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(54) **DOOR DEVICE FOR RAILROAD CAR, RAILROAD CAR HAVING THE SAME, EMERGENCY DOOR UNLOCKING DEVICE, AND METHOD OF UNLOCKING DOOR BODY LOCKED WITH LOCKING MECHANISM**

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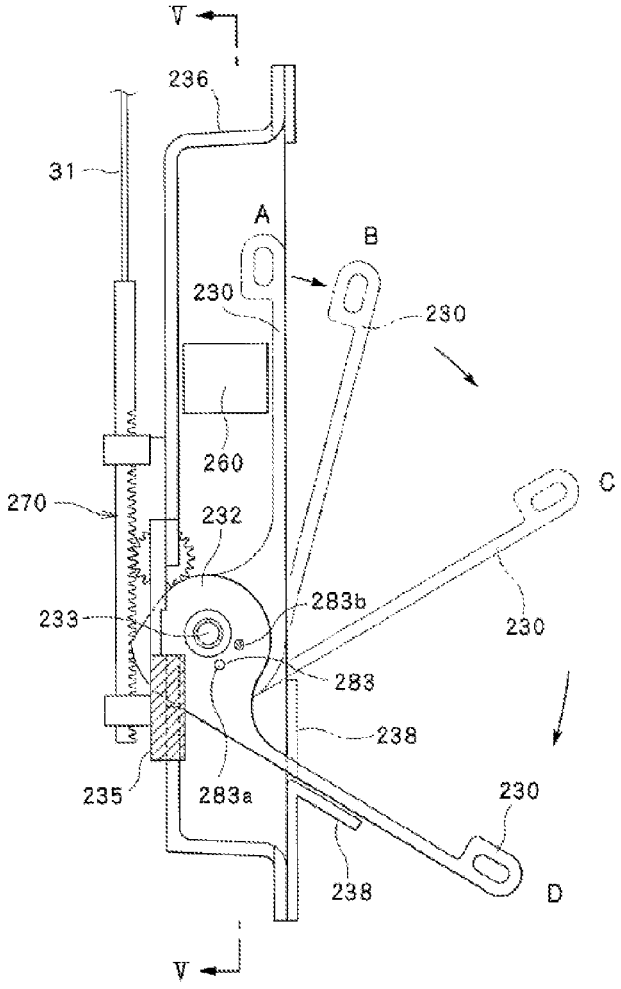
(57) **ABSTRACT**

A door device with a locking mechanism includes an operation member that is operated to unlock a door body. When a power supply for a railroad car is normal, it is determined whether the door body is allowed to be opened by operating the operation member. The door body is unlocked only when it is determined that opening of the door body is allowed. Whereas when the power supply for the railroad car is in an abnormal state, the door body is unlocked by the locking mechanism by operating the operation member.



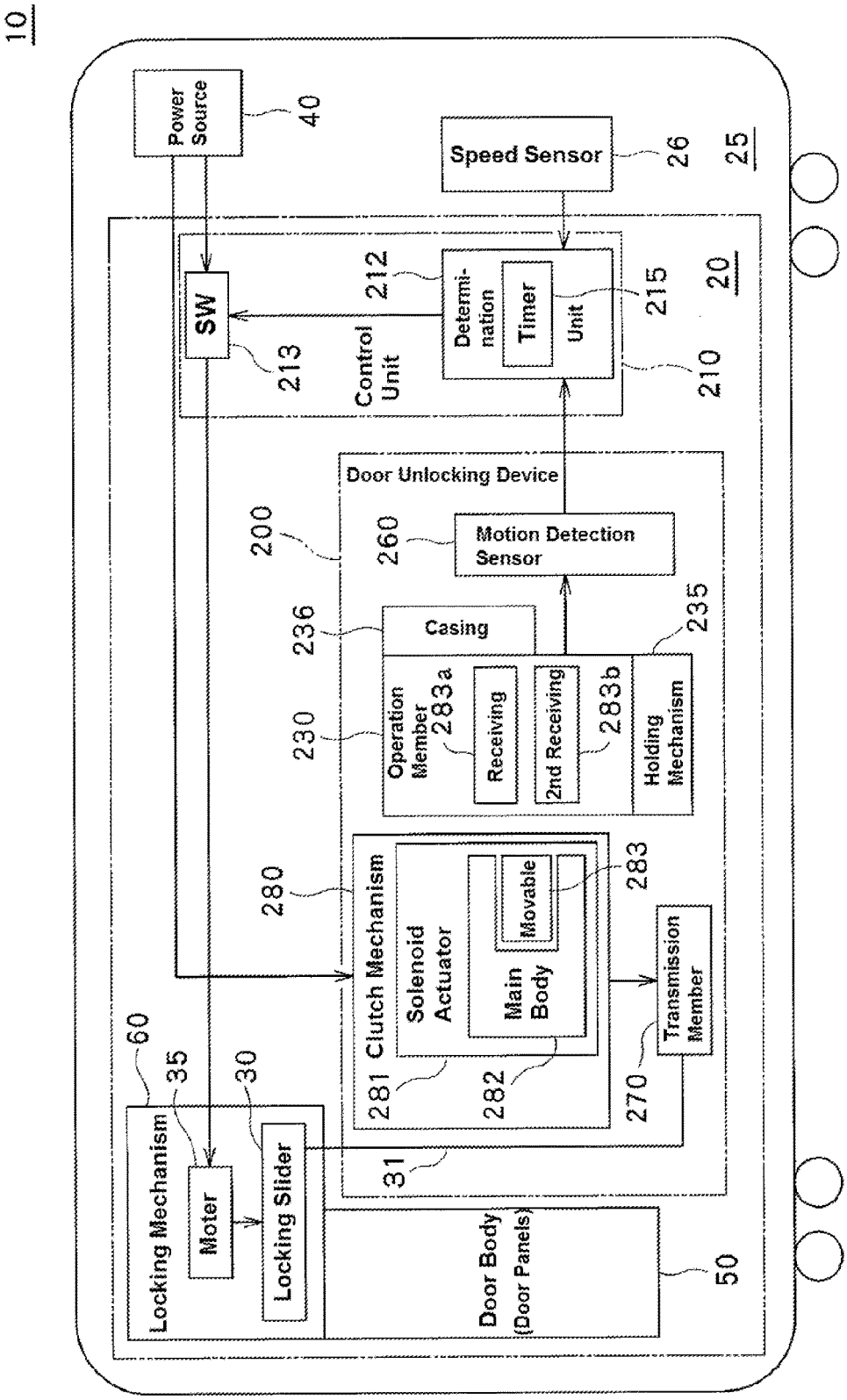

10
Power Source
40
Speed Sensor
26
25
SW
213
212
Determi-nation
Timer
215
Unit
210
Control Unit
20
Door Unlocking Device
200
260
Motion Detection Sensor
236
Casing
235
230
Operation Member
283a
Receiving
2nd Receiving
283b
Holding Mechanism
280
Clutch Mechanism
Solenoid Actuator
Movable
283
Main Body
281
282
270
Transmission Member
60
35
30
Locking Mechanism
Moter
Locking Slider
31
Door Body (Door Panels)
50

Fig. 1

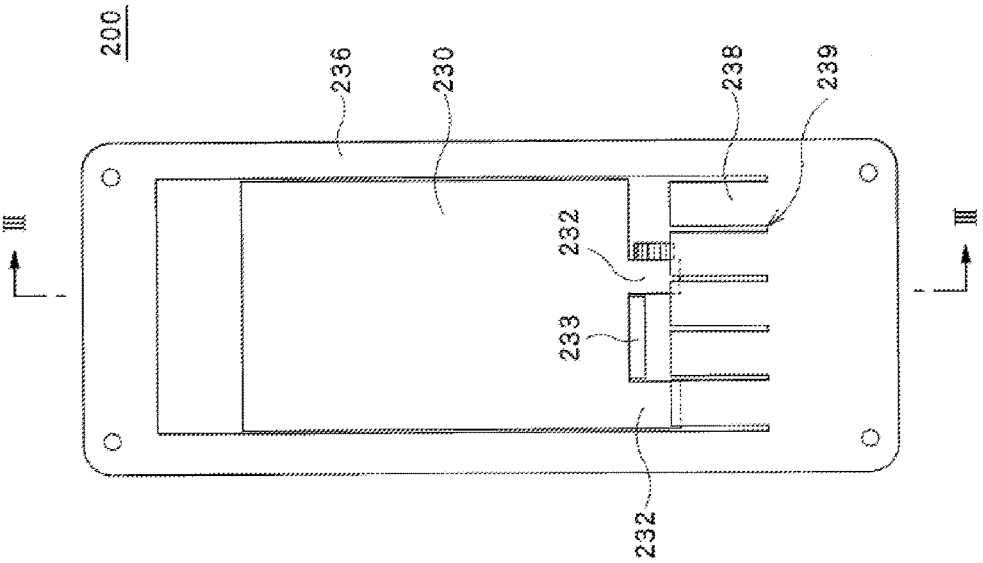


Fig. 2

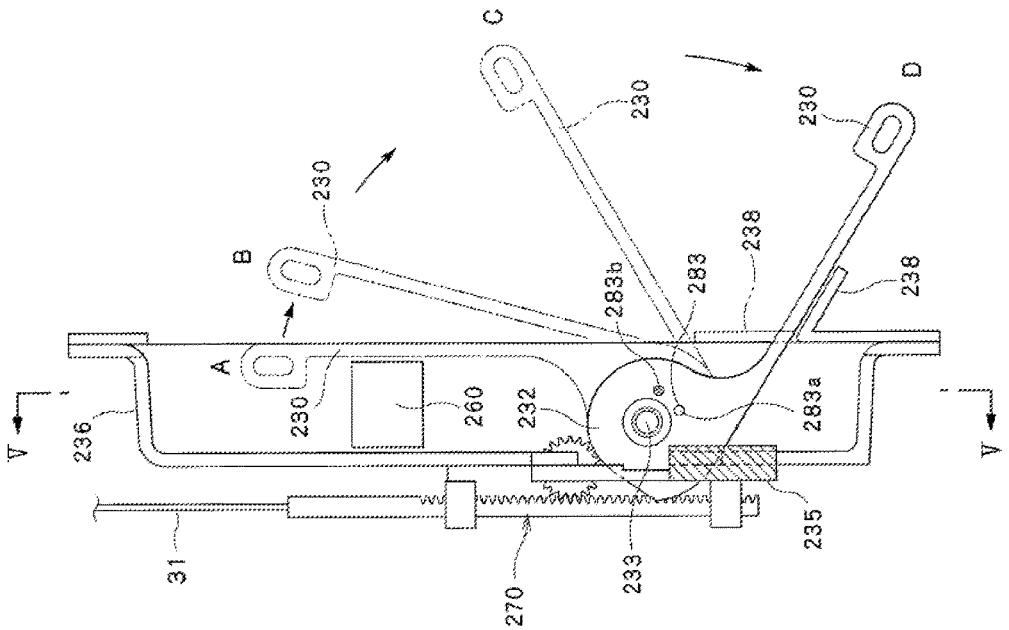

A
B
C
D
230
230
230
230
238
238
283
283b
283a
232
260
236
V
V
31
270
233
235

Fig. 3

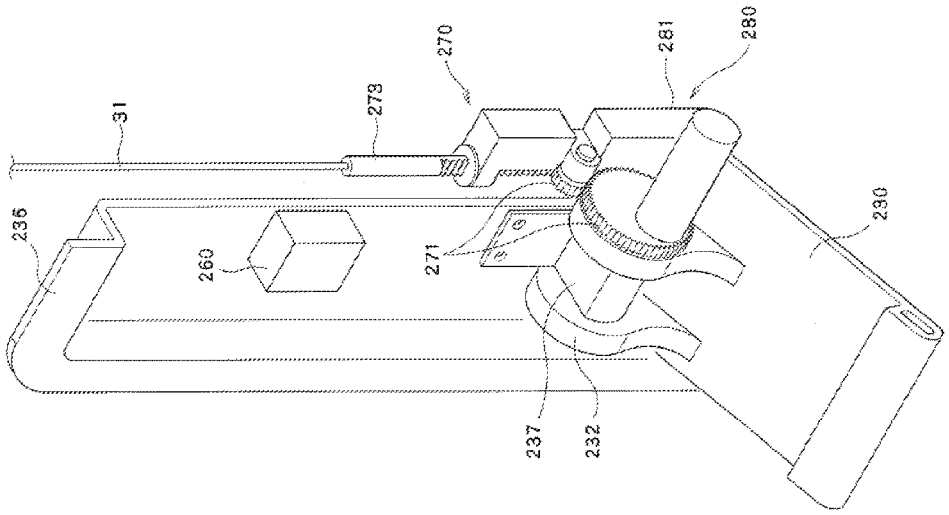


Fig. 4

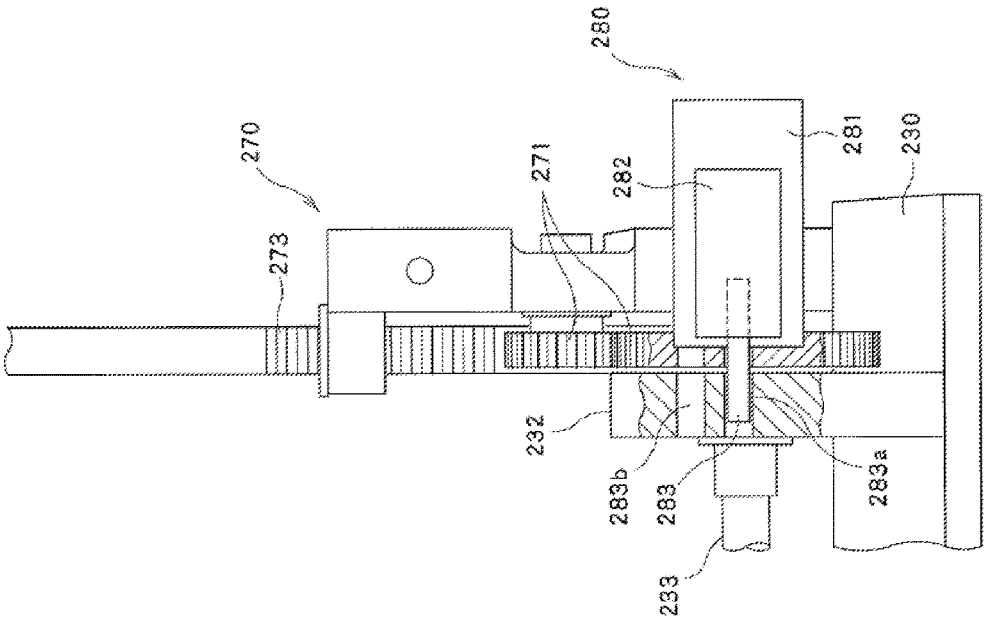


Fig. 5

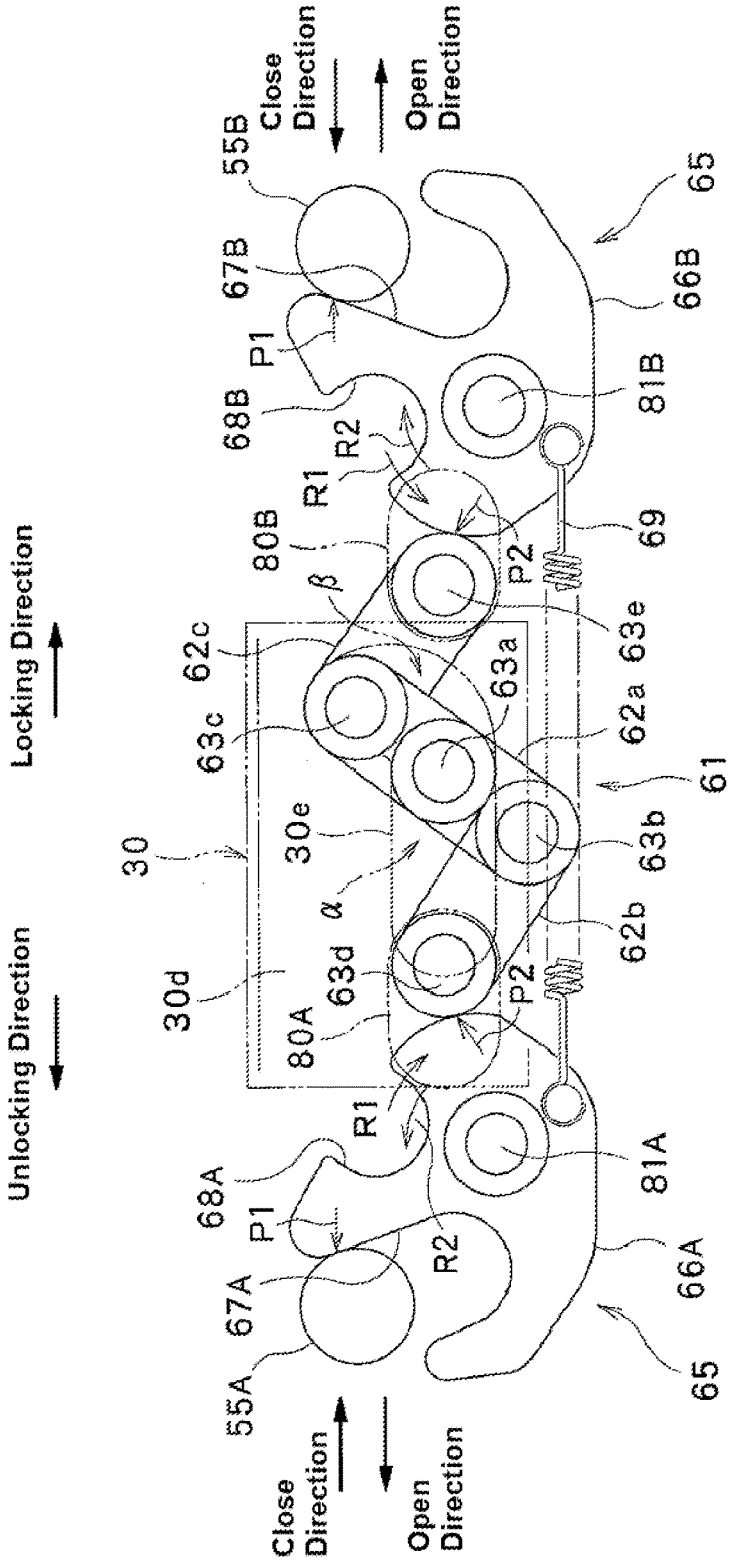

Locking Direction
Unlocking Direction
Close Direction
Open Direction
Close Direction
Open Direction
55B
67B
P1
68B
R2
R1
80B
β
62c
63c
30
30e
α
30d
63d
80A
R1
68A
P1
67A
55A
R2
P2
63e
63a
62a
61
63b
62b
P2
69
81B
66B
65
81A
66A
65

Fig. 6

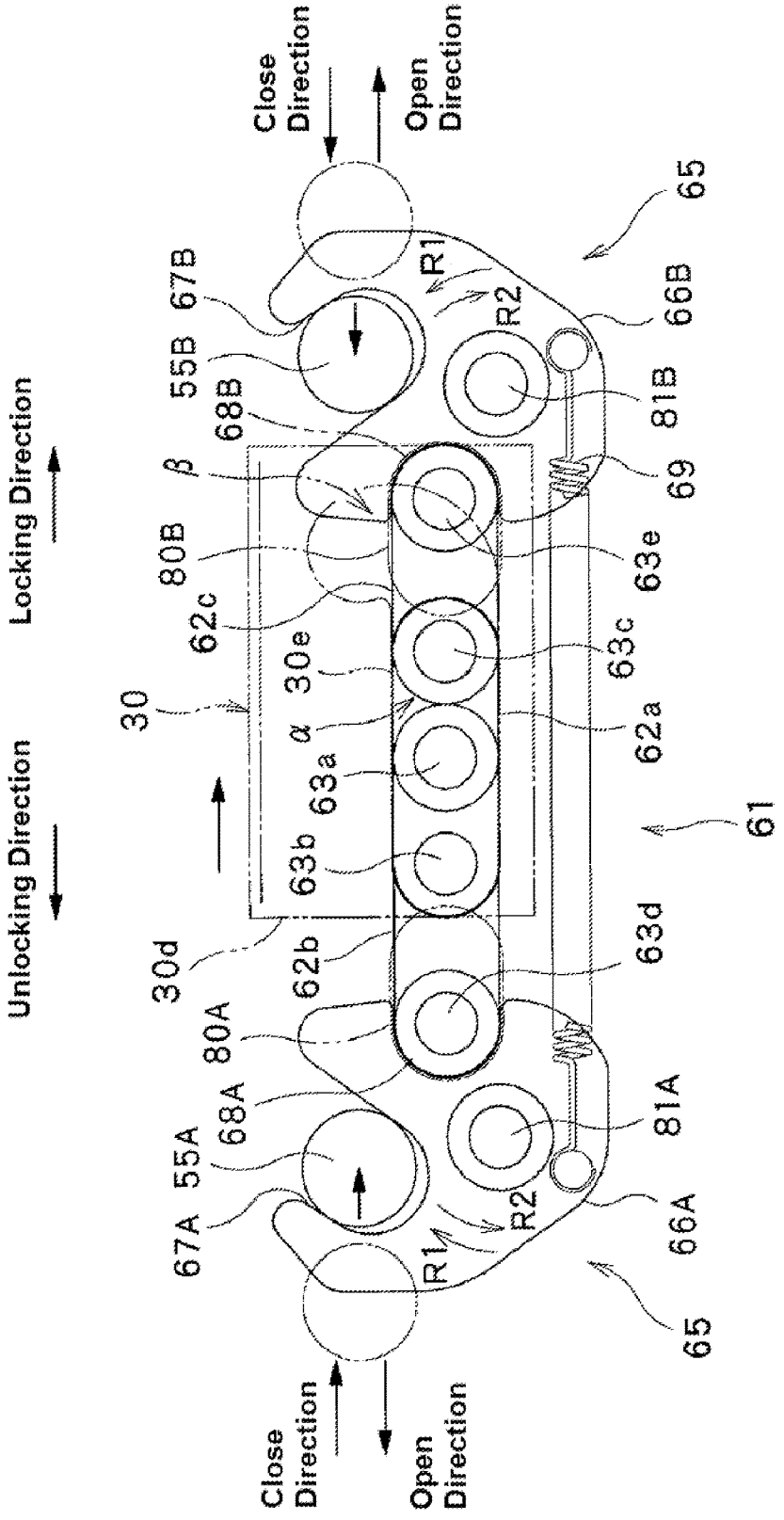

Close Direction
Open Direction
Locking Direction
Unlocking Direction
Close Direction
Open Direction
65
67B
55B
68B
β
80B
62c
30
30e
α
63a
63b
30d
62b
80A
68A
55A
67A
R1
R2
66B
81B
69
63e
63c
62a
61
63d
81A
66A
R2
R1
65

Fig. 7

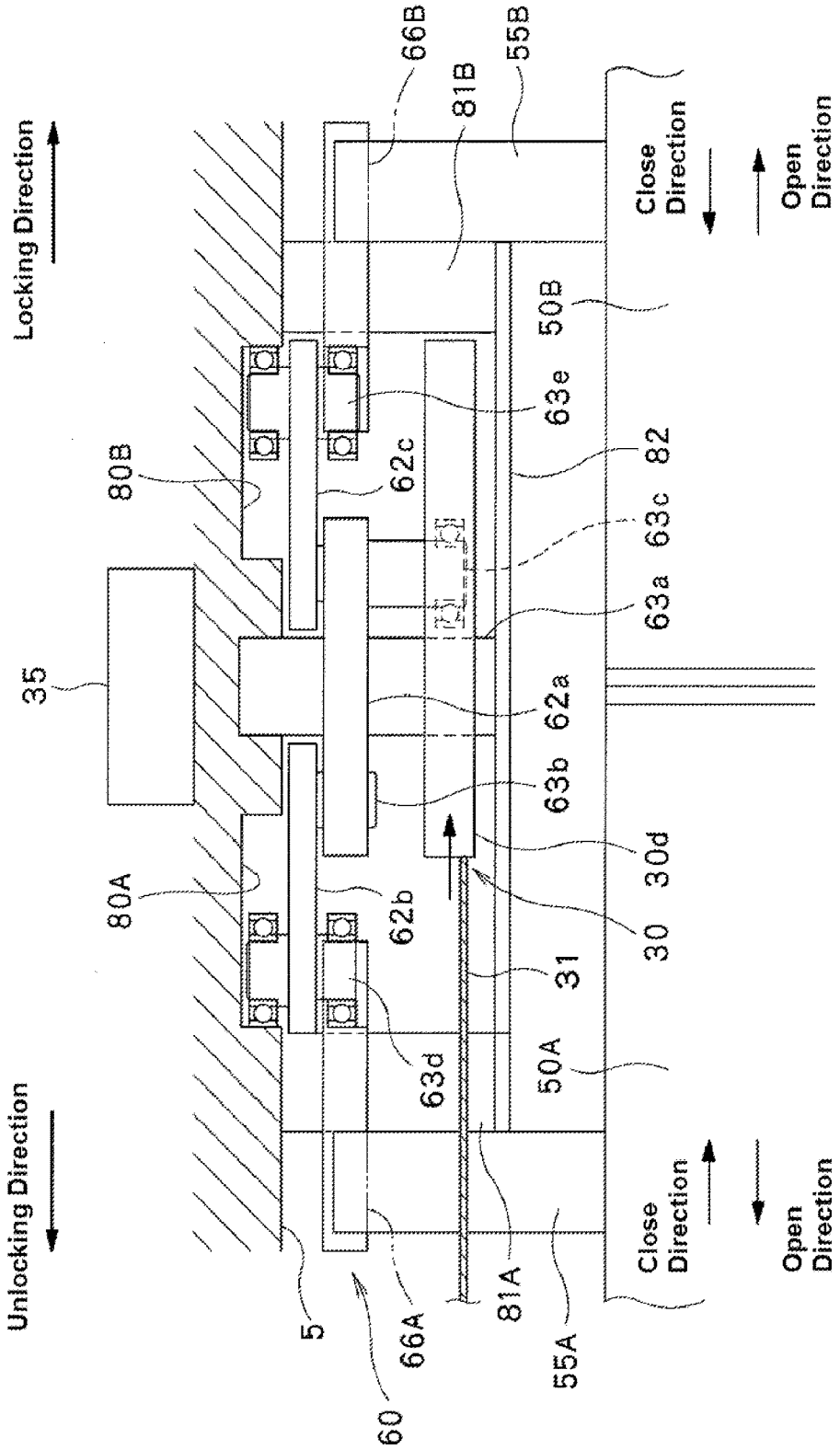

Locking Direction
Unlocking Direction
Close Direction
Open Direction
Close Direction
Open Direction
66B
81B
55B
50B
63e
82
80B
62c
63c
63a
35
62a
63b
80A
62b
30d
30
31
63d
50A
5
66A
60
81A
55A

Fig. 8

DOOR DEVICE FOR RAILROAD CAR, RAILROAD CAR HAVING THE SAME, EMERGENCY DOOR UNLOCKING DEVICE, AND METHOD OF UNLOCKING DOOR BODY LOCKED WITH LOCKING MECHANISM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is based on and claims the benefit of priority from Japanese Patent Application Serial No. 2017-027029 (filed on Feb. 16, 2017), the contents of which are hereby incorporated by reference in its entirety

TECHNICAL FIELD

[0002] The present invention relates to a door device for railroad cars and a railroad car provided with the door device for a railroad car. The invention also relates to a door unlocking device for unlocking a door body in an emergency and a method of unlocking a door body that is locked by a locking mechanism.

BACKGROUND

[0003] A door device for railroad cars includes a door body and a locking mechanism for locking the door body to maintain the door in a closed state. The door device is designed such that the door body is locked by the locking mechanism while railroad cars travel to prevent the door from unexpectedly being opened for passengers' safety. As a method of opening such a locked door body by a passenger in an emergency, the following procedures are known.

[0004] First, when power is properly supplied to a railroad car, a passenger can push a button or the like provided in the vicinity of the door body to send a request signal that requests unlocking of the door body to a member of a crew in a driver seat or the like. After it is determined by the crew member that the door body is allowed to be opened, the passenger mechanically unlocks the door body using a lever or the like provided in the vicinity of the door body. The reason why the passenger needs to obtain such a confirmation from the crew prior to unlocking the door body is that the passenger's safety should be ensured while the railroad car is traveling when the power is normally supplied and it should be confirmed that the speed of the car before the unlocking be below a predetermined speed and any other conditions may be checked if needed. In this example, the lever for unlocking the door body cannot be operated until the confirmation of the crew is obtained.

[0005] Whereas when power for opening the door body is not properly supplied, the railroad car is generally stopped. Therefore, it is not necessary to perform the confirmation, and the passenger can unlock the door body simply by operating the lever.

[0006] Alternatively, when the above-described lever is operated, not only the unlocking operation of the door is performed but also a request signal for unlocking the door may be transmitted. In this case, the lever may be designed to be operated in two stages. When the power is properly supplied, the lever can be operated only up to the first stage until the confirmation by a crew is obtained. When power is properly supplied, the request signal for requesting unlocking of the door body is transmitted by operating the lever to the first stage by a passenger, and once the confirmation by the crew is obtained, the passenger is allowed to operate the lever to the second stage to unlock the door. Whereas when power is not properly supplied, the passenger immediately unlocks the door body by operating the lever to the second stage with one push.

[0007] Here, it is a passenger to perform the unlocking operation of the door body as described above, and it is an emergency that such an unlocking operation is performed. Therefore, it is desirable that the unlocking operation of the door body be simple and the number of steps in the unlocking operation be small so as to be intuitively grasped by passengers.

[0008] However, the unlocking operation of the door body when the power is properly supplied is complicated as described above, and is different from the operation that can be intuitively grasped from the lever. More specifically, in order to unlock the door body, it is necessary to press the button before pulling the lever, or to operate the lever in the two stages.

[0009] In addition, if an object to be operated or an operation method is different between when the power is properly supplied and when the power is not properly supplied, a passenger has to try two or more operation methods in order to unlock the door body, which hinders prompt unlocking in an emergency.

SUMMARY

[0010] The present invention has been made in view of the above and one object of the invention is to provide a door device with which it is possible to perform unlocking operation of a door body in a simple and intuitive manner in an emergency, and a railroad car provided with the door device. Another object of the invention is to provide a door unlocking device and a method of unlocking a door body with which it is possible to perform unlocking operation of a door body simply and intuitively in an emergency.

[0011] A door device according to one aspect of the invention is a door device used for a railroad car. The door device includes: a door body that is openable and closeable; a locking mechanism locking the door body in a closed state; and an operation member operated to unlock the door body. When a power supply for the railroad car is in a normal state, it is determined whether the door body is allowed to be opened by operating the operation member, and the door body is unlocked by the locking mechanism only when it is determined that opening of the door body is allowed, and when the power supply for the railroad car is in an abnormal state, the door body is unlocked by the locking mechanism by operating the operation member.

[0012] The door device may further include a timer activated after the operation member is operated. When a predetermined time has elapsed after the timer is activated, it may be determined that the door body is allowed to be opened.

[0013] A railroad car according to another aspect of the invention includes the above-described door device, and a car body equipped with the door device.

[0014] A railroad car according to another aspect of the invention includes the above-described door device, a car body equipped with the door device, and a speed sensor measuring a speed of the car body. When a measurement result of the speed sensor indicates that the car body is stopped or a detected speed of the car body is at or lower

than a predetermined speed, it is determined that the door body is allowed to be opened.

[0015] A railroad car according to another aspect of the invention includes a door device equipped with the above-described timer; a car body equipped with the door device; and a speed sensor measuring a speed of the car body. When a measurement result of the speed sensor indicates that the car body is stopped or a detected speed of the car body is at or lower than a predetermined speed and when a predetermined time has elapsed after the timer is activated, it is determined that the door body is allowed to be opened.

[0016] A method of unlocking a door body according to another aspect of the invention is a method of unlocking a door body of a railroad car that is locked by a locking mechanism in a closed state. The method includes operating an operation member to unlock the door body; and when a power supply for the railroad car is in a normal state, determining whether the door body is allowed to be opened after the operation member is operated, and unlocking the door body by the locking mechanism only when it is determined that opening of the door body is allowed, when the power supply for the railroad car is in an abnormal state, unlocking the door body by the locking mechanism after the operation member is operated without determining whether opening of the door body is allowed.

[0017] In the method of unlocking the door body according to the aspect of the invention, it may be determined that the door body is allowed to be opened when a predetermined time has elapsed after the operation member is operated.

[0018] In the method of unlocking the door body, when the car body is stopped or the speed of the car body is at or lower than a predetermined speed, it may be determined that the door body is allowed to be opened.

[0019] In the method of unlocking the door body, when the car body is stopped or the speed of the car body is at or lower than a predetermined speed and when a predetermined time has elapsed after the operation member is operated, it may be determined that the door body is allowed to be opened.

[0020] A door unlocking device according to another aspect of the invention is a door unlocking device for unlocking a door body of a railroad car locked by a locking mechanism in a closed state. The door unlocking device includes: an operation member operated to unlock the door body; a motion detection sensor detecting a movement of the operation member and transmitting an electric signal; a transmission member transmitting the movement of the operation member to the locking mechanism; and a clutch mechanism engaging and disengaging transmission of the movement from the operation member to the transmission member.

[0021] In the door unlocking device, the clutch mechanism disengages transmission of the movement from the operation member to the transmission member when electric power is supplied to the clutch mechanism, and engages transmission of the movement from the operation member to the transmission member when electric power is not supplied to the clutch mechanism.

[0022] In the door unlocking device, the clutch mechanism may include a solenoid actuator.

[0023] In this case, the solenoid actuator includes an actuator main body supported by one of the operation member or the transmission member, and a movable portion movable relative to the actuator main body. The movable portion may protrude out from the main body to engage the other of the operation member or the transmission member when the solenoid actuator is demagnetized.

[0024] In this case, the other of the operation member or the transmission member may have a receiving portion that receives the movable portion of the demagnetized solenoid actuator.

[0025] In the door unlocking device, the operation member is movable between a non-operation position where the operation member is situated when the operation member is not operated, and an operation position where the motion detection sensor transmit the electric signal and a second operation position where the door body is allowed to be unlocked by the locking mechanism, and the door unlocking device may further include a holding mechanism that inhibits the operation member from returning to the non-operation position from the operation position or the second operation position after the operation member has been moved to the operation position or the second operation position from the non-operation position.

[0026] In this case, the holding mechanism may be a latch mechanism and allows the operation member to move from the operation position and the second operation position so as to move further away from the non-operation position.

[0027] In this case, the door unlocking device may further include a casing that holds the operation member such that the operation member is movable from the non-operation position to a third operation position via the operation position and the second operation position. The casing may be deformed by contacting the operation member that moves from the second operation position to the third operation position.

[0028] In this case, the casing may have, at a portion where is deformed by contacting the operation member that moves from the second operation position to the third operation position, a strength reduction feature for lowering the strength of the portion.

[0029] In the door unlocking device, the clutch mechanism includes a solenoid actuator, the solenoid actuator includes an actuator main body supported by one of the operation member or the transmission member, and a movable portion movable relative to the actuator main body, and the movable portion protrudes out from the main body to engage the other of the operation member or the transmission member when the solenoid actuator is demagnetized, the other of the operation member or the transmission member has a receiving portion that receives the movable portion of the demagnetized solenoid actuator when the operation member is situated at a non-operation position where the operation member is unoperated, and a second receiving portion that receives the demagnetized movable portion when the operation member is situated at a second operation position.

[0030] A door device according to another aspect of the invention includes the above-described door unlocking device.

[0031] A railroad car according to another aspect of the invention includes the above-described door unlocking device.

[0032] According to the aspect of the invention, an operator only has to perform one operation to unlock the door body. Therefore, it is possible to facilitate operator's intuitive grasping of the unlocking operation method of the door body.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033] FIG. **1** is a schematic diagram showing a configuration of a railroad car according to one embodiment of the invention.

[0034] FIG. **2** is a front view of a door unlocking device shown in FIG. **1**.

[0035] FIG. **3** is a cross-sectional view of the door unlocking device shown in FIG. **2**.

[0036] FIG. **4** is a perspective view of the door unlocking device showing an operation member, a transmission member, and a clutch mechanism in the door unlocking device shown in FIG. **2**.

[0037] FIG. **5** is a cross-sectional view of the door unlocking device to illustrate the clutch mechanism.

[0038] FIG. **6** is a plan view of a locking mechanism in an unlocked state.

[0039] FIG. **7** is a plan view of the locking mechanism in a locked state.

[0040] FIG. **8** is a side view of the locking mechanism in the locked state.

DESCRIPTION OF THE EMBODIMENTS

[0041] Embodiments of the invention will now be described with reference to the attached drawings.

[0042] FIG. **1** is a block diagram schematically showing an overall configuration of a railroad car according to an embodiment of the invention. Referring to FIG. **1**, a railroad car **10** includes a door device **20**, and a car body **25** to which the door device **20** is installed. Electric power is supplied to each part of the railroad car **10** from a power supply **40** provided in the car body **25**. The car body **25** is provided with a speed sensor **26** for measuring a speed of the car body **25**.

[0043] As shown in FIG. **1**, the door device **20** includes a door body (door panel) **50** that can be opened and closed, a locking mechanism **60** that locks the door body **50** in a closed state, and a door unlocking device **200** for unlocking the door body **50** of the railroad car **10** with the locking mechanism **60** in an emergency. The locking mechanism **60** has a movable member (locking slider) **30** capable of unlocking the door body **50** by sliding in a hereunder-described unlocking direction within the locking mechanism **60**, and a motor **35** that drives the locking slider **30**. One end of a wire **31** is connected to the locking slider **30**. When electric power is properly supplied from the power supply **40** (hereinafter also referred to as "when the power supply works normally" or "in the normal power supply state"), the door unlocking device **200** is configured to drive the motor **35** of the locking mechanism **60** via a hereunder-described control unit **210** to slide the locking slider **30** in the unlocking direction. Whereas when electric power is not properly supplied from the power supply **40** (hereinafter also referred to as "when there is some failure in the power supply" or "in the abnormal power supply state), the door unlocking device **200** is configured to pull the wire **31** to slide the locking slider **30** in the unlocking direction.

[0044] The door device **20** further includes the control unit **210** that controls unlocking of the door body **50** when electric power is properly supplied from the power supply **40**.

[0045] Hereinafter, the door unlocking device **200** of the embodiment will be described in detail with reference to FIGS. **2** to **5**. FIG. **2** is a front view of the door unlocking device **200** when it is not operated, and FIG. **3** is a sectional view of the door unlocking device **200** along the line III-III shown in FIG. **2**. FIG. **4** is a perspective view of the door unlocking device **200** when it is operated. FIG. **5** is a cross-sectional view of the door unlocking device along the line V-V shown in FIG. **3**.

[0046] As shown in FIG. **2** and FIG. **3**, the door unlocking device **200** includes an operation member **230** that is operated to unlock the door body **50** in an emergency, a casing **236** that holds the operation member **230** such that the operation member **230** is rotatable. Further, the door unlocking device **200** has a motion detection sensor **260** that detects a movement of the operation member **230**, and a holding mechanism **235** that restricts movement of the operated operation member **230**. Referring to FIG. **4**, the door unlocking device **200** includes a transmission member **270** that transmits a movement of the operation member **230** to the locking mechanism **60**, and a clutch mechanism **280** that engages and disengages transmission of the movement from the operation member **230** to the transmission member **270**.

[0047] As shown in FIGS. **2** to **5**, the operation member **230** is generally a plate-like member. A bearing **232** is provided on an end portion of one surface of the operation member **230**.

[0048] The casing **236** has a support portion **237** rotatably supporting a shaft **233** that passes through the bearing **232** of the operation member **230**. The casing **236** holds the operation member **230** such that the operation member is movable from a non-operation position A situated when the operation member is not operated, to a third operation position D via an operation position B and a second operation position C. To allow an operator to intuitively grasp even in an emergency that he/she should move the operation member **230** from the non-operation position A to the second operation position C, a portion **238** of the casing **236** is designed such that it comes into contact with the operation member **230** when the operation member **230** is moved to the second operation position C. The portion **238** is also designed to deform such that it allows the operation member **230** to be further moved to the third operation position D if necessary. That is, while the operation member **230** moves from the second operation position C to the third operation position D, the portion **238** is deformed by contacting the operation member **236**. More specifically, the portion **238** of the casing **236** has a notch **239** as a strength reduction feature for reducing the strength of the portion **238** where is deformed when it contacts the operation member **236**. Other configurations for the strength reduction may be possible such as thinning and formation of a through hole.

[0049] When the operation member **230** is moved to the operation position B, the motion detection sensor **260** is configured to transmit an electric signal. The motion detection sensor **260** may include a magnetic sensor, for example, and can detect approach of the operation member **230**.

[0050] Once the operation member **230** is moved to the operation position B or the second operation position C from the non-operation position A, the holding mechanism **235** inhibits the operation member **230** from returning to the non-operation position A from the operation position B or the second operation position C. In the embodiment, the holding mechanism **235** is a latch mechanism and allows the operation member **230** to move from the operation position B and the second operation position C so as to move further away from the non-operation position A. With such a

holding mechanism **235**, it is prevented that the operation member **230** that has been moved to the operation position B or the second operation position C returns to the non-operation position A, and if necessary, the operation member **230** can be further moved from the operation position B to the second operation position C or from the second operation position C to the third operation position D.

[0051] The clutch mechanism **280** is configured to disengage transmission of the movement from the operation member **230** to the transmission member **270** when electric power is properly supplied from the power supply **40**. Whereas when electric power is not properly supplied from the power supply **40**, the clutch mechanism **280** is configured to engage transmission of the movement from the operation member **230** to the transmission member **270**.

[0052] As shown in FIG. **4** and FIG. **5**, the clutch mechanism **280** includes a solenoid actuator **281** that receives electric power from the power supply **40** and generates a magnetic field therearound. The solenoid actuator **281** includes an actuator main body **282** supported by the transmission member **270** and a movable portion **283** movable relative to the actuator main body **282**. In a state where the solenoid actuator **281** is excited, the movable portion **283** is accommodated in the main body **282**, for example, when electric power is normally supplied from the power supply **40**. Further, in a state where the solenoid actuator **281** is demagnetized, for example, when electric power supply from the power supply **40** is abnormal, the movable portion **283** protrudes out from the main body **282** to engage with the operation member **230**. More specifically, the operation member **230** has a receiving portion **283***a* that receives the protruded movable portion **283** of the demagnetized solenoid actuator **281**. The receiving portion **283***a* is provided at a position where it can receive the protruded movable portion **283** when the operation member **230** is situated at the non-operation position A. The operation member **230** is further provided with a second receiving portion **283***b* that receives the protruded movable portion **283** so that the operation member **230** can engage with the movable portion **283** even when the operation member **230** is moved to the second operation position C. More specifically, the second receiving portion **283***b* is provided at a position where it can receive the protruded movable portion **283** when the operation member **230** is situated at the second operation position C.

[0053] In the example shown in FIG. **3**, although the operation position B and the second operation position C are situated at different positions, but they may be at the same position. That is, the operation position of the operation member **230** where the motion detection sensor **260** sends an electric signal (the operation position B in the example shown in FIG. **3**) and the operation position where the movable portion **283** of the clutch mechanism **280** is able to engage with the second receiving portion **283***b* (the second operation position C in the example shown in FIG. **3**) may correspond with each other.

[0054] The actuator main body **282** may be supported by the operation member **230**. In this case, the receiving portion **283***a* and the second receiving portion **283***b* are provided in the transmission member **270**, and the movable portion **283** protruding out from the main body **282** is engaged with the transmission member **270**.

[0055] The transmission member **270** includes a pinion **271** and a rack **273**. When the movable portion **283** of the clutch mechanism **280** is engaged with the operation member **230**, the pinion **271** rotates in conjunction with rotation of the operation member **230**. The rack **273** is configured to move in the vertical direction in accordance with rotation of the pinion **271**. A tip portion of the rack **273** is coupled to the other end of the wire **31** that is coupled to the locking slider **30** of the locking mechanism **60**. In this manner, the movement of the rack **273** is transmitted to the locking slider **30** of the locking mechanism **60** via the wire **31**.

[0056] Referring again to FIG. **1**, the control unit **210** will be now described. As shown in FIG. **1**, the control unit **210** includes a determination unit **212** that determines whether the door body **50** is allowed to be opened, a switch (SW) unit **213** that electrically connects or disconnects the motor **35** of the locking mechanism **60** to/from the power supply **40**.

[0057] When the door unlocking device **200** is operated while electric power is supplied properly from the power supply **40**, the determination unit **212** determines whether the door body **50** is allowed to be opened. As shown in FIG. **1**, the determination unit **212** has a timer **215**. The timer **215** is activated upon receiving an electric signal sent from the motion detection sensor **260**.

[0058] The determination unit **212** determines that the door body **50** is allowed to be opened only when following first condition and second condition are satisfied. The first condition is that a measurement result of the above-described speed sensor **26** shows that the car body **25** is stopped or a detected speed of the car body **25** is at or lower than a predetermined speed. The second condition is that a predetermined time has elapsed since the timer **215** was activated. Alternatively, the determination unit **212** may determine that opening of the door body **50** is allowed when either one of the first condition and the second condition is satisfied.

[0059] Moreover, instead of providing the determination unit **212**, a member of a crew may determine whether opening of the door body **50** is allowed or not based on the speed sensor **26**, the timer **215**, and other instruments.

[0060] The switch unit **213** is switched so as to supply electric power from the power supply **40** to the motor **35** only when the determination unit **212** determines that opening of the door body **50** is allowed. The switch unit **213** may be operated to be switched by a member of a crew at his/her discretion.

[0061] The locking mechanism **60** according the embodiment will be described in detail with reference to FIGS. **6** to **8**. FIG. **6** is a plan view of the locking mechanism **60** in an unlocked state, and FIG. **7** is a plan view of the locking mechanism **60** in a locked state. FIG. **8** is a side view of the locking mechanism **60** in the locked state. In the examples shown in FIGS. **6** to **8**, the door body **50** includes a pair of right and left door panels **50**A and **50**B of a sliding type.

[0062] As shown in FIG. **8**, the locking mechanism **60** is supported by a base **5** that is fixed to the car body **25** above the door body **50**. The base **5** extends along the opening and closing direction of the door body **50**. As shown in FIGS. **6** to **8**, the locking mechanism **60** includes a link mechanism **61** that is deformable between a linear state and a flexion state in a horizontal plane, and a link retaining mechanism **65** that operates within the horizontal plane. The link mechanism **61** is formed by coupling three links **62***a*, **62***b*, and **62***c*. At a central portion in its longitudinal direction, the central link **62***a* is rotatably fixed to the base **5** by a coupling pin **63***a*. One end of the central link **62***a* is coupled to one end

of the link **62***b* by a coupling pin **63***b*. The other end of the central link **62***a* is coupled to one end of the link **62***c* by a guide coupling pin **63***c*. A pin **63***d* and a pin **63***e* are provided at ends of the links **62***b*, **62***c* respectively on the side opposite the points of coupling between the links **62***b*, **62***c* and the link **62***a*.

[0063] Further, the locking mechanism **60** has the locking slider **30** which is a movable member for switching the locking mechanism **60** between the locked state and the unlocked state. The locking slider **30** is supported by the base **5** and slidable along the opening and closing direction of the door body **50**. The locking slider **30** is configured to slide when it receives a driving force exerted by the motor **35**. As shown in FIG. **8**, one end of the wire **31** is connected to one end of the locking slider **30**, and the locking slider is able to slide also by a pulling force exerted by the wire **31**.

[0064] As shown in FIGS. **6** to **8**, the pins **63***d* and **63***e*, situated at the ends of the link mechanism **61**, have ends thereof respectively inserted in guide grooves **80**A and **80**B (indicated by alternate long and two short dashes lines in FIGS. **6** and **7**) that are formed linearly in the base **5** in parallel to the sliding direction of the locking slider **30**. In this way, the pins **63***d* and **63***e* are installed so as to be movable along the guide grooves **80**A and **80**B. In other words, the movements of the pins **63***d* and **63***e* are respectively restricted by the guide grooves **80**A and **80**B.

[0065] An end of the guide coupling pin **63***c* of the link mechanism **61** situated closer to the locking slider **30** is inserted in a slit **30***e* of the locking slider **30**. The slit **30***e* has a first hole α that is formed lineally in parallel to the moving direction of the locking slider **30**, and a second hole β that has a curved shape and is connected to the end portion of the first hole α on the side closer to the guide groove **80**B. The first hole α is aligned with the guide grooves **80**A, **80**B in the moving direction of the locking slider **30**. On the other hand, an end of the second hole β on the side opposite to the side connected to the first hole α is not aligned with the first hole α and the guide grooves **80**A, **80**B in the moving direction of the locking slider **30**. The guide connecting pin **63***c* is configured such that it can be displaced from the first hole α to the second hole β or from the second hole β to the first hole α according to the position of the locking slider **30**. The position of the guide coupling pin **63***c* is thus restricted by the position of the locking slider **30**. Therefore the central link **62***a* is rotated by the movement of the locking slider **30** and it is possible to switch between the linear state and the flexion state of the link mechanism **61**.

[0066] The link retaining mechanism **65** includes a pair of engaging members **66**A and **66**B that are provided near the respective ends of the link mechanism **61** symmetrically with reference to the link mechanism **61** (with reference to the coupling pin **63***a*) such that they are rotatable within the horizontal plane. The link retaining mechanism **65** further includes a coupling spring **69** that couples the pair of engaging members to each other. The engaging members **66**A and **66**B respectively have, at peripheral portions thereof, first engaging portions **67**A and **67**B and second engaging portions **68**A and **68**B that are formed in concave shapes. Rotation shafts **81**A and **81**B of the engaging members **66**A and **66**B are fixedly provided on the base **5** (see FIG. **8**). A bridge member **82** is fixed to the pair of rotation shafts **81**A and **81**B, and the coupling pin **63***a* for rotatably fixing the central link **62***a* of the link mechanism **61** is supported by the bridge member **82**.

[0067] When no external force exerts on the link retaining mechanism **65**, the engaging members **66**A and **66**B receive a force from the coupling spring **69** and are retained in the state as shown in FIG. **6**. In this state, the engaging members **66**A and **66**B constrain, by their peripheral portions (portions indicated by the arrows P**2** in FIG. **6**), an extending movement of the link mechanism **61** into the linear state. When the link mechanism **61** is thus held in the flexion state by the engaging members **66**A and **66**B, the locking slider **33** is prevented from moving in the locking direction (the direction indicated by the arrow in FIG. **6**) via the slit **33***e* and the guide coupling pin **63***c*.

[0068] Meanwhile, when edges (portions indicated by P**1** in FIG. **6**) of the first engaging portions **67**A and **67**B are urged by the movement of the locking pins **55**A and **55**B in the closing directions (directions indicated by the arrows in FIG. **6**) that are respectively fixed to the door panels **50**A and **50**B, the engaging members **66**A and **66**B turn in directions (directions indicated by the arrows R**1** in FIG. **6**) in which the second engaging portions **68**A and **68**B approach the link mechanism **61** against the urging force of the coupling spring **69**. In a state where the door panels **50**A and **50**B are in a fully closed position, the locking pins **55**A, **55**B and the first engaging portions **67**A, **67**B are engaged with each other as shown in FIG. **7**, and the second engaging portions **68**A and **68**B are situated at the positions where they can engage with the pins **63***d* and **63***e* disposed at the ends of the link mechanism **61**. That is, the engaging members **66**A and **66**B are in a state where they do not constrain the deformation of the link mechanism **61**. If at this point, the locking slider **30** moves in the locking direction, the link mechanism **61** is made to transition from the flexion state to the linear state by the guide connecting pin **63***c* that moves along the slit **33***e*. The pins **63***d* and **63***e* that are situated at the ends of the link mechanism **61** then engage with the second engaging potions **68**A and **68**B of the engaging members **66**A and **66**B respectively. Turning of the engaging members **66**A and **66**B are thereby constrained. Movements of the locking pins **55**A and **55**B in opening directions (directions indicated by the arrows in FIG. **7**) are thus constrained by the first engaging portions **67**A and **67**B.

[0069] Next, operation of the railroad car **10** having the door device **20** of the embodiment will be described.

[0070] When an operator tries to open the door body **50**, the door body **50** is closed and locked by the locking mechanism **60**. That is, the link mechanism **61** in the locking mechanism **60** is in the linear state shown in FIG. **7**. Further, the operation member **230** of the door unlocking device **200** is in the non-operation position A shown in FIGS. **2** and **3**. The switch unit **213** is switched to the position where electric power is not supplied to the motor **35** of the locking mechanism **60** from the power supply **40**.

[0071] Firstly described is a case where electric power is properly supplied to the railroad car **10** from the power supply **40** when an operator begins to operate the operation member **230**. In this case, the solenoid actuator **281** of the clutch mechanism **280** in the door unlocking device **200** is excited by electric power supplied from the power supply **40**. Therefore, the movable portion **283** of the clutch mechanism **280** remains accommodated in the main body **282** and is not engaged with the operation member **230**. Accordingly, even if the operator operates the operation member **230**, the operational movement of the operation member **230** is not transmitted to the transmission member **270**.

[0072] In this state, in order to unlock the door body **50** that has been locked in the closed state by the locking mechanism **60**, the operator moves the operation member **230** of the door unlocking device **200** from the non-operation position A to the operation position B. When the operation member **230** is moved, the movement of the operation member **230** is detected by the motion detection sensor **260**. When the operation member **230** is moved to the operation position B, an electric signal is transmitted by the motion detection sensor **260**.

[0073] The operation member **230** that has been moved to the operation position B is held by the holding mechanism **235** of the door unlocking device **200**. Consequently the operation member **230** is retained at the operation position B without returning to the non-operation position A.

[0074] When the determination unit **212** receives the electric signal from the motion detection sensor **260**, the determination unit **212** activates the timer **215** and determines whether opening of the door body **50** is allowed. More specifically, the determination unit **212** determines if a measurement result of the above-described speed sensor **26** shows that the car body **25** is stopped or a detected speed of the car body **25** is at or lower than a predetermined speed (the first condition). Further, the determination unit **212** determines if a predetermined time has elapsed after the operation member **230** is operated, that is, determines if a predetermined time has elapsed since the timer **215** was activated (the second condition). The determination unit **212** determines that the door body **50** is allowed to be opened after confirming that the first condition and the second condition are satisfied. Note that the car body **25** can be moved to a place suitable for a crew to get off the car after the timer **215** is activated and before the predetermined time elapses.

[0075] When the determination unit **212** determines that the door body **50** is allowed to be opened, the switch unit **213** is switched such that electric power is supplied from the power supply **40** to the motor **35** of the locking mechanism **60**. When electric power is supplied to the motor **35**, the locking slider **30** receives the driving force of the motor **35** and slides in the unlocking direction.

[0076] Here, the determination as to whether opening of the door body **50** is allowed may be made by a member of a crew based on information obtained from the speed sensor **26**, the timer **215** and other instruments as described above. In addition, the operation of releasing the locking mechanism **60**, such as switching of the switch unit **213** may also be carried out manually by a member of a crew.

[0077] As the locking slider **30** is moved in the unlocking direction, the guide connecting pin **63***c* of the link mechanism moves along the edge of the slit **30***e* from the first hole α to the second hole β. Thereby the link mechanism **61** is made a transition from the linear state to the flexion state. Consequently engagements between the second engaging potions **68**A, **68**B of the engaging members **66**A, **66**B and the pins **63***d*, **63***e* that are situated at the ends of the link mechanism **61** are released. Then, due to the tensile elastic force of the connecting spring **69** that connects the pair of engaging members **66**A, **66**B, the engaging members **66**A, **66**B receives the force that turns the first engaging portions **67**A, **67**B in the R**2** direction shown in FIG. **7** to face outward (to face away from the link mechanism **61**). The locking pins **55**A and **55**B that are engaged with the second engaging portions **68**A and **68**B respectively are thereby allowed to move in the opening directions and the door panels **50**A and **50**B are unlocked.

[0078] Once the door is unlocked, an operator draws the door panels **50**A, **50**B to open the door body **50**.

[0079] Next, described is a case where power supply to the railroad car **10** from the power supply **40** is abnormal when an operator begins to operate the operation member **230**. In this case, the solenoid actuator **281** of the clutch mechanism **280** is demagnetized since it does not receive the electric power from the power supply **40**. Accordingly, the movable portion **283** protrudes out from the main body **282**. The movable portion **283** that protrudes from the main body **282** is received by a receiving portion **283***a* of the operation member **230** and is engaged with the operation member **230**.

[0080] In this state, when the operator moves the operation member **230** from the non-operation position A to the second operation position C, this movement of the operation member **230** is transmitted to the transmission member **270** via the clutch mechanism **280**. The pinion **271** of the transmission member **270** rotates in accordance with the movement of the operation member **230** to move the rack **273** in the downward direction. Consequently, the wire **31** whose other end is connected to the tip of the rack **273** is pulled downward.

[0081] When the wire **31** is pulled downward, the locking slider **30** of the locking mechanism **60** slides in the unlocking direction by the pulling force of the wire **31**. As a result, the door body **50** is unlocked by the locking mechanism **60**.

[0082] Described next is a case where some failure occurs in the power supply **40** of the railroad car **10** after an operator begins to operate the operation member **230**, more specifically, during the operator moves the operation member **230** from the non-operation position A to the second operation position C, or after the operator moved the operation member to the second operation position C.

[0083] In this case, due to occurrence of a failure in the power supply **40**, the solenoid actuator **281** of the clutch mechanism **280** shifts from the excited state to the demagnetized state. Therefore the movable portion **283** accommodated in the main body moves relative to the main body **282** and protrudes out from the main body **282**. When the operation member **230** is moved to the second operation position C (if the operation member **230** has been moved to the second operation position C, at the second operation position C), the movable portion **283** that protrudes out from the main body **282** is received by the second receiving portion **283***b* of the operation member **230**, and engaged with the operation member **230**.

[0084] In this state, when the operator further moves the operation member **230** to the third operation position D, this movement of the operation member **230** is transmitted to the transmission member **270** via the clutch mechanism **280**. Consequently, the wire **31** that is connected to the rack **273** of the clutch mechanism **280** is pulled downward. The locking slider **30** of the locking mechanism **60** slides in the unlocking direction when the wire **31** is pulled downward, and the door body **50** is unlocked by the locking mechanism **60**. The displacement of the operation member **230** from the second operation position C to the third operation position D is not hindered because the portion **238** provided with the strength reduction feature of the casing **236** deforms when the operation member **230** comes into contact with the portion **238**.

[0085] As for the door device **20** used for the railroad car **10** according to the embodiment, the door device **20** includes the door body **50** that can be opened and closed, the locking mechanism **60** for locking the door body **50** in a closed state, and the operation member **230** that is operated to unlock the door body **50**. When the power supply **40** of the railroad car **10** is normal, it is determined whether the door body **50** is allowed to be opened by operating the operation member **230**. The door body **50** is unlocked by the locking mechanism **60** only when it is determined that opening of the door body **50** is allowed. Whereas when the power supply **40** of the railroad car **10** is in an abnormal state, the door body **50** is unlocked by the locking mechanism **60** by operating the operation member **230**.

[0086] According to the above-described door device **20**, an operator has to perform only one movement to unlock the door body **50** in an emergency. Therefore, it is possible to facilitate operator's intuitive grasping of the unlocking operation method of the door body **50**. Further, the operation object and the operation method are the same between the normal power supply state and the abnormal power supply state. Therefore, it is possible to prompt an operator to try one operation method that is intuitively grasped from the operation member **230** to unlock the door body **50**.

[0087] Moreover, the door device **20** further includes the timer **215** that is activated after the operation member **230** is operated. When a predetermined time has elapsed after the timer **215** is activated, it is determined that the door body **50** is allowed to be opened. According to the door device **20**, after the operation member **230** is operated and before the door body **50** is unlocked by the locking mechanism **60**, the speed of the car body **25** can be sufficiently reduced or the car body **25** can be moved to a place suitable for letting passengers and a crew get off. Therefore, it is possible to secure the safety of the crew of the railroad car **10**.

[0088] The railroad car **10** according to an embodiment includes the above-described door device **20**, and the car body **25** equipped with the door device **20**.

[0089] According to the above-described railroad car **10**, an operator only has to perform one movement to unlock the door body **50** in an emergency. Therefore, it is possible to facilitate operator's intuitive grasping of the unlocking operation method of the door body **50**. Further, the operation object and the operation method are the same between the normal power supply state and the abnormal power supply state. Therefore, it is possible to prompt an operator to try one operation method that is intuitively grasped from the operation member **230** to unlock the door body **50**.

[0090] The railroad car **10** according to an embodiment includes the above-described door device **20**, the car body **25** equipped with the door device **20**, and the speed sensor **26** that measures the speed of the car body **25**. When a measurement result of the speed sensor **26** indicates that the car body **25** is stopped or a detected speed of the car body **25** is at or lower than a predetermined speed, it is determined that the door body **50** is allowed to be opened.

[0091] According to the railroad car **10** as described above, the door body **50** is unlocked after the car body **25** is stopped or after the speed of the car body **25** is sufficiently reduced. Therefore, it is possible to secure the safety of the crew of the railroad car **10**.

[0092] The railroad car **10** according to an embodiment includes the above-described door device **20** equipped with the timer **215**, the car body **25** equipped with the door device **20**, and the speed sensor **26** that measures the speed of the car body **25**. When a measurement result of the speed sensor **26** indicates that the car body **25** is stopped or a detected speed of the car body **25** is at or lower than a predetermined speed and when a predetermined time has elapsed after the timer **215** is activated, it is determined that the door body **50** is allowed to be opened.

[0093] According to the railroad car **10** as described above, the door body **50** is unlocked after the car body **25** is stopped or after the speed of the car body **25** is sufficiently reduced. Further, after the operation member **230** is operated and before the door body **50** is unlocked by the locking mechanism **60**, it is possible to move the car body **25** to a place suitable for letting people getting off from the car. Therefore, it is possible to secure the safety of the crew of the railroad car **10**.

[0094] A method of unlocking the door body **50** of the railroad car **10** locked by the locking mechanism in a closed state according to an embodiment includes: operating the operation member **230** to unlock the door body **50**; and when the power supply for the railroad car **10** is in a normal state, determining whether the door body **50** is allowed to be opened after the operation member **230** is operated, and unlocking the door body **50** by the locking mechanism **60** only when it is determined that opening of the door body **50** is allowed, and when the power supply **40** for the railroad car **10** is in an abnormal state, unlocking the door body **50** by the locking mechanism **60** after the operation member **230** is operated without determining whether opening of the door body **50** is allowed.

[0095] According to this unlocking method, an operator only has to perform one operation to unlock the door body **50** in an emergency. Therefore, it is possible to facilitate operator's intuitive grasping of the unlocking operation method of the door body **50**. Further, the operation object and the operation method are the same between the normal power supply state and the abnormal power supply state. Therefore, it is possible to prompt an operator to try one operation method that is intuitively grasped from the operation member **230** to unlock the door body **50**.

[0096] In addition, in the above-described unlocking method, it is determined that the door body **50** is allowed to be opened when a predetermined time has elapsed after the operation member **230** is operated. According to this unlocking method, after the operation member **230** is operated and before the door body **50** is unlocked by the locking mechanism **60**, the speed of the car body **25** can be sufficiently reduced or the car body **25** can be moved to a place suitable for letting passengers and a crew get off. Therefore, it is possible to secure the safety of the crew of the railroad car **10**.

[0097] In the above described unlocking method, when the car body **25** is stopped or the speed of the car body **25** is at or lower than a predetermined speed, it is determined that the door body **50** is allowed to be opened. According to the unlocking method, the door body **50** is unlocked after the car body **25** is stopped or after the speed of the car body **25** is sufficiently reduced. Therefore, it is possible to secure the safety of the crew of the railroad car **10**.

[0098] In the above described unlocking method, when the car body **25** is stopped or the speed of the car body **25** is at or lower than a predetermined speed and when a predetermined time has elapsed after the operation member **230** is operated, it is determined that the door body **50** is allowed

to be opened. According to the unlocking method, the door body **50** is unlocked after the car body **25** is stopped or after the speed of the car body **25** is sufficiently reduced. Further, after the operation member **230** is operated and before the door body **50** is unlocked by the locking mechanism **60**, it is possible to move the car body **25** to a place suitable for letting people getting off from the car. Therefore, it is possible to secure the safety of the crew of the railroad car **10**.

[0099] The door unlocking device **200** according to an embodiment for unlocking the door body **50** of the railroad car **10** locked by the locking mechanism **60** in a closed state, includes the operation member **230** operated to unlock the door body **50**, the motion detection sensor **260** that detects a movement of the operation member **230** and transmits an electric signal, the transmission member **270** that transmits the movement of the operation member **230** to the locking mechanism **60**, and the clutch mechanism **280** that engages and disengages transmission of the movement from the operation member **230** to the transmission member **270**.

[0100] According to the above-described door unlocking device **200**, an operator has to perform only one movement to unlock the door body **50** in an emergency. Therefore, it is possible to facilitate operator's intuitive grasping of the unlocking operation method of the door body **50**. Further, it is possible to make the operation object and the operation method same between the normal power supply state and the abnormal power supply state. Therefore, it is possible to prompt an operator to try one operation method that is intuitively grasped from the operation member **230** to unlock the door body **50**.

[0101] More specifically, the clutch mechanism **280** disengages transmission of the movement from the operation member **230** to the transmission member **270** when electric power is supplied to the clutch, and engages transmission of the movement from the operation member **230** to the transmission member **270** when electric power is not supplied to the clutch. According to this door unlocking device **200**, it is easy to make the operation object and the operation method same between the normal power supply state and the abnormal power supply state. Therefore, it is possible to prompt an operator to try one operation method that is intuitively grasped from the operation member **230** to unlock the door body **50**.

[0102] More specifically the clutch mechanism **280** includes the solenoid actuator **281**. The solenoid actuator **281** includes the actuator main body **282** supported by one of the operation member **230** or the transmission member **270**, and the movable portion **283** movable relative to the actuator main body **282**. The movable portion **283** protrudes out from the main body **282** to engage the other of the operation member **230** or the transmission member **270** when the solenoid actuator **281** is demagnetized. The other of the operation member **230** or the transmission member **270** has the receiving portion **283***a* that receives the movable portion **283** of the demagnetized solenoid actuator **281**.

[0103] In the door unlocking device **200**, the operation member **230** is movable between the non-operation position A where the operation member **230** is situated when the operation member **230** is not operated, and the operation position B where the motion detection sensor **260** transmit the electric signal and the second operation position C where the door body **50** is allowed to be unlocked by the locking mechanism **60**. The door unlocking device **200** further includes the holding mechanism **235** that inhibits the operation member **230** from returning to the non-operation position A from the operation position B or the second operation position C after the operation member **230** has been moved to the operation position B or the second operation position C from the non-operation position A. According to this door unlocking device **200**, it is possible to prevent the operation member **230** from returning to the non-operation position A after the operation member **230** has been moved to the operation position B so that insufficient transmission of the electric signal by the motion detection sensor **260** is prevented. Moreover, it is possible to prevent the operation member **230** from returning to the non-operation position A after the operation member **230** has been moved to the second operation position C so that it is possible to prevent that the door body **50** is unintentionally locked again.

[0104] More specifically, the holding mechanism **235** is a latch mechanism and allows the operation member **230** to move from the operation position B and the second operation position C so as to move further away from the non-operating position A. According to this door unlocking device **200**, it is possible to further move the operation member **230** that is situated at the operation position B or the second operation position C to move away from the non-operation position A. In this way, it is possible to secure an operation amount of the operation member **230** necessary for unlocking the door body **50** by the locking mechanism **60** in preparation for occurrence of a failure of the power supply during operation of the operation member **230**.

[0105] The door unlocking device **200** may further include the casing **236** that holds the operation member **230** such that the operation member **230** is movable from the non-operation position A to the third operation position D via the operation position B and the second operation position C. The casing **236** is deformed by contacting the operation member **230** that moves from the second operation position C to the third operation position D. According to this door unlocking device **200**, an operator is able to intuitively grasp even in an emergency that he/she should move the operation member **230** from the non-operation position A to the operation position B, and moreover it is possible for the operator to stably operate the operation member **230** from the non-operation position A to the operation position B.

[0106] More specifically, the casing **236** has, at a portion **238** where is deformed by contacting the operation member **230** that moves from the second operation position C to the third operation position D, the strength reduction feature **239** for lowering the strength of the portion **238**.

[0107] Further in the door unlocking device **200**, the clutch mechanism **280** includes the solenoid actuator **281**. The solenoid actuator **281** includes the actuator main body **282** supported by one of the operation member **230** or the transmission member **270**, and the movable portion **283** movable relative to the actuator main body **282**. The movable portion **283** protrudes out from the main body **282** to engage the other of the operation member **230** or the transmission member **270** when the solenoid actuator **281** is demagnetized. The other of the operation member **230** or the transmission member **270** has a receiving portion **283***a* that receives the movable portion **283** of the demagnetized solenoid actuator **281** when the operation member **230** is situated at a non-operation position A where the operation member **230** is unoperated, and the second receiving portion **283***b* that receives the movable portion **283** of the demag-

netized solenoid actuator **281** when the operation member **230** is situated at the second operation position C.

[0108] According to this door unlocking device **200**, it is easy to make the operation object and the operation method same between the normal power supply state and the abnormal power supply state. Due to the presence of the receiving portions **283***a* and **283***b*, even when any failure occurs in the power supply after operation of the operating member **230** is started, the movable portion **283** of the clutch mechanism **280** is engaged with the operation member **230** or the transmission member **270** to allow the door body **50** to be unlocked by the locking mechanism **60**.

[0109] The door device **20** according to an embodiment includes the above-described door unlocking device **200**. According to this door device **20**, an operator has to perform only one movement to unlock the door body **50** in an emergency. Therefore, it is possible to facilitate operator's intuitive grasping of the unlocking operation method of the door body **50**. Further, it is possible to make the operation object and the operation method same between the normal power supply state and the abnormal power supply state. Therefore, it is possible to prompt an operator to try one operation method that is intuitively grasped from the operation member **230** to unlock the door body **50**.

[0110] The railroad car **10** according to an embodiment include the above-described door unlocking device **200**. According to this door device **20**, an operator has to perform only one movement to unlock the door body **50** in an emergency. Therefore, it is possible to facilitate operator's intuitive grasping of the unlocking operation method of the door body **50**. Further, it is possible to make the operation object and the operation method same between the normal power supply state and the abnormal power supply state. Therefore, it is possible to prompt an operator to try one operation method that is intuitively grasped from the operation member **230** to unlock the door body **50**.

[0111] The embodiments described herein represent a number of possible examples and is not intended to limit the scope of the invention. The foregoing embodiments may be implemented in various other ways and various omissions, replacements and modifications can be made to the embodiments without departing from the spirit of the invention. The embodiments and any such modifications are intended to be included within the spirit and scope of the invention and included in the scope of the invention defined by the following claims and equivalents thereof.

What is claimed is:

1. A door device used for a railroad car, comprising:

a door body that is openable and closeable;

a locking mechanism locking the door body in a closed state; and

an operation member operated to unlock the door body,

wherein when a power supply for the railroad car is in a normal state, it is determined whether the door body is allowed to be opened by operating the operation member, and the door body is unlocked by the locking mechanism only when it is determined that opening of the door body is allowed, and

when the power supply for the railroad car is in an abnormal state, the door body is unlocked by the locking mechanism by operating the operation member.

2. The door device according to claim **1**, further comprising:

a timer activated after the operation member is operated,

wherein when a predetermined time has elapsed after the timer is activated, it is determined that the door body is allowed to be opened.

3. A railroad car comprising:

the door device according to claim **1**: and

a car body equipped with the door device.

4. A railroad car comprising:

the door device according to claim **1**;

a car body equipped with the door device; and

a speed sensor measuring a speed of the car body,

wherein when a measurement result of the speed sensor indicates that the car body is stopped or a detected speed of the car body is at or lower than a predetermined speed, it is determined that the door body is allowed to be opened.

5. A railroad car comprising:

the door device according to claim **2**;

a car body equipped with the door device; and

a speed sensor measuring a speed of the car body,

wherein when a measurement result of the speed sensor indicates that the car body is stopped or a detected speed of the car body is at or lower than a predetermined speed and when a predetermined time has elapsed after the timer is activated, it is determined that the door body is allowed to be opened.

6. A method of unlocking a door body of a railroad car that is locked by a locking mechanism in a closed state, comprising:

operating an operation member to unlock the door body; and

when a power supply for the railroad car is in a normal state, determining whether the door body is allowed to be opened after the operation member is operated, and unlocking the door body by the locking mechanism only when it is determined that opening of the door body is allowed, and when the power supply for the railroad car is in an abnormal state, unlocking the door body by the locking mechanism after the operation member is operated without determining whether opening of the door body is allowed.

7. The method according to claim **6**, wherein it is determined that the door body is allowed to be opened when a predetermined time has elapsed after the operation member is operated.

8. The method according to claim **6**, wherein when the car body is stopped or the speed of the car body is at or lower than a predetermined speed, it is determined that the door body is allowed to be opened.

9. The method according to claim **6**, wherein when the car body is stopped or the speed of the car body is at or lower than a predetermined speed and when a predetermined time has elapsed after the operation member is operated, it is determined that the door body is allowed to be opened.

10. A door unlocking device for unlocking a door body of a railroad car locked by a locking mechanism in a closed state, comprising:

an operation member operated to unlock the door body;

a motion detection sensor detecting a movement of the operation member and transmitting an electric signal;

a transmission member transmitting the movement of the operation member to the locking mechanism; and

a clutch mechanism engaging and disengaging transmission of the movement from the operation member to the transmission member.

11. The door unlocking device according to claim **10**, wherein the clutch mechanism disengages transmission of the movement from the operation member to the transmission member when electric power is supplied to the clutch mechanism, and engages transmission of the movement from the operation member to the transmission member when electric power is not supplied to the clutch mechanism.

12. The door unlocking device according to claim **10**, wherein

the clutch mechanism includes a solenoid actuator,

the solenoid actuator includes an actuator main body supported by one of the operation member or the transmission member, and a movable portion movable relative to the actuator main body, and

the movable portion protrudes out from the main body to engage the other of the operation member or the transmission member when the solenoid actuator is demagnetized.

13. The door unlocking device according to claim **12**, wherein the other of the operation member or the transmission member has a receiving portion that receives the movable portion of the demagnetized solenoid actuator.

14. The door unlocking device according to claim **10**, wherein

the operation member is movable between a non-operation position where the operation member is situated when the operation member is not operated, and an operation position where the motion detection sensor transmit the electric signal and a second operation position where the door body is allowed to be unlocked by the locking mechanism, and

the door unlocking device further includes a holding mechanism that inhibits the operation member from returning to the non-operation position from the operation position or the second operation position after the operation member has been moved to the operation position or the second operation position from the non-operation position.

15. The door unlocking device according to claim **14**, wherein the holding mechanism is a latch mechanism and allows the operation member to move from the operation position and the second operation position so as to move further away from the non-operation position.

16. The door unlocking device according to claim **15**, further comprising:

a casing that holds the operation member such that the operation member is movable from the non-operation position to a third operation position via the operation position and the second operation position,

wherein the casing is deformed by contacting the operation member that moves from the second operation position to the third operation position.

17. The door unlocking device according to claim **16**, wherein the casing has, at a portion where is deformed by contacting the operation member that moves from the second operation position to the third operation position, a strength reduction feature for reducing the strength of the portion.

18. The door unlocking device according to claim **12**, wherein

the clutch mechanism includes a solenoid actuator,

the solenoid actuator includes an actuator main body supported by one of the operation member or the transmission member, and a movable portion movable relative to the actuator main body, and

the movable portion protrudes out from the main body to engage the other of the operation member or the transmission member when the solenoid actuator is demagnetized,

the other of the operation member or the transmission member has a receiving portion that receives the movable portion of the demagnetized solenoid actuator when the operation member is situated at a non-operation position where the operation member is unoperated, and a second receiving portion that receives the demagnetized movable portion when the operation member is situated at a second operation position.

19. A door device comprising the door unlocking device according to claim **10**.

20. A railroad car comprising the door unlocking device according to claim **10**.

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