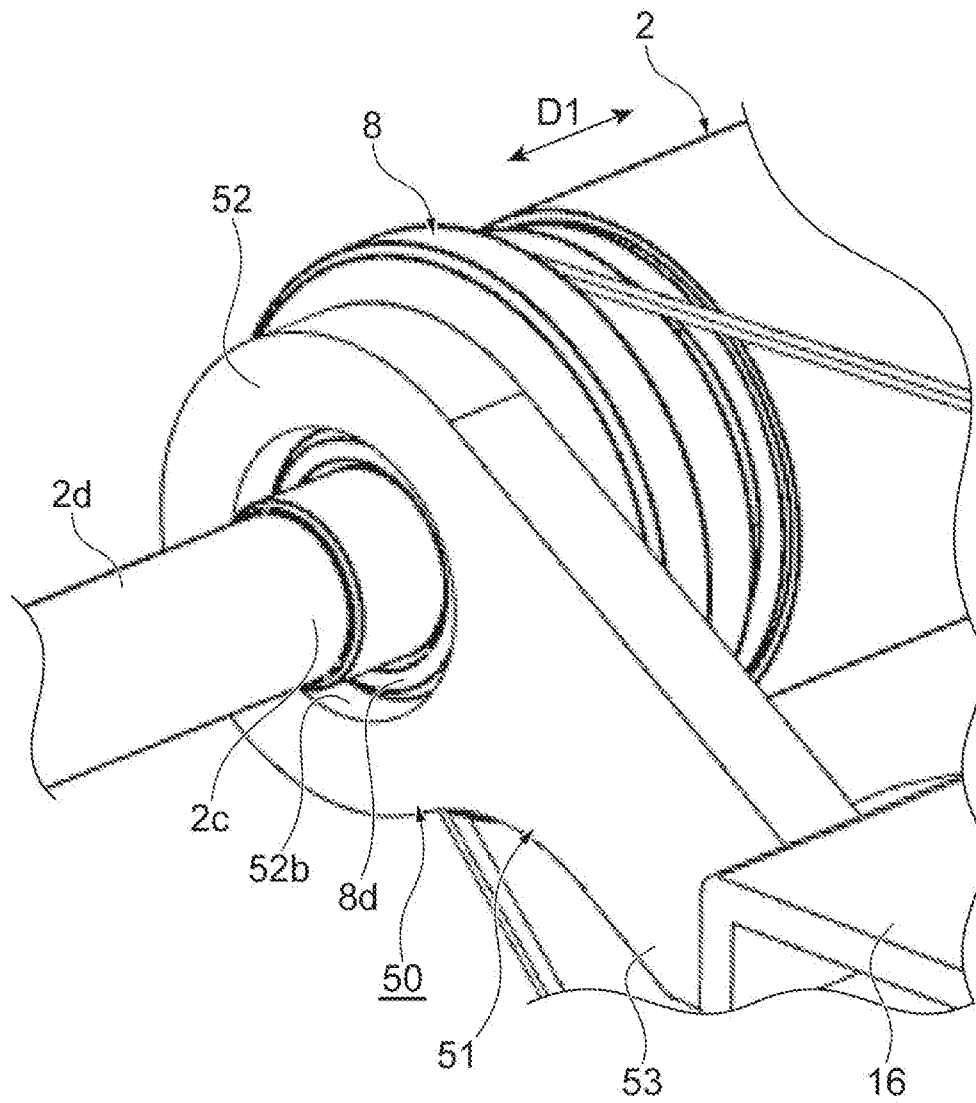
Fig.16

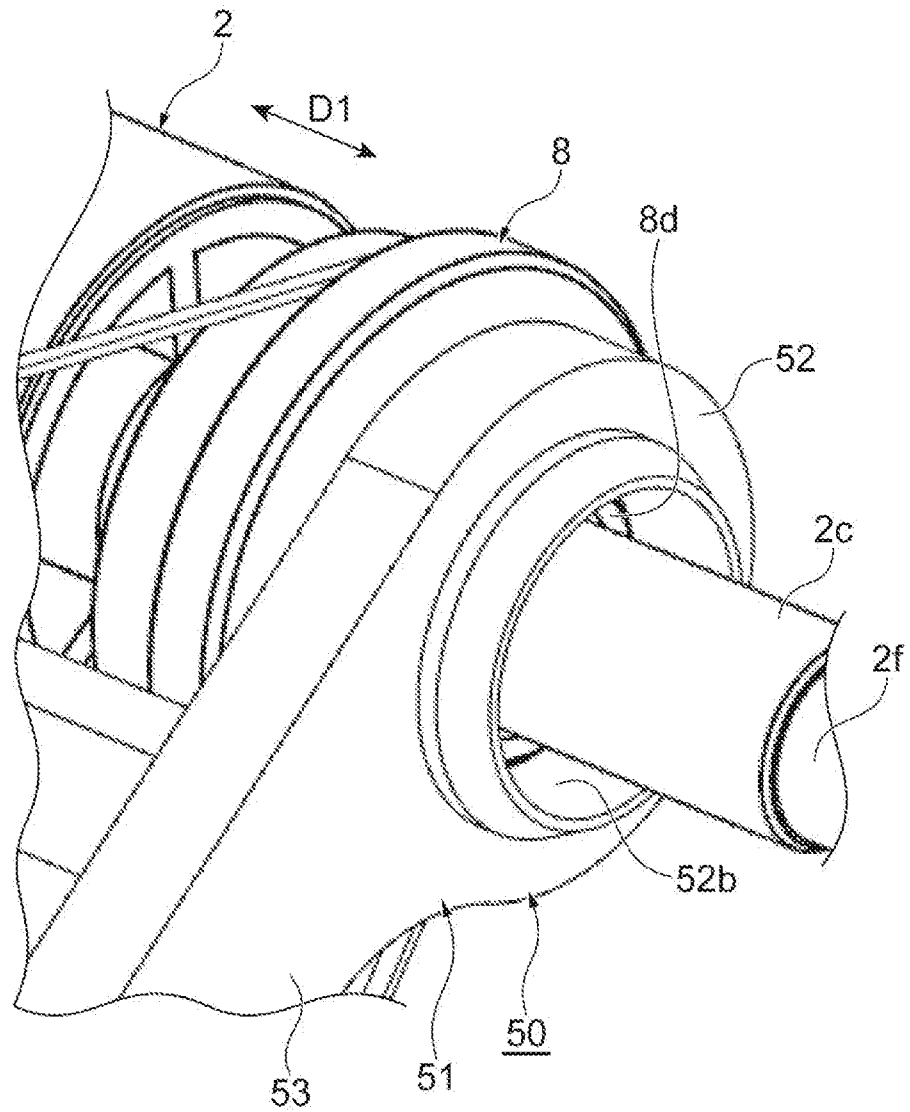
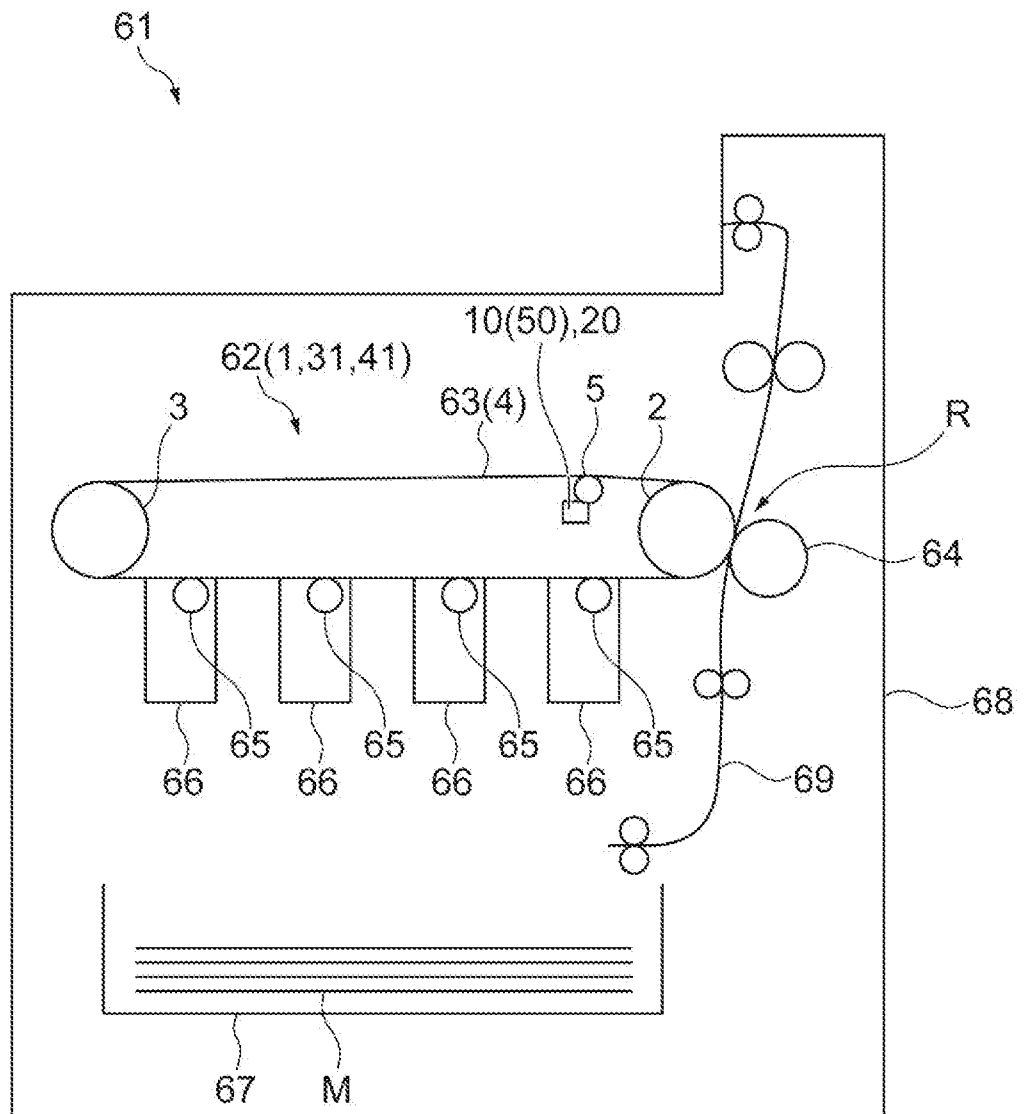
Fig.17

Fig.18

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 2020/013608

A. CLASSIFICATION OF SUBJECT MATTER		
G03G 15/16 (2006.01)		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
G03G 13/10, G03G 15/00, G03G15/02, G03G 15/10, G03G 15/11, G03G 15/16, G03G 15/20, G03G 16/00, G03G 21/00, G03G 21/06		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
EAPATIS, ESPACENET, J-PlatPat, PatSearch, RUABRU, RUABU1, RUPAT, RUPAT OLD, RUPTO, USPTO, USPTO DB, WIPO, google.com		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2015/0277297 A1 (FUJI XEROX CO., LTD) 01.10.2015, [0014]-[0015], [0017], [0021]-[0023], [0028], [0041]-[0042], [0051]-[0058], [0062]-[0063], claims 1-4, fig. 2, abstract	1-15
A	US 8238793 B2 (RICOH COMPANY LIMITED) 07.08.2012	1-15
A	US 8837989 B2 (CANON KABUSHIKI KAISHA) 16.09.2014	1-15
A	US 8126364 B2 (FUJI XEROX CO., LTD.) 28.02.2012	1-15
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family	
"A" document defining the general state of the art which is not considered to be of particular relevance		
"E" earlier document but published on or after the international filing date		
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)		
"O" document referring to an oral disclosure, use, exhibition or other means		
"P" document published prior to the international filing date but later than the priority date claimed		
Date of the actual completion of the international search	Date of mailing of the international search report	
08 April 2020 (08.04.2020)	16 April 2020 (16.04.2020)	
Name and mailing address of the ISA/RU: Federal Institute of Industrial Property, Berezhkovskaya nab., 30-1, Moscow, G-59, GSP-3, Russia, 125993 Facsimile No: (8-495) 531-63-18, (8-499) 243-33-37	Authorized officer E. Panferova Telephone No. 499-240-60-15	