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Matsuda

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(54) **IMAGE FORMING APPARATUS WITH A STOPPER TO BLOCK INSERTION OF A TONER CONTAINER**

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G03G 21/16 (2006.01)
G03G 15/08 (2006.01)
G03G 21/18 (2006.01)

(52) **U.S. Cl.**
CPC ***G03G 21/1647*** (2013.01); ***G03G 15/0867*** (2013.01); ***G03G 15/0872*** (2013.01); ***G03G 21/1633*** (2013.01); ***G03G 21/1676*** (2013.01); ***G03G 21/1842*** (2013.01); *G03G 2215/0665* (2013.01); *G03G 2221/169* (2013.01)

(58) **Field of Classification Search**
CPC G03G 21/1647; G03G 15/0867; G03G 21/1676; G03G 15/0872; G03G 15/0886; G03G 21/1633; G03G 2221/169; G03G 2215/0665; G03G 2215/0695; G03G 21/1842
See application file for complete search history.

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Primary Examiner — Stephanie E Bloss
Assistant Examiner — Laura Roth
(74) *Attorney, Agent, or Firm* — XSENSUS LLP

(57) **ABSTRACT**

An image forming apparatus includes an apparatus body, a detachable unit detachably attached to the apparatus body, a metal plate component, an insertion cover, and a stopper. The insertion cover has an insertion opening into which the detachable unit is insertable in an insertion direction. The stopper includes a blocking projection and a contact. The blocking projection is inside the insertion opening of the insertion cover. The blocking projection has a shape that matches with a groove of the detachable unit compatible with the apparatus body and does not match with a groove of the detachable unit incompatible with the apparatus body. The contact contacts the metal plate component in a direction orthogonal to the insertion direction.

11 Claims, 21 Drawing Sheets

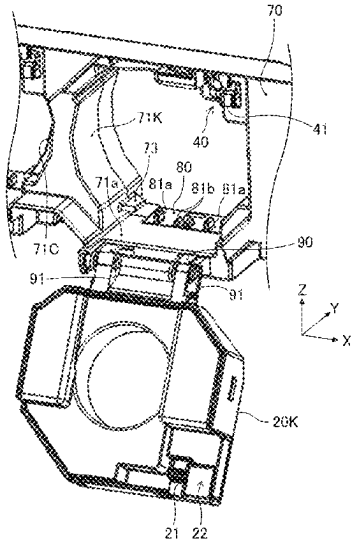

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FIG. 1

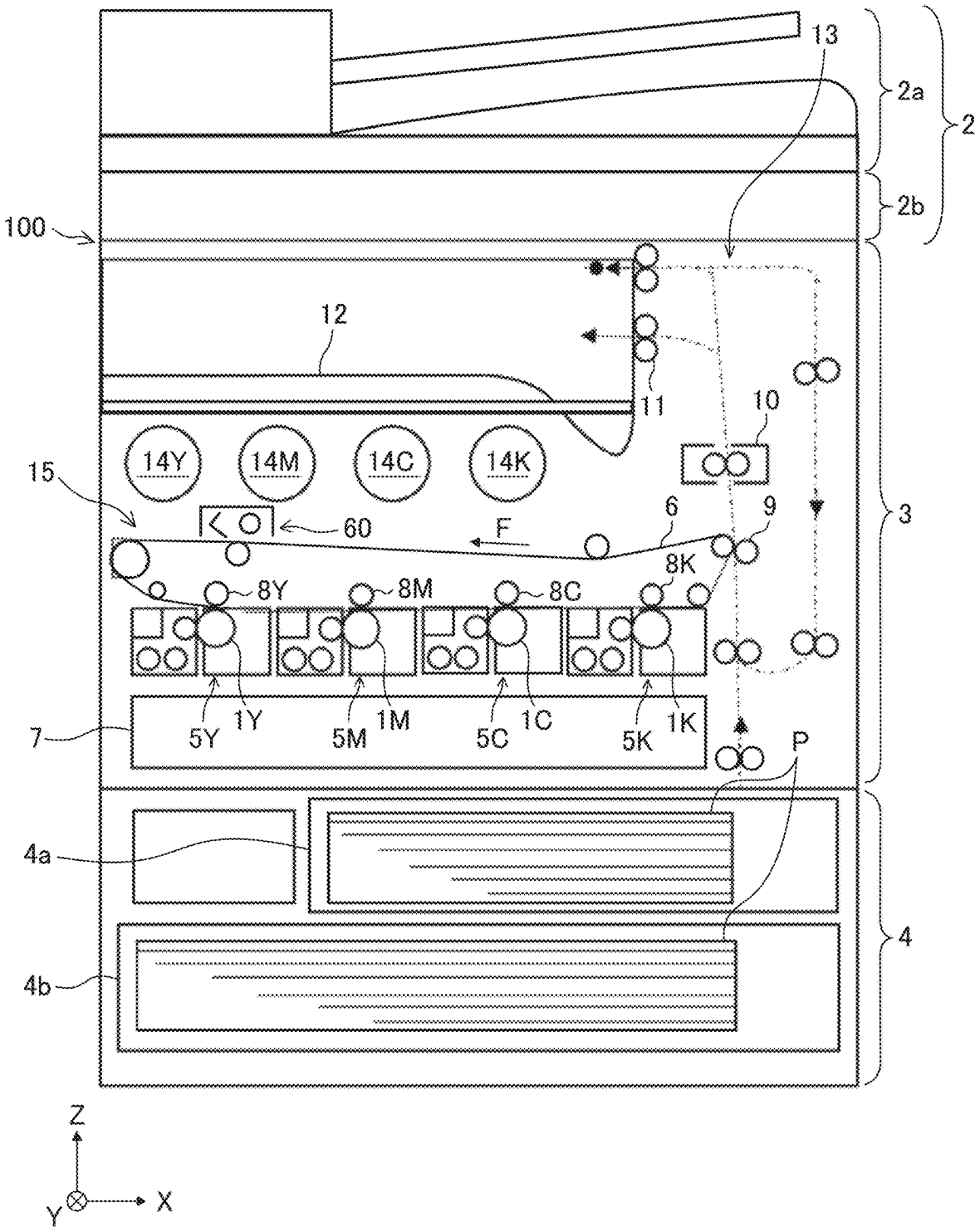
13
2a
2
2b
100
12
11
10
14Y
14M
14C
14K
15
60
F
6
9
3
8K
8Y
8M
8C
7
5Y
1Y
5M
1M
5C
1C
5K
1K
P
4a
4
4b
Z
Y
X

FIG. 2A

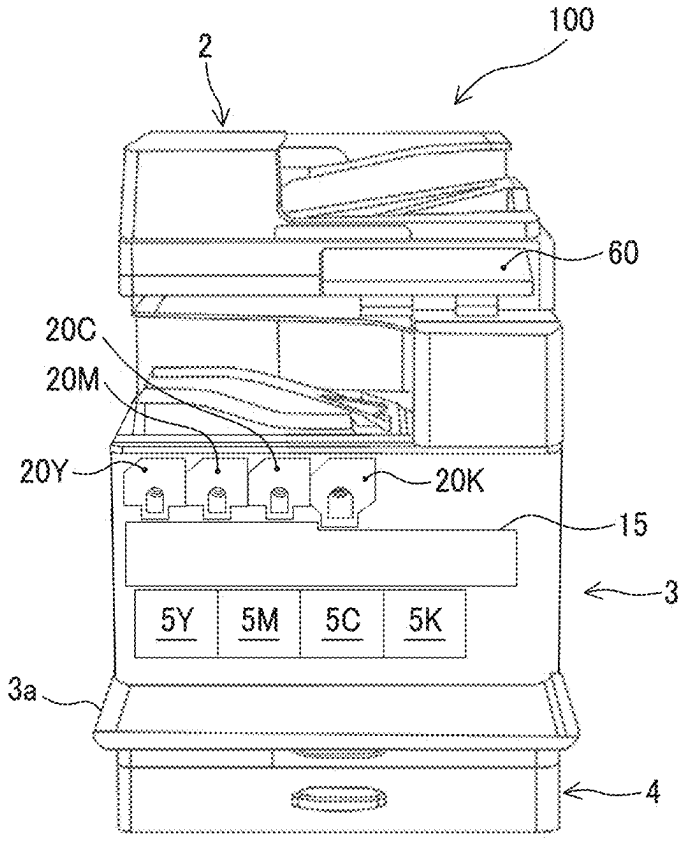
100
2
60
20C
20M
20Y
20K
15
3
5Y
5M
5C
5K
3a
4

FIG. 2B

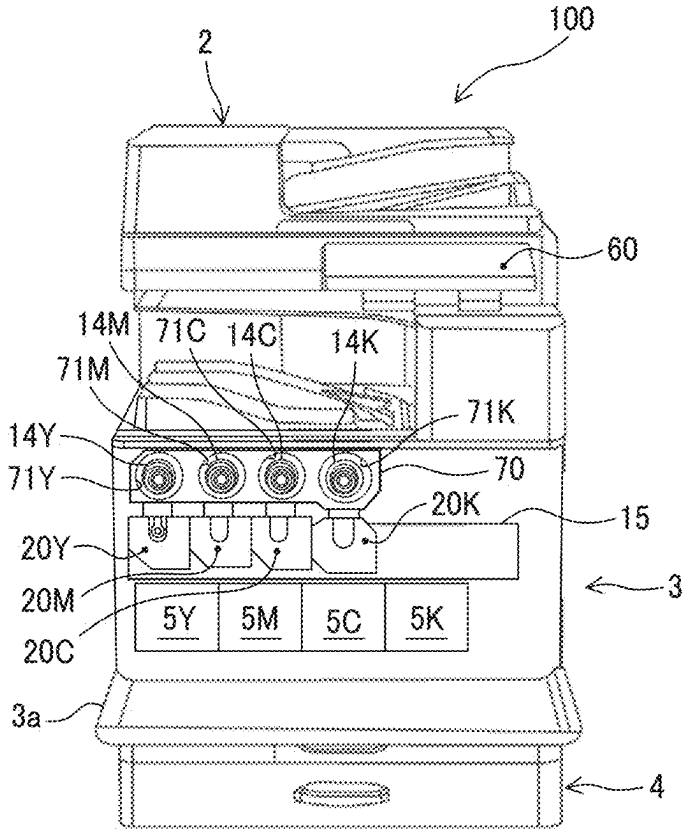
100
2
60
14M
71C
14C
14K
71M
71K
14Y
71Y
70
20K
15
20Y
20M
20C
3
5Y
5M
5C
5K
3a
4

FIG. 3

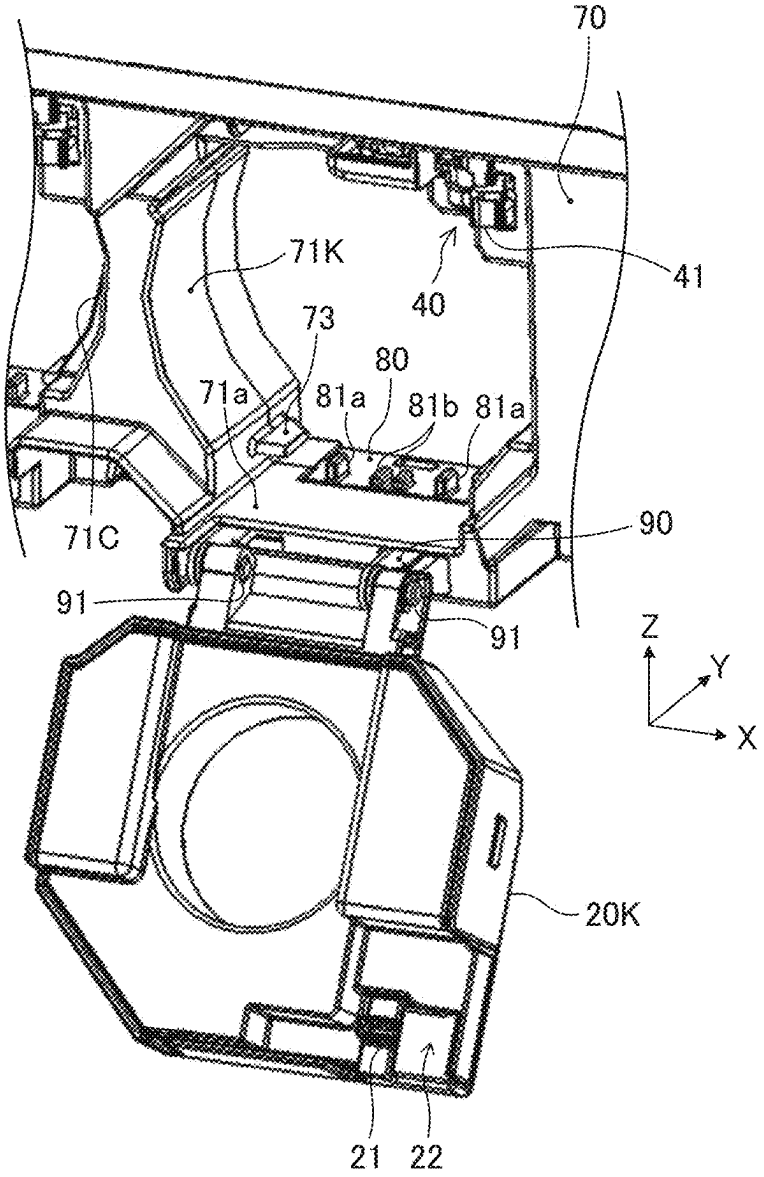

FIG. 4

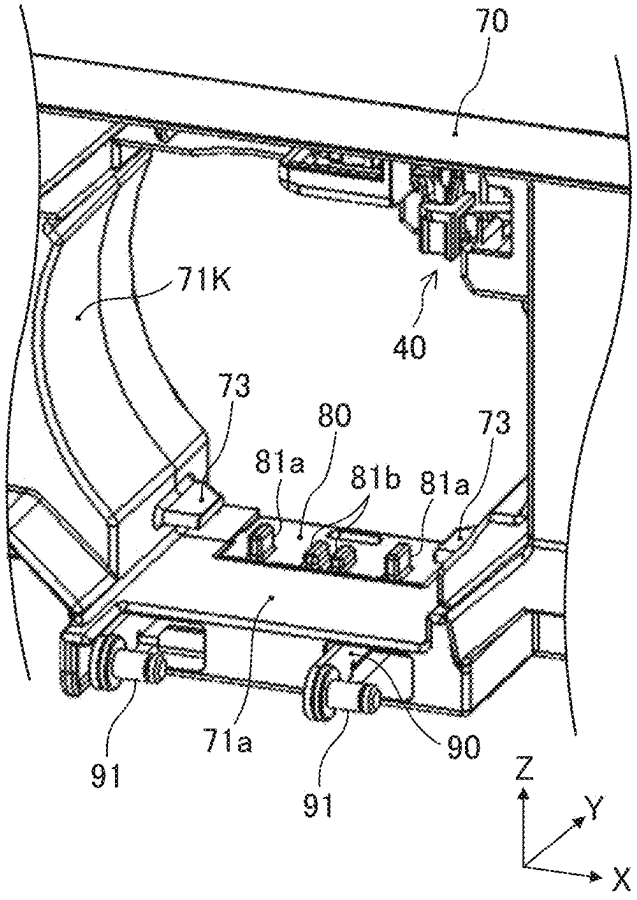

FIG. 5

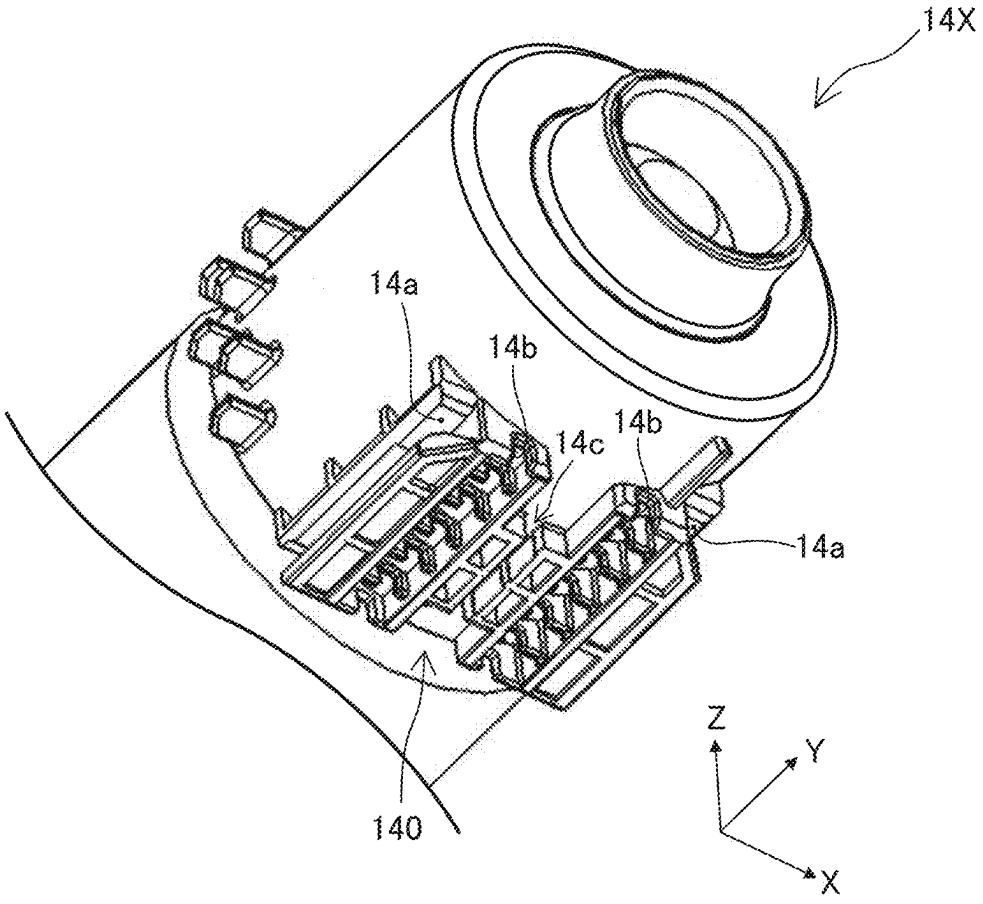

FIG. 6

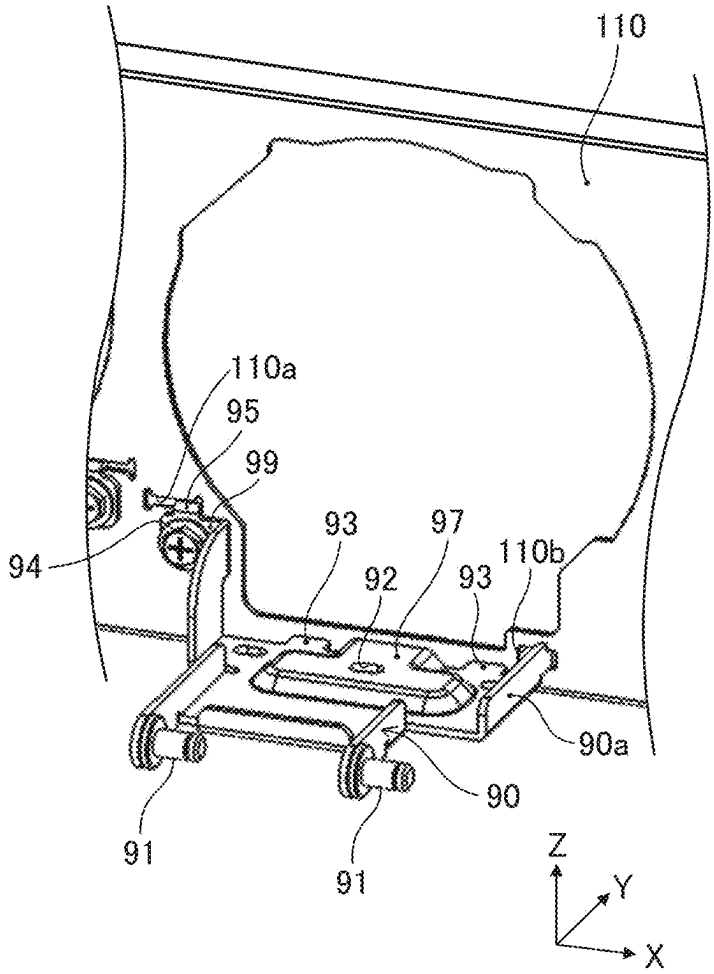

FIG. 7

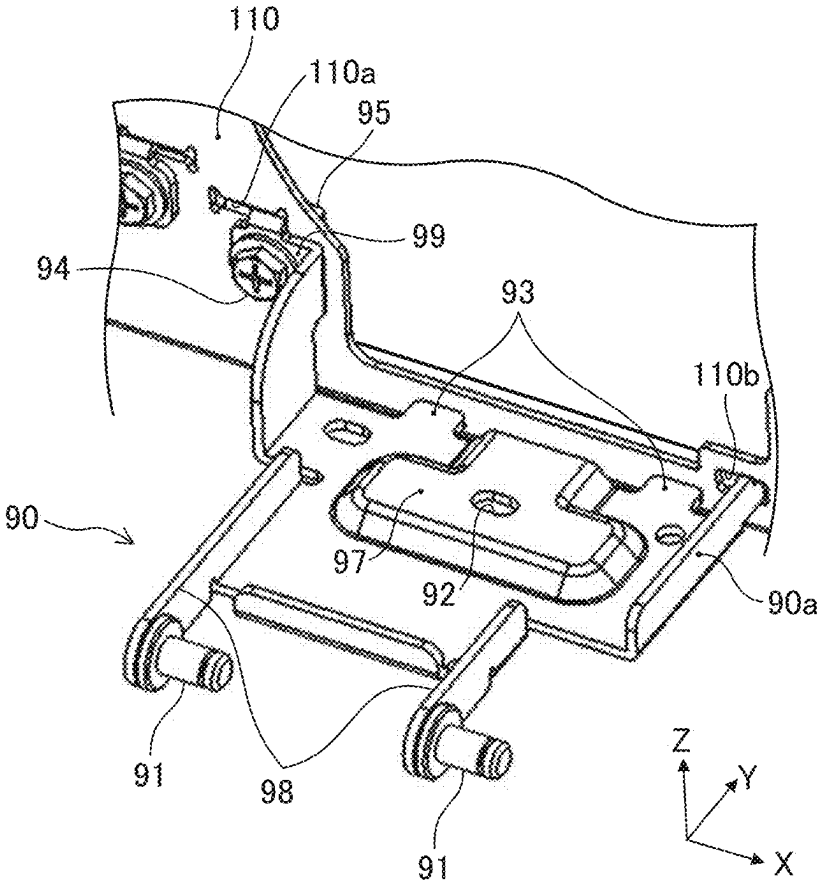

FIG. 8

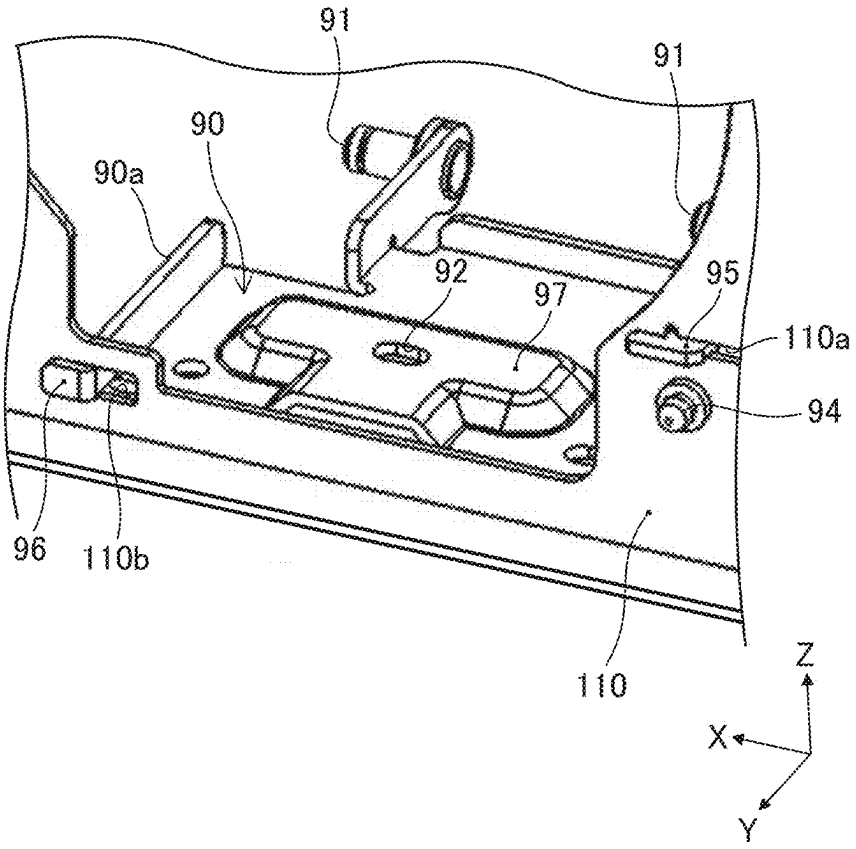
91
91
90
90a
92
97
95
110a
94
96
110b
110
Z
X
Y

FIG. 9

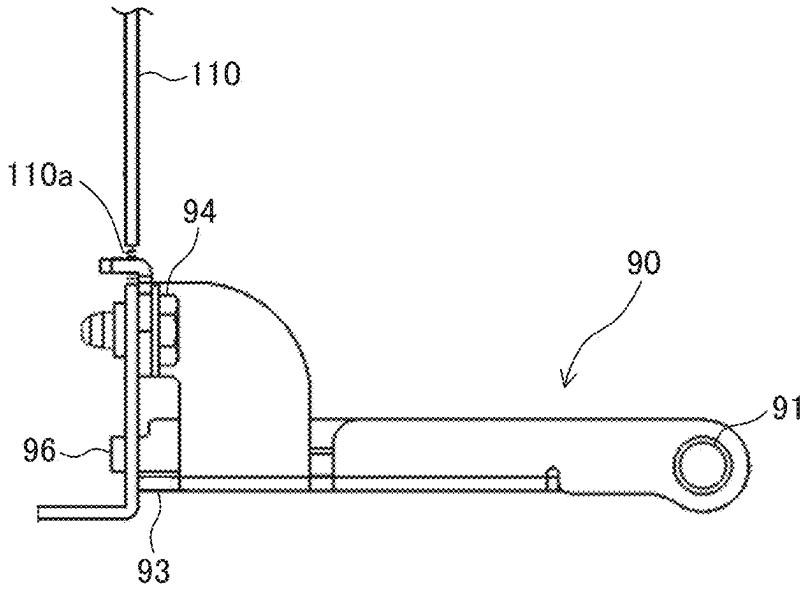
110
110a
94
90
91
96
93

FIG. 10

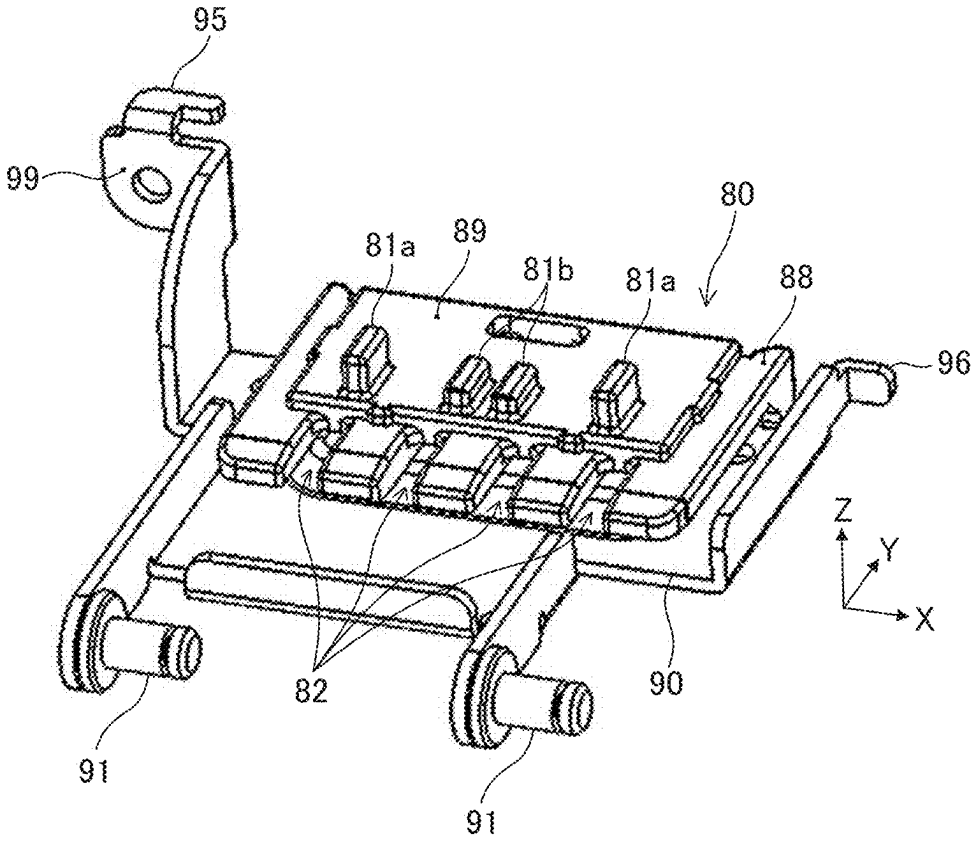

FIG. 11

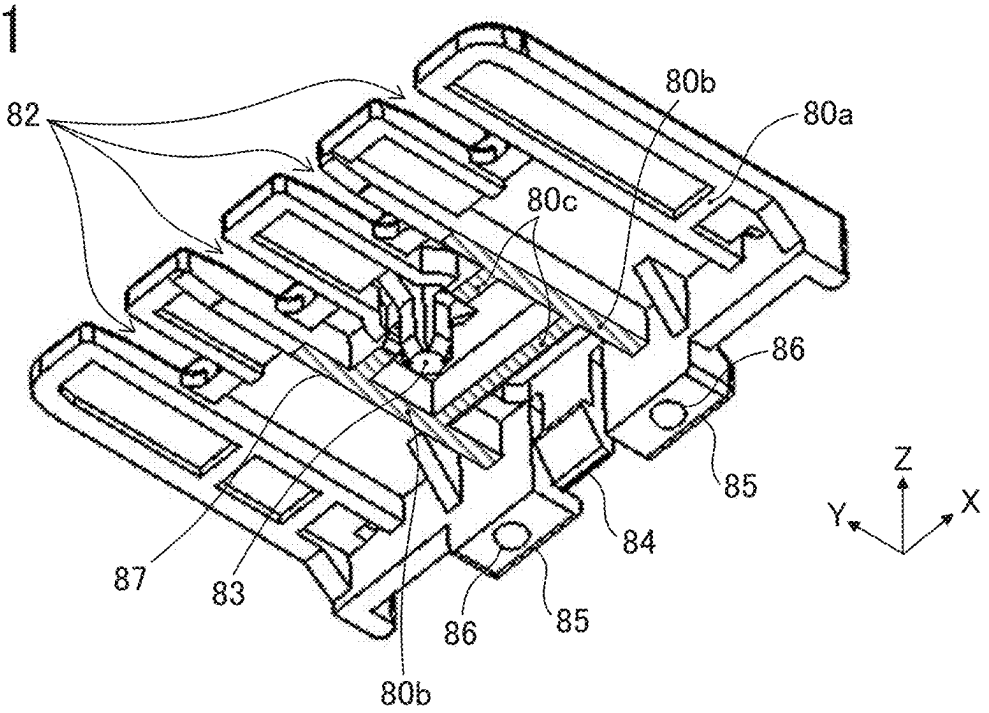
82
80b
80a
80c
86
85
84
87
83
86
85
80b
Z
Y
X

FIG. 12

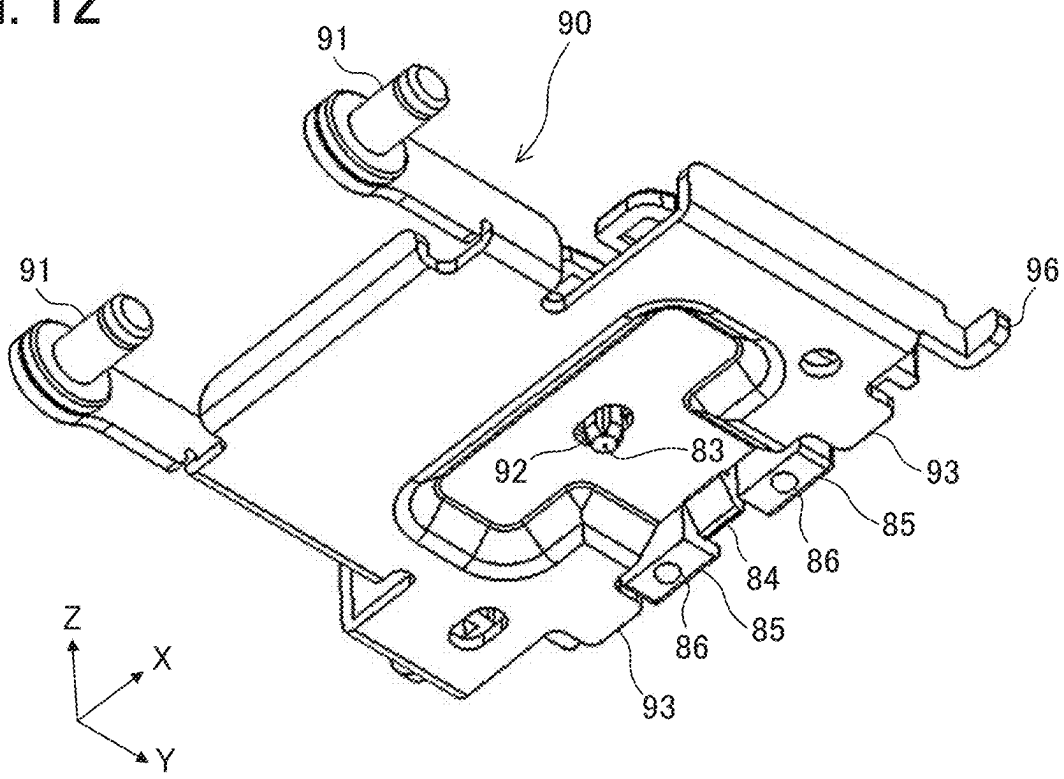
91
90
91
96
92
83
93
85
86
84
86
85
93
Z
X
Y

FIG. 13

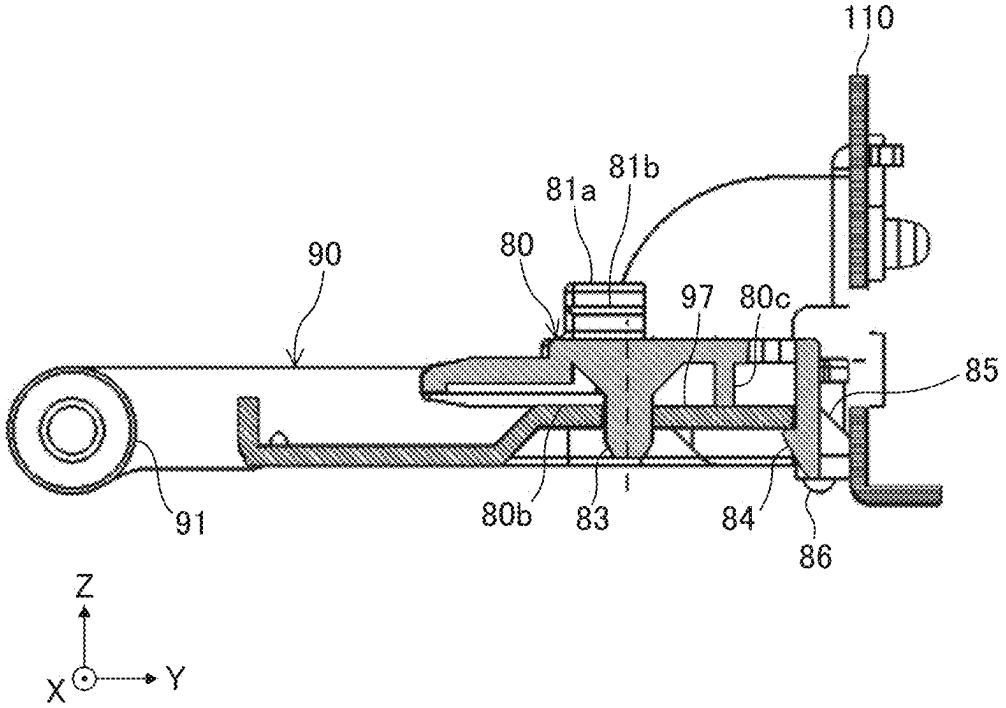

FIG. 14

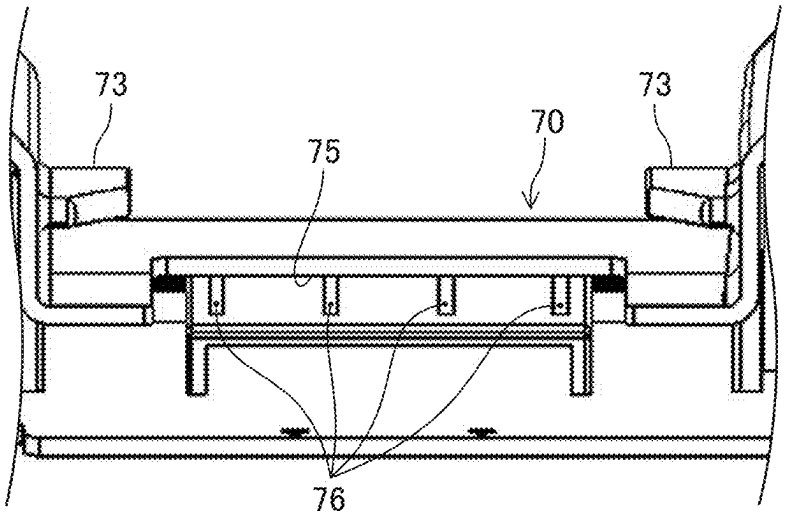

FIG. 15

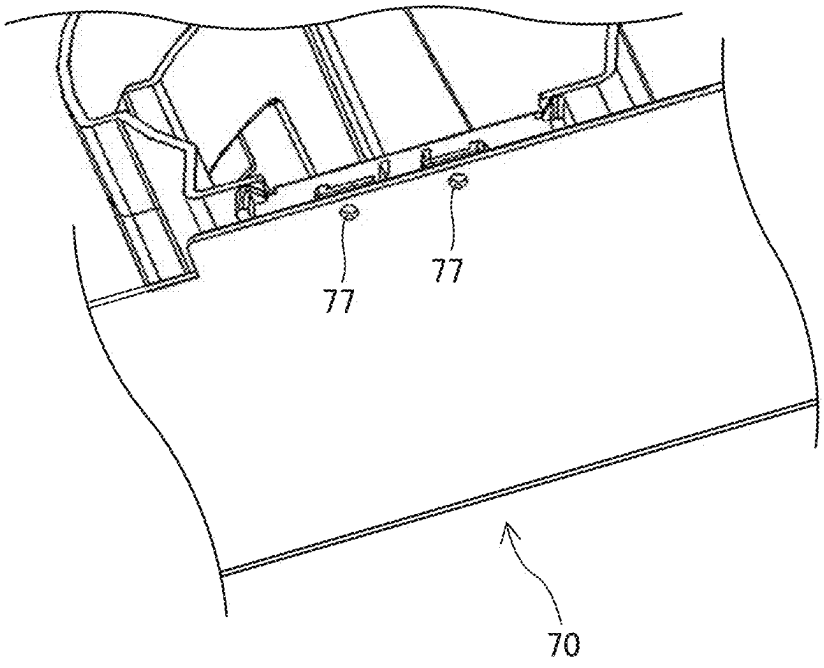

FIG. 16

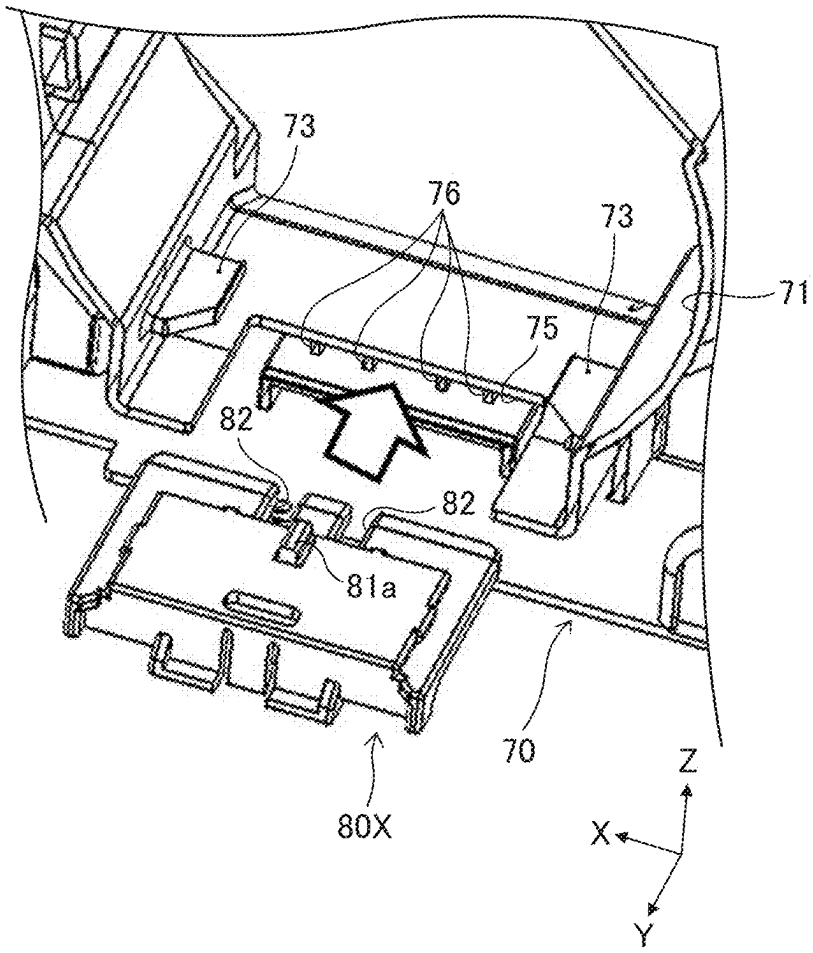

FIG. 17

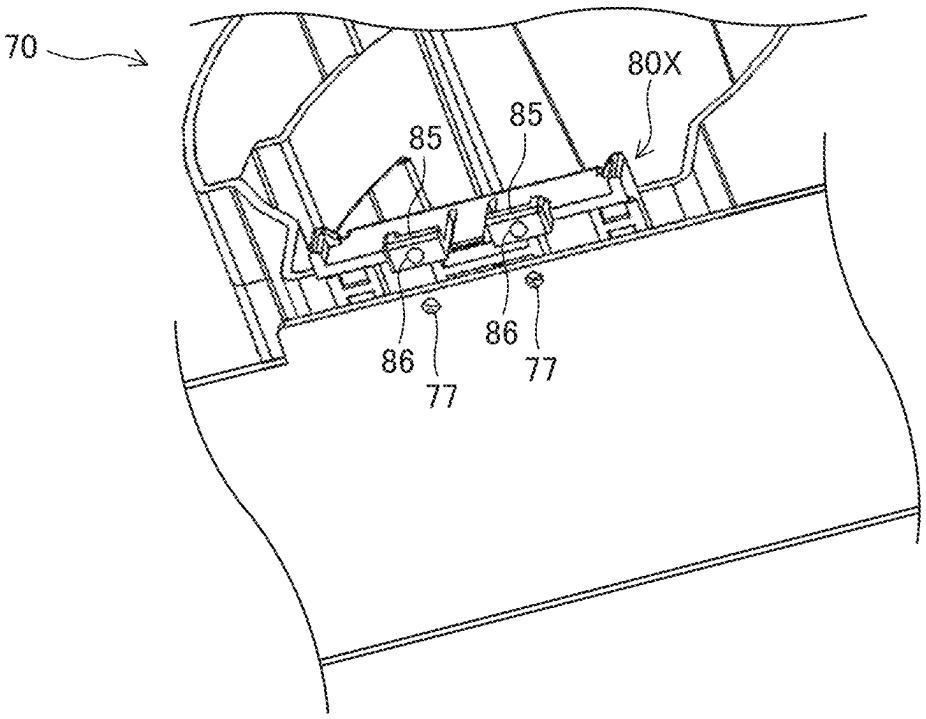

FIG. 18

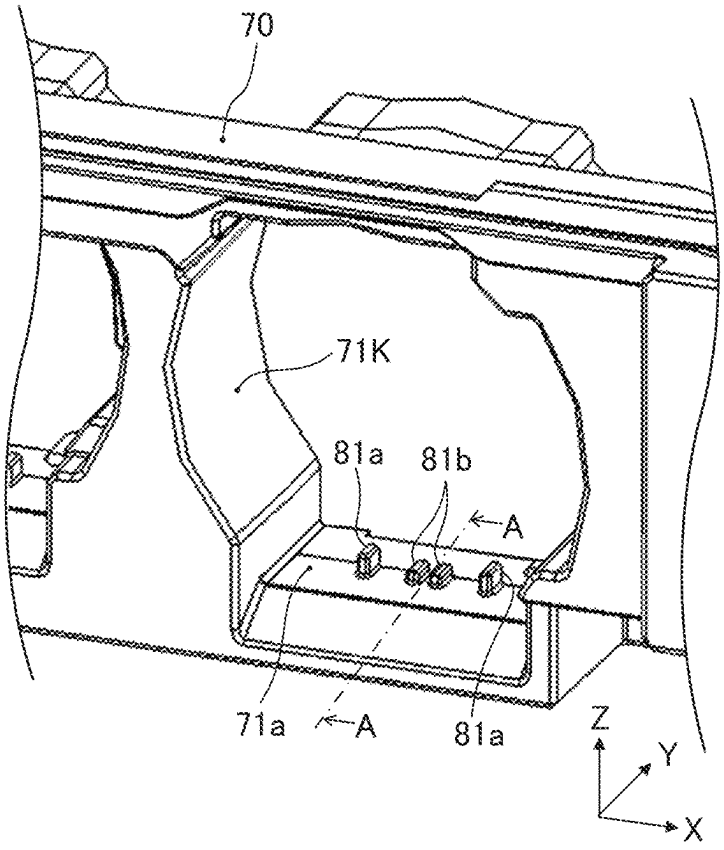

FIG. 19A

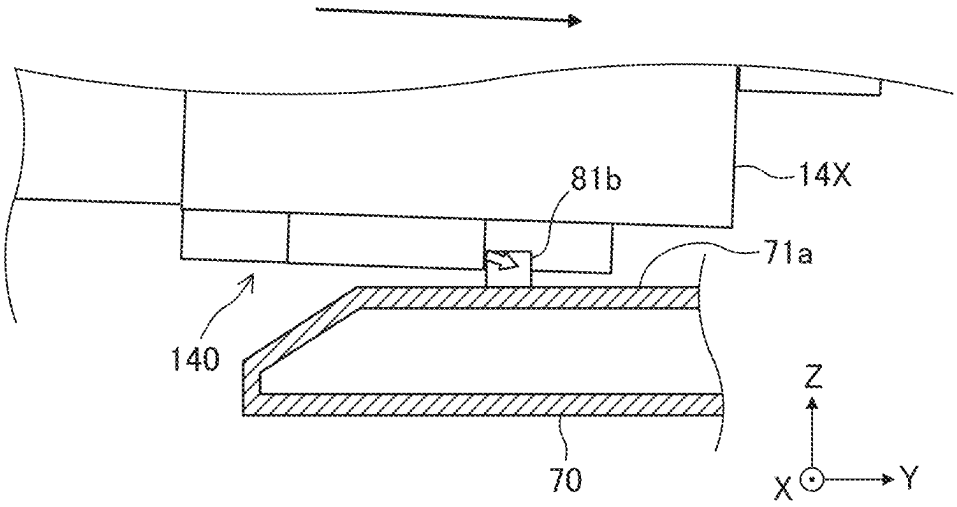

FIG. 19B

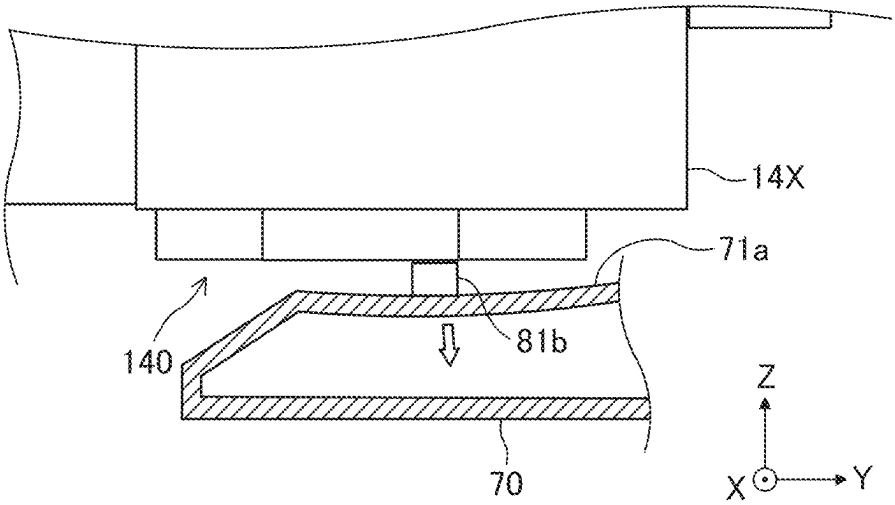

FIG. 20

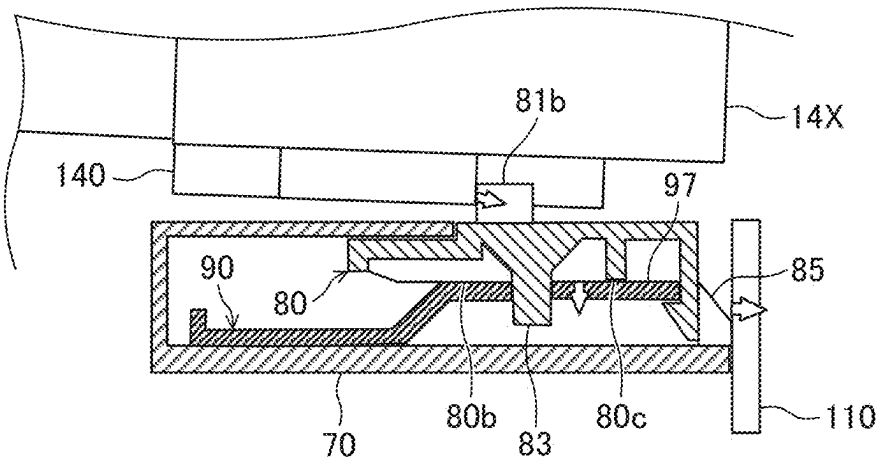

FIG. 21

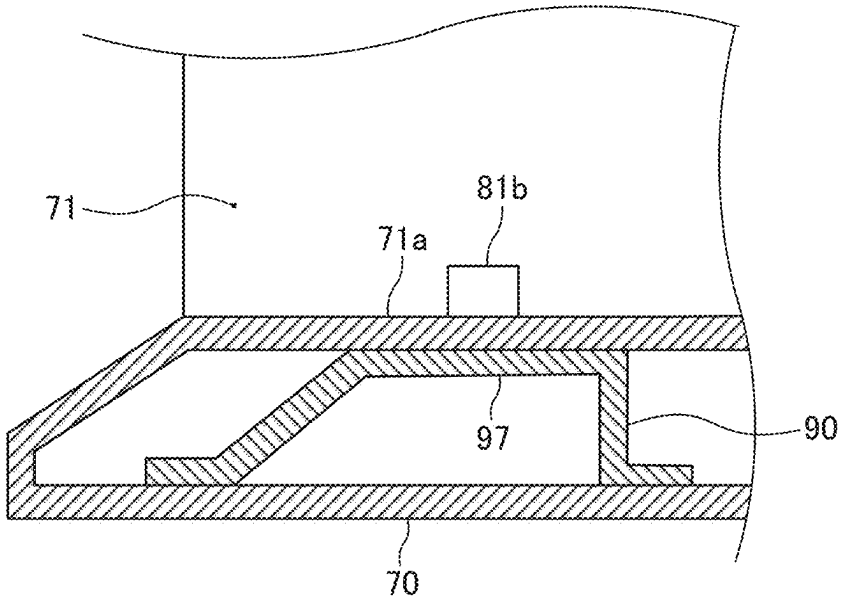

FIG. 22

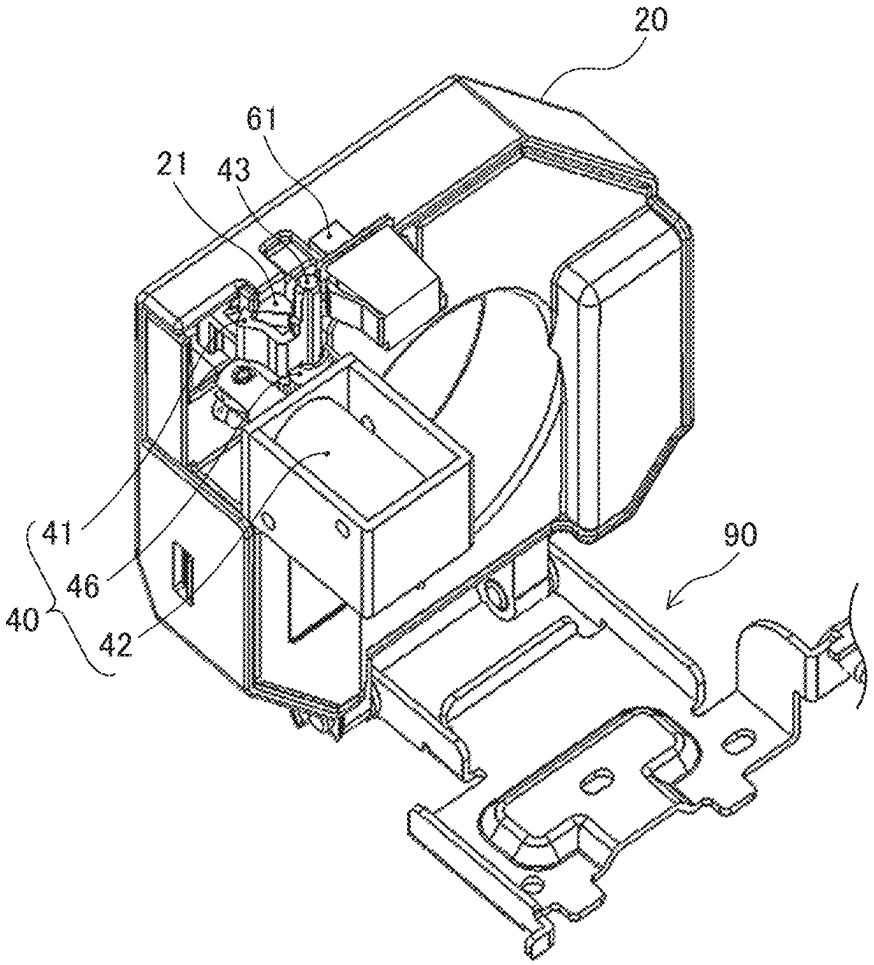

FIG. 23A

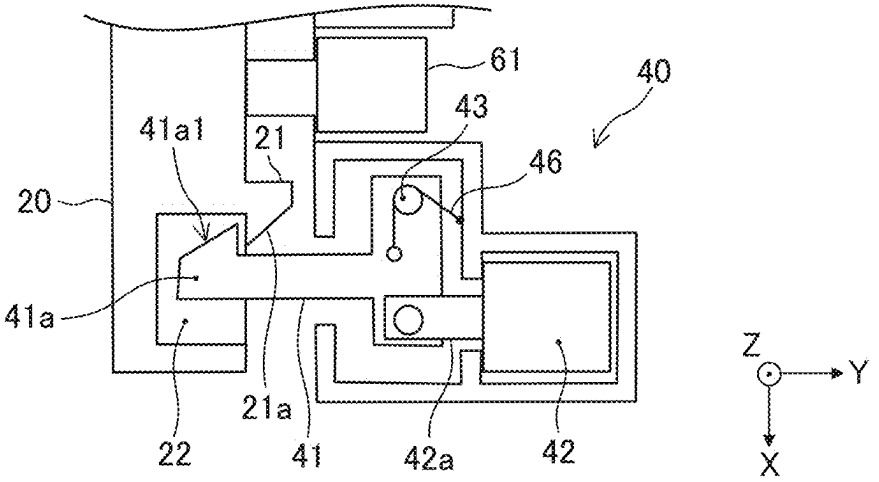

FIG. 23B

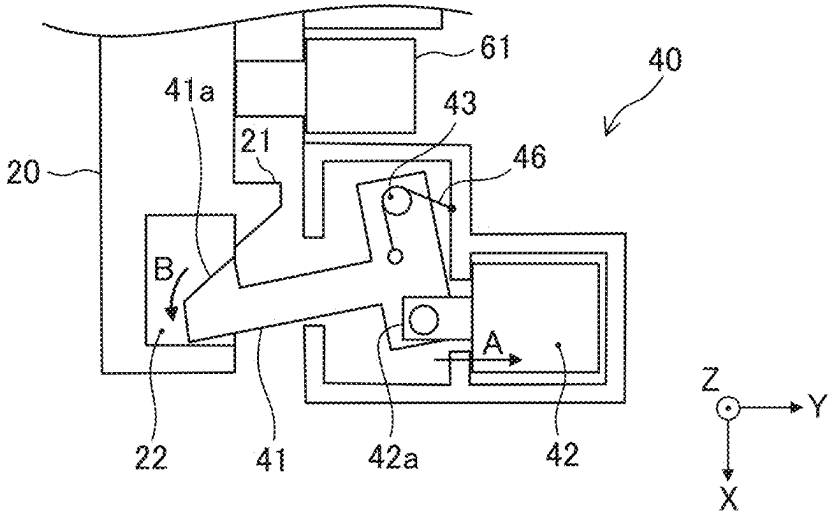

FIG. 24

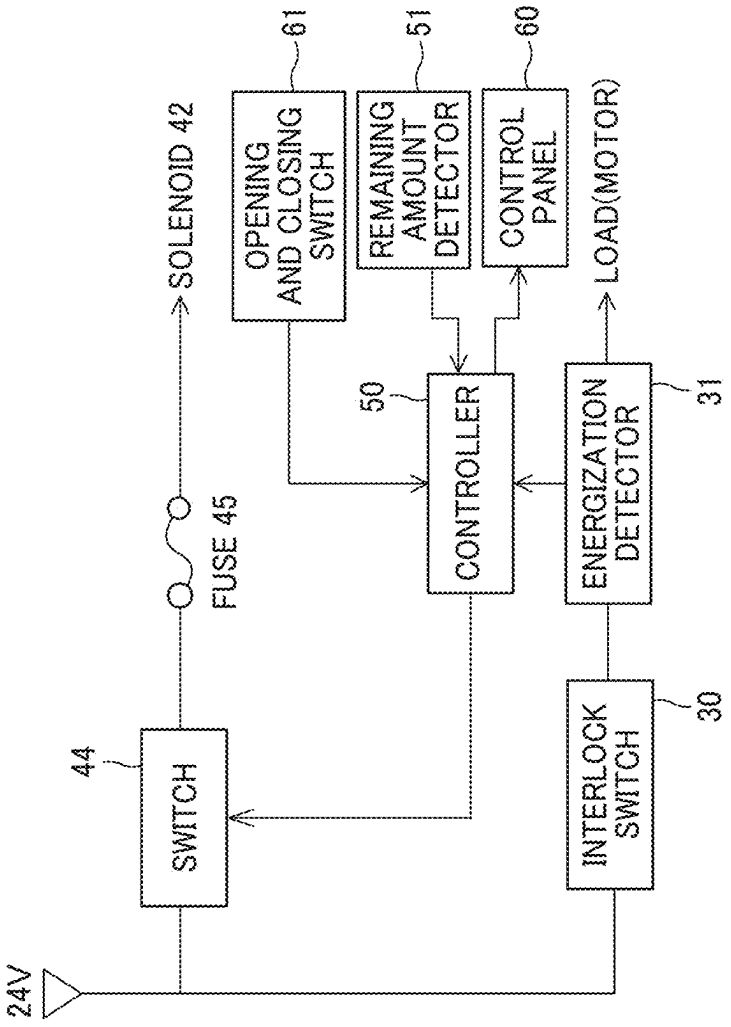
24V
SWITCH
44
FUSE 45
SOLENOID 42
OPENING AND CLOSING SWITCH
61
REMAINING AMOUNT DETECTOR
51
CONTROL PANEL
60
CONTROLLER
50
ENERGIZATION DETECTOR
31
LOAD(MOTOR)
INTERLOCK SWITCH
30

FIG. 25

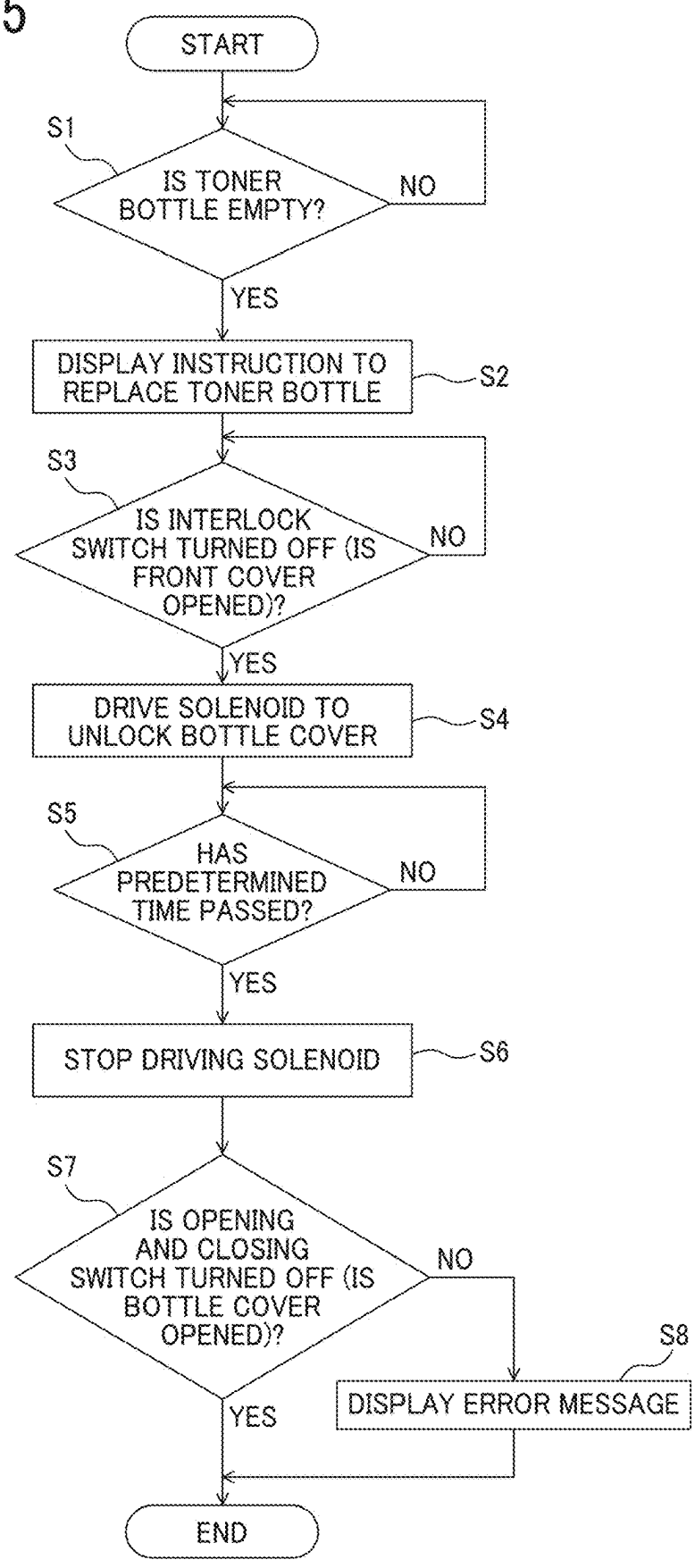
START
S1
IS TONER BOTTLE EMPTY?
NO
YES
DISPLAY INSTRUCTION TO REPLACE TONER BOTTLE
S2
S3
IS INTERLOCK SWITCH TURNED OFF (IS FRONT COVER OPENED)?
NO
YES
DRIVE SOLENOID TO UNLOCK BOTTLE COVER
S4
S5
HAS PREDETERMINED TIME PASSED?
NO
YES
STOP DRIVING SOLENOID
S6
S7
IS OPENING AND CLOSING SWITCH TURNED OFF (IS BOTTLE COVER OPENED)?
NO
S8
DISPLAY ERROR MESSAGE
YES
END

IMAGE FORMING APPARATUS WITH A STOPPER TO BLOCK INSERTION OF A TONER CONTAINER

CROSS-REFERENCE TO RELATED APPLICATION

This patent application is based on and claims priority pursuant to 35 U.S.C. § 119(a) to Japanese Patent Application No. 2022-189139, filed on Nov. 28, 2022, in the Japan Patent Office, the entire disclosure of which is hereby incorporated by reference herein.

BACKGROUND

Technical Field

Embodiments of the present disclosure relate to an image forming apparatus.

Related Art

In the related art, an image forming apparatus includes an apparatus body having an insertion opening, a detachable unit inserted into the insertion opening and detachably attached to the apparatus body, and a blocking projection to prevent an incompatible unit from being inserted into the insertion opening.

SUMMARY

This specification describes an improved image forming apparatus that includes an apparatus body, a detachable unit detachably attached to the apparatus body, a metal plate component, an insertion cover, and a stopper. The insertion cover has an insertion opening into which the detachable unit is insertable in an insertion direction. The stopper includes a blocking projection and a contact. The blocking projection is inside the insertion opening of the insertion cover. The blocking projection has a shape that matches with a groove of the detachable unit compatible with the apparatus body and does not match with a groove of the detachable unit incompatible with the apparatus body. The contact contacts the metal plate component in a direction orthogonal to the insertion direction.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of embodiments of the present disclosure and many of the attendant advantages and features thereof can be readily obtained and understood from the following detailed description with reference to the accompanying drawings, wherein:

FIG. **1** is a schematic diagram illustrating a configuration of an image forming apparatus according to an embodiment of the present disclosure;

FIG. **2**A is a front view of the image forming apparatus of FIG. **1** in which a front cover is opened;

FIG. **2**B is a front view of the image forming apparatus of FIG. **1** in which the front cover and bottle covers are opened;

FIG. **3** is an enlarged schematic view of the bottle cover covering a toner bottle to store black toner and parts around the bottle cover;

FIG. **4** is an enlarged schematic view of the parts around the bottle cover after the bottle cover is removed from FIG. **3**;

FIG. **5** is a perspective view of a lower portion of a downstream end of a toner bottle incompatible with the image forming apparatus of FIG. **1** in a direction in which the toner bottle is inserted into the apparatus body;

FIG. **6** is a perspective view of a metal plate component and a front side plate of the image forming apparatus;

FIG. **7** is an enlarged perspective view of the metal plate component of FIG. **6** and parts around the metal plate component;

FIG. **8** is an enlarged perspective view of the metal plate component and the parts of FIG. **7** viewed from the inside of the image forming apparatus;

FIG. **9** is a side view of the metal plate component attached to the front side plate of the image forming apparatus;

FIG. **10** is a perspective view of a key and the metal plate component;

FIG. **11** is a perspective view of the key including a bottom side of the key;

FIG. **12** is a perspective view of the metal plate component to which the key is attached, including a bottom side of the metal plate component;

FIG. **13** is a cross-sectional view of the metal plate component to which the key is attached;

FIG. **14** is a view of a lower portion of a bottle insertion opening of a bottle insertion cover;

FIG. **15** is a perspective view of the bottle insertion cover viewed from below;

FIG. **16** is a perspective view of a key that is incompatible with the image forming apparatus of FIG. **1** and moved toward the bottle insertion cover;

FIG. **17** is a perspective view of the key incompatible with the image forming apparatus of FIG. **1**, illustrating the key not to be assembled to the bottle insertion cover;

FIG. **18** is a perspective view of a bottle insertion cover according to a comparative example;

FIGS. **19**A and **19**B are schematic diagrams illustrating an incompatible toner bottle erroneously inserted into the bottle insertion cover according to the comparative example;

FIG. **20** is a schematic diagram illustrating a fitting portion of the incompatible toner bottle butting on a blocking projection in the image forming apparatus of FIG. **1**;

FIG. **21** is a schematic diagram illustrating a configuration of a modification of the embodiment;

FIG. **22** is a perspective view of a bottle cover, a lock device, a switch, and the metal plate component;

FIGS. **23**A and **23**B are schematic diagrams each illustrating a configuration of the lock device viewed from above;

FIG. **24** is a block diagram of a circuit to drive a solenoid; and

FIG. **25** is a flowchart of control to unlock the bottle cover.

The accompanying drawings are intended to depict embodiments of the present disclosure and should not be interpreted to limit the scope thereof. The accompanying drawings are not to be considered as drawn to scale unless explicitly noted. Also, identical or similar reference numerals designate identical or similar components throughout the several views.

DETAILED DESCRIPTION

In describing embodiments illustrated in the drawings, specific terminology is employed for the sake of clarity. However, the disclosure of this specification is not intended to be limited to the specific terminology so selected and it is

to be understood that each specific element includes all technical equivalents that have a similar function, operate in a similar manner, and achieve a similar result.

Referring now to the drawings, embodiments of the present disclosure are described below. As used herein, the singular forms "a," "an," and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise.

The following describes an electrophotographic image forming apparatus according to an embodiment of the present disclosure.

FIG. **1** is a schematic diagram illustrating a configuration of an image forming apparatus **100** according to the present embodiment.

In FIG. **1**, a vertical direction in the image forming apparatus **100** is indicated by an arrow Z, a front-back direction in the image forming apparatus **100** is indicated by an arrow Y, and a left and right direction in the image forming apparatus **100** is indicated by an arrow X.

The image forming apparatus **100** includes an image forming section **3**, a sheet feeding section **4**, and an image reading device **2** that reads an image of a document as an image forming target. The image reading device **2** is disposed above the image forming section **3** and includes a document feeder **2***a* and a scanner **2***b*. The sheet feeding section **4** is disposed below the image forming section **3** and includes two sheet trays **4***a* and **4***b* for storing sheets P.

The image forming section **3** includes an intermediate transfer unit **15** including an intermediate transfer belt **6** and four image forming units **5**Y, **5**M, **5**C, and **5**K for forming respective color images. The intermediate transfer belt **6** rotates in a direction indicated by an arrow F in FIG. **1**. The image forming units **5**Y, **5**M, **5**C, and **5**K are arranged along the intermediate transfer belt **6**. The image forming units **5**Y, **5**M, **5**C, and **5**K include photoconductors **1**Y, **1**M, **1**C, and **1**K, respectively, as drum-shaped image bearers. In addition, the image forming section **3** includes an exposure device **7**.

The intermediate transfer unit **15** includes the intermediate transfer belt **6** having an endless shape and wound around multiple support rollers, primary transfer rollers **8**Y, **8**C, **8**M, and **8**K, and a belt cleaner **6***a* to clean the surface of the intermediate transfer belt **6**. The primary transfer rollers **8**Y, **8**M, **8**C, and **8**K are disposed inside the loop of the intermediate transfer belt **6** and transfer the toner images from the photoconductors **1**Y, **1**M, **1**C, and **1**K onto the intermediate transfer belt **6**. A secondary transfer roller **9** is disposed downstream from the primary transfer rollers **8**Y, **8**M, **8**C, and **8**K in a direction that the intermediate transfer belt **6** moves. The secondary transfer roller **9** faces the intermediate transfer belt **6**. In addition, the image forming section **3** includes a fixing device **10** to fix an image onto the sheet P and an output roller pair **11** that are above the secondary transfer roller **9**.

The four image forming units **5**Y, **5**M, **5**C, and **5**K have a similar configuration except for the color of toner used therein. In the following description, the suffixes Y, M, C, and K are omitted when color discrimination is not necessary. Around the photoconductor **1**, the image forming unit **5** includes a charging device to charge the surface of the photoconductor **1** and a developing device to develop a latent image on the photoconductor **1** with toner into a toner image. Additionally, the image forming unit **5** includes a cleaning device to clean the surface of the photoconductor **1** after the toner image is transferred from the photoconductor **1** to the intermediate transfer belt **6**.

Operations of the image forming apparatus **100** according to the present embodiment are described below.

In response to receiving a start signal to start image formation, a controller **50** as circuitry in the image forming apparatus **100** controls a driver to start rotating the intermediate transfer belt **6**. The driver also starts rotating the photoconductor **1**Y in the image forming unit **5**Y to form the yellow toner image, and the charging device uniformly charges the photoconductor **1**Y The exposure device **7** irradiates the photoconductor **1**Y with a laser beam to form an electrostatic latent image. The developing device develops the electrostatic latent image to form the yellow toner image on the photoconductor **1**Y Similarly, the image forming units **5**M, **5**C, and **5**K form a magenta toner image, a cyan toner image, and a black toner image on the photoconductors **1**M, **1**C, and **1**K, respectively. With the movement of the intermediate transfer belt **6**, the primary transfer rollers **8**Y, **8**M, **8**C, and **8**K sequentially transfer the yellow, magenta, cyan, and black toner images from the photoconductors **1**Y, **1**M, **1**C, and **1**K to the intermediate transfer belt **6**, respectively to form a composite color image on the intermediate transfer belt **6**. The controller **50** performs the image forming operations for forming the yellow, magenta, cyan, and black toner images at different timings from the upstream side to the downstream side in the direction that the intermediate transfer belt **6** moves so that the yellow, magenta, cyan, and black toner images are transferred to and superimposed on the same position of the intermediate transfer belt **6**.

On the other hand, the sheet feeding section **4** feeds the sheet P from the upper sheet tray **4***a* or the lower sheet tray **4***b*, and conveyance rollers convey the sheet P to a secondary transfer nip formed by the intermediate transfer belt **6** and the secondary transfer roller **9**. The secondary transfer roller **9** transfers the composite color image on the intermediate transfer belt **6** onto the sheet P to form a color image on the sheet P. The sheet P bearing the color image is sent to the fixing device **10** to fix the color image onto the sheet P. After the color image is fixed onto the sheet P in the fixing device **10**, the output roller pair **11** ejects the sheet P to stack the sheet P on an output tray **12**, or the sheet P is sent to a reverse path **13** to form a toner image on the other side of the sheet P.

The cleaning device in each of the image forming units **5**Y, **5**M, **5**C, and **5**K cleans residual toner on each of the photoconductors **1**Y, **1**M, **1**C, and **1**K after the toner image is transferred. The belt cleaner **6***a* cleans residual toner on the intermediate transfer belt **6** after the composite color image is transferred.

The above-described image formation consumes toner in each of the developing devices. The image forming apparatus **100** includes toner bottles **14**Y, **14**M, **14**C, and **14**K filled with yellow, magenta, cyan, and black toners, respectively and illustrated on the upper left side in FIG. **1**. A predetermined amount of toner is supplied from each toner bottle to each developing device through a toner conveyance path. The arrangement order of the four image forming units **5**Y, **5**M, **5**C, and **5**K and the toner bottles **14**Y, **14**M, **14**C, and **14**K is not limited to the example illustrated in FIG. **1**.

When the image forming apparatus **100** according to the present embodiment forms a copy of the document, the document having a sheet shape is set on the document feeder **2***a* of the image reading device **2**. After the document is set on the document feeder **2***a*, pushing a copy start switch causes the image reading device **2** to start a document reading operation. Specifically, the document feeder **2***a* conveys the document, and the scanner **2***b* reads the document.

In parallel with the document reading operation, the devices in the image forming units **5**Y, **5**M, **5**C, and **5**K, the intermediate transfer belt **6**, the secondary transfer roller **9**, and the fixing device **10** start operations. Based on image data read by the image reading device **2**, the exposure device **7** is driven and controlled to form the yellow, magenta, cyan, and black toner images on the photoconductors **1**Y, **1**M, **1**C, and **1**K, respectively.

The yellow, magenta, cyan, and black toner images are transferred onto the intermediate transfer belt **6** and superimposed on the intermediate transfer belt **6** to form a four color toner image.

Almost simultaneously with the start of the document reading operation, the sheet feeding section **4** starts a sheet feeding operation. The sheet feeding section **4** includes the sheet trays **4***a* and **4***b* accommodated and overlapped in the image forming apparatus **100**. In the sheet feeding operation, one of the sheet trays **4***a* and **4***b* feeds the sheet P. The conveyance rollers convey the fed sheet P toward the secondary transfer nip.

FIG. **2**A is a front view of the image forming apparatus **100** in which the front cover **3***a* is opened, and FIG. **2**B is a front view of the image forming apparatus **100** in which the front cover **3***a* and bottle covers **20**Y, **20**M, **20**C, and **20**K are opened. The bottle cover is an example of a rotating member.

As illustrated in FIG. **2**A, the lower end of the front cover **3***a* is rotatably supported by the image forming section **3**. Opening the front cover **3***a* exposes the intermediate transfer unit **15** and the image forming units **5**Y, **5**M, **5**C, and **5**K. As a result, the intermediate transfer unit **15** and the image forming units can be attached to and detached from the image forming apparatus **100**.

In addition, opening the front cover **3***a* exposes the bottle covers **20**Y, **20**M, **20**C, and **20**K that open and close bottle insertion openings **71**Y, **71**M, **71**C, and **71**K of a bottle insertion cover **70** of the image forming section **3**. The bottle insertion cover **70** is made of resin. Opening the bottle covers **20**Y, **20**M, **20**C, and **20**K exposes the toner bottles **14**Y, **14**M, **14**C, and **14**K stored in the bottle housing of the image forming section **3**, and the toner bottles **14**Y, **14**M, **14**C, and **14**K can be attached to and detached from the bottle insertion openings **71**Y, **71**M, **71**C, and **71**K, respectively.

Lock devices **40** (see FIGS. **3**, **22**, and **23**A and **23**B) lock the bottle covers **20**Y, **20**M, **20**C, and **20**K at closed positions at which the bottle covers **20**Y, **20**M, **20**C, and **20**K cover the bottle insertion openings **71**Y, **71**M, **71**C, and **71**K, respectively. In response to toner depletion of any one of the yellow, magenta, cyan, and black toners in the toner bottles, the controller **50** controls the lock device to unlock the bottle cover corresponding to the toner depletion.

As illustrated in FIGS. **2**A and **2**B, the image forming apparatus **100** includes a control panel **60**.

FIG. **3** is an enlarged schematic view of the bottle cover **20**K covering the toner bottle **14**K to store black toner and parts around the bottle cover **20**K. FIG. **4** is an enlarged schematic view of the parts around the bottle cover **20**K after the bottle cover **20**K is removed from FIG. **3**.

Above the bottle insertion opening **71**K of the bottle insertion cover **70**, the lock device **40** is disposed. The lock device **40** locks the bottle cover **20**K at the closed position. The bottle cover **20**K has a locked portion **21** and a lock claw housing **22**. The lock device **40** includes a lock lever **41** having a lock claw. The lock claw enters the lock claw housing **22** and engages the locked portion **21**. The lock device **40** is described in detail later.

The bottle insertion cover **70** includes a metal plate component **90**. The metal plate component **90** includes a pair of support shafts **91**. The pair of support shafts **91** rotatably supports the bottle cover **20**K. The bottle insertion cover **70** has a recessed portion forming a lower part of the bottle insertion opening **71**K. The recessed portion includes a bottom face portion **71***a*. The bottom face portion **71***a* includes a key **80** made of resin. The key **80** serves as a stopper and includes blocking projections **81***a* and **81***b* to prevent the toner bottle incompatible with the image forming apparatus from being mounted. In addition, guide projections **73** are disposed on both sides of the recessed portion to guide the toner bottle **14**K.

Regarding the toner bottles **14**Y, **14**M, and **14**C, the image forming apparatus is similarly configured.

FIG. **5** is a perspective view of a lower portion of a downstream end of a toner bottle **14**X incompatible with the image forming apparatus **100** in a direction in which the toner bottle **14**X is inserted into the apparatus body.

As illustrated in FIG. **5**, the toner bottle **14**X includes a fitting portion **140**. The fitting portion **140** has guide grooves **14***a* on both sides of the fitting portion **140** in the X direction that is the lateral direction of the image forming apparatus. The guide projection **73** enters the guide groove **14***a*. The fitting portion **140** has clearance grooves **14***b* and **14***c* to avoid interference between the fitting portion **140** and the blocking projections **81***a* and **81***b*. The blocking projections **81***a* and **81***b* enter the clearance grooves **14***b* and **14***c*, respectively. The clearance grooves **14***b* are arranged side by side in the X direction. As illustrated in FIGS. **3** and **4**, the key **80** includes the blocking projections **81***a* arranged side by side in the X direction, and the blocking projection **81***a* is taller than the blocking projection **81***b*. The blocking projections **81***a* enter the clearance grooves **14***b* to avoid the interference between the fitting portion **140** and the key **80**. The clearance groove **14***c* is at the center of the fitting portion **140** in the X direction. As illustrated in FIGS. **3** and **4**, the blocking projection **81***b* is at the center of the key **80** in the X direction, and the blocking projection **81***b* is shorter than the blocking projection **81***a*. The blocking projection **81***b* enters the clearance groove **14***c* to avoid the interference between the fitting portion **140** and the key **80**. The clearance groove **14***c* is shorter than the clearance groove **14***b* in the Y direction that is the direction in which the toner bottle is inserted into the apparatus body and disposed substantially in the vicinity of the center of the clearance groove **14***b* in the Y direction.

As illustrated in FIG. **5**, the toner bottle **14**X incompatible with the image forming apparatus **100** has one clearance groove **14***c* in which the short blocking projection **81***b* in a center portion of the key **80** in the X direction can enter. In contrast, each of the toner bottles **14**Y, **14**M, **14**C, and **14**K compatible with the image forming apparatus **100** has two clearance grooves **14***c*. Two short blocking projections **81***b* arranged side by side in the X direction in the center portion of the key **80** can enter the two clearance grooves **14***c* to avoid the interference between the key **80** and the toner bottle. In other words, the key **80** as the stopper includes a blocking projection having a shape that matches with a groove of the detachable unit compatible with the apparatus body, such as each of the toner bottles **14**Y, **14**M, **14**C, and **14**K, and does not match with a groove of the detachable unit incompatible with the apparatus body, such as the toner bottle **14**X. Other than the above-described structure, the structure of the toner bottle compatible with the image

forming apparatus **100** is the same as the structure of the toner bottle **14**X incompatible with the image forming apparatus **100**.

Inserting the incompatible toner bottle **14**X into the bottle insertion opening **71** causes the guide projections **73** to enter the guide grooves **14***a* of the fitting portion **140**, and the tall blocking projections **81***a* arranged side by side in the X direction enter the clearance grooves **14***b*. The guide projections **73** and the tall blocking projections **81***a* guide the incompatible toner bottle **14**X inserted. However, as illustrated in FIGS. **3** and **4**, there are two short blocking projections **81***b* disposed on the apparatus body. The fitting portion **140** of the incompatible toner bottle **14**X butts against the blocking projections **81***b*. The blocking projections **81***b* prevent the incompatible toner bottle **14**X from being inserted into the bottle insertion opening **71**.

In contrast, each of the toner bottles compatible with the image forming apparatus **100** has two clearance grooves **14***c* as described above. Two short blocking projections **81***b* arranged side by side in the X direction in the center portion of the key **80** can enter the two clearance grooves **14***c* to avoid the interference between the key **80** and the toner bottle. The two short blocking projections **81***b* arranged side by side in the X direction in the center portion of the key **80** enter the two clearance grooves **14***c*, respectively while the compatible toner bottle is inserted and guided by the guide projections **73** and the tall blocking projections **81***a*. As a result, the toner bottle compatible with the image forming apparatus can be inserted into the bottle insertion opening **71** and stored in the bottle housing.

When the two short blocking projections **81***b* arranged side by side in the X direction in the center portion of the key **80** enter the two clearance grooves **14***c*, respectively, the guide projections **73** and the tall blocking projections **81***a* guide the downstream end of the toner bottle **14** in the direction in which the toner bottle is inserted into the apparatus body. The above-described structure in the toner bottle **14** compatible with the image forming apparatus enables smoothly entering each of the short blocking projections **81***b* arranged side by side in the X direction in the center portion of the key **80** to the clearance groove **14***c* corresponding to the each of the short blocking projections **81***b*. As a result, the toner bottle can be easily installed into the apparatus body.

FIG. **6** is a perspective view of a metal plate component **90** and a front side plate **110** of the image forming apparatus. FIG. **7** is an enlarged perspective view of the metal plate component **90** and parts around the metal plate component **90**. FIG. **8** is an enlarged perspective view of the metal plate component **90** and the parts of FIG. **7** viewed from the inside of the image forming apparatus. FIG. **9** is a side view of the metal plate component **90** attached to the front side plate **110** of the image forming apparatus.

The metal plate component **90** includes support shafts **91** and a pair of arms **98**. The pair of arms extends from the front side plate **110** toward the outside of the image forming apparatus. The support shaft **91** is disposed at the distal end of the arm **98** and rotatably supports the bottle cover **20**. The support shaft **91** extends from the arm **98** to the right side in FIGS. **6** and **7**. Accordingly, moving the bottle cover **20** to the left side in FIGS. **6** and **7** enables the bottle cover **20** to be supported by the support shafts **91**.

The support shaft **91** on the metal plate component **90** having high rigidity to support the bottle cover **20** has the following advantage. Closing the front cover **3***a* while the bottle cover **20** is opened causes the front cover **3***a* to butt against the bottle cover **20**, applying an impact to the support shaft supporting the bottle cover. At this time, the above-described structure can prevent deformation of the arm **98**. As a result, the above-described structure can prevent occurrence of a disadvantage such as the support shaft **91** being inclined and the bottle cover **20** not being closed.

In addition, the metal plate component **90** includes a contact pedestal **97** with which the key **80** comes into contact.

The contact pedestal **97** has a positioning hole **92** substantially at the center of the contact pedestal **97** to position the key **80**.

The metal plate component **90** includes a fastened portion **99** on the left side in FIGS. **6** and **7**. The fastened portion **99** is fastened to the front side plate **110** made of a sheet metal by a screw **94**. In addition, the metal plate component **90** includes a bent portion **90***a* on the right side in FIGS. **6** and **7**. The metal plate component **90** includes a hook **95** disposed on a back side of the fastened portion **99** and a hook **96** disposed on a back side of the bent portion **90***a* to hook the metal plate component **90** to the front side plate **110** of the image forming apparatus. As illustrated in FIG. **8**, the distal ends of the hooks **95** and **96** extend to the right side (that is the +X direction) of the image forming apparatus.

The front side plate **110** of the image forming apparatus has hook holes **110***a* and **110***b* that extend in the X direction. The hook **95** on the fastened portion **99** passes through the hook hole **110***a* and projects from the back side of the front side plate **110**. The hook **96** on the back side of the bent portion **90***a* passes through the hook hole **110***b* and projects from the back side of the front side plate **110**.

Sliding the metal plate component **90** to the right side of the image forming apparatus in FIGS. **6** and **7** (that is, to the +X direction) after the hooks **95** and **96** pass through the hook holes **110***a* and **110***b*, respectively allows the hooks **95** and **96** to hold the metal plate component **90** on the front side plate **110** of the image forming apparatus. The screw **94** fastens the fastened portion **99** to the front side plate **110** of the image forming apparatus to assemble the metal plate component **90** to the front side plate **110**. In addition, the metal plate component **90** includes a pair of abutting portions **93** that abuts against the front side of the front side plate **110** of the image forming apparatus.

FIG. **10** is a perspective view of the key **80** and the metal plate component **90**. FIG. **11** is a perspective view of the key **80** including a bottom side of the key **80**. FIG. **12** is a perspective view of the metal plate component **90** to which the key **80** is attached, including a bottom side of the metal plate component **90**. FIG. **13** is a cross-sectional view of the metal plate component **90** to which the key **80** is attached.

As illustrated in FIG. **10**, the key **80** has an exposed face **89**. The blocking projections **81***a* and **81***b* are on the exposed face **89** and form a part of the bottom face portion **71***a* in the recessed portion forming a part of the bottle insertion opening **71**. In addition, the key **80** includes a storage portion **88** around the exposed face **89**. The storage portion **88** is one step lower than the exposed face **89** and stored in the bottle insertion cover **70**. The key **80** has four fitting grooves **82** in front of the storage portion **88**. The bottle insertion cover **70** includes four fitting projections **76** (see FIG. **14**) that enter the four fitting grooves **82**, respectively.

As illustrated in FIG. **11**, the key **80** includes a positioning boss **83** substantially at the center of the bottom side of the key **80** to position the key **80** with respect to the metal plate component **90**. In addition, the key **80** includes a fitting claw **84** at the center of the back side of the key **80** in the X direction (that is the left-right direction of the image forming apparatus). The fitting claw **84** is snapped into the metal

plate component **90** and fixed on the metal plate component **90**. The key **80** includes a pair of abutting portions **85** adjacent to both sides of the fitting claw **84**. The pair of the abutting portions **85** abut against the front side plate **110** of the image forming apparatus (see FIG. **13**). Each of the pair of abutting portions **85** includes a hemispherical projection **86** on the bottom face of the abutting portion **85**. The hemispherical projection **86** is fitted into a hole **77** (see FIG. **15**) of the bottle insertion cover **70**.

The key **80** includes reinforcing ribs **80***a*, **80***b*, and **80***c* on the bottom side of the key **80**. The reinforcing ribs **80***b* and **80***c* face the contact pedestal **97** of the metal plate component **90** and are higher than the other reinforcing ribs **80***a*. The hatched portion **87** illustrated in FIG. **11** and formed by the reinforcing ribs **80***b* and **80***c* facing the contact pedestal **97** of the metal plate component **90** comes into contact with the contact pedestal **97**, and the key **80** is supported by the metal plate component **90** (see also FIG. **13**).

As illustrated in FIGS. **12** and **13**, inserting the positioning boss **83** into the positioning hole **92** of the metal plate component **90** positions the key **80** on the metal plate component **90**. Hooking the fitting claw **84** on the back side of the contact pedestal **97** of the metal plate component **90** assembles the key **80** to the metal plate component **90**.

As illustrated in FIG. **13**, assembling the key **80** to the metal plate component **90** causes the reinforcing ribs **80***b* and **80***c* to come into contact with the contact pedestal **97** of the metal plate component **90**, and the key **80** is supported by the metal plate component **90**. As illustrated in FIG. **13**, the pair of abutting portions **85** of the key **80** also abuts against the front side of the front side plate **110** of the image forming apparatus.

FIG. **14** is a view of a lower portion of the bottle insertion opening **71** of the bottle insertion cover **70**. FIG. **15** is a perspective view of the bottle insertion cover **70** viewed from below.

As illustrated in FIG. **14**, the bottle insertion cover **70** has a key insertion opening **75**. The front side of the storage portion **88** (see FIG. **10**) of the key **80** is inserted into the key insertion opening **75**. The bottle insertion cover **70** includes four fitting projections **76** disposed in the key insertion opening **75**. As illustrated in FIG. **15**, the bottle insertion cover **70** has a pair of holes **77** in the bottom of the bottle insertion cover **70**. The pair of projections **86** of the key **80** are fitted into the pair of holes **77**.

Inserting the front side of the storage portion **88** of the key **80** into the key insertion opening **75** causes the four fitting projections **76** to enter and fit into the corresponding fitting grooves **82** of the key **80**. When the fitting projection **76** is fitted into the fitting groove **82**, the pair of projections **86** of the key **80** is fitted into the pair of holes **77** of the bottle insertion cover **70**. As a result, the key **80** is assembled to the bottle insertion cover **70**.

FIG. **16** is a perspective view of a key **80**X that is incompatible with the image forming apparatus **100** and moved toward the bottle insertion cover **70**.

The key **80**X is assembled to another image forming apparatus and incompatible with the image forming apparatus **100**. The key **80**X includes one blocking projection **81***a* at the center of the key **80**X and has two fitting grooves **82**. Even if the key **80**X incompatible with the image forming apparatus **100** is tried to be assembled to the bottle insertion cover **70** of the image forming apparatus **100**, the fitting projection **76** is not fitted into the fitting groove **82** because the fitting groove **82** and the fitting projection **76** are not matched with each other. The front side of the storage portion **88** of the key **80**X cannot be inserted into the key insertion opening **75**. As a result, as illustrated in FIG. **17**, the pair of projections **86** of the key **80**X is not fitted into the pair of holes **77** of the bottle insertion cover **70**, and the key **80**X incompatible with the image forming apparatus **100** is not erroneously assembled to the bottle insertion cover **70**.

FIG. **18** is a perspective view of a bottle insertion cover **70** according to a comparative example, and FIGS. **19**A and **19**B are schematic diagrams illustrating the incompatible toner bottle **14**X erroneously inserted into the bottle insertion cover **70** according to the comparative example.

As illustrated in FIG. **18**, the bottle insertion cover **70** according to the comparative example is made of resin and molded together with the blocking projections **81***a* and **81***b*. As illustrated in FIGS. **19**A and **19**B, the inside of the bottom face structure including the bottom face portion **71***a* in the recessed portion of the bottle insertion cover **70** is hollow in order to remove the molded bottle insertion cover **70** from a mold of the bottle insertion cover **70**.

FIG. **19**A illustrates the blocking projections **81***b* in the comparative example butted by the fitting portion **140** of the incompatible toner bottle **14**X illustrated in FIG. **5**. The incompatible toner bottle **14**X is tried to be inserted into the bottle insertion opening **71**.

Inserting the incompatible toner bottle **14**X into the bottle insertion opening **71** from obliquely above applies a downward force to the blocking projection **81**. The downward force may deform the bottom face portion **71***a*, and the bottom face portion **71***a* may be bent downward and form a concave shape as illustrated in FIG. **19**B. On the bottom face portion, the blocking projection **81***b* of the bottle insertion cover **70** is formed. As a result, the blocking projection **81***b* may be displaced downward. Displacing the blocking projection **81***b* downward as described above may cause the fitting portion **140** to ride over the blocking projection **81***b*. As a result, the incompatible toner bottle **14**X may be inserted into the image forming apparatus **100**.

To prevent the above-described disadvantage, disposing a reinforcing rib on the bottom face portion **71***a* on which the blocking projection **81***b* is formed to increase the rigidity of the bottom face portion **71***a* may be considered. However, the reinforcing rib has to extend in the front-back direction (that is the Y direction) in order to allow the mold for molding the bottle insertion cover **70** to be removed after molding the bottle insertion cover **70**. Such a reinforcing rib cannot reinforce the bottom face portion **71***a*. The reinforcing rib extending in the X direction can be provided on the upper face of the bottom face portion **71***a* (the face on which the blocking projection **81***b* is provided), but the appearance is deteriorated. Increasing the thickness of the bottom face portion **71***a* to increase the rigidity of the bottom face portion **71***a* causes sink marks, which deteriorates dimensional accuracy.

FIG. **20** is a schematic diagram illustrating the fitting portion **140** of the incompatible toner bottle **14**X butting on the blocking projection **81***a* in the image forming apparatus **100** according to the present embodiment.

In the image forming apparatus **100**, the metal plate component **90** supports the key **80** including the blocking projections **81***b*. The metal plate component **90** can receive the downward force applied to the blocking projections **81***b* by inserting the incompatible toner bottle **14**X into the bottle insertion opening **71** from obliquely above. The metal plate component **90** has a higher rigidity than a component made of resin. Therefore, the bending deformation due to the above-described force in the present embodiment is smaller than that in the component made of resin in the comparative

example. Accordingly, the downward displacement of the blocking projection **81***b* is reduced.

Further, the pair of abutting portions **85** of the key **80** and the pair of abutting portions **93** (see FIG. **7**) of the metal plate component **90** abut against the front side plate **110** of the image forming apparatus. The metal plate component **90** is fastened to the front side plate **110** of the image forming apparatus. The downward force applied to the blocking projection **81** presses the front end of the metal plate component **90** downward, but the above-described structure prevents the metal plate component **90** from tilting together with the key **80**. As a result, the downward displacement of the blocking projection **81***b* is further reduced.

In the present embodiment, the front side plate **110** made by a sheet metal having higher rigidity than the component made of resin receives the force that tries to incline the metal plate component **90** together with the key **80** from the abutting portions **85** and **93** and the fastened portion **99**. A deformation amount when the front side plate **110** receives the force that tries to incline the metal plate component **90** together with the key **80** from the abutting portions **85** and **93** is smaller than a deformation amount when the component made of resin receives the force from the abutting portions **85** and **93**. The downward force applied to the blocking projection **81** presses the front end of the metal plate component **90** downward, but the above-described structure further prevents the metal plate component **90** from tilting together with the key **80**.

The above-described structure in the present embodiment can favorably prevent the blocking projection **81***b* from being displaced downward when the fitting portion **140** of the incompatible toner bottle **14**X collides with the blocking projection **81***b*. As a result, the described structure can favorably prevent the fitting portion **140** from getting over the blocking projection **81***b* and the incompatible toner bottle **14**X from being inserted.

In the present embodiment, the blocking projection **81***b* is disposed on a separate member from the bottle insertion cover **70**, which enables forming a member in which the blocking projection **81***b* is disposed (that is the key **80**) to be a plate shape. Forming the member to be the plate shape enables molding the member to have the reinforcing rib **80***b* extending in the Y direction (that is the front-back direction of the image forming apparatus) and the reinforcing rib **80***c* extending in the X direction (that is the left-right direction of the image forming apparatus) that are on the back face of the member opposite to the face on which the blocking projections **81***a* and **81***b* are disposed (that is the exposed face **89**) without any difficulty. The above-described structure can increase the rigidity of the key **80**. As a result, the above-described structure can prevent the key from deforming when the downward force is applied to the blocking projection **81***b* and further prevent the blocking projection **81***b* from moving downward.

In addition, a face of the metal plate component **90** orthogonal to the vertical direction other than the contact pedestal **97** raised upward is in contact with the bottle insertion cover **70**. The above-described structure enables the bottle insertion cover **70** to receive the downward force applied to the blocking projections **81***a* and **81***b*. The above-described double structure including the metal plate component **90** and the bottle insertion cover **70** and receiving the downward force applied to the blocking projections **81***a* and **81***b* can further reduce the downward displacement of the blocking projections **81***a* and **81***b*.

In the present embodiment, the guide projections **73** are disposed on the recessed portion forming the bottle insertion opening **71** as illustrated in FIG. **4**. When the toner bottle **14** is inserted, the guide projection **73** enters the guide groove **14***a* illustrated in FIG. **5**, and the toner bottle **14** is inserted into the bottle insertion opening **71** while being guided by the guide projections **73**. The guide projections **73** regulate the posture of the toner bottle **14** to some extent when the toner bottle **14** is inserted into the bottle insertion opening **71**. The above-described structure can prevent the toner bottle **14** from being inserted in a posture in which the downstream side of the toner bottle **14** in an insertion direction in which the toner bottle is inserted is inclined downward. As a result, the above-described structure can reduce the downward force applied to the blocking projection **81***b* when the fitting portion **140** butts against the blocking projection **81***b*. Accordingly, the above-described structure can further reduce the downward displacement of the blocking projection **81***b* and favorably prevent the incompatible toner bottle from riding over the blocking projection **81***b* and being inserted into the image forming apparatus.

In the present embodiment, the left portion of the key **80** in FIG. **20** is inserted into the bottle insertion cover **70** so that the left portion of the key **80** faces the lower face of the bottle insertion cover **70**.

Hitting the fitting portion **140** of the toner bottle **14** against the blocking projection **81***b* applies a force in the insertion direction to the blocking projection **81***b* so as to rotate the key **80** clockwise in FIG. **20**. However, the key **80** does not rotate clockwise in FIG. **20** because the left portion of the key **80** abuts the bottle insertion cover **70**. The above-described structure can prevent the positioning boss **83** of the key **80** from coming off from the positioning hole of the metal plate component **90** and the key **80** from coming off from the metal plate component **90**.

FIG. **21** is a schematic diagram illustrating a configuration of a modification of the present embodiment.

In this modification, the blocking projection **81***b* is molded integrally with the bottle insertion cover **70** made of resin, and the metal plate component **90** is inside the hollow of the bottle insertion cover **70**. The contact pedestal **97** of the metal plate component **90** contacts the bottom face portion **71***a* of the bottle insertion cover **70** on which the blocking projections **81***b* is formed in the bottle insertion opening **71**. Even in such a configuration, the metal plate component **90** can receive the downward force applied to the blocking projection **81** when the fitting portion **140** of the incompatible toner bottle **14**X collides with the blocking projection **81***b*. The above-described structure can reduce the downward displacement of the blocking projection **81***b* and prevent the incompatible toner bottle **14**X from being inserted into the bottle insertion opening **71**. In FIG. **21**, the bottle insertion cover **70** serves as the stopper.

The following describes the lock device **40** to lock the bottle cover **20** at the closed position.

FIG. **22** is a perspective view of the bottle cover **20**, the lock device **40**, an opening and closing switch **61**, and the metal plate component **90**. FIGS. **23**A and **23**B are schematic diagrams each illustrating a configuration of the lock device **40** viewed from above. In FIG. **23**A, the lock device **40** locks the bottle cover **20**. In FIG. **23**B, the lock device **40** unlocks the bottle cover **20**.

Above the bottle insertion opening **71**, the lock device **40** and the opening and closing switch **61** are disposed. The lock device **40** locks the bottle cover **20**Y at the closed position. The opening and closing switch **61** detects whether the bottle cover **20** is closed or opened.

The lock device **40** includes a solenoid **42** and the lock lever **41** including the lock claw **41***a* at a tip of the lock lever **41**. The lock device **40** includes a support shaft **43** rotatably supporting the lock lever **41**. The lock device **40** includes a torsion spring **46** serving as a biasing member attached to the support shaft **43**. The torsion spring **46** applies a force to the lock lever **41** to be positioned at a lock position illustrated in FIG. **23**A. The lock lever **41** is rotatably attached to a plunger **42***a* (a movable metallic core) of the solenoid **42**.

As illustrated in FIG. **23**A, the bottle cover **20** has the locked portion **21** and the lock claw housing **22** into which the lock claw **41***a* of the lock lever **41** enters.

When the bottle cover **20** is locked at a closed position, the lock claw **41***a* of the lock lever **41** enters the lock claw housing **22** and faces the locked portion **21**. The lock claw **41***a* is in front of the locked portion **21** in the bottle cover **20**. In the above-described structure, opening the bottle cover **20** causes the locked portion **21** to butt the lock claw **41***a*. As a result, the bottle cover **20** is locked at the closed position.

As illustrated in FIG. **23**B, energizing the solenoid **42** generates an electromagnetic force pulling the plunger **42***a* in a direction indicated by an arrow A illustrated in FIG. **23**B. The plunger **42***a* rotates the lock lever **41** in a direction indicated by an arrow B in FIG. **23**B against the force applied by the torsion spring **46**. As a result, the lock claw **41***a* of the lock lever **41** does not face the locked portion **21**, and the lock is released. Thus, the bottle cover **20** can be opened. A biasing member applies force to the bottle cover **20** such that the bottle cover **20** is automatically rotated to an open position. However, the biasing member is unnecessary if the bottle cover **20** can be moved to the open position by its own weight.

Cutting off the energization of the solenoid **42** loses the electromagnetic force pulling the plungers **42***a*, and the force applied by the torsion spring **46** rotates the lock lever **41** clockwise in FIG. **23**B to position the lock lever **41** at the lock position. Subsequently, closing the bottle cover **20** causes the projection **21***a* of the locked portion **21** to butt against an inclined portion **41***al* of the lock claw **41***a*. Further closing the bottle cover **20** causes the lock lever **41** to rotate counterclockwise in FIGS. **23**A and **23**B and causes the lock claw **41***a* to climb over the locked portion **21** into the lock claw housing **22**. After the lock claw **41***a* enters the lock claw housing **22**, the force applied by the torsion spring **46** rotates the lock lever **41** clockwise in FIG. **23**A. As a result, the lock claw **41***a* faces the locked portion **21**, and the bottle cover **20** is locked.

In addition, an upper portion of the bottle cover **20** at the closed position pushes the opening and closing switch **61** to turn on the opening and closing switch **61**. On the other hand, opening the bottle cover **20** turns off the opening and closing switch **61**. As a result, the opening and closing switch **61** can detect opening and closing of the bottle cover **20**.

FIG. **24** is a block diagram of a circuit to drive the solenoid **42**.

As illustrated in FIG. **24**, the solenoid **42** is coupled to a 24V power supply via a switch **44** and a fuse **45**. Opening the front cover **3***a* turns off the interlock switch **30** to cut off an electrical connection between the 24V power supply and a load (i.e., an electric component) such as a motor for the image forming section **3**. Between the interlock switch **30** and the load, an energization detector **31** is disposed to detect whether a voltage is applied from the 24V power supply to the load. When opening the front cover **3***a* turns off the interlock switch **30**, the energization detector **31** detects that no voltage is applied to the load (0V). As a result, the controller **50** can detect that the front cover **3***a* is opened. On the other hand, when closing the front cover **3***a* turns on the interlock switch **30**, the energization detector **31** detects that the voltage is applied to the load. As a result, the controller **50** can detect that the front cover **3***a* is closed. As described above, the opening-and-closing detector in the present embodiment to detect whether the front cover **3***a* is opened or closed includes the interlock switch **30** and the energization detector **31**.

Alternatively, the opening-and-closing detector to detect whether the front cover **3***a* is opened or closed may include, for example, a filler disposed on the front cover **3***a* and an optical sensor to detect the filler. Based on an output voltage from the optical sensor, the controller **50** may determine whether the front cover **3***a* is opened or closed. The opening-and-closing detector may include a magnet disposed on the front cover **3***a* and a magnetic sensor to detect a magnetic force of the magnet. Based on an output voltage from the magnetic sensor, the controller **50** may determine whether the front cover **3***a* is opened or closed. However, the interlock switch **30** to detect whether the front cover **3***a* is opened or closed has the following advantage. The opening-and-closing detector including the interlock switch **30** can reduce the number of components to be smaller than other opening-and-closing detectors including additional components to detect whether the front cover **3***a* is opened or closed. As a result, the cost of the image forming apparatus can be reduced.

The controller **50** is coupled to the energization detector **31**, a remaining amount detector **51** that detects the amount of toner remaining in each of the toner bottles **14**Y, **14**M, **14**C, and **14**K, a control panel **60**, the switch **44** that turns on or off the energization of the solenoid **42**, and the opening and closing switch **61** that detects the opening and closing the bottle cover **20**.

The remaining amount detector **51** may use any one of various detection methods. For example, the remaining amount detector **51** may determine the amount of toner remaining in each of the toner bottles based on a calculation result of a toner consumption amount in each color image that can be calculated from a number of sheets printed and other factors. Alternatively, the remaining amount detector **51** may determine the amount of toner remaining in each of the toner bottles based on an electrostatic capacity in each of the toner bottles **14** or an electrostatic capacity in a toner conveyance path to convey each toner from the toner bottle **14** to the corresponding developing device.

The remaining amount detector **51** may use a toner supply system that supplies the toner to the developing device. For example, the toner supply system includes a toner concentration sensor detecting a toner concentration in developer in the developing device, and the controller controls a toner supply system to supply the toner to the developing device so that the toner concentration detected by the toner concentration sensor is in a target toner concentration range. Alternatively, the toner supply system may include an optical sensor detecting the image density of an image pattern formed on the photoconductor or the intermediate transfer belt, and the controller controls the toner supply system to supply the toner to the developing device so that the image density detected by the optical sensor is in a target image density range. When the toner density or the image density does not reach the target value although the toner is supplied by the above-described toner supply system, the controller can determine that the toner depletion occurs in the toner bottle. As described above, the remaining amount detector **51** may be formed.

The remaining amount detector **51** may use a toner remaining amount sensor assembled to a sub-hopper on the toner conveyance path between the toner bottle **14** and the corresponding developing device. The toner depletion in the toner bottle causes a decrease in an amount of toner in the sub-hopper. When the toner remaining amount sensor detects amounts of toner that each are equal to or smaller than an experimentally determined amount of toner for an experimentally determined time, the controller can determine that the toner depletion occurs in the toner bottle.

When the remaining amount detector **51** detects the toner depletion of any one of the yellow, magenta, cyan, and black toners in the toner bottles **14**, the controller **50** controls the control panel **60** to display a notification indicating the toner bottle in which the toner depletion is detected and an instruction to replace the toner bottle with a new toner bottle **14**. In addition, the controller **50** determines whether the front cover **3***a* is opened based on detection results of the energization detector **31** that detects whether the interlock switch **30** is turned on or off when the remaining amount detector **51** detects the toner depletion. In response to determination that the front cover **3***a* is opened, the controller **50** turns on the switch **44**.

As a result, the 24V power supply supplies electric power to the solenoid **42** to open the lock of the bottle cover **20** corresponding to the toner bottle in which the toner depletion is detected.

Subsequently, the controller **50** determines whether the opening and closing switch **61** is turned off after the predetermined time has passed since the 24V power supply supplies the electric power to the solenoid **42**. If the opening and closing switch **61** is not turned off and cannot detect the opening of the bottle cover **20**, the controller **50** controls the control panel **60** to display an error message.

In the present embodiment, opening the front cover **3***a* turns off the interlock switch **30** but does not turn off the switch **44** to supply power to the solenoid **42**. If the solenoid **42** causes a short circuit, an excessive current flows to the solenoid **42**. The fuse **45** shuts off the excessive current to protect circuits in the apparatus main body.

FIG. **25** is a flowchart of control to unlock the bottle cover **20**.

When the remaining amount detector **51** detects the toner depletion of any one of the yellow, magenta, cyan, and black toners in the toner bottles **14** (Yes in step S**1**), the controller **50** controls the control panel **60** to display the instruction to replace the toner bottle in which the toner depletion is detected with a new toner bottle **14** in step S**2**.

The user opens the front cover **3***a* to replace the toner bottle **14** with a new one. Opening the front cover **3***a* turns off the interlock switch **30**, and the controller **50** detects that the front cover **3***a* has been opened (Yes in S**3**).

After the controller **50** detects that the front cover **3***a* is opened, the controller **50** turns on the switch **44** to energize the solenoid **42** and drives the solenoid **42** in step S**4**. The driven solenoid **42** rotates the lock lever **41** to unlock the bottle cover **20** as described above. As a result, the above-described control opens the bottle cover **20** corresponding to the toner bottle **14** in which the toner depletion is detected together with the front cover **3***a* and exposes the toner bottle **14** in which the toner depletion is detected. Opening the bottle cover **20** corresponding to the toner bottle **14** in which the toner depletion is detected as described above enables the user to easily specify the toner bottle **14** to be replaced, and the replacement workability of the toner bottle **14** can be enhanced.

After the controller **50** turns on the switch **44** to start energization of the solenoid **42**, the controller **50** starts measuring time. In response to the elapse of a predetermined amount of time (Yes in step S**5**), the controller **50** turns off the switch **44** to cut off the energization to the solenoid **42** and stop the driving of the solenoid **42** in step S**6**.

Subsequently, the controller **50** determines whether the opening and closing switch **61** is turned off in step S**7**. If the opening and closing switch **61** is turned on (No in step S**7**), the bottle cover **20** is not physically opened and some abnormality may occur. Accordingly, the controller **50** controls the control panel **60** to display the error message together with a notification that the bottle cover **20** corresponding to the toner bottle **14** in which the toner depletion is detected is not opened in step S**8**.

In the present embodiment, the controller **50** detects that the front cover **3***a* is opened in response to turning off the interlock switch **30** and unlocks the bottle cover corresponding to the toner bottle in which the toner depletion is detected. Unlocking the bottle cover causes opening the bottle cover **20** together with the front cover **3***a*. Since the bottle cover is opened, the controller **50** may stop driving the solenoid **42** and return the lock lever **41** to the lock position to lock the bottle cover in response to the elapse of the predetermined amount of time after the start of driving of the solenoid **42**. The above-described structure and control can reduce the energization time to the solenoid **42**. For example, the controller **50** may energize the solenoid **42** to unlock the bottle cover **20** after the remaining amount detector **51** detects the toner depletion and cut off the energization to the solenoid **42** after the controller **50** detects that the bottle cover **20** is opened. However, the energization time to the solenoid **42** in such a structure and control is longer than the energization time to the solenoid **42** in the present embodiment.

In the present embodiment, the controller **50** unlocks the bottle cover corresponding to the toner bottle in which the toner depletion is detected, and the bottle cover corresponding to the toner bottle in which the toner depletion is detected automatically opens. The above-described structure and control can enhance the replacement workability of the toner bottle **14** to be better than an image forming apparatus in which the user operates the control panel **60** to unlock the bottle cover corresponding to the toner bottle in which the toner depletion is detected.

In the present embodiment, the solenoid **42** rotates the lock lever **41**, but the present disclosure is not limited to this. For example, a gear mechanism may rotate the lock lever **41**.

In the present embodiment, the blocking projection of the key **80** is used to block inserting the toner bottle incompatible with the image forming apparatus **100** into the bottle insertion opening, but the present disclosure is not limited to this. For example, the blocking projection may be used to block inserting a toner bottle containing toner with a color different from a corresponding color into the bottle insertion opening. In this case, the number, shapes, and positions in the X direction of the blocking projections provided on the key **80** are made different among yellow, magenta, cyan and black. The above-described structure can prevent, for example, the toner bottle filled with yellow toner from being erroneously inserted into the bottle housing for the toner bottle filled with black toner.

In addition, the keys for yellow, magenta, cyan, and black are designed to have a different number of the fitting grooves **82** differently positioned in the X direction. As a result, the

key incompatible with the color cannot be entered into the key insertion opening **75**, thereby preventing erroneous assembly of the key.

The above-described embodiments are illustrative and do not limit this disclosure. Thus, numerous additional modifications and variations are possible in light of the above teachings. For example, elements and/or features of different illustrative embodiments may be combined with each other and/or substituted for each other within the scope of this disclosure. For example, the present disclosure may be used to prevent a detachable unit detachably attached to the apparatus body such as the image forming unit from erroneously being attached to the apparatus body in addition to the toner bottle.

The configurations according to the above-descried embodiments are examples, and embodiments of the present disclosure are not limited to the above. For example, the following aspects can achieve effects described below.

First Aspect

In a first aspect, an image forming apparatus such as the image forming apparatus **100** includes an apparatus body, a detachable unit such as the toner bottle **14**, a metal plate component such as the metal plate component **90**, an insertion cover such as the bottle insertion cover **70**, and a stopper such as the key **80**. The detachable unit is detachably attached to the apparatus body. The insertion cover has an insertion opening such as the bottle insertion opening **71** into which the detachable unit is insertable in an insertion direction. The stopper includes a blocking projection such as the blocking projection **81***b* and a contact such as the reinforcing ribs **80***b* and **80***c*. The blocking projection is inside the insertion opening of the insertion cover. The blocking projection has a shape that matches with a groove of the detachable unit compatible with the apparatus body, such as each of the toner bottles **14**Y, **14**M, **14**C, and **14**K, and does not match with a groove of the detachable unit incompatible with the apparatus body, such as the toner bottle **14**X. The contact contacts the metal plate component in a direction orthogonal to the insertion direction. The direction orthogonal to the insertion direction is the vertical direction in the above embodiments.

According to the first aspect, as described in the embodiments, the rigidity of the metal plate component can prevent the breakage contacting the metal plate component in the direction orthogonal to the insertion direction from being bent in the direction orthogonal to the insertion direction by the force in the direction orthogonal to the insertion direction that is applied to the blocking projection when the unit incompatible with the apparatus body butts on the block projection. The above-described structure can prevent the incompatible unit from getting over the blocking projection and being attached to the apparatus body.

Second Aspect

In a second aspect, the apparatus body in the image forming apparatus according to the first aspect includes a side plate such as the front side plate **110**, and the metal plate component such as the metal plate component **90** is fastened to the side plate.

According to the second aspect, as described in the embodiments, the side plate such as the front side plate **110** can prevent the metal plate component such as the metal plate component **90** from being inclined together with the stopper such as the key **80** when the unit incompatible with the apparatus body such as the incompatible toner bottle butts on the blocking projection such as the blocking projection **81***b* and applies the force to the blocking projection in the direction orthogonal to the insertion direction. The above-described structure can reduce the downward displacement of the blocking projection and favorably prevent the incompatible unit from being mounted over the blocking projection **81***b*.

Third Aspect

In a third aspect, the apparatus body in the image forming apparatus according to the first aspect or the second aspect includes a side plate such as the front side plate **110**, and the metal plate component such as the metal plate component **90** includes a contact portion such as the abutting portion **93** contacting the side plate in the insertion direction.

According to the second aspect, as described in the embodiments, the side plate such as the front side plate **110** can prevent the metal plate component such as the metal plate component **90** from being inclined together with the stopper such as the key **80** when the unit incompatible with the apparatus body such as the incompatible toner bottle butts on the blocking projection such as the blocking projection **81***b* and applies the force to the blocking projection in the direction orthogonal to the insertion direction. The above-described structure can reduce the downward displacement of the blocking projection and favorably prevent the incompatible unit from being mounted over the blocking projection **81***b*.

Fourth Aspect

In a fourth aspect, an upstream end of the stopper such as the key **80** in the insertion direction is inside the insertion cover such as the bottle insertion cover **70**.

According to the fourth aspect, as described in the embodiments, the insertion cover such as the bottle insertion cover **70** can prevent the upstream end of the stopper in the insertion direction from being pushed up by the force in the insertion direction when the incompatible unit such as the incompatible toner bottle butts against the blocking projection **81***b*. The above-described structure can prevent the stopper from being detached from the metal plate component **90**.

Fifth Aspect

In a fifth aspect, the apparatus body in the image forming apparatus according to any one of the first to fourth aspects includes a side plate such as the front side plate **110**, and the stopper such as the key **80** includes a contact portion such as the abutting portion **85** contacting the side plate in the insertion direction.

According to the second aspect, as described in the embodiments, the side plate such as the front side plate **110** can prevent the metal plate component such as the metal plate component **90** from being inclined together with the stopper such as the key **80** when the unit incompatible with the apparatus body such as the incompatible toner bottle butts on the blocking projection such as the blocking projection **81***b* and applies the force to the blocking projection in the direction orthogonal to the insertion direction.

Sixth Aspect

In a sixth aspect, the metal plate component such as the metal plate component **90** in the image forming apparatus

according to any one of the first to fifth aspects contacts the insertion cover such as the bottle insertion cover **70** in the direction orthogonal to the insertion direction.

According to the sixth aspect, as described in the embodiments, the double structure including the metal plate component and the insertion cover such as the bottle insertion cover **70** and receiving the downward force applied to the blocking projection **81***b* can further reduce the downward displacement of the blocking projection **81***b*.

Seventh Aspect

In a seventh aspect, the image forming apparatus according to any one of the first to sixth aspects further includes a rotator such as the bottle cover **20**, and the metal plate component such as the metal plate component **90** includes a support shaft such as the support shaft **91** rotatably supporting the rotator.

According to the seventh aspect, as described in the embodiments, the metal plate component can prevent the support shaft such as the support shaft **91** from being deformed and inclined by an impact applied to the rotator such as the bottle cover **20**.

Eighth Aspect

In an eighth aspect, the insertion cover such as the bottle cover **20** in the image forming apparatus according to the seventh aspect includes the rotator to openably close the insertion opening such as the bottle insertion opening.

The structure according to the eighth aspect can prevent the occurrence of the disadvantage that the cover such as the bottle cover cannot be closed.

Ninth Aspect

In a ninth aspect, the detachable unit in the image forming apparatus according to any one of the first to eighth aspects includes a toner bottle.

The structure according to the ninth aspect can prevent the incompatible toner bottle from being attached to the image forming apparatus.

The above-described embodiments are illustrative and do not limit the present invention. Thus, numerous additional modifications and variations are possible in light of the above teachings. For example, elements and/or features of different illustrative embodiments may be combined with each other and/or substituted for each other within the scope of the present invention. Any one of the above-described operations may be performed in various other ways, for example, in an order different from the one described above.

The functionality of the elements disclosed herein may be implemented using circuitry or processing circuitry which includes general purpose processors, special purpose processors, integrated circuits, application specific integrated circuits (ASICs), digital signal processors (DSPs), field programmable gate arrays (FPGAs), conventional circuitry and/or combinations thereof which are configured or programmed to perform the disclosed functionality. Processors are considered processing circuitry or circuitry as they include transistors and other circuitry therein. In the disclosure, the circuitry, units, or means are hardware that carry out or are programmed to perform the recited functionality. The hardware may be any hardware disclosed herein or otherwise known which is programmed or configured to carry out the recited functionality. When the hardware is a processor which may be considered a type of circuitry, the circuitry, means, or units are a combination of hardware and software, the software being used to configure the hardware and/or processor.

The invention claimed is:

1. An image forming apparatus comprising:
an apparatus body;
a detachable unit detachably attached to the apparatus body, the detachable unit including a groove;
a metal plate component;
an insertion cover having an insertion opening into which the detachable unit is insertable in an insertion direction; and
a stopper including:
a projection inside the insertion opening of the insertion cover, the projection being within the groove when the detachable unit is fully attached to the apparatus body where the detachable unit dispenses a substance to the apparatus body; and
a protrusion contacting the metal plate component in a projection direction of the projection,
wherein the metal plate component contacts the insertion cover in a direction orthogonal to the insertion direction.

2. The image forming apparatus according to claim **1**, wherein:
the apparatus body includes a side plate, and
the metal plate component is fastened to the side plate.

3. The image forming apparatus according to claim **1**, wherein:
the apparatus body includes a side plate, and
the metal plate component includes a contact portion contacting the side plate in the insertion direction.

4. The image forming apparatus according to claim **1**, wherein:
an upstream end of the stopper in the insertion direction is inside the insertion cover.

5. The image forming apparatus according to claim **1**, wherein:
the apparatus body includes a side plate, and
the stopper includes a contact portion contacting the side plate in the insertion direction.

6. The image forming apparatus according to claim **1**, wherein:
the detachable unit includes a toner bottle, and
the substance includes toner.

7. The image forming apparatus according to claim **1**, wherein:
the groove is on an underside of the detachable unit, and
the detachable unit includes a toner container.

8. The image forming apparatus according to claim **1**, wherein:
the projection prevents an incompatible detachable unit from being mounted in the image forming apparatus.

9. The image forming apparatus according to claim **1**, further comprising:
a closing cover,
wherein the metal plate component includes a support shaft rotatably supporting the closing cover.

10. The image forming apparatus according to claim **9**, wherein:
the insertion cover includes the closing cover to openably close the insertion opening.

11. The image forming apparatus according to claim **9**, wherein:

the support shaft supporting the closing cover is oriented in a horizontal direction, relative to an orientation of the image forming apparatus.

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