



(11)

EP 4 512 983 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
26.02.2025 Bulletin 2025/09

(51) International Patent Classification (IPC):
E05B 85/12 ^(2014.01) **E05B 79/20** ^(2014.01)
E05B 83/36 ^(2014.01) **E05B 81/90** ^(2014.01)

(21) Application number: **24195371.0**

(52) Cooperative Patent Classification (CPC):
E05B 79/20; E05B 15/006; E05B 15/0086;
E05B 81/90; E05B 83/363; E05B 85/12

(22) Date of filing: **20.08.2024**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL
NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
GE KH MA MD TN

(72) Inventors:
• **Sakaki, Genta**
Chiyoda-ku, Tokyo, 102-0093 (JP)
• **Hatta, Masahiro**
Chiyoda-ku, Tokyo, 102-0093 (JP)

(30) Priority: **22.08.2023 JP 2023134360**
14.05.2024 JP 2024078838

(74) Representative: **Grünecker Patent- und**
Rechtsanwälte
PartG mbB
Leopoldstraße 4
80802 München (DE)

(71) Applicant: **Nabtesco Corporation**
Tokyo 102-0093 (JP)

(54) **MANUAL UNLOCKING DEVICE**

(57) An aspect of the present invention provides a manual unlocking device (1, 201) for manually unlocking a locking device (16), the locking device being (16) configured to lock a door device (15), the door device (15) being configured to open or close a doorway (10) of a vehicle, the manual unlocking device (1, 201) including: an operating member (2) configured to perform rotational motion between a locking position and an unlocking position by being manually operated; a converting mechanism (3, 203) configured to convert the rotational motion of the operating member (2) into linear motion; and a drawing member (4) coupled at one end thereof to the converting mechanism (3, 203) and at the other end thereof to the locking device (16), the drawing member (4) being configured to transmit, to the locking device, the linear motion transmitted thereto from the converting mechanism (3, 203), thereby unlocking the door device (15), the converting mechanism (3, 203) has a plurality of links (21, 22, 221, 222, 223) configured to reach a dead center as a result of the rotational motion of the operating member (2) from the locking position to the unlocking position.

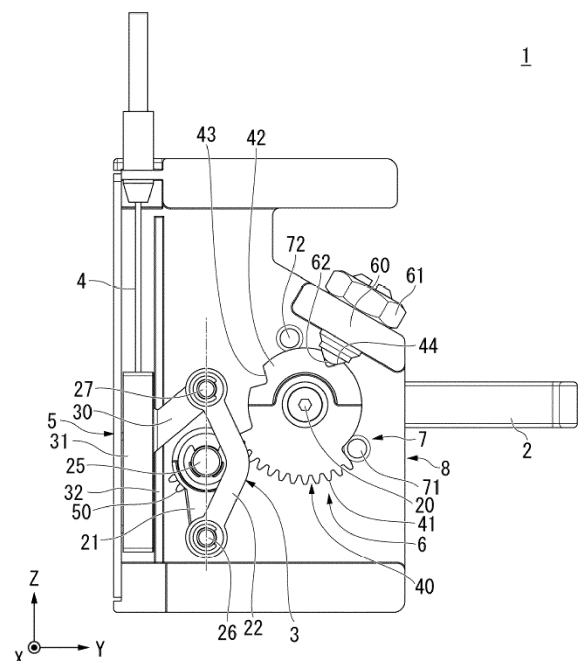


Fig. 5

Description

TECHNICAL FIELD

5 [0001] The present invention relates to a manual unlocking device.

BACKGROUND

10 [0002] Patent Literature 1 discloses a technique of manually unlocking a latch lock locking a door by operating a handle device connected to a cable.

RELEVANT REFERENCE

LIST OF RELEVANT PATENT LITERATURE

15 [0003] Patent Literature 1: Japanese Patent Application Publication No. 2010-174435

SUMMARY

20 [0004] The handle device has an operating unit that is generally connected directly to the inner cable. While the handle device is in an unlocking state, an external force may be applied in a locking direction to the cable from the latch lock. In this case, the external force directly pulls the operating unit. To address this issue, a ball plunger or the like may be provided to place the operating unit at a fixed position, so that the operating unit can remain at an unlocking position. In this manner, such an external force does not accidentally bring the operating unit back to a locking position. As long as the ball plunger
25 exerts strong retaining force, the operating unit can be prevented from returning to the locking position when acted upon by an external force. To operate the operating unit, however, a great deal of efforts are required.

[0005] The present invention is intended to overcome the above problem, and one object thereof is to provide a manual unlocking device that is capable of retaining an operating member in an unlocking position without requiring electric power even if an external force is applied to a drawing member from a locking device while the manual unlocking device is in an
30 unlocking state.

[0006] To overcome the above drawback, aspects of the present invention are configured as follows.

(1) An aspect of the present invention provides a manual unlocking device for manually unlocking a locking device, the locking device being configured to lock a door device, the door device being configured to open or close a doorway of a
35 vehicle, the manual unlocking device including: an operating member configured to perform rotational motion between a locking position and an unlocking position by being manually operated; a converting mechanism configured to convert the rotational motion of the operating member into linear motion; and a drawing member coupled at one end thereof to the converting mechanism and at the other end thereof to the locking device, the drawing member being configured to transmit, to the locking device, the linear motion transmitted thereto from the converting mechanism, thereby unlocking the door device. The converting mechanism has a plurality of links configured to reach
40 a dead center as a result of the rotational motion of the operating member from the locking position to the unlocking position.

According to the above, the operating member is operated to perform rotational motion, so that the operating member reaches the unlocking position. As a result, the door device can be unlocked. On completion of this, the links may be at
45 a dead center. An external force may be applied by the locking device to the drawing member while the operating member is at the unlocking position. Even so, the operating member can stay at the unlocking position without requiring electric power consumption.

(2) In the manual unlocking device of (1), the drawing member may be a cable, the manual unlocking device may
50 further include a slider mechanism to which the cable is secured, the slider mechanism supporting the cable such that the cable is movable in a direction along the linear motion, and the slider mechanism is connected to the operating member via the links.

(3) In the manual unlocking device of (2), the links may include: a first link coupled at one end thereof to the operating
55 member such that the first link is rotatable on a coupling portion where the one end of the first link is coupled with the operating member; and a second link coupled at one end thereof to the other end of the first link such that the second link is rotatable on a coupling portion where the one end of the second link is coupled with the other end of the first link, and coupled at the other end thereof to the slider mechanism such that the second link is rotatable on a coupling

portion where the other end of the second link is coupled with the slider mechanism. As a result of the rotational motion of the operating member from the locking position to the unlocking position, an imaginary line segment from the one end of the first link to the other end of the first link, and an imaginary line segment from the one end of the second link to the other end of the second link are positioned on a straight line, so that the first and second links are at a dead center.

(4) In the manual unlocking device of (3), the operating member may be rotatable 90 degrees on a support shaft between the locking position and the unlocking position, and the manual unlocking device may further include a gear mechanism configured to reduce rotation of the support shaft by a predetermined reduction ratio and transmit the reduced rotation to the one end of the first link.

(5) In the manual unlocking device of (4), the gear mechanism may include: a driving gear rotatably coupled with the support shaft with a center of rotation thereof being placed on the support shaft; and a driven gear having coupled with the one end of the first link with a center of rotation thereof being placed on the one end of the first link, the driven gear meshing with the driving gear to transmit the rotational motion of the operating member to the first link, the driving gear may have: a gear portion meshing with the driven gear; and a positioning portion being configured to place the driving gear at an intended position when the operating member is at the locking or unlocking position, and the gear portion and the positioning portion may be differently positioned on a circumference of an imaginary circle centered on the support shaft on which the driving gear is rotatable.

(6) In the manual unlocking device of (5), the drawing member may be the cable configured to move between a start point and an end point in a direction along the linear motion, and the manual unlocking device may further include a restriction wall configured to restrict rotational motion of the driving gear by contacting the driving gear before the cable reaches the start point or end point as a result of moving in the direction along the linear motion.

(7) In the manual unlocking device of any one of (4) to (6), the first link may be configured to rotate on a first shaft that is parallel to the support shaft and that is positioned in the coupling portion where the one end of the first link is coupled with the operating member, and the first shaft may be positioned such that the first shaft does not overlap a route of rotation of the second link, when seen in a direction in which the first shaft extends.

(8) In the manual unlocking device of (2), the links may include: a first link coupled at one end thereof to the operating member such that the first link is rotatable on a coupling portion where the one end of the first link is coupled with the operating member; a second link coupled at one end thereof to the other end of the first link such that the second link is rotatable on a coupling portion where the one end of the second link is coupled with the other end of the first link, and coupled at the other end thereof to a stationary site such that the second link is rotatable on a coupling portion where the other end of the second link is coupled with the stationary site; and a third link coupled at one end thereof to the one end of the second link such that the third link is rotatable on a coupling portion where the one end of the third link is coupled with the one end of the second link, and coupled at the other end thereof to the slider mechanism such that the third link is rotatable on a coupling portion where the other end of the third link is coupled with the slider mechanism. As a result of the rotational motion of the operating member from the locking position to the unlocking position, an imaginary line segment from the one end of the second link to the other end of the second link and an imaginary line segment from the one end of the third link to the other end of the third link may be positioned on a straight line, so that the second and third links are at a dead center.

(9) In the manual unlocking device of (8), the operating member may be rotatable on a support shaft between the locking position and the unlocking position, and the manual unlocking device may further include a transmission member configured to transmit rotation of the support shaft to the one end of the first link.

(10) In the manual unlocking device of (8) or (9), a length of the third link from the one end to the other end may be less than a length of the second link from the one end to the other end.

ADVANTAGEOUS EFFECTS

[0007] According to the present invention, the operating member can remain in the unlocking position without requiring electric power even if an external force is applied to the drawing member from the locking device while the manual unlocking device is in an unlocking state.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

Fig. 1 shows a vehicle door relating to a first embodiment viewed from outside in a width direction.
 Fig. 2 is a perspective view showing a manual unlocking device relating to the first embodiment in a locking state.
 Fig. 3 is a front view showing the manual unlocking device relating to the first embodiment in the locking state.
 Fig. 4 is a front view showing the manual unlocking device relating to the first embodiment in the middle of operating.
 Fig. 5 is a front view showing the manual unlocking device relating to the first embodiment in an unlocking state.
 Fig. 6 is a perspective view showing a manual unlocking device relating to a second embodiment in a locking state.
 Fig. 7 is a front view showing the manual unlocking device relating to the second embodiment in the locking state.
 Fig. 8 is a front view showing the manual unlocking device relating to the second embodiment in the middle of operating.
 Fig. 9 is a front view showing the manual unlocking device relating to the second embodiment in an unlocking state.
 Fig. 10 illustrates a linkage of the manual unlocking device relating to the second embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0009] Embodiments of the present invention will now be described with reference to the attached drawings. The following embodiments are described with reference to an example manual unlocking device configured to manually unlock a locking device for locking a door device for opening or closing a doorway of a railway vehicle (vehicle). In the following description, terms such as "parallel," "orthogonal," "center" and "coaxial" describe relative or absolute positions. These terms are not only strictly used but also allow some tolerances and relative differences in angle and distance as long as the same effects can be still produced. In the drawings used for the following description, members are shown to different scales into recognizable sizes.

<Vehicle Door>

[0010] Fig. 1 shows a vehicle door relating to a first embodiment from outside in a width direction. As shown in Fig. 1, the vehicle door is a double sliding door including a pair of door leaves 11 to open or close a doorway 10 of a vehicle. Fig. 1 shows a state where the door leaves 11 are fully closed.

[0011] In the following description, an XYZ orthogonal coordinate system is used as required. The X direction represents the front-rear direction of the vehicle. The Y direction represents the width direction of the vehicle. The Z direction represents the height direction of the vehicle (the gravitational direction), which is orthogonal to the X and Y directions. The following description is made with the arrows shown in the drawings indicating the X, Y and Z directions, and the head side and the tail side of each arrow indicate the positive (+) side and the negative (-) side, respectively. The outside and the inside in the width direction are respectively denoted as the +Y side and the -Y side. The upper side and the lower side in the gravitational direction are respectively denoted as the +Z side and the -Z side.

[0012] The door leaves 11 may move in the X direction to open or close the doorway 10 when acted upon by a driving force from a driving source (for example, motor), which is not shown. Above the doorway 10, a door device 15 for opening or closing the doorway 10 of the vehicle, and a locking device 16 for locking the door device 15 are provided.

<Manual Unlocking Device>

[0013] A manual unlocking device 1 is configured to manually unlock the locking device 16 for locking the door device 15, which is configured to open or lose the doorway 10 of the vehicle. The manual unlocking device 1 is connected to the locking device 16 via a drawing member 4. For example, the manual unlocking device 1 may be arranged such that it can be operated inside or outside the vehicle. For example, the manual unlocking device 1 may be positioned such that it can be operated by a passenger, a crew member, a station staff member in case of emergency. For example, the manual unlocking device 1 can be arranged in any other manners as required by design specifications.

[0014] Fig. 2 is a perspective view showing the manual unlocking device 1 relating to the first embodiment in a locking state. Fig. 3 is a front view showing the manual unlocking device 1 relating to the first embodiment in the locking state. Fig. 4 is a front view showing the manual unlocking device 1 relating to the first embodiment in the middle of operating. Fig. 5 is a front view showing the manual unlocking device 1 relating to the first embodiment in an unlocking state. Referring to Figs. 2 to 5, the manual unlocking device 1 includes an operating member 2, a converting mechanism 3, a drawing member 4, a slider mechanism 5, a gear mechanism 6 and a restriction wall 7. The manual unlocking device 1 further includes a case 8 housing therein part of the converting mechanism 3, drawing member 4, slider mechanism 5, gear mechanism 6 and restriction wall 7. In the respective drawings, part of the case 8 (for example, a cover) is not shown.

<Operating Member>

[0015] The operating member 2 is configured to perform rotational motion between a locking position (shown in Fig. 3) and an unlocking position (shown in Fig. 5) as operated manually. The operating member 2 is rotatable 90 degrees on a support shaft 20 between the locking position and the unlocking position. In the locking position, the operating member 2 extends in the vertical direction. In the unlocking position, the operating member 2 extends in the horizontal direction. The operating member 2 has a portion coupled with the support shaft 20, and another portion that is opposite to the coupled portion. The latter portion is externally exposed or positioned outside the case 8 when the operating member 2 moves between the locking position and the unlocking position.

<Converting Mechanism>

[0016] The converting mechanism 3 converts the rotational motion of the operating member 2 into linear motion. The converting mechanism 3 has a plurality of links 21 and 22 configured to reach a dead center as a result of the rotational motion of the operating member 2 from the locking position to the unlocking position. The slider mechanism 5 is connected to the operating member 2 via the links 21 and 22. The slider mechanism 5 and converting mechanism 3 together constitute a slider crank mechanism. The links 21 and 22 include a first link 21 and a second link 22. The first link 21 is coupled at its one end to the operating member 2 such that it is rotatable on the coupling portion where the one end of the first link 21 is coupled with the operating member 2. The second link 22 is coupled at its one end to the other end of the first link 21 such that it is rotatable on the coupling portion where the one end of the second link 22 is coupled with the other end of the first link 21, and coupled at its other end to the slider mechanism 5 such that it is rotatable on the coupling portion where the other end of the second link 22 is coupled with the slider mechanism 5.

[0017] The first link 21 is configured to rotate on a first shaft 25 that is parallel to the support shaft 20 and that is positioned in the coupling portion where the one end of the first link 21 is coupled with the operating member 2. The first link 21 extends in the vertical direction with the other end of the first link 21 being positioned above the one end when the operating member 2 is in the locking position. The first link 21 extends in the vertical direction with the other end of the first link 21 being positioned below the one end when the operating member 2 is in the unlocking position.

[0018] The second link 22 is configured to rotate on a second shaft 26 that is parallel to the first shaft 25 and that is positioned in the coupling portion where the one end of the second link 22 is coupled with the other end of the first link 21. The second link 22 extends in the vertical direction with the other end of the second link 22 being positioned above the one end when the operating member 2 is in either the locking or unlocking position. Specifically, the second link 22 originates at the one end and terminates at the other end, with the portion of the second link 22 including the one end extending toward the upper right in the drawing and the portion of the second link 22 including the other end extending toward the upper left in the drawing, when the operating member 2 is in either the locking or unlocking position. The second link 22 is V-shaped when seen in the direction in which the second shaft 26 extends. Specifically, the minimum angle of the V shape is obtuse.

<Drawing Member>

[0019] For example, the drawing member 4 is a cable. The drawing member 4 is coupled at its one end to the converting mechanism 3. The drawing member 4 is coupled at its other end to the locking device 16. The drawing member 4 can transmit, to the locking device 16, the linear motion transmitted thereto from the converting mechanism 3, thereby unlocking the door device 15. The drawing member 4 is configured to move between a start point P1 and an end point P2 in synchronization with a slider 31 in the direction along the linear motion.

[0020] Although not shown, the drawing member 4 may receive a pressing force (elastic force) acted upon by an elastic member such as a spring constituting the locking device 16. This means that the drawing member 4 is subject to a force that draws the drawing member 4 upwards in the vertical direction.

<Slider Mechanism>

[0021] The slider mechanism 5 supports the drawing member 4 (for example, an inner cable) such that the drawing member 4 is allowed to move in the direction along the linear motion. The other end of the drawing member 4 is secured onto the slider mechanism 5. The other end of the second link 22 is coupled with the slider mechanism 5.

[0022] According to the shown example, the slider mechanism 5 includes a slider 31 and a guide rail 32. The slider 31 has a protrusion 30 protruding toward the upper right in the drawing, and the guide rail 32 extends in the vertical direction. The slider 31 is supported on the guide rail 32 such that it can move along the guide rail 32. The slider mechanism 5 can be configured in any other manners as required by design specifications.

[0023] The slider 31 may receive the pressing force (elastic force) acted upon by the elastic member such as a spring via the drawing member 4. The slider 31 is thus subject to a force that draws the slider 31 as well as the drawing member 4

upward in the vertical direction.

[0024] The second link 22 is coupled at its other end to the tip of the protrusion 30 of the slider 31 such that it is rotatable on the coupling portion where the other end of the second link 22 is coupled with the tip of the protrusion 30. The second link 22 is configured to rotate on a third shaft 27 that is parallel to the second shaft 26 and that is positioned in the coupling portion where the other end of the second link 22 is coupled with the tip of the protrusion 30 of the slider 31.

<Gear Mechanism>

[0025] The gear mechanism 6 reduces the rotation of the support shaft 20 by a predetermined reduction ratio and transmits the reduced rotation to the one end of the first link 21. The gear mechanism 6 includes a driving gear 40 and a driven gear 50 that meshes with the driving gear 40 and that is driven to rotate.

[0026] The driving gear 40 is rotatably coupled with the support shaft 20 with the center of rotation being placed on the support shaft 20. The driven gear 50 is coupled with the one end of the first link 21 with the center of rotation being placed on the one end of the first link 21. The driven gear 50 meshes with the driving gear 40 to transmit the rotational motion of the operating member 2 to the first link 21.

[0027] Here, a gear ratio B/A is defined as $1/2$, where A and B respectively represent the numbers of teeth at the driving and driven gears 40 and 50. The gear ratio B/A is not limited to this value, and may be less than or greater than $1/2$. For example, the gear ratio B/A can be modified as required by design specifications.

[0028] The driving gear 40 includes a gear portion 41 and a positioning portion 42. The gear portion 41 can mesh with the driven gear 50, and the positioning portion 42 is configured to place the driving gear 40 at an intended position when the operating member 2 is at the locking or unlocking position. The gear and positioning portions 41 and 42 are differently positioned on the circumference of an imaginary circle centered on the support shaft 20, on which the driving gear 40 can rotate.

[0029] According to the shown example, the gear portion 41 occupies a central angle of approximately 90 degrees of the imaginary circle centered on the support shaft 20, on which the driving gear 40 can rotate. The gear portion 41 can be arranged in any other manners. The gear portion 41 may occupy a central angle of less than or greater than 90 degrees of the imaginary circle centered on the support shaft 20, on which the driving gear 40 can rotate. For example, the gear portion 41 can be arranged in any other manners as required by design specifications.

[0030] According to the shown example, the positioning portion 42 is positioned on the opposite side of the gear portion 41 in the radial direction of the circle centered on the support shaft 20, on which the driving gear 40 can rotate. The driving gear 40 includes a first depression 43 and a second depression 44. The first depression 43 can keep the driving gear 40 at an intended position while the operating member 2 is at the locking position, and the second depression 44 can keep the driving gear 40 at an intended position while the operating member 2 is at the unlocking position. The positioning portion 42 includes a wall portion having the first and second depressions 43 and 44 of the driving gear 40.

[0031] According to the shown example, a plunger 61 is provided on an inclined wall 60 of the case 8. The plunger 61 is a ball plunger, for example. The plunger 61 has a protrusion 62 (for example, a part of a ball) protruding toward the support shaft 20, on which the driving gear 40 can rotate. According to the shown example, the protrusion 62 of the plunger 61 protrudes toward the lower left in the drawing from the inclined wall 60 of the case 8. The present embodiment is not limited to the above, and the protrusion 62 of the plunger 61 can protrude in any other manners as required by design specifications.

[0032] For example, when the operating member 2 is at the locking position, the protrusion 62 of the plunger 61 is fitted in the first depression 43 of the driving gear 40. This enables the driving gear 40 to be at the intended position while the operating member 2 is at the locking position.

[0033] While the operating member 2 is at the unlocking position, on the other hand, the protrusion 62 of the plunger 61 is fitted in the second depression 44 of the driving gear 40. This enables the driving gear 40 to be at the intended position while the operating member 2 is at the unlocking position.

<Restriction Wall>

[0034] As the drawing member 4 moves in the direction along the linear motion, the restriction wall 7 can restrict the rotational motion of the driving gear 40 by contacting the driving gear 40 before the drawing member 4 reaches the start point P1 or end point P2. In the illustrated example, the restriction wall 7 is provided on the surface of the case 8 that faces the driving gear 40. The restriction wall 7 includes a first wall portion 71 and a second wall portion 72. The first wall portion 71 can restrict the rotational motion of the driving gear 40 by contacting the driving gear 40 before the drawing member 4 reaches the end point P2 as a result of moving in the direction along the linear motion from the start point P1 to the end point P2. The second wall portion 72 can restrict the rotational motion of the driving gear 40 by contacting the driving gear 40 before the drawing member 4 reaches the start point P1 as a result of moving in the direction along the linear motion from the end point P2 toward the start point P1.

[0035] For example, when the operating member 2 is at the locking position, a part of the driving gear 40 is in contact with the second wall portion 72. This part of the driving gear 40 is one of the ends of the gear portion 41 in the direction of the rotational motion of the driving gear 40. The second wall portion 72 can thus protect the gear portion 41 of the driving gear 40 by preventing a load from being applied to the gear portion 41 of the driving gear 40 even if the rotational motion of the operating member 2 results in the operating member 2 reaching beyond the locking position.

[0036] On the other hand, when the operating member 2 is at the unlocking position, a different part of the driving gear 40 is in contact with the first wall portion 71. The different part of the driving gear 40 is the other of the ends of the gear portion 41 in the direction of the rotational motion of the driving gear 40. The first wall portion 71 can thus protect the gear portion 41 of the driving gear 40 by preventing a load from being applied to the gear portion 41 of the driving gear 40 even if the rotational motion of the operating member 2 results in the operating member 2 reaching beyond the unlocking position.

<How to Arrange First Shaft>

[0037] The first shaft 25 is positioned such that it does not overlap the route of the rotation of the second link 22, when seen in the direction in which the first shaft 25 extends. The first shaft 25 is positioned lower than the one end of the second link 22 in the vertical direction when the operating member 2 is in the locking position. The first shaft 25 is positioned higher than the one end of the second link 22 in the vertical direction when the operating member 2 is in the unlocking position. The first shaft 25 is positioned in the space between the opposite ends of the second link 22 when the operating member 2 is in the unlocking position.

<Locking State/Unlocking Operation>

[0038] Fig. 3 is a front view showing the manual unlocking device 1 relating to the first embodiment in the locking state. Fig. 4 is a front view showing the manual unlocking device 1 relating to the first embodiment in the middle of operating. Fig. 5 is a front view showing the manual unlocking device 1 relating to the first embodiment in the unlocking state. The following now describes, as an example, the locked state of the door and how to manually unlock the door with reference to Figs. 3 to 5.

<Example of Locked State>

[0039] Referring to Figs. 1 and 3, the door leaves 11 are fully closed and locked by the locking device 16 in an ordinary circumstance, for example, while the vehicle is traveling. For example, the door leaves 11 are locked while the vehicle is traveling, or if the door leaves 11 face away from a platform and cannot be used for passengers boarding or disembarking.

[0040] Referring to Fig. 3, the cable (drawing member 4) is drawn upward in the vertical direction by a pressing force (elastic force) exerted by a not-shown elastic member such as a spring. Along with the cable, the slider 31 is also drawn upward in the vertical direction. The slider 31 is positioned near the start point P1 in the direction along the linear motion of the cable.

<Example of Unlocking Operation>

[0041] Referring to Figs. 3 to 5, the operating member 2 is rotated in the direction indicated by the arrow R in case of emergency or for maintenance purpose. For example, the operating member 2 is rotated 90 degrees on the support shaft 20 between the locking position and the unlocking position. In this case, the driving gear 40, which is rotatably coupled with the support shaft 20 with the center of rotation being placed on the support shaft 20, is rotated in the direction indicated by the arrow R1.

[0042] Here, the driven gear 50, which meshes with the driving gear 40, is rotated in the direction indicated by the arrow R2 on the first shaft 25. An example case is assumed where the gear ratio B/A is 1/2. In this case, a 90 degree rotation of the operating member 2 on the support shaft 20 can result in a 180 degree rotation of the driven gear 50 on the first shaft 25.

[0043] As a result of this rotation of the driven gear 50, the rotational motion of the operating member 2 is transmitted to the first link 21. The second link 22 then rotationally moves as shown in Figs. 3, 4 and 5. The one end of the second link 22 is located below the first shaft 25 in the vertical direction in Fig. 5.

[0044] As a result of the rotational movement of the second link 22, the rotational motion of the operating member 2 is converted into downward linear motion in the vertical direction. This causes the slider 31 to move downward in the vertical direction along the guide rail 32. Concurrently, the cable overcomes the pressing force applied by the elastic member such as a spring and is drawn via the slider 31 downward in the vertical direction. In this manner, the linear motion transmitted from the converting mechanism 3 is transmitted to the locking device 16, thereby unlocking the door device 15.

[0045] On completion of the rotational motion of the operating member 2 from the locking position to the unlocking position, an imaginary line segment from the one end of the first link 21 to the other end of the first link 21, and an imaginary

line segment from the one end of the second link 22 to the other end of the second link 22 are positioned on a straight line. In other words, the first and second links are at a dead center. When the operating member 2 is at the unlocking position as shown in Fig. 5, the imaginary line segment from the one end of the first link 21 to the other end of the first link 21 and the imaginary line segment from the one end of the second link 22 to the other end of the second link 22 are on the same vertical line.

[0046] While the operating member 2 is at the unlocking position as shown in Fig. 5, the protrusion 62 of the plunger 61 is fitted in the second depression 44 of the driving gear 40, so that the driving gear 40 is placed at the intended position. For example, while being in the unlocking position, the operating member 2 may move back to the original position (locking position) due to its own weight. The plunger 61 can stop this from happening.

<Advantageous Effects>

[0047] As described above, the manual unlocking device 1 relating to the first embodiment is configured to manually unlock the locking device 16 for locking the door device 15, which is configured to open or close the doorway 10 of the vehicle. The manual unlocking device 1 includes: the operating member 2 configured to perform rotational motion between the locking position and the unlocking position when manually operated; the converting mechanism 3 configured to convert the rotational motion of the operating member 2 into the linear motion; and the drawing member 4 coupled at one end thereof to the converting mechanism 3 and at the other end thereof to the locking device 16, the drawing member 4 being configured to transmit, to the locking device 16, the linear motion transmitted thereto from the converting mechanism 3, thereby unlocking the door device 15. The converting mechanism 3 has the links 21 and 22, which may reach a dead center as a result of the rotational motion of the operating member 2 from the locking position to the unlocking position.

[0048] According to the above, the operating member 2 is operated to perform rotational motion, so that the operating member 2 reaches the unlocking position. As a result, the door device 15 can be unlocked. On completion of this, the links 21 and 22 may be at a dead center. An external force may be applied from the locking device 16 to the drawing member 4 while the manual unlocking device 1 is in the unlocking state. According to the first embodiment, the operating member 2 can stay at the unlocking position without requiring electric power consumption.

[0049] The manual unlocking device 1 relating to the first embodiment uses a cable as the drawing member 4. The manual unlocking device 1 further includes the slider mechanism 5 to which the cable is secured. The slider mechanism 5 supports the cable such that the cable is movable in the direction along the linear motion. The slider mechanism 5 is connected to the operating member 2 via the links 21 and 22. As configured in this way, the cable can be drawn via the slider mechanism 5. Unlocking can be thus performed in a stable manner.

[0050] In the manual unlocking device 1 relating to the first embodiment, the links 21 and 22 include the first link 21 and second link 22. The first link 21 is coupled at its one end to the operating member 2 such that the first link is rotatable on the coupling portion where the one end of the first link 21 is coupled with the operating member 2. The second link 22 is coupled at its one end to the other end of the first link 21 such that the second link 22 is rotatable on the coupling portion where the one end of the second link 22 is coupled with the other end of the first link 21, and coupled at its other end to the slider mechanism 5 such that the second link 22 is rotatable on the coupling portion where the other end of the second link 22 is coupled with the slider mechanism 5. On completion of the rotational motion of the operating member 2 from the locking position to the unlocking position, the imaginary line segment from the one end of the first link 21 to the other end of the first link 21, and the imaginary line segment from the one end of the second link 22 to the other end of the second link 22 are positioned on a straight line. In other words, the first and second links are at a dead center. According to the above, the operating member 2 is operated to perform rotational motion, so that the operating member 2 reaches the unlocking position. As a result, the door device 15 can be unlocked. On completion of this, the imaginary line segment from the one end of the first link 21 to the other end of the first link 21, and the imaginary line segment from the one end of the second link 22 to the other end of the second link 22 are positioned on a straight line. In other words, the first and second links 21 and 22 are at a dead center. An external force may be applied from the locking device 16 to the drawing member 4 while the operating member 2 is at the unlocking position. According to the first embodiment, the operation member 2 can stay at the unlocking position without requiring electric power consumption.

[0051] In the manual unlocking device 1 relating to the first embodiment, the operating member 2 is rotatable 90 degrees on the support shaft 20 between the locking position and the unlocking position. The manual unlocking device 1 further includes the gear mechanism 6 configured to reduce the rotation of the support shaft 20 by a predetermined reduction ratio and transmit the reduced rotation to the one end of the first link 21. According to the above, since the amount of rotational motion of the operating member 2 can be amplified, the cable can be drawn by a certain amount with a shorter first link 21.

[0052] In the manual unlocking device 1 relating to the first embodiment, the gear mechanism 6 includes: the driving gear 40 rotatably coupled with the support shaft 20 with the center of rotation being placed on the support shaft 20; and the driven gear 50 coupled with the one end of the first link 21 with the center of rotation being placed on the one end of the first link 21, the driven gear 50 meshing with the driving gear 40 to transmit the rotational motion of the operating member 2 to the first link 21. The driving gear 40 includes: the gear portion 41 meshing with the driven gear 50; and the positioning

portion 42 configured to place the driving gear 40 at an intended position when the operating member 2 is at the locking or unlocking position. The gear portion 41 and positioning portion 42 are differently positioned on the circumference of an imaginary circle centered on the support shaft 20, on which the driving gear 40 can rotate. According to the above, the gear portion 41 and positioning portion 42 are arranged on the circumference of the same imaginary circle. For this reason, the positioning portion 42 can assist the operating member 2 in working stably, and the driving gear 40 does not require an increased size.

[0053] In the manual unlocking device 1 relating to the first embodiment, the drawing member 4, specifically, the cable is configured to move between the start point P1 and the end point P2 in the direction along the linear motion. The manual unlocking device 1 further includes the restriction wall 7 for restricting the rotational motion of the driving gear 40 by contacting the driving gear 40 before the cable reaches the start point P1 or end point P2 as a result of moving in the direction along the linear motion. According to the above, the restriction wall 7 can protect the gear portion 41 of the driving gear 40 by preventing a load from being applied to the gear portion 41 of the driving gear 40 even if excessive rotational motion of the operating member 2 results in the operating member 2 reaching beyond the locking or unlocking position.

[0054] In the manual unlocking device 1 relating to the first embodiment, the first link 21 is configured to rotate on the first shaft 25 that is parallel to the support shaft 20 and that is positioned in the coupling portion where the one end of the first link 21 is coupled with the operating member 2. The first shaft 25 is positioned such that it does not overlap the route of the rotation of the second link 22 when seen in the direction in which the first shaft 25 extends. In this manner, the manual unlocking device 1 can avoid an increase in size in the direction in which the first shaft 25 extends, when compared with a case where the first shaft 25 is arranged such that it overlaps the route of the rotation of the second link 22 when seen in the direction in which the first shaft 25 extends.

<Variations>

[0055] According to the foregoing description, the drawing member is a cable, but the present embodiment is not limited to such. For example, the drawing member may be any member other than a cable. For example, the drawing member 10 may include chains, rods and hooks. For example, the drawing member can be configured in any other manners as required by design specifications.

[0056] According to the foregoing description, the manual unlocking device further includes the slider mechanism to which the cable is secured, where the slider mechanism supports the cable such that the cable is movable in the direction along the linear motion. The present embodiment, however, is not limited to such. The manual unlocking device may be embodied without the slider mechanism. For example, the manual unlocking device may be configured such that the cable may be drawn without the slider mechanism. For example, the slider mechanism can be installed in any other manners as required by design specifications.

[0057] According to the foregoing description, the other end of the second link is coupled with the slider mechanism, but the present embodiment is not limited to such. For example, the other end of the second link may not be coupled with the slider mechanism. For example, the other end of the second link may be coupled with the cable without the slider mechanism. For example, the other end of the second link can be coupled in any other manners as required by design specifications.

[0058] According to the foregoing description, the operating member is rotatable 90 degrees on the support shaft between the locking position and the unlocking position, but the present embodiment is not limited to such. For example, the operating member may be rotatable less than or greater than 90 degrees on the support shaft between the locking position and the unlocking position. For example, the operating member can be configured to rotate any other degrees on the support shaft between the locking position and the unlocking position as required by design specifications.

[0059] According to the foregoing description, the manual unlocking device further includes the gear mechanism configured to reduce the rotation of the support shaft by a predetermined reduction ratio and transmit the reduced rotation to the one end of the first link, but the present embodiment is not limited to such. For example, the manual unlocking device may be embodied without the gear mechanism. For example, the manual unlocking device may include a belt pulley mechanism, a mechanism including a chain, or the like in place of the gear mechanism. For example, the one end of the first link may be coupled with the operating member such that the first link is rotatable on the coupling portion where the one end of the first link is coupled with the operating member. For example, the gear mechanism can be installed in any other manners as required by design specifications.

[0060] According to the foregoing description, the gear mechanism includes: the driving gear rotatably coupled with the support shaft with the center of rotation being placed on the support shaft; and the driven gear coupled with the one end of the first link with the center of rotation being placed on the one end of the first link, the driven gear meshing with the driving gear to transmit the rotational motion of the operating member to the first link. The driving gear includes: the gear portion meshing with the driven gear; and the positioning portion configured to position the driving gear at an intended position when the operating member is at the locked or unlocking position. The present embodiment, however, is not limited to such. For example, the driving gear may be embodied with the gear portion but without the positioning portion. For

example, the driving gear can be configured in any other manners as required by design specifications.

[0061] According to the foregoing description, the gear portion and positioning portion are differently positioned on the circumference of an imaginary circle centered on the support shaft, on which the driving gear can rotate. The present embodiment, however, is not limited to such. For example, the gear portion and positioning portion may not be differently positioned on the circumference of an imaginary circle centered on the support shaft, on which the driving gear can rotate. For example, the gear portion and positioning portion may be positioned on the circumferences of imaginary circles having different diameters that are both centered on the support shaft, on which the driving gear can rotate. For example, the gear portion and positioning portion can be arranged in any other manners as required by design specifications.

[0062] According to the foregoing description, the drawing member or cable is configured to move between the start point and the end point in the direction along the linear motion, and the manual unlocking device further includes the restriction wall for restricting the rotational motion of the driving gear by contacting the driving gear before the cable reaches the start or end point as a result of moving in the direction along the linear motion. The present embodiment, however, is not limited to such. For example, the manual unlocking device may be embodied without the restriction wall. For example, the restriction wall can be installed in any other manners as required by design specifications.

[0063] According to the foregoing description, the first link is rotatable on the first shaft that is parallel to the support shaft and that is positioned in the coupling portion where the one end of the first link is coupled with the operating member. The first shaft is positioned such that it does not overlap the route of the rotation of the second link when seen in the direction in which the first shaft extends. The present embodiment, however, is not limited to such. For example, the first shaft may be positioned such that it overlaps the route of the rotation of the second link, when seen in the direction in which the first shaft extends. For example, the first shaft can be installed in any other manners as required by design specifications.

<Second Embodiment>

[0064] The following describes a manual unlocking device 201 relating to a second embodiment. In the following description, parts having the same functions as those of the first embodiment will have the same names and reference numerals, and their functions will not be specifically described.

[0065] Fig. 6 is a perspective view showing the manual unlocking device 201 relating to the second embodiment in a locking state. Fig. 7 is a front view showing the manual unlocking device 201 relating to the second embodiment in the locking state. Fig. 8 is a front view showing the manual unlocking device 201 relating to the second embodiment in the middle of operating. Fig. 9 is a front view showing the manual unlocking device 201 relating to the second embodiment in an unlocking state. Referring to Figs. 6 to 9, the manual unlocking device 201 includes an operating member 2, a converting mechanism 203, a drawing member 4, a slider mechanism 5, a transmission member 209 and a case 8. In the respective drawings, part of the case 8 (for example, a cover) is not shown.

[0066] The operating member 2 is configured to rotate between a locking position (shown in Fig. 7) and an unlocking position (shown in Fig. 9) as operated manually. The operating member 2 is rotatable 90 degrees on a support shaft 20 between the locking position and the unlocking position. In the locking position, the operating member 2 extends in the vertical direction. In the unlocking position, the operating member 2 extends in the horizontal direction.

[0067] The converting mechanism 203 converts the rotational motion of the operating member 2 into linear motion. The converting mechanism 203 has a plurality of links 221, 222, 223 that are configured to reach a dead center as a result of the rotational motion of the operating member 2 from the locking position to the unlocking position. The slider mechanism 5 is connected to the operating member 2 via the links 221, 222, 223. The slider mechanism 5 and conversion mechanism 203 together constitute a slider crank mechanism. The links 221, 222 and 223 include a first link 221, a second link 222 and a third link 223. The first link 221 is coupled at its one end to the operating member 2 such that it is rotatable on the coupling portion where the one end of the first link 221 is coupled with the operating member 2. The second link 222 is coupled at its one end to the other end of the first link 221 such that the second link 222 is rotatable on the coupling portion where the one end of the second link 222 is coupled with the other end of the first link 221, and coupled at its other end to the case 8 (an example of a stationary site) such that the second link 222 is rotatable on the coupling portion where the other end of the second link 222 is coupled with the case 8. The third link 223 is coupled at its one end to the one end of the second link 222 such that the third link 223 is rotatable on the coupling portion where the one end of the third link 223 is coupled with the one end of the second link 222, and coupled at its other end to the slider mechanism 5 such that the third link 223 is rotatable on the coupling portion where the other end of the third link 223 is coupled with the slider mechanism 5.

[0068] The first link 221 is configured to rotate on a first shaft 225 that is parallel to the support shaft 20 and that is positioned in the coupling portion where the one end of the first link 221 is coupled with the operating member 2. The first link 221 extends toward the upper left with the other end of the first link 221 being positioned above the one end when the operating member 2 is in the locking position (see Fig. 7). The first link 221 extends toward the upper left with the other end of the first link 221 being positioned above the one end at a smaller gradient than in the case shown in Fig. 7 when the operating member 2 is in the unlocking position (see Fig. 9).

[0069] The first link 221 has one end supporting part of the transmission member 209 on either side in the X direction, and

the other end supporting one end of the second link 222 and one end of the third link 223 on either side in the X direction. The first link 221 is configured to support target components on either side. The present embodiment is not limited to this, and the first link 221 may be configured to support target components on one side. The first link 221 can be configured in any other manners as required by design specifications.

[0070] The length of the second link 222 from the one end to the other end is less than the length of the first link 221 from the one end to the other end. The second link 222 is configured to rotate on a second shaft 226 that is parallel to the first shaft 225 and that is positioned in the coupling portion where the one end of the second link 222 is coupled with the other end of the first link 221. The second link 222 is configured to rotate on a third shaft 227 that is parallel to the second shaft 226 and that is positioned in the coupling portion where the other end of the second link 222 is coupled with the case 8. The second link 222 extends toward the upper left with the other end of the second link 222 being positioned above the one end at a greater gradient than the first link 221 when the operating member 2 is at the locking position (see Fig. 7). The second link 222 extends in the vertical direction with the other end of the second link 222 being positioned above the one end when the operating member 2 is at the unlocking position.

[0071] The length of the third link 223 from the one end to the other end is less than the length of the second link 222 from the one end to the other end. The third link 223 is configured to rotate on the second shaft 226 that is positioned in the coupling portion where the one end of the third link 223 is coupled with the one end of the second link 222. The third link 223 is coupled such that it is rotatable on a fourth shaft 228 that is parallel to the third shaft 227 and that is positioned in the coupling portion where the other end of the third link 223 is coupled with the slide mechanism 5. The third link 223 extends toward the lower left with the other end of the third link 223 being positioned below the one end (at a gradient close to zero) when the operating member 2 is at the locking position (see Fig. 7). The third link 223 extends in the vertical direction with the other end of the third link 223 being positioned below the one end when the operating member 2 is at the unlocking position (see Fig. 9).

[0072] The drawing member 4 is coupled at one end to the converting mechanism 203. The drawing member 4 is coupled at the other end to the locking device 16. The drawing member 4 can transmit, to the locking device 16, the linear motion transmitted thereto from the converting mechanism 203, thereby unlocking the door device 15. The drawing member 4 is configured to move between a start point P1 and an end point P2 in synchronization with a slider 31 in the direction along the linear motion.

[0073] The slider mechanism 5 supports the drawing member 4 (for example, an inner cable) such that the drawing member 4 is allowed to move in the direction along the linear motion. The other end of the drawing member 4 is secured onto the slider mechanism 5. The third link 223 is coupled with the slider mechanism 5 such that it is rotatable on the coupling portion where the other end of the third link 223 is coupled with the slider mechanism 5.

[0074] The slider mechanism 5 includes the slider 31 and a guide rail 32. The slider 31 has the fourth shaft 228, and the guide rail 32 extends in the vertical direction. The slider 31 is supported on the guide rail 32 such that it can move along the guide rail 32. The present embodiment is not limited to the above, and the slider mechanism 5 can be configured in any other manners as required by the design specifications.

[0075] The slider 31 may receive a pressing force (elastic force) acted upon by an elastic member such as a spring via the drawing member 4. The slider 31 is thus subject to a force that draws the slider 31 as well as the drawing member 4 upward in the vertical direction.

[0076] The transmission member 209 transmits the rotation of the shaft 20 to the one end of the first link 221. The transmission member 209 includes a first transmission portion 291, a second transmission portion 292, and a positioning portion 42. The first transmission portion 291 has the support shaft 20. The second transmission portion 292 has the first shaft 225. The positioning portion 42 is configured to place the transmission member 209 at an intended position when the operating member 2 is at the locking or unlocking position.

[0077] The first transmission portion 291 is coupled with the operating member 2 via the support shaft 20 with the center of rotation being placed on the support shaft 20. The second transmission portion 292 is coupled with the first transmission portion 291 such that they constitute a single piece, and transmits the rotational motion of the operating member 2 to the first link 221.

[0078] The second transmission portion 292 has one end overlapping the support shaft 20 when seen in the direction in which the first shaft 225 extends. The second transmission portion 292 has the other end where the first shaft 225 is provided. The second transmission portion 292 extends such that the other end of the second transmission portion 292 is positioned on the right side of the one end when the operating member 2 is at the locking position (see Fig. 7). The second transmission portion 292 extends in the vertical direction with the other end of the second transmission portion 292 being positioned above the one end when the operating member 2 is at the unlocking position (see Fig. 9).

[0079] The positioning portion 42 is provided on the outer periphery of the first transmission portion 291 of the transmission member 209. The first transmission portion 291 has a first depression 43 and a second depression 44. The first depression 43 can keep the transmission member 209 at the intended position while the operating member 2 is at the locking position, and the second depression 44 can keep the transmission member 209 at the intended position while the operating member 2 is at the unlocking position. The positioning portion 42 includes a wall portion having the first and

second depressions 43 and 44 of the transmission member 209.

[0080] For example, when the operating member 2 is at the locking position, the protrusion 62 of the plunger 61 is fitted in the first depression 43 of the transmission member 209 (see Fig. 7). This enables the transmission member 209 to be at the intended position while the operating member 2 is at the locking position.

[0081] While the operating member 2 is at the unlocking position, on the other hand, the protrusion 62 of the plunger 61 is fitted in the second depression 44 of the transmission member 209 (see Fig. 9). This enables the transmission member 209 to be at the intended position while the operating member 2 is at the unlocking position.

[0082] The following describes, as an example, how the door leaves are locked and how to manually unlock the door leaves with reference to Figs. 7 to 9. For example, the door leaves 11 are fully closed and locked by the locking device 16 in an ordinary circumstance, for example, while the vehicle is traveling (see Fig. 1). For example, the door leaves 11 are locked while the vehicle is traveling, or if the door leaves 11 face away from a platform and cannot be used for passengers boarding or disembarking.

[0083] Referring to Fig. 7, which corresponds to the locking state, the cable (drawing member 4) is drawn upward in the vertical direction by a pressing force (elastic force) exerted by a not-shown elastic member such as a spring. Along with the cable, the slider 31 is drawn upward in the vertical direction. The slider 31 is positioned near the start point P1 in the direction along the linear motion of the cable.

[0084] Referring to Figs. 7 to 9, the operating member 2 is rotated in the direction indicated by the arrow R. For example, the operating member 2 is rotated 90 degrees on the support shaft 20 between the locking position and the unlocking position. In this case, the transmission member 209, which is coupled with the support shaft 20, is rotated in the direction indicated by the arrow R1.

[0085] As a result of this rotation of the transmission member 209, the rotational motion of the operating member 2 is transmitted to the first link 221. The second and third links 222 and 223 then rotationally move as shown in Figs. 7, 8 and 9. The one end of the second link 222 and the one end of the third link 223 are located below the third shaft 227 in the vertical direction in Fig. 9. Referring to Fig. 9, the second, third and fourth shafts 226, 227 and 228 are aligned with each other on the same vertical line.

[0086] As a result of the rotational movement of the third link 223, the rotational motion of the operating member 2 is converted into downward linear motion in the vertical direction. This causes the slider 31 to move downward in the vertical direction along the guide rail 32. Concurrently, the cable overcomes the pressing force applied by the elastic member such as a spring and is drawn via the slider 31 downward in the vertical direction. In this manner, the linear motion transmitted from the converting mechanism 203 is transmitted to the locking device 16, thereby unlocking the door device 15.

[0087] On completion of the rotational motion of the operating member 2 from the locking position to the unlocking position, an imaginary line segment from the one end of the second link 222 to the other end of the second link 222, and an imaginary line segment from the one end of the third link 223 to the other end of the third link 223 are positioned on a straight line. In other words, the second and third links 222 and 223 are at a dead center. When the operating member 2 is at the unlocking position as shown in Fig. 9, the imaginary line segment from the one end of the second link 222 to the other end of the second link 222 and the imaginary line segment from the one end of the third link 223 to the other end of the third link 223 are on the same vertical line.

[0088] While the operating member 2 is at the unlocking position as shown in Fig. 9, the protrusion 62 of the plunger 61 is fitted in the second depression 44 of the transmission member 209, so that the transmission member 209 is placed at the intended position. For example, while being in the unlocking position, the operating member 2 may move back to the original position (locking position) due to its own weight. The plunger 61 can stop this from happening.

[0089] Fig. 10 shows the linkage of the manual unlocking device 201 relating to the second embodiment. Referring to Fig. 10, the second link 222, third link 223 and slider 31 constitute the linkage. According to the shown example, the third shaft 227 is the fixed pivot, the fourth shaft 228 moves in the vertical direction, the symbols "F1" and "F2" respectively indicate the force applied to the second shaft 226 and the force drawing the cable, and the slider moves in the Z direction. When seen in the X direction, the distance between the central point of the second shaft 226 and the central point of the fourth shaft 228 is less than the distance between the central point of the second shaft 226 and the central point of the third shaft 227.

[0090] The angle (acute angle) formed by the central point of the third shaft 227, the central point of the second shaft 226 and the central point of the fourth shaft 228 is divided by a perpendicular line to the direction of the motion of the slider (Z direction) into an angle A1 and an angle A2. These values are related as indicated by the following Formula 1.

[0091] [Formula 1]

$$\frac{F2}{F1} = \frac{\sin A1 \sin A2}{\sin(A1+A2)} \quad \cdot \cdot \cdot \text{Formula (1)}$$

[0092] As the operating member 2 moves toward the unlocking position, the angle (A1 +A2) increases toward 180

degrees. Therefore, Formula 1 indicates that the force F1 required to produce the cable drawing force F2 may decline. When the operating member 2 is in the vicinity of the unlocking position, the cable drawing force F2 reaches the maximum value, but the force F1 (equivalent to the force required to operate the operating member 2) is reduced. Therefore, the operating member 2 achieves improved operability.

[0093] As described above, the manual unlocking device 201 relating to the second embodiment includes the first, second and third links 221, 222 and 223. The first link 221 is coupled at its one end to the operating member 2 such that it is rotatable on the coupling portion where the one end of the first link 221 is coupled with the operating member 2. The second link 222 is coupled at the one end to the other end of the first link 221 such that it is rotatable on the coupling portion where the one end of the second link 222 is coupled with the other end of the first link 221, and coupled at the other end to the case 8 such that it is rotatable on the coupling portion where the other end of the second link 222 is coupled the case 8. The third link 223 is coupled at its one end to the one end of the second link 222 such that it is rotatable on the coupling portion where the one end of the third link 223 is coupled with the one end of the second link 222, and coupled at its other end to the slider mechanism 5 such that it is rotatable on the coupling portion where the other end of the third link 223 is coupled with the slider mechanism 5. On completion of the rotational motion of the operating member 2 from the locking position to the unlocking position, the imaginary line segment from the one end of the second link 222 to the other end of the second link 222, and the imaginary line segment from the one end of the third link 223 to the other end of the third link 223 are positioned on a straight line. In other words, the second and third links 222 and 223 are at a dead center.

[0094] According to the above, when the operating member 2 is operated to perform rotational motion and reaches the unlocking position to unlock the door device 15, the imaginary line segment from the one end of the second link 222 to the other end of the second link 222 and the imaginary line segment from the one end of the third link 223 to the other end of the third link 223 are on a straight line. This means that the second and third links are at a dead center. An external force may be applied by the locking device 16 to the drawing member 4 while the operating member 2 is at the unlocking position. Even so, the operating member 2 can stay at the unlocking position without requiring electric power consumption.

[0095] In the manual unlocking device 201 relating to the second embodiment, the operating member 2 is rotatable on the support shaft 20 between the locking position and the unlocking position. The manual unlocking device 1 further includes the transmission member 209 configured to transmit the rotation of the support shaft 20 to the one end of the first link 221. As configured in this manner, the manual unlocking device 201 needs no gear mechanism (gear portion) for transmitting the rotation. This can result in improved strength and rigidity.

[0096] In the manual unlocking device 201 relating to the second embodiment, the length of the third link 223 from the one end to the other end is less than the length of the second link 222 from the one end to the other end. The third link 223 can thus follow the rotation of the first link 221 in a better manner than in the case where the length of the third link 223 from the one end to the other end is greater than the length of the second link 222 from the one end to the other end. The operating member 2 can thus achieve improved operability.

[0097] In the manual unlocking device 201 relating to the second embodiment, the second link 222, third link 223 and slider 31 constitute a linkage satisfying Formula 1 mentioned above. Since the links 222 and 223 are at a dead center when the operating member 2 is at the unlocking position, the retaining force can be advantageously increased. At the same time, as the operating member 2 approaches the unlocking position, the load may increase, but the force for drawing the cable can be exerted with reduced force for operating the operating member 2.

<Other Variations>

[0098] The technical scope of the present invention is not limited to the embodiments described above but is susceptible of various modification within the purport of the present invention.

[0099] According to the above embodiments, the vehicle door includes the pair of door leaves separately slidable to open or close the doorway of the railway vehicle. The embodiments, however, are not limited to such. For example, the vehicle door may be provided on vehicles other than railway vehicles. For example, the vehicle door may include a single leaf sliding door.

[0100] According to the second embodiment described above, the second link is coupled at the other end to the case such that the second link is rotatable on the coupling portion where the other end of the second link is coupled with the case, but the embodiment is not limited to such. For example, the second link may be coupled at the other end to a stationary site other than the case, for example, a vehicle body, such that the second link is rotatable on the coupling portion where the other end of the second link is coupled with the stationary site. The other end of the second link can be coupled in any other manners (to any other stationary sites) as required by design specifications.

[0101] The elements of the embodiments described above may be replaced with known elements within the purport of the present invention. Further, the variations described above may be combined. The foregoing embodiments disclosed herein describe a plurality of physically separate constituent parts. They may be combined into a single part, and any one of them may be divided into a plurality of physically separate constituent parts. Irrespective of whether or not the constituent parts are integrated, they are acceptable as long as they are configured to attain the object of the invention. According to

the foregoing embodiments disclosed herein, a plurality of functions are distributively provided. Some or all of the functions may be integrated. Conversely, a plurality of functions may be integrated. Some or all of the functions can be distributively provided. Irrespective of whether or not the functions are integrated or distributed, they are acceptable as long as they are configured to attain the object of the invention.

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LIST OF REFERENCE NUMBERS

[0102]

- 10 1, 201 manual unlocking device
- 2 operating member
- 3, 203 converting mechanism
- 4 drawing member
- 5 slider mechanism
- 15 6 gear mechanism
- 7 restriction wall
- 10 doorway
- 15 door device
- 16 locking device
- 20 20 support shaft
- 21, 221 first link
- 22, 222 second link
- 25 first shaft
- 40 driving gear
- 25 41 gear portion
- 42 positioning portion
- 50 driven gear
- 209 transmission member
- 223 third link
- 30 P1 start point
- P2 end point

Claims

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1. A manual unlocking device (1, 201) for manually unlocking a locking device (16), the locking device being (16) configured to lock a door device (15), the door device (15) being configured to open or close a doorway (10) of a vehicle, the manual unlocking device (1, 201) comprising:

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an operating member (2) configured to perform rotational motion between a locking position and an unlocking position by being manually operated;

a converting mechanism (3, 203) configured to convert the rotational motion of the operating member (2) into linear motion; and

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a drawing member (4) coupled at one end thereof to the converting mechanism (3, 203) and at the other end thereof to the locking device (16), the drawing member (4) being configured to transmit, to the locking device (16), the linear motion transmitted thereto from the converting mechanism (3, 203), thereby unlocking the door device (15),

wherein the converting mechanism (3, 203) has a plurality of links (21, 22, 221, 222, 223) configured to reach a dead center as a result of the rotational motion of the operating member (2) from the locking position to the unlocking position.

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2. The manual unlocking device (1, 201) of claim 1,

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wherein the drawing member (4) is a cable,

wherein the manual unlocking device (1, 201) further comprises a slider mechanism (5) to which the cable is secured, the slider mechanism (5) supporting the cable such that the cable is movable in a direction along the linear motion, and

wherein the slider mechanism (5) is connected to the operating member (2) via the links (21, 22, 221, 222, 223).

3. The manual unlocking device (1) of claim 2,
wherein the links (21, 22) include:

a first link (21) coupled at one end thereof to the operating member (2) such that the first link (21) is rotatable on a coupling portion where the one end of the first link (21) is coupled with the operating member (2); and
a second link (22) coupled at one end thereof to the other end of the first link (21) such that the second link (22) is rotatable on a coupling portion where the one end of the second link (22) is coupled with the other end of the first link (21), and coupled at the other end thereof to the slider mechanism (5) such that the second link (22) is rotatable on a coupling portion where the other end of the second link (22) is coupled with the slider mechanism (5), and
wherein, as a result of the rotational motion of the operating member (2) from the locking position to the unlocking position, an imaginary line segment from the one end of the first link (21) to the other end of the first link (21), and an imaginary line segment from the one end of the second link (22) to the other end of the second link (22) are positioned on a straight line, so that the first and second links (21, 22) are at a dead center.

4. The manual unlocking device (1) of claim 3,

wherein the operating member (2) is rotatable 90 degrees on a support shaft (20) between the locking position and the unlocking position, and
wherein the manual unlocking device (1) further comprises a gear mechanism (6) configured to reduce rotation of the support shaft (20) by a predetermined reduction ratio and transmit the reduced rotation to the one end of the first link (21).

5. The manual unlocking device (1) of claim 4,

wherein the gear mechanism (6) includes:

a driving gear (40) rotatably coupled with the support shaft (20) with a center of rotation thereof being placed on the support shaft (20); and
a driven gear (50) having coupled with the one end of the first link (21) with a center of rotation thereof being placed on the one end of the first link (21), the driven gear (50) meshing with the driving gear (40) to transmit the rotational motion of the operating member (2) to the first link (21),
wherein the driving gear (40) has:

a gear portion (41) meshing with the driven gear (50); and
a positioning portion (42) being configured to place the driving gear (40) at an intended position when the operating member (2) is at the locking or unlocking position, and
wherein the gear portion (41) and the positioning portion (42) are differently positioned on a circumference of an imaginary circle centered on the support shaft (20) on which the driving gear (40) is rotatable.

6. The manual unlocking device (1) of claim 5,

wherein the drawing member (4) is the cable configured to move between a start point (P1) and an end point (P2) in a direction along the linear motion, and
wherein the manual unlocking device (1) further comprises
a restriction wall (7) configured to restrict rotational motion of the driving gear (40) by contacting the driving gear (40) before the cable reaches the start point (P1) or end point (P2) as a result of moving in the direction along the linear motion.

7. The manual unlocking device (1) of any one of claims 4 to 6,

wherein the first link (21) is configured to rotate on a first shaft (25) that is parallel to the support shaft (20) and that is positioned in the coupling portion where the one end of the first link (21) is coupled with the operating member (2), and wherein the first shaft (25) is positioned such that the first shaft (25) does not overlap a route of rotation of the second link (22), when seen in a direction in which the first shaft (25) extends.

8. The manual unlocking device (201) of claim 2,
wherein the links (221, 222, 223) include:

a first link (221) coupled at one end thereof to the operating member (2) such that the first link (221) is rotatable on a coupling portion where the one end of the first link (221) is coupled with the operating member (2);
a second link (222) coupled at one end thereof to the other end of the first link (221) such that the second link (222) is rotatable on a coupling portion where the one end of the second link (222) is coupled with the other end of the first link (221), and coupled at the other end thereof to a stationary site such that the second link (222) is rotatable on a coupling portion where the other end of the second link (222) is coupled with the stationary site; and
a third link (223) coupled at one end thereof to the one end of the second link (222) such that the third link (223) is rotatable on a coupling portion where the one end of the third link (223) is coupled with the one end of the second link (222) and coupled at the other end thereof to the slider mechanism (5) such that the third link (223) is rotatable on a coupling portion where the other end of the third link (223) is coupled with the slider mechanism (5),
wherein, as a result of the rotational motion of the operating member (2) from the locking position to the unlocking position, an imaginary line segment from the one end of the second link (222) to the other end of the second link (222) and an imaginary line segment from the one end of the third link (223) to the other end of the third link (223) are positioned on a straight line, so that the second and third links (222, 223) are at a dead center.

9. The manual unlocking device (201) of claim 8,

wherein the operating member (2) is rotatable on a support shaft (20) between the locking position and the unlocking position, and

wherein the manual unlocking device (201) further comprises

a transmission member (209) configured to transmit rotation of the support shaft (20) to the one end of the first link (221).

10. The manual unlocking device (201) of claim 8 or 9, wherein a length of the third link (223) from the one end to the other end is less than a length of the second link (222) from the one end to the other end.

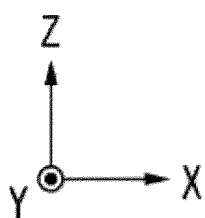
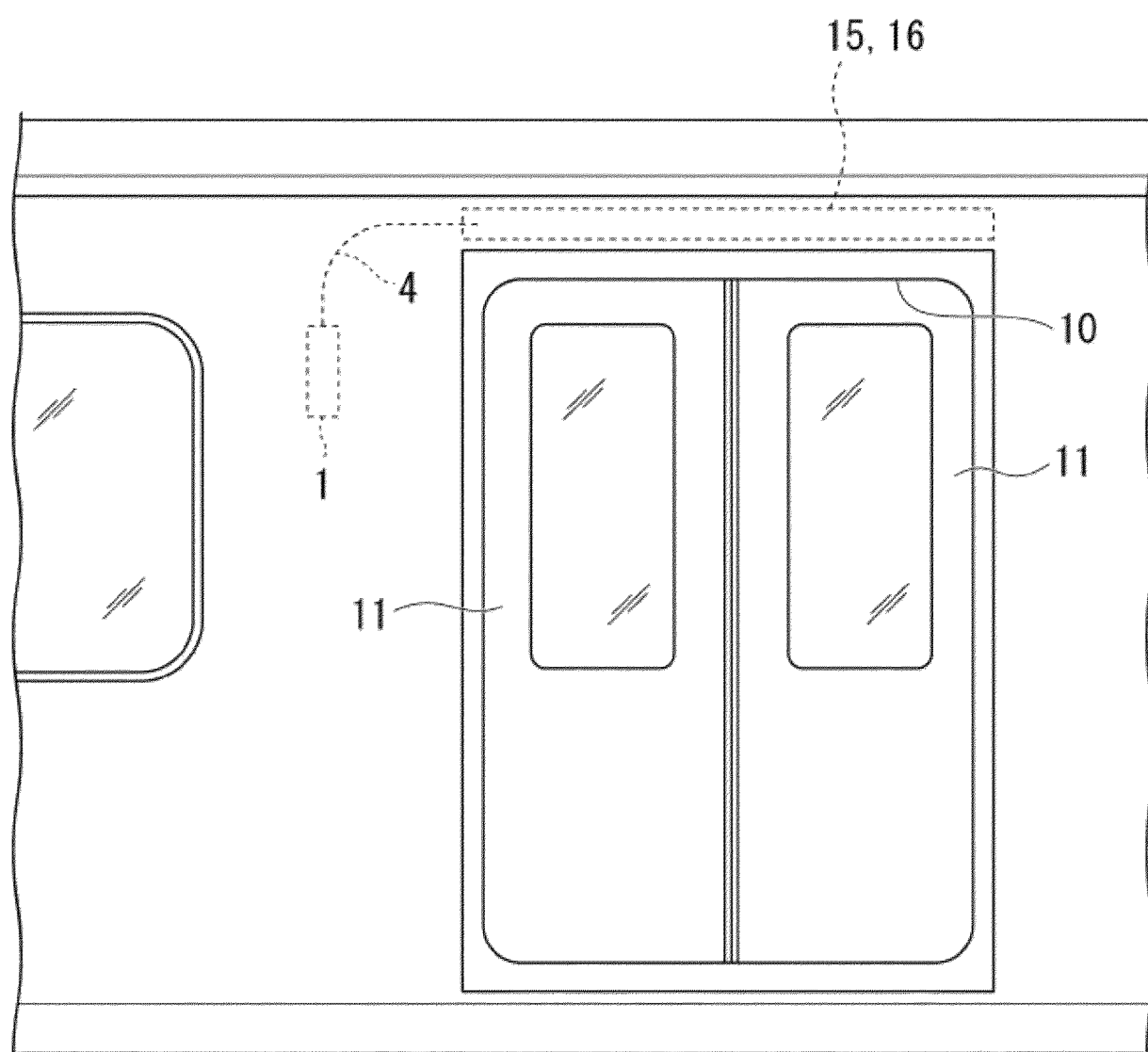


Fig. 1

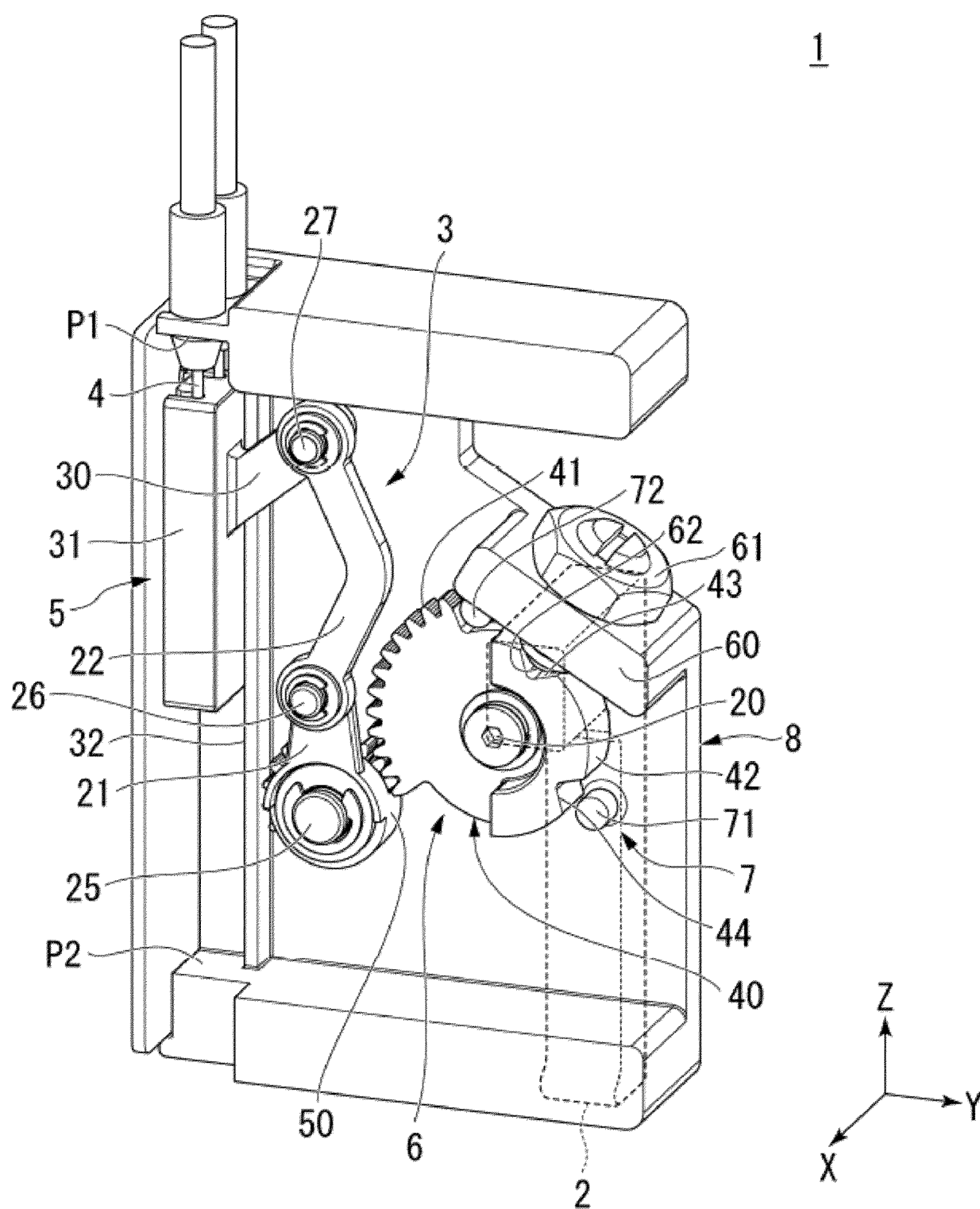


Fig. 2

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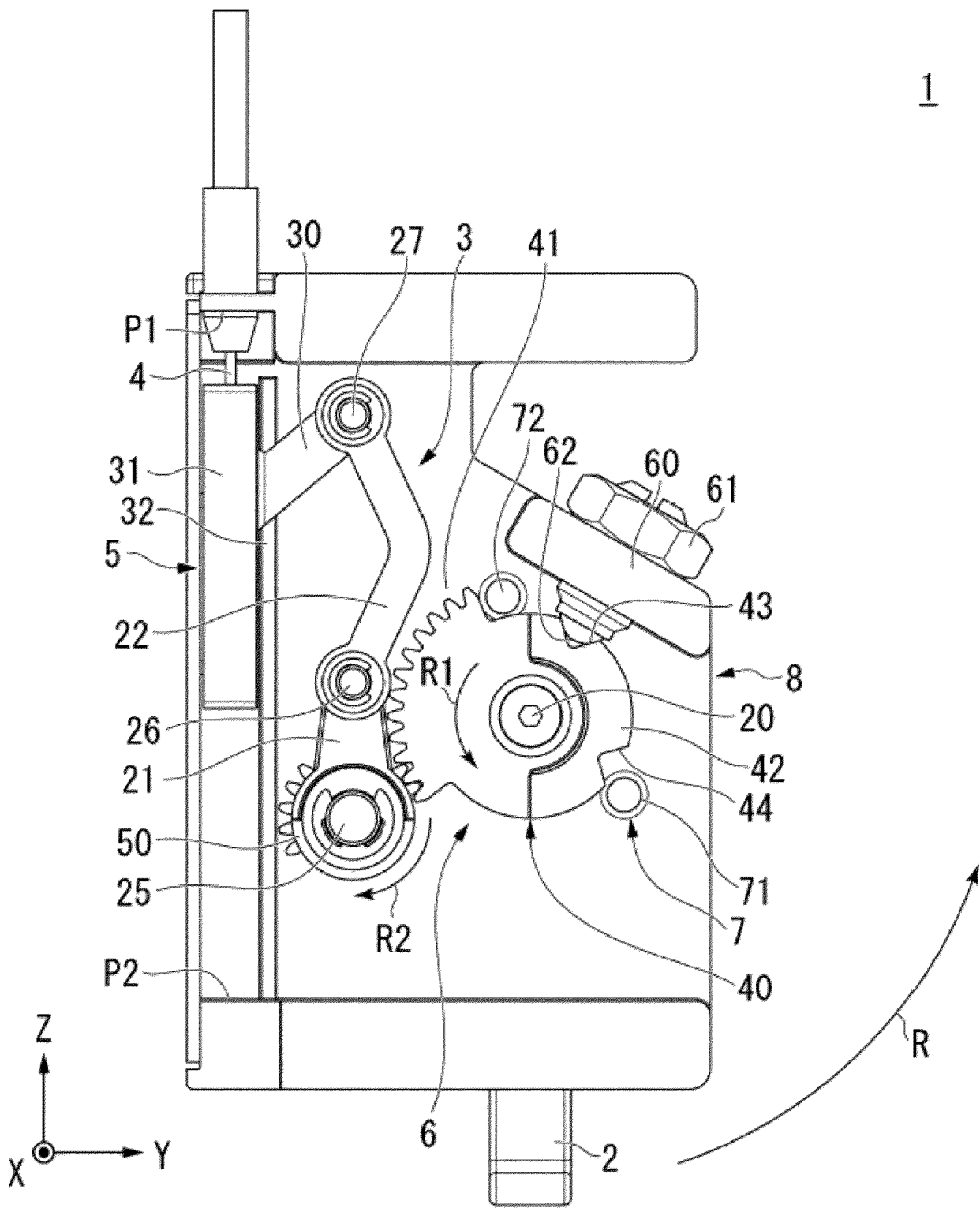


Fig. 3

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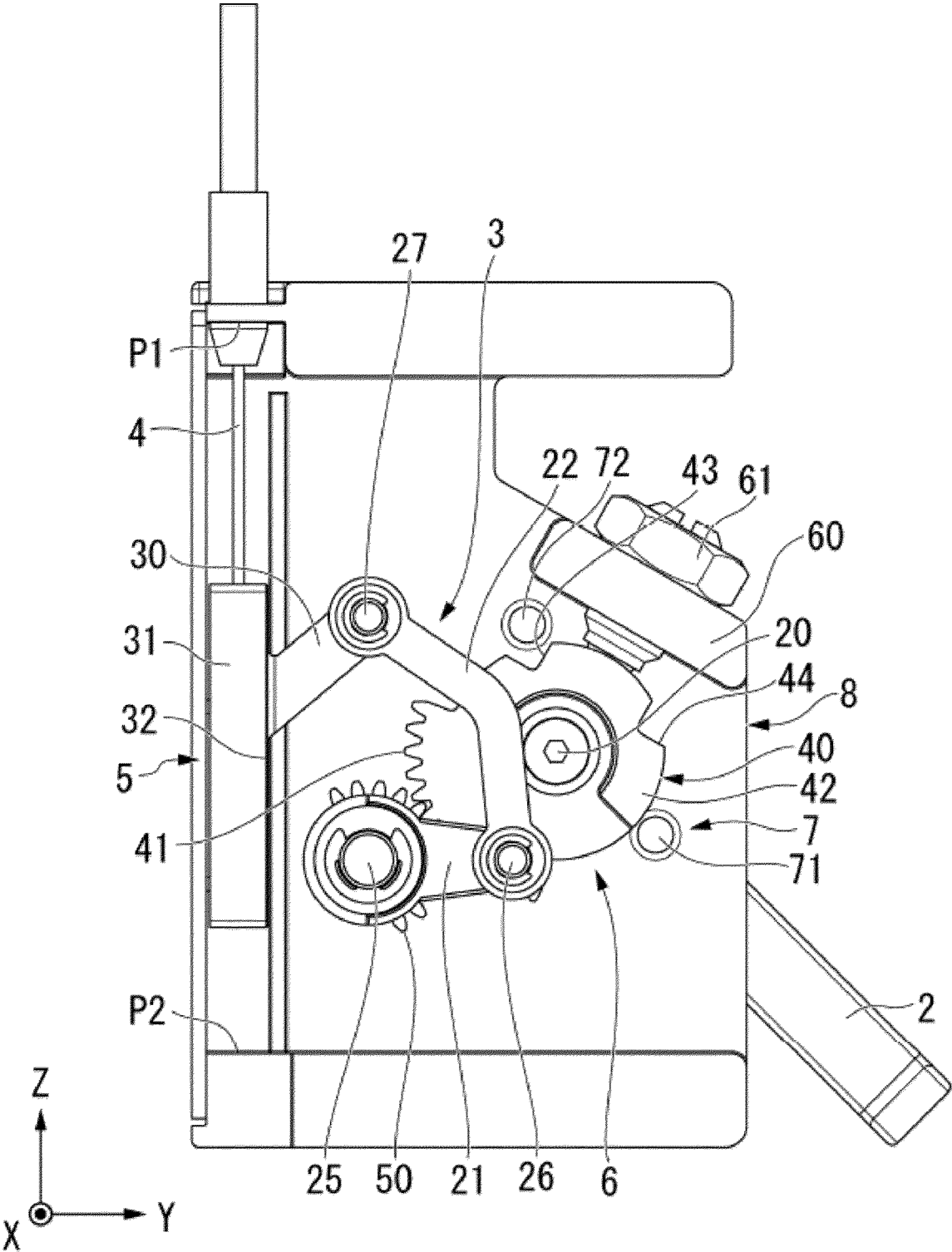


Fig. 4

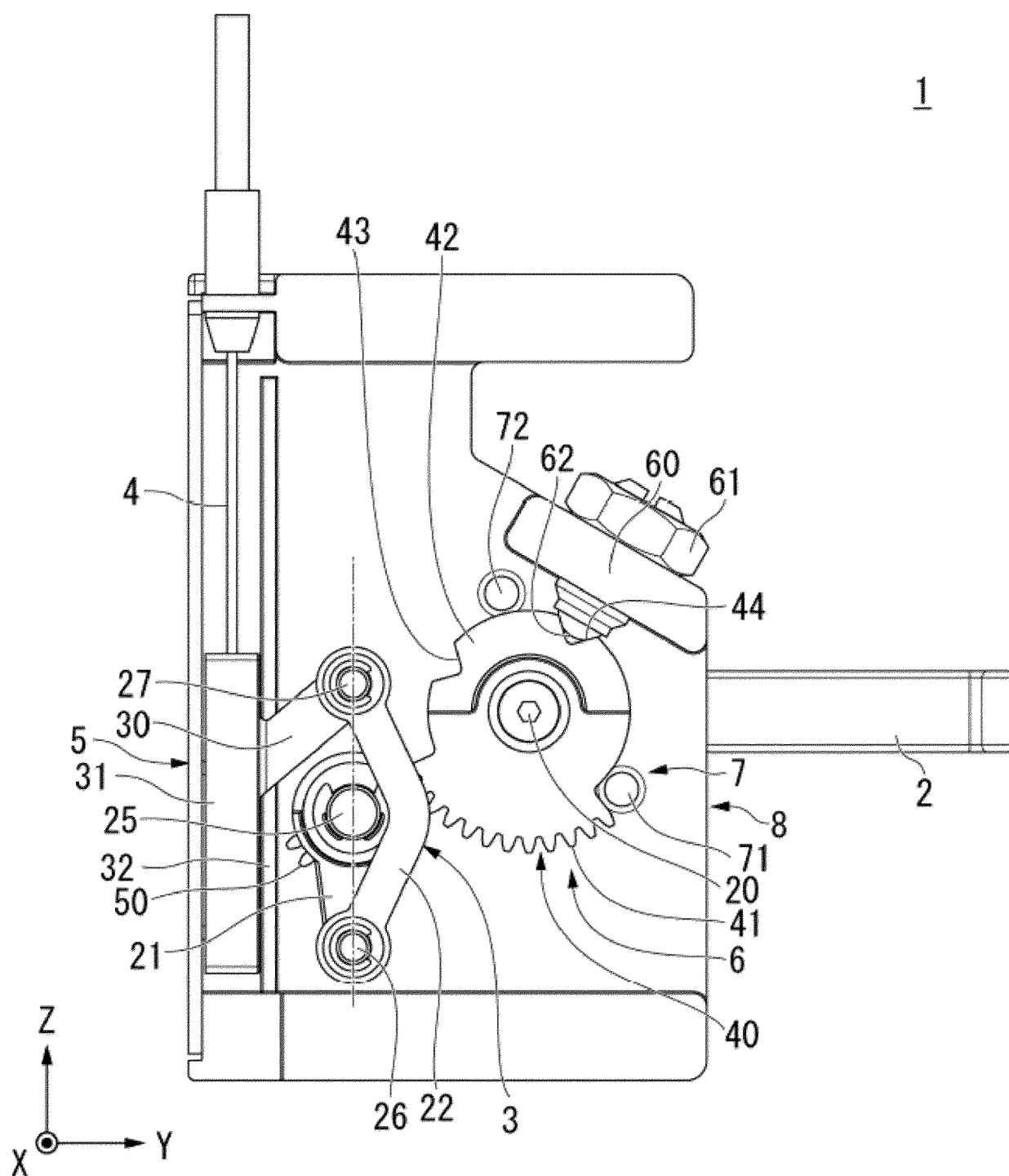


Fig. 5

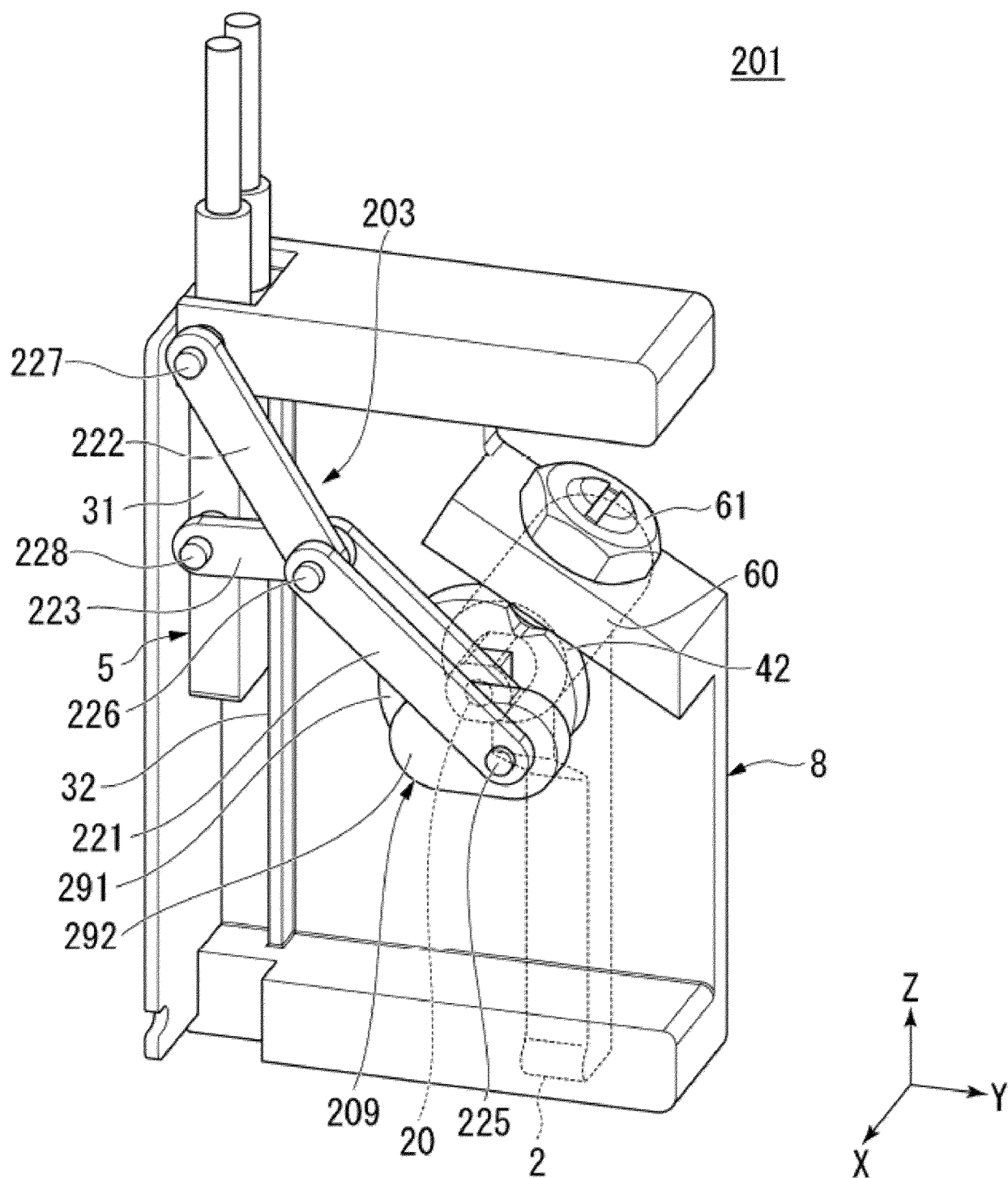


Fig. 6

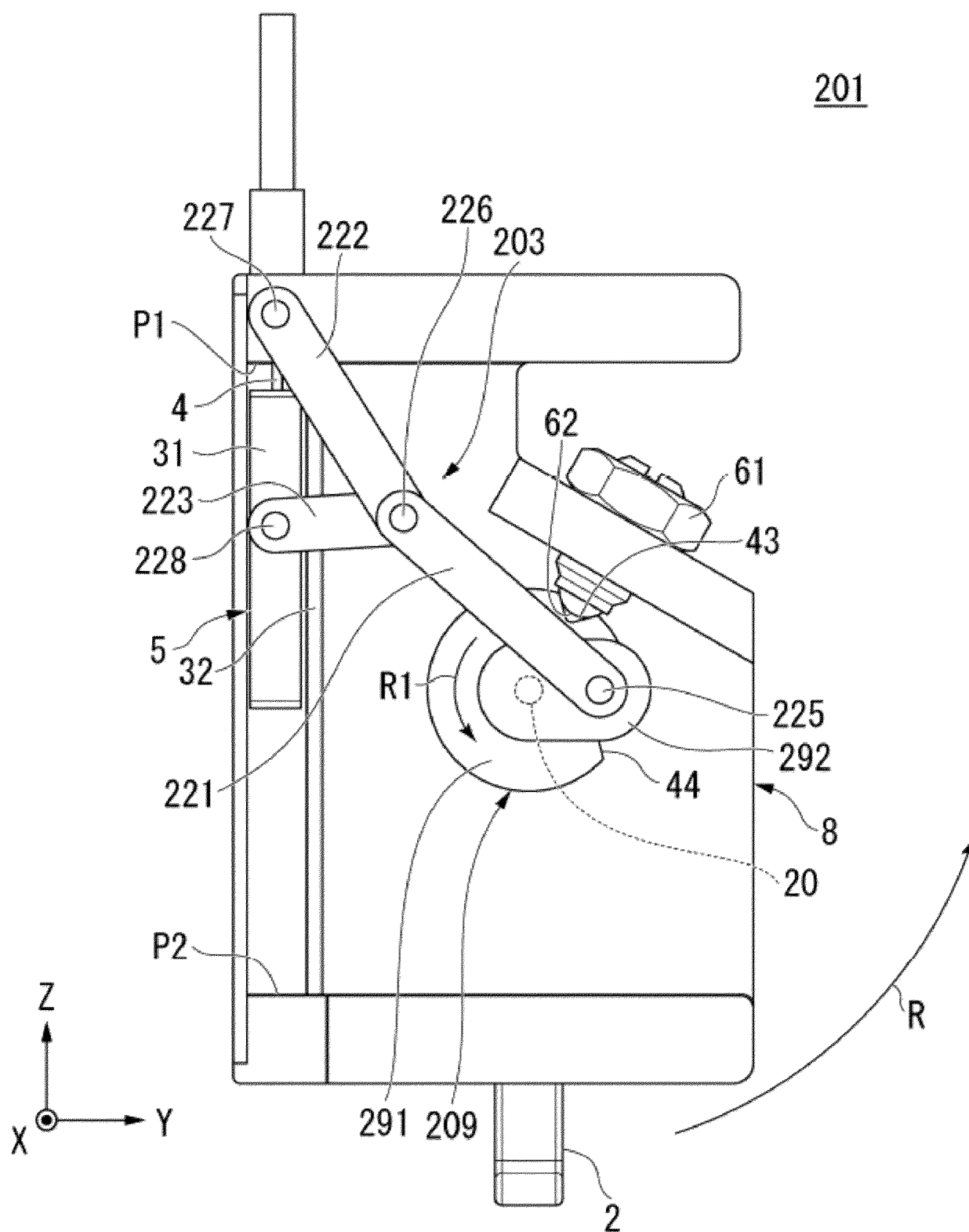


Fig. 7

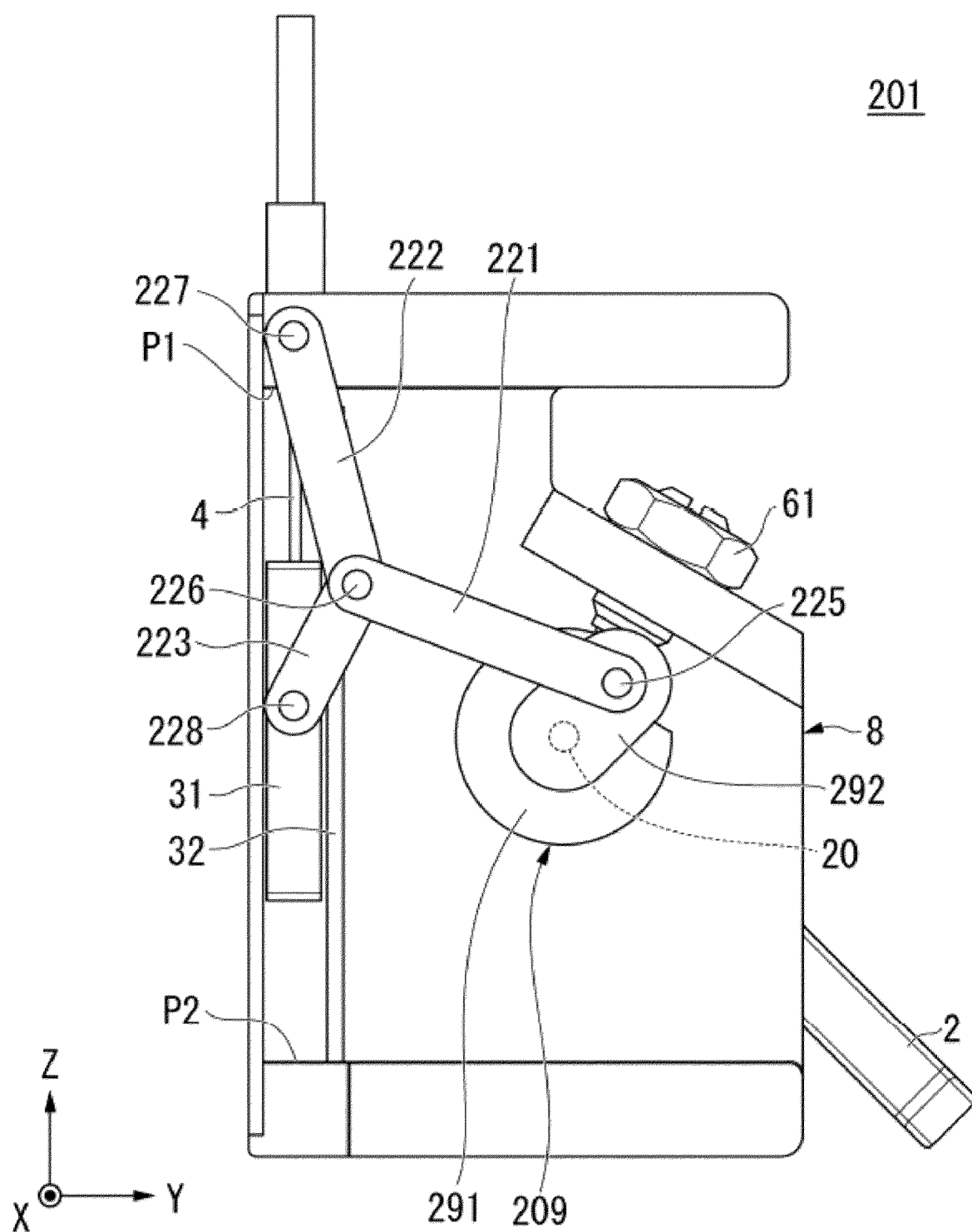


Fig. 8

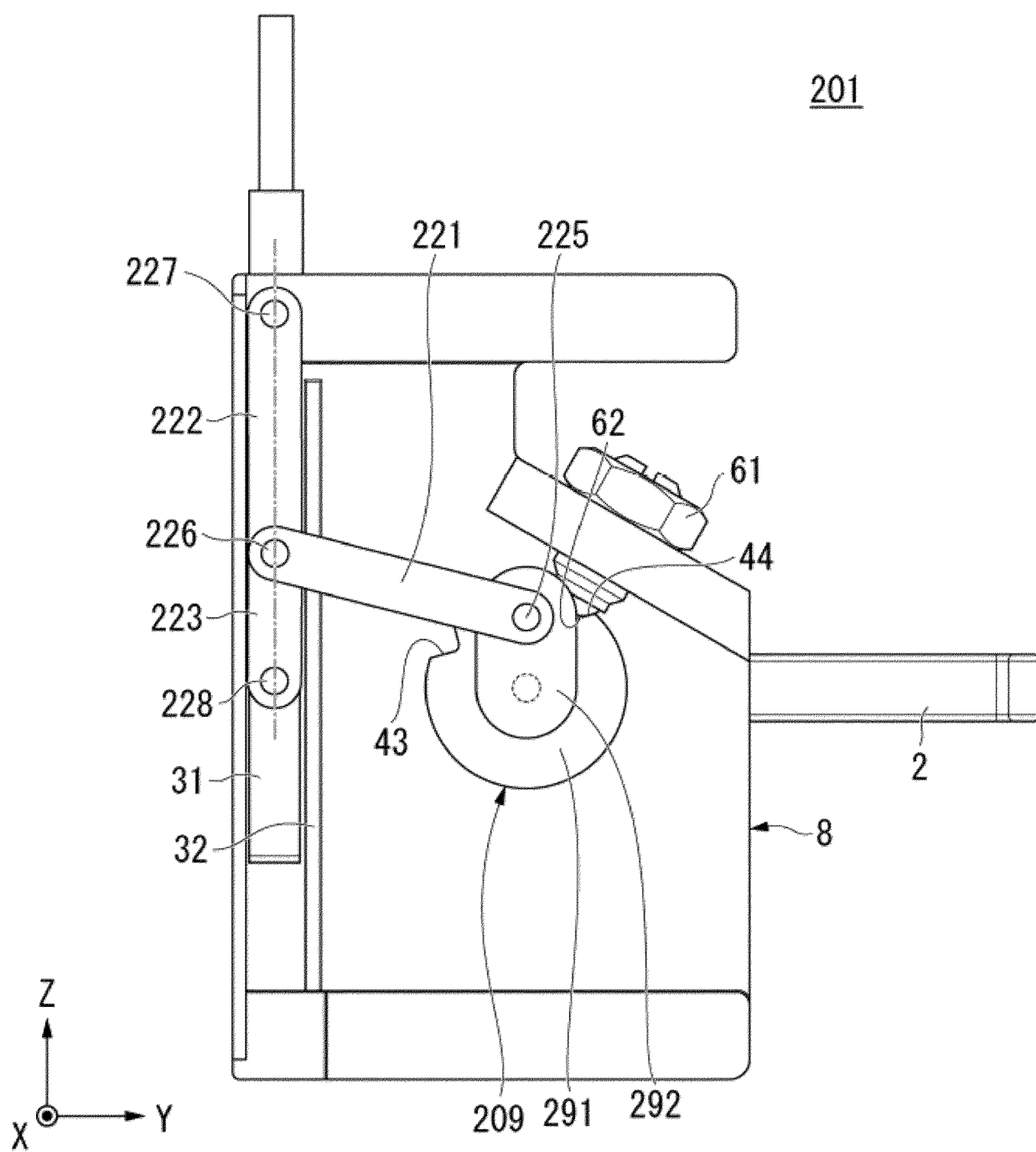


Fig. 9

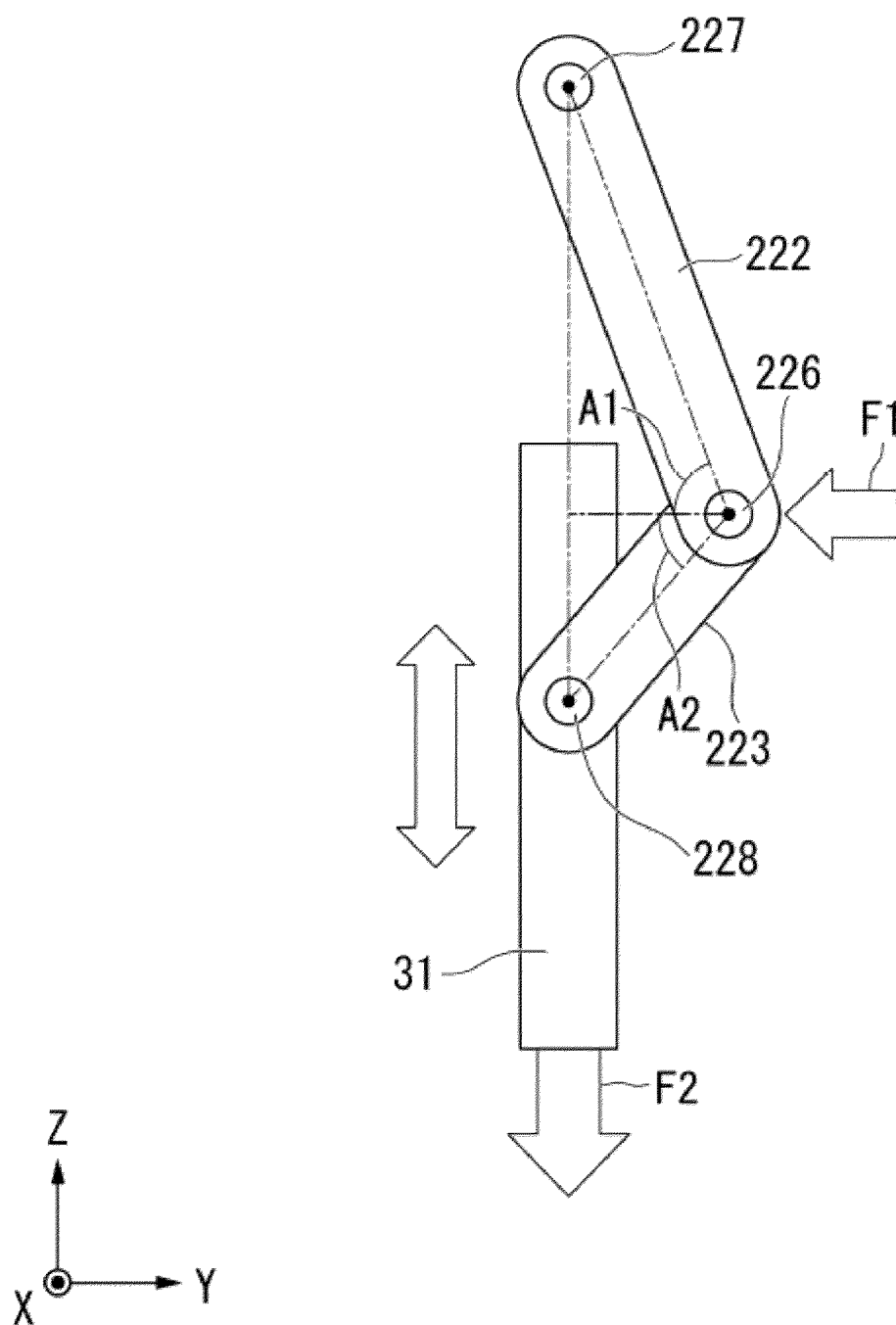


Fig. 10



EUROPEAN SEARCH REPORT

Application Number

EP 24 19 5371

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	DE 20 2021 002578 U1 (TEUFL MANFRED [AT]; ULTIMATE EUROPE TRANSP EQUIPMENT GMBH [AT]) 30 August 2021 (2021-08-30) * paragraph [0025] - paragraph [0043] * -----	1-10	INV. E05B85/12 E05B79/20 E05B83/36 E05B81/90
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			E05B
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		10 January 2025	Goddar, Claudia
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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10 - 01 - 2025

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