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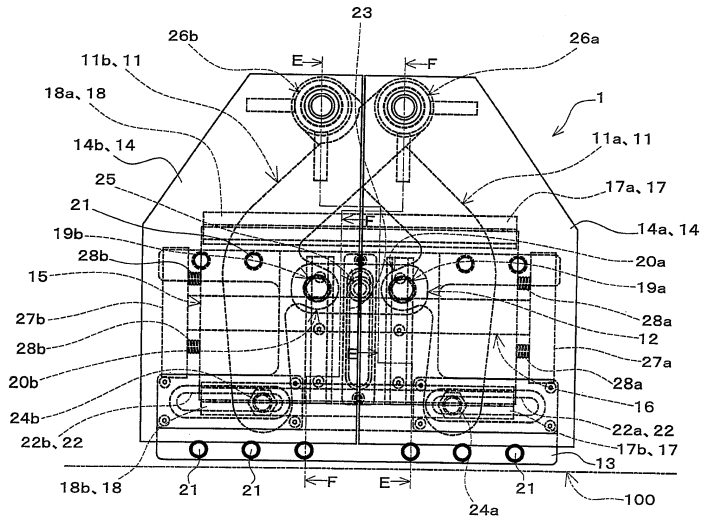
(54) STEP APPARATUS FOR VEHICLE

(57) Provided is a vehicle step apparatus for which a space for accommodating the vehicle step apparatus when it is accommodated in a railway vehicle can be reduced. A pair of step links 11 are swingably supported by a step block 12 at supporting points. Ends of the pair of step links 11 on one side move only in a direction that is parallel to an opening width direction of a door due to a first guide portion 22, and the step block 12 moves only in a direction that is orthogonal to the opening width direction of the door due to a second guide portion 23. A pair of step plates 14, by which the other ends of the pair of step links 11 are supported, move between an accommodation position and a projection position. A sliding board 15 is arranged at a position of being offset with respect to the pair of step plates 14 in the up-and-down direction when at the accommodation position. A first actuator 16 drives the pair of step plates 14 so as to project outward from the railway vehicle 100 in the vehicle width direction.

FIG. 4



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Description

Technical Field

[0001] The present invention relates to a step apparatus for vehicle (a vehicle step apparatus) that is installed in a railway vehicle and configured to project from the railway vehicle so as to bridge a gap between the railway vehicle and a platform.

Background Art

[0002] As a vehicle step apparatus that is installed in a railway vehicle, a vehicle step apparatus disclosed in Patent Document 1 has been known. The vehicle step apparatus disclosed in Patent Document 1 is configured to project from the railway vehicle so as to bridge a gap between the railway vehicle and a platform, enabling passengers getting on and off the railway vehicle to walk on the vehicle step apparatus. This vehicle step apparatus has a configuration such that its length in a direction that is parallel to an opening width direction of a door opening of the railway vehicle is substantially equal to the opening width of the door opening.

Citation List

Patent Document

[0003] Patent Document 1: Japanese Unexamined Patent Application Publication (Translation of PCT Application) No. 2006-521234

Disclosure of the Invention

Problem to be Solved by the Invention

[0004] As described above, the vehicle step apparatus disclosed in Patent Document 1 has a configuration such that its length in a direction that is parallel to an opening width direction of a door opening is substantially equal to the opening width of the door opening. Therefore, in the state in which the vehicle step apparatus is accommodated in the railway vehicle, the vehicle step apparatus will occupy a large space in the railway vehicle. Therefore, it is desired to achieve a vehicle step apparatus for which a space for accommodating the vehicle step apparatus when it is accommodated in the railway vehicle can be reduced.

[0005] In view of the circumstances, it is an object of the present invention to provide a vehicle step apparatus for which a space for accommodating the vehicle step apparatus when it is accommodated in the railway vehicle can be reduced.

Means for Solving the Problem

[0006] A vehicle step apparatus according to the first invention for achieving the object relates to a vehicle step apparatus that projects from a railway vehicle in which it is installed so as to bridge a gap between the railway vehicle and a platform. Also, the vehicle step apparatus of the first invention includes: a pair of step links that are provided as a pair of link members, and are supported so as to be able to swing around respective supporting points; a step block that is a block-shaped member for supporting the pair of step links at the supporting points via a rotation shaft; a step base that is fixed to a main body of the railway vehicle and includes a first guide portion for limiting swing of the pair of step links so that ends of the step links on one side are movable only along a direction that is parallel to an opening width direction of a door opening of the railway vehicle, and a second guide portion for limiting movement of the step block so that the step block is movable only along a direction that is orthogonal to the opening width direction and is horizontal; a pair of step plates that are provided as a pair of plate-shaped members by which other ends of the pair of step links are respectively supported via rotation shafts, and are installed so as to be movable between an accommodation position of being accommodated in the railway vehicle and a projection position of having projected from the railway vehicle; a sliding board that is arranged at a position of being offset with respect to the pair of step plates in an up-and-down direction when the pair of step plates are located at the accommodation position, and that slides with respect to the pair of step plates when the pair of step plates project toward the projection position while separating from each other in the direction parallel to the opening width direction; and a first actuator that drives the pair of step plates so as to project outward from the railway vehicle in a vehicle width direction of the railway vehicle.

[0007] According to this invention, the vehicle step apparatus is installed, with its step base, which includes the first

and second guide portions, being fixed to the railway vehicle. Also, by the first actuator operating in the state in which the pair of step plates are located at the accommodation position, the pair of step plates project outward in the vehicle width direction from the accommodation position to the projection position. At this time, with the operation of the first actuator, the other ends of the step links that are rotatably supported by the step plates move together with the step plates, and the ends of the step links on one side are limited by the first guide portions so as to move in the direction that is parallel to the opening width direction of the door opening. At this time, the step links further swing around their supporting points at which the step links are rotatably supported by the step block, and the step block moves horizontally in the direction orthogonal to the opening width direction. Accordingly, the pair of step plates project toward the projection position while separating from each other in the direction parallel to the opening width direction. With the projection of the pair of step plates, the sliding board slides with respect to the pair of step plates, and specifically at a position between the pair of step plates where the sliding board is offset with respect to the pair of step plates in the up-and-down direction, the sliding board projects, together with the pair of step plates, outward in the vehicle width direction. Accordingly, a gap between the railway vehicle and the platform is bridged by the pair of step plates and the sliding board.

[0008] On the other hand, by the first actuator operating in a reverse direction with respect to the above-described operation direction, the pair of step plates, the sliding board, the step block, and the pair of step links perform reverse operations with respect to the above-described operation, so that the pair of step plates return from the projection position toward the accommodation position, while getting closer to each other. Also, in the state in which the pair of step plates have returned to the accommodation position, the sliding board is arranged at a position of being offset with respect to the pair of step plates in the up-and-down direction, and the vehicle step apparatus is accommodated in the railway vehicle. Accordingly, in the state in which the vehicle step apparatus is accommodated in the railway vehicle, the length of the vehicle step apparatus in the direction parallel to the opening width direction of the door opening is configured to be smaller than the opening width of the door opening. This achieves a reduction in the space for accommodating the vehicle step apparatus when it is accommodated in the railway vehicle.

[0009] According to the present invention, it is thus possible to provide a vehicle step apparatus for which a space for accommodating the vehicle step apparatus when it is accommodated in the railway vehicle can be reduced.

[0010] A vehicle step apparatus according to the second invention is the vehicle step apparatus of the first invention, in which the first actuator is provided as a linear-acting actuator and is installed so as to be capable of driving the pair of step plates such that both ends of the first actuator separate the pair of step plates from each other, and the both ends of the first actuator are supported by the pair of step plates on a front end side in a projection direction of the step plates.

[0011] According to this invention, with the operation of the first actuator, the pair of step plates are directly driven so as to separate from each other, projecting toward the projection position by the operation of the pair of step links. Further, since the first actuator, which is of a linear-acting type, is supported by the pair of step plates on the front end side in the projection direction, the first actuator is arranged outside in the vehicle width direction when the pair of step plates are at the projection position. Accordingly, it is possible to perform maintenance of the first actuator, which is a drive mechanism, when the vehicle step apparatus is installed in the railway vehicle. Therefore, in the vehicle step apparatus in which a reduction in a space for accommodating the vehicle step apparatus is achieved, a further improvement in maintenance property can be achieved.

[0012] A vehicle step apparatus according to the third invention is the vehicle step apparatus of the first invention, in which the first actuator is provided as a linear-acting actuator whose one end is supported by the step base or a main body of the railway vehicle, and whose other end is supported by the step block.

[0013] According to this invention, with the operation of the first actuator, the pair of step plates are driven via the step block and the pair of step links so as to project toward the projection position. Since, in this manner, the first actuator of the linear-acting type has a configuration such that it is arranged between the step base or the main body of the railway vehicle and the step block and transfers drive force via the pair of step links, it is possible to set an actuating stroke of the first actuator to be short. Therefore, in the vehicle step apparatus, it is possible to achieve a reduction in a space in which the first actuator is arranged in its longitudinal direction.

[0014] A vehicle step apparatus according to the fourth invention is the vehicle step apparatus of any one of the first to third inventions, in which the step block is rotatably supported by the step base.

[0015] According to this invention, the step block, which rotatably supports the supporting points of the step links that swing in accordance with the operation of the first actuator, is rotatably supported by the step base. It is thus possible to shift the locations of the supporting points of the step links relative to the center of rotation of the step block in the rotational direction of the step block. This makes it possible to swing the pair of step plates around the center of rotation of the step block via the pair of step links. Therefore, even if the pair of step plates project so as to abut against a platform whose edge portion is curved along a curved track of the railway vehicle, the pair of step plates can swing along the curve of the platform and abut against it. Consequently, it is possible, even in the case of the curved platform, to reliably bridge a gap between the railway vehicle and the platform.

[0016] A vehicle step apparatus according to the fifth invention is the vehicle step apparatus of the fourth invention

further including: a second actuator capable of driving the step block so as to rotate.

[0017] According to this invention, in addition to the first actuator for causing the pair of step plates to project outward from the railway vehicle, the second actuator for causing the step block to rotate is further provided. Therefore, while the first actuator causes the pair of step plates to project, the second actuator can be controlled so as to actively swing the pair of step plates around the center of rotation of the step block. When projecting toward a platform whose edge portion is curved along a curved track of the railway vehicle, the pair of step plates can thus be controlled so as to actively swing along the curve of the platform. This makes it possible, even in the case of the curved platform, to reliably bridge a gap between the railway vehicle and the platform. Since according to this invention, the pair of step plates can be controlled so as to actively swing, it is possible to swing the pair of step plates along the curve of the platform not only when the vehicle step apparatus is installed such that the pair of step plates are located at substantially the same level as that of the edge portion of the platform but also when the vehicle step apparatus is installed such that the pair of step plates project over the platform.

[0018] A vehicle step apparatus according to the sixth invention is the vehicle step apparatus of any one of the first to fifth inventions, in which the pair of step plates each include a guide mechanism for guiding a sliding direction of the sliding board, each guide mechanism including a door wheel having a rotation shaft that extends obliquely with respect to the up-and-down direction, and a guide member having a running surface that is inclined obliquely with respect to the up-and-down direction and on which the door wheel runs by its rolling surface rolling thereon.

[0019] According to this invention, by the door wheel, which rotates around the rotation shaft that extends obliquely with respect to the up-and-down direction, running on the running surface that extends obliquely with respect to the up-and-down direction, the sliding board slides with respect to the pair of step plates. Therefore, it is possible to easily achieve a smooth movement of the sliding board, as well as to stably support the load of passengers getting on and off when they walk on the sliding board that projected between the pair of step plates.

[0020] A vehicle step apparatus according to the seventh invention is the vehicle step apparatus of any one of the first to sixth inventions, in which wherein the sliding board is supported by the pair of step plates via elastic members.

[0021] This invention achieves a configuration such that the sliding board, which slides with respect to the pair of step plates, is supported by the step plates via elastic members. Therefore, in the state in which the pair of step plates have projected from the accommodation position to the projection position, it is possible to achieve, with a simple mechanism, a configuration such that the sliding board is supported while being centered on the middle of the pair of step plates. Then, since the sliding board is centered on the middle of the pair of step plates, at the projection position, it is possible to effectively cover a gap between the pair of step plates with a small sliding board.

[0022] A vehicle step apparatus according to the eighth invention is the vehicle step apparatus of any one of the first to fifth inventions, in which the sliding board includes: a first board that is tubular in shape and whose end is fixed to one of the pair of step plates in a cantilever manner; and a second board whose end is fixed to the other of the pair of step plates in a cantilever manner and whose front end is slidably inserted into the first board, and the sliding board moves such that a middle portion of the second board that was inserted into the first board is exposed from the first board when the pair of step plates move from the accommodation position toward the projection position.

[0023] According to this invention, the sliding board is constituted by the first and second boards that are respectively fixed to the step plates in a cantilever manner, the first board sliding with respect to one of the pair of step plates, and the second board sliding with respect to the other of the pair of step plates. Also, the sliding board expands by the second board being exposed from the first board when the pair of step plates are located at the accommodation position, whereas the sliding board is compactly accommodated, with the second board being inserted into the tubular first board, when the pair of step plates are located at the accommodation position. It is thus possible to downsize the sliding board when the pair of step plates are located at the accommodation position.

[0024] A vehicle step apparatus according to the ninth invention is a vehicle step apparatus of any one of the first to eighth inventions, in which the pair of step plates each have a portion whose size in the direction parallel to the opening width direction changes so as to decrease toward an inner end of the step plate in the vehicle width direction.

[0025] According to the present invention, since the pair of step plates have the portions whose sizes in the direction parallel to the opening width direction change so as to decrease toward inner ends of the step plates in the vehicle width direction, it is possible to further reduce a space for accommodating the pair of step plates at the accommodation position. Also, even at the projection position, the inner ends of the pair of step plates in the vehicle width direction are located under the main body of the railway vehicle. This makes it possible to prevent a reduction in the space in which passengers walk when getting on and off, when the pair of step plates are at the projection position.

Effects of the Invention

[0026] According to the present invention, it is possible to provide a vehicle step apparatus for which a space for accommodating the vehicle step apparatus when it is accommodated in the railway vehicle can be reduced.

Brief Description of the Drawings

[0027]

FIG. 1 is a diagram schematically illustrating an arrangement state in which a vehicle step apparatus according to an embodiment of the present invention is installed in a railway vehicle.
FIG. 2 is a diagram schematically illustrating the state of the railway vehicle of FIG. 1 whose door is opened, together with the vehicle step apparatus.
FIG. 3 is a diagram schematically illustrating the state in which the vehicle step apparatus of FIG. 1 bridges a gap between the railway vehicle and a platform.
FIG. 4 is a plan view illustrating the vehicle step apparatus of FIG. 1.
FIG. 5 is a front view illustrating the vehicle step apparatus of FIG. 4.
FIG. 6 is a schematic cross-sectional view that is taken along the line E-E-E in FIG. 4 and seen from a lateral side in the direction of the arrows E, with some of components being omitted.
FIG. 7 is a schematic cross-sectional view that is taken along the line F-F-F in FIG. 4 and seen from a lateral side in the direction of the arrows F, with some of components being omitted.
FIG. 8 is a plan view illustrating the state of the vehicle step apparatus of FIG. 4, in which a pair of step plates have projected from the accommodation position to the projection position.
FIG. 9 is a diagram schematically illustrating the state in which the vehicle step apparatus bridges a gap between the railway vehicle and the platform, when the vehicle step apparatus is installed such that its front end abuts against the upper end portion of the platform.
FIG. 10 is a plan view illustrating the state of the vehicle step apparatus of FIG. 4, in which the pair of step plates have swung with respect to the step base.
FIG. 11 is a plan view illustrating a vehicle step apparatus according to a modification.
FIG. 12 is a plan view illustrating a vehicle step apparatus according to a modification.
FIG. 13 is a diagram schematically illustrating a vehicle step apparatus according to a modification.
FIG. 14 is a plan view illustrating a vehicle step apparatus according to a modification.
FIG. 15 is a plan view illustrating the state of the vehicle step apparatus of FIG. 14, in which the pair of step plates have projected from the accommodation position to the projection position.

Description of Embodiments

[0028] Hereinafter, embodiments of the present invention will be described with reference to the drawings. Note that the present embodiments are widely applicable to vehicle step apparatuses that are installed in a railway vehicle and configured to project from the railway vehicle so as to bridge a gap between the railway vehicle and a platform.

[0029] FIG. 1 is a diagram schematically illustrating an arrangement state in which a step apparatus for vehicle (a vehicle step apparatus) 1 according to an embodiment of the present invention is installed in a railway vehicle 100. FIG. 1 is a diagram schematically illustrating part of the railway vehicle 100 from a lateral view (that is, the state seen in a direction that is parallel to the vehicle width direction of the railway vehicle 100).

[0030] As illustrated in FIG. 1, in each vehicle in a unit of the railway vehicles 100 (in FIG. 1, part of one vehicle is schematically illustrated), a plurality of door openings 102, through which passengers walk when they get on and off the railway vehicle 100, are provided along the vehicle width direction. In each door opening 102, doors (101, 101) are provided, for example, as a pair of double doors. Note that in FIG. 1, a double-headed solid line arrow A denotes the opening width direction of the door opening 102, and a double-headed dotted line arrow B denotes the opening width of the door opening 102.

[0031] FIG. 2 is a diagram that corresponds to FIG. 1, schematically illustrating, together with the vehicle step apparatus 1, the state of the railway vehicle 100 in which the doors (101, 101) have moved in the opening width direction of the door opening 102 and are opened. Further, FIG. 3 is a diagram schematically illustrating the state in which the vehicle step apparatus 1 bridges a gap 104 between the railway vehicle 100 and a platform 103. Note that FIG. 3 illustrates the state seen from a direction that is parallel to the opening width direction of the door opening 102, in which part of one railway vehicle 100 is shown, and the platform 103 is shown in a cross-sectional view.

[0032] As illustrated in FIGS. 1 to 3, the vehicle step apparatus 1 is installed in each door opening 102 of each railway vehicle 100. Note that FIG. 1 illustrates the state in which the vehicle step apparatus 1 is accommodated in the railway vehicle 100, and FIGS. 2 and 3 illustrate the state in which the vehicle step apparatus 1 has projected toward the platform 103 from the railway vehicle 100 so as to bridge the gap 104.

[0033] With a configuration of the vehicle step apparatus 1 that will be described later, the length of the vehicle step apparatus 1 in the direction parallel to the opening width direction of the door opening 102 (in FIG. 1, the length indicated by a double-headed dotted line arrow C1) is made shorter than the opening width of the door opening 102 (the length

of the double-headed arrow B) when the vehicle step apparatus 1 is accommodated in the railway vehicle 100. On the other hand, when the vehicle step apparatus 1 has projected from the railway vehicle 100, the length of the vehicle step apparatus 1 in the direction parallel to the opening width direction of the door opening 102 (the length indicated by a double-headed dotted line arrow C2 in FIG. 2) is made substantially the same as the opening width of the door opening 102. Also, by the vehicle step apparatus 1 projecting outward in the vehicle width direction of the railway vehicle 100 (in FIG. 3, the direction indicated by the double-headed solid line arrow D) to the platform 103, the gap 104 is bridged, so that passengers can walk on the vehicle step apparatus 1 and get on and off the railway vehicle 100. Hereinafter, the configuration of the vehicle step apparatus 1 is explained in detail.

[0034] FIG. 4 is a plan view illustrating the vehicle step apparatus 1, and FIG. 5 is a front view illustrating the vehicle step apparatus 1. Further, FIG. 6 is a schematic cross-sectional view that is taken along the line E-E-E in FIG. 4 and seen from a lateral side in the direction of the arrows E, with some of components being omitted. Furthermore, FIG. 7 is a schematic cross-sectional view that is taken along the line F-F-F in FIG. 4 and seen from a lateral side in the direction of the arrows F, with some of components being omitted. As illustrated in FIGS. 4 to 7, the vehicle step apparatus 1 is configured to include a pair of step links 11, a step block 12, a step base 13, a pair of step plates 14, a sliding board 15, an actuator 16, which is the first actuator according to the present embodiment, guide mechanisms (17, 18), and the like. In FIGS. 5 to 7, illustration of the actuator 16 is omitted.

[0035] The pair of step links 11 illustrated in FIGS. 4 to 7 are provided as a pair of link members, and configured to include a step link 11a and a step link 11b. Each step link (11a, 11b) has a boomerang-like shape whose cross-section is substantially a rectangle and that has two plate-like side portions, the portions constituting two straight extending plate-like sides being curved and continuous at their ends. Note that the step link 11a and the step link 11b are arranged at locations where they are offset up and down in an up-and-down direction in the state in which the vehicle step apparatus 1 is installed in the railway vehicle 100 (see FIG. 5). Accordingly, the step link 11a and the step link 11b have a configuration such that they can be arranged at locations where they overlap each other in the up-and-down direction.

[0036] Also, curved portions in the centers of the step links (11a, 11b) are each formed as a portion in which two sides extending in directions in which they cross at an obtuse angle continuous in an arc. At the curved portion in the center of the step link 11a, on the side where the two sides form an obtuse angle, a supporting point portion 20a is provided by which a rotation shaft 19a that is arranged on the supporting point in the swing operation is rotatably supported. Similarly, at the curved portion in the center of the step link 11b, on the side where the two sides form an obtuse angle, a supporting point portion 20b is provided by which a rotation shaft 19b that is arranged on the supporting point in the swing operation is rotatably supported. Therefore, the pair of step links 11 are supported so as to be able to swing around the respective supporting points.

[0037] The step block 12 illustrated in FIGS. 4 to 7 is provided as a thin-type block-shaped member, and is configured to support the pair of step links 11 at the respective supporting points via the rotation shafts (19a, 19b). Namely, the step link 11a is supported by the step block 12 via the rotation shaft 19a so as to swing around the supporting point that is the center of the supporting point portion 20a of the step link 11a. Also, the step link 11b is supported by the step block 12 via the rotation shaft 19b so as to swing around the supporting point that is the center of the supporting point portion 20b of the step link 11b. Note that both rotation shafts (19a, 19b) are rotatably supported by the step block 12.

[0038] The step base 13 illustrated in FIGS. 4 to 7 is fixed to a main body of the railway vehicle 100, serving as a base portion for the vehicle step apparatus 1 that is installed in the railway vehicle 100. This step base 13 is fixed, by being fastened on the main body of the railway vehicle 100 with, for example, a plurality of bolts 21 or the like. Further, an accommodation space in which the vehicle step apparatus 1 is accommodated is formed under the door opening 102 of the main body of the railway vehicle 100, and the vehicle step apparatus 1 is fixed at the bottom of this accommodation space with the plurality of bolts 21 or the like.

[0039] Also, the step base 13 is configured to include first guide portions 22 and a second guide portion 23. The first guide portions 22 are provided as a pair that corresponds to the pair of step links 11, the first guide portions 22 including a first guide portion 22a that corresponds to the step link 11a, and a first guide portion 22b that corresponds to the step link 11b.

[0040] Each first guide portion (22a, 22b) is provided as a portion that has a long hole formed as a through-hole extending in the direction parallel to the opening width direction of the door opening 102. A guide shaft 24a, which is fixed to one end of the step link 22a that is located on the outer side in the vehicle width direction, is arranged in a manner of being loosely fit into the long hole of the first guide portion 22a corresponding to the step link 11a. On the other hand, a guide shaft 24b, which is fixed to one end of the step link 22b that is located on the outer side in the vehicle width direction, is arranged in a manner of being loosely fit into the long hole of the first guide portion 22b corresponding to the step link 22b. Accordingly, the first guide portions (22a, 22b) are configured to be portions that limit swing of the step links (11a, 11b) so that the ends of the pair of step links 11 on one side are movable only along the direction parallel to the opening width direction of the door opening 102 of the railway vehicle 100.

[0041] The second guide portion 23 is provided in the central portion of the step base 13 and configured to be a portion that has a long hole formed as a through-hole horizontally extending in the direction that is orthogonal to the opening

width direction of the door opening 102 (that is, a direction parallel to the vehicle width direction of the railway vehicle 100). A guide shaft 25, which is fixed to the central portion of the step base 13, is arranged in a manner of being fit into the long hole of the second guide portion 23. Accordingly, the second guide portion 23 is configured to be a portion that limits movement of the step block 12 so that the step block 12 is only movable along the direction that is orthogonal to the opening width direction of the door opening 102 and horizontal. Since the guide shaft 25 is fixed to the step block 12 and arranged in a manner of being fit into the long hole of the second guide portion 23, the step block 12 is rotatably supported by the step base 13.

[0042] As illustrated in FIGS. 4 to 7, the pair of step plates 14 are provided as a pair of plate-shaped members and configured to include a step plate 14a and a step plate 14b. The step plates (14a, 14b) are arranged so that their plate-like surfaces extend in the horizontal direction, and together have a shape of a pentagon such that a square or a rectangle and a trapezoid are incorporated. The step plates (14a, 14b) are also arranged so that the longest sides of the pentagon extend along the direction parallel to the vehicle width direction of the railway vehicle 100.

[0043] Further, the step plates (14a, 14b) have wide portions on outer sides in the vehicle width direction, and narrow portions on the inner side in the vehicle width direction. Also, the narrow portions of the step plates (14a, 14b) are configured so that sides of the step plates (14a, 14b) that face each other extend parallel to each other, and sides that are opposite to the sides facing each other extend obliquely in directions in which they get closer to each other toward the inner side in the vehicle width direction. In this way, each of the pair of step plates 14 has a portion whose size in the direction parallel to the opening width direction of the door opening 102 changes so as to decrease toward the inner end in the vehicle width direction. Accordingly, the pair of step plates 14 is configured so that overall the portions at the inner side in the vehicle width direction are narrow in the state in which the vehicle step apparatus 1 is accommodated in the railway vehicle 100.

[0044] Moreover, the other end of the step link 11b that is located on the inner side in the vehicle width direction is rotatably supported by the step plate 14a at its one end that is located on the inner side in the vehicle width direction, via a rotation shaft 26a. On the other hand, the other end that is located on the inner side in the vehicle width direction is rotatably supported by the step plate 14b via a rotation shaft 26b. Accordingly, the other ends of the pair of step links 11 are supported by the pair of step plates 14 via the rotation shafts (26a, 26b), respectively.

[0045] Note that FIGS. 4 to 7 illustrate the vehicle step apparatus 1 in the state in which the pair of step plates 14 are located at the accommodation position where they are accommodated in the railway vehicle 100 (the state shown in FIG. 1). Starting from this state, an actuator 16 that will be described later actuates the pair of step plates 14 so that they move toward the projection position where they have projected from the railway vehicle 100. That is, the pair of step plates 14 are arranged so as to be movable between the accommodation position and the projection position.

[0046] In the present embodiment, the sliding board 15 illustrated in FIGS. 4 to 7 is provided as a rectangular plate-shaped member and is arranged at a position of being offset with respect to the pair of step plates 14 in the up-and-down direction in the state in which the pair of step plates 14 are located at the accommodation position. Speci.fically, in the present embodiment, the sliding board 15 is arranged at a position of being offset downward with respect to the pair of step plates 14 in the state in which the pair of step plates 14 are located at the accommodation position. This sliding board 15 is supported so as to be slidable with respect to the pair of step plates 14 by using guide mechanisms (17, 18) that will be described later. Therefore, when the pair of step plates 14 project toward the projection position, the sliding board 15 is configured to slide with respect to the pair of step plates 14, which project toward the projection position while separating from each other in the direction parallel to the opening width direction of the door opening 102.

[0047] Further, spring support members (27a, 27b), which are arranged so as to extend in the direction parallel to the vehicle width direction, are respectively fixed to the step plates (14a, 14b) on their outer sides in the direction parallel to the opening width direction of the door opening 102 (see FIGS. 4 and 5). Specifically, a spring support member 27a is fixed to the step plate 14a, and a spring support member 27b is fixed to the step plate 14b.

[0048] Furthermore, a plurality of coil springs 28a, which are elastic members according to the present embodiment, are arranged between the sliding board 15 and the spring support member 27a. One end of each of these coil springs 28a is coupled to the sliding board 15, and the other end is coupled to the spring support member 27a. Similarly, a plurality of coil springs 28b, which are elastic members according to the present embodiment, are arranged between the sliding board 15 and the spring support member 27b. One end of each of these coil springs 28b is coupled to the sliding board 15, and the other end is coupled to the spring support member 27b. Note that, the coil springs (28a, 28b) are configured to be pulled and extend by the movement of the pair of step plates 14 toward the projection position, thereby applying to the sliding board 15 the elastic resilience in the direction of shrinking. Accordingly, the sliding board 15 is supported by the pair of step plates 14 via the respective coil springs (28a, 28b), which are elastic members.

[0049] The guide mechanisms (17, 18) illustrated in FIGS. 4 to 7 are respectively provided on the pair of step plates 14 as mechanisms for guiding a direction in which the sliding board 15 slides. The guide mechanisms 17 are provided as a pair, including a guide mechanism 17a and a guide mechanism 17b, and are installed on the step plate 14a. The guide mechanism 17a is arranged so as to be adjacent to the inner side of the sliding board 15 in the vehicle width direction, and the guide mechanism 17b is arranged so as to be adjacent to the outer side of the sliding board 15 in the

vehicle width direction. On the other hand, the guide mechanisms 18 are provided as a pair, including a guide mechanism 18a and a guide mechanism 18b, and are installed on the step plate 14b. The guide mechanism 18a is arranged so as to be adjacent to the inner side of the sliding board 15 in the vehicle width direction, and the guide mechanism 18b is arranged so as to be adjacent to the outer side of the sliding board 15 in the vehicle width direction.

[0050] Further, each guide mechanism (17a, 17b, 18a, 18b) is configured to include a door wheel 29 and a guide member 30 (see FIGS. 6 and 7). Each door wheel 29 of the guide mechanism (17a, 17b, 18a, 18b) is configured to include a rotation shaft 29a and a wheel 29b. One end of the rotation shaft 29a is rotatably mounted on the edge portion of the sliding board 15, and the wheel 29b is mounted on the other end. The rotation shaft 29a is arranged on the edge portion of the sliding board 15 such that its axis direction extends obliquely with respect to the up-and-down direction.

[0051] Each guide member 30 of the guide mechanisms (17a, 17b, 18a, 18b) is arranged so as to extend along the edge portion of the sliding board 15 in the direction parallel to the opening width direction of the door opening 102, and is fixed to the corresponding step plate (14a, 14b). Furthermore, the guide member 30 includes a guide groove that is opened obliquely with respect to the up-and-down direction toward the edge portion of the sliding board 15, and is configured to extend in a longitudinal direction of the guide member 30 (that is, the direction parallel to the opening width direction of the door opening 102). Each guide groove of the guide member 30 has a running surface 30a that is inclined obliquely with respect to the up-and-down direction and on which the door wheel 29 runs by its rolling surface rolling thereon.

[0052] The actuator 16 illustrated in FIG. 4 is provided as an air cylinder mechanism that is actuated by, for example, compressed air being supplied and discharged, and is configured as the first actuator according to the present embodiment that drives the pair of step plates 14 so as to project outward from the railway vehicle 100 in the vehicle width direction of the railway vehicle 100. In the present embodiment, the actuator 16 is provided as a linear-acting actuator whose two ends are mounted on the spring support members (27a, 27b) or the step plates (14a, 14b) directly or via other members. Therefore, the actuator 16 is installed so as to be capable of driving the pair of step plates 14 so as to separate from each other. Further, both ends of the actuator 16 (that is, an end on a cylinder tube side and an end on a rod side) are supported on the front end side in a direction in which the pair of step plates 14 project.

[0053] Although, in the present embodiment, the explanation is given taking the example in which the actuator 16, which is the first actuator, is configured as an air cylinder mechanism, the actuator 16 is not limited to this. The actuator 16, which is the first actuator, may be configured as, for example, a hydraulic cylinder mechanism, an electric cylinder mechanism, a linear motor mechanism, or a mechanism with a rotational motor and a rack-and-pinion system.

[0054] Hereinafter, an operation of the vehicle step apparatus 1 will be explained. In the accommodation space under the door opening 102 of the railway vehicle 100, the vehicle step apparatus 1 is fixed with the step base 13 and installed in the railway vehicle 100. By the actuator 16 operating in the state in which the pair of step plates 14 are located at the accommodation position, the pair of step plates 14 project outward in the vehicle width direction from the accommodation position toward the projection position.

[0055] FIG. 8 is a plan view illustrating the vehicle step apparatus 1 in the state in which the pair of step plates 14 have projected from the accommodation position to the projection position. The operation of the actuator 16 for projecting the pair of step plates 14 from the accommodation position (the state illustrated in FIGS. 4 to 7) to the projection position (the state illustrated in FIG. 8) starts with compressed air being supplied from a compressed air source (not shown) to the actuator 16 in accordance with an instruction from a controller (not shown). At this time, the actuator 16 operates so that the rod projects outward from the cylinder tube and the pair of step plates 14 separate from each other.

[0056] With the operation of the actuator 16, the other end of the step link 11b that is rotatably supported by the step plate 14a via the rotation shaft 26a moves together with the step plate 14a, and the movement of the one end of the step link 11b is limited by the first guide portion 22b via the rotation shaft 24b, so that this one end moves in the direction parallel to the opening width direction of the door opening 102. Similarly, the other end of the step link 11a that is rotatably supported by the step plate 14b via the rotation shaft 26b moves together with the step plate 14b, and the movement of the one end of the step link 11a is limited by the first guide portion 22a via the rotation shaft 24a, so that this one end moves in the direction parallel to the opening width direction of the door opening 102.

[0057] Further in the above-explained operation, the step link 11a swings around its supporting point that is rotatably supported by the step block 12 via the rotation shaft 19a, and the step link 11b swings around its supporting point that is rotatably supported by the step block 12 via the rotation shaft 19b. Then, the step block 12, whose moving direction is limited by the second guide portion 23 via the guide shaft 25, moves horizontally in the direction orthogonal to the opening width direction of the door opening 102. Specifically, the step block 12 moves outward in the vehicle width direction of the railway vehicle 100.

[0058] As described above, with the operations of the pair of step plates 14, the pair of step links 11, and the step block 12, the pair of step plates 14 project toward the projection position (outward in the vehicle width direction of the railway vehicle 100), while separating from each other in the direction parallel to the opening width direction of the door opening 102. Then, with the projection of the pair of step plates 14, the sliding board 15, which is supported so as to be slidable on the pair of step plates 14 with the guide mechanisms (17, 18), slides with respect to the pair of step plates

14. Therefore, the sliding board 15, which is located at a position between the pair of step plates 14 where it is offset with respect the pair of step plates 14 in the up-and down-direction, projects, together with the pair of step plates 14, outward in the vehicle width direction of the railway vehicle 100. Since the sliding board 15 is elastically supported by the pair of step plates 14 via the plurality of coil springs (28a, 28b), the sliding board 15 is supported, while being centered between the pair of step plates 14.

[0059] As described above, by the operation of the vehicle step apparatus 1, the pair of step plates 14 are located at the projection position, and the vehicle step apparatus 1 comes into the state illustrated in FIG. 8. As a result, a gap between the railway vehicle 100 and the platform 103 is bridged by the pair of step plates 14 and the sliding board 15 (see FIGS. 3 and 8).

[0060] On the other hand, when compressed air is discharged from the actuator 16 in accordance with an instruction from the controller (not shown), the actuator 16 operates in the reverse direction with respect to the above-explained operation direction, and the rod recedes toward the cylinder tube. By the operation of the actuator 16 in the reverse direction with respect to the above-explained operation direction, the pair of step plates 14, the sliding board 15, the step block 12, and the pair of step links 11 perform reverse operations with respect to their above-explained operations, so that the pair of step plates 14 return from the projection position to the accommodation position, while getting closer to each other.

[0061] Then, when the pair of step plates 14 have returned to the accommodation position, the sliding board 15 is arranged at a position of being offset with respect to the pair of step plates 14 in the up-and-down direction, and the vehicle step apparatus 1 is accommodated in the railway vehicle 100. Therefore, in the state in which the vehicle step apparatus 1 is accommodated in the railway vehicle 100, its length in the direction parallel to the opening width direction of the door opening 102 (the length indicated by the double-headed arrow C1 in FIG. 1) is configured to be smaller than the opening width of the door opening 102 (the length indicated by the double-headed arrow B in FIG. 1). This makes it possible to reduce a space for accommodating the vehicle step apparatus 1 when it is accommodated in the railway vehicle 100.

[0062] Although, in the above-described embodiment, the explanation is given taking the example as illustrated in FIG. 3, in which the vehicle step apparatus 1 is installed so that front ends of the pair of step plates 14 project over the platform 103 in the state in which the pair of step plates 14 are located at the projection position, the installation of the vehicle step apparatus 1 is not limited to this. As illustrated in FIG. 9, the vehicle step apparatus 1 may also be installed such that the front ends of the pair of step plates 14 abut against the upper end portion of the platform 103 in the state in which the pair of step plates 14 are located at the projection position.

[0063] When the vehicle step apparatus 1 is installed at a position illustrated in FIG. 9, in the case of a platform 103 for the railway vehicle 100 whose track extends straight, both step plates (14a, 14b) project in the direction parallel to the vehicle width direction and abut against, with their front ends, the upper end portion of the platform 103 (see FIG. 8). However, in the case of a platform 103 whose edge portion is curved along a curved track of the railway vehicle 100, the pair of step plates 14 abut against the upper end portion of the platform 103, in the state of being swung with respect to the step base 13.

[0064] FIG. 10 is a plan view illustrating the state at the projection position in which the front ends of the pair of step plates 14 abut against the upper end portion of the platform 103, in the state of being swung with respect to the step base 13. In the vehicle step apparatus 1, the step block 12, which rotatably supports the supporting points of the step links (11a, 11b) that swing in accordance with the operation of the actuator 16, is rotatably supported by the step base 13. Therefore, as illustrated in FIG. 10, it is possible to shift the locations of the supporting points of the step links (11a, 11b) relative to the center of rotation of the step block 12 in the rotational direction of the step block 12. This makes it possible to let the pair of step plates 14 swing around the center of rotation of the step block 12 via the pair of step links 11.

[0065] Accordingly, even if the pair of step plates 14 project so as to abut against the platform 103 whose edge portion is curved along a curved track, the vehicle step apparatus 1 enables the pair of step plates 14 to swing along the curve of the platform 103 and abut thereon. It is thus possible to reliably bridge the gap 104 between the railway vehicle 100 and the platform 103 even if the platform 103 is curved.

[0066] As explained above, according to the present embodiment, it is possible to provide the vehicle step apparatus 1 for which a space for accommodating the vehicle step apparatus 1 when it is accommodated in the railway vehicle 100 can be reduced.

[0067] Further, according to the vehicle step apparatus 1, the actuator 16 directly drives the pair of step plates 14 so that they separate from each other, and by the operation of the pair of step links 11, the pair of step plates 14 project toward the projection position. Since the actuator 16 of the linear-acting type is supported by the pair of step plates 14 on their front end side in the projection direction, the actuator 16 is located outward in the vehicle width direction of the railway vehicle 100 in the state of the projection position. Therefore, it is possible to perform maintenance of the actuator 16, which is a drive mechanism, while the vehicle step apparatus 1 is installed in the railway vehicle 100. Therefore, in the vehicle step apparatus 1 in which a reduction in the accommodation space is achieved, it is possible to improve the maintenance property as well.

[0068] Furthermore, according to the vehicle step apparatus 1, the step block 12, which rotatably supports the supporting points of the step links (11a, 11b), is rotatably supported by the step base 13 as described above, and the pair of step plates 14 are configured to be swingable. Therefore, even if the pair of step plates 14 project so as to abut against the platform 103 whose edge portion is curved along a curved track, it is possible to let the pair of step plates 14 swing along the curve of the platform 103 and abut thereon. Consequently, even if the platform 103 is curved, it is possible to reliably bridge the gap between the railway vehicle 100 and the platform 103.

[0069] Moreover, according to the vehicle step apparatus 1, by the door wheels 29 of the guide mechanisms (17, 18), which rotate around the rotation shafts 29a that extend obliquely with respect to the up-and-down direction, running on the running surface 30a that extend obliquely with respect to the up-and-down direction, the sliding board 15 slides with respect to the pair of step plates 14. It is thus possible to easily achieve a smooth movement of the sliding board 15, as well as to stably support the load of passengers getting on and off when they walk on the sliding board 15 that projects between the pair of step plates 14.

[0070] The vehicle step apparatus 1 is also configured such that the sliding board 15, which slides with respect to the pair of step plates 14, is supported by the step plates (14a, 14b) via the coil springs (28a, 28b), which are elastic members. Therefore, in the state in which the pair of step plates 14 have projected from the accommodation position to the projection position, it is possible to achieve, with a simple mechanism, a configuration such that the sliding board 15 is supported while being centered on the middle of the pair of step plates 14. Then, since the sliding board 15 is centered on the middle of the pair of step plates 14, at the projection position, it is possible to effectively cover a gap between the pair of step plates 14 with the small sliding board 15.

[0071] Moreover, according to the vehicle step apparatus 1, each of the pair of step plates 14 has a portion whose size in the direction parallel to the opening width direction of the door opening 102 changes so as to decrease toward the inner end in the vehicle width direction of the railway vehicle 100. This makes it possible to further reduce a space for accommodating the pair of step plates 14 at the accommodation position. On the other hand, even at the projection position, the inner ends of the pair of step plates 14 in the vehicle width direction are located below the main body of the railway vehicle 100. Therefore, it is also possible to prevent, at the projection position, a space in which getting on and off passengers walk from being narrowed.

[0072] Although the embodiment of the present invention has been described so far, the present invention is not limited to the above-described embodiment, and various modifications of the present invention may be implemented within the scope of Claims. For example, the following modifications are possible.

[0073] (1) The shapes of the pair of step plates, the pair of step links, the step base, the step block, and the sliding board are not limited to those in the example of the above-described embodiment, and various modifications in shape are possible.

[0074] (2) Although, in the above-described embodiment, the explanation is given taking the example in which the two ends of the first actuator are mounted on the step plates directly or via other members, the location where the first actuator is arranged is not limited to the location shown in the example of the above-described embodiment, and various modifications in location are possible. FIGS. 11 and 12 are plan views illustrating vehicle step apparatuses (1a, 1b) according to modifications relating to the location where the first actuator is arranged. Note that, in the explanation of the vehicle step apparatuses (1a, 1b) according to the modifications illustrated in FIGS. 11 and 12, the same reference numerals are given to the elements that have the same configurations similar to those in the vehicle step apparatus 1 of the above-described embodiment and their descriptions are omitted, and only the location where the first actuator is arranged, which is a difference in the configuration between the modifications and the above-described embodiment, will be described.

[0075] In the vehicle step apparatus 1a according to the modification illustrated in FIG. 11, an actuator 31, which is the first actuator according to the present modification, is provided as a linear-acting actuator. One end of the actuator 31 is supported by the step base 13 or the main body of the railway vehicle 100, and the other end of the actuator 31 is supported by the step block 12.

[0076] According to the vehicle step apparatus 1a including the actuator 31, the pair of step plates 14 are driven by the operation of the actuator 31 via the step block 12 and the pair of step links 11 so as to project toward the projection position. Since, in this manner, the linear-acting actuator 31 is arranged between the step base 13 or the main body of the railway vehicle 100 and the step block 12, and transfers the drive force via the pair of step links 11, it is possible to set the actuating stroke of the actuator 31 to be short. Therefore, in the vehicle step apparatus 1a, a reduction can be achieved in a space in which the actuator 31, which is the first actuator, is placed in its longitudinal direction.

[0077] In the vehicle step apparatus 1b according to the modification illustrated in FIG. 12, an actuator 32, which is the first actuator according to the present modification, is provided as a linear-acting actuator. One end of the actuator 32 is supported by the guide shaft 24a that passes through the long hole of the first guide portion 22a, and the other end of the actuator 32 is supported by the guide shaft 24b that passes through the long hole of the first guide portion 22b. The vehicle step apparatus 1 in which such an actuator 32 is provided as the first actuator operates similarly to the vehicle step apparatus 1, making it possible to achieve an effect similar to that of the vehicle step apparatus 1.

[0078] Note that, if the pair of step plates do not need to swing with respect to the step base, a vehicle step apparatus may be implemented in which first actuators of the linear-acting type are provided in correspondence with the step plates so as to directly cause the respective step plates to project along the vehicle width direction of the railway vehicle. In this case, a configuration is also possible in which ends of the first actuators on one side are mounted on the inner ends of the step plates in the vehicle width direction, and the other ends of the first actuators are mounted on the main body of the railway vehicle.

[0079] (3) Although, in the above-described embodiment, the explanation is given taking the example in which the guide mechanisms guide the sliding direction of the sliding board provided as a plate-like rectangular member, and the sliding board is supported by the pair of step plates via the elastic members, the configuration of the sliding board is not limited to the configuration of the example of the above-described embodiment, and various modifications are also possible. FIG. 13 schematically illustrates a vehicle step apparatus 1c according to a modification. Note that FIG. 13 is a plan view schematically illustrating the vehicle step apparatus 1c, in which only the pair of step plates 14 and sliding boards 33 are shown. Specifically, FIG. 13(a) illustrates the state in which the pair of step plates 14 are located at the accommodation position, and FIG. 13(b) illustrates the state in which the pair of step plates 14 are located at the projection position. Note that the pair of step plates 14, and the pair of step links, the step block, the step base, and the first actuator (not shown) have configurations that are equivalent to those in the vehicle step apparatus 1 of the above-described embodiment, and therefore their descriptions are omitted.

[0080] As illustrated in FIG. 13, the sliding boards 33 are configured to include a first board 33a and a second board 33b. The first board 33a is shaped as a rectangular tube whose one end 34a is fixed in a cantilever manner to the step plate 14a, which is one of the pair of step plates 14. Also, the other end of the first board 33a that is opposite to the end 34a is opened in a tubular shape toward the step plate 14b side.

[0081] On the other hand, the second board 33b is fixed, with its end 34b, to the step plate 14b, which is the other of the pair of step plates 14, in a cantilever manner. This second board 33b is arranged so that its front end is slidably inserted into the first board 33a. Also, at the accommodation position illustrated in FIG. 13(a), the second board 33b is arranged so that its portion from a front end 35 that is opposite to the end 34b to its middle portion is inserted into the first board 33a. Note that the second board 33b is formed so that the entire outer shape in its cross-section is accommodated within the tube hole in its cross-section of the first board 33a, and the second board 33b is formed as a rectangular tube, for example. In this case, the first board 33a and the second board 33b are configured as double nested tubes.

[0082] Further, the sliding boards 33 move such that, when the pair of step plates 14 move from the accommodation position toward the projection position, the middle portion of the second board 33b that is inserted into the first board 33a is exposed from the first board 33a. Accordingly, at the projection position, the sliding boards 33 are arranged extending in the region between the pair of step plates 14.

[0083] According to the vehicle step apparatus 1c the sliding boards 33 are configured to include the first board 33a and the second board 33b, which are respectively fixed to the step plates (14a, 14b) in a cantilever manner, the first board 33a sliding with respect to one of the pair of step plates 14, and the second board 33b sliding with respect to the other of the pair of step plates 14. And, in the state in which the pair of step plates 14 are located at the accommodation position, the second board 33b is exposed from the first board 33a so that the sliding board 33 extends, and in the state in which the pair of step plates 14 are located at the accommodation position, the second board 33b is inserted into the tubular first board 33a, thus being compactly accommodated. It is thus possible to downsize the sliding boards 33 in the state in which the step plates 14 are located at the accommodation position.

[0084] (4) A vehicle step apparatus may be implemented that includes, in addition to the first actuator that drives the pair of step plates so that they project outward in the vehicle width direction of the railway vehicle, a second actuator that can drive the step block so that it rotates. FIG. 14 is a plan view illustrating a vehicle step apparatus 1d that includes a first actuator 36, and additionally a second actuator 37, in which the pair of step plates 14 are located at the accommodation position. Note that, in the description of the vehicle step apparatus 1d according to a modification illustrated in FIG. 14, the same reference numerals are given to the elements that have configurations similar to those in the vehicle step apparatus 1 of the above-described embodiment and their descriptions are omitted, and only configurations of the first actuator 36 and the second actuator 37, which have different configurations from those in the above-described embodiment, will be described.

[0085] In the vehicle step apparatus 1d according to the modification illustrated in FIG. 14, the first actuator 36 is provided as a linear-acting actuator. One end of the first actuator 36 is supported by the step base 13 or the main body of the railway vehicle 100, and the other end of the first actuator 36 is rotatably supported by the guide shaft 25. The pair of step plates 14 are driven by this first actuator 36 so as to project outward in the vehicle width direction of the railway vehicle 100.

[0086] The second actuator 37 may be configured as, for example, an air cylinder mechanism, a hydraulic cylinder mechanism, an electric cylinder mechanism, a linear motor mechanism, or a mechanism with a rotational motor and a rack-and-pinion system, and provided as a linear-acting actuator. One end of the second actuator 37 is rotatably supported

by the step base 13 or the main body of the railway vehicle 100, and the other end of the second actuator 37 is rotatably supported by the rotation shaft 19a. Accordingly, the second actuator 37 can drive the step block 12 so that it rotates.

[0087] Note that, although in the present modification, the explanation is given taking the example in which the second actuator 37 is supported by the step base 13 or the main body of the railway vehicle 100 and by the rotation shaft 19a, the configuration of the second actuator 37 is not limited to this. For example, a configuration is also possible in which the second actuator 37 is supported by the step base 13 or the main body of the railway vehicle 100 and by the rotation shaft 19b. Alternatively, a plurality of the second actuators 37 may be provided. In this case, for example, one of the second actuators 37 is supported by the step base 13 or the main body of the railway vehicle 100 and by the rotation shaft 19a. The other of the second actuators 37 is supported by the step base 13 or the main body of the railway vehicle 100 and by the rotation shaft 19b.

[0088] FIG. 15 is a plan view illustrating the vehicle step apparatus 1d in the state in which the pair of step plates 14 are located at the projection position. In the vehicle step apparatus 1d, the projection operation of the pair of step plates 14 is controlled so that the extension stroke differs between the first actuator 36 and the second actuator 37 in accordance with an instruction of the controller (not shown). Therefore, as illustrated in FIG. 15, the second actuator 37 can be controlled so as to rotate the step block 12, and to swing the pair of step plates 14 around the center of rotation of the step block 12.

[0089] Note that various aspect of control may be employed for the above-described control over the projection operation of the pair of step plates 14. For example, when the pair of step plates 14 project toward a platform 103 whose edge portion is curved along a curved track, it is possible to employ an aspect of control in which the first actuator 36 and the second actuator 37 project with extension strokes that were preset, thereby rotating the step block 12. In this case, the extension strokes of the first actuator 36 and the second actuator 37 may be preset as different strokes, so that the pair of step plates 14 project while swinging with a preset pattern of swing angles.

[0090] Further, it is possible to employ, as another aspect of control over the projection operation of the pair of step plates 14, an aspect in which range sensors for measuring sizes of gaps between the platform 103 and the step plates (14a, 14b) are provided at ends of the step plates (14a, 14b), and operations of the first actuator 36 and the second actuator 37 are controlled according to the shape of the curve of the platform 103. In this case, the range sensors measure distances between the platform 103 and the step plates (14a, 14b). The configuration for measuring distances between the platform 103 and the step plates (14a, 14b) with the range sensors may differ depending on the positional relations of the vehicle step apparatus 1d and the platform 103 installed in FIG. 3 and FIG. 9.

[0091] In the case of FIG. 3, that is, in the case in which the vehicle step apparatus 1d is arranged so that front ends of the pair of step plates 14 project over the platform 103 when they are located at the projection position, sizes of the gaps below the step plates (14a, 14b) are measured by the range sensors. In other words, distances between the step plates (14a, 14b) and the top surface of the platform 103 that is located below the step plates are measured. On the other hand, in the case of FIG. 9, that is, in the case in which the vehicle step apparatus 1d is arranged so that front ends of the pair of step plates 14 project at substantially the same level as the edge on the upper end portion of the platform 103 when they are located at the projection position, sizes of the gaps in a direction in which the step plates (14a, 14b) project are measured by the range sensor. In other words, distances between the front ends of the step plates (14a, 14b) and the end face of the edge on the upper end portion of the platform 103 are measured.

[0092] According to the vehicle step apparatus 1d, in addition to the first actuator 36 for causing the pair of step plates 14 to project outward the railway vehicle 100, the second actuator 37 for causing the step block 12 to rotate is provided. Accordingly, while the first actuator 36 causes the pair of step plates 14 to project, it is possible to control the second actuator 37 so that it actively swings the pair of step plates 14 around the center of rotation of the step block 12. Therefore, when the pair of step plates 14 project toward the platform 103 whose edge portion is curved along a curved track, it is possible to perform control so that the pair of step plates 14 actively swing along the curve of the platform 103. This makes it possible to reliably bridge a gap between the railway vehicle 100 and the platform 103 even if the platform 103 is curved.

[0093] Further, according to the vehicle step apparatus 1d, it is possible to control the pair of step plates 14 so that they actively swing, and therefore the pair of step plates 14 can also swing along the curve of the platform 103, irrespective of the position where the vehicle step apparatus 1 is arranged. That is, it is possible to swing the pair of step plates 14 along the curve of the platform 103, not only when the vehicle step apparatus 1d is arranged so that the pair of step plates 14 are located at substantially the same level as the edge portion of the platform 103 but also when the vehicle step apparatus 1d is arranged so that the pair of step plates 14 project over the platform 103.

[0094] Furthermore, according to the vehicle step apparatus 1d, the linear-acting actuators (36, 37) are provided between the step base 13 or the main body of the railway vehicle 100, and the step block 12. It is thus possible to set actuating strokes of the first actuator 36 and the second actuator 37 to be short. Consequently, in the vehicle step apparatus 1d, it is possible to reduce spaces in which the first actuator 36 and the second actuator 37 are placed in their longitudinal directions.

Industrial Applicability

[0095] The present invention is widely applicable to vehicle step apparatuses that are installed in a railway vehicle, and are configured to project from the railway vehicle so as to bridge a gap between the railway vehicle and a platform.

Descriptions of Reference Numerals

[0096]

1	Vehicle step apparatus
11	Pair of step links
11a, 11b	Step link
12	Step block
13	Step base
14	Pair of step plates
14a, 14b	Step plate
15	Sliding board
16	Actuator (first actuator)
22, 22a, 22b	First guide portion
23	Second guide portion

Claims

1. A vehicle step apparatus that projects from a railway vehicle in which it is installed so as to bridge a gap between the railway vehicle and a platform, comprising:

a pair of step links that are provided as a pair of link members, and are supported so as to be able to swing around respective supporting points;
a step block that is a block-shaped member for supporting the pair of step links at the supporting points via a rotation shaft;
a step base that is fixed to a main body of the railway vehicle and includes a first guide portion for limiting swing of the pair of step links so that ends of the step links on one side are movable only along a direction that is parallel to an opening width direction of a door opening of the railway vehicle, and a second guide portion for limiting movement of the step block so that the step block is movable only along a direction that is orthogonal to the opening width direction and is horizontal;
a pair of step plates that are provided as a pair of plate-shaped members by which other ends of the pair of step links are respectively supported via rotation shafts, and are installed so as to be movable between an accommodation position of being accommodated in the railway vehicle and a projection position of having projected from the railway vehicle;
a sliding board that is arranged at a position of being offset with respect to the pair of step plates in an up-and-down direction when the pair of step plates are located at the accommodation position, and that slides with respect to the pair of step plates when the pair of step plates project toward the projection position while separating from each other in the direction parallel to the opening width direction; and
a first actuator that drives the pair of step plates so as to project outward from the railway vehicle in a vehicle width direction of the railway vehicle.

2. The vehicle step apparatus according to claim 1,
wherein the first actuator is provided as a linear-acting actuator and is installed so as to be capable of driving the pair of step plates such that both ends of the first actuator separate the pair of step plates from each other, and the both ends of the first actuator are supported by the pair of step plates on a front end side in a projection direction of the step plates.

3. The vehicle step apparatus according to claim 1,
wherein the first actuator is provided as a linear-acting actuator whose one end is supported by the step base or a main body of the railway vehicle, and whose other end is supported by the step block.

4. The vehicle step apparatus according to any one of claims 1 to 3, wherein the step block is rotatably supported by the step base.

5. The vehicle step apparatus according to claim 4, further comprising:

a second actuator capable of driving the step block so as to rotate.

6. The vehicle step apparatus according to any one of claims 1 to 5, wherein the pair of step plates each include a guide mechanism for guiding a sliding direction of the sliding board, each guide mechanism including a door wheel having a rotation shaft that extends obliquely with respect to the up-and-down direction, and a guide member having a running surface that is inclined obliquely with respect to the up-and-down direction and on which the door wheel runs by its rolling surface rolling thereon.

7. The vehicle step apparatus according to any one of claims 1 to 6, wherein the sliding board is supported by the pair of step plates via elastic members.

8. The vehicle step apparatus according to any one of claims 1 to 5, wherein the sliding board includes: a first board that is tubular in shape and whose end is fixed to one of the pair of step plates in a cantilever manner; and a second board whose end is fixed to the other of the pair of step plates in a cantilever manner and whose front end is slidably inserted into the first board, and the sliding board moves such that a middle portion of the second board that was inserted into the first board is exposed from the first board when the pair of step plates move from the accommodation position toward the projection position.

9. The vehicle step apparatus according to any one of claims 1 to 8, wherein the pair of step plates each have a portion whose size in the direction parallel to the opening width direction changes so as to decrease toward an inner end of the step plate in the vehicle width direction.

FIG. 1

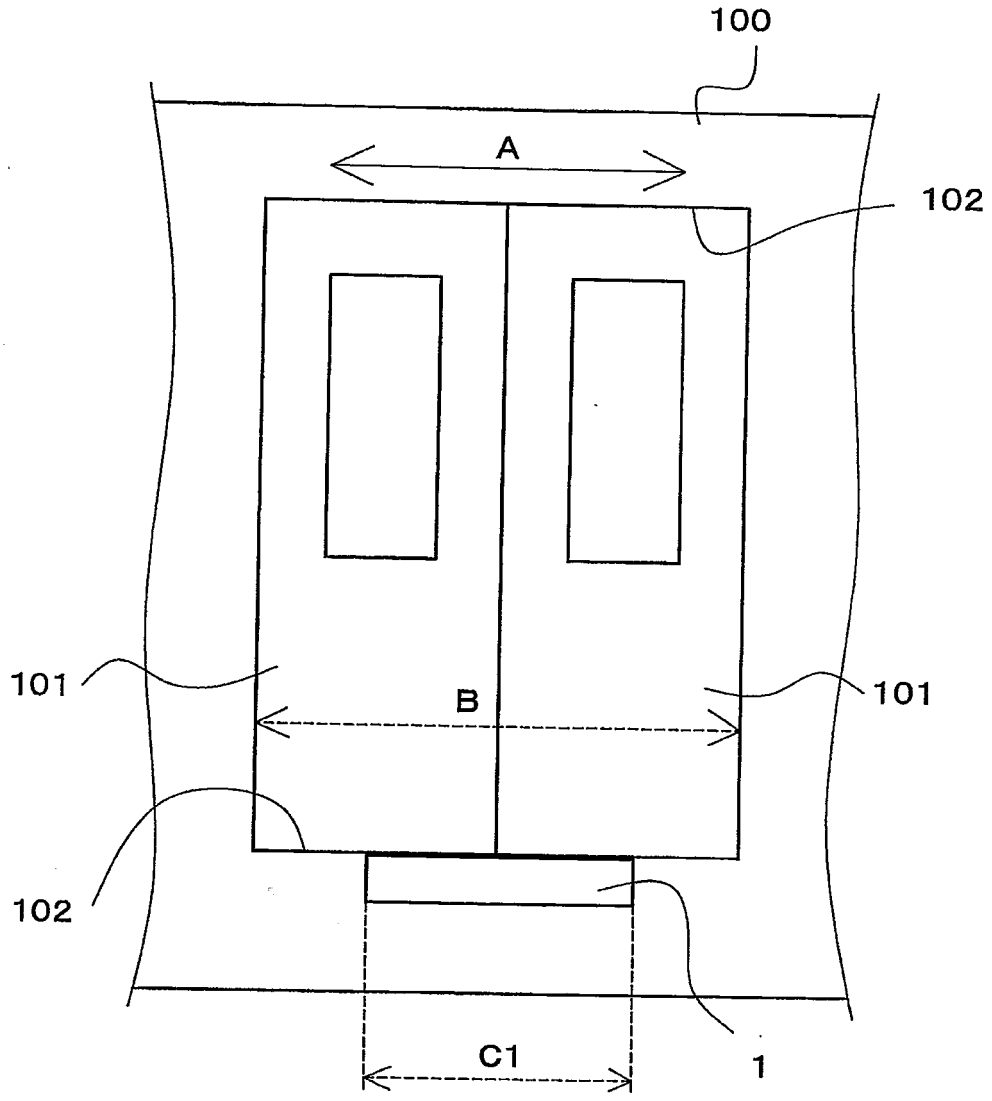


FIG. 2

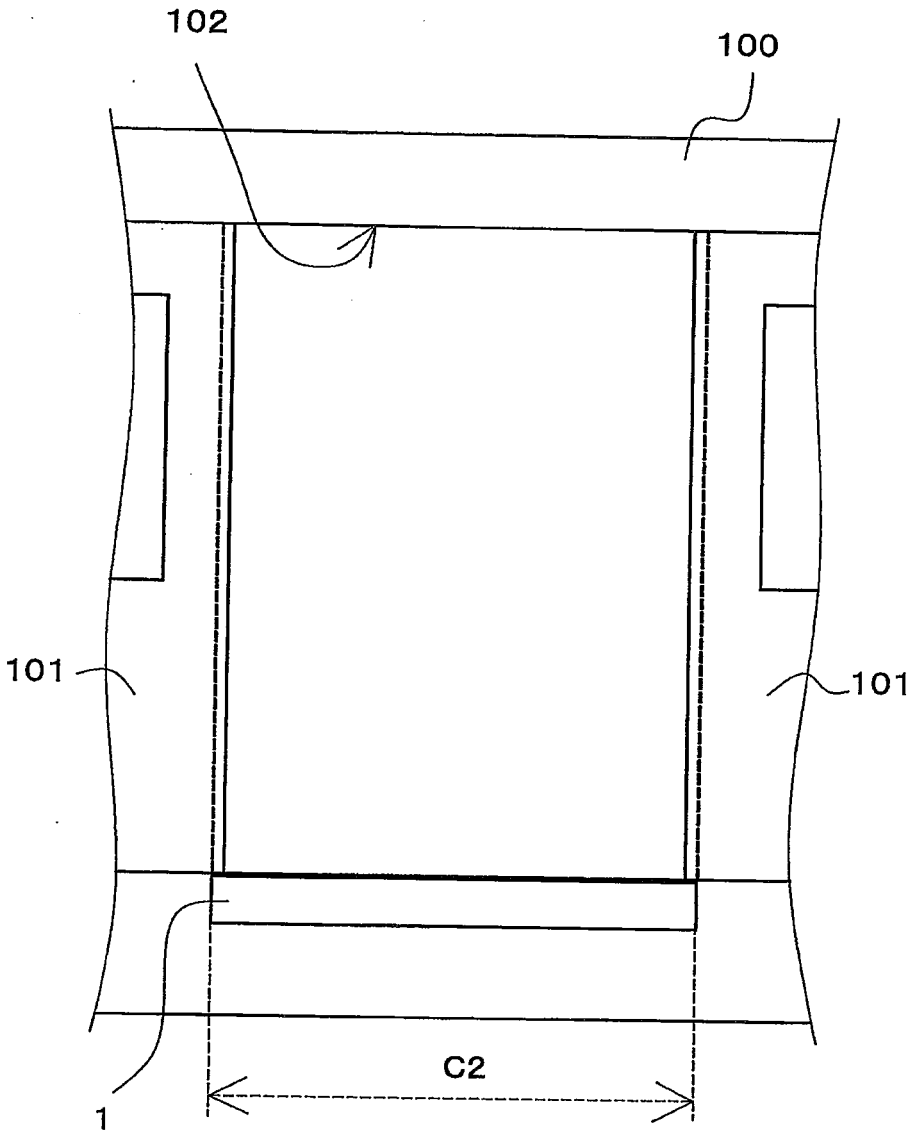
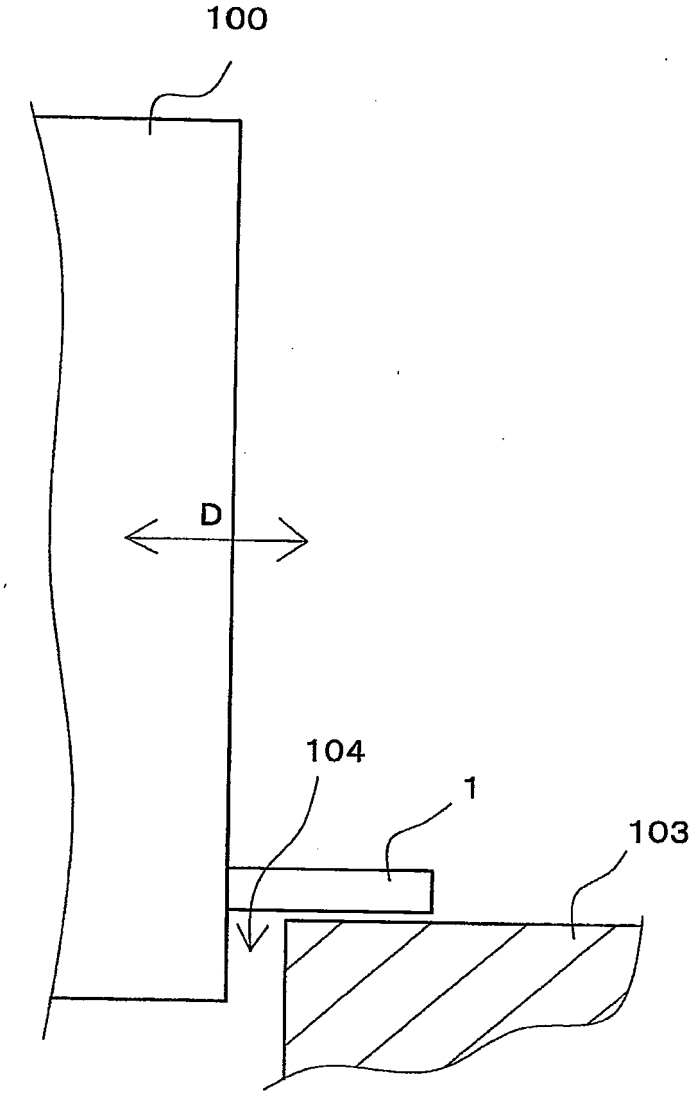


FIG. 3



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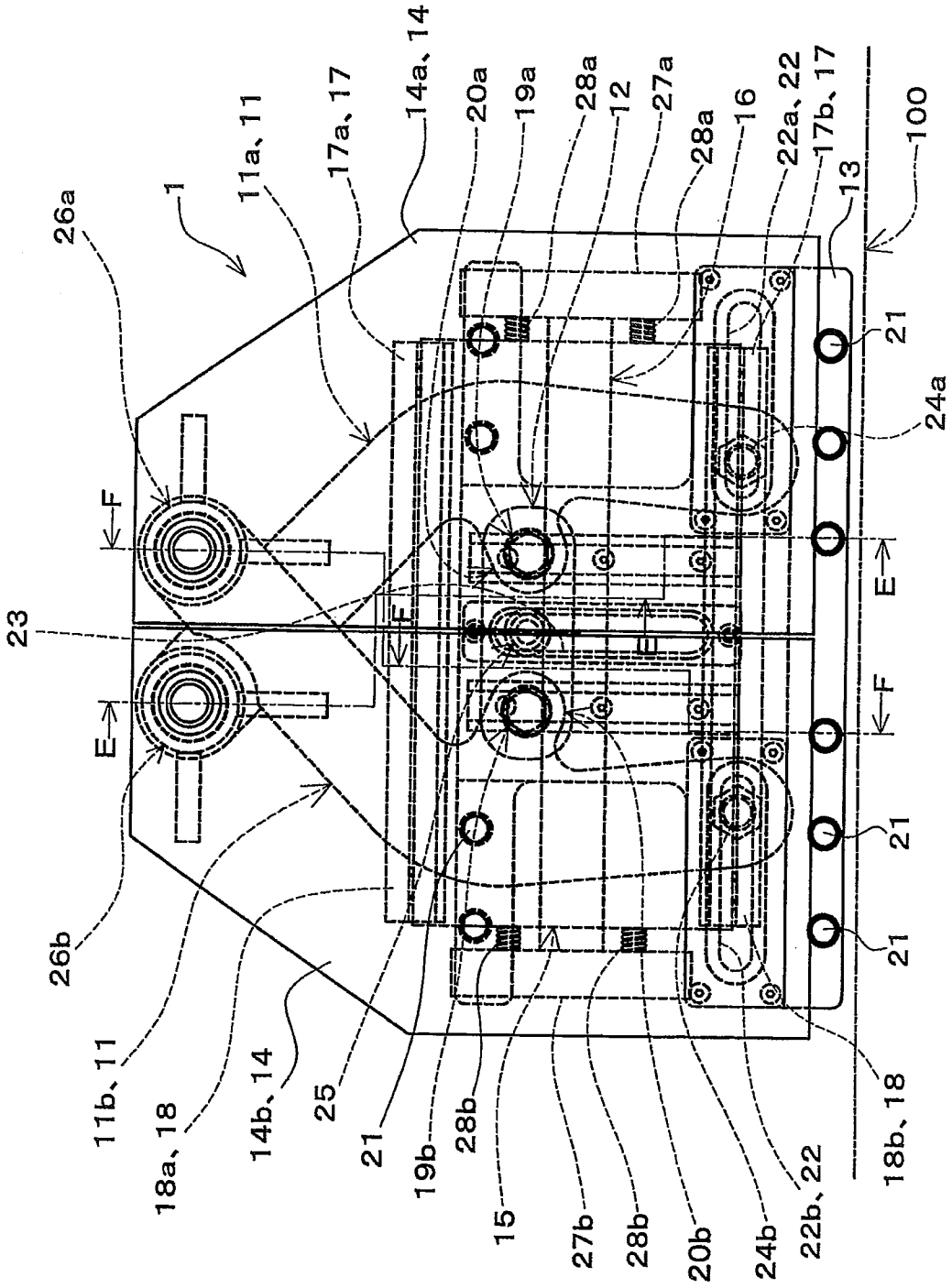
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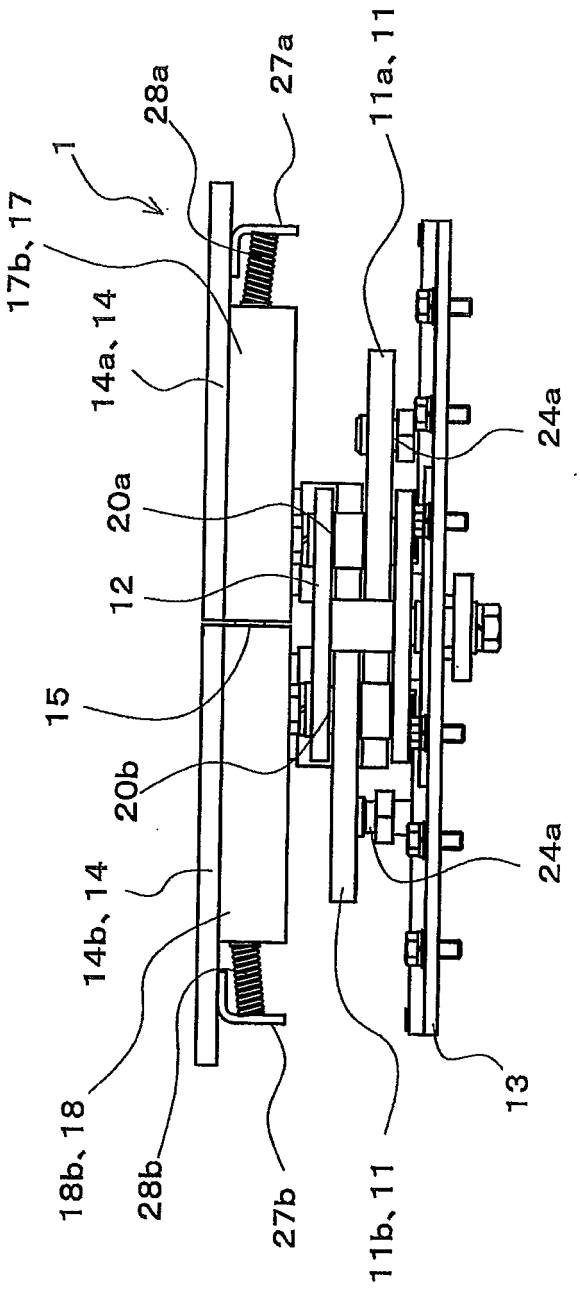
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FIG. 5

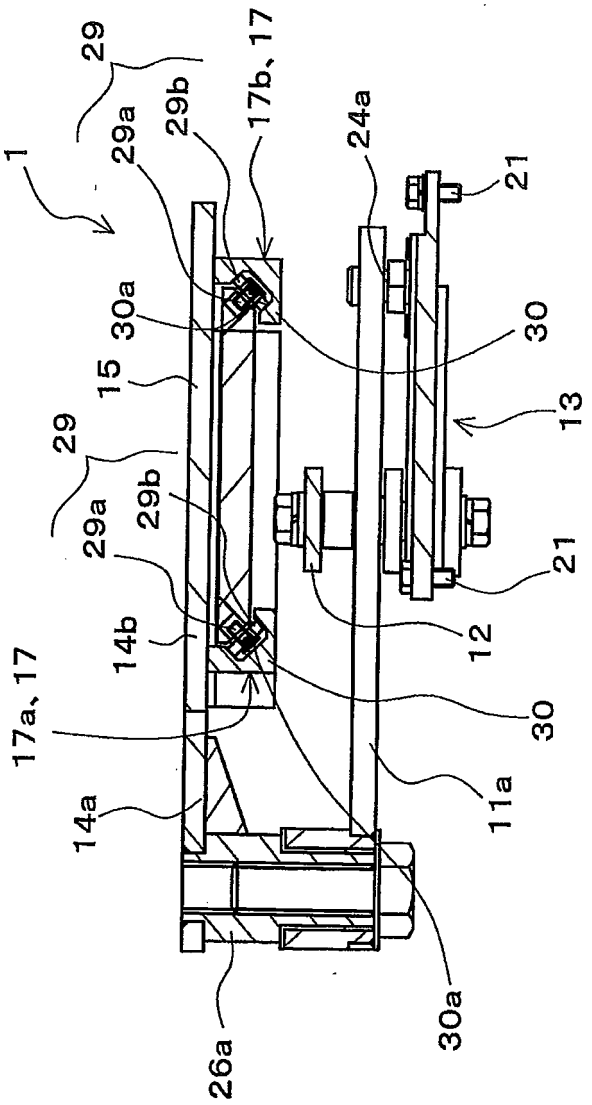
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FIG. 6

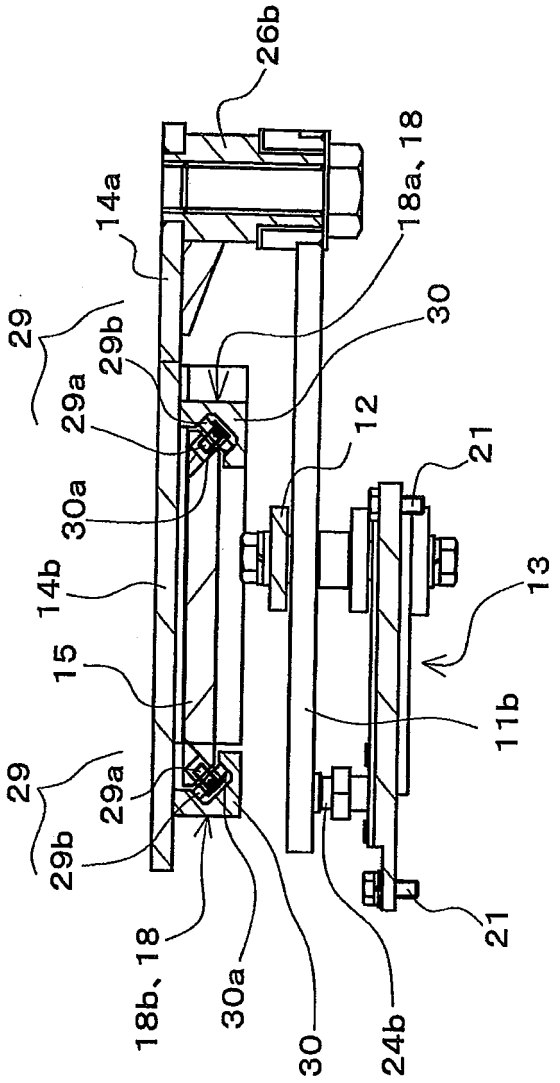
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FIG. 7

FIG. 8

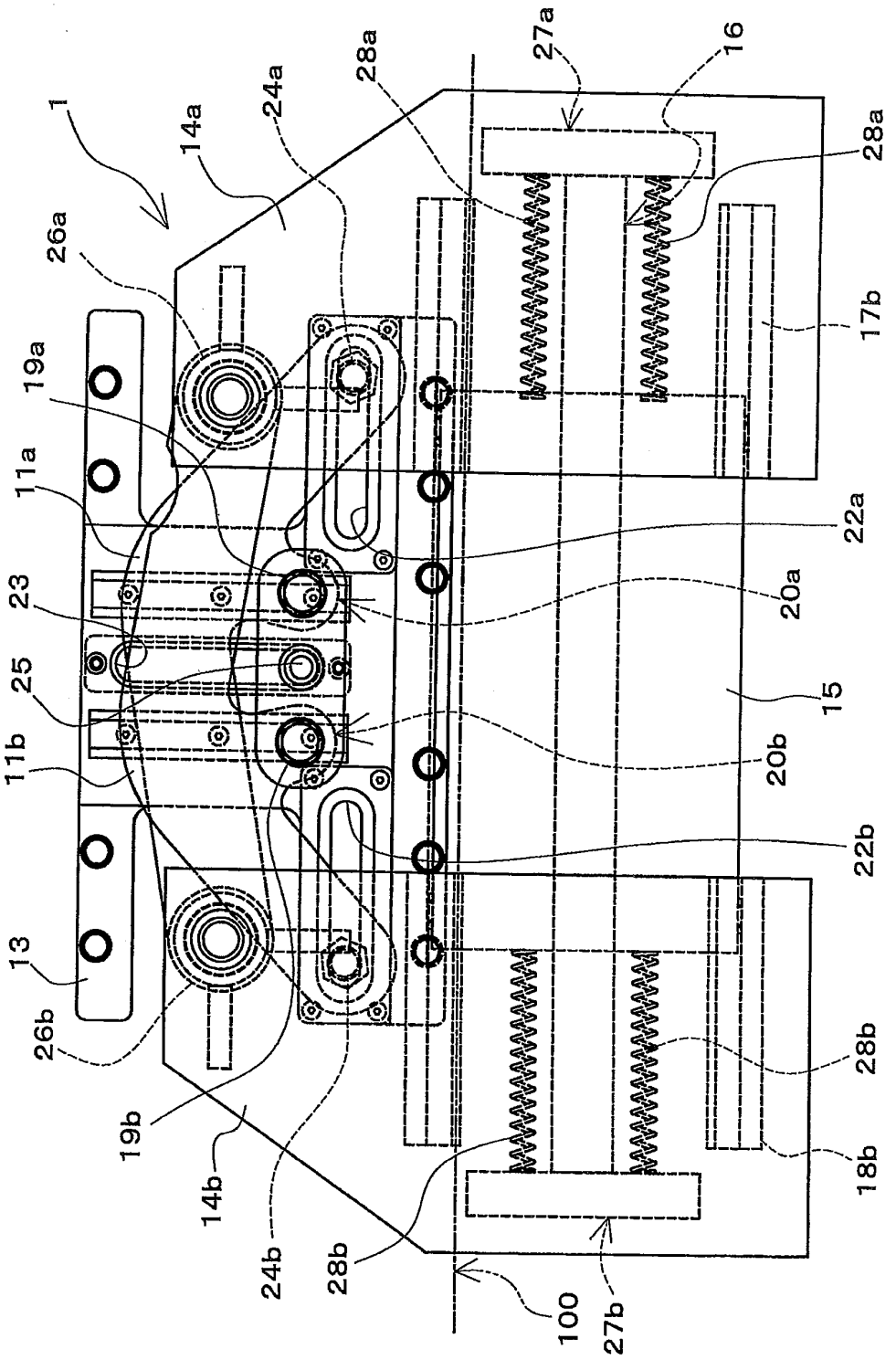
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FIG. 9

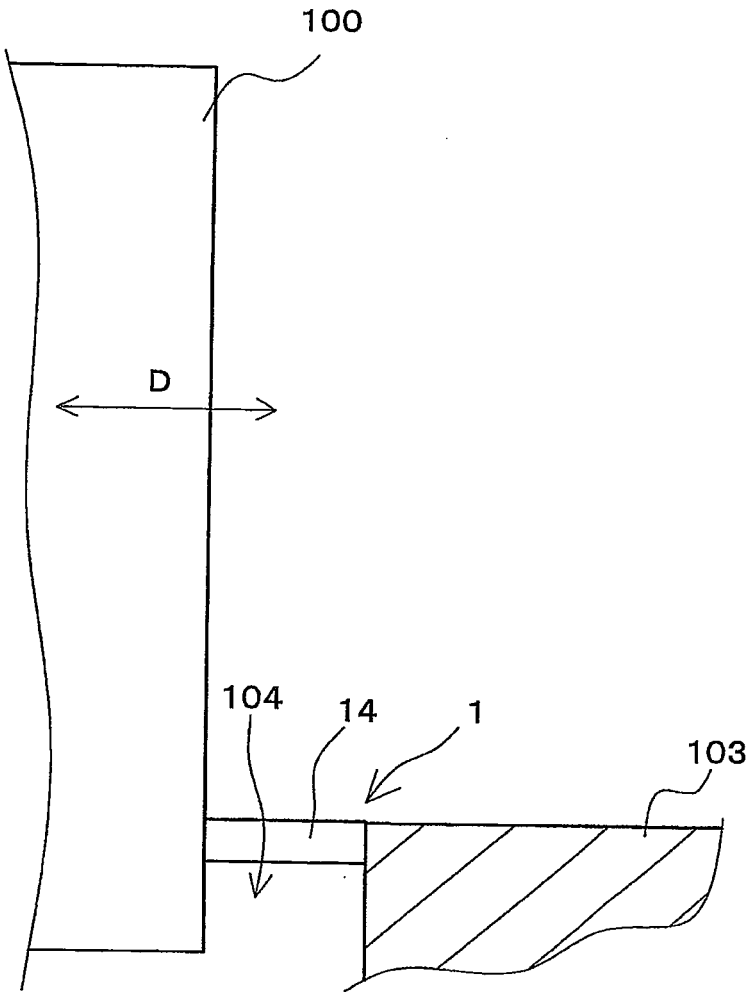

FIG. 10

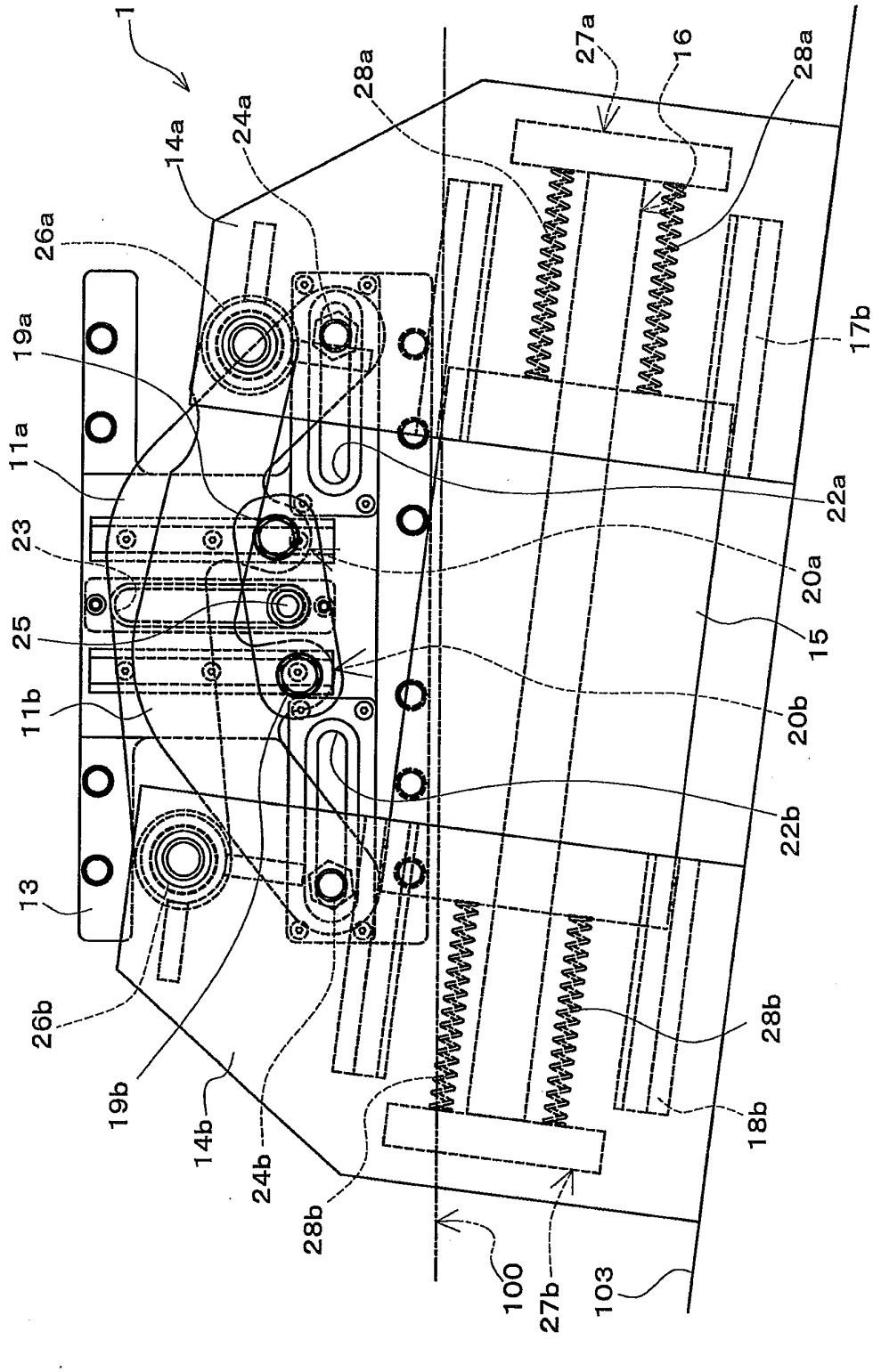
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FIG. 11

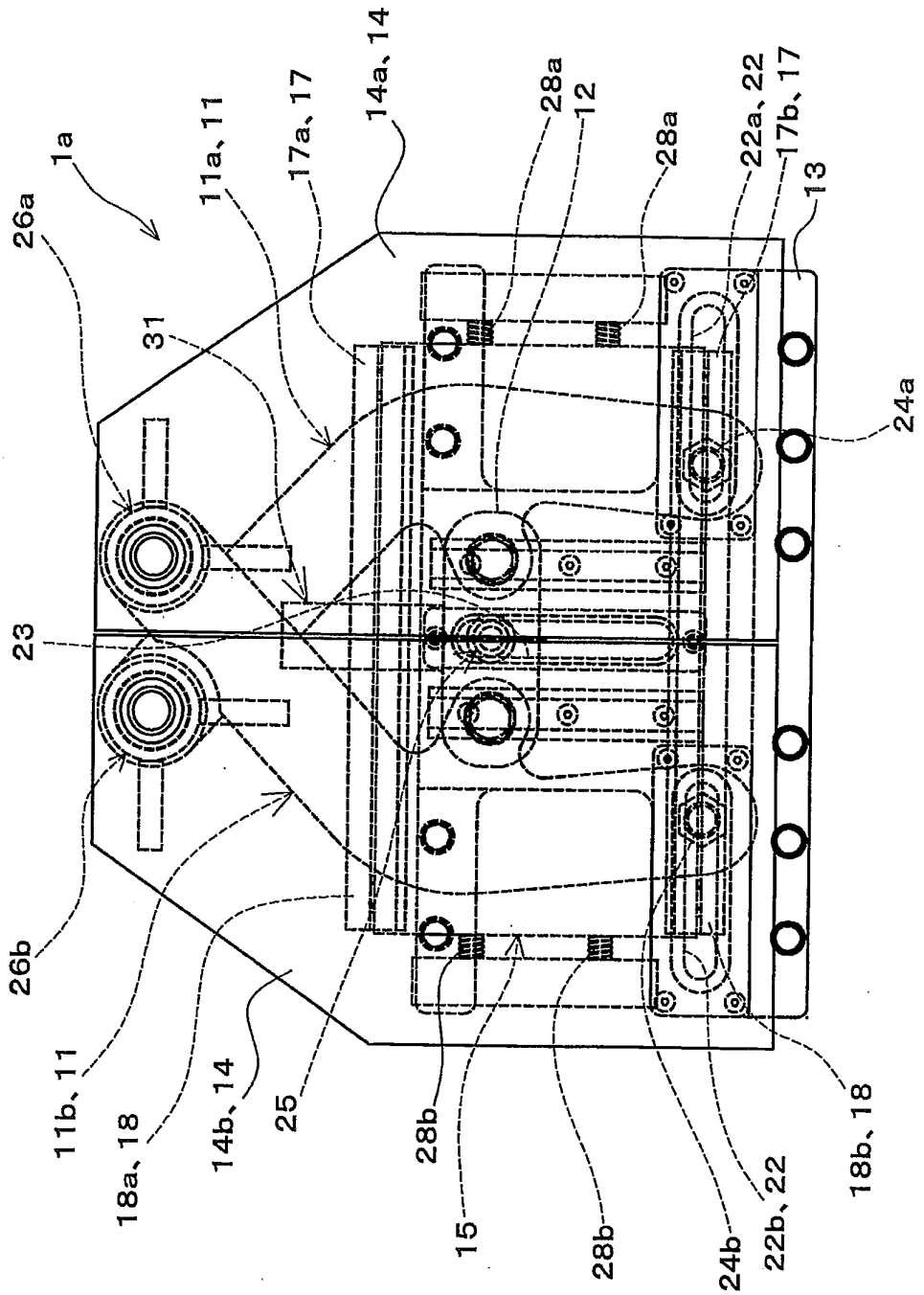
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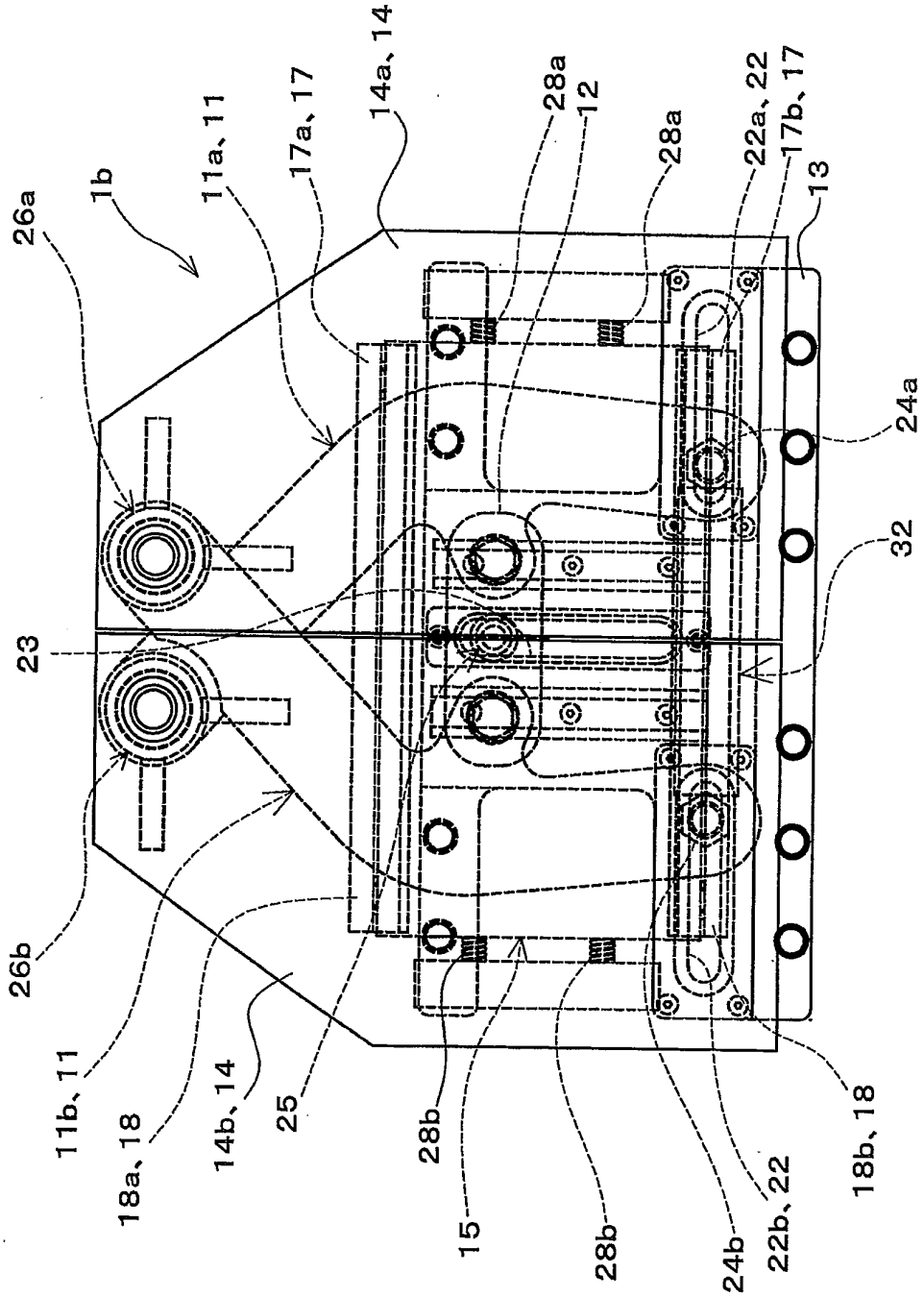
FIG. 12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28b
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18b、18

FIG. 13

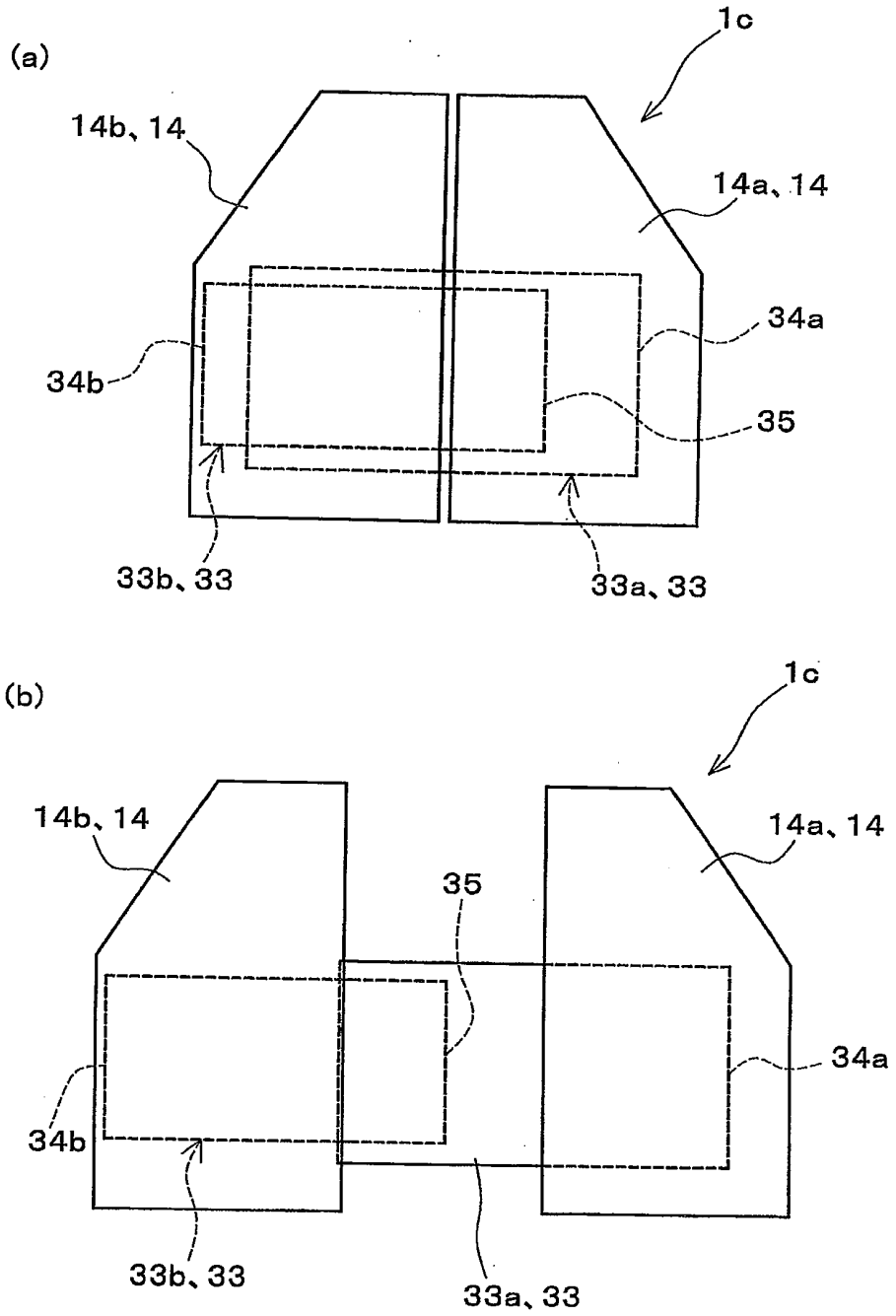
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FIG. 14

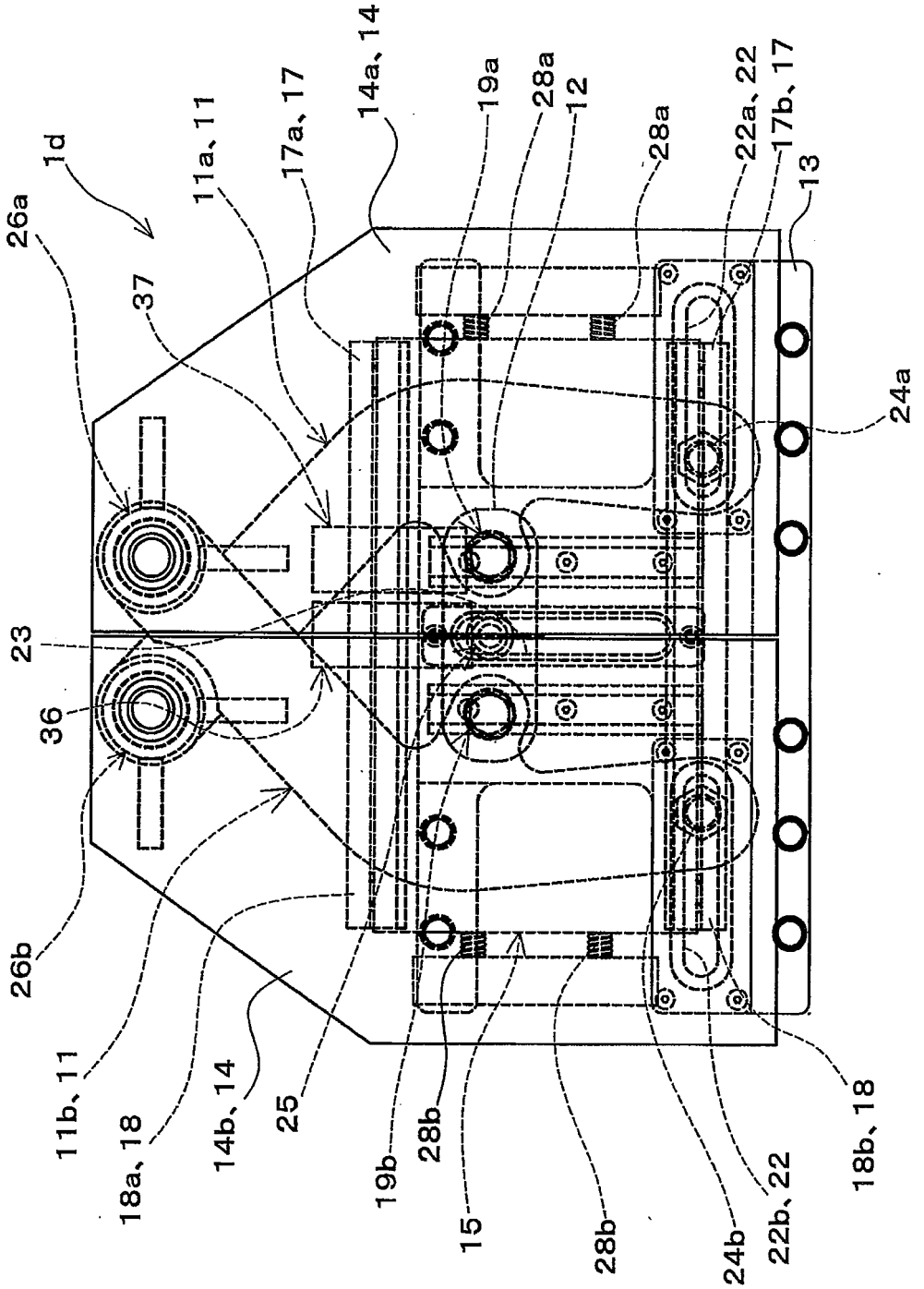
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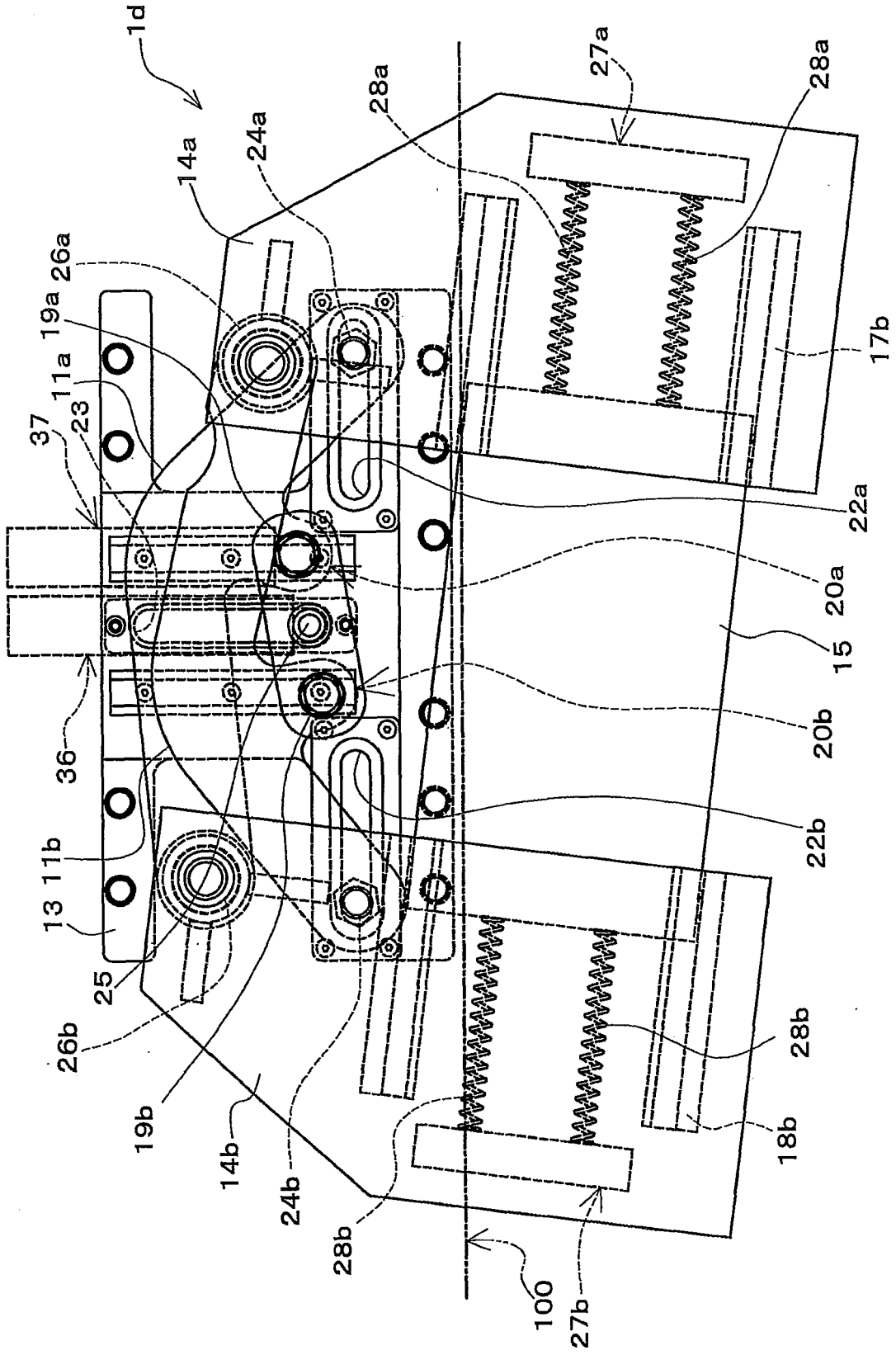
FIG. 15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27b

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/070718

A. CLASSIFICATION OF SUBJECT MATTER
B61D23/02(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B61D23/00-23/02, B61B1/02, B60R3/00-3/04, E01F1/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2011
Kokai Jitsuyo Shinan Koho	1971-2011	Toroku Jitsuyo Shinan Koho	1994-2011

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2006-521234 A (Knorr-Bremse GmbH), 21 September 2006 (21.09.2006), entire text; all drawings	1-9
A	JP 2-81767 A (The Kinki Sharyo Co., Ltd.), 22 March 1990 (22.03.1990), entire text; all drawings	1-9
A	JP 35-6617 Y1 (Yasuzo ISHII), 08 April 1960 (08.04.1960), entire text; all drawings	1-9
A	JP 2003-182564 A (Nabco Ltd.), 03 July 2003 (03.07.2003), entire text; all drawings	4

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
05 December, 2011 (05.12.11)	20 December, 2011 (20.12.11)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/070718

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 79602/1989(Laid-open No. 19766/1991) (Tokyu Car Corp.), 26 February 1991 (26.02.1991), entire text; all drawings	1-9
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 105560/1990(Laid-open No. 62265/1992) (Kawasaki Heavy Industries, Ltd.), 28 May 1992 (28.05.1992), entire text; all drawings	1-9

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2011/070718

JP 2006-521234 A	2006.09.21	US 2007/0200313 A1 EP 1610994 A1 WO 2004/085222 A1 AT 4722003 A CA 2519048 A1 PL 377261 A1 KR 10-2005-0121688 A CN 1764567 A ES 2276280 T3 RU 2324614 C2 BR PI0408713 A AU 2004224230 A1
JP 2-81767 A	1990.03.22	(Family: none)
JP 35-6617 Y1	1960.04.08	(Family: none)
JP 2003-182564 A	2003.07.03	(Family: none)
JP 3-19766 U	1991.02.26	(Family: none)
JP 4-62265 U	1992.05.28	(Family: none)

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Patent documents cited in the description

- JP 2006521234 PCT **[0003]**