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Shiohara

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(54) **SHEET TRAY DEVICE WITH SLIDE PORTION AND IMAGE FORMING APPARATUS HAVING THE SHEET TRAY DEVICE**

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(73) Assignee: **Brother Kogyo Kabushiki Kaisha**, Nagoya-shi, Aichi-ken (JP)

(21) Appl. No.: **13/542,373**

(22) Filed: **Jul. 5, 2012**

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(64) Patent No.: **7,748,692**
Issued: **Jul. 6, 2010**
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Filed: **Feb. 21, 2007**

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(51) **Int. Cl.**
B65H 3/44 (2006.01)
B65H 5/26 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***B65H 1/26*** (2013.01); *B65H 2402/31* (2013.01); *B65H 2402/32* (2013.01); *B65H 2405/31* (2013.01); *B65H 2405/332* (2013.01)

(58) **Field of Classification Search**
USPC 271/162, 164, 145, 9.07, 9.08, 9.11
See application file for complete search history.

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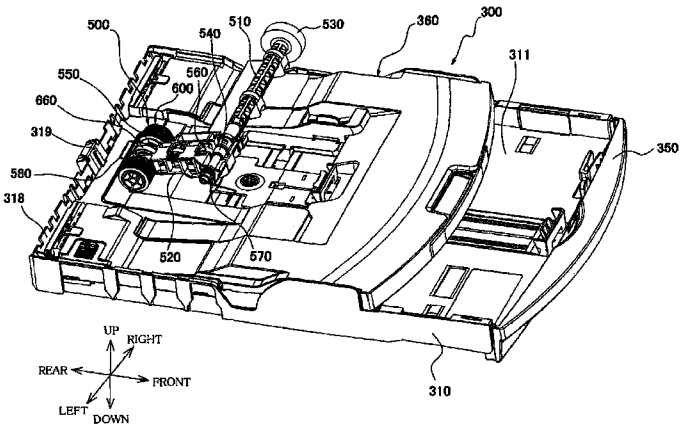
Primary Examiner — Joseph Kaufman

(74) *Attorney, Agent, or Firm* — Baker Botts L.L.P.

(57) **ABSTRACT**

A sheet tray device **[**including**]** *includes* (a) a first tray and (b) a second tray which is disposed on an upper side of the first tray and which includes (b-1) a support member which bridges between opposite side walls of the first tray and which is movable relative to the opposite side walls, and (b-2) a supported body pivotably supported by the support member. Each of the opposite side walls includes a first rail portion and a second rail portion that is located on an upper side of the first rail portion. The support member includes **[**(i)**]** a main slide portion that is slidably held in contact with an upper surface of the first rail portion, **[**(ii)**]** a removal-preventing slide portion that extends through a space between the first and second rail portions, and **[**(iii)**]** a rotation-preventing slide portion that is slidably held in contact with a side surface of the first rail portion. **[**Also disclosed is an image forming apparatus including the sheet tray device.**]**

13 Claims, 28 Drawing Sheets



(51) **Int. Cl.**
B65H 1/30 (2006.01)
B65H 1/26 (2006.01)

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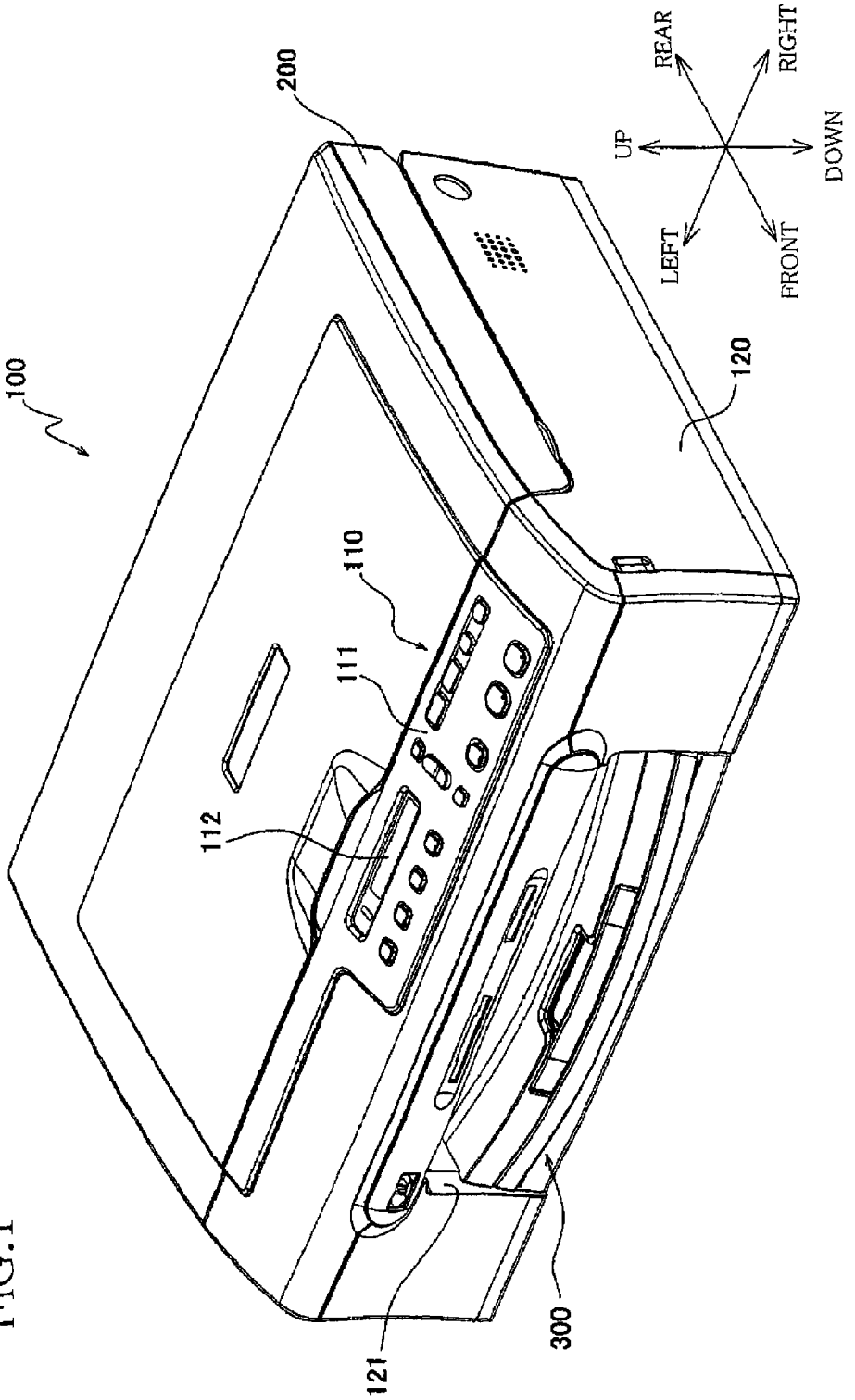


FIG.1

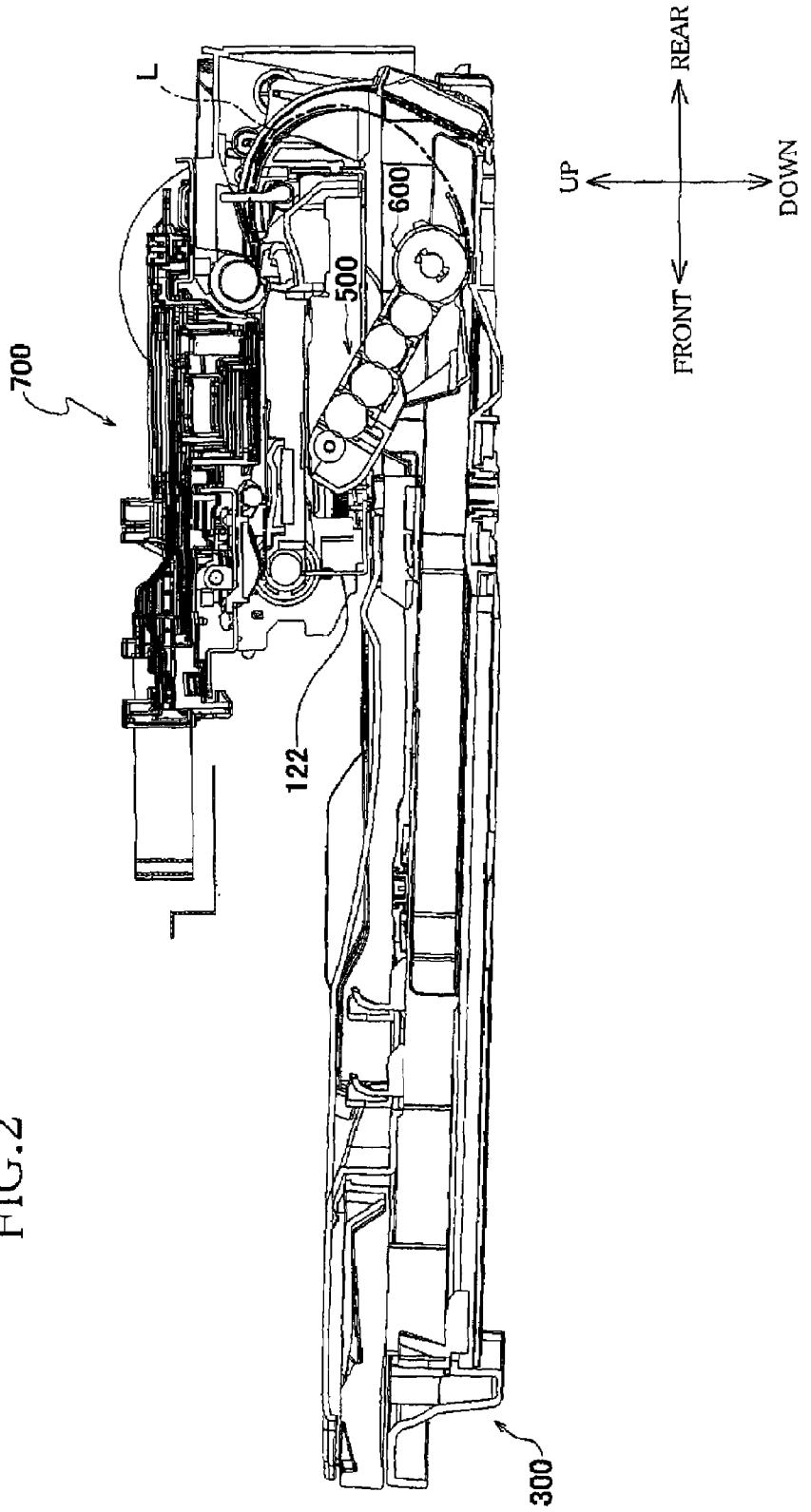
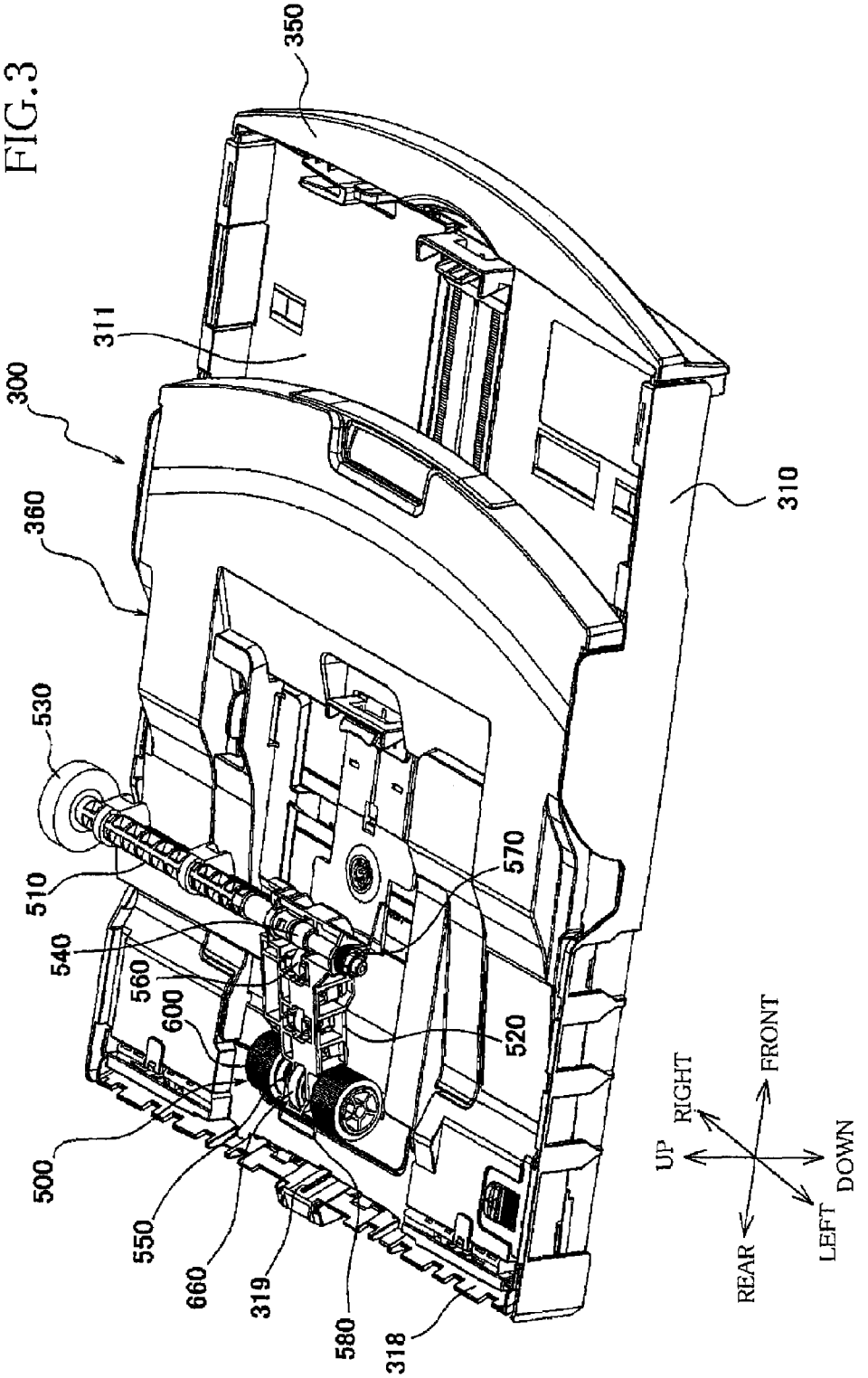


FIG.2

FIG.3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311
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360
310
530
510
540
560
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570
520
500
550
660
319
580
318
UP
RIGHT
FRONT
DOWN
LEFT
REAR

FIG.4

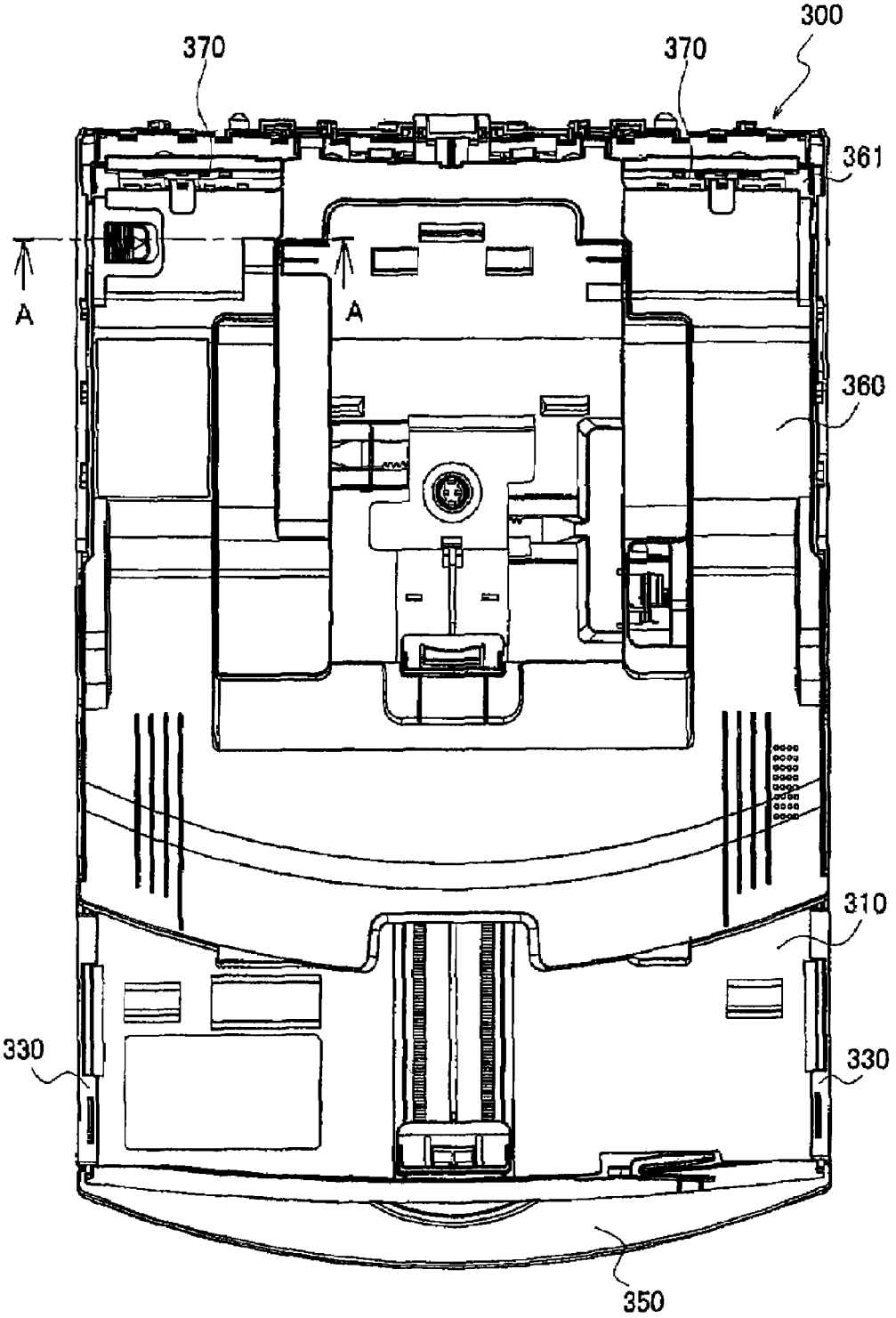


FIG.5

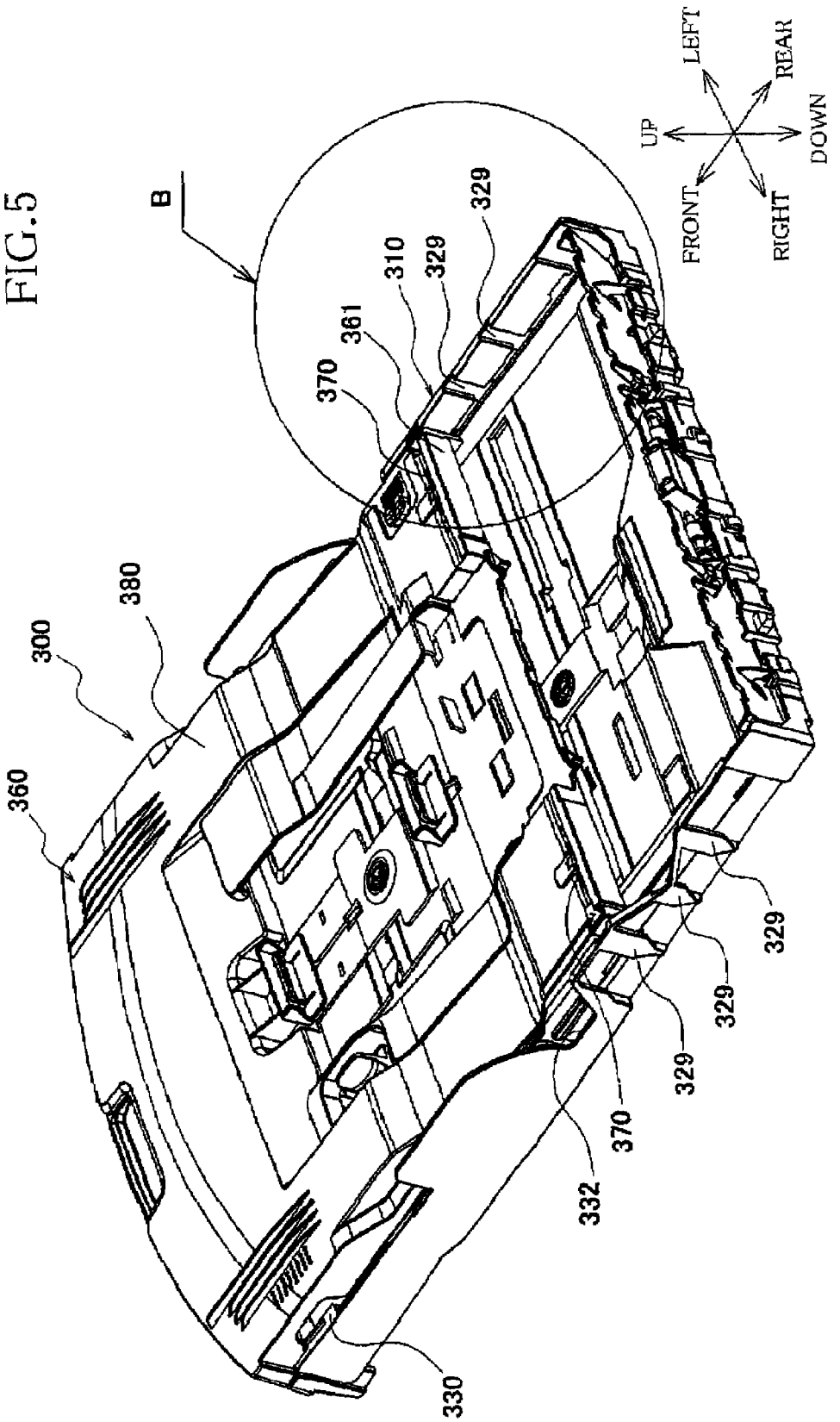

B
329
310
329
361
370
380
300
360
329
329
329
370
332
330
UP
LEFT
REAR
FRONT
RIGHT
DOWN

FIG.6

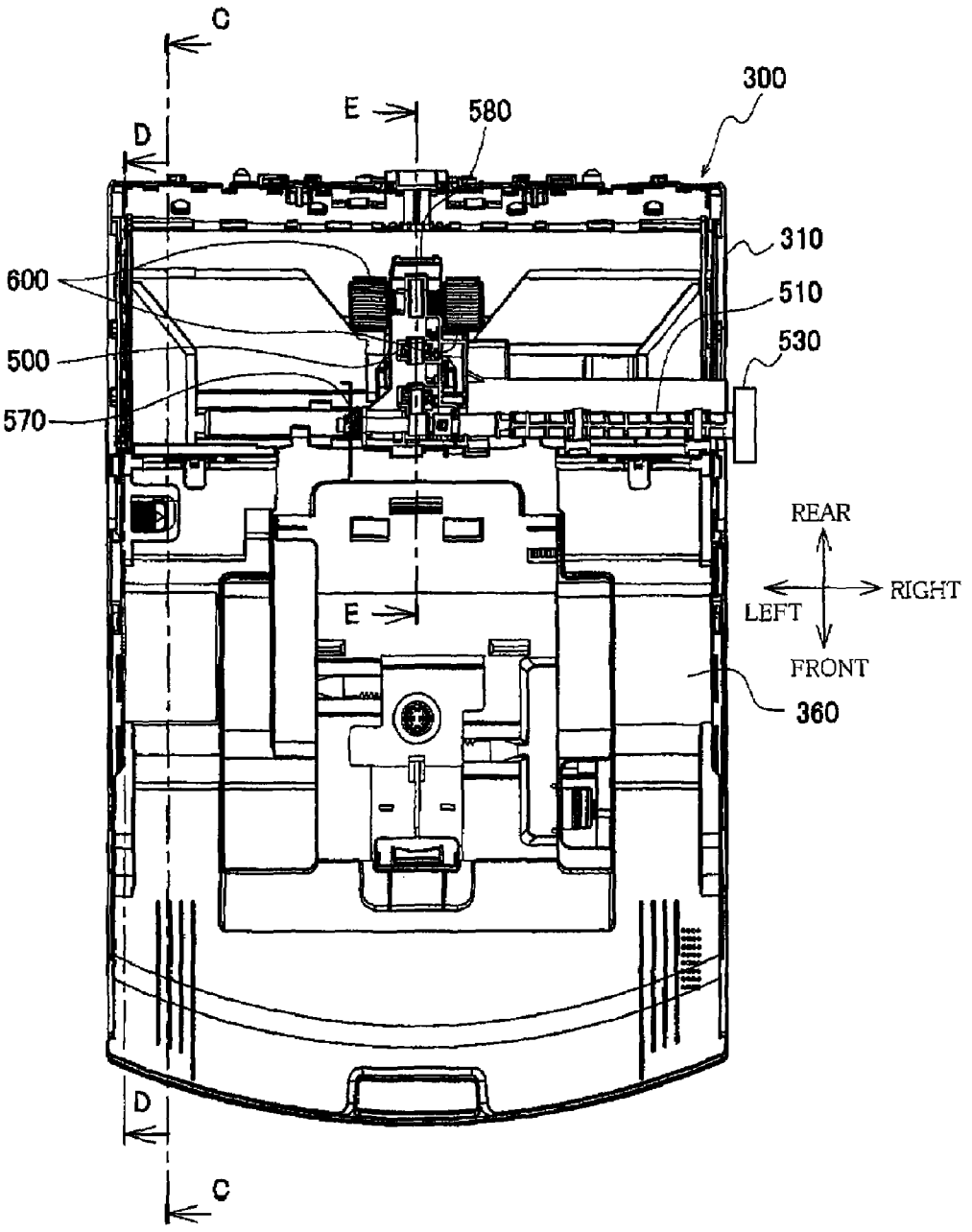
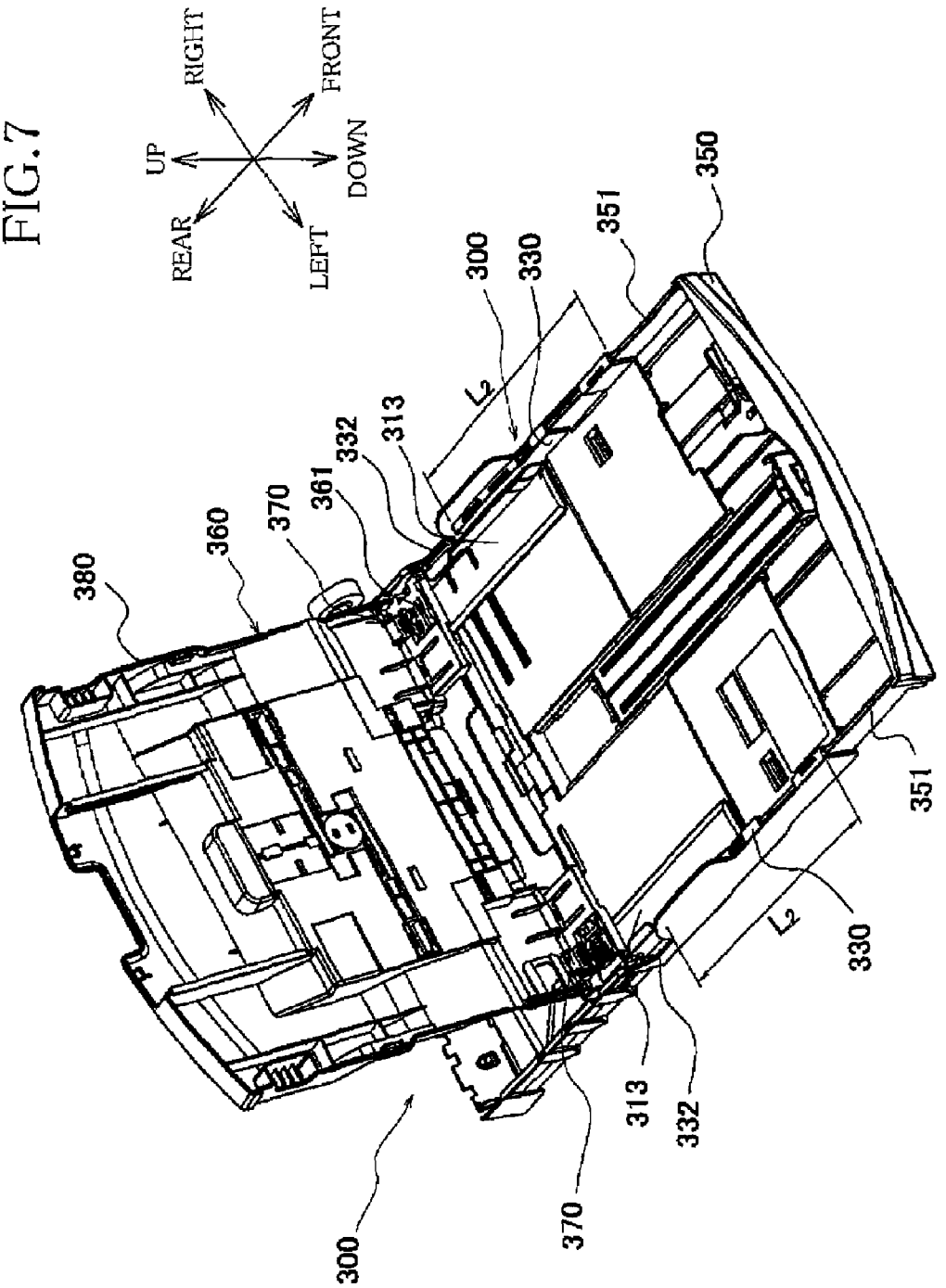

C
E
580
300
D
310
600
510
500
530
570
REAR
RIGHT
LEFT
FRONT
E
360
D
C

FIG.7


RIGHT
FRONT
UP
DOWN
REAR
LEFT
300
330
351
350
313
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370
360
380
L2
L2
351
330
313
332
370
300

FIG.8

ENLARGEMENT OF PORTION B

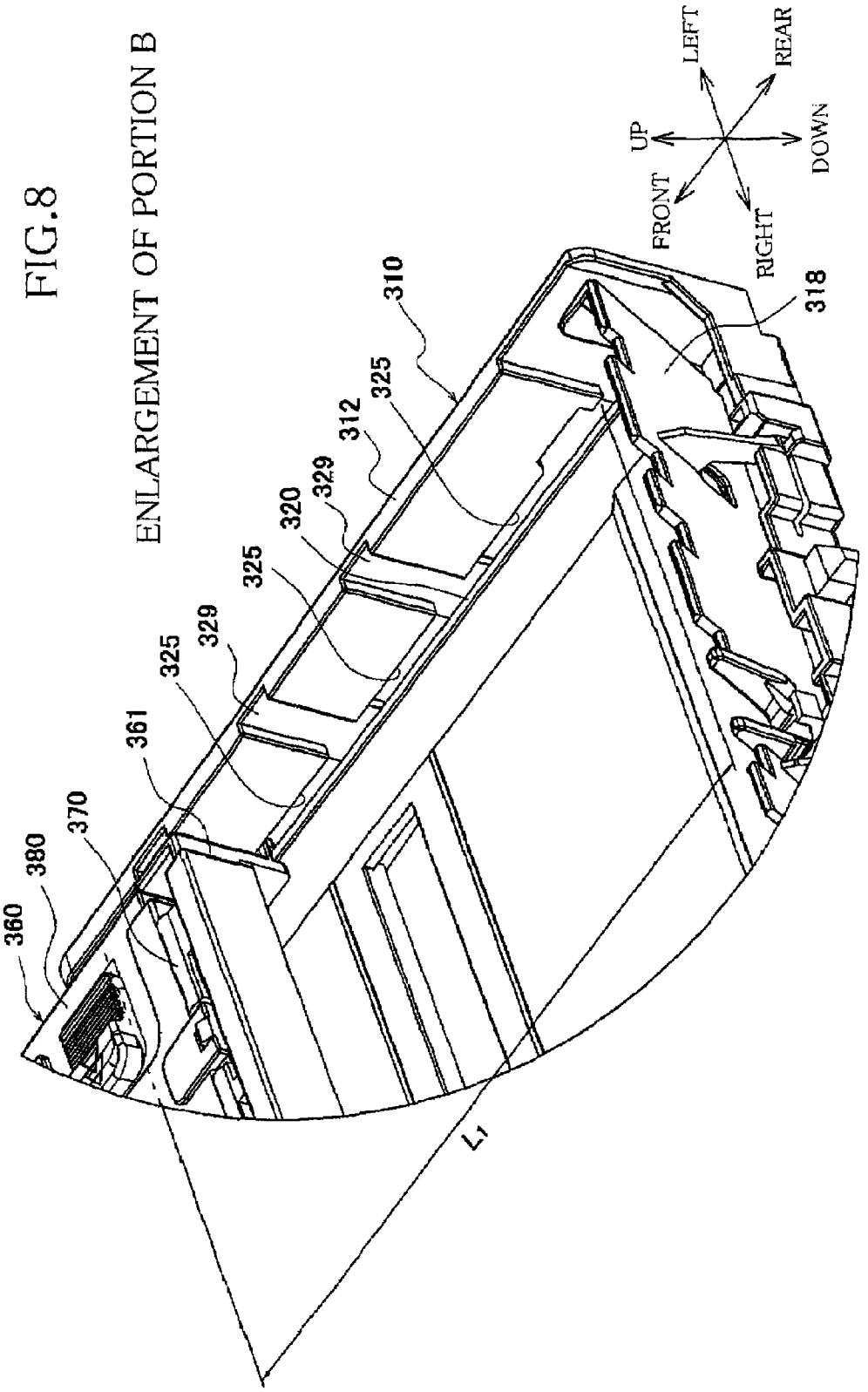


FIG.9

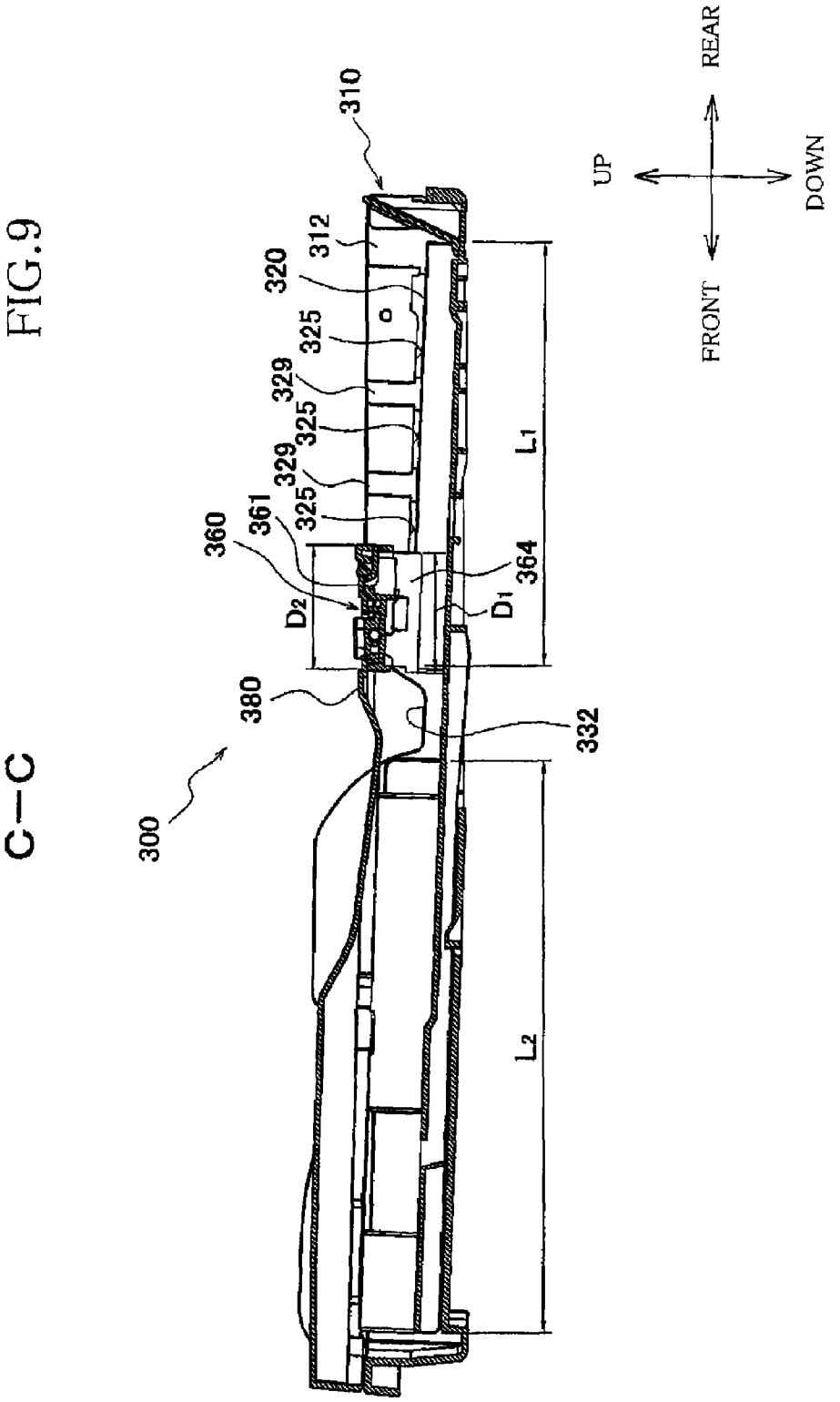
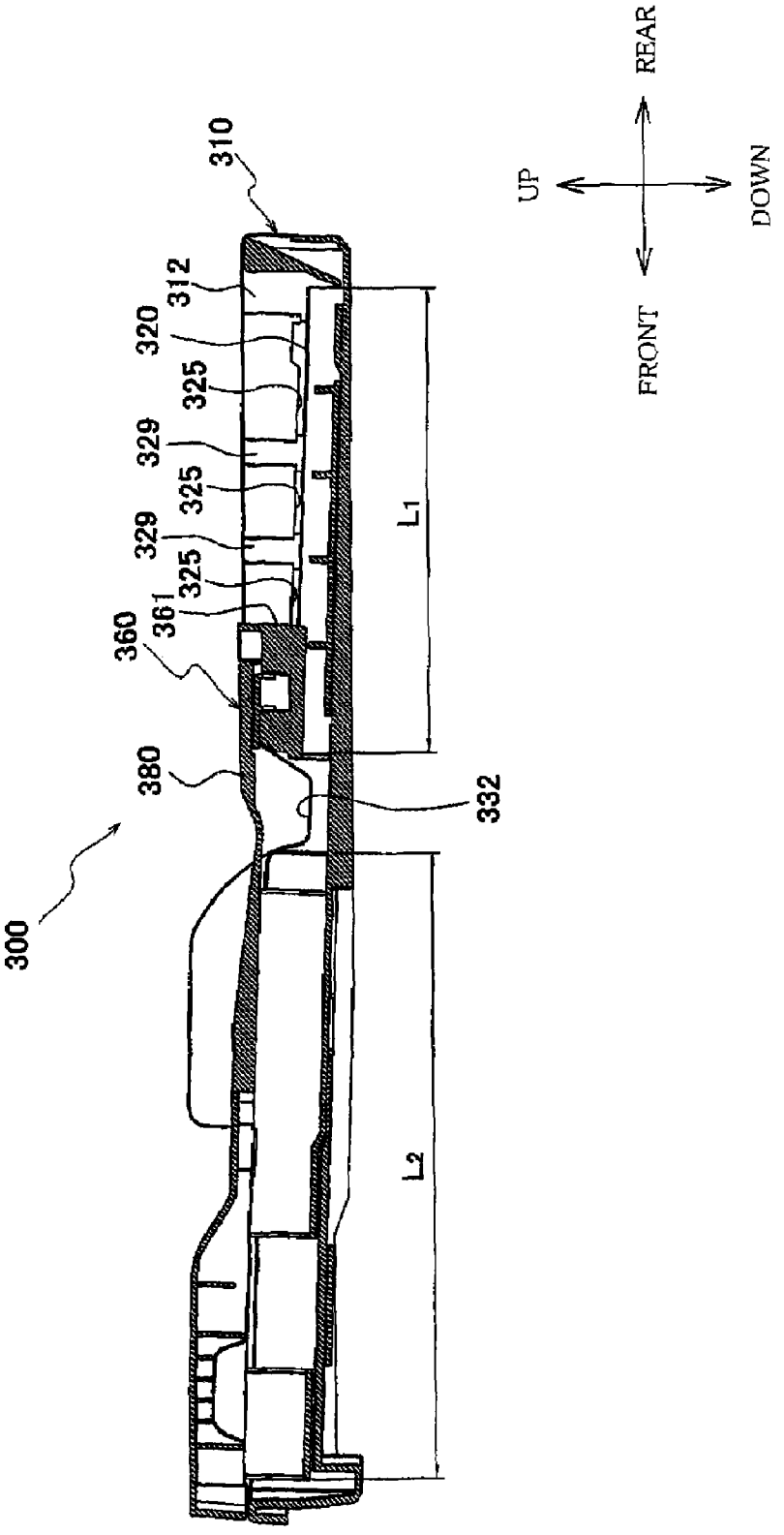

C—C
300
310
312
320
325
329
325
329
325
361
360
380
332
D2
D1
364
L1
L2
UP
DOWN
REAR
FRONT

FIG.10


D-D
300
310
312
320
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329
325
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361
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380
332
L1
L2
UP
DOWN
REAR
FRONT

FIG.11

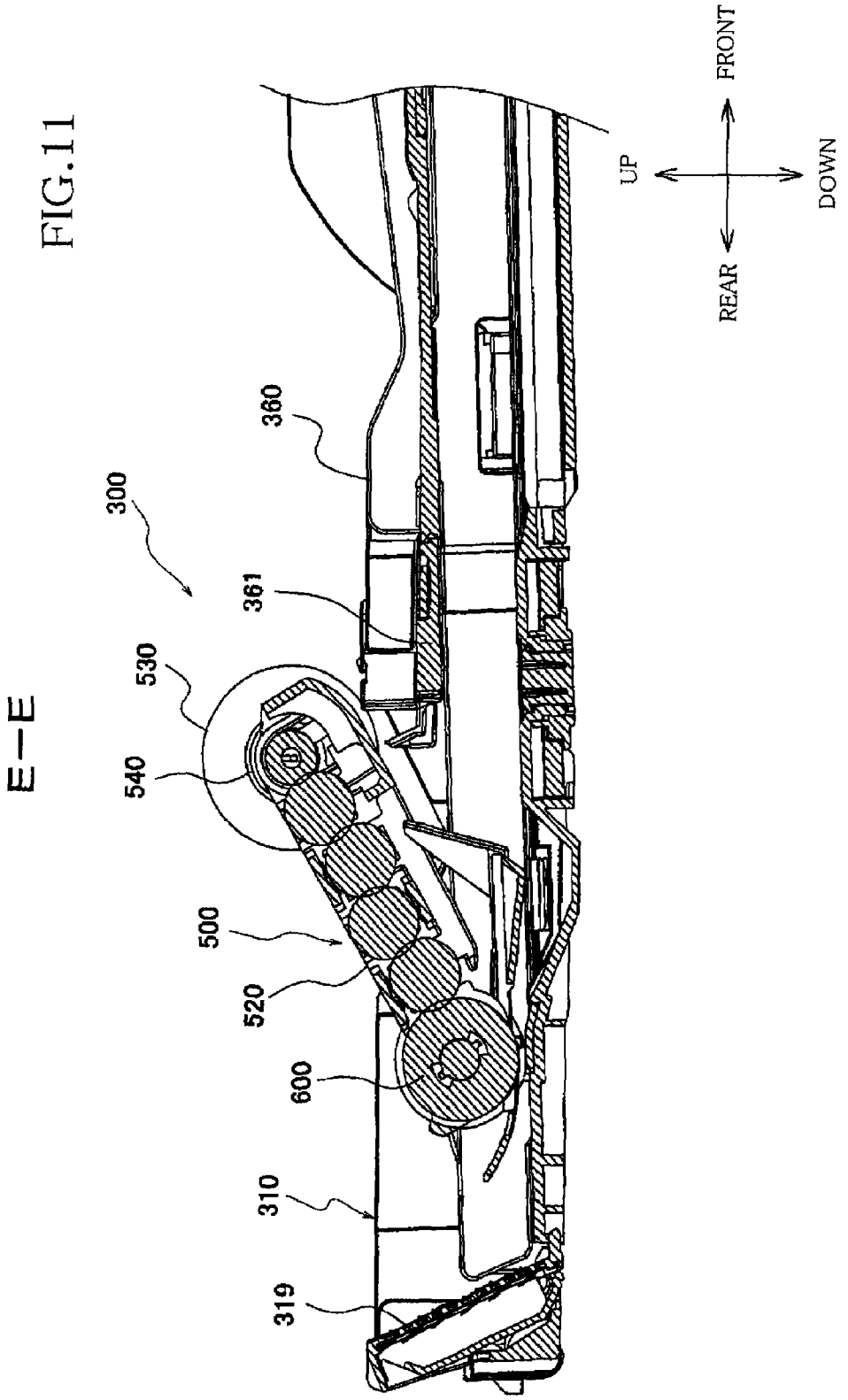


FIG.12

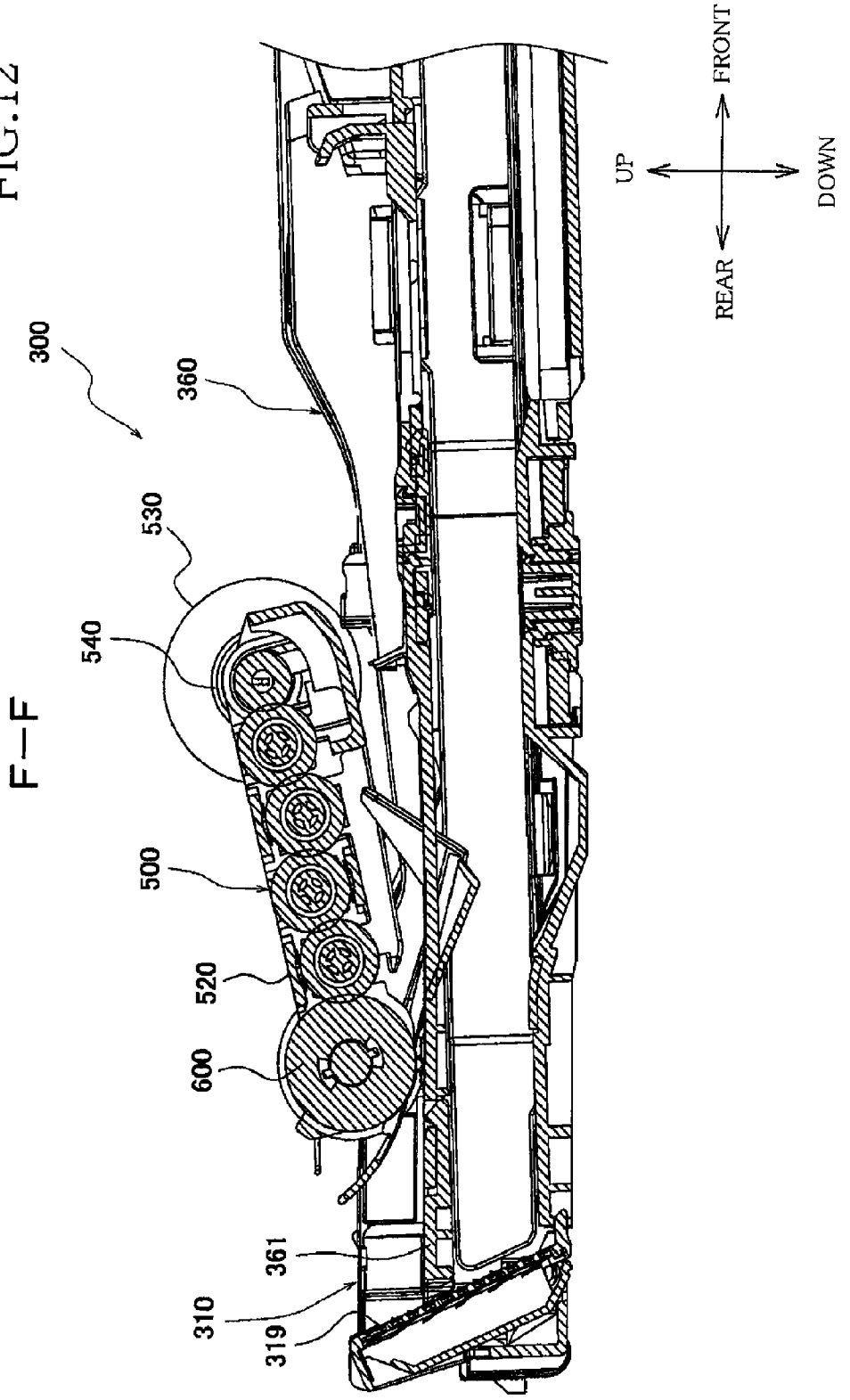
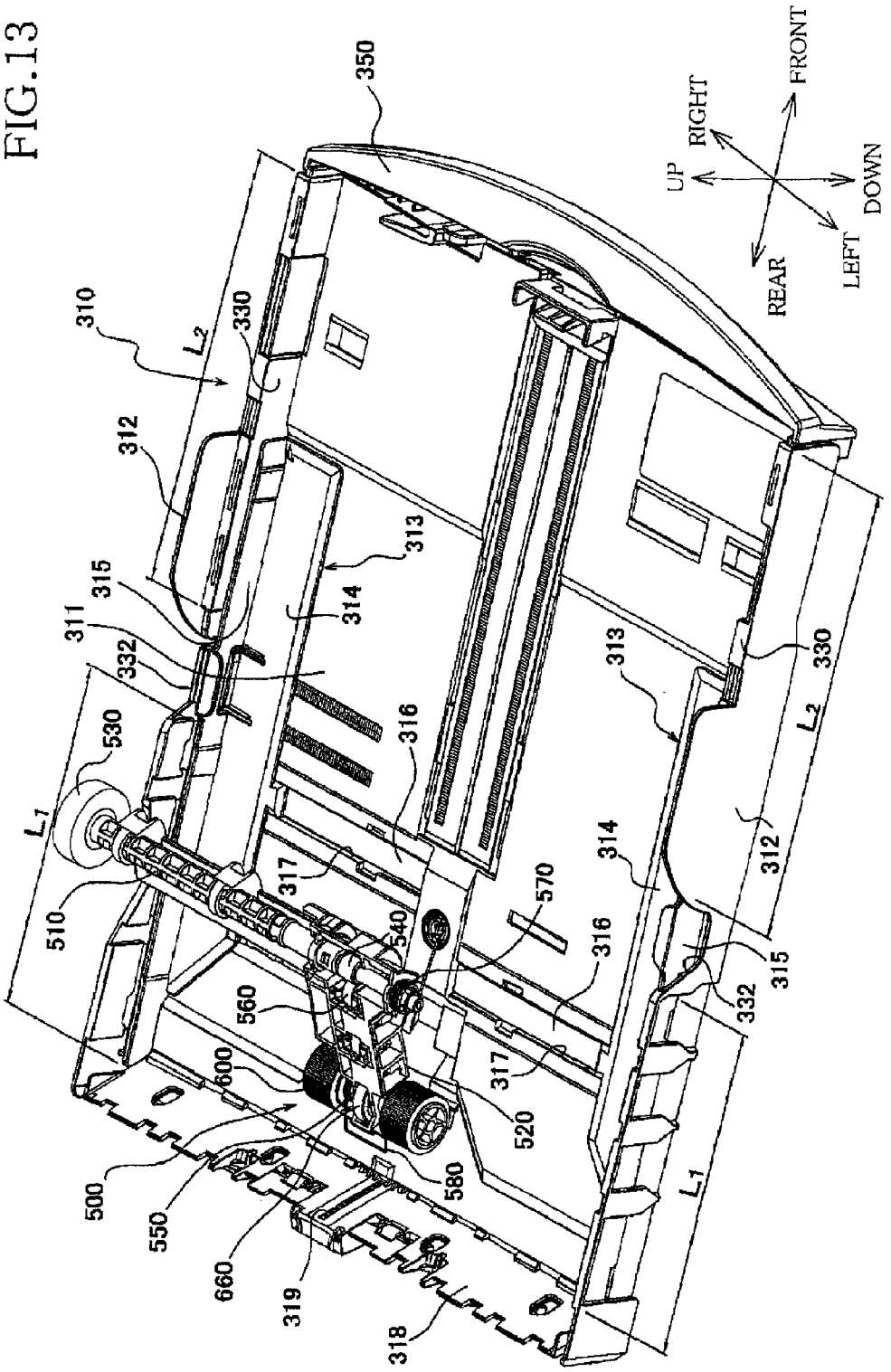


FIG.13


350
UP
RIGHT
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REAR
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330
L_2
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315
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314
332
316
530
L_1
510
317
540
570
560
600
500
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319
318
580
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L_1
L_2
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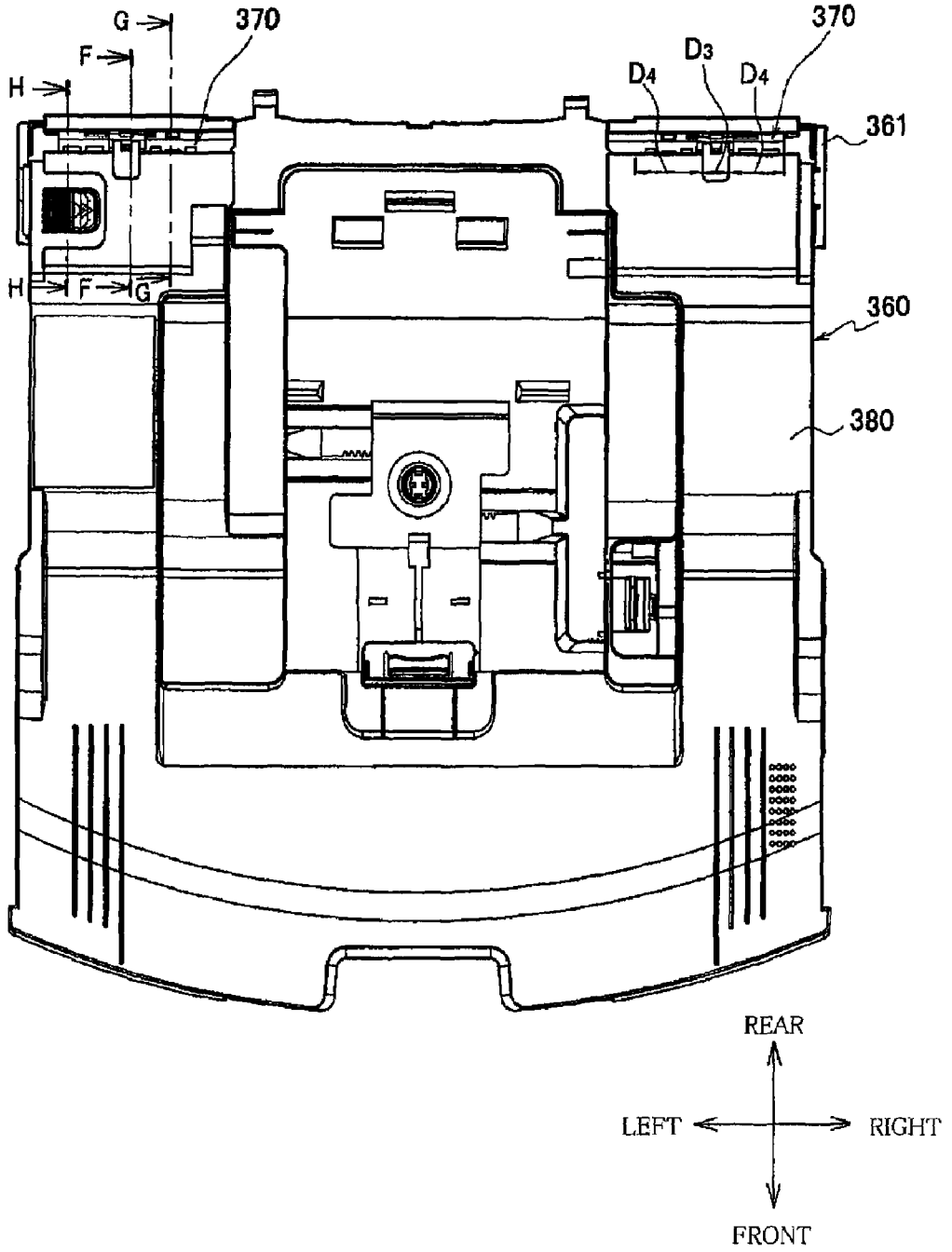
332
317

FIG.14



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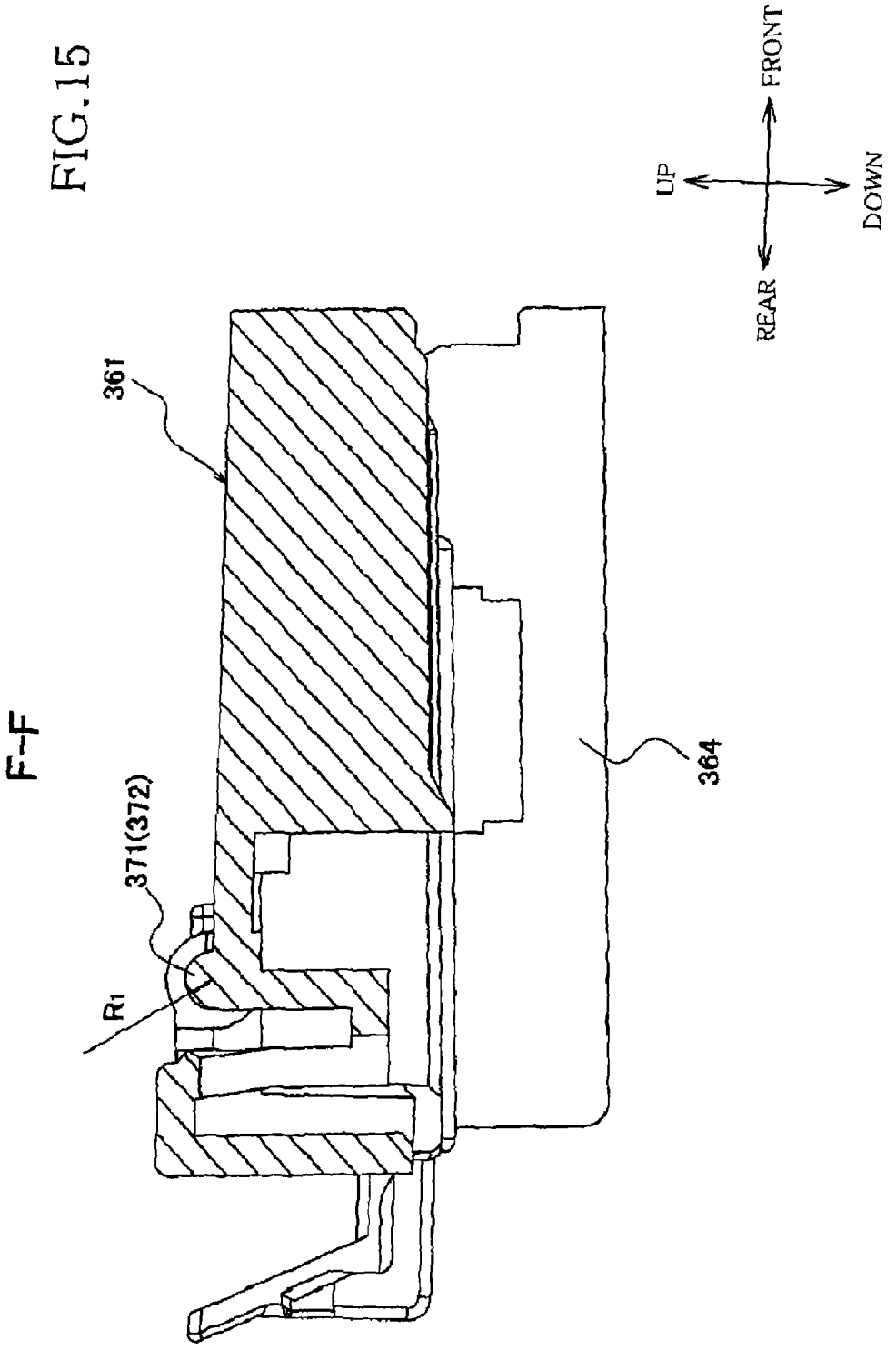
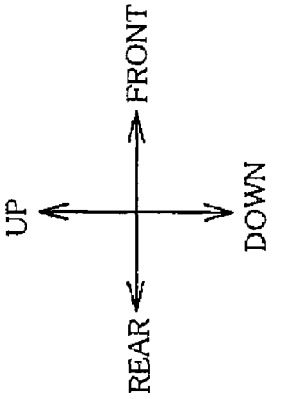


FIG.16



F-F

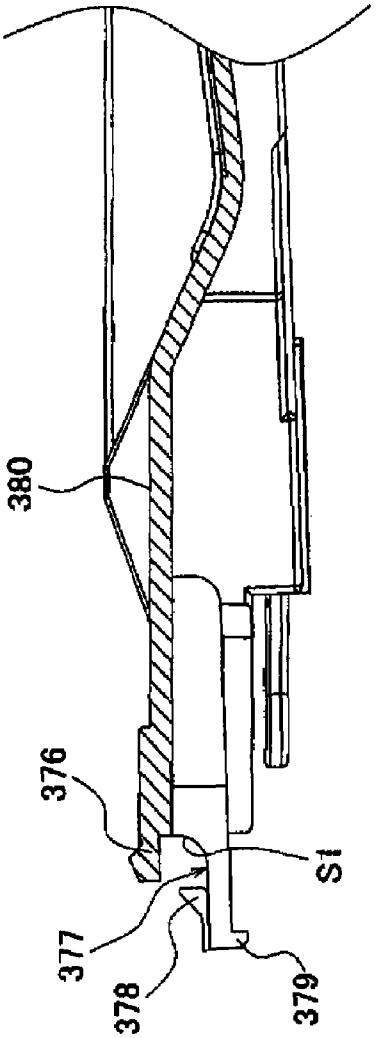


FIG.17

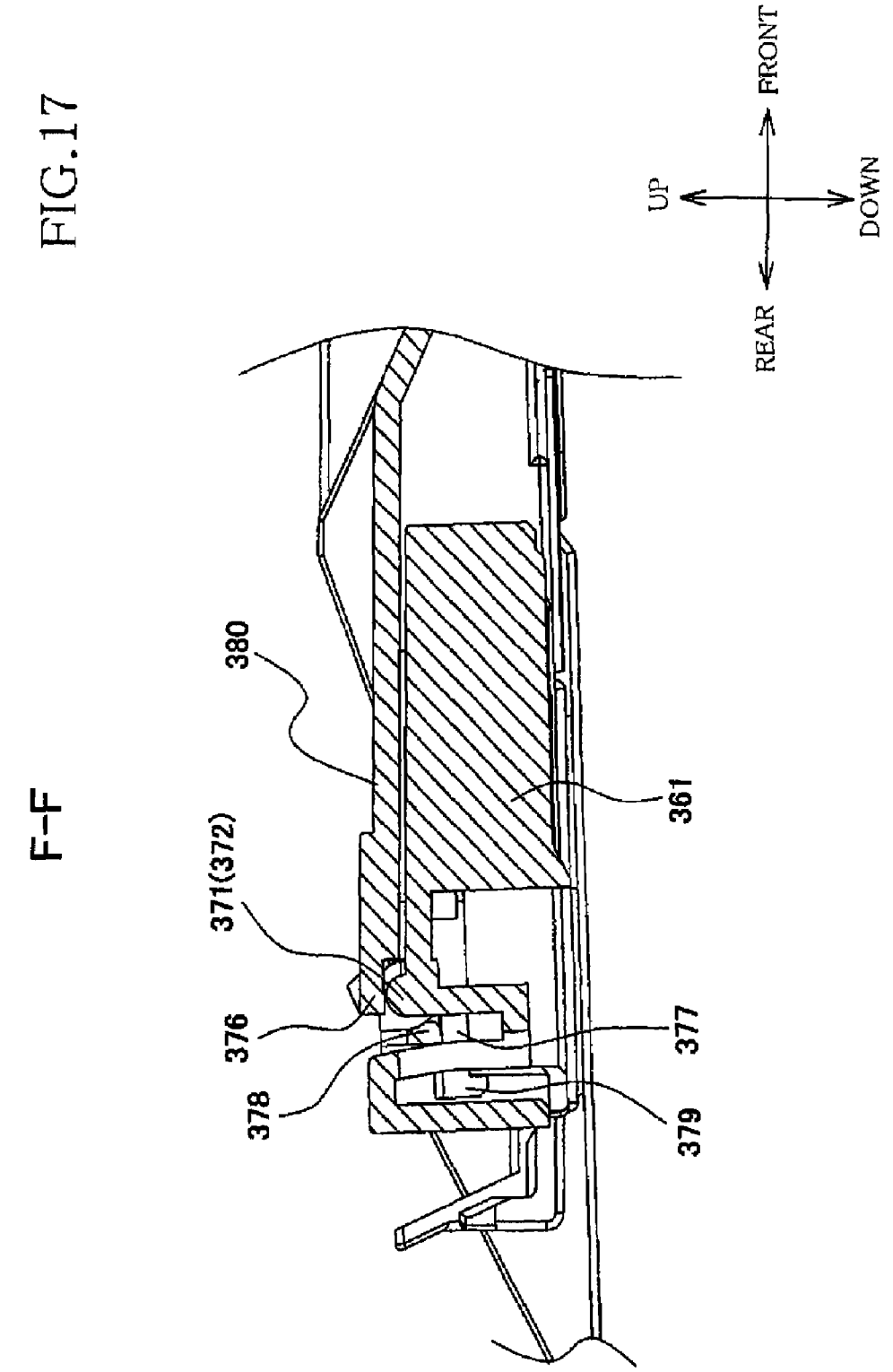


FIG.18

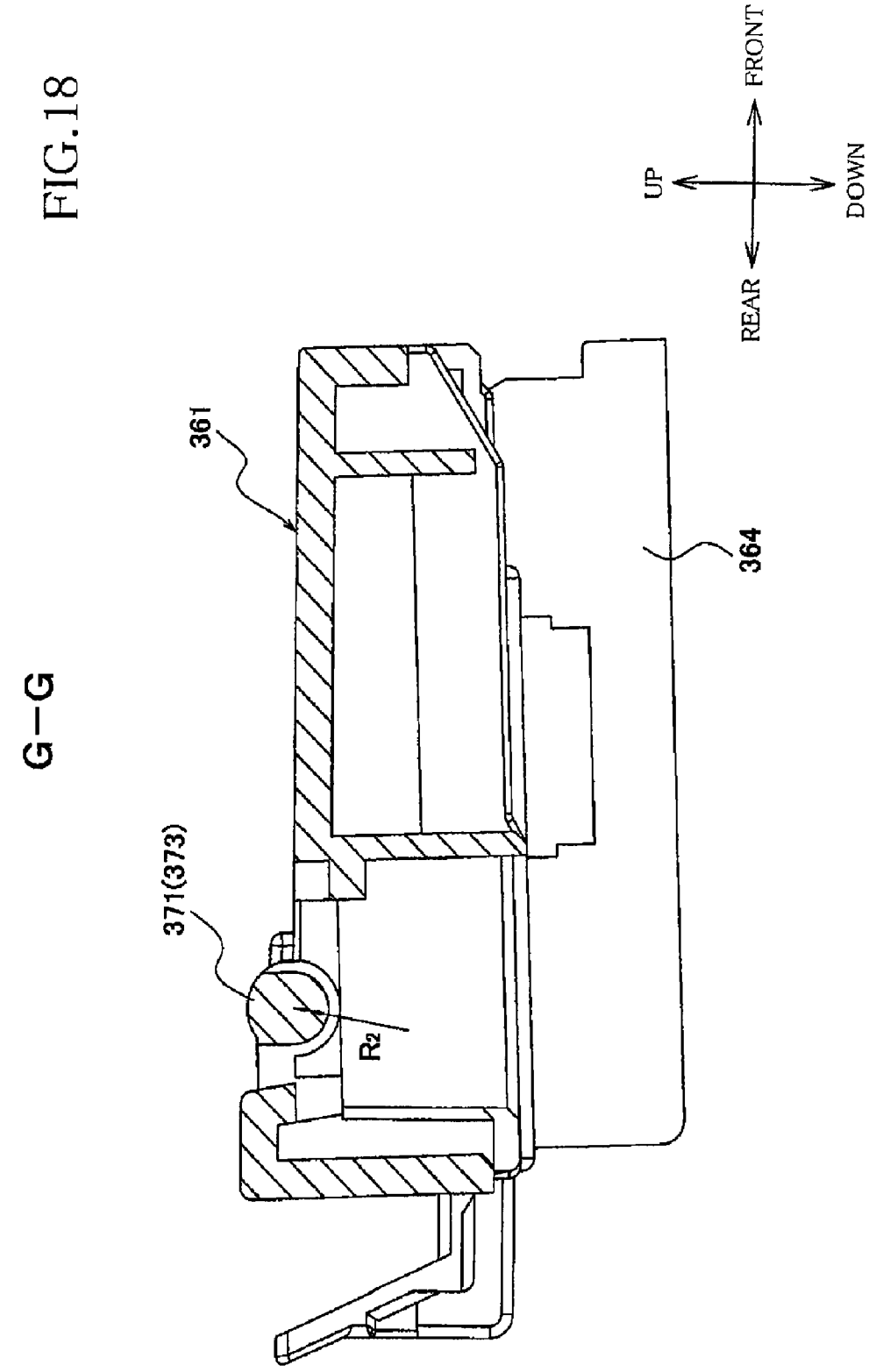


FIG.19

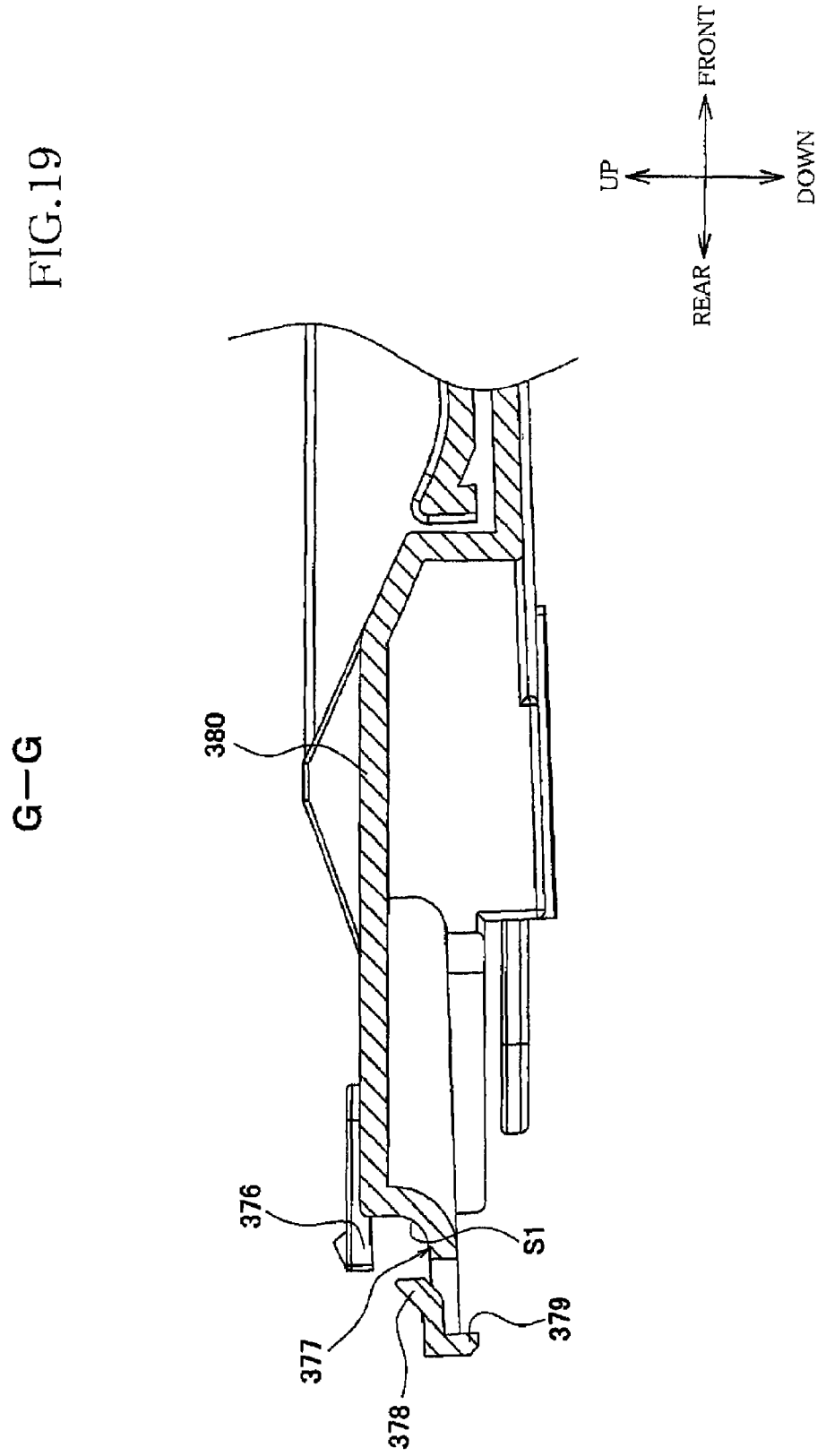


FIG.20

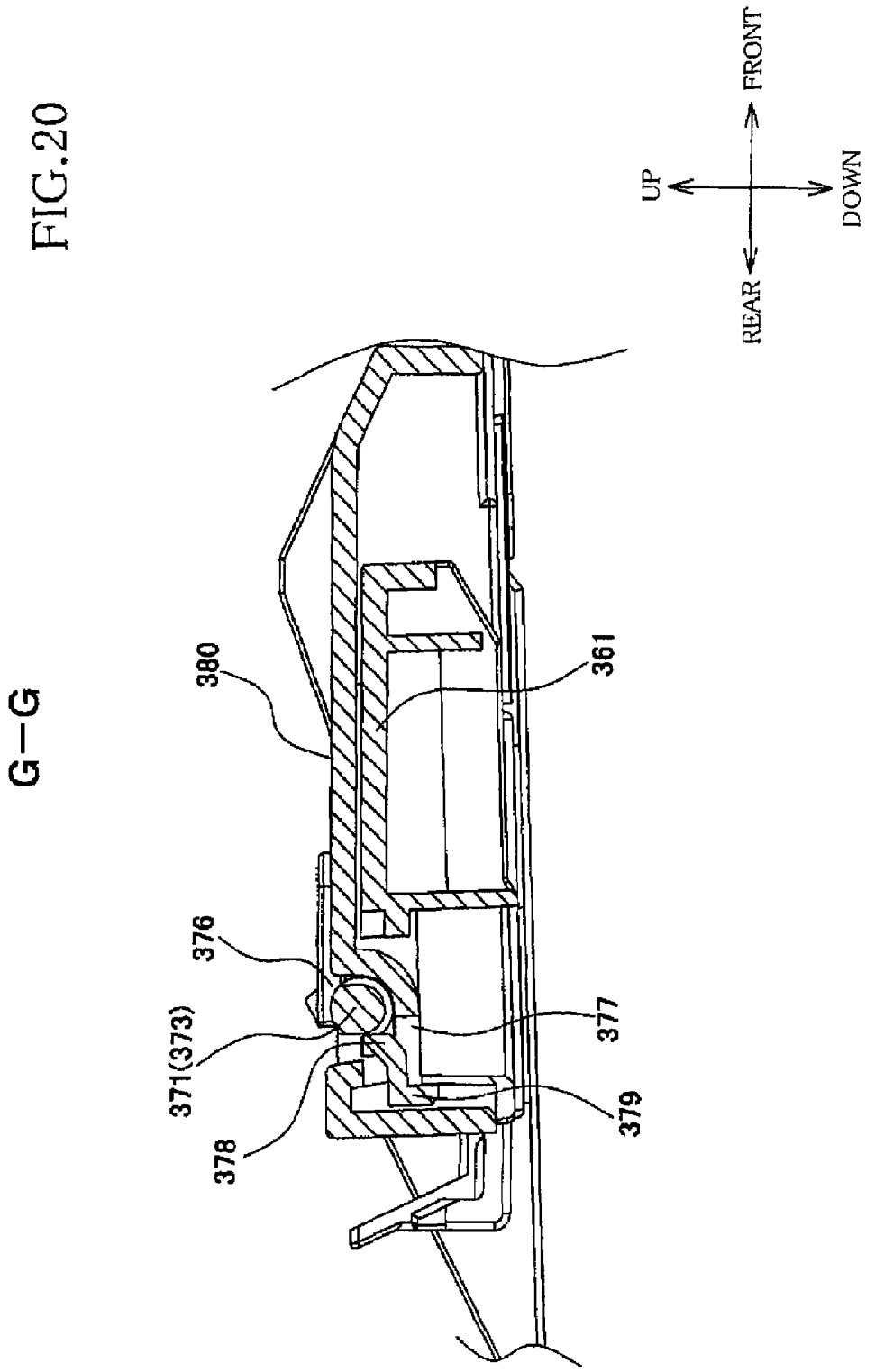
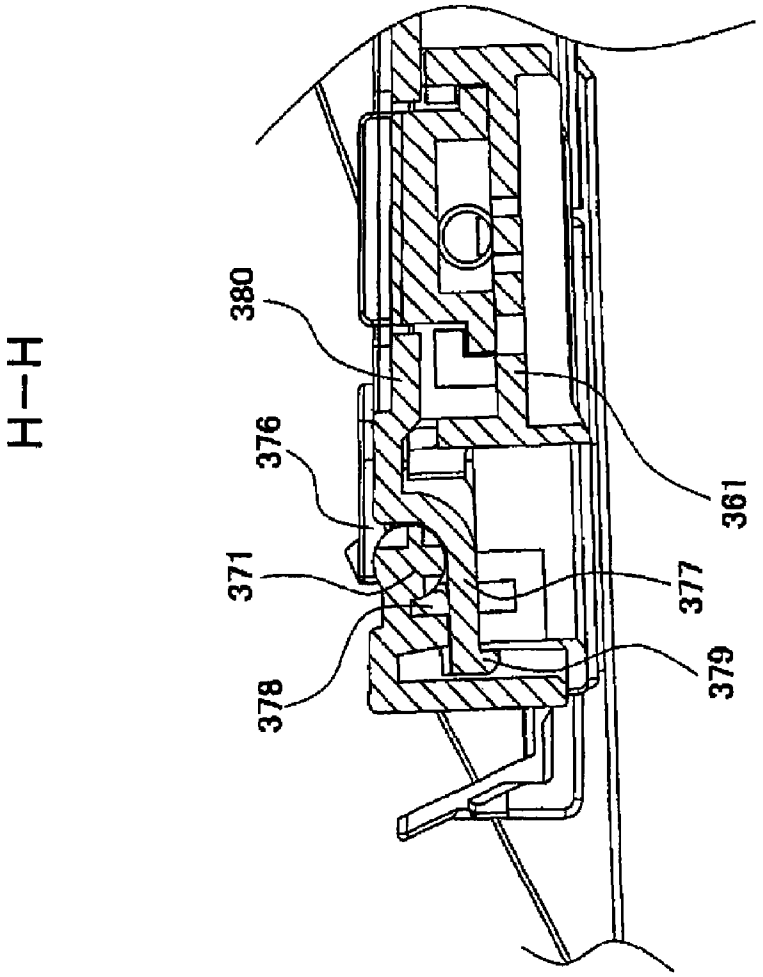


FIG.21



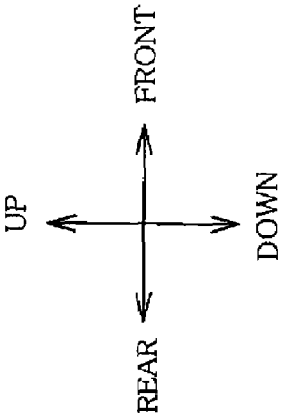
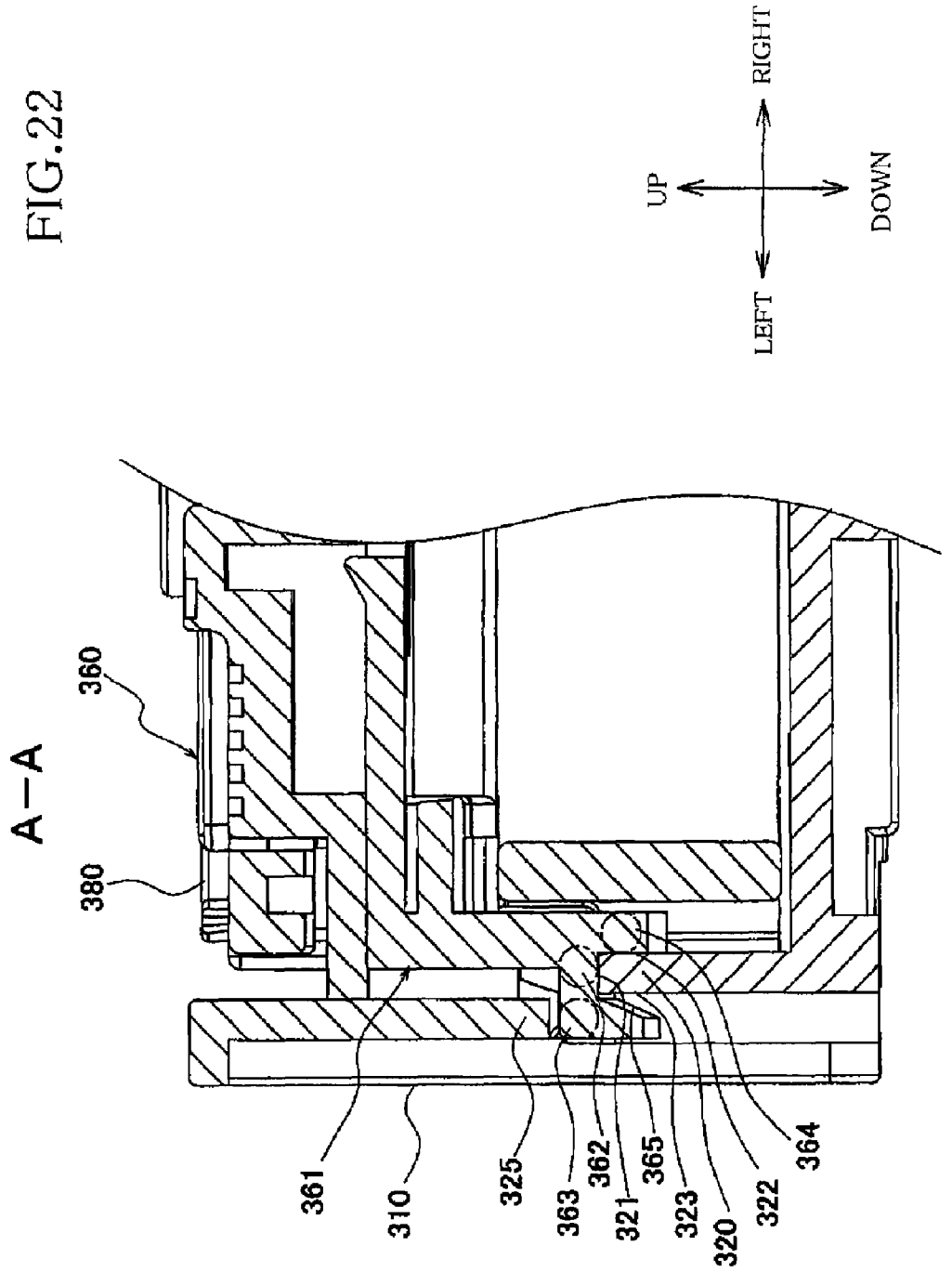


FIG.22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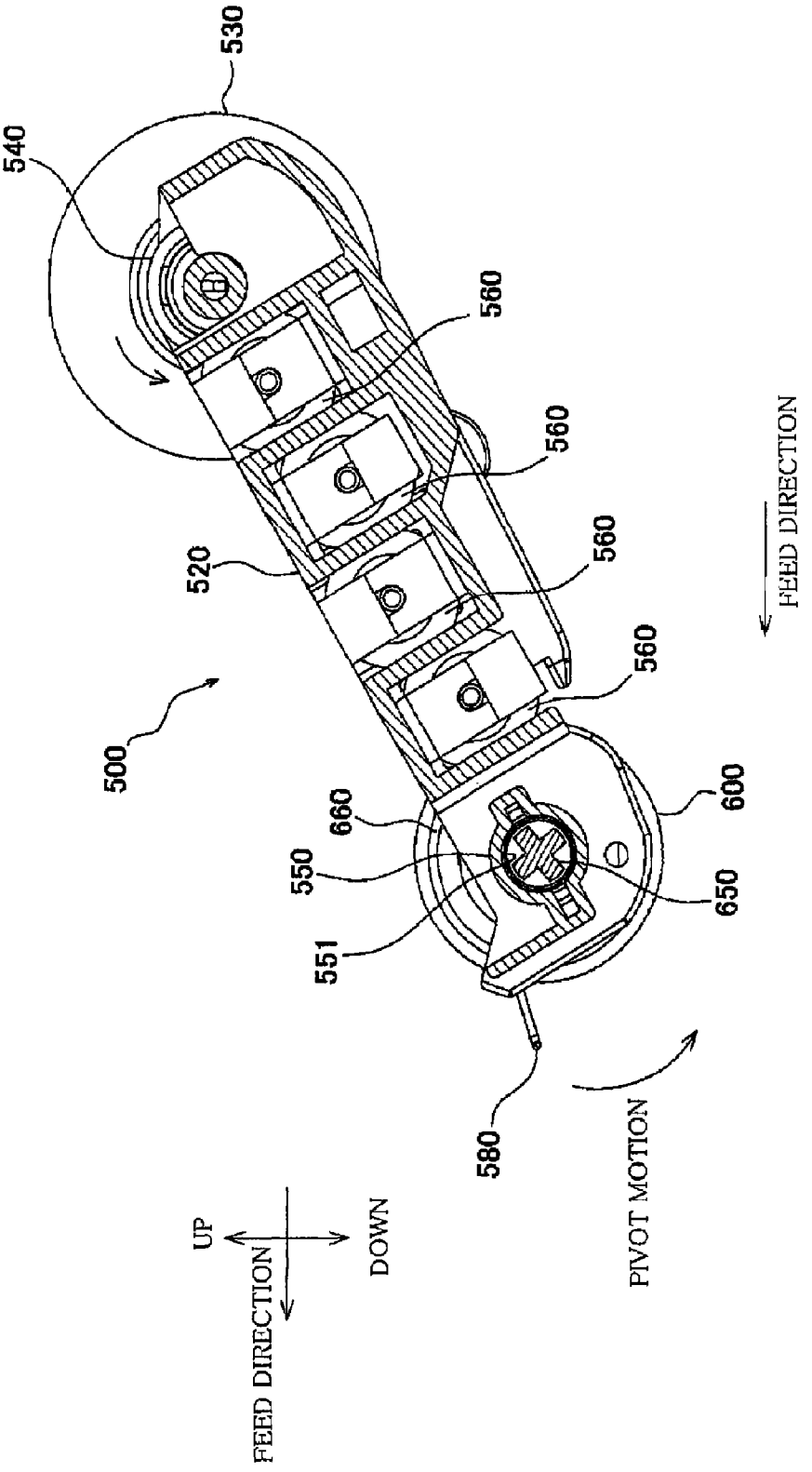
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650
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FEED DIRECTION
PIVOT MOTION
UP
DOWN
FEED DIRECTION

FIG.23

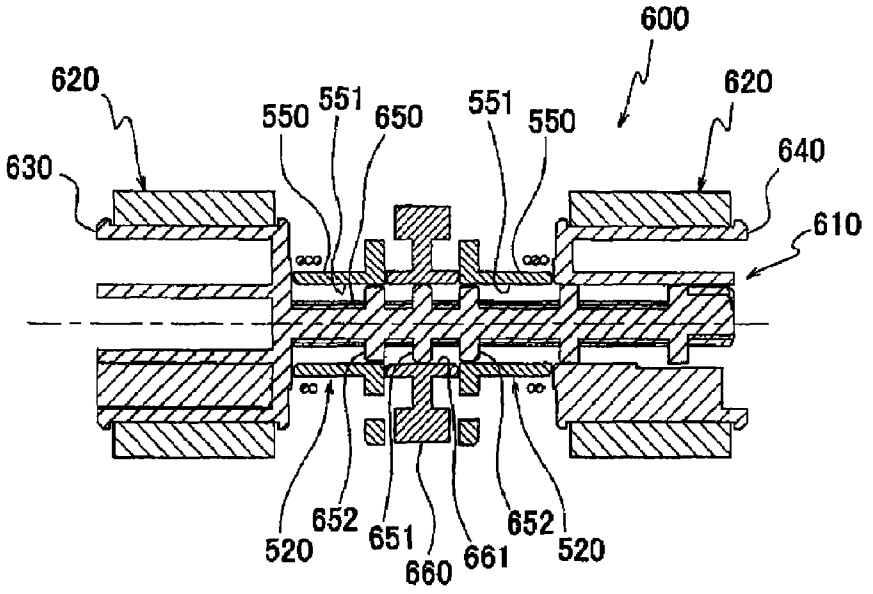


FIG.24A

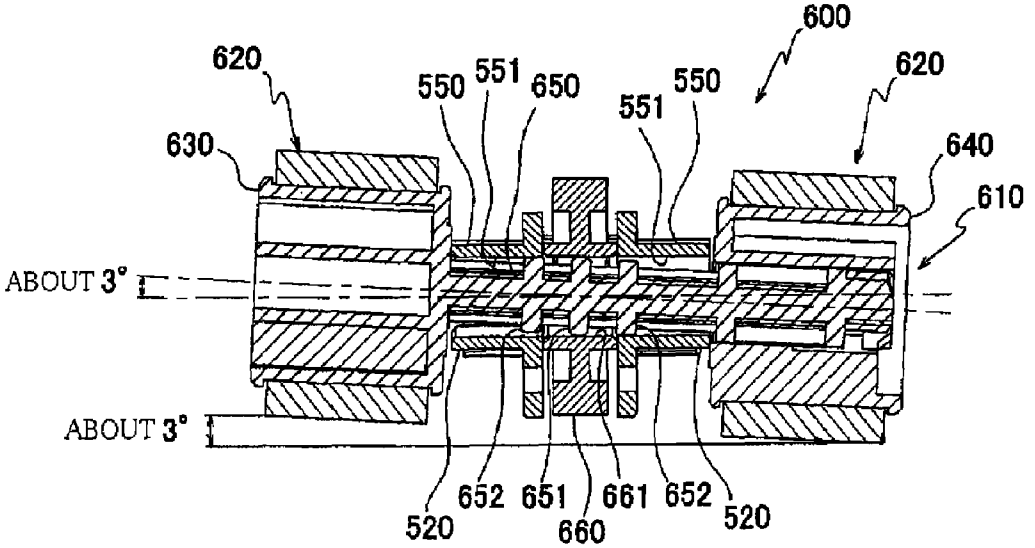


FIG.24B

FIG.25A

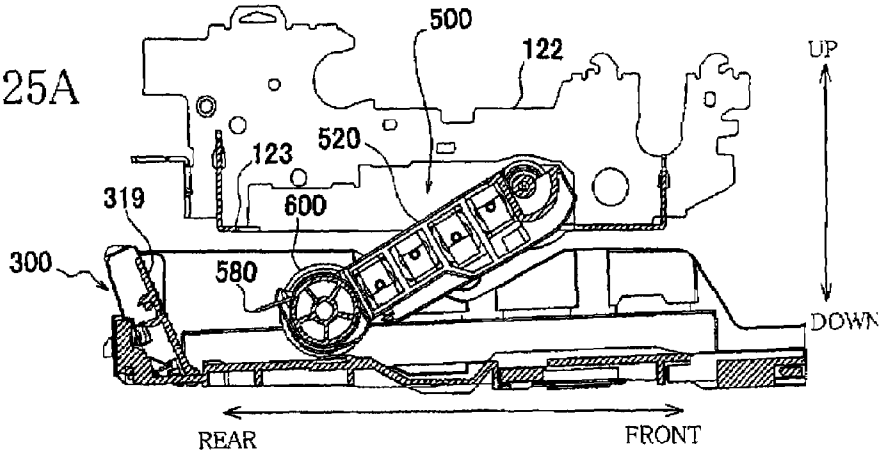


FIG.25B

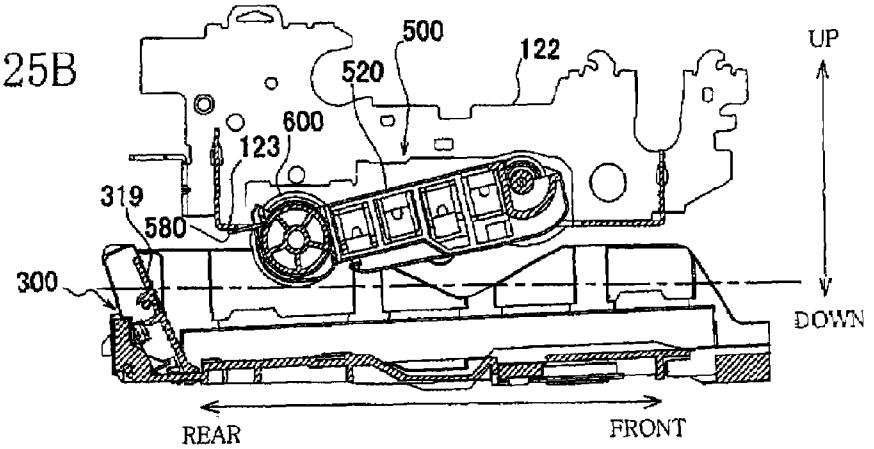
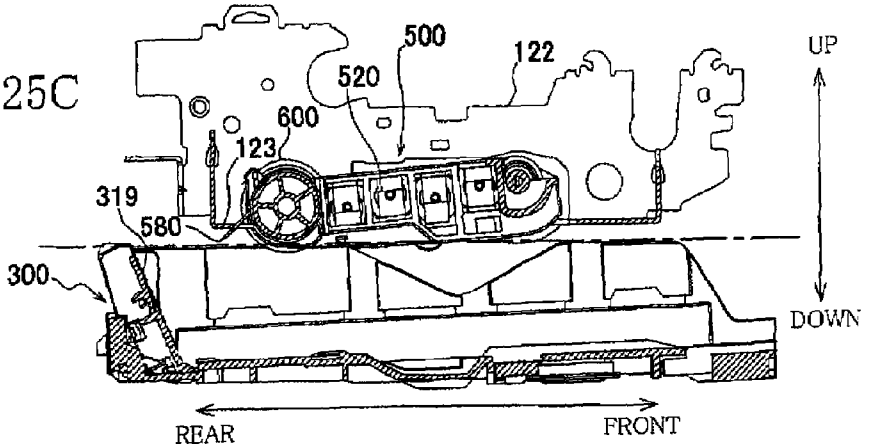


FIG.25C



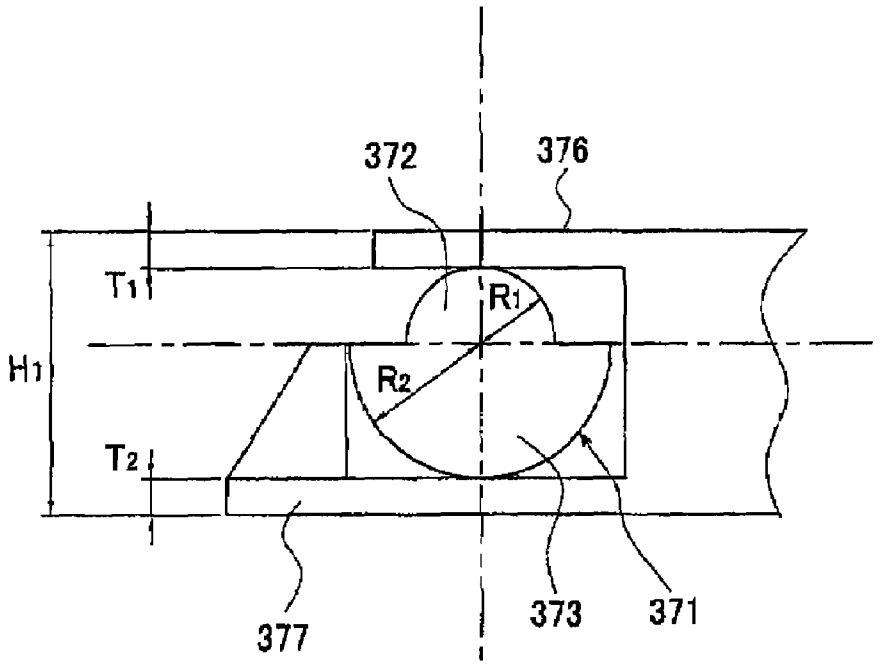


FIG.26A

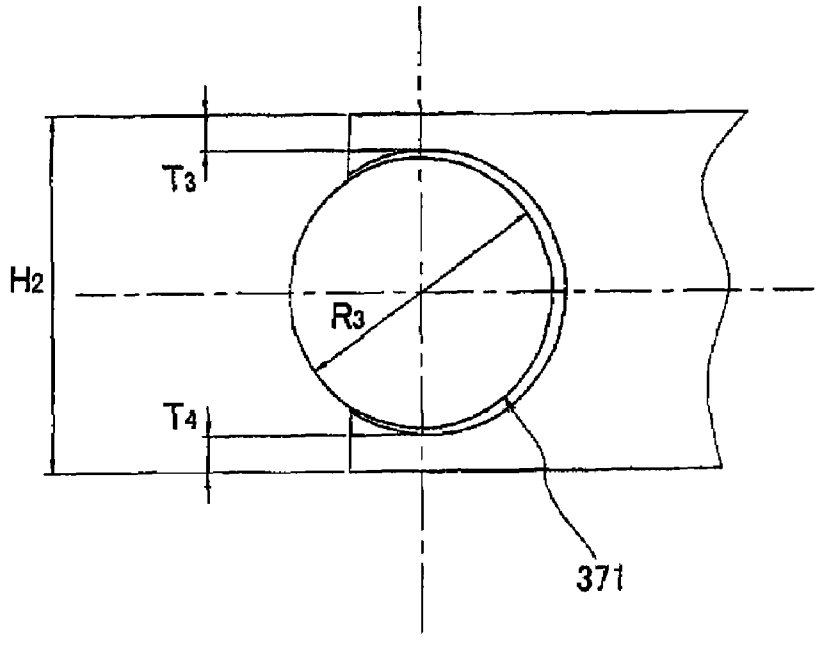


FIG.26B

FIG.27

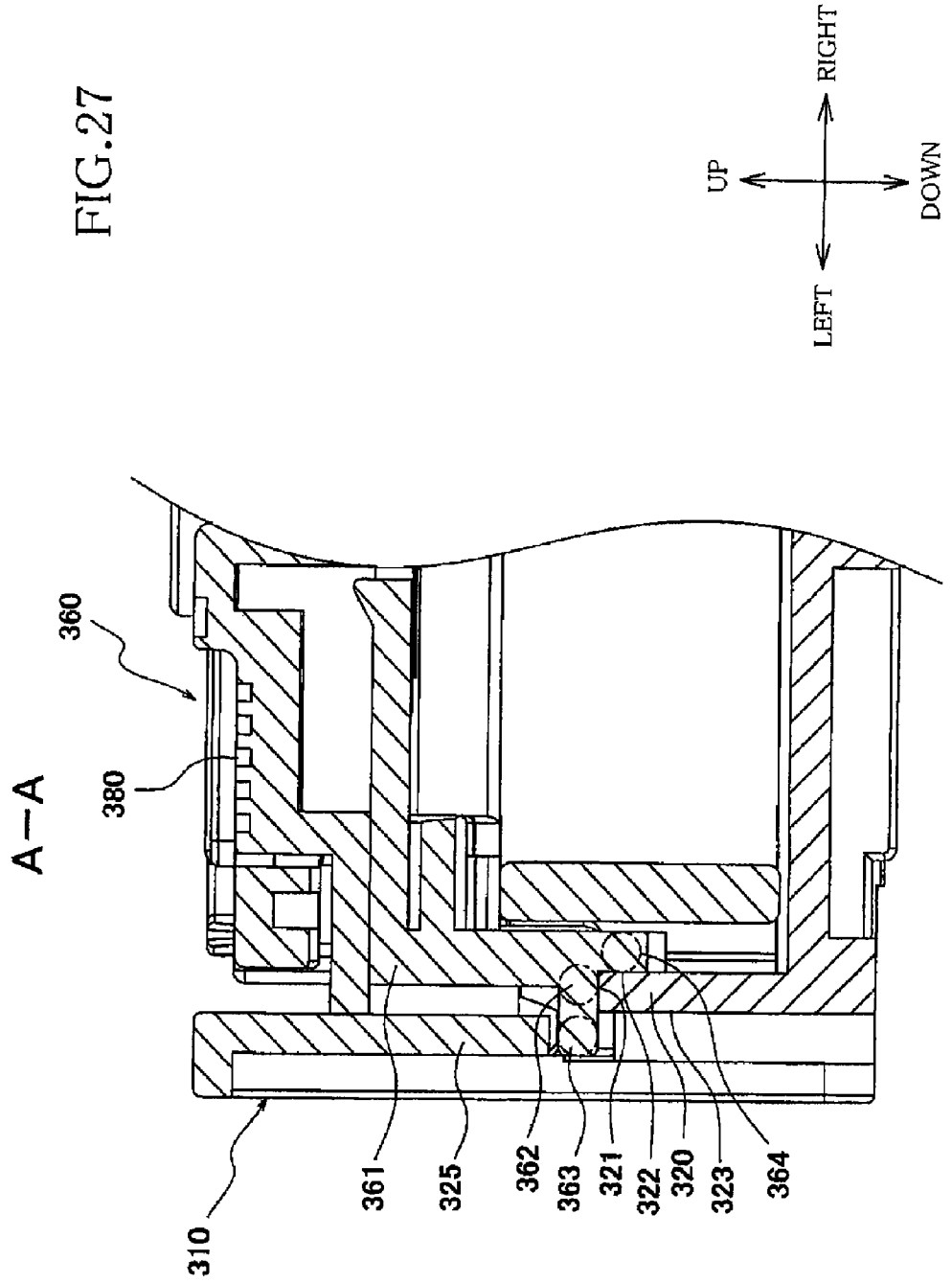

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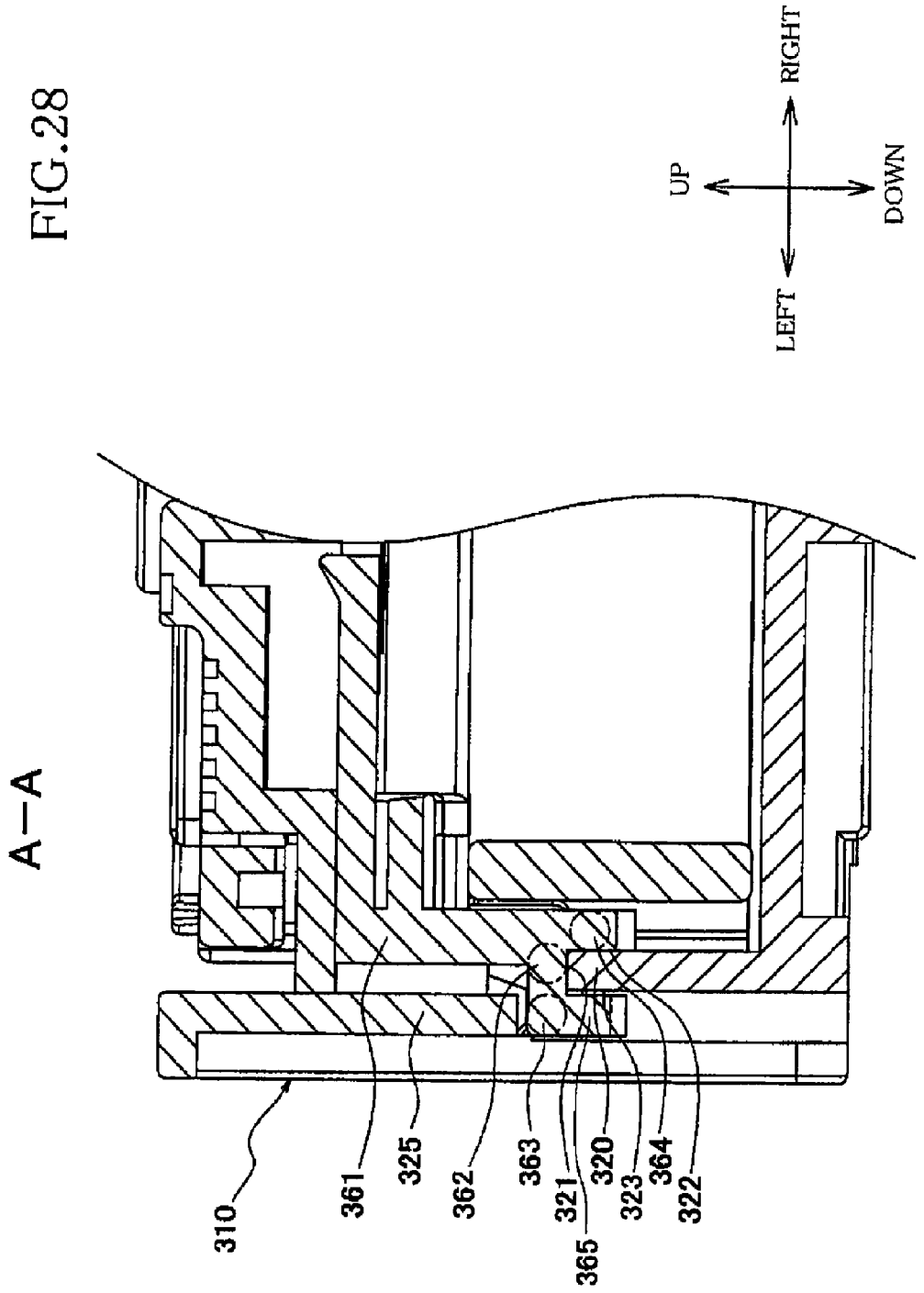
FIG.28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SHEET TRAY DEVICE WITH SLIDE PORTION AND IMAGE FORMING APPARATUS HAVING THE SHEET TRAY DEVICE

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

This application *is a reissue application of U.S. Pat. No. 7,748,692 B2, which is issued from U.S. application Ser. No. 11/677,122 and which* is based on Japanese Patent Application No. 2006-048514 filed on Feb. 24, 2006, the [content] *contents* of which [is] *are* incorporated hereinto by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a sheet tray device for accommodating a media sheet such as paper sheet, OHP sheet, envelop and postal card, and also an image forming apparatus including such a sheet tray device.

2. Discussion of Related Art

It is common that a sheet tray device for use in an image forming apparatus is provided by a single tray member that is removably introduced into a main body of the image forming apparatus, as disclosed in JP-2005-314067A.

The sheet tray device is required to accommodate the media sheets of various sizes such as A4-sized papers and A-5 sized papers. However, the media sheets of plurality of different sizes can not be concurrently accommodated in the single tray member. Every time the size of the media sheets (on which an image forming or printing operation is to be performed) is changed to another size of those, the sheet tray device has to be removed from the main body of the image forming apparatus, for carrying out a sheet replacement operation, namely, for changing the media sheets with those of the other size.

That is, where the image forming operation is to be carried out on the media sheets of various sizes, the sheet replacement operation has to be frequently done. Since such a sheet replacement operation is generally cumbersome, the conventional image forming apparatus is poor in maneuverability, particularly, for a user who has to carry out the image forming operation on the media sheets of various sizes.

The above problem could be solved, for example, by employing an image forming apparatus such as large-sized copier machine equipped with a sheet tray device that has a plurality of trays for accommodating respective different sizes of media sheets. In the large-sized copier machine in which the media sheets of different sizes can be concurrently accommodated in the respective trays, the sheet replacement operation is not required every time the size of the media sheets is changed. However, the large-sized image forming apparatus is not feasible for a domestic use in which there is not a large space available for installation of the apparatus.

For solving the above problem, the present inventor manufactured, by way of trial, a double-deck sheet tray device including the conventional tray as a first tray for accommodating first size sheets, and a second tray for accommodating second size sheets whose size is smaller

than that of the first size sheets, wherein the second tray is movably disposed on an upper side of the first tray. However, another problem is encountered in this double-deck sheet tray device. The problem is that refilling the first tray with the sheets could be made difficult by the arrangement in which the second tray is disposed to cover an upper opening of the first tray.

In view of this, in the double-deck sheet tray device manufactured by way of trial, the second tray is constituted by a support member and a supported body. The support member is arranged to bridge between opposite side walls of the first tray, while the supported body is supported by the support member and is pivotable to open and close the upper opening of the first tray. However, the double-deck sheet tray device suffers from still another problem that the second tray could be rotated relative to the first tray or removed from the first tray during movement of the second tray relative to the first tray.

SUMMARY OF THE INVENTION

The present invention was made in view of the background prior art discussed above. It is therefore a first object of the invention to provide a sheet tray device in which a second tray can be advantageously moved relative to a first tray without risk of rotation of the second tray relative to the first tray or removal of the second tray from the first tray. It is a second object of the invention to provide an image forming apparatus including the sheet tray device that provides the above technical advantage. The first object may be achieved according to a first aspect of the invention that is described below. The second object may be achieved according to a second aspect of the invention that is described below.

The first aspect of the invention provides a sheet tray device that is removably introduced into a main body of an image forming apparatus through an opening of the main body, so as to hold a media sheet that is to be supplied to an image forming unit of the image forming apparatus by which an image forming operation is performed on the media sheet. The sheet tray device includes: (a) a first tray accommodating a larger or first size sheet as the media sheet; and (b) a second tray disposed on an upper side of the first tray and accommodating a smaller or second size sheet as the media sheet. The second tray includes (b-1) a support member which bridges between opposite side walls of the first tray and which is movable relative to the opposite side walls, and (b-2) a supported body pivotably supported by the support member so as to open and close an upper opening of the first tray. Each of the opposite side walls of the first tray includes first and second rail portions that extend in a rail extending direction in which the support member is movable relative to the opposite side walls. The second rail portion is located on an upper side of the first rail portion and being spaced apart from the first rail portion. The support member of the second tray includes (i) a main slide portion that is slidably held in contact with an upper surface of the first rail portion, (ii) a removal-preventing slide portion that extends through a gap or space between the first and second rail portions so as to prevent removal of the support member of the second tray from the first tray, and (iii) a rotation-preventing slide portion that is slidably held in contact with an inside or outside surface of the first rail portion so as to prevent rotation of the support member of the second tray relative to the first tray.

In the sheet tray device constructed according to the first aspect of the invention, the main slide portion is slidably

held in contact with the upper surface of the first rail portion, whereby the support member of the second tray is movably held by the first tray.

Further, since the removal-preventing slide portion extends through the space between the first and second rail portions, removal of the support member of the second tray from the first tray can be prevented by engagement of the removal-preventing slide portion with at least one of the first and second rail portions.

Moreover, since the rotation-preventing slide portion is slidably held in contact with the inside or outside surface of the first rail portion, it is possible to prevent rotation of the second tray relative to the first tray.

Therefore, in the present sheet tray device, it is possible to avoid problems such as rotation of the second tray relative to the first tray and removal of the second tray from the first tray, when the second tray is moved relative to the first tray.

It is noted that, in the present sheet tray device, the main slide portion and the rotation-preventing slide portion may be provided by either respective members that are independent from each other, or may be formed integrally with each other to be provided by a single common member.

It is further noted that, in the present sheet tray device, the first and second rail portions may be either offset or not offset from each other in a lateral direction in which the opposite side walls of the first tray are opposed to each other.

The second aspect of the invention provides an image forming apparatus including the sheet tray device defined in the first aspect of the invention, an image forming unit operable to perform an image forming operating on a media sheet, and a sheet supplying unit operable to supply the media sheet held by the sheet tray device, to the image forming unit.

In the image forming apparatus according to this second aspect of the invention, owing to incorporation of the sheet tray device defined in the first aspect of the invention, it is possible to enjoy the above-described technical advantages provided by the sheet tray device. That is, in the sheet tray device of the image forming apparatus, the second tray can be advantageously moved relative to the first tray without risk of rotation of the second tray relative to the first tray or removal of the second tray from the first tray.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features, advantages and technical and industrial significance of the present invention will be better understood by reading the following detailed description of presently preferred embodiments of the invention, when considered in connection with the accompanying drawings, in which;

FIG. **1** is a perspective view of an image forming apparatus **100** that is constructed according to an embodiment of the present invention;

FIG. **2** is a side view partially in cross section of a sheet supplying unit **500** and an image forming unit **700** that are incorporated in the image forming apparatus **100** of FIG. **1**;

FIG. **3** is a perspective view of the sheet supplying unit **500** and a sheet tray device **300** that is to be removably introduced into the image forming apparatus **100** of FIG. **1**, wherein the sheet tray device **300** includes a first tray **310** and a second tray **360**;

FIG. **4** is an upper plan view of the sheet tray device **300** of FIG. **3**;

FIG. **5** is a perspective view of the sheet tray device **300** of FIG. **3** when the second tray **360** has been forwardly moved relative to the first tray **310**;

FIG. **6** is an upper plan view of the sheet tray device **300** of FIG. **3** together with the sheet supplying unit **500** when the second tray **360** has been forwardly moved relative to the first tray **310**;

FIG. **7** is a perspective view of the sheet tray device **300** of FIG. **3** when an upper opening of the first tray **310** is exposed and an extension tray **350** is drawn out of the first tray **310**;

FIG. **8** is a perspective view showing in enlargement a portion B of FIG. **5**;

FIG. **9** is a cross sectional view taken along line C-C of FIG. **6**;

FIG. **10** is a cross sectional view taken along line D-D of FIG. **6**;

FIG. **11** is a cross sectional view taken along line E-E of FIG. **6**;

FIG. **12** is a cross sectional view taken along line E-E of FIG. **6** when the second tray **360** has been rearwardly moved relative to the first tray **310**;

FIG. **13** is a perspective view of the sheet supplying unit **500** and the sheet tray device **300** of FIG. **3** in absence of the second tray **360**;

FIG. **14** is an upper plan view of the second tray **360**;

FIG. **15** is a cross sectional view of a support member **361** of the second tray **360**, taken along line F-F of FIG. **14**;

FIG. **16** is a cross sectional view of a supported body **380** of the second tray **360**, taken along line F-F of FIG. **14**;

FIG. **17** is a cross sectional view of the support member **361** and the supported body **380** of the second tray **360**, taken along line F-F of FIG. **14**;

FIG. **18** is a cross sectional view of the support member **361** of the second tray **360**, taken along line G-G of FIG. **14**;

FIG. **19** is a cross sectional view of the supported body **380** of the second tray **360**, taken along line G-G of FIG. **14**;

FIG. **20** is a cross sectional view of the support member **361** and the supported body **380** of the second tray **360**, taken along line G-G of FIG. **14**;

FIG. **21** is a cross sectional view of the support member **361** and the supported body **380** of the second tray **360**, taken along line H-H of FIG. **14**;

FIG. **22** is a cross sectional view taken along line A-A of FIG. **4**;

FIG. **23** is a cross sectional view of the sheet supplying unit **500**;

FIG. **24**A is a view showing a state in which a sheet supplying roller **600** (rotary shaft **650**) is in parallel with axes of through-holes **551** of respective shaft supporting portions **550**;

FIG. **24**B is a view showing another state in which the sheet supplying roller **600** (rotary shaft **650**) is inclined with respect to the axes of the through-holes **551** of the respective shaft supporting portions **550**;

FIGS. **25**A-**25**C are views showing an operation of a second coil spring **580**;

FIG. **26**A is a view schematically showing a hinge **370** in the embodiment of the invention;

FIG. **26**B is a view schematically showing a C-type hinge;

FIG. **27** is a view showing a modification of the support member **361** of the second tray **360**; and

FIG. **28** is a view showing another modification of the support member **361** of the second tray **360**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

There will be described an image forming apparatus **100** that is constructed according to an embodiment of the

invention. The image forming apparatus **100** is a multi function device having various functions such as printer function, scanner function, color copier function and facsimile function.

1. Basic Construction of Image Forming Apparatus **100**

FIG. **1** is a perspective view of the image forming apparatus **100**. FIG. **2** is a side view partially in cross section of a sheet supplying unit **500** and an image forming unit **700** that are incorporated in the image forming apparatus **100** of FIG. **1**. The image forming apparatus **100** has a main body in the form of a casing body **120** that is provided by a rectangular parallelepiped box-like body made of a resin. This apparatus **100** is installed for use, with its front portion and upper portion as seen in FIG. **1** facing forwardly and upwardly, respectively.

An operator's control panel **110** is provided on an upper surface of a front portion of the casing body **120**, and includes an input portion **111** and a display portion **112**. The input portion **111** has various keys that are manually operable by an operator of the apparatus **100** to input various command signals for various operations to be performed by the apparatus **100**. The display portion **112** is provided for indicating a message and an image to provide the operator with information.

A scanner unit **200** is provided in an upper portion of the casing body **120** and is located on a rear side of the operator's control panel **110**, so as to read an image or script carried on an original. The scanner unit **200** serves as an image reader that is operable when the scanner function, color copy function or facsimile function is used. Since the scanner unit **200** has a known construction with an image pick-up device such as CCD and CIS, redundant description of the scanner unit **200** is not provided in the present specification.

As shown in FIG. **2**, a sheet tray device **300** is provided in a lower portion of the casing body **120**, so as to hold or accommodate recording or media sheets such as paper sheets and OHP sheets that are superposed on each other. The sheet tray device **300** can be removed from the casing body **120** of the apparatus **100**, by forwardly and horizontally moving the tray device **300** out of the casing body **120** through an opening **121** that is provided in a front surface of the casing body **120**. The tray device **300** can be introduced into the casing body **120**, by rearwardly and horizontally moving the tray device **300** into the casing body **120** through the opening **121**.

A sheet supplying unit **500** is provided to feed or supply the media sheets stacked in the sheet tray device **300**, one after another, to the image forming unit **700**. The sheet supplying unit **500** is supported by a frame **122** (see FIG. **2**) that is fixed to the casing body **120**, so as to be located on an upper side of the sheet tray device **300**.

In a rear end portion of the casing body **120** that corresponds to a rear end portion of the sheet tray device **300**, a sheet feed path L is defined to interconnect the sheet tray device **300** and the image forming unit **700**. The sheet feed path L has a U-shaped cross sectional shape as seen in FIG. **2**, so that each of the media sheets separated from the sheet tray device **300** is first moved in a rearward direction and is then moved in a forward direction. That is, the sheet feed path has a U turn portion by which a feed direction of each media sheet is changed from the rearward direction to the forward direction by substantially about 180°.

The image forming unit **700** is provided on an upper side of the sheet supplying unit **500**, so as to perform an image forming (printing) operation on each media sheet that has been fed (supplied) along the sheet feed path L. Each media sheet, after being subjected to the image forming operation, is discharged to a front portion of an upper surface of the sheet tray device **300**. Since the image forming unit **700** is of a known inkjet type and accordingly has a known construction, redundant description of the image forming unit **700** is not provided in the present specification.

2. Construction of Sheet Tray Device **300**

2.0. Description of Drawing related to Sheet Tray Device **300**

FIG. **3** is a perspective view of the sheet supplying unit **500** and the sheet tray device **300** in a state in which a second tray (sub tray) **360** is mounted on a first tray (main tray) **310**. FIG. **4** is an upper plan view of the sheet tray device **300** in the same state as in FIG. **3**. FIG. **5** is a perspective view of the sheet tray device **300** in a state in which the second tray **360** is positioned in a front position relative to the first tray **310**.

FIG. **6** is an upper plan view of the sheet tray device **300** together with the sheet supplying unit **500** in the same state as in FIG. **5**. FIG. **7** is a perspective view of the sheet tray device **300** in a state in which an upper opening of the first tray **310** is exposed and an extension tray **350** is drawn out of the first tray **310**.

FIG. **8** is a perspective view showing in enlargement a portion B of FIG. **5**. FIG. **9** is a cross sectional view taken along line C-C of FIG. **6**. FIG. **10** is a cross sectional view taken along line D-D of FIG. **6**. FIG. **11** is a cross sectional view taken along line E-E of FIG. **6**. FIG. **12** is a cross sectional view taken along line E-E of FIG. **6** in a state in which the second tray **360** is positioned in a rear position relative to the first tray **310**. FIG. **13** is a perspective view of the sheet supplying unit **500** and the sheet tray device **300** without the second tray **360** being mounted on the first tray **310**.

FIG. **14** is an upper plan view of the second tray **360**. FIG. **15** is a cross sectional view of a support member **361** of the second tray **360**, taken along line F-F of FIG. **14**. FIG. **16** is a cross sectional view of a main body (supported body) **380** of the second tray **360**, taken along line F-F of FIG. **14**. FIG. **17** is a cross sectional view taken along line F-F of FIG. **14**.

FIG. **18** is a cross sectional view of the support member **361** of the second tray **360**, taken along line G-G of FIG. **14**. FIG. **19** is a cross sectional view of the main body **380** of the second tray **360**, taken along line G-G of FIG. **14**. FIG. **20** is a cross sectional view taken along line G-G of FIG. **14**. FIG. **21** is a cross sectional view taken along line H-H of FIG. **14**. FIG. **22** is a cross sectional view taken along line A-A of FIG. **4**.

2.1. Basic Construction of Sheet Tray Device **300**

The sheet tray device **300** is provided to hold or accommodate the media sheets that are to be supplied to the image forming unit **700**. As shown in FIG. **3**, the sheet tray device **300** includes the first tray **310** provided by a rectangular parallelepiped plate-like body that has an upper opening, the second tray **360** disposed on an upper side of the first tray **310** so as to cover a part of the upper opening of the first tray **310**, and the extension tray **350** movably attached to the first tray **310**. The extension tray **350** is movable relative to the first tray **310** in forward and rearward directions that are parallel to tray-device introduction and removal directions in which the sheet tray device **300** is introducible into and removable from the casing body **120** of the image forming apparatus **100**.

2.2. Construction of First Tray **310**

As shown FIG. **13**, the first tray **310** is provided by the thin plate-like body having the rectangular parallelepiped shape. In the present embodiment, the first tray **310** has a

size which permits A4-sized papers to be accommodated therein as maximum-sized media sheets when the extension tray **350** is not drawn out thereof, and which permits legal-sized papers to be accommodated therein as maximum-sized media sheets when the extension tray **350** is drawn out thereof.

The first tray **310** includes a bottom portion **311** (hereinafter referred to as bottom wall **311**), and opposite side walls **312** which are located on respective end portions (i.e., right and left end portions in the present embodiments) of the first tray **310** that are opposite to each other in a horizontal direction perpendicular to the above-described tray-device introduction and removal directions. The opposite side walls **312** project upwardly from the bottom wall **311**, and is elongated in the tray-device introduction and removal directions. In the present embodiment, the opposite side walls **312** and the bottom wall **311** are integrally formed of a resin.

A pair of guide members **313** are provided in the bottom wall **311** of the first tray **310**, and are arranged to be movable in respective opposite directions that are parallel to a lateral direction of the sheet tray device **300** in which the opposite side walls **312** are opposed to each other (i.e., in respective opposite directions corresponding to right and left directions in the present embodiment). The pair of guide members **313** are movable together with each other in respective opposite directions, so that a center between the guide members **313** always lies in a constant position (i.e., in a laterally central portion of the sheet tray device **300** in the present embodiment), irrespective of positions of the guide members **313**.

As shown in FIG. **13**, each of the guide members **313** includes a bottom plate portion **314** on which the media sheets are to be mounted, a side plate portion **315** which extends vertically upwardly from a laterally outer end of the bottom plate portion **314**, and a linear guide bar portion **316** which extends from a bottom surface of the bottom plate portion **314** toward the other of the guide members **313**.

The linear guide bar portions **316** of the respective guide members **313** are in parallel to each other and are spaced apart from each other in a longitudinal direction of the sheet tray device **300** (corresponding to the sheet feed direction), and are slidably fitted in respective grooves **317** that are formed in the bottom wall **311** of the first tray **310** and extend in the lateral direction. Each of the linear guide bar portions **316** has teeth (not shown) formed in its surface opposed to a surface of the other of the linear guide bar portions **316**, so as to serve as a rack.

The linear guide bar portions **316**, which serve as the racks, mesh with a pinion (not shown) that is rotatably disposed in a laterally central portion of the bottom wall **311**. Thus, the pair of guide members **313** are mechanically connected to each other through the pinion, so as to be slidable or movable in the respective opposite directions such that the center between the guide members **313** always lies in the constant position.

The side plate portion **315** of each of the guide members **313** has a contact surface that is to be in contact with a corresponding one of widthwise opposite ends of each media sheet. The contact surface of the side plate portion **315** is provided by a flat surface that is parallel to the longitudinal direction of the sheet tray device **300**. Thus, each media sheet is fed to the sheet feed path L to be supplied to the image forming unit **700** while widthwise opposite ends of each media sheet are being positioned by the guide members **313**.

The first tray **310** further includes a slant plate portion **318** that is provided in its rear end portion, i.e., its lower stream end portion as viewed in the sheet feed direction. The slant plate portion **318** is inclined for converting the feed direction of the media sheet (that is given a feed force by the sheet supplying unit **500**) into an upward direction. A separator **319** is provided in a laterally central portion of the slant plate portion **318**.

The separator **319** is constituted by a plurality of metallic protrusions which are vertically arranged at a certain pitch and which slightly protrude from a front surface of the slant plate portion **318**. Owing to the separator **319**, when the media sheets are pressed onto the slant plate portion **318** by the sheet supplying unit **500**, the media sheets are brought into contact at their leading ends with distal ends of the respective protrusions of the separator **319**. In this instance, the media sheet brought into contact with the protrusions of the separator **319** receive resistance acting against their feed movements, and an uppermost one of the media sheets is separated from the other media sheets so as to be moved toward the image forming unit **700**. Thus, the media sheets are supplied, one after another, to the image forming unit **700**.

Each of the opposite side walls **312** of the first tray **310** includes first and second rail portions **320**, **325** that are provided in its portion close to the slant plate portion **318**, as shown in FIG. **8**, for movably supporting the second tray **360**. The first and second rail portions **320**, **325** extend in a rail extending direction (i.e., the longitudinal direction of the sheet tray device **300**) in which the second tray **360** is movable relative to the first tray **310**, as shown in FIG. **8**. The second rail portion **325** is located on an upper side of the first rail portion **320**, and is spaced apart from the first rail portion **320** in a vertical direction (that is perpendicular to the lateral direction and the rail extending direction). The first and second rail portions **320**, **325** are offset from each other in the lateral direction, and do not overlap with each other as seen in the vertical direction.

Since the first and second rail portions **320**, **325** do not overlap with each other as seen in the vertical direction, an upper portion of each side wall **312** located on an upper side of an upper end of the first rail portion **320** and a lower portion of each side wall **312** located on a lower side of a lower end of the second rail portion **325** are separated from each other.

Therefore, where the opposite side walls **312** (each including the first and second rail portions **320**, **325**) and the bottom wall **311** are to be integrally formed of a resin in an injection molding using upper and lower mold halves, there is a risk that it is impossible to form a portion of each side wall **312** interconnecting the above-described upper and lower portions of the side wall **312**.

In the present embodiment, for solving such an inconvenience, each of the opposite side walls **312** of the first tray **310** further includes a plurality of interconnecting portions **329** which interconnect the first and second rail portions **320**, **325**, as shown in FIG. **8**. The interconnecting portions **329** are spaced apart from each other in the longitudinal direction of the sheet tray device **300**, and are disposed in a region L**1** of each side wall **312** throughout which the first rail portion **320** extends in the longitudinal direction. This region L**1** of each side wall **312** corresponds to a range L**1** within which the second tray **360** (support member **361**) is movable relative to the first tray **310**.

Each of the interconnecting portions **329** includes a portion which bridges the upper and lower portions of the side wall **312** and which is located on a laterally outside of the second rail portion **325**, as shown in FIG. **5**, so as to interconnect the first and second rail portions **320**, **325**.

The extension tray **350** is attached to the first tray **310**, movably relative to the first tray **310** in the rail extending direction (i.e., the longitudinal direction of the sheet tray device **300**), as shown in FIGS. **7** and **13**. The extension tray **350** can be drawn out of the first tray **310**, by moving the extension tray **350** in the forward direction relative to the first tray **310**. The extension tray **350** can be introduced into the first tray **310**, by moving the extension tray **350** in the rearward direction relative to the first tray **310**. The extension tray **350** has opposite side walls **351** each of which is slidably accommodated in a sheath-shaped accommodating portion **330** of a corresponding one of the opposite side walls **312** of the first tray **310**. The accommodating portion **330** is provided by a front region L**2** of each side wall **312**.

Each of the opposite side walls **312** of the first tray **310** has a cutout **332**, as shown in FIGS. **9** and **13**, which is provided for facilitating an operation to move the guide members **313**. The cutout **332** is located between the above-described regions L**1**, L**2** as viewed in the rail extending direction. Specifically, the cutout **332** is located on a downstream side of the region L**1** and on an upstream side of the region L**2**, as viewed in the sheet feed direction.

2.3. Construction of Second Tray **360**

The second tray **360** is provided to accommodate the media sheets whose size is smaller than a size of the media sheets accommodated in the first tray **310**. Specifically, the second tray **360** is designed to accommodate envelops or postal cards as the smaller-sized media sheets.

As shown in FIG. **7**, the second tray **360** includes the support member **361** which extends in the lateral direction so as to bridge between the opposite side walls **312** of the first tray **310** and which is movable relative to the opposite side walls **312** in the rail extending direction, and the main body **380** pivotably supported by the support member **361**. The second tray **360** further includes a hinge **370** through which the main body **380** is pivotable relative to the support member **361** so as to open and close the upper opening of the first tray **310**.

2.3.1. Detailed Description of Second Tray **360**

The support member **361** of the second tray **360** includes engaged portions at which the support member **361** is engaged with the opposite side walls **312** of the first tray **310**. As shown in FIG. **22**, each of the engaged portions of the support member **361** includes a main slide portion **362** that is slidably held in contact with an upper surface **321** of the first rail portion **320**, a removal-preventing slide portion **363** that extends through a space between the first and second rail portions **320**, **325** in a direction perpendicular to the rail extending direction (i.e., in the lateral direction of the sheet tray device **300** in the present embodiment) so as to prevent removal of the support member **361** of the second tray **360** from the first tray **310**, and a rotation-preventing slide portion **364** that is slidably held in contact with an inside surface **322** of the first rail portion **320** so as to prevent rotation of the support member **361** of the second tray **360** relative to the first tray **310**.

The support member **361** of the second tray **360** further includes an extending wall portion **365** which extends from the removal-preventing slide portion **363** and which is located on the side of an outside surface **323** of the first rail portion **320**. The extending wall portion **365** cooperates with the rotation-preventing slide portion **364** to interpose the first rail portion **320** therebetween in the lateral direction. In the present embodiment, the extending wall portion **365** and the removal-preventing slide portion **363** are integrated with each other. The extending wall portion **365** has an opposed surface which is opposed to the first rail portion **325** in the lateral direction, and which is inclined such that a distance between the opposed surface and the first rail portion **320** increases in a downward direction away from the upper surface **321** of the first rail portion **320**.

In the present embodiment, the removal-preventing slide portion **363** is formed integrally with the main slide portion **362**, and extends from the main slide portion **362** in a laterally outward direction, i.e., in a leftward direction as seen in FIG. **22**. The extending wall portion **365** is formed integrally with the main slide portion **362**, and projects downwardly from a distal end of the removal-preventing slide portion **363**. The rotation-preventing slide portion **364** is formed integrally with the main slide portion **362**, and projects downwardly from a proximal end of the main slide portion **362**.

As shown in FIG. **9**, the rotation-preventing slide portion **364** of the support member **361** has a length D**1** as measured in the rail extending direction, while the support member **362** as a whole has a length D**2** as measured in the rail extending direction, such that the length D**1** and the length D**2** are substantially equal to each other.

The above-described region or range L**1**, within which the support member **361** of the second tray **360** is movable relative to the first tray **310**, is determined such that the support member **361** is positioned in a position that is distant from an operational region of the sheet supplying unit **500** when the media sheets accommodated in the first tray **310** are supplied to the image forming unit **700** by the sheet supplying unit **500**, as shown in FIG. **11**.

On the other hand, when the media sheets accommodated in the second tray **360** are supplied to the image forming unit **700** by the sheet supplying unit **500**, as shown in FIG. **12**, the support member **361** is positioned in the vicinity of the sheet supplying unit **500**.

2.3.2. Detailed Description of Hinge **370**

As shown in FIGS. **15** and **18**, the hinge **370** includes a shaft portion **371** which is provided in the support member **361**, and first and second bearing portions **376**, **377** which are provided in the main body **380** and which cooperate with each other to support the shaft portion **371**. The first and second bearing portions **376**, **377** are rotatably held in contact with an outer circumferential surface of the shaft portion **371**.

As shown in FIGS. **17** and **20**, the first and second bearing portions **376**, **377** are located on respective opposite sides of the shaft portion **371** in a diametrical direction of the shaft portion **371**. In the present embodiment, the first bearing portions **376** are located on an upper side of the shaft portion **371** (see FIG. **17**) while the second bearing portions **377** are located on a lower side of the shaft portion **371** (see FIG. **20**).

The first and second bearing portion **376**, **377** are offset from each other in an axial direction of the shaft portion **371**, such that each first bearing portion **376** is located between two second bearing portions **377** in an axial direction of the shaft portion **371**.

The shaft portion **371** includes a small diameter portion **372** having a radius R**1** (see FIG. **15**) and a large diameter portion **373** having a radius R**2** (see FIG. **18**) that is smaller than the radius R**1**. The small diameter portion **372** and the large diameter portion **373** are arranged to be contactable with the first bearing portion **376** and the second bearing portion **377**, respectively.

In the present embodiment, the first diameter portion **372** and the second diameter portion **373** are arranged to be coaxial with each other. The small diameter portion **372** has

an axial length D3 that is smaller than an axial length D4 of the large diameter portion **373**, as shown in FIG. **14**.

Further, the small diameter portion **372** and the large diameter portion **373** are not completely circular in cross section. Rather, the small diameter portion **372** has an arcuate cross section only in its upper portion that is contactable with the first bearing portion **376** (see FIG. **15**), while the large diameter portion **373** has an arcuate cross section only in its lower portion that is contactable with the second bearing portion **377** (see FIG. **18**).

The hinge **370** further includes a removal preventer portion **378** that is provided in the second bearing portion **377** so as to prevent removal of the shaft portion **371** from the first and second bearing portions **376**, **377**, as shown in FIGS. **16** and **19**. Specifically, the removal preventer portion **378** is located between the first and second bearing portions **376**, **377** in a circumferential direction of the shaft portion **371**, for preventing removal of the shaft portion **371** through a space between the first and second bearing portions **376**, **377** in the circumferential direction. The removal preventer portion **378** is provided by a projecting portion of the main body **380** of the second tray **360**, and projects from a surface contiguous to a sliding contact surface S1 of the second bearing portion **377** at which the second bearing portion **377** is to be contact with the shaft portion **371**.

In the present embodiment, a front surface of the removal preventer portion **378**, which faces the shaft portion **371** to be contactable with the shaft portion **371**, is substantially perpendicular to the above-described surface contiguous to the sliding contact surface S1, while a rear surface of the removal preventer portion **378** is inclined with respect to the front surface of the removal preventer portion **378** such that a cross section of the removal preventer portion **378** reduces in an upward direction toward a distal end of the removal preventer portion **378**, as shown in FIGS. **16** and **19**.

The inclination of the rear surface of the removal preventer portion **378** facilitates an operation to attach the main body **380** to the support member **361**, since the above-described inclined rear surface of the removal preventer portion **378** serves as a guide surface so as to cause the removal preventer portion **378** to be elastically deformed upon introduction of the shaft portion **371** into a space surrounded by the first and second bearing portions **376**, **377**.

In an assembled state in which the shaft portion **371** is introduced into the space surrounded by the first and second bearing portions **376**, **377**, as shown in FIGS. **17**, **19** and **20**, the first and second bearing portions **376**, **377** are located on respective opposite sides of the shaft portion **371** in a diametrical direction of the shaft portion **371**, while the removal preventer portion **378** and an end face of the main body **380** of the second tray **360** (that is close to proximal ends of the first and second bearing portions **376**, **377**) are located on respective opposite sides of the shaft portion **371** in another diametrical direction that is perpendicular to the above-described diametrical direction.

The hinge **370** further includes a stopper portion **379** that is provided in the second bearing portion **377**, so as to define a maximum angle by which the main body **380** of the second tray **360** is pivotable relative to the first tray **310**. The stopper portion **379** projects from one of opposite side surfaces of a distal end portion of the second bearing portion **377** (which one is remote from the removal preventer portion **378**), and is to be brought into contact with a part of the support member **361** so as to limit a pivot motion of the main body **380** of the second tray **360** in a direction away from the first tray **310**.

3. Construction of Sheet Supplying Unit **500**

FIG. **23** is a cross sectional view of the sheet supplying unit **500**. FIGS. **24**A and **24**B are cross sectional views of the sheet supplying roller **600**, wherein FIG. **24**A shows a state in which a rotary shaft **650** of the sheet supplying roller **600** is in parallel with axes of through-holes **551** of respective shaft supporting portions **550** (which are aligned with each other), while FIG. **24**B shows another state in which the rotary shaft **650** of the sheet supplying roller **600** is inclined with respect to the axes of the through-holes **551**. FIGS. **25**A-**25**C are views showing an operation of a second coil spring **580**.

The sheet supplying unit **500** is a mechanism that is arranged to apply the feed force to the media sheets accommodated in the first and second trays **310**, **360** of the sheet tray device **300** so as to feed or supply the media sheets to the image forming unit **700**. As shown in FIG. **3**, the sheet supplying unit **500** is rockably or pivotably supported by a support shaft **510** which is located on an upper side of the sheet tray device **300** and which extends from a laterally central portion of the casing body **120** of the image forming apparatus **100** toward one of laterally opposite ends of the casing body **120** (toward a right end of the casing body **120** in the present embodiment).

The support shaft **510** is held by a metal frame **122** (see FIG. **2**). A component of an external force exerted to the support shaft **510**, which component acts in a radial direction of the support shaft **510**, is received primarily by the metal frame **122**. Meanwhile, the support shaft **510** primarily transmits or receives a torque acting on the support shaft **510**.

A large gear **530** is mounted on one of axially opposite end portions of the support shaft **510** (that corresponds to a right end of the sheet tray device **300** in the present embodiment), so as to transmit a rotational force (generated by a drive source) to the support shaft **510**. A small gear **540** (see FIG. **23**) is mounted on the other of the axially opposite end portions of the support shaft **510** (that corresponds to a laterally central portion of the sheet tray device **300** in the present embodiment), so as to be rotated integrally with the support shaft **510**.

A roller arm **520** is provided by a member which is rotatably attached to the support shaft **510** and which extends in a radial direction of the support shaft **510**. The sheet supplying roller **600**, which is rotatable about an axis of the rotary shaft **650**, is held by a distal end portion of the roller arm **520** (see FIG. **24**). In this arrangement, when the roller arm **520** is pivoted about an axis of the support shaft **510** in a direction toward the bottom wall **311** of the first tray **310**, i.e., toward the media sheets, the sheet supplying roller **600** is pressed against the media sheets, namely, there is generated a pressing force forcing the sheet supplying roller **600** onto the media sheets.

The sheet supplying roller **600** is rotated while being held in contact with an uppermost one of the media sheets stacked in the sheet tray device **300**, so as to apply the feed force to the uppermost one of the media sheets. As shown in FIG. **24**, the sheet supplying roller **600** includes a cylindrical main body **610** and a pair of roller members **620** that are mounted on respective axially opposite end portions of the main body **610**.

In the present embodiment, the cylindrical main body **610** is made of a hard synthetic resin, while each of the roller members **620** is made of a rubber or the like which is elastically deformable and which has a high coefficient of friction. The cylindrical main body **610** includes a pair of roller supporting portions **630**, **640** on which the respective

roller members **620** are mounted, a gear contact portion **651** provided in an axially central portion of the rotary shaft **650** that interconnects the roller supporting portions **630**, **640**, and a pair of arm contact portions **652** provided in respective portions of the rotary shaft **650** that are located on respective opposite sides of the axially central portion of the rotary shaft **650**.

The rotary shaft **650** has a generally cross shape in its transversal cross section, as shown in FIG. **23**. The gear contact portion **651** is provided by a cylindrical portion and protruding portions, wherein the cylindrical portion has a diameter that is larger than a maximum size of the rotary shaft **650** while the protrusion portions protrude radially outwardly from respective diametrically opposite ends of the cylindrical portion. Each of the arm contact portions **652** is provided by a cylindrical portion having a diameter that is larger than the maximum size of the rotary shaft **650**.

The shaft support portions **550** are provided by the distal end portion of the roller arm **520**, and define the respective through-holes **551**, as shown in FIGS. **24**A and **24**B. The rotary shaft **650** is introduced in the through-holes **551** that are coaxial with each other, so as to be rotatably held by the shaft support portions **550**.

Each of the arm contact portions **652**, which are located on respective opposite sides of the gear contact portion **651**, is slidably contacted at its outer circumferential surface with an inner circumferential surface of a corresponding one of the through-holes **551**, so that the rotary shaft **650** is rotatably held by the shaft support portions **550**. Since the diameter of the arm contact portions **652** is slightly smaller than an inside diameter of the through-holes **551**, the rotary shaft **650** is rotatable even in the state, as shown in FIG. **24**B, in which the rotary shaft **650** is inclined with respect to the axes of the through-holes **551**.

A gear **660** is provided between the two shaft support portions **550** of the roller arm **520**, rotatably relative to the roller arm **520**, so as to transmit a drive force to the sheet supplying roller **600** (rotary shaft **650**). The gear contact portion **651** is located within a through-hole **661** that is formed through an axis of the gear **660** (about which the gear **660** is rotatable).

In an inner circumferential surface of the through-hole **661**, fan-shaped grooves are formed to receive therein the above-described protruding portions of the gear contact portion **651**. That is, the gear contact portion **651** is fitted at its protruding portions in the grooves of the inner circumferential surface of the through-hole **661**, so that the gear **660** and the gear contact portion **651** are held in engagement with each other.

In the present embodiment, a length of each of the fan-shaped grooves as measured in a circumferential direction of the through-hole **661** is larger than a length of a corresponding one of the protruding portions of the gear contact portion **651** as measured in a circumferential direction of the gear contact portion **651**, so that there is a play between each fan-shaped groove and the corresponding protruding portion, which allows the gear **660** to be rotated relative to the gear contact portion **651** by a predetermined degree of angle (by about 60° in the present embodiment).

The roller arm **520** has a plurality of intermediate gears **560** incorporated therein to transmit the drive force from the small gear **540** (fixed to the support shaft **510**) to the gear **660**. The intermediate gears **560** are arranged in a direction in which the roller arm **520** extends, as shown in FIG. **23**.

The number of the intermediate gears **560** is determined such that a direction of tangent line between the sheet supplying roller **600** and an uppermost one of the stacked media sheets coincides with the feed direction of each of the media sheets when the roller arm **520** is pivoted in a direction causing its distal end portion to be displaced toward the media sheets (bottom wall **311**) by rotating the support shaft **510** (small gear **540**) in a direction indicated by arrow in FIG. **23**.

As the drive force is applied to the sheet supplying roller **600**, the feed force is given to the uppermost media sheet, while the roller arm **520** is forced by a reaction acting on the sheet supplying roller **600** to be pivoted toward the media sheet. Therefore, the feed force is reliably given to the media sheet from the sheet supplying roller **600** to which the drive force is applied, without separation of the sheet supplying roller **600** from the media sheet.

In the above-described arrangement in which the sheet supplying roller **600** is pressed onto the stacked media sheets by utilizing the reaction against the drive force that causes rotation of the sheet supplying roller **600**, the pressing force (by which the roller **600** is pressed on the media sheets) is easily changeable, and is not generated, particularly, in a stage of initiation of feed of the media sheets in which the drive force is not yet applied to the sheet supplying roller **600**.

In the present embodiment, as shown in FIG. **3**, a first torsion coil spring **570** is disposed on the side of the support shaft **510** so as to constantly generate an elastic force that forces the roller arm **520** to be pivoted toward the media sheets, while the above-described second torsion coil spring **580** is disposed on the side of the distal end portion of the roller arm **520** so as to generate an elastic force that forces the roller arm **520** to be pivoted toward the media sheets.

The second torsion coil spring **680** is held in contact with a contact member **123** provided in the frame **122** so as to be elastically deformed, when an angle defined by the roller arm **520** and the uppermost media sheet is small, namely, when the roller arm **520** extends substantially in a horizontal direction, as shown FIGS. **25**B and **25**C. In this instance, the roller arm **520** is pressed (biased) toward the media sheets, owing to the elastic deformation of the second torsion coil spring **580**. It is noted that the uppermost media sheet is represented by one-dot chain line in FIGS. **25**B and **25**C.

On the other hand, when the angle defined by the roller arm **520** and the uppermost media sheet is large, as shown in FIG. **25**A, the second torsion coil spring **580** is separated from the contact member **123**, so that the second torsion coil spring **580** does not generate the elastic force that forces the roller arm **520** toward the media sheets. That is, the second torsion coil spring **580** presses (biases) the roller arm **520** toward the media sheets, only when the roller arm **520** is substantially parallel to the horizontal direction.

4. Characteristics of Image Forming Apparatus

FIG. **26**A is a view schematically showing the hinge **370** in the present embodiment of the invention. FIG. **26**B is a view schematically showing a C-type hinge in which a shaft portion is fitted in a bearing portion that has a letter C shape.

As shown in FIG. **26**A, the hinge **370** has a height or thickness H**1** that is equal to a sum of a distance R**1** between an axis of the small diameter portion **372** and the first bearing portion **376**, a height or thickness T**1** of the first bearing portion **376**, a distance R**2** between an axis of the large diameter portion **373** and the second bearing portion **377** and a height or thickness T**2** of the second bearing portion **377**.

On the other hand, as shown in FIG. **26**B, the C-type hinge has a height or thickness H**2** that is equal to a sum of a height or thickness T**3** of a part of the bearing portion at which the bearing portion is in contact with one of diametri-

cally opposite ends of the shaft portion **371**, a height or thickness T**4** of another part of the bearing portion at which the bearing portion is in contact with the other of the diametrically opposite ends of the shaft portion **371** and a diameter R**3** of the shaft portion **371**.

Therefore, the height or thickness H**1** of the hinge **370** in the present embodiment is smaller than the height or thickness H**2** of the C-type hinge, as long as a radius of the shaft portion **371** of the C-type hinge is equal to a radius of the large diameter portion **373** of the shaft portion **371** of the hinge **370** in the present embodiment, and a sum of the height or thickness T**1** of the first bearing portion **376** and the height or thickness T**2** of the second bearing portion **377** is equal to a sum of the height or thickness T**3** of the part of the bearing portion at which the bearing portion is in contact with the above-described one of the diametrically opposite ends of the shaft portion **371** and the height or thickness T**4** of the above-described another part of the bearing portion at which the bearing portion is in contact with the above-described other of the diametrically opposite ends of the shaft portion **371**.

That is, H**1**=R**1**+R**2**+**2**×t and H**2**=**2**×R**2**+**2**×t, when T**1**=T**2**=T**3**=T**4**=t and R**3**=**2**×R**2**. Therefore, the height (thickness) H**1** of the hinge **370** in the present embodiment is smaller than the height (thickness) H**2** of the C-type hinge.

Further, in the present embodiment, the shaft portion **371** is interposed between the first and second bearing portions **376**, **377**, and is prevented by the removal preventer portion **378** from being removed from the first and second bearing portions **376**, **377**, whereby removal of the main body (supported body) **380** from the support member **361** is reliably prevented.

Therefore, in present embodiment, the hinge **370** can be made small in size whereby the sheet tray device **300** as a whole can be made compact in size, while the removal of the main body (supported body) **380** from the support member **361** is reliably prevented.

Since the radius R**1** of the small diameter portion **372** is smaller than the radius R**2** of the large diameter portion **373**, the smaller diameter portion **372** has a rigidity smaller than that of the large diameter portion **373**. In general, a portion having a smaller rigidity is likely to surfer from a fatigue fracture before a portion having a large rigidity suffers from it.

However, in the present embodiment, since the axial length D**3** of the small diameter portion **372** is smaller than the axial length D**4** of the large diameter portion **373**, it is possible to prevent the fatigue fracture of the small diameter portion **372** from taking place before that of the large diameter portion **373**.

Further, in the present embodiment, the hinge **370** includes the stopper portion **379** for defining the maximum angle by which the main body **380** of the second tray **360** is pivotable relative to the first tray **310**. The provision of the stopper portion **379** is effective to prevent problems such as breakage of the hinge **370** (that could be caused if the main body **380** were pivoted by an excessively large angle) and removal of the main body **380** from the support member **361**.

Further, in the present embodiment, the main slide portion **362** is slidably held in contact with the upper surface of the first rail portion **362**, as shown in FIG. **22**, whereby the support member **361** of the second tray **360** is movably held by the first tray **310**.

Further, since the removal-preventing slide portion **363** extends through the space between the first and second rail portions **320**, **325**, removal of the support member **361** of the second tray **360** from the first tray **310** can be prevented by engagement of the removal-preventing slide portion **363** with at least one of the first and second rail portions **320**, **325**.

Moreover, since the rotation-preventing slide portion **364** is slidably held in contact with the inside surface **322** of the first rail portion **320**, it is possible to prevent rotation of the second tray **360** relative to the first tray **310**.

Therefore, in the sheet tray device **300** in the present embodiment, it is possible to avoid problems such as rotation of the second tray **360** relative to the first tray **310** and removal of the second tray **360** from the first tray **310**, when the second tray **360** is moved relative to the first tray **310**.

In the present embodiment, the first tray **310** including the opposite side walls **312** is a product that is formed of a resin according to a forming process (e.g., injection molding) using molds. Therefore, if the first and second rail portions **320**, **325** were positioned relative to each other to overlap with each other as seen in the vertical direction, it would be necessary to use, in addition to the upper and lower mold halves, a core (insert) or a slide mold, for obtaining the space between the first and second rail portions **320**, **325**.

Thus, if the first and second rail portions **320**, **325** were arranged to overlap with each other as seen in the vertical direction, the required cost for the mold assembly and the efficiency in the forming process would be increased and reduced, respectively, possibly resulting in a considerable increase in the cost of manufacturing the first tray **310** (sheet tray device **300**).

In the present embodiment, the first and second rail portions **320**, **325** are offset from each other in the lateral direction, and do not overlap with each other as seen in the vertical direction, thereby making it possible to obtain the space between the first and second rail portions **320**, **325** in the forming process using the upper and lower mold halves without the core (insert) or slide mold.

It is therefore possible to avoid the increase in the required cost for the mold assembly and the reduction in the efficiency in the forming process, thereby preventing the increase in the cost of manufacturing the first tray **310** (sheet tray device **300**).

However, in the arrangement in which the first and second rail portions **320**, **325** are offset from each other in the lateral direction, the removal-preventing slide portion **363** are contactable, at its contact regions that are offset from each other in the lateral direction, with the respective first and second rail portions **320**, **325**. Since the contact regions of the removal-preventing slide portion **363** contactable with the respective first and second rail portions **320**, **325** are offset from each other in the lateral direction, the removal-preventing slide portion **363** is likely to receive a bending moment such that the contact region contacted with the first rail portion **320** acts as a fulcrum while the contact region contacted with the second rail portion **325** acts as a point of action.

If the removal-preventing slide portion **363** is considerably deformed or bent as a result of application of the bending moment thereto, there is a risk that the removal-preventing slide portion **363** could be removed through the space between the first and second rail portions **320**, **325**, and accordingly the support member **361** could be removed from the first tray **310**.

In the present embodiment, however, the extending wall portion **365** is provided to extend from the removal-preventing slide portion **363** such that the first rail portion **320** is located between the extending wall portion **365** and the rotation-preventing slide portion **364** in the lateral direction.

When the bending moment acts on the removal-preventing slide portion **363**, the extending wall portion **365** is brought into contact with the outside surface **323** of the first rail portion **320**, so as to serve as a stopper or restrainer for restraining deformation of the removal-preventing slide portion **363**.

Therefore, even when the bending moment is applied to the removal-preventing slide portion **363**, it is possible to prevent considerable deformation of the removal-preventing slide portion **363**, and accordingly avoid removal of the removal-preventing slide portion **363** from through the space between the first and second rail portions **320**, **325**.

As is clear from the above description, in the present embodiment, it is possible to restrain increase in the cost required for manufacturing the sheet tray device **300** while preventing the support member **361** of the second tray **360** being removed from the first tray **310**.

The above-described bending moment can be reduced with reduction in an amount of offset of the first and second rail portions **320**, **325** from each other in the lateral direction in which the opposite side walls **312** are opposed to each other. However, the reduction in the offset amount makes it difficult to attach the support member **361** to the opposite side walls **312**, since the extending wall portion **365** has to pass through the space between the first and second rail portions **320**, **325** that is small in its cross section that is perpendicular to the vertical direction.

In view of such a difficulty, in the present embodiment, the opposed surface of the extending wall portion **365** (that is opposed to the first rail portion **325** in the lateral direction) is inclined with respect to the vertical direction such that the distance between the opposed surface and the first rail portion **320** increases in the downward direction away from the upper surface **321** of the first rail portion **320**. The inclination of the opposed surface of the extending wall portion **365** facilitates an operation to cause the extending wall portion **365** to pass through the space between the first and second rail portions **320**, **325**, since the above-described inclined opposed surface of the extending wall portion **365** serves as a guide surface. Thus, the extending wall portion **365** can be easily caused to pass through the space between the first and second rail portions **320**, **325**, even where the above-described offset amount is small.

Therefore, without making it difficult to attach the support member **361** to the opposite side walls **312**, it is possible to reliably prevent removal of the support member **361** from the first tray **310** due to the bending moment acting on the removal-preventing slide portion **363**.

In the present embodiment, the cutout **332** is formed in a portion of each of the opposite side walls **312** that is located in a front side of the above-described region or range L**1** within which the second tray **360** (support member **361**) is movable relative to the first tray **310**, so that the range of the movement of the second tray **360** is not limited by the presence of the cutout **332**.

Further, the above-described region or range L**1** is determined such that the support member **361** is positioned in the position that is distant from the operational region of the sheet supplying unit **500** when the media sheets accommodated in the first tray **310** are supplied to the image forming unit **700** by the sheet supplying unit **500**, so that the sheet supplying unit **500** is prevented from being interfered by the support member **361**.

While the presently preferred embodiment of the invention has been described above in detail, it is to be understood that the invention is not limited to the details of the illustrated embodiment, but may be otherwise embodied without departing from the spirit of the invention.

For example, the arrangement for connection of the support member **361** with each of the opposite side walls **312** is not limited to details shown in FIG. **22**, and may be modified as shown in FIG. **27** in which the extending wall portion **365** is not provided, or may be modified as shown in FIG. **28** in which the opposed surface of the extending wall portion **365** (opposed to the first rail portion **325**) is not inclined with the respect to the vertical direction.

Further, in the above-described embodiment, the main slide portion **362**, removal-preventing slide portion **363** and rotation-preventing slide portion **364** are located in substantially the same position in the rail extending direction, namely, these portions **362**, **363**, **364** can be represented by a single cross section perpendicular to the rail extending direction. However, these portions **362**, **363**, **364** may be offset from each other in the rail extending direction.

Further, while the first and second rail portions **320**, **325** are offset from each other in the lateral direction in the above-described embodiment, the first and second rail portions **320**, **325** does not necessarily have to be offset from each other but may overlap with each other as seen in the vertical direction.

In the above-described embodiment, the extending wall portion **365** is positioned outside the first rail portion **320** while the rotation-preventing slide portion **364** are positioned inside the first rail portion **320**. However, the extending wall portion **365** and the rotation-preventing slide portion **364** may be positioned inside and outside the first rail portion **320**, respectively.

While the axial length D**3** of each small diameter portion **372** is smaller than the axial length D**4** of each large diameter portion **373** in the present embodiment, the axial length D**3** of the small diameter portion **372** may be equal to or larger than the axial length D**4** of the large diameter portion **373**.

While each small diameter portion **372** is located between two large diameter portions **373** in the above-described embodiment, each large diameter portion **373** may be located between two small diameter portions **372**.

In the above-described embodiment, the small diameter portion **372** and the large diameter portion **373** are arranged to be contactable with the first and second bearing portions **376**, **377**, respectively. However, the portions **372**, **373** may be arranged such that the small diameter portion **372** is contactable with the second bearing portion **377** while the large diameter portion **373** is contactable with the first bearing portion **376**. Further, in the above-described embodiment, the first bearing portions **376** are located on the upper side of the shaft portion **371** while the second bearing portions **377** are located on the lower side of the shaft portion **371**. However, the first bearing portions **376** are located on the lower side of the shaft portion **371** while the second bearing portions **377** are located on the upper side of the shaft portion **371**.

In the above-described embodiment, the small diameter portion **372** has the arcuate cross section only in its upper portion that is contactable with the first bearing portion **376** (see FIG. **15**), while the large diameter portion **373** has the arcuate cross section only in its lower portion that is contactable with the second bearing portion **377** (see FIG. **18**). However, each of the small diameter portion **372** and the large diameter portion **373** may be completely circular in cross section.

In the above-described embodiment, the shaft portion **371** is provided in the support member **361** of the second tray

360 while the first and second bearing portions 376, 377 are provided in the main body 380 of the second tray 360. However, this arrangement may be modified such that the shaft portion 371 is provided in the main body 380 while the first and second bearing portions 376, 377 are provided in the support member 361.

In the above-described embodiment, the image forming unit 700 is of inkjet type. However, the invention is equally applicable to a case where the image forming unit 700 is of electrophotographic type.

What is claimed is:

1. A sheet tray device that is [removably] introduced into a main body of an image forming apparatus through an opening of the main body, so as to hold a media sheet that is to be supplied to an image forming unit of the image forming apparatus by which an image forming operation is performed on the media sheet, said sheet tray device comprising:

(a) a first tray accommodating a first size sheet as the media sheet, and having a bottom wall and opposite side walls that project upwardly from said bottom wall, such that at least said bottom wall and said opposite side walls are provided by a single piece; and

(b) a second tray movably disposed on an upper side of said first tray and accommodating a second size sheet as the media sheet, [the second size sheet having a size smaller than a size of the first size sheet,]

wherein said second tray includes (b-1) a support member which bridges between said opposite side walls of said first tray and which is movable relative to said opposite side walls, and (b-2) a supported body pivotably supported by said support member so as to open and close an upper opening of said first tray,

wherein [each] *at least one* of said opposite side walls of said first tray includes first and second rail portions that extend in a rail extending direction in which said support member is movable relative to said opposite side walls, said second rail portion being located on an upper side of said first rail portion and being spaced apart from said first rail portion,

wherein said support member of said second tray includes (i) a main slide portion that is slidably held in contact with an upper surface of said first rail portion, (ii) a removal-preventing slide portion that extends through a space between said first and second rail portions so as to prevent removal of said support member of said second tray from said first tray, and (iii) a rotation-preventing slide portion that is slidably held in contact with a side surface of said first rail portion so as to prevent rotation of said support member of said second tray relative to said first tray,

wherein said first and second rail portions are offset from each other in a lateral direction in which said opposite side walls of said first tray are opposed to each other, such that said first and second rail portions do not overlap with each other as seen in a vertical direction that is perpendicular to said lateral direction and said rail extending direction,

wherein said support member of said second tray further includes (iv) an extending wall portion which extends from said removal-preventing slide portion, such that said first rail portion is located between said extending wall portion and said rotation-preventing slide portion in said lateral direction,

wherein said rotation-preventing slide portion extends downwardly from said main slide portion, and is slidably held in contact with, as said side surface, one of opposite side surfaces of said first rail portion that is located on an inner side of the other of said opposite side surfaces in said lateral direction,

wherein said removal-preventing slide portion extends outwardly from said main slide portion in said lateral direction,

and wherein said extending wall portion extends downwardly from said removal-preventing slide portion, such that said extending wall portion, said removal-preventing slide portion, said main slide portion and said rotation-preventing slide portion cooperate with one another to define a generally inverted U shape in a cross-section thereof that is perpendicular to said rail extending direction.

2. The sheet tray device according to claim 1,

wherein said extending wall portion has an opposed surface that is opposed to said first rail portion in said lateral direction,

and wherein said opposed surface is inclined such that a distance between said opposed surface and said first rail portion increases in a downward direction away from said upper surface of said first rail portion.

3. The sheet tray device according to claim 1, wherein said rotation-preventing slide portion of said support member has a length as measured in said rail extending direction, while said support member has a length as measured in said rail extending direction, such that said length of said rotation-preventing slide portion and said length of said support member are substantially equal to each other.

4. The sheet tray device according to claim 1, wherein said rotation-preventing slide portion of said support member extends in said rail extending direction substantially throughout an entirety of said support member.

5. An image forming apparatus comprising:

the sheet tray device defined in claim 1;

an image forming unit performing an image forming operation on a media sheet; and

a sheet supplying unit supplying the media sheet held by said sheet tray device, to said image forming unit.

6. The sheet tray device according to claim 1, wherein said first and second rail portions are offset from each other in said lateral direction such that said second rail portion located on an outer side of said first rail portion in said lateral direction.

7. The sheet tray device according to claim 6, wherein said single piece providing at least said bottom wall and said opposite side walls of said first tray is a product that is molded in an injection molding using upper and lower mold halves.

8. The sheet tray device according to claim 7, wherein said single piece is made of a resin.

9. The sheet tray device according to claim 1, wherein each of said first and second rail portions is provided by a plate-like shaped portion having a width as measured in said vertical direction and a thickness as measured in said lateral direction such that said width is larger than said thickness.

10. The sheet tray device according to claim 1, which is removably introduced into the main body of the image forming apparatus through the opening of the main body.

11. The sheet tray device according to claim 1, wherein said second tray accommodates the second size sheet having a size less than a size of the first size sheet.

12. The sheet tray device according to claim 1, wherein each of said opposite side walls of said first tray includes said first and second rail portions.

13. The sheet tray device according to claim 1, which is removably introduced into the main body of the image forming apparatus through the opening of the main body,

wherein said second tray accommodates the second size sheet having a size that is smaller than a size of the first size sheet, and

wherein each of said opposite side walls of said first tray includes said first and second rail portions.

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