

(12) STANDARD PATENT APPLICATION (11) Application No. AU 2024203675 A1
(19) AUSTRALIAN PATENT OFFICE

(54) Title
DEVELOPING CARTRIDGE

(51) International Patent Classification(s)
G03G 15/08 (2006.01) **G03G 21/16** (2006.01)

(21) Application No: **2024203675** (22) Date of Filing: **2024.05.31**

(43) Publication Date: **2024.06.20**

(43) Publication Journal Date: **2024.06.20**

(62) Divisional of:
2022202159

(71) Applicant(s)
Brother Kogyo Kabushiki Kaisha

(72) Inventor(s)
Wang, Yuwen;Hashimoto, Junichi;Kishi, Isao;Ooka, Kazuaki

(74) Agent / Attorney
PHILLIPS ORMONDE FITZPATRICK, PO Box 323, COLLINS STREET WEST, VIC, 8007, AU

[ABSTRACT]

A developing cartridge (1) includes: a casing (10); a developing roller (30); a shaft (61); and a first inclined surface (621). The shaft (61) is movable in a first direction relative to the casing (10) and the developing roller (30), and is movable in a second direction together with the casing (10) and the developing roller (30). The first inclined surface (621) is positioned at one end portion (61A) of the shaft (61) in the first direction and movable together with the shaft (61). The first inclined surface (621) is inclined relative to the first direction such that a distance between the shaft (61) and the first inclined surface (621) in the second direction increases in a direction from the one end portion (61A) of the shaft (61) in the first direction to another end portion of the shaft (61) in the first direction.

DESCRIPTION

Title of Invention: DEVELOPING CARTRIDGE

- [0001] The present application is a divisional application from Australian Patent Application No. 2022202159 filed on 30 March 2022, the entire disclosure of which is incorporated herein by reference.
- Technical Field
- [0002] The present disclosure relates to a developing cartridge.
- Background Art
- [0003] An electro-photographic type image forming apparatus such as a laser printer and an LED printer is well known in the art. A developing cartridge is used for the image forming apparatus. The developing cartridge includes a developing roller for supplying toner. The conventional image forming apparatuses are described, for example, in Japanese Patent Application Publication Nos. 2011-59510 and 2013-54058. An image forming apparatus described in Japanese Patent Application Publication No. 2011-59510 includes a drawer unit. The drawer unit includes a photosensitive drum. The developing cartridge is attachable to the drawer unit. When the developing cartridge is attached to the drawer unit, the developing roller contacts the photosensitive drum.
- [0004] A developing cartridge disclosed in Japanese Patent Application Publication No. 2013-54058 is attachable to a drum cartridge. The drum cartridge includes a photosensitive drum. When the developing cartridge is attached to the drum cartridge, the developing roller contacts the photosensitive drum. Then, the drum cartridge to which the developing cartridge has been attached is attached to a main casing of an image forming apparatus.
- [0005] The above discussion of the background to the invention is intended to facilitate an understanding of the invention. However, it should be appreciated that the discussion is not an acknowledgement or admission that any aspect of the discussion was part of the common general knowledge as at the priority date of the application.
- [0006] Where any or all of the terms "comprise", "comprises", "comprised" or "comprising" are used in this specification (including the claims) they are to be interpreted as specifying the presence of the stated features, integers, steps or components, but not precluding the presence of one or more other features, integers, steps or components.
- Citation List
- Patent Literature
- [0007] PTL 1: Japanese Patent Application Publication No. 2011-59510
PTL 2: Japanese Patent Application Publication No. 2013-54058
- Summary of Invention
- Technical Problem
- [0008] The image forming apparatuses disclosed in Japanese Patent Application Publication Nos. 2011-59510 and 2013-54058 are switchable between a state in which the developing roller and the photosensitive drum are in contact with each other, and a state in which the developing roller and the photosensitive drum are separated from each other. In Japanese Patent Application Publication Nos. 2011-59510 and 2013-54058, a component for moving the developing cartridge to separate the developing roller from the photosensitive drum is provided on both ends of the drawer unit or the drum cartridge, and both components for moving the developing cartridge are required to receive driving force from a main body of the image forming apparatus.
- [0009] In view of the foregoing, it is therefore desirable to provide a developing cartridge movable relative to the photosensitive drum by driving force acting on only one end of

the developing cartridge, not by driving force acting on both ends of the developing cartridge.

[0010] The present disclosure includes aspects 1 through 105.

[0011] Aspect 1 is directed to a developing cartridge for use with a drum cartridge including a photosensitive drum, the developing cartridge comprising:
a casing configured to accommodate developer therein;
a developing roller rotatable about a first axis extending in a first direction, the developing roller having an outer circumferential surface including one end portion and another end portion in a second direction, the one end portion being exposed to an outside of the casing, the another end portion being positioned inside the casing;
a shaft extending along a second axis extending in the first direction, the shaft being movable in the first direction relative to the casing and the developing roller, the shaft being movable in the second direction together with the casing and the developing roller, the shaft having one end portion and another end portion in the first direction;
and
a first cam positioned at the one end portion of the shaft in the first direction and movable together with the shaft, the first cam being configured to move the shaft and the casing in the second direction relative to the photosensitive drum when the first cam moves in the first direction together with the shaft.

[0012] Aspect 2 is directed to the developing cartridge according to aspect 1, wherein the first cam has a first inclined surface inclined relative to the first direction such that a distance between the shaft and the first inclined surface in a radial direction of the shaft increases in a direction from the one end portion of the shaft in the first direction to the another end portion of the shaft in the first direction.

[0013] Aspect 3 is directed to the developing cartridge according to aspect 1, wherein the shaft has a first inclined surface, and
wherein a distance between the second axis and the first inclined surface in a radial direction of the shaft increases in a direction from the one end portion of the shaft in the first direction to the another end portion of the shaft in the first direction.

[0014] Aspect 4 is directed to the developing cartridge according to aspect 2, wherein the first inclined surface is inclined relative to the first direction by an acute angle.

[0015] Aspect 5 is directed to the developing cartridge according to any one of aspects 2 through 4, wherein an angle between the first inclined surface and the first direction is greater than or equal to 43 degrees and smaller than or equal to 47 degrees.

[0016] Aspect 6 is directed to the developing cartridge according to any one of aspects 2 through 4, wherein the first inclined surface includes a first sloped surface and a second sloped surface arrayed with each other in the first direction,
wherein the first sloped surface is positioned farther from the another end portion of the shaft in the first direction than the second sloped surface is from the another end portion of the shaft in the first direction, and
wherein the first sloped surface is inclined relative to the first direction, the second sloped surface being inclined relative to the first direction, an angle between the first sloped surface and the first direction being greater than an angle between the second sloped surface and the first direction.

[0017] Aspect 7 is directed to the developing cartridge according to aspect 6, wherein the angle between the first sloped surface and the first direction is greater than or equal to 43 degrees and smaller than or equal to 47 degrees, and
wherein the angle between the second sloped surface and the first direction is greater than or equal to 12 degrees and smaller than or equal to 17 degrees.

- [0018] Aspect 8 is directed to the developing cartridge according to any one of aspects 1 through 7, further comprising a second cam positioned at the another end portion of the shaft in the first direction and movable together with the shaft, the second cam being configured to move the shaft and the casing in the second direction relative to the photosensitive drum when the second cam moves in the first direction together with the shaft.
- [0019] Aspect 9 is directed to the developing cartridge according to aspect 8, wherein the second cam has a second inclined surface inclined relative to the first direction such that a distance between the shaft and the second inclined surface in the radial direction of the shaft decreases in the direction from the another end portion of the shaft in the first direction to the one end portion of the shaft in the first direction.
- [0020] Aspect 10 is directed to the developing cartridge according to aspect 8, wherein the shaft has a second inclined surface inclined relative to the first direction such that a distance between the second axis and the second inclined surface in the radial direction of the shaft decreases in the direction from the another end portion of the shaft in the first direction to the one end portion of the shaft in the first direction.
- [0021] Aspect 11 is directed to the developing cartridge according to aspect 9 or 10, wherein the second inclined surface is inclined relative to the first direction by an acute angle.
- [0022] Aspect 12 is directed to the developing cartridge according to any one of aspects 135 through 137, an angle between the second inclined surface is greater than or equal to 43 degrees and smaller than or equal to 47 degrees.
- [0023] Aspect 13 is directed to the developing cartridge according to any one of aspects 9 through 11, wherein the second inclined surface includes a third sloped surface and a fourth sloped surface arrayed with each other in the first direction, wherein the third sloped surface is positioned closer to the first inclined surface than the fourth sloped surface is to the first inclined surface in the first direction, and wherein the third sloped surface is inclined relative to the first direction, the fourth sloped surface being inclined relative to the first direction, an angle between the third sloped surface and the first direction being greater than an angle between the fourth sloped surface and the first direction.
- [0024] Aspect 14 is directed to the developing cartridge according to aspect 13, wherein the angle between the third sloped surface and the first direction is greater than or equal to 43 degrees and smaller than or equal to 47 degrees, and wherein the angle between the fourth sloped surface and the first direction is greater than or equal to 12 degrees and smaller than or equal to 17 degrees.
- [0025] Aspect 15 is directed to the developing cartridge according to any one of aspects 1 through 14, wherein the second direction is crossing the outer circumferential surface of the one end portion of the developing roller that is exposed to the outside of the casing.
- [0026] Aspect 16 is directed to the developing cartridge according to any one of aspects 1 through 15, wherein the shaft is not rotatable about the second axis relative to the casing.
- [0027] Aspect 17 is directed to the developing cartridge according to any one of aspects 1 through 15, wherein the shaft is rotatable about the second axis relative to the casing, and wherein the first cam is rotatable together with the shaft about the second axis relative to the casing, the first cam having one of a cone shape and a pyramid shape centered on the second axis.
- [0028] Aspect 18 is directed to the developing cartridge according to any one of aspects 8 through 15, wherein the shaft is rotatable about the second axis relative to the casing, and

wherein the second cam is rotatable together with the shaft about the second axis relative to the casing, the second cam having one of a cone shape and a pyramid shape centered on the second axis.

- [0029] Aspect 19 is directed to the developing cartridge according to any one of aspects 1 through 18, wherein the casing includes:
a container configured to accommodate developer therein and having an opening; and
a lid covering the opening of the container and having a through-hole penetrating the lid in the first direction, and
wherein the shaft is inserted into the through-hole.
- [0030] Aspect 20 is directed to the developing cartridge according to any one of aspects 1 through 19, wherein the shaft is movable in the first direction relative to the casing between a first position and a second position, and
wherein the casing is movable in the second direction together with the shaft relative to the drum cartridge when the shaft moves between the first position and the second position.
- [0031] Aspect 21 is directed to the developing cartridge according to any one of aspects 1 through 20, wherein the shaft is movable in the first direction relative to the casing between a first position and a second position, and
wherein the casing is movable in the second direction together with the shaft relative to the photosensitive drum when the shaft moves between the first position and the second position.
- [0032] Aspect 22 is directed to the developing cartridge according to aspect 21, wherein the first cam is slidingly movable relative to a portion of the drum cartridge while contacting the portion of the drum cartridge when the shaft moves between the first position and the second position, and
wherein the casing and the developing roller are movable in the second direction when the first cam is slidingly moved relative to the portion of the drum cartridge.
- [0033] Aspect 23 is directed to the developing cartridge according to any one of aspects 8 through 14, the drum cartridge having a first receiving surface and a second receiving surface different from the first receiving surface,
wherein the shaft is movable in the first direction relative to the casing between a first position and a second position,
wherein the casing is movable in the second direction together with the shaft relative to the photosensitive drum when the shaft moves between the first position and the second position,
wherein the first cam is slidingly movable relative to the first receiving surface while contacting the first receiving surface when the shaft moves between the first position and the second position,
wherein the second cam is slidingly movable relative to the second receiving surface while contacting the second receiving surface when the shaft moves between the first position and the second position, and
wherein the casing and the developing roller are movable in the second direction when the first cam is slidingly moved relative to the first receiving surface and the second cam is slidingly moved relative to the second receiving surface.
- [0034] Aspect 24 is directed to the developing cartridge according to any one of aspects 8 through 14 and 23, wherein the shaft is movable from the first position to the second position when the second cam receives a pressing force directed from the another end portion to the one end portion of the shaft in the first direction.
- [0035] Aspect 25 is directed to the developing cartridge according to aspect 24, further comprising an elastic member configured to extend and contract in the first direction,

the elastic member having one end and another end in the first direction, the one end of the elastic member in the first direction being connected to the second inclined surface, the another end of the elastic member in the first direction being connected to the casing.

- [0036] Aspect 26 is directed to the developing cartridge according to aspect 25, wherein the elastic member is a coil spring configured to extend and contract in the first direction between a first length and a second length shorter than the first length, the elastic member providing the first length when the shaft is in the first position, the elastic member providing the second length when the shaft is in the second position.
- [0037] Aspect 27 is directed to the developing cartridge according to any one of aspects 1 through 26, wherein the casing has a first outer surface and a second outer surface separated from the first outer surface in the first direction, the first outer surface being one end portion of the casing in the first direction, the second outer surface being another end portion of the casing in the first direction, and wherein the first cam is positioned at the first outer surface, the first inclined surface being sloped away from the developing roller in the second direction in a direction from the first outer surface toward the second outer surface in the first direction.
- [0038] Aspect 28 is directed to the developing cartridge according to aspect 27, further comprising a coupling for rotating the developing roller, the coupling being positioned at the second outer surface.
- [0039] Aspect 29 is directed to the developing cartridge according to aspect 28, wherein the coupling is positioned closer to the developing roller than the shaft and the first cam are to the developing roller in the second direction.
- [0040] Aspect 30 is directed to the developing cartridge according to aspect 28 or 29, wherein the coupling is configured to receive a driving force, and wherein the shaft is configured to receive a pressing force directed from the second outer surface to the first outer surface.
- [0041] Aspect 31 is directed to the developing cartridge according to any one of aspects 28 through 30, further comprising an electrode positioned at the first outer surface and electrically connected to the developing roller.
- [0042] Aspect 32 is directed to the developing cartridge according to aspect 31, wherein the electrode is positioned closer to the developing roller than the shaft and the first cam are to the developing roller in the second direction.
- [0043] Aspect 33 is directed to the developing cartridge according to any one of aspects 1 through 32, further comprising an agitator rotatable about a third axis extending in the first direction, the agitator configured to agitate the developer, wherein the developing roller is spaced apart from the agitator in the second direction.
- [0044] Aspect 34 is directed to the developing cartridge according to aspect 33, wherein the agitator is positioned closer to the developing roller than the shaft is to the developing roller in the second direction.
- [0045] Aspect 35 is directed to a developing cartridge comprising:
a casing configured to accommodate developer therein;
a developing roller rotatable about a first axis extending in an axial direction;
a shaft extending along a second axis extending in the axial direction, the shaft being movable along the second axis; and
a cam movable along the second axis in response to axial movement of the shaft, the cam having a cam surface non-parallel with the second axis.
- [0046] Aspect 36 is directed to the developing cartridge according to aspect 35, wherein the developing roller has an outer circumferential surface,

wherein one end portion of the outer circumferential surface is exposed to an outside of the casing,

wherein another end portion of the outer circumferential surface is positioned inside the casing, and

wherein the cam surface is inclined relative to in a direction connecting the one end portion of the outer circumferential surface and the another end portion of the outer circumferential surface.

- [0047] Aspect 37 is directed to the developing cartridge according to aspect 35 or 36, wherein the cam surface is inclined relative to the second axis.
- [0048] Aspect 38 is directed to the developing cartridge according to aspect 37, wherein the cam surface is inclined relative to the second axis by an acute angle.
- [0049] Aspect 39 is directed to the developing cartridge according to any one of aspects 35 through 38, wherein the cam is movable together with the shaft relative to the casing along the second axis in response to the axial movement of the shaft along the second axis.
- [0050] Aspect 40 is directed to the developing cartridge according to any one of aspects 35 through 39, wherein the cam is movable together with the casing in a direction non-parallel with the second axis in response to the axial movement of the shaft along the second axis.
- [0051] Aspect 41 is directed to the developing cartridge according to aspect 40, wherein the developing roller has an outer circumferential surface, wherein one end portion of the outer circumferential surface is exposed to an outside of the casing, wherein another end portion of the outer circumferential surface is positioned inside the casing, and wherein the direction non-parallel with the second axis includes a direction connecting the one end portion of the outer circumferential surface and the another end portion of the outer circumferential surface.
- [0052] Aspect 42 is directed to the developing cartridge according to any one of aspects 35
- [0053] Aspect 43 is directed to the developing cartridge according to any one of aspects 36 through 42, wherein the developing roller is at least partially exposed to an outside of the casing.
- [0054] Aspect 44 is directed to the developing cartridge according to aspect 43, wherein at least a part of an outer circumferential surface of the developing roller is exposed to an outside of the casing.
- [0055] Aspect 45 is directed to the developing cartridge according to any one of aspects 35 through 44, wherein the cam is positioned at a peripheral surface of the shaft.
- [0056] Aspect 46 is directed to the developing cartridge according to any one of aspects 35 through 45, wherein the cam is positioned at one end portion of the shaft in the axial direction.
- [0057] Aspect 47 is directed to the developing cartridge according to any one of aspects 35 through 46, wherein the casing includes:
a container configured to accommodate developer therein and having an opening; and
a lid covering the opening of the container and having a through-hole penetrating the lid in the axial direction, and
wherein the shaft is inserted into the through-hole.
- [0058] Aspect 48 is directed to the developing cartridge according to any one of aspects 35 through 45, wherein the shaft has one end portion in the axial direction and another end portion separated from the one end portion in the axial direction, and

wherein the cam is positioned at each of the one end portion and the another end portion.

- [0059] Aspect 49 is directed to the developing cartridge according to aspect 48, wherein the cam is positioned at a peripheral surface of each of the one end portion and the another end portion.
- [0060] Aspect 50 is directed to the developing cartridge according to any one of aspects 35 through 49, wherein the developing cartridge is for use with a drum cartridge, and wherein the cam surface is movable along the second axis to engage the drum cartridge.
- [0061] Aspect 51 is directed to the developing cartridge according to aspect 50, wherein the cam surface is movable along the second axis to engage a frame of the drum cartridge.
- [0062] Aspect 52 is directed to the developing cartridge according to aspect 51, wherein engagement between the cam surface and the frame moves the developing roller away from a photosensitive drum of the drum cartridge.
- [0063] Aspect 53 is directed to the developing cartridge according to aspect 52, wherein the photosensitive drum is rotatable about a rotational axis extending in the axial direction.
- [0064] Aspect 54 is directed to the developing cartridge according to any one of aspects 35 through 53, wherein the cam surface provides a camming movement in response to movement of the shaft along the second axis.
- [0065] Aspect 55 is directed to the developing cartridge according to aspect 54, wherein the camming movement engages a frame of a drum cartridge to move the developing cartridge away from the drum cartridge.
- [0066] Aspect 56 is directed to the developing cartridge according to any one of aspects 35 through 55, further comprising a separation member including the cam and the shaft.
- [0067] Aspect 57 is directed to the developing cartridge according to any one of aspects 35 through 56, wherein the cam surface is inclined relative to the shaft and angled relative to the second axis.
- [0068] Aspect 58 is directed to the developing cartridge according to aspect 57, wherein the cam surface is positioned at an end portion of the shaft extending in a first direction, the cam surface being inclined relative to shaft by an acute angle.
- [0069] Aspect 59 is directed to the developing cartridge according to aspect 58, wherein the cam includes a first cam surface disposed at a first end portion of the shaft and a second cam surface disposed at a second end portion of the shaft opposite to the first end portion, the second cam surface being movable together with the shaft, the second cam surface being angled relative to the shaft such that a radial distance from the second axis to the second cam surface increases as a distance from the first cam surface to the second cam surface increases.
- [0070] Aspect 60 is directed to the developing cartridge according to aspect 59, wherein the first cam surface is angled relative to the shaft such that a radial distance from the second axis to the first cam surface decreases as a distance from the first cam surface to the second cam surface increases.
- [0071] Aspect 61 is directed to the developing cartridge according to aspect 59, wherein the first cam surface includes a first sloped surface angled relative to the second axis and a second sloped surface extending from and angled relative to the first sloped surface, an angle between the first sloped surface and the second axis being greater than an angle between the second sloped surface and the second axis.
- [0072] Aspect 62 is directed to the developing cartridge according to aspect 61, wherein the second cam surface includes a third sloped surface angled relative to the second axis and a fourth sloped surface extending from and angled relative to the third sloped surface, an angle between the third sloped surface and the second axis being greater than an angle between the fourth sloped surface and the second axis.

- [0073] Aspect 63 is directed to the developing cartridge according to any one of aspects 35 through 62 wherein the cam is movable along the second axis relative to the developing roller and the casing.
- [0074] Aspect 65 is directed to the developing cartridge according to aspect 63, wherein the cam is further movable together with the developing roller and the casing in a direction perpendicular to the second axis.
- [0075] Aspect 65 is directed to the developing cartridge according to any one of aspects 35 through 64, wherein the developer is accommodated within the casing.
- [0076] Aspect 66 is directed to the developing cartridge according to any one of aspects 35 through 65, wherein the cam has one of a cone shape and a pyramid shape centered on the second axis, and wherein the cam surface is a lateral surface of the cam.
- [0077] Aspect 67 is directed to the developing cartridge according to any one of aspects 35 through 66, wherein the cam has a fixed position relative to the shaft.
- [0078] Aspect 68 is directed to the developing cartridge according to any one of aspects 35 through 67, wherein the developing cartridge is for use with a drum cartridge.
- [0079] Aspect 69 is directed to the developing cartridge according to aspect 68, the drum cartridge comprising a photosensitive drum, the drum cartridge having a frame, wherein the photosensitive drum extends along a rotational axis parallel with the first axis, and wherein the cam surface is axially movable to engage the frame of the drum cartridge.
- [0080] Aspect 70 is directed to the developing cartridge according to aspect 69, wherein engagement between the cam surface and the frame moves the developing roller away from the photosensitive drum.
- [0081] Aspect 71 is directed to a developing cartridge comprising: a casing configured to accommodate developer therein; a developing roller rotatable about a first axis extending in an axial direction; and a cam movable along a second axis extending in the axial direction, the cam having a cam surface non-parallel with the second axis, wherein the cam surface provides a camming movement in response to movement of the cam along the second axis.
- [0082] Aspect 72 is directed to the developing cartridge according to aspect 71, wherein the developing roller has an outer circumferential surface, wherein one end portion of the outer circumferential surface is exposed to an outside of the casing, wherein another end portion of the outer circumferential surface is positioned inside the casing, and wherein the cam surface is inclined relative to in a direction connecting the one end portion of the outer circumferential surface and the another end portion of the outer circumferential surface.
- [0083] Aspect 73 is directed to the developing cartridge according to aspect 71 or 72, wherein the cam surface is inclined relative to the second axis.
- [0084] Aspect 74 is directed to the developing cartridge according to aspect 73, wherein the cam surface is inclined relative to the second axis by an acute angle.
- [0085] Aspect 75 is directed to the developing cartridge according to any one of aspects 71 through 74, further comprising a shaft extending along the second axis and movable along the second axis, wherein the cam is movable together with the shaft relative to the casing along the second axis in response to axial movement of the shaft along the second axis.

- [0086] Aspect 76 is directed to the developing cartridge according to any one of aspects 71 through 75, further comprising a shaft extending along the second axis and movable along the second axis, wherein the cam surface provides the camming movement together with the casing in response to axial movement of the shaft along the second axis.
- [0087] Aspect 77 is directed to the developing cartridge according to aspect 76, wherein the developing roller has an outer circumferential surface, wherein one end portion of the outer circumferential surface is exposed to an outside of the casing, wherein another end portion of the outer circumferential surface is positioned inside the casing, and wherein the cam surface provides the camming movement in a direction non-parallel with the second axis, the direction non-parallel with the second axis including a direction connecting the one end portion of the outer circumferential surface and the another end portion of the outer circumferential surface.
- [0088] Aspect 78 is directed to the developing cartridge according to any one of aspects 71 through 77, wherein the cam is positioned at an exterior surface of the casing.
- [0089] Aspect 79 is directed to the developing cartridge according to any one of aspects 71 through 78, wherein the developing roller is at least partially exposed to an outside of the casing.
- [0090] Aspect 80 is directed to the developing cartridge according to aspect 79, wherein at least a part of an outer circumferential surface of the developing roller is exposed to an outside of the casing.
- [0091] Aspect 81 is directed to the developing cartridge according to any one of aspects 71 through 80, further comprising a shaft extending along the second axis and movable along the second axis, wherein the cam is positioned at a peripheral surface of the shaft.
- [0092] Aspect 82 is directed to the developing cartridge according to any one of aspects 71 through 81, further comprising a shaft extending along the second axis and movable along the second axis, wherein the cam is positioned at one end portion of the shaft in the axial direction.
- [0093] Aspect 83 is directed to the developing cartridge according to any one of aspects 71 through 82, further comprising a shaft extending along the second axis and movable along the second axis, wherein the casing includes:
 a container configured to accommodate developer therein and having an opening; and
 a lid covering the opening of the container and having a through-hole penetrating the lid in the axial direction, and
 wherein the shaft is inserted into the through-hole.
- [0094] Aspect 84 is directed to the developing cartridge according to any one of aspects 71 through 81, further comprising a shaft extending along the second axis and movable along the second axis, the shaft having one end portion in the axial direction and another end portion separated from the one end portion in the axial direction, wherein the cam is positioned at each of the one end portion and the another end portion.
- [0095] Aspect 85 is directed to the developing cartridge according to aspect 84, wherein the cam is positioned at a peripheral surface of each of the one end portion and the another end portion.

- [0096] Aspect 86 is directed to the developing cartridge according to any one of aspects 71 through 85, wherein the developing cartridge is for use with a drum cartridge, and wherein the cam surface is movable along the second axis to engage the drum cartridge.
- [0097] Aspect 87 is directed to the developing cartridge according to aspect 86, wherein the cam surface is movable along the second axis to engage a frame of the drum cartridge.
- [0098] Aspect 88 is directed to the developing cartridge according to aspect 87, wherein engagement between the cam surface and the frame moves the developing roller away from a photosensitive drum of the drum cartridge.
- [0099] Aspect 89 is directed to the developing cartridge according to aspect 88, wherein the photosensitive drum is rotatable about a rotational axis extending in the axial direction.
- [0100] Aspect 90 is directed to a developing cartridge comprising:
a casing configured to accommodate developer therein;
a developing roller rotatable about a first axis and being at least partially exposed to an outside of the casing; and
a cam surface oriented in a direction non-parallel with the first axis and movable in a direction parallel with the first axis to engage a frame of a drum cartridge.
- [0101] Aspect 91 is directed to the developing cartridge according to aspect 90, wherein the developing roller has an outer circumferential surface,
wherein one end portion of the outer circumferential surface is exposed to an outside of the casing,
wherein another end portion of the outer circumferential surface is positioned inside the casing, and
wherein the cam surface is inclined relative to in a direction connecting the one end portion of the outer circumferential surface and the another end portion of the outer circumferential surface.
- [0102] Aspect 92 is directed to the developing cartridge according to aspect 90 or 91, wherein the cam surface is inclined relative to the first axis.
- [0103] Aspect 93 is directed to the developing cartridge according to aspect 92, wherein the cam surface is inclined relative to the first axis by an acute angle.
- [0104] Aspect 94 is directed to the developing cartridge according to any one of aspects 90 through 93, wherein the cam is positioned at an exterior surface of the casing.
- [0105] Aspect 95 is directed to the developing cartridge according to any one of aspects 90 through 94, wherein the developing roller is at least partially exposed to an outside of the casing.
- [0106] Aspect 96 is directed to the developing cartridge according to aspect 95, wherein at least a part of an outer circumferential surface of the developing roller is exposed to an outside of the casing.
- [0107] Aspect 97 is directed to the developing cartridge according to any one of aspects 90 through 96, wherein the cam is positioned at a peripheral surface of the shaft.
- [0108] Aspect 98 is directed to the developing cartridge according to any one of aspects 90 through 97, further comprising a separation member including the cam and the shaft.
- [0109] Aspect 99 is directed to the developing cartridge according to any one of aspects 90 through 98, wherein the cam is movable along a second axis parallel with the first axis relative to the developing roller and the casing.
- [0110] Aspect 100 is directed to the developing cartridge according to aspect 99, wherein the cam is further movable together with the developing roller and the casing in a direction perpendicular to the second axis.
- [0111] Aspect 101 is directed to the developing cartridge according to any one of aspects 90 through 100, wherein the developer is accommodated within the casing.

- [0112] Aspect 102 is directed to the developing cartridge according to any one of aspects 90 through 101, wherein the cam has one of a cone shape and a pyramid shape centered on the second axis, and wherein the cam surface is a lateral surface of the cam.
- [0113] Aspect 103 is directed to the developing cartridge according to any one of aspects 90 through 102, the drum cartridge comprising a photosensitive drum, wherein the photosensitive drum extends along a rotational axis parallel with the first axis, and wherein the cam surface is axially movable to engage the frame of the drum cartridge.
- [0114] Aspect 104 is directed to the cartridge developing cartridge according to aspect 103, wherein engagement between the cam surface and the frame moves the developing roller away from the photosensitive drum.
- [0115] Aspect 105 is directed to a cartridge assembly comprising: the drum cartridge according to any one of aspects 90 through 104; and the developing cartridge according to any one of aspects 90 through 104.

[Advantageous Effects of Invention]

- [0116] According to the present disclosure, a pressing force directed in the first direction causes the shaft to move in the first direction relative to the casing and the developing roller. When the first inclined surface contacts other component due to the movement of the shaft in the first direction, the first inclined surface moves also in the second direction along the other component. The casing and the developing roller also move in the second direction in accordance with the movement of the first inclined surface in the second direction. With this configuration, the developing cartridge is movable in the second direction by the driving force directed in the first direction, not by the driving force acting on both ends of the developing cartridge. In addition, since the developing cartridge has the first inclined surface and the shaft, the shaft does not interrupt attachment of the developing cartridge to the drum cartridge and detachment of the developing cartridge from the drum cartridge, compared to a case where the drum cartridge includes a shaft.
- [0117] According to aspect 6, the first sloped surface first contacts the other component. Accordingly, in the beginning of the movement of the shaft in the first direction, the amount of movement of the shaft in the second direction can be increased. Further, subsequent to the first sloped surface, the second sloped surface whose inclination is smaller than the first sloped surface contacts the other components. With this configuration, the shaft moves in the first direction while the movement of the shaft in the second direction is reduced. Therefore, driving load for pressing the shaft can be suppressed.
- [0118] According to aspect 13, the third sloped surface first contacts the other component. Accordingly, in the beginning of the movement of the shaft in the first direction, the amount of movement of the shaft in the second direction can be increased. Further, subsequent to the third sloped surface, the fourth sloped surface whose inclination is smaller than the third sloped surface contacts the other component. With this configuration, the shaft moves in the first direction while the movement of the shaft in the second direction is reduced. Therefore, driving load for pressing the shaft can be suppressed.
- [0119] According to aspects 16 and 18, the casing and the developing roller is movable in the second direction even if the shaft rotates.

- [0120] According to aspect 19, the shaft is supported by the lid. Accordingly, the shaft can be easily provided at the developing cartridge.
- [0121] According to aspects 21 and 23, the developing roller can separate relative to the photosensitive drum in accordance with the movement of the shaft in the first direction.
- [0122] According to aspect 25, shaft is movable relative to the casing and the developing roller in the first direction due to the elastic force of the elastic member. This configuration enables the developing cartridge to move back in the second direction when driving force directed in the first direction is released.
- [0123] According to aspect 29, the driving sources in an image forming apparatus can be collectively arranged on one side of the developing cartridge in the first direction.
- [Brief Description of Drawings]
- [0124] [Fig. 1] Fig. 1 is a schematic diagram of an image forming apparatus including a developing cartridge according to a first embodiment of the present disclosure;
- [Fig. 2] Fig. 2 is a perspective view of the developing cartridge according to the first embodiment;
- [Fig. 3] Fig. 3 is another perspective view of the developing cartridge according to the first embodiment;
- [Fig. 4] Fig. 4 is a plan view of the developing cartridge according to the first embodiment as viewed in a first direction;
- [Fig. 5] Fig. 5 is another plan view of the developing cartridge according to the first embodiment as viewed in the first direction;
- [Fig. 6] Fig. 6 is an exploded perspective view of a separation member of the developing cartridge according to the first embodiment;
- [Fig. 7] Fig. 7 is an exploded enlarged view of a shaft and a first cam of the separation member;
- [Fig. 8] Fig. 8 is a view for description of movement of the separation member in the first direction relative to a casing and a developing roller of the developing cartridge according to the first embodiment;
- [Fig. 9] Fig. 9 is another view for description of movement of the separation member in the first direction relative to the casing and the developing roller;
- [Fig. 10] Fig. 10 is a plan view of the developing cartridge according to the first embodiment as viewed in the third direction;
- [Fig. 11] Fig. 11 is a perspective view of a drawer to which the developing cartridge according to the first embodiment is detachably attached;
- [Fig. 12] Fig. 12 is a plan view of the drawer as viewed in the third direction;
- [Fig. 13] Fig. 13 is a perspective view of the drawer and the developing cartridges according to the first embodiment, and illustrating a state where the developing cartridges are attached to the drawer;
- [Fig. 14] Fig. 14 is a plan view of the drawer and the developing cartridges according to the first embodiment as viewed in the third direction, and illustrating a state where the developing cartridges are attached to the drawer;
- [Fig. 15] Fig. 15 is a plan view of the drawer and the developing cartridges according to the first embodiment as viewed in the first direction, and illustrating a state where the developing cartridges are attached to the drawer;
- [Fig. 16] Fig. 16A is a view for description of separation movement of the developing cartridge according to the first embodiment performed by the separation member; and Fig. 16B is another view for description of separation movement of the developing cartridge according to the first embodiment performed by the separation member;

[Fig. 17] Fig. 17 is a perspective view of the developing cartridge according to the first embodiment and a photosensitive drum of the drawer in a contact state of the image forming apparatus;

[Fig. 18] Fig. 18 is a perspective view of the developing cartridge according to the first embodiment and the photosensitive drum in a separation state of the image forming apparatus;

[Fig. 19] Fig. 19 is a plan view of a developing cartridge according to a second embodiment of the present disclosure as viewed in the third direction; and

[Fig. 20] Fig. 20A is a view for description of separation movement of the developing cartridge according to the second embodiment performed by the separation member; and Fig. 20B is another view for description of separation movement of the developing cartridge according to the second embodiment performed by the separation member.

[Description of Embodiments]

[0125] <1. First Embodiment>

[0126] Hereinafter, an image forming apparatus 100 including a developing cartridge 1 according to a first embodiment will be described with reference to Figs. 1 through 18.

[0127] <1.1. Configuration of Image Forming Apparatus>

[0128] Fig. 1 is a schematic diagram of the image forming apparatus 100. The image forming apparatus 100 is an electro-photographic type printer. For example, the image forming apparatus 100 may be a laser printer or an LED printer.

[0129] The image forming apparatus 100 includes four developing cartridges 1, a drawer 2, a main frame 101, and a controller 102.

[0130] The developing cartridges 1 are attachable to the drawer 2. That is, the developing cartridges 1 are for use with the drawer 2. The drawer 2 is a drum cartridge to which the four developing cartridges 1 are attachable, and includes four slots 2A. The four developing cartridges 1 are attachable to the corresponding slots 2A. The developing cartridges 1 are attachable to the main frame 101 in a state where the developing cartridges 1 are attached to the corresponding slots 2A. The four developing cartridges 1 accommodate developers (such as toner) of colors different from each other (such as cyan, magenta, yellow, and black). The plurality of developing cartridges 1, however, may accommodate developers of the same color. The number of the developing cartridges 1 attachable to the drawer 2 may be one, two, or three, or five or more.

[0131] The image forming apparatus 100 is configured to form images on printing papers using the developers supplied from the four developing cartridges 1.

[0132] Each of the four developing cartridges 1 includes an IC chip 51. The IC chip 51 is a storage medium from which information is readable and to which information is writable. The storage medium may be a flush ROM or an EEPROM, for example. When the developing cartridges 1 attached to the slots 2A of the drawer 2 are attached to the main frame 101, the IC chips 51 of the developing cartridges 1 and the controller 102 are electrically connected to each other. The controller 102 is configured of, for example, a circuit board. The controller 102 includes a processor such as a CPU, and various memories. The controller 102 is configured to execute various types of processing in the image forming apparatus 100 by operating the processor in accordance with programs.

[0133] <1.2. Developing Cartridge>

[0134] Figs. 2 and 3 are perspective views of the developing cartridge 1. Figs. 4 and 5 are plan views of the developing cartridge 1 as viewed in a first direction.

[0135] In the following description, a direction in which a rotational axis (i.e., a first axis) of a developing roller 30 extends will be referred to as "first direction" (an example of an axial direction). The first direction also denotes a direction in which a rotational axis (a

drum axis) of a photosensitive drum 21 (described later) of the drawer 2 extends. Here, an outer circumferential surface of the developing roller 30 includes one end portion exposed to the outside of a casing 10, and another end portion positioned inside the casing 10. A direction in which the one end portion of the circumferential surface of the developing roller 30 and the other end portion of the circumferential surface are arrayed will be referred to as “second direction”. The second direction also denotes a direction crossing the circumferential surface of the developing roller 30 which is exposed to the outside of the casing 10 of the developing cartridge 1. The second direction may denote a direction which the outer circumferential surface of the developing roller 30 is separated from and/or approaches an outer circumferential surface the photosensitive drum 21 (described later). The first direction and the second direction crosses each other. Preferably, the first direction and the second direction are perpendicular to each other.

- [0136] The developing cartridge 1 includes the casing 10 configured to accommodate developer therein. The casing 10 has a first outer surface 11 and a second outer surface 12 those are separated from each other in the first direction. The casing 10 extends in the first direction between the first outer surface 11 and the second outer surface 12. That is, the first outer surface 11 is one end of the casing 10 in the first direction, and the second outer surface 12 is another end of the casing 10 in the first direction.
- [0137] The casing 10 includes a container 10A and a lid 10B. The container 10A is configured to accommodate developer therein, and has an opening (not illustrated). The lid 10B covers the opening (not illustrated) of the container 10A. The container 10A and the lid 10B are disposed at a position between the first outer surface 11 and the second outer surface 12 in the first direction.
- [0138] The casing 10 also extends in a predetermined direction. Hereinafter, the predetermined direction in which the casing 10 extends will be referred to as “third direction”. The third direction crosses the first direction. Preferably, the third direction is perpendicular to the first direction. The third direction may denote a direction which the developing cartridges 1 are inserted into and/or extracted from the corresponding slots 2A (see Fig. 1) of the drawer 2. The casing 10 has an opening 10C. The opening 10C is positioned at one end portion of the casing 10 in the third direction. The container 10A and an outside of the casing 10 are in communication with each other through the opening 10C.
- [0139] The developing cartridge 1 further includes an agitator 20. The agitator 20 is rotatable about an axis (i.e., a third axis) extending in the first direction. The agitator 20 is a member configured to agitate the developer accommodated in the container 10A. The agitator 20 includes a shaft extending in the first direction, and an agitation blade extending radially outward from the shaft. Upon rotation of the shaft, the developer accommodated in the container 10A is agitated by the agitation blade.
- [0140] The developing cartridge 1 further includes the developing roller 30. The developing roller 30 is spaced apart from the agitator 20 in the second direction. Further, the agitator 20 is positioned closer to the developing roller 30 than a shaft 61 (described later) is to the developing roller 30 in the second direction. The developing roller 30 is positioned at the opening 10C, which is positioned at the one end portion of the casing 10 in the third direction. The developing roller 30 is a roller supported by the casing 10 so as to be rotatable about the first axis extending in the first direction.
- [0141] The developing roller 30 includes a developing roller body 31 and a developing roller shaft 32. The developing roller body 31 has a hollow cylindrical shape extending in the first direction. The developing roller body 31 is made of a material having elasticity, such as rubber. The developing roller shaft 32 has a columnar shape extending through the developing roller body 31 in the first direction. The developing roller shaft 32 is

made of metal or a resin having electrical conductivity. The developing roller body 31 is fixed to the developing roller shaft 32 so as not to rotate relative to the developing roller shaft 32. With this configuration, the developing roller body 31 is rotatable together with the developing roller shaft 32. The developing roller 30 (i.e., the developing roller body 31) is at least partially exposed to the outside of the casing 10. That is, at least a part of an outer circumferential surface of the developing roller 30 is exposed to the outside of the casing 10. More specifically, the one end portion of an outer circumferential surface of the developing roller body 31 in the second direction is exposed to the outside of the casing 10 through the opening 10C. The other end portion of the outer circumferential surface of the developing roller body 31 in the second direction is positioned inside the casing 10. That is, the other end portion of the outer circumferential surface of the developing roller body 31 in the second direction is not exposed to the outside of the casing 10.

- [0142] The developing cartridge 1 further includes a developing electrode 33 (an example of an electrode). The developing electrode 33 is positioned at one end of the developing roller shaft 32 in the first direction. Here, the developing roller shaft 32 to which the developing electrode 33 is provided is rotatably attached to a bearing (not illustrated) of the casing 10. The bearing may be integrally formed at the casing 10, or may be separately formed from the casing 10. The developing electrode 33 is positioned at the first outer surface 11. The developing electrode 33 is electrically connected to the developing roller shaft 32 of the developing roller 30. The developing electrode 33 is an electrode for applying a developing bias to the developing roller 30. The developing electrode 33 is positioned closer to the developing roller 30 than the shaft 61 and a first cam 62 of a separation member 60 (described later) are to the developing roller 30 in the second direction.
- [0143] A developing roller gear (not illustrated) is coupled to another end portion of the developing roller shaft 32 in the first direction. The developing roller gear is positioned at the second outer surface 12. The developing roller shaft 32 is fixed to the developing roller gear so as not to rotate relative to the developing roller gear. When the developing roller gear rotates, the developing roller shaft 32 also rotates, thereby causing rotation of the developing roller body 31 together with the developing roller shaft 32.
- [0144] Incidentally, the developing roller shaft 32 may not extend through the developing roller body 31 in the first direction. For example, each of a pair of developing roller shafts 32 may extend in the first direction from each end portion of the developing roller body 31 in the first direction.
- [0145] The developing cartridge 1 further includes a supply roller (not illustrated). The supply roller is disposed inside the container 10A at a position between the developing roller 30 and the agitator 20. The supply roller is rotatable about a rotational axis extending in the first direction. When the developing cartridge 1 receives a driving force, the developer is supplied from the container 10A of the casing 10 to the outer circumferential surface of the developing roller 30 (i.e., an outer circumferential surface of the developing roller body 31) through the supply roller. At this time, the developer is triboelectric charged between the supply roller and the developing roller 30. In the meantime, a developing bias is applied to the developing roller shaft 32 of the developing roller 30. Accordingly, the developer is attracted to the outer circumferential surface of the developing roller body 31 by the electrostatic force generated between the developing roller shaft 32 and the developer.
- [0146] The developing cartridge 1 further includes a layer-thickness regulation blade (not illustrated). The layer-thickness regulation blade regulates a thickness of a layer of the

developer supplied onto the outer circumferential surface of the developing roller body 31 so that the thickness of the layer of the developer is formed to a constant thickness. The developer on the outer circumferential surface of the developing roller body 31 is then supplied to the photosensitive drum 21 (described later, see Fig. 11) of the drawer 2. At this time, the developer is transferred from the developing roller body 31 to the photosensitive drum 21, in accordance with an electrostatic latent image formed on the outer circumferential surface of the photosensitive drum 21. Accordingly, the electrostatic latent image formed on the outer circumferential surface of the photosensitive drum 21 becomes a visible image.

- [0147] As illustrated in Figs. 3 and 4, the developing cartridge 1 further includes a gear portion 40. The gear portion 40 is positioned at the second outer surface 12 of the casing 10. The gear portion 40 includes a coupling 41 and the developing roller gear (not illustrated).
- [0148] The coupling 41 is a gear which receives the driving force applied from the main frame 101 of the image forming apparatus 100. The coupling 41 is rotatable about a rotational axis extending in the first direction. The coupling 41 is positioned closer to the developing roller 30 than the shaft 61, the first cam 62, and a second cam 63 of the separation member 60 (described later) are to the developing roller 30 in the second direction. The coupling 41 has a coupling hole 411 recessed in the first direction. When the developing cartridge 1 attached to the slot 2A of the drawer 2 is attached to the main frame 101 of the image forming apparatus 100, a drive shaft (not illustrated) of the image forming apparatus 100 is inserted into the coupling hole 411. Thus, the drive shaft and the coupling 41 are coupled with each other so that relative rotation between the drive shaft and the coupling 41 is prevented. Accordingly, when the drive shaft rotates, the coupling 41 also rotates. Further, as the coupling 41 rotates, a supply shaft connected to the supply roller (not illustrated) and the developing roller gear rotate. By this rotation, the supply roller rotates together with the supply shaft, and the developing roller 30 rotates together with the developing roller gear. The rotation of the coupling 41 also causes rotation of the agitator 20 through another gear (not illustrated).
- [0149] The image forming apparatus 100 has a contact state and a separation state. In the contact state of the image forming apparatus 100, the developing roller 30 and the photosensitive drum 21 of the drawer 2 are in contact with each other in a state where the developing cartridge 1 is attached to the slot 2A of the drawer 2. In the separation state of the image forming apparatus 100, the developing roller 30 and the photosensitive drum 21 of the drawer 2 are separated from each other. At the time of attachment of the developing cartridge 1 to the slot 2A of the drawer 2, the image forming apparatus 100 is in the contact state.
- [0150] The developing cartridge 1 further includes the separation member 60. The separation member 60 is a member for switching a state of the image forming apparatus 100 between the contact state and the separation state. In the present embodiment, when the image forming apparatus 100 is switched from the contact state to the separation state, the developing roller 30 separates from the photosensitive drum 21 in the second direction which is a separation direction of the developing roller 30 from the photosensitive drum 21.
- [0151] The separation member 60 is disposed at the lid 10B. The separation member 60 is movable in the first direction relative to the casing 10 and the developing roller 30. In addition, the separation member 60 is movable in the second direction together with the casing 10 and the developing roller 30.
- [0152] Fig. 6 is an exploded perspective view of the separation member 60. Of the casing 10, only the lid 10B at which the separation member 60 is disposed is illustrated in Fig. 6.

Fig. 7 is an exploded enlarged view of the shaft 61 and the first cam 62 in the separation member 60. Figs. 8 and 9 are views for description of movement of the separation member 60 in the first direction relative to the casing 10 and the developing roller 30. Fig. 10 is a plan view of the developing cartridge 1 as viewed in the third direction. Hereinafter, the separation member 60 will be described with reference to Figs. 2 through 10.

- [0153] The separation member 60 includes the shaft 61 that extends along an axis (i.e., a second axis) extending in the first direction. The shaft 61 has a circular columnar shape. The shaft 61, however, may have a rectangular columnar shape. The lid 10B has a groove 10B1, a hole 10B4, and a hole 10B5 each penetrating the lid 10B in the first direction. Each of the groove 10B1, the hole 10B4, and the hole 10B5 has a diameter greater than a diameter of the shaft 61. The shaft 61 is inserted through the groove 10B1, the hole 10B4, and the hole 10B5. The shaft 61 inserted into the groove 10B1, the hole 10B4, and the hole 10B5 is movable in the first direction relative to the lid 10B of the casing 10 between a first position (a position illustrated in Fig. 8) and a second position (a position illustrated in Fig. 9). The shaft 61 in the second position is closer to the first outer surface 11 than the shaft 61 in the first position is to the first outer surface 11. Note that, while the lid 10B has two holes (i.e., the hole 10B4 and the hole 10B5) in the present embodiment, the lid 10B may have at least one hole as long as the lid 10B can movably support the shaft 61.
- [0154] Preferably, the shaft 61 is made of material having rigidity. For example, the shaft 61 is made of iron. Alternatively, the shaft 61 may be made of resin.
- [0155] In the present embodiment, the casing 10 includes ring-shaped portions 10B2 and 10B3. The ring-shaped portion 10B2 is formed at one end portion of the lid 10B in the first direction, while the ring-shaped portion 10B3 is formed at another end portion of the lid 10B in the first direction. Both the ring-shaped portions 10B2 and 10B3 are integrally formed at the lid 10B. The through-hole penetrating the ring-shaped portion 10B2 is the hole 10B4, and the through-hole penetrating the ring-shaped portion 10B3 is the hole 10B5. The groove 10B1 formed along the first direction are exposed between the ring-shaped portion 10B2 and the ring-shaped portion 10B3. That is, the shaft 61 inserted into the groove 10B1, the hole 10B4, and the hole 10B5 is exposed from the lid 10B at a position between the ring-shaped portion 10B2 and the ring-shaped portion 10B3. Since the shaft 61 has rigidity, a portion of the shaft 61 exposed from the lid 10B will not be bent toward the second direction or the third direction (i.e., directions other than the first direction).
- [0156] Incidentally, only one ring-shaped portion may be formed at the lid 10B. Alternatively, an additional ring-shaped portion(s) may be disposed between the ring-shaped portions 10B2 and 10B3. Although the shaft 61 is exposed at a position between the ring-shaped portions 10B2 and 10B3 in the first direction in the present embodiment, the shaft 61 may not be exposed from the lid 10B. That is, the shaft 61 may be accommodated inside the lid 10B.
- [0157] As described above, the shaft 61 is supported by the lid 10B so as to be movable in the first direction along the second axis. Accordingly, the shaft 61 can be easily disposed at the casing 10.
- [0158] The first cam 62 (an example of a cam) is disposed at one end portion 61A (an example of a first end portion) of the shaft 61 in the first direction. The first cam 62 is made of rubber or resin, for example. As illustrated in Fig. 7, the first cam 62 has a hole 62A penetrating the first cam 62 in the first direction. The one end portion 61A of the shaft 61 has a diameter smaller than a diameter of a portion of the shaft 61 other than the one end portion 61A. The one end portion 61A of the shaft 61 is inserted into the hole 62A.

The one end portion 61A inserted into the hole 62A has a distal end exposed from the first cam 62 in the first direction, and a retaining ring 61B is attached to the exposed distal end of the one end portion 61A. With this configuration, the first cam 62 is fixed to the one end portion 61A of the shaft 61. Alternatively, the first cam 62 may be adhesively fixed to the shaft 61.

- [0159] The first cam 62 has a first inclined surface 621 (an example of a cam surface and an example of a first cam surface) that is non-parallel with the second axis. In the present embodiment, the first inclined surface 621 is positioned at a portion of a peripheral surface of the shaft 61 as illustrated in Fig. 5. More specifically, the first inclined surface 621 is positioned at one end portion of the shaft 61 in the second direction. The one end portion of the shaft in the second direction is closer to the developing roller 30 than another end portion of the shaft 61 in the second direction is to the developing roller 30. The first cam 62 further has a contact surface 622 that faces the lid 10B. The contact surface 622 is disposed at another portion of the peripheral surface of the shaft 61, that is different from the portion of the peripheral surface at which the first inclined surface 621 is positioned. In other words, the contact surface 622 faces the casing 10, i.e., an outer surface of the casing 10. Since the contact surface 622 faces the lid 10B, even if the first cam 62 tries to rotate about the shaft 61, the contact surface 622 contacts the lid 10B, thereby preventing rotation of the first cam 62. Although the first inclined surface 621 is disposed at a portion of the peripheral surface of the shaft 61 in the present embodiment, the first inclined surface 621 may be disposed at the whole of the peripheral surface of the shaft 61.
- [0160] The first inclined surface 621 is inclined relative to the shaft 61 extending in the first direction and angled relative to the second axis. In other words, the first inclined surface 621 is inclined relative to a direction connecting the one end portion of the outer circumferential surface of the developing roller 30 and the another end portion of the outer circumferential surface of the developing roller 30. An angle between the first inclined surface 621 and the first direction is greater than or equal to 43 degrees and smaller than or equal to 47 degrees. More preferably, the angle between the first inclined surface 621 and the first direction is about 45 degrees.
- [0161] The first cam 62, i.e., the first inclined surface 621 is positioned at the first outer surface 11 of the casing 10. As the first inclined surface 621 extends in a direction away from the first outer surface 11 in the first direction, the first inclined surface 621 extends away from the developing roller 30 in the second direction. That is, the first inclined surface 621 is formed such that a distance between the shaft 61 (i.e., the second axis) and the first inclined surface 621 in a radial direction of the shaft 61 (i.e., the second direction) increases in a direction from the one end portion 61A of the shaft 61 in the first direction toward the other end portion of the shaft 61 in the first direction. In other words, the first inclined surface 621 is inclined relative to the first direction such that the distance between the first inclined surface 621 and the shaft 61 in a direction perpendicular to the first axis increases from the one end portion 61A of the shaft 61 in the first direction to the other end portion of the shaft 61 in the first direction. Further in other words, the first inclined surface 621 is inclined relative to the first direction such that a distance between the first inclined surface 621 and the developing roller 30 in the second direction increases or decreases relative to the casing 10 in the first direction. Further in other words, the first inclined surface 621 is inclined relative to the first direction such that one end of the first inclined surface 621 in the first direction is closer to the shaft 61 than another end of the first inclined surface 621 in the first direction is to the shaft 61 in the second direction. The first inclined surface 621 is inclined relative to the shaft 61 by an acute angle.

- [0162] The first cam 62 is formed like the half of a cone centered on the second axis. In other words, the first cam 62 has a portion of a circumferential surface of the cone serving as the first inclined surface 621.
- [0163] Note that the first cam 62 may have a pyramid shape instead of a cone shape. In this case, the second axis passes through a vertex and the center of a bottom surface of the pyramid, and a portion of a lateral surface of the pyramid serves as the first inclined surface 621. Further, while the first inclined surface 621 is smoothly inclined relative to the shaft 61 in the present embodiment, the first inclined surface 621 may have protrusions and recessed portions, such as steps. Alternatively, the first inclined surface 621 may be curved.
- [0164] The second cam 63 (another example of the cam) is disposed at another end portion (an example of a second end portion) of the shaft 61 in the first direction. The second cam 63 is made of rubber or resin, for example. Similar to the first cam 62 described with reference to Fig. 7, the second cam 63 is fixed to the other end portion of the shaft 61 in the first direction.
- [0165] The second cam 63 has a second inclined surface 631 (another example of the cam surface and an example of a second cam surface) that is non-parallel with the second axis. In the present embodiment, the second inclined surface 631 is positioned at the whole peripheral surface of the shaft 61, as illustrated in Fig. 4. Incidentally, the second inclined surface 631 may be disposed at a portion of the peripheral surface of the shaft 61. In this case, the second inclined surface 631 is positioned at the one end portion of the shaft 61 in the second direction, i.e., the end portion positioned closer to the developing roller 30 than the other end portion to the developing roller 30.
- [0166] The second inclined surface 631 is inclined relative to the shaft 61 that extends in the first direction and angled relative to the second axis. In other words, second inclined surface 631 is inclined relative to the direction connecting the one end portion of the outer circumferential surface of the developing roller 30 and the another end portion of the outer circumferential surface of the developing roller 30. An angle between the second inclined surface 631 and the first direction is greater than or equal to 43 degrees and smaller than or equal to 47 degrees. More preferably, the angle between the second inclined surface 631 and the first direction is about 45 degrees.
- [0167] The second inclined surface 631 is formed such that a distance between the shaft 61 (i.e., the second axis) and the second inclined surface 631 in the radial direction of the shaft 61 (i.e., the second direction) increases in the direction from the one end portion 61A of the shaft 61 in the first direction to the other end portion of the shaft 61 in the first direction. In other words, the second inclined surface 631 is inclined relative to the first direction such that the distance between the second inclined surface 631 and the shaft 61 in a direction perpendicular to the first axis increases from the one end portion 61A of the shaft 61 in the first direction to the other end portion of the shaft 61 in the first direction. Further in other words, the second inclined surface 631 is inclined relative to the first direction such that a distance between the second inclined surface 631 and the developing roller 30 in the second direction increases or decreases relative to the casing 10 in the first direction. Further in other words, the second inclined surface 631 is inclined relative to the first direction such that one end of the second inclined surface 631 in the first direction is closer to the shaft 61 than another end of the second inclined surface 631 in the first direction is to the shaft 61 in the second direction. The second inclined surface 631 is inclined relative to the shaft 61 by an acute angle. That is, the first inclined surface 621 of the first cam 62 and the second inclined surface 631 of the second cam 63 are inclined in the same direction relative to the first direction.

- [0168] A radial distance from the second axis to the second cam surface 631 increases as a distance from the first cam surface 621 to the second cam surface 631 increases, and a radial distance from the second axis to the first cam surface 621 decreases as a distance from the first cam surface 621 to the second cam surface 631 increases.
- [0169] The second cam 63 has a cone shape centered on the second axis. In other words, the second cam 63 has a portion of a circumferential surface of the cone serving as the second inclined surface 631.
- [0170] The second cam 63 may have a pyramid shape, not a cone shape. In this case, the second axis passes through a vertex and the center of a bottom surface of the pyramid, and a portion of a lateral surface of the pyramid serves as the second inclined surface 631. In the present embodiment, the second inclined surface 631 is smoothly inclined relative to the shaft 61. However, the second inclined surface 631 may have protrusions or recessed portions, such as steps. Alternatively, the second inclined surface 631 may be curved.
- [0171] As illustrated in Figs. 8 and 9, both the first cam 62 and the second cam 63 are movable in the first direction together with the shaft 61. That is, both the first cam 62 and the second cam 63 are axially movable together with the shaft 61 along the second axis in response to axial movement of the shaft 61 in the first direction. When the shaft 61 moves from the first position to the second position in the first direction, the second cam 63 approaches the lid 10B, and the first cam 62 recedes from the lid 10B. When the shaft 61 moves from the second position to the first position in the first direction, the second cam 63 recedes from the lid 10B, and the first cam 62 approaches the lid 10B. In other words, when the shaft 61 moves from the first position to the second position in the first direction, the second cam 63 approaches the casing 10, and the first cam 62 moves away from the casing 10. When the shaft 61 moves from the second position to the first position in the first direction, the second cam 63 moves away from the casing 10, and the first cam 62 approaches the casing 10.
- [0172] In the present embodiment, the contact surface 622 of the first cam 62 faces the lid 10B, and this configuration prevents rotation of the first cam 62 from rotating. Accordingly, the shaft 61 to which the first cam 62 is fixed, and the second cam 63 fixed to the shaft 61 are also not rotatable relative to the lid 10B. That is, the shaft 61 inserted through the hole 10B5 and the hole 10B4 is not rotatable about the second axis extending in the first direction relative to the lid 10B of the casing 10. However, the shaft 61 may be rotatable about the second axis extending in the first direction relative to the lid 10B. In a case where the shaft 61 is configured so as to be rotatable relative to the first cam 62 and the second cam 63, only the shaft 61 rotates relative to the lid 10B, the first cam 62 and the second cam 63, and the first cam 62 and the second cam 63 do not rotate. Alternatively, the shaft 61 may be rotatable about the second axis together with the first cam 62 and the second cam 63.
- [0173] The separation member 60 further includes a coil spring 64 as an example of an elastic member. The coil spring 64 is positioned at the other end portion of the shaft 61 in the first direction. Specifically, the shaft 61 is inserted into the coil spring 64. The coil spring 64 is positioned between the second cam 63 and the lid 10B in the first direction. One end of the coil spring 64 in the first direction is in contact with the lid 10B through, for example, a washer 65. Another end of the coil spring 64 in the first direction is in contact with the second cam 63. That is, the one end of the coil spring 64 is connected to the casing 10, while the another end of the coil spring 64 is connected to the second inclined surface 631. The coil spring 64 is covered with a cover 66 in a circumferential direction of the shaft 61. Although the coil spring 64 is connected to the shaft 61 through the second cam 63, the coil spring 64 may be directly connected to the shaft 61.

- [0174] The coil spring 64 is an elastic member configured to extend (expand) and contract in the first direction between a first length and a second length shorter than the first length. As will be described later in detail, the second cam 63 is pressed by a pressing force applied in a direction from the other end portion of the shaft 61 to the one end portion 61A of the shaft 61 in the first direction. Accordingly, the shaft 61 moves from the first position illustrated in Fig. 8 to the second position illustrated in Fig. 9 together with the first cam 62 and the second cam 63. When the shaft 61 moves from the first position to the second position, the coil spring 64 is compressed from the first length to the second length. When the pressing force applied to the second cam 63 is released, the coil spring 64 is restored from the second length to the first length due to a restoring force of the coil spring 64, whereby the shaft 61 moves back, from the second position to the first position, together with the first cam 62 and the second cam 63. In this way, the shaft 61, the first cam 62, and the second cam 63 are movable in the first direction relative to the casing 10 due to the pressing force applied in the first direction and the elastic force (restoring force) of the coil spring 64.
- [0175] <1.3. Drawer>
- [0176] Fig. 11 is a perspective view of the drawer 2 as an example of a drum cartridge. Fig. 12 is a plan view of the drawer 2 as viewed in the third direction. Fig. 13 is a perspective view of the drawer 2 and the developing cartridges 1, illustrating a state where the developing cartridges 1 are attached to the corresponding slots 2A of the drawer 2. Fig. 14 is a plan view of the drawer 2 and the developing cartridges 1 as viewed in the third direction, and illustrating the state where the developing cartridges 1 are attached to the corresponding slots 2A of the drawer 2. Fig. 15 is a plan view of the drawer 2 and the developing cartridges 1 as viewed in the first direction, and illustrating the state where the developing cartridges 1 are attached to the corresponding slots 2A of the drawer 2.
- [0177] The drawer 2 includes a frame 200. The frame 200 includes the four slots 2A. The developing cartridges 1 are respectively attachable to the corresponding slots 2A. The drawer 2 also includes the photosensitive drums 21. Each of the photosensitive drums 21 is disposed corresponding to each of the four slots 2A. Each of the photosensitive drums 21 is rotatable about the rotational axis (the drum axis) extending in the first direction. Each of the developing cartridges 1 is attachable to the corresponding slot 2A of the drawer 2 such that the outer circumferential surface of the developing roller 30 faces the outer circumferential surface of the photosensitive drum 21. The drawer 2 which the developing cartridge 1 has been attached to each slot 2A is attached to the main frame 101 (see Fig. 1).
- [0178] The frame 200 of the drawer 2 includes a first side frame 201 and a second side frame 202. The first side frame 201 and the second side frame 202 are spaced apart from each other in the first direction. The four photosensitive drums 21 are disposed at positions between the first side frame 201 and the second side frame 202 in the first direction. When the developing cartridges 1 are attached to the slots 2A, the developing cartridges 1 are positioned between the first side frame 201 and the second side frame 202 in the first direction. In this state, the first outer surface 11 of each developing cartridge 1 faces the first side frame 201 in the first direction, and the second outer surface 12 of each developing cartridge 1 faces the second side frame 202 in the first direction.
- [0179] The first side frame 201 has a first recessed portion 201A formed corresponding to each of the four slots 2A. Each of the first recessed portions 201A penetrates the first side frame 201 in the first direction and recessed toward the corresponding photosensitive drum 21 in the third direction. In a state where each developing cartridge 1 is attached to the corresponding slot 2A of the drawer 2, the IC chip 51 of each developing

cartridge 1 covered with a cover 45 is positioned in the corresponding first recessed portion 201A, as illustrated in Figs. 13 and 14.

- [0180] The second side frame 202 has second recessed portions 202A. Similar to the first recessed portions 201A, each second recessed portion 202A is formed corresponding to each slot 2A. Each of the second recessed portions 202A penetrates the second side frame 202 in the first direction to expose a portion of the developing cartridge 1 to the outside of the drawer 2, and is open toward a direction away from the corresponding photosensitive drum 21 in the third direction. In a state where each developing cartridge 1 is attached to the corresponding slot 2A of the drawer 2, the second cam 63 of each developing cartridge 1 is positioned in the corresponding second recessed portions 202A, as illustrated in Figs. 13 through 15.
- [0181] The second side frame 202 further has through-holes 202B. Each through-holes 202B is formed corresponding to each of the slots 2A. Each of the through-holes 202B penetrates the second side frame 202 in the first direction. In a state where each developing cartridge 1 is attached to the corresponding slot 2A of the drawer 2, the coupling hole 411 of the coupling 41 of each developing cartridge 1 is exposed from the corresponding through-hole 202B, as illustrated in Figs. 13 through 15. The drive shaft of the image forming apparatus 100 is inserted into each coupling hole 411 through the corresponding through-hole 202B. Accordingly, the drive shafts and the corresponding couplings 41 are coupled with each other so as not to rotate relative to each other.
- [0182] The drawer 2 has the first receiving surface 22 and the second receiving surface 23 for each slot 2A. The first receiving surface 22 is spaced apart from the second receiving surface 23 in the first direction. That is, the first receiving surface 22 is positioned at one end portion of each slot 2A in the first direction, while the second receiving surface 23 is positioned at another end portion of each slot 2A in the first direction.
- [0183] Each of the first receiving surface 22 is positioned at a surface of the first side frame 201 that faces the second side frame 202. The first receiving surface 22 is inclined relative to the first direction. More specifically, the first receiving surface 22 is disposed so as to face the first cam 62 of the developing cartridge 1 attached to the slot 2A of the drawer 2 in the second direction. The first receiving surface 22 contacts the first inclined surface 621 of the first cam 62 as illustrated in Fig. 14. The first receiving surface 22 is formed such that a distance between the first receiving surface 22 and the developing cartridge 1 in the second direction increases in a direction away from the first side frame 201 in the first direction (i.e., a direction from the first side frame 201 to the second side frame 202 in the first direction).
- [0184] The second receiving surface 23 is positioned at each second recessed portion 202A formed at the second side frame 202. The second receiving surface 23 is inclined relative to the first direction in the same direction as the first receiving surface 22. More specifically, the second receiving surface 23 is disposed such that the second receiving surface 23 faces the second cam 63 of the developing cartridge 1 attached to each slot 2A of the drawer 2. The second receiving surface 23 contacts the second inclined surface 631 of the second cam 63 as illustrated in Fig. 14. The second receiving surface 23 is formed such that a distance between the second receiving surface 23 and the developing cartridge 1 in the second direction increases in the direction away from the first side frame 201 in the first direction (i.e., a direction from the first side frame 201 to the second side frame 202 in the first direction).
- [0185] <1.4. Separation Movement by Separation Member 60>
- [0186] Next, movement of the developing cartridge according to the present embodiment in the image forming apparatus 100 when the image forming apparatus 100 is switched between the contact state and the separation state will be described.

- [0187] Figs. 16A and 16B are views for description of separation movement of the developing cartridge 1 performed by the separation member 60. Fig. 16A illustrates the developing cartridge 1 in the contact state of the image forming apparatus 100. Fig. 16B illustrates the developing cartridge 1 in the separation state of the image forming apparatus 100. Fig. 17 is a perspective view of the developing cartridge 1 and the photosensitive drum 21, and illustrating a state where the developing roller 30 and the photosensitive drum 21 are in contact with each other. Fig. 18 is a perspective view of the developing cartridge 1 and the photosensitive drum 21, and illustrating a state where the developing roller 30 and the photosensitive drum 21 are separated from each other.
- [0188] When each developing cartridge 1 is attached to the corresponding slot 2A of the drawer 2, the developing roller 30 of each developing cartridge 1 contacts the corresponding photosensitive drum 21, as illustrated in Fig. 17. That is, the image forming apparatus 100 is in the contact state. In this contact state of the image forming apparatus 100, as illustrated in Fig. 16A, the first inclined surface 621 of the first cam 62 contacts the first receiving surface 22, and the second inclined surface 631 of the second cam 63 contacts the second receiving surface 23. In other words, the first inclined surface 621 and the second inclined surface 631 engage the frame 200.
- [0189] More precisely, at the time of attachment of the developing cartridge 1 to the drawer 2, the first inclined surface 621 is separated from the first receiving surface 22, and the second inclined surface 631 is separated from the second receiving surface 23. Then, as the developing cartridge 1 moves by a predetermined distance in the first direction, the first inclined surface 621 is brought into contact with the first receiving surface 22, and the second inclined surface 631 is brought into contact with the second receiving surface 23. Incidentally, the first inclined surface 621 may contact the first receiving surface 22 and the second inclined surface 631 may contact the second receiving surface 23 at the time of attachment of the developing cartridge 1 to the drawer 2.
- [0190] The first inclined surface 621 extends radially outward of the shaft 61 in the direction from the first cam 62 toward the second cam 63 in the first direction. The first receiving surface 22 contacts a portion of the first inclined surface 621. A distance between the portion of the first inclined surface 621 and the shaft 61 in the radial direction of the shaft 61 is smaller than a distance between another portion of the first inclined surface 621 and the shaft 61 in the radial direction of the shaft 61. Similarly, the second inclined surface 631 extends radially outward of the shaft 61 in the direction from the first cam 62 toward the second cam 63 in the first direction. The second receiving surface 23 contacts a portion of the second inclined surface 631. A distance between the portion of the second inclined surface 631 and the shaft 61 in the radial direction of the shaft 61 is smaller than a distance between another portion of the second inclined surface 631 and the shaft 61 in the radial direction of the shaft 61.
- [0191] As described above, each of the first cam 62 and the second cam 63 has a cone shape. Thus, even if the shaft 61 rotates about the second axis, the first inclined surface 621 and the second inclined surface 631 can reliably contact (engage) the first receiving surface 22 and the second receiving surface 23, respectively.
- [0192] The image forming apparatus 100 includes a driving unit 103 and a pressing member 104. The driving unit 103 is configured to move the pressing member 104 in the first direction. The driving unit 103 is, for example, a motor. The pressing member 104 has a circular columnar shape or a rectangular columnar shape and extends in the first direction. The pressing member 104 is movable in the first direction between a contact position and a non-contact position. The pressing member 104 in the contact position contacts the second cam 63 of the developing cartridge 1 attached to slot 2A of the

drawer 2, while the pressing member 104 in the non-contact position does not contact the second cam 63.

- [0193] In order to separate the developing roller 30 from the photosensitive drum 21, the driving unit 103 moves the pressing member 104 toward the direction from the second cam 63 to the first cam 62 in the first direction. Accordingly, the second cam 63 is pressed by the pressing member 104 toward the direction from the second cam 63 to the first cam 62 in the first direction. When the second cam 63 receives pressing force from the pressing member 104, the shaft 61, the first cam 62, and the second cam 63 move toward the direction from the second cam 63 to the first cam 62 in the first direction relative to the casing 10 and the developing roller 30.
- [0194] In this instance, the first inclined surface 621 of the first cam 62 moves toward the direction from the second cam 63 to the first cam 62 in the first direction while maintaining contact with the first receiving surface 22. As described above, the first incline surface 621 is formed so as to extend radially outward of the shaft 61 in the direction from the first cam 62 to the second cam 63. Therefore, when the first cam 62 moves toward the direction from the second cam 63 to the first cam 62 in the first direction, a portion of the first inclined surface 621 contacting the first inclined surface 621 recedes from the shaft 61 in the radial direction of the shaft 61. The first inclined surface 621 and the first receiving surface 22 face each other in the second direction. That is, when the first inclined surface 621 moves toward the direction from the second cam 63 to the first cam 62 in the first direction, the first inclined surface 621 also moves toward a direction away from the first receiving surface 22 in the second direction, as illustrated in Fig. 16B.
- [0195] Similar to the first inclined surface 621, the second inclined surface 631 of the second cam 63 moves toward the direction from the second cam 63 to the first cam 62 in the first direction while contacting the second receiving surface 23. As described above, the second inclined surface 631 is formed such that the second inclined surface 631 extends radially outward of the shaft 61 in the direction from the first cam 62 to the second cam 63. Accordingly, when the second cam 63 moves toward the direction from the second cam 63 to the first cam 62 in the first direction, a portion of the second inclined surface 631 contacting the second receiving surface 23 comes away from the shaft 61 in the radial direction of the shaft 61. The second inclined surface 631 and the second receiving surface 23 face each other in the second direction. That is, when the second inclined surface 631 moves toward the direction from the second cam 63 to the first cam 62 in the first direction, the second inclined surface 631 also moves toward a direction away from the second receiving surface 23 in the second direction, as illustrated in Fig. 16B.
- [0196] As the first cam 62 and the second cam 63 move in the second direction while moving in the first direction, the shaft 61 also moves in the same manner. When the shaft 61, the first cam 62, and the second cam 63 move in the second direction, the casing 10 and the developing roller 30 also move in the second direction, as illustrated in Fig. 16B. In other words, the first cam 62 and the second cam 63 are movable together with the casing 10 and the developing roller 30 in a direction non-parallel with the second axis in response to the axial movement of the shaft 61 along the second axis. Further in other words, each of the first inclined surface 621 and the second inclined surface 631 provides a camming movement in response to the axial movement of the shaft 61 along the second axis. This movement causes the developing roller 30 to be separated from the photosensitive drum 21 in the second direction, as illustrated in Fig. 18. Accordingly, the image forming apparatus 100 is brought into the separation state.

- [0197] The movement of the shaft 61, the first cam 62, and the second cam 63 in the first direction cause expansion and contraction of the coil spring 64 in the first direction. As described above, the coil spring 64 has the first length when the shaft 61 is positioned at the first position, as illustrated in Fig. 8. To the contrary, the coil spring 64 has the second length shorter than the first length when the shaft 61 is positioned at the second position, as illustrated in Fig. 9. The coil spring 64 is compressed from the first length to the second length due to the pressing force of the pressing member 104, and extends from the second length to the first length when the pressing force acting on the separation member 60 by the pressing member 104 is released.
- [0198] When the shaft 61 moves back from the second position to the first position together with the first cam 62 and the second cam 63, a portion of the first inclined surface 621 contacting the first receiving surface 22 approaches the shaft 61 in the second direction due to mechanism which is reverse of the mechanism described above. Similarly, a portion of the second inclined surface 631 contacting the second receiving surface 23 approaches the shaft 61 in the second direction. These movements of the shaft 61, the first cam 62, and the second cam 63 cause the casing 10 and the developing roller 30 to move in the second direction, thereby allowing the developing roller 30 to approach the photosensitive drum 21 in the second direction. As a result, the outer circumferential surface of the developing roller 30 comes into contact with the outer circumferential surface of the photosensitive drum 21. Thus, the image forming apparatus 100 is brought into the contact state.
- [0199] <1.5. Advantageous Effects of First Embodiment>
- [0200] In the present embodiment, the first cam 62 and the second cam 63 are disposed at both ends of the shaft 61 in the first direction, respectively. This configuration can prevent one of ends of the casing 10 and the developing roller 30 in the first direction from being inclined while the image forming apparatus 100 is switched between the separation state and the contact state in comparison with a case where only one of the first cam 62 and the second com 63 is disposed at the shaft 61.
- [0201] As described above, the pressing force directed in the first direction causes the shaft 61 to move in the first direction relative to the casing 10 and the developing roller 30. When the first inclined surface 621 contacts the first receiving surface 22 due to the movement of the shaft 61 in the first direction, the first inclined surface 621 moves in the second direction along the first receiving surface 22. The casing 10 and the developing roller 30 also move in the second direction in accordance with the movement of the first inclined surface 621 in the second direction. With this configuration, the developing cartridge 1 is movable in the second direction by the driving force directed in the first direction, not by driving force acting on both ends of the developing cartridge 1. In addition, the developing cartridge 1 has the first inclined surface 621 and the shaft 61. Thus, compared to a case where the drum cartridge includes a shaft, the shaft 61 does not interrupt attachment of the developing cartridge 1 to the slot 2A and detachment of the developing cartridge 1 from the slot 2A.
- [0202] Further, when the shaft 61 is to move in the first direction, the driving force from both ends of the shaft 61 in the first direction is not required. That is, the developing cartridge 1 is movable due to the driving force applied from one end of the shaft 61 in the first direction.
- [0203] In the present embodiment, the image forming apparatus 100 further includes a driving source disposed at one side the main frame 101 at which one end of the developing cartridge 1 and the drawer 2 in the first direction is positioned. The driving source is configured to drive the developing roller 30 and the photosensitive drum 21 to rotate. The driving unit 103, that serves as a driving source used to move the pressing member

104 in the first direction, can be disposed in the vicinity of the driving source. With this arrangement, the driving sources of the image forming apparatus 100 (i.e., the driving unit 103 and the driving source for driving the developing roller 30 and the photosensitive drum 21) can be collectively arranged on one side of the developing cartridge 1 and the drawer 2. Accordingly, downsizing of the image forming apparatus 100 can be realized. Further, since the components for moving the developing cartridge 1 need not be disposed on both ends of the drawer 2 in the first direction, the configuration of the drawer 2 can be simplified, and the drawer 2 can be downsized.

[0204] <2. Second Embodiment>

[0205] Next, a developing cartridge 1 according to a second embodiment will be described with reference to Figs. 19 through 20B, wherein like parts and components are designated with the same reference numerals as those shown in the first embodiment to avoid duplicating description.

[0206] In the first embodiment, each of the first inclined surface 621 and the second inclined surface 631 is inclined relative to the first direction at a constant angle. To the contrary, in the second embodiment, each of the first inclined surface 621 and the second inclined surface 631 has at least two inclined surfaces defining different angles. Hereinafter, different points of the second embodiment from the first embodiment will be described.

[0207] Fig. 19 is a plan view of the developing cartridge 1 according to the second embodiment as viewed in the third direction.

[0208] The first inclined surface 621 of the first cam 62 has a sloped surface 621A and a sloped surface 621B. The sloped surface 621A and the sloped surface 621B are arrayed with each other in the first direction. The sloped surface 621A is positioned farther from the second cam 63 than the sloped surface 621B is from the second cam 63 in the first direction. Further, the sloped surface 621A provides an inclination relative to the first direction steeper than an inclination of the sloped surface 621B relative to the first direction. Specifically, the sloped surface 621A is inclined relative to the first direction to define an acute angle between the sloped surface 621A and the first direction; the sloped surface 621B is also inclined relative to the first direction to define an acute angle between the sloped surface 621B and the first direction; and an angle between the sloped surface 621A and the first direction is greater than an angle between the sloped surface 621B and the first direction.

[0209] The angle between the sloped surface 621A and the first direction is greater than or equal to 43 degrees and smaller than or equal to 47 degrees. More preferably, the angle between the sloped surface 621A and the first direction is 45 degrees. The angle between the sloped surface 621B and the first direction is greater than or equal to 12 degrees and smaller than or equal to 17 degrees. Preferably, the angle between the sloped surface 621B and the first direction is greater than or equal to 14 degrees and smaller than or equal to 15 degrees. More preferably, the angle between the sloped surface 621B and the first direction is 14 degrees or 15 degrees. The sloped surface 621A is an example of a first sloped surface, and the sloped surface 621B is an example of a second sloped surface.

[0210] The ratio of a length of the sloped surface 621A in the first direction to a length of the sloped surface 621A in the radial direction of the shaft 61 (i.e., the second direction) is, for example, 1:1 (one to one). Further, the ratio of a length of the sloped surface 621B in the first direction to a length of the sloped surface 621B in the radial direction of the shaft 61 (i.e., the second direction) is, for example, 4:1 (four to one).

[0211] The second inclined surface 631 of the second cam 63 has a sloped surface 631A and a sloped surface 631B. The sloped surface 631A and the sloped surface 631B are arrayed with each other in the first direction. The sloped surface 631A is positioned closer to

the first cam 62 (i.e., the first inclined surface 621) than the sloped surface 631B is to the first cam 62 (i.e., the first inclined surface 621) in the first direction. Further, the sloped surface 631A provides an inclination relative to the first direction steeper than an inclination of the sloped surface 631B relative to the first direction. Specifically, the sloped surface 631A is inclined relative to the first direction to define an acute angle between the sloped surface 631A and the first direction; the sloped surface 631B is also inclined relative to the first direction to define an acute angle between the sloped surface 631B and the first direction; and an angle between the sloped surface 631A and the first direction is greater than an angle between the sloped surface 631B and the first direction.

- [0212] The angle between the sloped surface 631A and the first direction is greater than or equal to 43 degrees and smaller than or equal to 47 degrees. More preferably, the angle between the sloped surface 631A and the first direction is 45 degrees. The angle between the sloped surface 631B and the first direction is greater than or equal to 12 degrees and smaller than or equal to 17 degrees. Preferably, the angle between the sloped surface 631B and the first direction is greater than or equal to 14 degrees and smaller than or equal to 15 degrees. More preferably, the angle between the sloped surface 631B and the first direction is 14 degrees or 15 degrees. The sloped surface 631A is an example of a third sloped surface, and the sloped surface 631B is an example of a fourth sloped surface.
- [0213] The ratio of a length of the sloped surface 631A in the first direction to a length of the sloped surface 631A in the radial direction of the shaft 61 (i.e., the second direction) is, for example, 1:1 (one to one). The ratio of a length of the sloped surface 631B in the first direction to a length of the sloped surface 631B in the radial direction of the shaft 61 (i.e., the second direction) is, for example, 4:1 (four to one).
- [0214] It is preferable that the sloped surface 621A and the sloped surface 631A are inclined relative to the first direction so as to define angles the same as each other. Further, it is also preferable that the sloped surface 621B and the sloped surface 631B are inclined relative to the first direction so as to define angles the same as each other.
- [0215] <2.1. Separation Movement by Separation Member 60>
- [0216] Movement of the developing cartridge 1 according to the second embodiment in the image forming apparatus 100 when the image forming apparatus 100 is switched between the contact state and the separation state will next be described.
- [0217] Figs. 20A and 20B are views for description of separation movement of the developing cartridge 1 performed by the separation member 60. Fig. 20A illustrates the developing cartridge 1 in the contact state of the image forming apparatus 100. Fig. 20B illustrates the developing cartridge 1 in the separation state of the image forming apparatus 100.
- [0218] In the contact state of the image forming apparatus 100 where the developing roller 30 of the developing cartridge 1 is in contact with the photosensitive drum 21, the sloped surface 621A of the first inclined surface 621 contacts the first receiving surface 22 and the sloped surface 631A of the second inclined surface 631 contacts the second receiving surface 23, as illustrated in Fig. 20A.
- [0219] More precisely, at the time of attachment of the developing cartridge 1 to the drawer 2, the sloped surface 621A is separated from the first receiving surface 22, and the sloped surface 631A is separated from the second receiving surface 23. Then, as the developing cartridge 1 moves by a predetermined distance in the first direction, the sloped surface 621A is brought into contact with the first receiving surface 22, and the sloped surface 631A is brought into contact with the second receiving surface 23. Incidentally, the sloped surface 621A may contact the first receiving surface 22, and the

sloped surface 631A may contact the second receiving surface 23 at the time of attachment of the developing cartridge 1 to the drawer 2.

[0220] When the second cam 63 is pressed by the pressing member 104 toward the second cam 62 in the first direction, the shaft 61, the first cam 62, and the second cam 63 move in the first direction relative to the casing 10 and the developing roller 30. At this time, the sloped surface 621A of the first inclined surface 621 moves toward the direction from the second cam 63 to the first cam 62 in the first direction while contacting the first receiving surface 22. In addition, the sloped surface 631A of the second inclined surface 631 moves toward the direction from the second cam 63 to the first cam 62 in the first direction while contacting the second receiving surface 23. Thus, the first inclined surface 621 also moves toward the direction away from the first receiving surface 22 in the second direction, as illustrated in Fig. 20B. In addition, the second inclined surface 631 also moves in the direction away from the second receiving surface 23 in the second direction, as illustrated in Fig. 20B. Through this movement, the developing roller 30 separates from the photosensitive drum 21 in the second direction (see Fig. 18).

[0221] When the shaft 61, the first cam 62 and the second cam 63 further move toward the direction from the second cam 63 to the first cam 62 in the first direction, the sloped surface 621B of the first inclined surface 621 contacts the first receiving surface 22 to move toward the direction from the second cam 63 to the first cam 62 in the first direction along the first receiving surface 22. Further, the sloped surface 631B of the second inclined surface 631 contacts the second receiving surface 23 to move toward the direction from the second cam 63 to the first cam 62 in the first direction along the second receiving surface 23.

[0222] When the shaft 61 moves back from the second position to the first position together with the first cam 62 and the second cam 63, a portion of the first inclined surface 621 contacting the first receiving surface 22 approaches the shaft 61 in the second direction due to mechanism which is reverse of the mechanism described above. Similarly, a portion of the second inclined surface 631 contacting the second receiving surface 23 approaches the shaft 61 in the second direction. Accordingly, the casing 10 and the developing roller 30 move in the second direction so that the developing roller 30 approaches the photosensitive drum 21 in the second direction. Thus, the image forming apparatus 100 is brought into the contact state.

[0223] <2.2. Advantageous Effects of Second Embodiment>

[0224] As described above, the pressing force from the pressing member 104 causes the shaft 61 to move in the first direction relative to the casing 10 and the developing roller 30. When the first inclined surface 621 contacts the first receiving surface 22 due to the movement of the shaft 61 in the first direction, the first inclined surface 621 moves in the second direction along the first receiving surface 22. The casing 10 and the developing roller 30 also move in the second direction, in accordance with the movement of the first inclined surface 621 in the second direction. With this configuration, the developing cartridge 1 is movable in the second direction by the driving force directed in the first direction, not by driving force acting on both ends of the developing cartridge 1. In addition, the developing cartridge 1 has the first inclined surface 621 and the shaft 61. Thus, compared to a case where the drum cartridge includes a shaft, the shaft 61 does not interrupt attachment of the developing cartridge 1 to the slot 2A and detachment of the developing cartridge 1 from the slot 2A.

[0225] Further, when the shaft 61 is to move in the first direction, the driving force from both ends of the shaft 61 in the first direction is not required. That is, the developing

cartridge 1 is movable due to the driving force applied from one end of the shaft 61 in the first direction.

- [0226] Also in the second embodiment, the image forming apparatus 100 further includes a driving source disposed at one side the main frame 101 at which one end of the developing cartridge 1 and the drawer 2 in the first direction is positioned. The driving source is configured to drive the developing roller 30 and the photosensitive drum 21 to rotate. The driving unit 103, that serves as a driving source used to move the pressing member 104 in the first direction, can be disposed in the vicinity of the driving source. With this arrangement, the driving sources of the image forming apparatus 100 (i.e., the driving unit 103 and the driving source for driving the developing roller 30 and the photosensitive drum 21) can be collectively arranged on one side of the developing cartridge 1 and the drawer 2. Accordingly, downsizing of the image forming apparatus 100 can be realized. Further, since the components for moving the developing cartridge 1 need not be disposed on both ends of the drawer 2 in the first direction, the configuration of the drawer 2 can be simplified, and the drawer 2 can be downsized.
- [0227] The sloped surface 621A of the first inclined surface 621 that first contacts the first receiving surface 22 during the movement of the first cam 62 toward the direction from the second cam 63 to the first cam 62 in the first direction is steeper than the sloped surface 621B. Similarly, the sloped surface 631A of the second inclined surface 631 that first contacts the second receiving surface 23 during the movement of the second cam 63 toward the direction from the second cam 63 to the first cam 62 in the first direction is steeper than the sloped surface 631B. With this configuration, in the beginning of the movement of the separation member 60 in the first direction, the amount of movement of the separation member 60 in the second direction can be increased. Thus, the developing roller 30 can be separated from the photosensitive drum 21 while reducing amount of movement of the separation member 60 in the first direction.
- [0228] Further, the sloped surface 621B whose inclination relative to the first direction is smaller than the sloped surface 621A contacts the first receiving surface 22, and the sloped surface 631B whose inclination relative to the first direction is smaller than the sloped surface 631A contacts the second receiving surface 23. Accordingly, the separation member 60 can move in the first direction with less amount of movement in the second direction. This configuration can reduce driving load of the pressing member 104.
- [0229] <3. Modification>
- [0230] While the description has been made in detail with reference to the embodiments thereof, it would be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the scope of the above-described embodiments.
- [0231] In the above-described embodiments, the separation member 60 includes the first cam 62 and the second cam 63. The separation member 60, however, may include at least one of the first cam 62 and the second cam 63. In addition, the separation member 60 may include at least one of the first inclined surface 621 and the second inclined surface 631. In other words, in a case where only the first cam 62 is provided, only the first inclined surface 621 is provided in the separation member 60. On the other hand, in a case where only the second cam 62 is provided, only the second inclined surface 631 is provided in the separation member 60. Alternatively, the first inclined surface 621 and the second inclined surface 631 may be formed without providing the first cam 62 and the second cam 63. For example, the first inclined surface 621 and the second inclined

surface 631 may be formed by machining the shaft 61 so that the peripheral surfaces of the end portions of the shaft 61 is inclined relative to the first direction.

- [0232] Although the coil spring 64 serves as an example of the elastic member in the above-described embodiments, the elastic member is not limited to the coil spring 64. For example, material having elasticity, such as a plate spring, a torsion spring, a rubber, a sponge, or the like can be employed as the elastic member.
- [0233] Further, various features appearing in the above-described embodiments and the modifications may be suitably combined together avoiding conflicting combination.

[Reference Signs List]

- [0234] 1: developing cartridge 2: drawer 2A: slot 10: casing 10A: container 10B: lid 10B1: groove 10B4: hole 10B5: hole 10C: opening 11: first outer surface 12: second outer surface 20: agitator 21: photosensitive drum 22: first receiving surface 23: second receiving surface 30: developing roller 31: developing roller body 32: developing roller shaft 33: developing electrode 40: gear portion 41: coupling 45: cover 51: IC chip 60: separation member 61: shaft 62: first cam 63: second cam 64: coil spring 65: washer 66: cover 100: image forming apparatus 101: main frame 102: controller 103: driving unit 104: pressing member 200: frame 201: first side frame 201A: first recessed portion 202: second side frame 202A: second recessed portion 202B: through-hole 411: coupling hole 621: first inclined surface 631: second inclined surface

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

[Claim 1]

A developing cartridge comprising:
a casing configured to accommodate developer therein;
a developing roller rotatable about a first axis extending in an axial direction;
a shaft extending along a second axis extending in the axial direction, the shaft being movable along the second axis; and
a cam movable along the second axis in response to axial movement of the shaft, the cam having a cam surface non-parallel with the second axis.

[Claim 2]

The developing cartridge according to claim 1, wherein the developing roller has an outer circumferential surface,
wherein one end portion of the outer circumferential surface is exposed to an outside of the casing,
wherein another end portion of the outer circumferential surface is positioned inside the casing, and
wherein the cam surface is inclined relative to in a direction connecting the one end portion of the outer circumferential surface and the another end portion of the outer circumferential surface.

[Claim 3]

The developing cartridge according to claim 1 or 2, wherein the cam surface is inclined relative to the second axis.

[Claim 4]

The developing cartridge according to claim 3, wherein the cam surface is inclined relative to the second axis by an acute angle.

[Claim 5]

The developing cartridge according to any one of claims 1 through 4, wherein the cam is movable together with the shaft relative to the casing along the second axis in response to the axial movement of the shaft along the second axis.

[Claim 6]

The developing cartridge according to any one of claims 1 through 5, wherein the cam is movable together with the casing in a direction non-parallel with the second axis in response to the axial movement of the shaft along the second axis.

[Claim 7]

The developing cartridge according to claim 6, wherein the developing roller has an outer circumferential surface,
wherein one end portion of the outer circumferential surface is exposed to an outside of the casing,
wherein another end portion of the outer circumferential surface is positioned inside the casing, and
wherein the direction non-parallel with the second axis includes a direction connecting the one end portion of the outer circumferential surface and the another end portion of the outer circumferential surface.

[Claim 8]

The developing cartridge according to any one of claims 1 through 7, wherein the cam is positioned at an exterior surface of the casing.

[Claim 9]

The developing cartridge according to any one of claims 2 through 8, wherein the developing roller is at least partially exposed to an outside of the casing.

[Claim 10]

The developing cartridge according to claim 9, wherein at least a part of an outer circumferential surface of the developing roller is exposed to an outside of the casing.

[Claim 11]

The developing cartridge according to any one of claims 1 through 10, wherein the cam is positioned at a peripheral surface of the shaft.

[Claim 12]

The developing cartridge according to any one of claims 1 through 11, wherein the cam is positioned at one end portion of the shaft in the axial direction.

[Claim 13]

The developing cartridge according to any one of claims 1 through 12, wherein the casing includes:

a container configured to accommodate developer therein and having an opening; and

a lid covering the opening of the container and having a through-hole penetrating the lid in the axial direction, and

wherein the shaft is inserted into the through-hole.

[Claim 14]

The developing cartridge according to any one of claims 1 through 11, wherein the shaft has one end portion in the axial direction and another end portion separated from the one end portion in the axial direction, and

wherein the cam is positioned at each of the one end portion and the another end portion.

[Claim 15]

The developing cartridge according to claim 14, wherein the cam is positioned at a peripheral surface of each of the one end portion and the another end portion.

[Claim 16]

The developing cartridge according to any one of claims 1 through 15, wherein the developing cartridge is for use with a drum cartridge, and

wherein the cam surface is movable along the second axis to engage the drum cartridge.

[Claim 17]

The developing cartridge according to claim 16, wherein the cam surface is movable along the second axis to engage a frame of the drum cartridge.

[Claim 18]

The developing cartridge according to claim 17, wherein engagement between the cam surface and the frame moves the developing roller away from a photosensitive drum of the drum cartridge.

[Claim 19]

The developing cartridge according to claim 18, wherein the photosensitive drum is rotatable about a rotational axis extending in the axial direction.

[Claim 20]

The developing cartridge according to any one of claims 1 through 19, wherein the cam surface provides a camming movement in response to movement of the shaft along the second axis.

[Claim 21]

The developing cartridge according to claim 20, wherein the camming movement engages a frame of a drum cartridge to move the developing cartridge away from the drum cartridge.

[Claim 22]

The developing cartridge according to any one of claims 1 through 21, further comprising a separation member including the cam and the shaft.

[Claim 23]

The developing cartridge according to any one of claims 21 through 22, wherein the cam surface is inclined relative to the shaft and angled relative to the second axis.

[Claim 24]

The developing cartridge according to claim 23, wherein the cam surface is positioned at an end portion of the shaft extending in a first direction, the cam surface being inclined relative to shaft by an acute angle.

[Claim 25]

The developing cartridge according to claim 24, wherein the cam includes a first cam surface disposed at a first end portion of the shaft and a second cam surface disposed at a second end portion of the shaft opposite to the first end portion, the second cam surface being movable together with the shaft, the second cam surface being angled relative to the shaft such that a radial distance from the second axis to the second cam surface increases as a distance from the first cam surface to the second cam surface increases.

[Claim 26]

The developing cartridge according to claim 25, wherein the first cam surface is angled relative to the shaft such that a radial distance from the second axis to the first cam surface decreases as a distance from the first cam surface to the second cam surface increases.

[Claim 27]

The developing cartridge according to claim 25, wherein the first cam surface includes a first sloped surface angled relative to the second axis and a second sloped surface extending from and angled relative to the first sloped surface, an angle between the first sloped surface and the second axis being greater than an angle between the second sloped surface and the second axis.

[Claim 28]

The developing cartridge according to claim 27, wherein the second cam surface includes a third sloped surface angled relative to the second axis and a fourth sloped surface extending from and angled relative to the third sloped surface, an angle between the third sloped surface and the second axis being greater than an angle between the fourth sloped surface and the second axis.

[Claim 29]

The developing cartridge according to any one of claims 1 through 28, wherein the cam is movable along the second axis relative to the developing roller and the casing.

[Claim 30]

The developing cartridge according to claim 29, wherein the cam is further movable together with the developing roller and the casing in a direction perpendicular to the second axis.

[Claim 31]

The developing cartridge according to any one of claims 1 through 30, wherein the developer is accommodated within the casing.

[Claim 32]

The developing cartridge according to any one of claims 1 through 31, wherein the cam has one of a cone shape and a pyramid shape centered on the second axis, and wherein the cam surface is a lateral surface of the cam.

[Claim 33]

The developing cartridge according to any one of claims 1 through 32, wherein the cam has a fixed position relative to the shaft.

[Claim 34]

The developing cartridge according to any one of claims 1 through 33, wherein the developing cartridge is for use with a drum cartridge.

[Claim 35]

The developing cartridge according to claim 34,
the drum cartridge comprising a photosensitive drum, the drum cartridge having a frame,
wherein the photosensitive drum extends along a rotational axis parallel with the first axis, and
wherein the cam surface is axially movable to engage the frame of the drum cartridge.

[Claim 36]

The developing cartridge according to claim 35, wherein engagement between the cam surface and the frame moves the developing roller away from the photosensitive drum.

[Claim 37]

A developing cartridge comprising:
a casing configured to accommodate developer therein;
a developing roller rotatable about a first axis extending in an axial direction;
a cam movable along a second axis extending in the axial direction, the cam having a cam surface non-parallel with the second axis,
wherein the cam surface provides a camming movement in response to movement of the cam along the second axis.

[Claim 38]

The developing cartridge according to claim 37, wherein the developing roller has an outer circumferential surface,
wherein one end portion of the outer circumferential surface is exposed to an outside of the casing,
wherein another end portion of the outer circumferential surface is positioned inside the casing, and
wherein the cam surface is inclined relative to in a direction connecting the one end portion of the outer circumferential surface and the another end portion of the outer circumferential surface.

[Claim 39]

The developing cartridge according to claim 37 or 38, wherein the cam surface is inclined relative to the second axis.

[Claim 40]

The developing cartridge according to claim 39, wherein the cam surface is inclined relative to the second axis by an acute angle.

[Claim 41]

The developing cartridge according to any one of claims 37 through 40, further comprising a shaft extending along the second axis and movable along the second axis,
wherein the cam is movable together with the shaft relative to the casing along the second axis in response to axial movement of the shaft along the second axis.

[Claim 42]

The developing cartridge according to any one of claims 37 through 41, further comprising a shaft extending along the second axis and movable along the second axis,
wherein the cam surface provides the camming movement together with the casing in response to axial movement of the shaft along the second axis.

[Claim 43]

The developing cartridge according to claim 42, wherein the developing roller has an outer circumferential surface,

wherein one end portion of the outer circumferential surface is exposed to an outside of the casing,

wherein another end portion of the outer circumferential surface is positioned inside the casing, and

wherein the cam surface provides the camming movement in a direction non-parallel with the second axis, the direction non-parallel with the second axis including a direction connecting the one end portion of the outer circumferential surface and the another end portion of the outer circumferential surface.

[Claim 44]

The developing cartridge according to any one of claims 37 through 43, wherein the cam is positioned at an exterior surface of the casing.

[Claim 45]

The developing cartridge according to any one of claims 37 through 44, wherein the developing roller is at least partially exposed to an outside of the casing.

[Claim 46]

The developing cartridge according to claim 45, wherein at least a part of an outer circumferential surface of the developing roller is exposed to an outside of the casing.

[Claim 47]

The developing cartridge according to any one of claims 37 through 46, further comprising a shaft extending along the second axis and movable along the second axis, wherein the cam is positioned at a peripheral surface of the shaft.

[Claim 48]

The developing cartridge according to any one of claims 37 through 47, further comprising a shaft extending along the second axis and movable along the second axis, wherein the cam is positioned at one end portion of the shaft in the axial direction.

[Claim 49]

The developing cartridge according to any one of claims 37 through 48, further comprising a shaft extending along the second axis and movable along the second axis, wherein the casing includes:

a container configured to accommodate developer therein and having an opening; and

a lid covering the opening of the container and having a through-hole penetrating the lid in the axial direction, and

wherein the shaft is inserted into the through-hole.

[Claim 50]

The developing cartridge according to any one of claims 37 through 47, further comprising a shaft extending along the second axis and movable along the second axis, the shaft having one end portion in the axial direction and another end portion separated from the one end portion in the axial direction,

wherein the cam is positioned at each of the one end portion and the another end portion.

[Claim 51]

The developing cartridge according to claim 50, wherein the cam is positioned at a peripheral surface of each of the one end portion and the another end portion.

[Claim 52]

The developing cartridge according to any one of claims 37 through 51, wherein the developing cartridge is for use with a drum cartridge, and
wherein the cam surface is movable along the second axis to engage the drum cartridge.

[Claim 53]

The developing cartridge according to claim 52, wherein the cam surface is movable along the second axis to engage a frame of the drum cartridge.

[Claim 54]

The developing cartridge according to claim 53, wherein engagement between the cam surface and the frame moves the developing roller away from a photosensitive drum of the drum cartridge.

[Claim 55]

The developing cartridge according to claim 54, wherein the photosensitive drum is rotatable about a rotational axis extending in the axial direction.

[Claim 56]

A developing cartridge comprising:
a casing configured to accommodate developer therein;
a developing roller rotatable about a first axis and being at least partially exposed to an outside of the casing; and
a cam surface oriented in a direction non-parallel with the first axis and movable in a direction parallel with the first axis to engage a frame of a drum cartridge.

[Claim 57]

The developing cartridge according to claim 56, wherein the developing roller has an outer circumferential surface,
wherein one end portion of the outer circumferential surface is exposed to an outside of the casing,
wherein another end portion of the outer circumferential surface is positioned inside the casing, and
wherein the cam surface is inclined relative to in a direction connecting the one end portion of the outer circumferential surface and the another end portion of the outer circumferential surface.

[Claim 58]

The developing cartridge according to claim 56 or 57, wherein the cam surface is inclined relative to the first axis.

[Claim 59]

The developing cartridge according to claim 58, wherein the cam surface is inclined relative to the first axis by an acute angle.

[Claim 60]

The developing cartridge according to any one of claims 56 through 59, wherein the cam is positioned at an exterior surface of the casing.

[Claim 61]

The developing cartridge according to any one of claims 56 through 60, wherein the developing roller is at least partially exposed to an outside of the casing.

[Claim 62]

The developing cartridge according to claim 61, wherein at least a part of an outer circumferential surface of the developing roller is exposed to an outside of the casing.

[Claim 63]

The developing cartridge according to any one of claims 56 through 62, wherein the cam is positioned at a peripheral surface of the shaft.

[Claim 64]

The developing cartridge according to any one of claims 56 through 63, further comprising a separation member including the cam and the shaft.

[Claim 65]

The developing cartridge according to any one of claims 56 through 64, wherein the cam is movable along a second axis parallel with the first axis relative to the developing roller and the casing.

[Claim 66]

The developing cartridge according to claim 65, wherein the cam is further movable together with the developing roller and the casing in a direction perpendicular to the second axis.

[Claim 67]

The developing cartridge according to any one of claims 56 through 66, wherein the developer is accommodated within the casing.

[Claim 68]

The developing cartridge according to any one of claims 56 through 67, wherein the cam has one of a cone shape and a pyramid shape centered on the second axis, and wherein the cam surface is a lateral surface of the cam.

[Claim 69]

The developing cartridge according to any one of claims 56 through 68, the drum cartridge comprising a photosensitive drum, wherein the photosensitive drum extends along a rotational axis parallel with the first axis, and wherein the cam surface is axially movable to engage the frame of the drum cartridge.

[Claim 70]

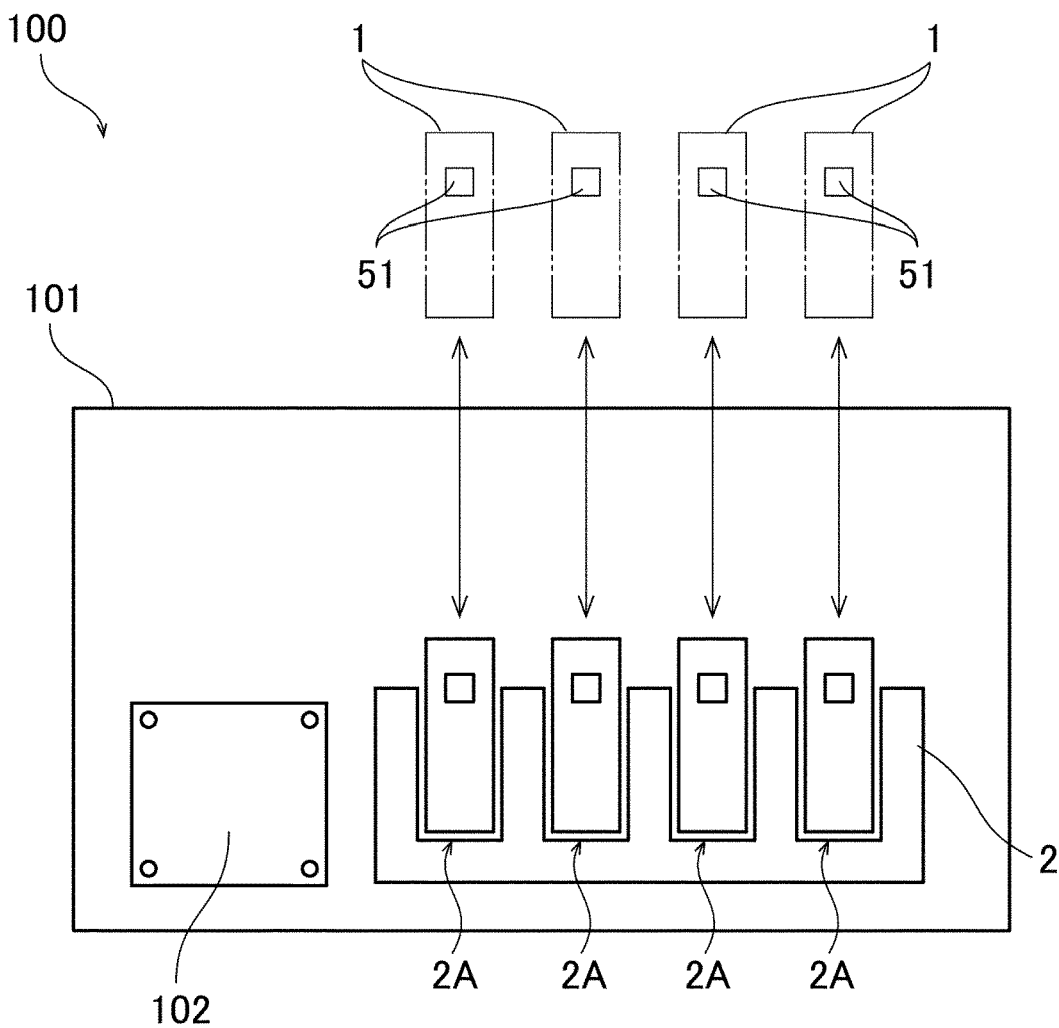
The cartridge developing cartridge according to claim 69, wherein engagement between the cam surface and the frame moves the developing roller away from the photosensitive drum.

[Claim 71]

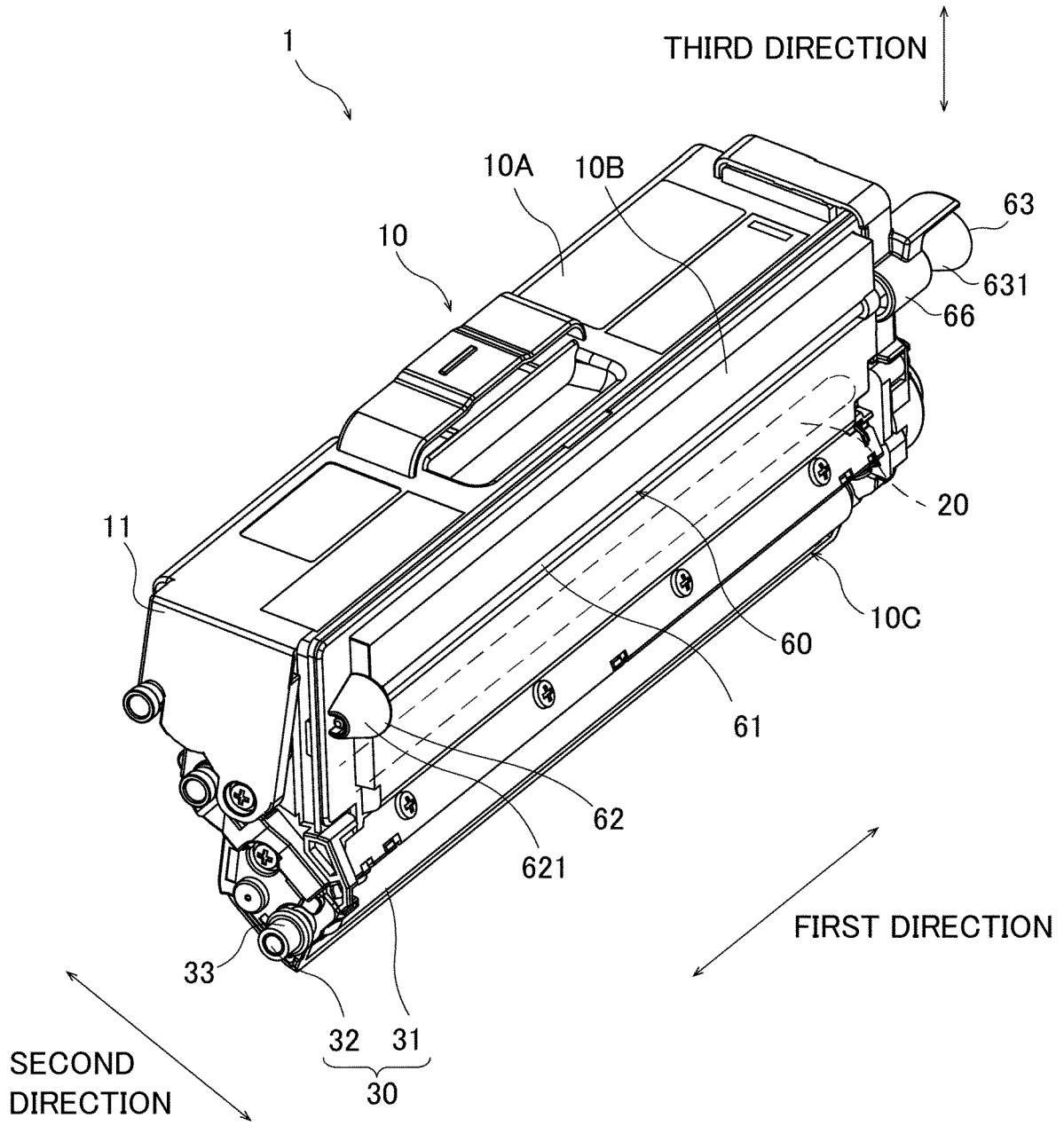
A cartridge assembly comprising:
the drum cartridge according to any one of claims 56 through 70; and
the developing cartridge according to any one of claims 56 through 70.

2024203675 31 May 2024

[Fig. 1]

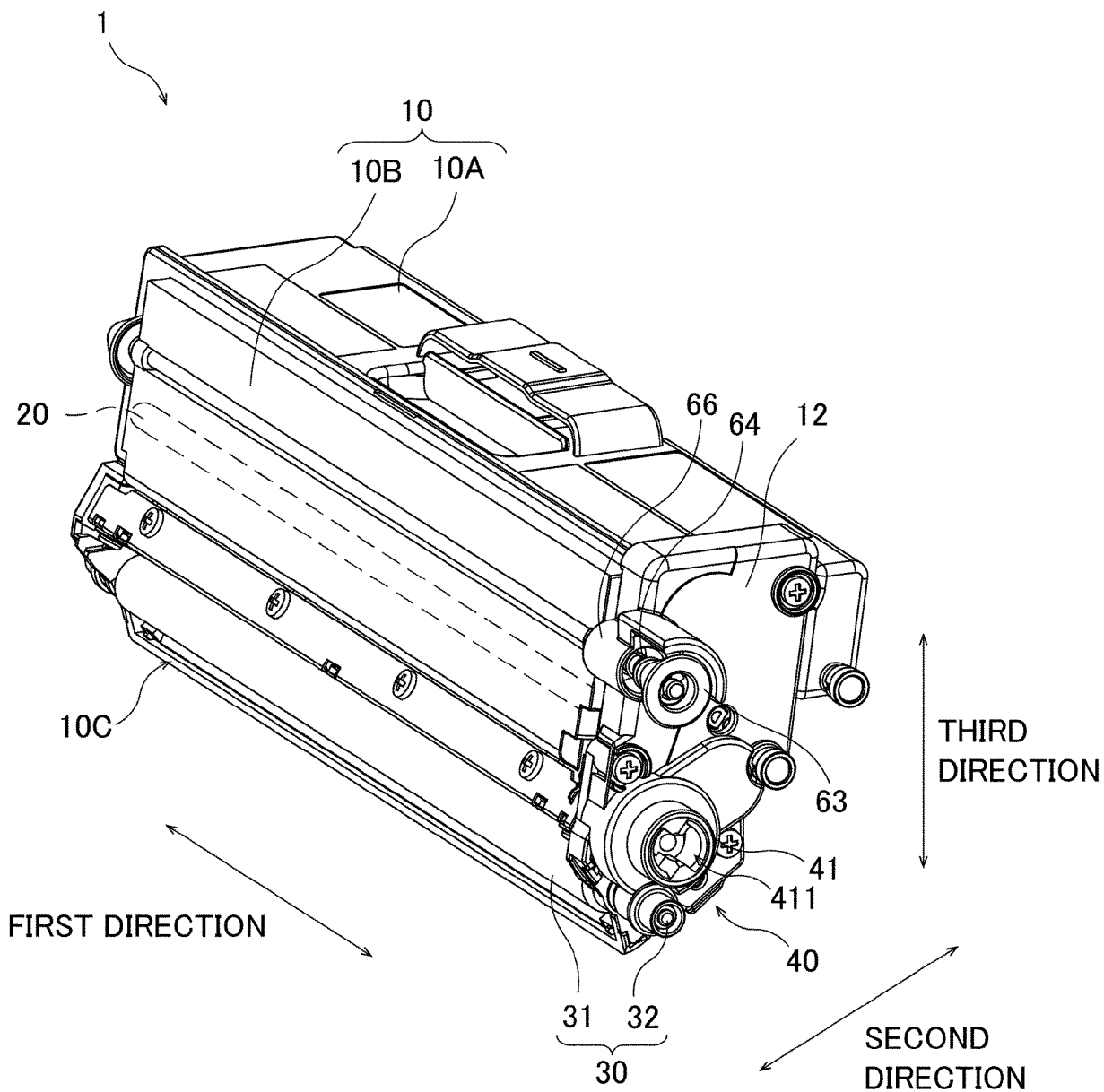


[Fig. 2]



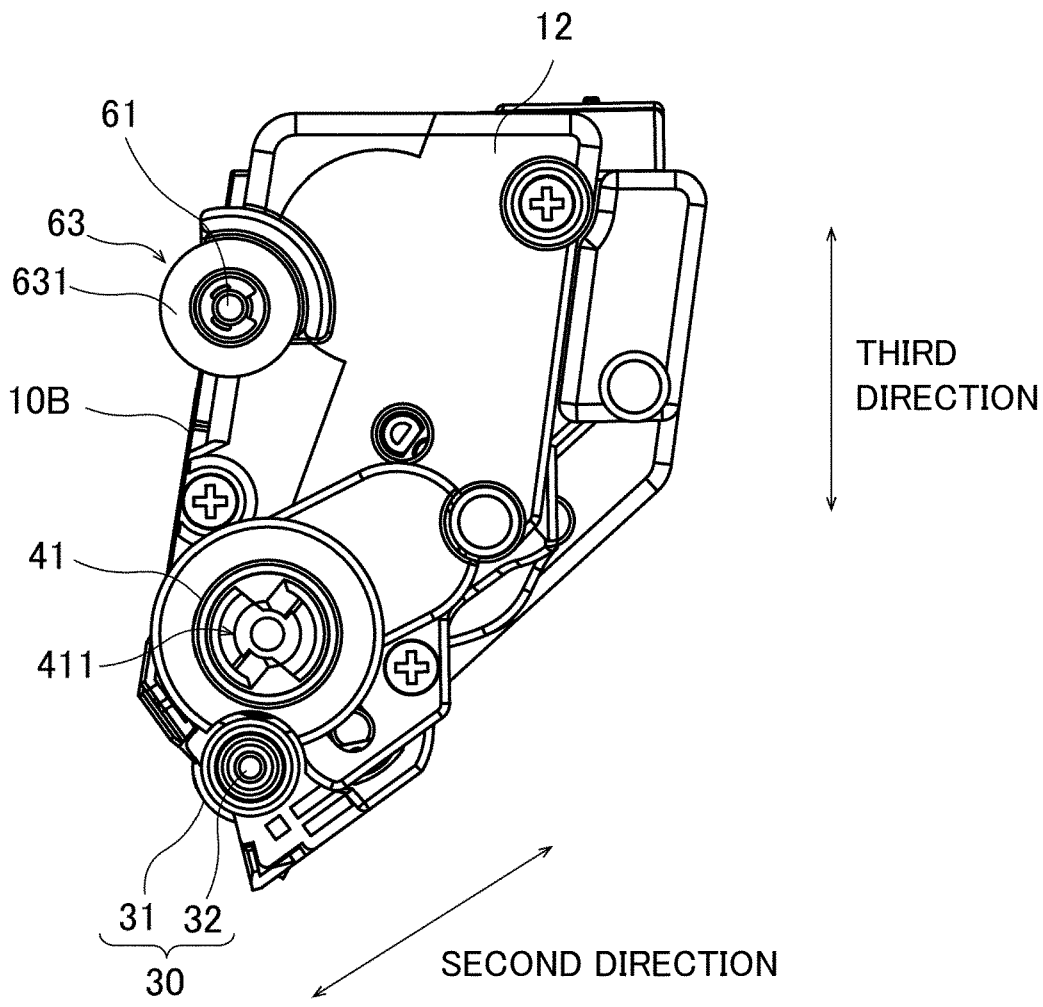
2024203675 31 May 2024

[Fig. 3]



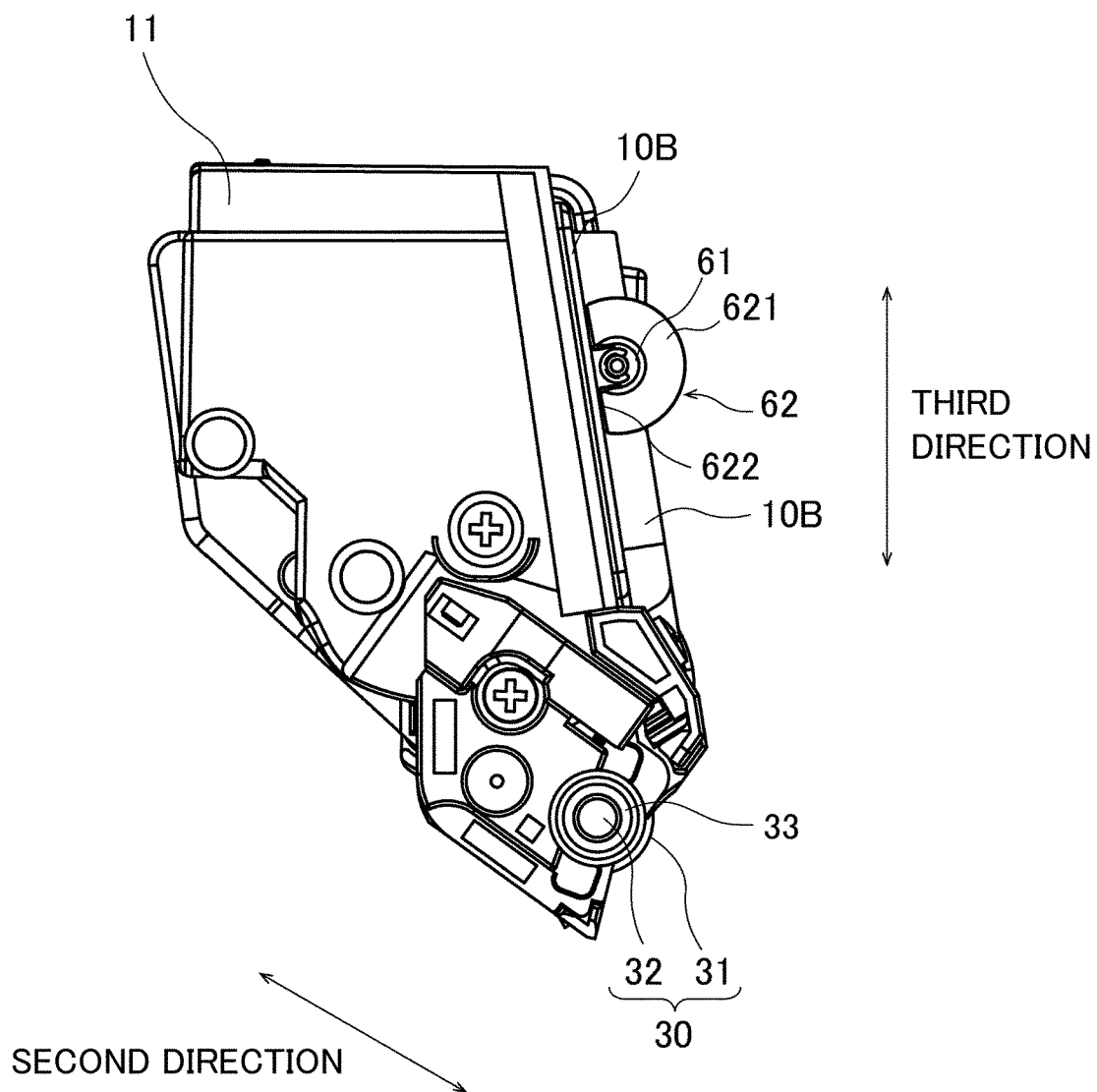
2024203675 31 May 2024

[Fig. 4]

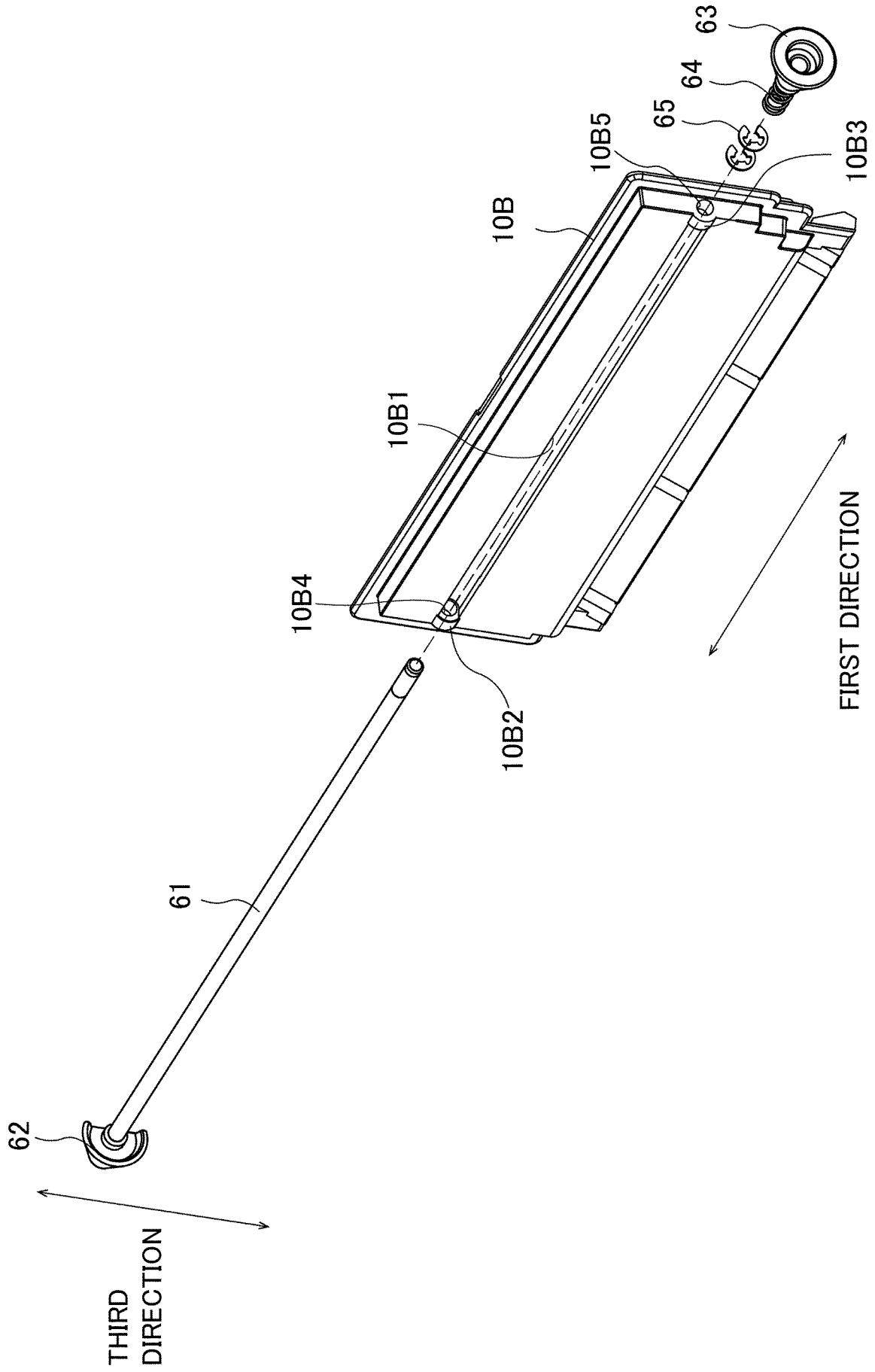


2024203675 31 May 2024

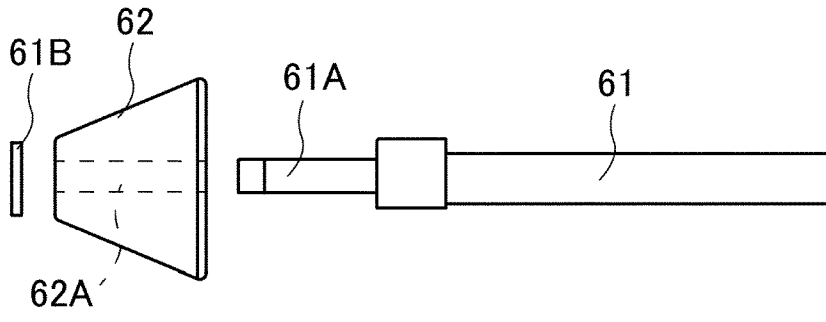
[Fig. 5]



[Fig. 6]

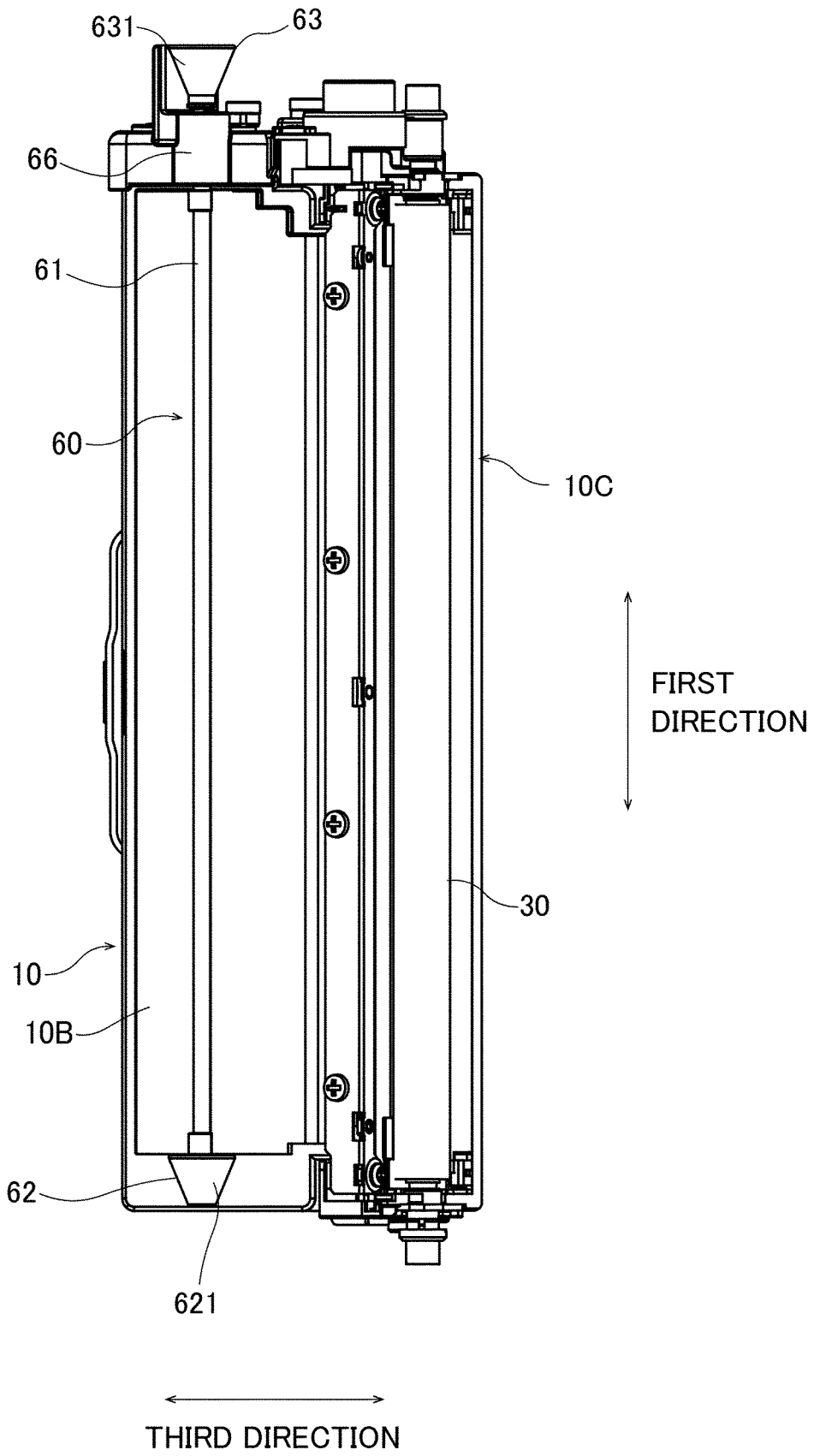


[Fig. 7]



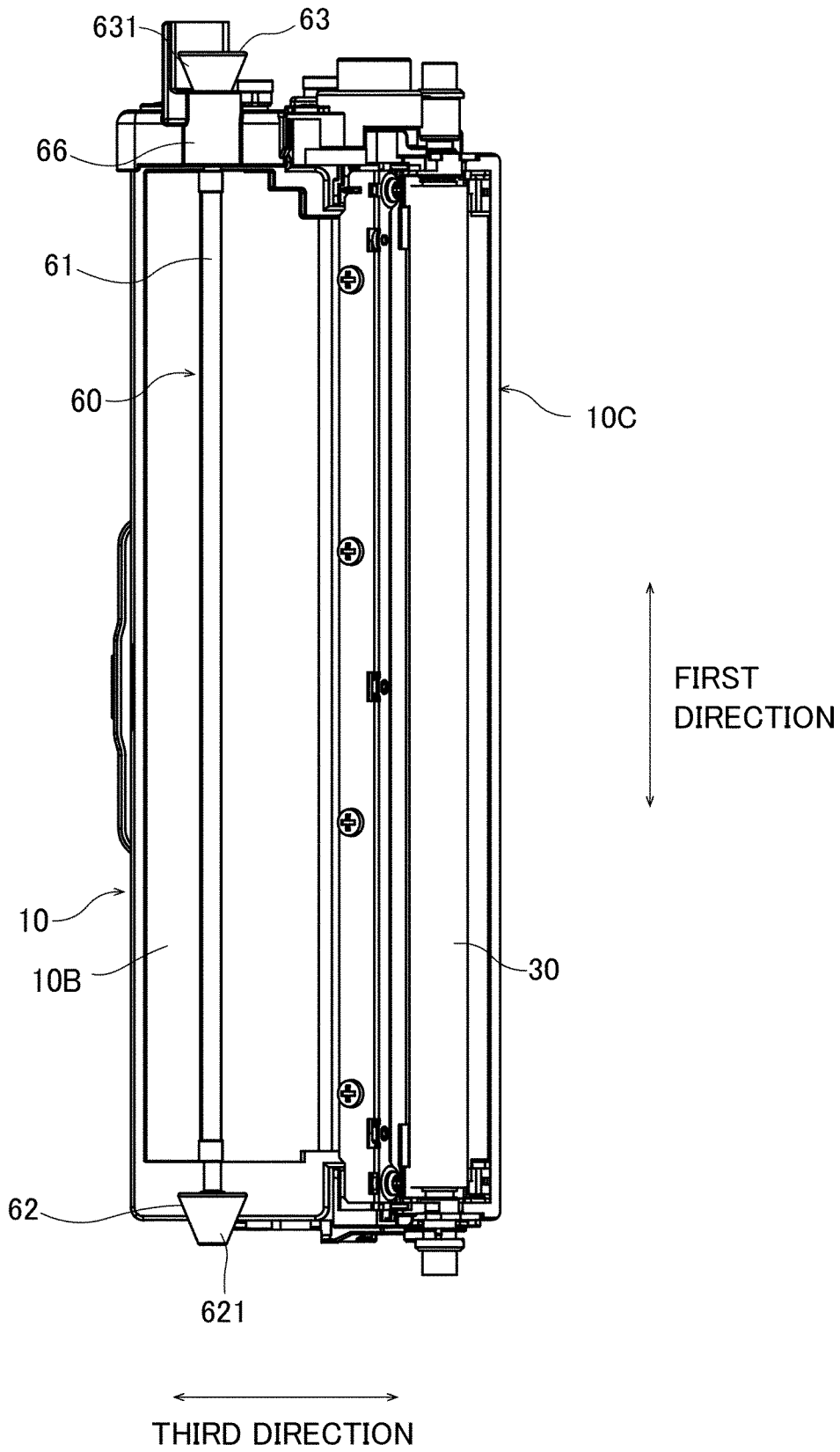
2024203675 31 May 2024

[Fig. 8]

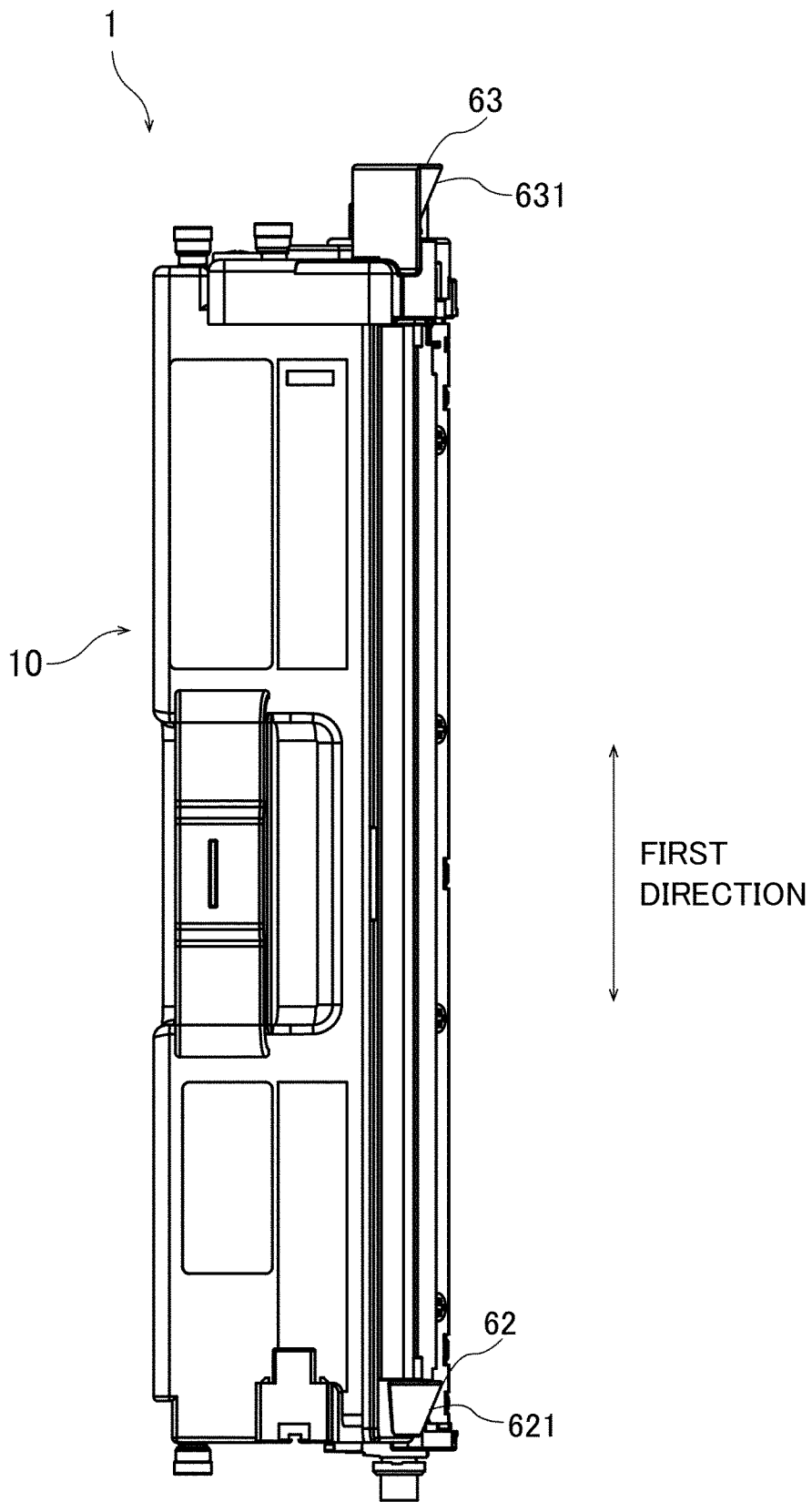


2024203675 31 May 2024

[Fig. 9]

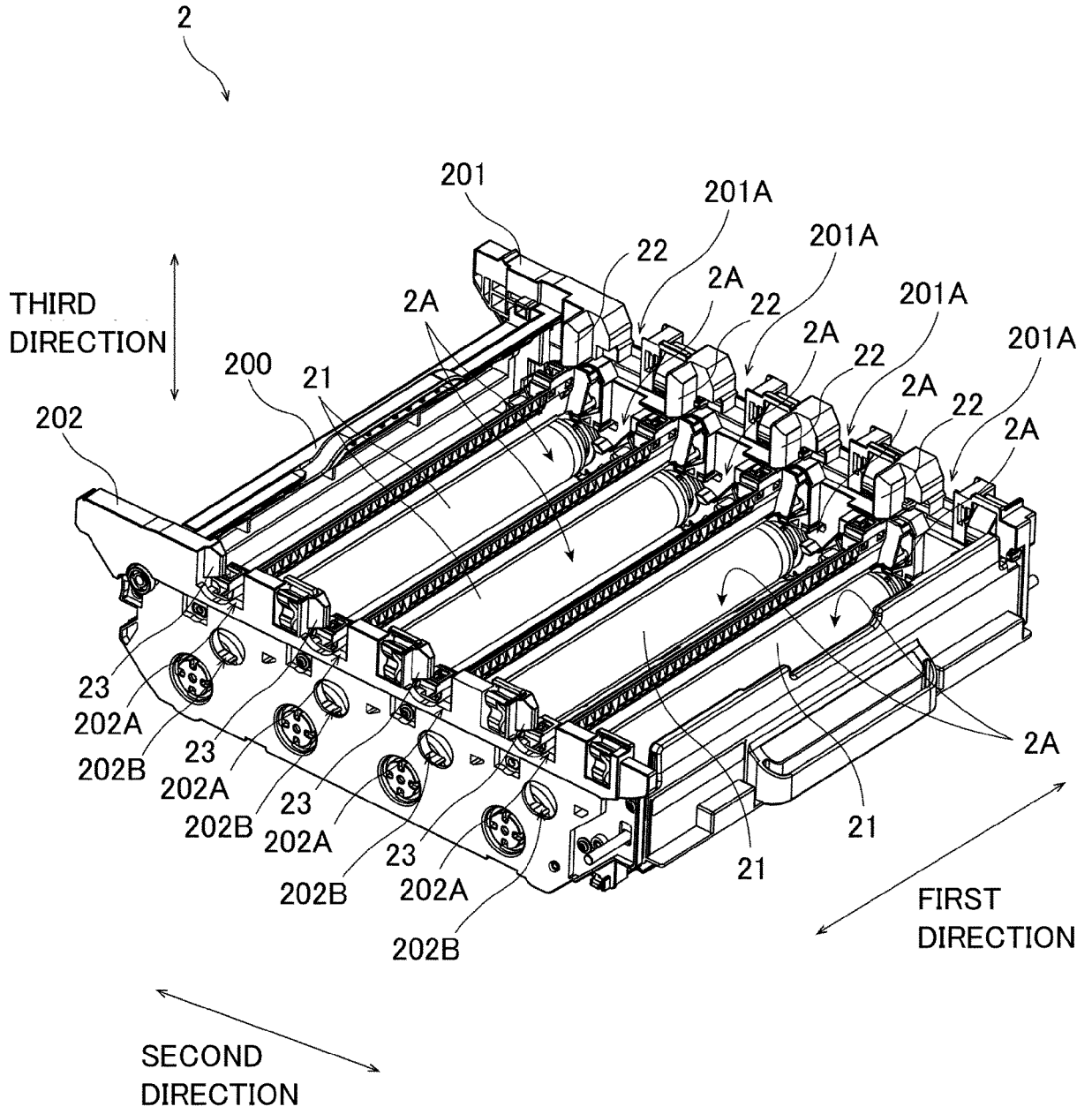


[Fig. 10]



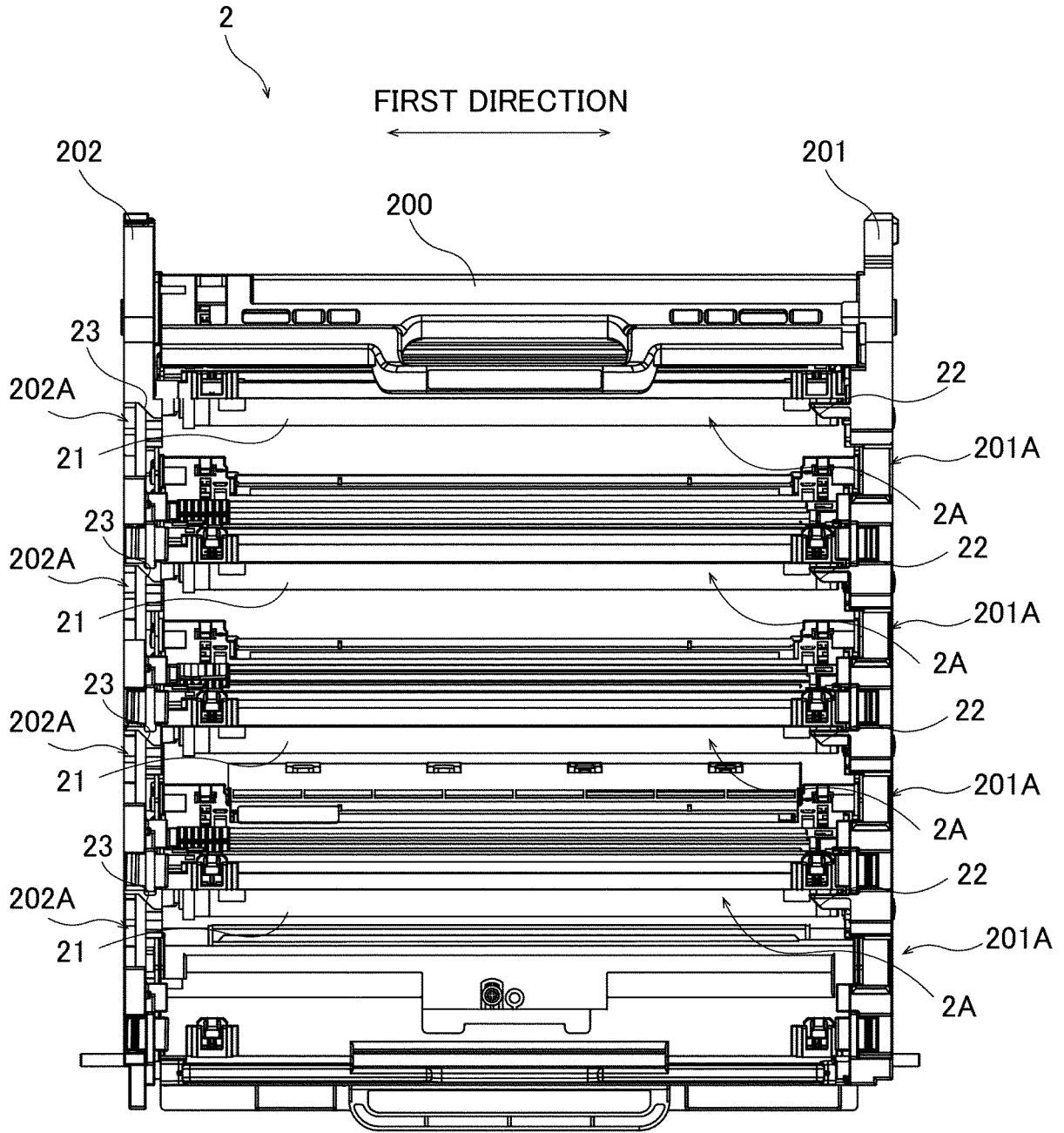
2024203675 31 May 2024

[Fig. 11]



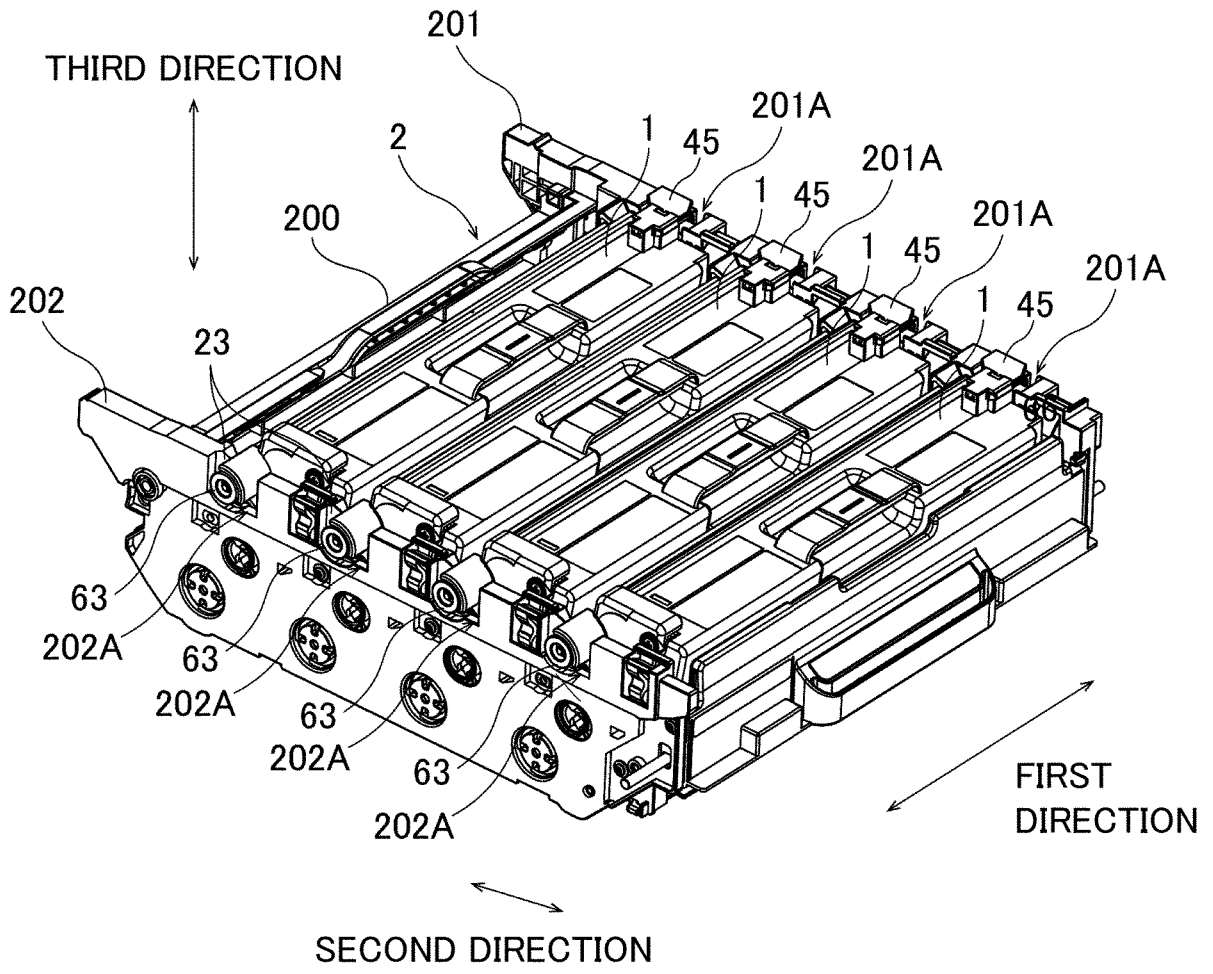
2024203675 31 May 2024

[Fig. 12]



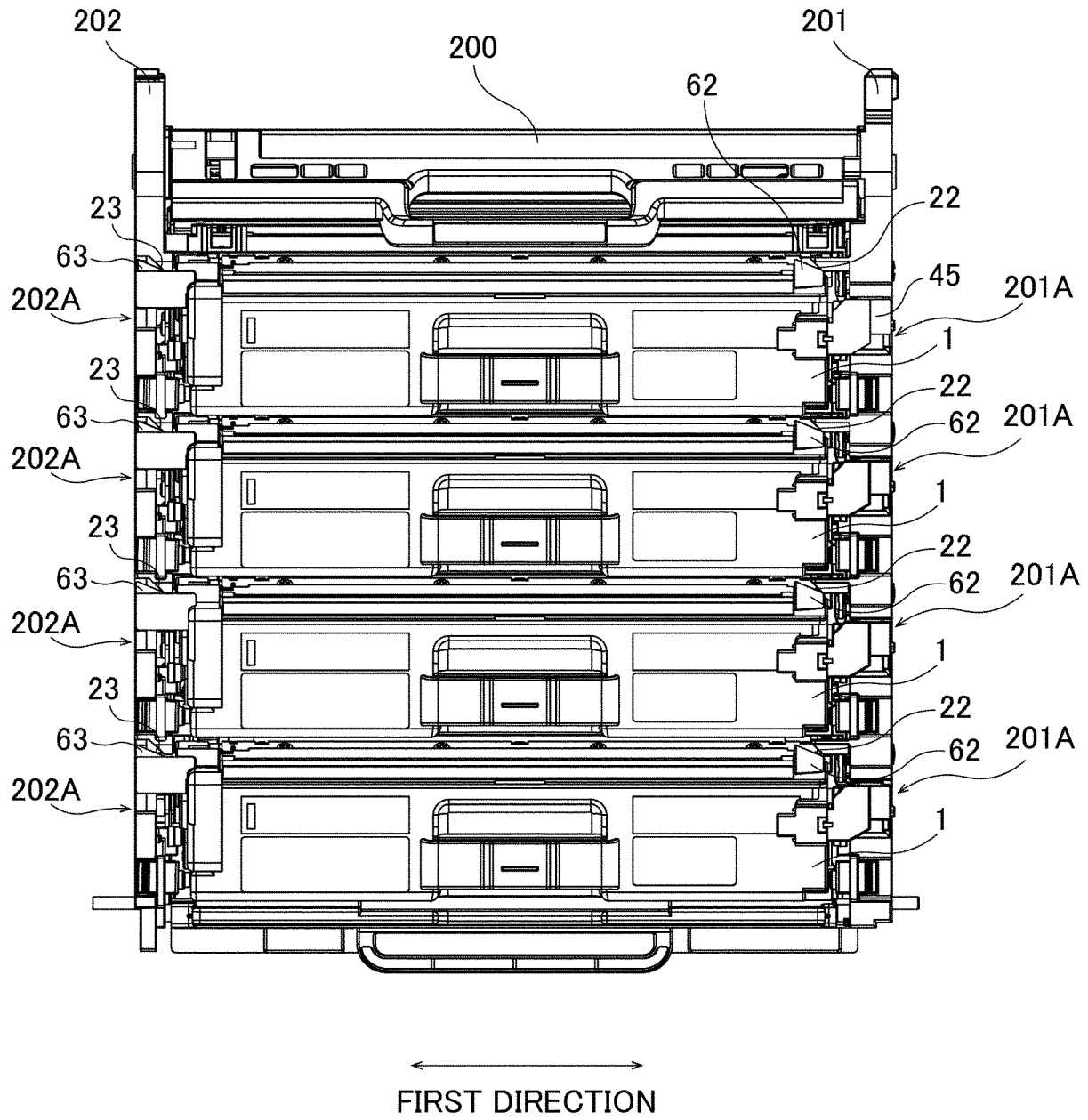
2024203675 31 May 2024

[Fig. 13]



2024203675 31 May 2024

[Fig. 14]



2024203675 31 May 2024

[Fig. 15]

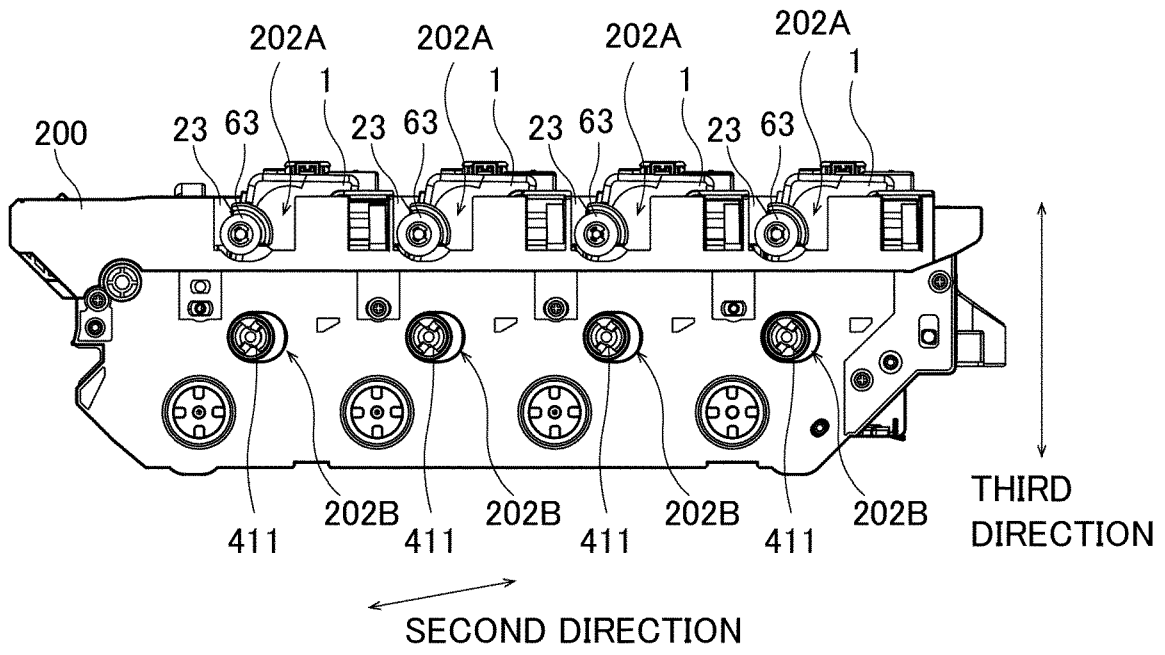


FIG. 16A

[Fig. 16]

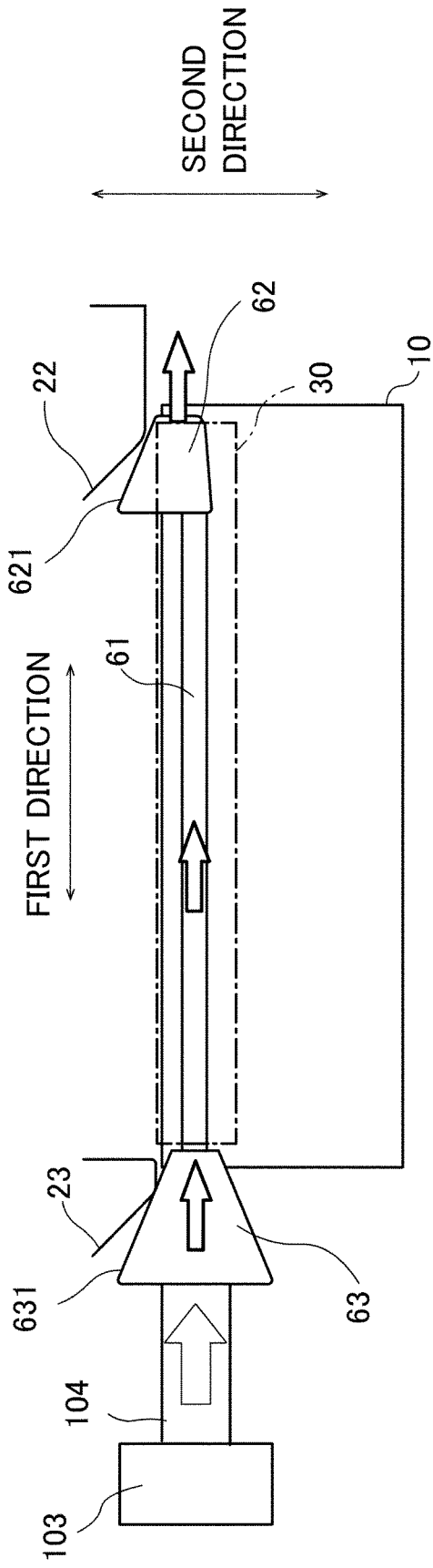
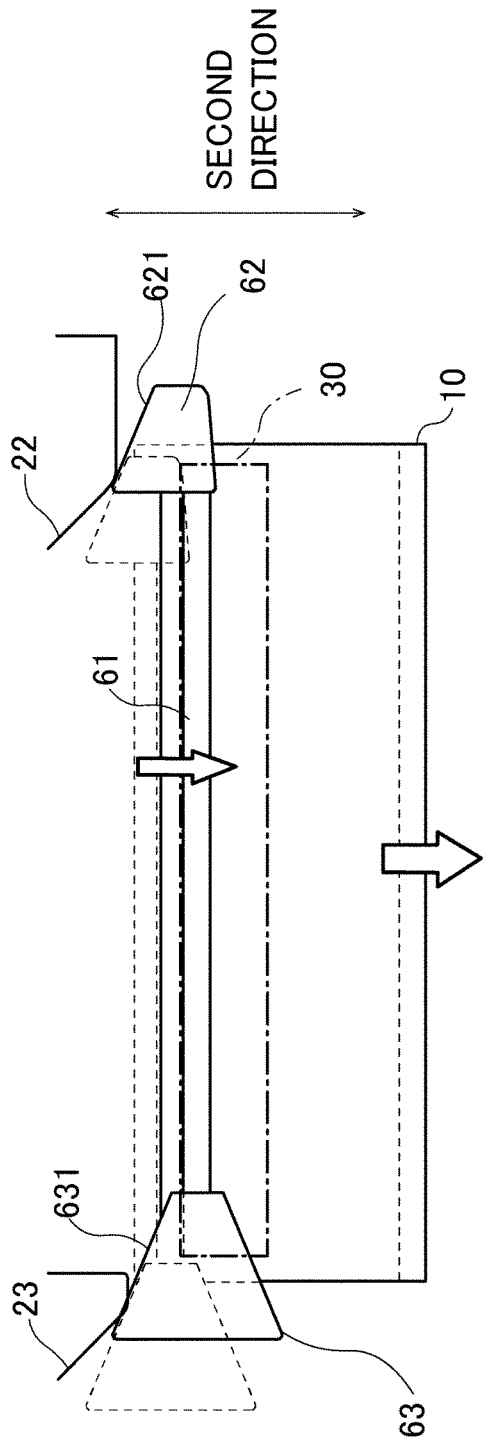
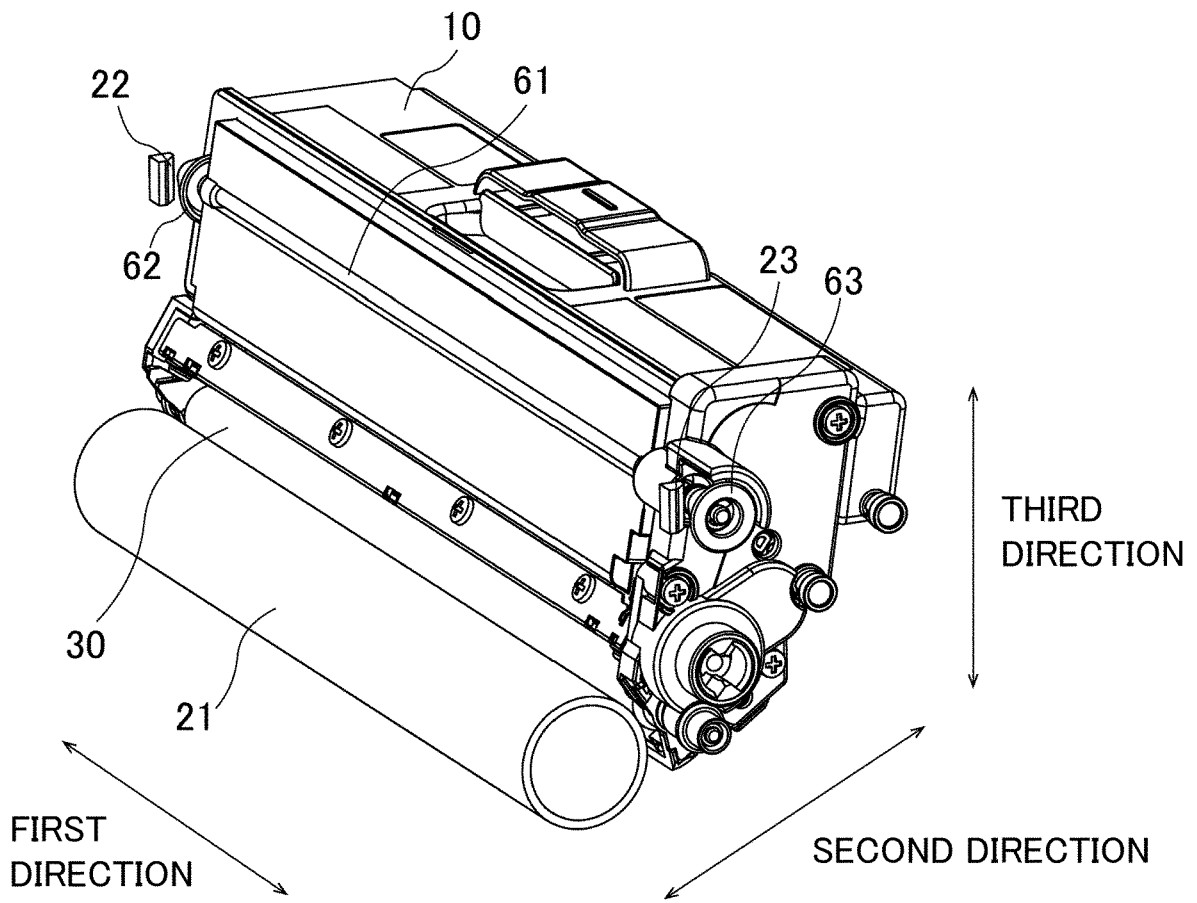


FIG. 16B



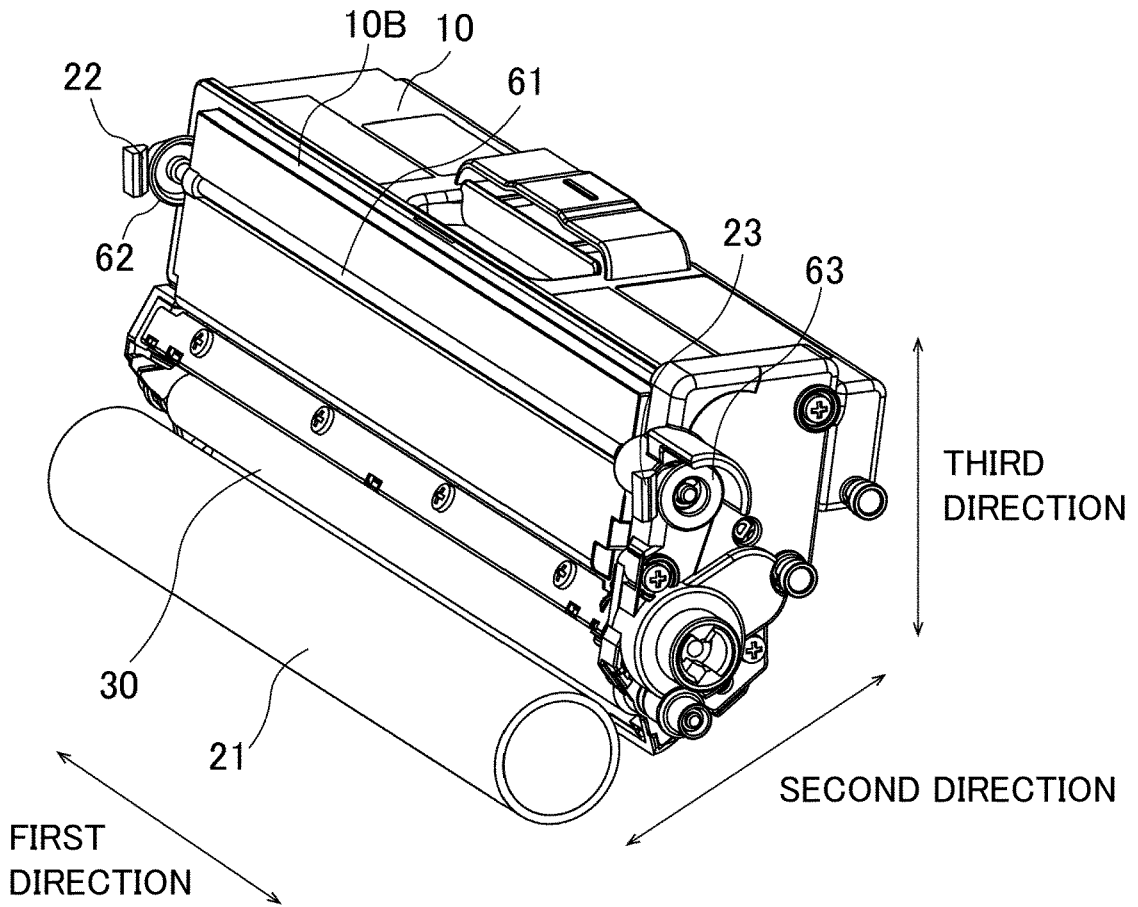
2024203675 31 May 2024

[Fig. 17]



2024203675 31 May 2024

[Fig. 18]



[Fig. 19]

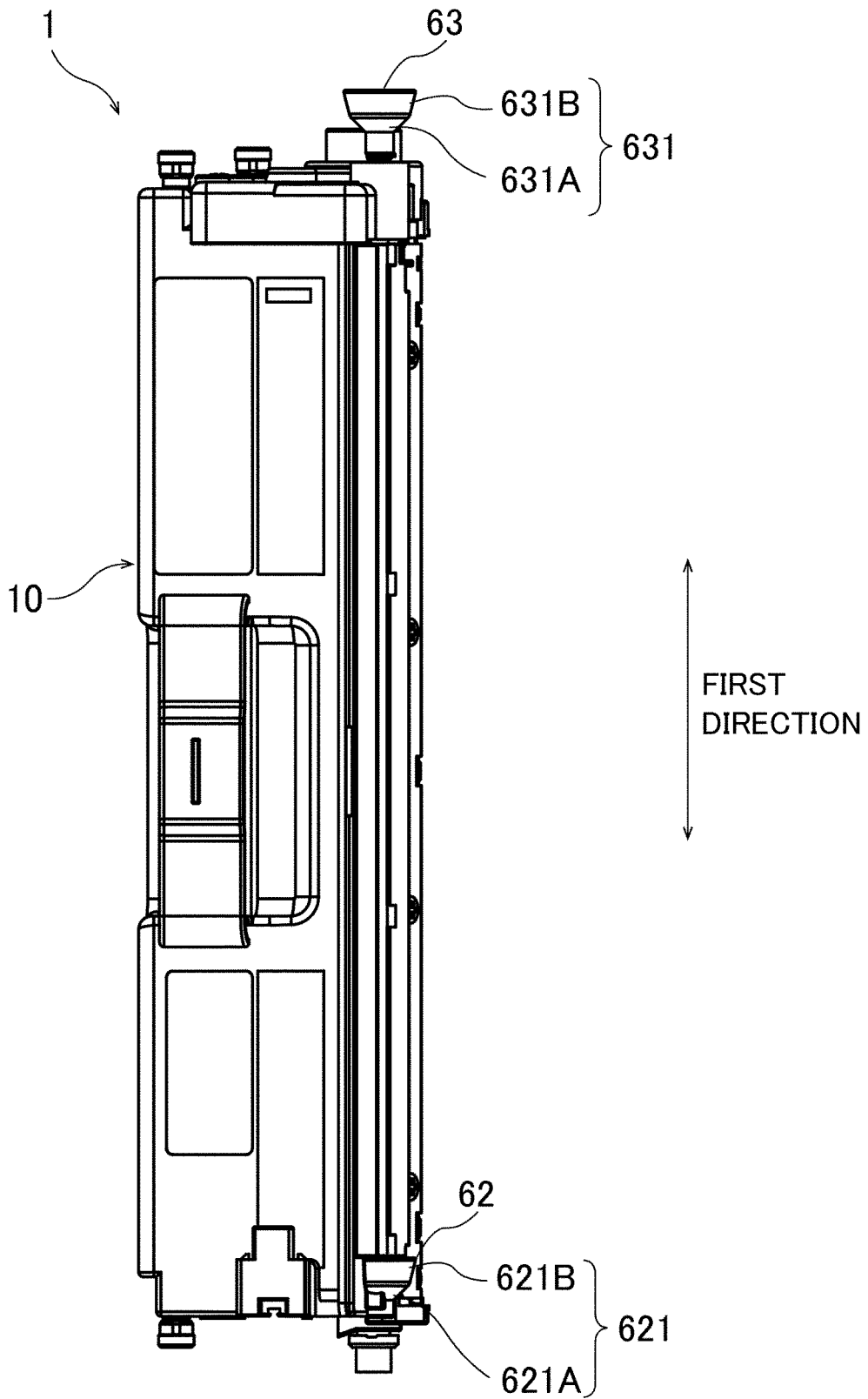


FIG. 20A

[Fig. 20]

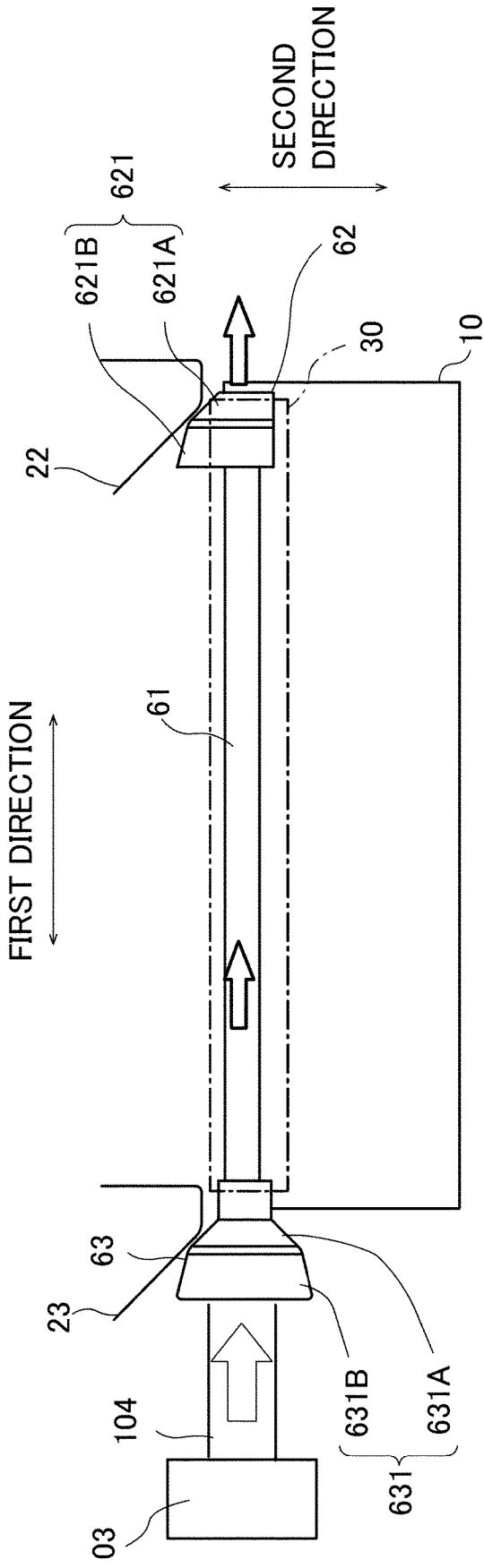


FIG. 20B

