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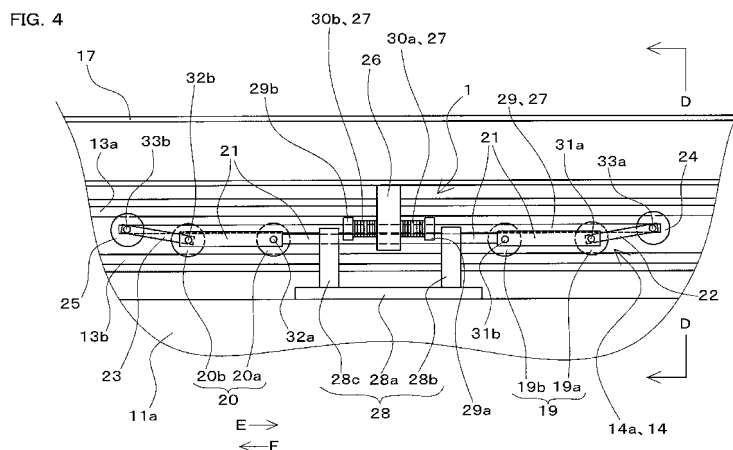
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(54) **DOOR HANGING APPARATUS AND DOOR APPARATUS PROVIDED WITH THE SAME**

(57) A door hanging apparatus is provided that can reliably prevent the derailing of door rollers and the tilting of a door when the door is opened and closed, while having little running resistance caused by a derailing prevention mechanism.

Upper and lower rails (13a, 13b) are provided with running surfaces (18a, 18b) opposing each other in the vertical direction. First door rollers (19, 20) run in contact with the lower rail 13b, and are rotatably supported to a first door roller supporting member 21 that suspends a door 11. Second door rollers (24, 25) are rotatably sup-

ported to swing members (22, 23) swingably connected to the first door roller supporting member 21, and are provided so as to be capable of coming into contact with the upper rail 13a. A drive connection portion 26 is provided for holding and connecting the door 11 to an open-close drive mechanism 12. An elastic connection mechanism 27 includes an elastic portion (30a, 30b) capable of changing the relative position between the second door rollers (24, 25) and the drive connection portion 26, and connects the swing members (22, 23) to the drive connection portion 26.



Description

Patent Document 1: WO2008/149632

Technical Field

Disclosure of the Invention

[0001] The present invention relates to a door hanging apparatus that supports a door provided in a structure and driven to be opened and closed by an open-close drive mechanism, in a state in which the door is suspended to the structure so as to be slidably moved, and that is connected to the open-close drive mechanism, and a door apparatus provided with the door hanging apparatus.

Background Art

[0002] Conventionally, door hanging apparatuses that support a door provided in a structure and driven to be opened and closed by an open-close drive mechanism, in a state in which the door is suspended to the structure so as to be slidably moved, and that is connected to the open-close drive mechanism are known (for example, see Patent Document 1). As a door hanging apparatus used in a railroad vehicle serving as a structure, Patent Document 1 discloses a door hanging apparatus including a rail member including an upper rail and a lower rail, and a door roller device including door rollers that run on the rail member. Also, in Patent Document 1, a door that is suspended to the door hanging apparatus is driven to be opened and closed by an open-close drive mechanism connected to the door hanging apparatus, and the door is supported in a state of being suspended to the structure, which is a side wall of the railroad vehicle, so as to be slidably moved.

[0003] Further, the door roller device of the above-described door hanging apparatus is provided with a supporting member disposed along the lengthwise direction of the rail member, and this supporting member is provided with a first door roller capable of running on the lower rail and a second door roller capable of running on the upper rail. The second door roller is provided at one end of the supporting member, and a suspender capable of suspending the door is provided on the other end of the supporting member. Accordingly, the self weight of the door acts on the suspender, the second door roller comes into contact with the upper rail with the first door roller, which runs on the lower rail, serving as a fulcrum, and thereby, the door is supported. Accordingly, it is possible to provide a door hanging apparatus that can prevent the derailing of doors from a rail member, enable smooth and safe opening and closing of doors, and achieve a reduction in manufacturing and installation costs.

Citation List

Patent Document

[0004]

5 Problem to be Solved by the Invention

[0005] With the door hanging apparatus disclosed in Patent Document 1, a mechanism is provided that prevents the derailing of the door rollers from the rail by causing the self weight of the door to exert the load for pressing the second door roller against the upper rail with the first door roller running on the lower rail as a fulcrum, and therefore, it is also possible to prevent the tilting of the door. However, with the door hanging apparatus of Patent Document 1, the second door roller runs on the upper rail while being constantly pressed against the upper rail at a certain degree of contact pressure due to the load acting with the first door roller as a fulcrum, exerted by the self weight of the door. Accordingly, when the door rollers are running on the rail, a specific running resistance is generated in the derailing prevention mechanism, which results in a reduction in the driving efficiency of the open-close drive mechanism when driving the doors to be opened and closed. Further, the generation of running resistance may promote wear of the door rollers.

[0006] In view of the above-described circumstances, it is an object of the present invention to provide a door hanging apparatus that can reliably prevent the derailing of door rollers and the tilting of a door when the door is opened and closed, while having little running resistance caused by a derailing prevention mechanism, and also to provide a door apparatus provided with the door hanging apparatus.

35 Means for Solving the Problem

[0007] A door hanging apparatus of a first aspect of the present invention for achieving the above-described objects relates to a door hanging apparatus that supports a door provided in a structure and driven to be opened and closed by an open-close drive mechanism, in a state in which the door is suspended to the structure so as to be slidably moved, and that is connected to the open-close drive mechanism. The door hanging apparatus of the first aspect of the invention includes: a rail including an upper rail and a lower rail that are fixed to the structure and are provided with respective running surfaces opposing each other in the vertical direction; a first door roller that runs in contact with the running surface of the lower rail; a first door roller supporting member that suspends the door and rotatably supports the first door roller; a plurality of swing members that are swingably connected to the first door roller supporting member; a second door roller that is rotatably supported to at least one of the swing members and is provided so as to be capable of coming into contact with the running surface of the upper rail; a drive connection portion for holding and connecting the door to the open-close drive mechanism; and

an elastic connection mechanism that includes an elastic portion capable of changing a relative position between the second door roller and the drive connection portion by elastic deformation and connects the swing members to the drive connection portion.

[0008] According to this aspect of the invention, the first door roller supported to the first door roller supporting member that suspends the door runs on the lower rail, and the second door roller supported to the swing members that are swingably connected to the first door roller supporting member are disposed so as to be capable of coming into contact with the upper rail. Accordingly, the first door roller and the second door roller that are disposed between the upper and lower rails and run thereon constitute a derailing prevention mechanism, and therefore, it is possible to reliably prevent the derailing of the door rollers and the tilting of the door when the door is opened and closed.

[0009] Furthermore, according to the present invention, the elastic connection mechanism that connects the drive connection portion for connecting the door to the open-close drive mechanism and the swing members includes an elastic portion, and the elastic connection mechanism is provided so as to be capable of changing the relative position between the second door roller and the drive connection portion by elastic deformation. Accordingly, at the time of acceleration when the door is driven to be opened and closed, the elastic connection mechanism and the swing members are relatively displaced with respect to the door by the elastic deformation of the elastic portion, and the contact pressure exerted on the upper rail from the second door roller is temporarily increased. However, the elastic deformation of the elastic portion is immediately restored when the velocity is constant, and consequently, the distance relationship between the upper rail and the second door roller is brought back to the original state. Further, even if a load is exerted from the door as the result of a foreign object having collided with or having been caught at the end of the door in the opening and closing direction, the elastic connection mechanism and the swing members are relatively displaced with respect to the door by elastic deformation of the elastic portion, and the position of the second door roller with respect to the upper rail is positioned in a suitable position according to the above-described load.

[0010] Therefore, according to the present invention, the second door roller is disposed in light contact with the upper rail or disposed so as to provide a gap within a predetermined range, and thereby, it is possible to set a state in which little running resistance is generated in a derailing prevention mechanism when the door rollers are running on the rail. Also, at the time of the acceleration/deceleration of the door or the collision with a foreign object, the door rollers can be positioned in suitable positions according to the load, and the derailing of the door rollers and the tilting of the door can be reliably prevented. Note that the gap within a predetermined range as used herein refers to a gap within a range that can secure a

riding width, which is a vertical spacing (width) between the lower end portion of the upper rail and the upper end portion of the second door roller in a state in which the lower end portion of the upper rail and the upper end portion of the second door roller are disposed overlapping each other in the horizontal direction. Further, the positional adjustment of the second door roller, namely, the degree to which the second door roller is in contact with the upper rail or the amount of the gap provided within a predetermined range, has little impact on the above-described derailing prevention performance. Accordingly, the positional adjustment requires little time and effort at the time of installing the door hanging apparatus of the present invention, and the installation operation can be performed easily.

[0011] Therefore, according to the present invention, it is possible to provide a door hanging apparatus that can reliably prevent the derailing of door rollers and the tilting of doors when the doors are opened and closed, while having little running resistance caused by a derailing prevention mechanism.

[0012] According to a door hanging apparatus of a second aspect of the present invention, in the door hanging apparatus of the first aspect of the present invention, the second door roller is provided on both a door leading end side, which is the side on which the end of the door in a closing direction is located, and a door trailing end side, which is the side on which the end of the door in an opening direction is located, with respect to the elastic connection mechanism.

[0013] According to this aspect of the invention, the second door roller is provided on both the door leading end side and the door trailing end side with respect to the elastic connection mechanism. Accordingly, both during the opening driving and the closing driving of the door, the position of the second door roller with respect to the upper rail can be positioned in a suitable position via operation of the elastic connection mechanism at the time of acceleration/deceleration or when a foreign object has collided with the end of the door. Accordingly, it is possible to achieve a door hanging apparatus that can reliably prevent the derailing of the door rollers and the tilting of the door, while having little running resistance caused by a derailing prevention mechanism, both during the opening driving and the closing driving of the door.

[0014] According to a door hanging apparatus of a third aspect of the present invention, in the door hanging apparatus of the first or second aspect of the present invention, a door leading end-side swing member that is connected to the first door roller supporting member on the door leading end side and a door trailing end-side swing member that is connected to the first door roller supporting member on the door trailing end side are provided as the swing members, the elastic connection mechanism includes a swingable connection member that is connected to the drive connection portion via the elastic portion such that a relative position thereof with respect to the drive connection portion can be changed

and to which the door leading end-side swing member and the door trailing end-side swing member are rotatably connected at opposite ends, respectively, and the first door roller supporting member, the door leading end-side swing member, the swingable connection member, and the door trailing end-side swing member, which are provided as four links, forms a quadrangular link mechanism.

[0015] According to this aspect of the invention, the door leading end-side and door trailing end-side swing members are respectively connected to opposite sides of the first door roller supporting member that supports the first door roller, and the swingable connection member of the elastic connection mechanism is further connected thereto so as to connect the two swing members, thus constituting a quadrangular link mechanism having four links. Accordingly, it is possible to construct, with a quadrangular link mechanism, a structure with a simple configuration that can position the position of the second door roller with respect to the upper rail in a suitable position via operation of the elastic connection mechanism in response to acceleration/deceleration of the door and the collision with a foreign object.

[0016] According to a door hanging apparatus of a fourth aspect of the present invention, in the door hanging apparatus of the third aspect of the present invention, the second door roller is rotatably supported to the door leading end-side swing member, and a connection position between the swingable connection member and the door leading end-side swing member is disposed on a side of the second door roller with respect to a connection position between the door leading end-side swing member and the first door roller supporting member.

[0017] According to this aspect of the invention, for the door leading end-side swing member that supports the second door roller, the connection position with the swingable connection member is disposed on the side of the second door roller with respect to the connection position with the first door roller supporting member. Accordingly, when the connection position with the swingable connection member is disposed in a position closer to the connection position with the first door roller supporting member, the response performance of the second door roller via the door leading end-side swing member via operation of the elastic connection mechanism can be set to be faster, which makes it possible to more quickly position the second door roller in a suitable position. Meanwhile, when the connection position with the swingable connection member is disposed in a position farther away from the connection position with the first door roller supporting member, a greater force can be easily secured as the force exerted on the upper rail from the second door roller via the door leading end-side swing member via operation of the elastic connection mechanism. Consequently, by simply changing the connection position with the swingable connection member with respect to the connection position with the first door roller supporting member for the door leading end-side swing

member, it is possible to easily adjust the setting of the response performance of the second door roller via operation of the elastic connection mechanism and the setting of the force exerted on the upper rail from the second door roller.

[0018] According to a door hanging apparatus of a fifth aspect of the present invention, in the door hanging apparatus of the fourth aspect of the present invention, the swingable connection member and the door leading end-side swing member are connected coaxially with an axle via which the second door roller is rotatably supported to the door leading end-side swing member.

[0019] According to this aspect of the invention, the swingable connection member and the door leading end-side swing member are rotatably connected coaxially with the axle of the second door roller, and therefore, the same shaft can be used as the axle of the second door roller and the rotational shaft of the swingable connection member and the door leading end-side swing member. Accordingly, it is possible to reduce the number of members, which makes it possible to further increase the compactness of the structure.

[0020] According to a door hanging apparatus of a sixth aspect of the present invention, in the door hanging apparatus of any one of the third to fifth aspects of the present invention, the second door roller is rotatably supported to the door trailing end-side swing member, and a connection position between the swingable connection member and the door trailing end-side swing member is disposed on a side of the second door roller with respect to a connection position between the door trailing end-side swing member and the first door roller supporting member.

[0021] According to this aspect of the invention, for the door trailing end-side swing member that supports the second door roller, the connection position with the swingable connection member is disposed on the side of the second door roller with respect to the connection position with the first door roller supporting member. Accordingly, when the connection position with the swingable connection member is disposed in a position closer to the connection position with the first door roller supporting member, the response performance of the second door roller via the door trailing end-side swing member via operation of the elastic connection mechanism can be set to be faster, which makes it possible to more quickly position the second door roller in a suitable position. Meanwhile, when the connection position with the swingable connection member is disposed in a position farther away from the connection position with the first door roller supporting member, a greater force can be easily secured as the force exerted on the upper rail from the second door roller via the door trailing end-side swing member via operation of the elastic connection mechanism. Consequently, by simply changing the connection position with the swingable connection member with respect to the connection position with the first door roller supporting member for the door trailing end-side swing

member, it is possible to easily adjust the setting of the response performance of the second door roller via operation of the elastic connection mechanism and the setting of the force exerted on the upper rail from the second door roller.

[0022] According to a door hanging apparatus of a seventh aspect of the present invention, in the door hanging apparatus of the sixth aspect of the present invention, the swingable connection member and the door trailing end-side swing member are connected coaxially with an axle via which the second door roller is rotatably supported to the door trailing end-side swing member.

[0023] According to this aspect of the invention, the swingable connection member and the door trailing end-side swing member are rotatably connected coaxially with the axle of the second door roller, and therefore, the same shaft can be used as the axle of the second door roller and the rotational shaft of the swingable connection member and the door trailing end-side swing member. Accordingly, it is possible to reduce the number of members, which makes it possible to further increase the compactness of the structure.

[0024] According to a door hanging apparatus of an eighth aspect of the present invention, in the door hanging apparatus of any one of the third to seventh aspects of the present invention, the swingable connection member is disposed passing through the drive connection portion, the elastic portion is provided as a pair of spring members disposed so as to bias the drive connection portion in opposite directions from opposite sides in a passing-through direction in which the swingable connection member passes through the drive connection portion, and the respective ends of the pair of spring members that are opposite to the ends thereof that bias the drive connection portion are supported to the swingable connection member.

[0025] According to this aspect of the invention, the respective ends of the pair of spring members are supported to the swingable connection member and the drive connection portion is biased by the pair of spring members in opposite directions, and thereby the elastic connection mechanism can be easily constructed with a simple structure. Note that as for the pair of spring members that apply biasing forces in opposite directions, the pair of spring members may be provided as tension springs that apply biasing forces in directions in which they pull against each other via the drive connection portion, or may be provided as compression springs that apply biasing forces in directions in which they press against each other via the drive connection portion.

[0026] According to another aspect of the present invention, it is possible to configure a door apparatus provided with any of the above-described door hanging apparatuses. That is, according to a door apparatus of a ninth aspect of the present invention, there is provided a door apparatus including: the door hanging apparatus of any of the first to eighth aspects of the present invention; a door that is provided in a structure and is supported by

the door hanging apparatus in a state of being suspended to the structure so as to be slidably moved; and an open-close drive mechanism that is connected to the door hanging apparatus and drives the door to be opened and closed.

[0027] According to this aspect of the invention, it is possible to provide a door apparatus that can reliably prevent the derailing of door rollers and the tilting of doors when the doors are opened and closed, while having little running resistance caused by a derailing prevention mechanism.

Effects of the Invention

[0028] According to the present invention, it is possible to provide a door hanging apparatus that can reliably prevent the derailing of door rollers and the tilting of doors when the doors are opened and closed, while having little running resistance caused by a derailing prevention mechanism, and a door apparatus provided with the door hanging apparatus.

Brief Description of the Drawings

[0029]

FIG. 1 is a front view showing a door apparatus according to one embodiment of the present invention. FIG. 2 is a front view showing a state in which doors are opened in the door apparatus shown in FIG. 1. FIG. 3 is a cross-sectional view of a rail of the door apparatus shown in FIG. 2, as viewed from the position of the arrows C-C.

FIG. 4 is a front view showing a door roller mechanism of a door hanging apparatus of the door apparatus shown in FIG. 1.

FIG. 5 is a cross-sectional view of first and second door rollers and a rail of the door roller mechanism, as viewed from the position of the arrows D-D in FIG. 4.

FIGS. 6 are diagrams illustrating a positional relationship between the second door roller and the rail shown in FIG. 5, and a modification thereof.

FIG. 7 is a front view schematically showing the door roller mechanism shown in FIG. 4, together with part of the rail and the door.

FIGS. 8 are schematic diagrams illustrating modifications for the connection position between a swingable connection member and a swing member.

FIG. 9 is a front view showing a door apparatus according to a modification.

FIG. 10 is a front view showing a door apparatus according to a modification.

FIG. 11 is a front view showing a door apparatus according to a modification.

Description of Embodiments

[0030] Hereinafter, an embodiment for carrying out the present invention will be described with reference to the accompanying drawings. The present invention is applicable as a door hanging apparatus that supports a door provided in a structure and driven to be opened and closed by an open-close drive mechanism, in a state in which the door is suspended to the structure so as to be slidably moved, and that is connected to the open-close drive mechanism, and as a door apparatus including the door hanging apparatus. Although this embodiment will be described, taking, as an example, a door hanging apparatus and a door apparatus that are used in a railroad vehicle, the present invention is not limited to this example and is widely applicable as a door hanging apparatus and a door apparatus that can be provided in a variety of structures.

[0031] FIG. 1 is a front view showing a door apparatus 2 according to one embodiment of the present invention. The door apparatus 2 shown in FIG. 1 can be used, for example, for a side wall of a railroad vehicle as a structure. Note that FIG. 1 shows a front view of the door apparatus 2, as viewed from the inside of the railroad vehicle. In addition, illustration of the side wall of the railroad vehicle is omitted in FIG. 1, and the door apparatus 2 is schematically illustrated. The door apparatus 2 includes door hanging apparatuses 1 according to one embodiment of the present invention, doors 11 (partly shown in FIG. 1), an open-close drive mechanism 12, and so forth.

[0032] The doors 11 are formed as sliding doors provided at a side wall of a railroad vehicle (hereinafter, referred to as a "structure"), are installed along the vertical direction, and constitute side doors provided in the railroad vehicle for loading and unloading of passengers. In the door apparatus 2, two doors, namely, door 11a and a door 11b, are provided as the doors 11. Also, the doors 11 (11a, 11b) are supported by the door hanging apparatuses 1, which will be described below, in a state in which it is suspended to the structure so as to be slidably moved. Note that rails 13 of the door hanging apparatuses 1 are fixed to the structure in a state in which they are disposed extending linearly in the horizontal direction. Also, the door 11a and the door 11b are supported by door roller mechanisms 14, which will be described below, of the respective door hanging apparatuses 1 at their upper ends, and are configured to be closed by approaching each other along the rail 13 and coming into contact and to be opened by moving away from each other.

[0033] The open-close drive mechanism 12 is installed in the structure, and is provided as a mechanism that is connected to the door hanging apparatuses 1 and that drives the doors 11 (11a, 11b) to be opened and closed. The open-close drive mechanism 12 shown in FIG. 1 includes, for example, a drive motor (not shown), a drive pulley 15, a driven pulley 16, and a belt 17. The belt 17 is configured as an endless belt that is wound around the

drive pulley 15 and the driven pulley 16 in a freely rotatable manner. Rotation of the drive pulley 15 connected to the drive motor causes the belt 17 wound around the drive pulley 15 to be rotated, thus causing the driven pulley 16 to rotate together with the belt 17.

[0034] The drive motor is controlled to be rotated by a predetermined amount in forward and reverse directions, in accordance with a command from a controller, which is not shown. Accordingly, the doors 11 (11a, 11b) that are supported in a state in which they are suspended via the door hanging apparatuses 1 connected to the belt 17 of the open-close drive mechanism 12 are driven in the opening direction and the closing direction. Note that FIG. 1 shows the state of a fully closed position in which the two doors 11 (11a, 11b) are closed, and FIG. 2 shows the state of a fully opened position in which the two doors 11 are opened. By operating the open-close drive mechanism 12 such that the belt 17 is rotated in the direction indicated by the arrow A in FIG. 1, door roller mechanisms (14a, 14b), which will be described below, of the door hanging apparatuses 1 are moved in directions away from each other, and the state of the two doors 11 (11a, 11b) is shifted to the state of the fully opened position shown in FIG. 2. On the other hand, by operating the open-close drive mechanism 12 such that the belt 17 is rotated in the direction indicated by the arrow B shown in FIG. 2, the door roller mechanisms (14a, 14b) are moved in directions approaching each other, and the state of the two doors 11 (11a, 11b) is shifted to the state of the fully closed position shown in FIG. 1.

[0035] As shown in FIGS. 1 and 2, a door hanging apparatus 1 includes a rail 13 and door roller mechanisms 14 (14a, 14b). FIG. 3 is a cross-sectional view of the rail 13, as viewed from the position of the arrows C-C in FIG. 2. The rail 13 shown in FIGS. 1 to 3 is fixed to the structure and includes an upper rail 13a and a lower rail 13b that are respectively provided with vertically opposed running surfaces (18a, 18b). The upper rail 13a and the lower rail 13b extend linearly in the horizontal direction, and are formed integrally via a bridging portion 13c of the rail 13. The cross section of the running surface 18a of the upper rail 13a is formed so as to bulge downward in an arc shape, and the cross section of the running surface 18b of the lower rail 13b is formed so as to bulge upward in an arc shape and opposing the running surface 18a. Note that the configuration of the rail 13 shown in FIGS. 1 to FIG. 3 is an example, and various modifications can be made to the cross-sectional shape of the rail 13. For example, the cross section may be formed so as to be recessed in an arc shape. Further, the upper rail 13a and the lower rail 13b do not need to be integrally formed. That is, the upper rail 13a and the lower rail 13b may be formed and disposed separately, or may be formed as separate parts and coupled to each other via another member.

[0036] As shown in FIGS. 1 and 2, the door roller mechanisms 14 (14a, 14b) are provided in one-to-one correspondence with the doors (11a, 11b), and are each con-

nected to the belt 17 of the open-close drive mechanism 12. Also, the door roller mechanism 14a supports the door 11a in a state in which the door 11a is suspended to the structure so as to be slidably moved, and the door roller mechanism 14b supports the door 11b in a state in which the door 11b is suspended to the structure so as to be slidably moved.

[0037] FIG. 4 is a front view showing the door roller mechanism 14a shown in FIG. 1, showing, in enlargement, a part of FIG. 1 in a cutaway state. As clearly shown in FIG. 4, the door roller mechanism 14a includes a plurality of first door rollers (19, 20), a first door roller supporting member 21, a plurality of swing members (22, 23), a plurality of second door rollers (24, 25), a drive connection portion 26, an elastic connection mechanism 27, a hanger 28, and so forth. Note that, of the two door roller mechanisms 14 shown in FIG. 1, the door roller mechanism 14a, which is disposed on the driven pulley 16 side and connected to the door 11a, is shown in FIG. 4. The door roller mechanism 14b, which is disposed on the drive pulley 15 side and connected to the door 11b, is configured in the same manner, except that its devices are arranged line-symmetric about the intermediate position between the two doors 11 with respect to the devices of the door roller mechanism 14a and that the drive connection portion 26 has a different length. Therefore, only the door roller mechanism 14a will be described in the following.

[0038] FIG. 5 is a cross-sectional view of the rail 13, as viewed from the position of the arrows D-D in FIG. 4, and shows the first door rollers 19 and the second door rollers 24 together. Note that illustration of the elements other than the rail 13, the first door rollers 19 and the second door rollers 24 is omitted in FIG. 5. As shown in FIGS. 4 and 5, the first door rollers (19, 20) are provided as door rollers that run in contact with the running surface 18b of the lower rail 13b. Also, the first door rollers (19, 20) are disposed in positions that are substantially line-symmetric about an imaginary center line (hereinafter, referred to as the "center line of the door roller mechanism 14a") extending vertically through the central position of the door roller mechanism 14a in a direction parallel to the lengthwise direction of the rail 13.

[0039] Door trailing end-side first door rollers 19 and door leading end-side first door rollers 20 are provided as the first door rollers (19, 20). The door trailing end-side first door rollers 19 (19a, 19b) are disposed on a door trailing end side, which is the side on which the end of the door in an opening direction (the direction indicated by the arrow E in FIG. 4) is located, with respect to the center line of the door roller mechanism 14a. A plurality of (in this embodiment, two) door trailing end-side first door rollers 19 are provided, and a door trailing end-side first door roller 19b and a door trailing end-side first door roller 19a are arranged in order from the center line of the door roller mechanism 14a toward the door trailing end side. On the other hand, the door leading end-side first door rollers 20 (20a, 20b) are disposed on a door

leading end side, which is the side on which the end of the door in the closing direction (the direction indicated by the arrow F in FIG. 4) is located, with respect to the center line of the door roller mechanism 14a. A plurality of (in this embodiment, two) door leading end-side first door rollers 20 are provided, and a door leading end-side first door roller 20a and a door leading end-side first door roller 20b are arranged in order from the center line of the door roller mechanism 14a toward the door leading end side. Note that the provision of a plurality of door trailing end-side first door rollers 19 and a plurality of door leading end-side first door rollers 20 in this way enables the load acting from the first door rollers (19, 20) to the lower rail 13b to be more efficiently dispersed, and therefore, it is possible to reduce the contact pressure generated between the first door rollers (19, 20) and the lower rail 13b, thus achieving a reduction in running resistance in the first door rollers (19, 20) and wear prevention.

[0040] Further, the cross section of the first door rollers (19a, 19b, 20a, 20b) that is perpendicular to the door roller circumferential direction of the rolling surface that rolls on the running surface 18b of the lower rail 13b when the first door rollers run on the lower rail 13b is formed so as to be recessed in an arc shape in conformity with the running surface 18b (see FIG. 5). Although this embodiment has been described, taking, as an example, a door roller mechanism 14a provided with a plurality of door trailing end-side first door rollers 19 and a plurality of door leading end-side first door roller 20, this need not be the case. It is also possible to adopt a configuration in which a door trailing end-side first door roller 19 and a door leading end-side first door roller 20 are provided.

[0041] As clearly shown in FIG. 4, the first door roller supporting member 21 is provided as a member that suspends the door 11a via the hanger 28 and rotatably supports the first door rollers (19, 20). Note that this embodiment describes, as an example, a first door roller supporting member 21 including a member that supports the door trailing end-side first door rollers (19a, 19b), a member that supports the door leading end-side first door rollers (20a, 20b), and a member that fixes these two members at both ends and couples them integrally, and thereby all the members are coupled together to form a single shaft. The first door roller supporting member 21 is disposed parallel to the lengthwise direction of the rail 13. On the door trailing end side of the first door roller supporting member 21, the door trailing end-side first door roller 19a is rotatably supported via an axle 31a, and the door trailing end-side first door roller 19b is rotatably supported via an axle 31b. On the door leading end side of the first door roller supporting member 21, the door leading end-side first door roller 20b is rotatably supported via an axle 32b, and the door leading end-side first door roller 20a is rotatably supported via an axle 32a.

[0042] The hanger 28 is provided as a mechanism for suspending the door 11a to the first door roller supporting member 21. Also, the hanger 28 includes a door coupling member 28a that is coupled and fixed to the upper end

of the door 11a, and attachment members (28b, 28c) that are fixed above the door coupling member 28a and are attached to the first door roller supporting member 21. The attachment members (28b, 28c) are attached to the first door roller supporting member 21 in opposite positions across the center line of the door roller mechanism 14a. Further, the attachment members (28b, 28c) are pivotably attached to the first door roller supporting member 21 via a hinge portion, in a state in which their relative movements with respect to each other in a direction parallel to the lengthwise direction of the rail 13 are restricted. Accordingly, when the door roller mechanism 14a is moved horizontally along the rail 13 by the operation of the open-close drive mechanism 12, the hanger 28 causes the door 11a to move horizontally together with the first door roller supporting member 21 in a state in which the door 11a is swingably supported to the first door roller supporting member 21.

[0043] As shown in FIG. 4, a plurality of (in this embodiment, two) swing members (22, 23) are provided, and each of the swing members is formed as a shaft-like member and swingably connected to the first door roller supporting member 21. A door trailing end-side swing member 22 connected to the first door roller supporting member 21 on the door trailing end side and a door leading end-side swing member 23 connected to the first door roller supporting member 21 on the door leading end side are provided as the swing members (22, 23). The door trailing end-side swing member 22 is rotatably connected, at one end thereof, to the door trailing end-side end of the first door roller supporting member 21, coaxially with the axle 31a. The door leading end-side swing member 23 is rotatably connected, at one end thereof, to the door leading end-side end of the first door roller supporting member 21, coaxially with the axle 32b.

[0044] Although this embodiment has been described, taking, as an example, a door roller mechanism 14a in which the swing members (22, 23) are rotatably connected to the first door roller supporting member 21, coaxially with the axles (31a, 32b) of the first door rollers (19a, 20b), this need not be the case; various modifications may be made to the connection position between the swing members (22, 23) and the first door roller supporting member 21. For example, the door trailing end-side swing member 22 may be rotatably connected to the first door roller supporting member 21 via a rotational shaft disposed parallel to the axles (31a, 31b) between a plurality of door trailing end-side first door rollers (19a, 19b). Likewise, the door leading end-side swing member 23 may be rotatably connected to the first door roller supporting member 21 via a rotational shaft disposed parallel to the axles (32a, 32b) between a plurality of door leading end-side first door rollers (20a, 20b).

[0045] As shown in FIG. 4, the second door rollers (24, 25) are provided as door rollers that are rotatably supported to the swing members (22, 23) and disposed so as to be capable of coming into contact with the upper rail 13a. Also, the second door rollers (24, 25) are dis-

posed in positions that are substantially line-symmetric about the center line of the door roller mechanism 14a, and are provided on both the door trailing end side and the door leading end side with respect to an elastic connection mechanism 27, which will be described below.

[0046] A door trailing end-side second door roller 24 disposed on the door trailing end side with respect to the center line of the door roller mechanism 14a and a door leading end-side second door roller 25 disposed on the door leading end side with respect to the center line of the door roller mechanism 14a are provided as the second door rollers (24, 25). The door trailing end-side second door roller 24 is rotatably supported via the axle 33a to the door trailing end-side swing member 22 at the other end of the door trailing end-side swing member 22, which is opposite to an end thereof connected to the first door roller supporting member 21. The door leading end-side second door roller 25 is rotatably supported via the axle 33b to the door leading end-side swing member 23 at the other end of the door leading end-side swing member 23, which is opposite to an end thereof connected to the first door roller supporting member 21. In this embodiment, the door trailing end-side second door roller 24 is disposed further toward the door trailing end side than the door trailing end-side first door roller 19a, which is the first door roller that is disposed closest to the door trailing end side in the door roller mechanism 14a. Also, the door leading end-side second door roller 25 is disposed further toward the door leading end side than the door leading end-side first door roller 20b, which is the first door roller disposed closest to the door leading end side in the door roller mechanism 14a.

[0047] Furthermore, in this embodiment, as shown in FIGS. 4 and 5, the second door rollers (24, 25) are disposed via a slight gap from, or disposed in slight contact with the running surface 18a of the upper rail 13a on the upper end side thereof, in a state in which the first door rollers (19, 20) are not running on the lower rail 13b (i.e., in a state in which the first door roller mechanism 14a is stationary with respect to the structure). Further, the cross section of the second door rollers (24, 25) that is perpendicular to the door roller circumferential direction of the rolling surface that rolls on the running surface 18a of the upper rail 13a when the door roller mechanism 14a is moved horizontally along the rail 13 is formed so as to be recessed in an arc shape in conformity with the running surface 18a.

[0048] Although this embodiment describes, as an example, a case where the second door rollers (24, 25) are disposed via a slight gap from, or disposed in slight contact with the upper rail 13a, the second door rollers (24, 25) may be disposed via a predetermined gap from the upper rail 13a. FIGS. 6 are enlarged views showing the cross section of a side face of a second door roller 24 and the rail 13. Note that FIG. 6(a) is a diagram showing a state in which the second door roller 24 is disposed via a slight gap from the upper rail 13a or disposed in a position where it is in light contact with the upper rail 13a

(the state according to this embodiment), and FIG. 6(b) is a diagram showing a state in which the second door roller 24 is disposed via a gap within an predetermined range from the rail 13a.

[0049] In the state shown in FIG. 6(a), the running surface 18a of the upper rail 13a and the rolling surface 24a of the second door roller 24 are slightly spaced away or in light contact. The riding width, which is the vertical spacing (width) between the lower end portion of the upper rail 13a and the upper end portion of the second door roller 24 in a state in which the lower end portion of the upper rail 13a and the upper end portion of the second door roller 24 are disposed overlapping each other in the horizontal direction, is the width dimension indicated by the double-ended arrow G1 in the drawing. That is, it is the width dimension between the lower end portion of the running surface 18a and a portion of the second door roller 24 that is located at the upper end of both edges 24b of the rolling surface 24a.

[0050] On the other hand, in the state shown in FIG. 6(b), the running surface 18a of the upper rail 13a and the rolling surface 24a of the second door roller 24 oppose each other via a gap having a dimension indicated by the double-ended arrow H in the drawing. In this state, the second door roller 24 is disposed such that the height position of a portion located at the upper end of the both edges 24b of the second door roller 24 is located above the height position (the position in the vertical direction) of the lower end portion of the running surface 18a opposing the central portion of the rolling surface 24a via a gap having a predetermined size. Accordingly, a riding width having the width dimension indicated by the double-ended arrow G2 in the drawing is secured as the riding width between the upper rail 13a and the second door roller 24. As illustrated in FIG. 6(b), the second door roller (24, 25) may be disposed via a gap within a predetermined range, which is the range in which a riding width can be secured, from the upper rail 13a.

[0051] As shown in FIG. 4, the drive connection portion 26 is provided as a member for holding and connecting the door 11a to the open-close drive mechanism 12. The drive connection portion 26 is fixed to the belt 17 at its end on the upper end side, and is connected to an elastic connection mechanism 27, which will be described below, on the lower end side. Thereby, the drive connection portion 26 holds and connects the door 11a to the belt 17 via the elastic connection mechanism 27, the swing members (22, 23), the first door roller supporting member 21, and the hanger 28.

[0052] Additionally, a through hole extending parallel to the lengthwise direction of the rail 13 is formed in the end of the drive connection portion 26 on the lower end side, and the central part of the first door roller supporting member 21 is disposed passing through the through hole in a state in which it is loosely fitted so as to be swingable and pivotable. Accordingly, when the first door roller supporting member 21 is relatively displaced with respect to the drive connection portion 26, the direction of relative

displacement of the first door roller supporting member 21 can be restricted so as to be guided in a direction parallel to the direction of movement of the drive connection portion 26. Thereby, the movement of the door 11a, which is connected to the first door roller supporting member 21 via the hanger 28, can be further restricted to a sliding movement in a plane parallel to the plane in which the upper and lower rails (13a, 13b) are disposed.

[0053] As shown FIG. 4, the elastic connection mechanism 27 is provided as a mechanism for elastically connecting the swing members (22, 23) to the drive connection portion 26, and includes a pair of spring members (30a, 30b) and a swingable connection member 29. The pair of spring members (30a, 30b) constitute an elastic portion of this embodiment that is capable of changing the relative position between the second door rollers (24, 25) and the drive connection portion 26 by elastic deformation. Also, the pair of spring members (30a, 30b) are provided as coil springs, and are disposed on opposite sides in a direction along the lengthwise direction of the rail 13 with respect to the drive connection portion 26. Note that the spring member 30a is disposed on the door trailing end side with respect to the drive connection portion 26, and the spring member 30b is disposed on the door leading end side with respect to the drive connection portion 26.

[0054] The swingable connection member 29 is provided as a shaft-like member that is connected to the drive connection portion 26 via the pair of spring members (30a, 30b) such that its relative position with respect to the drive connection portion 26 can be changed. An end of the door trailing end-side swing member 22 and an end of the door leading end-side swing member 23 are rotatably connected respectively at opposite ends of the swingable connection member 29.

[0055] Further, the swingable connection member 29 is disposed passing through the through hole that is formed in the drive connection portion 26 so as to extend parallel to the lengthwise direction of the rail 13, and the swingable connection member 29 passes through the inside of the spring members (30a, 30b), which are provided as coil springs, on opposite sides of the drive connection portion 26. Note that the swingable connection member 29 is disposed slidably passing through the through hole of the drive connection portion 26 in a state in which it is freely fitted so as to allow a predetermined tilting. Also, the pair of spring members (30a, 30b) are disposed so as to bias the drive connection portion 26 in opposite directions from opposite sides in a passing-through direction, in which the swingable connection member 29 passes through the drive connection portion 26. The ends of the spring members (30a, 30b) that are opposite to the ends that bias the drive connection portion 26 are respectively supported to collar portions (29a, 29b) that are formed in the swingable connection member 29 and disposed on opposite sides of the drive connection portion 26.

[0056] Note that the spring members (30a, 30b) may

be provided as tension springs that apply biasing forces in directions in which they pull against each other via the drive connection portion 26, or may be provided as compression springs that apply biasing forces in directions in which they press against each other via the drive connection portion 26. When the spring members (30a, 30b) are provided as tension springs, opposite ends of each of the spring members (30a, 30b) need to be fixed to the drive connection portion 26 and the collar portions (29a, 29b). On the other hand, when the spring members (30a, 30b) are provided as compression springs, opposite ends of each of the spring members (30a, 30b) may be either fixedly supported to or supported in contact with the drive connection portion 26 and the collar portions (29a, 29b).

[0057] Further, the connection position between the swingable connection member 29 and the door trailing end-side swing member 22 are disposed on the side of the second door roller 24 supported to the door trailing end side swing member 22 with respect to the connection position between the door trailing end side swing member 22 and the first door roller supporting member 21. Also, the swingable connection member 29 and the door trailing end-side swing member 22 are rotatably connected coaxially with the axle 33a via which the second door roller 24 is rotatably supported to the door trailing end-side swing member 22.

[0058] Further, the connection position between the swingable connection member 29 and the door leading end-side swing member 23 is disposed on the side of the second door roller 25 supported to the door leading end-side swing member 23 with respect to the connection position between the door leading end-side swing member 23 and the first door roller supporting member 21. Also, the swingable connection member 29 and the door leading end-side swing member 23 are rotatably connected coaxially with the axle 33b via which the second door roller 25 is rotatably supported to the door leading end-side swing member 23.

[0059] As described above, the door trailing end-side swing member 22 is rotatably connected to the first door roller supporting member 21, the swingable connection member 29 is rotatably connected to the door trailing end-side swing member 22, the door leading end-side swing member 23 is rotatably connected to the swingable connection member 29, and the first door roller supporting member 21 is rotatably connected to the door leading end-side swing member 23. Thus, the door roller mechanism 14a includes the first door roller supporting member 21, the door trailing end-side swing member 22, the swingable connection member 29, and the door leading end-side swing member 23, which are provided as four links, and these links constitute a quadrangular link mechanism.

[0060] Next, an operation of the door apparatus 2 and the door hanging apparatus 1 described above will now be described. As described above, with the door apparatus 2, the door roller mechanisms (14a, 14b) are moved in directions in which they move away from each other

by the open-close drive mechanism 12 operating in the state shown in FIG. 1, and thereby, the doors (11a, 11b) respectively suspended to the door roller mechanisms (14a, 14b) are opened as shown in FIG. 2. On the other hand, the door roller mechanisms (14a, 14b) are moved in directions in which they approach each other by the drive motor of the open-close drive mechanism 12 rotating in a direction opposite to the aforementioned opening operation in the state shown in FIG. 2, and thereby the doors (11a, 11b) are closed as shown in FIG. 1.

[0061] Further, with the door hanging apparatus 1, the door roller mechanism 14a and the door roller mechanism 14b respectively cause the door 11a and the door 11b to slidably move in the opening and closing direction along the lengthwise direction of the rail 13 via operation of the open-close drive mechanism 12. Note that the door roller mechanism 14a and the door roller mechanism 14b operate in the same manner in states line-symmetric about the intermediate position of the two doors 11, and therefore, only the operation of the door roller mechanism 14a will be described in the following.

[0062] FIG. 7 is a front view schematically showing the door roller mechanism 14a, together with part of the upper and lower rails (13a, 13b) and the door 11a, and schematically shows the first door roller supporting member 21, the door trailing end-side swing member 22, the swingable connection member 29, and the door leading end-side swing member 23 by the dashed line. In a state in which the open-close drive mechanism 12 is not operated and the door 11a is stationary with respect to the structure, the relative position between the second door rollers (24, 25) and the drive connection portion 26 is maintained in a predetermined positional state, with the biasing forces of the pair of spring members (30a, 30b) being balanced.

[0063] When the acceleration/deceleration operation (the operation performed before or after the constant velocity operation, and the duration is shorter than the duration of the constant velocity operation) of the door roller mechanism 14a via operation of the open-close drive mechanism 12 is performed in the above-described state, the relative positional state of the swingable connection member 29 and the swing members (22, 23) with respect to the door 11a is slightly changed by elastic deformation of the pair of spring members (30a, 30b), resulting in a change in the contact pressure exerted on the upper rail 13a from the second door rollers (24, 25). Similarly, in the case where a load is exerted from the door 11a, including, for example, cases where a foreign object has collided with or has been caught at the end of the door 11a in the opening and closing direction, the relative positional state of the swingable connection member 29 and the swing members (22, 23) with respect to the door 11a is changed by elastic deformation of the pair of spring members (30a, 30b). Note that, when the operation of the door roller mechanism 14a has been switched from the acceleration operation to the constant velocity operation, the deformation of the pair of spring

members (30a, 30b) ceases, their relative positional state of the swingable connection member 29 and the swing members (22, 23) with respect to the door 11a returns to the initial state, and the contact pressure exerted on the upper rail 13a from the second door rollers (24, 25) returns to the initial state, as a result of which the running resistance is substantially eliminated.

[0064] The directions of several forces acting on the door roller mechanism 14a when a foreign object has collided with the end of the door 11a on the door leading end side during the closing operation of the door 11a are indicated by the arrows (K1 to 6) in FIG. 7. Note that forces in the same directions as the directions indicated by the arrows in FIG. 7 act on the door roller mechanism 14a during the acceleration operation, and therefore, the description thereof has been omitted. Also, forces in directions opposite to the directions indicated by the arrows shown in FIG. 7 act on the door roller mechanism 14a during the deceleration operation, and the forces simply act in states line-symmetric with the door roller mechanism 14a during the acceleration operation. Therefore, the description thereof has been omitted.

[0065] As shown in FIG. 7, during the closing operation of the door 11a, a driving force in the direction toward the door leading end side is exerted on the drive connection portion 26 from the belt 17 of the open-close drive mechanism 12 as indicated by the arrow K1. When a foreign object has collided with the end of the door 11a on the door leading end side in this state, a load is exerted on the door 11a in the direction toward the door trailing end side as indicated by the arrow K2. When a load has been exerted on the door 11a in this way, this load is exerted on the door trailing end-side swing member 22 and the door trailing end-side second door roller 24 via the hanger 28 and the first door roller supporting member 21 in the door roller mechanism 14a. Thereby, the door trailing end-side swing member 22 is displaced so as to swing in a direction (the direction indicated by the arrow K3 in the drawing) in which it swings upward, with the door trailing end-side first door roller 19a as the center. Furthermore, the door trailing end-side second door roller 24 is displaced upward (in the direction indicated by the arrow K4 in the drawing) and thus comes into contact with the upper rail 13a, which results in an increase in the contact pressure between the upper rail 13a and the second door roller 24.

[0066] Then, as described above, the door trailing end-side second door roller 24 is displaced, and at the same time, the swingable connection member 29 is relatively displaced toward the door leading end side with respect to the drive connection portion 26 by elastic deformation of the pair of springs (30a, 30b). Thereby, the door leading end-side swing member 23 is displaced so as to swing in a direction (the direction indicated by the arrow K5 in the drawing) in which it swings downward, with the door leading end-side first door roller 19b as the center. Furthermore, the door leading end-side second door roller 25 is displaced downward (in the direction indicated by

the arrow K6 in the drawing) and thus is moved away from the upper rail 13b. At this time, the pair of spring members (30a, 30b) elastically deform such that they deform in opposite directions to each other.

[0067] Even if a load is exerted from the door 11a as the result of a foreign object having collided with the end of the door 11a on the door leading end side during the closing operation in this way, the four links (21, 22, 29, 23) are relatively displaced with respect to the door 11a by elastic deformation of the pair of spring members (30a, 30b). Thereby, the positions of the second door rollers (24, 25) with respect to the upper rail 13a are positioned in suitable positions according to the above-described load. Note that the amounts of displacement of the four links (21, 22, 29, 23) and the first and second door rollers (19, 20) described above are within a range that is allowable in the space between the upper and lower rails (13a, 13b).

[0068] With the door hanging apparatus 1 and the door apparatus 2 described thus far, the first door rollers (19, 20) supported to the first door roller supporting member 21 that suspends the doors 11 (11a, 11b) run on the lower rail 13b, and the second door rollers (24, 25) supported to the swing members (22, 23) that are swingably connected to the first door roller supporting member 21 are disposed so as to be capable of coming into contact with the upper rail 13a. Accordingly, the first door rollers (19, 20) and the second door rollers (24, 25) that are disposed between the upper and lower rails (13a, 13b) and run thereon constitute a derailing prevention mechanism, and therefore, it is possible to reliably prevent the derailing of the door rollers (19, 20, 24, 25) and the tilting of the doors 11 (11a, 11b) when the doors 11 (11a, 11b) are opened and closed.

[0069] Furthermore, with the door hanging apparatus 1 and the door apparatus 2, the elastic connection mechanism 27 that connects the drive connection portion 26 for connecting the doors 11 (11a, 11b) to the open-close drive mechanism 12 and the swing members (22, 23) includes the pair of spring members (30a, 30b) serving as an elastic portion, and the elastic connection mechanism 27 is provided so as to be capable of changing the relative position between the second door rollers (24, 25) and the drive connection portion 26 by elastic deformation. Accordingly, at the time of acceleration when the doors 11 (11a, 11b) are driven to be opened and closed, the swingable connection member 29 and the swing members (22, 23) are relatively displaced with respect to the doors 11 (11a, 11b) by the elastic deformation of the pair of spring members (30a, 30b), and the contact pressure exerted on the upper rail 13a from the second door rollers (24, 25) is temporarily increased. However, the elastic deformation of the pair of spring members (30a, 30b) is immediately restored when the velocity is constant, and consequently, the distance relationship between the upper rail 13a and the second door rollers (24, 25) is brought back to the original state. Further, even if a load is exerted from the doors 11 (11a, 11b) as the

result of a foreign object having collided with or having been caught at the end of the doors 11 (11a, 11b) in the opening and closing direction, the swingable connection member 29 and the swing members (22, 23) are relatively displaced with respect to the doors 11 (11a, 11b) by elastic deformation of the pair of spring members (30a, 30b), and the positions of the second door rollers (24, 25) with respect to the upper rail 13a are positioned in suitable positions according to the above-described load.

[0070] Accordingly, with the door hanging apparatus 1 and the door apparatus 2, the second door rollers (24, 25) are disposed in light contact with the upper rail 13a or disposed so as to provide a gap within a predetermined range that can secure a riding width between the upper rail 13a and the second door rollers (24, 25), and thereby, it is possible to set a state in which little running resistance is generated in a derailing prevention mechanism when the door rollers (19, 20, 24, 25) are running on the rail 13. Also, at the time of acceleration/deceleration of the doors 11 (11a, 11b) or the collision with a foreign object, the door rollers (19, 20, 24, 25) can be positioned in suitable positions according to the load, and the derailing of the door rollers (19, 20, 24, 25) and the tilting of the doors 11 (11a, 11b) can be reliably prevented. Further, the positional adjustment of the second door rollers (24, 25), namely, the degree to which the second door rollers (24, 25) is in contact with the upper rail 13a or the amount of the gap provided within a predetermined range, has little impact on the above-described derailing prevention performance. Accordingly, the positional adjustment requires little time and effort at the time of installing the door hanging apparatus 1, and the installation operation can be performed easily.

[0071] Therefore, according to this embodiment, it is possible to provide a door hanging apparatus 1 and a door apparatus 2 that can reliably prevent the derailing of door rollers (19, 20, 24, 25) and the tilting of doors 11 (11a, 11b) when the doors 11 (11a, 11b) are opened and closed, while having little running resistance caused by a derailing prevention mechanism.

[0072] With the door hanging apparatus 1 and the door apparatus 2, the second door rollers (24, 25) are provided on both the door leading end side and the door trailing end side with respect to the elastic connection mechanism 27. Accordingly, both during the opening driving and the closing driving of the doors 11 (11a, 11b), the positions of the second door rollers (24, 25) with respect to the upper rail 13a can be positioned in suitable positions via operation of the elastic connection mechanism 27 at the time of the acceleration/deceleration or when a foreign object has collided with the end of the doors. Accordingly, it is possible to achieve a door hanging apparatus 1 and a door apparatus 2 that can reliably prevent the derailing of the door rollers (19, 20, 24, 25) and the tilting of the doors 11 (11a, 11b), while having little running resistance caused by a derailing prevention mechanism, both during the opening driving and the closing driving of the doors 11 (11a, 11b).

[0073] With the door hanging apparatus 1 and the door apparatus 2, the door leading end-side and door trailing end-side swing members (22, 23) are respectively connected to opposite sides of the first door roller supporting member 21 that supports the first door rollers (19, 20), and the swingable connection member 29 of the elastic connection mechanism 27 is further connected thereto so as to connect the two swing members (22, 23), thus constituting a quadrangular link mechanism having four links. Accordingly, it is possible to construct, with a quadrangular link mechanism, a structure with a simple configuration that can position the positions of the second door rollers (24, 25) with respect to the upper rail 13a in suitable positions via operation of the elastic connection mechanism 27 in response to the acceleration/deceleration of the doors 11 (11a, 11b) and the collision with a foreign object.

[0074] With the door hanging apparatus 1 and the door apparatus 2, for the door trailing end-side swing member 22 that supports the door trailing end-side second door roller 24, the connection position with the swingable connection member 29 is disposed on the side of the door trailing end-side second door roller 24 with respect to the connection position with the first door roller supporting member 21. Accordingly, when the connection position with the swingable connection member 29 is disposed in a position closer to the connection position with the first door roller supporting member 21, the response performance of the door trailing end-side second door roller 24 via the door trailing end-side swing member 22 via operation of the elastic connection mechanism 27 can be set to be faster, which makes it possible to more quickly position the door trailing end-side second door roller 24 in a suitable position. Meanwhile, when the connection position with the swingable connection member 29 is disposed in a position farther away from the connection position with the first door roller supporting member 21, a greater force can be easily secured as the force exerted on the upper rail 13a from the door trailing end-side second door roller 24 via the door trailing end-side swing member 22 via operation of the elastic connection mechanism 27. Consequently, by simply changing the connection position with the swingable connection member 29 with respect to the connection position with the first door roller supporting member 21 for the door trailing end-side swing member 22, it is possible to easily adjust the setting of the response performance of the door trailing end-side second door roller 24 via operation of the elastic connection mechanism 27 and the setting of the force exerted on the upper rail 13a from the door trailing end-side second door roller 24.

[0075] With the door hanging apparatus 1 and the door apparatus 2, the swingable connection member 29 and the door trailing end-side swing member 22 are rotatably connected coaxially with the axle 33a of the door trailing end-side second door roller 24, and therefore, the same shaft can be used as the axle 33a of the door trailing end-side second door roller 24 and the rotational shaft of the

swingable connection member 29 and the door trailing end-side swing member 22. Accordingly, it is possible to reduce the number of members, which makes it possible to further increase the compactness of the structure.

[0076] With the door hanging apparatus 1 and the door apparatus 2, for the door leading end-side swing member 23 that supports the door leading end-side second door roller 25, the connection position with the swingable connection member 29 is disposed on the side of the door leading end-side second door roller 25 with respect to the connection position with the first door roller supporting member 21. Accordingly, when the connection position with the swingable connection member 29 is disposed in a position closer to the connection position with the first door roller supporting member 21, the response performance of the door leading end-side second door roller 25 via the door leading end-side swing member 23 via operation of the elastic connection mechanism 27 can be set to be faster, which makes it possible to more quickly position the door leading end-side second door roller 25 in a suitable position. Meanwhile, when the connection position with the swingable connection member 29 is disposed in a position farther away from the connection position with the first door roller supporting member 21, a greater force can be easily secured as the force exerted on the upper rail 13a from the door leading end-side second door roller 25 via the door leading end-side swing member 23 via operation of the elastic connection mechanism 27. Consequently, by simply changing the connection position with the swingable connection member 29 with respect to the connection position with the first door roller supporting member 21 for the door leading end-side swing member 23, it is possible to easily adjust the setting of the response performance of the door leading end-side second door roller 25 via operation of the elastic connection mechanism 27 and the setting of the force exerted on the upper rail 13a from the door leading end-side second door roller 25.

[0077] With the door hanging apparatus 1 and the door apparatus 2, the swingable connection member 29 and the door leading end-side swing member 23 are rotatably connected coaxially with the axle 33b of the door leading end-side second door roller 25, and therefore, the same shaft can be used as the axle 33b of the door leading end-side second door roller 25 and the rotational shaft of the swingable connection member 29 and the door leading end-side swing member 23. Accordingly, it is possible to reduce the number of members, which makes it possible to further increase the compactness of the structure.

[0078] With the door hanging apparatus 1 and the door apparatus 2, the respective ends of the pair of spring members (30a, 30b) are supported to the swingable connection member 29 and the drive connection portion 26 is biased by the pair of spring members (30a, 30b) in opposite directions, and thereby the elastic connection mechanism 27 can be easily constructed with a simple structure.

[0079] Although an embodiment of the present invention has been described thus far, the present invention is not limited to the above-described embodiment, and various modifications may be made within the scope recited in the claims. For example, a single door 11 may be provided, and the following variations may also be made.

[0080] (1) Although this embodiment has been described, taking, as an example, a case where the link mechanism formed by the first door roller supporting member, the swing members, and the swingable connection member is a quadrangular link mechanism constituted by four links, this need not be the case. That is, the link mechanism formed by the first door roller supporting member, the swing members, and the swingable connection member may be a link mechanism constituted by five or more links.

[0081] (2) Although this embodiment has been described, taking, as an example, a door roller mechanism in which the first door roller supporting member is disposed passing through the drive connection portion, this need not be the case. It is possible to adopt a configuration in which the first door roller supporting member is disposed in the state of being completely separated from the drive connection portion, without being connected thereto.

[0082] (3) The number of the first door rollers and the second door rollers provided in the door roller mechanism is not limited to those illustrated in this embodiment, and various modifications may be made. Although this embodiment has been described, taking, as an example, a configuration in which a second door roller is rotatably connected each of the swing members, this need not be the case. That is, it is sufficient to provide a second door roller that is rotatably supported to at least one of a plurality of swing members.

[0083] (4) Although this embodiment has been described, taking, as an example, a coil spring as the elastic portion, this need not be the case. Various modifications may be made for the member constituting the elastic portion. For example, it is possible to use an elastic member having any of various configurations, including, for example, sponge rubber formed in a cylindrical shape.

[0084] (5) Although this embodiment has been described, taking, as an example, a configuration in which the swingable connection member and the door trailing end-side swing member are connected coaxially with the axle of the door trailing end-side second door roller and the swingable connection member and the door leading end-side swing member are connected coaxially with the axle of the door leading end-side second door roller, this need not be the case. FIGS. 8 are schematic diagrams illustrating modifications in which the swingable connection member and the door trailing end-side swing member are connected at a position offset from the axle of the door trailing end-side second door roller, and schematically show part of the first door roller supporting member 21 and the swingable connection member 29,

the door trailing end-side swing member 22, the door trailing end-side first door rollers (19a, 19b), and the door trailing end-side second door roller 24. Note that although only modifications of the connection position between the swingable connection member and the door trailing end-side swing member will be described based on FIGS. 8, the swingable connection member and the door leading end-side swing member are also connected in a position offset from the axle of the door leading end-side second door roller.

[0085] In the modification shown in FIG. 8(a), the position of a rotational shaft 34 that rotatably connects the swingable connection member 29 to the door trailing end-side swing member 22, or in other words, the connection position between the swingable connection member 29 and the door trailing end-side swing member 22 is provided in a position between the connection position between the door trailing end-side swing member 22 and the first door roller supporting member 21 and the position of the axle 33a of the door trailing end-side second door roller 24. In this case, the response performance of the door trailing end-side second door roller 24 can be set to be faster, compared to the case where the connection position between the swingable connection member 29 and the door trailing end-side swing member 22 is provided coaxially with the axle 33a.

[0086] In the modification shown in FIG. 8(b), the position of a rotational shaft 35 that rotatably connects the swingable connection member 29 to the door trailing end-side swing member 22, or in other words, the connection position between the swingable connection member 29 and the door trailing end-side swing member 22 is provided in a position farther away from the axle 33a of the door trailing end-side second door roller 24 toward the door trailing end side with respect to the connection position between the door trailing end-side swing member 22 and the first door roller supporting member 21. That is, the axle 33a of the door trailing end-side second door roller 24 is provided in a position between the connection position between the door trailing end-side swing member 22 and the first door roller supporting member 21 and the connection position between the swingable connection member 29 and the door trailing end-side swing member 22. In this case, a greater force can be easily secured as the force exerted on the upper rail 13a from the door trailing end-side second door roller 24, compared to the case where the connection position between the swingable connection member 29 and the door trailing end-side swing member 22 is provided coaxially with the axle 33a.

[0087] (6) Although this embodiment has been described, taking, as an example, a door apparatus in which the open-close drive mechanism includes the drive motor, the drive pulley, the driven pulley, and the belt, this need not be the case; various modifications may be made as long as the open-close drive mechanism is a mechanism that can be provided in a structure and is capable of driving a door to be opened and closed. FIGS. 9 to 11

are front views respectively showing a door apparatus 3, a door apparatus 4, and a door apparatus 5 according to modifications in which open-close drive mechanisms different from that of this embodiment are provided, and the drawings correspond to FIG. 1 of this embodiment. Note that the description of those elements of the door apparatuses (3, 4, 5) shown in FIGS. 9 to 11 that are configured in the same manner as the door apparatus 2 of this embodiment are denoted by the same reference numerals in the drawings, and the description thereof has been omitted.

[0088] In the door apparatus 3 shown in FIG. 9, an open-close drive mechanism 40 includes a drive motor (not shown), a pinion 41, an upper rack 42, a lower rack 43, and so forth. The pinion 41 is connected to the drive motor, and is rotationally driven with rotation of the drive motor. Also, the pinion 41 is disposed so as to be meshed with the upper rack 42 that is disposed thereabove so as to extend horizontally and the lower rack 43 that is disposed therebelow so as to extend horizontally. The upper rack 42 and the lower rack 43 are supported to the structure so as to be slidably moved, parallel to the lengthwise direction of a rail 13. The upper rack 42 and the lower rack 43 are configured to be slidably moved in opposite directions to each other by rotation of the pinion 41. Further, the upper rack 42 is connected to a door roller mechanism 14b that supports a door 11b in a suspended state, and the lower rack 43 is connected to a door roller mechanism 14a that supports a door 11a in a suspended state. Accordingly, rotations of the pinion 41 with a forward operation and a reverse operation of the drive motor cause the doors 11 (11a, 11b) to be driven to be moved in the opening direction and the closing direction.

[0089] In the door apparatus 4 shown in FIG. 10, an open-close drive mechanism 50 includes a drive motor 51, a screw shaft 52, a rotation receiving portion 53, nut members (54a, 54b), and so forth. The screw shaft 52 is connected to the drive motor 51 at its one end, and is rotationally supported by the rotation receiving portion 53 at the other end. Accordingly, the screw shaft 52 is rotationally driven with rotation of the drive motor 51. Further, in the screw shaft 52, an externally threaded portion 52a formed from the center portion to one end and an externally threaded portion 52b formed from the center portion to the other end are formed as threaded portions in reverse directions. The nut members (54a, 54b) are provided as members that are threadedly engaged with the screw shaft 52 and are connected to the door hanging apparatus 1. Note that the nut member 54a is threadedly engaged with one of the externally threaded portions of the screw shaft 52, namely the externally threaded portion 52a, and is connected to a door roller mechanism 14a that supports a door 11a in a suspended state. The nut member 54b is threadedly engaged with the other externally threaded portion of the screw shaft 52, namely the externally threaded portion 52b, and is connected to a door roller mechanism 14b that supports a door 11b in a suspended state. Thereby, rotations of the screw shaft

52 with a forward operation and a reverse operation of the drive motor 51 cause the doors 11 (11a, 11b) to be driven to be moved in the opening direction and the closing direction.

[0090] In the door apparatus 5 shown in FIG. 11, an open-close drive mechanism 60 includes a drive motor 61, screw shafts (62a, 62b), rotation receiving portions (63a, 63b, 63c), gear portions (64a, 64b), nut members (65a, 65b), and so forth. The screw shaft 62a is connected to the drive motor 61 at its one end, and is rotatably supported by the rotation receiving portion 63a at the other end. Accordingly, the screw shaft 62a is rotationally driven with rotation of the drive motor 61. Meanwhile, the screw shaft 62b has a threaded portion formed therein in the same direction as that of the screw shaft 62a, and is rotatably supported by the rotation receiving portions (63b, 63c) at opposite ends. Also, the gear portion 64a having teeth of a spur gear formed on its outer circumference is fixed coaxially to the screw shaft 62a. The gear portion 64b having teeth of a spur gear formed on its outer circumference and meshing with the gear portion 64a is fixed coaxially to the screw shaft 62b. Thereby, upon rotation of the screw shaft 62a via operation of the drive motor 61, the screw shaft 62b rotates in a direction opposite to that of the screw shaft 62a via meshing between the gear portion 64a and the gear portion 64b. The nut member 65a is provided as a member that is threadedly engaged with the screw shaft 62b and is connected to a door roller mechanism 14a that supports a door 11a in a suspended state. Meanwhile, the nut member 65b is provided as a member that is threadedly engaged with the screw shaft 62a and is connected to a door roller mechanism 14b that supports a door 11b in a suspended state. Thereby, rotations of the screw shaft 62a with a forward operation and a reverse operation of the drive motor 61 cause the doors 11 (11a, 11b) to be driven to be moved in the opening direction and the closing direction.

Industrial Applicability

[0091] The present invention is widely applicable as a door hanging apparatus that supports a door provided in a structure and driven to be opened and closed by an open-close drive mechanism, in a state in which the door is suspended to the structure so as to be slidably moved, and that is connected to the open-close drive mechanism, and a door apparatus provided with the door hanging apparatus.

Descriptions of Reference Numerals

[0092]

1	Door hanging apparatus
11, 11a, 11b	Door
12	Open-close drive mechanism
13	Rail

13a	Upper rail
13b	Lower rail
18a, 18b	Running surface
19, 19a, 19b	Door trailing end-side first door roller (first door roller)
20, 20a, 20b	Door leading end side-first door roller (first door roller)
21	First door roller supporting member
22	Door trailing end-side swing member (swing member)
23	Door leading end-side swing member (swing member)
24	Door trailing end-side second door roller (second door roller)
25	Door leading end-side second door roller (second door roller)
26	Drive connection portion
27	Elastic connection mechanism
30a, 30b	Pair of spring members (elastic portion)

Claims

1. A door hanging apparatus that supports a door provided in a structure and driven to be opened and closed by an open-close drive mechanism, in a state in which the door is suspended to the structure so as to be slidably moved, and that is connected to the open-close drive mechanism, the apparatus comprising:

a rail including an upper rail and a lower rail that are fixed to the structure and are provided with respective running surfaces opposing each other in the vertical direction;

a first door roller that runs in contact with the running surface of the lower rail;

a first door roller supporting member that suspends the door and rotatably supports the first door roller;

a plurality of swing members that are swingably connected to the first door roller supporting member;

a second door roller that is rotatably supported to at least one of the swing members and is provided so as to be capable of coming into contact with the running surface of the upper rail;

a drive connection portion for holding and connecting the door to the open-close drive mechanism; and

an elastic connection mechanism that includes an elastic portion capable of changing a relative position between the second door roller and the drive connection portion by elastic deformation and connects the swing members to the drive connection portion.

2. The door hanging apparatus according to claim 1,

wherein the second door roller is provided on both a door leading end side, which is the side on which the end of the door in a closing direction is located, and a door trailing end side, which is the side on which the end of the door in an opening direction is located, with respect to the elastic connection mechanism.

3. The door hanging apparatus according to claim 1 or 2,
 wherein a door leading end-side swing member that is connected to the first door roller supporting member on the door leading end side and a door trailing end-side swing member that is connected to the first door roller supporting member on the door trailing end side are provided as the swing members, the elastic connection mechanism includes a swingable connection member that is connected to the drive connection portion via the elastic portion such that a relative position thereof with respect to the drive connection portion can be changed and to which the door leading end-side swing member and the door trailing end-side swing member are rotatably connected at opposite ends, respectively, and the first door roller supporting member, the door leading end-side swing member, the swingable connection member, and the door trailing end-side swing member, which are provided as four links, forms a quadrangular link mechanism.

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4. The door hanging apparatus according to claim 3, wherein the second door roller is rotatably supported to the door leading end-side swing member, and a connection position between the swingable connection member and the door leading end-side swing member is disposed on a side of the second door roller with respect to a connection position between the door leading end-side swing member and the first door roller supporting member.

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5. The door hanging apparatus according to claim 4, wherein the swingable connection member and the door leading end-side swing member are connected coaxially with an axle via which the second door roller is rotatably supported to the door leading end-side swing member.

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6. The door hanging apparatus according to any one of claims 3 to 5, wherein the second door roller is rotatably supported to the door trailing end-side swing member, and a connection position between the swingable connection member and the door trailing end-side swing member is disposed on a side of the second door roller with respect to a connection position between the door trailing end-side swing member and the first door roller supporting member.

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7. The door hanging apparatus according to claim 6, wherein the swingable connection member and the door trailing end-side swing member are connected coaxially with an axle via which the second door roller is rotatably supported to the door trailing end-side swing member.

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8. The door hanging apparatus according to any one of claims 3 to 7, wherein the swingable connection member is disposed passing through the drive connection portion, the elastic portion is provided as a pair of spring members disposed so as to bias the drive connection portion in opposite directions from opposite sides in a passing-through direction in which the swingable connection member passes through the drive connection portion, and the respective ends of the pair of spring members that are opposite to the ends thereof that bias the drive connection portion are supported to the swingable connection member.

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9. A door apparatus comprising:

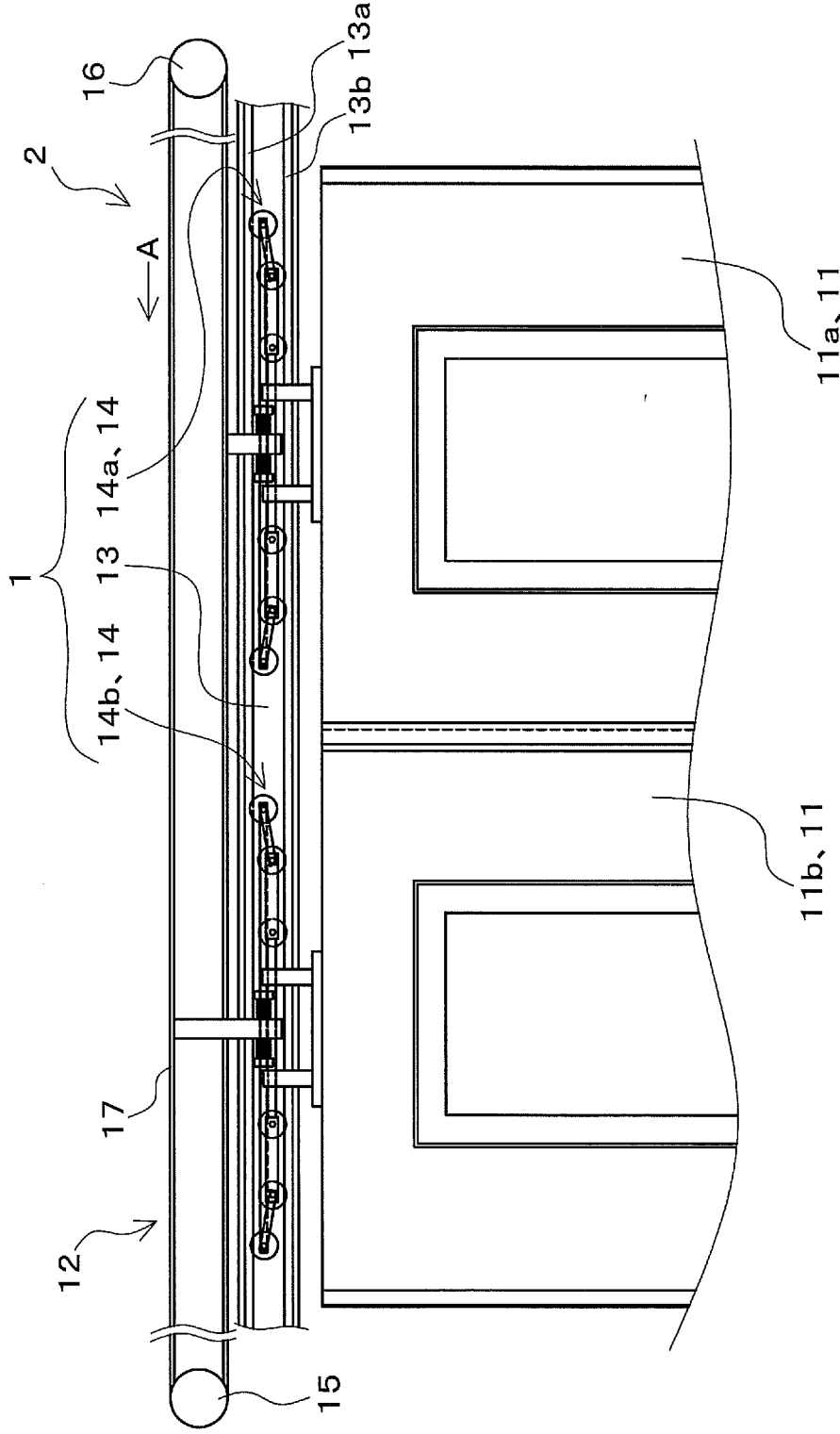
45

the door hanging apparatus according to any one of claims 1 to 8;

a door that is provided in a structure and is supported by the door hanging apparatus in a state of being suspended to the structure so as to be slidably moved; and

an open-close drive mechanism that is connected to the door hanging apparatus and drives the door to be opened and closed.

FIG. 1



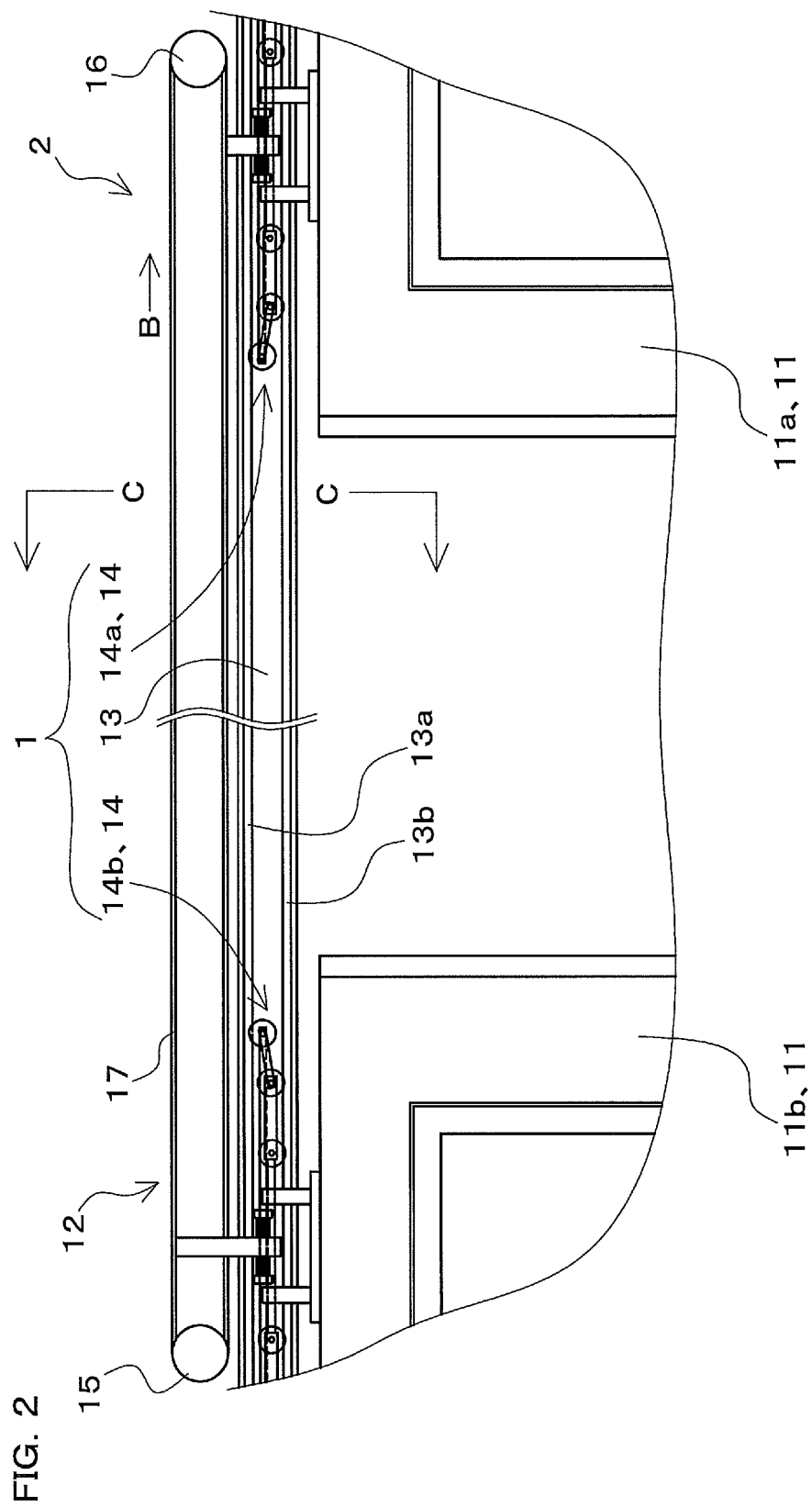


FIG. 3

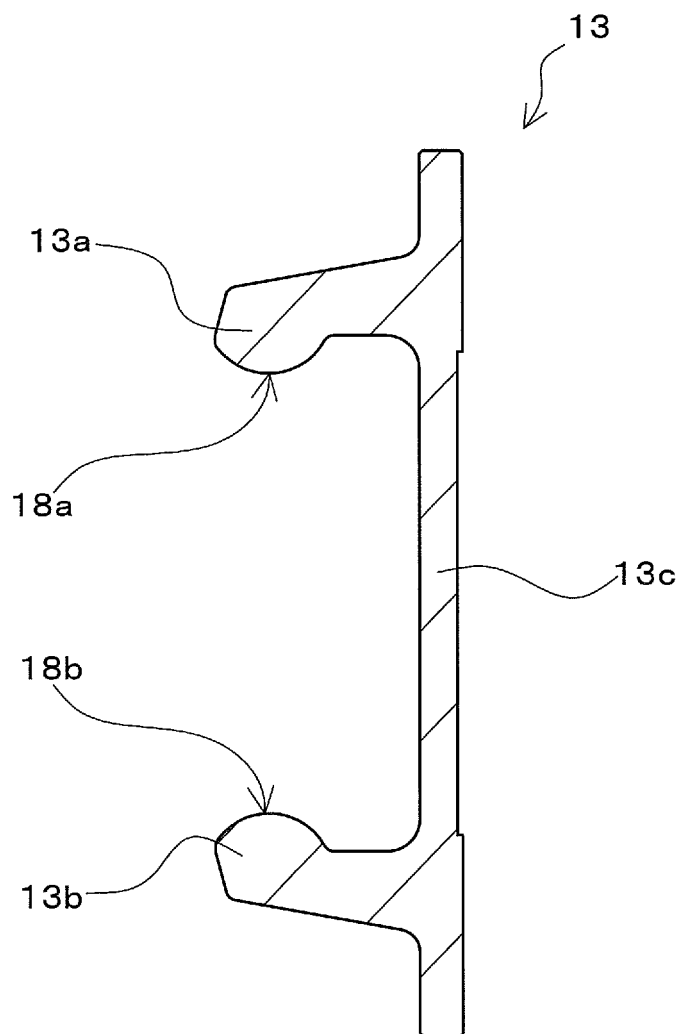


FIG. 4

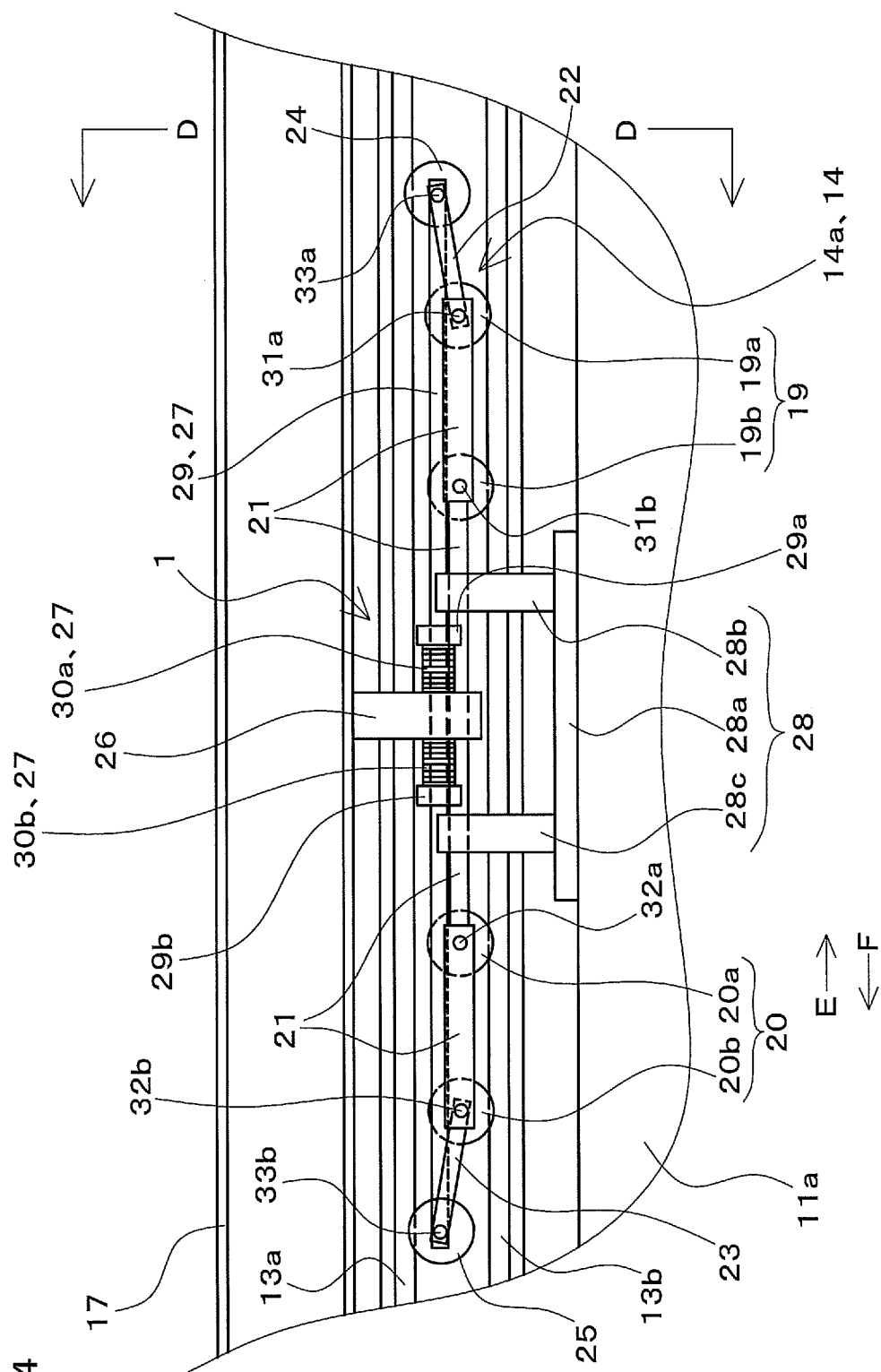
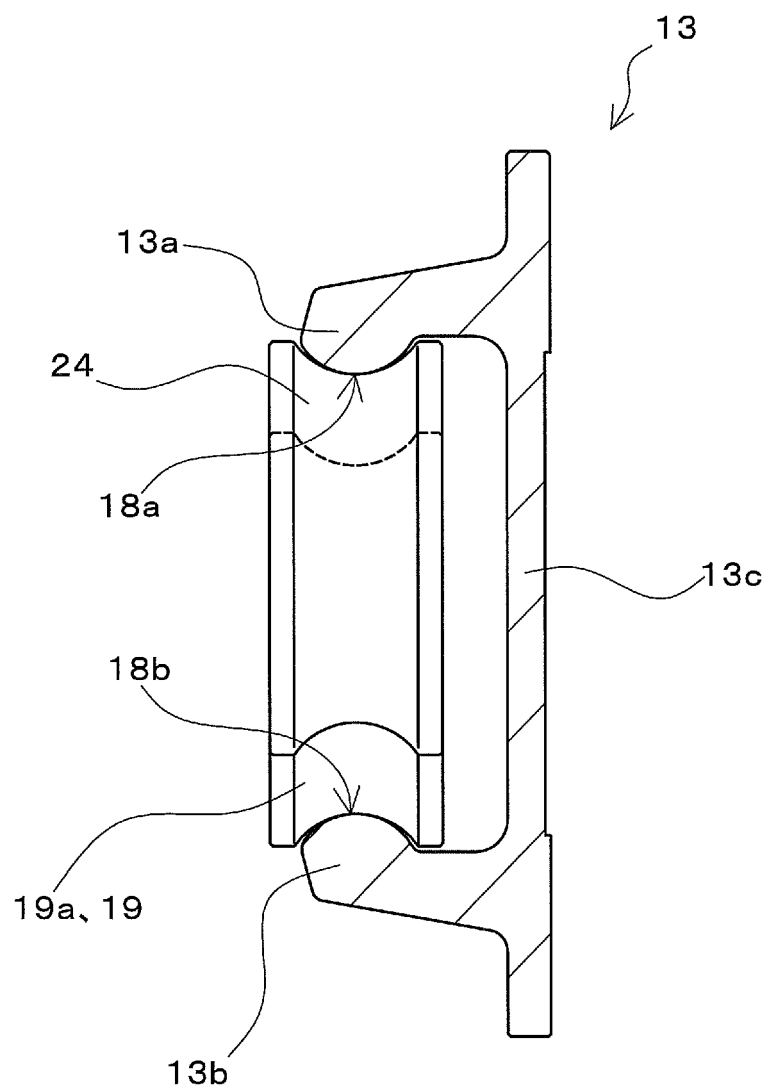


FIG. 5



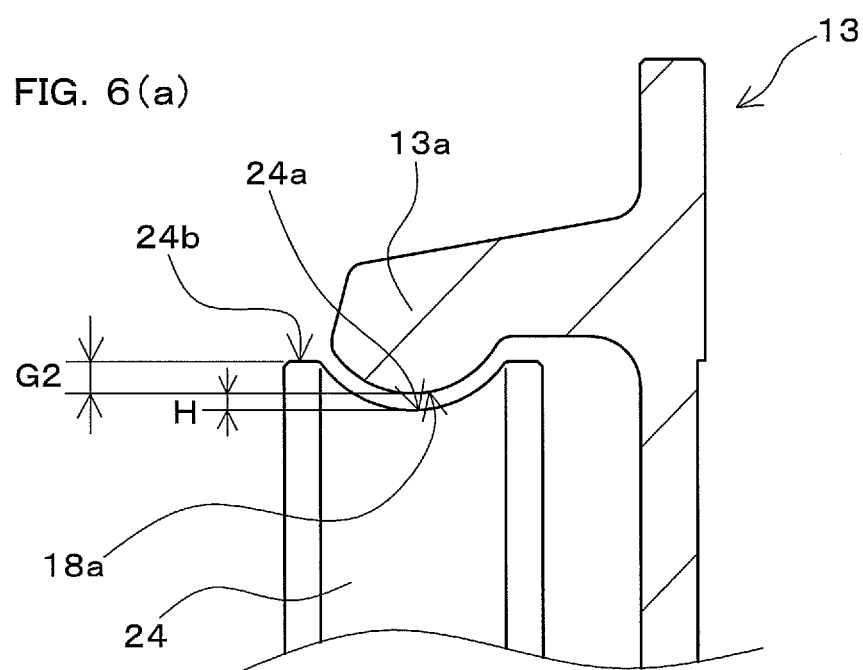
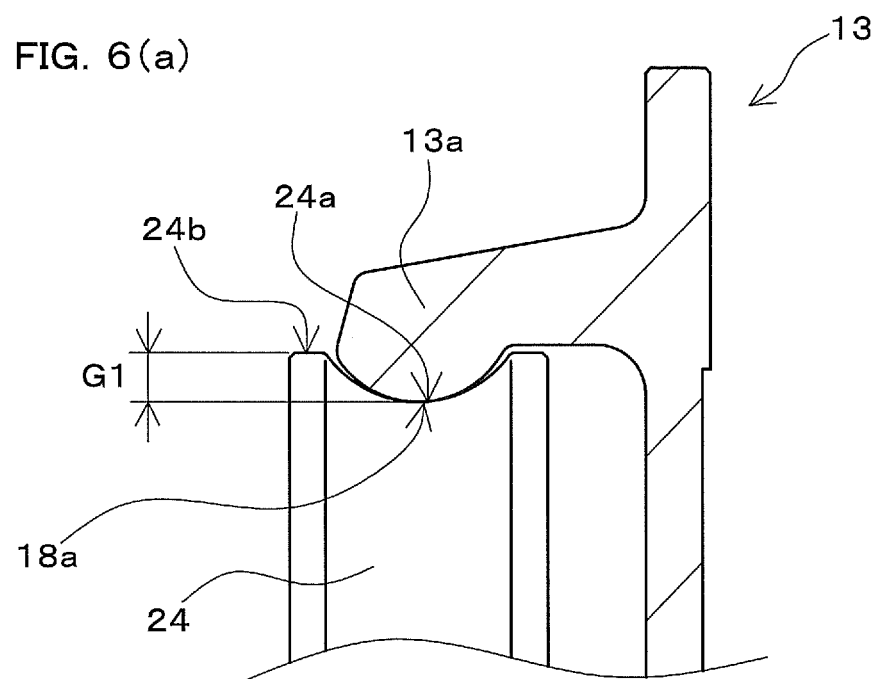


FIG. 7

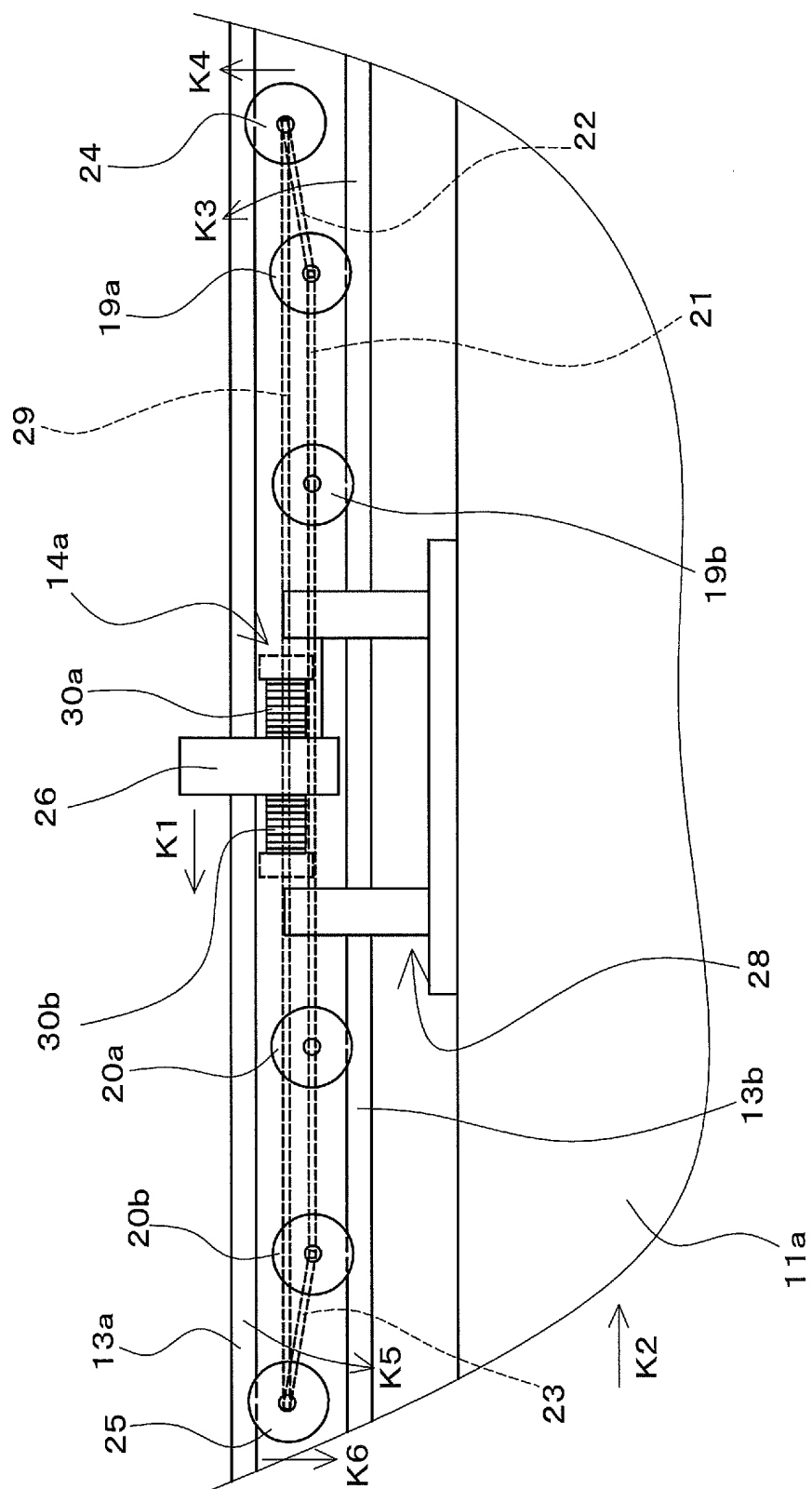


FIG. 8(a)

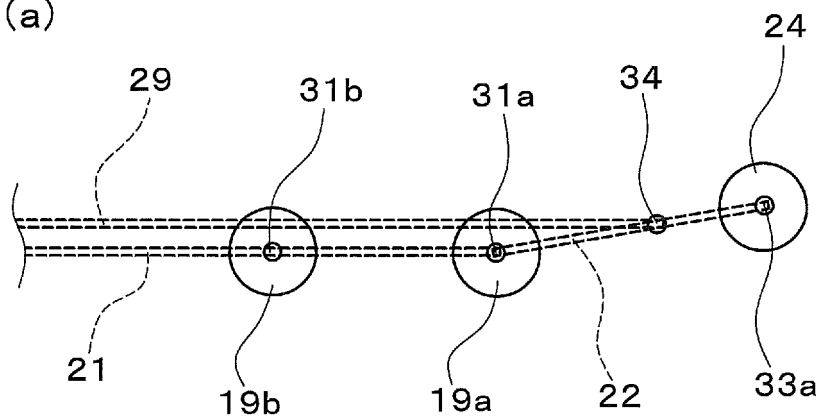
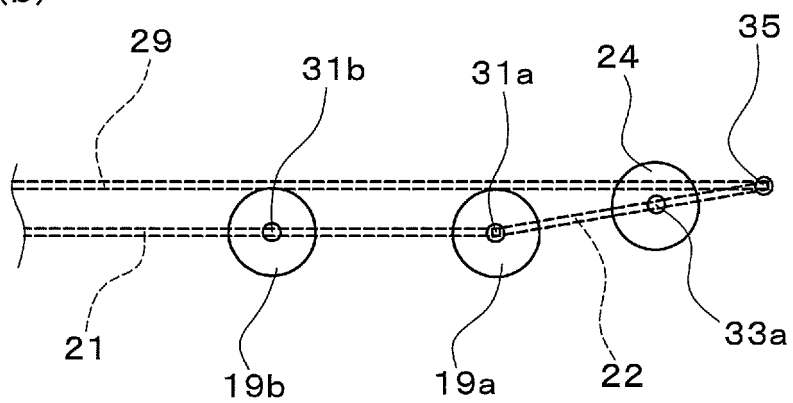


FIG. 8(b)



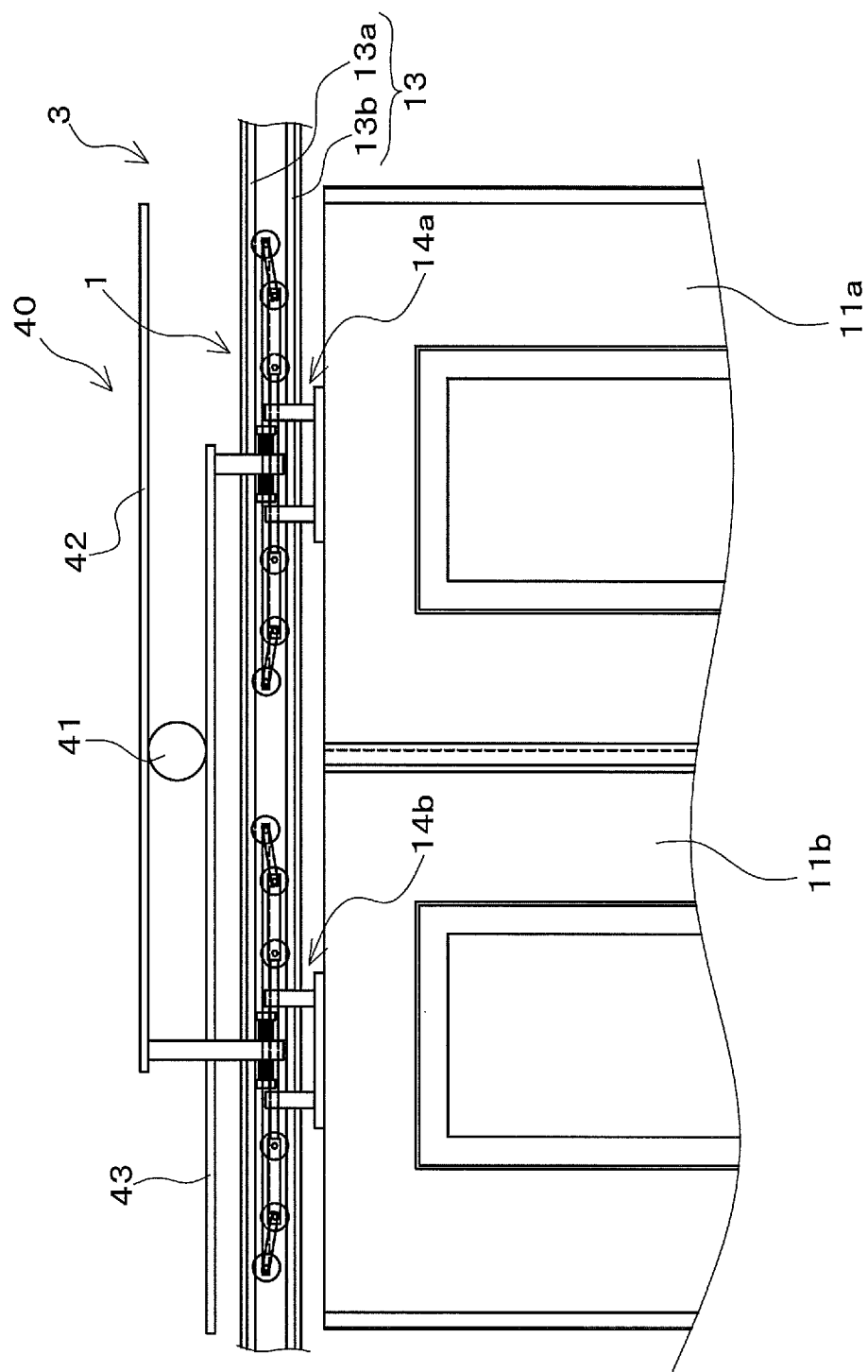


FIG. 9

FIG. 10

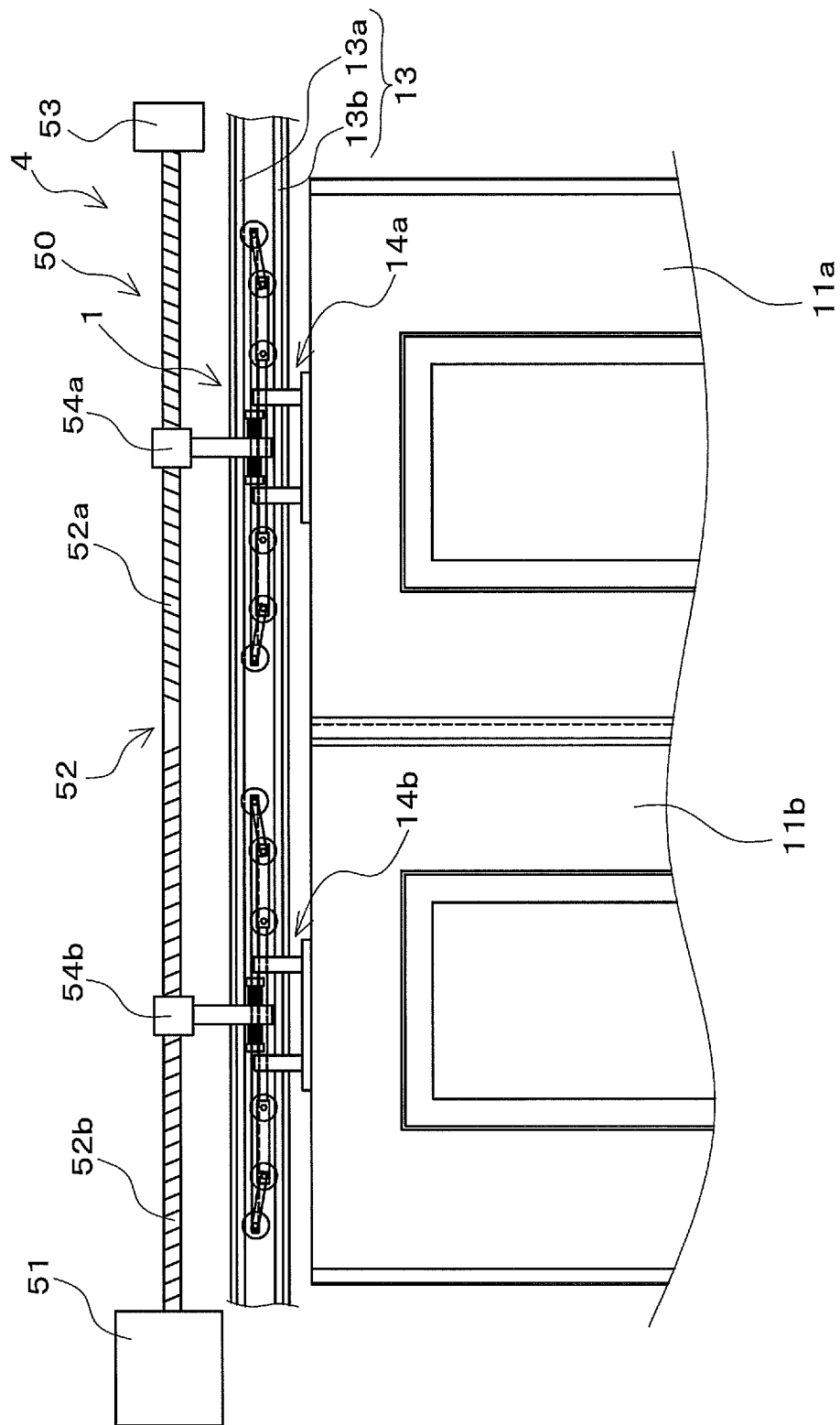
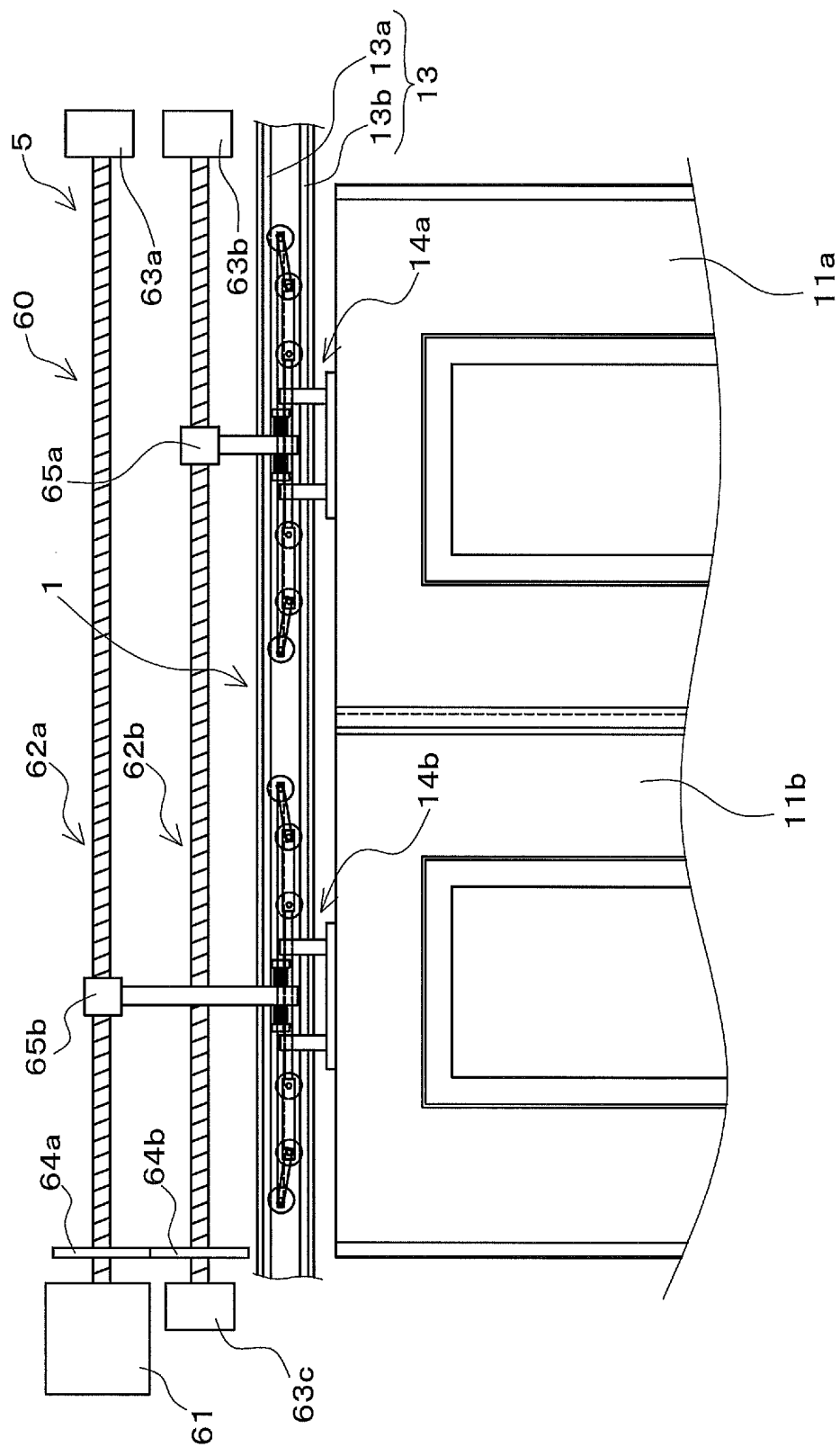


FIG. 11



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2010/068608

A. CLASSIFICATION OF SUBJECT MATTER

E05F15/14(2006.01)i, E05D15/06(2006.01)i, E05F7/04(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)

E05F15/14, E05D15/06, E05F7/04

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	1996-2010
Kokai Jitsuyo Shinan Koho	1971-2010	Toroku Jitsuyo Shinan Koho	1994-2010

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 58-26177 A (Nippon Air Brake Co., Ltd.), 16 February 1983 (16.02.1983), entire text; all drawings (Family: none)	1-9
A	JP 47-4623 Y1 (Taizo YAMAMURA), 17 February 1972 (17.02.1972), entire text; all drawings (Family: none)	1-9
A	JP 8-291669 A (Kabushiki Kaisha Yasumoto Tategu Seisakusho et al.), 05 November 1996 (05.11.1996), entire text; all drawings (Family: none)	1-9

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

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"&" document member of the same patent family

Date of the actual completion of the international search
02 December, 2010 (02.12.10)Date of mailing of the international search report
14 December, 2010 (14.12.10)Name and mailing address of the ISA/
Japanese Patent Office

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Facsimile No.

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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