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(72) Inventors:
• **Oshima, Kazuyoshi**
Tokyo, 101-8633 (JP)
• **Takamatsu, Shingo**
Tokyo, 101-8633 (JP)
• **Shinmura, Ken**
Tokyo, 101-8633 (JP)

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(71) Applicant: **Sugatsune Kogyo CO., LTD.**
Tokyo 101-8633 (JP)

(74) Representative: **Hallybone, Huw George**
Carpmaels & Ransford
One Southampton Row
London
WC1B 5HA (GB)

(54) **Hinge apparatus**

(57) basal end portion of a force transmitter 81 is rotatably disposed in a second support shaft 74 rotatably connecting an internal link 72 to a body 3. A distal end portion of the force transmitter 81 is projected out of a guide hole 3g formed in a top plate 3b of the body 3. A pressing portion 81b is disposed in the projected distal end portion of the force transmitter 81. A receiver 83 is

disposed in an end portion that is spaced from an instantaneous rotation center of a mounting member 4 when the mounting member 4 is positioned near a closed position. The pressing portion 81b is pressed against the receiver 83 by the torsion coil spring 82, thereby causing the mounting member 4 to be rotated toward the closed position.

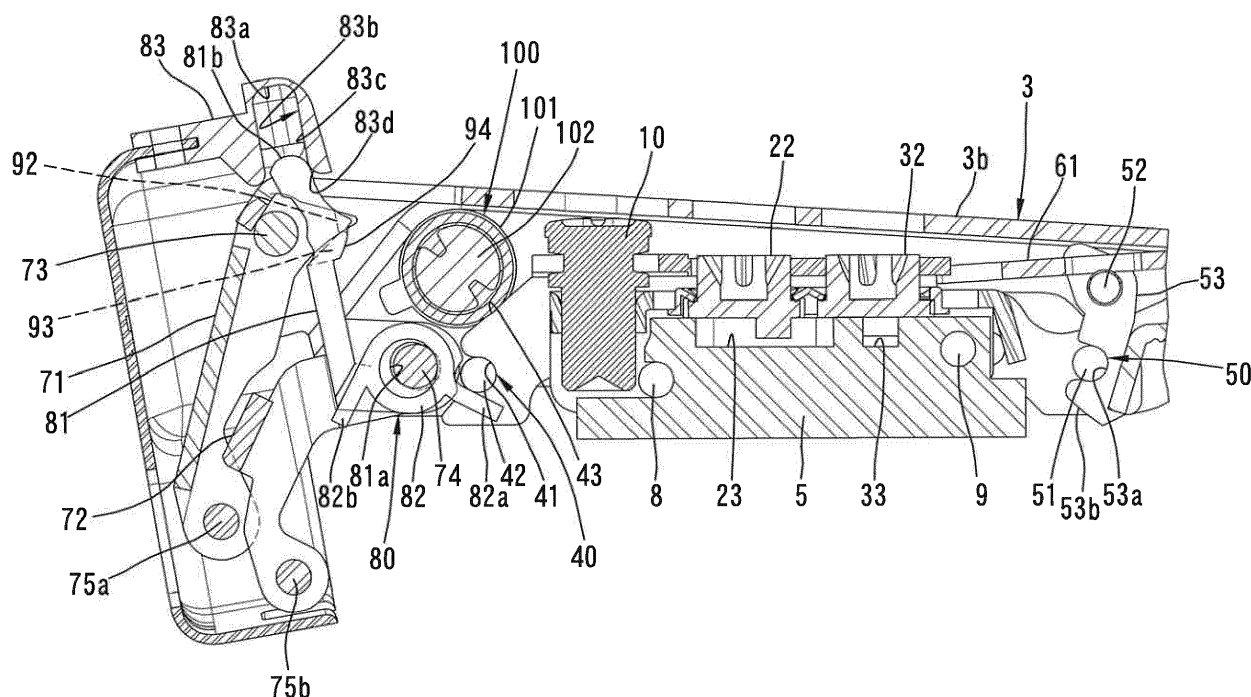


FIG. 11

Description

Field of the Invention

[0001] The present invention relates to a hinge apparatus suitable for rotatably connecting a door to a frame.

Background of the Invention

[0002] As disclosed in Patent Document 1 listed below, a hinge apparatus of this type generally includes a body and a mounting member rotatably connected to the body via a first link and a second link. The body is attached to a housing and the mounting member is attached to a door. As a result, the door is rotatably mounted to the housing via the hinge apparatus.

[0003] A rotational biasing means such as a torsion coil spring is disposed in the body. The rotational biasing means rotationally biases the mounting member via the first link or the second link. Specifically, one end portions of the first link and the second link are respectively rotatably connected to the body via a first support shaft and a second support shaft parallel to each other. The other end portions of the first link and the second link are respectively rotatably connected to the mounting member via a third support shaft and a fourth support shaft parallel to the first support shaft and the second support shaft. Accordingly, when the rotational biasing means rotationally biases the mounting member via the first link, the first link is rotationally biased by the rotational biasing means about the first support shaft. The rotationally biased first link then rotationally biases the mounting member via the third support shaft. When the rotational biasing means rotationally biases the mounting member via the second link, the second link rotationally biases the mounting member via the fourth support shaft. In this way, a rotational biasing force of the rotational biasing means acts on the mounting member via the third support shaft or the fourth support shaft.

Prior Art Documents

Patent Documents

[0004] Patent Document 1: Japanese Unexamined Patent Application Publication No. S60-112973

Summary of the Invention

Problem to be Solved by the Invention

[0005] An instantaneous rotation center of the mounting member is a point of intersection of a straight line connecting the first support shaft and the third support shaft and a straight line connecting the second support shaft and the fourth support shaft. The instantaneous rotation center is located in front in a direction from the first support shaft to the third support shaft and in front in a

direction from the second support shaft to the fourth support shaft. The third and fourth support shafts on which the rotational biasing force rotating the mounting member acts are disposed at locations nearer to the instantaneous rotation center. Accordingly, a distance between the instantaneous rotation center of the mounting member and the third support shaft or the fourth support shaft, i.e., a length of a moment arm of rotation for rotating the mounting member is relatively short. Therefore, it is required that the rotational biasing means for rotationally biasing the mounting member should have a large rotational biasing force. However, when the rotational biasing force of the rotational biasing means is great, a great frictional resistance is generated at points where components slidably contact each other accompanying the rotation of the mounting member, such as a point between the first link and the third support shaft or a point between the second link and the fourth support shaft. This may result in a problem in which the slidably contacted points may be worn away early.

Solution to the Problem

[0006] To solve the problem mentioned above, a first aspect of the present invention provides a hinge apparatus comprising a body; a mounting member connected to the body via first and second links such that the mounting member can be rotated between a closed position and an open position; and a rotational biasing means disposed in the body, the rotational biasing means biasing the mounting member such that the mounting member is rotated with respect to the body, one end portions of the first and second links rotatably connected to the body respectively via first and second support shafts parallel to each other, the other end portions of the first and second links rotatably connected to the mounting member respectively via third and fourth support shafts parallel to the first and second support shafts, characterized in that the rotational biasing means is disposed inside the body with a portion of the rotational biasing means projected out of the body and that the portion of the rotational biasing means projected out of the body is pressed to contact the mounting member, thereby rotationally biasing the mounting member.

In this case, it is preferable that the portion of the rotational biasing means pressed to contact the mounting member is projected out of the body in a direction perpendicular to axes of the first, second, third and fourth support shafts and in a direction away from an instantaneous rotation center of the mounting member.

Preferably, the body is formed to have a U-shaped cross-sectional configuration by a pair of side plates arranged to be opposed to each other and a top plate connecting one side portions of the pair of side plates, the first and second support shafts are disposed with the axes thereof oriented in a direction in which the side plates are opposed to each other, opposite end portions of the first support shaft and opposite end portions of the second

support shaft are supported by the side plates, notches are formed in the top plate and the portion of the rotational biasing means is projected out of the body through the notches.

Preferably, the rotational biasing means comprises a force transmitter displaceably disposed in the body and a biasing means that causes the force transmitter to be displaced, and a portion of the force transmitter is projected out of the body.

To solve the problem mentioned above, a second aspect of the present invention provides a hinge apparatus comprising: a body; a mounting member connected to the body via first and second links such that the mounting member can be rotated between a closed position and an open position; and a rotational biasing means disposed in the body, the rotational biasing means biasing the mounting member such that the mounting member is rotated with respect to the body, one end portions of the first and second links rotatably connected to the body respectively via first and second support shafts parallel to each other, the other end portions of the first and second links rotatably connected to the mounting member respectively via third and fourth support shafts parallel to the first and second support shafts, characterized in that an action portion is provided in the mounting member, rotational biasing force of the rotational biasing means acting on the action portion, and the action portion is disposed such that a distance between an instantaneous rotation center of the mounting member and the action portion is longer than a distance between the instantaneous rotation center of the mounting member and the third support shaft and a distance between the instantaneous rotation center of the mounting member and the fourth support shaft.

In this case, it is preferable that a direction of action of biasing force of the rotational biasing means acting on the action portion gradually changes accompanying the rotation of the mounting member.

Preferably, the rotational biasing means comprises a force transmitter disposed in the body and a biasing means rotationally biasing the force transmitter, one end portion of the force transmitter disposed inside the body is rotatably connected to the body, the other end portion of the force transmitter is projected out of the body, and the other end portion projected out of the body is pressed to contact the action portion of the mounting member, thereby causing the mounting member to be rotated by the biasing means via the force transmitter.

Preferably, a rotation prohibition mechanism are provided between the first link and the force transmitter and when the mounting member is rotated from one of the open position and the closed position toward the other of the open position and the closed position, until the mounting member reaches a released position a predetermined angle before the other of the open position and the closed position, the rotation prohibition mechanism prohibits the force transmitter from being rotated by the biasing means, thereby causing the force transmitter to

be held at a predetermined stopped position, and when the mounting member is rotated beyond the released position, the rotation prohibition mechanism allows the force transmitter to be rotated by the biasing means toward the other of the open position and the closed position.

Preferably, the rotation prohibition mechanism comprises a first engagement portion disposed in the first link and a second engagement portion disposed in the force transmitter, one of the first and second engagement portions comprises a concavely curved first circular-arc surface, a center of curvature of the first circular-arc surface being an axis of the first support shaft, the other of the first and second engagement portions comprises a convexly curved second circular-arc surface, a center of curvature of the second circular-arc surface being the axis of the first support shaft, until the mounting member reaches the released position, the first circular-arc surface and the second circular-arc surface contact each other such that each of the first circular-arc surface and the second circular-arc surface can be rotated about the axis of the first support shaft, thereby prohibiting the force transmitter from being rotated, and when the mounting member is rotated beyond the released position, the first circular-arc surface and the second circular-arc surface are spaced from each other, thereby allowing the force transmitter to be rotated.

Advantageous Effects of the Invention

[0007] According to the first aspect of the present invention having the above-mentioned features, a portion of the rotational biasing means rotationally biasing the mounting member is pressed to contact the mounting member and the portion is projected out of the body.

Therefore, a point at which the portion contacts the mounting member can be located far from the instantaneous rotation center of the mounting member. Assuming that the rotational biasing force of the rotational biasing means is constant, the rotational biasing force (moment of rotation) of the rotational biasing means acting on the mounting member can be enhanced by an amount corresponding to a distance by which the portion is located farther from the instantaneous rotation center of the mounting member. In other words, a required magnitude of the rotational biasing force of the rotational biasing means can be reduced by the amount by which the rotational biasing force acting on the mounting member can be enhanced. Accordingly, the early wearing out of the points where the components slidingly contact each other accompanying the rotation of the mounting member can be prevented.

According to the second aspect of the present invention, the distance between the instantaneous rotation center of the mounting member and the action portion is longer than the distance between the instantaneous rotation center of the mounting member and the third support shaft and the distance between the instantaneous rotation center of the mounting member and the fourth sup-

port shaft. Therefore, assuming that the rotational biasing force of the rotational biasing means is constant, the rotational biasing force (moment of rotation) that rotates the mounting member can be enhanced by an amount corresponding to a distance by which the distance between the instantaneous rotation center of the mounting member and the action portion is longer. In other words, the required magnitude of the rotational biasing force of the rotational biasing means can be reduced by the amount by which the rotational biasing force acting on the mounting member can be enhanced. Accordingly, the early wearing out of the points where the components slidingly contact each other accompanying to rotation of the mounting member can be prevented.

Brief Description of the Drawings

[0008]

FIG. 1 is a perspective view of a first embodiment of the present invention.

FIG. 2 is perspective view of the first embodiment of the present invention, showing a body detached from a base unit.

FIG. 3 is an exploded perspective view of the base unit according to the first embodiment of the present invention.

FIG. 4 is an exploded perspective view of the first embodiment of the present invention, showing the body, a mounting member and components disposed thereon.

FIG. 5 is a plan view of the first embodiment of the present invention, showing the mounting member rotated to a closed position.

FIG. 6 is an enlarged cross-sectional view taken along line X-X of FIG. 5, showing the body and the mounting member respectively attached to a housing and a door.

FIG. 7 is a partially-omitted cross-sectional view of the first embodiment of the present invention, similar to FIG. 6, showing the mounting member positioned in an open position.

FIG. 8 is a partially-omitted cross-sectional view of the first embodiment of the present invention, similar to FIG. 6, showing the mounting member rotated from the open position toward the closed position by a predetermined angle.

FIG. 9 is a partially-omitted cross-sectional view of the first embodiment of the present invention, similar to FIG. 6, showing the mounting member rotated from the open position toward the closed position up to a position where a force transmitter starts to contact an action portion of the mounting member.

FIG. 10 is a partially-omitted cross-sectional view of the first embodiment of the present invention, similar to FIG. 6, showing the mounting member rotated from the open position toward the closed position up to a released position.

FIG. 11 is a partially-omitted cross-sectional view of the first embodiment of the present invention, similar to FIG. 6, showing the mounting member rotated from the open position toward the closed position further beyond the released position shown in FIG. 10.

FIG. 12 is a partially-omitted cross-sectional view of the first embodiment of the present invention, similar to FIG. 6, showing the mounting member rotated from the open position toward the closed position further beyond the position shown in FIG. 11.

FIG. 13 is a partially-omitted cross-sectional view of the first embodiment of the present invention, similar to FIG. 6, showing the mounting member rotated from the open position toward the closed position further beyond the position shown in FIG. 12.

FIG. 14A is a perspective view of a first link used in the first embodiment of the present invention.

FIG. 14B is a front view of the first link of FIG. 14A.

FIG. 14C is a side view of the first link of FIG. 14A.

FIG. 14D is a plan view of the first link of FIG. 14A.

FIG. 14E is a cross-sectional view of the first link taken along line X-X of FIG. 14B.

FIG. 15 is a perspective view of a force transmitter used in the first embodiment of the present invention. FIG. 16 is a plan view of the force transmitter of FIG. 15.

FIG. 17 is a rear view of the force transmitter of FIG. 15.

FIG. 18 is a side view of the force transmitter of FIG. 15.

FIG. 19 is a cross-sectional view taken along line X-X of FIG. 17.

FIG. 20 is a perspective view of a second embodiment of the present invention.

FIG. 21 is a perspective view of a body used in the second embodiment of the present invention.

FIG. 22 is a perspective view of a force transmitter used in the second embodiment of the present invention.

FIG. 23 is a front view of the force transmitter of FIG. 22.

FIG. 24 is a side view of the force transmitter of FIG. 22.

FIG. 25 is a cross-sectional view of the second embodiment of the present invention, similar to FIG. 7.

FIG. 26 is a cross-sectional view of the second embodiment of the present invention, similar to FIG. 9.

FIG. 27 is a cross-sectional view of the second embodiment of the present invention, similar to FIG. 10.

FIG. 28 is a cross-sectional view of the second embodiment of the present invention, similar to FIG. 11.

FIG. 29 is a cross-sectional view of the second embodiment of the present invention, similar to FIG. 12.

FIG. 30 is a perspective view of a third embodiment of the present invention.

FIG. 31 is a perspective view of a body used in the third embodiment of the present invention.

FIG. 32 is a perspective view of an external link used in the third embodiment of the present invention.

FIG. 33 is a perspective view of a force transmitter used in the third embodiment of the present invention.

FIG. 34 is a perspective view of the force transmitter of FIG. 33, viewed from a different direction from FIG. 33.

FIG. 35 is a front view of the force transmitter of FIG. 33.

FIG. 36 is a side view of the force transmitter of FIG. 33.

FIG. 37 is a cross-sectional view taken along line X-X of FIG. 35.

FIG. 38 is a cross-sectional view of the third embodiment of the present invention, similar to FIG. 7.

FIG. 39 is a cross-sectional view of the third embodiment of the present invention, showing the mounting member positioned in an intermediate position.

FIG. 40 is a cross-sectional view of the third embodiment of the present invention, showing the mounting member positioned between the intermediate position and a released position.

FIG. 41 is a cross-sectional view of the third embodiment of the present invention, showing the mounting member positioned in the released position.

FIG. 42 is a cross-sectional view of the third embodiment of the present invention, showing the mounting member positioned between the released position and the closed position.

FIG. 43 is a cross-sectional view of the third embodiment of the present invention, showing the mounting member rotated further beyond the position shown in FIG. 40 toward the closed position and positioned at a predetermined angle before the closed position.

Description of the Preferred Embodiments

[0009] A best mode for carrying out the invention will be described hereinafter with reference to the drawings. FIGS. 1 to 19 show a first embodiment of the present invention. A hinge apparatus 1 of this embodiment includes a base unit 2, a body 3 and a mounting member 4 as shown in FIGS. 1, 2, 5 and 6.

[0010] As shown in FIG 6, the base unit 2 is fixed to a front end portion of an inner surface of a right side wall of a frame B. The frame B has an opening in a front surface portion thereof. The body 3 is removably attached to the base unit 2. The mounting member 4 is attached to a right end portion of a rear surface of a door D. The mounting member 4 is connected to a front end portion of the body 3 (left end portion in FIG. 6. The end portion is to be referred to as "front end portion" hereinafter.) via an external link (first link) 71 and an internal link (second link) 72 to be described later such that the mounting member 4 is rotatable in a horizontal direction. The mounting member 4 is rotatable between a closed position shown in FIG. 6 and an open position shown in

FIG. 7. Accordingly, the door D is also rotatable between a closed position and an open position. However, in a condition where the door D is mounted to the frame B via the hinge apparatus 1, when the door D is rotated from the open position toward the closed position and reaches a position slightly before the closed position (position about 1 to 2 degrees before the closed position), the door D is abutted against a front surface of the frame B, and the door D cannot be rotated further toward the closed position. Therefore, when the door D is supported by the frame B, the door D and the mounting member 4 are not rotated up to the respective closed positions shown in FIG. 6. Directions used in describing features of the first embodiment and second and third embodiments to be described later refer to a front-rear direction, a left-right direction and a vertical direction (direction perpendicular to the plane of FIG. 6) of the frame B shown in FIG. 6. It is to be understood that the present invention is not limited by specific directions.

[0011] As particularly shown in FIGS. 2 and 3, the base unit 2 includes a base member 5, a first movable member 6 and a second movable member 7.

[0012] As particularly shown in FIG. 3, the base member 5 includes a support part 5a having a generally quadrangular cross-section. A longitudinal direction of the support part 5a is oriented in the front-rear direction (the left-right direction, diagonally up and right, in FIG. 3). The support part 5a is solid. Alternatively, the support part 5a may be hollow having a U-shaped cross section. In this case, the support part 5a is disposed with an open portion of the support part 5a oriented toward the right side wall of the frame B. Fixing plates 5b, 5b projecting upward and downward are respectively formed in opposite side surfaces of the support part 5a facing upward and downward (leftward and rightward, diagonally down and right, in FIG. 3). The base member 5 is fixed to the inner surface of the right side wall of the frame B by tightening a screw (not shown) screwed into the right side wall of the frame B passing through the fixing plates 5b.

[0013] The first movable member 6 includes two side plates 6a, 6a opposed to each other and a top plate 6b connecting left side portions of the side plates 6a, 6a. As a result, the first movable member 6 has a generally U-shaped cross-section. The first movable member 6 has an open portion in the opposite side from the top plate 6b. The first movable member 6 is disposed with the open portion thereof oriented toward the right side wall of the frame B, a longitudinal direction of the side plate 6a oriented in the front-rear direction and a thickness direction of the side plate 6a oriented in the vertical direction. Accordingly, the side plates 6a, 6a are opposed to each other in the vertical direction.

[0014] The support part 5a of the base member 5 is disposed between the side plates 6a, 6a of the first movable member 6. A distance between inner surfaces of the side plates 6a, 6a opposed to each other is greater than a width of the support part 5a in the vertical direction. Therefore, the first movable member 6 is movable in the

vertical direction with respect to the base member 5 by a distance corresponding to a difference between the distance between the side plates 6a, 6a and the width of the support part 5a in the vertical direction.

[0015] Guide parts 6c, 6c respectively projecting upward and downward are disposed in a middle portion of the side plates 6a, 6a of the first movable member 6 in the vertical direction. The guide parts 6c, 6c are respectively disposed in guide recesses 5c, 5c respectively formed in the fixing plates 5b, 5b of the base member 5 such that each of the guide parts 6c, 6c is movable in the vertical direction but immovable in the front-rear direction. Accordingly, the first movable member 6 is movable in the vertical direction but immovable in the front-rear direction with respect to the base member 5. A front end portion and a rear end portion of the first movable member 6 are connected to the support part 5a via securing shafts 8, 9 such that the front end portion and the rear end portion of the first movable member 6 are movable in the vertical direction but immovable in the front-rear direction and in the left-right direction. Accordingly, the first movable member 6 is movable with respect to the base member 5 in the vertical direction only and immovable in the front-rear direction and in the left-right direction. Position of the first movable member 6 with respect to the base member 5 in the vertical direction is adjusted by a first position adjustment mechanism 20 to be described later.

[0016] As with the first movable member 6, the second movable member 7 includes a pair of side plates 7a, 7a opposed to each other in the vertical direction and a top plate 7b connecting left side portions of the pair of side plates 7a, 7a to form one member. The second movable member 7 is disposed in a similar attitude as the first movable member 6. The side plates 6a, 6a and the top plate 6b of the first movable member 6 are disposed between the pair of side plates 7a, 7a of the second movable member 7. A distance between inner surfaces of the pair of side plates 7a, 7a is generally the same as a distance between outer surfaces of the pair of side plates 6a, 6a of the first movable member 6. By this arrangement, the second movable member 7 is movable in the front-rear direction but immovable in the vertical direction with respect to the first movable member 6. Therefore, the second movable member 7 is moved together with the first movable member 6 in the vertical direction with respect to the base member 5 but the second movable member 7 is moved independently of the base member 5 and the first movable member 6 in the front-rear direction.

[0017] An elongated hole 7c extending in the front-rear direction is formed in a rear end portion of each of the side plates 7a, 7a of the second movable member 7. Upper and lower end portions of a securing shaft 9 respectively passing through the side plates 6a, 6a of the first movable member 6 are respectively disposed in the elongated holes 7c, 7c such that the upper and lower end portions of the securing shaft 9 are respectively rotatable and movable in a longitudinal direction of the elongated

holes 7c, 7c. An engagement groove 7d is formed in a front end portion of the top plate 7b. An adjustment screw 10 having an axis thereof oriented in the left-right direction is engaged with the engagement groove 7d such that the adjustment screw 10 is immovable in the left-right direction and in the vertical direction but is movable in the front-rear direction. The adjustment screw 10 is rotatable about the axis of the adjustment screw 10 with respect to the engagement groove 7d. A right end portion (lower end portion in FIG. 3) of the adjustment screw 10 is threadedly engaged with a screw hole 6d formed in a front end portion of the top plate 6b of the first movable member 6. Accordingly, when the adjustment screw 10 is rotated in normal and reverse directions, a front end portion of the second movable member 7 is rotated about the securing shaft 9 in the left-right direction, thereby adjusting the position of the front end portion of the second movable member 7 in the left-right direction.

[0018] As shown in FIG. 6, the first position adjustment mechanism 20 is disposed between the base member 5 and the first movable member 6. The first position adjustment mechanism 20 is provided for adjusting the position of the first movable member 6 in the vertical direction with respect to the base member 5. The first position adjustment mechanism 20 includes a guide plate 21 and a first adjustment shaft 22.

[0019] As shown in FIG. 3, the guide plate 21 has a shape of a generally rectangular flat plate. The guide plate 21 is disposed with a longitudinal direction thereof oriented in the front-rear direction and with a thickness direction thereof oriented in the left-right direction. A width of the guide plate 21, specifically, a width of the guide plate 21 in the vertical direction is designed to be slightly wider than a width of a guide hole 6e in the vertical direction. The guide hole 6e is formed in the top plate 6b of the first movable member 6 and extends in the front-rear direction. The guide plate 21 is press-fitted in the guide hole 6e such that the guide plate 21 is movable in the front-rear direction but immovable in the vertical direction. Accordingly, the guide plate 21 is moved together with the first movable member 6 in the vertical direction, but the guide plate 21 is relatively moved with respect to the first movable member 6 in the front-rear direction. Since the guide plate 21 is press-fitted in the guide hole 6e, a relatively great friction resistance is generated between an upper side surface of the guide plate 21 and an upper side portion of an inner circumferential surface of the guide groove 6e and between a lower side surface of the guide plate 21 and a lower side portion of the inner circumferential surface of the guide groove 6e. Therefore, the guide plate 21 is not moved in the front-rear direction unless a force greater than the friction resistance is applied. Reversely, by applying a force overcoming the friction resistance on the guide plate 21, the guide plate 21 can be moved in the front-rear direction with respect to the first movable member 6. Alternatively, the guide plate 21 may be inserted in the guide hole 6e in a condition where generally no frictional resistance is gen-

erated between the guide plate 21 and the guide hole 6e, and accordingly, the guide plate 21 is slidable in the front-rear direction.

[0020] As shown in FIG. 6, the first adjustment shaft 22 includes a first fitting portion 22a having a circular cross-section. The first fitting portion 22a is disposed with an axis thereof oriented in the left-right direction (vertical direction of FIG. 6). An outer diameter of the first fitting portion 22a is generally the same as an inner diameter of a first fitting hole 21a formed in a front end portion of the guide plate 21. The first fitting portion 22a is fitted in the first fitting hole 21a such that the first fitting portion 22a is rotatable and relatively movable in the left-right direction. Moreover, the first fitting portion 22a is fitted in the first fitting hole 21a such that the first fitting portion 22a is relatively immovable in the vertical direction and in the front-rear direction. Therefore, when the first fitting portion 22a is moved in the vertical direction, the guide plate 21 and the first movable member 6 is moved in the vertical direction according to the movement of the first fitting portion 22a. However, when the first fitting portion 22a is moved in the front-rear direction, the guide plate 21 only is moved in the front-rear direction in the guide hole 6e and the first movable member 6 is not moved in the front-rear direction. Alternatively, the first fitting portion 22a may be fitted in the first fitting hole 21a such that the first fitting portion 22a is immovable in the left-right direction.

[0021] A plurality of projections 21b extending in a circumferential direction along an inner circumferential surface of the first fitting hole 21a are formed in a left end portion of the inner circumferential surface of the first fitting hole 21a. The projection 21b is inclined such that a right end of the projection 21b is positioned more inward than a left end of the projection 21b in a radial direction of the first fitting hole 21a. A number of fine engaging teeth are formed in a distal end portion of each of the projections 21b. The engaging teeth are arranged in a circumferential direction of the projection 21b. Each of the engaging teeth is displaceable in an axial direction (left-right direction) of the first fitting hole 21a by an elastic deformation of the projection 21b.

[0022] A circumferential portion of a left end surface of the first fitting portion 22a is opposed to the projections 21b. A number of fine engaging grooves are formed in the circumferential portion of the left end surface of the first fitting portion 22a. The engaging grooves are arranged in a circumferential direction of the first fitting portion 22a. The first adjustment shaft 22 is prohibited from being rotated with a force of a predetermined magnitude by respective engagement of the engaging teeth of the projections 21b with the engaging grooves. When the first adjustment shaft 22 is rotated with a force greater than the predetermined magnitude, the distal end portions of the projections 21b are elastically deformed so as to be spaced leftward from the left end surface of the first fitting portion 22a. As a result, the engaging teeth are disengaged from the engaging grooves. Thus, the

first adjustment shaft 22 can be rotated by applying a force greater than the predetermined magnitude. It is to be understood that the first adjustment shaft 22, after being rotated, is prohibited from being rotated and held at the rotational position with a force of a predetermined magnitude by the engagement of the engaging teeth with the engaging grooves.

[0023] A first eccentric shaft 22b is formed in a right end surface (lower end surface in FIG. 3) of the first fitting portion 22a facing the base member 5. The first eccentric shaft 22b has a circular cross-section. An axis of the first eccentric shaft 22b is parallel to an axis of the first fitting portion 22a and is spaced from the axis of the first fitting portion 22a in a radial direction of the first fitting portion 22a. In other words, the first eccentric shaft 22b is decentered with respect to the first fitting portion 22a.

[0024] A first adjustment recess 23 is formed in a left side surface (upper side surface in FIG. 3) of the support part 5a opposed to the top plate 6b of the first movable member 6. The first adjustment recess 23 extends in the front-rear direction. The first eccentric shaft 22b is rotatably disposed in the first adjustment recess 23. Moreover, the first eccentric shaft 22b is disposed in the first adjustment recess 23 such that the first eccentric shaft 22b is movable in the front-rear direction but immovable in the vertical direction. Accordingly, when the first adjustment shaft 22 is rotated about the axis of the first fitting portion 22a in normal and reverse directions, the first eccentric shaft 22b is moved in the first adjustment recess 23 in the front-rear direction, while moving the first fitting portion 22a in the vertical direction. As a result, the first movable member 6 is moved with respect to the base member 5 in the vertical direction via the guide plate 21. Therefore, a position of the first movable member 6 with respect to the base member 5 in the vertical direction can be adjusted by rotating the first adjustment shaft 22 in the normal and reverse directions. Since the second movable member 7 is connected to the first movable member 6 such that the second movable member 7 is immovable in the vertical direction, when the position of the first movable member 6 is adjusted in the vertical direction, a position of the second movable member 7 is also adjusted in the vertical direction.

[0025] A first head 22c is formed in the left end surface of the first fitting portion 22a, i.e. in the end surface of the first fitting portion 22a opposed to the top plate 7b of the second movable member 7. The first head 22c has a circular cross-section. The first head 22c is disposed with an axis thereof coinciding with the axis of the first fitting portion 22a. The first head 22c is fitted in a first connecting hole 24 formed in the top plate 7b of the second movable member 7 such that the first head 22c is immovable in the vertical direction and in the front-rear direction. Accordingly, when the first adjustment shaft 22 is rotated in the normal and reverse directions, the second movable member 7 is moved in the vertical direction together with the first movable member 6. However, as mentioned above, the second movable member 7 is not moved to-

gether with the first movable member 6 in the front-rear direction. Instead, the second movable member 7 is moved with respect to the first movable member 6 in the front-rear direction together with the guide plate 21. The second movable member 7 is connected to the first movable member 6 such that the second movable member 7 is immovable in the vertical direction, and the second movable member 7 is moved in the vertical direction together with the first movable member 6. Therefore, the first head 22c is not necessarily fitted in the first connecting hole 24 of the second movable member 7. When the first head 22c is not fitted in the first connecting hole 24, provision of the first connecting hole 24 is not required.

[0026] As is clear from the fact that the first fitting portion 22a of the first adjustment shaft 22 is fitted in the first fitting hole 21a of the guide plate 21, the first head 22c is fitted in the first connecting hole 24 of the top plate 7b of the second movable member 7 and the first eccentric shaft 22b is disposed in the first adjustment recess 23 of the base member 5, the first adjustment shaft 22 passes through the top plate 6b of the first movable member 6 in the left-right direction. A second adjustment shaft 32 of a second position adjustment mechanism 30 to be described below similarly passes through the top plate 6b of the first movable member 6.

[0027] As shown in FIG. 6, the second position adjustment mechanism 30 is disposed between the base member 5 and the second movable member 7. The second position adjustment mechanism 30 is provided for adjusting a position of the second movable member 7 with respect to the base member 5 in the front-rear direction. The second position adjustment mechanism 30 includes the guide plate 21 and the second adjustment shaft 32.

[0028] A second fitting hole 21c is formed in a rear end portion of the guide plate 21. The second fitting hole 21c is formed through the guide plate 21 in the left-right direction. The second fitting hole 21c has a same shape and same dimensions as the first fitting hole 21a. A plurality of projections 21d having a same shape and same dimensions as the projections 21b are formed in an inner circumferential surface of the second fitting hole 21c. The second adjustment shaft 32 has a same shape and same dimensions as the first adjustment shaft 22. Accordingly, the second adjustment shaft 32 includes a second fitting portion 32a, a second eccentric shaft 32b and a second head 32c, respectively corresponding to the first fitting portion 22a, the first eccentric shaft 22b and the first head 22c of the first adjustment shaft 22. A number of engaging grooves are formed in an outer circumferential portion of a left end surface of the second fitting portion 32a. The engaging grooves are arranged in a circumferential direction of the second fitting portion 32a.

[0029] The second fitting portion 32a of the second adjustment shaft 32 is fitted in the second fitting hole 21c of the guide plate 21 such that the second fitting portion 32a is rotatable and movable in the left-right direction. Moreover, the second fitting portion 32a is fitted in the second fitting hole 21c such that the second fitting portion

32a is immovable in the vertical direction and in the front-rear direction. Therefore, the second fitting portion 32a is moved together with the guide plate 21 in the vertical direction and in the front-rear direction. In other words, when the second fitting portion 32a is moved in the vertical direction and in the front-rear direction, the guide plate 21 is moved together with the second fitting portion 32a in the vertical direction and in the front-rear direction. Alternatively, the second fitting portion 32a may be fitted in the second fitting hole 21c such that the second fitting portion 32a is immovable in the left-right direction.

[0030] A number of engaging teeth are formed in a distal end portion of the projections 21d. The number of engaging teeth are respectively engaged with the number of engaging grooves formed in the second fitting portion 32a. Therefore, the second adjustment shaft 32 is prohibited from being rotated with respect to the second fitting hole 21c with a force of a predetermined magnitude. In other words, the second adjustment shaft 32 can be rotated by applying a force greater than the predetermined magnitude as with the first adjustment shaft 22.

[0031] A second adjustment recess 33 is formed in the side surface of the support part 5a in which the first adjustment recess 23 is formed. The second adjustment recess 33 is disposed more to the rear than the first adjustment recess 23 and extends in the vertical direction. The second eccentric shaft 32b of the second adjustment shaft 32 is disposed in the second adjustment recess 33 such that the second eccentric shaft 32b is rotatable and movable in the vertical direction. Moreover, the second eccentric shaft 32b is disposed in the second adjustment recess 33 such that the second eccentric shaft 32b is immovable in the front-rear direction. Accordingly, when the second adjustment shaft 32 is rotated about the axis of the second fitting portion 32a, the second eccentric shaft 32b is moved in the second adjustment recess 33 in the vertical direction and moves the second fitting portion 32a in the front-rear direction. As a result, the guide plate 21 is moved in the guide hole 6e in the front-rear direction.

[0032] A second connecting hole 34 is formed in the top plate 7b of the second movable member 7. The second connecting hole 34 is located more to the rear than the first connecting hole 24. The second head 32c is fitted in the second connecting hole 34 such that the second head 32c is rotatable and movable in the left-right direction. Moreover, the second head 32c is fitted in the second connecting hole 34 such that the second head 32c is immovable in the vertical direction and in the front-rear direction. Accordingly, when the second fitting portion 32a is moved in the front-rear direction, the second movable member 7 is moved in the front-rear direction together with the second fitting portion 32a. Therefore, a position of the second movable member 7 with respect to the base member 5 and the first movable member 6 can be adjusted in the front-rear direction by rotating the second adjustment shaft 32 in the normal and reverse directions.

[0033] When the second movable member 7 is moved in the front-rear direction, the guide plate 21 is moved in the front-rear direction with respect to the first movable member 6. As a result, the first adjustment shaft 22 is moved in the front-rear direction with respect to the base member 5. The first eccentric shaft 22b of the first adjustment shaft 22 is fitted in the first adjustment recess 23 of the base member 5 such that the first eccentric shaft 22b can be moved in the front-rear direction. Therefore, the movement of the second movable member 7 in the front-rear direction is not disturbed by the base member 5 or the first adjustment shaft 22. Similarly, when the first movable member 6 is moved in the vertical direction, the second adjustment shaft 32 is moved in the vertical direction with respect to the base member 5. However, since the second eccentric shaft 32b of the second adjustment shaft 32 is disposed in the second adjustment recess 33 of the base member 5 such that the second eccentric shaft 32b is movable in the vertical direction, the movement of the first movable member 6 in the vertical direction is not disturbed by the base member 5 or the second adjustment shaft 32.

[0034] As mentioned above, the positions of the first and second movable members 6, 7 with respect to the base member 5 can be adjusted in the vertical direction by rotating the first adjustment shaft 22 and the position of the second movable member 7 with respect to the base member 5 and the first movable member 6 can be adjusted in the front-rear direction by rotating the second adjustment shaft 32. On the other hand, after the position adjustment, the first and the second movable members 6, 7 are fixed in position to the base member 5 with the force of the predetermined magnitude by the friction resistance generated between the guide plate 21 and the guide hole 6e, the engagement of the engaging teeth of the projections 21b of the first fitting hole 21a and the engaging grooves of the first adjustment shaft 22 and the engagement of the engaging teeth of the projections 21d of the second fitting hole 21c and the engaging grooves of the second adjustment shaft 32. When fixing mechanisms are respectively disposed between the base member 5 and the first movable member 6 and between the base member 5 and the second movable member 7, the fixing mechanisms respectively fixing the first movable member 6 and the second movable member 7 to the base member 5, the friction resistance between the guide plate 21 and the guide hole 6e and the engagements of the engaging teeth and the engaging grooves are not required.

[0035] The body 3 includes a pair of side plates 3a, 3a disposed so as to be opposed to each other and a top plate 3b connecting left side portions of the pair of side plates 3a, 3a. Accordingly, the body 3 has a generally U-shaped cross-section formed by the side plates 3a, 3a and the top plate 3b. The body 3 is disposed with a longitudinal direction of the body 3 oriented in the front-rear direction, a direction in which the side plates 3a, 3a are opposed oriented in the vertical direction and an open

portion of the body 3 oriented to the right (toward the second movable member 7). The second movable member 7 is removably inserted between the side plates 3a, 3a. A distance between inner surfaces of the side plates 3a, 3a opposed to each other is generally the same as a distance between outer surfaces of the side plates 7a, 7a of the second movable member 7. Therefore, when the second movable member 7 is inserted between the side plates 3a, 3a, the body 3 is connected to the second movable member 7 such that the body 3 is immovable in the vertical direction.

[0036] A front end portion of the body 3 is removably attached to a front end portion of the second movable member 7 via a first engagement mechanism 40. A rear end portion of the body 3 is removably attached to a rear end portion of the second movable member 7 via a second engagement mechanism 50.

[0037] The first engagement mechanism 40 will be described first. As shown in FIGS. 2, 3 and 6, first engagement recesses 41 that are open in front are respectively formed in front end surfaces of the side plates 7a, 7a of the second movable member 7. As shown in FIGS. 4 and 6, opposite end portions of a first engagement shaft 42 are respectively attached to front end portions of the side plates 3a, 3a of the body 3, at locations on the base member 5 side. The first engagement shaft 42 has a longitudinal direction thereof oriented in the vertical direction. The first engagement shaft 42 can be inserted in the first engagement groove 41 from the open portion of the first engagement groove 41 up to a bottom portion of the first engagement recess 41 by moving the body 3 rearward, with the first engagement shaft 42 opposed to the open portion of the first engagement recess 41. When the first engagement shaft 42 is inserted up to the bottom portion of the first engagement recess 41, the front end portion of the body 3 is caught by the front end portion of the second movable member 7 such that the body 3 is immovable in the left-right direction and immovable rearward. The front end portion of the body 3 is removably attached to the front end portion of the second movable member 7 in this manner.

[0038] The first engagement shaft 42 can be inserted into the first engagement recess 41 by being made to slide on an inclined surface 43 formed in the front end portion of the second movable member 7. Specifically, as shown in FIGS. 2 and 3, the inclined surface 43 is formed in a front end portion of the side plate 7a of the second movable member 7. The inclined surface 43 extends from an end portion of the side plate 7a near the top plate 7b to the first engagement recess 41. The inclined surface 43 is inclined such that the front end of the inclined surface 43 is closer to the first engagement recess 41 than the rear end of the inclined surface 43 in a direction from the top plate 7b to the first engagement recess 41. Therefore, when the body 3 is moved forward with the first engagement shaft 42 pressed against an end portion of the inclined surface 43 on the top plate 7b side, the first engagement shaft 42 is made to slide on

the inclined surface 43 forward. After the first engagement shaft 42 is moved past the inclined surface 43, the first engagement shaft 42 reaches the open portion of the first engagement recess 41. After that, by moving the body 3 rearward, the first engagement shaft 42 can be inserted in the first engagement recess 41.

[0039] The second engagement mechanism 50 will be described hereinafter. As shown in FIGS. 2, 3 and 6, a second engagement shaft 51 is disposed in the rear end portion of the side plates 7a, 7a of the second movable member 7. The second engagement shaft 51 is fixed in position with a longitudinal direction thereof oriented in the vertical direction. A support shaft 52 is disposed in the side plates 3 a, 3a of the body 3. The support shaft 52 is fixed in position with a longitudinal direction thereof oriented in the vertical direction. An action member 53 is rotatably supported by the support shaft 52. The action member 53 is rotatable between an engaged position shown in FIG. 6 and a released position spaced from the engaged position by a predetermined angle in a counter-clockwise direction of FIG. 3. The action member 53 is biased from the released position toward the engaged position by a biasing force of a torsion coil spring 54 disposed in the support shaft 52.

[0040] As shown in FIGS. 4 and 6, a second engagement recess 53a is formed in a surface of the action member 53 facing toward the front. The second engagement recess 53a is open toward the front. When the action member 53 is rotated from the released position up to the engaged position, the second engagement shaft 51 relatively enters the second engagement recess 53a from the open portion of the second engagement recess 53a until the second engagement shaft 51 is abutted against a bottom portion of the second engagement recess 53a. The position of the action member 53 when the second engagement shaft 51 is abutted against the bottom portion of the second engagement recess 53a is the engaged position. When the action member 53 is positioned in the engaged position, the movement of the body 3 in the left-right direction is prohibited by the engagement of the second engagement shaft 51 with the second engagement recess 53a, and the movement of the body 3 rearward is prohibited by the biasing force of the torsion coil spring 54. The rear end portion of the body 3 is removably attached to the rear end portion of the second movable member 7 in this manner. When the action member 53 is rotated from the engaged position to the released position against the biasing force of the torsion coil spring 54, the second engagement shaft 51 comes out of the second engagement recess 53a, thereby enabling the rear end portion of the body 3 to be disengaged from the rear end portion of the second movable member 7.

[0041] An inclined surface 53b is formed in the action member 53. The inclined surface 53b is formed continuously from the second engagement recess 53a to the right of the second engagement recess 53a (below the second engagement recess 53a in FIG. 6). The inclined

surface 53b is inclined such that a rear end of the inclined surface 53b is positioned more rightward than a rear end of the inclined surface 53b. Moreover, as shown in FIG. 6, the inclined surface 53b is disposed such that when the body 3 is rotated about the first engagement shaft 42 engaged with the first engagement recess 41 in a clockwise direction to bring the rear end portion of the body 3 closer to the second engagement shaft 51, the inclined surface 53b is abutted against the second engagement shaft 51. In a condition where the inclined surface 53b is abutted against the second engagement shaft 51, when the body 3 is rotated further in the clockwise direction, the action member 53 is rotated from the engaged position toward the released position against the biasing force of the torsion coil spring 54 by the second engagement shaft 51 and the inclined surface 53b. When the action member 53 is rotated, the second engagement shaft 51 is relatively moved forward on the inclined surface 53b according to the rotation of the action member 53. When the second engagement shaft 51 is moved over the inclined surface 53b (the released position of the action member 53 is slightly spaced from the position of the action member 53 at this time in the counter-clockwise direction), the action member 53 is rotated up to the engaged position by the torsion coil spring 54. As a result, the second engagement shaft 51 is inserted into the second engagement recess 53a from the open portion of the second engagement recess 53a until the second engagement shaft 51 is abutted against the bottom portion of the second engagement recess 53a.

[0042] The body 3 can be attached to the second movable member 7 in one of the following three methods. In a first method of attachment, the first engagement shaft 42 is inserted in the first engagement recess 41 first. In this condition, the body 3 is rotated about the first engagement shaft 42 in the clockwise direction to bring the rear end portion of the body 3 closer to the rear end portion of the second movable member 7. Then, as mentioned above, the inclined surface 53b is abutted against the second engagement shaft 51. After that, when the body 3 is rotated further in the clockwise direction, the action member 53 is rotated in a direction from the engaged position toward the released position (counter-clockwise direction of FIG. 6) against the biasing force of the torsion coil spring 54. When the second engagement shaft 51 is moved over the inclined surface 53b, the action member 53 is rotated toward the engaged position by the torsion coil spring 54, and the second engagement shaft 51 enters the second engagement recess 53a and the second engagement shaft 51 is engaged with the second engagement recess 53a. In this condition, the body 3 is prohibited from being moved in the left-right direction by the engagement of the first engagement shaft 42 and the first engagement recess 41 and the engagement of the second engagement shaft 51 and the second engagement recess 53a. Moreover, the body 3 is prohibited from being moved in the front-rear direction by the first engagement shaft 42 being pressed

against the bottom surface of the first engagement recess 41 and the second engagement shaft 51 being pressed against the bottom surface of the second engagement recess 53a by the biasing force of the torsion coil spring 54. The body 3 is prohibited from being moved in the vertical direction by the side plates 7a, 7a of the second movable member 7. The body 3 is removably attached to the second movable member 7. The body 3 is immovable when the body 3 is attached to the second movable member 7.

[0043] In a second method of attachment, in reverse to the first method, the second engagement shaft 51 is preliminarily engaged with the second engagement recess 53a. In this condition, the body 3 is rotated about the second engagement shaft 51 to bring the front end portion of the body 3 closer to the front end portion of the second movable member 7. Then, the first engagement shaft 42 is abutted against the inclined surface 43. When the front end portion of the body 3 is brought further closer to the front end portion of the second movable member 7, the first engagement shaft 42 slides forward on the inclined surface 43. At this time, the body 3 is moved forward accompanying the movement of the first engagement shaft 42 forward. As a result, the action member 53 is pushed rearward by the second engagement shaft 51 by a distance corresponding to the movement of the body 3, and the action member 53 is rotated from the engaged position side toward the released position. After that, when the first engagement shaft 42 is moved over the inclined surface 43, it becomes possible for the first engagement shaft 42 to enter the first engagement recess 41. Then, the action member 53 is rotated up to the engaged position by the torsion coil spring 54, and the body 3 is moved rearward according to the rotation of the action member 53. The first engagement shaft 42 is inserted in the first engagement recess 41 until the first engagement shaft 42 is abutted against the bottom portion of the first engagement recess 41 by the movement of the body 3 rearward. The body 3 is removably attached to the second movable member 7 in this manner.

[0044] In a third method of attachment, the first engagement shaft 42 and the second engagement shaft 51 are respectively made to contact the inclined surfaces 43, 53b at the same time. In this condition, when the body 3 is moved closer to the second movable member 7, the first engagement shaft 42 is moved forward on the inclined surface 43 and the second engagement shaft 51 is moved rearward on the inclined surface 53b. At this time, the action member 53 is rotated from the engaged position toward the released position by the second engagement shaft 51 accompanying the movement of the body 3 closer to the second movable member 7. When the first engagement shaft 42 and the second engagement shaft 51 are respectively moved over the inclined surfaces 43, 53b, the action member 53 is rotated from the released position toward the engaged position by the torsion coil spring 54, and the second engagement shaft 51 enters the second engagement recess 53a. When the

second engagement shaft 51 is abutted against the bottom portion of the second engagement recess 53a, the body 3 is moved rearward by the torsion coil spring 54, and the first engagement shaft 42 is inserted into the first engagement recess 41. The body 3 is removably attached to the second movable member 7 in this manner.

[0045] As shown in FIG. 4, first, second and third through holes 3d, 3e, 3f are formed in the top plate 3b of the body 3. The first, second and third through holes 3d, 3e, 3f are provided so that tools such as a screw driver for adjusting by rotating the adjustment screw 10, the first adjustment shaft 22 and the second adjustment shaft 32 can be respectively inserted through the first, second and third through holes 3d, 3e, 3f. The first, second and third through holes 3d, 3e, 3f are arranged such that the first, second and third through holes 3d, 3e, 3f are respectively opposed to the adjustment screw 10, the first adjustment shaft 22 and the second adjustment shaft 32 in the respective axial directions of the adjustment screw 10, the first adjustment shaft 22 and the second adjustment shaft 32.

[0046] A third engagement mechanism 60 is provided between the rear end portion of the body 3 and the rear end portion of the second movable member 7. The third engagement mechanism 60 prevents the body 3 from coming away from the second movable member 7. Specifically, as mentioned above, the body 3 is prohibited from being moved forward with respect to the second movable member 7 by the biasing force of the torsion coil spring 54. Therefore, if the body 3 is pushed forward with a force greater than the biasing force of the torsion coil spring 54, the body 3 is moved forward, and the first engagement shaft 42 comes out of the first engagement recess 41. As a result, the body 3 may come away from the second movable member 7 in the right direction. The third engagement mechanism 60 is provided to surely prevent such an event.

[0047] The third engagement mechanism 60 includes a lock member 61. The lock member 61 is rotatably attached to the rear end portion of the body 3 via the support shaft 52. The lock member 61 is rotatable between a locked position shown in FIG. 6 and an unlocked position spaced from the locked position by a predetermined angle in the counter-clockwise direction of FIG. 6. The lock member 61 is rotationally biased by the torsion coil spring 54 in a direction from the unlocked position toward the locked position. The lock member 61 may be rotationally biased in the direction from the unlocked position toward the locked position by another coil spring instead of the torsion coil spring 54. The lock member 61 may be rotatably attached to the rear end portion of the body 3 via another shaft instead of the support shaft 52.

[0048] Projections 61a, 61a projecting toward the second movable member 7 are respectively formed in upper and lower end portions of a distal end portion of the lock member 61. Lock grooves 62, 62 are formed in a left side portion (upper side portion in FIG. 3) of the rear end portion of the side plates 7a, 7a of the second movable mem-

ber 7. The lock groove 62 is dimensioned such that the projection 61a can be projected and retracted in the left-right direction. A dimension of the lock groove 62 in the front-rear direction is generally the same as a dimension of the projection 61a in the front-rear direction. Moreover, the lock groove 62 is disposed such that the projection 61a can be projected and retracted from the lock groove 62 only when the body 3 is attached to the second movable member 7 in a normal position. In other words, the projection 61a is disposed such that the projection 61a cannot enter the lock groove 62 until after the body 3 is attached to the second movable member 7 regardless of which of the three methods described above is used to attach the body 3 to the second movable member 7.

[0049] When the body 3 is attached to the second movable member 7 by one of the first to the third methods described above, at an initial stage of attaching, the projection 61a is abutted against the side plate 7a of the second movable member 7. Accordingly, when the body 3 is moved closer to the second movable member 7, the lock member 61 is rotated from the locked position toward the unlocked position according to the movement of the body 3. After that, when the body 3 is attached to the second movable member 7, that is when the first engagement shaft 42 of the first engagement mechanism 40 is inserted into the first engagement recess 41 until the first engagement shaft 42 is abutted against the bottom portion of the first engagement recess 41 and the second engagement shaft 51 of the second engagement mechanism 50 is inserted into the second engagement recess 53a until the second engagement shaft 51 is abutted against the bottom portion of the second engagement recess 53a, the lock member 61 is rotated from the unlocked position up to the locked position by the torsion coil spring 54, and the projection 61a enters the lock groove 62. Then, since the dimensions of the projection 61a and the lock groove 62 in the front-rear direction are the same, the body 3 is caught such that the body 3 is immovable with respect to the second movable member 7 in the front-rear direction. Therefore, the body 3 can be surely prevented from being moved forward and coming away from the second movable member 7.

[0050] Regardless of which of the first to the third methods is used to attach the body 3 to the second movable member 7, the body 3 can be removed from the second movable member 7 by rotating the action member 53 from the engaged position to the released position. When the action member 53 is rotated to the released position, the second engagement shaft 51 comes out of the second engagement recess 53a. Then, the rear end portion of the body 3 is moved leftward to be spaced from the second movable member 7 until the action member 53 is spaced leftward from the second engagement shaft 51 and the projection 61a comes out of the lock groove 62. In other words, the body 3 is rotated about the first engagement shaft 42 in the counter-clockwise direction of FIG. 6. Then, the body 3 is moved forward, thereby allowing the first engagement shaft 42 to come out of the

first engagement recess 41. After that, the body 3 can be removed from the second movable member 7 by moving the body 3 leftward.

[0051] One end portion of the external link (first link) 71 is rotatably connected to the front end portion of the body 3 via a first support shaft 73. The first support shaft 73 is disposed with an axis thereof oriented in the vertical direction. Opposite end portions of the first support shaft 73 are respectively supported by the front end portions of the side plates 3a, 3a of the body 3 at locations near the base unit 2. Since the axis of the first support shaft 73 is oriented in the vertical direction, the external link 71 is rotated in a horizontal plane. One end portion of the internal link (second link) 72 is rotatably connected to the front end portion of the body 3 via a second support shaft 74. The second support shaft 74 is disposed parallel to the first support shaft 73 and more to the front and left than the first support shaft 73. The second support shaft 74 may be disposed at a same location as or more to the rear than the first support shaft 73 in the front-rear direction.

[0052] As shown in FIGS. 4 and 6, the mounting member 4 is provided with a connecting shaft member 75. The connecting shaft member 75 includes two shafts 75a, 75a extending parallel to the first support shaft 73 and the second support shaft 74. The other end portion of the external link 71 is rotatably supported by one of the shafts (third support shaft) 75a. The other end portion of the internal link 72 is rotatably supported by the other of the shafts (fourth support shaft) 75b. As a result, the mounting member 4 is rotatably connected to the front end portion of the body 3 via the internal link 72 and the external link 71, and consequently, the door D is rotatably supported by the frame B via the hinge apparatus 1. Alternatively, the shafts 75a, 75b may be formed as separate shafts.

[0053] The mounting member 4 is rotatable between the closed position shown in FIG. 6 and the open position shown in FIG. 7. As shown in FIG. 6, the closed position of the mounting member 4 is defined by the abutment of the external link 71 against the mounting member 4. A pair of recesses 75c, 75c are formed in the shaft 75a. The recesses 75c, 75c are arranged such that portions of the internal link 72 can respectively enter the recesses 75c, 75c when the mounting member 4 is positioned in the closed position. By this arrangement, the mounting member 4 can be surely rotated up to the closed position. As shown in FIG. 7, the open position of the mounting member 4 is defined by the abutment of the internal link 72 against the mounting member 4. Alternatively, the closed position and the open position of the mounting member 4 may be defined by other well-known features.

[0054] In FIG. 6, the door D is depicted slightly inclined such that a free end of the door D is closer to the frame B than a supported side (side supported by the hinge apparatus 1) of the door D when the mounting member 4 is positioned in the closed position. However, in reality, the door D is never rotated up to the position shown in

FIG. 6. The door D is rotated only up to a position in which the door D is parallel to the front surface of the frame B due to the abutment of the free end of the door D against the front surface of the frame B. Therefore, in actual use of the hinge apparatus 1, the mounting member 4 is never rotated up to the closed position. Instead, the mounting member 4 is stopped at a position a slight angle (1 to 2 degrees, for example) to the open position from the closed position.

[0055] Since the mounting member 4 is rotatably supported by the body 3 via the two links 71, 72, when an instantaneous rotation center of the mounting member 4 is expressed as C, as shown in FIG. 8, the instantaneous rotation center C can be obtained as an intersection of a straight line perpendicular to axes of the first support shaft 73 and the shaft 75a and a straight line perpendicular to axes of the second support shaft 74 and the shaft 75b. The instantaneous rotation center C is located in front of the shaft 75a in a direction from the support shaft 73 to the shaft 75a and in front of the shaft 75b in a direction from the support shaft 74 to the shaft 75b regardless of the position of the mounting member 4 between the closed position and the open position. In other words, the first support shaft 73, the second support shaft 74 and the shafts 75a, 75b are arranged such that the instantaneous rotation center C is positioned as mentioned above regardless of the position of the mounting member 4 between the closed position and the open position.

[0056] A rotational biasing mechanism (rotational biasing means) 80 is provided between the front end portion of the body 3 and the mounting member 4. The rotational biasing mechanism 80 is provided for rotating the mounting member 4 up to the closed position when the mounting member 4 is positioned between a predetermined released position (position shown in FIG. 10) and the closed position, the released position being between the open position and the closed position, and for maintaining the mounting member 4 at the closed position. The rotational biasing mechanism 80 includes a force transmitter 81, a torsion coil spring (biasing means) 82 and a receiver 83.

[0057] As shown in FIG. 4 and FIGS. 15 to 19, a through hole 81a is formed in a basal end portion of the force transmitter 81 (end portion of the force transmitter 81 near the right side wall portion of the frame B in FIG. 6). The through hole 81a is disposed with an axis thereof oriented in the vertical direction. The through hole 81a is formed as an elongated hole inclined such that a left end of the through hole 81a is higher than a right end of the through hole 81a in FIG. 6. The second support shaft 74 is disposed in the through hole 81a such that the second support shaft 74 is rotatable and relatively movable in a longitudinal direction of the through hole 81a. Accordingly, the force transmitter 81 is rotatable about the second support shaft 74 and is movable in the longitudinal direction of the through hole 81a within a length of the through hole 81a. The through hole 81a may be formed to have a circular cross-section instead of being formed

as the elongated hole. In this case, the force transmitter 81 is rotatable with respect to the second support shaft 74 but is immovable in a radial direction of the second support shaft 74. Alternatively, instead of being disposed around the second support shaft 74, the force transmitter 81 may be disposed around a shaft provided in the body 3 in parallel to the second support shaft 74 such that the force transmitter 81 is rotatable and movable in the longitudinal direction of the through hole 81a or, alternatively, rotatably but immovably disposed around the shaft.

[0058] A guide hole 3g (notch) passes through the top plate 3b in the left-right direction and extends along a longitudinal direction of the top plate 3b. The guide hole 3g is formed in a front end portion of the top plate 3b of the body 3. A distal end portion of the force transmitter 81 is disposed through the guide hole 3g such that the distal end portion of the force transmitter 81 is movable in a longitudinal direction of the guide hole 3g. By this arrangement, the front end portion of the force transmitter 81 is prohibited from interfering with (being abutted against) the top plate 3b when the force transmitter 81 is rotated about the first support shaft 73. The guide hole 3g may be formed so as to be open to the front from a front end surface of the top plate 3b.

[0059] A pressing portion (the other end portion of the force transmitter 81 projecting out of the body 3; one portion) 81b is formed in the front end portion of the force transmitter 81. An outer surface of the pressing portion 81b is a convex curved surface, and particularly in this embodiment, is a convex circular arc surface. The circular arc surface is disposed with a center line thereof oriented in the vertical direction. That is, the circular arc surface extends in the vertical direction. As shown in FIGS. 6 to 13, the circular arc surface constituting the pressing portion 81b projects out of the body 3 through the guide hole 3g regardless of the position of the mounting member 4 between the open position and the closed position. An amount of projection of the circular arc surface increases as the mounting member 4 is rotated from the open position side toward the closed position.

[0060] A clearance recess 81c is formed in a portion of the distal end portion of the force transmitter 81 facing rearward (portion facing rightward in FIG. 18). The clearance recess 81c is composed of a circular arc surface that is concave toward the front. An end portion of the circular arc surface of the clearance recess 81c is disposed in contact with an end portion of the circular arc surface constituting the pressing portion 81b that is located on the right side in FIG. 18.

[0061] The torsion coil spring 82 is disposed around the second support shaft 74. One end portion 82a of the torsion coil spring 82 is abutted against the first engagement shaft 42. The other end portion 82b of the torsion coil spring 82 is abutted against the force transmitter 81. As a result, the torsion coil spring 82 constantly urges the force transmitter 81 such that the force transmitter 81 is rotated in the clockwise direction of FIG. 6. However,

when the mounting member 4 is positioned between the open position and the released position, the force transmitter 81 is prohibited from being rotated in the clockwise direction by a clutch mechanism 90 to be described later and maintained at a stopped position shown in FIG. 10. The torsion coil spring 82 urges the force transmitter 81 upward in FIG. 6. By this biasing force, a right lower end portion of the through hole 81 a is normally abutted against the second support shaft 74. Alternatively, the torsion coil spring 82 may be disposed around another shaft instead of the first support shaft 73. For example, when the force transmitter 81 is disposed around a shaft other than the second support shaft 74 as mentioned above, the torsion coil spring 82 may be disposed around the shaft.

[0062] The receiver 83 is attached to the mounting member 4. As shown in FIG. 6, the receiver 83 is disposed in an end portion of the mounting member 4, the end portion being located far from the instantaneous rotation center C when the mounting member 4 is positioned in the closed position. More specifically, the end portion of the mounting member 4 is located far from the instantaneous rotation center C in a direction perpendicular to the axes of the first support shaft 73 and the second support shaft 74. A recess 83a is formed in the receiver 83. An action portion 83b is formed in an inner side surface defining the recess 83 a and an outer surface of the receiver 83 continuous from the inner side surface of the recess 83a. A portion of the inner side surface of the recess 83 a is located in the rear side in FIG. 6 when the mounting member 4 is positioned in the closed position. The portion located in the rear side is a flat surface 83c facing toward the front. A circular arc surface 83d that is outwardly convex is formed at an intersection of the flat surface 83c and an outer surface (surface facing toward the bottom in FIG. 6) of the receiver 83 adjacent to an open portion of the recess 83a. The action portion 83b is composed of the flat surface 83c and the circular arc surface 83d. The action portion 83b is not necessarily composed of the flat surface 83c and the circular arc surface 83d, but may be composed of other curved surfaces.

[0063] A clutch mechanism (rotation prohibition mechanism) 90 is provided between the external link 71 and the force transmitter 81. The clutch mechanism 90 is provided for prohibiting the force transmitter 81 from being rotated in the clockwise direction of FIGS. 7 and 8 by the torsion coil spring 82 when the mounting member 4 is positioned between the open position and the predetermined released position and thereby maintaining the force transmitter 81 at the stopped position. The clutch mechanism 90 is constructed as follows.

[0064] As shown in FIGS. 7, 8 and 14, the external link 71 includes a pair of side plates 71 a, 71 a arranged to be opposed to each other in the vertical direction and a top plate 71b integrally formed in one side portions (left side portion in FIG. 14C) of the pair of side plates 71a, 71a and connecting the pair of side plates 71a, 71a. One

end portions (right end portions in FIG. 14A) of the side plates 71 a, 71 a are rotatably connected to the body 3 by the first support shaft 73 and the other end portions of the side plates 71a, 71a are rotatably connected to the mounting member 4 by the shaft 75a.

[0065] First projections 91, 91 projecting toward each other (in the vertical direction) are respectively formed in inner surfaces of the side plates 71 a, 71 a opposed to each other. The first projections 91, 91 are end portions of the inner surfaces of the side plates 71a, 71a opposed to each other nearer to the first support shaft 73. The first projections 91, 91 are disposed more to the rear than the first support shaft 73. A first engagement surface (first engagement portion) 92 is formed in a surface of the first projection 91 facing toward the front. The first engagement surface 92 is composed of a circular arc surface (first circular arc surface) that is concave around the axis of the first support shaft 73.

[0066] A pair of second projections 93, 93 projecting in the vertical direction are formed in the distal end portion of the force transmitter 81. The second projections 93, 93 are disposed slightly nearer to a basal end of the force transmitter 81 than the pressing portion 81b. A second engagement surface (second engagement portion) 94 is formed in a surface of the second projection 93 facing toward the rear. The second engagement surface 94 is composed of a convex circular arc surface (second circular arc surface) having a same radius of curvature as the circular arc surface constituting the first engagement surface 92. When the mounting member 4 is positioned between the open position and the released position, the force transmitter 81 is biased by the torsion coil spring 82 in the clockwise direction of FIG. 7, thereby bringing the second engagement surface 94 into abutment against the first engagement surface 92. As a result, the force transmitter 81 is prohibited from being rotated in the clockwise direction by the external link 71. The position of the force transmitter 81 at this time is the stopped position.

[0067] The second engagement surface 94 is disposed such that when the force transmitter 81 is positioned in the stopped position, a center line of the circular arc surface constituting the second engagement surface 94 coincides with the axis of the first support shaft 73 (center line of the first engagement surface 92). Accordingly, the biasing force of the torsion coil spring 82 transmitted to the external link 71 via the force transmitter 81 is received by the first support shaft 73. Therefore, the external link 71 is not rotated by the torsion coil spring 82, and the force transmitter 81 is maintained at the stopped position.

[0068] The force transmitter 81 is maintained at the stopped position by the clutch mechanism 90 only when the mounting member 4 is positioned between the open position and the released position. When the mounting member 4 is rotated beyond the released position toward the closed position, the force transmitter 81 is rotated in the clockwise direction by the biasing force of the torsion

coil spring 82. This causes the mounting member 4 to be rotated from the released position to the closed position.

[0069] As shown in FIGS. 7 and 8, when the mounting member 4 is positioned closer to the open position than the released position, the action portion 83b is spaced from the pressing portion 81b.

[0070] However, when the mounting member 4 is rotated from the open position toward the closed position and the mounting member 4 reaches a position a slight angle (5 degrees, for example) before the released position, as shown in FIG. 9, the circular arc surface 83d of the action portion 83b is abutted against the pressing portion 81b. In this case, when a point of the pressing portion 81b most spaced from the instantaneous rotation center C (referred to as first apex hereinafter) is expressed as P, the circular arc surface 83d of the action portion 83b is abutted against the pressing portion 81b at a point slightly spaced from the first apex P to the front (to the left in FIG. 9). Therefore, when the mounting member 4 is rotated further toward the closed position, the circular arc surface 83 d presses the pressing portion 81b rightward (downward in FIG. 9). As a result, the force transmitter 81 is moved rightward (downward in FIG. 9) along the longitudinal direction of the through hole 81a, and the second engagement surface 94 is moved rightward with respect to the first engagement surface 92 accompanying the movement of the force transmitter 81. At this time, while the first engagement surface 92 and the second engagement surface 94 are circular arc surfaces, the second engagement surface 94 is moved linearly. However, when the mounting member 4 is positioned near the released position, a length of contact of the first engagement surface 92 and the second engagement surface 94 is short. Moreover, a direction of movement of the second engagement surface 94 is a direction near a tangential direction of a contact portion in which the first engagement surfaces 92 and second engagement surface 94 contact each other, i.e. a direction forming a small angle with the tangent line of the contact portion. Therefore, the second engagement surface 94 can be smoothly moved with respect to the first engagement surface 92.

[0071] When the mounting member 4 reaches the released position, the circular arc surface 83d of the action portion 83b is brought to contact with the pressing portion 81b at the first apex P. At this time, the first engagement surface 92 is rotated with respect to the second engagement surface 94 about the first support shaft 73 in the counter-clockwise direction (generally upward in FIG. 9) and the second engagement surface 94 is moved with respect to the first engagement surface 92 rightward (generally downward in FIG. 9). This causes the first engagement surface 92 and the second engagement surface 94 to be spaced from each other in circumferential directions or tangential directions thereof or directions near from the tangential directions. In other words, a position of the mounting member 4 when the first engagement surface 92 and the second engagement surface 94

are spaced from each other is the released position. When the first engagement surface 92 and the second engagement surface 94 are spaced from each other, the force transmitter 81 is released from the prohibition of rotation by the clutch mechanism 90, and the force transmitter 81 becomes rotatable in the clockwise direction of FIG. 10. The force transmitter 81 is rotated about the second support shaft 74 in the clockwise direction of FIG. 10 by the torsion coil spring 82.

[0072] Here, a point of the circular arc surface constituting the pressing portion 81b most spaced from the axis of the second support shaft 74 (referred to as a second apex hereinafter) is expressed as Q. When the mounting member 4 is in the released position, the second apex Q is positioned more to the front than the first apex P (leftward in FIG. 10). Therefore, when the force transmitter 81 is rotated about the first support shaft 73 in the clockwise direction of FIG. 10, the pressing portion 81b is abutted against the circular arc surface 83d of the action portion 83b and the pressing portion 81b presses the receiver 83 rearward (rightward in FIG. 10). This rotates the mounting member 4 from the released position toward the closed position.

[0073] When the mounting member 4 is rotated from the released position toward the closed position, the force transmitter 81 pressed to be moved rightward by the action portion 83b is moved leftward by the torsion coil spring 82. When the mounting member 4 is rotated by a predetermined slight angle (5 degrees, for example) from the released position, the force transmitter 81 is moved leftward until a lower right end portion of the through hole 81a in FIG. 10 is abutted against the first support shaft 73. Accordingly, the force transmitter 81 is not moved in the longitudinal direction of the through hole 81 a thereafter, but is only rotated in the clockwise direction.

[0074] When the mounting member 4 reaches the closed position by the rotation of the force transmitter 81, the mounting member 4 is stopped by the abutment of the external link 71 against the mounting member 4. The force transmitter 81 is stopped accompanying the stopping of the mounting member 4. The mounting member 4 and the force transmitter 81 are maintained at their respective stopped position by the biasing force of the torsion coil spring 82.

[0075] When the mounting member 4 is rotated from the released position to the closed position, as shown in FIG. 11 to 13 and FIG. 6, a point at which the pressing portion 81b contacts the action portion 83b is moved from the circular arc surface 83d to the flat surface 83c. As a result, a rotational biasing force (rotational moment) of the torsion coil spring 82 acting on the mounting member 4 is increased.

[0076] Specifically, assuming that the rotational biasing force of the torsion coil spring 82 acting on the force transmitter 81 is constant regardless of the position of the mounting member 4, the rotational biasing force of the torsion coil spring 82 acting on the mounting member 4 is determined by a distance between the instantaneous

rotation center C and the point at which the pressing portion 81b contacts the action portion 83b and by an angle of pressing which is determined by a normal line at the point at which the pressing portion 81b contacts the action portion 83b (line of action of a force in a direction in which the pressing portion 81b presses the action portion 83d at the point of contact) and a line connecting the point of contact and the instantaneous rotation center C. As is clear from FIGS. 10 to 13, the distance between the instantaneous rotation center C and the point at which the pressing portion 81b contacts the action portion 83b is increased as the mounting member 4 is rotated from the released position toward the closed position. Similarly, the angle of pressing is gradually increased toward 90 degrees as the mounting member 4 is rotated from the released position toward the closed position. Accordingly, the rotational biasing force of the torsion coil spring 82 acting on the mounting member 4 is gradually increased as the mounting member 4 is rotated toward the closed position. Particularly in this embodiment, the biasing force is gradually increased until the mounting member 4 reaches the closed position. Alternatively, the rotational biasing force of the torsion coil spring 82 acting on the mounting member 4 may be gradually increased as the mounting member 4 is rotated from the released position up to a position slightly before the closed position and the rotational biasing force may be kept constant during the rest of the rotation of the mounting member 4.

[0077] When the mounting member 4 is rotated from the closed position toward the open position, the pressing portion 81b is pressed by the action portion 83b, and the force transmitter 81 is rotated in the counter-clockwise direction of FIGS. 6 to 13 against the biasing force of the torsion coil spring 82. When the mounting member 4 reaches a position the angle (5 degrees) mentioned above before the released position, afterwards, the force transmitter 81 is rotated accompanying the rotation of the mounting member 4 toward the open position and moreover, the force transmitter 81 is moved rightward along the longitudinal direction of the through hole 81a since the pressing portion 81b is pushed rightward by the circular arc surface 83d of the action portion 83b. The first engagement surface 92 and the second engagement surface 94 are moved closer to each other due to the rotation of the external link 71 accompanying the rotation of the mounting member 4 and the rotation and the movement of the force transmitter 81.

[0078] When the mounting member 4 rotated from the closed position reaches the released position, the circular arc surface 83d is brought to contact with the first apex P of the pressing portion 81b. Accordingly, when the mounting member 4 is rotated further from the released position toward the open position, the first link 71 is rotated accompanying the rotation of the mounting member 4 and moreover, the force transmitter 81 is moved leftward by the torsion coil spring 82. As a result, the first engagement surface 92 and the second engagement surface 94 are moved closer to each other and start to

contact each other at end portions thereof adjacent to each other. When the mounting member 4 is rotated from the released position toward the open position by about 5 degrees, the force transmitter 81 reaches the stopped position and the circular arc surface 83d of the action portion 83b contacts the pressing portion 81b at the second apex Q. Accordingly, the force transmitter 81 becomes rotatable about the second support shaft 74 in the clockwise direction of FIG. 9. However, since at this time the first engagement surface 92 and the second engagement surface 94 are in contact with each other, the force transmitter 81 is maintained in the stopped condition at the stopped position.

[0079] When the mounting member 4 is rotated further toward the open position, the action portion 83b is moved away from the pressing portion 81b. Accordingly, only the mounting member 4 is rotated thereafter and the force transmitter 81 is maintained at the stopped position. When the mounting member 4 is rotated up to the open position, the mounting member 4 is prohibited from being rotated further by the abutment of the internal link 72 against the external link 71, and the mounting member 4 is stopped at the open position.

[0080] As shown in FIG. 6, a rotary damper mechanism 100 is provided in the front end portion of the body 3. The rotary damper mechanism 100 is provided for prohibiting the mounting member 4 from being rotated rapidly toward the closed position and maintaining the rotation speed of the mounting member 4 at low. The rotary damper mechanism 100 maintains a rotation speed of the mounting member 4 toward the closed position at a low speed via the force transmitter 81.

[0081] The rotary damper mechanism 100 includes a casing 101 and a rotor 102. The casing 101 has a circular cylindrical configuration. The casing 101 is fixed to the body 3 with an axis thereof oriented in the vertical direction. The rotor 102 is disposed with an axis thereof coinciding with the axis of the casing 101. One end portion of the rotor 102 is rotatably disposed in the casing 101. A damper means (not shown) is disposed inside the casing 101. The damper means maintains rotation of the rotor 102 in one direction at a low speed and the damper allows the rotor 102 to be rotated at a high speed in the other direction. As shown in FIG. 4, the other end portion of the rotor 102 is protruded out of the casing 101. A first gear 103 is formed in the the other end portion that is protruded.

[0082] A second gear 104 is provided in the force transmitter 81. The second gear 104 is disposed such that an axis of the second gear 104 coincides with the axis of the first support shaft 73 when a right end portion of an inner surface of the through hole 81a is abutted against the second support shaft 74. The second gear 104 is engaged with the first gear 103. Accordingly, when the force transmitter 81 is rotated, the rotor 102 is rotated. In this case, when the force transmitter 81 is rotated from the stopped position in the clockwise direction of FIG. 6, i.e., when the mounting member 4 is rotated in the closing

direction, the rotor 102 is rotated in the one direction. As a result, the force transmitter 81 is prohibited from being rotated at a high speed in the clockwise direction, and consequently, the mounting member 4 is prohibited from being rotated at a high speed. Therefore, the mounting member 4 is rotated at a low speed in the closing direction. Reversely, when the force transmitter 81 is rotated in the counter-clockwise direction of FIG. 6, the rotor 102 is rotated in the other direction. Therefore, the force transmitter 81 is allowed to be rotated at a high speed and the mounting member 4 is allowed to be rotated at a high speed from the closed position toward the open position. The force transmitter 81 is movable along the longitudinal direction of the through hole 81 a by a distance corresponding to a length of the through hole 81 a. When the force transmitter 81 is moved leftward, a center of rotation of the force transmitter 81 (axis of the second support shaft 74) and the axis of the second gear 104 do not coincide with each other any more. However, the length of the through hole 81 a is short. Moreover, when the force transmitter 81 is moved leftward, a distance between a center of the first gear 103 and a center of the second gear 104 become slightly longer. Therefore, even when the force transmitter 81 is moved leftward, the first gear 103 and the second gear 104 are kept in proper engagement with each other.

[0083] In the hinge apparatus described above, the distal end portion (the other end portion; a portion) of the force transmitter 81 of the rotational biasing mechanism 80 is protruded out of the guide hole 3g formed in the top plate 3b of the body 3, and the pressing portion 81b is formed in the protruded distal end portion. The pressing portion 81b presses the action portion 83b of the receiver 83 disposed in the end portion of the mounting member 4, the end portion being spaced from the instantaneous rotation center C. A point at which the pressing portion 81b presses the action portion 83b is farther from the instantaneous rotation center C than the shafts 75a, 75b that respectively serve as the third and fourth support shafts. As a result, the biasing force of the torsion coil spring 82 is transmitted to the mounting member 4 as a great rotation moment. In other words, the biasing force of the torsion coil spring 82 can be reduced by an amount corresponding to an increase in the rotation moment. Therefore, force acting on the first and second support shafts 73, 74 and the shafts 75a, 75b, particularly the force acting on the shafts 75a, 75b can be reduced. Therefore, wearing of the shafts 73, 74, 75a, 75b, the mounting member 4 and the first and second support shafts 73, 74 can be reduced, and thus, a service life of the hinge apparatus 1 can be extended.

[0084] Other embodiments of the present invention will be described hereinafter. In the embodiments described below, only features different from the first embodiment will be described. The same components are denoted by the same reference signs and description thereof are omitted.

[0085] FIGS. 20 to 29 illustrate a second embodiment

of the present invention. In a hinge apparatus 1A of the second embodiment, a clutch mechanism (rotation prohibition mechanism) 110 is used instead of the clutch mechanism 90. The clutch mechanism 110 has the following features.

[0086] As shown in FIGS. 20 and 21, catch projections (first engagement portions) 111, 111 are respectively formed in front end portions of two inner surfaces of the guide hole 3g along the longitudinal direction thereof. The catch projections 111, 111 project in the vertical direction toward each other to be close to each other. By formation of the catch projections 111, 111 in the guide hole 3g, an inside of the guide hole 3g is divided into a front portion 3h located more to the front than the catch projections 111, 111 and a rear portion 3i located more to the rear than the catch projections 111, 111.

[0087] In the hinge apparatus 1A, a force transmitter 81A is used instead of the force transmitter 81. As shown in FIGS. 22 to 24, a pair of upper and lower abutment portions (second engagement portions) 112, 112 are formed in a distal end portion of the force transmitter 81A. The pair of abutment portions 112, 112 are disposed nearer to the basal end (lower side in FIG. 22) than the pressing portion 81b is. Moreover, the pair of abutment portions 112, 112 are disposed so as to sandwich the pressing portion 81b from above and below. A surface of the abutment portion 112 facing leftward (upward in FIG. 22) is composed of a circular arc surface that is leftwardly convex. The abutment portion 112 may be composed of another convex curved surface.

[0088] As shown in FIGS. 25 to 27, the abutment portions 112, 112 are inserted in the front portion 3h of the guide hole 3g when the mounting member 4 is positioned between the open position and the released position. The circular arc surface of the abutment portion 112 is pressed against the catch projection 111 by the biasing force of the torsion coil spring 82, thereby causing the force transmitter 81A to be stopped. A position of the force transmitter 81A at this time is a stopped position.

[0089] In the hinge apparatus 1A having the features described above, when the mounting member 4 is rotated from the open position up to a position a predetermined angle (5 degrees, for example) before the released position, the circular arc surface 83d of the action portion 83b is abutted against the pressing portion 81b as shown in FIG. 26. Then, while the mounting member 4 is rotated toward the released position, the action portion 83b presses the pressing portion 81b rightward (downward in FIG. 26), and moves the force transmitter 81A in the same direction. It is to be understood that the abutment portion 112 is also moved rightward accompanying the movement of the force transmitter 81A. When the mounting member 4 reaches the released position, as shown in FIG. 27, the abutment portion 112 is moved more to the right than the catch projection 111. As a result, the abutment portion 112 caught by the catch projection 111 is released from the caught state, thereby allowing the force transmitter 81A to be rotated from the released po-

sition to the closed position. The force transmitter 81A is rotated to the closed position by the torsion coil spring 82. Then the action portion 83b is pressed rearward by the pressing portion 81b, and the mounting member 4 is rotated to the closed position.

[0090] In a case where the mounting member 4 is rotated from the closed position toward the open position, while the mounting member 4 is rotated to the released position after the mounting member 4 reached the position the predetermined angle (5 degrees, for example) before the released position, the action portion 83b presses the pressing portion 81b rightward. This causes the force transmitter 81A to be moved rightward. As a result, the abutment portion 112 can pass the right side of the catch projection 111. When the mounting member 4 is rotated further from the released position by the predetermined angle (5 degrees), the mounting member 4 is moved leftward by the torsion coil spring 82, and the abutment portion 112 enters the front portion 3h of the guide hole 3g. This prohibits rotation of the force transmitter 81A in the clockwise direction. After that, the action portion 83b is moved away from the pressing portion 81b accompanying the rotation of the mounting member 4 toward the open position.

[0091] FIGS. 30 to 43 show a third embodiment of the present invention. In a hinge apparatus 1B of this embodiment, a clutch mechanism (rotation prohibition mechanism) 120 is used instead of the clutch mechanism 90. The hinge apparatus further includes a switching mechanism 130 that switches from a catching condition to a releasing condition of the clutch mechanism 120. The hinge apparatus 1B further includes an auxiliary rotational biasing mechanism 140 that urges the mounting member 4 toward the closed position.

[0092] The clutch mechanism 120 will be described first. As shown in FIG. 31, an elongated hole (notch) 121 extending in the vertical direction is formed in the front end portion of the body 3. The elongated hole 121 is disposed more to the front than the guide hole 3g. A length of the elongated hole 121 in the vertical direction is longer than a width of the guide hole 3g in the vertical direction. A front end portion of the guide hole 3g intersects with the elongated hole 121 at a rear side surface of the elongated hole 121. More specifically, the guide hole 3g intersects with the elongated hole 121 in a central portion of the elongated hole 121 in a longitudinal direction of the elongated hole 121. As a result, the elongated hole 121 and the guide hole 3g communicate with each other. Opposite end portions of the rear side surface of the elongated hole 121 in the vertical direction are left. A first engagement surfaces (first engagement portion) 122, 122 are respectively formed in the remaining opposite end portions of the rear side surface of the elongated hole 121.

[0093] FIGS. 33 to 37 show a force transmitter 81B used in the third embodiment of the present invention. An engagement portion 123 extending in the vertical direction is formed in a distal end portion (upper end portion

in FIGS. 33 to 37) of the force transmitter 81B. The pressing portion 81b is formed in a left portion (distal end side of the force transmitter 81B) of an outer surface of the engagement portion 123. A second engagement surface (second engagement portion) 124 is formed in a rear portion of the outer surface of the engagement portion 123. The second engagement surface 124 is formed continuously from the pressing portion 81b at a location nearer to a basal end of the force transmitter 81B.

[0094] A length of the engagement portion 123 in the vertical direction is sized to be generally the same as the length of the elongated hole 121 in the vertical direction. A width of the engagement portion 123 in the front-rear direction is sized to be generally the same as a width of the elongated hole 121 in the front-rear direction. When the mounting member 4 is positioned between the open position and the released position, the engagement portion 123 is inserted in the elongated hole 121 such that the engagement portion 123 is immovable in the front-rear direction but is movable in the longitudinal direction of the through hole 81 a. It is to be understood that at this time, the second engagement surface 124 is abutted against the first engagement surface 122 as shown in FIGS. 38 to 40, thereby prohibiting the force transmitter 81B from being rotated about the second support shaft 74 in the clockwise direction. The position of the force transmitter 81B at this time is a stopped position.

[0095] When the force transmitter 81B is moved leftward (upward in FIGS. 38 to 43) along the longitudinal direction of the through hole 81 a by a predetermined distance, the second engagement surface 124 is moved leftward away from the first engagement surface 122. At the same time, the engagement portion 123 escapes from the elongated hole 121 to the left. As a result, the force transmitter 81B becomes rotatable from the stopped position in the clockwise direction, and the force transmitter 81B is rotated in the clockwise direction by the torsion coil spring 82. When the force transmitter 81B is rotated in the clockwise direction, a narrow portion 81e formed in the force transmitter 81B in a portion continuing from the engagement portion 123 in a direction to the basal end of the force transmitter 81B enters the guide hole 3g such that the narrow portion 81e is movable in the front-rear direction.

[0096] In a condition where the force transmitter 81B is spaced from the stopped position in the clockwise direction, when the force transmitter 81B is rotated toward the stopped position, the narrow portion 81e escapes from the guide hole 3g to the front and the narrow portion 81e is abutted against a front inner surface of the elongated hole 121. After that, when the force transmitter 81B is moved rightward, the second engagement surface 124 becomes opposed to the first engagement surface 122 and the second engagement surface 124 is pressed against the first engagement surface 122 by the biasing force of the torsion coil spring 82. This causes the force transmitter 81B to be positioned in the stopped position.

[0097] The switching mechanism 130 will be described

next. As shown in FIG. 32, a pair of engagement projections 131, 131 are formed in the inner surfaces of the side plates 71a, 71a of the external link 71 opposed to each other. The engagement projections 131, 131 project in the vertical direction toward each other to be close to each other. The engagement projection 131 is disposed in the end portion of the side plate 71a near the first support shaft 73. The engagement projection 131 is spaced from the first support shaft 73 in a radial direction of the first support shaft 73 by a predetermined distance.

[0098] As shown in FIGS. 33 to 37, a pair of abutment projections 132 projecting in the vertical direction are formed in a generally central portion of the force transmitter 81B between the basal end and a distal end of the force transmitter 81B. A first inclined surface 133 and a second inclined surface 134 are formed in an upper surface of the abutment projection 132 facing toward the distal end of the force transmitter 81B. The first inclined surface 133 is inclined such that a rear end of the first inclined surface 133 is closer to the distal end of the force transmitter 81B than a front end of the first inclined surface 133. The second inclined surface 134 is inclined such that a rear end of the second inclined surface 134 is closer to the basal end of the force transmitter 81B than a front end of the second inclined surface 134. A rear end portion of the first inclined surface 133 and a front end portion of the second inclined surface 134 intersect each other. An angle formed between the first inclined surface 133 and the second inclined surface 134 is generally a right angle. The first inclined surface 133 and the second inclined surface 134 are smoothly continued via a convex curved surface such as a circular arc surface formed at an intersection of the first inclined surface 133 and the second inclined surface 134.

[0099] As shown in FIG. 38, when the mounting member 4 is positioned between the open position and an intermediate position spaced from the open position toward the closed position by a predetermined angle, the first inclined surface 133 is pressed against the engagement projection 131 of the external link 71 by the torsion coil spring 82. This prohibits the force transmitter 81B from moving leftward along the longitudinal direction of the through hole 81a. A position of the force transmitter 81B at this time in a direction along the through hole 81a is referred to as a caught position hereinafter. When the force transmitter 81B is in the caught position, the second support shaft 74 is positioned at a front left end portion side of the through hole 81a. Therefore, the force transmitter 81B can be moved rightward from the caught position along the longitudinal direction of the through hole 81a.

[0100] When the mounting member 4 is rotated from the open position toward the closed position, the external link 71 is rotated about the first support shaft 73 in the counter-clockwise direction accompanying the rotation of the mounting member 4. As a result, a point at which the engagement projection 131 and the first inclined surface 133 contact each other is moved toward a rear end

of the first inclined surface 133. At this time, since the first inclined surface 133 is inclined such that the rear end of the first inclined surface 133 is closer to the distal end of the force transmitter 81B than the front end of the first inclined surface 133, the force transmitter 81B is moved rightward against the biasing force of the torsion coil spring 82 along the longitudinal direction of the through hole 81a. When the mounting member 4 reaches the predetermined intermediate position, as shown in FIG. 39, the engagement projection 131 is brought to contact with the intersection of the first inclined surface 133 and the second inclined surface 134. At this time, the force transmitter 81B is moved to a right most position. The position of the force transmitter 81B along the through hole 81a at this time is referred to as a right limit position.

[0101] When the mounting member 4 is rotated further from the intermediate position toward the closed position and the external link 71 is further rotated about the first support shaft 73 in the counter-clockwise direction accompanying the rotation of the mounting member 4, the engagement projection 131 is brought to contact with the second inclined surface 134 as shown in FIG. 40. When the mounting member 4 is rotated further toward the closed position, a point at which the engagement projection 131 and the second inclined surface 134 contact each other is moved toward the rear of the second inclined surface 134 accompanying the rotation of the mounting member 4. At this time, since the second inclined surface 134 is inclined such that a rear end of the second inclined surface 134 is closer to the basal end of the force transmitter 81B than a front end of the second inclined surface 134, the force transmitter 81B is moved leftward by the biasing force of the torsion coil spring 82 along the longitudinal direction of the through hole 81a accompanying the rotation of the mounting member 4 in the closing direction.

[0102] As shown in FIG. 41, when the mounting member 4 is rotated from the open position toward the closed position and reaches the released position, the engagement projection 131 is moved rearward away from the second inclined surface 134. At the same time, the second engagement surface 124 is moved leftward away from the first engagement surface 122. As a result, the force transmitter 81B caught by the clutch mechanism 120 is released from the clutch mechanism 120, and the force transmitter 81B becomes rotatable from the stopped position in the clockwise direction. A position of the force transmitter 81B in the longitudinal direction of the through hole 81a at this time is referred to as a spaced position hereinafter. When the force transmitter 81B is positioned in the spaced position, a slight gap is formed between a right end portion of the through hole 81a and the second support shaft 74. Therefore, the force transmitter 81B can be moved slightly further toward the left from the spaced position accompanying the rotation of the mounting member 4. When the mounting member 4 is rotated from the released position in the closing direc-

tion by a predetermined angle (5 degrees, for example), the right end portion of the through hole 81a is abutted against the second support shaft 74. As a result, the force transmitter 81B is prohibited from being moved further leftward. A position of the force transmitter 81B at this time is referred to as a left limit position hereinafter.

[0103] As shown in FIG. 40, when the engagement projection 131 is in contact with the second inclined surface 134, the action portion 83b of the rotational biasing mechanism 80 is generally in contact with the pressing portion 81b. At this time, since the force transmitter 81B is moved in a generally the same direction as a tangential direction at a point at which the action portion 83b and the pressing portion 81b contact each other, the mounting member 4 is hardly rotationally biased in the closing direction by the torsion coil spring 82. However, when the mounting member 4 reaches the released position, since the force transmitter 81B is rotated about the second support shaft 74 in the clockwise direction, the action portion 83b is pressed rearward by the pressing portion 81b. This causes the mounting member 4 to be rotated toward the closed position. The point at which the pressing portion 81b and the action portion 83b contact each other is moved toward a deep side of the recess 83 a accompanying the rotation of the mounting member 4 until the mounting member 4 rotated from the released position reaches a free position which is a position a predetermined slight angle before the closed position. When the mounting member 4 is rotated beyond free position, the pressing portion 81b is moved away from the action portion 83b. Accordingly, when the mounting member 4 is positioned between the free position and the closed position, the rotational biasing force of the rotational biasing mechanism 80 in the closing direction does not act on the mounting member 4, and the mounting member 4 can be freely rotated. It is to be understood that as with the embodiments mentioned above, the rotational biasing mechanism 80 may bias the mounting member 4 in the closing direction regardless of the position of the mounting member 4 between the released position and the closed position.

[0104] When the mounting member 4 is rotated from the closed position in the opening direction and reaches the open position, the clutch mechanism 120 and the switching mechanism 130 return to their respective original states in the following manner. That is, assuming that the mounting member 4 is positioned in the closed position, the force transmitter 81B is positioned in the left limit position and the engagement projection 131 is spaced from the second inclined surface 134 at this time.

[0105] When the mounting member 4 is rotated from the closed position in the opening direction toward the open position and the mounting member 4 reaches a position that is a predetermined angle (5 degrees) before the released position, the action portion 83b is abutted against the pressing portion 81b. After that, the force transmitter 81B is pressed to be moved rightward accompanying the rotation of the mounting member 4 toward

the open position. When the mounting member 4 is rotated up to the released position, the force transmitter 81B is moved up to the spaced position. At this time, the engagement projection 131 is in contact with a right end edge of the second inclined surface 134. When the mounting member 4 is rotated beyond the released position further toward the open position, the engagement projection 131 is brought to contact with the second inclined surface 134 (see FIG. 40). Accordingly, when the mounting member 4 is rotated beyond the released position further toward the open position, the force transmitter 81B is moved rightward against the biasing force of the torsion coil spring 82. After that, the point at which the engagement projection 131 and the second inclined surface 134 contact each other is moved forward accompanying the rotation of the mounting member 4 toward the open position. After the engagement projection 131 is moved over the intersection of the first inclined surface 133 and the second inclined surface 134, the engagement projection 131 is brought to contact with the first inclined surface 133 (FIG. 38).

[0106] The auxiliary rotational biasing mechanism 140 will be described now. The auxiliary rotational biasing mechanism 140 rotationally biases the mounting member 4 toward the closed position when the mounting member 4 is positioned between the intermediate position and the released position. The auxiliary rotational biasing mechanism 140 is composed of the torsion coil spring 82, the engagement projection 131 and the second inclined surface 134.

[0107] Specifically, as mentioned above, when the mounting member 4 is positioned between the intermediate position and the released position, the second inclined surface 134 is pressed against the engagement projection 131 by the biasing force of the torsion coil spring 82, and the second inclined surface 134 presses the engagement projection 131. More specifically, the second inclined surface 134 presses the engagement projection 131 in a direction generally perpendicular to a line connecting the point at which the engagement projection 131 and the second inclined surface 134 contact each other and the axis of the first support shaft 73. The pressing force causes the external link 71 to be rotated about the first support shaft 73 in the counter-clockwise direction. This causes the mounting member 4 to be rotated toward the closed position.

[0108] When the mounting member 4 is positioned between the open position and the intermediate position, the first inclined surface 133 presses the engagement projection 131. However, at this time, a line of action of the pressing force of the first inclined surface 133 against the engagement projection 131 is generally parallel to and very close to or coincides with a line connecting the point at which the engagement projection 131 and the first inclined surface 133 contact each other and the axis of the first support shaft 73. Therefore, the biasing force of the torsion coil spring 82 acting on the engagement projection 131 via the first inclined surface 133 hardly

affects the external link 71 as a force rotating the external link 71. The biasing force of the torsion coil spring 82 acting on the engagement projection 131 via the first inclined surface 133 may be increased by changing an inclination angle of the first inclined surface 133 so that the mounting member 4 may be rotationally biased toward the closed position even when the mounting member 4 is positioned between the closed position and the intermediate position.

[0109] It is to be understood that the present invention is not limited to the embodiments described above, and various modifications may be adopted without departing from the spirit or scope of the invention.

For example, while in the embodiment described above, the rotational biasing mechanism 80 biases the mounting member 4 toward the closed position when the mounting member 4 is rotated from the released position toward the closed position, another rotational biasing mechanism may be used instead of the rotational biasing mechanism 80. The another rotational biasing mechanism biases the mounting member 4 toward the open position when the mounting member 4 is rotated from the predetermined released position toward the open position.

The clutch mechanisms (rotation prohibition mechanisms) 90, 110, 120 may be adopted in a rotational biasing mechanism having different features from the rotational biasing mechanism 80.

Industrial Applicability

[0110] The hinge apparatus according to the present invention may be used as a hinge apparatus for connecting a door to a housing.

Reference Signs List

[0111]

C	instantaneous rotation center	
1	hinge apparatus	
1A	hinge apparatus	
1B	hinge apparatus	
3	body	
3a	side plate	
3b	top plate	
3g	guide hole (notch)	
4	mounting member	
71	external link (first link)	
72	internal link (second link)	
73	first support shaft	
74	second support shaft	
75 a	shaft (third support shaft)	
75b	shaft (fourth support shaft)	
80	rotational biasing mechanism (rotational biasing means)	
81	force transmitter	
81A	force transmitter	
81B	force transmitter	

81b	pressing portion (the other end portion of the force transmitter; a part of the transmitter)
82	torsion coil spring (biasing means)
83b	action portion
5 90	clutch mechanism (rotation prohibition mechanism)
92	first engagement surface (first engagement portion)
94	second engagement surface (second engagement portion)
10 110	clutch mechanism (rotation prohibition mechanism)
111	catch projection (first engagement portion)
112	abutment portion (second engagement portion)
15 120	clutch mechanism (rotation prohibition mechanism)
122	first engagement surface (first engagement portion)
124	second engagement surface (second engagement portion)
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Claims

1.

A hinge apparatus (1; 1A; 1B) comprising:

a body (3);

a mounting member (4) connected to the body (3) via first and second links (71, 72) such that the mounting member (4) can be rotated between a closed position and an open position; and

a rotational biasing means (80) disposed in the body (3), the rotational biasing means (80) biasing the mounting member (4) such that the mounting member (4) is rotated with respect to the body (3),

one end portions of the first and second links (71, 72) rotatably connected to the body (3) respectively via first and second support shafts (73, 74) parallel to each other,

the other end portions of the first and second links (71, 72) rotatably connected to the mounting member (4) respectively via third and fourth support shafts (75a, 75b) parallel to the first and second support shafts (73, 74),

characterized in that the rotational biasing means (80) is disposed inside the body (3) with a portion (81b) of the rotational biasing means (80) projected out of the body (3) and that the portion (81b) of the rotational biasing means (80) projected out of the body (3) is pressed to contact the mounting member (4), thereby rotationally biasing the mounting member (4).

2.

The hinge apparatus according to claim 1, wherein

the portion (81b) of the rotational biasing means (80) pressed to contact the mounting member (4) is projected out of the body (3) in a direction perpendicular to axes of the first, second, third and fourth support shafts (73, 74, 75a, 75b) and in a direction away from an instantaneous rotation center (C) of the mounting member (4).

3.

The hinge apparatus according to claim 1 or 2, wherein the body (3) is formed to have a U-shaped cross-sectional configuration by a pair of side plates (3a, 3a) arranged to be opposed to each other and a top plate (3b) connecting one side portions of the pair of side plates (3a, 3a), the first and second support shafts (73, 74) are disposed with the axes thereof oriented in a direction in which the side plates (3a, 3a) are opposed to each other, opposite end portions of the first support shaft (73) and opposite end portions of the second support shaft (74) are supported by the side plates (3a, 3a), notches (3g; 3g, 121) are formed in the top plate (3b) and the portion (81b) of the rotational biasing means (80) is projected out of the body (3) through the notches (3g; 3g, 121).

4.

The hinge apparatus according to any one of claims 1 to 3, wherein the rotational biasing means (80) comprises a force transmitter (81; 81A, 81B) displaceably disposed in the body (3) and a biasing means (82) that causes the force transmitter (81; 81A, 81B) to be displaced, and a portion (81b) of the force transmitter (81; 81A, 81B) is projected out of the body (3).

5.

A hinge apparatus (1; 1A; 1B) comprising:

- a body (3);
- a mounting member (4) connected to the body (3) via first and second links (71, 72) such that the mounting member (4) can be rotated between a closed position and an open position; and
- a rotational biasing means (80) disposed in the body (3), the rotational biasing means (80) biasing the mounting member (4) such that the mounting member (4) is rotated with respect to the body (3),
- one end portions of the first and second links (71, 72) rotatably connected to the body (3) respectively via first and second support shafts (73, 74) parallel to each other,
- the other end portions of the first and second links (71, 72) rotatably connected to the mounting member (4) respectively via third and fourth support shafts (75a, 75b) parallel to the first and

second support shafts (73, 74),

characterized in that an action portion (83b) is provided in the mounting member (4), rotational biasing force of the rotational biasing means (80) acting on the action portion (83b), and the action portion (83b) is disposed such that a distance between an instantaneous rotation center (C) of the mounting member (4) and the action portion (83b) is longer than a distance between the instantaneous rotation center (C) of the mounting member (4) and the third support shaft (75a) and a distance between the instantaneous rotation center (C) of the mounting member (4) and the fourth support shaft (75b).

6.

The hinge apparatus according to claim 5, wherein a direction of action of biasing force of the rotational biasing means (80) acting on the action portion (83b) gradually changes accompanying the rotation of the mounting member (4).

7.

The hinge apparatus according to claim 5 or 6, wherein the rotational biasing means (80) comprises a force transmitter (81; 81A, 81B) disposed in the body (3) and a biasing means (82) rotationally biasing the force transmitter (81; 81A, 81B), one end portion of the force transmitter (81; 81A, 81B) disposed inside the body (3) is rotatably connected to the body (3), the other end portion (81b) of the force transmitter (81; 81A, 81B) is projected out of the body (3), and the other end portion (81b) projected out of the body (3) is pressed to contact the action portion (83b) of the mounting member (4), thereby causing the mounting member (4) to be rotated by the biasing means (82) via the force transmitter (81; 81A, 81B).

8.

The hinge apparatus according to claim 7, wherein a rotation prohibition mechanism (90; 110; 120) are provided between the first link (71) and the force transmitter (81; 81A, 81B) and when the mounting member (4) is rotated from one of the open position and the closed position toward the other of the open position and the closed position, until the mounting member (4) reaches a released position a predetermined angle before the other of the open position and the closed position, the rotation prohibition mechanism (90; 110; 120) prohibits the force transmitter (81; 81A, 81B) from being rotated by the biasing means (82), thereby causing the force transmitter (81; 81A, 81B) to be held at a predetermined stopped position, and when the mounting member (4) is rotated beyond the released position, the rotation prohibition mechanism (90; 110; 120) allows the force transmitter (81; 81A, 81B) to be rotated by the biasing means (82) toward the other of the open position and

the closed position.

9.

The hinge apparatus according to claim 8, wherein the rotation prohibition mechanism (90) comprises a first engagement portion (92) disposed in the first link (71) and a second engagement portion (94) disposed in the force transmitter (81), one (92) of the first and second engagement portions (92, 94) comprises a concavely curved first circular-arc surface, a center of curvature of the first circular-arc surface being an axis of the first support shaft (73), the other (94) of the first and second engagement portions (92, 94) comprises a convexly curved second circular-arc surface, a center of curvature of the second circular-arc surface being the axis of the first support shaft (73), until the mounting member (4) reaches the released position, the first circular-arc surface and the second circular-arc surface contact each other such that each of the first circular-arc surface and the second circular-arc surface can be rotated about the axis of the first support shaft (73), thereby prohibiting the force transmitter (81) from being rotated, and when the mounting member (4) is rotated beyond the released position, the first circular-arc surface and the second circular-arc surface are spaced from each other, thereby allowing the force transmitter (81) to be rotated.

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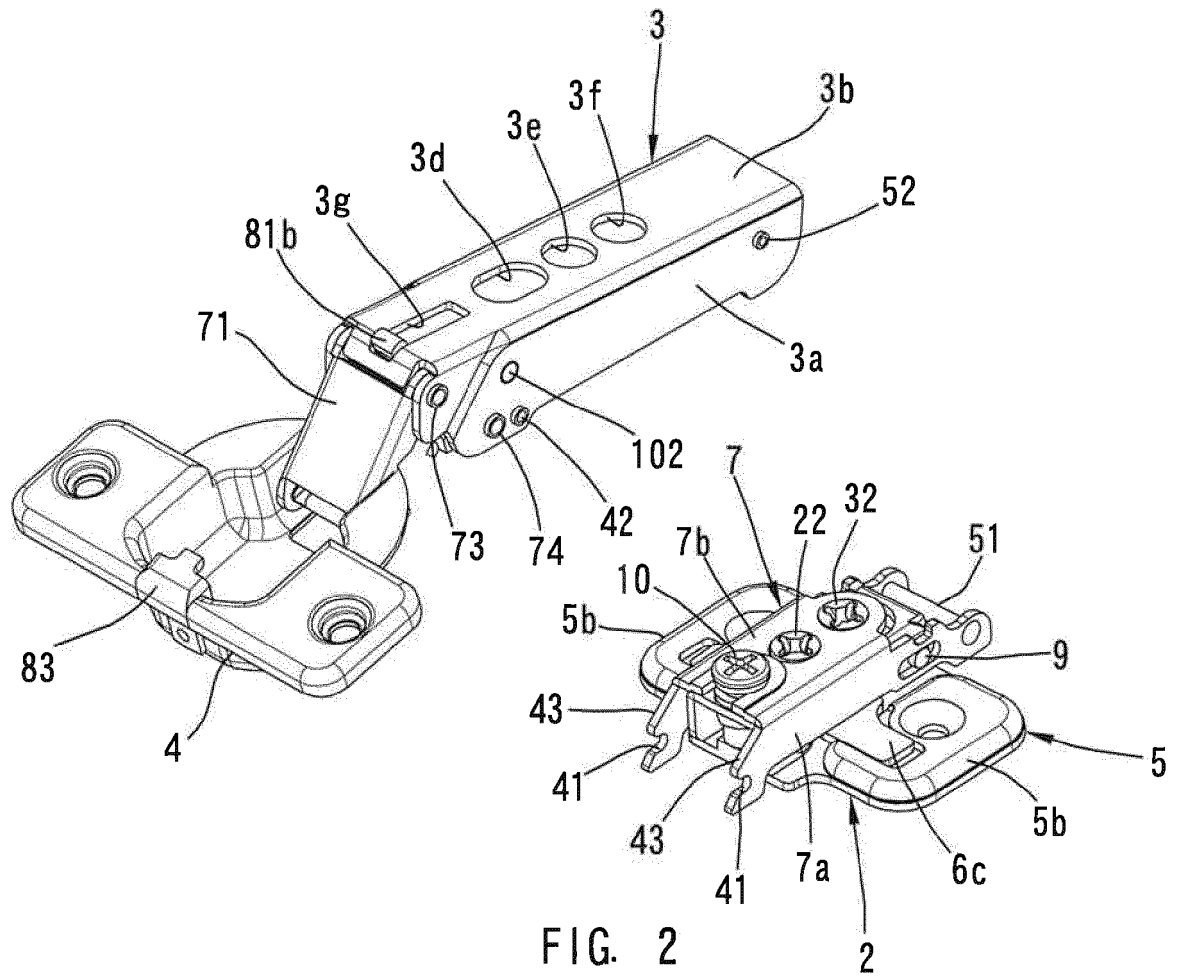
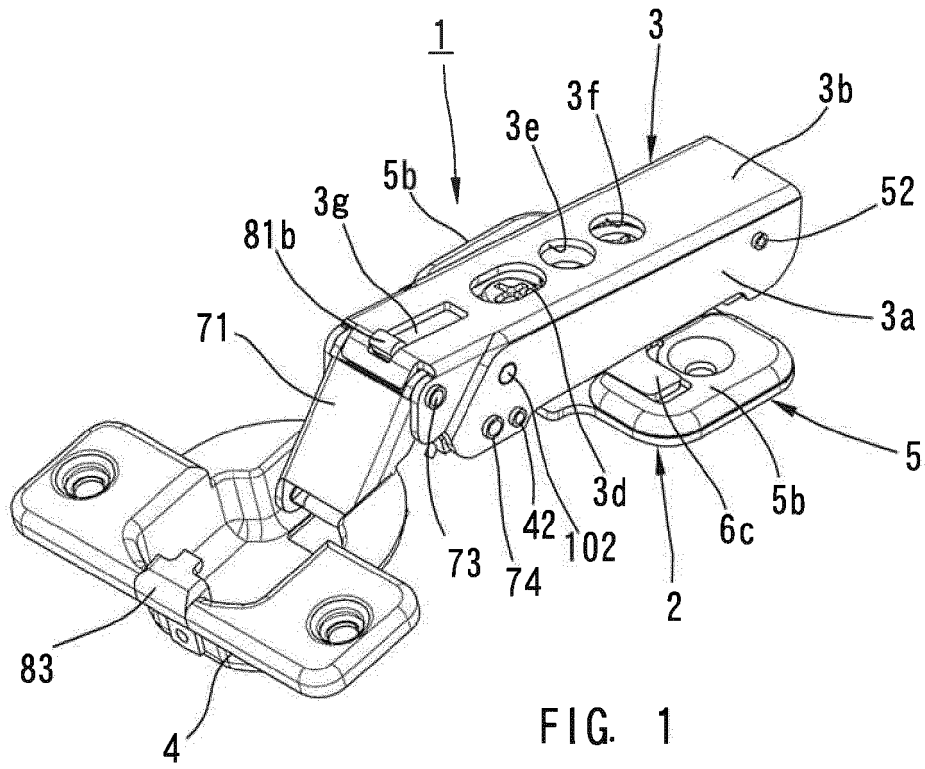
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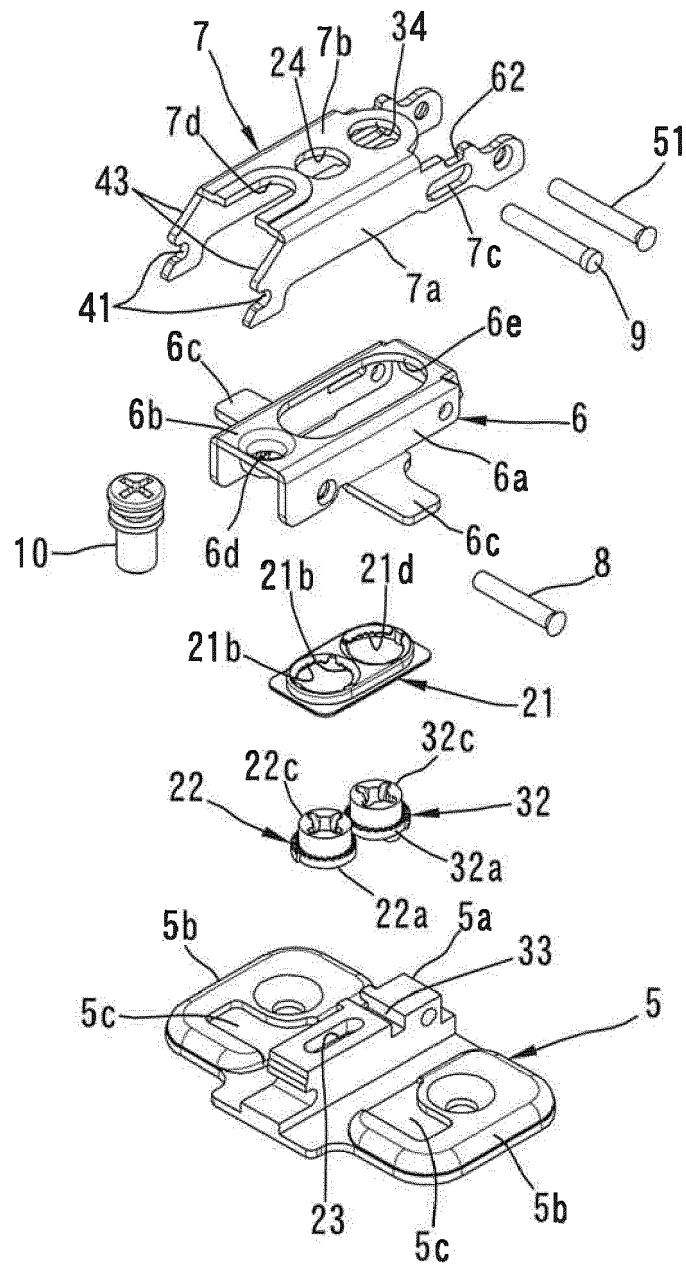


FIG. 3

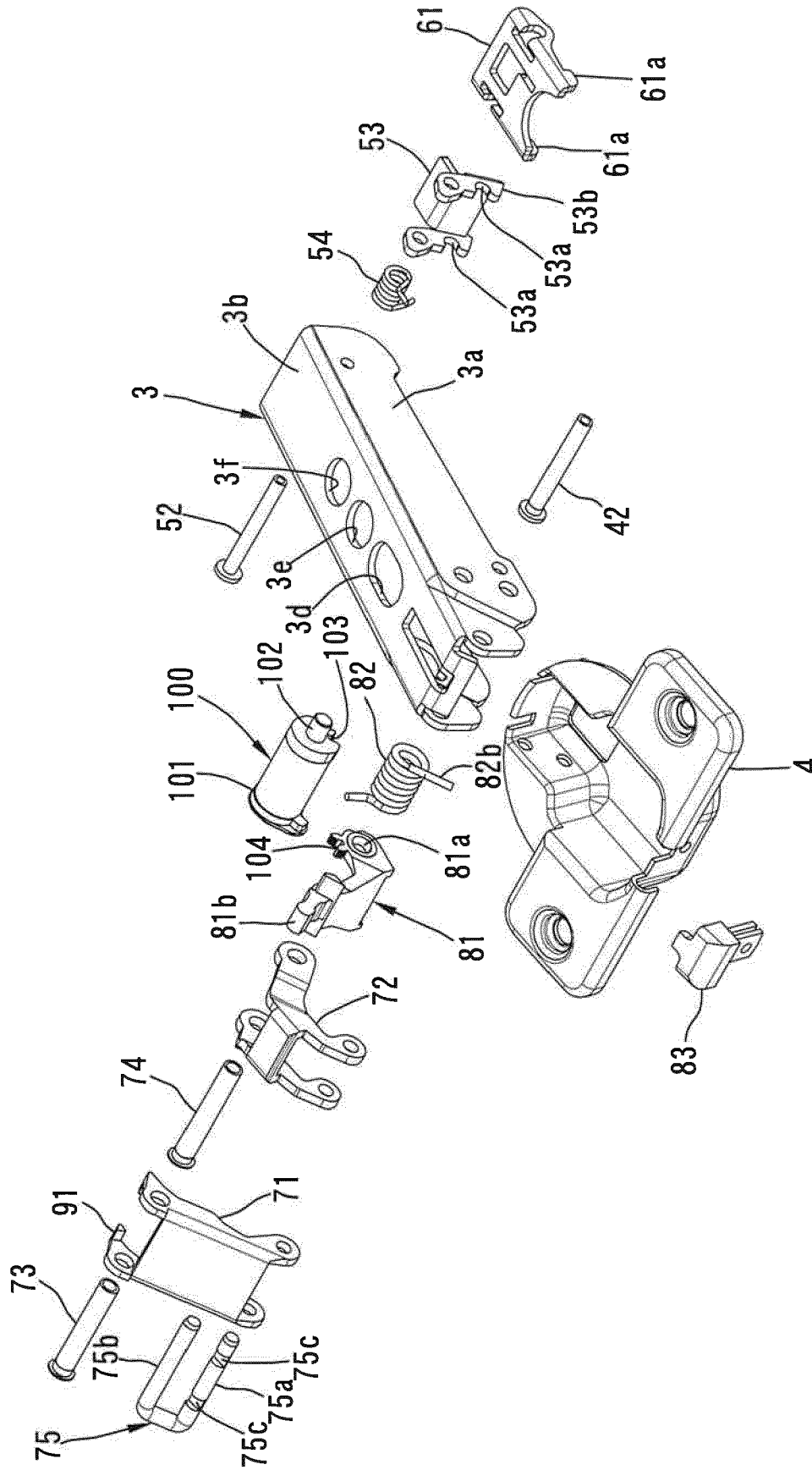


FIG. 4

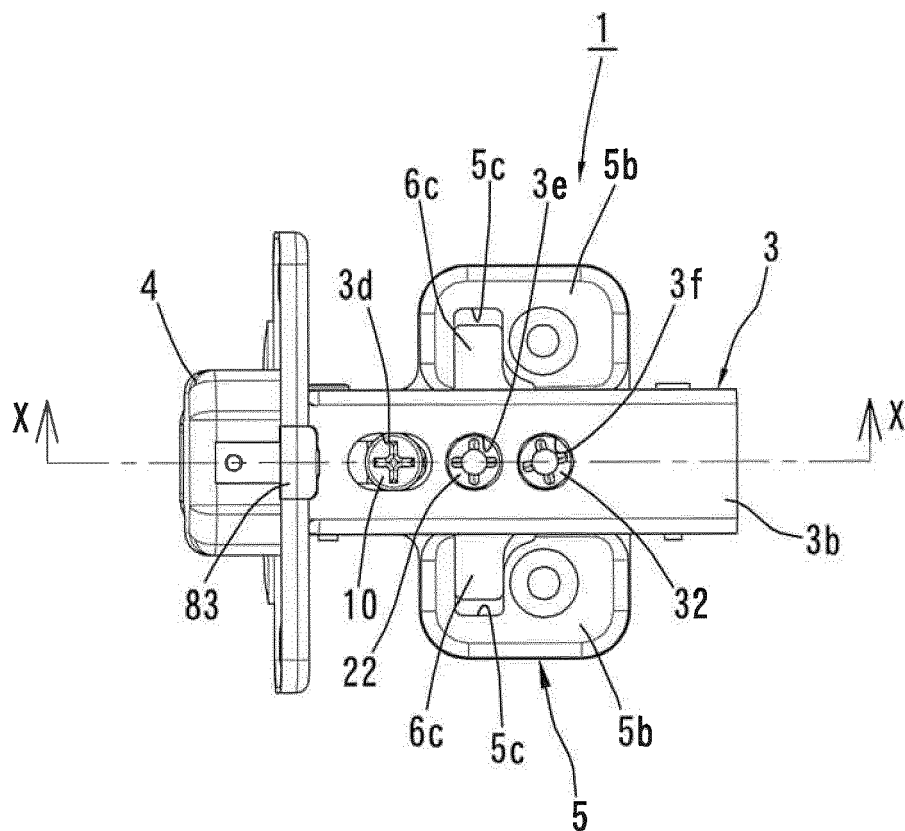


FIG. 5

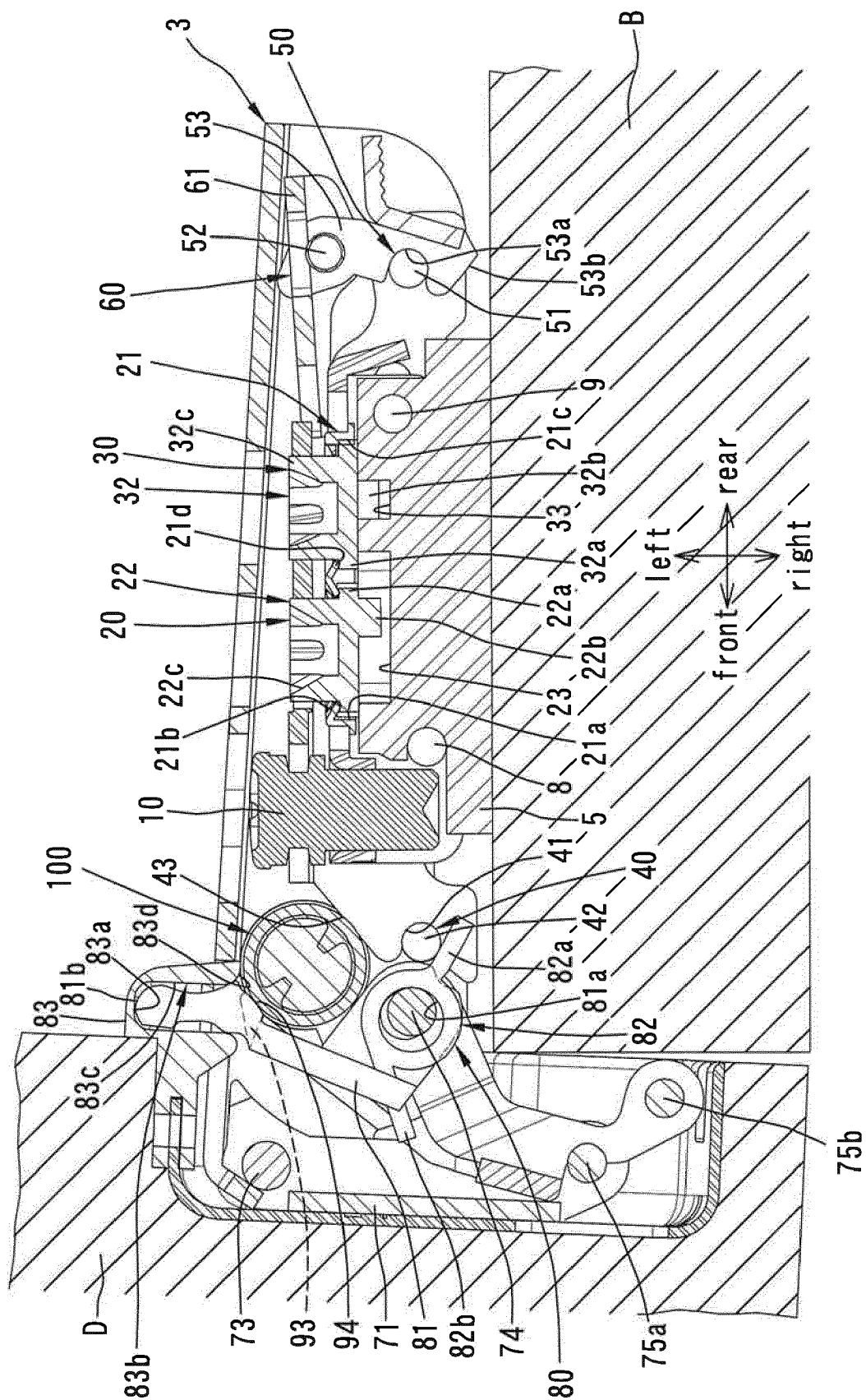


FIG. 6

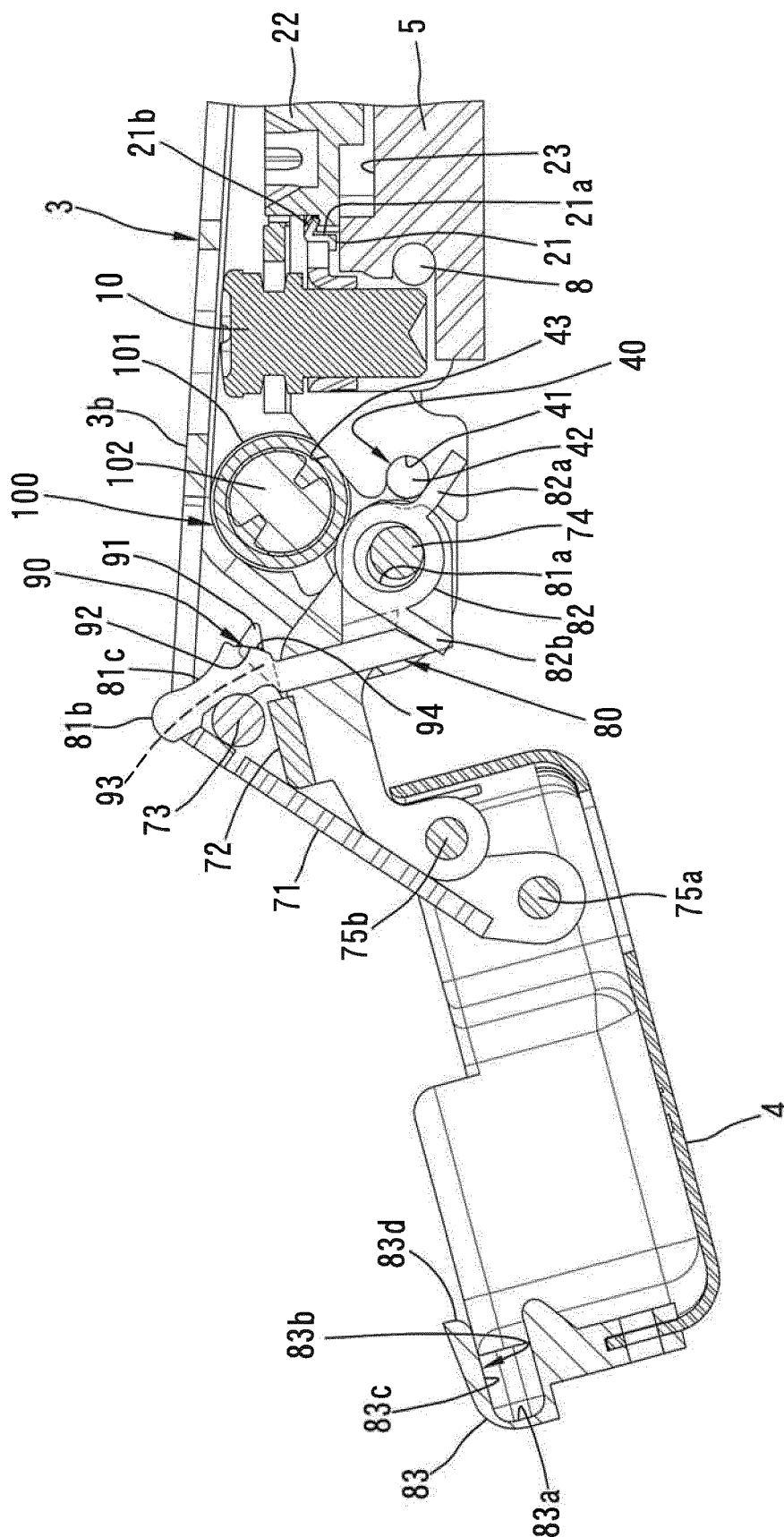
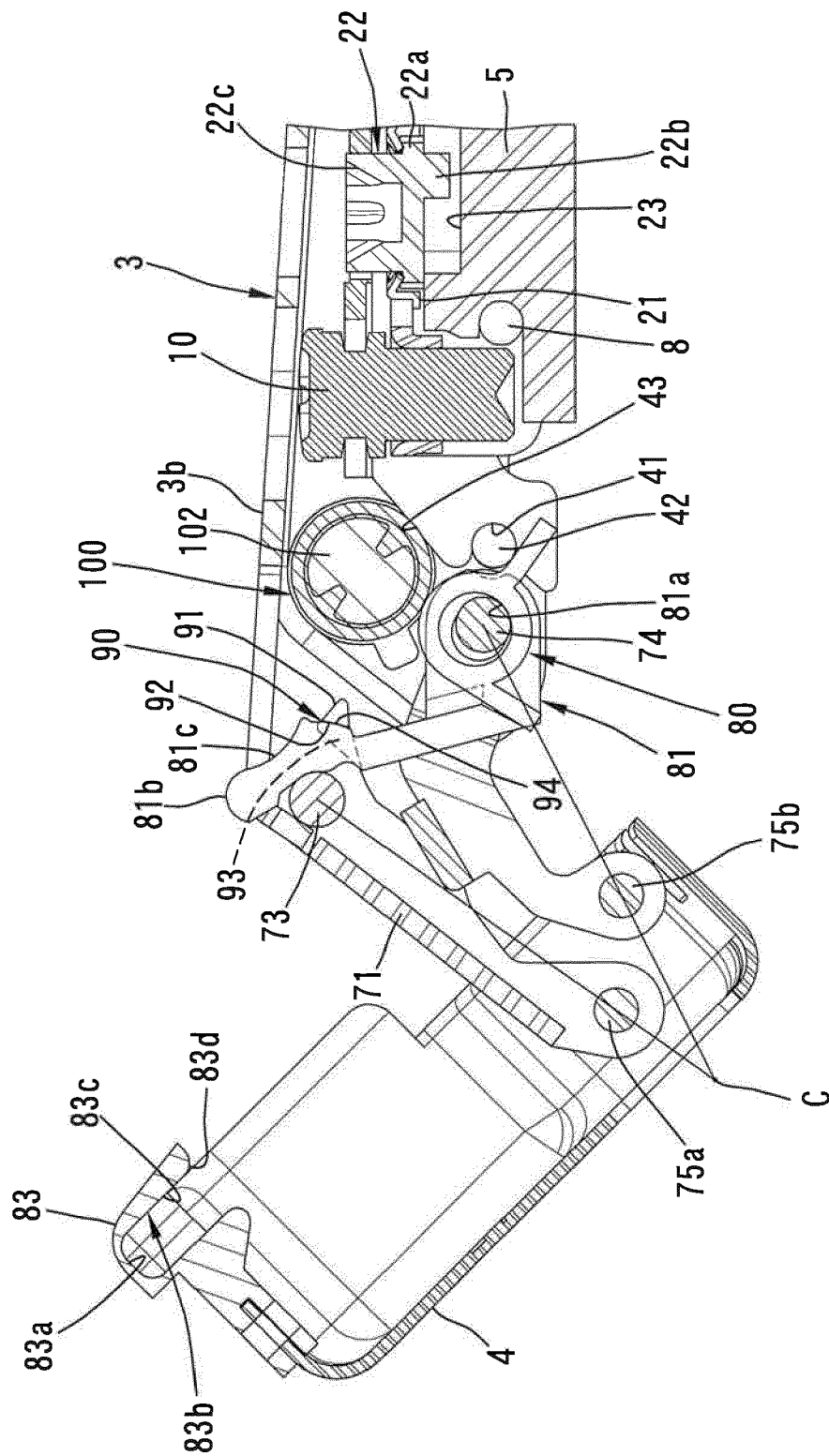


FIG. 7



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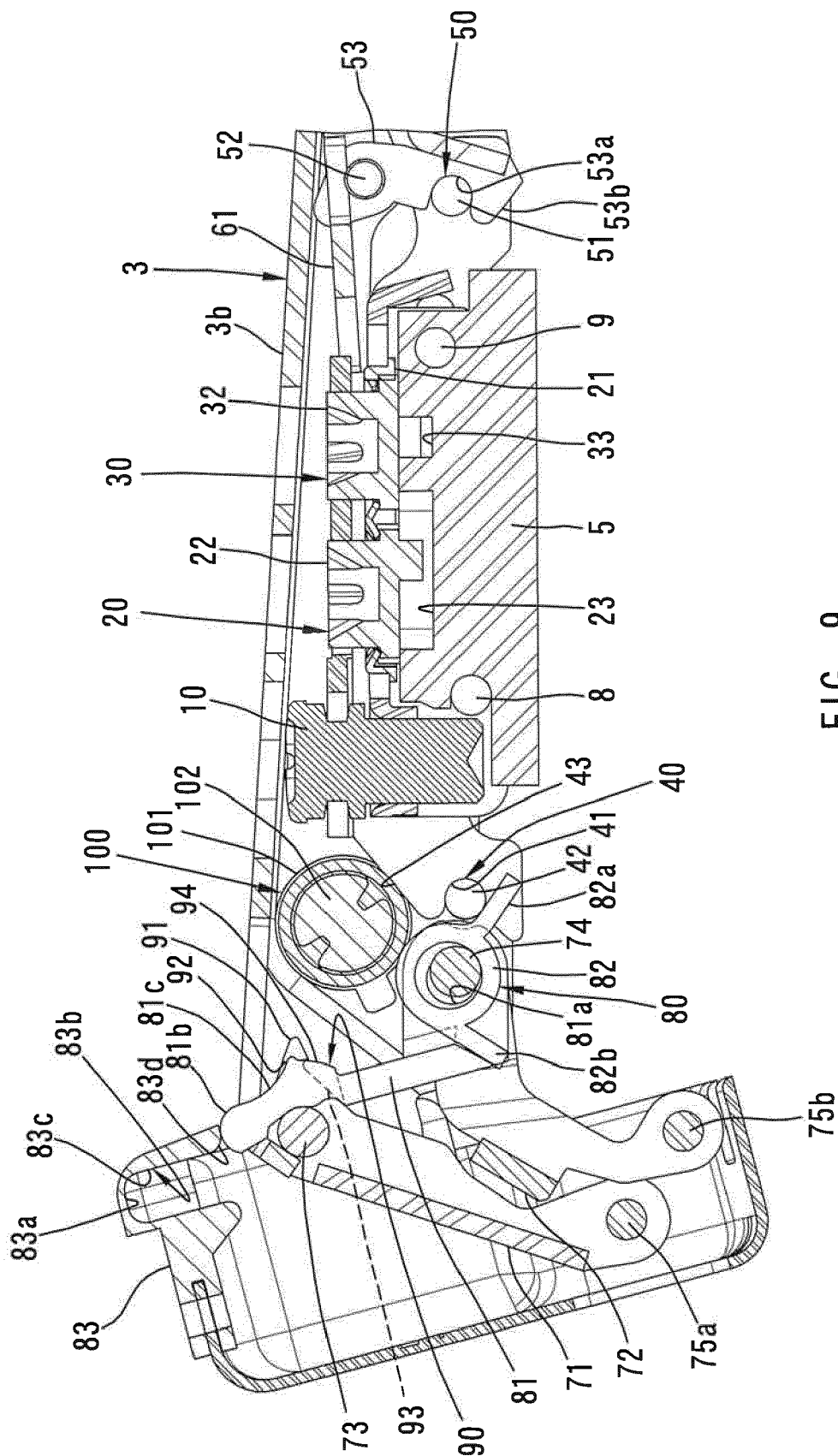


FIG. 9

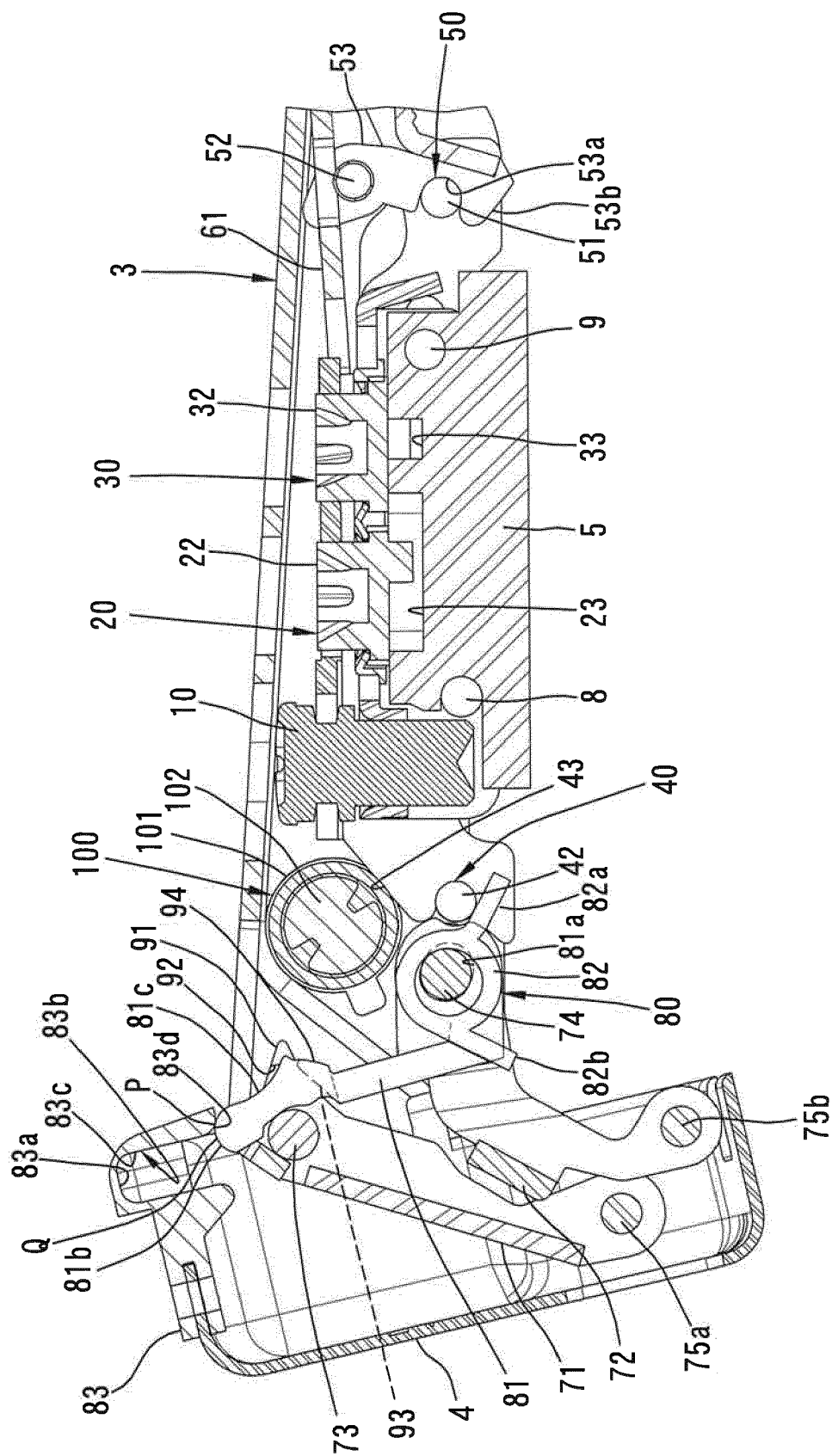


FIG. 10

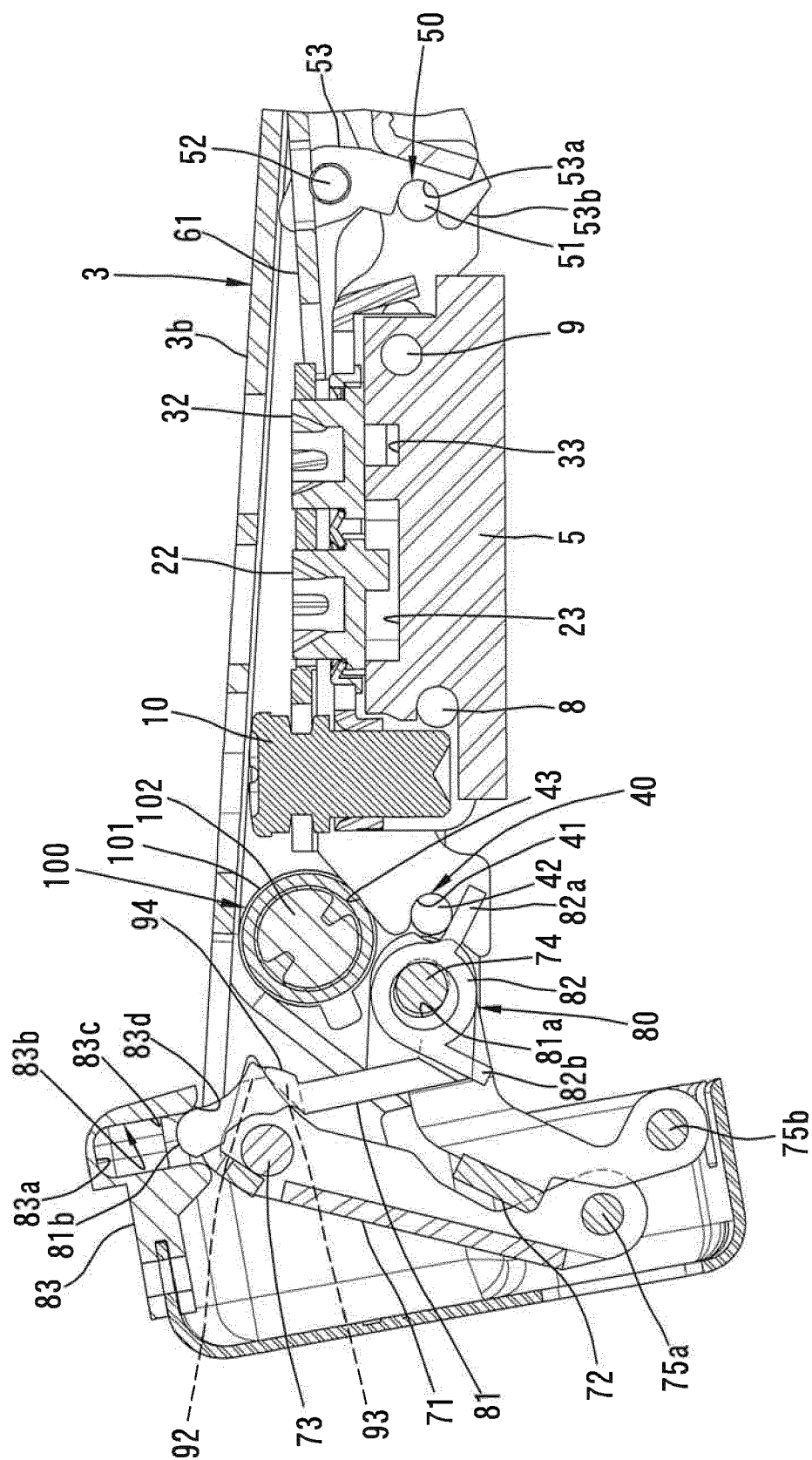


FIG. 11

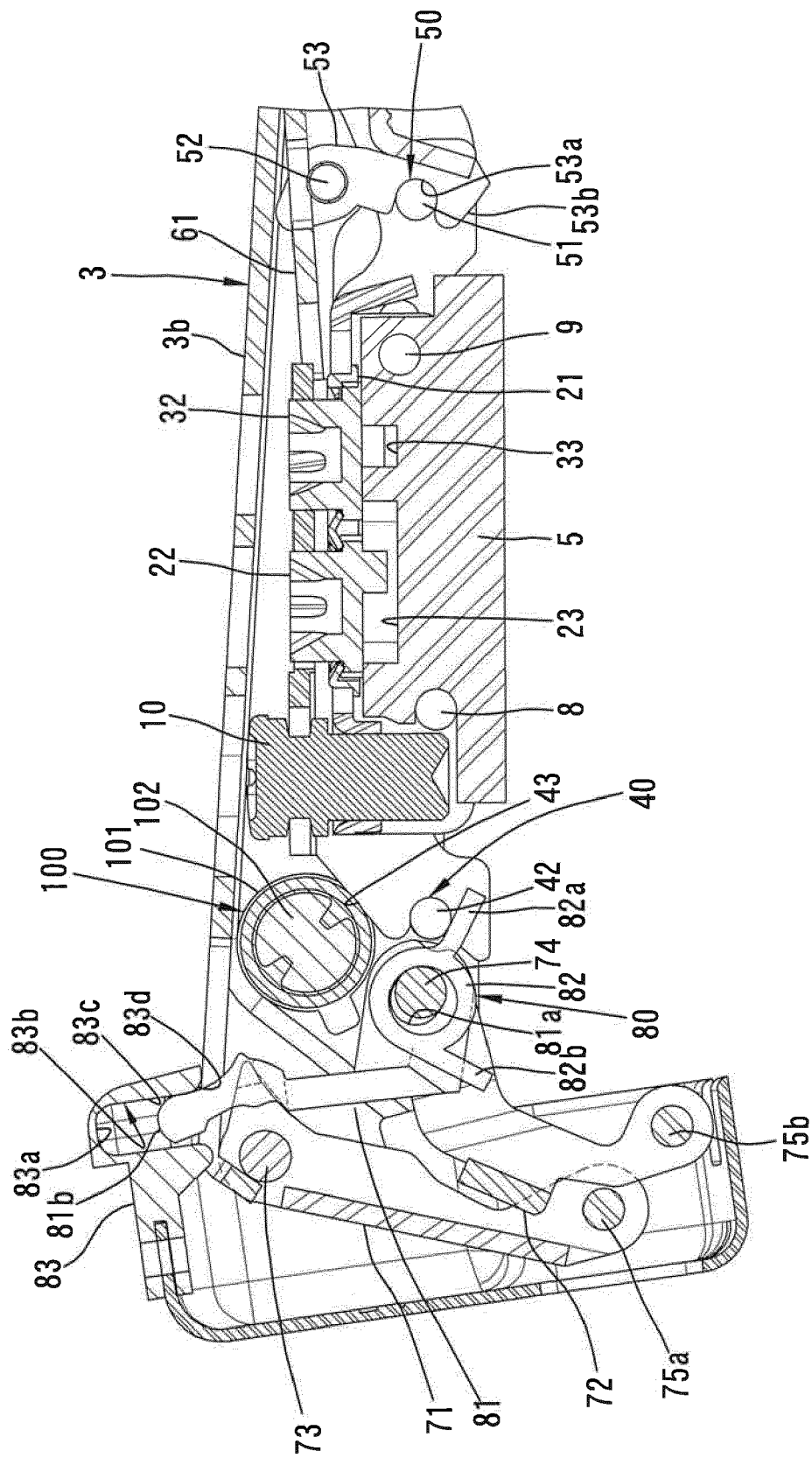


FIG. 12

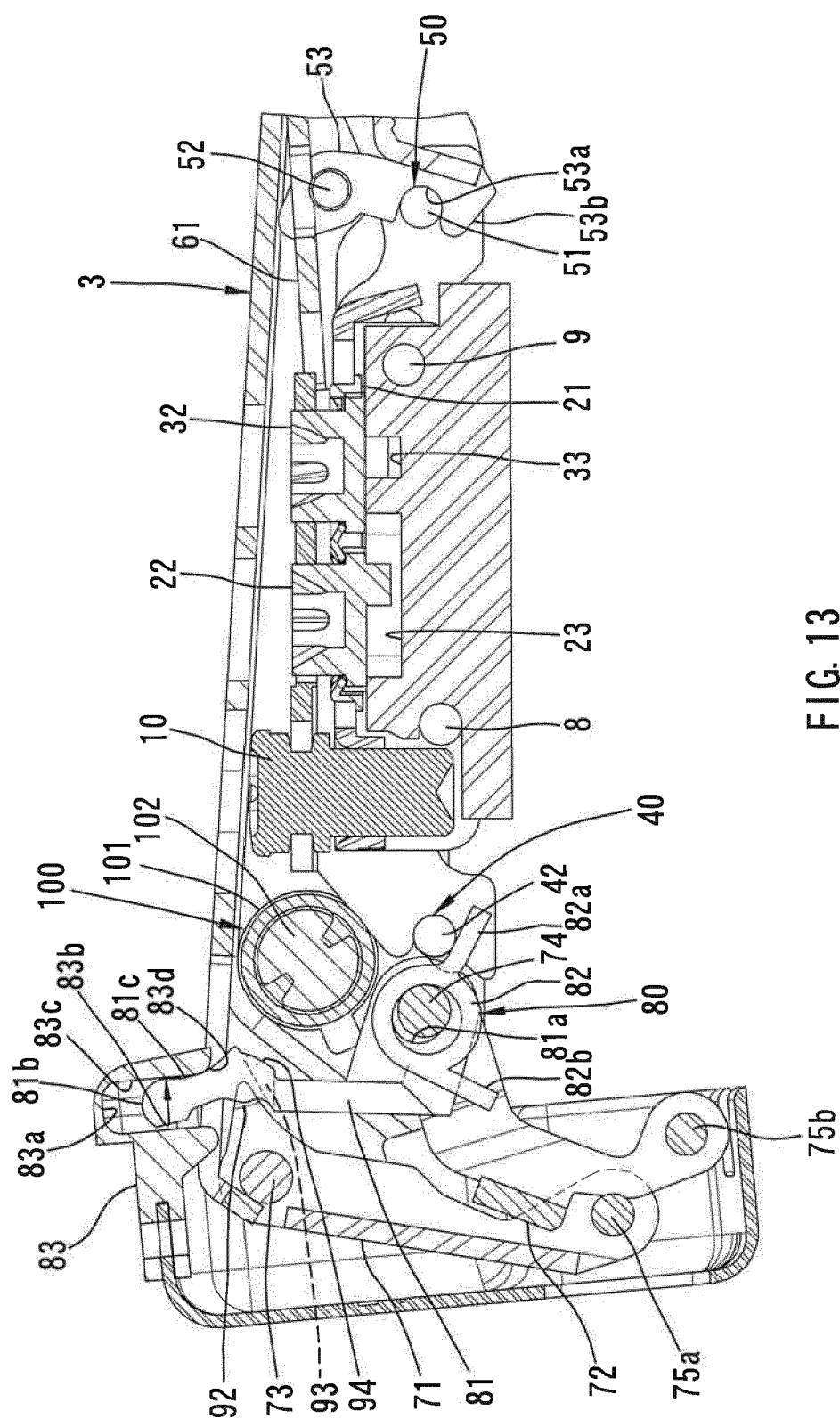


FIG. 13

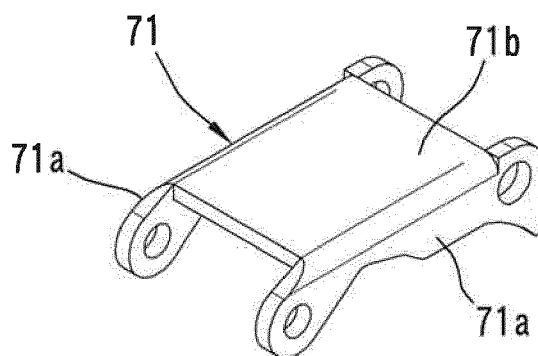


FIG. 14A

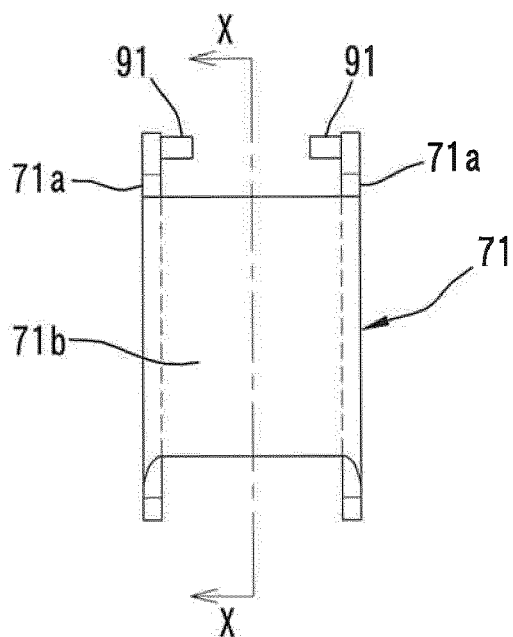


FIG. 14B

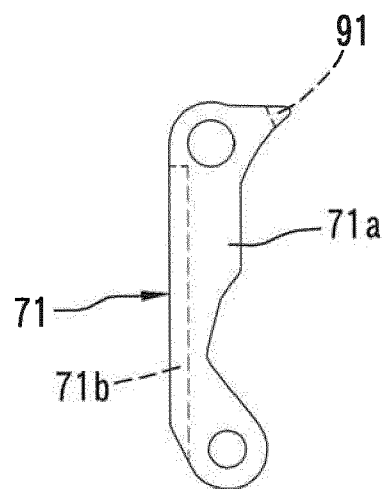


FIG. 14C

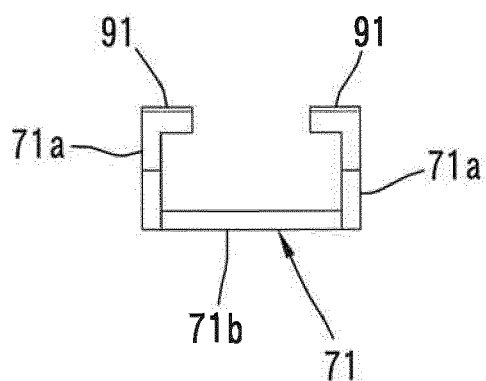


FIG. 14D

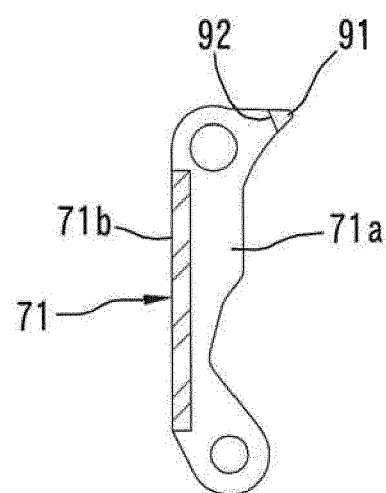


FIG. 14E

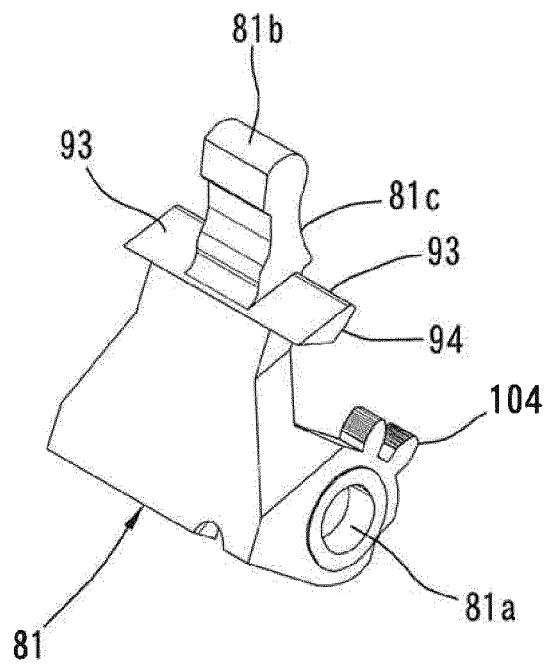


FIG. 15

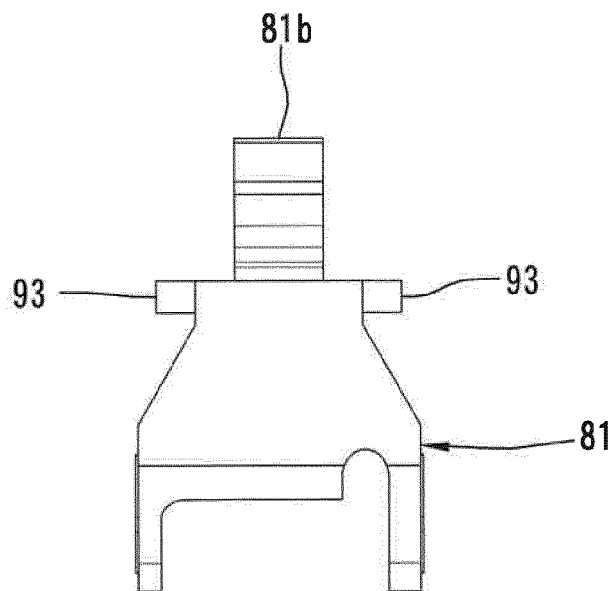


FIG. 16

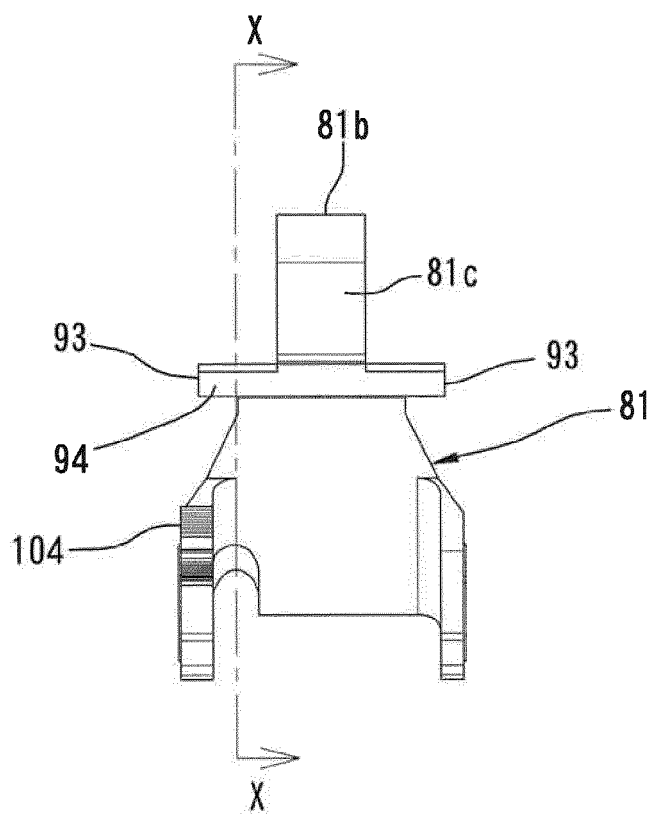


FIG. 17

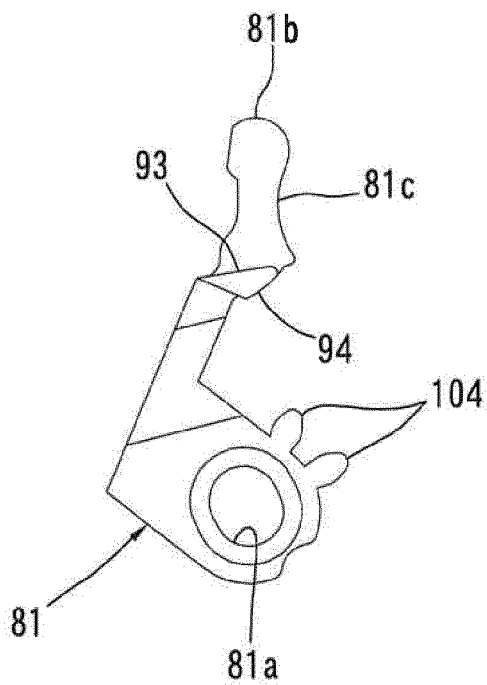


FIG. 18

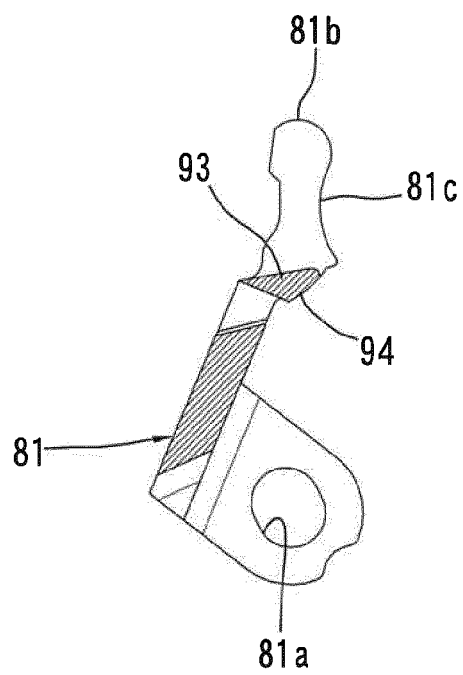


FIG. 19

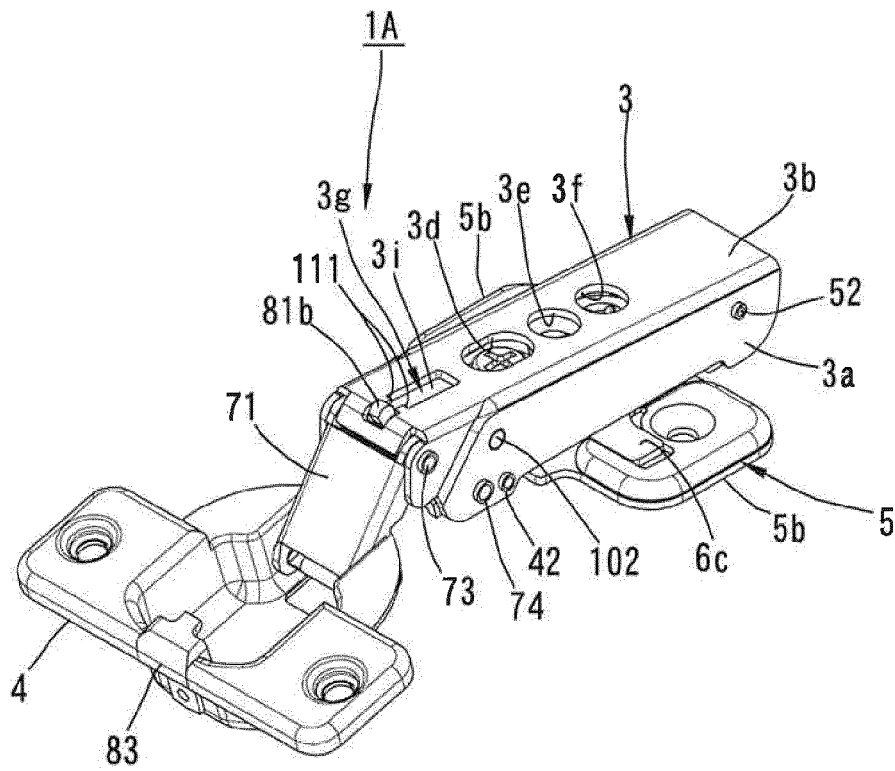


FIG. 20

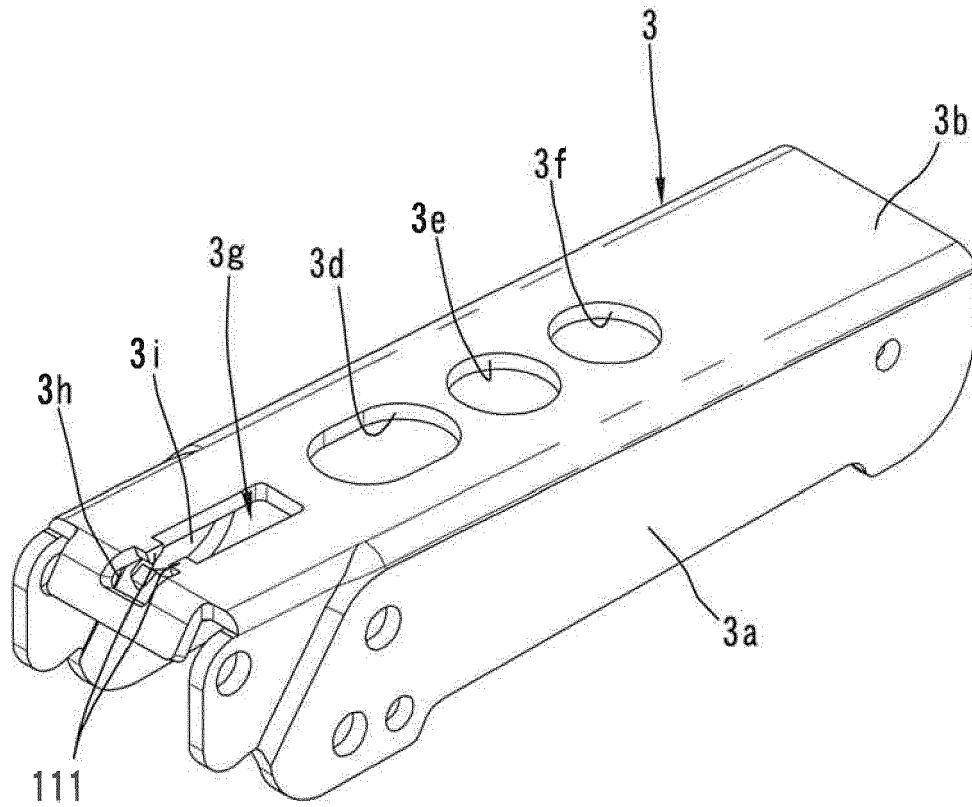


FIG. 21

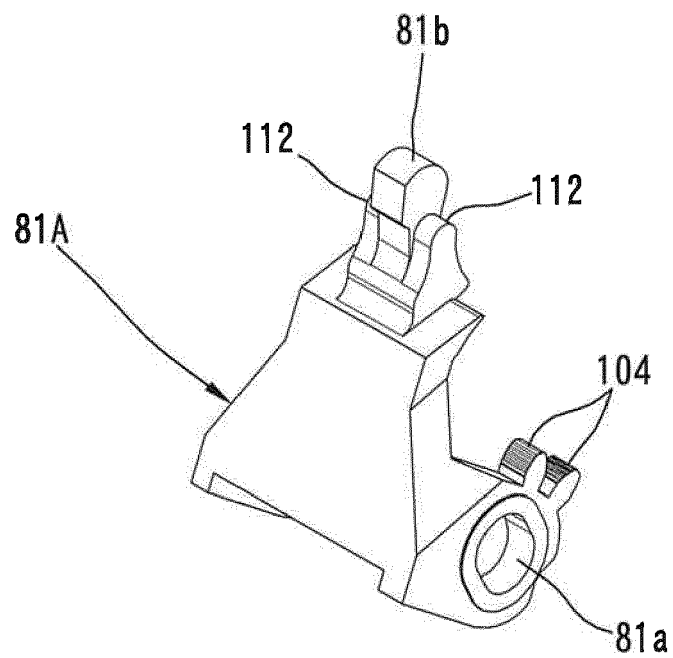


FIG. 22

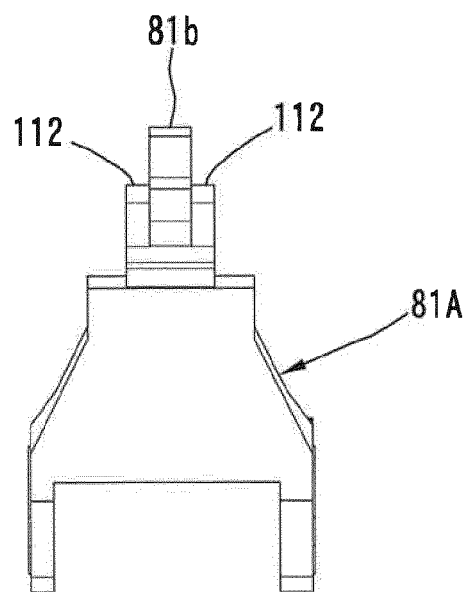


FIG. 23

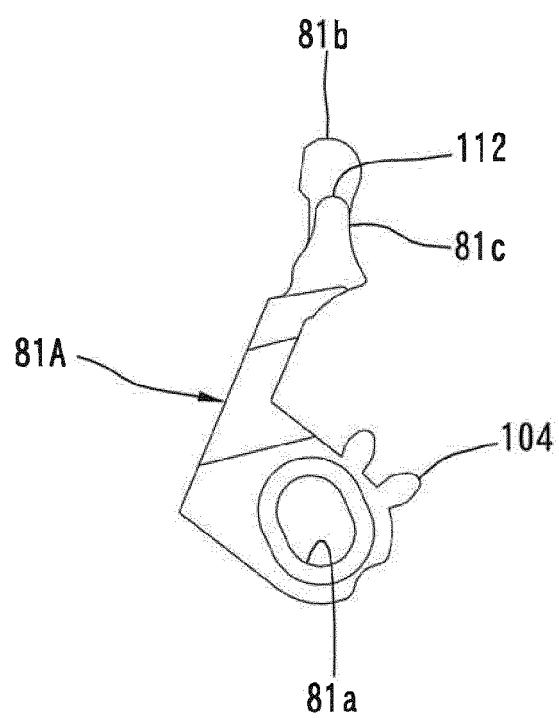


FIG. 24

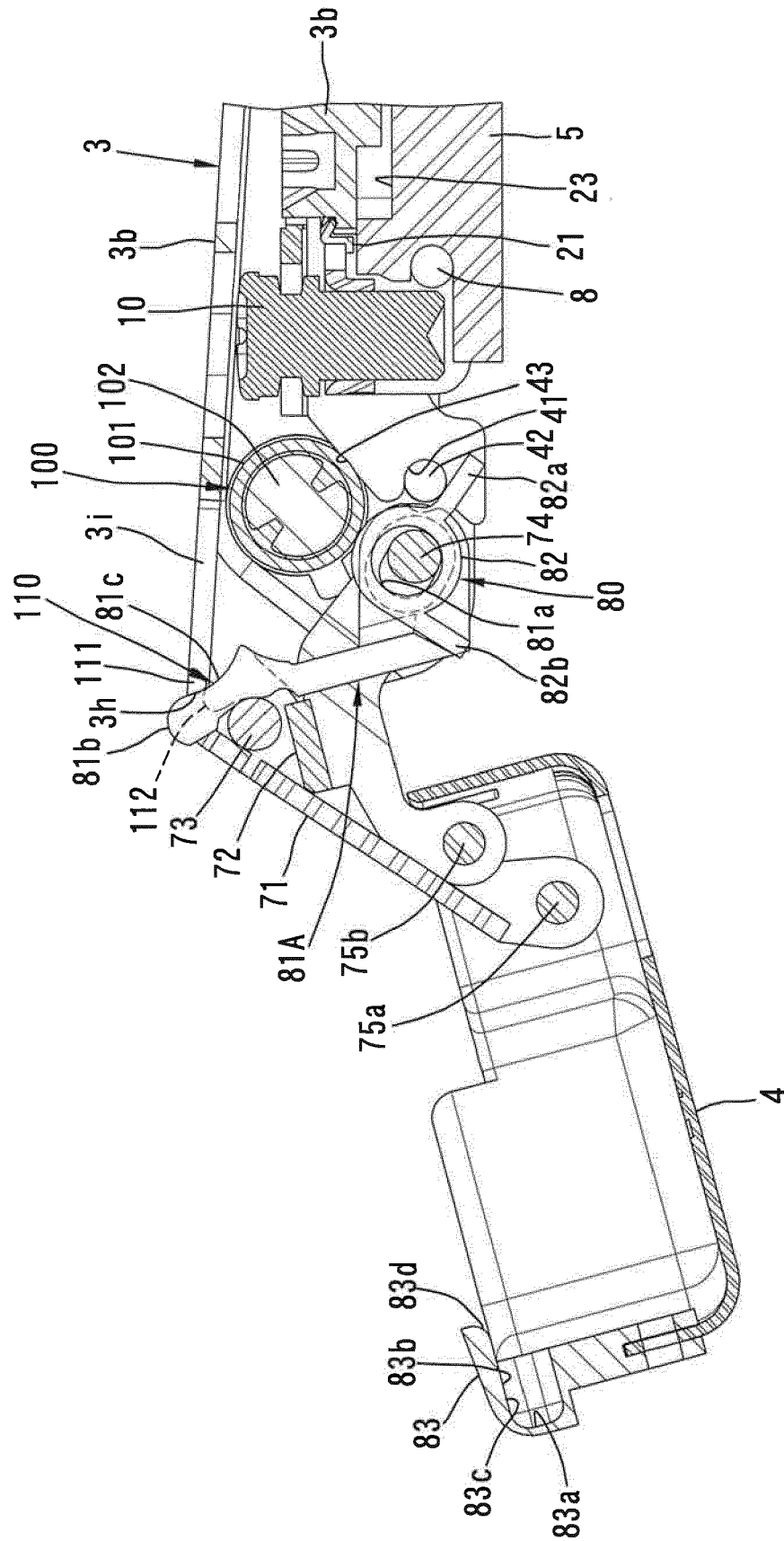


FIG. 25

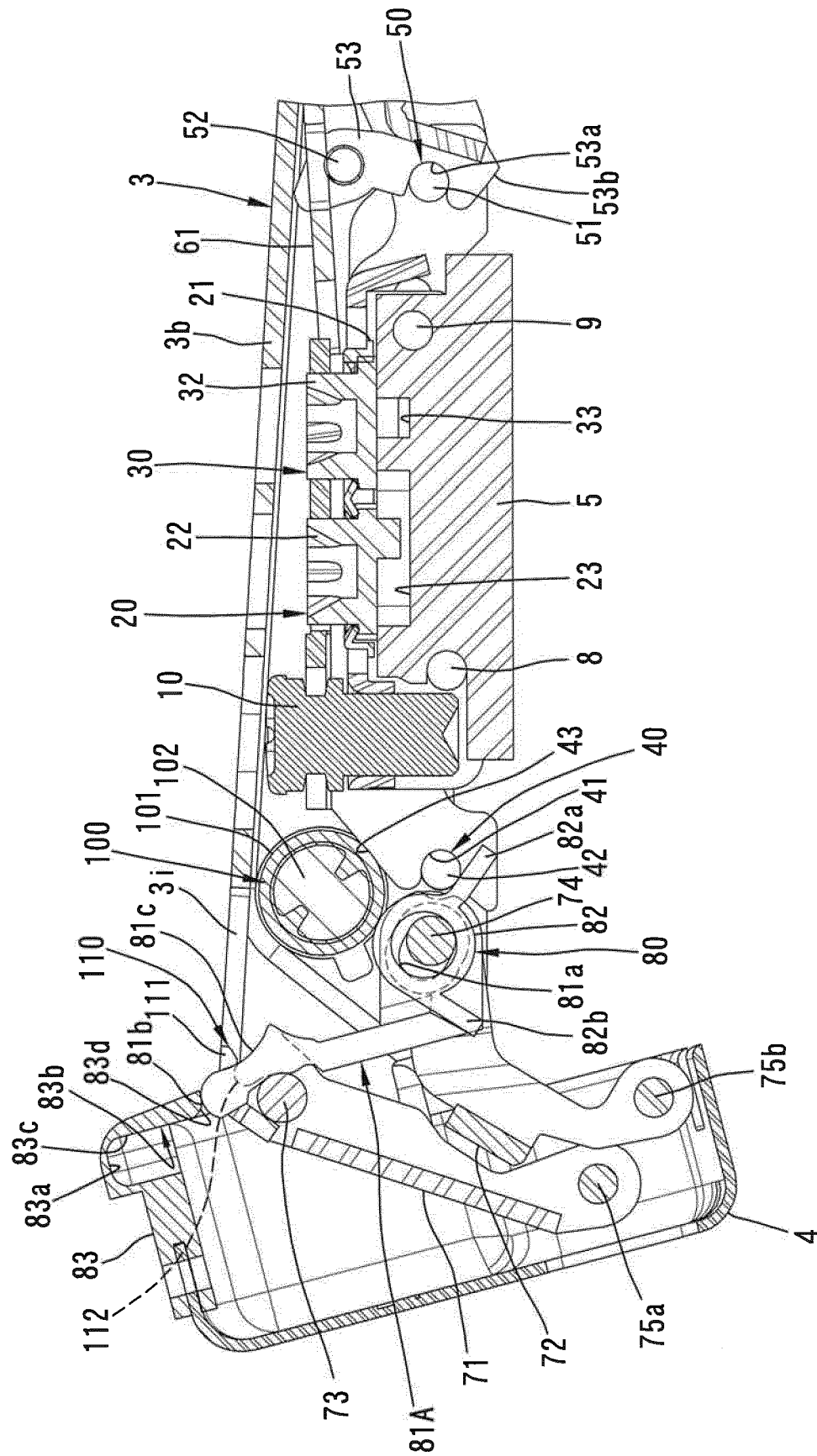


FIG. 26

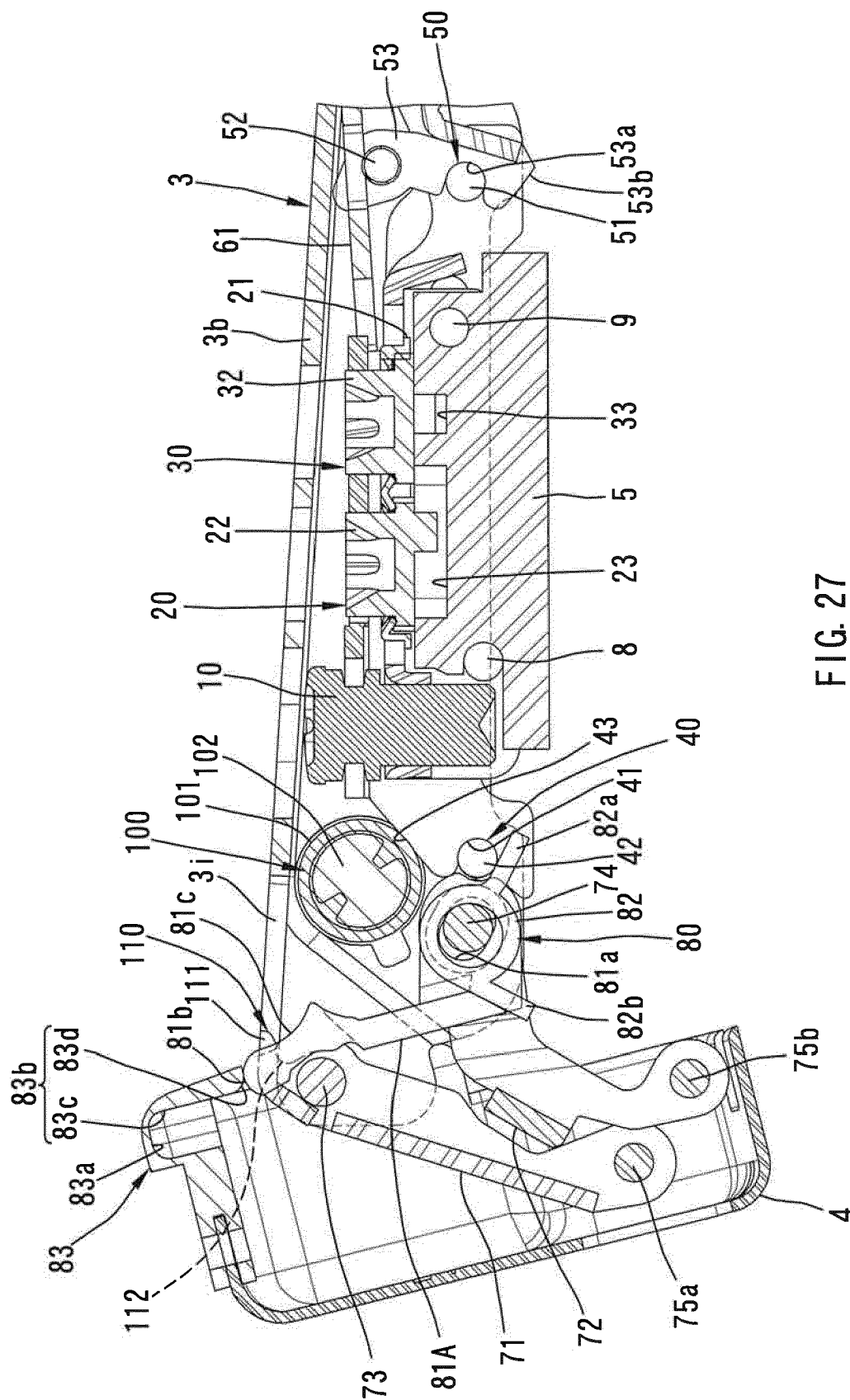


FIG. 27

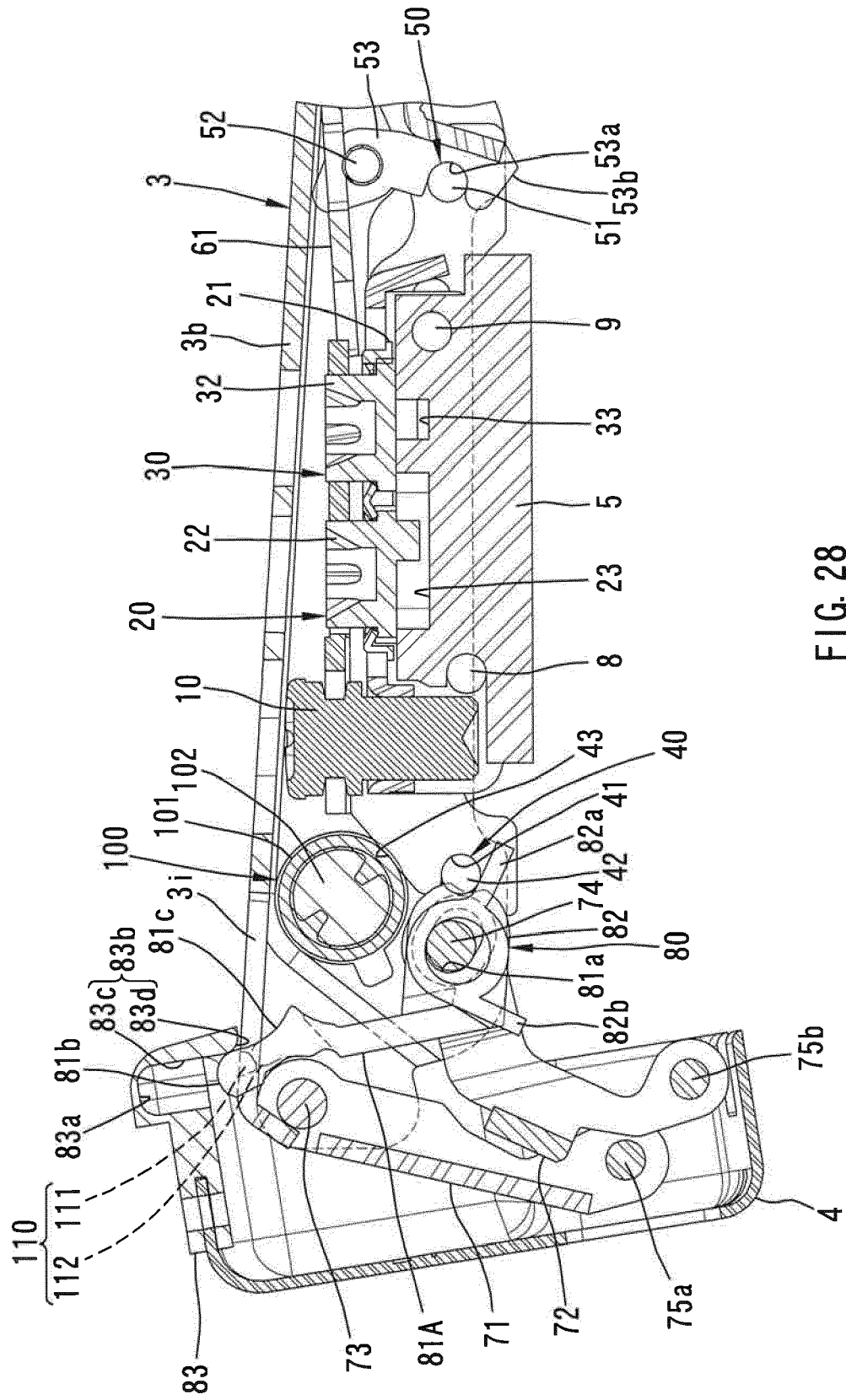


FIG. 28

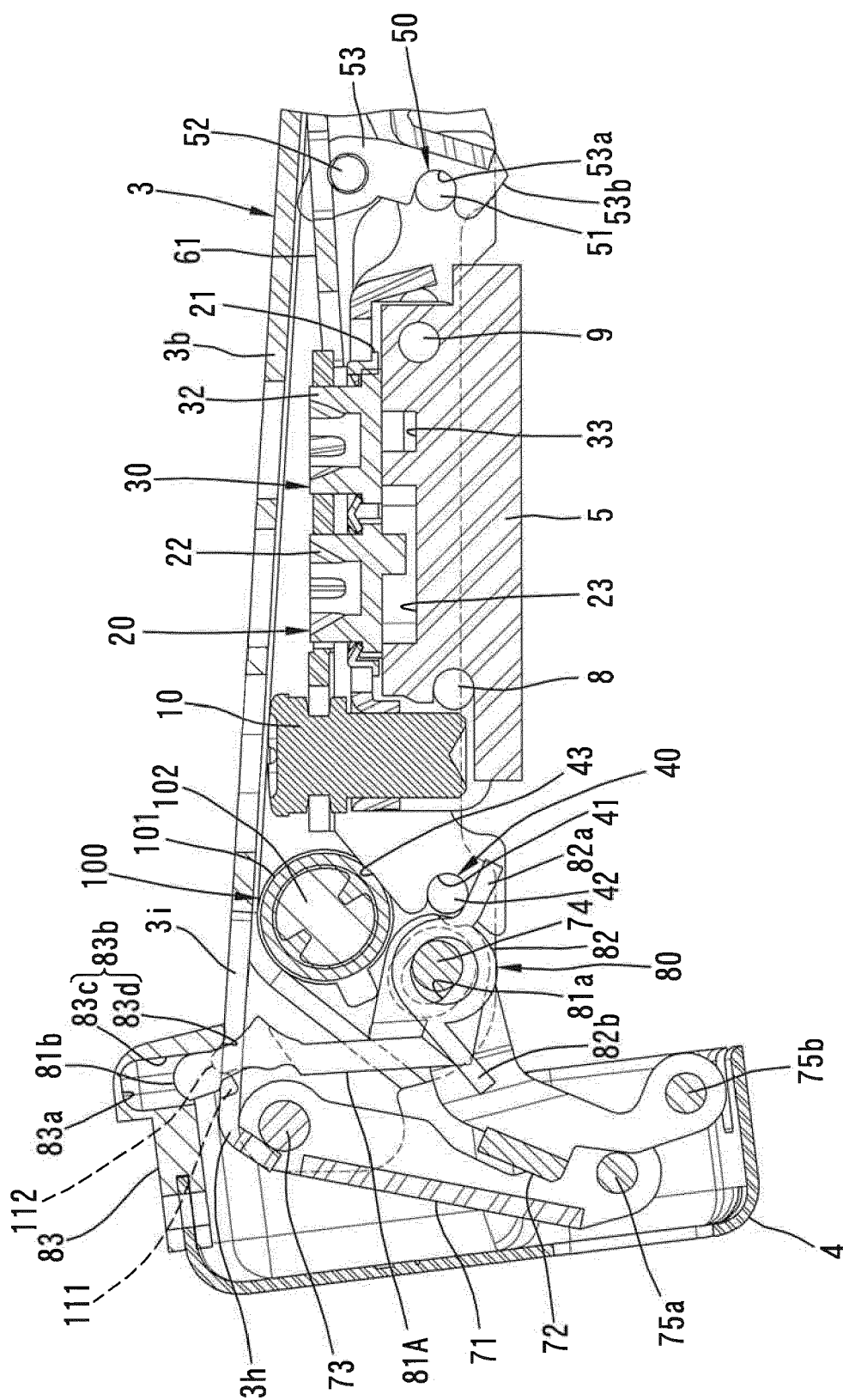


FIG. 29

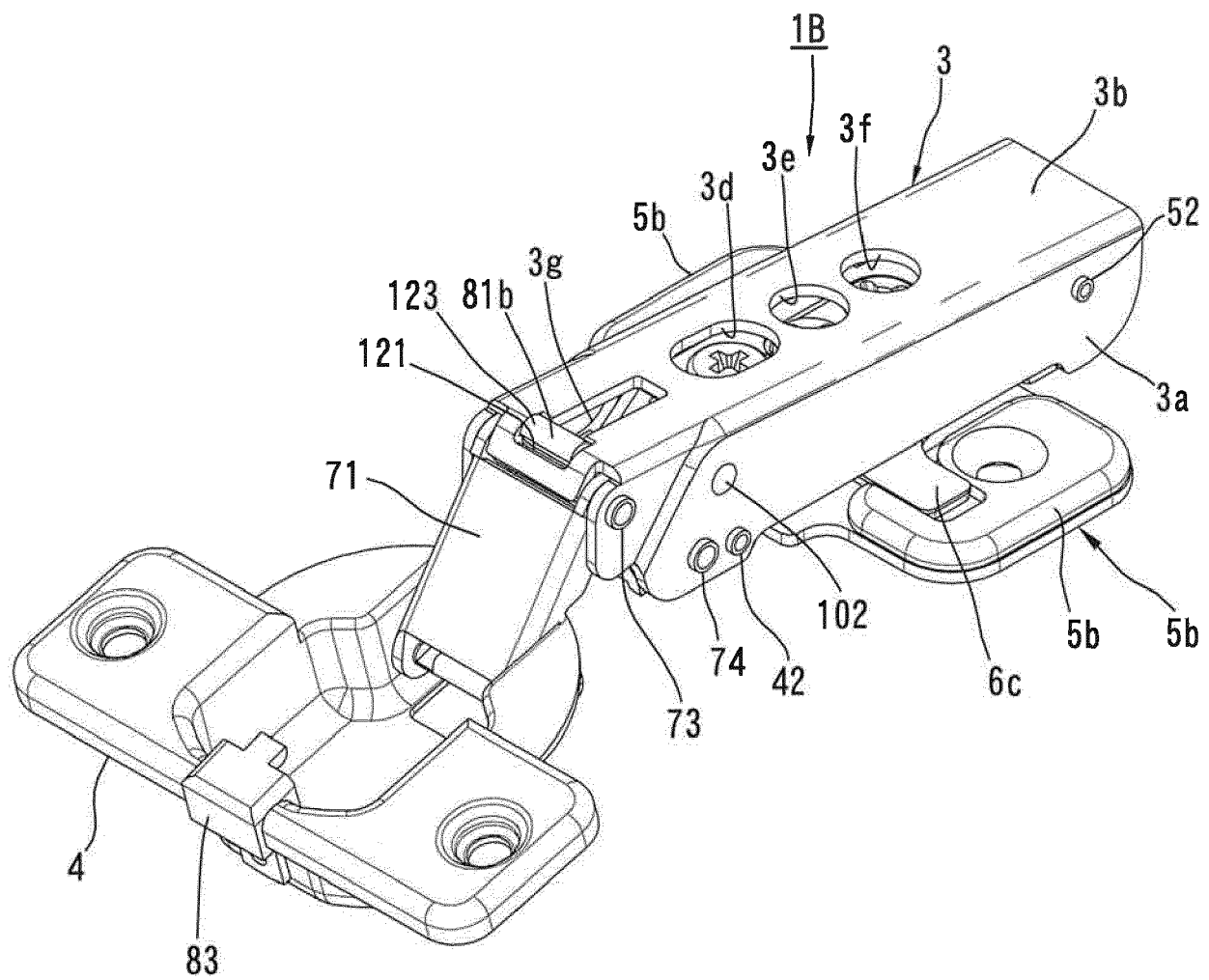


FIG. 30

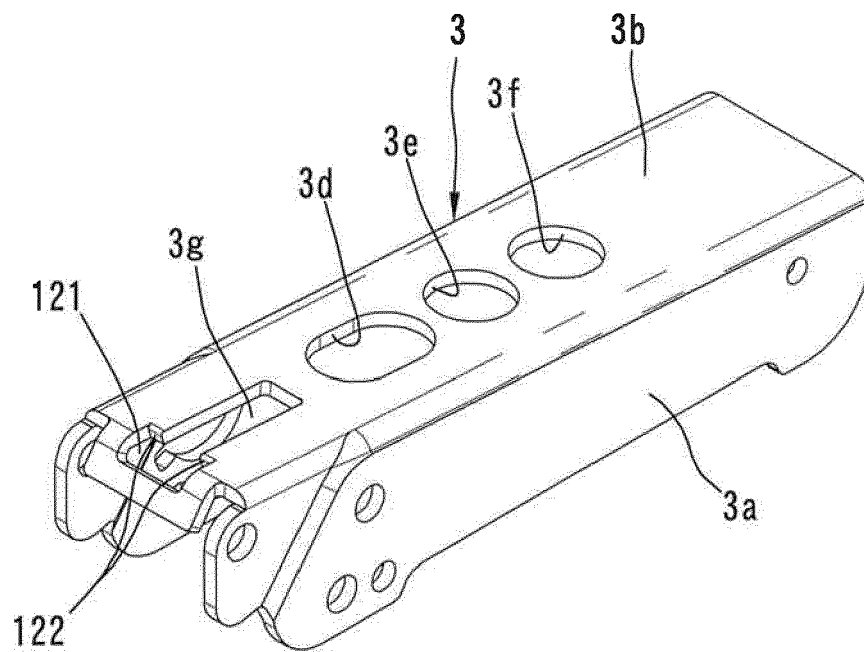


FIG. 31

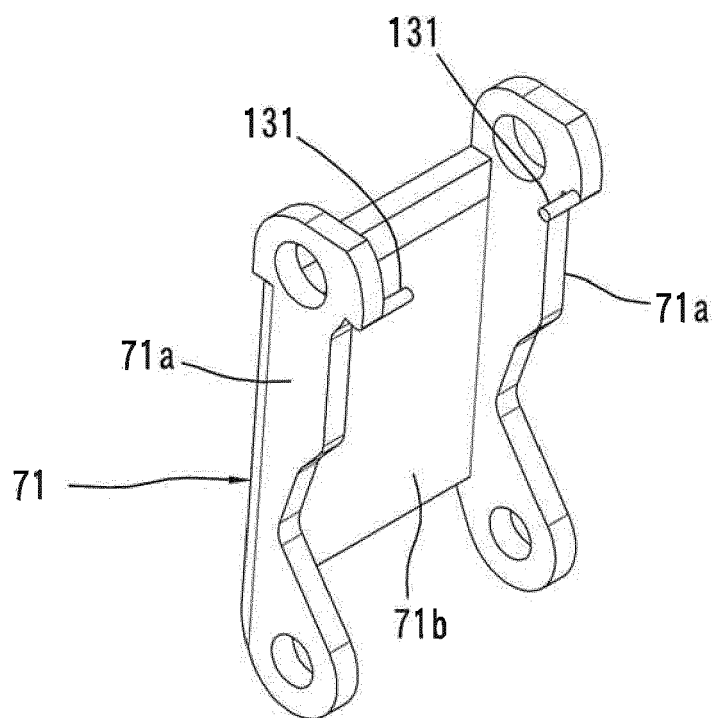


FIG. 32

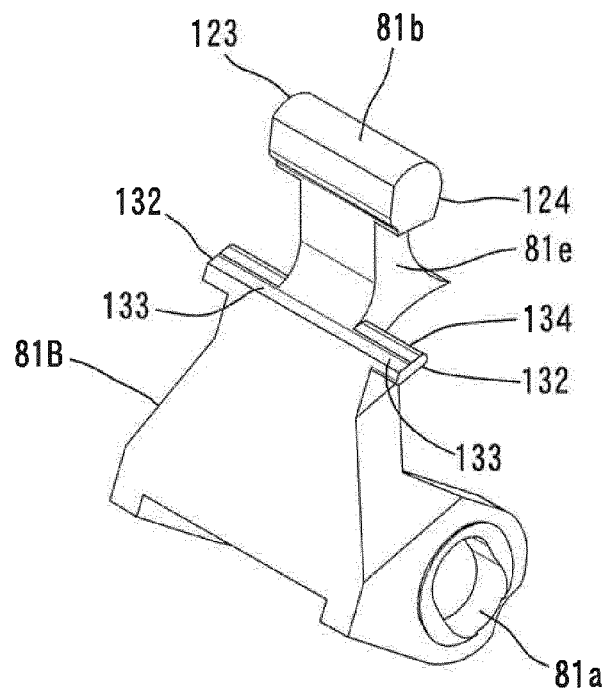


FIG. 33

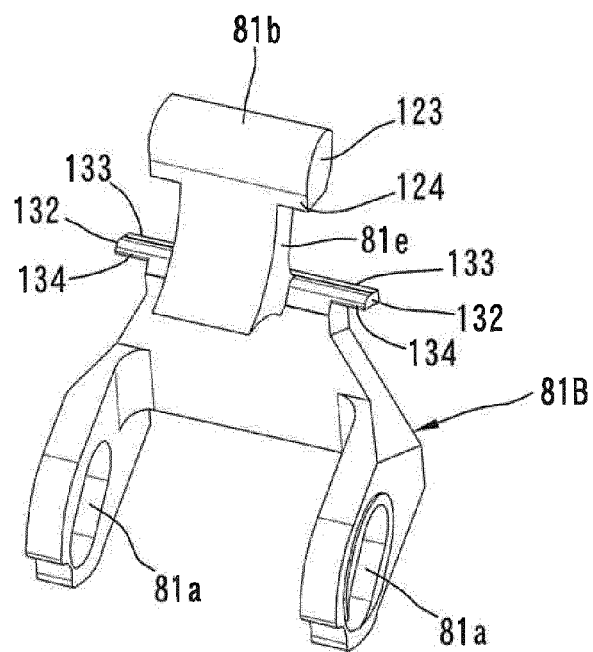


FIG. 34

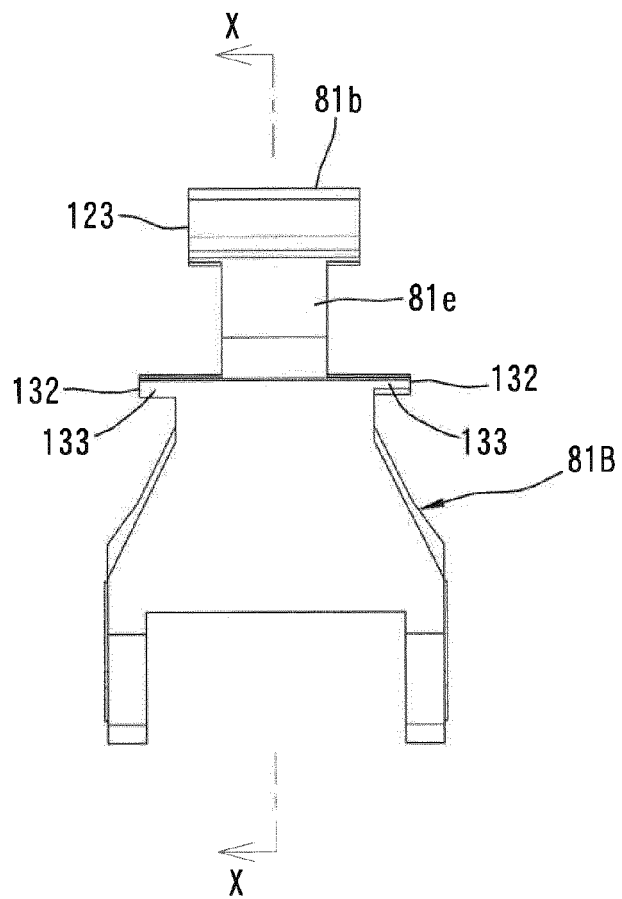


FIG. 35

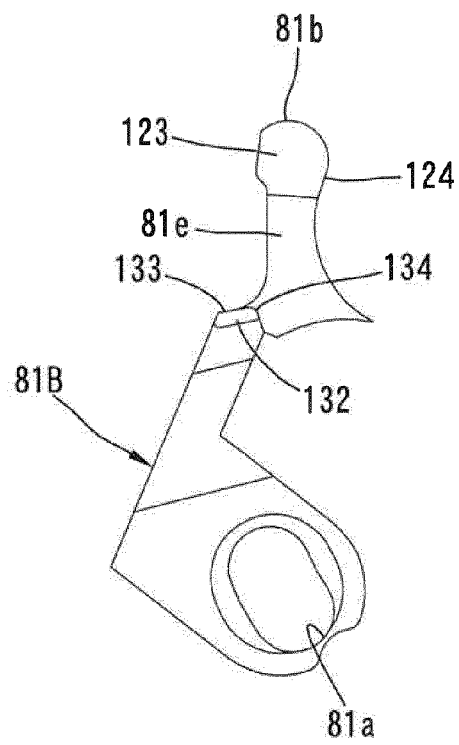


FIG. 36

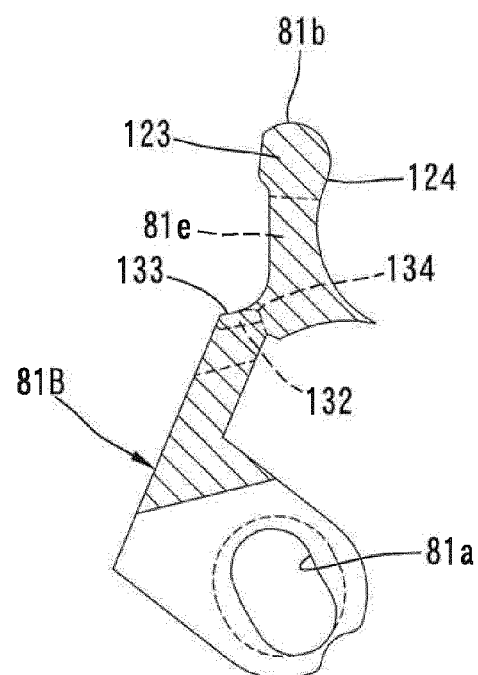


FIG. 37

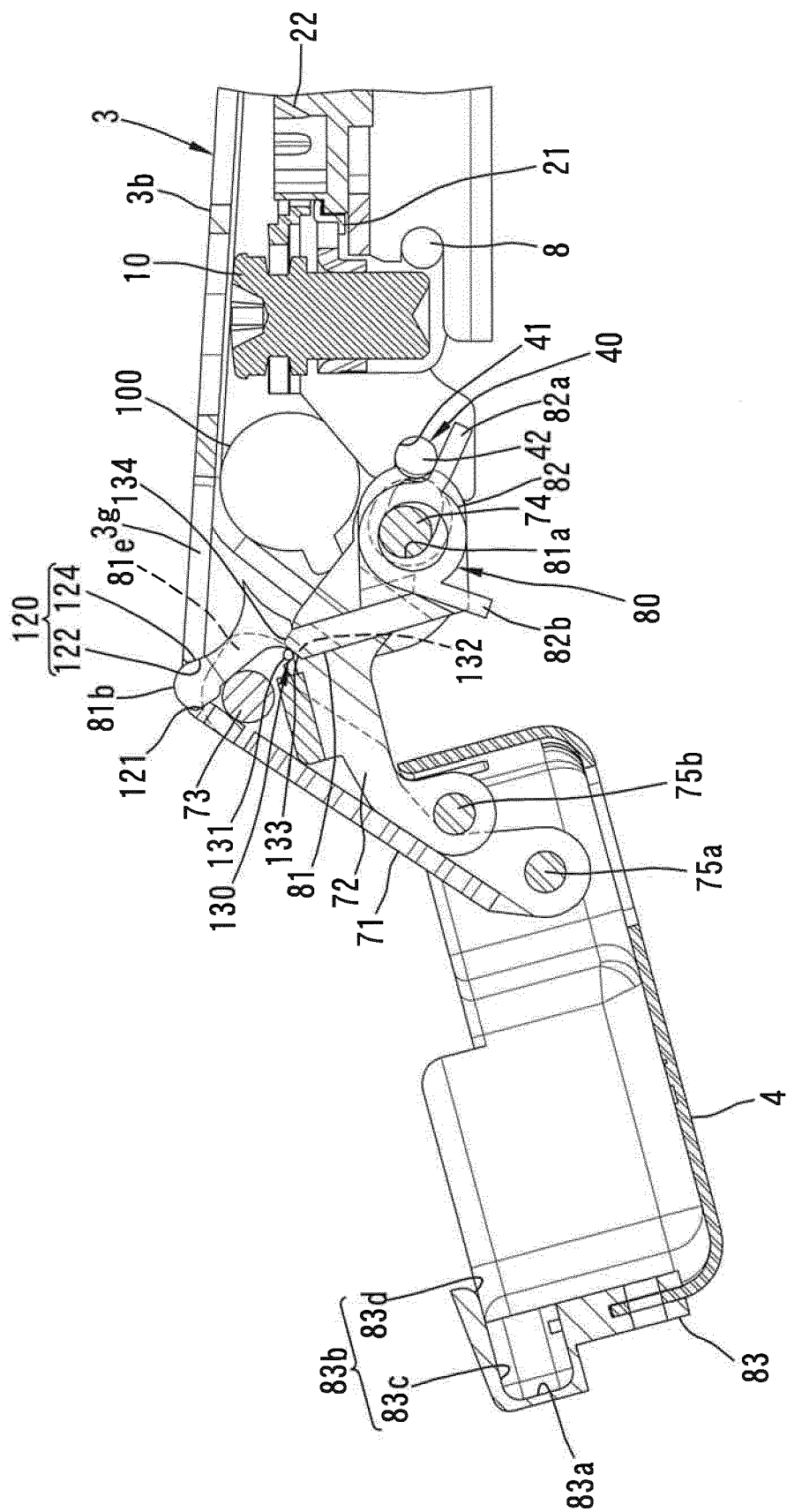


FIG. 38

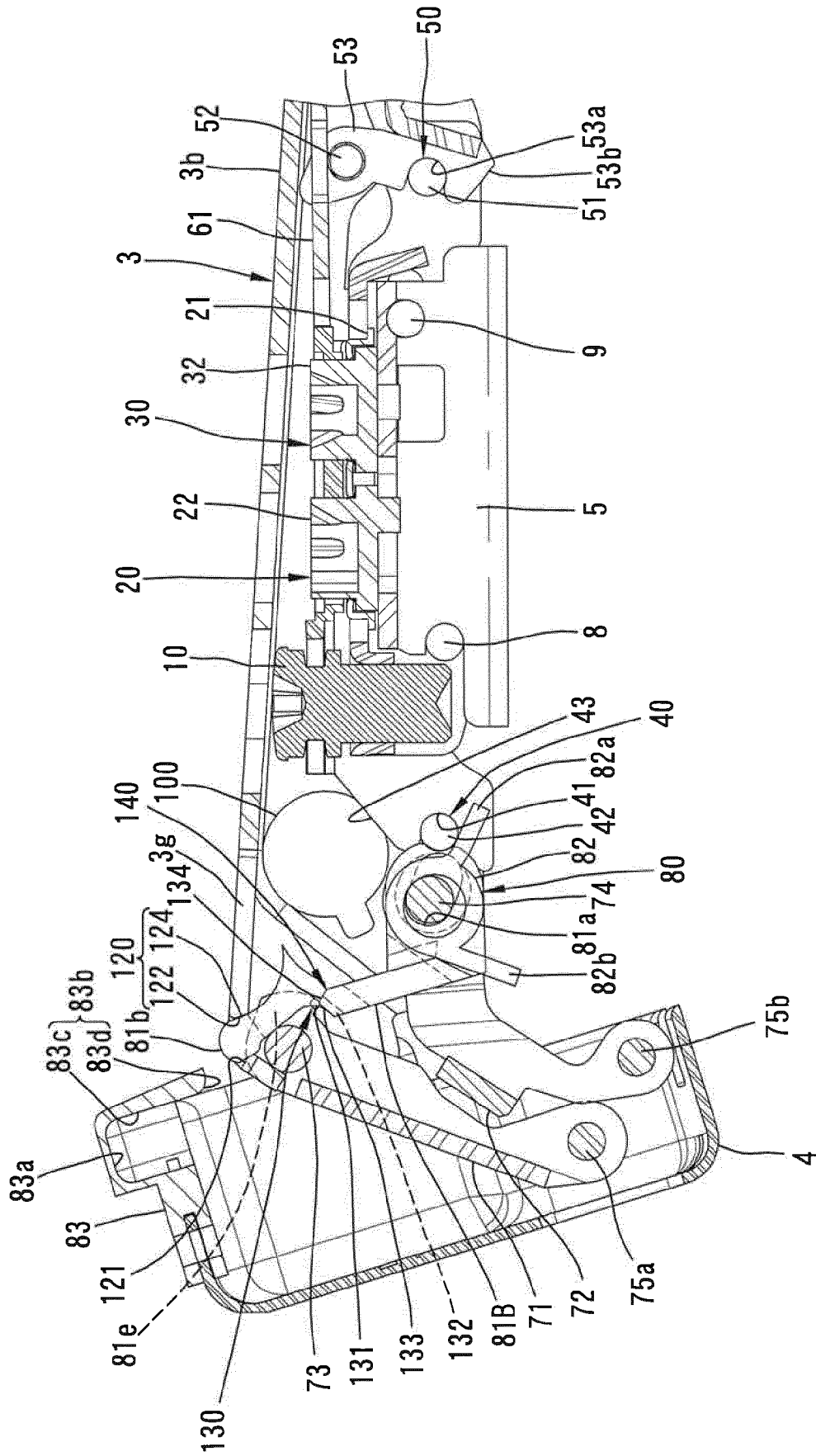


FIG. 39

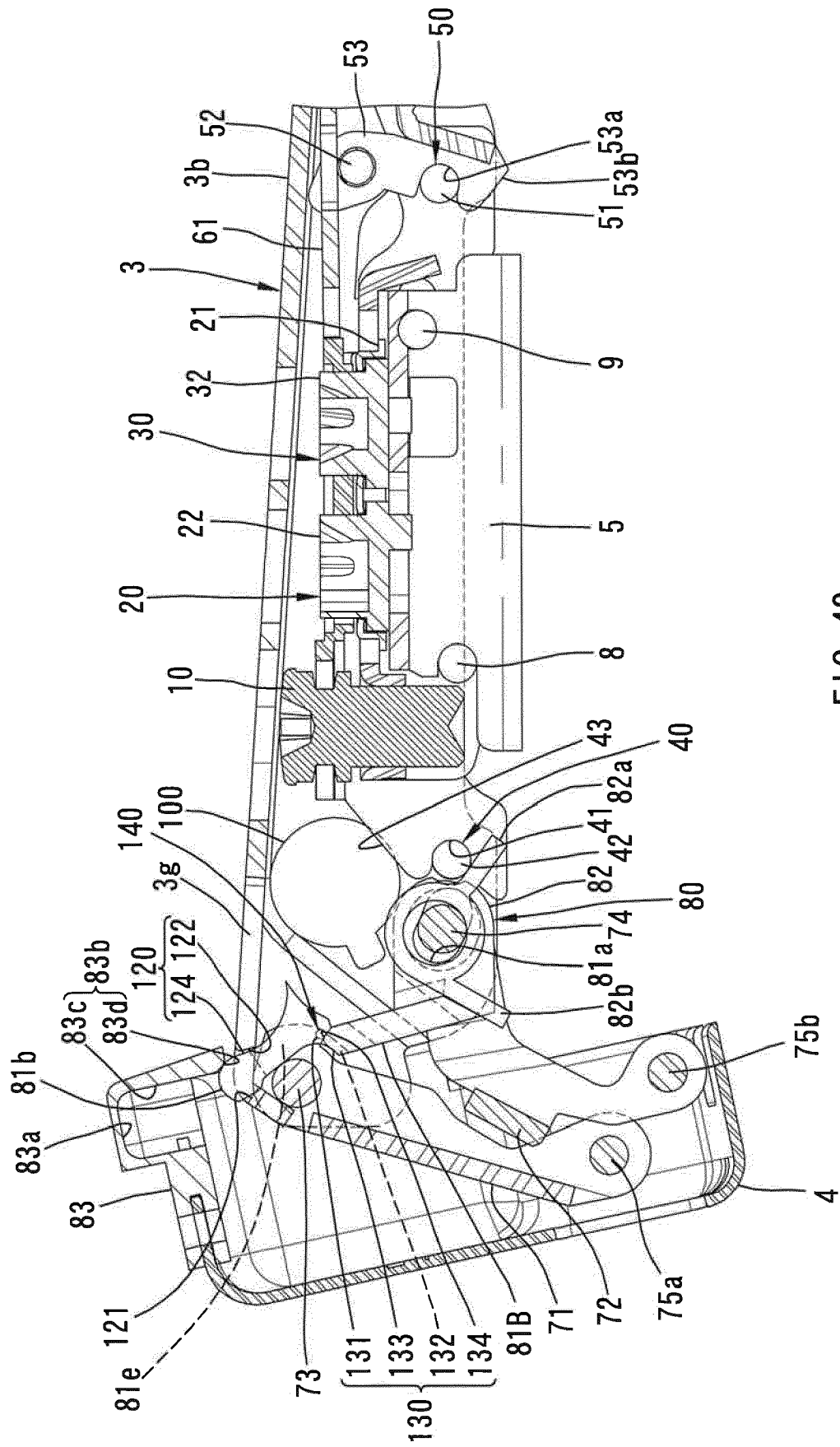


FIG. 40

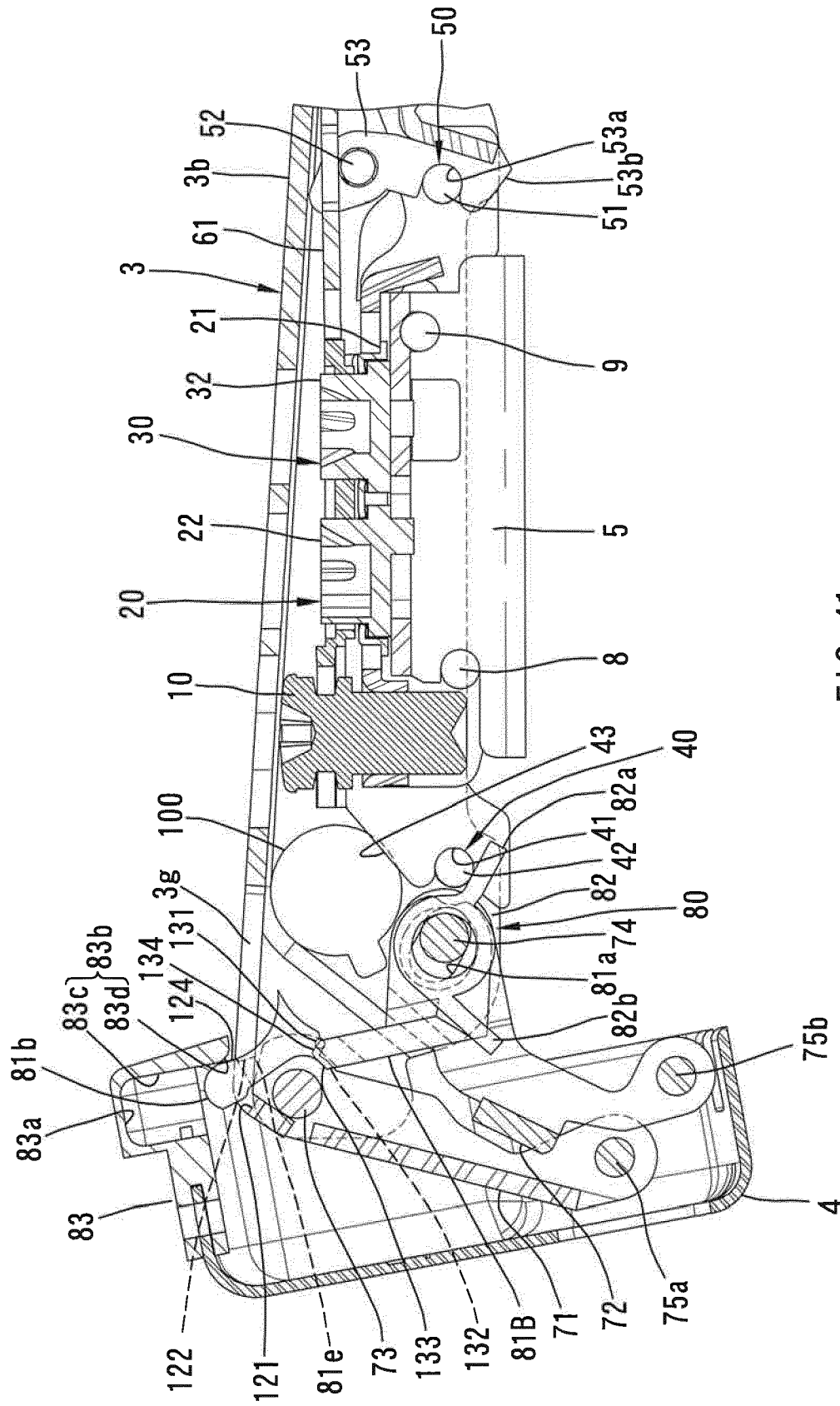


FIG. 41

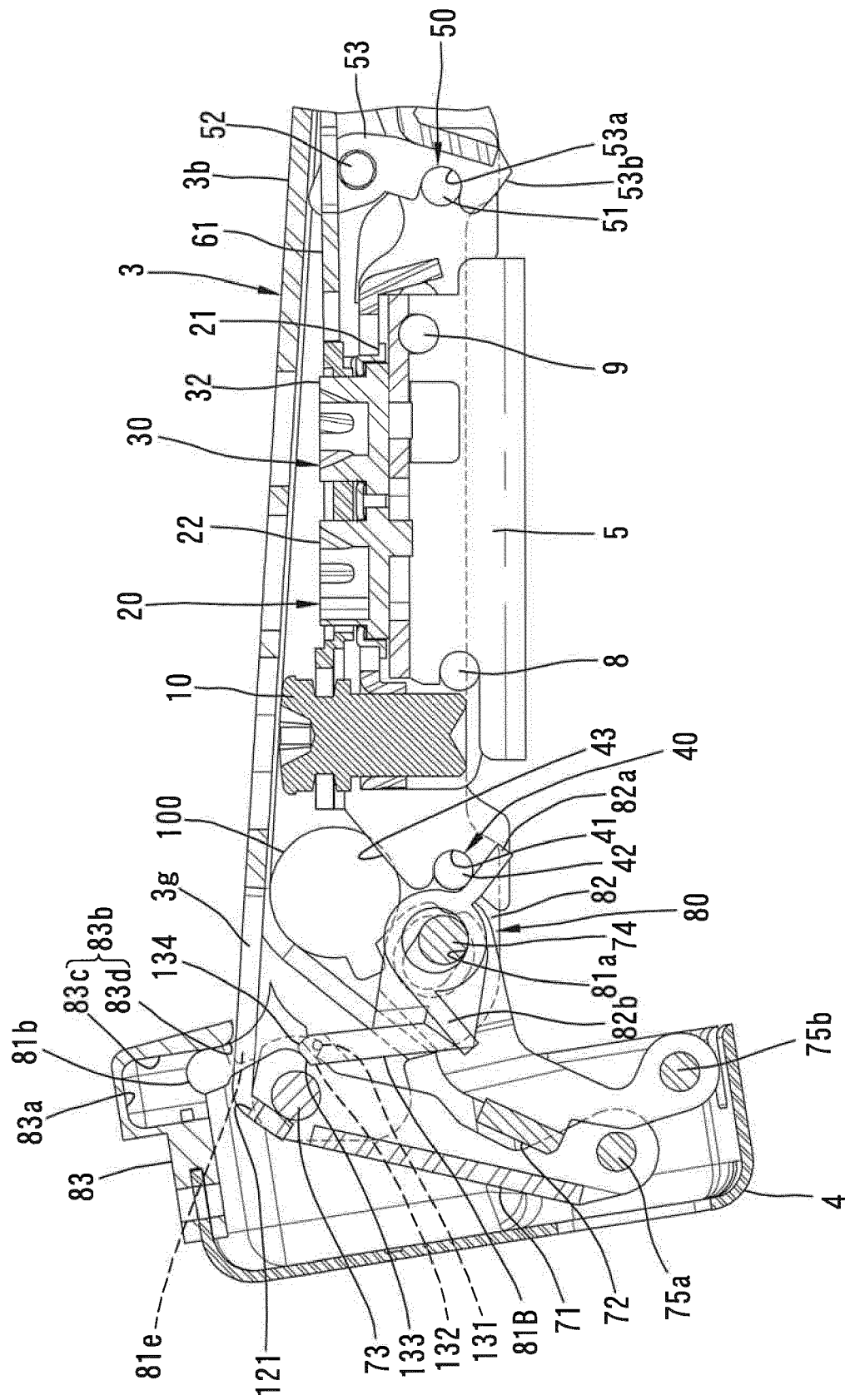


FIG. 42

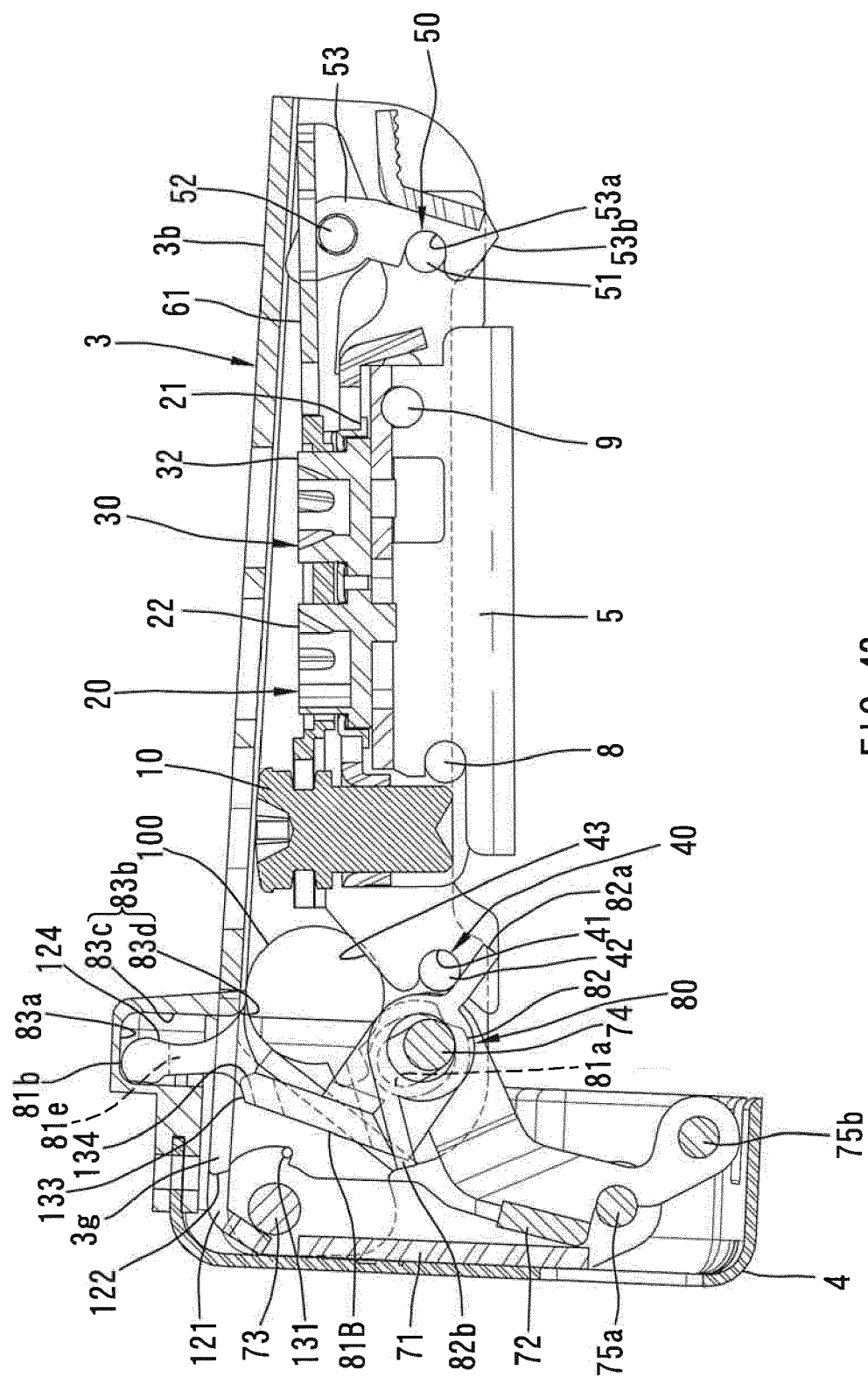


FIG. 43

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP S60112973 B [0004]