(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 447 130 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
02.05.2012 Bulletin 2012/18

(21) Application number: **10791941.7**

(22) Date of filing: **31.05.2010**

(51) Int Cl.:
B61D 19/02 *(2006.01)* ***E05B 65/12*** *(2006.01)*

(86) International application number:
PCT/JP2010/059180

(87) International publication number:
WO 2010/150623 (29.12.2010 Gazette 2010/52)

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

(30) Priority: **23.06.2009 JP 2009148966**

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(54) **DOOR SWITCH FOR RAILROAD VEHICLE, AND DOOR OPENING/CLOSING DEVICE ADAPTED FOR USE IN RAILROAD VEHICLE AND PROVIDED WITH THE DOOR SWITCH**

(57) A door switch 10 includes: a rod 22 which is arranged to be movable relative to a vehicle main body and is biased when one door 100a moves toward a full-closed position; a switch casing 30 which is arranged to be movable relative to the vehicle main body and the rod 22 and is biased when the other door 100b moves toward a full-closed position; a detection unit which outputs a detection signal when the rod 22 and the switch casing 30 take predetermined relative positions; and a spring 23 (biasing member) which biases the rod 22 and the switch casing 30 to prevent the rod 22 and the switch casing 30 from taking the predetermined relative positions.

FIG.4(a)

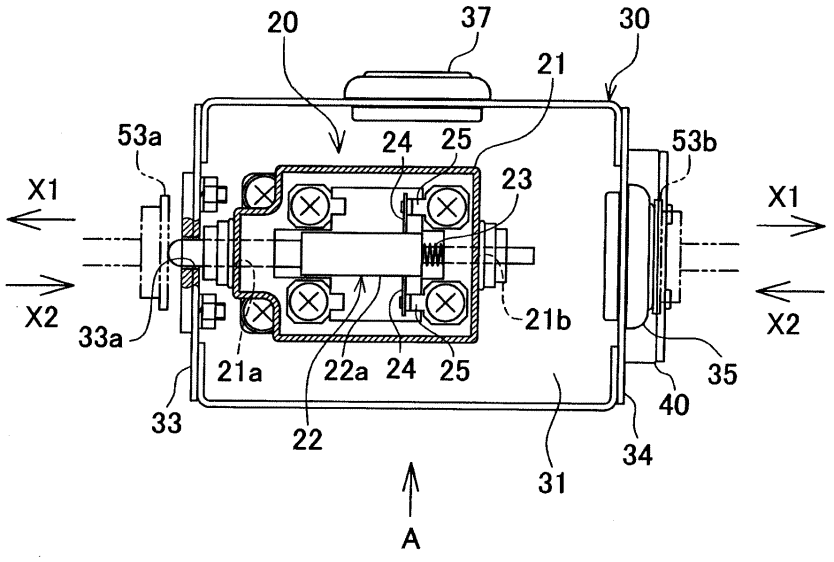

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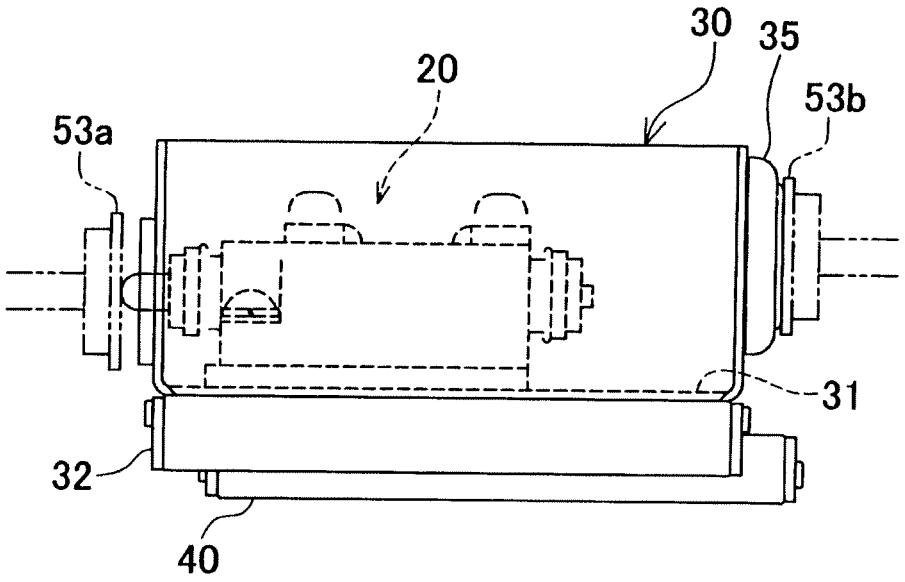
FIG.4(b)



Description

TECHNICAL FIELD

[0001] The present invention relates to a door opening/closing device for a railroad vehicle, and a door switch for a railroad vehicle, which detects that double doors have been closed.

BACKGROUND ART

[0002]

Patent Document 1 recites a known opening/closing device for double doors.

This door opening/closing device is provided with a door closing switch substantially at the center of a base plate which is fixed to the vehicle main body. When the double doors are completely closed, a switch operating metal part of a hanging metal part of one door contacts the door closing switch, and the switch detects that the double doors are closed. A solenoid or the like is excited by a signal from the door closing switch, with the result that a locking shaft is engaged with a locking unit so as to lock the doors.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0003]

Patent Document 1: Japanese Unexamined Patent Publication No. 2002-309849

SUMMARY OF INVENTION

PROBLEMS TO BE SOLVED BY INVENTION

[0004] The door opening/closing device above is arranged to operate so that the double doors are opened and closed by mechanically interlocking with each other. Therefore, when one of the double doors is at the full-closed position, the other door is usually at the full-closed position, too. It is therefore possible to determine, by using the door closing switch above, whether both of the double doors are at the full-closed positions.

However, since there is a possibility of a failure in the mechanism of causing the double doors to interlock with each other, a door switch for a railroad vehicle, which certainly detects whether the double doors are at the full-closed positions even if there is a failure in the mechanism causing the doors to interlock with each other, has been on demand.

A conceivable solution to the problem above is to provide two door closing switches each arranged as above, to correspond to the respective doors. This approach, however, requires another switch, and the increase in the number of electrical components may result in the increase in the failure rate of the entire system. Furthermore, the increase in the number of components results in the increase in the cost. Another conceivable solution to the problem above is to attach the door closing switch to one door instead of fixing it to the vehicle body, and the switch is operated by the other door. In this approach, however, since the wires of the door closing switch are moved for a long distance to the same degree as the opening/closing stroke, when the door is opened or closed, the wires are susceptible to disconnection and hence it is difficult to certainly detect whether the double doors are at the full-closed positions. Furthermore, since the wires are required to have high durability, cost increase is expected.

[0005] An object of the present invention in consideration of the problem above is to provide a door switch for a railroad vehicle, which can reliably detect whether double doors are at full-closed positions without needing another switch, and to provide a door opening/closing device for a railroad vehicle equipped with the door switch.

MEANS FOR SOLVING PROBLEMS

[0006] According to the first aspect of the present invention, a door switch for a railroad vehicle is installed in the railroad vehicle having double doors and includes: a first passive component which is arranged to be movable relative to a vehicle main body and is biased when one of the doors moves toward a full-closed position; a second passive component which is arranged to be movable relative to the vehicle main body and the first passive component and is biased when the other one of the doors is moves toward a full-closed position; a detection unit which outputs a detection signal when the first passive component and the second passive component take predetermined relative positions; a biasing member which biases the first passive component and the second passive component to prevent the first passive component and the second passive component from taking the predetermined relative positions; the predetermined relative positions being relative positions of the first passive component and the second passive component when the first passive component and the second passive component are biased by the double doors against a biasing force of the biasing member and both of the double doors eventually reach the full-closed positions.

[0007] According to this arrangement, when only one of the doors reaches the full-closed position whereas the other one of the doors has not reached the full-closed position, the biasing force of the biasing member prevents the first passive component and the second passive component from taking the predetermined relative positions, and hence no detection signal is output from the detection unit.

This makes it possible to certainly detect whether the double doors are at the full-closed positions, without

needing another switch.

[0008] In addition to the above, according to the second aspect of the present invention, the first passive component and the second passive component are arranged to be movable in opening/closing directions of the doors, with respect to the vehicle main body.

[0009] According to this arrangement, it is possible to provide the door switch in a space which extends in directions in parallel to the opening/closing directions of the doors.

[0010] In addition to the above, according to the third aspect of the present invention, the door switch further includes: a limit switch including the first passive component, the second passive component movably support the first passive component, an elastic component provided between the first passive component and the second passive component and functioning as the biasing component, and the detection unit which outputs the detection signal when the first passive component moves for a predetermined distance with respect to the second passive component against an elastic force of the elastic component, the limit switch being arranged to be movable with respect to the vehicle main body in directions in parallel to a direction of movement of the first passive component with respect to the second passive component, and as one of the doors is biased by the first passive component and the other one of the doors is biased by the second passive component, the first passive component moving with respect to the second passive component against the elastic force of the elastic component, and a moving distance of the first passive component with respect to the second passive component being equal to the predetermined distance when both of the doors reach the full-closed positions.

[0011] According to this arrangement, it is possible to certainly detect whether the double doors are at the full-closed positions by using the limit switch which outputs the detection signal when the moving distance of the first passive component with respect to the second passive component against the elastic force of the elastic component becomes equal to the predetermined distance. This ensures the reliability of the door switch because a conventional multi-purpose limit switch, which is highly reliable, is usable as the door switch.

[0012] In addition to the above, according to the fourth aspect of the present invention, the first passive component and the second passive component are rotatable about a rotation axis which is fixed to the vehicle main body, and the rotation axis extends in directions orthogonal to the flat plate-shaped doors.

[0013] According to this arrangement, downsizing is easily achieved by forming the first passive component and the second passive component to be thin in the directions in parallel to the rotation axis.

[0014] In addition to the above, according to the fifth aspect of the present invention, the detection unit outputs the detection signal when the first detection unit attached to the first passive component and the second detection unit attached to the second passive component take a predetermined positional relationship, the first detection unit is provided at a position further from the rotation axis of the first passive component than a position at which the first passive component is biased by said one of the doors, and the second detection unit is provided at a position further from the rotation axis of the second passive component than a position at which the second passive component is biased by the other one of the doors.

[0015] According to this arrangement, as compared to the moving distances of the doors in the closing directions, the degree of change in the relative positions of the first detection unit and the second detection unit is great. With this, by a simple structure, it is possible to prevent a detection signal indicating that the doors are closed from being erroneously output, when a foreign matter is caught in between the closing doors and hence the doors are not completely closed.

[0016] In addition to the above, according to the present invention, a door opening/closing device for a railroad vehicle, which is used for opening and closing double doors, includes: the door switch according to any one of claims 1 to 5; and a control unit which receives the detection signal output from the detection unit, the control unit driving a locking unit for locking the doors or controlling a drive output for opening and closing the doors, based on the detection signal.

[0017] According to this arrangement, it is possible to certainly detect whether the double doors are at the full-closed positions, and to utilize the detection signal output from the detection unit for locking the doors or controlling the operation of the doors.

This makes it possible to prevent the doors from being erroneously locked when at least one of the doors has not reached the full-closed position. Furthermore, it is possible to prevent the driving output for opening and closing the doors from being controlled when at least one of the doors has not reached the full-closed position.

ADVANTAGEOUS EFFECT OF INVENTION

[0018] The door switch for the railroad vehicle of the present invention and the door opening/closing device for the railroad vehicle equipped with the door switch make it possible to certainly detect whether the double doors are at the full-closed positions, without needing another switch.

BRIEF DESCRIPTION OF DRAWINGS

[0019]

Fig. 1 is a general view of a door opening/closing device according to an embodiment of the present invention.

Fig. 2 is an enlarged view of a door switch and its surroundings of the door opening/closing device shown in Fig. 1.

Fig. 3 shows the door switch of Fig. 2 when the vehicle is viewed from the front in the direction in parallel to the opening/closing directions of the doors .
Fig. 4 shows the details of the door switch of Fig. 2.
Fig. 5 shows the state in which no biasing force is exerted to the door switch of Fig. 4.
Fig. 6 is a schematic view for explaining the operation of the door switch shown in Fig. 2.
Fig. 7 is a schematic view for explaining a first modification of the present embodiment.
Fig. 8 is a schematic view for explaining the operation of a second modification of the present embodiment.
Fig. 9 is a schematic view for explaining the operation of the second modification of the present embodiment.
Fig. 10 is a schematic view for explaining the operation of a third modification of the present embodiment.
Fig. 11 is a schematic view of a fourth modification of the present embodiment.

DESCRIPTION OF EMBODIMENTS

[0020] The following will describe an embodiment of the present invention with reference to figures.

<Structure of Door Opening/Closing Device>

[0021] Fig. 1 is a general view of a door opening/closing device 1 according to an embodiment of the present invention.
The door opening/closing device 1 is fixed to a side wall of the main body of a railroad vehicle via a base plate 2. The door opening/closing device 1 opens and closes a pair of double doors (door 100a and door 100b) by using a rack-and-pinion mechanism. The doors 100a and 100b are flat plate-shaped doors arranged to fully cover an entrance made through a side wall of the main body of the railroad vehicle, when the doors are at the full-closed state. The rack-and-pinion mechanism is arranged to include a pair of racks 3a and 3b extending along the front-back directions of the vehicle and an unillustrated pinion engaged with the respective racks 3a and 3b.
[0022] The door opening/closing device 1 includes an unillustrated direct-drive electric motor which can rotated both forward and backward and is fixed to the vehicle main body and a planetary gear mechanism 4 which transfers the rotation of the electric motor to the rack-and-pinion mechanism. As the electric motor is driven, the pinion is rotated via the planetary gear mechanism 4 and the pair of racks 3a and 3b engaged with the pinion are moved in opposite directions.
[0023] The pair of racks 3a and 3b are connected to the door 100a and the door 100b, respectively, via a connecting mechanism. The connecting mechanism includes rack-side brackets 5a and 5b fixed to the leading ends of the respective racks 3a and 3b, rail components 6a and 6b fixed to the respective rack-side brackets 5a and 5b, and door-hanging brackets 7a and 7b fixed to the respective rail components 6a and 6b.
The rail components 6a and 6b are guided in directions in parallel to the movement directions of the rack-side brackets 5a and 5b, by guide rails 8a and 8b which are fixed to the vehicle main body. Each of the door-hanging brackets 7a and 7b is fixed to the door 100a or 100b at two parts of the upper end portion.
[0024] According to the arrangement above, the electric motor of the door opening/closing device 1 rotates the pinion in one direction so that the rack 3b moves toward the front of the vehicle (i.e., to the right in Fig. 1 and Fig. 2), with the result that the door 100b moves toward the front of the vehicle. At the same time, the rack 3a moves toward the rear of the vehicle (i.e., to the left in Fig. 1 and Fig. 2), and hence the door 100a moves rearward. In other words, as the electric motor of the door opening/closing device 1 rotates the pinion in said one direction, the door 100a and the door 100b simultaneously move in the opening directions (indicated by the arrows X1 in Fig. 1 and Fig. 2). On the other hand, as the electric motor of the door opening/closing device 1 rotates the pinion in a direction opposite to said one direction, the door 100a and the door 100b simultaneously move in the closing directions (indicated by the arrows X2 in Fig. 1 and Fig. 2).
[0025] As such, the door opening/closing device 1 carries out the opening and closing operations of the door 100a and the door 100b.
[0026] It is noted that the doors may not be opened and closed by using the rack-and-pinion mechanism. The opening/closing of the doors may be carried out by connecting an electric motor with doors by a belt, may be carried out by using ball screws, may be carried out by using a linear motor, or may be carried out by using fluid such as air or oil.
[0027] The door opening/closing device 1 is provided with a door switch 10 which can detect whether both of the door 100a and the door 100b are completely closed. The door switch 10 is provided at an upper part of the central portion of the entrance in the vehicle front-back directions (i.e., below the planetary gear mechanism 4), via a base plate 9. That is to say, the door switch 10 is arranged to locate above the anterior door ends of the respective doors 100a and 100b at the full-closed positions.

<Structure of Door Switch>

[0028] Fig. 2 is an enlarged view of the door switch 10 and its surroundings of the door opening/closing device 1 shown in Fig. 1. Fig. 3 shows the door switch 10 of Fig. 2 when the vehicle is viewed from the front (i.e., from the bush 35 side) in the direction in parallel to the opening/closing directions of the doors 100a and 100b . Fig. 4(a) shows the door switch 10 when viewed from the opposite side of the base plate 9. In Fig. 4(a), a part of a main body casing 21 of a limit switch 20 is omitted to show the

internal structure of the limit switch 20. Fig. 4(b) shows the door switch 10 of Fig. 4(a) when viewed in the direction indicated by the arrow A.

[0029] As shown in Fig. 2, the door switch 10 includes a limit switch 20 and a box-shaped switch casing 30 housing the limit switch 20 therein.

[0030] As shown in Fig. 3, the switch casing 30 is fixed to the base plate 9 via the rail 40.

As shown in Fig. 3 and Fig. 4, the rail 40 is fixed to the base plate 9 to extend in parallel to the opening/closing directions of the doors 100a and 100b. To a bottom plate 31 of the switch casing 30, a guide component 32 is fixed to be engaged with the rail 40. This guide component 32 is movable along the sliding rail 40 when engaged with the sliding rail 40. The switch casing 30 can therefore move in parallel to the opening/closing directions of the doors 100a and 100b, along the rail 40. Furthermore, in the present embodiment, the side of the switch casing 30 opposite to the bottom plate 31 is arranged to be open for the sake of easy maintenance of the limit switch 20.

[0031] As shown in Fig. 4, the limit switch 20 includes a main body casing 21 which can house a detection mechanism therein and a rod 22 which protrudes from the main body casing 21. The rod 22 is supported by the main body casing 21 such that the leading end side and the base end side of the rod 22 are inserted respectively to through holes 21a and 21b made through the main body casing 21 and hence the rod 22 is movable in the axial directions with respect to the main body casing 21. When the leading end of the rod 22 is pushed into the main body casing 21 for a predetermined degree, a detection signal is output. (Fig. 4 shows the state in which the rod 22 has been pushed into the case. See Fig. 5 for the state in which the rod 22 is not pushed into the case.)

[0032] More specifically, the rod 22 has an enlarged diameter portion 22a at a central part in the axial directions. This enlarged diameter portion 22a is formed to have a larger diameter than the leading end side and the base end side of the rod. Between the enlarged diameter portion 22a and the main body casing 21 is provided a spring 23. This spring 23 is provided to wrap the base end side of the rod 22 and biases the enlarged diameter portion 22a toward the leading end in the axial direction. Furthermore, a pair of plates 24 protrude from the enlarged diameter portion 22a in the directions orthogonal to the axial directions. Inside the main body casing 21 is a space in which the plates 24 can move for a predetermined distance in parallel to the axial directions of the rod 22. Furthermore, a pair of electrodes 25 are provided to oppose the pair of plates 24 in the axial direction toward the base end of the rod 22. A predetermined electrical circuit is constructed such that the electrodes 25 are electrically connected with each other and a detection signal is output as the pair of plates 24 contact the pair of electrodes 25.

With this, when the leading end of the rod 22 is biased in the axial direction and the rod 22 moves for a predetermined distance toward the base end against the biasing force of the spring 23, the pair of plates 24 contact the pair of electrodes 25, with the result that a detection signal is output to the control unit of the door opening/closing device 1.

[0033] The door opening/closing device 1 includes a control unit constituted by components such as a micro computer having a CPU and a memory. The detection signal output from the limit switch 20 is input to the control unit via a wire connector 37 and an unillustrated wire. The control unit controls the opening/closing mechanism of the doors and the locking unit of the doors, based on the detection signal.

[0034] The limit switch 20 is provided in the switch casing 30 such that the leading end of the rod 22 penetrates a through hole 33a made through the side wall 33 of the switch casing 30 and protrudes from the switch casing 30. The limit switch 20 is fixed to the bottom plate 31 of the switch casing 30 by a bolt or the like. The limit switch 20 is arranged so that the shaft of the rod 22 extends in parallel to the rail 40.

[0035] In addition to the above, on the external surface of the side wall 34 which is on the opposite side of the side wall 33 of the switch casing 30 through which the through hole 33a penetrated by the rod 22 is formed, a disc-shaped bush 35 is fixed. This bush 35 is made of a material such as rubber, which has a lower rigidity than the side wall 34. While the present embodiment is arranged so that the bush 35 is made of rubber to prevent excessive impact on the door switch 10 at the timing of contacting the doors, the bush 35 may be made of a metal because of the presence of a later-described damper mechanism in the present embodiment, or may be omitted when adverse effects such as the deformation of the side wall 34 are not expected.

[0036] As shown in Fig. 2, in the vicinities of the anterior door ends at the upper end portions of the doors 100a and 100b, supporting components 51a and 51b are fixed to extend upward. To the supporting components 51a and 51b, biasing shafts 52a and 52b are attached to extend in parallel to the opening/closing directions of the doors 100a and 100b.

[0037] The biasing shaft 52a attached to the door 100a on the leading end side of the rod 22 when viewed from the door switch 10 is arranged to be substantially coaxial with the rod 22. To the leading end of the biasing shaft 52a (i.e., the edge opposing the leading end of the rod 22), a biasing plate 53a is fixed to be orthogonal to the biasing shaft 52a. When the door 100a moves in the closing direction, the biasing plate 53a biases the leading end of the rod 22.

[0038] The biasing shaft 52b attached to the door 100b which is on the bush 35 side when viewed from the door switch 10 is arranged to be substantially coaxial with the central axis of the disc-shaped bush 35. To the leading end of the biasing shaft 52b (i.e., the edge opposing the bush 35), a biasing plate 53b is fixed to be orthogonal to the biasing shaft 52b. When the door 100b moves in the closing direction, the biasing plate 53b biases the bush

35.

[0039] Each of the biasing shafts 52a and 52b is provided with a damper mechanism. The damper mechanism has a function to dampen the impact caused when the biasing plates 53a and 53b contact the leading end of the rod 22 or the bush 35 as a result of the movement of the doors in the closing directions. While in the present embodiment the damper mechanism is constituted by a spring, the damper mechanism may be a combination of a spring and a shock absorber or made of rubber, on condition that the excessive impact on the door switch 10 at the time of the contact to the door is dampened.

<Operation of Door Switch>

[0040] Fig. 6 is a schematic view for illustrating the operation of the door switch 10.

It is noted that the components described in the embodiment correspond to the components schematically shown in Fig. 6 as follows.

The biasing shafts 52a and 52b and the biasing plates 53a and 53b shown in Fig. 2 are equivalent to biasing components 55a and 55b in Fig. 6. The rod 22 and the pair of plates 24 shown in Fig. 4 are equivalent to a rod unit 26 in Fig. 6 which includes a rod 26a and a detection target portion 26b. The spring 23 shown in Fig. 4 is equivalent to a spring 27 in Fig. 6 . The switch casing 30 shown in Fig. 4 is equivalent to a switch casing 36 in Fig. 6. The pair of electrodes 25 shown in Fig. 4 is equivalent to a detection unit 28 in Fig. 6.

[0041]

Fig. 6(a) shows a state in which two double doors are correctly conducting the closing operation (i.e. a state in which the door 100a has not reached the full-closed position and the door 100b has not reached the full-closed position, either).

Fig. 6(b) shows a state in which the two doors correctly conduct the closing operation and have reached the full-closed positions.

Fig. 6(c) shows a state in which, due to a failure in the door opening/closing device 1, only one of the two double doors, i.e., only the door 100a has reached the full-closed position.

Fig. 6(d) shows a state in which, due to a failure in the door opening/closing device 1, only the other one of the two double doors, i.e., only the door 100b has reached the full-closed position.

[0042] As shown in Fig. 6(a), when the two doors are away from the full-closed positions for predetermined distances, the biasing components 55a and 55b fixed to the respective doors 100a and 100b do not contact the door switch 10. In this state, the detection unit 28 is away from the detection target portion 26b on account of the biasing force of the spring 27.

As the doors 100a and 100b in the state shown in Fig. 6 (a) further move in the closing directions, the biasing components 55a and 55b fixed to the respective doors 100a and 100b move to approach each other (i.e. move in the directions indicated by the arrows X2 in Fig. 6), and consequently the biasing components 55a and 55b contact the leading end of the rod 26a and the switch casing 36, almost at the same time (as indicated by two-dot chain lines in Fig. 6(a)).

Furthermore, as the doors 100a and 100b move in the closing directions, the rod unit 26 is moved by the biasing force of the biasing component 55a in the same direction as the movement of the biasing component 55a, against the biasing force of the spring 27 (see Fig. 6(b)).

On the other hand, the switch casing 36 is moved by the biasing force of the biasing component 55b on the sliding rail 40 (not shown in Fig. 6) in the same direction as the movement of the biasing component 55b, against the biasing force of the spring 27.

That is to say, as the doors 100a and 100b move in the closing directions, the spring 27 is deformed and contracts, with the result that the relative positions of the rod unit 26 and the switch casing 36 are changed so that the distance between the detection target portion 26b and the detection unit 28 is shortened.

[0043] As shown in Fig. 6(b), when the both doors 100a and 100b reach the full-closed positions, the detection target portion 26b of the rod unit 26 contacts the detection unit 28. As the detection target portion 26b contacts the detection unit 28, a detection signal is output to the control unit of the door opening/closing device 1. Receiving the detection signal, the control unit determines that the doors are fully closed, and operates the locking unit to prevent the doors from moving in the opening directions. More specifically, for example, the detection signal excites the solenoid and hence the locking shaft attached to the solenoid is engaged with the doors 100a and 100b, with the result that the movement of the doors 100a and 100b in the opening directions is prevented. In so doing, the control unit may stop the operation of the electric motor which is used for rotating the pinion of the door opening/closing device 1.

[0044] As shown in Fig. 6(c), when the closing operation of the door 100b stops during movement of the doors 100a and 100b in the closing directions, only the door 100a moves in the closing direction and the door switch 10 is biased only by the biasing component 55a fixed to this door 100a. In short, only the rod unit 26 is directly biased in this case.

As only the rod unit 26 is directly biased as above, the switch casing 36 moves along the sliding rail 40 in the same direction as the movement of the biasing component 55a. In this case, the spring 27 rarely contracts and the distance between the detection target portion 26b and the detection unit 28 remains almost the same as the distance in the state shown in Fig. 6(a).

For this reason, no detection signal is output from the door switch 10 when the door 100b is not fully closed.

[0045] Similarly, as shown in Fig. 6(d), when the closing operation of the door 100a stops during the movement

of the doors 100a and 100b in the closing directions, only the door 100b moves in the closing direction and only the biasing component 55b fixed to this door 100b biases the door switch 10. In short, only the switch casing 36 is directly biased in this case.
As such, since only the switch casing 36 is directly biased, the switch casing 36 and the rod unit 26 move along the sliding rail 40 in the same direction as the movement of the biasing component 55b. In this case, the spring 27 rarely contracts and the distance between the detection target portion 26b and the detection unit 28 remains almost the same as the distance in the state shown in Fig. 6(a).
For this reason, no detection signal is output from the door switch 10 when the door 100a is not fully closed.

<Effects of Embodiment>

(1)

[0046] As described above, the door opening/closing device 1 according to the present embodiment is provided with the door switch 10.
This door switch 10 is a door switch for a railroad vehicle attached to a railroad vehicle having double doors 100a and 100b, and includes: a rod 22 (first passive component) which is provided to be movable relative to a base plate 9 (vehicle main body) and is biased when one door 100a moves in the full-closed position; a switch casing 30 (second passive component) which is arranged to be movable relative to the base plate 9 and the rod 22 and is biased when the other door 100b moves in the full-closed position; an electric circuit (detection unit) which outputs a detection signal when the rod 22 and the switch casing 30 take predetermined relative positions and a pair of plates 24 fixed to the rod 22 contact a pair of electrodes 25 fixed to the switch casing 30; and a spring 23 (biasing member) which biases the rod 22 and the switch casing 30 to prevent the rod 22 and the switch casing 30 from taking the predetermined relative positions (i.e., the relative positions when the plates 24 contact the electrodes 25). The aforesaid predetermined relative positions are the relative positions of the rod 22 and the switch casing 30 when the rod 22 and the switch casing 30 are biased by the biasing plates 53a and 53b of two double doors 100a and 100b against the biasing force of the spring 23 and both of the two doors 100a and 100b reach the full-closed positions.
[0047] According to this arrangement, when only one of the doors 100a and 100b reaches the full-closed position whereas the other door has not reached the full-closed position, the rod 22 and the switch casing 30 do not take the aforesaid predetermined relative positions because of the biasing force of the spring 23, and hence the plates 24 do not contact the electrodes 25. No detection signal is therefore output from the door switch 10 to the control unit.
This makes it possible to certainly detect whether the double doors 100a and 100b are both at the full-closed positions, without requiring another switch.

(2)

[0048] In the door switch 10, the rod 22 and the switch casing 30 are arranged to be able to move in parallel to the opening/closing directions of the doors 100a and 100b, with respect to the base plate 9.
[0049] According to this arrangement, it is possible to provide the door switch 10 in a space which extends in directions in parallel to the opening/closing directions of the doors 100a and 100b.
This makes it possible to provide the door switch 10 in a space which is below the door driving mechanism (the electric motor, the planetary gear mechanism 4, the rack-and-pinion mechanism, or the like) and is between the door-hanging bracket 7a fixed to the anterior door end side of the door 100a and the door-hanging bracket 7b fixed to the anterior door end side of the door 100b when the doors 100a and 100b are at the full-closed positions.

(3)

[0050] The door switch 10 is provided with a limit switch 20.
The limit switch 20 includes a rod 22, a switch casing 30 supporting the rod 22 to be axially movable, a spring 23 (elastic component) provided between the rod 22 and the switch casing 30, and an electric circuit (detection unit) which outputs a detection signal when the rod 22 moves for a predetermined distance with respect to the switch casing 30 against the elastic force of the spring 23 and a pair of plates 24 attached to the rod 22 contact a pair of electrodes 25.
The limit switch 20 is arranged to be movable with respect to the base plate 9 in directions in parallel to the axial movement of the rod 22 with respect to the switch casing 30. As the biasing plate 53a attached to one door 100a biases the rod 22 and the biasing plate 53b attached to the other door 100b biases the switch casing 30, the rod 22 moves with respect to the switch casing 30 against the elastic force of the spring 23. When both of the two doors 100a and 100b reach the full-closed positions, the rod 22 moves for the predetermined distance with respect to the switch casing 30 so that the pair of plates 24 contact the pair of electrodes 25.
[0051] According to this arrangement, whether the double doors are at the full-clased positions is certainly detected by using the limit switch 20 which outputs a detection signal when the rod 22 has moved for the predetermined distance with respect to the switch casing 30 against the elastic force of the spring 23. This ensures the reliability of the door switch 10 because a conventional multi-purpose limit switch, which is highly reliable, is usable as the door switch 10.

(4)

[0052] The above-described door opening/closing device 1 having the door switch 10 includes a control unit which receives a detection signal output from the door switch 10. Receiving the detection signal from the door switch 10, the control unit drives the locking unit so as to lock the doors 100a and 100b at the full-closed positions.

[0053] According to this arrangement, whether the double doors 100a and 100b are at the full-closed positions is certainly detected, and the detection signal output from the limit switch 20 is usable as a signal for determining the timing to lock the doors 100a and 100b.

It is therefore possible to prevent the locking unit from being mistakenly driven when at least one of the doors 100a and 100b has not reached the full-closed position.

[0054] In the present embodiment, the relative moving distance of the rod 22 with respect to the switch casing 30 is advantageously long. That is to say, as shown in Fig. 6, the moving distance of the door 100a from the timing at which the biasing component 55a starts to contact the rod unit 26 (i.e., the state where the biasing component 55a is at the position indicated by two-dot chain lines in Fig. 6(a)) to the timing at which the door 100a reaches the full-closed position (i.e., the state shown in Fig. 6(b)) is half as long as the relative moving distance of the rod unit 26 with respect to the switch casing 3 6 (i.e., the degree of deformation of the spring 27).

On this account, a thin matter caught in between the closing doors 100a and 100b is detectable without increasing the sensitivity of the sensor. In other words, it is possible to prevent a detection signal indicating that the doors 100a and 100b are closed from being erroneously output, when a foreign matter is caught in between the closing doors 100a and 100b and hence the doors 100a and 100b are not completely closed.

(First Modification)

[0055] The embodiment may be modified as below. Fig. 7 is a schematic view for explaining a first modification of the embodiment above. A door opening/closing device of the first modification is different from the device of the embodiment above in terms of the structure of the door switch. The following will therefore describe only the structure of the door switch and will not detail the other arrangements. It is noted that the components identical with those in the embodiment above will be denoted by the same reference numerals.

[0056] As shown in Fig. 7, a door switch 11 of the first modification includes a switch casing 61, two rods 62 and 63 provided so that the base end sides thereof are housed in the switch casing 61, springs 64 and 65 provided between the base ends of the rods 62 and 63 and the internal surface of the switch casing 61, a magnet 66 fixed to one rod 62, and a magnetic sensor 67 fixed to the other rod 63.

[0057] In addition to the above, biasing components 56a and 56b are provided to oppose the respective rods 62 and 63 in the opening/closing directions of the doors. The biasing components 56a and 56b are connected to the respective doors 100a and 100b and move in accordance with the movement of the doors 100a and 100b.

[0058] The switch casing 61 is directly fixed to a base plate 9. In other words, the switch casing 61 is fixed so as not to move relative to the vehicle main body.

[0059] The rod 62 is arranged so that its leading end protrudes from the switch casing 61 whereas its base end is housed in the switch casing 61. The rod 62 is arranged to be movable in the axial directions with respect to the switch casing 61. The moving directions of the rod 62 are in parallel to the opening/closing directions of the doors.

Between the rod 62 and the switch casing 61 is provided a spring 64. The spring 64 biases the rod 62 from the base end side to the leading end side.

To the rod 62, the magnet 66 is fixed at a central portion of the rod 62 in the axial directions. This magnet 66 is fixed to the rod 62 to oppose the rod 63 side.

As the door 100a conducts the closing operation and the biasing component 56a moves in the closing direction, the biasing component 56a biases the leading end of the rod 62.

[0060] The rod 63 is arranged so that its leading end protrudes from the switch casing 61 in the opposite direction to the rod 62 and its base end is housed in the switch casing 61. The rod 63 is arranged to be movable in the axial directions with respect to the switch casing 61. The moving directions of the rod 63 are in parallel to the opening/closing directions of the doors.

The rod 63 is at the substantially same position as the rod 62 in the direction orthogonal to the base plate 9 (i.e., the direction away from the viewer of Fig. 7) . In other words, the rods 62 and 63 are arranged so that the central axis of the rod 62 and the central axis of the rod 63 are on a single linear line when viewed in the vertical direction.

Between the rod 63 and the switch casing 61 is provided a spring 65. This spring 65 biases the rod 63 from the base end side to the leading end side.

To the rod 63, a magnetic sensor 67 is fixed at a central portion of the rod 63 in the axial directions. This the magnetic sensor 67 is fixed to the rod 63 to oppose the rod 62 side.

As the door 100b conducts the closing operation and the biasing component 56b moves in the closing direction, the biasing component 56b biases the leading end of the rod 63.

[0061] As shown in Fig. 7(a), when neither of the rods 62 and 63 is biased by the biasing components 56a and 56b, the rod 62 is retained in the state in which the rod has been moved to the biasing component 56a side by the biasing force of the spring 64 whereas the rod 63 is retained in the state in which the rod has been moved to the biasing component 56b side by the biasing force of the spring 65. For this reason, the magnet 66 is disposed

not to oppose the magnetic sensor 67.

[0062] As the doors 100a and 100b further move in the closing directions, the biasing component 56a contacts the rod 62 and the biasing component 56b contacts the rod 63, with the result that the rod 62 is moved toward the biasing component 56b side by the biasing force of the biasing component 56a against the biasing force of the spring 64 whereas the rod 63 is moved toward the biasing component 56a side by the biasing force of the spring 65 against the biasing force of the biasing component 56b.

[0063] Subsequently, as shown in Fig. 7(b), the two doors 100a and 100b correctly conduct the closing operations. When both of the doors reach the full-closed positions, the magnet 66 opposes the magnetic sensor 67. In other words, the distance between the magnet 66 and the magnetic sensor 67 becomes the shortest.

The magnetic sensor 67 detects a magnetic force of the magnet 66 when the magnet 66 falls within a predetermined range around the sensor (hereinafter, the detection range of the magnetic sensor 67), and outputs a detection signal to the control unit of the door opening/closing device. In the present modification, the distance between the rods 62 and 63 is adjusted so that the magnet 66 falls within the detection range of the magnetic sensor 67 only when the magnet 66 opposes the magnetic sensor 67 (i.e., only when the distance between the magnet 66 and the magnetic sensor 67 becomes the closest).

For this reason, the magnetic sensor 67 outputs the detection signal only when both of the two doors 100a and 100b reach the full-closed positions.

[0064] Therefore, as shown in Fig. 6(c), when only one door 100a reaches the full-closed position whereas the other door 100b stops halfway due to a failure in the door opening/closing device 1, the magnetic sensor 67 and the magnet 66 do not oppose each other and hence the magnetic sensor 67 does not output the detection signal. Similarly, as shown in Fig. 6(d), when only one door 100b reaches the full-closed position whereas the other door 100a stops halfway due to a failure in the door opening/closing device 1, the magnetic sensor 67 and the magnet 66 do not oppose each other and hence the magnetic sensor 67 does not output the detection signal.

(Effects of First Modification)

[0065] As described above, a door switch 11 according to the first modification includes a rod 62 (first passive component) which is provided to be movable relative to a base plate 9 (vehicle main body) and is biased when one door 100a moves toward the full-closed position, a rod 63 (second passive component) which is provided to be movable relative to the base plate 9 and the rod 62 and is biased when the other door 100b moves toward the full-closed position, a magnetic sensor 67 (detection unit) which outputs a detection signal when the rod 62 and the rod 63 take predetermined relative positions and the magnet 66 gets close to a detection range, and springs 64 and 65 (biasing members) which bias the rod 62 and the rod 63 to prevent the rod 62 and the rod 63 from taking the predetermined relative positions (i.e., the relative positions at which the magnet 66 falls within the detection range of the magnetic sensor 67). The aforesaid predetermined relative positions are relative positions of the rod 62 and the rod 63 when both of the two doors 100a and 100b have moved to the full-closed positions while the rod 62 and the rod 63 are biased by the biasing components 56a and 56b attached to the doors 100a and 100b against the biasing forces of the springs 64 and 65.

[0066] According to this arrangement, when only one of the doors 100a and 100b reaches the full-closed position whereas the other door has not reached the full-closed position, the rod 62 and the rod 63 do not take the aforesaid predetermined relative positions on account of the biasing forces of the springs 64 and 65, and hence the magnet 66 does not fall within the detection range of the magnetic sensor 67. No detection signal is therefore output to the control unit of the magnetic sensor 67.

This makes it possible to certainly detect whether both of the double doors 100a and 100b are at the full-closed positions, without requiring another switch.

(Second Modification)

[0067] The embodiment above may be modified as below.

Fig. 8 and Fig. 9 are schematic views of a second modification of the embodiment above. A door opening/closing device according to the second modification is different from the device in the embodiment above in terms of the structure of the door switch. The following will therefore describe only the structure of the door switch and will not detail the other arrangements. The components identical with those in the embodiment above will be denoted by the same reference numerals.

[0068] As shown in Fig. 8, a door switch 12 of the second modification includes a shaft 71 which is fixed to a base plate 9 and extends orthogonal to the base plate 9, a fan-shaped plate-like first rotatable component 72 which is arranged to be in parallel to the base plate 9 and to be rotatable about the shaft 71, a long plate-shaped second rotatable component 73 which is arranged to overlap the first rotatable component 72 and to be rotatable about the shaft 71, a spring 74 provided between the first rotatable component 72 and the second rotatable component 73, a magnetic sensor 75 attached to the first rotatable component 72, a magnet 76 attached to the second rotatable component 73, a first stopper 77 which is fixed to the base plate 9 to prevent the rotation of the first rotatable component 72 (i.e. , the rotation in the direction indicated by the arrow R1 in Fig. 8), and a second stopper 78 which is fixed to the base plate 9 to prevent the rotation of the second rotatable component 73 (i.e., the rotation in the direction indicated by the arrow R2 in

Fig. 8).

To the doors 100a and 100b, stick-shaped biasing components 57a and 57b extending in parallel to the opening/closing directions of the doors are fixed via the supporting components 51a and 51b.

[0069] The first rotatable component 72 is rotatably connected to the shaft 71, at a part close to the center of the fan. The magnetic sensor 75 is fixed to a point which is near the arc edge of the fan-shaped first rotatable component 72 and is near the linear edge on the side opposite to the linear edge that the first stopper 77 contacts.

[0070] The second rotatable component 73 is a long plate-shaped component whose length is substantially identical with the diameter of the first rotatable component 72. This second rotatable component 73 is rotatably connected to a part of the shaft 71 in the vicinity of one end, whereas the magnet 76 is fixed to a part of the shaft 71 in the vicinity of the other end. The second rotatable component 73 is arranged so that the distance between the shaft 71 and the magnet 76 is identical with the distance between the shaft 71 and the magnetic sensor 75.

[0071] An end of the spring 74 is fixed to a part of the first rotatable component 72, which part is in the vicinity of the linear edge contacting the first stopper 77 and substantially at a central part of the first rotatable component 72 in the radial directions. The other end of the spring 74 is fixed to a substantially central part of the second rotatable component 73 in the longitudinal directions. The spring 74 biases the first rotatable component 72 to rotate the component in one direction about the shaft 71 (i.e., in the counterclockwise direction in Fig. 8, as indicated by the arrow R1), and also biases the second rotatable component 73 to rotate the component in the other direction about the shaft 71 (i.e., in the clockwise direction in Fig. 8, as indicated by the arrow R2).

[0072] Therefore, when no external force (which is not exerted by the spring 74) is exerted to the first rotatable component 72 and the second rotatable component 73, as shown in Fig. 8(a), the first rotatable component 72 is retained to contact the first stopper 77 whereas the second rotatable component 73 is retained to contact the second stopper 78.

In this state, the magnetic sensor 75 and the magnet 76 are away form each other in the directions along the outer circumference of the shaft 71.

[0073] As the biasing components 57a and 57b move in the closing directions on account of the closing operations of the doors 100a and 100b, as shown in Fig. 8 (b), the biasing components 57a and 57b contact the edge portions of the first rotatable component 72 and the second rotatable component 73, respectively. More specifically, the biasing component 57a contacts the edge portion of the first rotatable component 72, which linearly extends in the radial directions. On the other hand, the biasing component 57b contacts the edge portion of the second rotatable component 73, which linearly extends in the longitudinal directions.

[0074] In addition to the above, as the biasing components 57a and 57b move in the closing directions, the first rotatable component 72 is biased by the biasing component 57a and rotates about the shaft 71 away from the first stopper 77 (i.e., in the direction indicated by the arrow R2 in Fig. 8), against the biasing force of the spring 74. Furthermore, the second rotatable component 73 is biased by the biasing component 57b and rotates about the shaft 71 away from the second stopper 78 (i.e., in the direction indicated by the arrow R1 in Fig. 8), against the biasing force of the spring 74.

In other words, as the biasing components 57a and 57b move in the closing directions, the magnetic sensor 75 and the magnet 76 move to approach each other.

[0075] When the two doors 100a and 100b correctly conduct the closing operation and reach the respective full-closed positions, as shown in Fig. 8(c), the magnetic sensor 75 overlaps the magnet 76. In other words, the distance between the magnet 76 and the magnetic sensor 75 becomes the shortest.

The magnetic sensor 75 detects a magnetic force of the magnet 76 when the magnet 75 falls within a predetermined range around the sensor (hereinafter, the detection range of the magnetic sensor 75), and outputs a detection signal to the control unit of the door opening/closing device. In the present modification, the distance between the first rotatable component 72 and the second rotatable component 73 (in the directions in parallel to the shaft 71) is adjusted so that the magnet 76 falls within the detection range of the magnetic sensor 75 only when the magnet 76 overlaps the magnetic sensor 75 (i.e., only when the distance between the magnet 76 and the magnetic sensor 75 becomes the shortest).

For this reason, the magnetic sensor 75 outputs the detection signal only when both of the two doors 100a and 100b are at the full-closed positions.

[0076] Therefore, as shown in Fig. 9(a), when only one door 100a reaches the full-closed position whereas the other door 100b stops halfway due to a failure in the door opening/closing device 1, the magnetic sensor 75 does not overlap the magnet 76 and hence no detection signal is output from the magnetic sensor 75.

Similarly, as shown in Fig. 9(b), when only one door 100b reaches the full-closed position whereas the other door 100a stops halfway due to a failure in the door opening/closing device 1, the magnetic sensor 75 does not overlap the magnet 76 and hence no detection signal is output from the magnetic sensor 75.

(Effects of Second Modification)

(1)

[0077] As described above, a door switch 12 according to the second modification includes a first rotatable component 72 (first passive component) which is provided to be rotatable relative to a base plate 9 (vehicle main body) and is biased when one door 100a moves toward the full-

closed position, a second rotatable component 73 (second passive component) which is provided to be rotatable relative to the base plate 9 and the first rotatable component 72 and is biased when the other door 100b moves toward the full-closed position, a magnetic sensor 75 (detection unit) which outputs a detection signal when the first rotatable component 72 and the second rotatable component 73 take predetermined relative positions and the magnet 76 gets close to a detection range, and a spring 74 (biasing member) which biases the first rotatable component 72 and the second rotatable component 73 to prevent the first rotatable component 72 and the second rotatable component 73 from taking the predetermined relative positions (i.e., the relative positions at which the magnet 76 falls within the detection range of the magnetic sensor 75) . The predetermined relative positions are relative positions of the first rotatable component 72 and the second rotatable component 73 when the first rotatable component 72 and the second rotatable component 73 are biased by the biasing components 57a and 57b attached to the double doors 100a and 100b against the biasing force of the spring 74 and eventually both of the two doors 100a and 100b reach the full-closed positions.

[0078] According to this arrangement, when only one of the two doors 100a and 100b reaches the full-closed position whereas the other door has not reached the full-closed position, the biasing force of the spring 74 prevents the first rotatable component 72 and the second rotatable component 73 from taking the aforesaid relative positions, with the result that the magnet 76 does not fall within the detection range of the magnetic sensor 75 and no detection signal is output from the magnetic sensor 75 to the control unit.

This makes it possible to certainly detect whether both of the double doors 100a and 100b are at the full-closed positions, without requiring another switch.

(2)

[0079] In the door switch 12, the first rotatable component 72 and the second rotatable component 73 are rotatably attached to the shaft 71 (rotation axis) which is fixed to the base plate 9, and the shaft 71 extends in the directions vertical to the flat plate-shaped doors 100a and 100b (i.e., in the width directions of the vehicle).

[0080] The first rotatable component 72 and the second rotatable component 73 are formed to be flat plates and arranged so that the width directions of these components are in parallel to the shaft 71. This makes it possible to reduce the size of the door switch 12 in the width directions of the vehicle.

(3)

[0081] In the door switch 12, when the magnetic sensor 75 (first detection unit) attached to the first rotatable component 72 and the magnet 76 (second detection unit) attached to the second rotatable component 73 take a predetermined positional relationship, i.e., when the magnet 76 enters the detection range of the magnetic sensor 75, the magnetic sensor 75 outputs a detection signal. The magnetic sensor 75 is provided at a position further from the shaft 71 than the position on the first rotatable component 72 at which the biasing force of the biasing component 57a is exerted. On the other hand, the magnet 76 is provided at a position further from the shaft 71 than the position on the second rotatable component 73 at which the biasing force of the biasing component 57a is exerted.

[0082] According to the arrangement above, as compared to the moving distances of the doors 100a and 100b in the closing directions (i.e. the moving distances after contacting the first rotatable component 72 and the second rotatable component 73), the degree of change in the relative positions of the magnetic sensor 75 and the magnet 76 is great. With this, a thin matter caught in between the closing doors 100a and 100b is detectable without increasing the sensitivity of the sensor. In other words, it is possible, by a simple structure, to prevent a detection signal indicating that the doors 100a and 100b are closed from being erroneously output, when a foreign matter is caught in between the closing doors 100a and 100b and hence the doors 100a and 100b are not completely closed.

(Third Modification)

[0083] In addition to the second modification in which the spring 74 is provided between the first rotatable component 72 and the second rotatable component 73, the arrangement shown in Fig. 10 may be employed.

[0084] According to this arrangement, a first spring holding unit 81 is fixed in the vicinity of the first stopper 77 on the base plate 9 to protrude from the base plate 9. Furthermore, in the vicinity of the second stopper 78, a second spring holding unit 82 is fixed to protrude from the base plate 9. Between the first spring holding unit 81 and the first rotatable component 72 is provided a first spring 83. This first spring 83 pulls the first rotatable component 72 to cause the first rotatable component 72 to approach the first stopper 77. Between the second spring holding unit 82 and the second rotatable component 73 is provided a second spring 84. The second spring 84 pulls the second rotatable component 73 to cause the second rotatable component 73 to approach the second stopper 78.

[0085] Therefore, when no external force (which is not exerted by the spring 74) is exerted to the first rotatable component 72 and the second rotatable component 73, as shown in Fig. 10(a), the first rotatable component 72 is retained to contact the first stopper 77 and the second rotatable component 73 is retained to contact the second stopper 78.

When both of the two doors reach the full-closed positions, as shown in Fig. 10(b), the magnetic sensor 75

overlaps the magnet 76.

[0086] As such, the arrangement shown in Fig. 10 also allows the door switch 12 to output a detection signal only when both of the two doors reach the respective full-closed positions.

(Fourth Modification)

[0087] In addition to the third modification in which the first rotatable component 72 is fan-shaped, the first rotatable component may be L-shaped or V-shaped as indicated by, for example, a first rotatable component 72' shown in Fig. 11. This reduces the weight of the first rotatable component 72' and also reduces the space required for the rotation of the first rotatable component 72'.

[0088] Furthermore, in addition to the second to fourth modifications in which the first rotatable component 72 and the second rotatable component 73 share the same rotation axis (shaft 71), the rotation axis of the first rotatable component 72 and the rotation axis of the second rotatable component 73 may be provided at different locations, as individual components.

[0089] The embodiment and modifications of the present invention have been described above. The present invention, however, is not limited to them and may be variously changed within the scope of claims.

INDUSTRIAL APPLICABILITY

[0090] The present invention can be used for a door opening/closing device for closing and opening double doors and a door switch for detecting whether the double doors are closed, which are provided in a railroad vehicle.

REFERENCE NUMERALS

[0091]

1 DOOR OPENING/CLOSING DEVICE
10 DOOR SWITCH
22 ROD (FIRST PASSIVE COMPONENT)
23 SPRING (BIASING MEMBER)
30 SWITCH CASING (SECOND PASSIVE COMPONENT)
100a, 100b DOOR
62, 63 ROD (FIRST PASSIVE COMPONENT, SECOND PASSIVE COMPONENT)
64,65 SPRING (BIASING MEMBER)
67 MAGNETIC SENSOR (DETECTION UNIT)
72 FIRST ROTATABLE COMPONENT (FIRST PASSIVE COMPONENT)
73 SECOND ROTATABLE COMPONENT (SECOND PASSIVE COMPONENT)
74 SPRING (BIASING MEMBER)
75 MAGNETIC SENSOR (DETECTION UNIT FIRST DETECTION UNIT)
76 MAGNET (SECOND DETECTION UNIT)

Claims

1. A door switch for a railroad vehicle, which is installed in the railroad vehicle having double doors, the door switch comprising:

   a first passive component which is arranged to be movable relative to a vehicle main body and is biased when one of the doors moves toward a full-closed position;
   a second passive component which is arranged to be movable relative to the vehicle main body and the first passive component and is biased when the other one of the doors is moves toward a full-closed position;
   a detection unit which outputs a detection signal when the first passive component and the second passive component take predetermined relative positions;
   a biasing member which biases the first passive component and the second passive component to prevent the first passive component and the second passive component from taking the predetermined relative positions;
   the predetermined relative positions being relative positions of the first passive component and the second passive component when the first passive component and the second passive component are biased by the double doors against a biasing force of the biasing member and both of the double doors eventually reach the full-closed positions.

2. The door switch according to claim 1, wherein the first passive component and the second passive component are arranged to be movable in opening/closing directions of the doors, with respect to the vehicle main body.

3. The door switch according to claim 2, further comprising:

   a limit switch including the first passive component, the second passive component movably supporting the first passive component, an elastic component provided between the first passive component and the second passive component and functioning as the biasing component, and the detection unit which outputs the detection signal when the first passive component moves for a predetermined distance with respect to the second passive component against an elastic force of the elastic component, the limit switch being arranged to be movable with respect to the vehicle main body in directions in parallel to a direction of movement of the first passive component with respect to the second passive component, and

as one of the doors is biased by the first passive component and the other one of the doors is biased by the second passive component, the first passive component moving with respect to the second passive component against the elastic force of the elastic component, and a moving distance of the first passive component with respect to the second passive component being equal to the predetermined distance when both of the doors reach the full-closed positions.

4. The door switch according to claim 1, wherein,
the first passive component and the second passive component are rotatable about a rotation axis which is fixed to the vehicle main body, and
the rotation axis extends in directions orthogonal to the flat plate-shaped doors.

5. The door switch according to claim 4, wherein,
the detection unit outputs the detection signal when the first detection unit attached to the first passive component and the second detection unit attached to the second passive component take a predetermined positional relationship,
the first detection unit is provided at a position further from the rotation axis of the first passive component than a position at which the first passive component is biased by said one of the doors, and
the second detection unit is provided at a position further from the rotation axis of the second passive component than a position at which the second passive component is biased by the other one of the doors.

6. A door opening/closing device for a railroad vehicle, which is used for opening and closing double doors, the door opening/closing device comprising:

the door switch according to any one of claims 1 to 5; and
a control unit which receives the detection signal output from the detection unit,
the control unit driving a locking unit for locking the doors or controlling a drive output for opening and closing the doors, based on the detection signal.

FIG.1

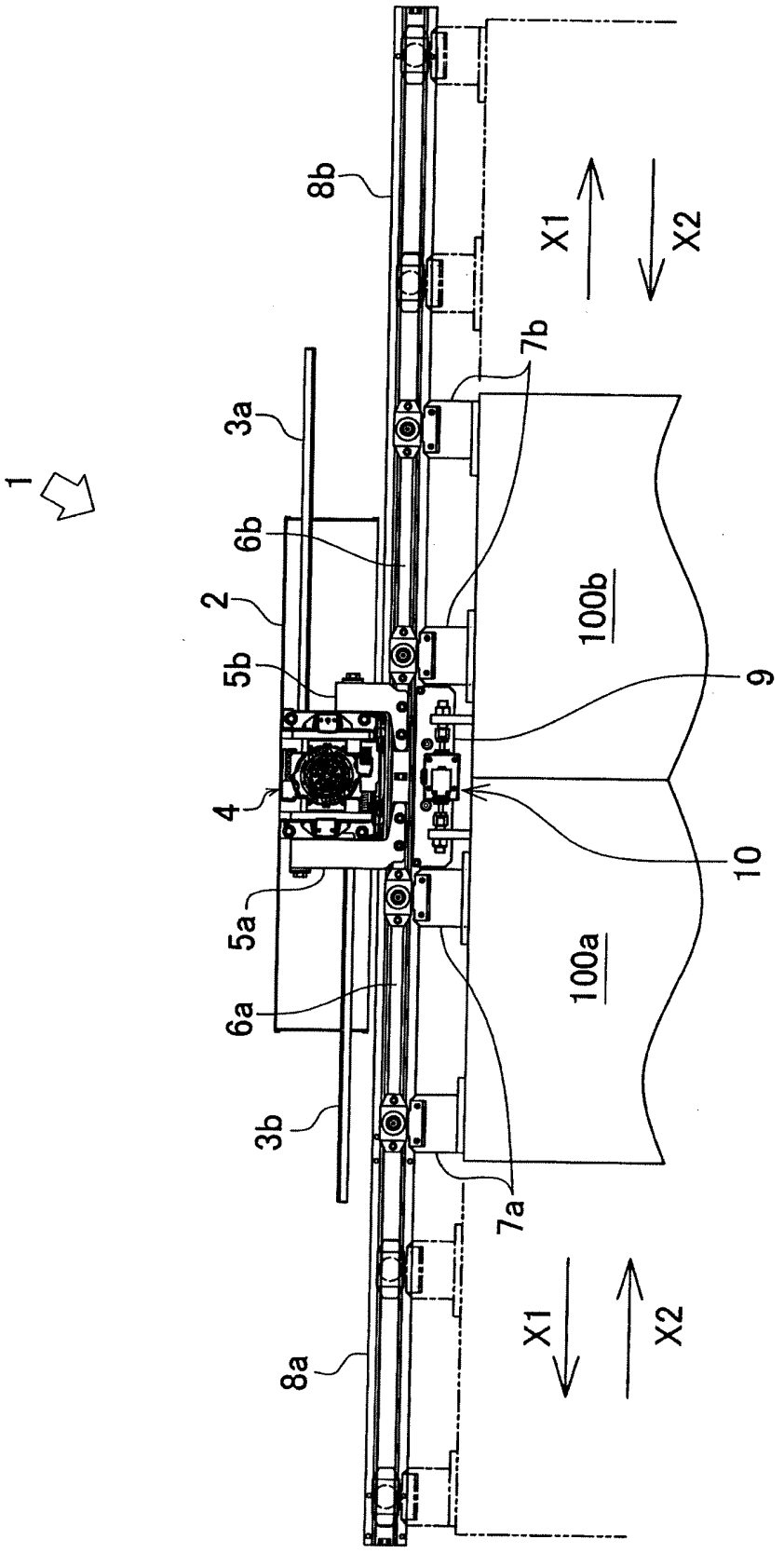


FIG.2

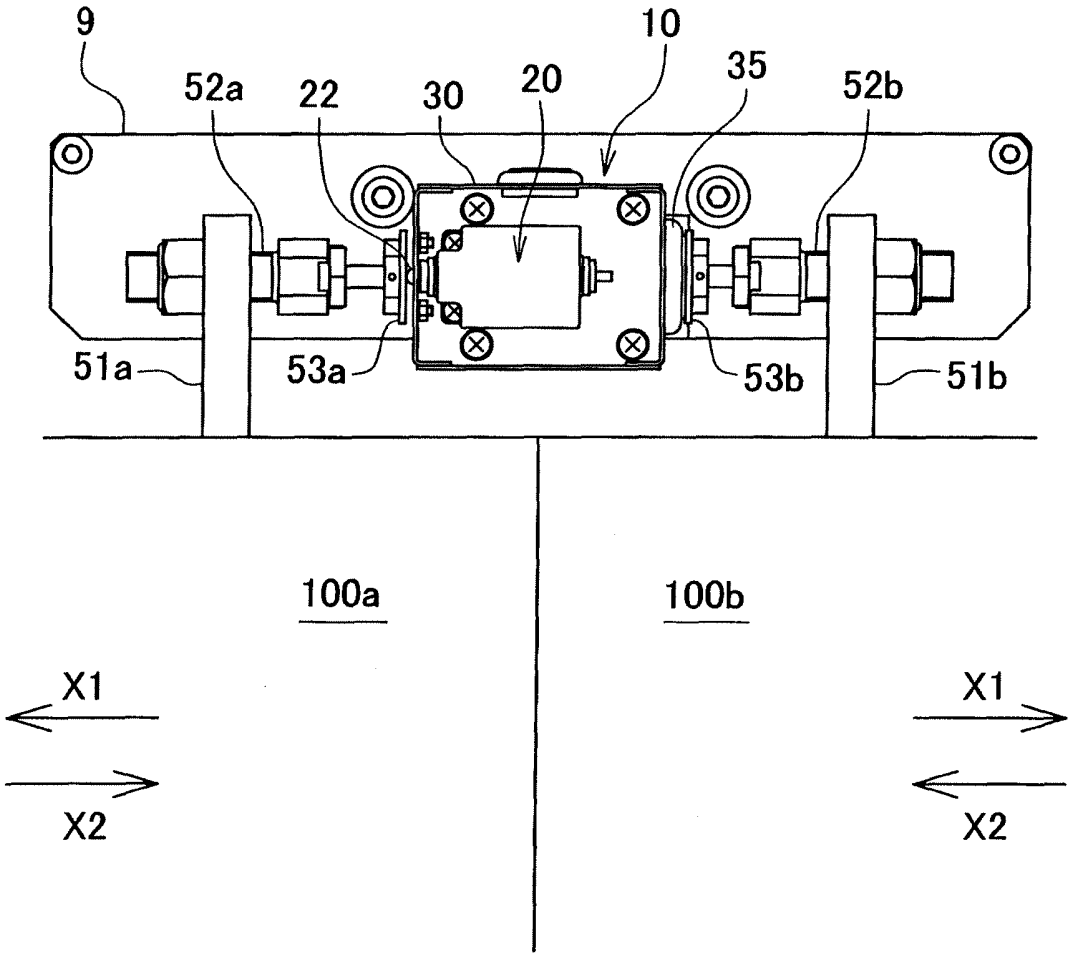


FIG.3

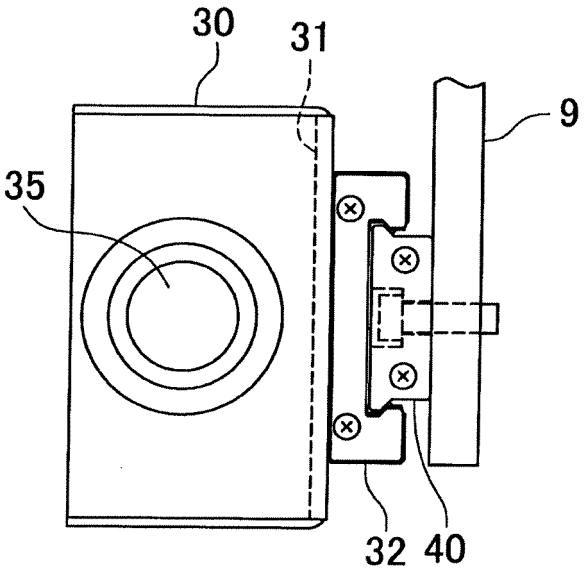


FIG.4(a)

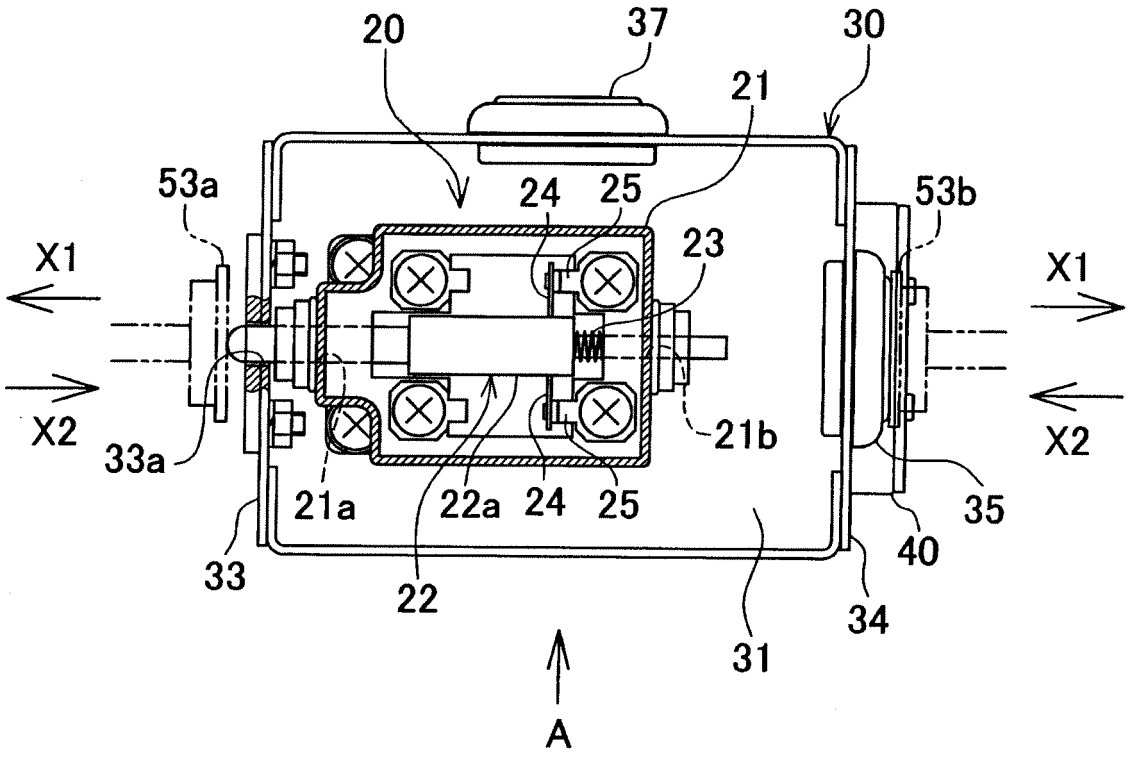
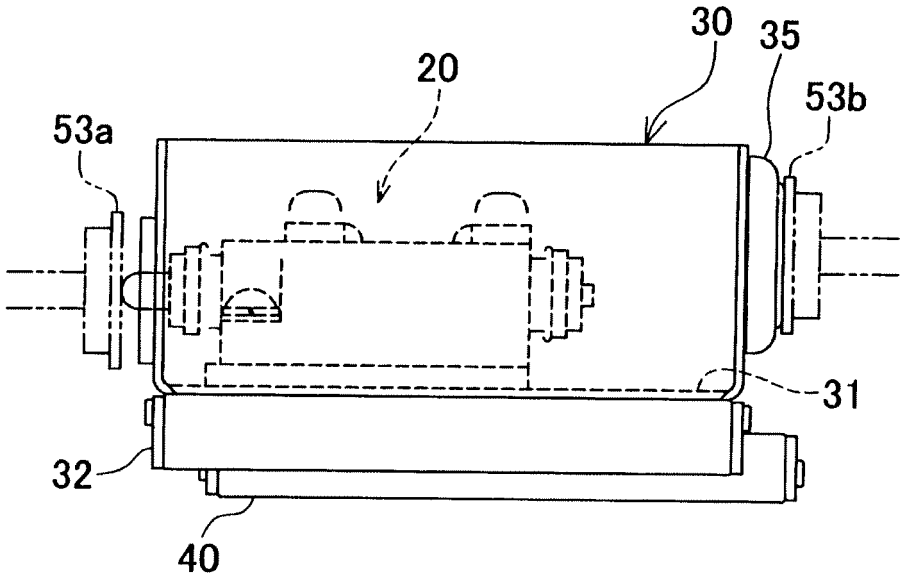

20
37
30
21
53a
24
25
53b
X1
23
X1
X2
X2
33a
21b
21a
22a
24
25
35
40
33
22
34
31
A

FIG.4(b)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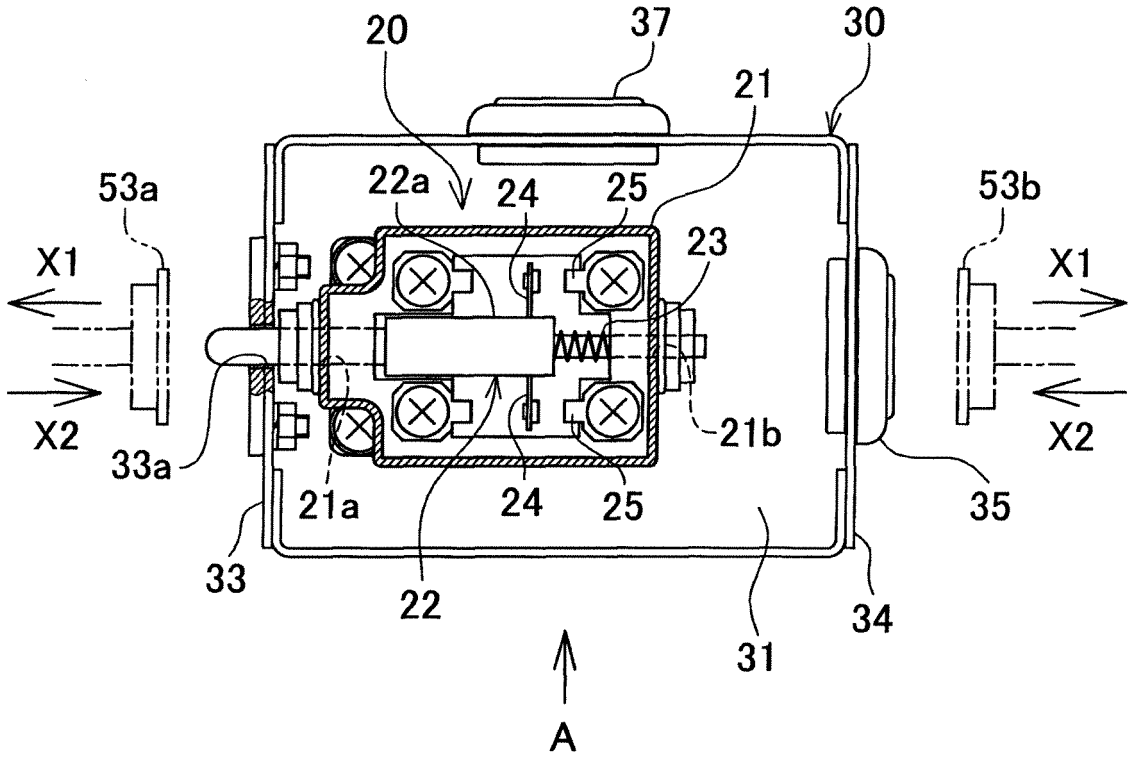
53b
53a
31
32
40

FIG.5(a)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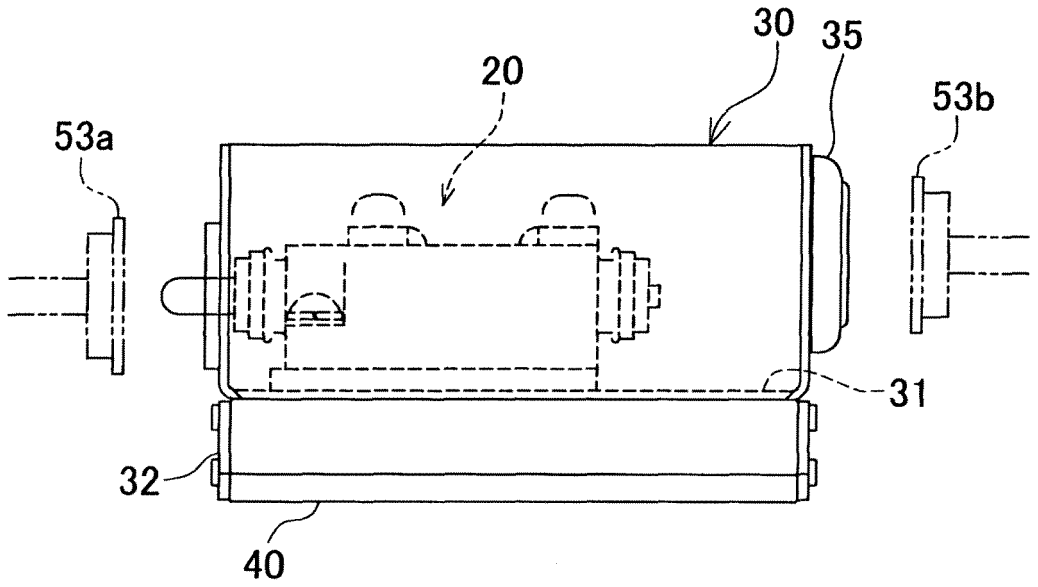
37
30
21
53a
22a
24
25
53b
X1
23
X1
X2
X2
33a
21b
21a
24
25
35
33
22
34
31
A

FIG.5(b)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35
20
53b
53a
31
32
40

FIG.6(a)

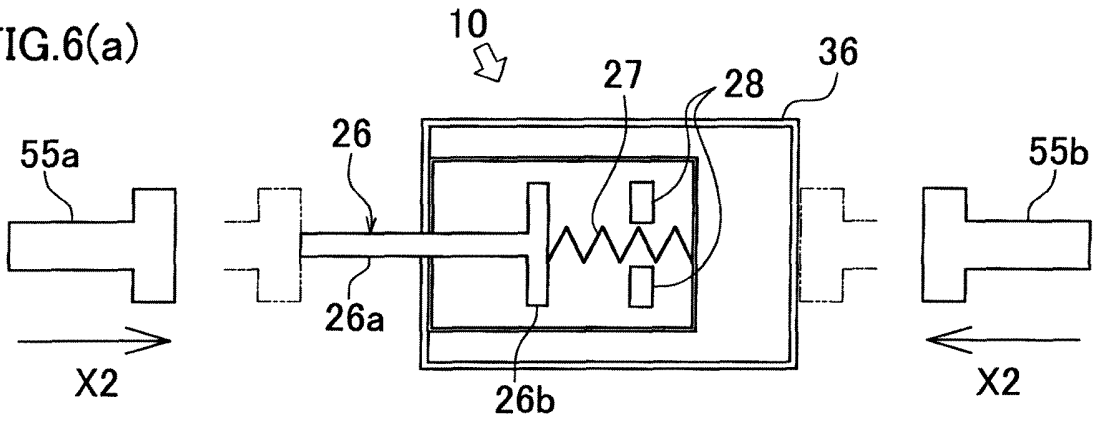


FIG.6(b)

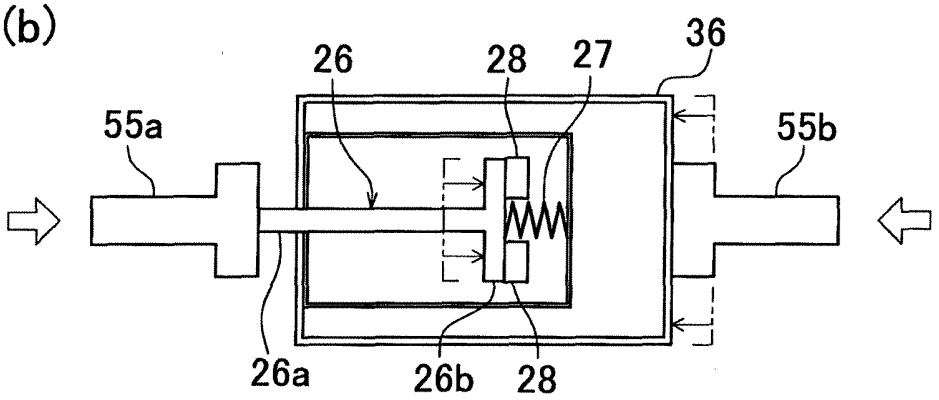


FIG.6(c)

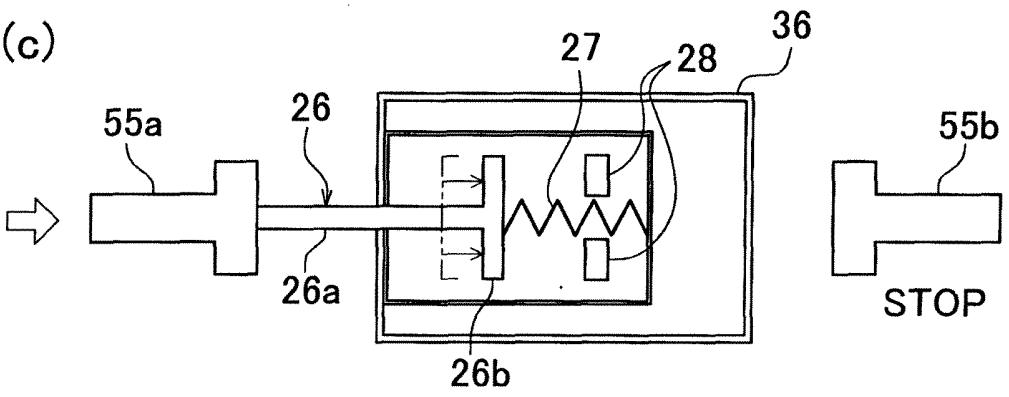


FIG.6(d)

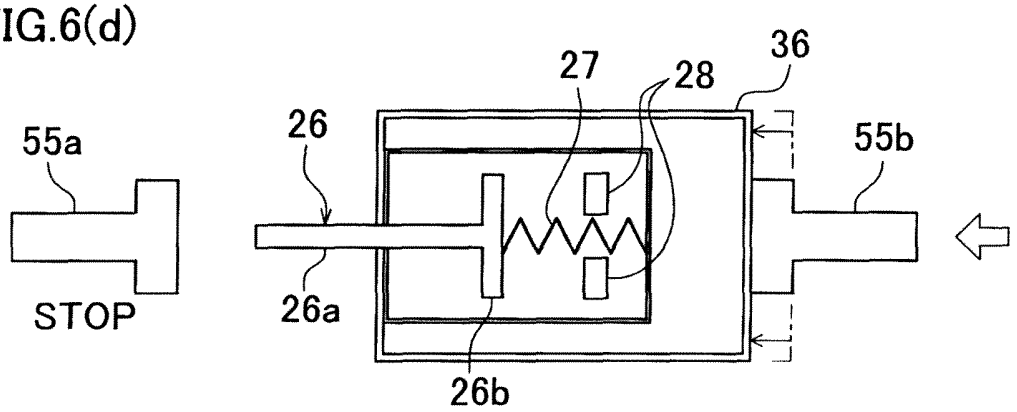


FIG.7(a)

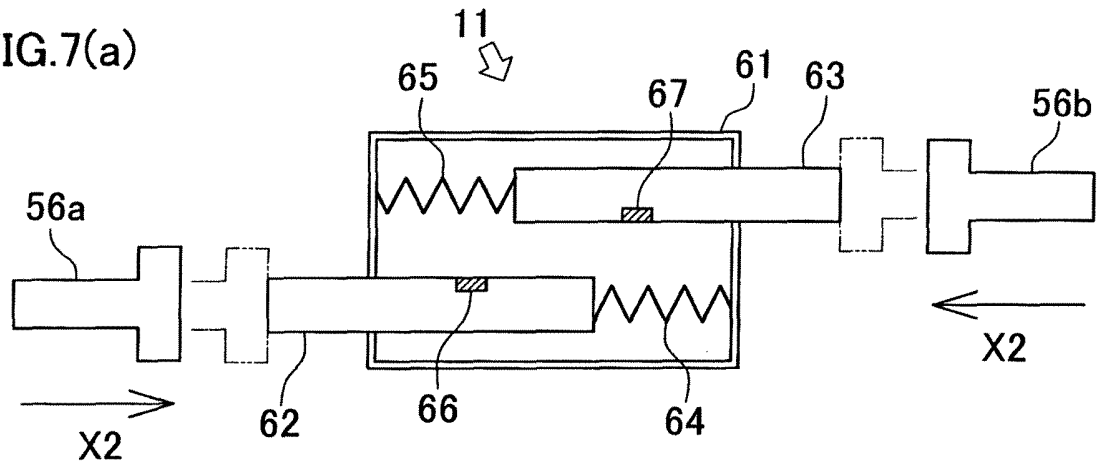


FIG.7(b)

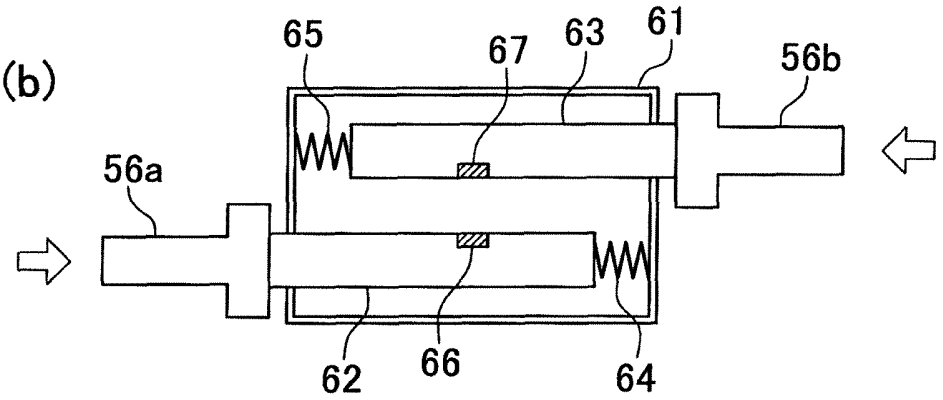


FIG.7(c)

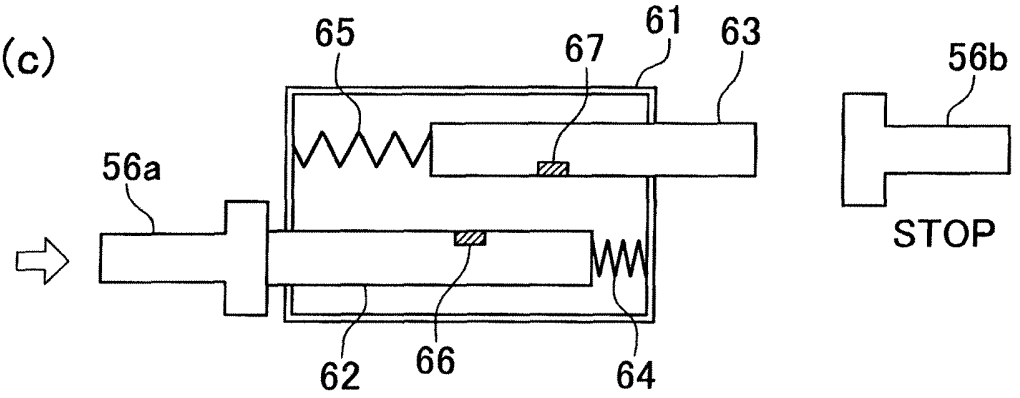


FIG.7(d)

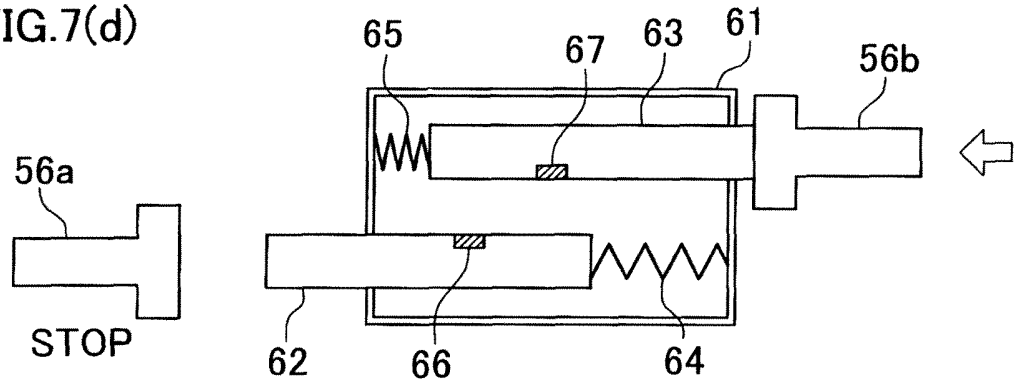


FIG.8(a)

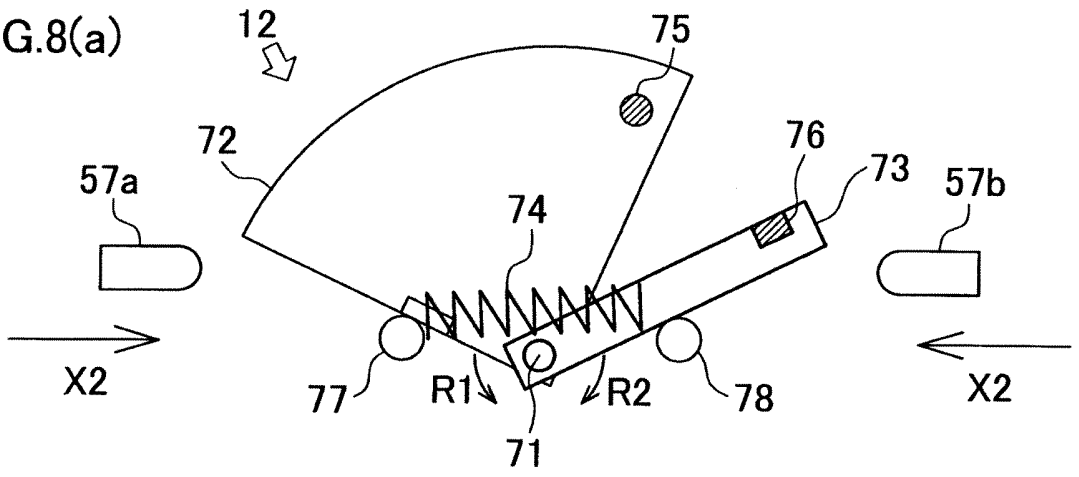


FIG.8(b)

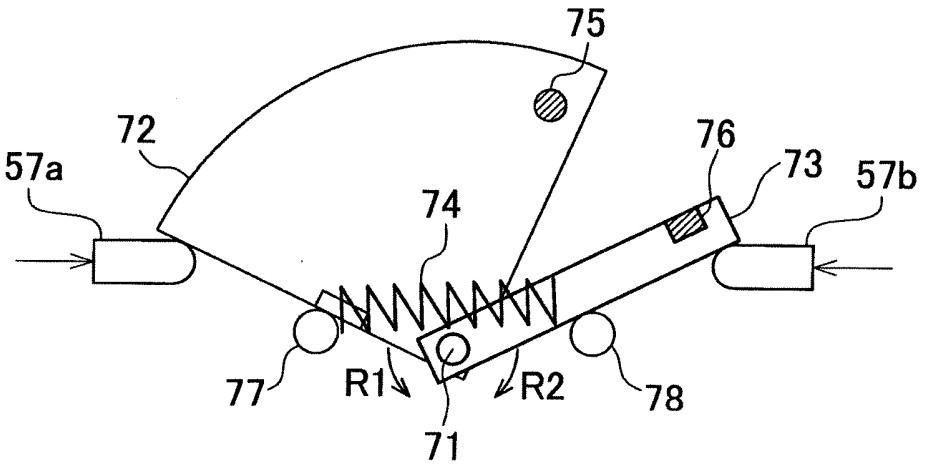


FIG.8(c)

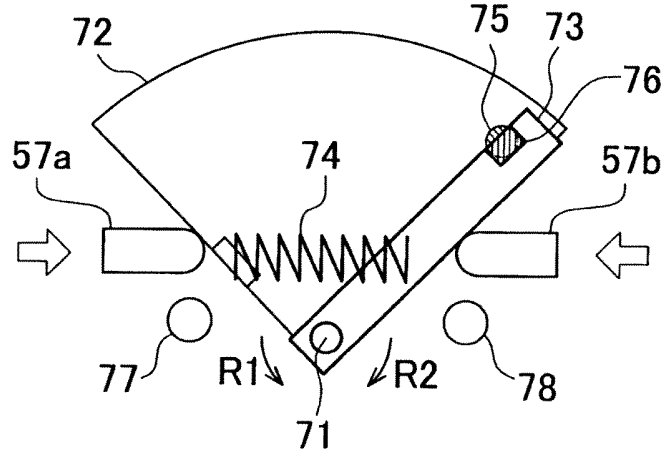


FIG.9(a)

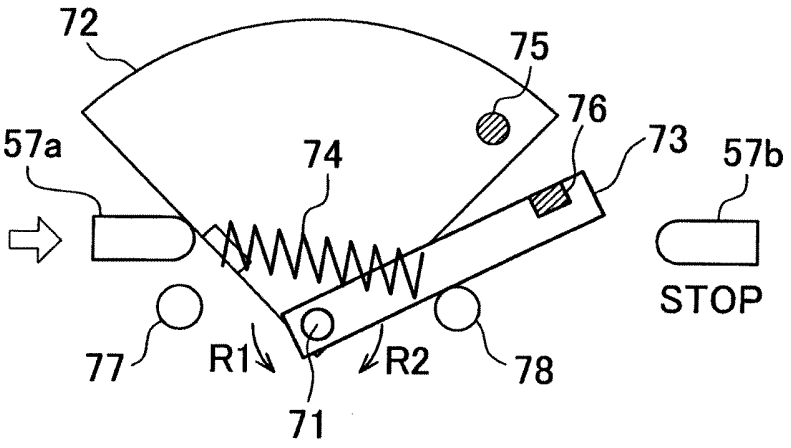

72
75
76
73
57a
74
57b
STOP
77
R1
R2
78
71

FIG.9(b)

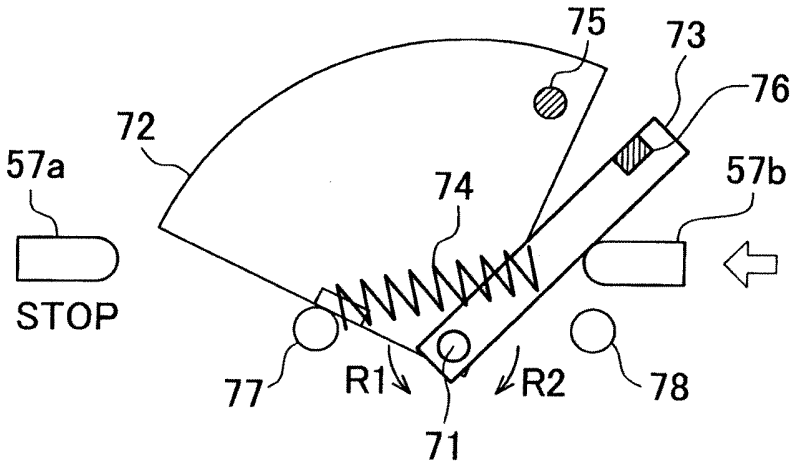

75
73
76
72
57a
74
57b
STOP
77
R1
R2
78
71

FIG.10(a)

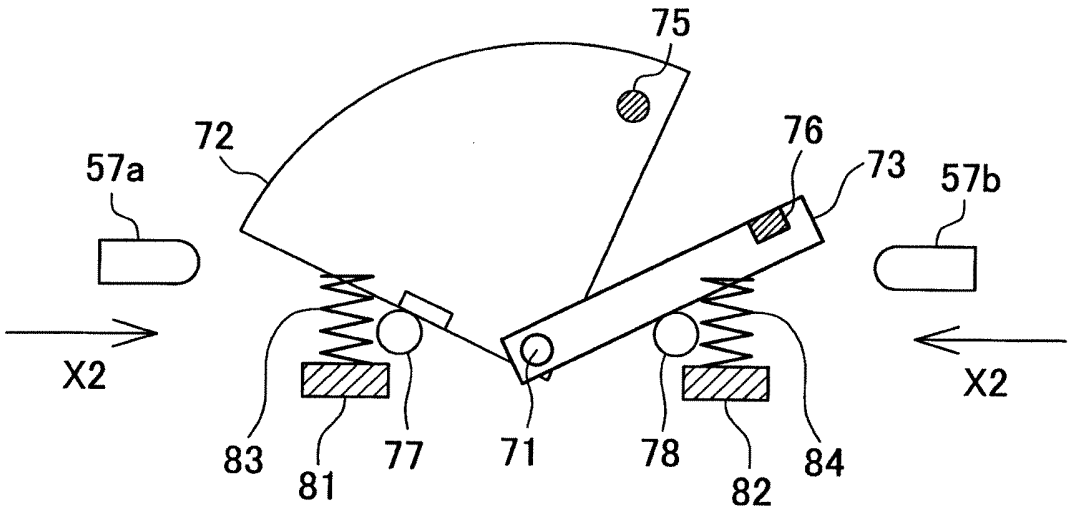


FIG.10(b)

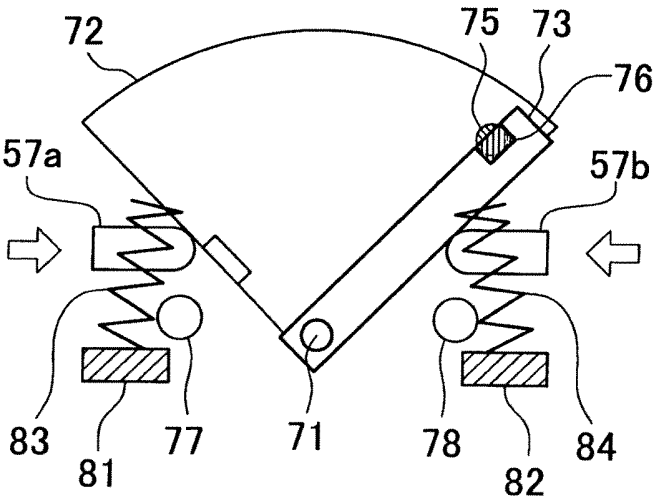
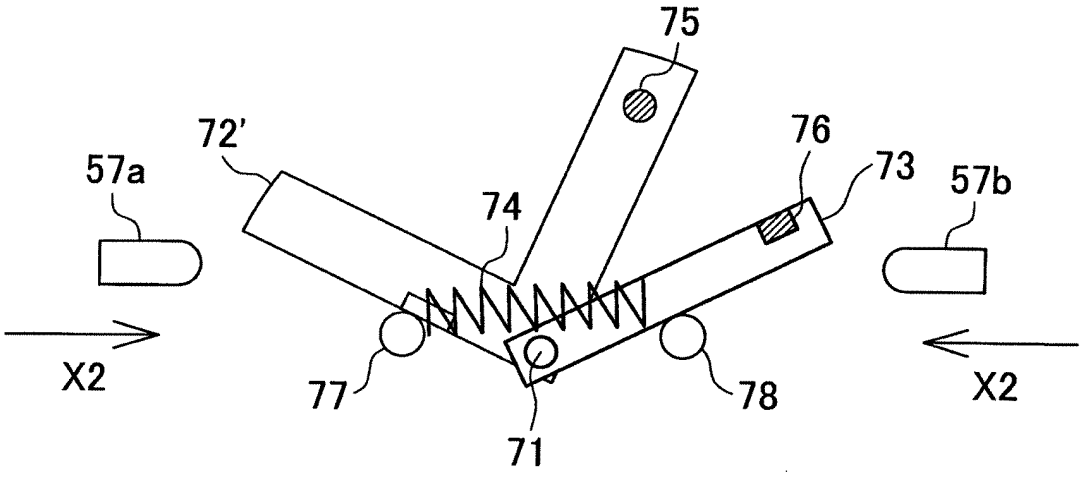


FIG.11



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/059180

A. CLASSIFICATION OF SUBJECT MATTER
B61D19/02(2006.01)i, *E05B65/12*(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)
B61D19/00-19/02, E05B65/12, H01H13/18, H01H36/00

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2010
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.
X Y A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 147936/1974(Laid-open No. 74903/1976) (Koito Industries, Ltd.), 12 June 1976 (12.06.1976), entire text; fig. 2 (Family: none)	1,2 6 3-5
X Y A	JP 9-301158 A (Koshin Seikosho, Ltd.), 25 November 1997 (25.11.1997), entire text; all drawings (Family: none)	1-3 6 4,5

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 August, 2010 (11.08.10)	24 August, 2010 (24.08.10)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/059180

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2002-309849 A (East Japan Transport Technology Co., Ltd., Fuso Electric Industrial Co., Ltd.), 23 October 2002 (23.10.2002), paragraph [0018]; fig. 1 (Family: none)	6
A	JP 43-24932 Y1 (Morio Denki Kabushiki Kaisha), 19 October 1968 (19.10.1968), entire text; all drawings (Family: none)	1
A	JP 43-24933 Y1 (Morio Denki Kabushiki Kaisha), 19 October 1968 (19.10.1968), entire text; all drawings (Family: none)	1
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 45097/1984(Laid-open No. 157468/1985) (Hitachi, Ltd.), 19 October 1985 (19.10.1985), specification, page 4, line 8 to page 5, line 20; fig. 4 (Family: none)	4,5

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/059180

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

The search revealed that the invention in claim 1 is disclosed in the document 1, and therefore is not novel.

As a result, the invention in claim 1 is not a special technical feature in the meaning of the second sentence of PCT Rule 13.2, since the invention does not make contribution over the prior art.

Therefore, there is no matter common to all of the inventions in claims 1 - 6.

Consequently, it is obvious that the inventions in claims 1 - 6 do not comply with the requirement of unity of invention.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2002309849 A **[0003]**