US012393160B2

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Furukawa

(10) **Patent No.: US 12,393,160 B2**
(45) **Date of Patent: Aug. 19, 2025**

(54) **IMAGE FORMING APPARATUS**

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(73) Assignee: **Canon Kabushiki Kaisha**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **18/666,772**

(22) Filed: **May 16, 2024**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

May 23, 2023 (JP) 2023-084481

(51) **Int. Cl.**
G03G 15/00 (2006.01)
G03G 21/16 (2006.01)
G03G 21/18 (2006.01)

(52) **U.S. Cl.**
CPC ***G03G 21/1871*** (2013.01); ***G03G 21/1652*** (2013.01); ***G03G 21/1814*** (2013.01); ***G03G 21/1842*** (2013.01)

(58) **Field of Classification Search**
CPC G03G 21/1652; G03G 21/1814; G03G 21/1842; G03G 21/1871
USPC 399/75, 88, 89, 111
See application file for complete search history.

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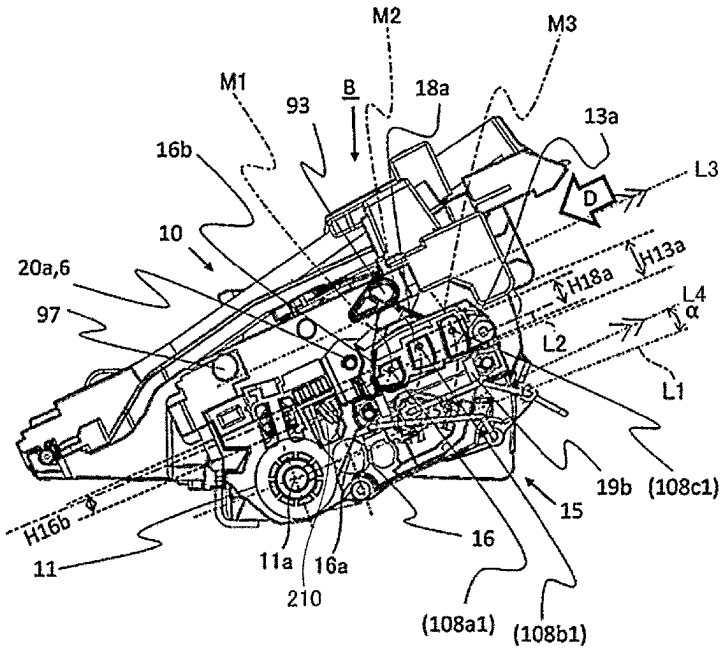
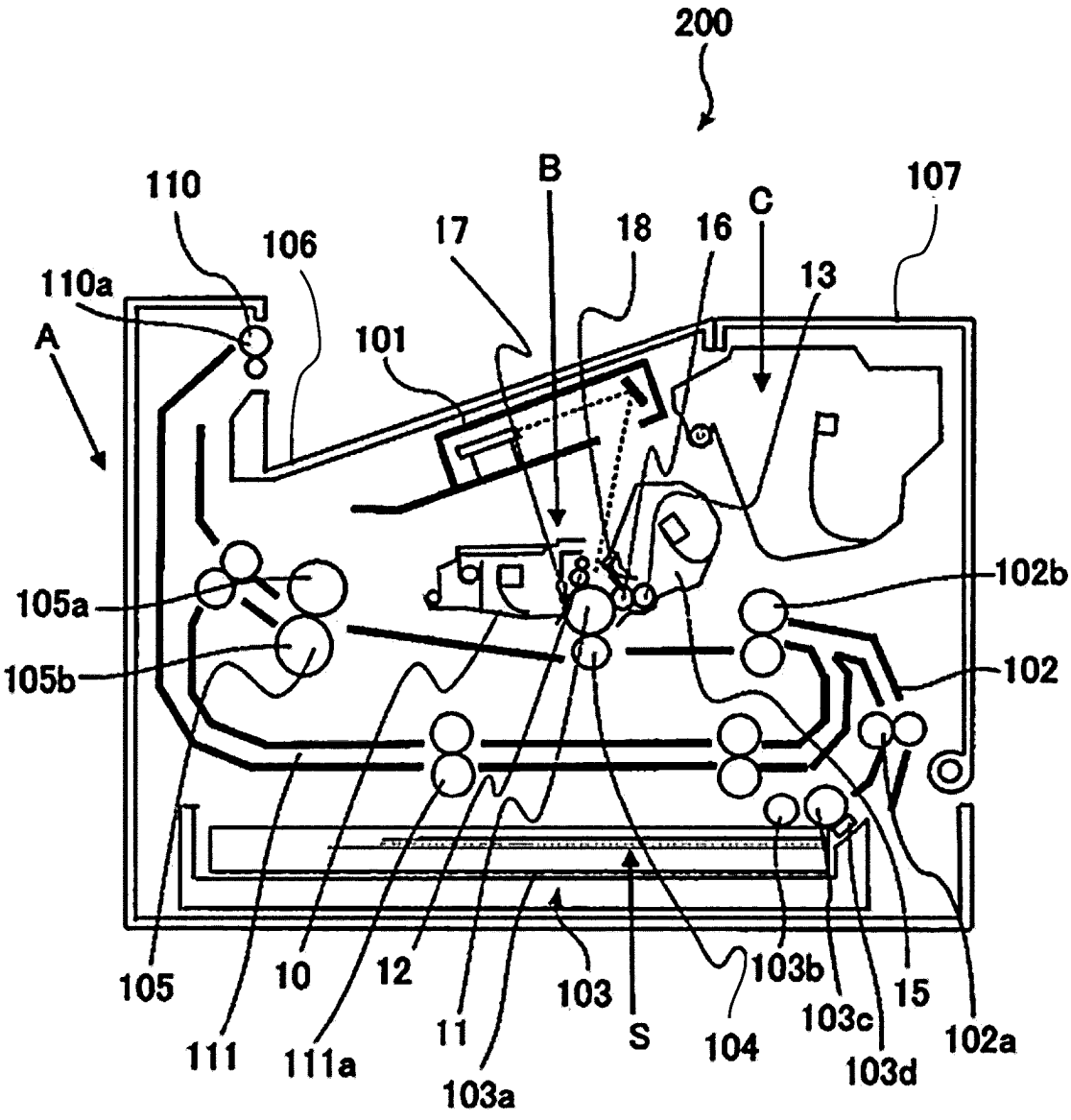
Primary Examiner — Hoan H Tran
(74) *Attorney, Agent, or Firm* — Venable LLP

(57) **ABSTRACT**

An image forming apparatus includes a unit including an electrical contact surface, and a main assembly which includes a contact member including first to fourth portions, and a contact portion, and a supporting member. A mounting and dismounting direction of the unit is a first direction. A direction crossing the first direction is a third direction. The supporting member includes an opposite wall opposing a side surface of the unit and being provided with an opening. The contact portion projects in the third direction through the opening toward an electrical contact surface side with respect to the opposite wall in the third direction. The contact member is provided so that the third and fourth portions are present on a side opposite from the electrical contact surface side with respect to the opposite wall. The fourth portion extends toward the third direction as viewed in the first direction.

17 Claims, 31 Drawing Sheets




200
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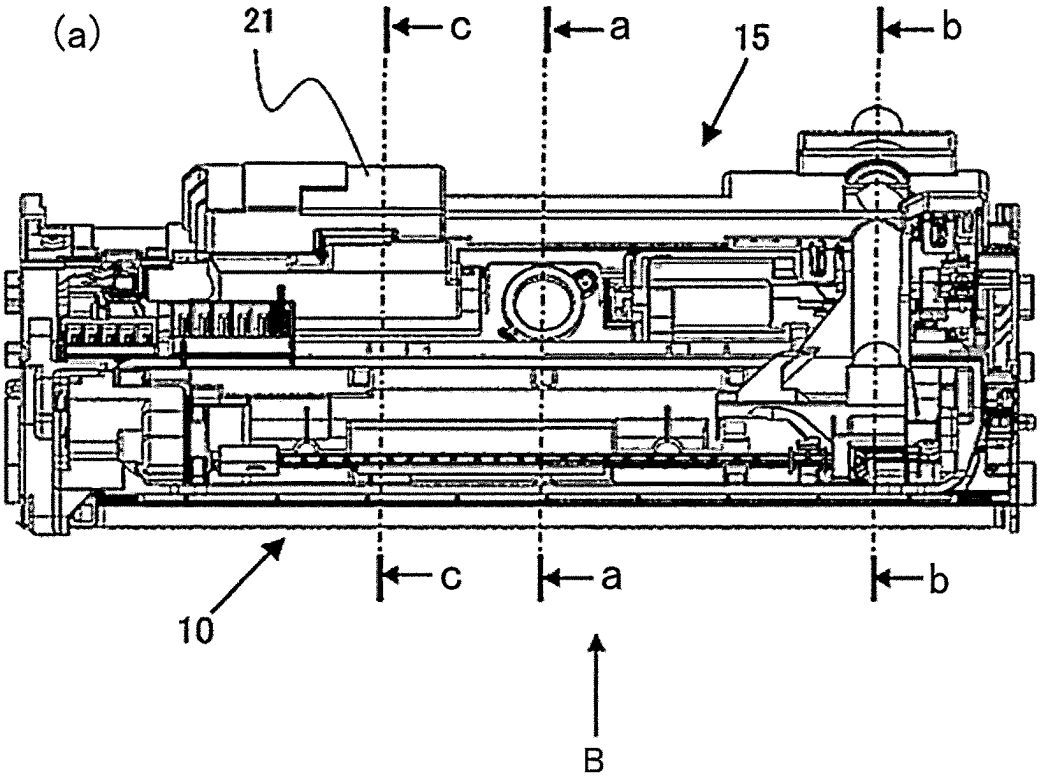
B
107
106
17
18
16
C
110a
13
A
101
105a
102b
105b
102
105
10
12
103
103b
15
111
111a
11
S
104
103c
102a
103a
103d

FIG. 1



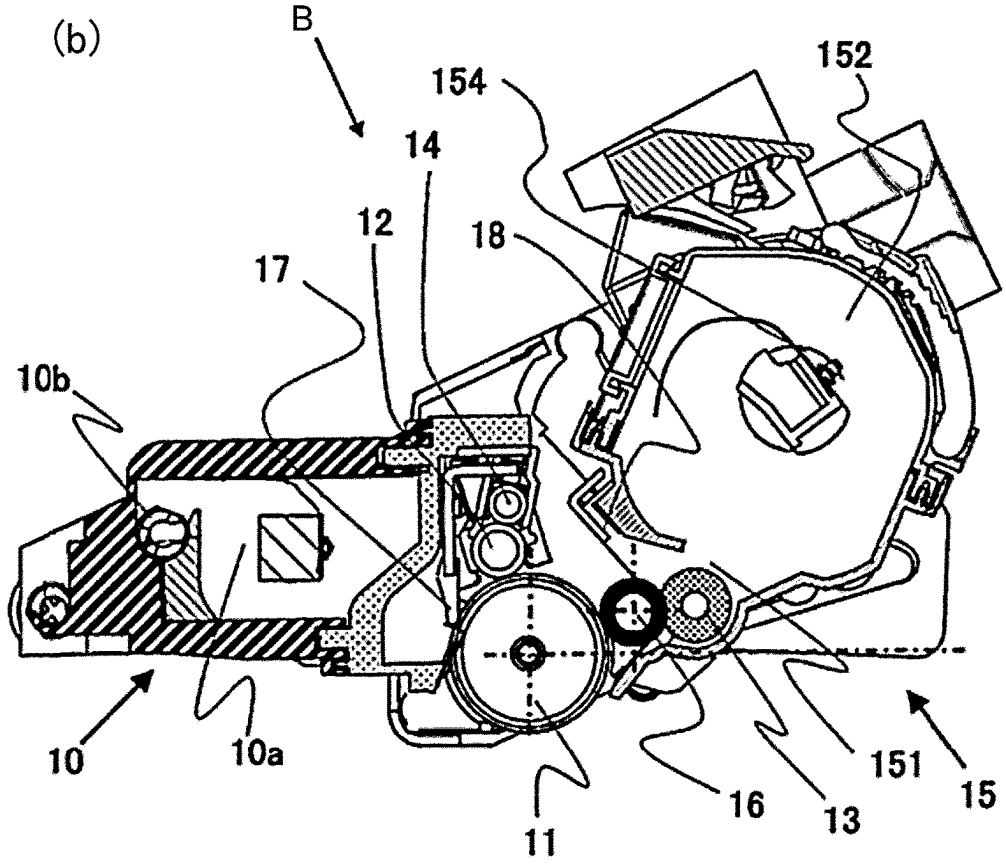


FIG. 2

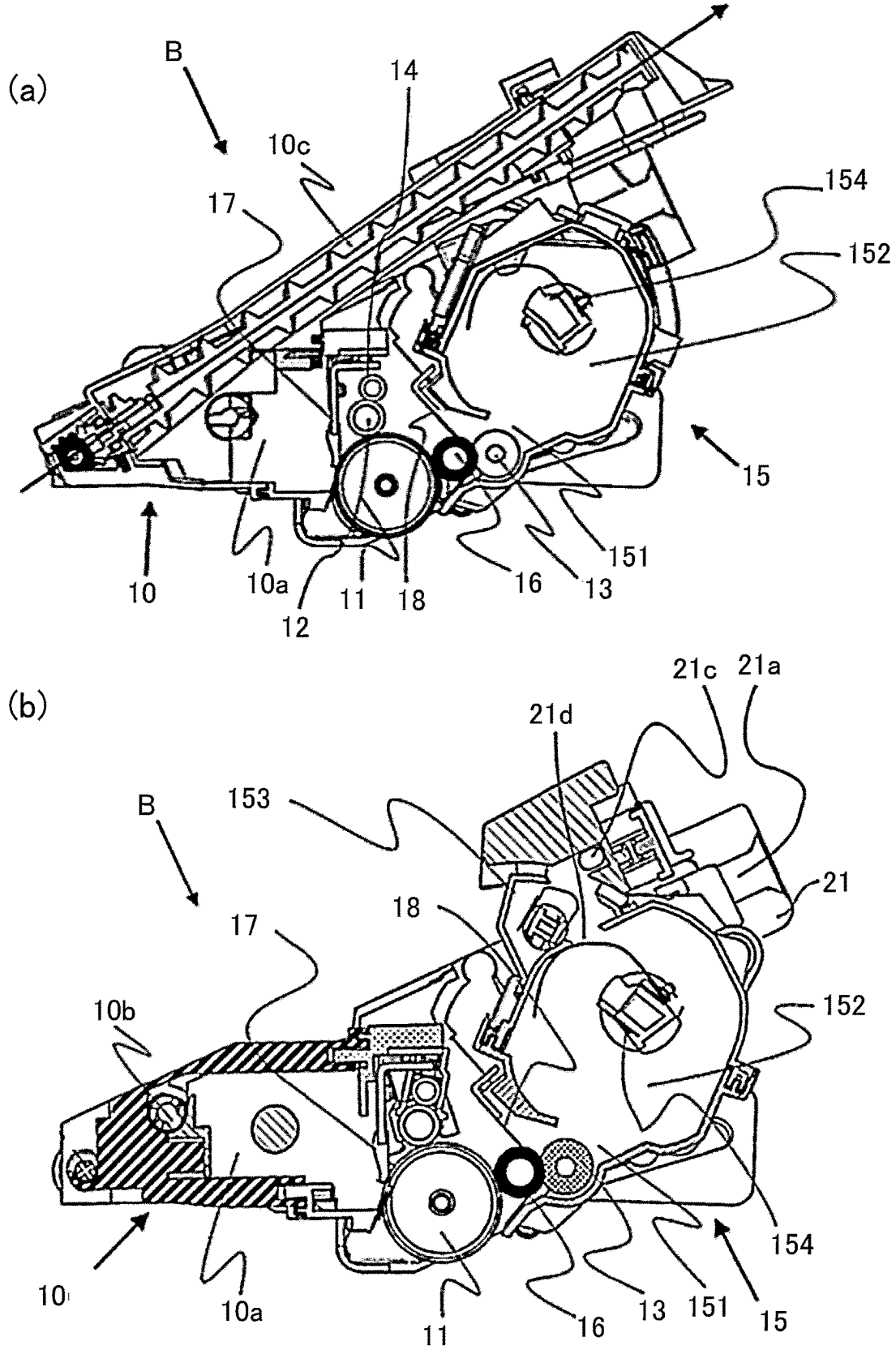

(a)
B
14
10c
17
154
152
15
151
10
10a
12
11
18
16
13
(b)
21c
21a
21d
B
153
21
18
17
10b
152
154
10
10a
11
16
13
151
15

FIG. 3

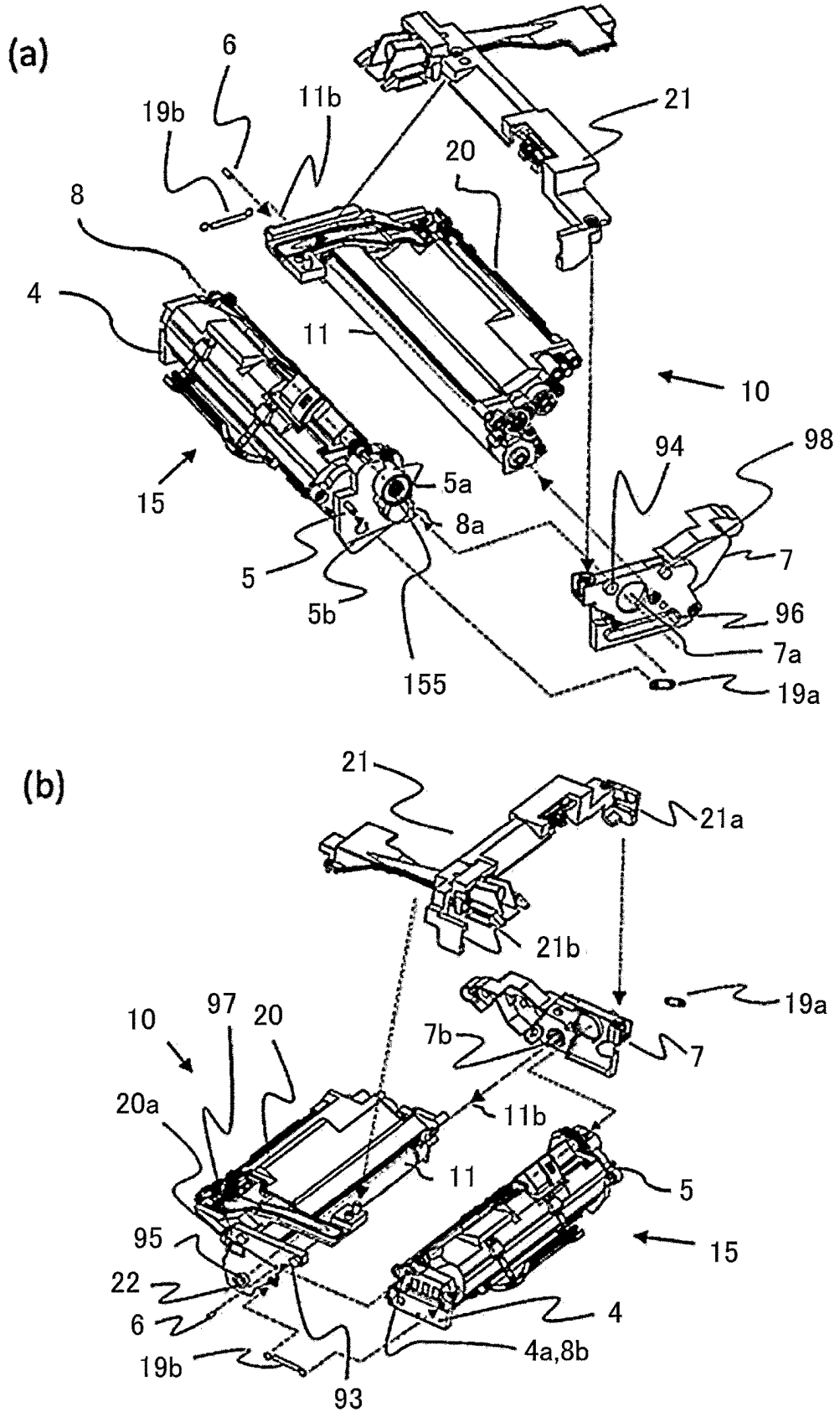

(a)
6
19b
11b
21
20
8
4
11
10
94
98
15
5a
8a
7
5
96
5b
7a
155
19a
(b)
21
21a
21b
19a
10
97
20
7b
7
20a
11b
11
5
95
15
22
6
4
19b
4a,8b
93

FIG. 4

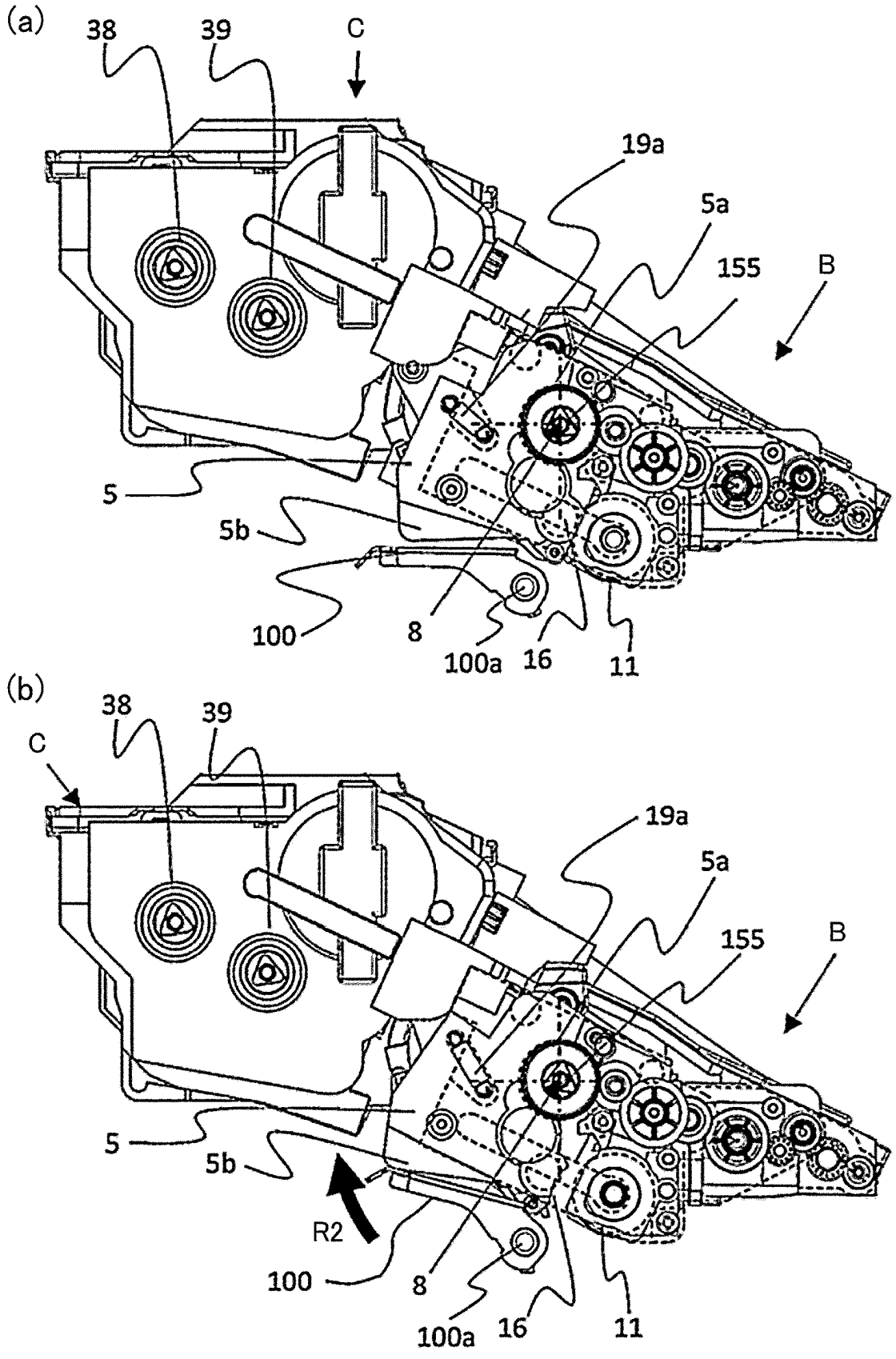

(a)
38
39
C
19a
5a
155
B
5
5b
100
8
100a
16
11
(b)
38
39
C
19a
5a
155
B
5
5b
R2
100
8
100a
16
11

FIG. 5

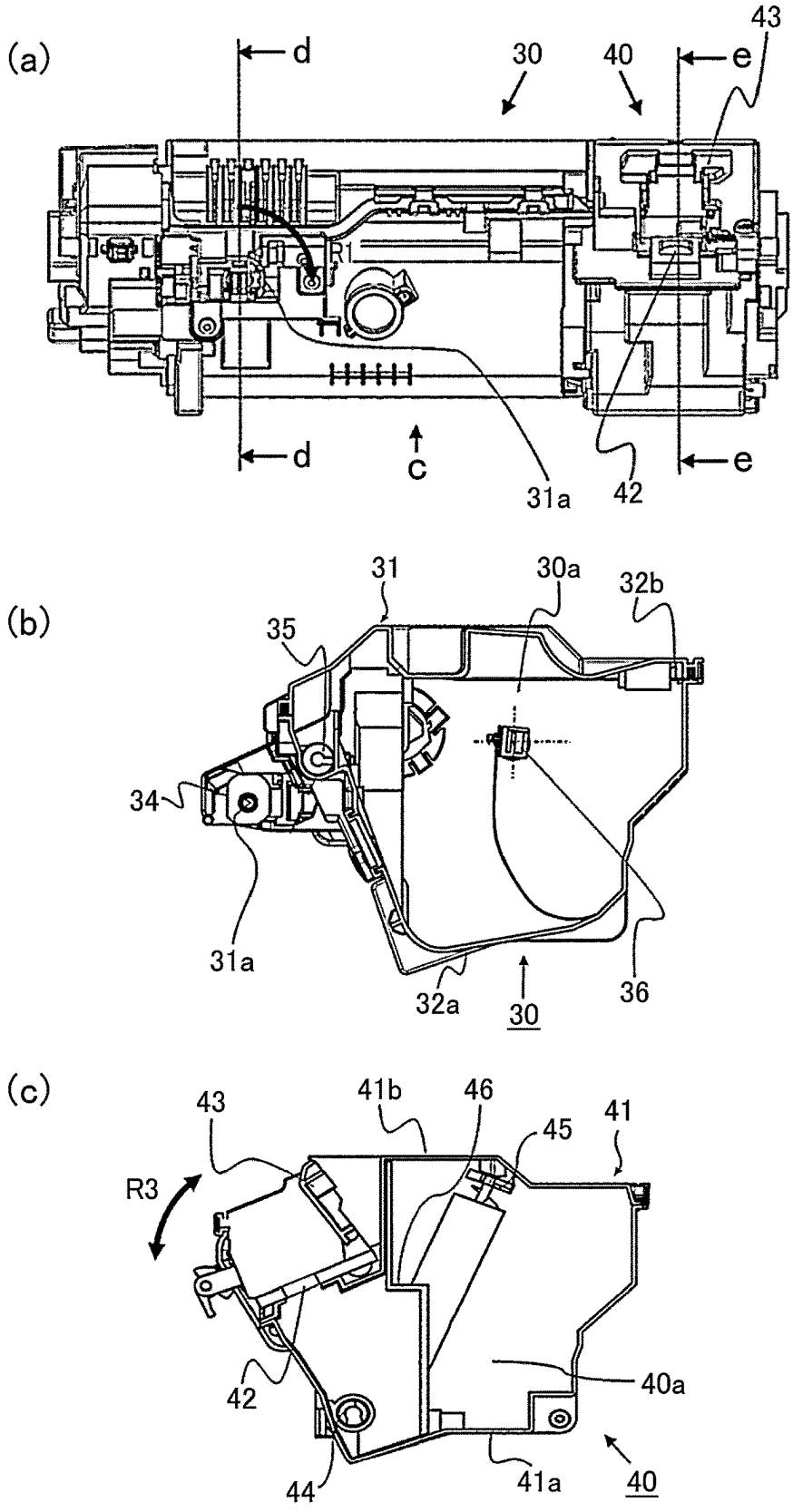

(a)
d
30
40
e
43
R1
d
c
31a
42
e
(b)
31
30a
32b
35
34
31a
32a
30
36
(c)
43
41b
46
45
41
R3
42
40a
44
41a
40

FIG. 6

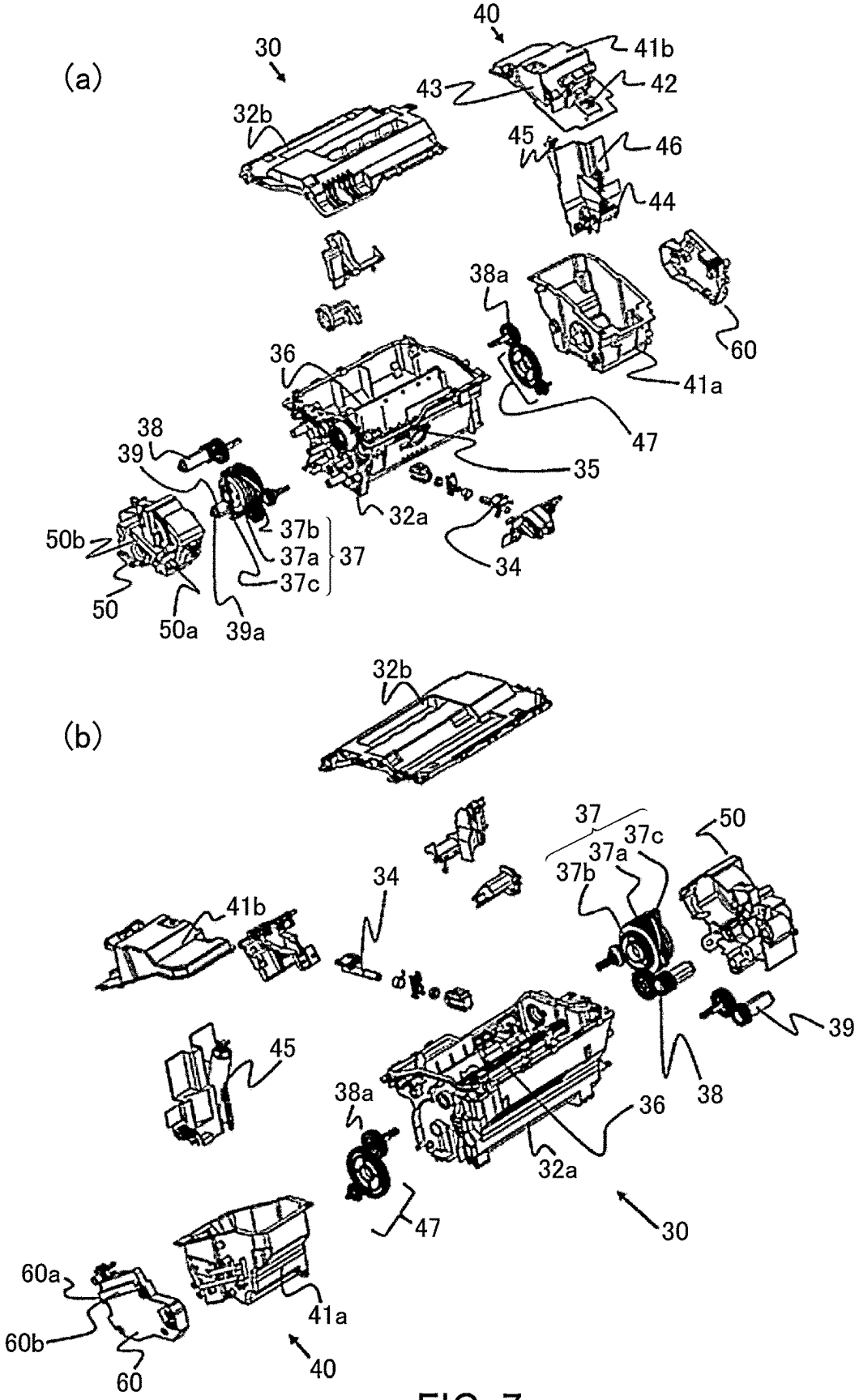

(a)
40
30
41b
43
42
32b
45
46
44
38a
60
36
41a
47
38
39
35
32a
37b
37a
37
37c
50b
34
50
50a
39a
(b)
32b
37
37c
50
37a
37b
34
41b
39
45
38a
36
38
32a
47
30
60a
60b
41a
60
40

FIG. 7

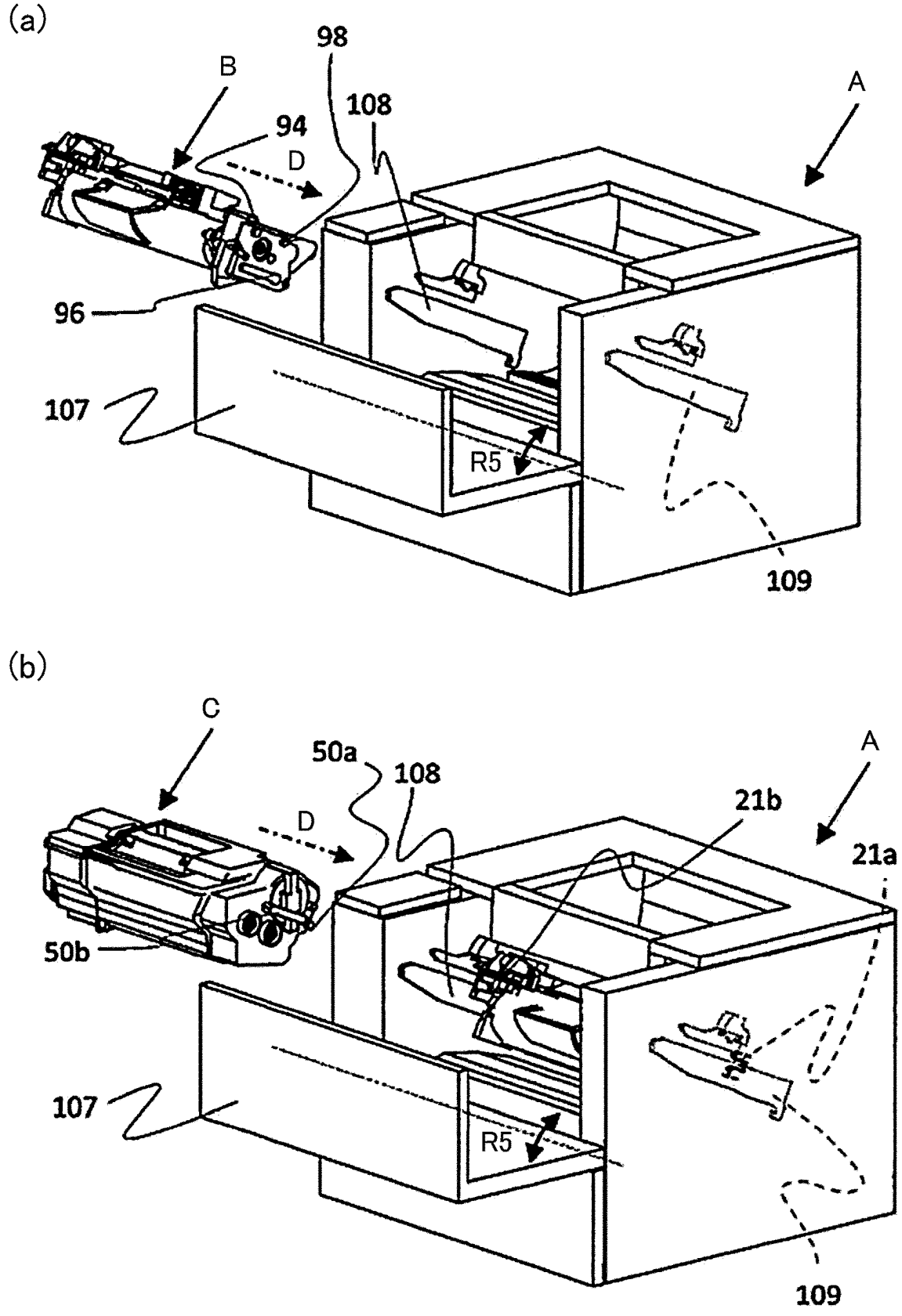


FIG. 8

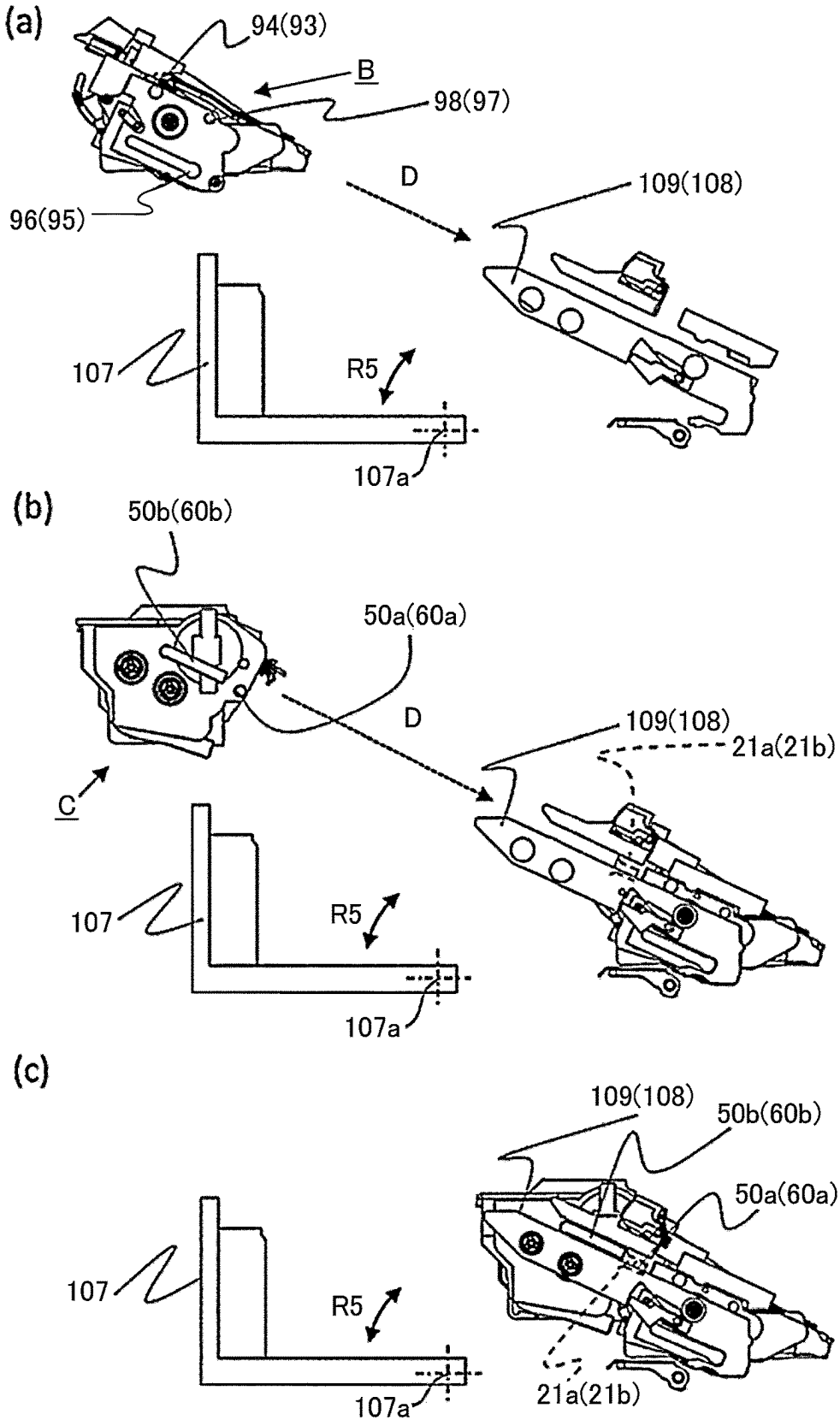

(a)
94(93)
B
98(97)
D
109(108)
96(95)
107
R5
107a
(b)
50b(60b)
50a(60a)
D
109(108)
21a(21b)
C
107
R5
107a
(c)
109(108)
50b(60b)
50a(60a)
107
R5
107a
21a(21b)

FIG. 9

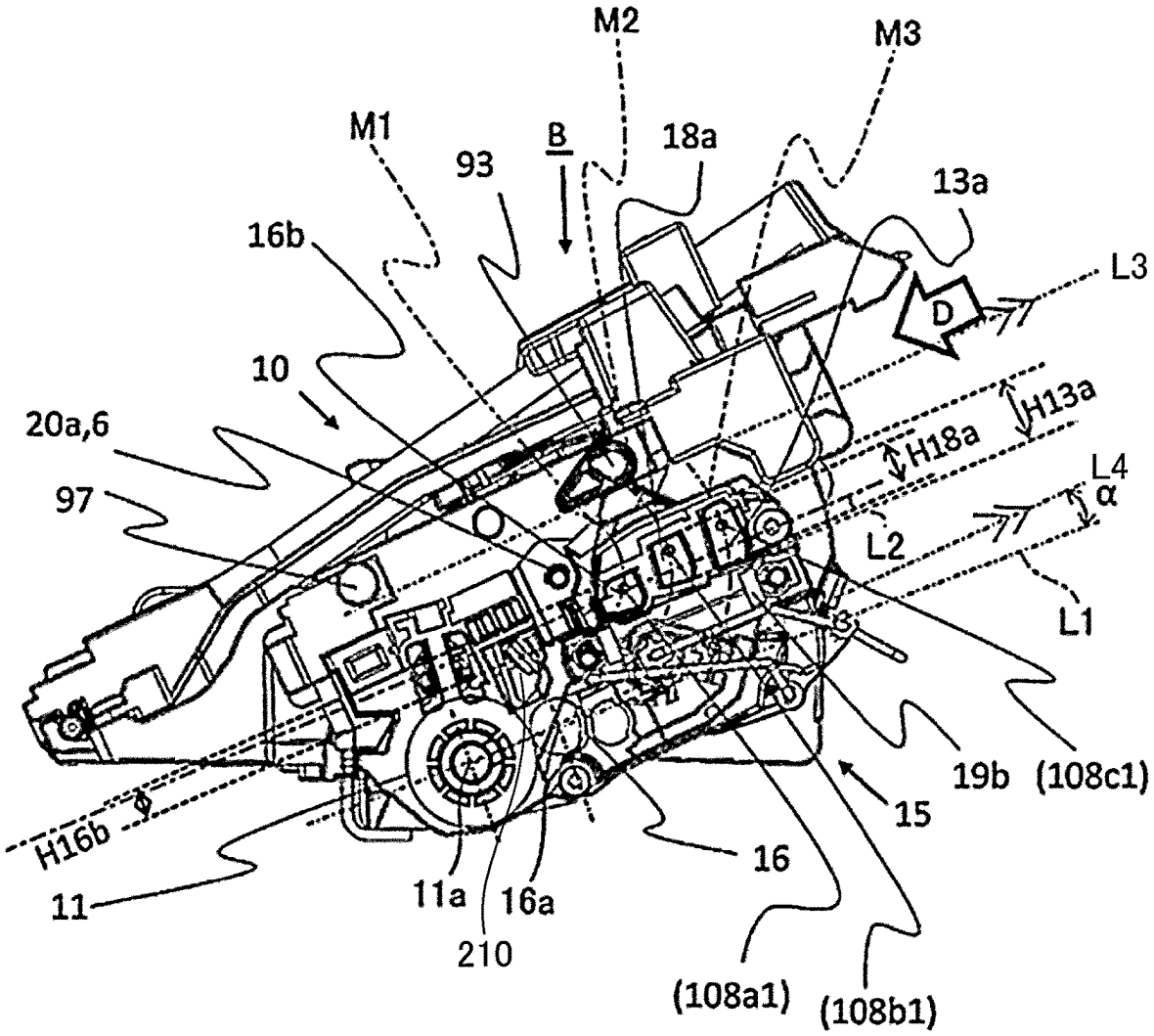

M2
M3
M1
B
18a
93
13a
16b
L3
D
10
20a,6
H13a
H18a
97
L4
α
L2
L1
19b
(108c1)
15
H16b
16
11
11a
16a
210
(108a1)
(108b1)

FIG. 10

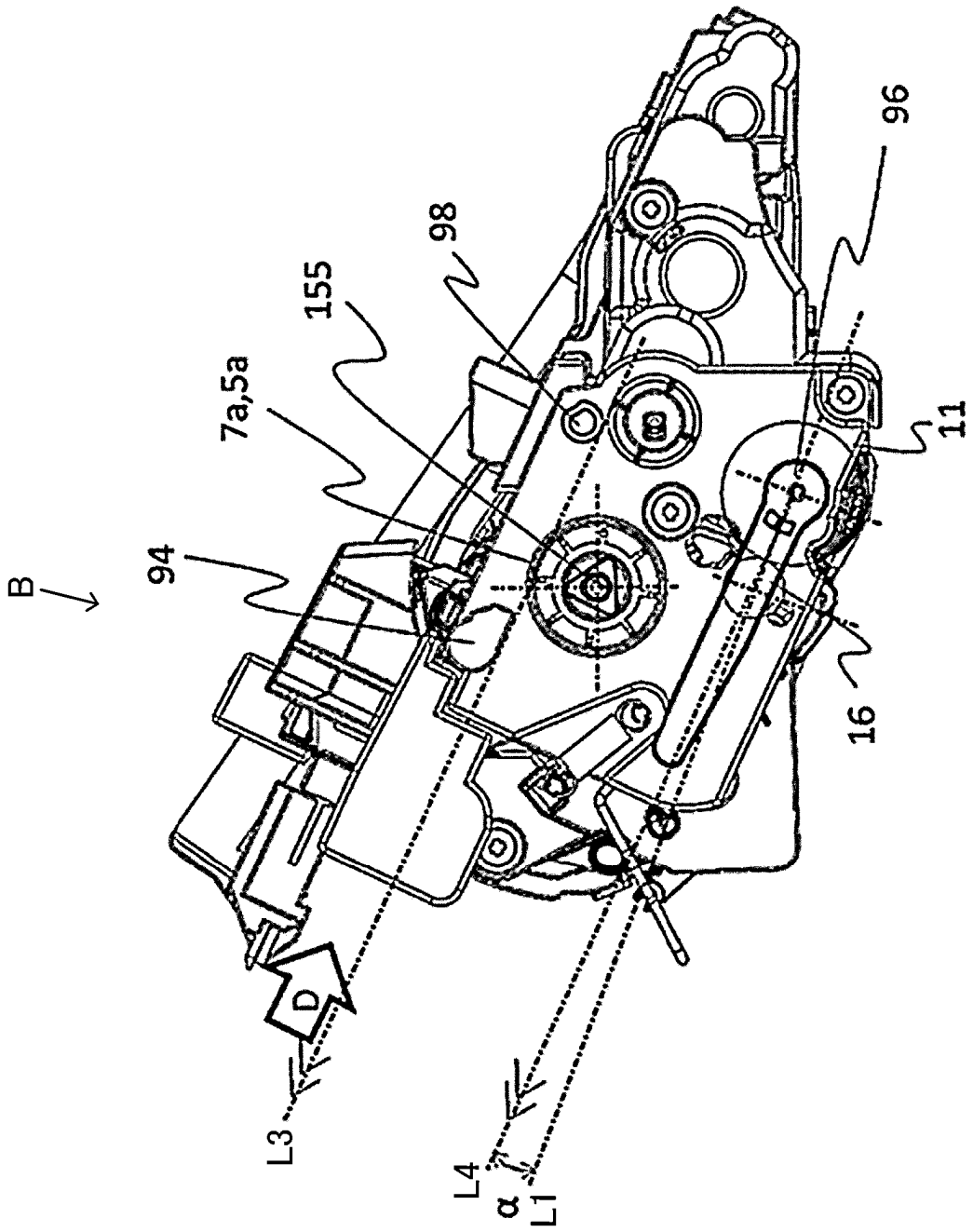


FIG. 11

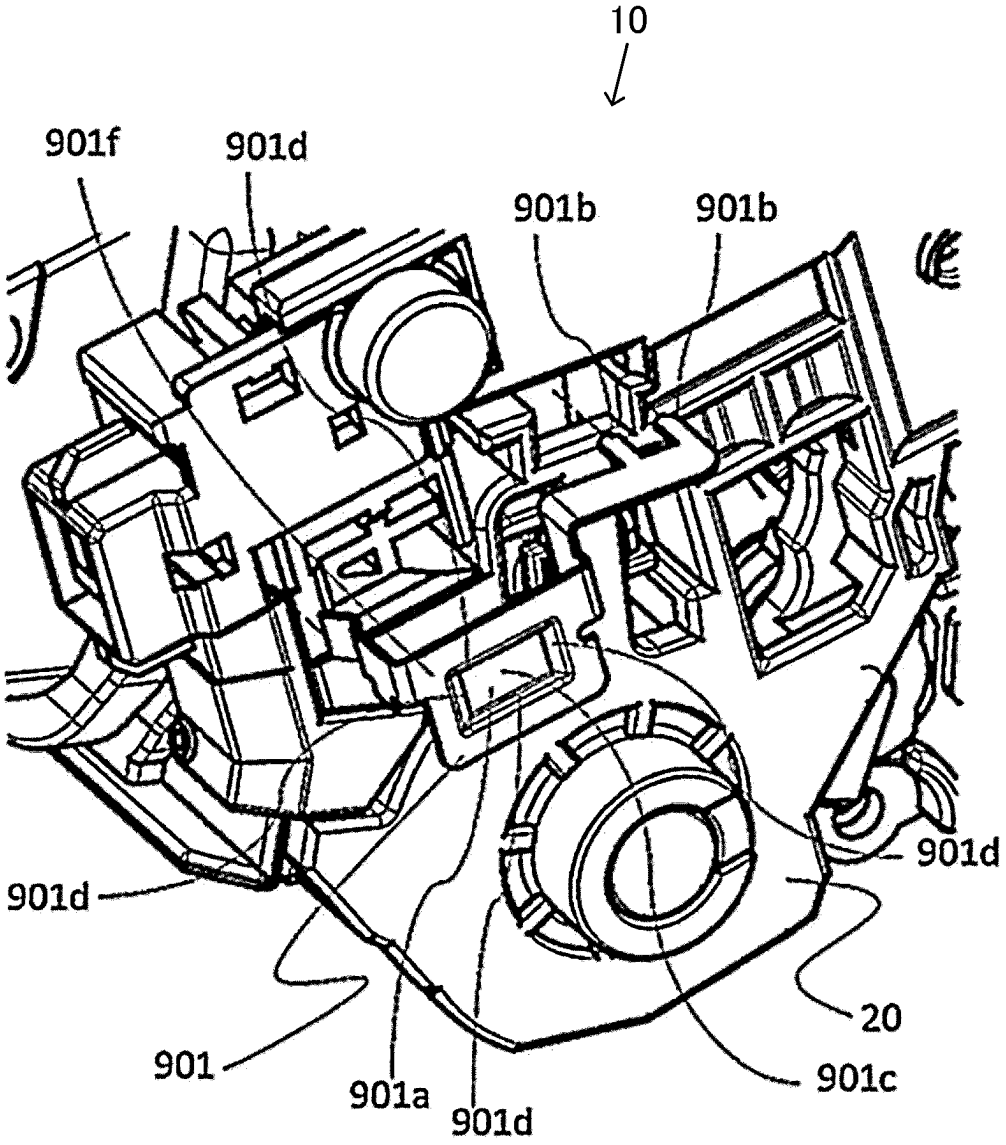
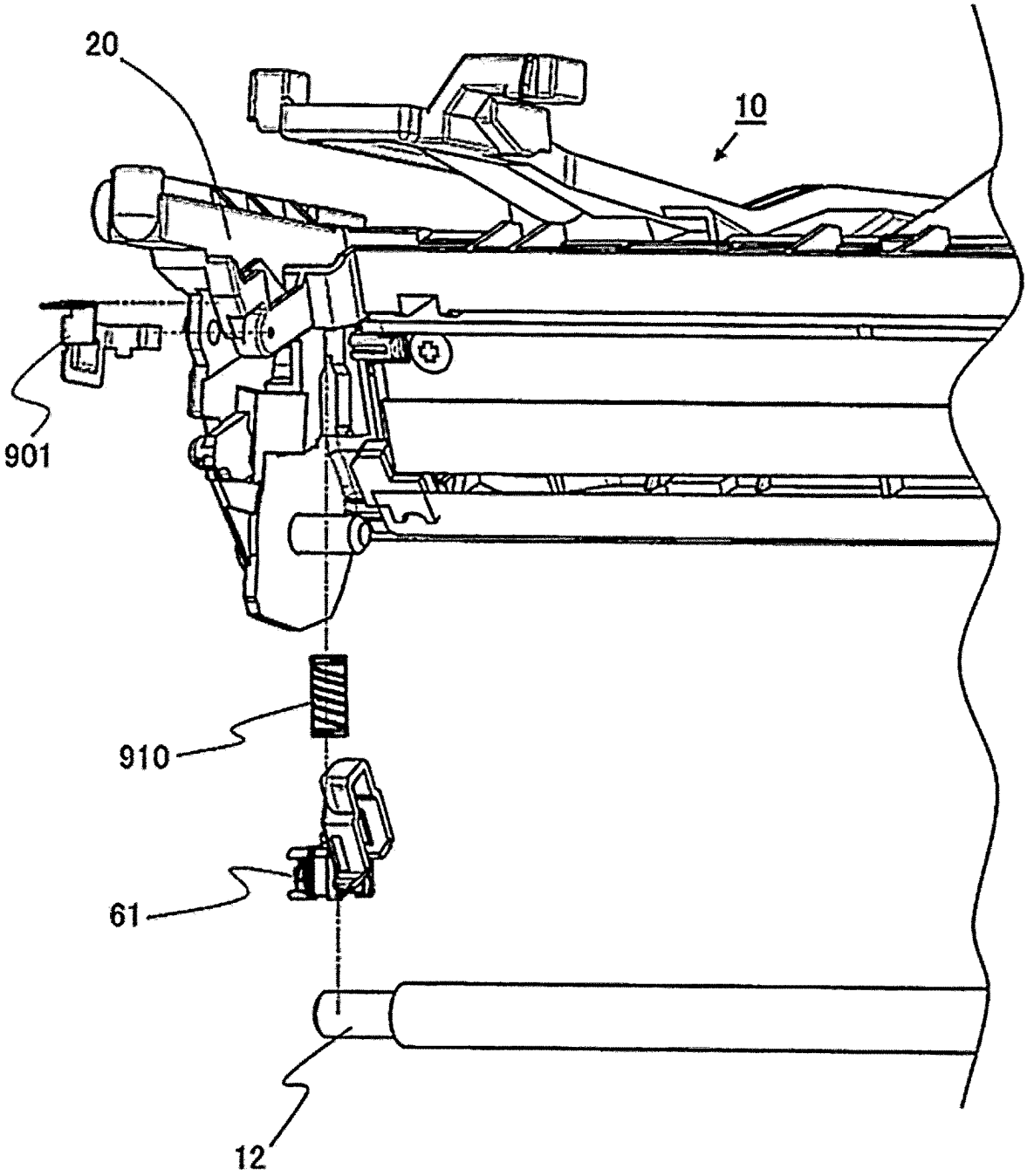


FIG. 12



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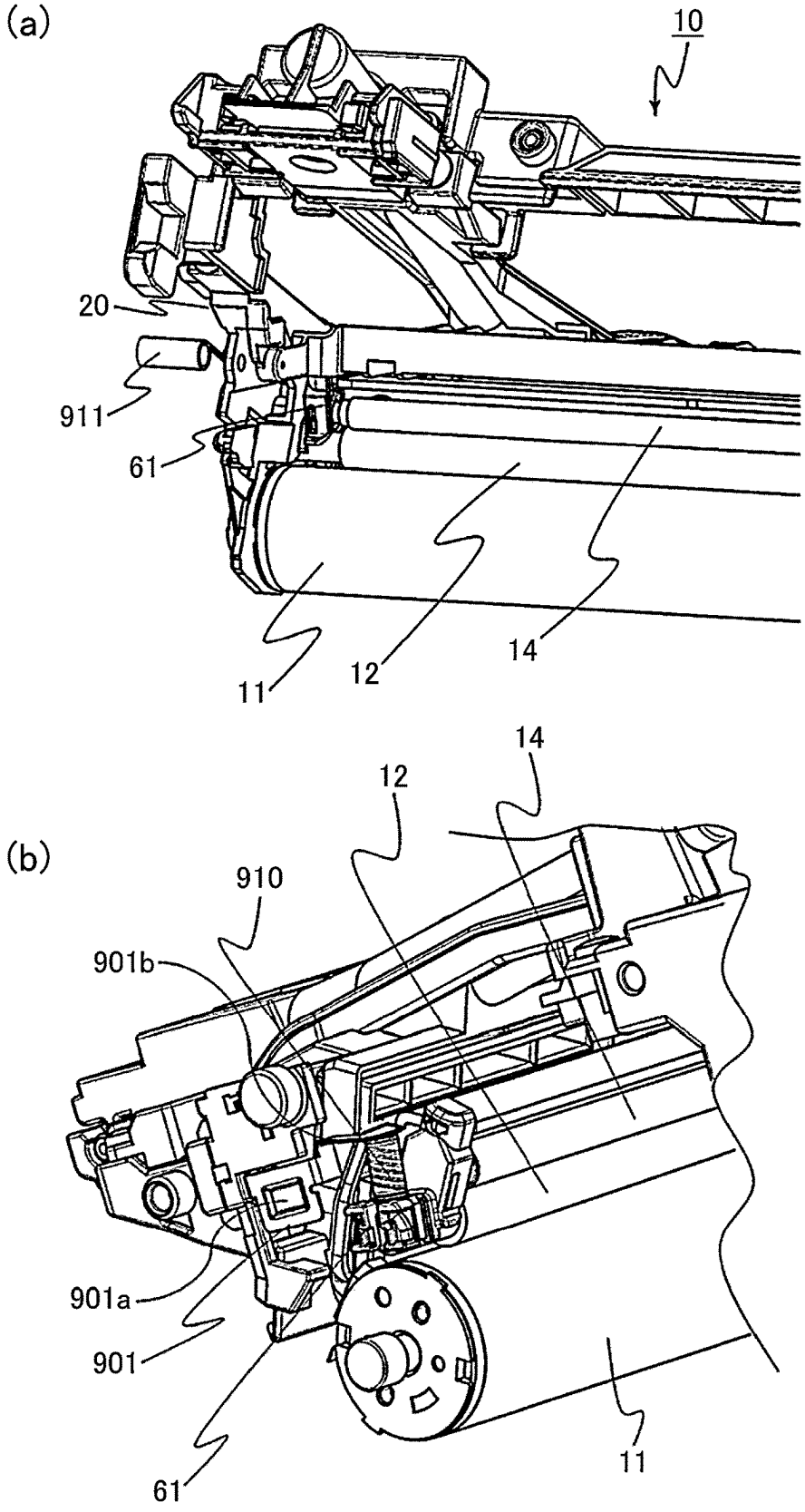

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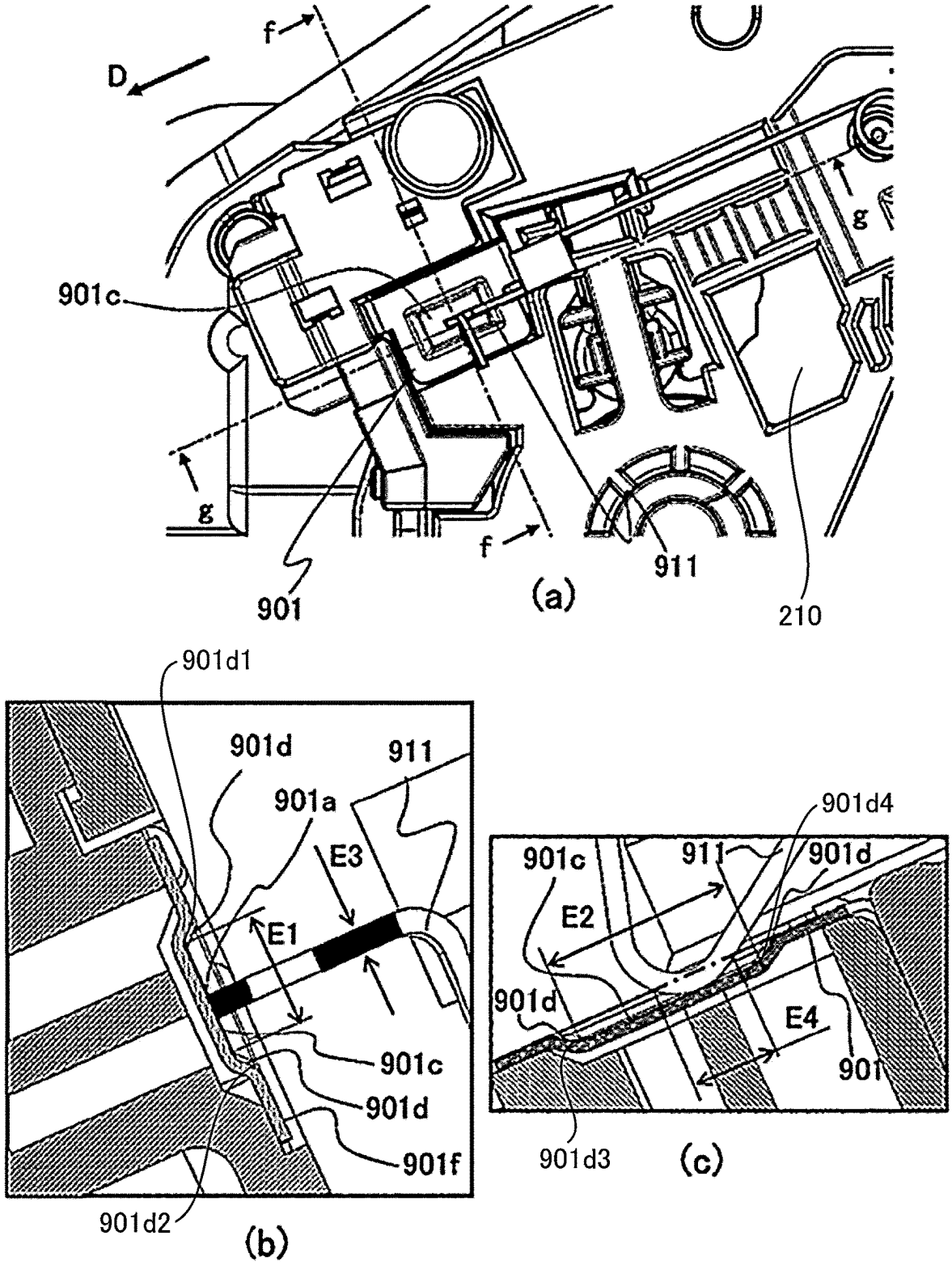
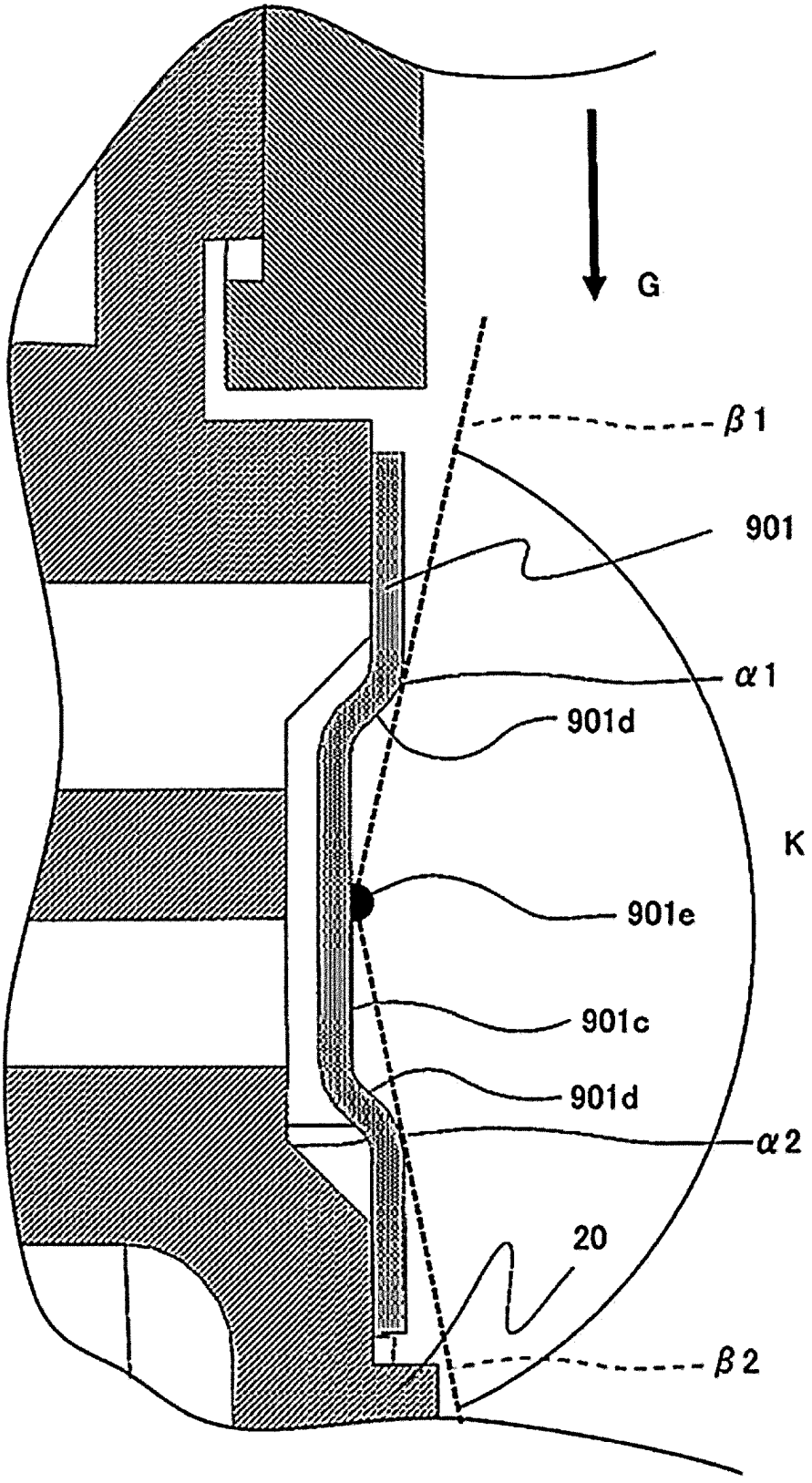

f
D
901c
g
g
f
901
911
210
(a)
901d1
901d
911
901a
E3
E1
901c
901d
901f
901d2
(b)
901d4
901c
911
901d
E2
901d
E4
901
901d3
(c)

FIG. 15



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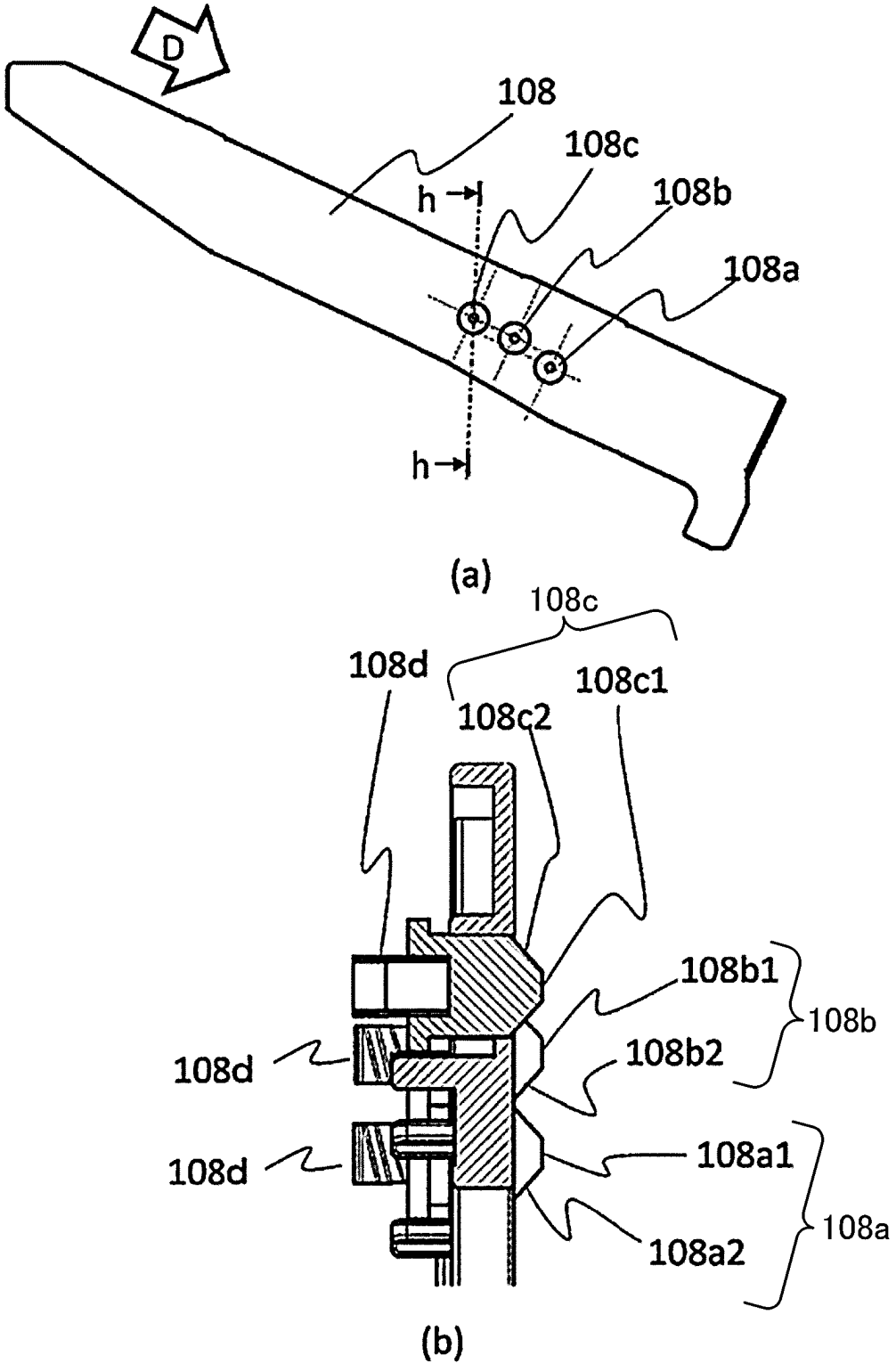

D
108
108c
h
108b
108a
h
(a)
108c
108d
108c1
108c2
108b1
108b
108d
108b2
108d
108a1
108a
108a2
(b)

FIG. 17

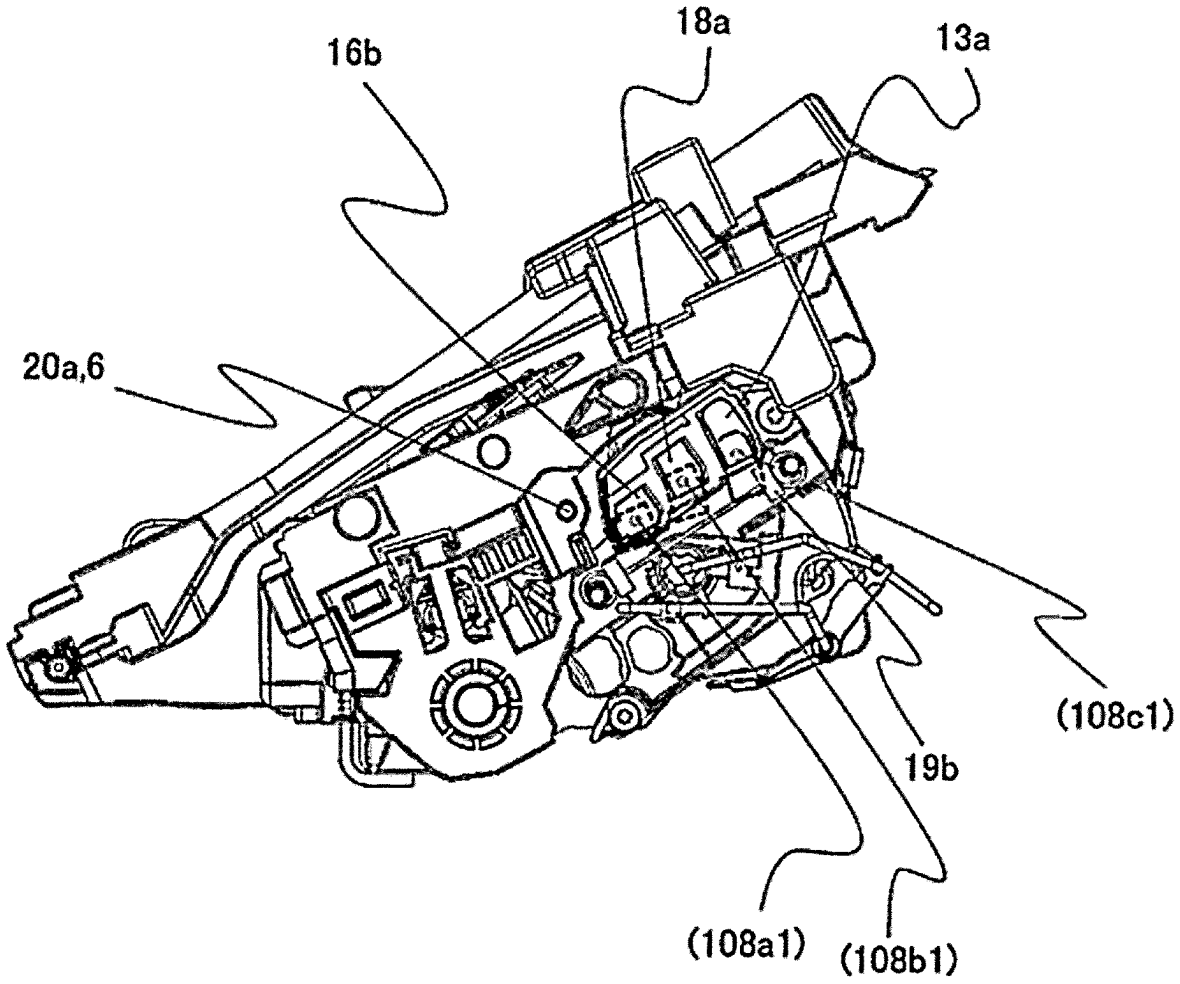


FIG. 18

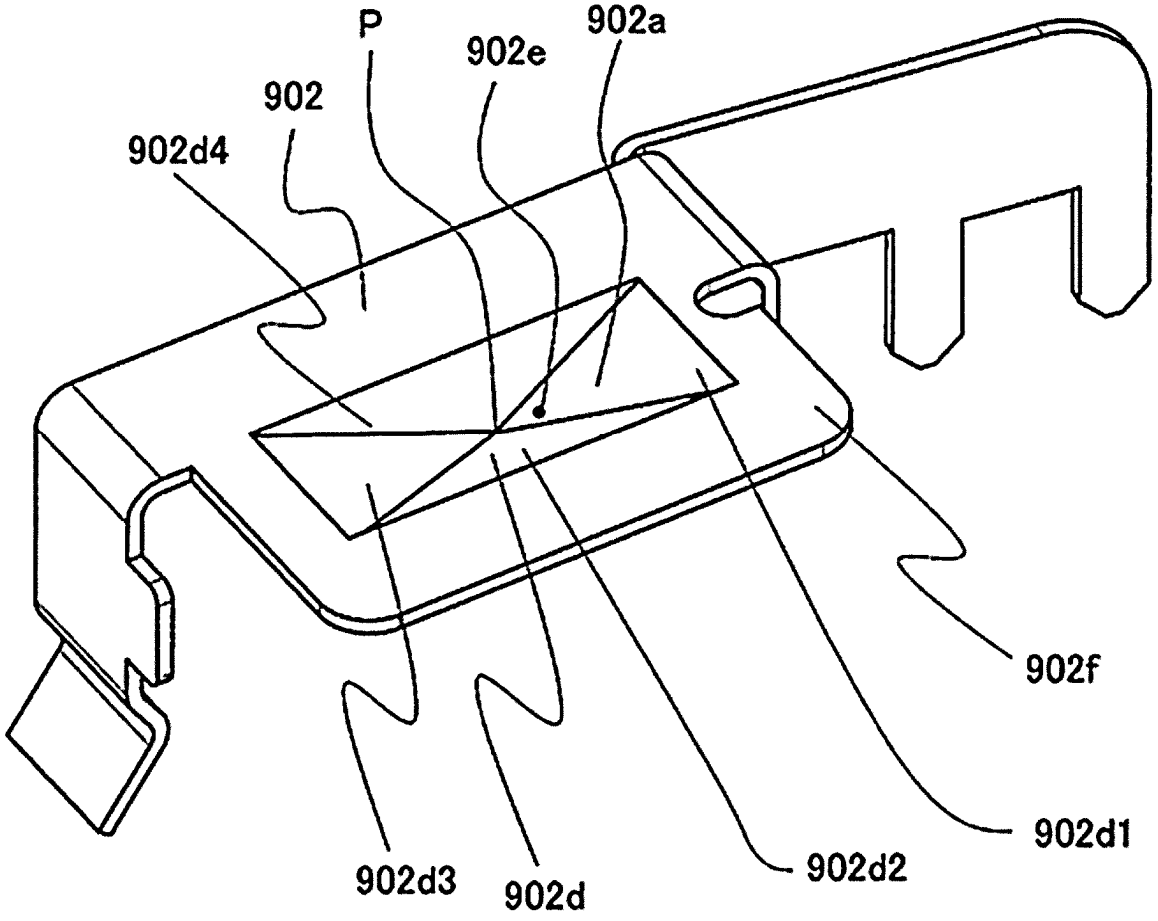


FIG. 19

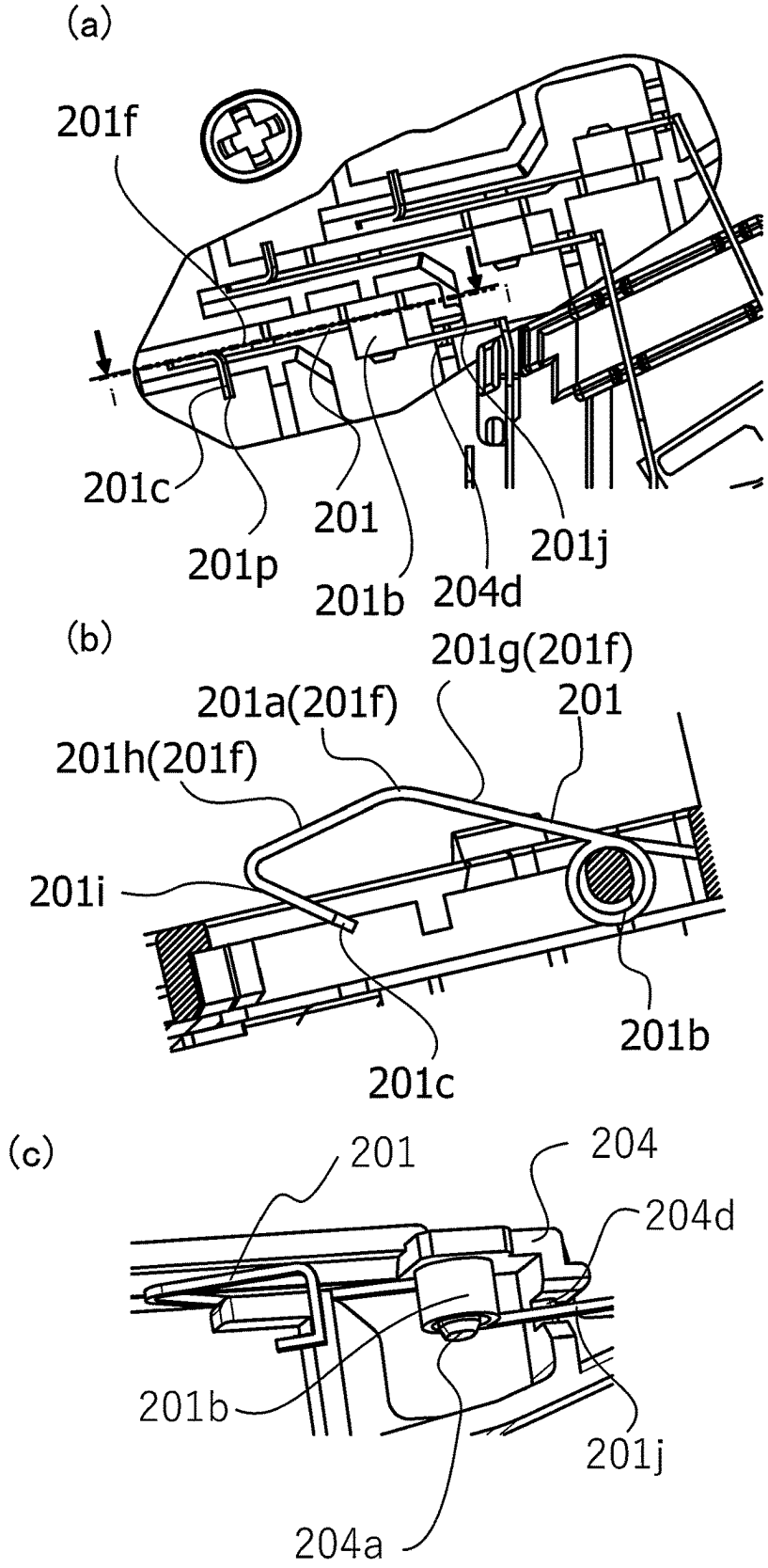

(a)
201f
201c
201p
201
201b
204d
201j
(b)
201g(201f)
201a(201f)
201
201h(201f)
201i
201b
201c
(c)
201
204
204d
201b
201j
204a

FIG. 20

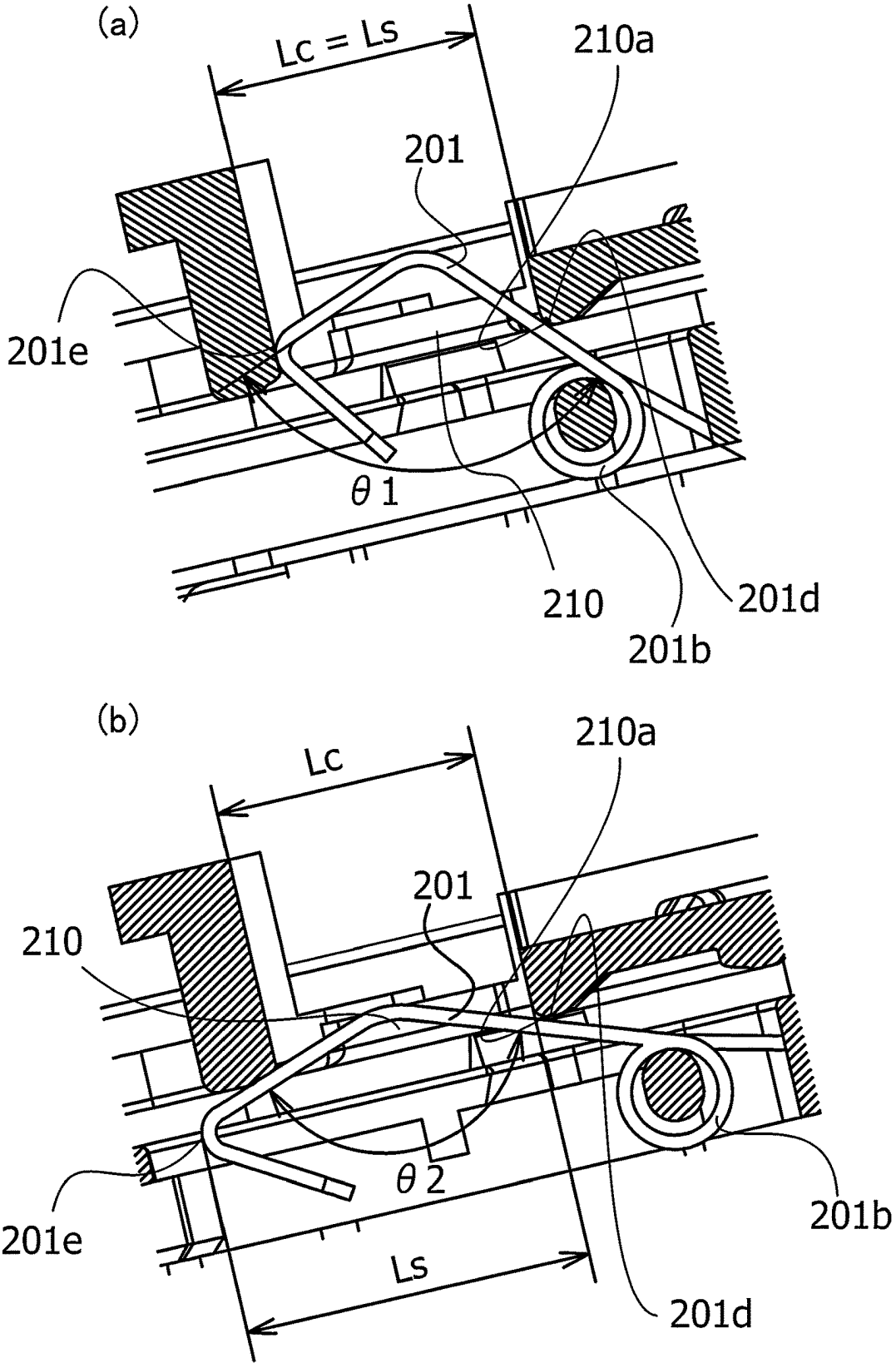

(a)
Lc = Ls
210a
201
201e
θ1
210
201d
201b
(b)
Lc
210a
201
210
θ2
201e
Ls
201b
201d

FIG. 21

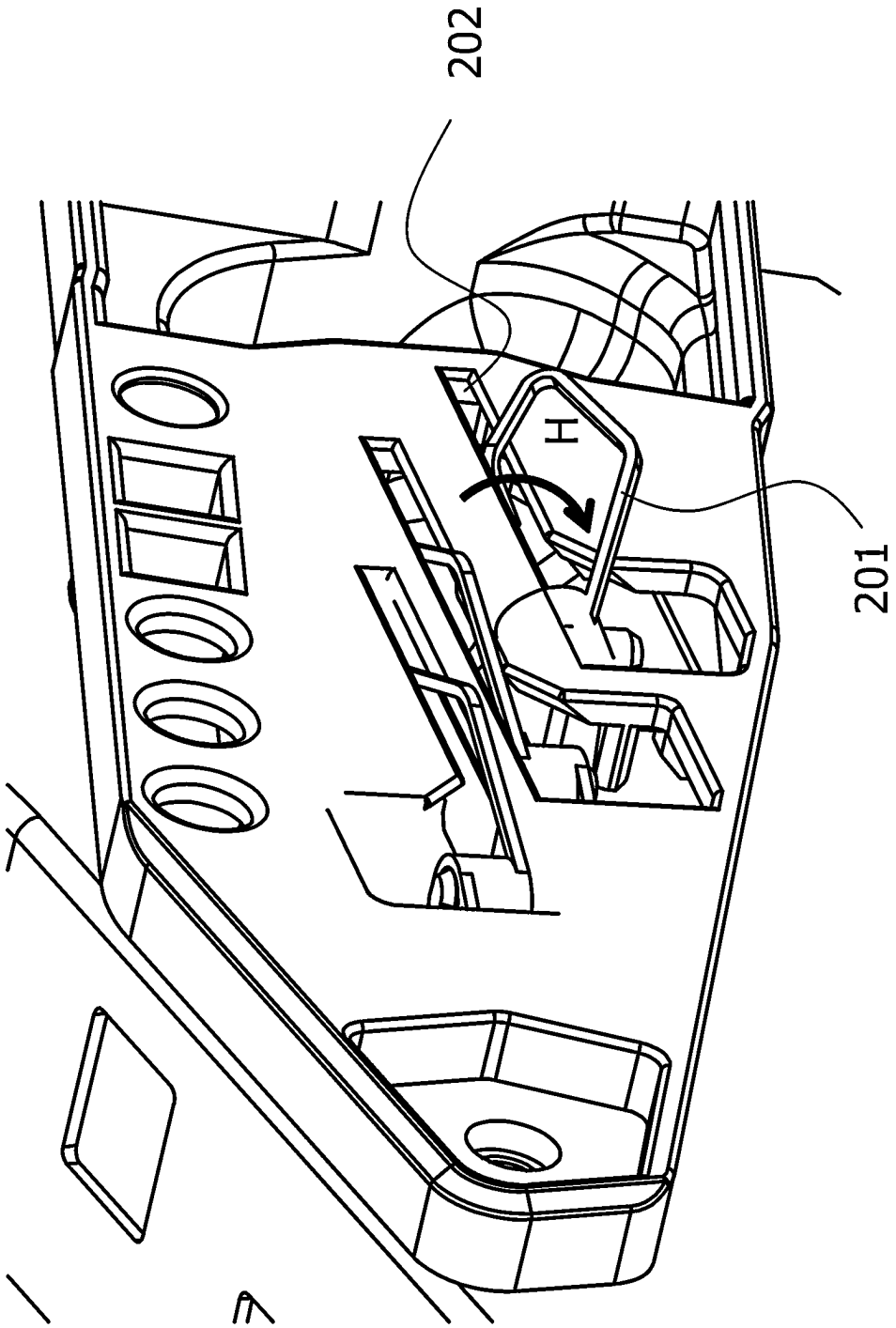


FIG. 22

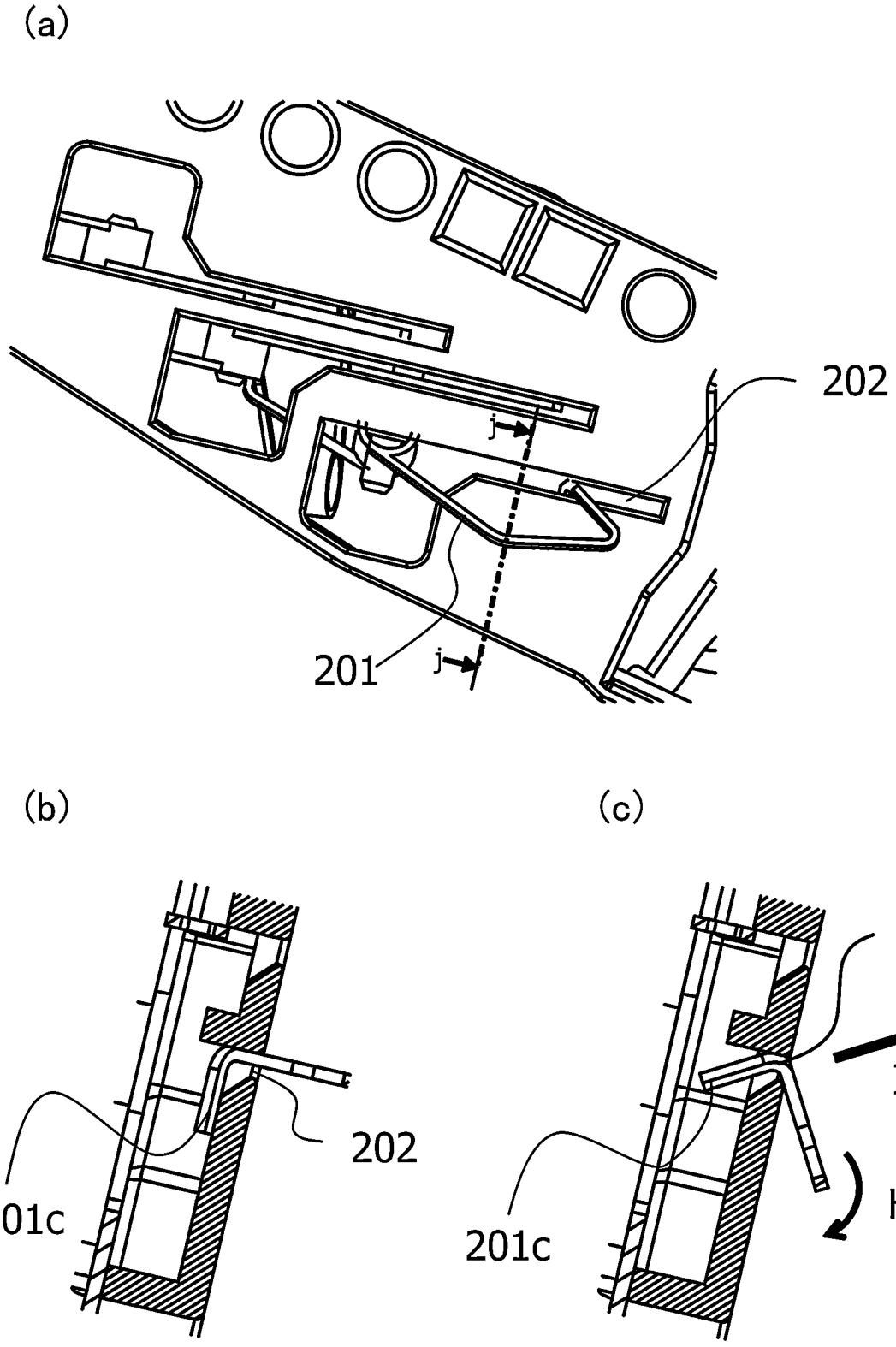


FIG. 23

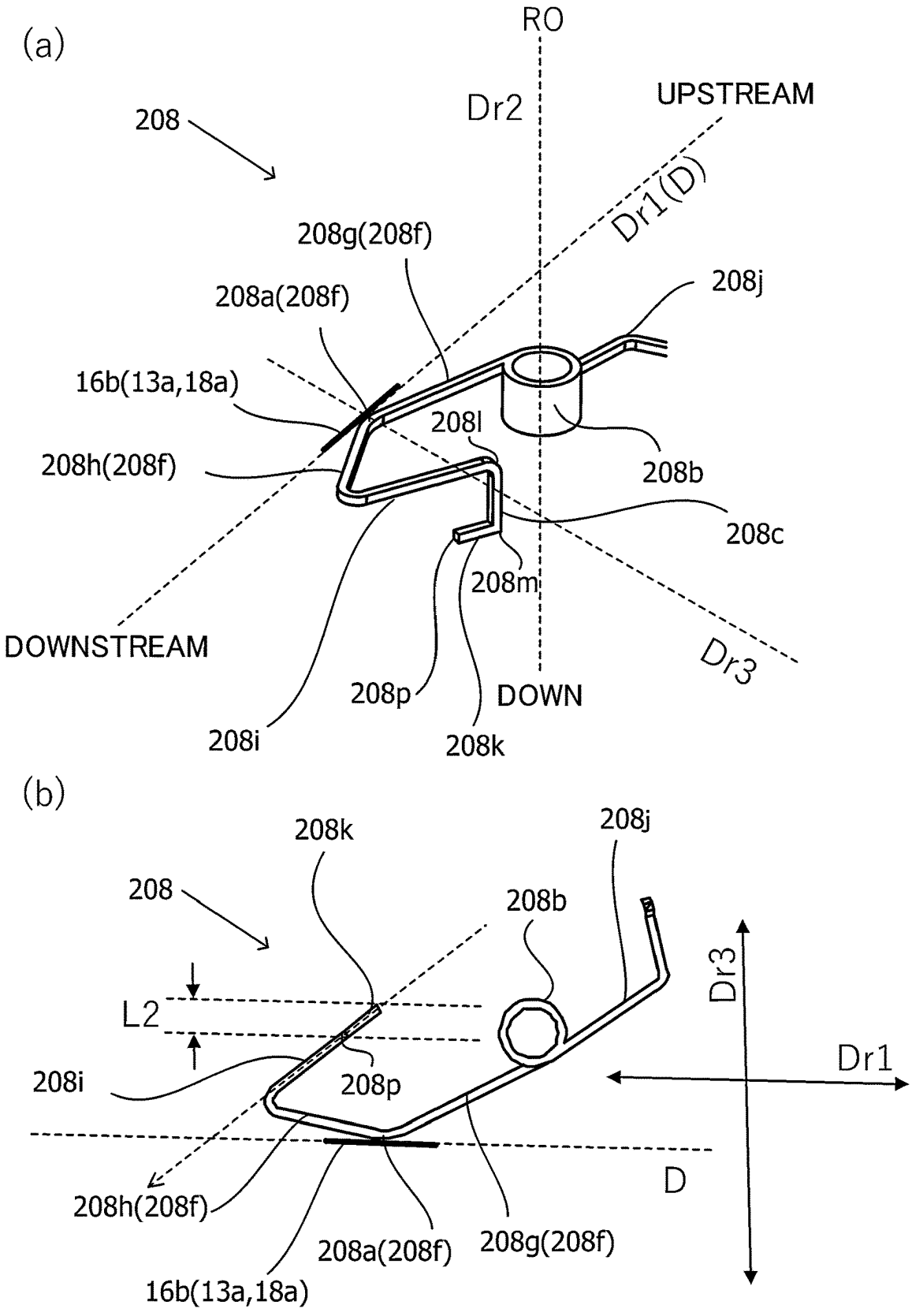
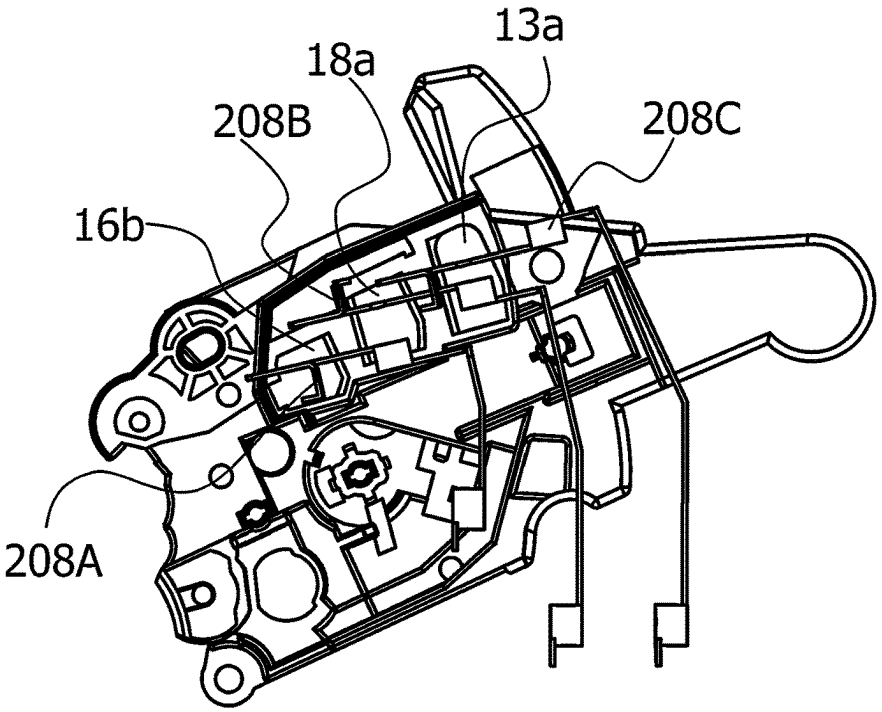

(a)
RO
Dr2
UPSTREAM
208
Dr1(D)
208g(208f)
208j
208a(208f)
16b(13a,18a)
208l
208h(208f)
208b
208c
208m
DOWNSTREAM
Dr3
208p
DOWN
208i
208k
(b)
208k
208j
208
208b
Dr3
L2
Dr1
208i
208p
D
208h(208f)
208a(208f)
208g(208f)
16b(13a,18a)

FIG. 24

(a)



(b)

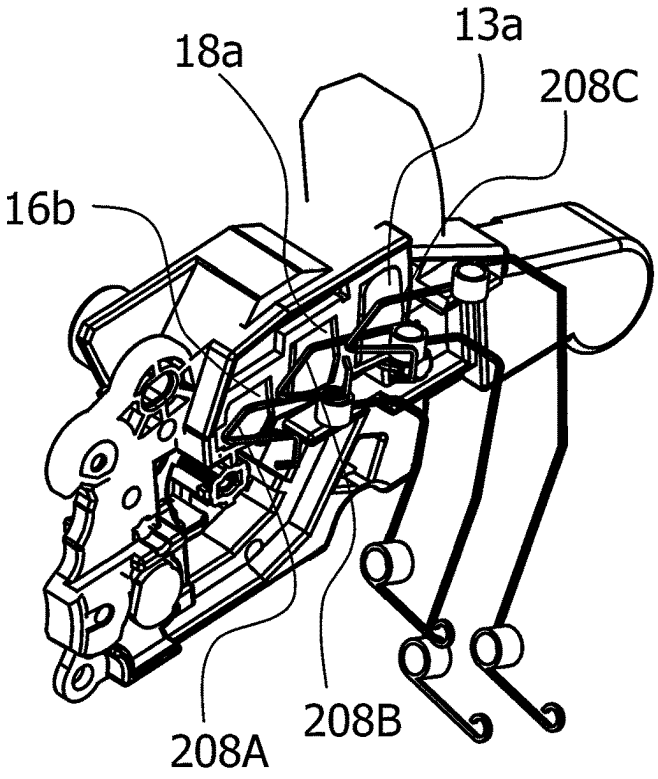


FIG. 25

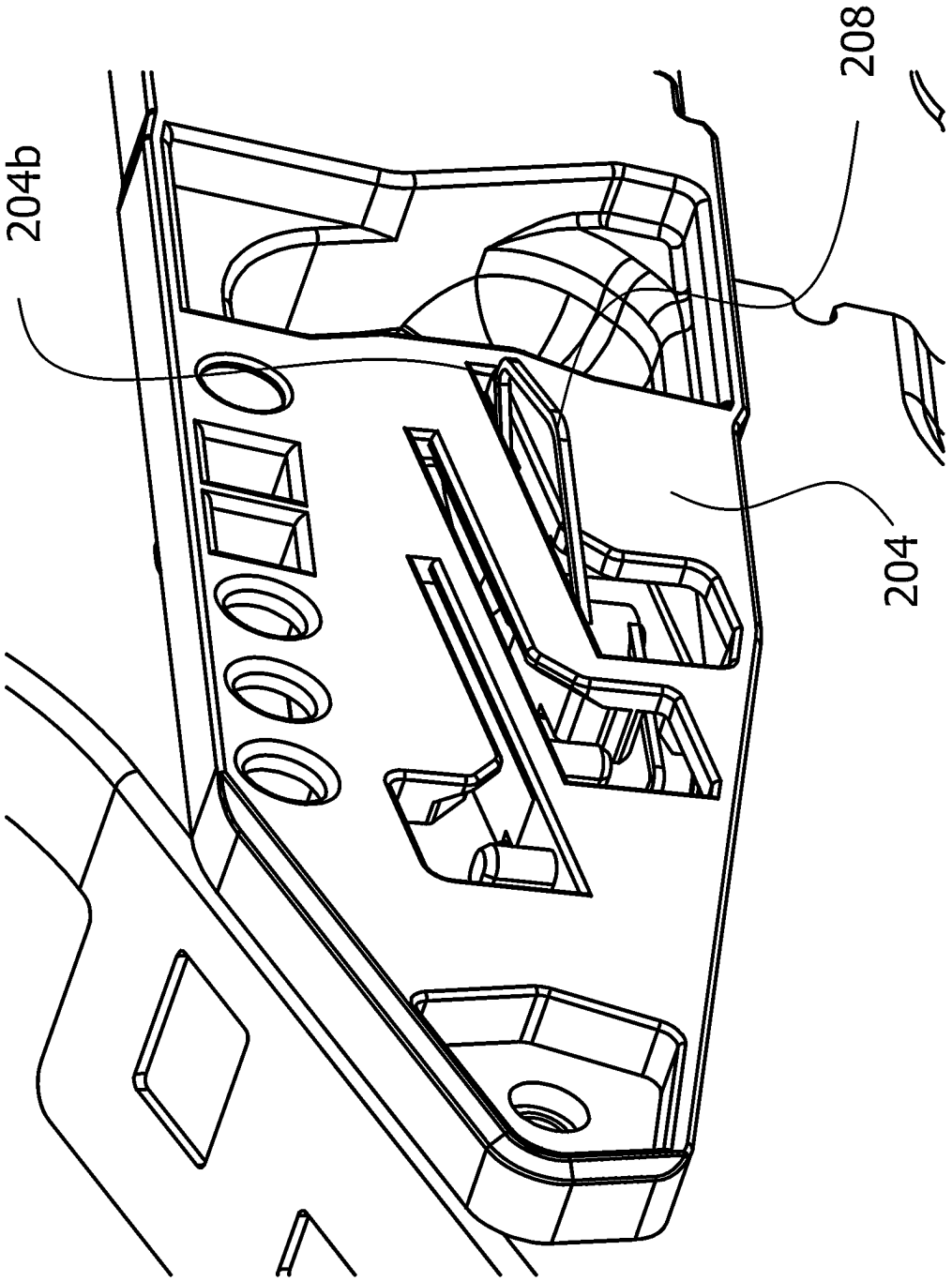


FIG. 26

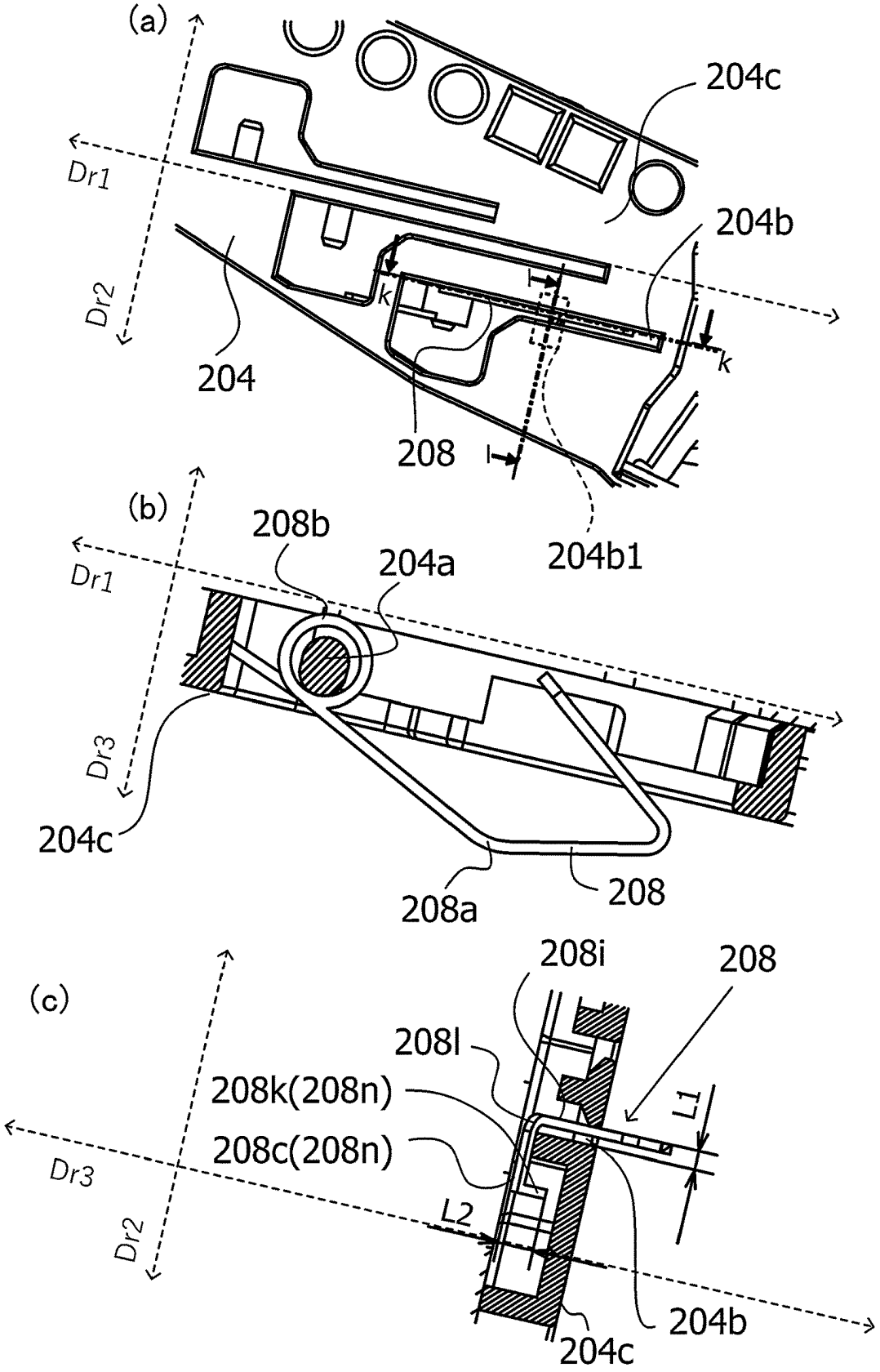

(a)
Dr1
Dr2
204c
204b
204
208
204b1
k
l
(b)
Dr1
Dr3
208b
204a
204c
208a
208
(c)
Dr3
Dr2
208i
208
208l
208k(208n)
208c(208n)
L1
L2
204b
204c

FIG. 27

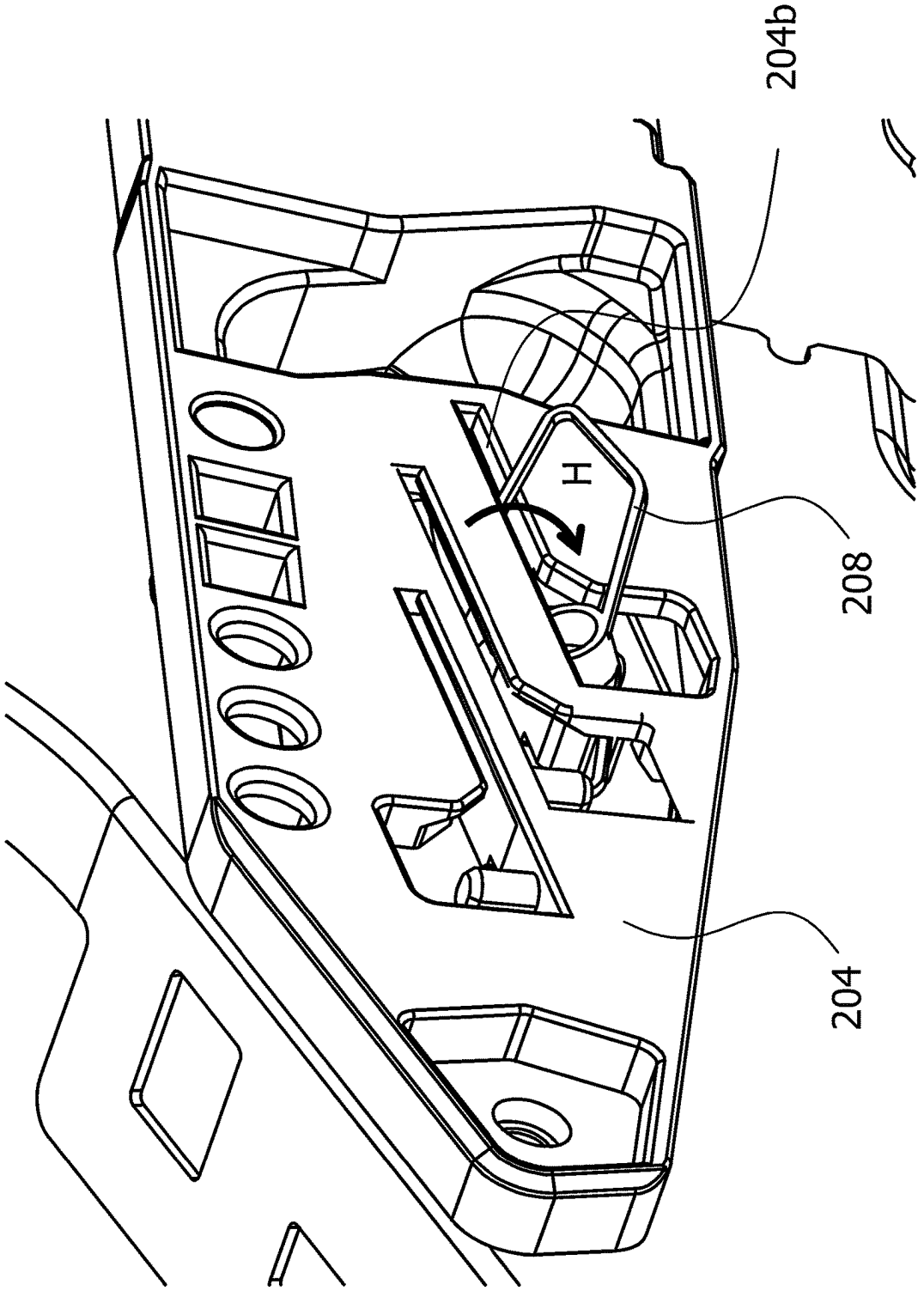


FIG. 28

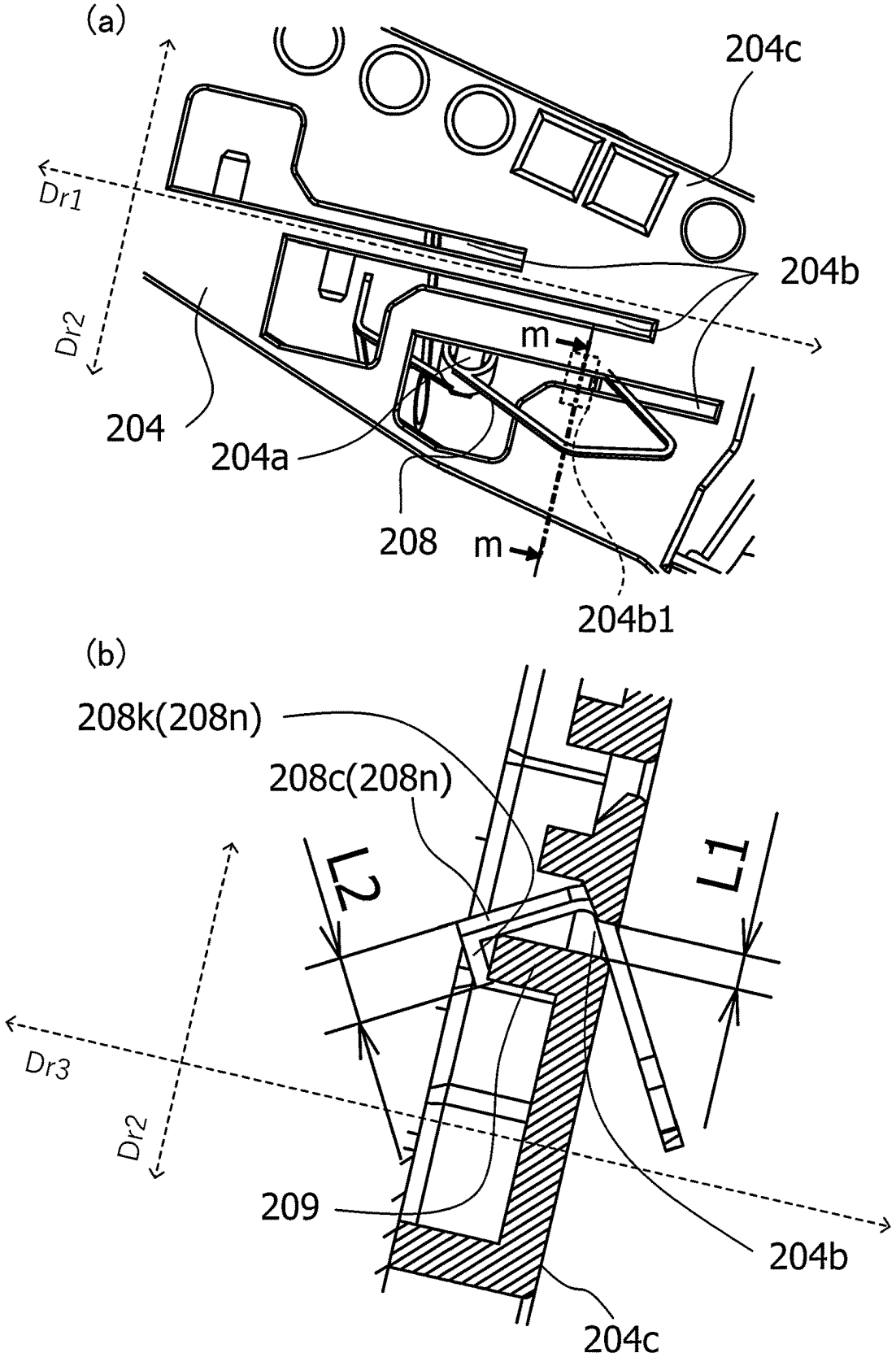

(a)
204c
Dr1
Dr2
204b
m
204
204a
208
m
204b1
(b)
208k(208n)
208c(208n)
L2
L1
Dr3
Dr2
209
204b
204c

FIG. 29

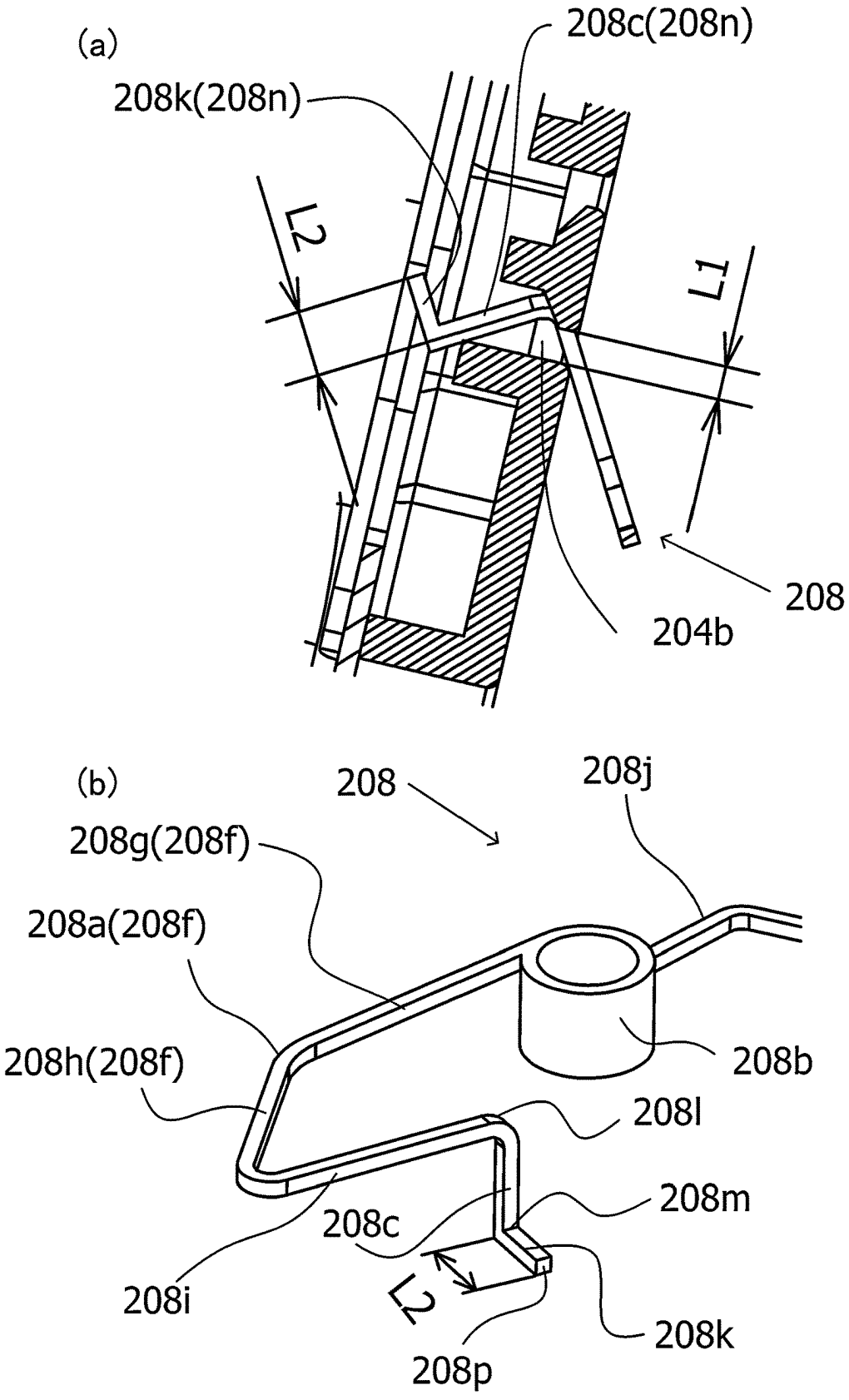

(a)
208c(208n)
208k(208n)
L2
L1
208
204b
(b)
208
208j
208g(208f)
208a(208f)
208h(208f)
208b
208l
208m
208c
208i
L2
208k
208p

FIG. 30

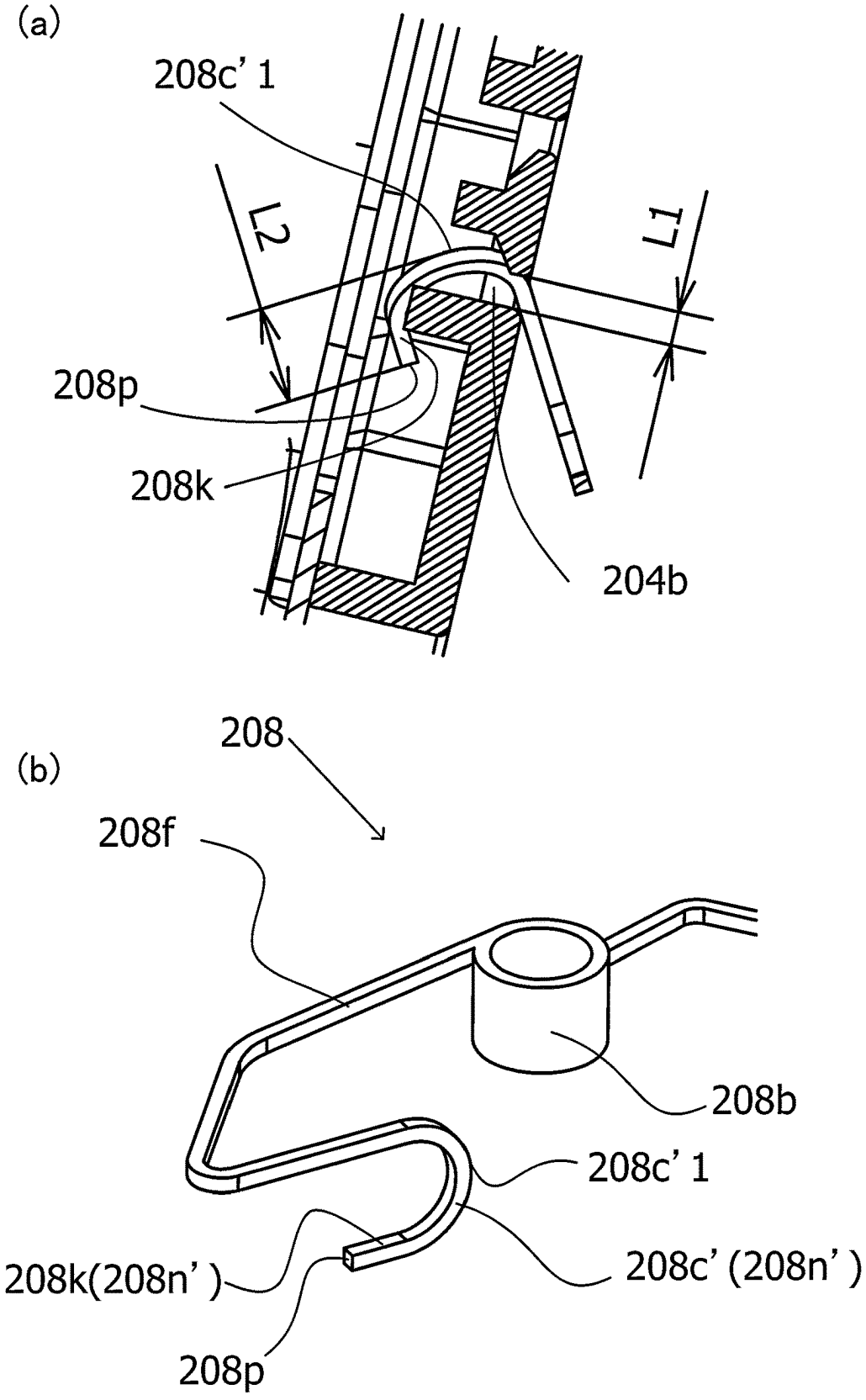

(a)
208c' 1
L2
L1
208p
208k
204b
(b)
208
208f
208b
208c' 1
208k(208n')
208c' (208n')
208p

FIG. 31

IMAGE FORMING APPARATUS

FIELD OF THE INVENTION AND RELATED ART

The present invention relates to an image forming apparatus.

Conventionally, a constitution in which members (process members), including a photosensitive drum and the like, used for image formation are collectively assembled into a cartridge made detachably mountable to an apparatus main assembly of the image forming apparatus has been known. Such a cartridge is constituted so that a main assembly-side electrode member provided in the apparatus main assembly and a cartridge-side electrode member contact each other and thus the process members and the apparatus main assembly are electrically connected to each other in a state in which the cartridge is mounted to the apparatus main assembly. Here, for example, in Japanese Laid-Open Patent Application No. 2012-063750, as an example of the cartridge-side electrode, a constitution in which an electroconductive resin is injected into a frame constituting the cartridge is disclosed. On the other hand, as the main assembly-side electrode member, a wire spring including a torsion coil portion is used in some cases. The wire spring projects toward the cartridge-side electrode member through a hole provided in an opposite wall opposing a side surface of the cartridge, and contacts the cartridge-side electrode member when the cartridge is mounted.

SUMMARY OF THE INVENTION

According to an aspect of the present invention, there is provided an image forming apparatus comprising: a unit including an electrical contact surface and a power receiving member configured to receive supply of electric power via the electric contact surface; and a main assembly to which the unit is detachably mounted, the main assembly including a contact member configured to supply the electric power to the power receiving member in contact with the electrical contact surface of the unit, the contact member being a wire spring including a coil portion and an arm portion which extends from the coil portion and which has a free end, wherein the arm portion includes a first portion, a contact portion, a second portion, a third portion, and a fourth portion in a named order between the coil portion and the free end, wherein the main assembly includes a supporting member provided with a supporting portion for supporting the coil portion, wherein when a mounting and dismounting direction of the unit is a first direction, a direction which is a direction of a center axis of the coil portion and which crosses the first direction is a second direction, and a direction crossing the first direction and the second direction is a third direction, the first portion, the contact portion, and the second portion are arranged along the first direction, the contact portion is configured to contact the electrical contact surface, the first portion extends so as to approach the electrical contact surface as the first portion approaches the contact portion from the coil portion in the first direction, the second portion extends away from the electrical contact surface as the second portion extends from the contact portion in the first direction toward a direction away from the first portion, and the third portion extends toward the second direction, wherein the supporting member includes an opposite wall which opposes a side surface of the unit provided with the electrical contact surface and which is provided with an opening extending in the first direction,

wherein the contact portion projects in the third direction through the opening toward a side where the electrical contact surface is present with respect to the opposite wall, wherein the contact member is provided so that the third portion and the fourth portion are present on a side opposite from the side where the electrical contact surface is present with respect to the opposite wall, and wherein the fourth portion of the contact member extends in the third direction as viewed toward the first direction.

Further features of the present invention will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic sectional view of an image forming apparatus according to an embodiment.

Part (a) of FIG. **2** is a front view of a process cartridge in the embodiment, and part (b) of FIG. **2** is a sectional view of the process cartridge taken along an a-a line of part (a) of FIG. **2**.

Part (a) of FIG. **3** is a sectional view of the process cartridge taken along a b-b line of part (a) of FIG. **2**, and part (b) of FIG. **3** is a sectional view of the process cartridge taken along a c-c line of part (a) of FIG. **2**.

Part (a) of FIG. **4** is an exploded perspective view of the process cartridge in the embodiment, and part (b) of FIG. **4** is an exploded perspective view of the process cartridge as viewed in a direction different from a direction in part (a) of FIG. **4**.

Part (a) of FIG. **5** is a side view of the process cartridge, showing a contact state of a developing unit to a photosensitive drum, and part (b) of FIG. **5** is a side view of the process cartridge, showing a separated state of the developing unit from the photosensitive drum.

Part (a) of FIG. **6** is a front view of a toner cartridge in the embodiment, part (b) of FIG. **6** is a sectional view of the toner cartridge taken along a d-d line of part (a) of FIG. **6**, and part (c) of FIG. **6** is a sectional view of the toner cartridge taken along an e-e line of part (a) of FIG. **6**.

Part (a) of FIG. **7** is an exploded perspective view of the toner cartridge in the embodiment, and part (b) of FIG. **7** is an exploded perspective view of the toner cartridge as viewed in a direction different from a direction in part (a) of FIG. **7**.

Part (a) of FIG. **8** is a schematic sectional view showing an inserting state of the process cartridge into an apparatus main assembly in the embodiment, and part (b) of FIG. **8** is a schematic sectional view showing an inserting state of the toner cartridge into the apparatus main assembly in the embodiment.

Part (a) of FIG. **9** is a schematic side view showing the inserting state of the process cartridge into the apparatus main assembly in the embodiment, part (b) of FIG. **9** is a schematic side view showing the inserting state of the toner cartridge into the apparatus main assembly in the embodiment, and part (c) of FIG. **9** is a schematic side view showing a mounted state of the process cartridge and the toner cartridge in the apparatus main assembly in the embodiment.

FIG. **10** is a side view of the process cartridge in the embodiment.

FIG. **11** is a side view of the process cartridge as viewed from a side opposite from the side in FIG. **10** in the embodiment.

FIG. **12** is a perspective view showing a principal portion of a periphery of an electrode member of the process cartridge in the embodiment.

FIG. **13** is an exploded perspective view showing an extracted part of a structure of the periphery of the electrode member of the process cartridge in the embodiment.

Part (a) of FIG. **14** is a perspective view of the extracted part of the structure of the periphery of the electrode member of the process cartridge as viewed from a charging roller side in the embodiment, and part (b) of FIG. **14** is a perspective view of the extracted part of the structure of the periphery of the electrode member of the process cartridge as viewed from an electrode member side.

Part (a) of FIG. **15** is a front view showing a relationship between the electrode member of the process cartridge and a spring contact of the apparatus main assembly in the embodiment, part (b) of FIG. **15** is a sectional view taken along an f-f line of part (a) of FIG. **15**, and part (c) of FIG. **15** is a sectional view taken along a g-g line of part (a) of FIG. **15**.

FIG. **16** is a sectional view for illustrating a restricting range of a spark in the electrode member in the embodiment.

Part (a) of FIG. **17** is a front view in which a structure of a periphery of an electrical contact of the apparatus main assembly corresponding to an electrical contact of the developing unit of the process cartridge in the embodiment is extracted, and part (b) of FIG. **7** is a sectional view taken along an h-h line of part (a) of FIG. **17**.

FIG. **18** is a side view of the process cartridge in a separated state between the photosensitive drum and the developing roller in the embodiment.

FIG. **19** is a perspective view of an electrode member in the embodiment.

Part (a) of FIG. **20** is a front view showing an electrical contact portion of an apparatus main assembly using a conventional torsion coil spring for comparison with an embodiment 1, part (b) of FIG. **20** is a sectional view taken along an i-i line of part (a) of FIG. **20**, and part (c) of FIG. **20** is a schematic view for illustrating a rotation stopper.

Parts (a) and (b) of FIG. **21** are sectional views each showing the electrical contact portion of the apparatus main assembly using the conventional torsion coil spring for comparison with the embodiment 1.

FIG. **22** is a perspective view showing the electrical contact portion of the apparatus main assembly using the conventional torsion coil spring for comparison with the embodiment 1.

Parts (a) to (c) of FIG. **23** are schematic views each showing the conventional torsion coil spring for comparison with the embodiment 1, in which part (a) is the schematic view showing the electrical contact portion of the apparatus main assembly using the conventional torsion coil spring as viewed from an inside of the apparatus main assembly, part (b) is a sectional view taken along a j-j line of part (a) before the conventional torsion coil spring is inclined, and part (c) is a sectional view taken along the j-j line of part (a) after the conventional torsion coil spring is inclined.

Part (a) of FIG. **24** is a perspective view showing a structure of a torsion coil spring in the embodiment 1, and part (b) of FIG. **24** is a sectional view of the torsion coil spring as viewed from below.

Part (a) of FIG. **25** is a front view showing a contact state between an electrical contact portion of an apparatus main assembly using the torsion coil spring and an electrode member of a process cartridge in the embodiment 1, and part (b) of FIG. **25** is a perspective view showing the contact portion.

FIG. **26** is a perspective view showing the electrical contact portion of the apparatus main assembly using the torsion coil spring in the embodiment 1.

Part (a) of FIG. **27** is a sectional view showing the electrical contact portion of the apparatus main assembly using the torsion coil spring as viewed from the inside of the apparatus main assembly, part (b) of FIG. **27** is a sectional view taken along a k-k line of part (a) of FIG. **27**, and part (c) of FIG. **27** is a sectional view taken along an 1-1 line of part (a) of FIG. **27**.

FIG. **28** is a perspective view showing a state in which the electrical contact portion of the apparatus main assembly using the torsion coil spring in the embodiment 1 is inclined.

Part (a) of FIG. **29** is a sectional view showing the state in which the electrical contact portion of the apparatus main assembly using the torsion coil spring in the embodiment 1 is inclined, and part (b) of FIG. **29** is a sectional view taken along an m-m line of part (a) of FIG. **29**.

Part (a) of FIG. **30** is a sectional view showing a state in which an electrical contact portion of an apparatus main assembly using a torsion coil spring is inclined in an embodiment 2, and part (b) of FIG. **30** is a perspective view of an enlarged portion of the torsion coil spring.

Part (a) of FIG. **31** is a sectional view showing a state in which an electrical contact portion of an apparatus main assembly using a torsion coil spring is inclined in an embodiment 3, and part (b) of FIG. **31** is a perspective view of an enlarged portion of the torsion coil spring.

DESCRIPTION OF THE EMBODIMENTS

Embodiments

An embodiment will be described using FIG. **1** to part (c) of FIG. **18**. First, a schematic structure of an image forming apparatus of this embodiment will be described using FIG. **1**.

[Image Forming Apparatus]

An image forming apparatus **200** is a laser beam printer of an electrophotographic type. As shown in FIG. **1**, the image forming apparatus **200** includes an apparatus main assembly (printer main assembly) A, a process cartridge B as an image forming portion, and a toner cartridge C. The apparatus main assembly A includes a laser scanner **101**, a sheet conveying portion **102**, a sheet feeding portion **103**, a transfer roller **104**, a fixing portion **105**, a sheet discharging portion **110**, a reverse conveying portion **111**, and the like. Further, although described specifically later, in the apparatus main assembly A, the process cartridge B and the toner cartridge C are disposed detachably mountable to the apparatus main assembly A. For this purpose, the apparatus main assembly A is provided with an openable door **107**.

The process cartridge B includes a cleaning unit **10**, a photosensitive drum **11** which is an image bearing member and a photosensitive member, a charging roller **12** which is a charging member, a developing unit **15**, and a cleaning blade **17** which is a cleaning member. Above the process cartridge B, the laser scanner **101** which is an exposure device is provided.

The charging roller **12** is disposed in contact with an outer peripheral surface of the photosensitive drum **11** and electrically charges the photosensitive drum **11** under application of a voltage from the apparatus main assembly A. Further, the charging roller **12** is rotated by rotation of the photosensitive drum **11**. The developing unit **15** includes a developing roller **16** which is a developer carrying member for carrying and conveying toner which is a developer, and includes a supplying roller **13** and a developing blade **18**. The developing roller **16** is provided opposed to the photosensitive drum **11**.

The cleaning blade **17** is an elastic member disposed in contact with the outer peripheral surface of the photosensitive drum **11**, and cleans the surface of the photosensitive drum **11**. The cleaning blade **17** elastically contacts the photosensitive drum **11** at a free end thereof, and thus removes, from the photosensitive drum **11**, toner remaining after a sheet S described later passes through between the photosensitive drum **11** and the transfer roller **104**.

The sheet feeding portion **103** includes a cassette **103***a*, a pick-up roller **103***b*, a separation roller **103***c*, and a separation pad **103***d*. The pick-up roller **103***b* feeds an uppermost sheet accommodated in the cassette **103***a*. The separation roller **103***c* and the separation pad **103***d* separate the sheet S one by one fed by the pick-up roller **103***b*. The sheet conveying portion **102** includes a conveying roller pair **102***a* and a registration roller pair **102***b* which are used for conveying the sheet S fed from the sheet feeding portion **103**. The registration roller pair **102***b* conveys the sheet S to a transfer portion between the photosensitive drum **11** and the transfer roller **104** in synchronism with a timing of a toner image formed on the photosensitive drum **11**.

The fixing portion **105** includes a fixing roller **105***a* heated by a heating source such as a heater and a pressing roller **105***b* forming a fixing nip in which the sheet S is nipped between the fixing roller **105***a* and the pressing roller **105***b*. The sheet S on which the toner image is transferred in the transfer portion is conveyed to the fixing portion **105** and is heated and pressed in the fixing nip. By this, the toner image is fixed on the sheet S.

The sheet discharging portion **110** includes a discharging roller pair **110***a*, and the sheet S on which the toner image is fixed is discharged onto a discharge tray **106** by the discharging roller pair **110***a*. The reverse conveying portion **111** includes a reverse conveying roller **111***a*, and reverses front and back sides (surfaces) of the sheet S passed through the fixing portion **105** in the case where images are formed on both sides of the sheet S, and then conveys the sheet S toward the registration roller pair **102***b*.

Next, an operation of the image forming apparatus **200** will be described using FIG. **1**. The photosensitive drum **11** rotationally driven by a driving source (motor) (not shown) is electrically charged uniformly to a predetermined potential by the charging roller **12**. The surface of the photosensitive drum **11** after the charging is exposed to light on the basis of image information by the laser scanner **101**, and an electric charge in an exposure portion is removed, so that an electrostatic latent image is formed. To the electrostatic latent image on the photosensitive drum **11**, the toner is supplied from the developing roller **16**, so that the electrostatic latent image is visualized as the toner image.

On the other hand, in parallel to such a toner image forming operation, the sheet S is fed from the sheet feeding portion **103**. The sheet S fed from the sheet feeding portion **103** is conveyed to the transfer portion by the registration roller pair **102***b* while being timed to formation of the toner image on the photosensitive drum **11**. When the sheet S passes through the transfer portion, a voltage is applied from the apparatus main assembly A to the transfer roller **104**, so that the toner image on the photosensitive drum **11** is transferred as an unfixed image onto the sheet S. Thereafter, the sheet S on which the toner image is transferred is conveyed to the fixing portion **105**, so that the unfixed image is heated and pressed, and thus is fixed on the surface of the sheet S. The sheet S on which the toner image is fixed is discharged and stacked on the discharge tray **106** by the sheet discharging portion **110**. Incidentally, in the case where the images are formed on both sides of the sheet S, the sheet S is conveyed to the reverse conveying portion **111**, and the toner image is formed on the back side of the sheet S similarly as described above.

[Process Cartridge]

The process cartridge B will be described using FIGS. **2** to **5**. Part (a) of FIG. **2** is a front view of the process cartridge B, part (b) of FIG. **2** is a sectional view of the process cartridge B taken along an a-a line of part (a) of FIG. **2**, and part (a) of FIG. **3** is a sectional view of the process cartridge B taken along a b-b line of part (a) of FIG. **2**. As shown in part (a) of FIG. **2** to part (a) of FIG. **3**, the process cartridge B includes the cleaning unit (unit, drum unit) **10** and the developing unit (unit) **15**. The cleaning unit **10** includes the photosensitive drum **11**, the cleaning blade **17**, and the like. The developing unit **15** includes the developing roller **16**. The process cartridge B is constituted by the cleaning unit **10** provided with the cleaning blade **17** and the like and the developing unit **15** provided with the developing roller **16**. The cleaning unit **10** includes the photosensitive drum **11**, the cleaning blade **17**, the charging roller **12**, a charging roller cleaner **14** which is a cleaning member for the charging roller **12**, a residual toner primary accommodating portion **10***a*, a first residual toner conveying passage **10***b*, and a second residual toner conveying passage **10***c*. Toner (residual toner) removed from the photosensitive drum **11** by the cleaning blade **17** is conveyed from the residual toner primary accommodating portion **10***a* to the toner cartridge C through the first residual toner conveying passage **10***b* and the second residual toner conveying passage **10***c*.

Part (b) of FIG. **3** is a sectional view of the process cartridge B taken along a c-c line of part (a) of FIG. **2**. As shown in part (b) of FIG. **3**, the developing unit **15** includes the developing roller **16**, the supplying roller **13**, the developing blade **18**, a developing chamber **151**, a developer accommodating chamber **152**, and a toner receiving chamber **153** for receiving the toner supplied from the toner cartridge C. In the developing chamber **151**, the developing roller **16** is disposed. The developer accommodating chamber **152** supplies the toner to the developing chamber **151**. The toner receiving chamber **153** receives the toner supplied from the toner cartridge C.

The developing roller **16** rotates while carrying the toner and supplies the toner to a developing region. Then, the developing roller **16** develops the electrostatic latent image, with the toner, formed on the photosensitive drum **11**. The supplying roller **13** supplies the toner in the developing chamber **151** to the developing roller **16**. Such a supplying roller **13** is disposed so that a rotational axis direction thereof is parallel to a rotational axis direction of the developing roller **16**, and on an outer peripheral surface thereof, an elastic layer such as a sponge or the like is formed so that the developer is easily conveyed. The developing blade **18** contacts a peripheral surface of the developing roller **16** and regulates a layer thickness (amount) of the toner deposited (carried) on the peripheral surface of the developing roller **16**. Further, the developing blade **18** imparts an electric charge charged by friction with the toner (triboelectric charge) to the toner.

The developer accommodating chamber **152** communicates with the developing chamber **151** and accommodates the toner supplied to the developing chamber **151**. The toner accommodated in the developer accommodating chamber **152** is sent to the developing chamber **151** by rotation of a stirring member **154** and then is supplied to the developing roller **16**. A remaining amount of the toner in the developer accommodating chamber **152** is detected by a remaining amount detecting portion (not shown). Then, when the

amount of the toner in the developer accommodating chamber **152** becomes a certain amount or less, the toner is supplied from the toner cartridge C to the process cartridge B.

The toner receiving chamber **153** communicates with the developer accommodating chamber **152**, and supplies the toner, supplied from the toner cartridge C, to the developer accommodating chamber **152**.

Supply of the toner from the toner cartridge C to the developing unit **15** of the process cartridge B is made through a supply opening **21***c* of a stay **21**, the toner receiving chamber **153**, and a delivery opening **21***d*, so that the toner is accommodated in the developer accommodating chamber **152**.

Next, the constitution of the process cartridge B will be described more specifically using part (b) of FIG. **2**, parts (a) and (b) of FIG. **4**, and parts (a) and (b) of FIG. **5**. Part (a) of FIG. **4** is an exploded perspective view of the process cartridge B, and part (b) of FIG. **4** is an exploded perspective view of the process cartridge B as viewed from a direction different from a direction in part (a). Part (a) of FIG. **5** is a side view of the process cartridge B showing a contact state of the developing unit **15** to the photosensitive drum **11**, and part (b) of FIG. **5** is a side view of the process cartridge B showing a separated state of the developing unit **15** from the photosensitive drum **11**.

As described above, the cleaning unit **10** includes the photosensitive drum **11**, the charging roller **12**, and the cleaning blade **17**. The developing unit **15** includes the developing roller **16**, the developing blade **18**, the developing chamber **151**, the developer accommodating chamber **152**, and the toner receiving chamber **153**.

As shown in parts (a) and (b) of FIG. **4**, the cleaning unit **10** is constituted by a cleaning frame **20**, the stay **21**, and a side cover **7**. The cleaning frame **20** supports the cleaning blade **17**, the charging roller **12**, and the charging roller cleaner **14**. As shown in part (b) of FIG. **4**, the photosensitive drum **11** is rotatably supported by a drum pin **22** mounted on the cleaning frame **20** on one side and by a photosensitive drum supporting portion **7***b* provided on the side cover **7** on the other side (opposite side).

Further, as shown in parts (a) and (b) of FIG. **4**, at an end portion of the developing roller **16** with respect to an axial direction, bearing members **4** and **5** are disposed, and the developing unit **15** is connected to the cleaning unit **10** so as to be rotatable about a swing axis **8** defined by a rectilinear line including supporting axes **8***a* and **8***b*. The swing axis **8** is disposed substantially parallel to a rotational axis **11***b* of the photosensitive drum **11**.

A constitution in which the developing unit **15** is supported by the cleaning unit **10** will be specifically described. As shown in part (a) of FIG. **4**, a cylindrical shape portion **5***a* provided on the bearing member **5** is supported by a cylindrical hole portion **7***a* provided in the side cover **7**. The supporting axis **8***b* is defined by a common axis to the cylindrical hole portion **7***a* of the side cover **7** and the cylindrical shape portion **5***a* of the bearing member **5**. Further, at a rotation center of the cylindrical shape portion **5***a* of the bearing member **5**, a developing coupling **155** which is a drive input member for receiving drive from the apparatus main assembly A is provided.

Further, as shown in part (b) of FIG. **4**, a pin **6** is inserted so as to extend over a cylindrical hole portion **20***a* of the cleaning frame **20** of the cleaning unit **10** and the cylindrical hole portion **4***a* of the bearing member **4**. The supporting axis **8***b* is defined by a common axis to the pin **6** and the cylindrical hole portion **4***a* of the bearing member **4**. The supporting axes **8***a* and **8***b* are disposed coaxially with each other, and as described above, the swing axis **8** is defined by a rectilinear line including the supporting axes **8***a* and **8***b*.

As described above, the developing unit **15** is supported rotatably about the swing axis **8** relative to the cleaning unit **10**. Further, the developing unit **15** is urged toward the photosensitive drum **11** of the cleaning unit **10** by pressing springs **19***a* and **19***b* which are elastic members, so that the developing roller **16** is contacted to the photosensitive drum **11**.

Next, a contact and separation operation of the developing unit **15** relative to the cleaning unit **10** will be described using parts (a) and (b) of FIG. **5**. Incidentally, parts (a) and (b) of FIG. **5** are illustrations in which the side cover **7** is omitted for illustrating a separation mechanism **100** of the apparatus main assembly A. As shown in part (a) of FIG. **5**, a projected portion **5***b* is provided in a position where the bearing member **5** opposes the separation mechanism **100**. In this embodiment, in a state in which the process cartridge B is mounted in the apparatus main assembly A, the separation mechanism **100** is provided below the developing unit **15**. Further, the projected portion **5***b* is provided at a lower end portion of the bearing member **5**. The separation mechanism **100** is provided in the apparatus main assembly A and is swingable substantially in up-down direction about a swing axis **100***a* as a center by a driving source such as a motor (not shown).

As shown in part (a) of FIG. **5**, in a position where the projected portion **5***b* does not contact the separation mechanism **100**, the developing roller **16** is contacted to the photosensitive drum **11** by an urging force of the pressing springs **19***a* and **19***b*.

This position is an image forming position where the electrostatic latent image formed on the surface of the photosensitive drum **11** is capable of being developed by the developing roller **16**.

As shown in part (b) of FIG. **5**, the separation mechanism **100** provided in the apparatus main assembly A swings about the swing axis **100***a* and contacts the projected portion **5***b*, and the projected portion **5***b* receives a force from the separation mechanism **100**, so that the developing unit **15** is rotated about the swing axis **8** as a rotation center in an arrow R2 direction. By this, the developing roller **16** is separated from the photosensitive drum **11** against the urging force of the pressing springs **19***a* and **19***b*. This position is a non-image forming position retracted from the image forming position.

When the separation mechanism **100** returns from the position of part (b) of FIG. **5** to the position of part (a) of FIG. **5** which is an original position, the separation mechanism **100** is separated from the projected portion **5***b*. Then, by the urging force of the pressing springs **19***a* and **19***b*, the developing roller **16** is contacted to the photosensitive drum **11** again. Thus, in this embodiment, the position of the developing unit **15** is capable of being switched between a contact position (image forming position) and a separated position (non-image forming position) by the separation mechanism **100**. That is, an attitude of the developing unit **15** in the process cartridge B is switchable between the contact position and the separated position relative to the photosensitive drum **11**. By this, it is possible to suppress toner deterioration and unnecessary toner consumption during non-image formation.

As described above, the developing unit **15** has a constitution in which the developing unit **15** rotates about the swing axis **8** and thus moves between the contact position and the separated position. For that reason, when the devel-

oping unit **15** moves between the contact position and the separated position relative to the cleaning unit **10**, a positional change of the developing coupling **155** can be suppressed to a minute level which is a degree of engagement play (backlash). Specifically, the cylindrical shape portion **5***a* of the bearing member **5** engages with the cylindrical hole portion **7***a* of the side cover **7** (part (a) of FIG. **4**). However, the cylindrical shape portion **5***a* of the bearing member **5** and the cylindrical hole portion **7***a* of the side cover **7** engage with each other with engagement play of 0.13 mm or less. Therefore, the position of the developing coupling **155** when the developing unit **15** moves between the contact position and the separated position does not change in a degree corresponding to the engagement play or more.

[Toner Cartridge]

Next, the toner cartridge C will be described using FIGS. **6** and **7**. Part (a) of FIG. **6** is a front view of the toner cartridge C, part (b) of FIG. **6** is a sectional view of the toner cartridge C taken along a d-d line of part (a) of FIG. **6**, and part (c) of FIG. **6** is a sectional view of the toner cartridge C taken along an e-e line of part (a) of FIG. **6**. Part (a) of FIG. **7** is an exploded perspective view of the toner cartridge C, and part (b) of FIG. **7** is an exploded perspective view of the toner cartridge C as viewed from a direction different from a direction in part (a) of FIG. **7**.

As shown in part (a) of FIG. **6**, the toner cartridge C includes a toner supplying unit **30** and a residual toner accommodating unit **40**. The toner cartridge C is detachably mountable together with the process cartridge B to the apparatus main assembly A and is also detachably mountable to the process cartridge B. The toner supplying unit **30** is capable of supplying the toner to the process cartridge B. The residual toner accommodating unit **40** is capable of accommodating the residual toner collected by the process cartridge B.

[Toner Supplying Unit]

The toner supplying unit **30** includes, as shown in part (b) of FIG. **6**, a toner supplying container **31** which is a first accommodating container and a toner discharge opening **31***a* for permitting discharge of the toner from the toner supplying container **31** to an outside. The toner supplying container **31** is formed by a supplying portion frame **32***a* including the toner accommodating portion **30***a* and by a supplying portion cover **32***b*. Further, the supplying portion frame **32***a* is provided with the toner discharge opening **31***a* through which the toner is discharged from the toner accommodating portion **30***a*. Further, a shutter member **34** capable of opening and closing the toner discharge opening **31***a* is provided. The shutter member **34** is rotated in an arrow R**1** direction in interrelation with a mounting and dismounting operation of the toner cartridge C relative to the process cartridge B, so that the shutter member **34** opens and closes the toner discharge opening **31***a*. The shutter member **34** is disposed outside the supplying portion frame **32***a*.

Further, the toner accommodating portion **30***a* includes, as a toner conveying member for conveying the toner to the toner discharge opening **31***a*, a screw member **35** for conveying the toner toward the toner discharge opening **31***a*. Further, the toner accommodating portion **30***a* includes a stirring and conveying unit **36** for conveying the toner toward the screw member **35**.

Further, as shown in parts (a) and (b) of FIG. **7**, the toner conveyed to the toner discharge opening **31***a* is discharged to an outside of the toner discharge opening **31***a* by a volume fluctuation of a pump **37***a* provided in a pump unit **37**. The pump unit **37** is constituted by the pump **37***a* changing in volume by expansion and contraction, a cam **37***b* expanding and contracting the pump **37***a* by rotation thereof, and a link arm **37***c*. Further, as shown in FIG. **5** and parts (a) and (b) of FIG. **7**, the toner supplying unit **30** includes a stirring drive input portion **38** and a pump/screw drive input portion **39**. The stirring drive input portion **38** functions as a toner conveying and driving portion for driving the toner conveying member, and drives the stirring and conveying unit **36**. The pump/screw drive input portion **39** drives the pump unit **37** and the screw member **35**. The pump/screw drive input portion **39** is provided with a pump/screw coupling portion **39***a* which is a projection shape portion to which a rotational driving force is inputted from the apparatus main assembly A. This rotational driving force is converted into reciprocating motion by the cam **37***b* and the link arm **37***c*. Then, by using this reciprocating motion, a bellow-shaped portion of the pump **37***a* is expanded and contracted, so that a volume fluctuation is made.

[Residual Toner Accommodating Unit]

As shown in part (c) of FIG. **6**, the residual toner accommodating unit **40** includes a residual toner receiving opening **42** for receiving the residual toner from the process cartridge B, and a residual toner accommodating container **41** which is a second accommodating container in which the residual toner received through the residual toner receiving opening **42** is accommodated.

The residual toner accommodating container **41** is formed by a residual toner accommodating portion frame **41***a* including the residual toner accommodating portion **40***a* and by a residual toner accommodating cover **41***b*. The residual toner accommodating cover **41***b* is provided with a residual toner receiving opening **42** for receiving the residual toner collected from the process cartridge B. The residual toner accommodating cover **41***b* includes a residual toner shutter member **43** for opening and closing the residual toner receiving opening **42**. The residual toner shutter member **43** is opened and closed in an arrow R**3** direction of part (c) of FIG. **6** in interrelation with the mounting and demounting of the toner cartridge C relative to the apparatus main assembly A.

As shown in part (c) of FIG. **6** and part (a) of FIG. **7**, in the residual toner accommodating unit **40**, a partition member **46** and a first residual toner accommodating screw **44** and a second residual toner accommodating screw **45** which are as a residual toner feeding member for feeding the residual toner in the residual toner accommodating portion **40***a*. The partition member **46** partitions a space in the residual toner accommodating unit **40** into a plurality of accommodating portions. The first residual toner accommodating screw **44** conveys the residual toner, dropped through the residual toner receiving opening **42**, in a longitudinal direction of the toner cartridge C (direction perpendicular to the drawing sheet of FIG. **6**). The second residual toner accommodating screw **45** receives drive from the first residual toner accommodating screw **44** and conveys the residual toner, conveyed by the first residual toner accommodating screw **44**, obliquely upward.

As shown in parts (a) and (b) of FIG. **7**, a driving force inputted from the above-described stirring drive input portion **38** is transmitted to a non-driving side of the toner supplying unit **30** via the stirring and conveying unit **36**, and thus is conveyed to a stirring member non-driving side gear **38***a*. By the stirring member non-driving side gear **38***a* and a residual toner accommodating portion gear train **47**, drive is transmitted to the first residual toner accommodating screw **44**. To the toner supplying unit **30** side and the residual toner accommodating unit **40** side, a driving-side

toner cartridge side cover **50** and a non-driving-side toner cartridge side cover **60** are mounted, respectively.

By the above-described constitution, even when the pump/screw drive input portion **39** is not driven, the stirring drive input portion **38** can be driven. That is, even when the toner supplying unit **30** does not supply the toner to the process cartridge B, a residual toner collectable state can be maintained by driving the first residual toner accommodating screw **44** and the second residual toner accommodating screw **45** in the residual toner accommodating unit **40**.

Further, the drive from the apparatus main assembly A can be inputted to one end of the toner cartridge C, so that a gear train of the apparatus main assembly A can be simplified. Further, by using the stirring and conveying unit **36**, the drive is transmitted from one end of the other end of the supplying portion frame **32**, so that the drive can be transmitted to the residual toner accommodating unit **40** without increasing the number of parts for drive transmission. By this, the residual toner can be accommodated in the toner cartridge C while suppressing upsizing of the toner cartridge C and the apparatus main assembly A in the rotational axis direction due to driving means for the toner cartridge C.

[Mounting and Dismounting Method of Process Cartridge B and Toner Cartridge C]

Then, a mounting and dismounting method of the process cartridge B and the toner cartridge C into and from the apparatus main assembly A will be described using FIGS. **4**, **7**, **8**, **9**, **10**, and **11**. Part (a) of FIG. **8** is a schematic view showing an inserting state of the process cartridge B into the apparatus main assembly A, and part (b) of FIG. **8** is a schematic perspective view showing an inserting state of the toner cartridge C into the apparatus main assembly A. Part (a) of FIG. **9** is a schematic side view showing the inserting state of the process cartridge B into the apparatus main assembly A, and part (b) of FIG. **9** is a schematic side view showing the inserting state of the toner cartridge C into the apparatus main assembly A. Part (c) of FIG. **9** is a schematic side view showing a mounted state of the process cartridge B and the toner cartridge C into the apparatus main assembly A. FIG. **10** is a side view of the process cartridge B, and FIG. **11** is a side view of the process cartridge B as viewed from a side opposite from a side in FIG. **10**.

As shown in part (a) of FIG. **8**, an inside space of the apparatus main assembly A is a mounting portion for the process cartridge B and the toner cartridge C. The openable door **107** is provided so as to be rotatable in an arrow R**5** direction about a rotational axis **107***a* relative to the apparatus main assembly A (see parts (a) to (c) of FIG. **9**). Parts (a) and (b) of FIG. **18** are schematic view showing a state in which the openable door **107** is open.

Further, the apparatus main assembly A includes guiding portions **108** and **109**. The guiding portions **108** and **109** are provided along a mounting direction D (mounting and dismounting direction) of the process cartridge B and the toner cartridge C, on opposite sides, respectively, with respect to the longitudinal direction of the process cartridge B and the toner cartridge C in a mounted state. The process cartridge B is, as shown in FIGS. **4**, **10**, and **11**, provided with upper bosses **93** and **94** and lower bosses **95** and **96** on opposite sides, respectively, with respect to the longitudinal direction, and on a side downstream of the upper bosses **93** and **94**, end bosses **97** and **98** are provided, respectively.

The mounting of the process cartridge B and the toner cartridge C into the apparatus main assembly A is performed from the process cartridge B. First, when the process cartridge B is mounted into the apparatus main assembly A, as shown in part (a) of FIG. **8** and part (a) of FIG. **9**, the upper boss **93** and the end boss **98** ride on the guiding portion **108** and sandwich the guiding portion **108** in cooperation with the lower boss **96**. Similarly, on the opposite side with respect to the longitudinal direction, the upper boss **93** and the end boss **97** ride on the guiding portion **109** and sandwich the guiding portion **109** in cooperation with the lower boss **95**. Thus, the process cartridge B is inserted while sandwiching the guiding portions **108** and **109** by the upper bosses **93** and **94**, the end bosses **97** and **98**, and the lower bosses **95** and **96**. By this, the process cartridge B is guided to the mounting portion inside the apparatus main assembly A along the guiding portions **108** and **109**.

This will be described more specifically. The mounting direction D of the process cartridge B is, as shown in FIG. **10**, a direction of a line L**3** connecting a lower end of the end boss **97** and a lower end of the upper boss **93**. When a user mounts the process cartridge B in the apparatus main assembly A with the end boss **97** (**98**) as a starting point in a raised attitude, the lower boss **96** (**95**) abuts on the guiding portion **108** (**109**), so that the attitude of the process cartridge B is restricted. A deviation amount between a direction at this time and the mounting direction D is a degree corresponding to play between the guiding portion **108** (**109**) and the lower boss **96** (**95**).

When the user mounts the process cartridge B with the upper boss **94** (**93**) as a starting point in a raised attitude, the lower boss **96** (**95**) abuts on the guiding portion **108** (**109**), so that the attitude of the process cartridge B is restricted. A deviation amount between a direction at this time and the mounting direction D is a degree corresponding to play between the guiding portion **108** (**109**) and the lower boss **96** (**95**).

As described above, the mounting direction D has some angle width depending on a mounting method of the user. In this embodiment, as another manner of expression of the mounting direction D, the mounting direction D is defined as follows. That is, the mounting direction D is defined as a direction (line L**4**) in which in a state that the photosensitive drum **11** and the developing roller **16** are in contact with each other, an angle α formed between the direction (line LA) and a line (first virtual line L**1**) connecting axial centers of the photosensitive drum **11** and the developing roller **16** is 3.8°±5°.

The toner cartridge C is provided with positioning bosses **50***a* and **60***a* on a front side (downstream side) with respect to the mounting direction D and on opposite sides with respect to the longitudinal direction as shown in parts (a) and (b) of FIG. **7**. Further, the toner cartridge C is provided with portions-to-be-guided **50***b* and **60***b* on a rear side (upstream side) with respect to the mounting direction D than the positioning bosses **50***a* and **60***a* and on opposite sides with respect to the longitudinal direction. The positioning boss **50***a* and the portion-to-be-guided **50***b* are provided on an outside end surface of the driving-side toner cartridge side cover **50** with respect to the axial direction. The positioning boss **60***a* and the portion-to-be-guided **60***b* are provided on an outside end surface of the non-driving-side toner cartridge side cover **60** with respect to the axial direction. The process cartridge B is provided with toner cartridge positioning portions **21***a* and **21***b* on the stay **21** as shown in parts (a) and (b) of FIG. **4**.

As shown in part (b) of FIG. **8** and part (b) of FIG. **9**, when the toner cartridge C is mounted into the apparatus main assembly A, the portions-to-be-guided **50***b* and **60***b* are placed on the guiding portions **108** and **109**, respectively, and are mounted in the mounting direction D. As shown in part (c) of FIG. **9**, when the toner cartridge C is mounted to

a mounting completion position, the positioning bosses **50***a* and **60***a* of the toner cartridge C enter the toner cartridge positioning portions **21***a* and **21***b*, respectively, of the process cartridge B. At this time, leading end sides of the portions-to-be-guided **50***b* and **60***b* with respect to the mounting direction D are separated from the guiding portions **108** and **109**, and trailing ends thereof are in a contact state with the guiding portions **108** and **109**. By this, the toner cartridge C is positioned to the process cartridge B. Further, the trailing ends of the portions-to-be-guided **50***b* and **60***b* contact the guiding portions **108** and **109**, so that a position of the toner cartridge C in the apparatus main assembly A is determined.

When the openable door **107** is closed after the process cartridge B and the toner cartridge C are mounted, the image forming apparatus **200** is in a state in which the image is capable of being formed. When the toner cartridge C and the process cartridge B are dismounted, a procedure reveres to the above-described procedure is performed. Incidentally, as shown in FIG. **10**, the process cartridge B is provided with a hole portion **210**.

[Charging Contact Constitution of Process Cartridge]

Next, details of a charging contact constitution of the process cartridge B in this embodiment will be described using FIGS. **12** to **16**. FIG. **12** is a perspective view of a periphery of an electrode member of the process cartridge B, and FIG. **13** is an exploded perspective view showing an extracted part of a structure of the periphery of the electrode member of the process cartridge B. Part (a) of FIG. **14** is a perspective view of the extracted part of the structure of the periphery of the electrode member of the process cartridge as viewed from a charging roller side in the embodiment, and part (b) of FIG. **14** is a perspective view of the extracted part of the structure of the periphery of the electrode member of the process cartridge B as viewed from an electrode member side. Part (a) of FIG. **15** is a front view showing a relationship between the electrode member of the process cartridge B and a spring contact of the apparatus main assembly A in the embodiment, part (b) of FIG. **15** is a sectional view taken along an f-f line of part (a) of FIG. **15**, and part (c) of FIG. **15** is a sectional view taken along a g-g line of part (a) of FIG. **15**.

FIG. **16** is a sectional view for illustrating a range in which diffusion of a spark in the electrode member is capable of being restricted (hereinafter, this range is referred to as a restricting range). FIG. **16** also shows a gravitational direction G.

As shown in FIGS. **12** and **13**, the cleaning unit **10** is provided with the cleaning frame **20** which is a frame and with the charging roller **12** which is the process member and the charging member. The process member is a member used in image formation, and the charging roller **12** is a rotatable member which is rotatably supported by the cleaning frame **20** and which is used in the image formation. Further, the cleaning frame **20** is constituted by a resin material, and in this embodiment, the cleaning frame **20** is constituted by a resin material of which grade of flame retardancy in UL94 standard is HB.

As shown in FIG. **13** and part (a) of FIG. **14**, a charging roller bearing **61** is connected to the cleaning frame **20** via a charging roller bearing spring **910**, so that the charging roller **12** is rotatably supported by the cleaning frame **20** via the charging roller bearing **61**. The charging roller **12** uniformly charges the surface of the photosensitive drum **11** by rotation thereof while being supplied with a predetermined voltage.

As shown in FIG. **12** and part (b) of FIG. **14**, in order to impart the predetermined voltage to the charging roller **12**, the cleaning unit **10** includes an electrode plate **901** which is an electrode member made of metal. The electrode plate **901** includes, as shown in parts (a) to (c) of FIG. **15**, an electroconductive connecting portion **901***b* (see FIG. **12**) electrically connected to the charging roller **12**. In addition, the electrode plate **901** includes a contact point portion (contact portion) **901***a* which is an electrical contact portion electrically connected to a spring contact **911** which is a main assembly-side electrode member provided on the apparatus main assembly A side.

The contact portion **901***a* is provided so as to be exposed to an outside of the cleaning frame **20** with respect to the rotational axis direction of the charging roller **12**. On the other hand, the electroconductive connecting portion **901***b* is inserted into the cleaning frame **20** and contacts the charging roller bearing spring **910**. Then, as shown in parts (a) to (c) of FIG. **15**, the contact portion **901***a* contacts the spring contact **911** which is an energizing member provided in the apparatus main assembly A. By the above-described constitution, the apparatus main assembly A is electrically connected to the charging roller **12** via the spring contact **911**, the electrode plate **901**, the charging roller bearing spring **910**, and the charging roller bearing **61**. Incidentally, the rotational axis direction of the charging roller **12** is substantially parallel to the longitudinal direction of the process cartridge B.

(Electrode Plate **901**)

Then, the electrode plate **901** will be further specifically described. As shown in FIGS. **12** and **15**, the contact portion **901***a* of the electrode plate **901** includes a bottom (surface) **901***c* which is an electrical contact surface, an inner wall surface **901***d* which is a connecting surface provided at a periphery of the bottom **901***c*, and an outermost surface which is a second surface. The outermost surface **901***f* is a surface positioned on an outermost side when the electrode plate **901** is mounted on the cleaning frame **20**. The bottom **901***c* is a single flat surface provided at a position lower than the outermost surface **901***f* by one stage with respect to a normal direction to the bottom **901***c* (see parts (b) and (c) of FIG. **15**).

That is, the outermost surface **901***f* is positioned on an outer side of the cleaning frame **20** than the bottom **901***c* with respect to the normal direction of the bottom **901***c*. In this embodiment, the outermost surface **901***f* is positioned on an outer side of the cleaning frame **20** than the bottom **901***c* with respect to the rotational axis direction of the charging roller **12**. Further, the bottom **901***c* and the outermost surface **901***f* are formed substantially parallel to each other, and are disposed so as to face the outside of the cleaning frame **20** with respect to the rotational axis direction of the charging roller **12**. Further, the bottom **901***c* is provided so that an angle of the bottom **901***c* falls within a range of −45° or more and +45° or less with respect to the gravitational direction in a state in which the process cartridge B is mounted in the apparatus main assembly A. The bottom **901***c* is provided so that the angle of the bottom **901***c* may preferably fall within a range of −30° or more and +30° or less, more preferably −10° or more and +10° or less, with respect to the gravitational direction. In this embodiment, the bottom **901***c* is provided parallel to the gravitational direction. Incidentally, the outermost surface **901***f* may only be required to be positioned on the outer side of the cleaning frame **20** than the bottom **901***c*, and may also be not parallel to the bottom **901***c*.

(Spring Contact **911**)

The spring contact **911** provided on the apparatus main assembly A side is disposed so as to enter toward the bottom **901***c* from a position opposing the electrode plate **901**. Specifically, the spring contact **911** is formed by bending a bar-like member made of metal. This bent portion passes through a level of the outermost surface **901***f* from the outside of the cleaning frame **20** and enters toward the bottom **901***c*, and thus becomes contactable to a part of the bottom **901***c* without contacting the outermost surface **901***f*. In this embodiment, the spring contact **911** is constituted so as to enter toward the bottom **901***c* side in a direction from the outside toward the inside of the cleaning frame **20** with respect to the rotational axis direction of the charging roller **12**.

The inner wall surface **901***d* of the contact portion **901***a* of the electrode plate **901** is an inclined surface provided so as to connect the outermost surface **901***f* and the bottom **901***c*, and is inclined with respect to the normal direction to the bottom **901***c*. An inside peripheral edge portion (inner peripheral edge portion) of the outermost surface **901***f* on the bottom **901***c* side is positioned outside an outer peripheral edge portion of the bottom **901***c*. The inner wall surface **901***d* is the inclined surface connecting the outer peripheral edge portion of the bottom **901***c* and the inner peripheral edge portion of the outermost surface **901***f*, and an inclination direction is a direction in which the inner wall surface **901***d* is away from the bottom **901***c* toward the outermost surface **901***f* from the bottom **901***c*.

Further, the inner wall surface **901***d* covers a whole periphery of the bottom **901***c*. The bottom **901***c*, the inner wall surface **901***d*, and the outermost surface **901***f* in this embodiment are formed so as to partially depressing a metal plate. Incidentally, the inner wall surface **901***d* may only be required to connect the outermost surface **901***f* and the bottom **901***c*, and needs not to cover the whole periphery of the bottom **901***c*. However, from a viewpoint of suppressing scattering of a spark described later, the inner wall surface **901***d* may preferably cover the whole periphery of the bottom **901***c*.

Here, the inner wall surface **901***d* may desirably be that a distance between opposing portions of the inner wall surface **901***d* is made sufficiently longer than a width of entrance of the spring contact **911** into the contact portion **901***a*. In this embodiment, as shown in part (a) of FIG. **15** or the like, the bottom **901***c* is a rectangular surface, and the outer peripheral edge portion of the bottom **901***c* has four sides. For this reason, as shown in parts (b) and (c) of FIG. **15**, the inner wall surface **901***d* has four surfaces **901***d***1**, **901***d***2**, **901***d***3**, and **901***d***4**. At this time, in the inner wall surface **901***d*, a distance between a side where the surface **901***d***1** connects with the outer peripheral edge portion of the bottom **901***c* and an opposite side where the surface **901***d***2** connects with the outer peripheral edge portion of the bottom **901***c* is a distance E**1**. Further, in the inner wall surface **901***d*, a distance between a side where the surface **901***d***3** connects with the outer peripheral edge portion of the bottom **901***c* and an opposite side where the surface **901***d***4** connects with the outer peripheral edge portion of the bottom **901***c* is a distance E**2**.

Further, when the spring contact **911** enters the contact portion **901***a*, a width of the spring contact **911** as viewed in part (b) of FIG. **15** is a width E**3**, and a width of the spring contact **911** as viewed in part (c) of FIG. **15** is a width E**4**. In this case, it is desirable that relationships of E**1**>E**3** and E**2**>E**4** are satisfied. By this, the spring contact **911** is capable of contacting the bottom **901***c* without contacting the inner wall surface **901***d*. Accordingly, an arrangement such that at a periphery of a contact point **901***e* (see FIG. **16**) between the spring contact **911** and the bottom **901***c*, the inner wall surface **901***d* is present, and on an outer surface side of the spring contact **911**, the outermost surface **901***f* is present is realized.

By this arrangement, as shown in FIG. **16**, even if a flammable foreign matter is caught by the contact point **901***e* and a spark is generated by a tracking phenomenon, the inner wall surface **901***d* which is a metal member functions a flame spread preventing wall. That is, a scattering direction of the generated spark is restricted to within a restriction range K. Here, the restriction range K is defined as follows.

(Restriction Range K)

That is, as shown in FIG. **16**, in a cross section perpendicular to the bottom **901***c*, an arbitrary point on a boundary between the inner wall surface **901***d* and the outermost surface **901***f* is a first point α**1**, and a point at a position opposing the first point α**1** on the boundary between the inner wall surface **901***d* and the outermost surface **901***f* is a second point α**2**. In this case, a line connecting a center of the bottom **901***c* and the first point α**1** is a first line β**1**, and a line connecting the center of the bottom **901***c* and the second point α**2** is a second line **2**. In an example of the illustration of FIG. **16**, at the center of the bottom **901***c*, the contact point **901***e* between the bottom **901***c* and the spring contact **911** exists. Further, a range from the first line β**1** to the second line β**2** is defined as the restriction range K in which the scattering of the spark is restricted. In this embodiment, this restriction range k is 120° or more. That is, an angle formed between the first line β**1** and the second line **2** is 120° or more. The angle formed between the first line β**1** and the second line β**2** may preferably be 170° or less, more preferably be 160° or less, further preferably be 150° or less.

Thus, by setting the angle formed between the first line β**1** and the second line β**2**, a depth of the bottom **901***c* from the outermost surface **901***f* and an interval of opposite boundaries each between the bottom **901***c* and the outermost surface **901***f* can be appropriately set. Here, when the depth of the bottom **901***c* from the outermost surface **901***f* is excessively deep, a dimension of the electrode plate **901** with respect to a depth direction becomes large, and leads the upsizing of the apparatus. Further, relative to this depth, when the interval of the opposite boundaries each between the bottom **901***c* and the outermost surface **901***f* is excessively short, there is a liability that the scattering of the spark cannot be sufficiently suppressed. For this reason, in this embodiment, the restriction range K is restricted as described above.

Further, in this embodiment, the bottom **901***c* is disposed substantially parallel to the gravitational direction G. For this reason, the scattered spark drops in the gravitational direction G, and thus is not readily deposited on the cleaning frame **20**. Incidentally, the bottom **901***c* may also be not parallel to the gravitational direction G, and for example, the bottom **901***c* may be inclined with respect to the gravitational direction G so as to be directed downward.

In this embodiment, as described above, the scattering of the spark toward the cleaning frame **20** can be suppressed, and therefore, as the resin material of the cleaning frame **20**, it is possible to select a material low in flame retardancy. In general, relative to the material low in flame retardancy, a resin material high in flame retardancy is high in resin weight and large in environmental load by adding an additive thereto. By restricting the diffusion of the spark and by

selecting the material low in flame retardancy, it is possible to obtain a constitution good in safety and environmental property.

[Electrical Contact of Developing Unit of Process Cartridge]

Subsequently, electrical contacts of the developing unit **15** of the process cartridge B will be described using FIGS. **10**, **11**, **17**, and **18**. Parts (a) and (b) of FIG. **17** are schematic views showing electrical contacts of the apparatus main assembly A corresponding to the developing unit **15** of the process cartridge B. FIG. **18** is a side view showing positions of the electrical contacts of the developing unit **15** in a state in which the developing roller **16** of the process cartridge B is separated from the photosensitive drum **11**.

As shown in FIGS. **10** and **11**, the process cartridge B includes a developing contact (first electrical contact portion) **16***b*, a developing blade contact (second electrical contact portion) **18***a*, and a supplying roller contact (third electrical contact portion) **13***a* at an end portion on a side opposite from the developing coupling **155** with respect to the longitudinal direction thereof. The developing contact **16***b* is a contact for supplying electric power from the apparatus main assembly A to the developing roller **16** which is a power receiving member. The developing blade contact **18***a* is a contact for supplying the electric power to the developing blade **18** which is a power receiving member. The supplying roller contact **13***a* is a contact for supplying the electric power to the supplying roller **13** which is a power receiving member.

That is, the developing contact **16***b* is an electrical contact portion electrically connected to the developing roller **16** and for being supplied with the electric power, for being supplied to the developing roller **16**, from the outside of the process cartridge B. The developing blade contact **18***a* is an electrical contact portion electrical by connected to the developing blade **18** and for being supplied with the electric power, for being supplied to the developing blade **18**, from the outside of the process cartridge B. The supplying roller contact **13***a* is an electrical contact portion electrically connected to the supplying roller **13** and for being supplied with the electric power, for being supplied to the supplying roller **13**, from the outside of the process cartridge B.

Here, the photosensitive drum **11** is constituted so as to be rotated about a first rotational axis **11***a*. The developing roller **16** is constituted so as to be rotated about a second rotational axis **16***a*. As shown in FIG. **10**, as viewed in a direction of the first rotational axis **11***a*, a virtual line passing through the first rotational axis **11***a* and the second rotational axis **16***a* is a first virtual line L**1**. In this case, the developing contact **16***b* which is a first electrical contact surface, the developing blade contact **18***a* which is a second electrical contact surface, and the supplying roller contact **13***a* which is a third electrical contact surface are provided on a second virtual line L**2** parallel to the first virtual line L**1**, and are arranged in a direction in which the second vertical line L**2** extends. Further, of the developing contact **16***b*, the developing blade contact **18***a*, and the supplying roller contact **13***a*, the developing contact **16***b* is in a position closest to the developing roller **16**. Further, in the direction in which the second virtual line L**2** extends, from a side close to the developing roller **16**, the developing contact **16***b*, the developing blade contact **18***a*, and the supplying roller contact **13***a* are arranged in a named order. Further, with respect to a direction perpendicular to the second virtual line L**2**, a length of each of the developing contact **16***b*, the developing blade contact **18***a*, and the supplying roller contact **13***a* is longer as the contact is in a position remoter from the developing roller **16** in the direction in which the second virtual line L**2** extends. Incidentally, the order of arrangement of these three electrical contact surfaces may also be not the above-described order of the developing contact **16***b*, the developing blade contact **18***a*, and the supplying roller contact **13***a*.

In this embodiment, each of the contacts is disposed on a side upstream of the swing axis **8** with respect to the mounting direction D. Further, the order of the respective contacts is such that from a downstream side toward an upstream side of the mounting direction D, the developing contact **16***b*, the developing blade contact **18***a*, and the supplying roller contact **13***a* are arranged in a named order. The developing contact **16***b*, the developing blade contact **18***a*, and the supplying roller contact **13***a* are disposed so that their heights (lengths) H**16***b*, H**18***a*, and H**13***a*, respectively, in a direction perpendicular to the mounting direction D satisfy a relationship of: H**13***a*>H**18***a*>H**16***b*.

Further, also, as regards lengths of the developing contact **16***b*, the developing blade contact **18***a*, and the supplying roller contact **13***a* in a swing direction about the swing axis **8** (pin **6**) which is a swing center of the developing unit **15**, these lengths become longer as the associated contact is remoter from the swing axis **8**. In FIG. **10**, a virtual arc M**1** about the swing axis **8**, a virtual arc M**2** about the swing axis **8**, and a virtual arc M**3** about the swing axis **8** pass through the developing contact **16***b*, the developing blade contact **18***a*, and the supplying roller contact **13***a*, respectively. Each of directions indicated by these virtual arcs is the swing direction of the developing unit **15** with the swing axis **8** (pin **6**) as a swing center, and the length in this direction becomes longer as the associated contact is away from the swing axis **8**. Incidentally, in this embodiment, when the developing unit **15** is viewed in the direction of the first rotational axis **11***a*, with respect to the direction in which the second virtual line L**2** extends, the position of the swing axis **8** (pin **6**) of the developing unit **15** is present between the second rotational axis **16***a* and the developing contact **16***b*.

The apparatus main assembly A includes, as shown in part (a) of FIG. **17**, a main assembly(-side) developing contact **108***a*, a main assembly(-side) developing blade contact **108***b*, and a main assembly(-side) supplying roller contact **108***c* as contacts corresponding to the developing contact **16***b*, the developing blade contact **18***a*, and the supplying roller contact **13***a*, respectively. With respect to the mounting direction D, these contacts **108***a*, **108***b*, and **108***c* are disposed so as to become higher, in a direction perpendicular to the mounting direction D, toward the upstream side of the mounting direction D. That is, the main assembly developing contact **108***a*, the main assembly developing blade contact **108***b*, and the main assembly supplying roller contact **108***c* are disposed, so as to become higher in the named order.

As shown in part (b) of FIG. **17**, the main assembly supplying roller contact **108***c* is urged so as to be projected toward the process cartridge B by an urging spring **108***d* urged toward the supplying roller contact **13***a*. During mounting of the process cartridge B, by a taper-shaped portion **108***c***2** of the main assembly supplying roller contact **108***c*, the process cartridge B is capable of being received. After the mounting of the process cartridge B is completed, a main assembly supplying roller contact end **108***cl* of the main assembly supplying roller contact **108***c* contacts the supplying roller contact **13***a*, so that electric power supply is carried out. The main assembly developing contact **108***a* and the main assembly developing blade contact **108***b* also have similar constitutions. That is, the main assembly developing contact **108***a* includes a taper-shaped portion **108***a***2** and a

main assembly developing contact end **108***a***1**. The main assembly developing blade contact **108***b* includes a taper-shaped portion **108***b***2** and a main assembly developing blade contact end **108***b***1**.

When the main assembly contacts are disposed as described above, the ends of the main assembly contacts are disposed in the following manner. That is, as shown in FIG. **10**, points where the respective contacts of the process cartridge B contact the ends (**108***a***1**, **108***b***1**, **108***c***1**) of the main assembly contacts are disposed so as to become high toward the upstream side of the mounting direction D.

As shown in FIG. **18**, even in a state in which the developing roller **16** is separated from the photosensitive drum **11**, each of the contacts is separated away from the swing center toward the upstream side of the mounting direction D, and therefore, a movement amount of each contact becomes large. As described above, the heights of the contacts in the direction perpendicular to the mounting direction D satisfy H**13***a*>H**18***a*>H**16***b*, so that the ends (**108***a***1**, **108***b***1**, **108***c***1**) of the main assembly contacts are not detached from the contacts (**16***b*, **18***a*, **13***a*) of the process cartridge B.

That is, also during the separation, the electric power can be supplied to each of the contacts.

Further, as shown in FIG. **18**, a most upstream contact with respect to the mounting direction D is disposed so that a position thereof during contact between the photosensitive drum **11** and the developing roller **16** and a position thereof during separation between the photosensitive drum **11** and the developing roller **16** at least partially overlap with each other as viewed in an axial direction of the developing roller **16**. By the above, energizing contacts can be stably obtained even during the separation without upsizing the process cartridge B. Further, in this embodiment, the order of arrangement of the contacts is the developing contact **16***b*, the developing blade contact **18***a*, and the supplying roller contact **13***a* from a downstream side of the mounting direction D, but may also be a different order.

Incidentally, in the above-described embodiment, the case where the electrode plate **901** which is the charging contact is the metal plate was described. However, the electrode plate **901** may also be made of an electroconductive resin, and even in this case, an effect similar to the above-described effect can be obtained.

Another Embodiment

Another embodiment will be described using FIG. **19**. Incidentally, this (another) embodiment is different from the above-described embodiment in constitution of the electrode plate **902** which is the charging contact. Other constitutions and actions are similar to those in the above-described embodiment, and therefore, constituent elements in another embodiment similar to those in the above-described embodiment are omitted from illustration and description or briefly described by adding the same reference numerals or symbols thereto, and in the following, a difference from the above-described embodiment will be principally described.

A contact portion **902***a* of an electrode plate **902** in this (another) embodiment includes an inner wall surface **902***d* which is an electrical contact surface and an outermost surface **902***f* which is a second surface positioned on an outside of the cleaning frame **20** than the inner wall surface **902***d* with respect to the longitudinal direction of the process cartridge B. The inner wall surface **902***d* is constituted by a plurality of flat surfaces different in normal direction from each other. The plurality of flat surfaces connect an apex P remote from the outermost surface **902***f* with the outermost surface **901***f* with respect to the longitudinal direction of the process cartridge B. In the another embodiment, by the plurality of flat surfaces, a polygonal pyramid-shaped portion (excluding a bottom) is constituted. For this reason, it can also be said that the plurality of flat surfaces constitute side surfaces of the polygonal pyramid and connect the apex P with the outermost surface **901***f*. The outermost surface **902***f* is positioned outside the cleaning frame **20** than the apex P of the polygonal pyramid with respect to the longitudinal direction of the process cartridge B. Further, in the another embodiment, the inner wall surface **902***d* is constituted by four flat surfaces each having a triangular shape.

In such a shape, the spring contact **911** and the electrode plate **902** contact at a contact point **902***e* on the inner wall surface **902***d*. By this, in the case where a spark generated from the contact point **902***e* on the inner wall surface **902***d* is scattered, each of other surfaces of the inner wall surface **902***d* which are not the surface as a part of the inner wall surface **902***d* at which the spark is generated, is capable of restricting the scattering of the spark.

For example, as shown in FIG. **19**, it is assumed that the contact point **902***e* exists on a surface **902***d***1** which is a part of the inner wall surface **902***d*, and that the spark is generated at this surface **902***d***1**. Even in that case, the inner wall surface **902***d* has the above-described polygonal pyramid shape, and therefore, other surfaces **902***d***2**, **902***d***3**, and **902***d***4** of the inner wall surface **902***d* function as a flame preventing wall. By this, it is possible to suppress the scattering of the spark to the cleaning frame **20**.

Further, in the another embodiment, a restriction range K is defined in the following manner. An arbitrary point on a boundary between the plurality of the flat surfaces and the outermost surface **902***f* is a first point, and on the boundary between the plurality of flat surfaces and the outermost surface **902***f*, a point at a position opposing the first point in a cross section passing through the apex P and the first point is a second point. In this case, a range between a first line connecting the apex P and the first point and a second line connecting the apex P and the second point is defined as the restriction range K. Further, an angle formed between the first line and the second line is 120° or more.

In other words, of the plurality of flat surfaces constituting the inner wall surface **902***d*, in the case where an arbitrary flat surface is a first flat surface and a flat surface at a position opposing the first flat surface is a second flat surface, a range from the first flat surface to the second flat surface is the restriction range K. In the another embodiment, this restriction range is 120° or more. That is, an angle formed between the first flat surface and the second flat surface is 120° or more. Specifically, an angle formed between the surface **902***d***1** and the surface **902***d***3** opposing the surface **902***d***1** is 120° or more, and an angle formed between the surface **902***d***2** and the surface **902***d***4** opposing the surface **902***d***2** is 120° or more. An upper limit of the restriction range K is similar to the upper limit in the above-described embodiment.

Incidentally, in the above-described embodiments, the inner wall surface **902***d* has the recessed shape which is the polygonal pyramid shape, but the inner wall surface **902***d* may also have a conical shape. Further, a cross-sectional shape of the inner wall surface **902***d* parallel to the outermost surface **902***f* may be, other than the polygonal shape and the circular shape, shapes such as an elliptical shape and a combination of an arc and a flat surface, and the like.

As described above, the electrode member on the cartridge side is constituted as in the above-described embodi-

ments, so that it is possible to provide a cartridge high in freedom of selection of the material of the frame. In the following, a constitution of the wire spring which is the main assembly-side electrode member will be described.

Embodiment 1

[Main Assembly Contact Constitution Using Conventional Coil Spring]

A conventional constitution for comparison with an embodiment 1 will be described using parts (a) to (c) of FIG. **20**. Part (a) of FIG. **20** is a front view showing an electrical contact portion of an apparatus main assembly using a conventional coil spring, part (b) of FIG. **20** is a sectional view taken along an i-i line of part (a) of FIG. **20**, and part (c) of FIG. **20** is a schematic view for illustrating a rotation stopper. Parts (a) and (b) of FIG. **21** are sectional views each showing the electrical contact portion of the apparatus main assembly A using the conventional coil spring for comparison with the embodiment 1. Incidentally, the embodiment 1 is different from the above-described embodiments in constitution of main assembly(-side) contacts (main assembly (-side) developing contact, main assembly(-side) supplying roller contact). Other constitutions and actions are similar to those in the above-described embodiments, and therefore, constituent elements in the embodiment 1 similar to those in the above-described embodiments are omitted from illustration and description or briefly described by adding the same reference numerals or symbols thereto, and in the following, a difference from the above-described embodiments will be principally described.

In the case of the main assembly contacts as shown in FIG. **17** described in the above-described embodiments, part costs of the main assembly developing contact **108***a*, the main assembly developing blade contact **108***b*, the main assembly supplying roller contact **108***c*, and the urging spring **108***d* are high. For this reason, a wire spring constitution including a torsion coil shown in FIG. **20** is employed in some instances.

A wire spring **201** which is a contact member includes a torsion coil portion **201***b* which is a coil portion, a first arm portion **201***f* extending from the torsion coil portion **201***b*, and a second arm portion **201***j* extending from the torsion coil portion **201***b* toward a side opposite from the first arm portion **201***f*. The torsion coil portion **201***b* is on a side upstream of the first arm portion **201***f* with respect to the mounting direction. The first arm portion **201***f* includes, between the torsion coil portion **201***b* and a free end **201***p*, a first portion **201***g*, a projected portion **201***a* which is a contact portion, a second portion **201***h*, a fifth portion **201***i*, and a retainer **201***c* which is a third portion in a named order. The torsion coil portion **201***b* is mounted to a boss portion **204***a* which is a supporting portion of a main assembly guiding part **204**.

The first portion **210***g* extends so as to approach the bottom **901***c* as the first portion **201***g* approaches from the torsion coil portion **201***b* toward the projected portion **201***a* in the mounting direction. The second portion **201***h* extends so as to be away from the bottom **901***c* as the second portion **201***h* extends from the projected portion **201***a* toward a direction in which the second portion **201***h* is away from the first portion **201***g* in the mounting direction. Each of the first portion **201***g* and the second portion **201***h* extends linearly. Of angles formed between the first portion **201***g* and the second portion **201***h*, a smaller angle is an obtuse angle.

The retainer **201***c* extends toward a second direction Dr**2**. Incidentally, the mounting direction of the process cartridge B is a first direction Dr**1**, a direction which is a direction of a center axis R**0** of the torsion coil portion **201***b* and which crosses the mounting direction is the second direction Dr**2**, and a direction perpendicular to the mounting direction and a rotational axis direction is a third direction Dr**3**. The fifth portion **201***i* is provided between the second portion **201***h* and the retainer **201***c*. The fifth portion **201***i* extends toward an upstream side of the mounting direction.

Further, the main assembly guiding part **204** includes the rotation stopper **204***d* which is a restricting portion contacting the second arm portion **201***j* of the wire spring **201** so as to restrict rotation of the wire spring **201** when the projected portion **201***a* of the wire spring **201** receives a force in the third direction Dr**3**.

However, in the case of the wire spring **201**, the projected portion **201***a* (contact point) of the wire spring **201** rotates about the torsion coil portion **201***b*. For this reason, there is a liability that the projected portion **201***a* of the wire spring **201** enters the hole portion **210** of the process cartridge B and is stuck in the hole portion **210** during insertion and extraction of the process cartridge B, and thus the wire spring **201** is broken. The hole portion **210** of the process cartridge B described herein refers to a hole portion which open at a side surface of the process cartridge B as shown in FIGS. **10** and **11**.

In the conventional process cartridge B, a position of the hole portion was shifted or the like so that the wire spring **201** does not enter the hole portion **210** of the process cartridge B during the insertion and the extraction of the process cartridge B, but it would be considered that there is no room for the shift in position of the hole portion **210** with downsizing of the process cartridge B. For example, as shown in FIG. **10**, when the process cartridge B is inserted in the mounting direction D or extracted in an opposite direction, a locus of the hole portion **210** of the process cartridge B and the end **108***a***1** of the main assembly contact overlap with each other. In order to avoid this, for example, it would be considered that the position of the hole portion **210** is shifted in a direction perpendicular to the mounting direction D. However, when the position of the hole portion **210** is moved to another position for downsizing the process cartridge B, such movement has the influence on another part, and therefore, a state in which the position of the hole portion **210** cannot be moved even in the direction perpendicular to the mounting direction D.

Parts (a) and (b) of FIG. **21** are schematic views each for illustrating the wire spring **201** and the hole portion **210** of the process cartridge B as viewed in the same cross-sectional direction as part (b) of FIG. **20**. Part (a) of the FIG. **21** is the schematic view showing a state in which the wire spring **201** enters the hole portion **210** of the process cartridge B and is stuck in the hole portion **210**, and part (b) of FIG. **21** is the schematic view showing a state in which countermeasures are taken so that the wire spring **201** does not enter the hole portion **210** of the process cartridge B.

FIG. **22** is a schematic view showing a state in which the wire spring **201** is inclined, and part (a) of FIG. **23** is a schematic view in which the wire spring **201** is viewed from an inside of the image forming apparatus **200**. Part (b) of FIG. **23** is a sectional view taken along a j-j line of part of FIG. **23** before the wire spring **201** is inclined, and part (c) of FIG. **23** is a sectional view taken along the j-j line of part (a) of FIG. **23** after the wire spring **201** is inclined.

As the countermeasures to the entrance of the wire spring **201** into the hole portion **210**, a bending angle θ**1** of the wire spring **201** shown in part (a) of FIG. **21** is made large so as to become a bending angle θ**2** shown in part (b) of FIG. **21**

(θ2>θ1). By this, a wire spring length Ls becomes longer than a hole width Lc of the hole portion **210** of the process cartridge B (Ls>Lc), so that it becomes possible to prevent that the wire spring **201** enters the hole portion **210** of the process cartridge B and is stuck in the hole portion **210**. Here, the wire spring length Ls is length, in the mounting direction D, from a bent portion **201***e* of the wire spring **201** to the contact portion **201***d* where the wire spring **201** contacts an edge portion **210***a* of the hole portion **210** (see FIG. **21**).

However, correspondingly to an increase in bending angle of the wire spring **201**, the wire spring **201** is upsized. When the wire spring **201** is upsized and is inclined in an arrow H direction as shown in FIG. **22**, a rotation angle increases. Then, as shown from part (b) of FIG. **23** to part (c) of FIG. **23**, the retainer **201***c* of the wire spring **201** is inclined, so that there is a liability that the wire spring **201** is slipped out of a slit-like hole portion **202** of the main assembly guiding part in an arrow I direction of part (c) of FIG. **23**. For that reason, even when a user touches the wire spring **201** or the like and thus the wire spring **201** is inclined, there is a need to take countermeasures to disengagement of the wire spring **201** from the image forming apparatus **200**.

[Main Assembly Contact Constitution]

Next, a constitution of a wire spring **208** which is a contact member contacting each of the contacts of the process cartridge B in the embodiment 1 will be described using FIGS. **24**, **25**, and **26**. Part (a) of FIG. **24** is a schematic view showing a constitution of the wire spring **208** in the embodiment 1, and part (b) of FIG. **24** is a schematic view showing the constitution of the wire spring **208** as viewed from "DOWN" shown in part (a) of FIG. **24**. Incidentally, in FIG. **24**, the first direction Dr**1**, the second direction Dr**2**, the third direction Dr**3**, and the like are also shown. Parts (a) and (b) of FIG. **25** are schematic views for illustrating a contact state of the wire spring **208** to each of the contacts of the process cartridge B, in which part (a) of FIG. **25** is the schematic view of the wire spring **208** and the contacts of the process cartridge B as viewed from a side surface of the image forming apparatus **200**, and part (b) of FIG. **25** is a perspective view of the wire spring **208** and the contacts of the process cartridge B.

As shown in FIG. **24**, the wire spring **208** which is a contact member includes a torsion coil portion **208***b* which is a coil portion, a first arm portion **208***f* extending from the torsion coil portion **208***b*, and a second arm portion **208***j* extending from the torsion coil portion **208***b* toward a side opposite from the first arm portion **208***f*. The first arm portion **208***f* includes, between the torsion coil portion **208***b* and a free end **208***p*, a first portion **208***g*, a projected portion **208***a* which is a contact portion, a second portion **208***h*, a fifth portion **208***i*, a retainer **208***c* which is a third portion, and a fourth portion **208***k* is a named order.

The first portion **208***g* extends so as to approach the developing contact **16***b* (or the developing blade contact **18***a* or the supplying roller contact **13***a*) as the first portion **208***g* approaches from the torsion coil portion **208***b* toward the projected portion **208***a* in the mounting direction. The second portion **208***h* extends so as to be away from the developing contact **16***b* (or the developing blade contact **18***a* or the supplying roller contact **13***a*) as the second portion **208***h* extends from the projected portion **208***a* toward a direction in which the second portion **208***h* is away from the first portion **208***g* in the mounting direction. Of angles formed between the first portion **208***g* and the second portion **208***h*, a smaller angle is an obtuse angle. This angle is 120 degrees or more and 160 degrees or less. The retainer **208***c* extends linearly toward the second direction Dr**2**.

As shown in FIG. **25**, a main assembly(-side) developing contact **208**A which is a first contact member contacts the developing contact **16***b* of the process cartridge B. A main assembly(-side) supplying roller contact **208**B which is a second contact member contacts the supplying roller contact **13***a*. A main assembly(-side) developing blade contact **208**C which is a third contact member contacts the developing blade contact **18***a*.

FIG. **26** is a schematic view for illustrating the wire spring **208** in a state in which the process cartridge B is pulled out from the image forming apparatus **200**. Part (a) of FIG. **27** is a schematic view in which the wire spring **208** is viewed from an inside of the image forming apparatus **200**, part (b) of FIG. **27** is a sectional view taken along a k-k line of part (a) of FIG. **27**, and part (c) of FIG. **27** is a sectional view taken along an 1-1 line of part (a) of FIG. **27**. Incidentally, in part (a) of FIG. **27**, a rectangular frame line **204***b***1** indicated by a broken line in a hole portion **204***b* is an opening portion corresponding to a position where the retainer **208***c* exists with respect to the first direction Dr**1**.

As shown in part (b) of FIG. **27**, the torsion coil portion **208***b* of the wire spring **208** is mounted to the boss portion **204***a* which is a supporting portion of the main assembly guiding part **204**. The main assembly guiding part **204** is a supporting member provided with the boss portion **204***a* supporting the torsion coil portion **208***b*. Incidentally, the main assembly guiding part **204** includes the rotation stopper **204***d* which is a restricting portion contacting the second arm portion **208***j* of the wire spring **208** so as to restrict rotation of the wire spring **208** when the projected portion **208***a* receives a force in the third direction Dr**3** (see part (c) of FIG. **20**).

The wire spring **208** forms the projected portion (contact portion) **208***a* which passes through the hole portion **204***b* of the main assembly guiding part **204** and which contacts each of the contacts of the process cartridge B. The hole portion **204***c* has a slit shape, for example. As shown in part (c) of FIG. **27**, the wire spring **208** then passes through the hole portion **204***b* of the main assembly guiding part **204** again, so that the retainer **208***c* functioning as a rotation stopper and a retainer during rotation of an end of the wire spring **208** on an outside of an insertion and extraction area of the process cartridge B, and the fourth portion **208***k* (the retainer **208***c* and the fourth portion **208***k* are a wire spring end portion **208***n*) are formed. The wire spring end portion **208***n* includes a first bending portion **208***l* and a second bending portion **208***m* on the outside of the insertion and extraction area of the process cartridge B (see part (a) of FIG. **24**). The wire spring end portion **208***n* has a shape, after being bent at the first bending portion **208***l* and the second bending portion **208***m*, having a width L**2** wider than a width L**1** of the hole portion **204***b* of the main assembly guiding part **204** (L**2**>L**1**). Incidentally, the wire spring **208** in the embodiment 1 includes the fourth portion **208***k* bent from the retainer **208***c*, and therefore, although a constitution in which the wire spring **208** is not readily disengaged from the hole portion **204***b*, the wire spring **208** becomes further hard to be disengaged from the hole portion **204***b* by satisfying the relationship of L**2**>L**1**.

Here, the width L**2** is a length of the fourth portion **208***k* in the third direction Dr**3** when the wire spring **208** is viewed in the second direction Dr**2**. Thus, the fourth portion **208***k* of the wire spring **208** extends toward the third direction Dr**3** as viewed in the mounting direction.

The width L2 of the fourth portion **208***k* as viewed in the mounting direction is wider than the width L1 of the opening in the second direction Dr2 at a position where the retainer **208***c* with respect to the mounting direction when the main assembly guiding part **204** is viewed in a direction perpendicular thereto (see part (c) of FIG. **27**).

Thus, the wire spring **208** in the embodiment 1 has a shape such that the wire spring **208** extends, toward the cartridge-side electrical contact, to the projected portion **208***a* and is bent at the projected portion **208***a*, and then extends in a direction away from the cartridge-side electrical contact. The wire spring **208** includes the wire spring end portion **208***n* for restricting rotation of the wire spring **208** when the wire spring **208** is rotated. For that reason, a constitution in which even when the wire spring **208** is rotated about the torsion coil portion **208***b*, the wire spring end portion **208***n* cannot be disengaged by being caused to pass through the hole portion **204***b* of the main assembly guiding part **204** is realized.

[Constitution in Case that Main Assembly Contact is Inclined]

Next, a constitution in which the wire spring **208** in the embodiment 1 is inclined will be described using FIGS. **28** and **29**. FIG. **28** is a schematic view for illustrating a state in which the wire spring **208** in FIG. **26** is inclined, part (a) of FIG. **29** is a schematic view in which the wire spring **208** is viewed from the inside of the image forming apparatus **200**, and part (b) of FIG. **29** is a sectional view taken along an m-m line of part (a) of FIG. **29**. The main assembly guiding part **204** includes an opposite wall **204***c* which opposes a side surface of the process cartridge B provided with the developing contact **16***b* (or the developing blade contact **18***a* or the supplying roller contact **13***a*) and which is provided with the hole portion **204***b* which is an opening extending in the mounting direction. The wire spring **208** is disposed so that the projected portion **208***a* projects relative to the opposite wall **204***c* through the hole portion **204***b* in the third direction Dr3 toward a side where the developing contact **16***b* (or the developing blade contact **18***a* or the supplying roller contact **13***a*) exists and so that the retainer **208***c* and the fourth portion **208***k* exist on a side opposite from the side where the developing contact **16***b* (or the developing blade contact **18***a* or the supplying roller contact **13***a*) exists, with respect to the opposite wall **204***c*. Further, the main assembly guiding part **204** includes a rib **209** which is an engaging portion engaging with the retainer **208***c* so as to restrict movement of the first arm portion **208***f* in a direction in which the first arm portion **208***f* approaches the developing contact **16***b* (or the developing blade contact **18***a* or the supplying roller contact **13***a*) in the third direction Dr3.

In FIG. **28**, a state in which the wire spring **208** is inclined in an arrow H direction is shown, and as shown in part (b) of FIG. **29**, even when the wire spring **208** is inclined, the width L2 of the fourth portion **208***k* is wider than the width L1 of the hole portion **204***b* of the main assembly guiding part **204**. A constitution in which even when the wire spring **208** is inclined within a deformable range, the fourth portion **208***k* cannot be disengaged through passing thereof through the hole portion **204***b* of the main assembly guiding part **204**, by satisfying L1<L2 is employed. Further, by the rib **209** shown in part (b) of FIG. **29**, the fourth portion **208***k* is caught by the rib **209**, and therefore, a constitution in which the fourth portion **208***k* does not further readily approach the hole portion **204***b* of the main assembly guiding part **204** is realized.

By the above-described constitutions, the electric power can be supplied to each of the contacts of the process cartridge B by the wire spring **208**, and it becomes possible to prevent that even when the wire spring **208** is inclined, the fourth portion **208***k* passes through the hole portion **204***b* of the main assembly guiding part **204** and is disengaged through the hole portion **204***b*. Further, by employing the constitution of the embodiment 1, the wire spring can be used as the main assembly contact, so that it becomes possible to reduce a cost of the main assembly contact.

As described above, according to the embodiment 1, even in the case where a force is applied to the wire spring, the wire spring can be made hard to be disengaged from the apparatus main assembly.

Embodiment 2

An embodiment 2 will be described using parts (a) and (b) of FIG. **30**. Part (a) of FIG. **30** shows the case where a shape of the wire spring end portion is different on the same sectional view as part (b) of FIG. **29**, and part (b) of FIG. **30** is a detailed perspective view of a wire spring end portion. In the embodiment 1, a constitution in which the wire spring end portion **208***n* was bent so that the wire spring end portion **208***n* had a roughly U-shape as shown in part (b) of FIG. **29** was described.

However, as shown in parts (a) and (b) of FIG. **30**, a constitution in which a first bending portion **208***l* and a second bending portion **208***m* are provided in a direction in which the wire spring end portion **208***n* does not have the roughly U-shape and in which **208***n* is bent is employed, so that a constitution in which L1<L2 is satisfied may be realized.

That is, in the embodiment 1, the fourth portion **208***k* was bent so as to be parallel to a virtual plane defined by the fifth portion **208***i* and the retainer **208***c*, specifically, so as to fall within the virtual plane. In the embodiment 2, the fourth portion **208***k* is bent in a direction (for example, the third direction Dr3) crossing a virtual plane defined by the fifth portion **208***i* and the retainer **298***c*. By doing so, a constitution in which the wire spring end portion **208***n* cannot be disengaged from the main assembly guiding part **204** through passing thereof through the hole portion **204***b* of the main assembly guiding part **204** is realized.

As described above, according to the embodiment 2, even when a force is applied to the wire spring, the wire spring can be made hard to be disengaged from the apparatus main assembly.

Embodiment 3

An embodiment 3 will be described using parts (a) and (b) of FIG. **31**. Part (a) of FIG. **31** shows the case where a shape of the wire spring end portion is different on the same sectional view as part (b) of FIG. **29**, and part (b) of FIG. **31** is a detailed perspective view of a wire spring end portion **208***n*'. In the embodiment 1, a constitution in which the wire spring end portion **208***n* was bent so that the wire spring end portion **208***n* had a roughly U-shape as shown in part (b) of FIG. **29** was described.

However, as shown in parts (a) and (b) of FIG. **31**, a retainer **208***c*' may have a shape such that the retainer **208***c*' extends curvedly. By employing a constitution in which the retainer **208***c*' extends in a substantially U-shape or a circular arc shape toward a free end **208***p*, a constitution in which L1<L2 is satisfied may be realized.

Incidentally, as shown in part (b) of FIG. **31**, in the case where the wire spring **208** includes the substantially U-shaped retainer **208***c*', the width L**2** is defined in the following manner. As shown in part (a) of FIG. **31**, the width L**2** includes the free end **208***p* and the fourth portion **208***k* as viewed in the second direction Dr**2** and is a length from the free end **208***p* to a projected portion **208***c*'**1** of the retainer **208***c*' in the third direction Dr**3**. By doing so, a constitution in which the wire spring end portion **208***n*' cannot be disengaged from the main assembly guiding part **204** through passing thereof through the hole portion **204***b* of the main assembly guiding part **204** is realized.

As described above, according to the embodiment 3, even when a force is applied to the wire spring, the wire spring can be made hard to be disengaged from the apparatus main assembly.

OTHER EMBODIMENTS

In the above-described embodiments, description was made by taking, as an example, the electrode plate constitution provided to the process cartridge B as the cartridge, but this is an example of the constitution of the present invention, and an effect thereof is not limited to the effect of such a process cartridge B. For example, an electroconductive contact portion provided to the developing unit **15** may be used. In this case, for example, at least one of the developing roller **16**, the supplying roller **13**, and the developing blade **18** corresponds to a process member.

Here, the cartridge refers to a cartridge (unit) which includes at least one of a developer, an image bearing member such as the photosensitive drum, and the process member, such as the charging member, actable on the photosensitive drum and which is detachably mountable to the apparatus main assembly of the image forming apparatus of the electrophotographic type. As a representative example of the cartridge, it is possible to cite a process cartridge using the photosensitive drum and the developing unit in combination, and a drum cartridge (the above-described cleaning unit) including the photosensitive drum, the charging roller, and the cleaning member. In addition, it is possible to cite a developing cartridge (the above-described developing unit), a toner cartridge for accommodating the toner, and the like. The present invention is applicable to these various cartridges.

Further, in the above-described embodiments, the image forming apparatus including the single photosensitive drum was described, but the present invention is not limited thereto. For example, the present invention is also applicable to a color image forming apparatus of a tandem type including a plurality of photosensitive drums.

Further, in the above-described embodiment, as the image forming apparatus, the laser printer was described as an example, but the image forming apparatus may also be an LED printer or the like. The image forming apparatus forms an image on a recording medium (for example, sheet materials such as plain paper, a synthetic resin sheet which is a substitute for the plain paper, thick paper, a sheet for an overhead projector, and so on). Accordingly, the image forming apparatus in the present invention includes a copying machine, a printer, a facsimile machine, a multi-function machine having a plurality of functions of these machines.

As described above, also in the above-described other embodiments, even in the case where a force is applied to the wire spring, the wire spring can be made hard to be disengaged from the apparatus main assembly.

While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

This application claims the benefit of Japanese Patent Application No. 2023-084481 filed on May 23, 2023, which is hereby incorporated by reference herein in its entirety.

What is claimed is:

1. An image forming apparatus comprising:

a unit including an electrical contact surface and a power receiving member configured to receive supply of electric power via the electric contact surface; and

a main assembly to which the unit is detachably mounted, the main assembly including

a contact member configured to supply the electric power to the power receiving member in contact with the electrical contact surface of the unit, the contact member being a wire spring including a coil portion and an arm portion which extends from the coil portion and which has a free end, wherein the arm portion includes a first portion, a contact portion, a second portion, a third portion, and a fourth portion in a named order between the coil portion and the free end,

wherein the main assembly includes a supporting member provided with a supporting portion for supporting the coil portion,

wherein when a mounting and dismounting direction of the unit is a first direction, a direction which is a direction of a center axis of the coil portion and which crosses the first direction is a second direction, and a direction crossing the first direction and the second direction is a third direction,

the first portion, the contact portion, and the second portion are arranged along the first direction,

the contact portion is configured to contact the electrical contact surface,

the first portion extends so as to approach the electrical contact surface as the first portion approaches the contact portion from the coil portion in the first direction,

the second portion extends away from the electrical contact surface as the second portion extends from the contact portion in the first direction toward a direction away from the first portion, and

the third portion extends toward the second direction,

wherein the supporting member includes an opposite wall which opposes a side surface of the unit provided with the electrical contact surface and which is provided with an opening extending in the first direction,

wherein the contact portion projects in the third direction through the opening toward a side where the electrical contact surface is present with respect to the opposite wall,

wherein the contact member is provided so that the third portion and the fourth portion are present on a side opposite from the side where the electrical contact surface is present with respect to the opposite wall, and

wherein the fourth portion of the contact member extends toward the third direction as viewed in the first direction.

2. The image forming apparatus according to claim **1**, wherein a length of the fourth portion as viewed in the first direction is longer than a width of the opening in the second

direction in a position where the third portion is present in the first direction as viewed in a direction perpendicular to the supporting member.

3. The image forming apparatus according to claim **1**, wherein the third portion extends linearly.

4. The image forming apparatus according to claim **1**, wherein the third portion extends curvedly.

5. The image forming apparatus according to claim **1**, wherein the coil portion is on a side upstream of the arm portion with respect to a mounting direction of the first direction.

6. The image forming apparatus according to claim **1**, wherein the arm portion includes a fifth portion between the second portion and the third portion, and

wherein the fifth portion extends toward an upstream side of a mounting direction of the first direction.

7. The image forming apparatus according to claim **1**, wherein each of the first portion and the second portion extends linearly, and

wherein a smaller angle of angles formed between the first portion and the second portion is an obtuse angle.

8. The image forming apparatus according to claim **7**, wherein the smaller angle is 120 degrees or more and 160 degrees or less.

9. The image forming apparatus according to claim **1**, wherein the supporting member includes a restricting portion contacting the fourth portion of the wire spring so as to restrict rotation of the wire spring when the contact portion of the wire spring receives a force in the third direction.

10. The image forming apparatus according to claim **1**, wherein the supporting member includes an engaging portion configured to engage with the third portion so as to restrict movement of the arm portion in a direction approaching the electrical contact surface in the third direction.

11. The image forming apparatus according to claim **1**, wherein the power receiving member is a developing roller which carries toner.

12. The image forming apparatus according to claim **11**, wherein when the electrical contact surface and the power receiving member are a first electrical contact surface and a first power receiving member, respectively, the unit includes a second electrical contact surface and a second power receiving member configured to receive the supply of the electric power via the second electrical contact surface,

wherein when the contact member is a first contact member, the main assembly includes a second contact member configured to supply the electric power to the second power receiving member in contact with the second electrical contact surface, and

wherein the second contact member has the same shape as the first contact member.

13. The image forming apparatus according to claim **12**, wherein the unit includes a third electrical contact surface and a third power receiving member configured to receive the supply of the electric power via the third electrical contact surface,

wherein the main assembly includes a third contact member configured to supply the electric power to the third power receiving member in contact with the second electrical contact surface, and

wherein the third contact member has the same shape as the first contact member.

14. The image forming apparatus according to claim **13**, wherein the first electrical contact surface, the second electrical contact surface, and the third electrical contact surface are arranged along the first direction.

15. The image forming apparatus according to claim **12**, wherein when the opening of the opposite wall is a first opening, the opposite wall is provided with a second opening,

wherein when the contact portion is a first contact portion, the second contact member includes a second contact portion projecting in the third direction through the second opening toward a side where the second electrical contact surface is present, so as to contact the second electrical contact surface, and

wherein the second opening includes a portion which is in a position different from the first opening with respect to the second direction and which is in the same position as the first opening with respect to the first direction.

16. The image forming apparatus according to claim **12**, wherein the second power receiving member is a developing blade configured to regulate a layer thickness of the toner on the developing roller.

17. The image forming apparatus according to claim **12**, wherein the second power receiving member is a developing blade configured to regulate a layer thickness of the toner on the developing roller, and

wherein the third power receiving member is a supplying roller configured to supply the toner to the developing roller.

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