

DESCRIPTION

Title of the Invention: Door Closing Device

Technical Field

[0001]

5 The present invention relates to a door closing device, and more particularly, it relates to a door closing device including a restrictor to restrict movement of a door body in the opening direction of the door body.

Background Art

10 [0002]

 A door closing device including a restrictor to restrict movement of a door body in the opening direction of the door body is known in general. Such a door closing device is disclosed in Japanese Patent Laid-Open No. 2003-
15 237569, for example.

[0003]

 A sliding door apparatus (door closing device) disclosed in Japanese Patent Laid-Open No. 2003-237569 includes a moving body that hangs a door body provided at
20 the entrance/exit of a train and moves in a right-left direction. Furthermore, the sliding door apparatus includes a locking mechanism to maintain the door body (moving body) in a closed state and lock the door body (moving body). The locking mechanism includes a latch rod
25 slidable in an upward-downward direction. The latch rod

enters and exits a latch hole provided in the moving body,
and engages with the moving body by being fitted into the
latch hole. Thus, the door body is locked. Furthermore, a
latch plate is fixed to the head of the latch rod.

5 [0004]

The sliding door apparatus includes an
electromagnetic solenoid. The electromagnetic solenoid is
turned on such that a plunger provided on the
electromagnetic solenoid protrudes upward. Then, the
10 plunger protruding upward contacts and presses the latch
plate to lift the latch rod through the latch plate. Thus,
the latch rod is disengaged from the latch hole such that
the engagement between the latch rod and the latch hole is
released, and the door body is unlocked in an open state.

15 Prior Art

Patent Document

[0005]

Patent Document 1: Japanese Patent Laid-Open No. 2003-
237569

20 Summary of the Invention

Problem to be Solved by the Invention

[0006]

However, in Japanese Patent Laid-Open No. 2003-237569,
noise is disadvantageously generated due to contact
25 (collision) between components such as contact (collision)

between the plunger and the latch plate as described above during the unlocking operation.

[0007]

5 The present invention has been proposed in order to solve the aforementioned problem, and an object of the present invention is to provide a door closing device capable of reducing noise generated when a locked state in which movement of a door body is restricted is released.

Means for Solving the Problem

10 [0008]

In order to attain the aforementioned object, a door closing device according to an aspect of the present invention includes a drive source configured to open and close a door body, and a restrictor configured to restrict movement of the door body in an opening direction of the door body by driving of the drive source. The restrictor includes a pin member configured to restrict the movement of the door body in the opening direction by engaging with a door body fixed portion fixed to the door body, the pin member being configured to be urged toward a position of engagement with the door body fixed portion, a pin holding member configured to hold the pin member, the pin holding member being configured to move integrally with the pin member, a shaft drive including a shaft, the shaft drive being configured to move the pin holding member in a

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direction away from the position of the engagement by
linearly moving the shaft and pressing the pin holding
member, the shaft drive being configured to move the pin
member held by the pin holding member in the direction
5 away from the position of the engagement, and a shock
absorber configured to cushion an impact caused by
collision between components of the restrictor when the
engagement between the pin member and the door body fixed
portion is released as the pin member is moved in the
10 direction away from the position of the engagement such
that a locked state in which the movement of the door body
is restricted is released.

[0009]

As described above, the door closing device according
15 to this aspect of the present invention includes the shock
absorber configured to cushion the impact caused by the
collision between the components of the restrictor when
the locked state is released. Accordingly, noise
generated by the collision between the components of the
20 restrictor can be reduced. Consequently, noise generated
when the locked state in which the movement of the door
body is restricted is released can be reduced.

[0010]

In the aforementioned door closing device according
25 to this aspect, the shock absorber preferably includes an

elastic member. With this configuration, when the locked state in which the movement of the door body is restricted is released, the impact caused by the collision between the components of the restrictor can be easily cushioned
5 by elastic deformation of the elastic member.
Consequently, the noise generated by the collision between the components of the restrictor can be further reduced.
[0011]

In the aforementioned door closing device according
10 to this aspect, the shock absorber preferably includes a first shock absorbing member provided at a tip end of the shaft on the pin holding member side. With this configuration, noise generated when the tip end of the shaft and the pin holding member collide with each other
15 can be reduced by the first shock absorbing member.
[0012]

In this case, the first shock absorbing member preferably includes a first portion fixed to the tip end of the shaft, and a second portion held by the first
20 portion and provided between the pin holding member and the first portion. With this configuration, the noise generated when the tip end of the shaft and the pin holding member collide with each other can be reduced by the second portion when the locked state in which the
25 movement of the door body is restricted is released.

[0013]

In the aforementioned door closing device in which the first shock absorbing member includes the first portion and the second portion, the first portion preferably includes a holding surface configured to hold the second portion and an annular side surface portion arranged so as to surround the holding surface and provided so as to extend from the holding surface side to the pin holding member side. With this configuration, the side surface portion is provided so as to extend from the holding surface side to the pin holding member side such that even when the second portion is damaged or falls off from the first portion, the pin holding member can be easily pressed by the side surface portion. Furthermore, the side surface portion is provided in an annular shape such that the area of a surface of the side surface portion that collides with the pin holding member can be relatively increased, and thus noise generated when the side surface portion collides with the pin holding member can be reduced when the locked state in which the movement of the door body is restricted is released. Moreover, the second portion is held by the holding surface such that the second portion can be stably held.

[0014]

In the aforementioned door closing device in which

the first shock absorbing member includes the first portion and the second portion, a first recess is preferably provided on a surface of the pin holding member on the first shock absorbing member side, and the shock absorber preferably includes a second shock absorbing member arranged in the first recess of the pin holding member, the second shock absorbing member being configured to contact the second portion of the first shock absorbing member. With this configuration, the noise generated when the tip end of the shaft and the pin holding member collide with each other can be further reduced by the second shock absorbing member when the locked state in which the movement of the door body is restricted is released. Furthermore, even when the second portion falls off from the first portion, the noise generated when the tip end of the shaft and the pin holding member collide with each other can be reduced by the second shock absorbing member.

[0015]

In this case, a portion of the second portion that contacts the second shock absorbing member preferably has a substantially flat surface shape. With this configuration, the second portion and the second shock absorbing member can be brought into surface contact with each other, and thus the noise generated when the locked

state in which the movement of the door body is restricted is released can be reduced as compared with a case in which the second portion comes into point contact with the second shock absorbing member.

5 [0016]

In the aforementioned door closing device according to this aspect, the shaft drive preferably includes a solenoid including the shaft and a solenoid main body into which the shaft is inserted, the solenoid being configured to move the shaft in an axial direction of the shaft by a force of a magnetic field, and a stopper provided on the shaft on a side opposite to a tip end of the shaft on the pin holding member side with respect to the solenoid main body, the stopper being configured to stop movement of the shaft toward the pin holding member at a predetermined position by being restricted movement of the stopper toward the pin holding member by the solenoid main body. The shock absorber preferably includes a third shock absorbing member provided between the stopper and the solenoid main body. With this configuration, an impact caused by collision between the stopper and the solenoid main body can be cushioned by the third shock absorbing member, and thus the noise generated by the collision between the stopper and the solenoid main body can be reduced when the locked state in which the movement of the

door body is restricted is released.

[0017]

In the aforementioned door closing device according to this aspect, an engaging member configured to engage
5 with the pin holding member is preferably provided at an end of the pin member on a side opposite to the door body fixed portion, the pin holding member preferably includes a support surface configured to support the engaging member from the door body side, and the shock absorber
10 preferably includes a sheet-shaped fourth shock absorbing member provided between the support surface and the engaging member. With this configuration, when the locked state in which the movement of the door body is restricted is released, an impact caused by collision between the
15 support surface and the engaging member can be cushioned by the fourth shock absorbing member, and thus noise generated by collision between the support surface and the engaging member can be reduced.

[0018]

20 In this case, the pin holding member preferably includes a through-hole into which the end of the pin member is inserted and in which the engaging member provided at the end of the pin member is housed, a clearance is preferably provided between the engaging
25 member and an inner wall surface of the through-hole in

the through-hole, and the shock absorber preferably includes a gel-like fifth shock absorbing member filled in the clearance of the through-hole and provided such that the engaging member is interposed between the gel-like fifth shock absorbing member and the fourth shock absorbing member. With this configuration, the engaging member is interposed between the fourth shock absorbing member and the fifth shock absorbing member such that an impact caused by collision between the engaging member and the inner wall surface of the through-hole can be cushioned inside the through-hole when the locked state in which the movement of the door body is restricted is released. Consequently, noise generated by collision between the engaging member and the inner wall surface of the through-hole can be reduced.

[0019]

In the aforementioned door closing device according to this aspect, the shock absorber is preferably configured to cushion the impact caused by the collision between the components of the restrictor when the locked state of the door body provided on a railroad vehicle is released. With this configuration, the noise generated when the locked state in which the movement of the door body is restricted is released in the railroad vehicle can be reduced.

Effect of the Invention

[0020]

According to the present invention, as described above, it is possible to reduce the noise generated when
5 the locked state in which the movement of the door body is restricted is released.

Brief Description of the Drawings

[0021]

FIG. 1 is a perspective view showing the
10 configuration of a door closing device according to an embodiment.

FIG. 2 is a diagram illustrating the operation of the door closing device according to the embodiment (FIG. 2A is a diagram showing a door closed state. FIG. 2B is a
15 diagram showing a door open state).

FIG. 3 is a front view of a locking device in the locked state according to the embodiment.

FIG. 4 is a front view of the locking device upon release of the locked state according to the embodiment.

20 FIG. 5 is a sectional view taken along the line 200-200 in FIG. 3.

FIG. 6 is a partially enlarged sectional view of the vicinity of a solenoid according to the embodiment.

FIG. 7 is a perspective view showing the
25 configuration of the solenoid according to the embodiment.

FIG. 8 is a plan view showing a fixed portion and a contact portion as viewed from the Z1 direction side according to the embodiment.

FIG. 9 is a partially enlarged view of the vicinity of a cap in FIG. 5.

Modes for Carrying Out the Invention

[0022]

An embodiment embodying the present invention is hereinafter described on the basis of the drawings.

[0023]

This Embodiment

The configuration of a door closing device 100 according to this embodiment is now described with reference to FIGS. 1 to 9.

[0024]

Configuration of Door Closing Device

As shown in FIG. 1, the door closing device 100 is an electric device that opens and closes door bodies A and B. The door closing device 100 is mounted on a railroad vehicle. The door closing device 100 includes a drive source 10, a direction changing device 20, and a locking device 30. The locking device 30 is provided to restrict movement of the door bodies A and B in the opening directions of the door bodies A and B due to driving of the drive source 10. The locking device 30 is an example

of a "restrictor" in the claims.

[0025]

In the following description, the opening-closing directions of the door bodies (A, B) are defined as an X direction, one direction in the X direction is defined as an X1 direction, and the other direction in the X direction is defined as an X2 direction. Furthermore, an upward-downward direction is defined as a Z direction, one direction in the Z direction is defined as a Z1 direction (upward direction), and the other direction in the Z direction is defined as a Z2 direction (downward direction). A direction orthogonal to the X and Z directions is defined as a Y direction, one direction in the Y direction is defined as a Y1 direction (inboard direction), and the other direction in the Y direction is defined as a Y2 direction (outboard direction).

Furthermore, a state in which the door bodies (A, B) are moved in the closing direction and closed is defined as a door closed state (see FIG. 2A), and a state in which the door bodies (A, B) are moved in the opening direction and opened is defined as a door open state (see FIG. 2B).

[0026]

The drive source 10 generates a driving force to open and close the door bodies (A, B). Specifically, the drive source 10 includes an electric motor including an output

shaft that rotates around a rotation center axis extending in a direction along the Y direction.

[0027]

As shown in FIG. 2, the direction changing device 20 includes a housing 21 (see FIG. 1), a pinion gear 22, a first rack 23, a first connecting arm 24, a second rack 25, a second connecting arm 26, and an engaging body 27. The housing 21 has an elongated box shape extending along the X direction. The pinion gear 22, the first rack 23, the first connecting arm 24, the second rack 25, and the second connecting arm 26 are housed in the housing 21. The pinion gear 22 is attached to the output shaft of the drive source 10. The pinion gear 22 rotates as the output shaft rotates. The engaging body 27 is an example of a "door body fixed portion" in the claims.

[0028]

The first rack 23 is arranged on the X1 direction side in the door closed state. The first rack 23 extends in the X direction. The first rack 23 moves in the X direction along guide rail 23a due to rotation of the pinion gear 22. The first connecting arm 24 connects the door body A to the first rack 23. Thus, the first connecting arm 24 moves integrally with the first rack 23 in the X direction.

[0029]

Specifically, the first rack 23 moves in the X2 direction along the guide rail 23a due to rotation of the pinion gear 22 in an R1 direction (clockwise direction). At this time, the first connecting arm 24 moves in the X2 direction together with the first rack 23 such that the door body A (see FIG. 1) moves in the X2 direction. Thus, the door body A is opened. The first rack 23 moves in the X1 direction along the guide rail 23a due to rotation of the pinion gear 22 in an R2 direction (counterclockwise direction). At this time, the first connecting arm 24 moves in the X1 direction together with the first rack 23 such that the door body A moves in the X1 direction. Thus, the door body A is closed.

[0030]

The second rack 25 is arranged on the X2 direction side in the door closed state. The second rack 25 extends in the X direction. The second rack 25 moves in the X direction along a guide rail 25a due to rotation of the pinion gear 22. The second connecting arm 26 connects the door body B (see FIG. 1) to the second rack 25. Thus, the second connecting arm 26 moves integrally with the second rack 25 in the X direction.

[0031]

Specifically, the second rack 25 moves in the X1 direction along the guide rail 25a due to rotation of the

pinion gear 22 in the R1 direction (clockwise direction).

At this time, the second connecting arm 26 moves in the X1 direction together with the second rack 25 such that the door body B moves in the X1 direction. Thus, the door

5 body B is opened. The second rack 25 moves in the X2 direction along the guide rail 25a due to rotation of the pinion gear 22 in the R2 direction (counterclockwise

direction). At this time, the second connecting arm 26 moves in the X2 direction together with the second rack 25

10 such that the door body B moves in the X2 direction. Thus, the door body B is closed.

[0032]

The engaging body 27 includes a portion that engages with a lock pin 31 (see FIG. 3) of the locking device 30,

15 which is described below. The engaging body 27 is a member extending in the X direction. The end of the

engaging body 27 on the X2 direction side is fixed to the second connecting arm 26. Thus, the engaging body 27

moves integrally with the second connecting arm 26 in the

20 X direction. The lock pin 31 is an example of a "pin member" in the claims.

[0033]

As shown in FIGS. 3 and 4, the locking device 30

restricts (locks) movement of the door body A and the door

25 body B in the X direction in order to prevent the railroad

vehicle, for example, from opening a door while traveling. Specifically, the locking device 30 includes the lock pin 31, a pin holding member 32, a solenoid 33, a base 34 (see FIG. 5), and a slide unit 35 (see FIG. 5). The solenoid 33 is an example of a "shaft drive" in the claims.

[0034]

The base 34 is a plate-shaped member that holds the solenoid 33 and the slide unit 35. The solenoid 33 and the slide unit 35 are fixed to the base 34 by a fastening member (not shown).

[0035]

As shown in FIG. 5, the lock pin 31 restricts movement of the door body B in the opening direction by engaging with the engaging body 27 fixed to the door body B (see FIG. 3). Movement of the lock pin 31 is restricted only to movement in the upward-downward direction (Z direction) by a pin guide member 31a. The pin guide member 31a is a guide member including a through-hole 31b through which the lock pin 31 passes. That is, movement of the lock pin 31 in the Z direction is guided in the through-hole 31b of the pin guide member 31a. Specifically, the lock pin 31 is arranged in the pin guide member 31a so as to be movable in the Z direction with a portion on the Z1 direction side and a portion on the Z2 direction side protruding.

[0036]

A male threaded portion 31f (see FIG. 9) is formed at the end 31d (see FIG. 9) of the lock pin 31 protruding to the Z1 direction side. A protruding portion of the lock pin 31 on the Z2 direction side contacts the engaging body 27 such that the lock pin 31 and the engaging body 27 engage with each other, and thus the door body B (see FIG. 1) can be put in a restricted state in which movement of the door body B in the X1 direction is restricted. The movement of the door body B in the X1 direction is an example of "movement of the door body in an opening direction of the door body" in the claims.

[0037]

A spring member 31c that urges the lock pin 31 toward a position of engagement between the lock pin 31 and the engaging body 27 (toward the Z2 direction side) is provided in the through-hole 31b of the pin guide member 31a.

[0038]

The lock pin 31 moves in the Z1 direction against the urging force of the spring member 31c due to movement of a shaft 33a described below in the Z1 direction. The lock pin 31 moves the shaft 33a in the Z2 direction according to the urging force of the spring member 31c. That is, the shaft 33a moves in the Z1 direction as described below

such that the locked state is released. The shaft 33a moves in the Z2 direction by the urging force of the spring member 31c such that the door bodies (A, B) return to the locked state.

5 [0039]

As shown in FIGS. 3 and 4, the pin holding member 32 holds the lock pin 31 and moves integrally with the lock pin 31. The pin holding member 32 is made of a metal (ferrous material) plate-shaped member. The pin holding member 32 holds the lock pin 31 by supporting, from the Z2 direction side by a support surface 32g, a nut 31e that engages with the lock pin 31, as described below.

[0040]

The pin holding member 32 includes a flat plate portion 32a pressed by the shaft 33a described below of the solenoid 33, and a cap 32b into which the end 31d of the lock pin 31 is inserted. The flat plate portion 32a and the cap 32b are fastened by a fastening member (not shown). The cap 32b is arranged on a surface of the flat plate portion 32a on the Z1 direction side. The flat plate portion 32a and the cap 32b may be integrally formed.

[0041]

A slider mount 36 (see FIG. 5) attached to a slider 35b described below is fastened to the pin holding member 32 by a fastening member (not shown). That is, the pin

holding member 32 (the flat plate portion 32a and the cap 32b) moves integrally with the slider mount 36. In FIGS. 3 and 4, the illustration of the slider mount 36 is omitted for the sake of simplicity. The slider mount 36 is made of the same material as the pin holding member 32. [0042]

The solenoid 33 includes the shaft 33a that moves back and forth in the Z direction. Furthermore, the solenoid 33 includes a solenoid main body 33b into which the shaft 33a is inserted. The solenoid 33 linearly moves the shaft 33a in the Z direction (the axial direction of the shaft) by a force of a magnetic field generated inside the solenoid main body 33b. The shaft 33a is made of metal (stainless steel, for example). [0043]

The solenoid 33 presses the pin holding member 32 (flat plate portion 32a) by the shaft 33a by linearly moving the shaft 33a to the Z1 side (pin holding member 32 side). Thus, the solenoid 33 moves the pin holding member 32 in a direction (Z1 direction) away from the position of engagement between the lock pin 31 and the engaging body 27, and moves the lock pin 31 held by the pin holding member 32 in the direction (Z1 direction) away from the position of engagement (see FIG. 4). As the lock pin 31 is moved in the direction away from the position of

engagement, the engagement state between the lock pin 31 and the engaging body 27 is released, and thus the locked state in which movement of the door bodies A and B is restricted is released.

5 [0044]

In this embodiment, the locking device 30 includes a shock absorber 40 to cushion an impact caused by collision between components of the locking device 30 when the locked state is released. Specifically, the shock
10 absorber 40 prevents at least metal components from colliding with each other. The details of the shock absorber 40 are described below.

[0045]

As shown in FIG. 5, the slide unit 35 has a slide
15 rail 35a and the slider 35b. The slide rail 35a extends in the Z direction. The slide rail 35a is fixed to the base 34. The slider 35b is attached so as to be movable in the Z direction along the slide rail 35a. The slider mount 36 is attached to the slider 35b.

20 [0046]

Configuration of Shock Absorber

In this embodiment, as shown in FIGS. 3 and 4, the shock absorber 40 includes a shock absorbing member 41 provided at the tip end 33c of the shaft 33a on the pin
25 holding member 32 side. Specifically, the shock absorbing

member 41 is provided between the tip end 33c of the shaft 33a and the pin holding member 32 (flat plate portion 32a). The shock absorbing member 41 is an example of a "first shock absorbing member" in the claims.

5 [0047]

Specifically, as shown in FIG. 6, the shock absorbing member 41 includes a fixed portion 41a fixed to the tip end 33c of the shaft 33a. Furthermore, the shock absorbing member 41 includes a contact portion 41b held by the fixed portion 41a and provided between the pin holding member 32 (flat plate portion 32a) and the fixed portion 41a. The fixed portion 41a and the contact portion 41b are formed separately. Thus, when either the fixed portion 41a or the contact portion 41b is damaged, only the damaged one needs to be replaced. The contact portion 41b is fixed by being adhered to a holding surface 41c of the fixed portion 41a, which is described below. The fixed portion 41a and the contact portion 41b are examples of a "first portion" and a "second portion" in the claims, respectively.

20 [0048]

The tip end 33c of the shaft 33a is inserted into a recess 41d provided at the end on the shaft 33a side (Z2 direction side) such that the fixed portion 41a is fixed to the tip end 33c of the shaft 33a. The tip end 33c of

the shaft 33a and an inner wall surface of the recess 41d are adhered to each other by an adhesive.

[0049]

In this embodiment, the fixed portion 41a includes
5 the holding surface 41c to hold the contact portion 41b.
The holding surface 41c has a flat surface shape that extends orthogonally to the Z direction. Furthermore, the fixed portion 41a includes an annular side surface portion 41e (see FIG. 7) arranged so as to surround the holding
10 surface 41c and provided so as to extend from the holding surface 41c side to the pin holding member 32 (flat plate portion 32a) side. In other words, the fixed portion 41a includes the holding surface 41c and the side surface portion 41e such that a recess in which the contact
15 portion 41b is arranged is formed.

[0050]

The contact portion 41b is provided so as to protrude toward the pin holding member 32 relative to the end of the side surface portion 41e on the pin holding member 32
20 side. Specifically, a length L1 from the lower end (the end on the Z2 side) of the fixed portion 41a to the upper end (the end on the Z1 side) of the contact portion 41b is larger than the length L2 of the fixed portion 41a in the Z direction. The length L2 of the fixed portion 41a is
25 sufficiently long to release the locked state by pressing

of the pin holding member 32 (flat plate portion 32a) by the upper end (the end on the Z1 side) of the side surface portion 41e even if the contact portion 41b falls off from the fixed portion 41a. Specifically, a difference (L1 -
5 L2) between the length L1 and the length L2 is about 2 mm, for example. The difference between the length L1 and the length L2 is smaller than the length L2. Furthermore, the difference between the length L1 and the length L2 is smaller than the stroke of the shaft 33a (a distance by
10 which the shaft 33a is movable in the Z direction).

[0051]

In this embodiment, the shock absorbing member 41 includes an elastic member. Specifically, the contact portion 41b is made of a resin such as urethane. The
15 fixed portion 41a is made of metal. The fixed portion 41a may be made of a resin as an elastic member like the contact portion 41b. In this case, the contact portion 41b and the fixed portion 41a may be integrally formed.

[0052]

20 A recess 32e is provided on a surface 32d of the pin holding member 32 (flat plate portion 32a) on the shock absorbing member 41 side. The recess 32e is an example of a "first recess" in the claims.

[0053]

25 In this embodiment, the shock absorber 40 includes a

shock absorbing member 42 arranged in the recess 32e of the pin holding member 32 (flat plate portion 32a) to contact the contact portion 41b of the shock absorbing member 41. The shock absorbing member 42 is adhered to the bottom surface (the surface on the Z1 side) 32f of the recess 32e. The shock absorbing member 42 is an example of a "second shock absorbing member" in the claims.

[0054]

As shown in FIG. 8, the shock absorbing member 42 has a circular shape as viewed from the Z2 direction side. The shock absorbing member 42 is provided so as to overlap the entire fixed portion 41a in the Z direction.

[0055]

The shock absorbing member 42 includes an elastic member. Specifically, the shock absorbing member 42 is made of a resin such as chloroprene rubber.

[0056]

In this embodiment, as shown in FIG. 6, a portion of the contact portion 41b that contacts the shock absorbing member 42 has a substantially flat surface shape. Specifically, the contact portion 41b includes a circular end face 41f that contacts the shock absorbing member 42. That is, the contact portion 41b comes into surface contact with the shock absorbing member 42. The diameter r of the end face 41f is about 10 mm, for example. The

contact portion 41b has a cylindrical shape that tapers toward the Z1 direction side. That is, the contact portion 41b has a truncated cone shape.

[0057]

5 The end face 41f of the contact portion 41b and the shock absorbing member 42 contact each other in the locked state in which the lock pin 31 and the engaging body 27 engage with each other. That is, a contact state between the contact portion 41b and the shock absorbing member 42
10 is maintained in the operation of releasing the locked state.

[0058]

A shock absorbing member 50 is attached to the lower surface 33d of the solenoid main body 33b on the Z2
15 direction side. The shock absorbing member 50 is an annular member provided such that the shaft 33a passes therethrough. Furthermore, the shock absorbing member 50 is made of PET resin. The shock absorbing member 50 may be made of another material (such as urethane resin or
20 chloroprene rubber).

[0059]

The solenoid 33 includes a stopper 33e provided on the shaft 33a on the side opposite to the tip end 33c of the shaft 33a on the pin holding member 32 side (Z1
25 direction side) with respect to the solenoid main body 33b.

The stopper 33e is provided on the Z2 direction side relative to the shock absorbing member 50. The stopper 33e is fixed to the shaft 33a, and thus the stopper 33e moves in the Z direction as the shaft 33a moves in the Z direction. Furthermore, movement of the stopper 33e toward the pin holding member 32 (Z1 direction side) is restricted by the solenoid main body 33b such that the stopper 33e stops movement of the shaft 33a toward the pin holding member 32 at a predetermined position.

[0060]

The stopper 33e is an annular member provided such that the shaft 33a passes therethrough. The stopper 33e is a metal member.

[0061]

In this embodiment, the shock absorber 40 includes a shock absorbing member 43 provided between the stopper 33e and the solenoid main body 33b (shock absorbing member 50). Specifically, the shock absorbing member 43 is provided on the upper surface 33f (the surface on the Z1 direction side) of the stopper 33e. Thus, when the locked state is released, the stopper 33e moves in the Z1 direction together with the shaft 33a such that the shock absorbing member 43 moves in the Z1 direction. When the shock absorbing member 43 contacts the shock absorbing member 50 (see FIG. 4), movement of the shaft 33a is stopped. The

shock absorbing member 43 is also an annular member provided such that the shaft 33a passes therethrough, like the stopper 33e. The shock absorbing member 43 is an example of a "third shock absorbing member" in the claims.

5 [0062]

The shock absorbing member 43 includes an elastic member. Specifically, the shock absorbing member 42 is made of a resin such as chloroprene rubber.

[0063]

10 As shown in FIG. 9, the nut 31e that engages with the pin holding member 32 (flat plate portion 32a) is provided at the end 31d of the lock pin 31 on the side opposite to the engaging body 27. The pin holding member 32 (flat plate portion 32a) includes a support surface 32g to
15 support the nut 31e from the door body A and B sides (Z2 direction side). The support surface 32g is a surface that engages with the nut 31e. The nut 31e is engaged with (screwed to) the male threaded portion 31f of the lock pin 31. The nut 31e is an example of an "engaging
20 member" in the claims.

[0064]

A nut 31h is provided at the end 31d of the lock pin 31 so as to overlap the nut 31e on the Z1 direction side of the nut 31e. The nut 31h is provided to prevent the
25 nut 31e from loosening.

[0065]

With this configuration, the shaft 33a (see FIG. 3, for example) presses the pin holding member 32 (flat plate portion 32a) in the Z1 direction such that the nut 31e that engages with the pin holding member 32 (flat plate portion 32a) is moved in the Z1 direction, and the lock pin 31 that engages with (is screwed to) the nut 31e is moved to the Z1 direction. Consequently, the engagement between the lock pin 31 and the engaging body 27 is released, and the locked state of the locking device 30 is released.

[0066]

The pin holding member 32 includes a through-hole 32h in which the nut 31e into which the end 31d (male threaded portion 31f) of the lock pin 31 is inserted and that is provided at the end 31d of the lock pin 31 is housed. Specifically, the through-hole 32h is provided in the cap 32b. The nut 31h is also housed in the through-hole 32h of the cap 32b.

[0067]

A recess 32i is provided in the through-hole 32h of the cap 32b such that the outer peripheral edge 31g of the nut 31e enters the recess 32i. The recess 32i is provided circumferentially around the lock pin 31 in accordance with the shape of the annular nut 31e.

[0068]

As described above, after the pin holding member 32 (flat plate portion 32a) and the lock pin 31 are integrally moved in the Z1 direction, an inertial force acts on the lock pin 31 at the moment when movement of the shaft 33a (see FIG. 3, for example) is stopped and movement of the pin holding member 32 is stopped, and thus only the lock pin 31 tries to move further in the Z1 direction. In this case, the outer peripheral edge 31g of the nut 31e is caught in the recess 32i such that the lock pin 31 is prevented from moving in the Z1 direction. On the other hand, the outer peripheral edge 31g of the nut 31e collides with the cap 32b in the recess 32i.

[0069]

Immediately after this, the nut 31e and the support surface 32g of the pin holding member 32 (flat plate portion 32a) collide with each other when the nut 31e returns to the Z2 direction side (support surface 32g side).

[0070]

In this embodiment, the shock absorber 40 includes a sheet-shaped shock absorbing member 44 provided between the support surface 32g and the nut 31e. Specifically, the shock absorbing member 44 is an annular member provided such that the lock pin 31 passes therethrough.

The shock absorbing member 44 is an example of a "fourth shock absorbing member" in the claims.

[0071]

5 The shock absorbing member 44 has a thickness t in the Z direction. The shock absorbing member 44 is provided such that a clearance $C1$ in the Z direction between the recess 32i and the outer peripheral edge 31g of the nut 31e can be reduced. Consequently, noise generated when the nut 31e collides with the cap 32b in
10 the recess 32i can be reduced. The clearance $C1$ in the Z direction between the recess 32i and the outer peripheral edge 31g of the nut 31e may be set to zero.

[0072]

15 The shock absorbing member 44 includes an elastic member. Specifically, the shock absorbing member 44 is made of a resin such as Teflon (registered trademark). Thus, the nut 31e becomes slippery, and thus noise generated by friction in the nut 31e can be reduced. The shock absorbing member 44 may be made of urethane resin or
20 chloroprene rubber, for example.

[0073]

A clearance $C2$ is provided between both the nut 31e and the nut 31h and the inner wall surface 32j of the through-hole 32h in the through-hole 32h. Thus, the lock
25 pin 31 can move slightly in a plane orthogonal to the Z

direction. That is, the lock pin 31 is not completely restrained from moving in the plane orthogonal to the Z direction in the through-hole 32h. Consequently, damage to the lock pin 31 can be significantly reduced or prevented when a force is applied to the lock pin 31 in the plane. The clearance C2 includes the clearance C1 described above.

[0074]

In this embodiment, the shock absorber 40 includes a gel-like shock absorbing member 45 filled in the clearance C2 of the through-hole 32h and provided such that the nut 31e is interposed between the gel-like shock absorbing member 45 and the shock absorbing member 44. That is, as described above, when the outer peripheral edge 31g of the nut 31e collides with the cap 32b in the recess 32i, the outer peripheral edge 31g of the nut 31e collides with the cap 32b via the shock absorbing member 45. Furthermore, the shock absorbing member 45 also penetrates into the recess 32i. The shock absorbing member 45 is an example of a "fifth shock absorbing member" in the claims.

[0075]

Advantageous Effects of This Embodiment

According to this embodiment, the following advantageous effects are achieved.

[0076]

According to this embodiment, as described above, the locking device 30 (restrictor) includes the shock absorber 40 configured to cushion the impact caused by collision between the components of the locking device 30 when the locked state in which movement of the door bodies (A, B) is restricted is released. Accordingly, noise generated by the collision between the components of the locking device 30 can be reduced. Consequently, noise generated when the locked state in which movement of the door bodies (A, B) is restricted is released can be reduced.

[0077]

According to this embodiment, as described above, in the door closing device 100, the shock absorber 40 includes the elastic member. Accordingly, when the locked state in which movement of the door bodies (A, B) is restricted is released, the impact caused by the collision between the components of the locking device 30 (restrictor) can be easily cushioned by elastic deformation of the elastic member. Consequently, the noise generated by the collision between the components of the locking device 30 can be further reduced.

[0078]

According to this embodiment, as described above, in the door closing device 100, the shock absorber 40 includes the shock absorbing member 41 (first shock

absorbing member) provided at the tip end 33c of the shaft 33a on the pin holding member 32 side. Accordingly, noise generated when the tip end 33c of the shaft 33a and the pin holding member 32 collide with each other can be reduced by the shock absorbing member 41.

[0079]

According to this embodiment, as described above, in the door closing device 100, the shock absorbing member 41 (first shock absorbing member) includes the fixed portion 41a (first portion) fixed to the tip end 33c of the shaft 33a, and the contact portion 41b (second portion) held by the fixed portion 41a and provided between the pin holding member 32 and the fixed portion 41a. Accordingly, the noise generated when the tip end 33c of the shaft 33a and the pin holding member 32 collide with each other can be reduced by the contact portion 41b when the locked state in which movement of the door bodies (A, B) is restricted is released.

[0080]

According to this embodiment, as described above, in the door closing device 100, the fixed portion 41a (first portion) includes the holding surface 41c configured to hold the contact portion 41b (second portion) and the annular side surface portion 41e arranged so as to surround the holding surface 41c and provided so as to

extend from the holding surface 41c side to the pin
holding member 32 side. Accordingly, the side surface
portion 41e is provided so as to extend from the holding
surface 41c side to the pin holding member 32 side such
5 that even when the contact portion 41b is damaged or falls
off from the fixed portion 41a, the pin holding member 32
can be easily pressed by the side surface portion 41e.
Furthermore, the side surface portion 41e is provided in
an annular shape such that the area of a surface of the
10 side surface portion 41e that collides with the pin
holding member 32 can be relatively increased, and thus
noise generated when the side surface portion 41e collides
with the pin holding member 32 can be reduced when the
locked state in which movement of the door bodies (A, B)
15 is restricted is released. Moreover, the contact portion
41b is held by the holding surface 41c such that the
contact portion 41b can be stably held.

[0081]

According to this embodiment, as described above, in
20 the door closing device 100, the shock absorber 40
includes the shock absorbing member 42 (second shock
absorbing member) arranged in the recess 32e (first
recess) of the pin holding member 32 and configured to
contact the contact portion 41b (second portion) of the
25 shock absorbing member 41 (first shock absorbing member).

Accordingly, the noise generated when the tip end 33c of the shaft 33a and the pin holding member 32 collide with each other can be further reduced by the shock absorbing member 42 when the locked state in which movement of the door bodies (A, B) is restricted is released. Furthermore, even when the contact portion 41b falls off from the fixed portion 41a, the noise generated when the tip end 33c of the shaft 33a and the pin holding member 32 collide with each other can be reduced by the shock absorbing member 42.

[0082]

According to this embodiment, as described above, in the door closing device 100, a portion of the contact portion 41b (second portion) that contacts the shock absorbing member 42 (second shock absorbing member) has a substantially flat surface shape. Accordingly, the contact portion 41b and the shock absorbing member 42 can be brought into surface contact with each other, and thus the noise generated when the locked state in which movement of the door bodies (A, B) is restricted is released can be reduced as compared with a case in which the contact portion 41b comes into point contact with the shock absorbing member 42.

[0083]

According to this embodiment, as described above, in the door closing device 100, the shock absorber 40

includes the shock absorbing member 43 (third shock absorbing member) provided between the stopper 33e and the solenoid main body 33b. Accordingly, an impact caused by collision between the stopper 33e and the solenoid main body 33b can be cushioned by the shock absorbing member 43, and thus the noise generated by the collision between the stopper 33e and the solenoid main body 33b can be reduced when the locked state in which movement of the door bodies (A, B) is restricted is released.

[0084]

According to this embodiment, as described above, in the door closing device 100, the shock absorber 40 includes the sheet-shaped shock absorbing member 44 (fourth shock absorbing member) provided between the support surface 32g and the nut 31e (engaging member). Accordingly, when the locked state in which movement of the door bodies (A, B) is restricted is released, an impact caused by collision between the support surface 32g and the nut 31e can be cushioned by the shock absorbing member 44, and thus noise generated by the collision between the support surface 32g and the nut 31e can be reduced.

[0085]

According to this embodiment, as described above, in the door closing device 100, the shock absorber 40

includes the gel-like shock absorbing member 45 (fifth shock absorbing member) filled in the clearance C2 of the through-hole 32h and provided such that the nut 31e (engaging member) is interposed between the gel-like shock absorbing member 45 and the shock absorbing member 44 (fourth shock absorbing member). Accordingly, the nut 31e is interposed between the shock absorbing member 44 and the shock absorbing member 45 such that an impact caused by collision between the nut 31e and the inner wall surface 32j of the through-hole 32h can be cushioned inside the through-hole 32h when the locked state in which movement of the door bodies (A, B) is restricted is released. Consequently, noise generated by the collision between the nut 31e and the inner wall surface 32j of the through-hole 32h can be reduced.

[0086]

According to this embodiment, as described above, in the door closing device 100, the shock absorber 40 is configured to cushion the impact caused by the collision between the components of the locking device 30 (restrictor) when the locked states of the door bodies (A, B) provided on the railroad vehicle are released. Accordingly, the noise generated when the locked state in which movement of the door bodies (A, B) is restricted is released in the railroad vehicle can be reduced.

[0087]

Modified Examples

The embodiment disclosed this time must be considered as illustrative in all points and not restrictive. The
5 scope of the present invention is not shown by the above description of the embodiment but by the scope of claims for patent, and all modifications (modified examples) within the meaning and scope equivalent to the scope of claims for patent are further included.

10 [0088]

For example, while the example in which the shock absorber 40 includes the elastic member has been shown in the aforementioned embodiment, the present invention is not restricted to this. The shock absorber may not
15 include the elastic member as long as the hardness is lower than that of metal.

[0089]

While the example in which the shaft 33a is linearly moved by the solenoid 33 has been shown in the
20 aforementioned embodiment, the present invention is not restricted to this. A mechanism (a hydraulic cylinder, for example) other than a solenoid may alternatively be used as long as the same linearly moves the shaft 33a.

[0090]

25 While the example in which the shock absorber 40

includes the shock absorbing member 41 (first shock absorbing member), the shock absorbing member 42 (second shock absorbing member), the shock absorbing member 43 (third shock absorbing member), the shock absorbing member 44 (fourth shock absorbing member), and the shock absorbing member 45 (fifth shock absorbing member) has been shown in the aforementioned embodiment, the present invention is not restricted to this. The shock absorber 40 may alternatively include at least one of the shock absorbing member 41 (first shock absorbing member), the shock absorbing member 42 (second shock absorbing member), the shock absorbing member 43 (third shock absorbing member), the shock absorbing member 44 (fourth shock absorbing member), and the shock absorbing member 45 (fifth shock absorbing member).

[0091]

While the example in which the contact portion 41b (second portion) is held by the fixed portion 41a (first portion) has been shown in the aforementioned embodiment, the present invention is not restricted to this. The contact portion 41b may alternatively be directly fixed to the shaft 33a.

[0092]

While the example in which the side surface portion 41e of the fixed portion 41a (first portion) has an

annular shape has been shown in the aforementioned embodiment, the present invention is not restricted to this. The side surface portion 41e may alternatively have a shape other than an annular shape. For example, the
5 side surface portion 41e may include a plurality of linearly formed portions.

[0093]

While the example in which the shock absorbing member 42 (second shock absorbing member) is provided in the
10 recess 32e of the pin holding member 32 has been shown in the aforementioned embodiment, the present invention is not restricted to this. The shock absorbing member 42 (second shock absorbing member) may alternatively be attached to the surface 32d (see FIG. 6) of the pin
15 holding member 32 on the Z2 direction side.

[0094]

While the example in which the portion (end face 41f) of the contact portion 41b (second portion) that contacts the shock absorbing member 42 (second shock absorbing
20 member) has a flat surface shape has been shown in the aforementioned embodiment, the present invention is not restricted to this. The end face 41f of the contact portion 41b (second portion) may alternatively have a shape (a spherical shape, for example) other than a flat
25 surface shape.

[0095]

While the example in which the locking device 30 (restrictor) restricts movement of the door bodies (A, B) provided on the railroad vehicle has been shown in the
5 aforementioned embodiment, the present invention is not restricted to this. The locking device 30 (restrictor) may alternatively restrict movement of door bodies provided on an elevator or a bus, for example, other than a railroad vehicle.

10 Description of Reference Numerals

[0096]

10: drive source
27: engaging body (door body fixed portion)
30: locking device (restrictor)
15 31: lock pin (pin member)
31d: end
31e: nut (engaging member)
32: pin holding member
32d: surface
20 32e: recess (first recess)
32g: support surface
32h: through-hole
32j: inner wall surface
33: solenoid (shaft drive)
25 33a: shaft

33b: solenoid main body
 33c: tip end
 33e: stopper
 40: shock absorber
 5 41: shock absorbing member (first shock absorbing member)
 41a: fixed portion (first portion)
 41b: contact portion (second portion)
 41c: holding surface
 10 41e: side surface portion
 42: shock absorbing member (second shock absorbing member)
 43: shock absorbing member (third shock absorbing member)
 15 44: shock absorbing member (fourth shock absorbing member)
 45: shock absorbing member (fifth shock absorbing member)
 100: door closing device
 20 A, B: door body
 C2: clearance

CLAIMS

[Claim 1] A door closing device comprising:

5 a drive source configured to open and close a door body; and

a restrictor configured to restrict movement of the door body in an opening direction of the door body by driving of the drive source; wherein

the restrictor includes:

10 a pin member configured to restrict the movement of the door body in the opening direction by engaging with a door body fixed portion fixed to the door body, the pin member being configured to be urged toward a position of engagement with the door body fixed portion;

15 a pin holding member configured to hold the pin member, the pin holding member being configured to move integrally with the pin member;

a shaft drive including a shaft, the shaft drive being configured to move the pin holding member in a direction away from the position of the engagement by linearly moving the shaft and pressing the pin holding member, the shaft drive being configured to move the pin member held by the pin holding member in the direction away from the position of the engagement; and

20

25 a shock absorber configured to cushion an impact

caused by collision between components of the restrictor
when the engagement between the pin member and the door
body fixed portion is released as the pin member is moved
in the direction away from the position of the engagement
5 such that a locked state in which the movement of the door
body is restricted is released.

[Claim 2] The door closing device according to claim
1, wherein the shock absorber includes an elastic member.
10

[Claim 3] The door closing device according to claim
1 or 2, wherein the shock absorber includes a first shock
absorbing member provided at a tip end of the shaft on the
pin holding member side.
15

[Claim 4] The door closing device according to claim
3, wherein the first shock absorbing member includes a
first portion fixed to the tip end of the shaft, and a
second portion held by the first portion and provided
20 between the pin holding member and the first portion.

[Claim 5] The door closing device according to claim
4, wherein the first portion includes a holding surface
configured to hold the second portion and an annular side
25 surface portion arranged so as to surround the holding

surface and provided so as to extend from the holding
surface side to the pin holding member side.

[Claim 6] The door closing device according to claim
5 4 or 5, wherein

a first recess is provided on a surface of the pin
holding member on the first shock absorbing member side;
and

the shock absorber includes a second shock absorbing
10 member arranged in the first recess of the pin holding
member, the second shock absorbing member being configured
to contact the second portion of the first shock absorbing
member.

15 [Claim 7] The door closing device according to claim
6, wherein a portion of the second portion that contacts
the second shock absorbing member has a substantially flat
surface shape.

20 [Claim 8] The door closing device according to any
one of claims 1 to 7, wherein

the shaft drive includes:

a solenoid including the shaft and a solenoid
main body into which the shaft is inserted, the solenoid
25 being configured to move the shaft in an axial direction

of the shaft by a force of a magnetic field; and

5 a stopper provided on the shaft on a side opposite to a tip end of the shaft on the pin holding member side with respect to the solenoid main body, the stopper being configured to stop movement of the shaft toward the pin holding member at a predetermined position by being restricted movement of the stopper toward the pin holding member by the solenoid main body; and

10 the shock absorber includes a third shock absorbing member provided between the stopper and the solenoid main body.

[Claim 9] The door closing device according to any one of claims 1 to 8, wherein

15 an engaging member configured to engage with the pin holding member is provided at an end of the pin member on a side opposite to the door body fixed portion;

20 the pin holding member includes a support surface configured to support the engaging member from the door body side; and

the shock absorber includes a sheet-shaped fourth shock absorbing member provided between the support surface and the engaging member.

25 [Claim 10] The door closing device according to claim

9, wherein

the pin holding member includes a through-hole into which the end of the pin member is inserted and in which the engaging member provided at the end of the pin member is housed;

a clearance is provided between the engaging member and an inner wall surface of the through-hole in the through-hole; and

the shock absorber includes a gel-like fifth shock absorbing member filled in the clearance of the through-hole and provided such that the engaging member is interposed between the gel-like fifth shock absorbing member and the fourth shock absorbing member.

[Claim 11] The door closing device according to any one of claims 1 to 10, wherein the shock absorber is configured to cushion the impact caused by the collision between the components of the restrictor when the locked state of the door body provided on a railroad vehicle is released.