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

(11) **EP 2 128 370 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
02.12.2009 Bulletin 2009/49

(51) Int Cl.:
E05F 5/02 *(2006.01)*

(21) Application number: **09160008.0**

(22) Date of filing: **12.05.2009**

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

(30) Priority: **28.05.2008 JP 2008139107**

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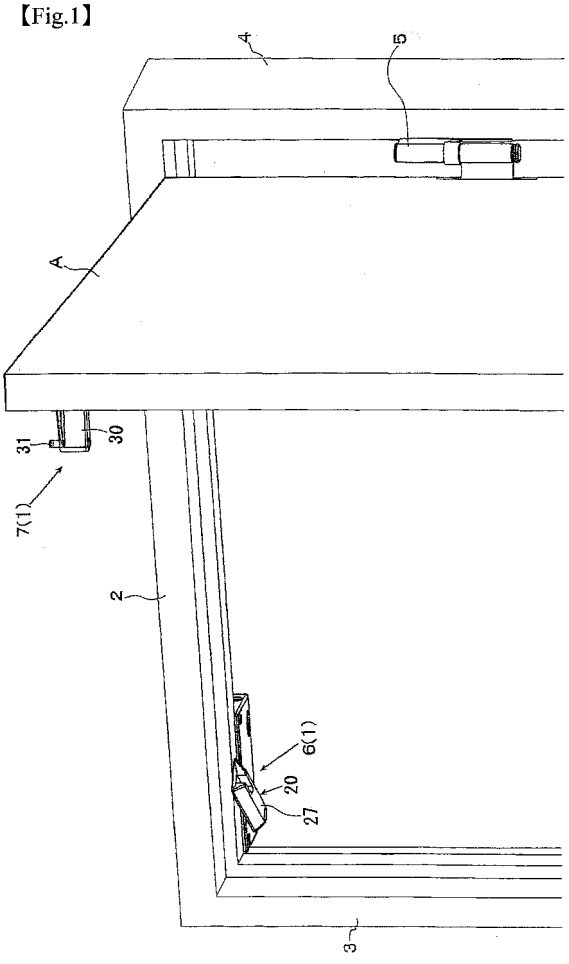
(54) **Door closing device and door device provided therewith**

(57) A door closing device includes a device main body 6 attached to a door frame and a guided member 7 attached to a door A. The device main body 6 includes a door closing arm 20 which moves into and out of engagement with the guided member 7 with the turning of the door A, a biasing mechanism which holds the door closing arm 20 in a standby position in which the door closing arm 20 can engage with the guided member 7 when the guided member 7 is not engaged with the door closing arm 20, and forcedly turns the door closing arm 20 in the direction that closes the door A when the guided member 7 is engaged with the door closing arm 20, and a direct-acting shock-absorbing mechanism which suppresses the turning of the door closing arm 20 when the door closing arm 20 is turning in the direction that closes the door A, and promotes the turning thereof when the door closing arm 20 is turning in an opposite direction.

【Fig.1】



EP 2 128 370 A2

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a door closing device and a door device provided therewith for forcedly and noiselessly closing a door by which a doorway of an entrance or a room is opened and closed.

2. Description of the Related Art

[0002] There already exists a door closing device which closes a door noiselessly by slowing it down just before it is closed completely, the door by which an opening of a house, such as a doorway of an entrance or a room, is opened and closed, as is disclosed in JP-A-2007-120140 (pages 4 to 8, FIGS. 1 and 4 to 6).

[0003] Such a conventional door closing device 100 has, as shown in FIG. 8, a device main body 101 which is attached to a door A and a bracket 102 which is attached to an upper frame member (a member forming an upper edge part of a door frame and extending in a horizontal direction) B of the door frame provided around an opening of a house. The device main body 101 is attached to a portion of an upper end part of the back surface of the door A, the portion near a side edge to which a hinge 103 is attached. The bracket 102 is attached to a part of the upper frame member B, the part corresponding to a position in which the device main body 101 is attached and near a vertical frame member (a member forming a right or left side edge part (in an example shown in the figure, a right side edge part) of the door frame and extending in a vertical direction) C to which the hinge 103 is attached. The device main body 101 has an arm 104 bent in the form of a circular arc. In an arm main body 105 of the arm 104, a guide groove 105a is formed. At the end of the bracket 102, a pin 102a, which engages in the guide groove 105a of the arm 104, is provided.

[0004] In this conventional door closing device 100, before the pin 102a of the bracket 102 engages in the guide groove 105a of the arm 104 of the device main body 101, as shown in FIG. 9(A), a protrusion 108a of a slider 108 biased by a spring 107 is in contact with a projected portion 106a provided in a supporting portion 106 of the arm 104. As a result, the arm 104 is subjected to a counterclockwise moment indicated by an arrow in the figure, and is subjected to a clockwise moment as a result of a side edge of an arc-shaped vertical plate 106b of the supporting portion 106 thereof coming into contact with a boss (not shown) of a housing 109 to which a shock-absorbing mechanism 110 is attached or a flange 110a of the shock-absorbing mechanism 110. Thus, the arm 104 is held in an angular position corresponding to a predetermined closing angle (an angle which the door A forms with the upper frame member B) shown in the figure at which it can engage with the pin 102a of the bracket 102. When the door A is being closed further, the pin 102a of the bracket 102 reaches a position of an opening (a part through which the pin 102a enters and leaves the guide groove 105a) of the guide groove 105a shown in the figure to engage in the guide groove 105a of the arm 104.

[0005] After the pin 102a engages in the guide groove 105a, the pin 102a starts to move relative to the arm 104 along the guide groove 105a with the movement of the door A in the direction indicated by an arrow in FIG. 9(B), that is, with the closing of the door A. At this time, since an area of the slider 108 in which it makes contact with the projected portion 106a of the arm 104 is changed from the protrusion 108a of the slider 108 to a closed-end face thereof as soon as the arm 104 starts to rotate in a clockwise direction indicated by an arrow in the figure, the arm 104 is subjected to a clockwise moment indicated by an arrow in the figure. The arm 104 starts to rotate as a result of it being subjected to such a moment, and, at the same time, the door A automatically rotates in the direction of an arrow in the figure and closes as shown in FIG. 9(C). Incidentally, in the above-described rotation of the arm 104, since the rotational speed is reduced by the shock-absorbing mechanism 110 which acts on the rotation axis of the arm 104, the rotation of the door A is also slowed down at the time of closing of the door A. As a result, the door A is closed noiselessly without causing a problem such as bumping against a doorstop (not shown) and generating impact noise or the like.

[0006] Incidentally, when the door A is opened from a state of FIG. 9(C), that is, a state in which the door A is closed, the pin 102a of the bracket 102 moves relative to the arm 104 along the guide groove 105a thereof, and the arm 104 rotates in a counterclockwise direction indicated by an arrow in the figure while countering a bias force of the spring 107. Then, when the state is changed to a state shown in FIG. 9(A), the engagement of the pin 102a of the bracket 102 with the guide groove 105a of the arm 104 is released, and the arm 104 is held in an angular position corresponding to a predetermined closing angle as described above in a position where the engagement is released.

[0007] As in the door closing device described above, when a structure is adopted in which the device main body 101 having the shock-absorbing mechanism 110 attached thereto is attached to a portion of the upper end part of the back surface of the door A, the portion near a side edge to which the hinge 103 is attached, and the bracket 102 is attached to a portion of the upper frame member B, the portion corresponding to a position of the device main body 101 and near the vertical frame member C to which the hinge 103 is attached, it is true that the objective of closing the door A noiselessly can be achieved. However, this makes it necessary to apply stronger force to a handle of the door A when opening the door A compared with when the device main body 101 is attached to a part of the upper end part of the back

surface of the door A, the part near a side edge opposite to the side edge to which the hinge 103 is attached, and the bracket 102 is accordingly attached to a part of the upper frame member B, the part near a vertical frame member D. Furthermore, the necessity of exerting a strong force undesirably results in an increase in load applied to the hinge.

[0008] In addition, the shock-absorbing mechanism 110 used in the door closing device described above is of the rotary type, forming a structure in which a force counteracting the rotation of the rotation axis of the arm 104 is always exerted on that rotation axis, which becomes a cause of the problem described above. Additionally, this structure makes it difficult to make settings to facilitate the rotation of the arm at desired timing at the time of rotation of the arm 102, for example, when the door A is being opened.

[0009] Moreover, the rotary type shock-absorbing mechanism 110 generally has larger dimensions, leading to an increase in the size of the device main body 101 to which the shock-absorbing mechanism 110 is attached. This makes it difficult to attach the device main body 101 to a narrow region like the upper frame member B. As a result, the device has to be a type of device that attaches the device main body 101 on the door A side and attaches the bracket 102 to the upper frame member B as described above, making it difficult to enhance the appearance of the device.

[0010] Problems that the invention is to solve are to achieve a door closing device that can close a door noiselessly by suppressing an abrupt turning of the door just before it is closed and can open the door by a weak force when opening the door without an increase in the size of a device main body, thereby making it possible to attach the device main body to a door frame, and to provide a door device provided with the door closing device.

SUMMARY OF THE INVENTION

[Door closing device]

[0011] In order to solve the above problems, an door closing device according to an aspect of the present invention is a door closing device (1) forcedly closing a door (A) which is connected to a door frame via a hinge (5) in such a way that the door (A) can turn in a horizontal direction, the door closing device (1) including:

a device main body (6) attached to the door frame; and
a guided member (7) fixed to the door (A),

wherein the device main body (6) includes:

a fixed component (40) fixed to an upper edge part of an opening of the door frame;
a turning piece (14) including a shaft portion (14c) supported on the fixed component (40) in such a way that the shaft portion (14c) can turn in a horizontal direction and first and second arm portions (14a, 14b) projecting outward from the shaft portion (14c) in different horizontal directions;
a door closing arm (20) which turns with the turning piece (14) in a horizontal direction and moves into and out of engagement with the guided member (7) with the turning of the door (A);
a biasing mechanism (50) which exerts an elastic force on the first arm portion (14a) of the turning piece (14) to hold the door closing arm (20) in a standby position in which the door closing arm (20) stands ready to engage with the guided member (7) when the guided member (7) is not engaged with the door closing arm (20), and to turn the door closing arm (20) forcedly in the direction that closes the door (A) after the guided member (7) engages with the door closing arm (20); and
a direct-acting shock-absorbing mechanism (60) which exerts a force on the second arm portion (14b) of the turning piece (14) to suppress the turning of the door closing arm (20) when the door closing arm (20) is turning in the direction that closes the door (A), and to promote the turning thereof when the door closing arm (20) is turning in an opposite direction.

[0012] With the above-described structure, when the guided member is not engaged with the door closing arm, that is, when the door is opened wider than the degree of opening which permits engagement between the door closing arm and the guided member, the door closing arm is held in the standby position by the elastic force of the biasing mechanism. When the door is being closed, the guided member approaches the device main body together with the door, and,
when the degree of opening of the door reaches a predetermined degree of opening, the guided member engages with the door closing arm. Then, when the door is being closed further, the door closing arm starts to turn from the standby position in the direction that closes the door. At the same time, the elastic force of the biasing mechanism starts to act as a force that forcedly turns the door closing arm in the direction that closes the door. With the forced turning of the door closing arm, the door is being closed forcedly. At this time, the reaction of the shock-absorbing mechanism starts to act and suppress the turning of the door closing arm, whereby an abrupt movement of the door is prevented. As a result, the door is closed forcedly and noiselessly. On the other hand, when the door is opened from a state in which the door is closed completely, the door closing arm starts to turn in the direction that puts the door closing arm in the standby position with the opening movement of the door. At the same time, the repulsion of the shock-absorbing mechanism starts to act as a force that turns the door closing arm in the direction that opens the door, whereby the turning of the door closing arm in the direction that opens the door is promoted. This eliminates the need to

apply a strong force to the handle of the door when opening the door by hand. Since a direct-acting shock-absorbing mechanism is used as the shock-absorbing mechanism, it is possible to achieve the door closing device that can close the door noiselessly when closing the door and can open the door by a weak force when opening the door without an increase in the size of the device main body.

[0013] In the door closing device (1) of the invention, it is preferable that the fixed component (40) include a housing (70) fixed to the door frame and having a flat rectangular parallelepiped shape, and the turning piece (14), the biasing mechanism (50), and the shock-absorbing mechanism (60) be housed in the housing (70), in a bottom plate (8b, 10a) of the housing (70), an insertion hole (8a1, 10a6) for connecting a connecting shaft (28a3) of the door closing arm (20) to the shaft portion (14c) of the turning piece (14) be formed, and the door closing arm (20) turn along a lower surface of the housing (70). As described above, by adopting a structure in which the turning piece, the biasing mechanism, and the shock-absorbing mechanism are housed in the housing having a flat rectangular parallelepiped shape, and the door closing arm turns along the lower surface of the housing, it is possible to reduce the size of the fixed component which is fixed to the door frame and achieve the door closing device which has a simple appearance and appears to be provided as a movable part with only the door closing arm.

[0014] Moreover, it is preferable that insertion holes (8a1, 10a6) for connecting the connecting shaft (28a3) of the door closing arm (20) to the shaft portion (14c) of the turning piece (14) be formed in the upper and lower surfaces of the housing (70), and the connecting shaft (28a3) of the door closing arm (20) can be connected to the shaft portion (14c) of the turning piece (14) through any one of the insertion holes (8a1, 10a6). This makes it possible to use the door closing device for both a right-hinged door and a left-hinged door.

[0015] Furthermore, it is preferable that the biasing mechanism (50) include a spring (16) exerting an elastic force on the first arm portion (14a) of the turning piece (14),
the shock-absorbing mechanism (60) include a direct-acting damper (19) which generates a braking force by being compressed and pushing back in a horizontal direction with the turning of the second arm portion (14b) of the turning piece (14) when the door closing arm (20) is turning in the direction that closes the door (A), and
the spring (16) and the damper (19) be arranged parallel to each other. This makes it easy to reduce the size of the fixed component.

[0016] In addition, it is preferable that the device main body (1) include an adjusting unit (17) for adjusting the elastic force of the biasing mechanism (50). This makes it possible to adjust the turning speed of the door when it is being closed and the reaction from the spring when the door is being opened.

[0017] Moreover, it is preferable that the shock-absorbing mechanism (60) be configured such that, when the door (A) is being closed, a force suppressing the turning of the second arm portion (14b) of the turning piece (14) is not exerted on the second arm portion (14b) from a point when a latch provided on an edge face of the door (A), the edge face located on that side of the door (A) where a handle is provided, starts to engage in a latch hole provided in the door frame. This prevents the reaction from the shock-absorbing mechanism from acting from a point when the latch provided on the edge face of the door starts to engage in the latch hole in the door frame, making it possible to close the door reliably.

[0018] Furthermore, it is preferable that, when the door (A) is closed, the whole of the door closing arm (20) be located under the lower surface of the housing (70), and, when the door closing arm (20) is in the standby position, an end thereof protrude from under the lower surface of the housing (70) toward the door (A). With this structure, when the door is being closed, the guided member engages with the door closing arm in a standby status with the end thereof protruding from under the lower surface of the housing toward the door with the turning of the door. Then, when the door is being closed further, the door closing arm turns in the direction that closes the door, and, when the door is closed, the door closing arm fits under the housing, that is, the housing and the door closing arm are placed one on top of another.

[0019] In addition, it is preferable that the guided member (7) include a supporting portion (30) jutting from a board face of the door (A) in a horizontal direction and a sliding part (31) jutting upward from an end of the supporting portion (30), the door closing arm (20) include a guide groove (27c) extending in the direction of the radius of the turning of the door closing arm (20), and
when the door closing arm (20) is in the standby position, an end of the sliding part (31) be received in the guide groove (27c) with the turning in the direction in which the door (A) is closed.

[Door device]

[0020] In order to solve the above problems, a door device according to another aspect of the present invention is a door device including:

a door frame;
a door (A) which is connected to the door frame via a hinge (5) in such a way that the door (A) can turn in a horizontal direction; and
a door closing device (1) forcedly closing the door (A),

wherein the door closing device (1) includes:

a device main body (6) attached to the door frame; and
a guided member (7) fixed to the door (A), and

the device main body (6) includes:

a fixed component (40) fixed to an upper edge part of an opening of the door frame;
a turning piece (14) including a shaft portion (14c) supported on the fixed component (40) in such a way that the shaft portion (14c) can turn in a horizontal direction and first and second arm portions (14a, 14b) projecting outward from the shaft portion (14c) in different horizontal directions;
a door closing arm (20) which turns with the turning piece (14) in a horizontal direction and moves into and out of engagement with the guided member (7) with the turning of the door (A);
a biasing mechanism (50) which exerts an elastic force on the first arm portion (14a) of the turning piece (14) to hold the door closing arm (20) in a standby position in which the door closing arm (20) stands ready to engage with the guided member (7) when the guided member (7) is not engaged with the door closing arm (20), and to turn the door closing arm (20) forcedly in the direction that closes the door (A) after the guided member (7) engages with the door closing arm (20); and
a direct-acting shock-absorbing mechanism (60) which exerts a force on the second arm portion (14b) of the turning piece (14) to suppress the turning of the door closing arm (20) when the door closing arm (20) is turning in the direction that closes the door (A), and to promote the turning thereof when the door closing arm (20) is turning in an opposite direction.

[0021] With the above-described structure, when the guided member is not engaged with the door closing arm, that is, when the door is opened wider than the degree of opening which permits engagement between the door closing arm and the guided member, the door closing arm is held in the standby position by the elastic force of the biasing mechanism. When the door is being closed, the guided member approaches the device main body together with the door, and,
when the degree of opening of the door reaches a predetermined degree of opening, the guided member engages with the door closing arm. Then, when the door is being closed further, the door closing arm starts to turn from the standby position in the direction that closes the door. At the same time, the elastic force of the biasing mechanism starts to act as a force that forcedly turns the door closing arm in the direction that closes the door. With the forced turning of the door closing arm, the door is being closed forcedly. At this time, the reaction of the shock-absorbing mechanism starts to act and suppress the turning of the door closing arm, whereby an abrupt movement of the door is prevented. As a result, the door is closed forcedly and noiselessly. On the other hand, when the door is opened from a state in which the door is closed completely, the door closing arm starts to turn toward the standby position with the opening movement of the door. At the same time, the repulsion (restoring force) of the shock-absorbing mechanism starts to act as a force that turns the door closing arm in the direction that opens the door, whereby the turning of the door closing arm in the direction that opens the door is promoted. This eliminates the need to apply a strong force to the handle of the door when opening the door by hand.

[0022] In the door device of the invention, it is preferable that the fixed component (40) be secured to an end part of an upper frame member of the door frame, the end part on the side opposite to the side to which the hinge is attached. As a result of the fixed component being attached to an end part of the upper frame member of the door frame, the end part on the side opposite to the side to which the hinge is attached, it is possible to make the repulsion (restoring force) of the shock-absorbing mechanism act as efficiently as possible as a force for promoting the opening of the door when opening the door. This makes it possible to obtain the effect of facilitating the opening of the door when opening the door even when the repulsion (restoring force) of the shock-absorbing mechanism is weak.

[0023] In the door device of the invention, it is preferable that the fixed component (40) include a housing (70) fixed to the door frame and having a flat rectangular parallelepiped shape, and the turning piece (14), the biasing mechanism (50), and the shock-absorbing mechanism (60) be housed in the housing (70), in a bottom plate (8b, 10a) of the housing (70), an insertion hole (8a1, 10a6) for connecting a connecting shaft (28a3) of the door closing arm (20) to the shaft portion (14c) of the turning piece (14) be formed, and the door closing arm (20) turn along a lower surface of the housing (70).
As described above, by adopting a structure in which the turning piece, the biasing mechanism, and the shock-absorbing mechanism are housed in the housing having a flat rectangular parallelepiped shape, and the door closing arm turns along the lower surface of the housing, it is possible to reduce the size of the fixed component which is fixed to the door frame and achieve the door closing device which has a simple appearance and appears to be provided as a movable part with only the door closing arm.

[0024] Moreover, in the door device of the invention, it is preferable that the biasing mechanism (50) include a spring (16) exerting an elastic force on the first arm portion (14a) of the turning piece (14),
the shock-absorbing mechanism (60) include a direct-acting damper (19) which generates a braking force by being compressed and pushing back in a horizontal direction with the turning of the second arm portion (14b) of the turning piece (14) when the door closing arm (20) is turning in the direction that closes the door (A), and
the spring (16) and the damper (19) be arranged parallel to each other. This makes it easy to reduce the size of

the fixed component.

[0025] Furthermore, in the door device of the invention, it is preferable that the device main body (1) include an adjusting unit (17) for adjusting the elastic force of the biasing mechanism (50). This makes it possible to adjust the turning speed of the door when it is being closed and the reaction from the spring when the door is being opened.

[0026] In addition, in the door device of the invention, it is preferable that the shock-absorbing mechanism (60) be configured such that, when the door (A) is being closed, a force suppressing the turning of the second arm portion (14b) of the turning piece (14) is not exerted on the second arm portion (14b) from a point when a latch provided on an edge face of the door (A), the edge face on that side of the door (A) where a handle is provided, starts to engage in a latch hole provided in the door frame. This prevents the reaction from the shock-absorbing mechanism from acting from a point when the latch provided on the edge face of the door starts to engage in the latch hole in the door frame, making it possible to close the door reliably.

[0027] Moreover, in the door device of the invention, it is preferable that, when the door (A) is closed, the whole of the door closing arm (20) be located under the lower surface of the housing (70), and, when the door closing arm (20) is in the standby position, an end thereof protrude from under the lower surface of the housing (70) toward the door (A). With this structure, when the door is being closed, the guided member engages with the door closing arm in a standby status with the end thereof protruding from under the lower surface of the housing toward the door with the turning of the door. Then, when the door is being closed further, the door closing arm turns in the direction that closes the door, and, when the door is closed, the door closing arm fits under the housing, that is, the housing and the door closing arm are placed one on top of another.

[0028] Furthermore, in the door device of the invention, it is preferable that the guided member (7) include a supporting portion (30) secured to a board face of the door (A) and a sliding part (31) jutting upward from an end of the supporting portion (30), the door closing arm (20) include a guide groove (27c) extending in the direction of the radius of the turning of the door closing arm (20), and

when the door closing arm (20) is in the standby position, an end of the sliding part (31) be received in the guide groove (27c) with the turning in the direction in which the door (A) is closed.

[0029] According to the present invention, it is possible to close the door noiselessly by suppressing an abrupt turning of the door just before it is closed by the reaction of the shock-absorbing mechanism while forcedly closing the door by the elastic force of the biasing mechanism when closing the door, and open the door by a weak force by promoting the movement of the door by the repulsion of the shock-absorbing mechanism when opening the door. Since a direct-acting shock-absorbing mechanism is used as the shock-absorbing mechanism for suppressing an abrupt movement of the door just before it is closed and promoting the movement of the door when it is being opened, it is possible to make the device main body smaller than that of a conventional door closing device. This makes it possible to attach the device main body to the door frame.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030]

FIG. 1 is a diagram of a state in which a door closing device according to an embodiment of the invention is attached;

FIG. 2(A) is an exploded perspective view of a device main body of the door closing device of FIG. 1 and FIG. 2(B) is a perspective view of the device main body of the door closing device of FIG. 1;

FIG. 3 is a perspective view of the device main body of FIG. 1 as viewed from below;

FIG. 4 is a diagram for explaining operation of the door closing device of FIG. 1 as viewed from above;

FIG. 5 is a diagram for explaining operation of the door closing device of FIG. 1 as viewed from above, the operation continued from the operation of FIG. 4;

FIG. 6 is a diagram for explaining operation of the door closing device of FIG. 1 as viewed from below;

FIG. 7 is a diagram for explaining return operation of the door closing device of FIG. 1;

FIG. 8 is a diagram of a state in which a conventional door closing device is attached; and

FIG. 9 is a diagram for explaining operation of the door closing device of FIG. 8.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0031] The best mode for carrying out the invention will be explained with reference to FIGS. 1 to 7. In this embodiment, the invention is applied to a so-called right-hinged door A.

[0032] A door closing device 1 of this embodiment is a device that makes it possible not only to close the door A which is connected to a door frame rotatably (turnably, in an openable and closable manner) via a hinge 5 noiselessly, the door frame attached to a doorway or the like of a house or a room as shown in FIG. 1, by slowing down the door A immediately before it is closed (just before it is closed), but also to open the door A without applying a strong force to a handle (not shown) of the door A when opening the door A. The door frame has an upper frame member 2 provided in an upper edge part of an opening, such as a doorway of a house, and vertical frame members 3 and 4 provided in the right and left side edge parts of the opening. The door A is rotatably connected to the vertical frame member 4, which is one (the right-hand

one in the figure) of the two vertical frame members 3 and 4 via the hinge 5.

[0033] The door closing device 1 has a device main body 6 (also see FIG. 3) attached to the upper frame member 2 and a guided member 7 attached to the door A. The device main body 6 is attached to a portion of the upper frame member 2, the portion near the vertical frame member 3 on the side opposite to the vertical frame member 4 to which the hinge 5 is attached. The guided member 7 is attached to a portion near an upper edge of the back surface of the door A and near an edge part thereof to which the hinge 5 is not provided, the portion corresponding to a position in which the device main body 6 is placed.

[0034] The device main body 6 has: a fixed component 40 fixed to the upper frame member 2 of the door frame; a turning piece 14 having a shaft portion 14c supported on the fixed component 40 in such a way that it can turn in a horizontal direction and first and second arm portions 14a and 14b projecting outward from the shaft portion 14c in different horizontal directions; a door closing arm 20 which turns with the turning piece 14 in a horizontal direction and moves into and out of engagement with the guided member 7 with the turning of the door A; a biasing mechanism 50 which exerts elastic repulsion on the first arm portion 14a of the turning piece 14 to hold the door closing arm 20 in a standby position (see FIG. 4(A)) in which the door closing arm 20 can engage with the guided member 7 when the guided member 7 is not engaged with the door closing arm 20, and to turn the door closing arm 20 forcedly in the direction that closes the door A when the guided member 7 is engaged with the door closing arm 20; and a direct-acting shock-absorbing mechanism 60 which exerts a force on the second arm portion 14b of the turning piece 14 to suppress the turning of the door closing arm 20 when the door closing arm 20 is turning in the direction that closes the door A, and to promote the turning of the door closing arm 20 when the door closing arm 20 is turning in an opposite direction, that is, when the door closing arm 20 is turning in the direction that opens the door A.

[0035] The fixed component 40 has a housing 70 fixed to the upper frame member 2 of the door frame and having a flat rectangular parallelepiped shape. The turning piece 14, the biasing mechanism 50, and the shock-absorbing mechanism 60 are housed in the housing 70.

[0036] In a bottom plate (8b, 10a) of the housing 70, an insertion hole (8a1, 10a6) for connecting a connecting shaft 28a3 of the door closing arm 20 to the shaft portion 14c of the turning piece 14 is formed. The door closing arm 20 has the connecting shaft 28a3 connected to the shaft portion 14c of the turning piece 14 through the insertion hole (8a1, 10a6) of the bottom plate (8b, 10a) of the housing 70. This allows the door closing arm 20 to turn along a lower surface of the housing 70. Incidentally, the housing 70 has the insertion holes 8a1 and 10a6 formed in the upper and lower surfaces thereof, respectively, the insertion holes 8a1 and 10a6 for connecting the connecting shaft 28a3 of the door closing arm 20 to the shaft portion 14c of the turning piece 14, and can connect the connecting shaft 28a3 of the door closing arm 20 to the shaft portion 14c of the turning piece 14 through any one of the insertion holes 8a1 and 10a6.

[0037] The biasing mechanism 50 has a first slider 15 which linearly moves backward and forward in the direction of the longer sides of the housing 70 and a spring 16 which exerts elastic repulsion on the first arm portion 14a of the turning piece 14 via the first slider 15.

[0038] The shock-absorbing mechanism 60 has a direct-acting damper 19 which generates a braking force by being compressed and pushing back in a horizontal direction with the turning of the second arm portion 14b of the turning piece 14 when the door closing arm 20 is turning in the direction that closes the door A.

[0039] In the housing 70, the coil spring 16 and the damper 19 are arranged parallel to each other.

[0040] The device main body 6 has an adjusting unit 17 for adjusting the elastic repulsion of the biasing mechanism 50.

[0041] When the door A is closed, the whole of the door closing arm 20 is located under the lower surface of the housing 70 (see FIG. 5(B)); when the door closing arm 20 is in the standby position, the end thereof protrudes from under the lower surface of the housing toward the door A (see FIG. 4(A)).

[0042] The guided member 7 has a supporting portion 30 secured to a board face of the door A and a sliding part 31 jutting upward from the end of the supporting portion 30.

[0043] The door closing arm 20 has a guide groove 27c extending in the direction of the radius of the turning thereof. When the door closing arm 20 is in the standby position, the upper end of the sliding part 31 is received in the guide groove 27c with the turning in the direction in which the door A is closed.

[0044] The shock-absorbing mechanism 60 is configured such that, when the door A is being closed, a force suppressing the turning of the second arm portion 14b of the turning piece 14 is not exerted on the second arm portion 14b from a point when a latch (not shown) provided on an edge face of the door A, the edge face located on that side of the door A where the handle is provided, starts to engage in a latch hole (not shown) provided in the door frame.

[0045] With the structure described above, when the guided member 7 is not engaged with the door closing arm 20, that is, when the door A is opened wider than the degree of opening which permits engagement between the door closing arm 20 and the guided member 7, the door closing arm 20 is held in the standby position by the elastic repulsion of the biasing mechanism 50 (FIG. 4(A)). When the door A is being closed, the guided member 7 approaches the device main body 6 together with the door A, and, when the degree of opening of the door A reaches a predetermined degree of opening, the guided member 7 engages with the door closing arm 20

(FIG. 6(A)). Then, when the door A is being closed further, the door closing arm 20 starts to turn from the standby position in the direction that closes the door A. At the same time, the elastic repulsion of the biasing mechanism 50 starts to act as a force that forcedly turns the door closing arm 20 in the direction that closes the door A. With the forced turning of the door closing arm 20, the door A is being closed forcedly. At this time, the reaction of the shock-absorbing mechanism 60 starts to act and suppress the turning of the door closing arm 20, whereby an abrupt movement of the door A is prevented. As a result, the door A is closed forcedly and noiselessly. On the other hand, when the door A is opened from a state in which the door A is closed completely (FIG. 6(B)), the door closing arm 20 starts to turn toward the standby position with the opening movement of the door A. At the same time, the repulsion of the shock-absorbing mechanism 60 starts to act as a force that turns the door closing arm 20 in the direction that opens the door A, whereby the turning of the door closing arm 20 in the direction that opens the door A is promoted. This eliminates the need to apply a strong force to the handle of the door A when opening the door A by hand. Since a direct-acting shock-absorbing mechanism is used as the shock-absorbing mechanism 60, it is possible to achieve the door closing device 1 that can close the door A noiselessly when closing the door and can open the door A by a weak force when opening the door without an increase in the size of the device main body 6.

Moreover, as a result of the device main body 6 being attached to an end part of the upper frame member 2 forming the door frame, the end part on the side opposite to the side to which the hinge 5 is attached, it is possible to make the repulsion (restoring force) of the shock-absorbing mechanism 60 act as efficiently as possible as a force for promoting the opening of the door A when opening the door A. This makes it possible to obtain the effect of facilitating the opening of the door A when opening the door A even when the repulsion (restoring force) of the shock-absorbing mechanism 60 is weak.

Furthermore, by adopting a structure in which the turning piece 14, the biasing mechanism 50, and the shock-absorbing mechanism 60 are housed in the housing 70 having a flat rectangular parallelepiped shape, and the door closing arm 20 turns along the lower surface of the housing 70, it is possible to reduce the size of the fixed component 40 which is fixed to the upper frame member 2 of the door frame and achieve the door closing device 1 which has a simple appearance and appears to be provided as a movable part with only the door closing arm 20.

In addition, the insertion holes 8a1 and 10a6 for connecting the connecting shaft 28a3 of the door closing arm 20 to the shaft portion 14c of the turning piece 14 are formed respectively in the upper and lower surfaces of the housing 70, and the connecting shaft 28a3 of the door closing arm 20 can be connected to the shaft portion 14c of the turning piece 14 through any one of the insertion holes 8a1 and 10a6. This makes it possible to use the door closing device 1 for both a right-hinged door and a left-hinged door.

Moreover, the spring 16 and the damper 19 are arranged parallel to each other, making it easy to reduce the size of the fixed component 40.

Furthermore, since the adjusting unit 17 for adjusting the elastic force of the biasing mechanism 50 is provided, it is possible to adjust properly the turning speed of the door A when it is being closed and the reaction from the spring 16 when the door is being opened.

In addition, when the door A is being closed, the reaction from the shock-absorbing mechanism 60 is prevented from acting from a point when the latch provided on the edge face of the door A starts to engage in the latch hole in the door frame. This makes it possible to close the door A reliably.

[0046] Next, the structure of the device main body 6 will be explained in more detail.

As described above, the device main body 6 has the fixed component 40 fixed to the upper frame member 2 of the door frame. As shown in FIG. 2(A), the fixed component 40 has the housing 70 fixed to the upper frame member 2 of the door frame and having a flat rectangular parallelepiped shape and blocks 12 and 13 fixedly provided in the housing 70.

[0047] The housing 70 includes an outer housing main body 8, an outer housing side plate body 9, and an inner housing main body 10 and an inner housing upper plate body 11 which are placed in the outer housing main body 8.

[0048] In an example of FIGS. 2(A), 4, and 5, in the inner housing main body 10, the left fixed block 12 is placed in a far left corner, and the right fixed block 13 is placed in a far right corner. Between the fixed blocks 12 and 13, the turning piece 14 turnably provided near the left fixed block 12, the first slider 15 having one side which makes contact with a small rotor 23 of the first arm portion 14a of the turning piece 14, the spring 16 seated on a spring washer provided on the other side of the slider 15 and biasing the slider 15 toward the left fixed block 12, a second slider 18 having one side which makes contact with the second arm portion 14b of the turning piece 14 to a certain point and does not make contact with it from a certain point, and two direct-acting dampers (shock-absorbing mechanism) 19, each being disposed such that a movable portion 19a thereof makes contact with the other side of the second slider 18 and a fixed portion 19b thereof makes contact with the right fixed block 13, are provided. The adjusting unit 17 is provided in the right fixed block 13.

[0049] Of these component members of the device main body 6, the inner housing main body 10, the inner housing upper plate body 11, and the members placed in an inner housing formed with the inner housing main body 10 and the inner housing upper plate body 11 will be explained.

[0050] The inner housing main body 10 is, as shown in FIG. 2(A), an elongate, thin, flat, hollow member having

a virtually rectangular parallelepiped shape and having an opening in the upper surface thereof. In a lower plate 10a of the inner housing main body 10, the insertion hole (lower fit hole) 10a6 is provided rather near a left edge of the lower plate 10a, a short bearing ring 21a is provided in a manner so as to protrude therefrom along the outer edge of the insertion hole 10a6 toward the inside of the inner housing main body 10, and elongate guide slots 10a1 and 10a2, each being formed from a point which is slightly away from the bearing ring 21a to a point near the center of the lower plate 10a along the longer sides thereof, are provided with a predetermined space left between them. Furthermore, in the lower plate 10a, a protrusion 22 having a virtually square shape and formed by cutting the lower plate 10a in the shape of the letter U and folding an uncut part located along the longer sides of the lower plate 10a toward the inside of the inner housing main body 10 is provided in a manner so as to protrude therefrom rather near the ends of the guide slots 10a1 and 10a2, the ends located opposite to the bearing ring 21a, in the vicinity of the center between the guide slots 10a1 and 10a2, relatively large locating slots 10a3 and 10a4 (of which the slot 10a4 is not shown), each being formed from a point rather near the end of the guide slot 10a2 to a point rather near the right edge of the lower plate 10a, are provided at substantially equal distances from an extension of the center line of the guide slot 10a2, and a relatively small guide slot 10a5 is provided in a part rather near the right edge of the lower plate 10a in such a way that the center line thereof roughly coincides with an extension of the center line of the guide slot 10a1. In upper edge parts of long side plates 10b of the inner housing main body 10,

convex protruding portions 10b1 are provided with a predetermined space left between them. Moreover, in the center of an upper edge part of each short side plate 10c of the inner housing main body 10, a convex protruding portion 10c1 is provided. Of these side plates 10c, the one located on the right edge of the inner housing main body 10 in FIGS. 2(A), 4, and 5 has an inverted U-shaped operating hole 10c2 formed therein, and the operating hole 10c2 is formed in such a way that the center line of the inverted U-shaped hole and the center line of the guide slot 10a5 intersect one another at right angles.

Incidentally, although a detailed explanation is omitted, a plurality of holes of various sizes provided in the lower plate 10a are bolt holes for attaching the device main body 6 including the inner housing main body 10 and the like to the upper frame member 2, or pin holes for positioning of the inner housing upper plate body 11 and the fixed blocks 12 and 13 relative to the inner housing main body 10.

[0051] The inner housing upper plate body 11 is a rectangular, thin, flat plate-shaped member, which is mounted as an upper surface plate body of the inner housing main body 10. An insertion hole (upper fit hole) 11a of the inner housing upper plate body 11 is provided as a counterpart of the insertion hole 10a6 of the inner housing main body 10 such that it is formed to be concentric with the insertion hole 10a6 and has the same hole diameter as that of the insertion hole 10a6, guide slots 11b and 11c of the inner housing upper plate body 11 are provided as counterparts of the guide slots 10a1 and 10a2 of the inner housing main body 10 such that they have the same slot width and the same slot length as those of the guide slots 10a1 and 10a2, and a guide slot 11d of the inner housing upper plate body 11 is provided as a counterpart of the guide slot 10a5 of the inner housing main body 10 such that it has the same slot width and the same slot length as those of the guide slot 10a5. Incidentally, also in the inner housing upper plate body 11, as is the case with the inner housing main body 10, a short bearing ring 21b is provided in a manner so as to protrude therefrom along the outer edge of the insertion hole 11a on the lower surface side of the inner housing upper plate body 11. In the longer sides of the inner housing upper plate body 11, concave notches 11e are provided, one for each of the protruding portions 10b1 of the inner housing main body 10. Moreover, in the shorter sides of the inner housing upper plate body 11, concave notches 11f are provided, one for each of the protruding portions 10c1 of the inner housing main body 10.

Furthermore, a notch 11g for preventing interference with a flange portion 26b of an adjusting screw 26 of the adjusting unit 17, which will be described later, is provided near a right-edge side, in FIG. 2(A), of the inner housing upper plate body 11 along that side at some distance from the guide slot 11d.

Incidentally, although a detailed explanation is omitted, a plurality of holes of various sizes provided in the inner housing upper plate body 11 are bolt holes for attaching the device main body 6 including the inner housing upper plate body 11 and the like to the upper frame member 2, or pin holes for positioning of the inner housing upper plate body 11 and the like as described above.

[0052] Of the members placed in the inner housing formed with the inner housing main body 10 and the inner housing upper plate body 11, first, the left fixed block 12 is a thin, flat block member having a virtually U shape and formed with an elongate horizontal block 12a, a thick and short horizontal block 12b, and a vertical block 12c connecting the blocks 12a and 12b. The left fixed block 12 is disposed in such a way that, when it is placed in the inner housing main body 10, as shown in FIGS. 4 and 5, part of the shaft portion 14c of the turning piece 14 faces a U-shaped space of the left fixed block 12, the first arm portion 14a of the turning piece 14 comes into contact with an inclined surface 12a1 provided rather near the end of the horizontal block 12a with the rotation of the turning piece 14, and the second arm portion 14b of the turning piece 14 comes into contact with an end surface 12b1 of the horizontal block 12b with the rotation of the turning piece 14.

Incidentally, although a detailed explanation is omitted, two large and small holes provided in the left fixed block 12 are a bolt hole for attaching the device main body 6

including the left fixed block 12 and the like to the upper frame member 2 and a pin hole for positioning the left fixed block 12 in the inner housing main body 10.

[0053] The right fixed block 13 is a thin, flat block member having a virtually L shape and formed with a large horizontal block 13a and a vertical block 13b. From a side surface of the horizontal block 13a, the side surface making contact with the side plate 10c of the inner housing main body 10 when the right fixed block 13 is placed in the inner housing main body 10, to a nearly central part of the horizontal block 13a, a groove hole 13a1 in which the adjusting unit 17 is placed along the longitudinal center line of the horizontal block 13a is provided so as to open on an upper surface (a surface making contact with the inner housing upper plate body 11 when the right fixed block 13 is placed in the inner housing main body 10) and a lower surface (a surface making contact with the inner housing main body 10 when the right fixed block 13 is placed in the inner housing main body 10). On the other hand, a through bore 13a2 communicating with the groove hole 13a1 is provided so as to open on a side surface of the horizontal block 13a, the side surface opposite to the side surface making contact with the side plate 10c, and is provided in such a way that the central axis thereof roughly coincides with the central axis of an adjusting block 25 of the adjusting unit 17 placed in the horizontal block 13a. As will be described later, the through bore 13a2 is configured such that a cylindrical portion 25b of the adjusting block 25 can enter and leave it as the adjusting block 25 of the adjusting unit 17 moves backward and forward. Moreover, the end face of the fixed portion 19b of the damper 19 makes contact with a side surface of the vertical block 13b, the side surface located on the side opposite to the surface making contact with the side plate 10c of the inner housing main body 10 when the right fixed block 13 is placed in the inner housing main body 10.

Incidentally, although a detailed explanation is omitted, a plurality of holes of various sizes provided in the right fixed block 13 are a bolt hole for attaching the device main body 6 including the right fixed block 13 and the like to the upper frame member 2 and a pin hole for positioning the right fixed block 13 in the inner housing main body 10.

[0054] The turning piece 14 is a member formed with the shaft portion 14c having a virtually short cylinder shape and having a hole with a virtually square shape in the center of the cylinder, the first arm portion 14a formed on the circumference of the shaft portion 14c, the first arm portion 14a having a tapered shape and having an arc-shaped end, and the second arm portion 14b having a virtually rectangle shape and having an end whose corners are chamfered, and the first arm portion 14a and the second arm portion 14b are provided in a manner so as to protrude from the shaft portion 14c such that their center lines form an angle of approximately 90°. On the upper and lower surfaces of the shaft portion 14c described above, small shaft portions 14c1, each being in the shape of an extremely short cylinder having a shaft diameter smaller than that of the shaft portion 14c and having a square hole in the center of the upper and lower surfaces, are provided (in FIG. 2(A), only the small shaft portion 14c1 on the upper surface of the shaft portion 14c is shown), the square holes on the upper and lower surfaces of the small shaft portions 14c1 communicate with each other via a screw hole, and the small shaft portion 14c1 on the upper surface and the small shaft portion 14c1 on the lower surface loosely fit in the bearing ring 21b of the inner housing upper plate body 11 and the bearing ring 21a of the inner housing main body 10, respectively. Furthermore, a slit 14a1 in which the small rotor 23 is placed is provided at the end of the first arm portion 14a, and end pieces 14a2 and 14a3 of the first arm portion 14a, the end pieces 14a2 and 14a3 facing each other across the slit 14a1, have through bores formed to be concentric with each other. A short small-diameter pin 24 to which the small rotor 23 is attached is fitted into these through bores by insertion. Although this embodiment deals with a case in which the first arm portion 14a is provided with the small rotor 23, the present invention is not limited thereto. When such a small rotor 23 is not provided, it goes without saying that the first arm portion 14a makes direct contact with the first slider 15.

[0055] The first slider 15 is formed of a thin, flat member having a virtually rectangular parallelepiped shape. On a side surface 15a on one side (the side with which the small rotor 23 of the first arm portion 14a of the turning piece 14 makes contact) of the slider 15, an apex 15a1 is provided rather near the longitudinal center line of the inner housing main body 10, the center line located in an offset position from the longitudinal center line of the slider 15 when the slider 15 placed in the inner housing main body 10 is viewed from above, and inclined surfaces 15a2 and 15a3 which form a predetermined angle of inclination with the apex are provided (see FIGS. 4 and 5). Moreover, on the upper and lower surfaces of the slider 15, elongate ribs 15b1 and 15b2 (of which the rib 15b2 is not shown) which are loosely inserted into the guide slot 11b of the inner housing upper plate body 11 and the guide slot 10a1 of the inner housing main body 10 are formed from the side surface 15a on one side of the slider 15 to a point near a nearly central part of the slider 15 along the longitudinal center line of the slider 15, and the slider 15 is made to slide by being guided by the guide slots 11b and 10a1. Furthermore, in the center of a side surface on the other side of the slider 15, a closed-end grooved hole 15c having an opening in that side surface is provided.

[0056] The spring 16 is a common coil spring having a predetermined spring constant. The spring 16 is inserted into the grooved hole 15c of the slider 15 and the through bore 13a2 of the right fixed block 13, and is placed between them in such a way as to run between them. At the same time, the spring 16 is placed between them in such a way as to give a force to the slider 15, the

force biasing the slider 15 toward the left fixed block 12, by using the closed end of the grooved hole 15c as one spring washer and the end face of the cylindrical portion 25b of the adjusting block 25 of the adjusting unit 17, the end face entering and leaving the through bore 13a2 of the right fixed block 13, as the other spring washer.

[0057] The adjusting unit 17 is a device for adjusting a bias force of the spring 16, and is formed, in this embodiment, with the adjusting block 25 and the adjusting screw 26. Of them, the adjusting block 25 is formed with a rectangular parallelepiped portion 25a and the cylindrical portion 25b connected to one end face of the rectangular parallelepiped portion 25a. The rectangular parallelepiped portion 25a has a screw hole 25a1, which is opened on the other end face of the rectangular parallelepiped portion 25a along the longitudinal central axis thereof. Moreover, on the circumferential surface of the cylindrical portion 25b in a part rather near the rectangular parallelepiped portion 25a, short angular ribs 25b1 and 25b2 are formed so as to be separated from each other by a phase angle of 180°. On the other hand, the adjusting screw 26 is formed with a head 26a having on one end face thereof an operation groove in which an operating device, such as a screwdriver, engages, a flange portion 26b connected to the other end face of the head 26a, and a screw portion 26c connected to the flange portion 26b, the screw portion 26c which is screwed into the screw hole 25a1 of the rectangular parallelepiped portion 25a.

[0058] When such an adjusting unit 17 is mounted on the right fixed block 13, it is mounted thereon such that the rectangular parallelepiped portion 25a of the adjusting block 25 can slide in an angular groove portion 13a11 of the groove hole 13a1, and, as described above, the cylindrical portion 25b of the adjusting block 25 can enter and leave the through bore 13a2. It is to be noted that the ribs 25b1 and 25b2 of the adjusting block 25 are loosely inserted respectively into the guide slot 11d of the inner housing upper plate body 11 and the guide slot 10a5 of the inner housing main body 10 via an opening formed in the lower surface of the groove hole 13a1 of the right fixed block 13. On the other hand, the screw portion 26c of the adjusting screw 26 of the adjusting unit 17 is screwed into the screw hole 25a1 of the rectangular parallelepiped portion 25a as described above, and the flange portion 26b thereof is fitted into a nearly semicircular groove portion 13a12 of the groove hole 13a1. At this time, a face of the head 26a of the adjusting screw 26, the face in which the operation groove of the head 26a is formed, is roughly flush with the surface of the vertical block 13b of the right fixed block 13. In such an adjusting unit 17, the adjusting block 25 moves backward and forward when the adjusting screw 26 is turned, making it possible to adjust a bias force of the spring 16.

[0059] The second slider 18 is formed of a thin, flat member having a virtually square shape. On a side surface 18a on one side (the side with which the second arm portion 14b of the turning piece 14 makes contact) of the slider 18, an inclined surface 18a1 is formed in such a way as to form a predetermined angle of inclination from a point near the width direction center line of the side surface 18a of the slider 18, the center line orthogonal to the direction in which the slider 18 slides, when the slider 18 placed in the inner housing main body 10 is viewed from above (see FIGS. 4 and 5). As will be described in detail later, such an inclined surface 18a1 is provided to prevent the reaction from the damper 19 from acting on the second arm portion 14b of the turning piece 14 via the slider 18 from when the rotation of the turning piece 14 reaches a certain point, that is, from when the latch provided in the handle of the door A starts to engage in the latch hole provided in the vertical frame member 3 with the opening movement of the door A. As described above, the end faces of the movable portions 19a of the two dampers 19 make contact with a side surface 18b on the other side of the slider 18. Furthermore, on the upper and lower surfaces of the slider 18, elongate ribs 18c1 and 18c2 (of which the rib 18c2 is not shown) which are loosely inserted into the guide slot 11c of the inner housing upper plate body 11 and the guide slot 10a2 of the inner housing main body 10 are formed along the center line of the slider 18, the center line connecting the side surface 18a and the side surface 18b when the slider 18 is viewed from above, and the slider 18 is made to slide by being guided by the guide slots 11c and 10a2.

[0060] The damper 19 is a shock absorber having a predetermined damping coefficient, and is of the direct acting type formed with the movable portion 19a that can move backward and forward and the fixed portion 19b that allows the movable portion 19a to appear and disappear, the fixed portion 19b in which a viscous fluid, such as silicon oil, is encapsulated. This makes it possible to make the device main body 6 compact and attach it to the door frame. When the damper 19 is mounted on the inner housing main body 10, it is mounted thereon such that the fixed portion 19b thereof is properly positioned based on the locating slots 10a3 and 10a4 (of which the slot 10a4 is not shown) and the protrusion 22 of the inner housing main body 10, and, as described above, the fixed portion 19b is made to make contact with the vertical block 13b of the right fixed block 13 and the end face of the movable portion 19a is made to make contact with the side surface 18b of the slider 18 such that an acting force of the damper 19 acts on the slider 18. Although this embodiment deals with a case in which the two dampers 19 placed parallel to each other are used, the present invention is not limited thereto. Depending on the specifications, three or more dampers 19, for example, may be placed parallel to one another, or one damper, which is larger in capacity than the damper 19 may be placed.

[0061] The door closing arm 20 is a thin, flat plate-shaped member having a virtually rectangle shape, and, in this embodiment, has a cross section in the shape of a circular truncated cone, the cross section taken along

the longitudinal center line of this member, as shown in FIGS. 1 and 3. On an upper surface side of the circular truncated cone, an upper bottom surface (one surface of the arm (a back surface in FIG. 2(A))) 27 is formed, on a lower surface side of the circular truncated cone, a lower bottom surface (the other surface of the arm (a front surface in FIG. 2(A))) 28 is formed, and an inclined surface 27d having a predetermined inclination is formed by a generating line of the circular truncated cone. The upper bottom surface 27 has a stepped hole 27a formed in the center at one end of the upper bottom surface 27, an opening 27b formed at the other end of the upper bottom surface 27, the opening whose width becomes wider as it gets closer to the open end, and the guide groove (guide portion) 27c formed from the opening 27b to a point near the center of the door closing arm 20 along the longitudinal center line of the door closing arm 20, the guide groove 27c in which the sliding part 31 of the guided member 7 slides (see FIG. 3). Moreover, in a part of the lower bottom surface 28, the part rather near an end thereof opposite to the end of the upper bottom surface 27 at which the opening 27b is formed, a mount 28a is provided in a manner so as to protrude therefrom. The mount 28a is formed with a large-diameter fit shaft 28a1 in the shape of a short large-diameter cylinder whose center coincides with the center of the stepped hole 27a, a short small-diameter fit shaft 28a2 in the shape of a short small-diameter cylinder, the small-diameter fit shaft 28a2 put and firmly fixed on the fit shaft 28a1, and the short connecting shaft 28a3 in the shape of a square, the connecting shaft 28a3 put and firmly fixed on the fit shaft 28a2. In the center of the fit shafts 28a1 and 28a2 and the connecting shaft 28a3, a screw hole into which a mounting bolt 29 is screwed is formed.

[0062] When the door closing arm 20 is mounted in such a way as to operate simultaneously with the turning of the turning piece 14, since the turning piece 14 is placed in the inner housing main body 10 and the inner housing main body 10 is inserted into the outer housing main body 8, the fit shaft 28a1 of the mount 28a is loosely fitted into the insertion hole 8b1 (which is not shown in the figure) of the outer housing main body 8, which will be described later, the fit shaft 28a2 of the mount 28a is loosely fitted into the bearing ring 21a of the inner housing main body 10, and the connecting shaft 28a3 of the mount 28a is loosely fitted into a square hole of the small shaft portion 14c1 of the shaft portion 14c of the turning piece 14, and then the mounting bolt 29 is screwed into the screw hole of the fit shafts 28a1 and 28a2 and the connecting shaft 28a3 of the mount 28a from the upper bottom surface 27 side of the door closing arm 20. At this time, the mounting bolt 29 is mounted by screwing it into the screw hole in such a way that the head thereof is buried in the stepped hole 27a and the end of the screw portion thereof does not stick out from the small shaft portion 14c1 side of the turning piece 14 (see FIG. 3).

[0063] Next, the outer housing main body 8 and the outer housing side plate body 9 will be described. The outer housing main body 8 is an elongate, thin, flat, hollow member having a virtually rectangular parallelepiped shape and having an opening in one edge thereof running in the longer-side direction. In this member, the inner housing formed with the inner housing main body 10 and the inner housing upper plate body 11 is housed. In an upper plate body 8a and a lower plate body 8b of the outer housing main body 8, the insertion hole (upper fit hole) 8a1 and the insertion hole (lower fit hole) 8b1 (of which only the insertion hole 8a1 is shown in FIG. 2(A)) are respectively provided as counterparts of the insertion hole 11a of the inner housing upper plate body 11 and the insertion hole 10a6 of the inner housing main body 10, and a guide slot 8a2 and a guide slot 8b2 (of which only the guide slot 8a2 is shown in FIG. 2(A)) are respectively provided as counterparts of the guide slot 11d of the inner housing upper plate body 11 and the guide slot 10a5 of the inner housing main body 10. Incidentally, tick marks shown in FIGS. 2 and 3 are placed near the guide slot 8a2 and the guide slot 8b2 for convenience in adjusting a bias force of the spring 16. Furthermore, notch portions 8a3 and 8a4 are provided with a predetermined space left between them at a longer edge of the upper plate body 8a, the longer edge bordering the opening of the outer housing main body 8, and notch portions 8b3 and 8b4 are provided with a predetermined space left between them at a longer edge of the lower plate body 8b, the longer edge bordering the opening of the outer housing main body 8. These notch portions are provided in such a way that the notch portion 8a3 faces the notch portion 8b3 and the notch portion 8a4 faces the notch portion 8b4. Still further, in a side plate 8c of the outer housing main body 8, the side plate 8c facing the side plate 10c of the inner housing main body 10 in which the operating hole 10c2 is provided, a circular operating hole 8c1 is provided as a counterpart of the operating hole 10c2. Incidentally, two holes provided in the upper plate body 8a and the lower plate body 8b are bolt holes for attaching the device main body 6 including the outer housing main body 8 and the like to the upper frame member 2.

[0064] The outer housing side plate body 9 is a rectangular, thin, flat plate-shaped member, which is mounted as a side plate body of the outer housing main body 8. At the edges of the longer sides of the back surface of the outer housing side plate body 9, locking lugs 9a1 and 9a2 are provided in a manner so as to protrude therefrom for the notch portions 8a3 and 8a4, respectively, of the outer housing main body 8, and locking lugs 9a3 and 9a4 are provided in a manner so as to protrude therefrom for the notch portions 8b3 and 8b4, respectively, of the outer housing main body 8. By locking the locking lug 9a1 and the like in the notch portion 8a3 and the like, the housing 70 shown in FIG. 2(B) is assembled. Then, by connecting the turning piece 14 inside the housing 70 and the door closing arm 20 outside the housing 70 to the assembled housing 70 by the mounting bolt 29, assembly of the device main body 6 is completed (see FIG.

3).

[0065] Next, the guided member 7 according to the embodiment will be explained with reference to FIGS. 1, 6, and 7.

[0066] The guided member 7 has the supporting portion 30 having a virtually isosceles triangle shape in appearance as seen in a plan view. A part corresponding to the base of the isosceles triangle is attached to the door A, and the sliding part 31 in the shape of an elongate cylinder, the sliding part 31 to which a stop ring 32 is attached at a lowermost end thereof, is inserted into an insertion hole (not shown) provided near a part corresponding to the apex of the isosceles triangle in such a way that the sliding part 31 can move up and down. When no external force acts on the sliding part 31, an upper end part of the sliding part 31 protrudes from an upper surface 30a of a block member 30 by a bias force of a spring (not shown) placed in the insertion hole, and the stop ring 32 thereof is locked in a lower surface 30b of the block member 30. When an external force acts on the sliding part 31, the sliding part 31 is pushed down against the bias force of the spring, and the locking of the stop ring 32 is released (see FIG. 7).

[0067] Next, how the door closing device 1 operates will be explained with reference to FIGS. 4 to 6.

First, an outline of operation of the door closing device 1 is explained with reference to FIG. 6.

When the door A is opened in a state shown in FIG. 1 in which the device main body 6 and the guided member 7 are not engaged with each other, the door closing arm 20 of the device main body 6 is held in an angular position corresponding to a predetermined closing angle at which it can engage with the sliding part 31 of the guided member 7.

From this state, the door starts to be closed by means of the handle of the door A, and, when the door A reaches a point immediately before the closing movement of the door closing device 1, that is, a position shown in FIG. 6 (A) (in this embodiment, a position forming an angle of about 15° in the figure), the sliding part 31 starts to engage in the guide groove 27c of the door closing arm 20. After this, in synchronism with the relative movement of the sliding part 31 along the guide groove 27c of the door closing arm 20, the door A is being closed forcedly and, even when it is being closed at high closing speed, noiselessly as a result of the speed being reduced, as will be described later, and enters a state shown in FIG. 6(B). On the other hand, to open the door A from a state shown in FIG. 6(B) through a state shown in FIG. 6(A), it is necessary simply to open the latch by grasping the handle of the door A and then apply a force to the handle. At this time, as described above, the installation positions of the device main body 6 and the guided member 7 make it possible to open the door A without applying a strong force to the handle of the door A. Furthermore, as will be described later, since the rotation of the door closing arm 20 is promoted by the damper 19, it is possible to reduce the force applied to the handle of the door A.

[0068] Next, the workings that enable the above-described operation of the door closing device 1 shown in FIG. 6 will be explained with reference to FIGS. 4 and 5. It is to be noted that the door A and the guided member 7 are not shown in FIGS. 4 and 5.

[0069] As is the case with FIG. 6(A), FIG. 4 (A) depicts a state immediately before the closing movement of the door closing device 1, the state in which the door closing arm 20 of the device main body 6 is held in an angular position corresponding to a predetermined closing angle at which it can engage with the sliding part 31 of the guided member 7. At this time, since the turning piece 14 is subjected to a clockwise moment in FIG. 4(A) from the spring 16 via the slider 15 as a result of the small rotor 23 of the turning piece 14 coming into contact with the slider 15 on the inclined surface 15a2 of the slider 15, and is subjected to a counterclockwise moment from the left fixed block 12 as a result of the second arm portion 14b of the turning piece 14 coming into contact with the end surface 12b1 of the left fixed block 12, the door closing arm 20 is held in an angular position corresponding to the above-described predetermined closing angle. On the other hand, in this embodiment, the damper 19 is set so as not to exert a force on the second arm portion 14b via the slider 18.

[0070] Then, when a force is applied to the door A to make the door closing device 1 start the door closing movement from the state shown in FIG. 4(A), the turning piece 14 enters a state in which the small rotor 23 of the turning piece 14 gets over the apex 15a1 of the slider 15 and comes into contact with the slider 15 on the inclined surface 15a3, that is, a state shown in FIG. 4(B). In this state,

since the turning piece 14 is subjected to a counterclockwise moment (the direction of an arrow A1 in the figure) in FIG. 4(B) by the elastic repulsion (such elastic repulsion can be adjusted as appropriate by the adjusting unit 17) of the spring 16, the elastic repulsion provided via the slider 15, the door closing arm 20 is also subjected to a counterclockwise moment (the direction of an arrow A2 in the figure), whereby the door A is automatically closed further. At this time, since the damper 19 makes the side surface 18a of the second slider 18 come into contact with the second arm portion 14b of the turning piece 14, and provides a clockwise moment to the turning piece 14 via the second slider 18, the speed of counterclockwise rotation of the turning piece 14 is suppressed and reduced. Then, when the turning piece 14 rotates and reaches a state shown in FIG. 5(A), that is, reaches a point when the latch provided in the handle of the door A starts to engage in the latch hole provided in the vertical frame member 3 with the closing of the door A,

the turning piece 14 is subjected continuously to a counterclockwise moment by a bias force of the spring 16 in a manner similar to that described above until it enters a state shown in FIG. 5(B). As a result, the door closing arm 20 is also subjected continuously to a counterclockwise moment. However, since a part in which the second

arm portion 14b of the turning piece 14 makes contact with the slider 18 is changed to the inclined surface 18a1 of the slider 18, the reaction from the damper 19 ceases to act on the turning piece 14 via the slider 18. As a result, only the counterclockwise moment by the spring 16 acts on the turning piece 14. This ensures that the latch engages in the latch hole, making it possible to obtain a reliable closed state of the door A.

[0071] In the state shown in FIG. 5(B), the turning piece 14 is subjected to a counterclockwise moment in FIG. 5 (B) as described above, and the first arm portion 14a of the turning piece 14 makes contact with the inclined surface 12a1 of the left fixed block 12 and is subjected to a clockwise moment from the left fixed block 12, whereby the balance is achieved. As a result, the closed state of the door A is maintained.

[0072] To open the door A from the state shown in FIG. 5(B), that is, the state in which the door A is closed completely, it is necessary simply to open the latch by grasping the handle of the door A and then apply a force to the handle, the force counteracting the bias force (such a bias force can be adjusted as appropriate by the adjusting unit 17) of the spring 16, the bias force provided to the turning piece 14 via the slider 15. The force applied at this time can be reduced in the door closing device 1 in which the installation positions of the device main body 6 and the guided member 7 are adopted as described above as compared with the conventional one. Furthermore, since the damper 19 comes into contact with the second arm portion 14b of the turning piece 14 via the slider 18, and starts to provide a clockwise moment in FIG. 5(A) (the direction of an arrow B1 in the figure) to the turning piece 14, the door closing arm 20 is also provided with a clockwise moment (the direction of an arrow B2 in the figure). This promotes the clockwise rotation of the door closing arm 20, whereby the force applied to the door A can be further reduced.

Incidentally, it goes without saying that, when the door closing arm 20 of the device main body 6 goes out of engagement with the sliding part 31 of the guided member 7 with the progress of the opening movement of the door A, the door closing arm 20 is held in an angular position corresponding to a predetermined closing angle at which it can engage with the sliding part 31.

[0073] Next, with reference to FIG. 7, how to return the door closing arm 20 to the above-described angular position when the angular position of the door closing arm 20 of the device main body 6, the door closing arm 20 which has been held in the angular position corresponding to the above-described predetermined closing angle, is changed for some reasons will be explained.

[0074] In the door closing device 1, even when the above-described angular position is changed, by turning the door A in the direction that closes the door (the direction indicated by an arrow in the figure) as shown in FIG. 7(A), in other words, by bringing the guided member 7 closer to the device main body 6, thereby making the sliding part 31 of the guided member 7 come into contact with the inclined surface 27d of the door closing arm 20, and turning the door A in the direction of the arrow while keeping the sliding part 31 in contact with the inclined surface 27d, as shown in FIG. 7(B), the sliding part 31 protruding from the upper surface 30a of the block member 30 receives a force from the door closing arm 20 and is pushed down against a force of the spring attached to the guided member 7, and a lower end part of the sliding part 31 protrudes from the lower surface 30b of the block member 30 by the same amount by which the sliding part 31 is pushed down. Then, when the door A is turned continuously in the direction of the arrow while keeping such a contact state, as shown in FIG. 7(C), the sliding part 31 passes the inclined surface 27d and a horizontal surface portion of the door closing arm 20, and is then inserted into the guide groove 27c, whereby the door closing arm 20 is engaged with the sliding part 31. As a result, the stop ring 32 is locked in the lower surface 30b of the block member 30.

[0075] When the door A is opened after the sliding part 31 is engaged in the guide groove 27c of the door closing arm 20 as described above, the door opening movement progresses through the above-described state shown in FIG. 7(C). Then, after engagement between the door closing arm 20 and the sliding part 31 is released, the door closing arm 20 is held in an angular position corresponding to a predetermined closing angle at which it can engage with the sliding part 31. In this way, the door closing arm 20 is returned to the above-described angular position.

[0076] Incidentally, as in this embodiment, for the right-hinged door A, the door closing arm 20 is attached to the lower plate body 8b of the outer housing main body 8 of the device main body 6 via the mount 28a. The door closing device 1 can support a left-hinged door by attaching the door closing arm 20 to the upper plate body 8a of the outer housing main body 8 of the device main body 6 via the mount 28a of the door closing arm 20. Specifically, the door closing device 1 can support a left-hinged door by loosely fitting, in the door closing arm 20, the large-diameter fit shaft 28a1 of the mount 28a into the insertion hole 8a1 of the outer housing main body 8, the small-diameter fit shaft 28a2 of the mount 28a into the bearing ring 21b of the inner housing upper plate body 11, and the connecting shaft 28a3 of the mount 28a into the square hole of the small shaft portion 14c1 of the shaft portion 14c of the turning piece 14, and then screwing the mounting bolt 29 into the screw hole of the fit shafts 28a1 and 28a2 and the connecting shaft 28a3 of the mount 28a from the upper bottom surface 27 side of the door closing arm 20. Therefore, since the door closing device 1 can be used for both a right-hinged door and a left-hinged door, it is easy to use at the time of installation.

[0077] The door closing device of the invention can be used widely and commonly as a device of this type because it has a device structure in which the device main body is made compact by adopting a direct acting-type shock absorber as the shock absorber which is attached

to the device main body, making it possible to attach the device main body to a narrow portion of the door frame, and has a device structure in which the shock absorber is made to operate so as to close the door noiselessly by reducing the closing speed of the door when the door is being closed and to facilitate the opening movement of the door when the door is being opened, such that the door can be opened without the application of a strong force to the handle of the door.

Claims

1. A door closing device (1) forcedly closing a door (A) which is connected to a door frame via a hinge (5) in such a way that the door (A) can turn in a horizontal direction, the door closing device (1) comprising:

a device main body (6) attached to the door frame; and
a guided member (7) fixed to the door (A),
wherein
the device main body (6) comprises:

a fixed component (40) fixed to an upper edge part of an opening of the door frame;
a turning piece (14) including a shaft portion (14c) supported on the fixed component (40) in such a way that the shaft portion (14c) can turn in a horizontal direction and first and second arm portions (14a, 14b) projecting outward from the shaft portion (14c) in different horizontal directions;
a door closing arm (20) which turns with the turning piece (14) in a horizontal direction and moves into and out of engagement with the guided member (7) with a turning of the door (A);
a biasing mechanism (50) which exerts an elastic force on the first arm portion (14a) of the turning piece (14) to hold the door closing arm (20) in a standby position in which the door closing arm (20) stands ready to engage with the guided member (7) when the guided member (7) is not engaged with the door closing arm (20), and to turn the door closing arm (20) forcedly in a direction that closes the door (A) after the guided member (7) engages with the door closing arm (20); and
a direct-acting shock-absorbing mechanism (60) which exerts a force on the second arm portion (14b) of the turning piece (14) to suppress a turning of the door closing arm (20) when the door closing arm (20) is turning in a direction that closes the door (A), and to promote the turning thereof when the door closing arm (20) is turning in an opposite direction.

2. The door closing device according to claim 1, wherein
the fixed component (40) includes a housing (70) fixed to the door frame and having a flat rectangular parallelepiped shape,
the turning piece (14), the biasing mechanism (50), and the shock-absorbing mechanism (60) are housed in the housing (70),
in a bottom plate (8b, 10a) of the housing (70), an insertion hole (8a1, 10a6) for connecting a connecting shaft (28a3) of the door closing arm (20) to the shaft portion (14c) of the turning piece (14) is formed, and
the door closing arm (20) turns along a lower surface of the housing (70).

3. The door closing device according to claim 2, wherein the biasing mechanism (50) includes a spring (16) exerting an elastic force on the first arm portion (14a) of the turning piece (14),
the shock-absorbing mechanism (60) includes a direct-acting damper (19) which generates a braking force by being compressed and pushing back in a horizontal direction with a turning of the second arm portion (14b) of the turning piece (14) when the door closing arm (20) is turning in a direction that closes the door (A), and
the spring (16) and the damper (19) are arranged parallel to each other.

4. The door closing device according to claim 3, wherein the device main body (1) includes an adjusting unit (17) for adjusting the elastic force of the biasing mechanism (50).

5. The door closing device according to claim 2, wherein
when the door (A) is closed, a whole of the door closing arm (20) is located under the lower surface of the housing (70), and
when the door closing arm (20) is in the standby position, an end thereof protrudes from under the lower surface of the housing (70) toward the door (A).

6. The door closing device according to claim 5, wherein the guided member (7) includes a supporting portion (30) secured to a board face of the door (A) and a sliding part (31) jutting upward from an end of the supporting portion (30),
the door closing arm (20) includes a guide groove (27c) extending in a direction of a radius of the turning of the door closing arm (20), and
when the door closing arm (20) is in the standby position, an end of the sliding part (31) is received in the guide groove (27c) with the turning in a direction in which the door (A) is closed.

7. The door closing device according to any one of claims 1 to 6, wherein
the shock-absorbing mechanism (60) is configured such that, when the door (A) is being closed, a force suppressing a turning of the second arm portion (14b) of the turning piece (14) is not exerted on the second arm portion (14b) from a point when a latch provided on an edge face of the door (A), the edge face located on that side of the door (A) where a handle is provided, starts to engage in a latch hole provided in the door frame.

8. A door device comprising:

a door frame;
a door (A) which is connected to the door frame via a hinge (5) in such a way that the door (A) can turn in a horizontal direction; and
a door closing device (1) forcedly closing the door (A),

wherein
the door closing device (1) includes:

a device main body (6) attached to the door frame; and
a guided member (7) fixed to the door (A), and the device main body (6) includes:

a fixed component (40) fixed to an upper edge part of an opening of the door frame;
a turning piece (14) including a shaft portion (14c) supported on the fixed component (40) in such a way that the shaft portion (14c) can turn in a horizontal direction and first and second arm portions (14a, 14b) projecting outward from the shaft portion (14c) in different horizontal directions;
a door closing arm (20) which turns with the turning piece (14) in a horizontal direction and moves into and out of engagement with the guided member (7) with a turning of the door (A);
a biasing mechanism (50) which exerts an elastic force on the first arm portion (14a) of the turning piece (14) to hold the door closing arm (20) in a standby position in which the door closing arm (20) stands ready to engage with the guided member (7) when the guided member (7) is not engaged with the door closing arm (20), and to turn the door closing arm (20) forcedly in a direction that closes the door (A) after the guided member (7) engages with the door closing arm (20); and
a direct-acting shock-absorbing mechanism (60) which exerts a force on the second arm portion (14b) of the turning piece (14) to suppress a turning of the door closing arm (20) when the door closing arm (20) is turning in a direction that closes the door (A), and to promote the turning thereof when the door closing arm (20) is turning in an opposite direction.

9. The door device according to claim 8, wherein
the fixed component (40) is secured to an end part of an upper frame member forming the door frame, the end part on a side opposite to a side to which the hinge is attached.

10. The door device according to claim 8 or 9, wherein
the fixed component (40) includes a housing (70) fixed to the door frame and having a flat rectangular parallelepiped shape,
the turning piece (14), the biasing mechanism (50), and the shock-absorbing mechanism (60) are housed in the housing (70),
in a bottom plate (8b, 10a) of the housing (70), an insertion hole (8a1, 10a6) for connecting a connecting shaft (28a3) of the door closing arm (20) to the shaft portion (14c) of the turning piece (14) is formed, and
the door closing arm (20) turns along a lower surface of the housing (70).

11. The door device according to claim 10, wherein
the biasing mechanism (50) includes a spring (16) exerting an elastic force on the first arm portion (14a) of the turning piece (14),
the shock-absorbing mechanism (60) includes a direct-acting damper (19) which generates a braking force by being compressed and pushing back in a horizontal direction with a turning of the second arm portion (14b) of the turning piece (14) when the door closing arm (20) is turning in a direction that closes the door (A), and
the spring (16) and the damper (19) are arranged parallel to each other.

12. The door device according to claim 11, wherein
the device main body (1) includes an adjusting unit (17) for adjusting the elastic force of the biasing mechanism (50).

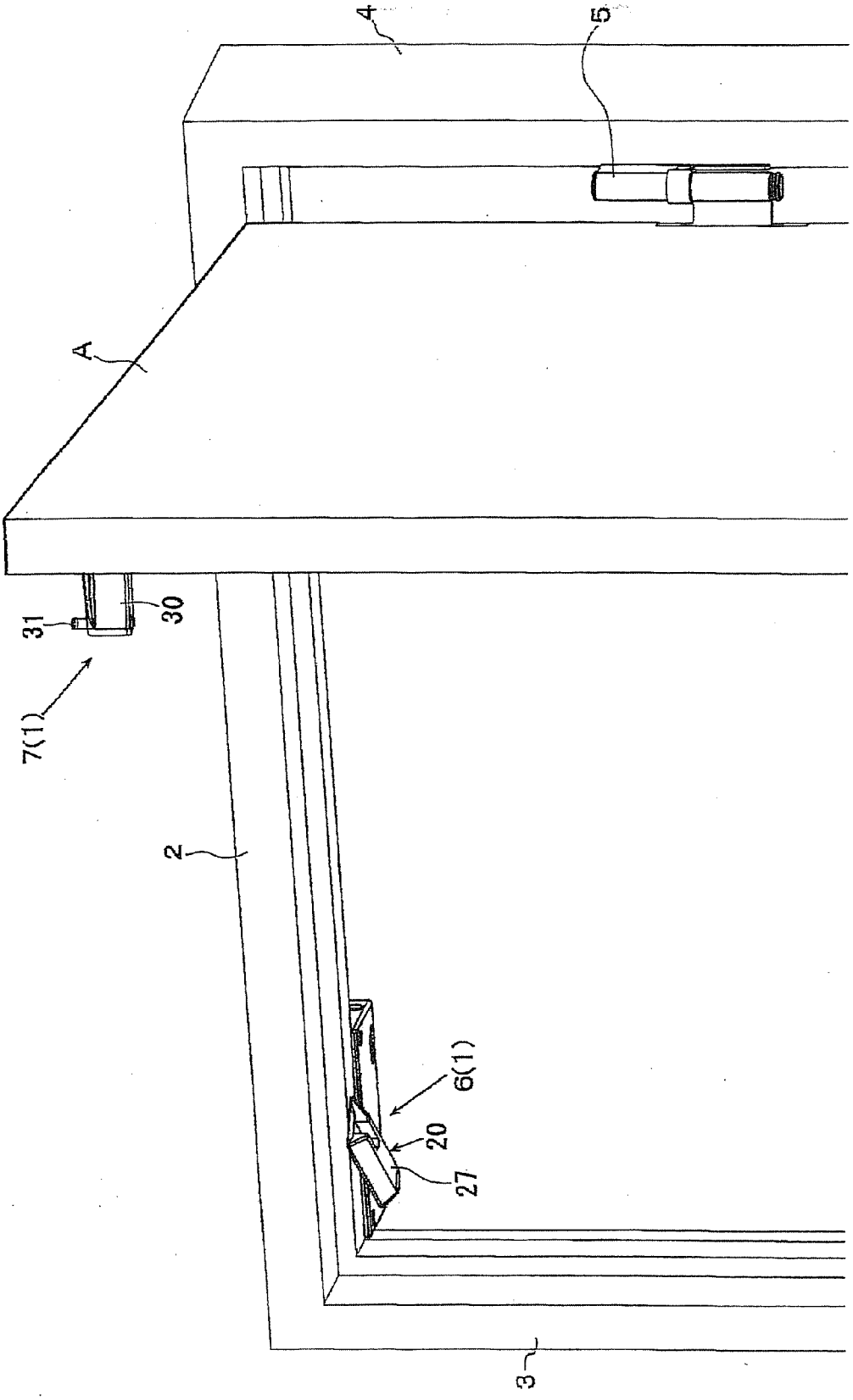
13. The door device according to claim 8, wherein
when the door (A) is closed, a whole of the door closing arm (20) is located under the lower surface of the housing (70), and
when the door closing arm (20) is in the standby position, an end thereof protrudes from under the lower surface of the housing (70) toward the door (A).

14. The door device according to claim 12, wherein
the guided member (7) includes a supporting portion (30) secured to a board face of the door (A) and a

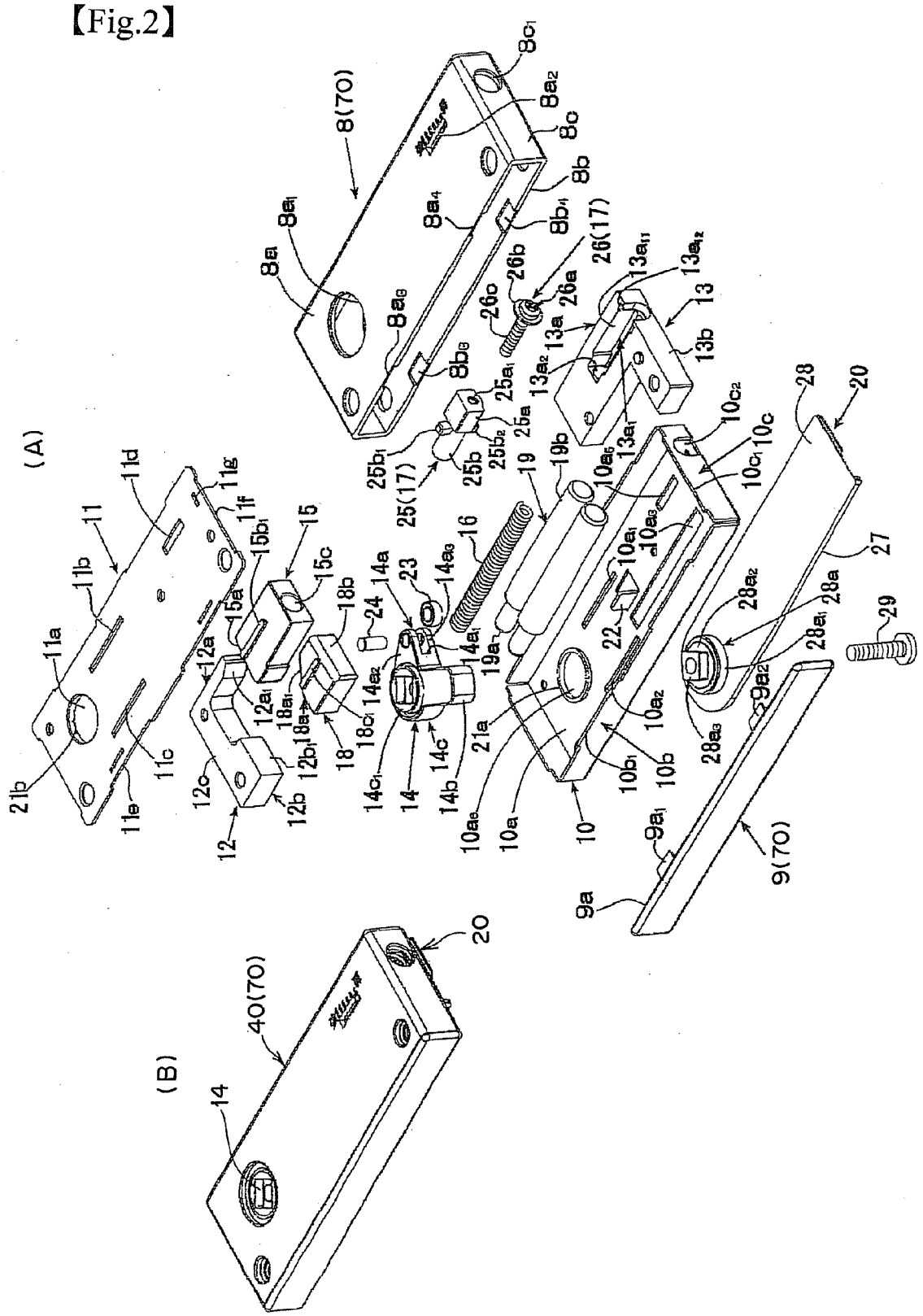
sliding part (31) jutting upward from an end of the supporting portion (30),
the door closing arm (20) includes a guide groove (27c) extending in a direction of a radius of the turning of the door closing arm (20), and
when the door closing arm (20) is in the standby position, an end of the sliding part (31) is received in the guide groove (27c) with the turning in a direction in which the door (A) is closed.

15. The door device according to any one of claims 11 to 14, wherein
the shock-absorbing mechanism (60) is configured such that, when the door (A) is being closed, a force suppressing a turning of the second arm portion (14b) of the turning piece (14) is not exerted on the second arm portion (14b) from a point when a latch provided on an edge face of the door (A), the edge face on that side of the door (A) where a handle is provided, starts to engage in a latch hole provided in the door frame.

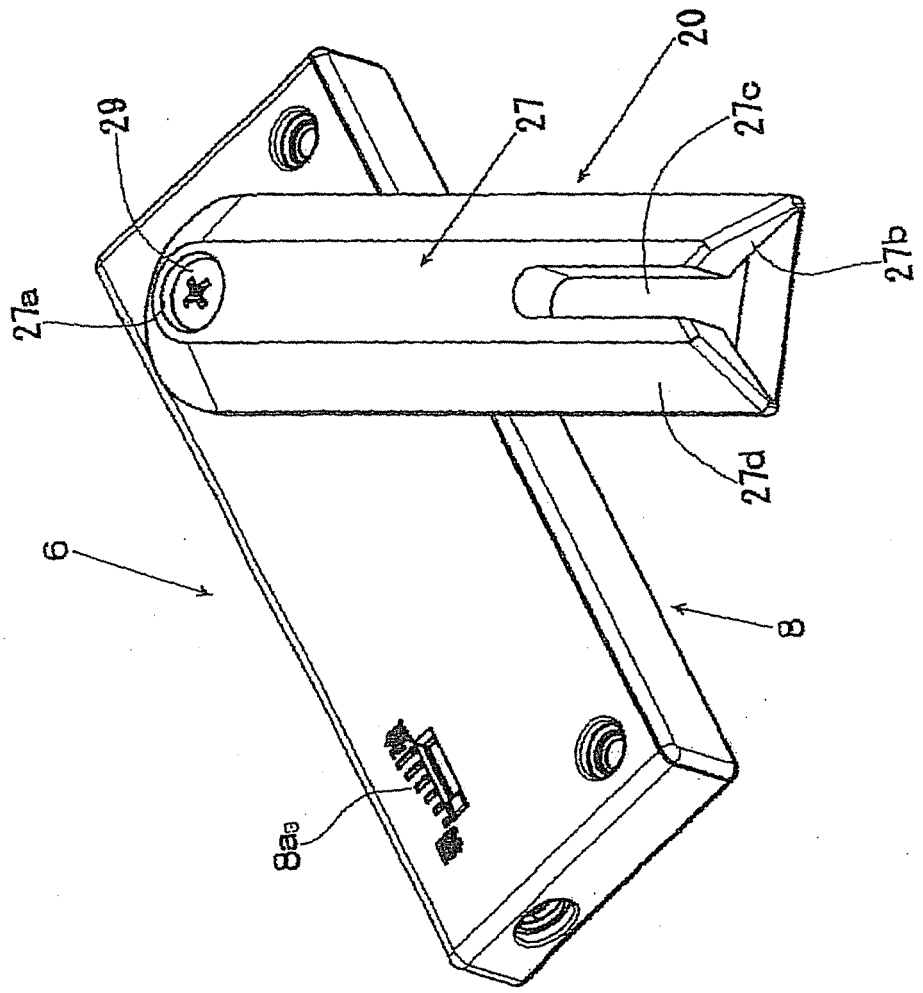
【Fig.1】



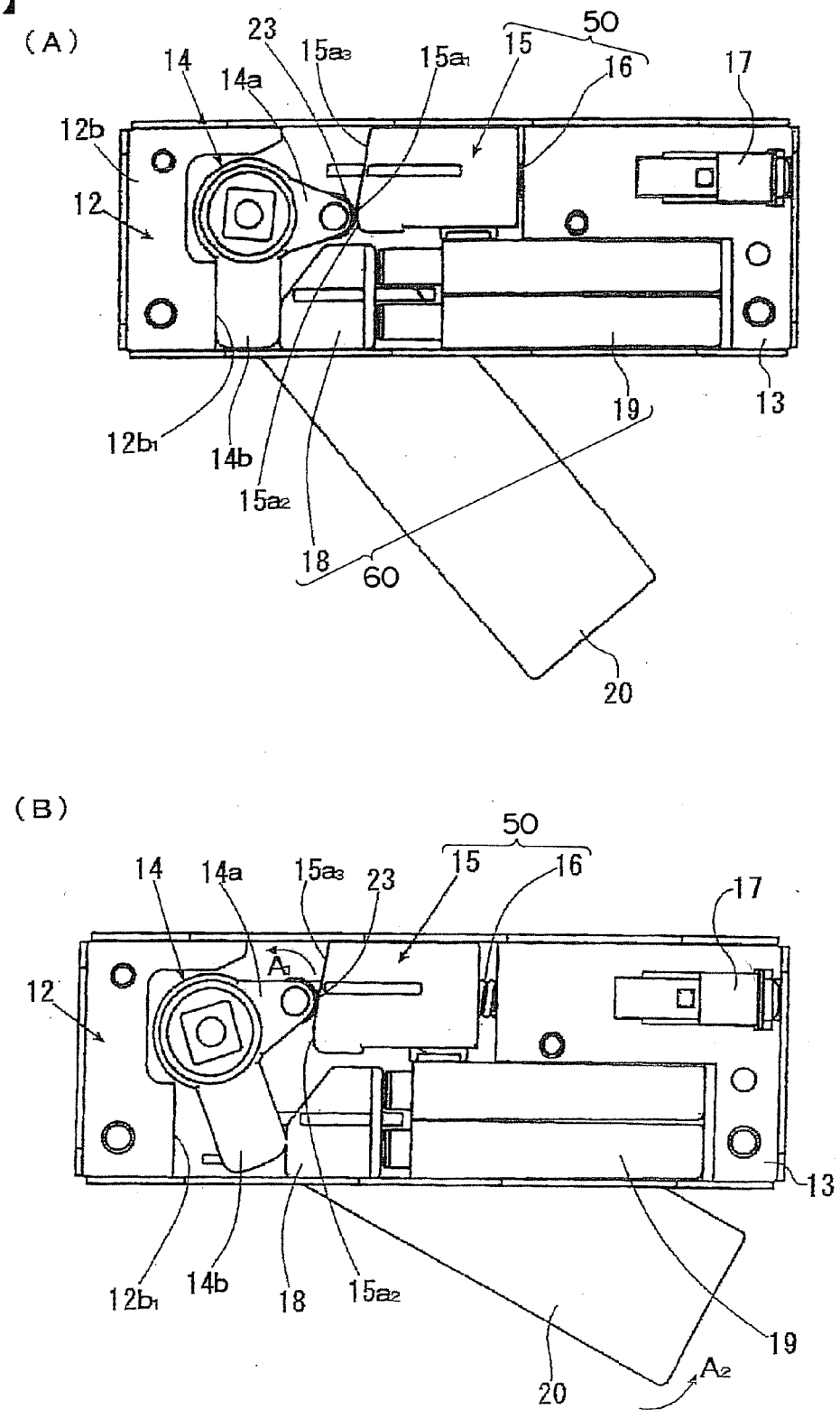
【Fig.2】



【Fig.3】



【Fig.4】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17
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12b
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14b
15a2
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19
13
20
(B)
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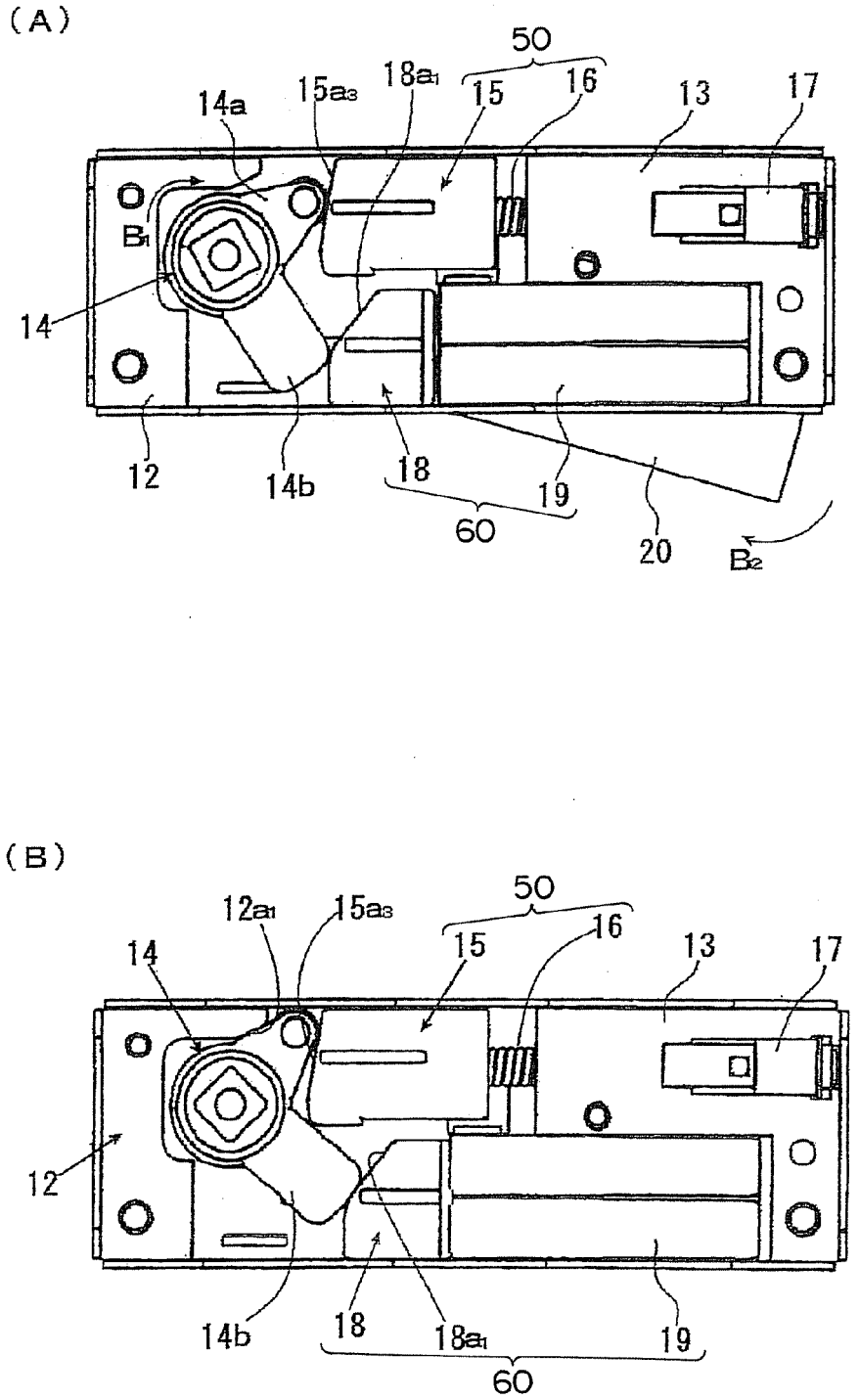
A2

【Fig.5】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14b
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18a1
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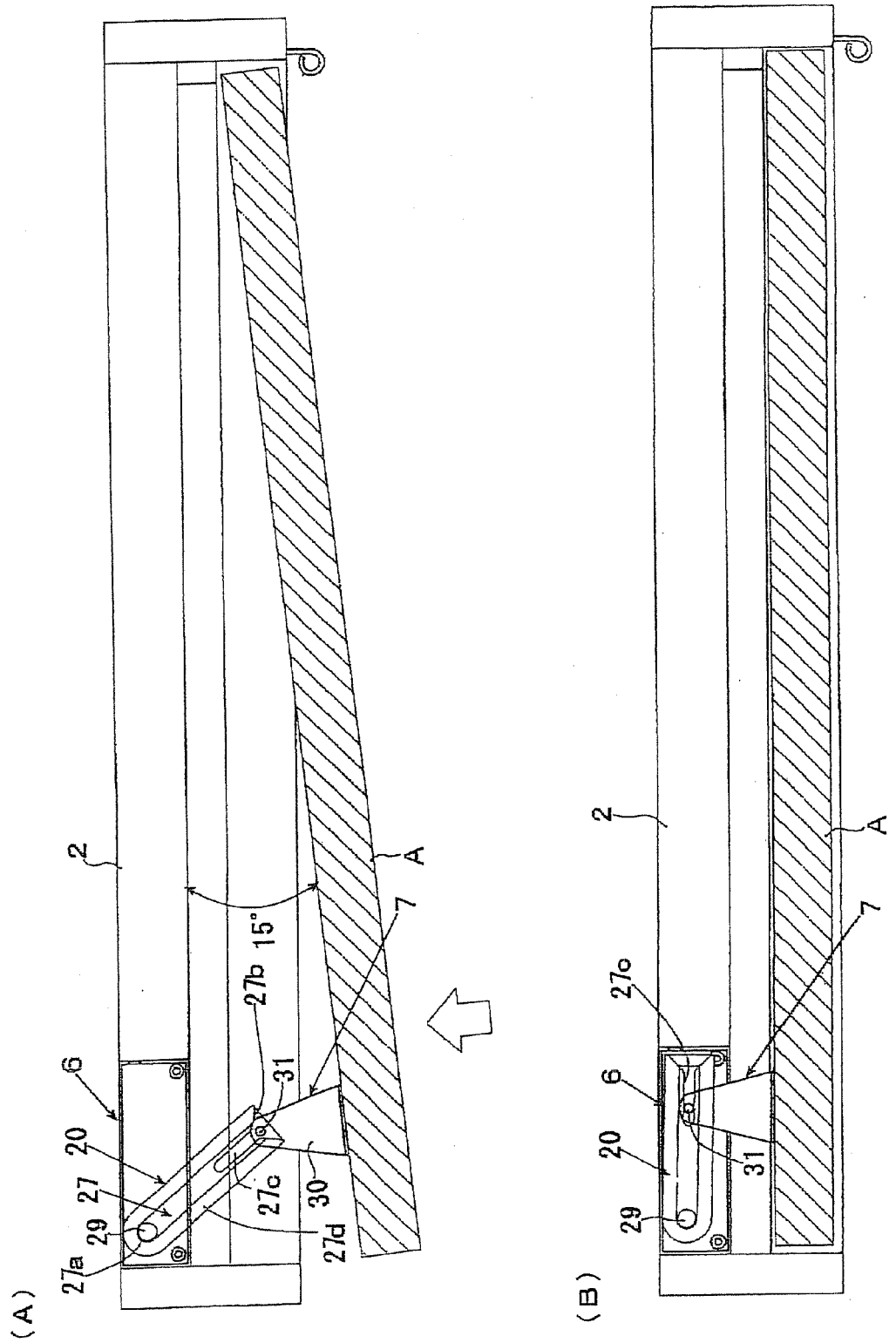
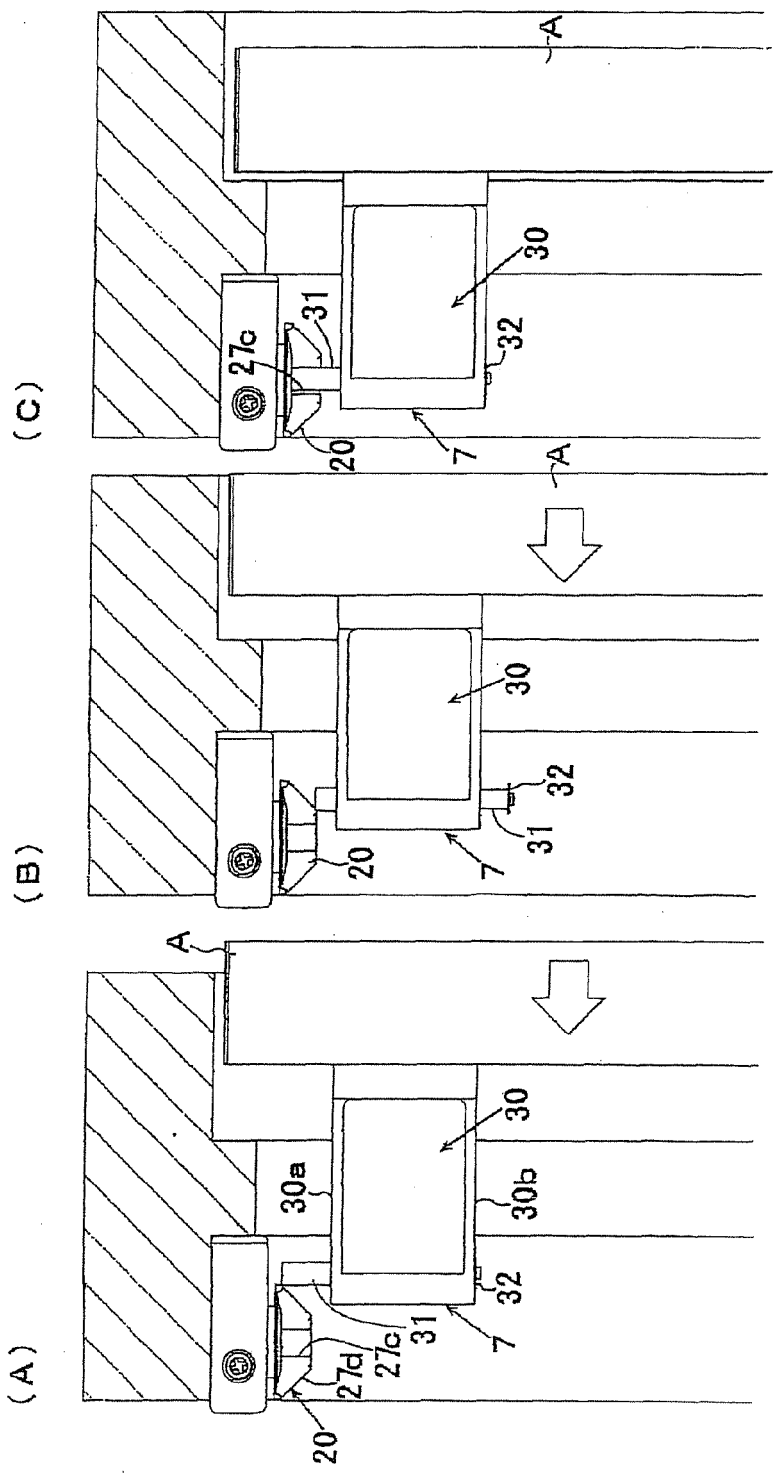
60

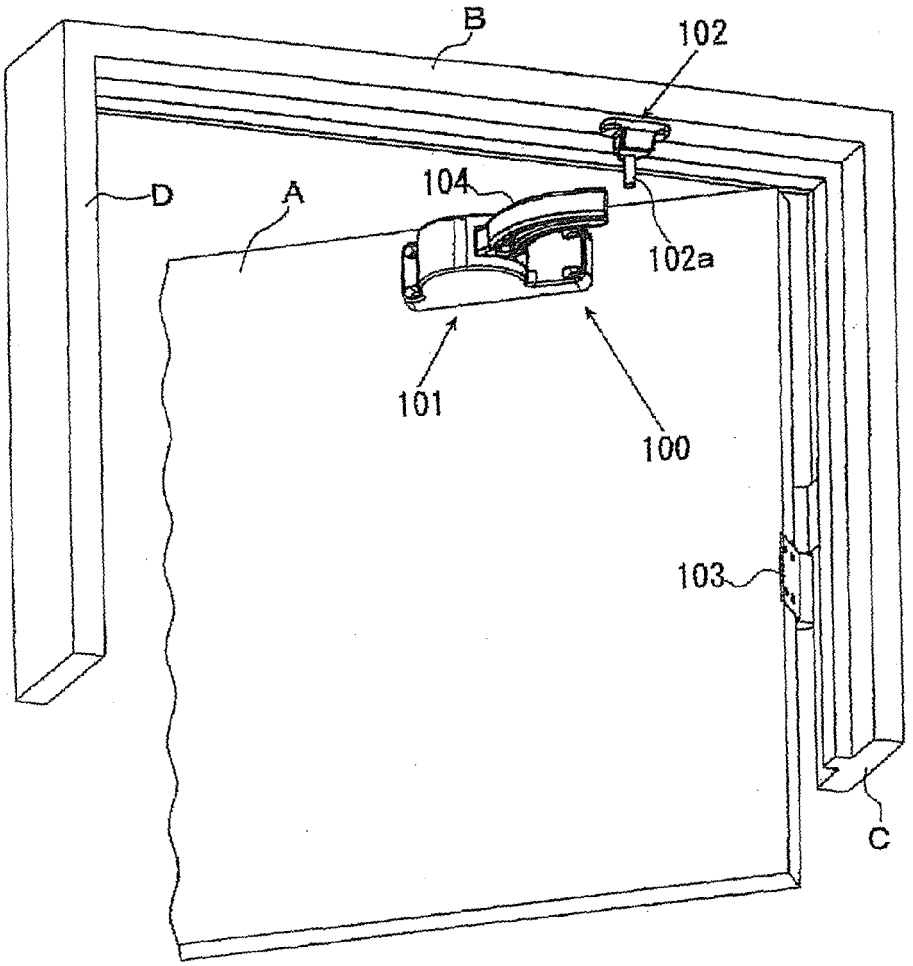
【Fig.6】



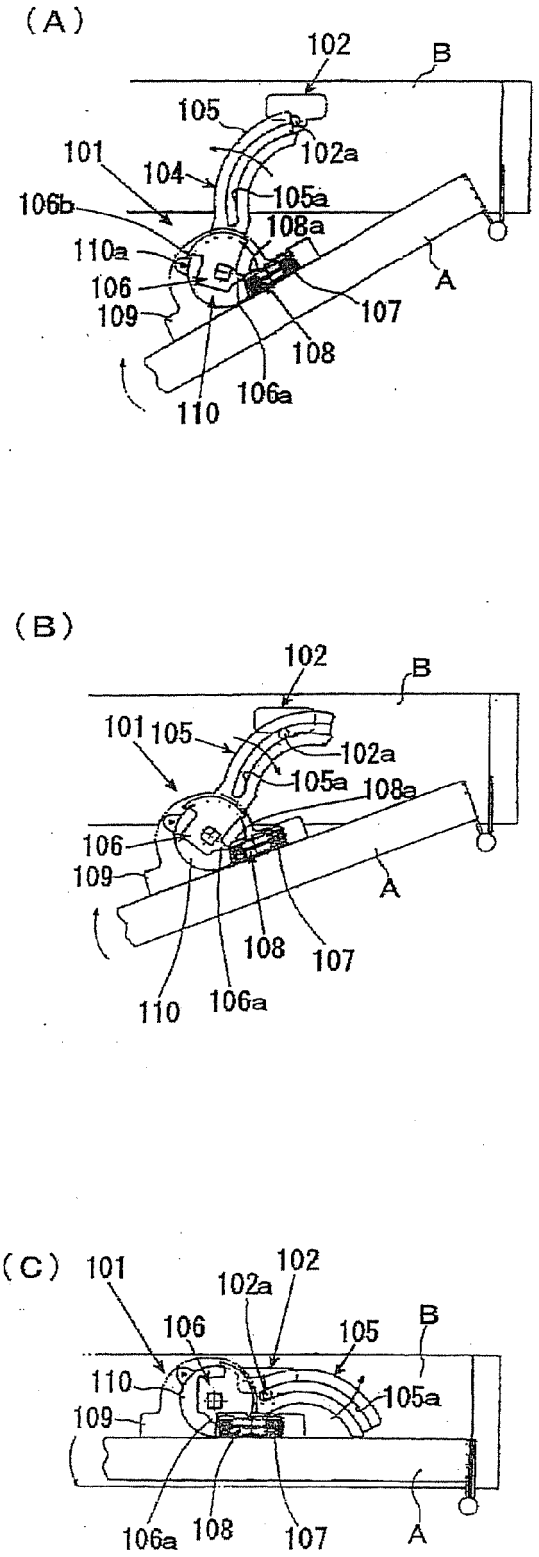
【Fig.7】



【Fig.8】



【Fig.9】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(C)
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102a
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108
107
A

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