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(54) **PLUG DOOR DEVICE**

(57) One aspect of the present invention provides a plug door device 1 including a stationary base 3 fixedly attached to a body of a vehicle, a slidable base 4 having a door 2 attached thereto to open or close a doorway 15 of the vehicle, where the slidable base 4 being movable in a width direction of the vehicle relative to the stationary base 3 when acted upon by a driving force from a drive source 6, and a restricting mechanism 40 for restricting the slidable base 4 from moving in the width direction when the door 2 is fully closed. The restricting mechanism 40 includes two stationary members 42 fixedly attached to the stationary base 3, where the stationary members 42 each have a restricting part 41, two movable members 43 attached to two portions of the slidable base 4 that are separate from each other in a front-rear direction of the vehicle, and a connecting shaft 44 connecting together the two movable members 43. When the door 2 is fully closed, the two movable members 43 touch the restricting parts 41, so that the slidable base 4 is restricted from moving in the width direction.

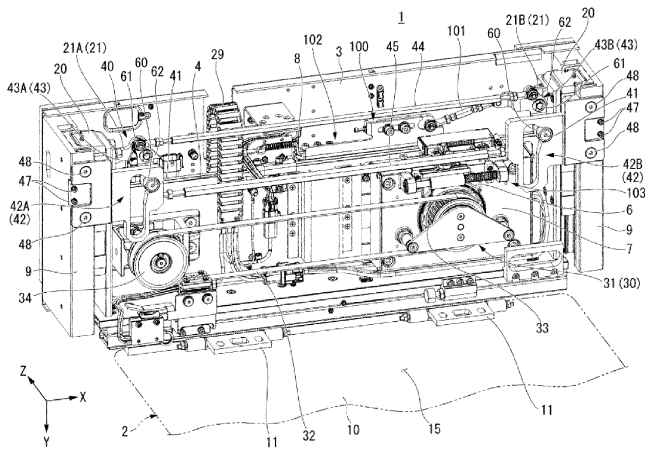

Fig. 1

EP 4 063 601 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a plug door device.

BACKGROUND

[0002] In the conventional art, a known plug door device actuates a door in a plugging manner, in other words, moves the door in the width direction of a railway vehicle while moving the door in the front-rear direction of the vehicle. For example, Patent Literature 1 discloses a plug door device including a door leaf, a rotatable pillar connected to the door leaf and being rotatable, a support oriented in a direction in which the door leaf is slidable, a first locking mechanism provided on a top portion of the door leaf, and a second locking mechanism provided on a bottom portion of the door leaf. In such a plug door device, the door leaf becomes slidable by moving the support and the rotatable pillar with a driving force from a motor or other drive source. The door leaf is locked by the first and second locking mechanisms when fully closed. Another known plug door device includes a stationary base fixedly attached to a vehicle body, a slidable base having a door attached thereto and being slidable in a width direction of the vehicle relative to the stationary base when acted upon by a driving force from a drive source, and a lock mechanism configured to lock the door. The lock mechanism includes a locking roller rotatable around an axis extending in a height direction of the vehicle. When the door is fully closed and the lock mechanism is in a locked state, an external force is applied to move the locking roller, so that the locking roller touches a block of a door hunger. In this manner, the door is locked by the locking roller when fully closed. When such a plug door device is used, a pressure difference may occur between the inside and the outside of the vehicle, creating a negative pressure outside the vehicle. If such is the case, the slidable base may rotate around the locking roller depending on where the locking roller is placed.

RELEVANT REFERENCES

LIST OF RELEVANT PATENT LITERATURE

[0003] Patent Literature 1: Japanese Patent Application Publication No. 2016-538171

SUMMARY

[0004] If the slidable base rotates around the locking roller, the door attached to the slidable base also rotates. This may result in a gap between the outer surface of the door and the outer surface of the vehicle body side wall, which may compromise the airtightness.

[0005] The present invention is intended to overcome the above problems, and an object thereof is to provide a plug door device that is capable of preventing compromised airtightness caused by rotation of the slidable base.

[0006] To solve the above-described problems, aspects of the present invention are configured as follows.

(1) An aspect of the present invention provides a plug door device including a stationary base fixedly attached to a body of a vehicle, a slidable base having a door attached thereto to open or close a doorway of the vehicle, the slidable base being movable in a width direction of the vehicle relative to the stationary base when acted upon by a driving force from a drive source, and a restricting mechanism for restricting the slidable base from moving in the width direction when the door is fully closed. The restricting mechanism includes two stationary members fixedly attached to the stationary base, where the stationary members each have a restricting part, two movable members attached to two portions of the slidable base that are separate from each other in a front-rear direction of the vehicle, the two movable members respectively pairing up with the two stationary members, and a connecting shaft connecting together the two movable members. When the door is fully closed, the two movable members connected together via the connecting shaft touch the restricting parts, so that an external force causes the movable members to unitedly move toward restriction areas where the slidable base is restricted from moving in the width direction. Here, the term "external force" includes at least one of an elastic force produced by an elastic member such as a spring, or a driving force produced by a drive source such as a motor and an actuator. Here, the term "unitedly" means that the parts move perfectly unitedly and also allows a difference as long as the difference does not adversely affect the capability of restricting the slidable base from moving in the width direction.

With the above-described arrangement, when the door is fully closed, the two movable members, which are connected together via the connecting shaft, unitedly move toward the restriction areas. This makes it possible to reliably restrict the slidable base from moving in the width direction. This can prevent compromised airtightness, which may be caused by the rotation of the slidable base. In addition, since the connecting shaft is connected to the two movable members, the two portions of the slidable base that are separate from each other in the front-rear direction can move in the width direction in synchronization. This makes it possible to allow the two portions of the door that are separate from each other in the front-rear direction to move in the width direction in synchronization. In addition, when the door is fully closed, the two movable members unitedly move to-

ward the restriction areas under the influence of the external force. This can result in restricting the two portions of the slidable base that are separate from each other in the front-rear direction from moving in the width direction when the door is fully closed. In this way, when the door is fully closed, the two portions of the door that are separate from each other in the front-rear direction can be restricted from moving in the width direction. Accordingly, while the two portions of the door that are separate from each other in the front-rear direction can be controlled to move in the width direction in synchronization, the two portions of the door that are separate from each other in the front-rear direction can be restricted from moving in the width direction when the door is fully closed.

(2) In the plug door device of (1), the two movable members may be provided at ends of the slidable base in the front-rear direction.

(3) In the plug door device of (1) or (2), the restricting parts may be recesses formed in the stationary members and depressed toward one of sides in the front-rear direction, and the two movable members may each have a projecting part configured to, when the door is fully closed, fit in the recess under influence of the external force.

(4) In the plug door device of (3), each of the stationary members may further have a guide wall for guiding a corresponding one of the movable members as the movable member moves in the width direction, and the projecting part of the movable member may be fitted onto the guide wall when the movable member is positioned in a non-restriction area where the slidable base is allowed to move in the width direction.

(5) In the plug door device of any one of (1) to (4), the two movable members may each include a contact part configured to touch the restricting part when the door is fully closed, and a coupling arm coupled to the contact part such that the coupling arm is rotatable around a rotational shaft extending in a height direction of the vehicle. The two coupling arms may be connected to the connecting shaft while each coupling arm may be connected to the rotational shaft and to the connecting shaft at different positions when seen in the height direction. When the door is about to be fully closed, the external force may cause the coupling arms to rotate around the rotational shafts, so that the contact parts of the two movable members may unitedly move toward the restriction areas.

(6) In the plug door device of (5), the two coupling arms may constitute a parallelogram linkage when seen in the height direction.

(7) In the plug door device of (6), the connecting shaft may extend parallel to the front-rear direction when seen in the height direction.

(8) In the plug door device of (6) or (7), the connecting shaft connecting together the two coupling arms may have a connecting-side adjusting mechanism for adjusting a length of the connecting shaft.

(9) In the plug door device of any one of (5) to (8), a torsion spring may be attached to at least one of the rotational shafts of the two coupling arms, and the torsion spring may be configured to rotate the coupling arms by applying the external force to the coupling arms.

(10) The plug door device of any one of (5) to (9) may further include a transmission mechanism for transmitting, to a locking mechanism for locking the door, an output from the drive source, so that the locking mechanism is activated. The transmission mechanism may have an unlocking shaft connecting one of the coupling arms to the transmission mechanism. When the transmission mechanism is acted upon by the output from the drive source and moves in a direction to release the door from being locked, the movement of the transmission mechanism may cause, via the unlocking shaft, the one of the coupling arms to rotate, so that the contact parts may move from the restriction areas toward non-restriction areas where the slidable base is allowed to move in the width direction.

(11) In the plug door device of (10), the unlocking shaft may have an unlocking-side adjusting mechanism for adjusting a length of the unlocking shaft.

(12) In the plug door device of (10) or (11), the transmission mechanism may have an elastic member for applying the external force in a form of an elastic force.

(13) In the plug door device of any one of (1) to (12), the restricting mechanism may further include a stationary shaft connecting together the two stationary members.

(14) The plug door device of any one of (1) to (13) may further include two rail bases respectively fixedly attached to two portions of the stationary base that are separate from each other in the front-rear direction, where the rail bases support the two portions of the slidable base that are separate from each other in the front-rear direction such that the two portions of the slidable base are movable in the width direction. The two stationary members may be respectively fixedly attached to the two rail bases.

ADVANTAGEOUS EFFECTS

[0007] The present invention can provide a plug door device capable of preventing compromised airtightness caused by rotation of a slidable base.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

Fig. 1 is a perspective view showing a plug door device relating to an embodiment.
Fig. 2 is a perspective view showing a restricting mechanism relating to the embodiment.
Fig. 3 is a perspective view showing one of portions of the restricting mechanism relating to the embodiment.
Fig. 4 is a perspective view showing the other of the portions of the restricting mechanism relating to the embodiment.
Fig. 5 is a bottom view showing the restricting mechanism relating to the embodiment.
Fig. 6 is a bottom view showing the other portion of the restricting mechanism relating to the embodiment and surrounding parts.
Fig. 7 is a bottom view showing that a door of the plug door device relating to the embodiment is fully opened.
Fig. 8 is a bottom view showing that the door of the plug door device relating to the embodiment is fully closed.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0009] Embodiments of the present disclosure will now be described with reference to the attached drawings. The following embodiments are described with reference to an example plug door device including a single-leaf door slidable to open or close the doorway of a railway vehicle (vehicle). In the following description, terms such as "parallel," "orthogonal," "around" 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, the parts are shown to different scales into recognizable sizes.

<Embodiments>

[0010] Fig. 1 is a perspective view of a plug door device relating to an embodiment. Fig. 2 is a perspective view showing a restricting mechanism relating to the embodiment. As shown in Fig. 1, a plug door device 1 includes a door 2, a stationary base 3, a slidable base 4, and a restricting mechanism 40. In Fig. 1, the door 2 is shown by the chain double-dashed line. Figs. 1 and 2 show the restricting mechanism 40 with the door 2 being fully closed.

[0011] In the following description, an XYZ orthogonal coordinate system is used as required. The X direction coincides with the front-rear direction of the vehicle. The Y direction coincides with the width direction of the vehicle. The Z direction is orthogonal to the X and Y directions and indicates the height direction (gravitational direction) of the vehicle. 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 respectively indicating the positive (+) side and the negative (-) side. 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] When fully closed, the door 2 of the plug door device 1 is supported such that the external surface of the door 2 is flush with the external surface of the vehicle body side wall. The door 2 includes a door leaf 10 and a door hunger 11 coupled to the door leaf 10. The door 2 is attached to the slidable base 4. The door hunger 11 is supported by the slidable base 4 such that the door hunger 11 is movable in the front-rear direction relative to the slidable base 4.

[0013] The stationary base 3 is fixedly attached to the body of the vehicle. The body forms the framework of the vehicle. The stationary base 3 is positioned above a doorway 15 of the vehicle. The stationary base 3 extends in the front-rear direction over the upper edge of the doorway 15. Rail bases 9 extending in the width direction are coupled to the front and rear ends of the stationary base 3 (mentioned here as an example of two portions of a stationary base that are separate from each other in the front-rear direction).

[0014] The slidable base 4 is slidable in the width direction relative to the stationary base 3 with a driving force from a drive source 6, thereby moving the door 2 in the width direction. The slidable base 4 is positioned below the stationary base 3. The slidable base 4 extends in the front-rear direction along the upper edge of the doorway 15. The front and rear ends of the slidable base 4 are movable in the width direction along the rail bases 9.

[0015] The drive source 6 is configured to output the driving force to move the door 2. For example, the drive source 6 is a motor. The output shaft of the motor is rotatable about an axis extending along the height direction. For example, the output shaft of the motor is rotatable in two opposite directions (in positive and negative directions) around the axis extending along the height direction. The drive source 6 is connected to a movable power source cable 29 or, a cableveyor (registered trademark). The drive source 6 is housed within a rectangular casing 7 having a length in the X direction when viewed from below. The drive source 6 is interposed between the slidable base 4 and a power transmission mechanism 30. The drive source 6 is provided on the +X-side portion of the slidable base 4. The drive source 6 is movable in

the width direction as the slidable base 4 moves in the width direction.

[0016] The power transmission mechanism 30 includes a power conversion mechanism 31 for changing the direction of the driving force from the drive source 6, and an endless belt 32 extending along the front-rear direction. The power conversion mechanism 31 converts the rotation of the output shaft of the motor around the axis extending along the height direction into circulation of the belt 32. The power conversion mechanism 31 includes a gear 33 rotatable around an axis extending along the height direction. The center of rotation of the gear 33 is aligned with the output shaft of the motor. A pulley 34 is provided at a position away in the front-rear direction from the gear 33. The pulley 34 is rotatable around an axis parallel to the axis of rotation of the gear 33 (extending along the height direction).

[0017] The belt 32 bridges the gear 33 and the pulley 34. The belt 32 is moved by the rotation of the gear 33 and is configured to move around the gear 33 and the pulley 34 (circulate). The belt 32 is connected to the door hunger 11. The door hunger 11 moves in the front-rear direction as the belt 32 moves.

[0018] A coupling member (not shown) is attached to the belt 32 and movable as the belt 32 moves. The coupling member supports a roller (not shown) that is rollable along the opening/closing path (not shown) of the door 2 while being guided along a guide rail (not shown), when the door 2 is opened or closed. In Fig. 1, the reference number 8 indicates a locking mechanism for locking the door 2 when the door 2 is fully closed. The following describes the example manner of how the door is actuated in a plugging manner, or how the door is moved in the width direction while being moved in the front-rear direction.

[0019] The door 2 is connected, via the door hunger 11, to the +Y-side portion of the belt 32. As described above, the belt 32 bridges the gear 33 and the pulley 34, which are spaced away from each other in the front-rear direction. The +Y-side portion of the belt 32 is thus movable in the front-rear direction. As the belt 32 moves, the door 2 moves in the front-rear direction.

[0020] The door 2 moves from the fully closed position shown in Fig. 1 (where the external surface of the vehicle body side wall is flush with the external surface of the door 2) to the fully opened position, as the driving force from the drive source 6 is transmitted to the belt 32 and then the door hunger 11 connected to the belt 32 moves. When fully opened, the door 2 opens (fully opens) the doorway 15 and is positioned outside the vehicle. According to the example shown in Fig. 1, the door 2 first moves from the fully closed position outward in the width direction (specifically, obliquely relative to the width direction) and then moves linearly toward one side in the front-rear direction (for example, toward the +X side), to reach the fully opened position.

[0021] Although not shown, the opening/closing path provided by the guide rail is divided into a linear portion extending along the front-rear direction and an inclined portion inclined relative to the linear portion. When the door is closed from the fully opened position, the roller first moves linearly along the linear portion and then moves inwardly in the width direction (specifically, obliquely relative to the width direction) along the inclined portion. As described above, the roller is supported on the slidable base 4 via the coupling member, the belt 32 and the like. With such a design, as the roller moves along the inclined portion, the slidable base 4 moves in the width direction. The door leaf 10 is supported by the slidable base 4 via the door hunger 11 and the like. With such a design, the door leaf 10 moves in the width direction when the slidable base 4 moves in the width direction.

[0022] In the above description, the door is driven using the power transmission mechanism 30 including the belt 32, or using the belt system. The present invention, however, is not limited to such. As an alternative example, the door may be driven using the screw system. Specifically, a motor rotates a screw shaft corresponding to a bolt, so that a door attached to a ball nut corresponding to a nut is opened or closed. As a yet another alternative example, the door may be driven using the rack and pinion system. Specifically, a motor rotates a pinion of a rack and pinion mechanism, so that a door attached to a rack rail is opened or closed. For example, the door driving system may be changed in accordance with required specifications.

[0023] The restricting mechanism 40 is configured to restrict the slidable base 4 from moving in the width direction when the door 2 is fully closed. The restricting mechanism 40 includes two stationary members 42, two movable members 43 , and a connecting shaft 44 connecting the two movable members 43. The two stationary members 42 are fixedly attached to the stationary base 3 and each have a recess 41 (an example of a restricting part). The two movable members 43 are provided at the front and rear ends of the slidable base 4 (an example of two portions of the slidable base 4 that are separate from each other in the front-rear direction). In the drawings, the symbol "A" is appended to the reference numerals of the constituent elements at one (the -X-side one) of the front and rear ends of the restricting mechanism 40, and the symbol "B" is appended to the reference numerals of the constituent elements at the other end (the +X-side end). The symbols "A" and "B", however, are omitted unless they are particularly distinguished.

[0024] The stationary members 42 are fixedly attached to the stationary base 3. The stationary members 42 are fixedly attached to the rail bases 9 using fasteners such as bolts. Each stationary member 42 is provided below the corresponding rail base 9 using a plurality of (for example, two, in the present embodiment) first bolts 47 that are next to each other in the width direction and a plurality of (for example, two, in the present embodiment) second bolts 48 that are next to each other in the width direction with the two first bolts 47 being sandwiched therebetween.

[0025] As shown in Fig. 2, each stationary member 42 has an opening 50 extending through the stationary member 42 in the height direction. The opening 50 is positioned inside the rail base 9 in the front-rear direction. The opening 50 is a through hole shaped like an L when seen in the height direction. The opening 50 is divided into a restriction area 51 and a non-restriction area 52. The restriction area 51 is designed to restrict the slidable base 4 from moving in the width direction when the door is fully closed. The non-restriction area 52 is designed to allow the slidable base 4 to move in the width direction.

[0026] The restriction area 51 is the +X-side portion of the opening 50. The restriction area 51 is curved following the contour of a roller 60 when seen in the height direction. The non-restriction area 52 is the -X-side portion of the opening 50. The non-restriction area 52 is long in the width direction as viewed in the height direction. The non-restriction area 52 is curved, at each side in the width direction, following the contour of the roller 60 when seen in the height direction.

[0027] The recess 41 is depressed from the vicinity of the -Y-side end of the non-restriction area 52 toward the +X side (mentioned as an example of toward one side in the front-rear direction), when seen in the height direction. The restriction area 51 corresponds to the recess 41.

[0028] Each stationary member 42 has guide walls 53 for guiding the corresponding movable member 43 as the movable member 43 moves in the width direction. The guide walls 53 extend in the width direction when seen in the height direction. The guide walls 53 are a pair of inner walls facing each other in the front-rear direction and delineating the opening 50. When viewed in the height direction, the guide walls 53 are aligned with the no-restriction area 52. The guide walls 53 extend in the width direction parallel to each other, when seen in the height direction. The length of one of the guide walls 53 in the width direction is greater than that of the other guide wall 53 (the guide wall 53 closer to the recess 41 in the front-rear direction) in the width direction. The length of the guide walls 53 in the width direction is greater than the outer diameter of the roller 60.

[0029] The opening 50 is not necessarily a through hole extending through the stationary member 42 in the height direction and shaped like an L when seen in the height direction. For example, the opening 50 may be a groove shaped like an L when seen in the height direction. For example, the hole or groove formed in the stationary member 42 as the opening 50 can be configured in various manners in accordance with required specifications.

[0030] As shown in Fig. 1, the two movable members 43 are attached to the front and rear ends of the slidable base 4. The two movable members 43 respectively pair up with the two stationary members 42. The two movable members 43 each include a roller 60 (an example of a contact part) and a coupling arm 62. The roller 60 is configured to touch the recess 41 when the door 2 is fully closed. The coupling arm 62 is coupled to the roller 60 such that it is rotatable around a rotational shaft 61 extending in the height direction.

[0031] Fig. 3 is a perspective view showing one of the portions of the restricting mechanism 40 relating to the embodiment. Fig. 4 is a perspective view showing the other of the portions of the restricting mechanism 40 relating to the embodiment. Fig. 5 is a bottom view showing the restricting mechanism 40 relating to the embodiment. Figs. 3 to 5 show the restricting mechanism 40 when the door is fully closed. As shown in Fig. 3, the coupling arm 62 includes an arm base 63, a first arm 64, and a second arm 66. The arm base 63 is coaxial with the rotational shaft 61 extending in the height direction. The first arm 64 extends from the arm base 63 toward the opening 50. The second arm 66 has a transmission shaft 65 spaced away from the rotational shaft 61. For example, the arm base 63, the first arm 64 and the second arm 66 may be formed as a single unit piece and made of the same material.

[0032] The arm base 63 is shaped like a tube extending in the height direction along the rotational shaft 61. The arm base 63 is positioned above the stationary member 42. The arm base 63 surrounds the rotational shaft 61. For example, a bearing may be provided between the inner periphery of the arm base 63 and the rotational shaft 61 for supporting the rotational shaft 61 rotatably.

[0033] The first arm 64 extends radially outward (outward in the direction orthogonal to the arm base 63) from the arm base 63. The first arm 64 extends radially outward from the arm base 63, then bends downward and finally extend radially outward. As shown in Fig. 5, when the door is fully closed, the first arm 64 extends from the arm base 63 toward the +Y side until it overlaps the opening 50, when seen in the height direction.

[0034] As shown in Fig. 3, the roller 60 is positioned below the first arm 64. The roller 60 is coupled to the tip end (the most distant portion from the arm base 63) of the first arm 64 such that the roller 60 is rotatable around an axis extending in the height direction. As shown in Fig. 5, the roller 60 is shaped like a circle when seen in the height direction. The roller 60 has a projecting part 60a that fits into the recess 41 when the door is fully closed. The projecting part 60a of the roller 60 is arc-shaped following the inner wall of the recess 41 when viewed in the height direction. The projecting part 60a of the roller 60 touches the inner wall of the recess 41 when the door is fully closed.

[0035] The second arm 66 extends radially outward from the arm base 63 but originates from a different portion than the first arm 64 does. The second arm 66 extends in an opposite direction to the direction in which the first arm 64 extends (from the arm base 63 toward the -Y side), when seen in the height direction. The second arm 66 extends at an angle toward the -X side relative to the extension of the first arm 64, when seen in the height direction.

[0036] The first and second arms 64 and 66 extend in intersecting directions when seen in the height direction. For example, when seen in the height direction, the angle

Aa formed between the first and second arms 64 and 66 is approximately 150 degrees. Here, the angle Aa refers to the angle formed, when seen in the height direction, between (i) an imaginary straight line running through the central axis of the rotational shaft 61 and the center of rotation of the roller 60 (the center of the tip end of the first arm 64) and (ii) an imaginary straight line running through the central axis of the rotational shaft 61 and the central axis of the transmission shaft 65. For example, since the angle Aa formed between the first arm 64 and the second arm 66 is approximately 150 degrees when seen in the height direction, the connecting shaft 44 can be accommodated within a limited space of a vehicle.

[0037] When seen in the height direction, the angle Aa formed between the first and second arms 64 and 66 is not necessarily approximately 150 degrees. For example, when seen in the height direction, the angle Aa formed between the first and second arms 64 and 66 may be from 10 degrees to 140 degrees, or from 160 degrees to 170 degrees. For example, when seen in the height direction, the angle Aa formed between the first and second arms 64 and 66 may not exceed 180 degrees. For example, when seen in the height direction, the angle Aa formed between the first and second arms 64 and 66 may be 180 degrees. For example, when seen in the height direction, the angle Aa formed between the first and second arms 64 and 66 can be adjusted in accordance with required specifications as long as the restricting mechanism 40 can produce the above-described advantageous effects.

[0038] As shown in Fig. 1, sliders 20, which are movable in the width direction along the rail bases 9, are fixedly attached to the front and rear ends of the slidable base 4. The sliders 20 extend in the width direction along the rail bases 9. A stay 21 is fixedly attached to each slider 20. The stay 21 extends from the slider 20 inward in the front-rear direction.

[0039] A first one of the stays (21 A) is longer than a second one of the stays (21B) in the front-rear direction. The tip end of the first stay 21A (the most distant portion from the slider 20) is positioned above the tip end of the second stay 21B (the most distant portion from the slider 20). As shown in Fig. 3, the distance in the height direction between (i) the tip end of the first stay 21A and (ii) the coupling arm 62 of a first one of the movable members (43A) is greater than the distance in the height direction between (i) the tip end of the second stay 21B and (ii) the coupling arm 62 of a second one of the movable members (43B) (see Fig. 4).

[0040] As shown in Fig. 3, the rotational shaft 61 extends in the height direction. The upper end of the rotational shaft 61 is coupled to the tip end of the stay 21 (the most distant portion from the slider 20). The rotational shaft 61 is connected to each of the front and rear ends of the slidable base 4 via the corresponding stay 21 and slider 20.

[0041] The transmission shaft 65 extends parallel to the rotational shaft 61 (in the height direction). The upper end of the transmission shaft 65 is coupled to the tip end of the second arm 66 (the most distant portion from the arm base 63).

[0042] As shown in Fig. 5, the two coupling arms 62 constitute a parallelogram linkage when seen in the height direction. In other words, when seen in the height direction, an imaginary straight line extending along the longitudinal direction of the second arm 66 of the coupling arm 62 of the first movable member 43A is parallel to an imaginary straight line extending along the longitudinal direction of the second arm 66 of the coupling arm 62 of the second movable member 43B. Here, the imaginary straight line extending along the longitudinal direction of the second arm 66 of the coupling arm 62 of the first movable member 43A indicates an imaginary straight line running through, when seen in the height direction, the central axis of the transmission shaft 65 and the central axis of the rotational shaft 61 of the coupling arm 62 of the first movable member 43A. The imaginary straight line extending along the longitudinal direction of the second arm 66 of the coupling arm 62 of the second movable member 43B indicates an imaginary straight line running through, when seen in the height direction, the central axis of the transmission shaft 65 and the central axis of the rotational shaft 61 of the coupling arm 62 of the second movable member 43B.

[0043] The front and rear ends of the connecting shaft 44 are connected to the transmission shafts 65 of the two coupling arms 62. The connecting shaft 44 extends linearly to bridge the transmission shafts 65 of the two coupling arms 62. The connecting shaft 44 extends parallel to the front-rear direction when seen in the height direction. The ends of the connecting shaft 44 are rotatable around the transmission shafts 65.

[0044] The connecting shaft 44 is rigid enough to satisfactorily transmit the rotational force exerted by one of the two coupling arms 62 to the other coupling arm 62. For example, the connecting shaft 44 can be a metal shaft member. For example, the connecting shaft 44 is preferably a member that can be ideally deemed to be rigid. The connecting shaft 44 may not be a member that is never deformed by a force of any level but a member that may experience some deformation when acted upon by a force of a predetermined level or more. For example, the connecting member connecting together the two movable members 43 may include a flexible member such as a rope (for example, a wire rope). For example, the connecting member may include two ropes one of which connects the transmission shafts 65 and the other of which connects the rollers 60.

[0045] The connecting shaft 44 connecting together the two coupling arms 62 has a connecting-side adjusting mechanism 70 for adjusting the length of the connecting shaft 44. The connecting-side adjusting mechanism 70 is configured to adjust the distance between the transmission shafts 65 of the two coupling arms 62. The connecting-side adjusting mechanism 70 includes a bolt 71 and nuts 72. The bolt 71 is coaxial with the connecting

shaft 44, and configured to be screwed into the nuts 72. The nuts 72 constituting the connecting-side adjusting mechanism 70 are provided at the front and rear ends of the connecting shaft 44.

[0046] For example, when the bolt 71 is rotated clockwise around the connecting shaft 44, the heads of the bolt 71 (in other words, the main body of the connecting shaft 44) approach the nuts 72. As a result, the connecting shaft 44 can become shorter (in other words, the distance is decreased between the transmission shafts 65 of the two coupling arms 62). When the bolt 71 is rotated counterclockwise around the connecting shaft 44, on the other hand, the heads of the bolt 71 move away from the nuts 72. As a result, the connecting shaft 44 can become longer (in other words, the distance is increased between the transmission shafts 65 of the two coupling arms 62).

[0047] The connecting-side adjusting mechanism 70 does not necessarily include the bolt 71 coaxial with the connecting shaft 44 and the nuts 72 into which the bolt 71 is screwed. For example, the connecting-side adjusting mechanism 70 may include nuts provided on the connecting shaft 44 and also include bolts configured to be screwed into the nuts. For example, the connecting-side adjusting mechanism 70 can be configured in various manners in accordance with required specifications.

[0048] The two coupling arms 62 are connected to the connecting shaft 44 while each coupling arm 62 is connected to the corresponding rotational shaft 61 and to the connecting shaft 44 at different positions, when seen in the height direction.

[0049] The rotational shafts 61 of the two coupling arms 62 are aligned with each other in the front-rear direction when seen in the height direction. The transmission shafts 65 of the two coupling arms 62 are aligned with each other in the front-rear direction when seen in the height direction.

[0050] The connecting shaft 44 constitutes, together with the two coupling arms 62, a parallelogram linkage when seen in the height direction. More specifically, as seen in the height direction, the imaginary straight line extending along the connecting shaft 44 is parallel to the imaginary straight line running through the central axes of the rotational shafts 61 of the two coupling arms 62. The imaginary straight line extending along the connecting shaft 44 indicates the imaginary straight line running through the central axes of the transmission shafts 65 of the two coupling arms 62.

[0051] When the door is fully closed, the rollers 60 of the two movable members 43 are positioned on the +Y side of the rotational shafts 61 as seen in the height direction. When the door is fully closed, the roller 60 of each movable member 43 is aligned with the corresponding rotational shaft 61 in the width direction (stated differently, on an imaginary straight line running through the central axis of the rotational shaft 61 and parallel to the width direction), when viewed in the height direction.

[0052] As shown in Fig. 7, when the door is fully opened, the rollers 60 of the two movable members 43 are positioned on the +Y side of the rotational shafts 61 as seen in the height direction. When the door is fully opened, the roller 60 of each movable member 43 is differently positioned from the corresponding rotational shaft 61 in the front-rear direction (specifically, on the -X side of the imaginary straight line running through the central axis of the rotational shafts 61 and parallel to the width direction), as seen in the height direction.

[0053] As shown in Fig. 3, a torsion spring 49 (an example of an elastic member) is attached to the rotational shaft 61 of the coupling arm 62 of the first movable member 43A. The torsion spring 49 exerts an elastic force (an example of an external force) on the coupling arm 62, causing it to rotate. The torsion spring 49 is wound around the rotational shaft 61 of the coupling arm 62 of the first movable member 43A. The torsion spring 49 is positioned between the tip end of a first one of the stays (21A) and the arm base 63 of the first movable member 43A. No torsion spring 49 is provided on the rotational shaft 61 of the coupling arm 62 of the second movable member 43B (see Fig. 4).

[0054] The elastic force from the torsion spring 49 is constantly applied to the coupling arm 62 of the first movable member 43A. As shown in Fig. 5, the torsion spring 49 exerts an elastic force counterclockwise (in the direction indicated by the arrow Ra) around the rotational shaft 61 when seen from below. The torsion spring 49 applies an elastic force to the coupling arm 62 so that the roller 60 remains in contact with the recess 41 when the door is fully closed. The torsion spring 49 applies an elastic force to the coupling arm 62 so that the roller 60 remains in contact with the guide walls 53 when the roller 60 is in the non-restriction area 52 (see Fig. 7).

[0055] Fig. 6 is a bottom view showing the other of the portions of the restricting mechanism 40 relating to the embodiment and surrounding parts. Fig. 6 shows how the restricting mechanism 40 works when the door is fully closed. As shown in Fig. 6, the coupling arm 62 of the second movable member 43B is differently shaped than the coupling arm 62 of the first movable member 43A (see Fig. 5). The coupling arm 62 of the second movable member 43B includes the arm base 63, first arm 64 and second arm 66, and also has a third arm 68 including an unlocking rod 67 that is spaced away from the rotational shaft 61. For example, the arm base 63, the first arm 64, the second arm 66 and the third arm 68 constituting the second movable member 43B may be formed as a single unit piece and made of the same material.

[0056] The third arm 68 extends radially outward from the arm base 63 but originates from a different portion than the first and second arms 64 and 66 do. The third arm 68 extends toward the -X side from the arm base 63, when seen in the height direction.

[0057] The first and third arms 64 and 68 extend in orthogonal directions when seen in the height direction. For example, when seen in the height direction, the angle Ba formed between the first and third arms 64 and 68 is approximately 90 degrees. Here, the angle Ba refers to

the angle formed, when seen in the height direction, between (i) an imaginary straight line running through the central axis of the rotational shaft 61 of the coupling arm 62 of the second movable member 43B and the center of rotation of the roller 60 (the center of the tip end of the first arm 64) and (ii) an imaginary straight line running through the central axis of the rotational shaft 61 of the coupling arm 62 of the second movable member 43B and the central axis of the unlocking rod 67 (the center of the tip end of the third arm 68).

[0058] The first and third arms 64 and 68 do not necessarily extend in orthogonal directions when seen in the height direction. For example, the first and third arms 64 and 68 may extend in obliquely intersecting directions when seen in the height direction. For example, when seen in the height direction, the angle Ba formed between the first and third arms 64 and 68 may be from 10 degrees to 80 degrees, or from 100 degrees to 170 degrees. For example, when seen in the height direction, the angle Ba formed between the first and third arms 64 and 68 may not exceed 180 degrees. For example, the angle Ba formed between the first and third arms 64 and 68 when seen in the height direction can be adjusted in accordance with required specifications as long as the restricting mechanism 40 can produce the above-described advantageous effects.

[0059] As shown in Fig. 4, the unlocking rod 67 extends parallel to the rotational shaft 61 (in the height direction). The lower end of the unlocking rod 67 is coupled to the tip end of the third arm 68 (the most distant portion from the arm base 63). As shown in Fig. 6, the distance between the central axis of the rotational shaft 61 of the coupling arm 62 of the second movable member 43B and the central axis of the unlocking rod 67 is greater than the distance between the central axis of the rotational shaft 61 of the coupling arm 62 of the second movable member 43B and the center of rotation of the roller 60.

[0060] As shown in Fig. 1, the plug door device 1 includes a transmission mechanism 100 for transmitting, to the locking mechanism 8 for locking the door 2, an output from the drive source 6, so that the locking mechanism 8 is activated.

[0061] The transmission mechanism 100 is not necessarily configured to transmit the output from the drive source 6, which is placed between the power transmission mechanism 30 and the slidable base 4, in order to activate the lock mechanism 8. For example, the transmission mechanism 100 may be configured to transmit an output from a different drive source than the drive source 6 to activate the locking mechanism 8. For example, the drive source for producing an output to be transmitted to the locking mechanism 8 can be configured in various manners in accordance with required specifications.

[0062] The transmission mechanism 100 includes an unlocking shaft 101, a first transmission member 102, and a second transmission member 103. The unlocking shaft 101 connects together the transmission mechanism 100 and the coupling arm 62 of the second movable member 43B (an example of a first one of coupling arms). The first transmission member 102 transmits a first force (an example of an external force) to the unlocking shaft 101. The second transmission member 103 transmits a second force (an example of an external force) to the unlocking shaft 101.

[0063] As shown in Fig. 6, the front and rear ends of the unlocking shaft 101 are connected to the unlocking rod 67 of the coupling arm 62 of the second movable member 43B and to an unlocking-side transmission rod 105 of the first transmission member 102. The unlocking shaft 101 extends linearly to bridge the unlocking rod 67 and the unlocking-side transmission rod 105. The unlocking shaft 101 extends at an angle relative to the front-rear direction when seen in the height direction. The ends of the unlocking shaft 101 are rotatable respectively around the unlocking rod 67 and the unlocking-side transmission rod 105.

[0064] The unlocking shaft 101 is rigid enough to satisfactorily transmit one of (i) the rotational force produced by the second coupling arm 62 and (ii) the moving force produced by the first transmission member 102 to the other. For example, the unlocking shaft 101 can be a metal shaft member. For example, the unlocking shaft 101 is preferably a member that can be ideally deemed to be rigid. The unlocking shaft 101 may not be a member that is never deformed by a force of any level but a member that may experience some deformation when acted upon by a force of a predetermined level or more.

[0065] The unlocking shaft 101 connecting together the unlocking rod 67 and the unlocking-side transmission rod 105 has an unlocking-side adjusting mechanism 110 for adjusting the length of the unlocking shaft 101. The unlocking-side adjusting mechanism 110 is configured to adjust the distance between the unlocking rod 67 and the unlocking-side transmission rod 105. The unlocking-side adjusting mechanism 110 includes a bolt 111 and nuts 112. The bolt 111 is coaxial with the unlocking shaft 101, and configured to be screwed into the nuts 112. The nuts 112 constituting the unlocking-side adjusting mechanism 110 are provided at the front and rear ends of the unlocking shaft 101.

[0066] For example, when the bolt 111 is rotated clockwise around the unlocking shaft 101, the heads of the bolt 111 (in other words, the main body of the unlocking shaft 101) approach the nuts 112. As a result, the unlocking shaft 101 can become shorter (in other words, the distance is decreased between the unlocking rod 67 and the unlocking-side transmission rod 105). When the bolt 111 is rotated counterclockwise around the unlocking shaft 101, on the other hand, the heads of the bolt 111 move away from the nuts 112. As a result, the unlocking shaft 101 can become longer (in other words, the distance is increased between the unlocking rod 67 and the unlocking-side transmission rod 105).

[0067] The unlocking-side adjusting mechanism 110 does not necessarily include the bolt 111 coaxial with the

unlocking shaft 101 and the nuts 112 into which the bolt 111 is screwed. For example, the unlocking-side adjusting mechanism 110 may include nuts provided on the unlocking shaft 101 and also include bolts configured to be screwed into the nuts. For example, the unlocking-side adjusting mechanism 110 can be configured in various manners in accordance with required specifications.

[0068] As shown in Fig. 6, the first transmission member 102 includes a support member 120 and a guide member 121. The support member 120 has the unlocking-side transmission rod 105, and the guide member 121 is configured to guide the support member 120 in the front-rear direction. The support member 120 has a support body 122 extending parallel to the front-rear direction, and a manipulation member 123 for manipulating the support body 122. The upper end of the unlocking-side transmission rod 105 is coupled to the +X-side end of the support body 122. The manipulation member 123 is a rod member extending parallel to the front-rear direction. The +X-side end of the manipulation member 123 is coupled to the -X-side end of the support body 122 through a through hole extending through the guide member 121 in the X direction.

[0069] The guide member 121 extends in the front-rear direction and is longer than the support member 120. The guide member 121 has an elongated hole 124 that penetrates through the guide member 121 in the height direction and that is long in the front-rear direction. The support member 120 is attached, via the elongated hole 124, to the guide member 121 by a plurality of bolts 125 (for example, two bolts spaced away from each other in the front-rear direction in the present embodiment).

[0070] The relative positions of the support and guide members 120 and 121 can be adjusted in the front-back direction. For example, the support member 120 can be moved toward the +X side relative to the guide member 121 by pushing the manipulation member 123 toward the +X side with the bolts 125, which are tightened onto the support member 120 via the elongated hole 124, being loosened, If the manipulation member 123 is pulled toward the -X side, on the other hand, the support member 120 can be moved toward the -X side relative to the guide member 121. After the positions of the support and guide members 120 and 121 are adjusted in the front-rear direction, the loosened bolts 125 are tightened. This can fix the positions of the support and guide members 120 and 121 in the front-rear direction.

[0071] The -X-side portion of the guide member 121 is coupled to a linear guide (not shown) of the locking mechanism 8 using a fastener such as a bolt. The guide member 121 is movable in the front-rear direction as the linear guide moves in the front-rear direction.

[0072] The -X-side portion of the guide member 121 may have a coil spring 127 (see Fig. 7, an example of an elastic member) attached thereto via a bracket using a fastener such as a bolt. The coil spring 127 exerts an elastic force (an example of an external force) on the first transmission member 102, so that the first transmission member 102 is pulled toward the -X side. The unlocking shaft 101 is acted upon, via the first transmission member 102, by the elastic force exerted by the coil spring 127, so that the unlocking shaft 101 is pulled toward the -X side.

[0073] As shown in Fig. 6, the second transmission member 103 has a first coupling member 131 and a second coupling member 133. The first coupling member 131 has a first shaft 130 extending parallel to the front-rear direction, and the second coupling member 133 has a second shaft 132 extending parallel to the first shaft 130.

[0074] The first coupling member 131 is provided on the -Y-side portion of the casing 7. The second coupling member 133 is provided on the +X- and +Y-side portions of the guide member 121 of the first transmission member 102. The first and second coupling members 131 and 133 are coupled together via a coupling shaft 134 extending in the width direction.

[0075] On the first coupling member 131, a first coil spring 135 (an example of an elastic member) is provided. The first coil spring 135 extends along the +X-side portion of the first shaft 130. The first coil spring 135 exerts an elastic force (an example of an external force) on the first coupling member 131, so that the first coupling member 131 is pushed toward the -X side. The unlocking shaft 101 is acted upon by the elastic force produced by the first coil spring 135 via the first coupling member 131, the coupling shaft 134, the second coupling member 133 and the first transmission member 102, so that the unlocking shaft 101 is pushed toward the -X side.

[0076] On the second coupling member 133, a second coil spring 136 (an example of an elastic member) is provided. The second coil spring 136 extends along the second shaft 132. The second coil spring 136 exerts an elastic force (an example of an external force) on the second coupling member 133, so that the second coupling member 133 is pushed toward the -X side. The unlocking shaft 101 is acted upon by the elastic force produced by the second coil spring 136 via the second coupling member 133 and the first transmission member 102, so that the unlocking shaft 101 is pushed toward the -X side.

[0077] As shown in Fig. 5, the restricting mechanism 40 includes a stationary shaft 45 connecting the two stationary members 42. The front and rear ends of the stationary shaft 45 are connected to the two stationary members 42. The stationary shaft 45 extends linearly to bridge the inner edges of the two stationary members 42 in the front-rear direction. The stationary shaft 45 extends parallel to the front-rear direction when seen in the height direction. The ends of the stationary shaft 45 are fixedly attached to the inner edges of the two stationary members 42 in the front-rear direction.

[0078] The stationary shaft 45 is rigid enough to be capable of supporting the two stationary members 42 at a certain position. For example, the stationary shaft 45 can be a metal shaft member. For example, the stationary shaft 45 is preferably a member that can be ideally

deemed to be rigid. The stationary shaft 45 may not be a member that is never deformed by a force of any level but a member that may experience some deformation when acted upon by a force of a predetermined level or more.

[0079] The stationary shaft 45 connecting together the two stationary members 42 has a stationary-side adjusting mechanism 80 for adjusting the length of the stationary shaft 45. The stationary-side adjusting mechanism 80 is configured to adjust the distance between the two stationary members 42 in the front-rear direction. The stationary-side adjusting mechanism 80 includes a bolt 81 and female screws 82. The bolt 81 is coaxial with the stationary shaft 45, and configured to be screwed into the female screws 82. The female screws 82 constituting the stationary-side adjusting mechanism 80 are provided at the inner edges of the two stationary members 42 in the front-rear direction.

[0080] For example, when the bolt 81 is rotated clockwise around the stationary shaft 45, the heads of the bolt 81 (in other words, the main body of the stationary shaft 45) approach the female screws 82 (in other words, the inner edges of the stationary members 42 in the front-rear direction). As a result, the stationary shaft 45 can become shorter (in other words, the two stationary members 42 are closer to each other in the front-rear direction). When the bolt 81 is rotated counterclockwise around the stationary shaft 45, on the other hand, the heads of the bolt 81 move away from the female screws 82. As a result, the stationary shaft 45 can become longer (in other words, the two stationary members 42 are more distant from each other in the front-rear direction).

[0081] The stationary-side adjusting mechanism 80 does not necessarily include the bolt 81 coaxial with the stationary shaft 45, and the female screws 82 into which the bolt 81 is screwed. For example, the stationary-side adjusting mechanism 80 may include nuts provided on the stationary shaft 45 and also include bolts configured to be screwed into the nuts. For example, the stationary-side adjusting mechanism 80 can be configured in various manners in accordance with required specifications.

[0082] Figs. 7 and 8 illustrate how the restricting mechanism 40 relating to the embodiment works. Fig. 7 is a bottom view showing the restricting mechanism 40 when the door of the plug door device 1 relating to the embodiment is fully opened. Fig. 8 is a bottom view showing the restricting mechanism 40 when the door of the plug door device 1 relating to the embodiment is fully closed. In Figs. 7 and 8, the stationary shaft 45 is not shown. Fig. 7 shows an example case where the slidable base 4 moves inward in the width direction (in the plug-in direction) (move as indicated by the arrow Wi shown in Fig. 7) as the door is closed from the fully opened state. For example, Fig. 7 shows how the door moves inward in the width direction from the fully opened position so that the door is positioned inside the vehicle.

[0083] As shown in Fig. 7, when the door is fully opened, the rollers 60 of the two movable members 43 are positioned in the non-restriction areas 52. When the slidable base 4 moves inward in the width direction while the door is fully opened, the two movable members 43 are guided inward in the width direction by the guide walls 53.

[0084] The elastic force from the torsion spring 49 pushes the coupling arm 62 of the first movable member 43A counterclockwise (as indicated by the arrow Ra) around the rotational shaft 61 when seen from below. The elastic force produced by the torsion spring 49 and acting on the coupling arm 62 of the first movable member 43A also acts on the coupling arm 62 of the second movable member 43B through the connecting shaft 44. The rollers 60 coupled to the two coupling arms 62 are each pressed against the +X-side one of the guide walls 53. Accordingly, when the slidable base 4 moves inward in the width direction, the rollers 60 of the two movable members 43 are guided inward in the width direction while rolling along the +X-side guide walls 53.

[0085] As shown in Fig. 8, when the door is about to be fully closed, the elastic force produced by the torsion spring 49 causes the coupling arms 62 to rotate around the rotational shafts 61, as a result of which the rollers 60 of the two movable members 43 unitedly move into the restriction areas 51. During this, the transmission mechanism 100 is allowed to move in the front-rear direction such that it does not interfere with the movement of the second movable member 43B.

[0086] The elastic force produced by the torsion spring 49 causes the two movable members 43, which are connected together by the connecting shaft 44, to rotate around the respective rotational shafts 61 in the same direction. The two movable members 43 connected together via the connecting shaft 44 touch the recesses 41 in the stationary members 42 when the door is fully closed. Under the influence of the elastic force produced by the torsion spring 49, the two movable members 43 unitedly move toward the restriction areas 51.

[0087] The rollers 60 of the two movable members 43 have the respective projecting parts 60a that are configured to, when the door is fully closed, fit into the recess 41 under the influence of the elastic force produced by the torsion spring 49. The projecting parts 60a of the rollers 60 of the two movable members 43 touch the inner walls of the recesses 41 under the influence of the elastic force produced by the torsion spring 49, when the door is fully closed. This can restrict the slidable base 4 from moving in the width direction when the door is fully closed.

[0088] In the present embodiment, when the restricting mechanism 40 works, the elastic force produced by the coil springs 127, 135 and 136 as well as the elastic force produced by the torsion spring 49 play a role. The elastic force exerted by the coil spring 127 pulls the first transmission member 102 toward the -X side, when seen from below. The elastic force exerted by the coil springs 135 and 136 pushes the second transmission member 103 toward the -X side, when seen from below. Accordingly, the coupling arm 62 of the second movable member 43B

is pushed by the elastic force produced by the coil springs 127, 135 and 136 counterclockwise (as indicated by the arrow Rb) around the rotational shaft 61 when seen from below. The elastic force produced by the coil springs 127, 135 and 136 and acting on the coupling arm 62 of the second movable member 43B also acts on the coupling arm 62 of the first movable member 43A through the connecting shaft 44.

[0089] When the door is about to be fully closed, the elastic force produced by the coil springs 127, 135 and 136 causes the coupling arms 62 to rotate around the rotational shafts 61, as a result of which the rollers 60 of the two movable members 43 unitedly move into the restriction areas 51. The two movable members 43 connected together via the connecting shaft 44 touch the recesses 41 in the stationary members 42 when the door is fully closed. Under the influence of the elastic force produced by the coil springs 127, 135 and 136, the two movable members 43 unitedly move toward the restriction areas 51.

[0090] The rollers 60 of the two movable members 43 have the respective projecting parts 60a that are configured to, when the door is fully closed, fit into the recesses 41 under the influence of the elastic force produced by the coil springs 127, 135 and 136. The projecting parts 60a of the rollers 60 of the two movable members 43 touch the inner walls of the recesses 41 under the influence of the elastic force produced by the coil springs 127, 135 and 136, when the door is fully closed. This can restrict the slidable base 4 from moving in the width direction when the door is fully closed.

[0091] The following describes an example of how to actuate the door in a plugging manner in a reverse direction when compared with the example where the door moves from the state shown in Fig. 7 to the state shown in Fig. 8, or an example case where the slidable base 4 moves outward in the width direction (in the plug-out direction) (moves from the state shown in Fig. 8 to the state shown in Fig. 7, moves in the opposite direction to the direction indicated by the arrow Wi shown in Fig. 7) as the door is opened from the fully closed state. For example, the case shown in Fig. 8 corresponds to a case where the door moves outward in the width direction from the fully closed position so that the door is positioned outside the vehicle.

[0092] As shown in Fig. 8, when the door is fully closed, the rollers 60 of the two movable members 43 are positioned in the restriction areas 51. The transmission mechanism 100 moves toward the +X side (in the direction of releasing the door from being locked) when acted upon by the output from the drive source 6. The transmission mechanism 100 overcomes the elastic force produced by the torsion spring 49 and the coil springs 127, 135, 136 and moves toward the +X side.

[0093] When the transmission mechanism 100 moves toward the +X side, the coupling arm 62 of the second movable member 43B rotates via the unlocking shaft 101 as a result of the movement of the transmission mechanism 100. When the transmission mechanism 100 moves toward the +X side, the coupling arm 62 of the second movable member 43B rotates clockwise around the rotational shaft 61 as seen from below (in the direction opposite to the direction indicated by the arrow Rb in Fig. 8).

[0094] When the transmission mechanism 100 moves toward the +X side, the rollers 60 of the two movable members 43 unitedly move into the non-restriction areas 52 as the coupling arms 62 overcome the above-mentioned elastic force and rotate around the rotational shafts 61. When the transmission mechanism 100 moves toward the +X-side, the two movable members 43, which are connected together via the connecting shaft 44 move away from the recesses 41 in the stationary members 42 and unitedly move into the non-restriction areas 52 against the above-mentioned elastic force.

[0095] As shown in Fig. 7, as the rollers 60 of the two movable members 43 move into the non-restriction areas 52, the slidable base 4 is now allowed to move in the width direction. Thus, the door can be opened.

[0096] As described above, the plug door device 1 relating to the present embodiment includes the stationary base 3 fixedly attached to the vehicle body of the vehicle, the slidable base 4 having the door 2 configured to open or close the doorway 15 of the vehicle attached thereto, where the slidable base 4 is movable in the width direction of the vehicle relative to the stationary base 3 by the driving force from the drive source 6, and the restricting mechanism 40 for restricting the slidable base 4 from moving in the width direction when the door 2 is fully closed. The restricting mechanism 40 includes the two stationary members 42 fixedly attached to the stationary base 3 and having the restricting parts 41, the two movable members 43 provided at the two portions of the slidable base 4 that are separate from each other in the front-rear direction of the vehicle and respectively pairing up with the two stationary members 42, and the connecting shaft 44 connecting the two movable members 43. The two movable members 43, which are connected together via the connecting shaft 44, touch the restricting parts 41 when the door 2 is fully closed. Under the influence of an external force, the two movable members 43 unitedly move toward the restriction areas 51 where the slidable base 4 is restricted from moving in the width direction. The two movable members 43 are attached to the front and rear ends of the slidable base 4. The restricting parts 41 are the recesses 41 formed in the stationary members 42 and depressed toward one of the sides in the front-rear direction. The two movable members 43 have the respective projecting parts 60a that are configured to fit into the recesses 41 under the influence of the external force, when the door 2 is fully closed. The stationary members 42 each have the guide walls 53 for guiding the corresponding movable member 43 as the movable member 43 moves in the width direction, and the projecting part 60a of the movable member 43 is fitted onto the guide walls 53 when the movable member 43 is positioned in the non-restriction area 52 where the sl-

idable base 4 is allowed to move in the width direction. The two movable members 43 each include the roller 60 configured to touch the recess 41 when the door 2 is fully closed, and also include the coupling arm 62 coupled to the roller 60 such that the coupling arm 62 is rotatable around the rotational shaft 61 extending in the height direction of the vehicle. The two coupling arms 62 are connected to the connecting shaft 44 while each coupling arm 62 is connected to the corresponding rotational shaft 61 and to the connecting shaft 44 at different portions, when seen in the height direction. When the door 2 is about to be fully closed, the external force causes the coupling arms 62 to rotate around the rotational shafts 61, as a result of which the rollers 60 of the two movable members 43 unitedly move into the restriction areas 51. The two coupling arms 62 constitute a parallelogram linkage when seen in the height direction. The connecting shaft 44 extends parallel to the front-rear direction when seen in the height direction. The connecting shaft 44 connecting together the two coupling arms 62 has the connecting-side adjusting mechanism 70 for adjusting the length of the connecting shaft 44. The torsion spring 49 is attached to one of the rotational shafts 61 of the two coupling arms 62. The torsion spring 49 is configured to rotate the coupling arms 62 by exerting the external force on the coupling arms 62. The plug door device 1 includes the transmission mechanism 100 for transmitting, to the locking mechanism 8 for locking the door 2, the output from the drive source 6, so that the locking mechanism 8 is activated. The transmission mechanism 100 includes the unlocking shaft 101 connecting together the transmission mechanism 100 and the coupling arm 62 of the second movable member 43B. When the transmission mechanism 100 moves in a direction to release the door 2 from being locked under the influence of the output from the drive source 6, the movement of the transmission mechanism 100 causes, via the unlocking shaft 101, the coupling arm 62 of the second movable member 43B to rotate, so that the rollers 60 move out of the restriction areas 51 and toward the non-restriction areas 52 where the slidable base 4 is allowed to move in the width direction. The unlocking shaft 101 includes the unlocking-side adjusting mechanism 110 for adjusting the length of the unlocking shaft 101. The transmission mechanism 100 has the coil springs 127, 135 and 136 for applying the external force in the form of an elastic force. The restricting mechanism 40 includes the stationary shaft 45 connecting together the two stationary members 42. The plug door device 1 includes the two rail bases 9 fixedly attached to the two portions of the stationary base 3 that are separate from each other in the front-rear direction. The rail bases 9 support the two portions of the slidable base 4 that are separate from each other in the front-rear direction such that the two portions are movable in the width direction. The two stationary members 42 are fixedly attached to the two rail bases 9.

[0097] With the above-described arrangement, the two movable members 43, which are connected together via the connecting shaft 44, unitedly move toward the restriction areas 51. Accordingly, when the door 2 is fully closed, the slidable base 4 can be reliably restricted from moving in the width direction. This can prevent compromised airtightness, which may be caused by the rotation of the slidable base 4. In addition, since the connecting shaft 44 is connected to the two movable members 43, the two portions of the slidable base 4 that are separate from each other in the front-rear direction can move in the width direction in synchronization. This makes it possible to control the two portions of the door 2 that are separate from each other in the front-rear direction to move in the width direction in synchronization. In addition, when the door 2 is fully closed, the external force causes the two movable members 43 to unitedly move toward the restriction areas 51. This can result in restricting the two portions of the slidable base 4 that are separate from each other in the front-rear direction from moving in the width direction when the door 2 is fully closed. In this way, when the door 2 is fully closed, the two portions of the door 2 that are separate from each other in the front-rear direction can be restricted from moving in the width direction. Accordingly, while the two portions of the door 2 that are separate from each other in the front-rear direction can be controlled to move in the width direction in synchronization, the two portions of the door 2 that are separate from each other in the front-rear direction can be restricted from moving in the width direction when the door 2 is fully closed. In addition, since the two movable members 43 are provided at the front and rear ends of the slidable base 4, the front and rear ends of the slidable base 4 are restricted from moving in the width direction. Accordingly, the present embodiment can reliably restrict the rotational movement of the slidable base 4. Furthermore, the restricting parts 41 are formed as the recesses 41 in the stationary members 42. The recesses 41 are depressed toward one of the sides in the front-rear direction. The two movable members 43 have the respective projecting parts 60a configured to, when the door 2 is fully closed, fit in the recesses 41 under the influence of the external force. In this manner, when the door 2 is fully closed, the projecting parts 60a of the two movable members 43 fit in the recesses 41. This can result in reliably restricting the slidable base 4 from moving in the width direction. In addition, each stationary member 42 has the guide walls 53 for guiding the corresponding movable member 43 as the movable member 43 moves in the width direction, and the projecting part 60a of the movable member 43 is fitted onto the guide walls 53 when the movable member 43 is positioned in the non-restriction area 52 where the slidable base 4 is allowed to move in the width direction. Accordingly, while the door 2 is moving to be fully closed, the movable members 43 are guided by the guide walls 53 as the movable members 43 move in the width direction. As a result, the movable members 43 can stably move in the width direction. In addition, the two movable members 43 each have the roller 60 configured to touch the recess 41 when the door

2 is fully closed and also have the coupling arm 62 coupled to the roller 60 such that the coupling arm 62 is rotatable around the rotational shaft 61 extending in the height direction of the vehicle. The two coupling arms 62 are connected to the connecting shaft 44 while each coupling arm 62 is connected to the corresponding rotational shaft 61 and to the connecting shaft 44 at different positions when seen in the height direction. Accordingly, when the door 2 is fully closed and the rollers 60 move into the restriction areas 51, the force causing the coupling arms 62 to rotate around the rotational shafts 61 (the force having the component acting in the direction to restrict the slidable base 4 from moving in the width direction) is applied to the recesses 41 formed in the stationary members 42. This can result in more reliably restricting the slidable base 4 from moving in the width direction when the door 2 is fully closed. In addition, the two coupling arms 62 constitute a parallelogram linkage when viewed in the height direction. When compared with the case where the two coupling arms 62 are not parallel to each other when seen in the height direction, the two coupling arms 62 can rotate around the rotational shafts 61 more stably. In addition, the connecting shaft 44 extends parallel to the front-rear direction when seen in the height direction. Accordingly, when compared with the case where the connecting shaft 44 extends in the direction intersecting the front-rear direction when seen in the height direction, the connecting shaft 44 occupies a reduced space in the width direction of the vehicle. As a result, the plug door device 1 related to the present embodiment can achieve a reduced size. Furthermore, the connecting shaft 44, which connects together the two coupling arms 62, has the connecting-side adjusting mechanism 70 configured to adjust the length of the connecting shaft 44. In this way, the length of the connecting shaft 44 can be adjusted such that the two coupling arms 62 can still constitute a parallelogram linkage when seen in the height direction, even when the distance between the transmission shafts 65 of the two coupling arms 62 deviates from a certain value. In addition, the torsion spring 49 is attached to one of the rotational shafts 61 of the two coupling arms 62, and the torsion spring 49 is configured to apply the external force to the coupling arm 62 in order to rotate the coupling arm 62. The torsion spring 49 can be provided in the dead space surrounding the rotational shaft 61. As a result, when compared with the case where a drive source such as an actuator is provided to apply the external force, the plug door device 1 can achieve a reduced size. In addition, the plug door device 1 includes the transmission mechanism 100 for transmitting, to the locking mechanism 8 for locking the door 2, the output from the drive source 6 so that the locking mechanism 8 is activated. The transmission mechanism 100 has the unlocking shaft 101 for connecting together the transmission mechanism 100 and the coupling arm 62 of the second movable member 43B. When the transmission mechanism 100 receives the output from the drive source 6 and moves in a direction to release the door 2 from being locked, the transmission mechanism 100 causes, via the unlocking shaft 101, the coupling arm 62 of the second movable member 43B to rotate, so that the roller 60 moves from the restriction area 51 to the non-restriction area 52 where the slidable base 4 is allowed to move in the width direction. Since the unlocking shaft 101 moves as the transmission mechanism 100 moves, the rollers 60 coupled with the coupling arms 62 move toward the non-restriction areas 52. Accordingly, the existing transmission mechanism 100 can be used to release the door 2 from being locked. Furthermore, the unlocking shaft 101 includes the unlocking-side adjusting mechanism 110 configured to adjust the length of the unlocking shaft 101. In this manner, even if the distance between the transmission mechanism 100 and the coupling arm 62 of the second movable member 43B departs, the length of the unlocking shaft 101 can be adjusted so that the coupling arm 62 of the second movable member 43B and the transmission mechanism 100 can be arranged with a desired distance being provided therebetween. Accordingly, the door 2 can be reliably released from being locked. In addition, the transmission mechanism 100 has the coil springs 127, 135 and 136 configured to apply the external force in the form of an elastic force. The coil springs 127, 135 and 136 can be provided in the dead space surrounding the transmission mechanism 100. As a result, when compared with the case where a drive source such as an actuator is provided to apply the external force, the plug door device 1 can achieve a reduced size. In addition, the elastic force produced by the torsion spring 49 and the elastic force produced by the coil springs 127, 135 and 136 interact with each other. Accordingly, when the door 2 is fully closed, the rollers 60 move into the restriction areas 51, which applies, to the recesses 41 formed in the stationary members 42, the rotational force (the force having the component acting in the direction to restrict the slidable base 4 from moving in the width direction) produced by the elastic force by the torsion spring 49 and the coil springs 127, 135 and 136. This can result in more reliably restricting the slidable base 4 from moving in the width direction when the door 2 is fully closed. In addition, the restricting mechanism 40 includes the stationary shaft 45 connecting the two stationary members 42. The stationary shaft 45 can contribute to improve the support rigidity of the two stationary members 42. In addition, the plug door device 1 includes the two rail bases 9 fixedly attached to the two portions of the stationary base 3 that are separate from each other in the front-rear direction. The rail bases 9 support the two portions of the slidable base 4 that are separate from each other in the front-rear direction such that the two portions of the slidable base 4 are movable in the width direction. As the two stationary members 42 are respectively fixedly attached to the two rail bases 9, the existing two rail bases 9 can be effectively used to respectively fixedly attach the two stationary members 42. Accordingly, when compared with the case where other members than the rail bases 9 are provided

to fixedly attach the two stationary members 42, the present embodiment can be practiced with a reduced number of parts.

[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 foregoing embodiment, the two movable members are respectively provided on the front and rear ends of the slidable base, but the present invention is not limited to such. As an alternative example, the two movable members may be provided on the slidable base between the front and rear ends thereof. For example, the two movable members can be provided anywhere as long as they are attached to the two portions of the slidable base that are separate from each other in the front-rear direction of the vehicle, and the two movable members respectively pair up with the two stationary members. For example, the two movable members can be provided in various manners in accordance with required specifications.

[0100] According to the above-described embodiment, the restricting parts are the recesses formed in the stationary members and depressed toward one of the sides in the front and rear directions, but the present invention is not limited to such. For example, the restricting parts may be recesses formed in the stationary members and depressed toward the other of the sides in the front-rear direction. For example, the restricting parts 41 may not be necessarily the recesses formed in the stationary members and depressed toward one of the sides in the front-rear direction. As an alternative example, the restricting parts may be openings penetrating through the stationary members in the front-rear direction. For example, the restricting part can be configured in various manners in accordance with required specifications.

[0101] According to the above-described embodiment, the two movable members each have the projecting part that is configured to fit into the recess under the influence of the external force, when the door is fully closed. The present invention, however, is not limited to such. For example, the two movable members may each have no projecting part configured to fit into the recess. For example, when the restricting parts are openings penetrating through the stationary members in the front-rear direction, the two movable members may each have a projecting part configured to fit into the opening under the influence of the external force when the door is fully closed. For example, the projecting parts of the two movable members can be configured in various manners in accordance with required specifications. -

[0102] According to the above-described embodiment, the stationary members each have the guide walls for guiding the corresponding movable member as the movable member moves in the width direction, and the projecting part of the movable member is fitted onto the guide walls when the movable member is positioned in the non-restriction area where the slidable base is allowed to move in the width direction. The present invention, however, is not limited to such. For example, the stationary members may be practiced without the guide walls. For example, the stationary members may only have the recesses. For example, the stationary members can be configured in various manners in accordance with required specifications.

[0103] According to the above-described embodiment, the two movable members each include the roller configured to touch the recess when the door is fully closed, and also include the coupling arm coupled to the roller such that the coupling arm is rotatable around the rotational shaft extending in the height direction of the vehicle. The present invention, however, is not limited to such. For example, the two movable members may be practiced without the coupling arms. For example, the movable members can be configured in various manners in accordance with required specifications.

[0104] According to the above-described embodiment, the contact parts configured to touch the restricting parts when the door is fully closed are the rollers provided on the tip ends of the first arms and rotatable around the rotational shafts extending in the height direction of the vehicle. The present invention, however, is not limited to such. For example, the contact parts may not be the rollers. For example, the contact parts may be pins fixedly and non-rotatably attached at the tip ends of the first arms. For example, the contact parts may be formed by the tip ends of the first arms. For example, the contact parts can be configured in various manners in accordance with required specifications.

[0105] According to the above-described embodiment, the two coupling arms constitute a parallelogram linkage when seen in the height direction. The present invention, however, is not limited to such. For example, the two coupling arms may not constitute a parallelogram linkage when seen in the height direction. For example, the two coupling arms may not be parallel to each other when seen in the height direction. For example, the two coupling arms can be arranged in various manners in accordance with required specifications.

[0106] According to the above-described embodiment, the connecting shaft extends parallel to the front-rear direction when seen in the height direction. The present invention, however, is not limited to such. For example, the connecting shaft may extend in the direction intersecting the front-rear direction when seen in the height direction. For example, the connecting shaft can be arranged in various manners in accordance with required specifications.

[0107] According to the above-described embodiment, the connecting shaft, which connects together the two coupling arms, has the connecting-side adjusting mechanism for adjusting the length of the connecting shaft. The present invention, however, is not limited to such. For example, the connecting shaft may be practiced without the connecting-side adjusting mechanism. For example, the connecting shaft can be configured in various

manners in accordance with required specifications.

[0108] According to the above-described embodiment, the torsion spring is attached to one of the rotational shafts of the two coupling arms, and the torsion spring is configured to apply the external force to the coupling arms to rotate the coupling arms. The present invention, however, is not limited to such. For example, the torsion spring may be attached to the other of the rotational shafts of the two coupling arms. For example, the torsion spring may be attached to at least one of the rotational shafts of the two coupling arms. For example, no torsion spring may be attached to the rotational shafts of the two coupling arms. For example, an elastic member other than the torsion spring, for example, a leaf or compressed spring may be attached to at least one of the rotational shafts of the two coupling arms, in order to apply the external force to the coupling arm and rotate the coupling arm. For example, no elastic members may be provided on the rotational shafts of the two coupling arms to apply the external force in the form of an elastic force. For example, a drive source such as a motor and an actuator may be provided on the rotational shafts of the two coupling arms to apply the external force. For example, the external force can be applied in various manners in accordance with required specifications.

[0109] According to the above-described embodiment, the plug door device includes the transmission mechanism for transmitting, to the locking mechanism for locking the door, an output from the drive source, so that the locking mechanism is activated. The present invention, however, is not limited to such. For example, the plug door device may be practiced without the transmission mechanism. For example, the plug door device can be configured in various manners in accordance with required specifications.

[0110] According to the above-described embodiment, the transmission mechanism includes the unlocking shaft connecting together the transmission mechanism and the coupling arm of the second movable member (an example of one of the coupling arms). The present invention, however, is not limited to such. For example, the unlocking shaft may connect together the transmission mechanism and the coupling arm of the first movable member. For example, the transmission mechanism may be practiced without the unlocking shaft. For example, the transmission mechanism can be configured in various manners in accordance with required specifications.

[0111] According to the above-described embodiment, the unlocking shaft has the unlocking-side adjusting mechanism for adjusting the length of the unlocking shaft. The present invention, however, is not limited to such. For example, the unlocking shaft may be practiced without the unlocking-side adjusting mechanism. For example, the unlocking shaft can be configured in various manners in accordance with required specifications.

[0112] According to the above-described embodiment, the transmission mechanism has the coil springs for applying the external force in the form of an elastic force. The present invention, however, is not limited to such. For example, the transmission mechanism may be practiced without the coil springs. For example, the transmission mechanism may have an elastic member other than a coil spring such as a leaf spring and a torsion spring, for applying the external force in the form of an elastic force. For example, the transmission mechanism may be practiced without an elastic member configured to apply an external force in the form of an elastic force. For example, the transmission mechanism may have a drive source such as a motor and an actuator to apply an external force in the form of a drive force. For example, the external force can be applied in various manners in accordance with required specifications.

[0113] According to the above-described embodiment, the restricting mechanism includes the stationary shaft connecting together the two stationary members. The present invention, however, is not limited to such. For example, the restricting mechanism may be practiced without the stationary shaft. For example, the two stationary members may be spaced away from each other in the front-rear direction without the stationary shaft. For example, the two stationary members may extend in the front-rear direction to be coupled to each other. For example, the two stationary members can be connected to each other in various manners in accordance with required specifications.

[0114] According to the above-described embodiment, the plug door device includes the two rail bases fixedly attached to the two portions of the stationary base that are separate from each other in the front-rear direction. The rail bases support the two portions of the slidable base that are separate from each other in the front-rear direction such that the two portions of the slidable base are movable in the width direction. The present invention, however, is not limited to such. For example, the plug door device may be practiced without the two rail bases. For example, the slidable base may be movable in the width direction of the vehicle relative to the stationary base without using the two rail bases. For example, the plug door device can be configured in various manners in accordance with required specifications.

[0115] According to the above-described embodiment, the two stationary members are respectively fixedly attached onto the two rail bases, but the present invention is not limited to such. For example, the two stationary members may be fixedly attached to other members than the rail bases. For example, the two stationary members can be fixed in various manners in accordance with required specifications.

[0116] For example, the foregoing embodiment is described with reference to an example plug door device including a single-leaf sliding door to open or close the doorway of a railway vehicle. The present invention, however, is not limited to such. For example, the plug door device may be provided on vehicles other than railway vehicles. For example, the plug door device may include a double leaf sliding door.

[0117] The elements of the embodiments described above may be replaced with known elements within the purport of the present invention. Further, the modifications 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 solve the problems.

LIST OF REFERENCE NUMBERS

[0118]

1	plug door device
2	door
3	stationary base
4	slidable base
6	drive source
8	locking mechanism
9	rail base
15	doorway
40	restricting mechanism
41	recess (restricting part)
42	stationary member
43	movable member
44	connecting shaft
45	stationary shaft
49	torsion spring
51	restriction area
52	non-restriction area
53	guide wall
60	roller (contact part)
60a	projecting part
61	rotational shaft
62	coupling arm
70	connecting-side adjusting mechanism
100	transmission mechanism
101	unlocking shaft
110	unlocking-side adjusting mechanism
127	coil spring (elastic member)
135	first coil spring (elastic member)
136	second coil spring

Claims

1. A plug door device (1) comprising:

a stationary base (3) fixedly attached to a body of a vehicle;
a slidable base (4) having a door (2) attached thereto to open or close a doorway (15) of the vehicle, the slidable base (4) being movable in a width direction of the vehicle relative to the stationary base (3) when acted upon by a driving force from a drive source (6); and
a restricting mechanism (40) for restricting the slidable base (4) from moving in the width direction when the door (2) is fully closed,
wherein the restricting mechanism (40) includes:

two stationary members (42) fixedly attached to the stationary base (3), the stationary members (42) each having a restricting part (41);
two movable members (43) attached to two portions of the slidable base (4) that are separate from each other in a front-rear direction of the vehicle, the two movable members (43) respectively pairing up with the two stationary members (42); and
a connecting shaft (44) connecting together the two movable members (43), and

wherein, when the door (2) is fully closed, the two movable members (43) connected together via the connecting shaft (44) touch the restricting parts (41), so that an external force causes the movable members (43) to unitedly move toward restriction areas (51) where the slidable base (4) is restricted from moving in the width direction.

2. The plug door device (1) of claim 1, wherein the two

movable members (43) are provided at ends of the slidable base (4) in the front-rear direction.

3. The plug door device (1) of claim 1 or 2, wherein the restricting parts (41) are recesses formed in the stationary members (42) and depressed toward one of sides in the front-rear direction, and
wherein the two movable members (43) each have a projecting part (60A) configured to, when the door (2) is fully closed, fit in the recess under influence of the external force.

4. The plug door device (1) of claim 3, wherein each of the stationary members (42) further has a guide wall (53) for guiding a corresponding one of the movable members (43) as the movable member (43) moves in the width direction, and the projecting part (60A) of the movable member (43) is fitted onto the guide wall (53) when the movable member (43) is positioned in a non-restriction area (52) where the slidable base (4) is allowed to move in the width direction.

5. The plug door device (1) of any one of claims 1 to 4, wherein the two movable members (43) each include:

a contact part (60) configured to touch the restricting part (41) when the door (2) is fully closed; and
a coupling arm (62) coupled to the contact part (60) such that the coupling arm (62) is rotatable around a rotational shaft (61) extending in a height direction of the vehicle,
wherein the two coupling arms (62) are connected to the connecting shaft (44) while each coupling arm (62) is connected to the rotational shaft (61) and to the connecting shaft (44) at different positions when seen in the height direction, and
wherein, when the door (2) is about to be fully closed, the external force causes the coupling arms (62) to rotate around the rotational shafts (61), so that the contact parts (60) of the two movable members (43) unitedly move toward the restriction areas (51).

6. The plug door device (1) of claim 5, wherein the two coupling arms (62) constitute a parallelogram linkage when seen in the height direction.

7. The plug door device (1) of claim 6, wherein the connecting shaft (44) extends parallel to the front-rear direction when seen in the height direction.

8. The plug door device (1) of claim 6 or 7, wherein the connecting shaft (44) connecting together the two coupling arms (62) has a connecting-side adjusting mechanism (70) for adjusting a length of the connecting shaft (44).

9. The plug door device (1) of any one of claims 5 to 8, wherein a torsion spring (49) is attached to at least one of the rotational shafts (61) of the two coupling arms (62), and the torsion spring (49) is configured to rotate the coupling arms (62) by applying the external force to the coupling arms (62).

10. The plug door device (1) of any one of claims 5 to 9, further comprising

a transmission mechanism (100) for transmitting, to a locking mechanism (8) for locking the door (2), an output from the drive source (6), so that the locking mechanism (8) is activated,
wherein the transmission mechanism (100) has an unlocking shaft (101) connecting one of the coupling arms (62) to the transmission mechanism (100), and
wherein, when the transmission mechanism (100) is acted upon by the output from the drive source (6) and moves in a direction to release the door (2) from being locked, the movement of the transmission mechanism (100) causes, via the unlocking shaft (101), the one of the coupling arms (62) to rotate, so that the contact parts (60) move from the restriction areas (51) toward non-restriction areas (51) where the slidable base (4) is allowed to move in the width direction.

11. The plug door device (1) of claim 10, wherein the unlocking shaft (101) has an unlocking-side adjusting mechanism (110) for adjusting a length of the unlocking shaft (101).

12. The plug door device (1) of claim 10 or 11, wherein the transmission mechanism (100) has an elastic member (127, 135, 136) for applying the external force in a form of an elastic force.

13. The plug door device (1) of any one of claims 1 to 12, wherein the restricting mechanism (40) further includes a stationary shaft (45) connecting together the two stationary members (42).

14. The plug door device (1) of any one of claims 1 to 13, further comprising

two rail bases (9) respectively fixedly attached to two portions of the stationary base (3) that are separate from each other in the front-rear direction, the rail bases (9) supporting the two portions of the slidable base (4) that are separate from each other in the front-rear direction such that the two portions of the slidable base (4) are movable in the width direction,
wherein the two stationary members (42) are

respectively fixedly attached to the two rail bases (9).

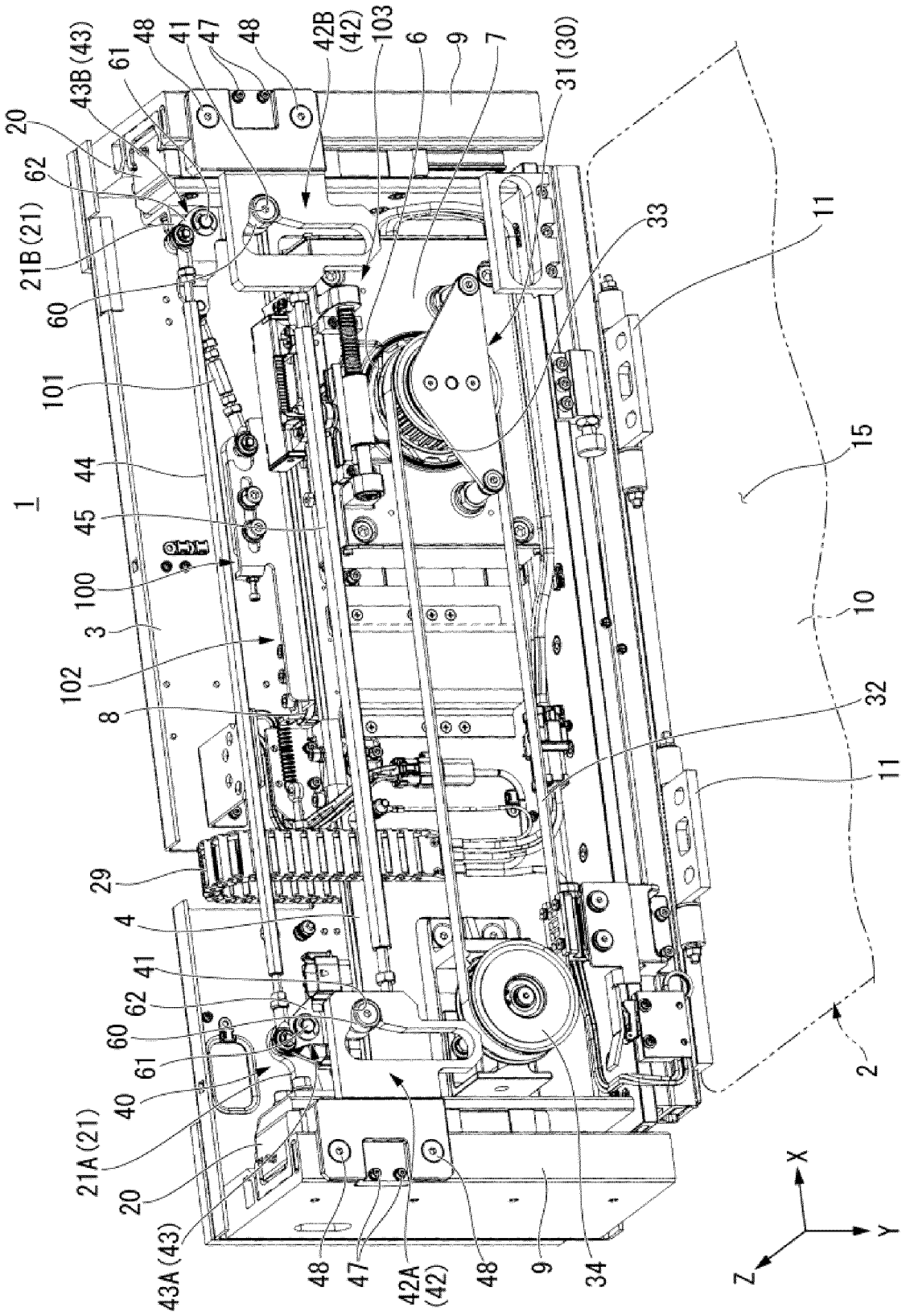
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Fig. 1

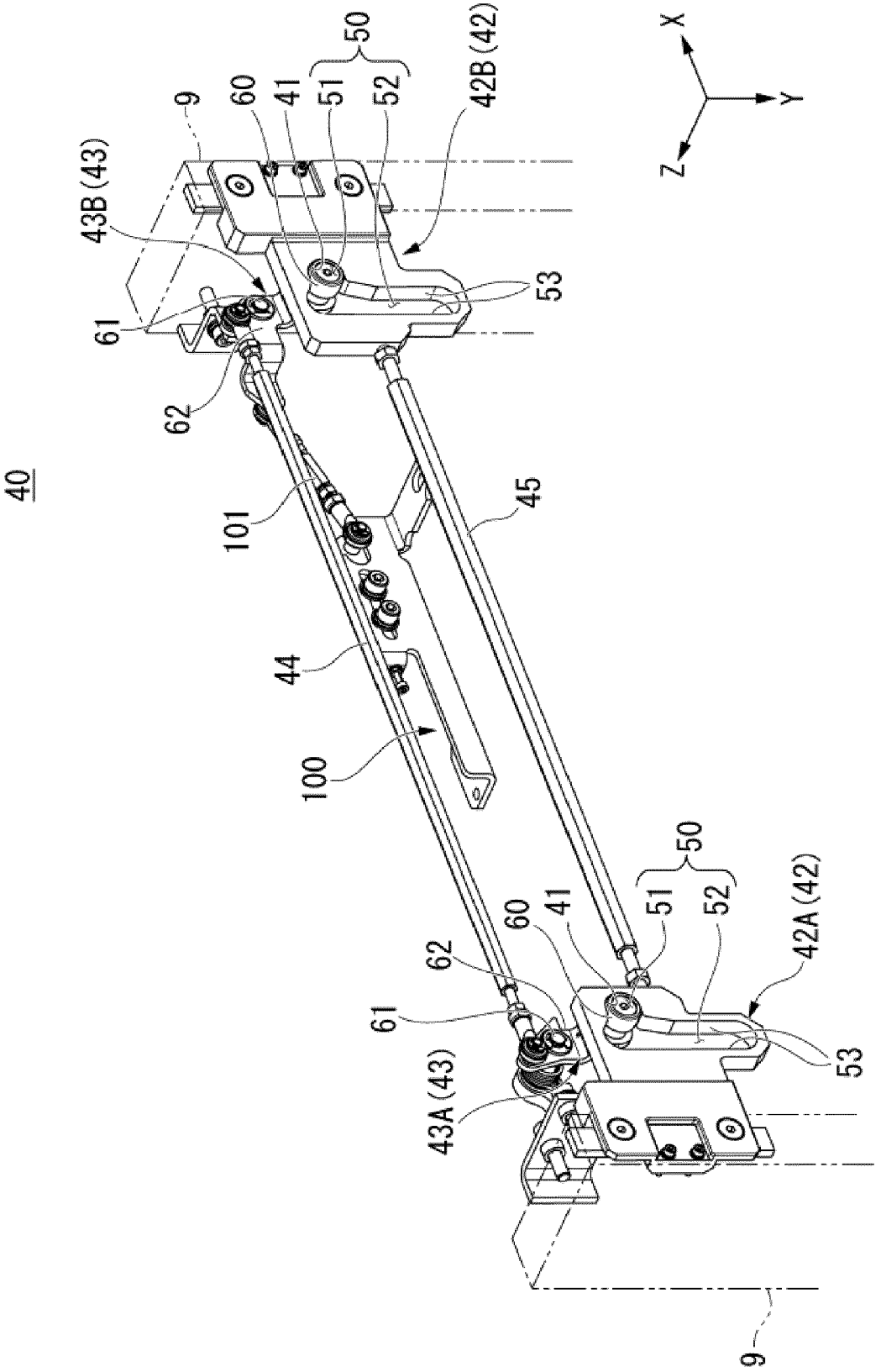
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Fig. 2

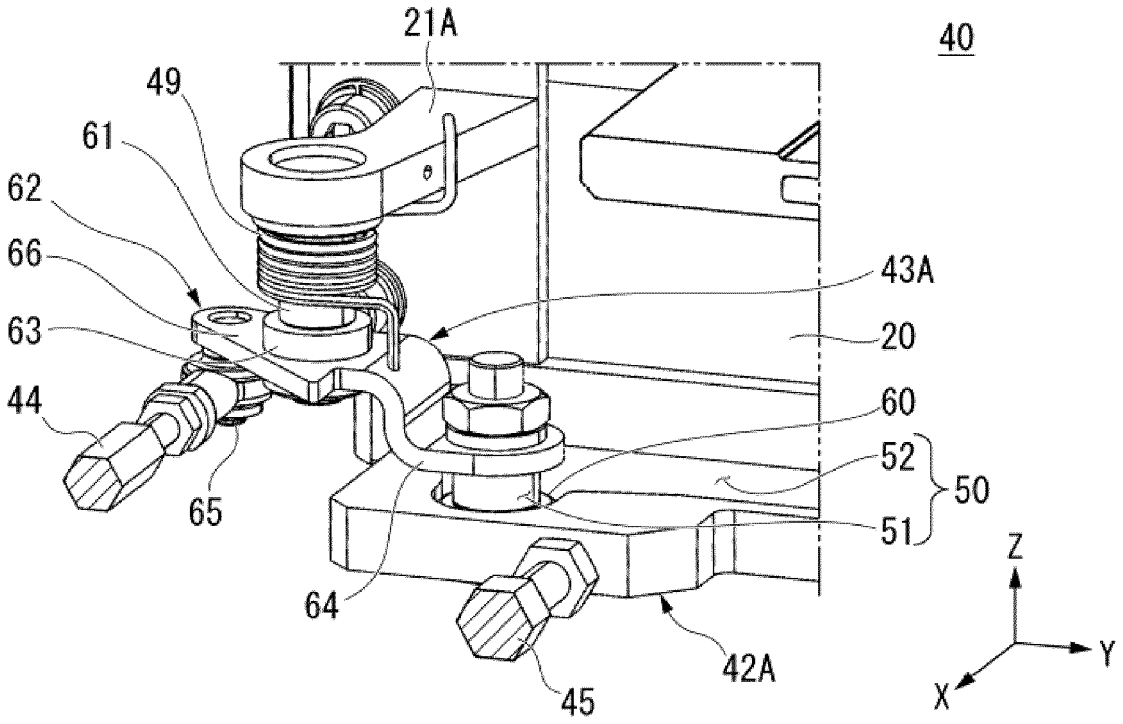

Fig. 3

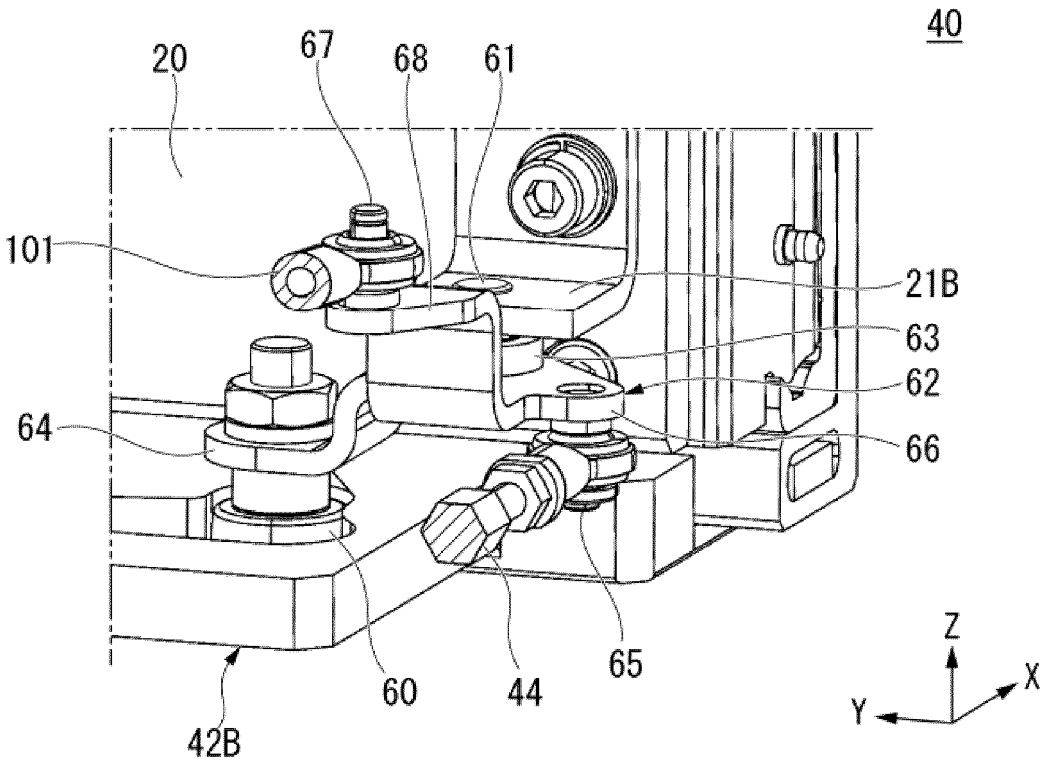

Fig. 4

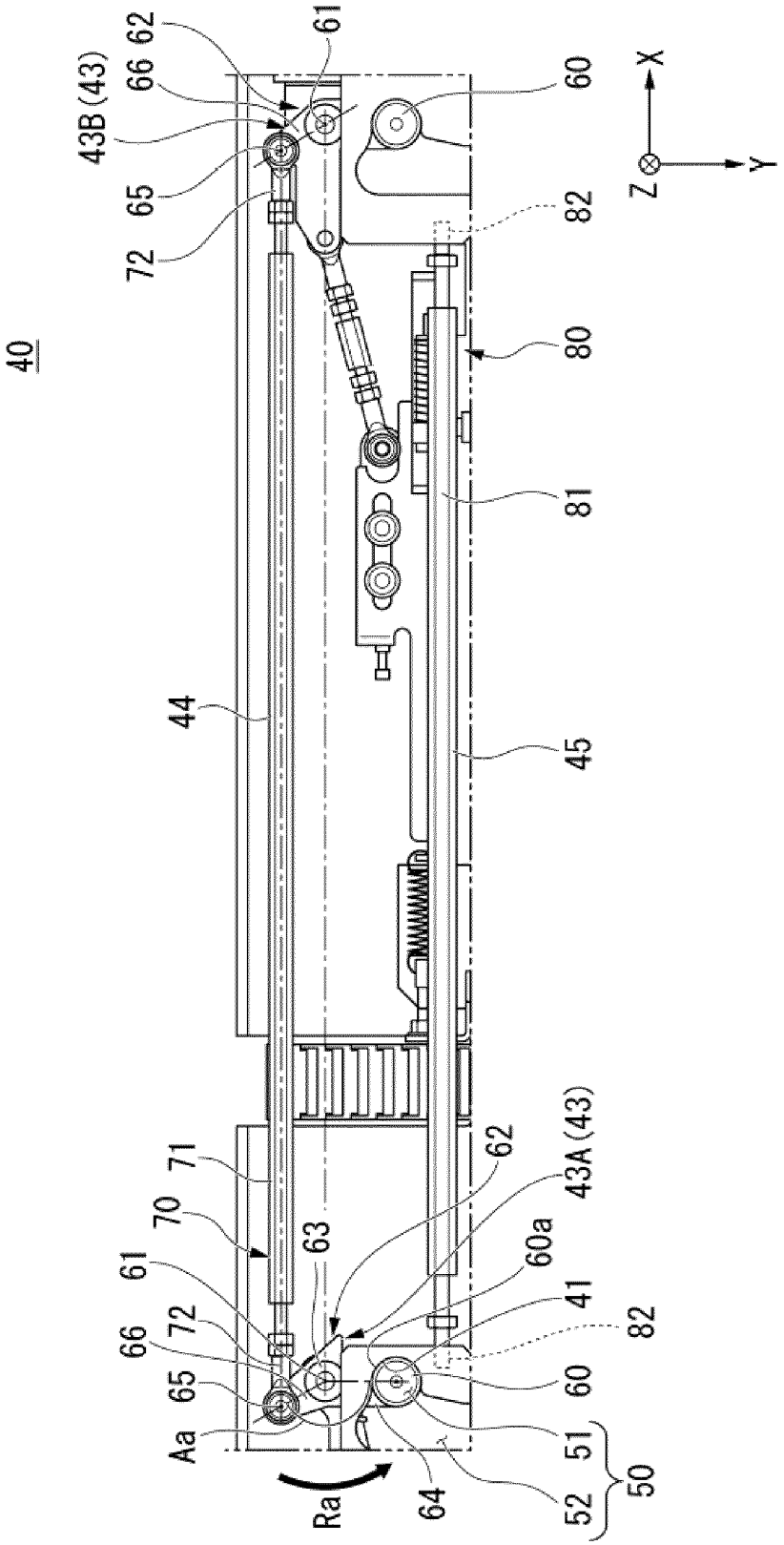
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Fig. 5

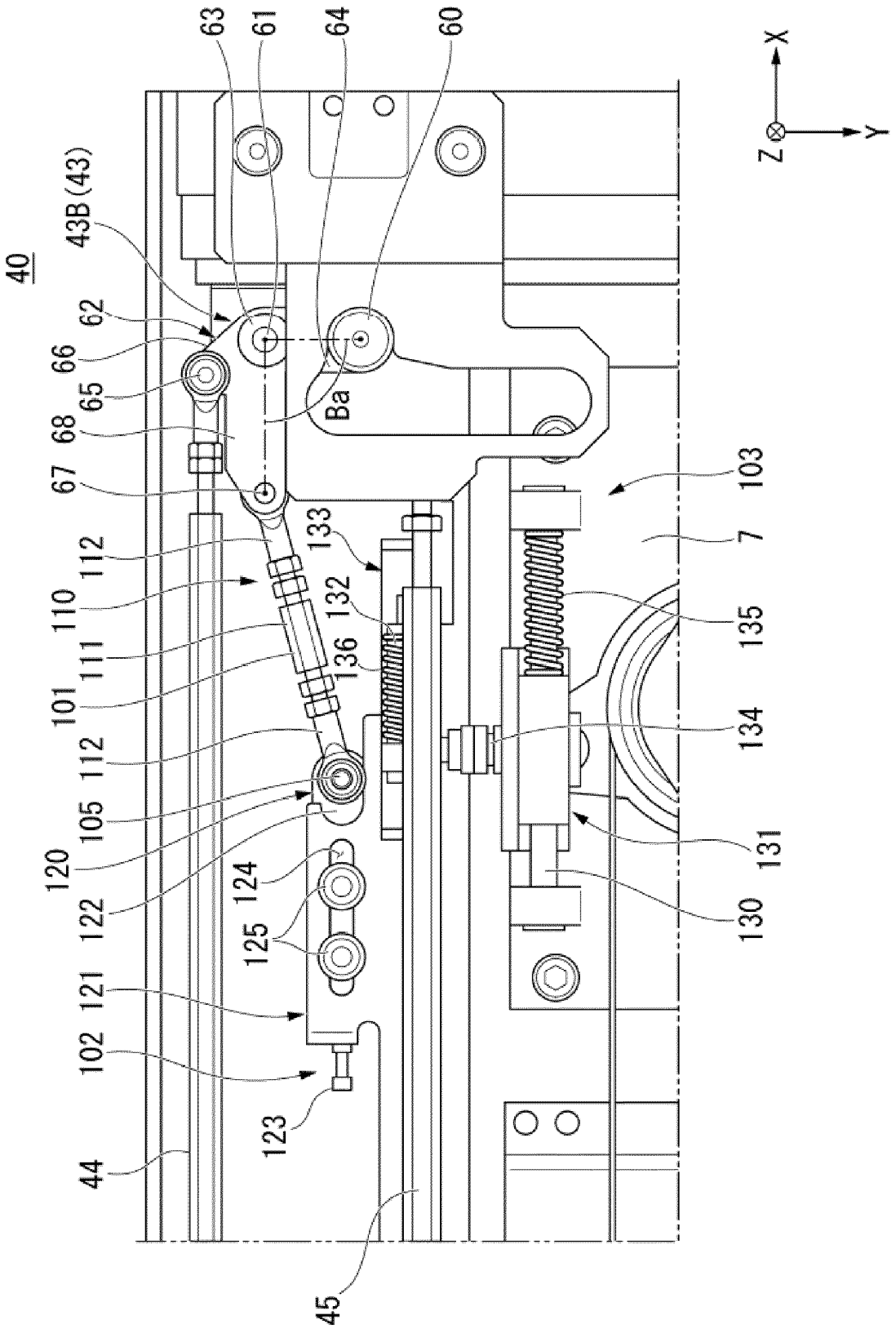
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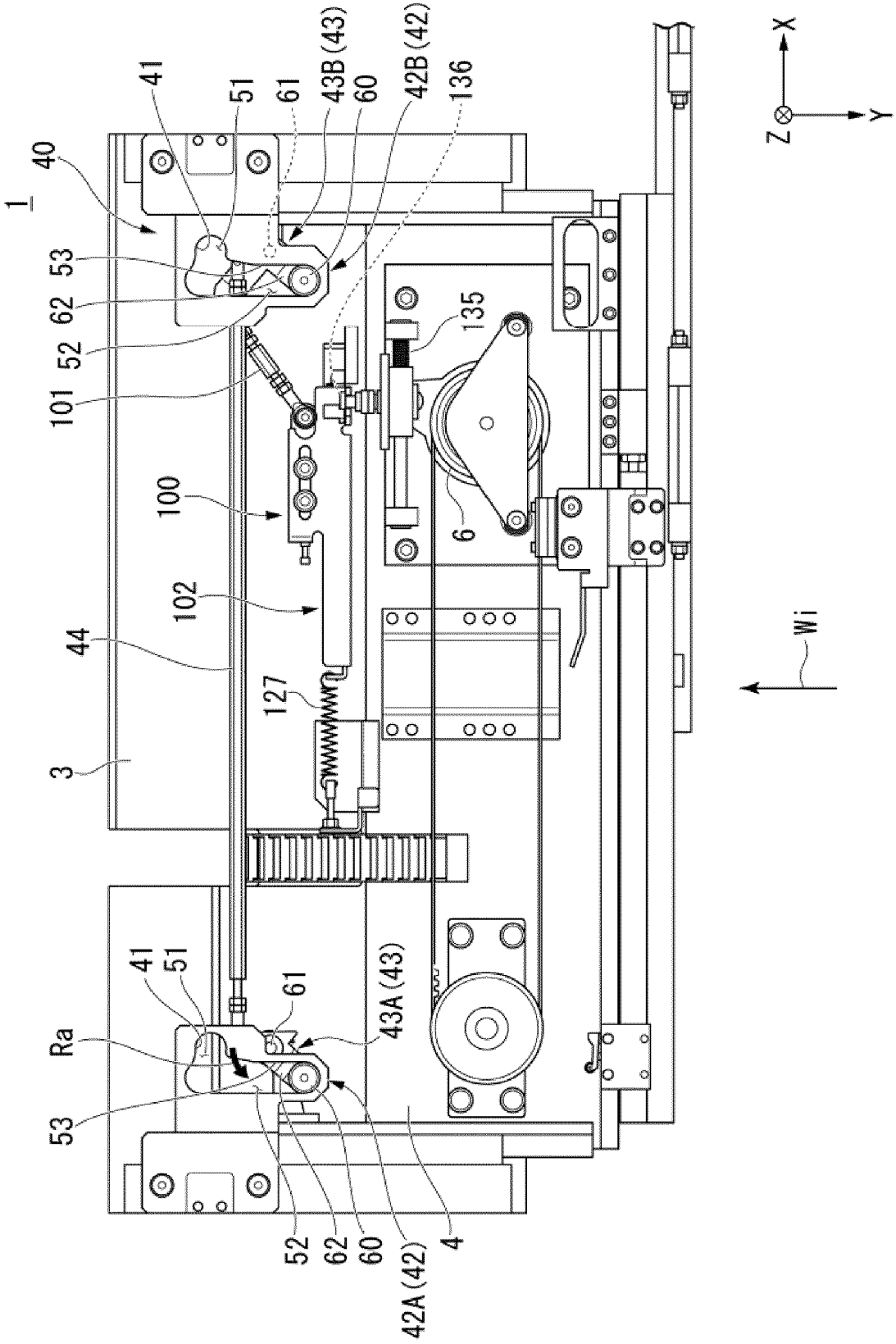
Fig. 6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40
41
51
61
43B (43)
60
42B (42)
136
53
62
52
101
135
100
6
102
44
127
3
Wi
X
Y
Z
41
51
61
43A (43)
Ra
53
52
62
60
42A (42)
4

Fig. 7

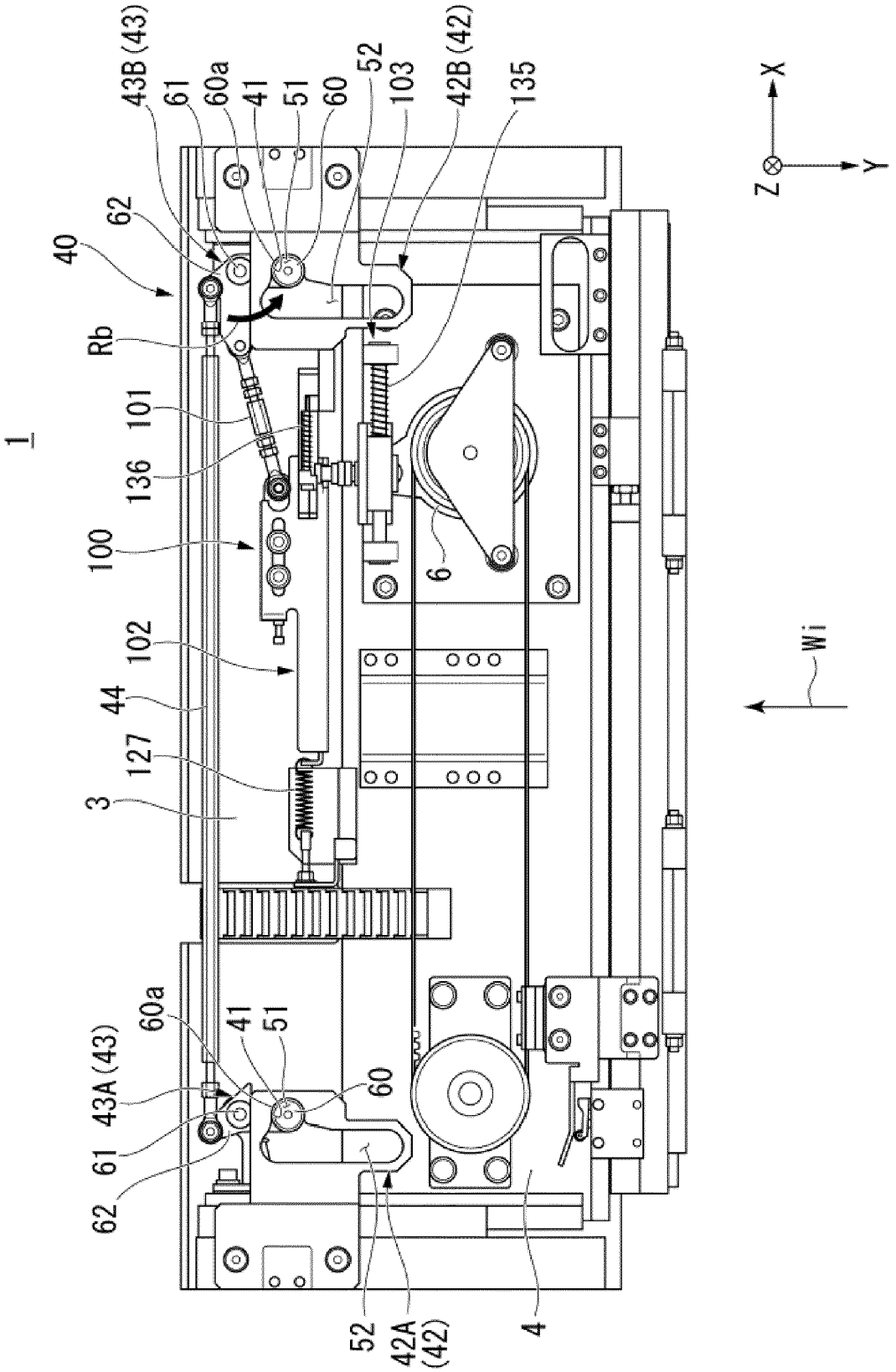
1
43B (43)
61
60a
41
51
60
52
103
42B (42)
135
62
40
Rb
101
136
100
102
44
127
3
6
Wi
X
Y
Z
60a
41
51
43A (43)
61
62
60
52
42A (42)
4

Fig. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 22 16 3316

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B61K
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Place of search	Date of completion of the search	Examiner
The Hague	15 July 2022	Witasse-Moreau, C

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