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

(11) Publication number : **0 545 624 A2**

(12) EUROPEAN PATENT APPLICATION

(21) Application number : **92310782.5**

(51) Int. Cl.[5] : **E05F 3/10**

(22) Date of filing : **25.11.92**

(30) Priority : **29.11.91 JP 105987/91**
10.12.91 JP 109129/91

(43) Date of publication of application :
09.06.93 Bulletin 93/23

(84) Designated Contracting States :
DE FR GB

(71) Applicant : **RYOBI LTD.**
No. 762, Mesaki-cho
Fuchu-shi, Hiroshima-ken (JP)

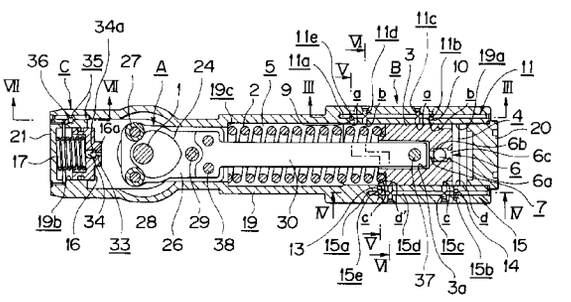
(72) Inventor : **Yamane, Motoharu**
c/o Ryobi Limited, 762 Mesaki-cho
Fuchu-shi, Hiroshima-ken (JP)

(74) Representative : **Heath, Peter William Murray et al**
FRY, HEATH & SPENCE, St. Georges House, 6 Yattendon Road
Horley, Surrey RH6 7BS (GB)

(54) Floor hinge.

(57) A floor hinge may independently perform a back check action, a delayed action, a first speed door closing action, a second speed door closing action and a latching action. When the door is fully opened, a back check piston (16) abuts against a rotational motion-linear motion converting mechanism (A) to stop or decelerate the opening motion of the door. A returning motion of a piston (3) is classified into four-speed modes. The closing motion of an output shaft (1) is changed in the four-speeds. In the door closing action, the working oil within a piston tear chamber (5) flows into a piston front chamber (4) through a first hydraulic passage (7). In the delayed action, the working oil within the piston front chamber (4) will flow into the piston rear chamber (5) only through a second hydraulic passage (11) and delayed action adjusting valve (9). In the first speed door closing action, the working oil within the piston front chamber (4) will flow into the piston rear chamber (5) only through the second hydraulic passage (11) and a first speed adjusting valve (10). In the second speed door closing action, the working oil within the piston front chamber (4) will flow into the piston rear chamber (5) only through a third hydraulic passage (15) and a second speed adjusting valve (13). In the latching action, the working oil within the piston front chamber (4) will flow into the piston rear chamber (5) only through the third hydraulic passage (15) and a latching action adjusting valve (14).

FIG.1A



EP 0 545 624 A2

BACKGROUND OF THE INVENTION

The present invention relates to a floor hinge in which a door opening rotational force of a door is converted into a linear motion, a piston is moved while accumulating a return spring by a door opening action, and the piston is then returned to an original position by the accumulated force of the return spring. In this case, the return speed of the piston is classified into four speeds by the action of a hydraulic pressure control circuit. The four speed modes correspond to a delayed action, a first speed door closing action, a second speed door closing action and a latching action of the door, respectively.

European Patent Publication No. 407150 discloses a floor hinge for achieving four speed modes, i.e., a delayed action, a first speed door closing action, a second speed door closing action and a latching action. In this floor hinge, a back check adjusting valve and a latching action adjusting valve are disposed in a first hydraulic passage for causing working oil within a piston rear chamber to flow into a piston front chamber, and a first speed adjusting valve and a second speed adjusting valve are disposed in a second hydraulic passage for causing the working oil within the piston front chamber to flow into the piston rear chamber.

It has been however found that the floor hinge disclosed in the above-described European Publication suffers from a disadvantage that it is impossible to independently adjust the first and second modes because the first speed adjusting valve and the second speed adjusting valve are juxtaposed to face the piston front chamber and would interfere with each other even if these adjusting valves are adjusted.

Further, if the back check adjusting valve is adjusted so that a back check force is increased to open the door slowly, each member of the flow hinge may be broken. If a safety mechanism is provided to avoid the breakage of a sealing portion of the floor hinge, such a safety mechanism must be provided on the piston to make the piston bulky and complicated and to make troublesome the working operation of the piston.

SUMMARY OF THE INVENTION

In view of the above described defects, an object of the present invention is to provide a floor hinge which may perform a door closing action concomitant with a delayed action, a first speed door closing action, a second speed door closing action and a latching action of the door and in which the four speeds modes may be adjusted independently of each other.

Another object of the present invention is to provide a floor hinge which can ensure a slow door opening operation within a range from a predetermined door opening angle to the maximum door opening angle and which has a back check mechanism functioning in such a manner that a piston motion is locked when the door is opened rapidly under the influence of a door opening force lower than a predetermined strength, and a piston motion is performed gradually.

In order to attain this and other objects, according to the present invention, there is provided a floor hinge having an output shaft connected to a door and serving as a rotary shaft of said door, a rotational motion-linear motion converting mechanism for translating a rotational motion of the output shaft into a linear motion, a floor hinge having an output shaft connected to a door and serving as a rotary shaft of said door, a rotational motion-linear motion converting mechanism for converting a rotational motion of the output shaft into a linear motion, a main piston connected to said output shaft through the rotational motion-linear motion converting mechanism for controlling the rotational motion of the output shaft, a return spring for being deformed by the rotational motion of the output shaft caused by a door opening action and for accumulating a spring force, in response to movement the main piston, the spring force returns the main piston to a door closing position, and a hydraulic control circuit for a delayed action for closing the door at an extremely low speed in a range from a maximum door opening angle to a predetermined door closing angle, a first speed door closing action for closing the door at a high speed, a second speed door closing action for closing the door at a low speed, and a latching action for closing the door at an extremely low speed near the full-closed condition for latching the door, characterized in that said hydraulic control circuit comprises a first hydraulic passage formed in said piston for communicating a piston front chamber and a piston rear chamber with each other and having a check valve for allowing working oil within the piston rear chamber to flow into the piston front chamber during a door opening action but preventing the working oil from moving in a reverse direction during a door closing action, a second hydraulic passage formed in a predetermined branch shape for switching communication between the piston front chamber and a piston rear chamber by using ports which are selectively opened and closed by said piston in response to movement of the piston during said delayed action and said first speed door closing action, said second hydraulic passage having a delayed action adjusting valve and a first speed adjusting valve and a third hydraulic passage formed in a predetermined branch shape for switching communication between the piston front chamber and a piston rear chamber with each other by using ports which are selectively open and closed by said piston in response to movement of the piston during said second speed door closing action and said latching action, said third hydraulic passage having a second speed adjusting valve and a latching action adjusting valve and a hydraulic cont

rol circuit for a delayed action for opening the door at an extremely low speed in a range from the maximum door opening angle to a predetermined door closing angle, a first speed door closing action for closing the door at a high speed, a second speed door closing action for closing the door at a low speed, and a latching action for closing the door at an extremely low speed near the full-closed condition for latching the door, characterized in that the hydraulic control circuit comprises: a first hydraulic passage formed in the main piston for communicating a piston front chamber and a piston rear chamber with each other and having a check valve for allowing working oil within the piston rear chamber to flow into the piston front chamber during a door opening action but preventing the working oil from moving in a reverse direction during a door closing action; a second hydraulic passage formed in a predetermined branch shape for switching communication between the piston front chamber and a piston rear chamber with each other by using ports which are selectively opened and closed by the piston in response to movement of the main piston during said delayed action and said first speed door closing action, said second hydraulic passage having a delayed action adjusting valve and a first speed adjusting valve; and a third hydraulic passage formed in a predetermined branch shape for switching communication between the piston front chamber and a piston rear chamber with each other by using ports which are selectively opened and closed by the piston in response to movement of the piston during the second speed door closing action and the latching action, the second hydraulic passage having a second speed adjusting valve and a latching action adjusting valve.

According to another aspect of the invention, there is provided a floor hinge having an output shaft connected to a door and serving as a rotary shaft of the door, a rotational motion-linear motion translating mechanism for converting a rotational motion of said output shaft into a linear motion, a floor hinge having an output shaft connected to a door and serving as a rotary shaft of said door, a rotational motion-linear motion converting mechanism for converting a rotational motion of the output shaft into a linear motion, a main piston connected to said output shaft through the rotational motion-linear motion converting mechanism for controlling the rotational motion of the output shaft, a return spring for being deformed by the rotational motion of the output shaft caused by a door opening action and for accumulating a spring force, in response to movement the main piston, the spring force returns the main piston to a door closing position, and a hydraulic control circuit for a delayed action for closing the door at an extremely low speed in a range from a maximum door opening angle to a predetermined door closing angle, a first speed door closing action for closing the door at a high speed, a second speed door closing action for closing the door at a low speed, and a latching action for closing the door at an extremely low speed near the full-closed condition for latching the door, characterized in that said hydraulic control circuit comprises a first hydraulic passage formed in said piston for communicating a piston front chamber and a piston rear chamber with each other and having a check valve for allowing working oil within the piston rear chamber to flow into the piston front chamber during a door opening action but preventing the working oil from moving in a reverse direction during a door closing action, a second hydraulic passage formed in a predetermined branch shape for switching communication between the piston front chamber and a piston rear chamber by using ports which are selectively opened and closed by said piston in response to movement of the piston during said delayed action and said first speed door closing action, said second hydraulic passage having a delayed action adjusting valve and a first speed adjusting valve and a third hydraulic passage formed in a predetermined branch shape for switching communication between the piston front chamber and a piston rear chamber with each other by using ports which are selectively open and closed by said piston in response to movement of the piston during said second speed door closing action and said latching action, said third hydraulic passage having a second speed adjusting valve and a latching action adjusting valveand a back check mechanism for decelerate openi ng speed of the door in a range from a predetermined door opening angle to the maximum door opening angle, characterized in that said back check mechanism comprises a back check cylinder provided at a position opposite to the piston with respect to the rotational motion-linear motion converting mechanism, a back check cylinder, an elastic member for urging the back check piston toward the output shaft, a back check hydraulic passage formed in the back check piston in which a check valve is provided to close the back check hydraulic passage when the door is rapidly opened to cause the rotational motion-linear motion converting mechanism to contact the back check piston to thereby retract the back check piston, a back check bypass passage for communicating the back check cylinder with the piston rear chamber, and a back check throttle means for controlling the working oil in the back check bypass passage.

When the door is opened from the fully closed condition, the output shaft is rotated, and the piston is moved toward the piston rear chamber while compressing the return spring by the rotational motion-linear motion converting mechanism so that the door is opened at a maximum door opening angle (for example, 120°) which is predetermined. At this time, since the check valve disposed in the first hydraulic passage is opened by the increase of working oil pressure within the piston rear chamber, the working oil within the piston rear chamber flows through the

first hydraulic passage into the piston front chamber for ensuring the movement of the piston.

When the door is opened at a predetermined angle, e.g. 75°, a part of the rotational motion-linear motion converting mechanism contacts one end of the back check piston urged by the elastic member. In case that the door is opened slowly, the back check valve 34 is kept open so that the working oil in the back check cylinder can flow into the piston rear chamber thereby ensuring the retracted motion of the back check piston. Therefore, the door can be opened slowly to the maximum opening angle.

In case that the door is rapidly opened, the back check valve is closed due to an rapid increase of the oil pressure in the back check cylinder thereby stopping the retracted motion of the back check piston. Therefore, a rapid door opening motion is stopped to avoid the breakage of each member of the door. In case that the door is blown to be opened toward a full opening angle, the bypass passage throttle means operates to ensure a slow retracted motion of the back check piston.

When the door opening force is released at the door maximum opening angle, the piston is returned toward the piston front chamber by the returning force of the spring. At this time, the check valve disposed in the first hydraulic passage is closed by the increase of the working oil pressure of the piston front chamber. In the delayed action (in the range of the door opening angle of, for example, 120 to 75°), the working oil within the piston front chamber will be able to flow into the piston rear chamber through the second hydraulic passage and the delayed action adjusting valve. Subsequently, in the first speed door closing action (in the range of the door opening angle of, for example, 75 to 25°), the working oil within the piston front chamber will flow into the piston rear chamber through the second hydraulic passage and the first speed adjusting valve. Subsequently, in the second speed door closing action (in the range of the door opening angle of, for example, 25 to 5°), the working oil within the piston front chamber will flow into the piston rear chamber through the third hydraulic passage and the second speed adjusting valve. Finally, in the latching action (in the range of the door opening angle of, for example, 5 to 0°), the working oil within the piston front chamber will flow into the piston rear chamber through the third hydraulic passage and the latching action adjusting valve. For this reason, the return motion of the piston is the four-speed mode corresponding to the restrictions of the delayed action adjusting valve, the first speed adjusting valve, the second speed adjusting valve and the latching action adjusting valve. The returning motion of the piston is transmitted to the output shaft in the four-speed modes by the rotational motion-linear motion converting mechanism so that the door is closed in the order of the delayed action, the first speed door closing action, the second speed door closing action and the latching action.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. 1A is a horizontal sectional view showing a floor hinge according to an embodiment of the invention;

FIG. 1B is a vertical sectional view showing the floor hinge shown in FIG. 1A;

FIG. 2A is a horizontal sectional view showing the floor hinge in the state of the door opening angle of 120° (a full-opened condition, i.e., delayed action);

FIG. 2B is a horizontal sectional view showing the floor hinge in the state of the door opening angle of 75° (starting the first speed door closing action or starting the back check in the door opening direction);

FIG. 2C is a horizontal sectional view showing the floor hinge in the state of the door opening angle of 25° (second speed door closing action);

FIG. 2D is a horizontal sectional view showing the floor hinge in the state of the door opening angle of 5° (starting the latching action);

FIG. 2E is a horizontal sectional view showing the floor hinge kept under a full-closed condition;

FIG. 3 is a cross-sectional view taken along the line III-III of FIG. 1A;

FIG. 4 is a cross-sectional view taken along the line IV-IV of FIG. 1A;

FIG. 5 is a cross-sectional view taken along the line V-V of FIG. 1A;

FIG. 6 is a cross-sectional view taken along the line VI-VI of FIG. 1A; and

FIG. 7 is a cross-sectional view taken along the line VII-VII of FIG. 1A.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A floor hinge according to embodiments of the present invention will now be described with reference to the accompanying drawings.

The floor hinge may be applied to any type of a right swing door, a left swing door and a biparting door. The floor hinge includes an output shaft 1 connected to the door and serving as a rotary shaft of the door and a main piston 3 connected to the output shaft 1 by a rotational motion-linear motion converting mechanism A which uses a cam mechanism. The piston 3 is reciprocatingly moved by the rotation of the output shaft 1 in response to the door opening action to thereby compress a return spring 2. Then, the piston is returned back to the original position (door closing position) by the returning force of the return spring 2 to thereby transmit the door closing force to

the output shaft 1 through the rotational motion-linear motion converting mechanism A. The moving speed of the piston during the door closing action is subjected to a speed control by controlling a flow rate of the working oil of the piston front chamber 4 to a piston rear chamber 5 through a hydraulic control circuit B in the following order. In a door closing action range from a maximum door opening angle of 120° to a door opening angle of 75° (i.e., a door closing action process from FIG. 2A to FIG. 2B), a delayed action for a extremely low speed door closing action is performed. Subsequently, in a door closing action range of the door opening angle of 75° to 25° (i.e., a door closing action process from FIG. 2B to FIG. 2C), a first speed door closing action for a high speed door closing operation is performed. Subsequently, in a door closing action range of the door opening angle of 25° to 5° (i.e., a door closing action process from FIG. 2C to FIG. 2D), a second speed door closing action for a slow door closing action is performed. Subsequently, in a door closing action range of a door opening angle of 5 to 0° in almost fully closing state (i.e., a door closing action process from FIG. 2D to FIG.2E), a latching action is performed for a high speed door closing action to close and latch the door. Also, in a door opening action range of a door opening angle of 75° to 120° (i.e., a door opening action process from FIG. 2B to FIG. 2A), the rotational motion-linear motion converting mechanism A is brought into contact with a back check piston 16 receiving a biasing force of a back check spring 17. In this case, when the door is slowly opened, the back check piston 16 causes the back check spring 17 to be compressed retracted. Accordingly, a check valve 34 for the back check is not closed. Thus, the returning action of the piston 3 is ensured and the door may be opened up to a maximum door opening angle. In the case where the door is opened quickly, since the check valve 34 for the back check is closed, the back check piston 16 is not retracted. Thus, the door opening action is decelerated and stopped. The quick door fully opening action is avoided. Further, when the door is blown in the wind in the full open direction, a back check hydraulic pressure control circuit C having a back check safety valve 36 causes the working oil within a back check cylinder 19b to escape into the piston rear chamber 5, thus ensuring the retraction of the back check piston 16 and avoiding the load imposed onto the output shaft 1 and a stationary portion of the door.

The floor hinge has a body case 19. The body case 19 is in the form of a longitudinal flat cylindrical shape and has, on its right end side, a main piston cylinder 19a which is liquid tightly sealed by a cylinder head for accommodating and, on its left side, the back check cylinder 19b which is liquid tightly sealed by a back check cylinder head 21. The back check cylinder 19b has, on its upper side, an opening which is liquid tightly closed by a lid plate 22 with the output shaft 1 projecting therethrough. The main piston 3 is received in the cylinder 19a. The back check cylinder 19b receives the back check piston 16 slidably. The piston front chamber 4 is defined between the piston 3 and the cylinder head 20. The piston rear chamber 5 is in fluid communication with the back check cylinder 19b through a bypass passage 35. The output shaft 1 is supported by a bearing 18 provided at a bottom of the body case 19 and a bearing 23 provided on the lid plate 22. A leaf shaped cam 24 is fixed within the body case 19. The output shaft 1 is fixedly inserted to an arm lever (not shown) fixed, at its outer end, to a lower end of the door (not shown). The cam 24 is interposed between an upper swing plate 25 and a lower swing plate 26. Three cam followers 27, 28 and 29 are pivotally supported between the upper and lower swing plates 25 and 26 which clamp a proximal end of a connecting rod 30 on the side of the piston 3, and the swing plates 25 and 26 are fixed by fastening screws 38. The connecting rod 30 is coupled, at its distal end, to a piston pin 37 which is inserted through a circumferential surface of the piston 3 into a recess formed in the rear side of the piston 3. The cam 24 is arranged with its apex being directed to the piston 3 and being aligned with the longitudinal direction of the body case 19 when the door is fully closed. The two cam followers 27 and 28 are located on the side of the check piston 16 relative to the cam 24 so that the two cam followers may be brought into contact with both shoulder portions, having the smallest radius, of the cam 24 when the door is full-closed, whereas the rest one 29 of the cam followers is located with a predetermined interval relative to the cam 24 on the side of the piston 3. Accordingly, when the output shaft 1 is rotated in the clockwise or counterclockwise direction to rotate the cam 24 together, one of the two cam followers 27 and 28 is pushed toward the back check piston 16, and the piston 3 is moved in a first direction toward the back check piston 16 against the spring force of the return spring 2. It should be noted that the rotational motion-linear motion converting mechanism A is thus constructed by utilizing the cam and cam followers. The return spring 2 is disposed in a compressed state within the body case 19 so as to surround the connecting rod 30 and is interposed between the piston located corresponding to the fully closed condition of the door and a stepped portion 19c formed in the body case 19. The back check piston 16 is urged by the back check spring 17 received in the compressed state within the back check cylinder 19b. An opening o is formed on a bottom of the body case 19 below the lower swing plate 26. A diaphragm packing 31 is applied to a stepped portion, directed downwardly, of an edge of the opening, thereby fluid-tightly closing the interior of the case body 19 with a cup-shaped plug 32. The diaphragm packing 31 is deformed inwardly to function to avoid a damage of the body case 19 in the case

where the working oil within the piston rear chamber 5 is expanded due to an accidental elevation of the temperature. The working oil is filled in the body case 19 by overturning the body case 19 and removing the cup-shaped plug 3 and the diaphragm packing 31.

The hydraulic control circuit B includes: a first hydraulic passage 7 formed between the piston front chamber 4 and the piston rear chamber 5 in an end wall of the piston 3 with the check valve 6 being arranged in a predetermined position for ensuring the door closing/opening operation; a second hydraulic passage 11 formed in wall of the cylinder in the form of plural branches for ensuring the delayed action (i.e., the door opening process ranging from the maximum door opening angle of 120° shown in FIG. 2a to the door opening angle 75° shown in FIG. 2b) and the first speed door closing operation (i.e., the door closing process ranging from the door opening angle of 75° shown in FIG. 2A to the door opening angle 25° shown in FIG. 2C); a third hydraulic passage 15 formed in the cylinder wall in the form of plural branches for ensuring the second speed door closing operation (i.e., the door closing process ranging from the door opening angle of 25° shown in FIG. 2C to the door opening angle of 5° shown in FIG. 2C) and the latching action (i.e., the door closing process from the door opening angle of 5° shown in FIG. 2C to the door opening angle of 0° shown in FIG. 2E).

Of the check valve 6 disposed in the first hydraulic passage 7, the valve body (ball) 6a is separated away from its valve seat 6b by the increased pressure of the working oil within the piston rear chamber 5 during the door opening operation, allowing the working oil to flow into the piston front chamber 4 and also serves to interrupt the flow of the working oil in the reverse direction during the door closing operation. The valve body 6a is maintained in the passage 7 by a plurality of projection 6c extended radially. The passage 7 is communicated with a space 3a provided in the piston 3. One end of the connecting rod 30 is inserted into the space 3a.

The second hydraulic passage 11 is formed, in the wall of the case 19, in the form of plural branches composed of a main passage 11a and four branch passages 11b (first branch), 11c second branch), 11d (third branch) and 11e (fourth branch) (FIGS. 1a and 3). Oil ports a (second) and b (first) of the branch passages 11b and 11c face the piston front chamber 4 at predetermined positions, and oil ports a' (fourth) and b'(third) of the branch passages 11d and 11e face the rear piston chamber 5 at predetermined positions. The first and second branch passages 11b and 11c are disposed close to each other and the third and fourth branch passages 11d and 11e are disposed close to each other. The first and second branch passages 11b and 11c are disposed in front position of the main piston cylinder 19a and the third and fourth branch passages 11d and 11e are disposed in a rear position of the main piston cylinder 19a. In the delayed action from the opening angle of 120° to the opening angle of 75°, the oil ports a (second) and a' (fourth) are in fluid communication with each other, and the oil port b' (third) is closed by the piston 3 so that the communication between the ports b and b' is interrupted. In the first speed door closing action from the door opening angle of 75° to the door opening angle 25°, the oil ports b and b' are in fluid communication with each other and the oil port a is closed by the piston 3 so that the communication between the oil ports a and a' is interrupted.

A delayed action adjusting valve 9 which is adjustable from the outside is provided to face the oil port a' (FIG. 3). A first speed adjustment valve 10 which is adjustable from the outside is provided to face the oil port b. The delayed action adjusting valve 9 and the first speed adjusting valve 10 are arranged so that they would not interfere with each other. The restriction of the delayed action adjusting valve 9 is adjusted to a large level in a predetermined manner. The restriction of the first speed adjusting valve 10 is adjusted to a small level in a predetermined manner.

In the same way as the second hydraulic passage 11, during the second speed door closing action and the latching action, the third hydraulic passage 15 is formed in the cylinder wall in the form of plural branches composed of a main passage 15a and four branch passages 15b (first), 15c (second), 15d (third) and 15e (fourth) and is offset from the second hydraulic passage 11 toward the cylinder head 20.

That is, a pair of first and second branch passages 15b and 15c are deviated from the first and second branch passages 11b and 11c of the second hydraulic passage 11 toward the cylinder head 20. A pair of third and fourth branch passages 15d and 15e are also deviated from the third and fourth branch passages 11d and 11e of the second hydraulic passage 11 toward the cylinder head 20. Oil ports c (second) and d (first) of the passages 15b and 15c face the piston front chamber 4 at predetermined positions. Oil ports c' (fourth) and d' (third) of the passages 15d and 15e face the piston rear chamber 5 at predetermined positions. During the second door closing action from the door opening angle of 25° to the door opening angle of 5°, the oil ports c and c' are in fluid communication with each other, and the oil port d' is closed by the piston 3 so that the fluid communication between the ports d and d' is interrupted. Also, in the latching action from the door opening angle of 5° to the door opening angle of 0°, the oil ports d and d' are in fluid communication with each other, and the oil port c is closed by the piston so that the fluid communication between the ports c and c' is interrupted. A second speed adjusting valve 13 which may be adjusted from the outside is disposed to face the oil port c', and a latching action adjusting valve 14 which may be adjusted from the outside is disposed to face the oil port

d (FIG.4). The second speed adjusting valve 13 and the latching action adjusting valve 14 are adjusted so that they would not interfere with each other. The restriction of the second adjusting valve 13 is adjusted to a large level in a predetermined manner. The restriction of the latching action adjusting valve 14 is adjusted to a small level in predetermined manner. As shown if FIGS. 5 and 6, the branch passages 11d and 15e are open to the piston front chamber 4 at the same height position so as to be opposed to each other, and the branch passages 11c and 15d are open to the piston front chamber 4 at the same height position so as to be opposed to each other. The pair of the branch passages 11d and 15e are disposed at a position higher than that of the pair of the branch passages 11c and 15d.

The back check piston 16 is slidingly inserted into the back check cylinder 19b. The back check piston 16 is biased to move in an axial direction toward the output shaft 1 by means of the back check spring 17 disposed in the back check cylinder 19b. A fourth hydraulic passage 33 is formed in the end face of the back check piston 16. A check valve 34 for the back check is disposed in the fourth hydraulic passage 33. Of the back check valve 34, when the pressure within the back check cylinder 19b is increased over the pressure within the piston rear chamber 5, its valve body (ball) 34a is seated on its valve seat 16a to close the valve 34, the check valve 34 prevents the working oil, held in the back check cylinder 19b, form flowing into the piston rear chamber 5. Also, when the pressure of the back check cylinder 19b is equal to that of the piston rear chamber 5, the valve body 34 is separated away from the valve seat 16a to open the valve 34, the check valve 34 allows the working oil within the back check cylinder 19b to flow into the piston rear chamber 5 to thereby ensure the retraction of the back check piston 16. A fifth hydraulic passage 35 (bypass) is formed in the wall of the back check cylinder 19b to communication the back check cylinder 19b with the piston rear chamber 5. A back check safety valve 36 is disposed in the fifth hydraulic passage 35. The back check safety valve 36 is provided so that a spherical valve body 36c is seated on a valve seat 19g by the spring force of a coil spring 36b (see FIG. 7) compressed by a screw plug 36a which may be adjusted from the outside by means of a screw driver, to close the fifth hydraulic passage 35. When the pressure of the back check cylinder 19b exceeds a predetermined level, the back check safety valve 36 is opened.

Instead of the back check safety valve 36, a back check safety valve having the same structure as the first speed adjusting valve 10 may be used.

The operation of the floor hinge in accordance with the above-described embodiment will now be described. Now, when the door is opened from the full-closed condition, the output shaft 1 is rotated so that the piston 3 is moved toward the piston rear chamber 5 while compressing the return spring 2 through the rotational motion-linear motion converting mechanism A. As a result, the door is opened at a predetermined maximum opening angle (for example, 120°). At this time, since the check valve 6 within the first hydraulic passage 7 is pressingly opened by the increase of pressure of working oil filled in the piston rear chamber 5, the working oil filled in the piston rear chamber 5 moves to the piston front chamber 4 through the first hydraulic passage 7 to thereby ensure the movement of the piston 3 toward the piston rear chamber 5.

Subsequently, when the door opening force is released from the condition that the door has been opened at the maximum door opening angle, the piston 3 is returned by the return force of the return spring 2. In this case, the check valve 6 in the first hydraulic passage 7 is closed by the increase of pressure of the working oil filled in the piston front chamber 4. In the delayed action (where the door opening angle is in the range of, for example, 120 to 75°), since the oil ports a and a' are only in fluid communication with each other in the second hydraulic passage 11, the working oil filled in the piston front chamber 4 will be introduced into the second hydraulic passage 11 from the oil port a and may flow into the piston rear chamber 5 from the oil port a' through the delayed action adjusting valve 9 which is provided to face the oil port a' and which may be adjusted to have a restriction at a high level. Subsequently, in the first speed door closing action (where the door opening angle is in the range of, for example, 75 to 25°), since the oil ports b and b' of the second hydraulic passage 11 are only in fluid communication with each other, the oil is introduced into the second hydraulic passage 11 from the oil port b and may flow into the piston rear chamber 5 from the oil port b' of the second hydraulic passage 11 from the first speed adjusting valve 10 which is provided so as to face oil port b and which has a restriction at a low level. Subsequently, in the second speed door closing action (where the door opening angle is in the range of, for example, 25 to 5°), since the oil ports c and c' of the third hydraulic passage 15 are only in fluid communication with each other, the oil will flow into the third hydraulic passage 15 through the oil port c and will flow into the piston front chamber 4 from the oil port c' through the second speed adjusting valve 13 which is provided so as to face the oil port c' and which may have a restriction at a predetermined high level. Finally, in the latching action (where the door opening angle is in the range of, for example, 5 to 0°), the oil may flow into the third hydraulic passage 15 from the oil port d and will flow into the piston front chamber 4 from the oil port d' through the latching action adjusting valve 14 which is provided to face the oil port d and which may be adjusted to a low restriction. For this reason, the return

movement of the piston 3 is classified into four-speed modes which correspond to the delayed action adjusting valve 9, the first speed adjusting valve 10, the second speed adjusting valve 13 and the latching action adjusting valve 14, respectively. The movement is converted into the adjusted return rotation of the output shaft 1 through the rotational motion-linear m otion converting mechanism A. Thus, the door may conduct respective actions such as the delayed action where the speed is kept at a low level, the first speed closing door action where the speed is kept at a high level, the second speed door closing action where the speed is kept at a low level and the latching action where the speed is kept at a remarkably low level in this order.

The back check operation which is available in the door opening action range of the door opening angle of 75 to 120° will be explained. In the door opening action range where the door is opened from the full-closed condition, the upper swing plate 25 and the lower swing plate 26 are out of contact with the back check piston 11. The pressure of the piston rear chamber 5 is transmitted to the back check cylinder 19b through the fourth hydraulic passage 33 formed in the back check piston 16. When the door is opened at the door opening angle of 75°, the upper swing plate 25 and the lower swing plate 26 contact the back check piston 16 to receive the biasing force of the back check spring 17 and then move in the left direction as viewed in FIG. 2 against the biasing force of the back check spring 17. In this case, in the case where the door is opened slowly, the back check valve 34 is kept opened, so that the working oil within the back check cylinder 19b may flow into the piston rear chamber 5 through the fourth hydraulic passage 33 and the back check valve 34. The back check piston 16 may be retracted in the left direction while compressing the back check spring 17. As a result, the back check valve 34 is not closed. As a result, the movement of the piston 3 is effected so that the door is opened at the maximum door opening angle. Also, when the door opening speed is increased, in order to respond quickly to the increase of the retraction speed of the back check piston 16, the pressure of the working oil within the back check cylinder 19b is increased, and the check valve 34 for back check provided in the back check piston 16 is closed. For this reason, the piston 16 will not be retracted due to the pressure of the working oil within the back check cylinder 19b. Thus, the speed of the piston 3 is decelerated to stop, thereby terminating the door opening operation and avoiding the quick fully opening of the door so that it is possible to avoid the damage of components such as a glass member provided on the door.

In contrast, when the door is slowly opened, the pressure of working oil within the back check cylinder 19b is equal to that within the piston rear chamber 5 to open the back check valve 34 and to ensure the retraction of the back check piston 16. Under the back check condition, if the extremely quick opening action would be effected, or the door would be blown by strong wind in the full open direction, in order to quickly respond to the quick retraction of the back check piston 16, the pressure of working oil within the back check cylinder 19b is increased, and the check valve 34 for back check provided in the back check piston 16 is closed. Then, when the pressure of the working oil within the back check cylinder 19b would exceed a constant level, the back check safety valve 36 interposed in the fifth hydraulic passage 35 is opened and the working oil within the back check cylinder 19b will escape into the piston rear chamber 5 through the fifth hydraulic passage 35 formed in the wall of the back check cylinder 19b. Even if the back check valve 34 is closed, it is possible to ensure the retraction of the back check piston 16. During the retraction of the back check piston 16, the back check safety valve 36 is opened and closed in response to the pressure of working oil in the back check cylinder 19b. Thus, the back check force is decelerated to avoid the over load imposed on the stationary parts of the door and the output shaft 1 and to avoid a damage of the floor hinge components such as the hinge case and door components.

Instead of the back check safety valve 36, a back check adjusting valve may be used. At that time, the throttling level of the valve is determined at a high level so that the back check valve 34 is closed due to the pressure increase of the working oil in the back check cylinder 19b when the door is blown to the full-open angle. After the back check valve 34 is closed, the working oil in the back check cylinder 19b flows into the piston rear chamber 5 through the back check adjusting valve to ensure the retraction of the back check piston 16.

As described above, with the floor hinge according to the present invention, during the door opening action, the working oil within the piston rear chamber will flow into the piston front chamber through the first hydraulic passage formed in the piston. During the first stage action for closing the door, i.e., the delayed action, the working oil within the piston front chamber will flow into the piston rear chamber only through the second hydraulic passage formed in the cylinder wall and the delayed action adjusting valve. During the second stage action for closing the door, i.e., the first speed door closing action, the working oil within the piston front chamber will flow into the piston rear chamber only through the second hydraulic passage formed in the cylinder wall and the first speed adjusting valve. Subsequently, during the third stage action for closing the door, i.e., the second speed door closing action, the working oil within the piston front chamber will flow into the piston rear chamber only through the second hydraulic passage formed in the

cylinder wall and the first speed adjusting valve. Subsequently, during the third stage action for closing the door, i.e., the second spaced door closing action, the working oil within the piston front chamber will flow into the piston rear chamber only through the third hydraulic passage formed in the cylinder wall and the second speed adjusting valve. Subsequently, during the fourth stage action for closing the door, i.e., the latching action, the working oil within the piston front chamber will flow into the piston rear chamber only through the third hydraulic passage and the latching action adjusting valve. With such an arrangement, it is possible to effect the door closing action having four-speed modes such as the delayed action, first speed action, second speed action and latching action. In particular, the four-speeds may be changed independently to perform the objects.

Further, in the range of a predetermined the door opening angle to the maximum door opening angle, the rotational motion-linear motion converting mechanism abuts against the back check piston. When the door is slowly opened, the back check valve is kept open, and the back check piston can be retracted because the working oil in the back check cylinder can flow into the piston rear chamber to cause the door to be fully opened. In contrast, when the door is rapidly opened, the back check valve is closed, the door opening motion is stopped. When the door is blown by a strong wind, the back check safety valve is operated to avoid the breakage of each element of the floor hinge.

Claims

1. A floor hinge having an output shaft (1) connected to a door and serving as a rotary shaft of said door, a rotational motion-linear motion converting mechanism (A) for converting a rotational motion of the output shaft (1) into a linear motion, a main piston (3) connected to said output shaft (1) through the rotational motion-linear motion converting mechanism (A) for controlling the rotational motion of the output shaft (1), a return spring (2) for being deformed by the rotational motion of the output shaft (1) caused by a door opening action and for accumulating a spring force, in response to movement the main piston, the spring force returns the main piston to a door closing position, and a hydraulic control circuit for a delayed action for closing the door at an extremely low speed in a range from a maximum door opening angle to a predetermined door closing angle, a first speed door closing action for closing the door at a high speed, a second speed door closing action for closing the door at a low speed, and a latching action for closing the door at an extremely low speed near the full-closed condition for latching the door, characterized in that said hydraulic control circuit comprises:

   a first hydraulic passage (7) formed in said piston (3) for communicating a piston front chamber (4) and a piston rear chamber (5) with each other and having a check valve (6) for allowing working oil within the piston rear chamber (5) to flow into the piston front chamber (4) during a door opening action but preventing the working oil from moving in a reverse direction during a door closing action;

   a second hydraulic passage (11) formed in a predetermined branch shape for switching communication between the piston front chamber (4) and a piston rear chamber (5) by using ports which are selectively opened and closed by said piston (3) in response to movement of the piston (3) during said delayed action and said first speed door closing action, said second hydraulic passage (11) having a delayed action adjusting valve (9) and a first speed adjusting valve (10); and

   a third hydraulic passage (15) formed in a predetermined branch shape for switching communication between the piston front chamber (4) and a piston rear chamber (5) with each other by using ports which are selectively open and closed by said piston (3) in response to movement of the piston (3) during said second speed door closing action and said latching action, said third hydraulic passage (15) having a second speed adjusting valve (13) and a latching action adjusting valve (14).

2. A floor hinge according to claim 1, wherein said first hydraulic passage (7) is communicated with a space provided in the main piston (3) for accommodating one end of a connecting rod (30) as a part of the rotational motion-linear motion converting mechanism.

3. A floor hinge according to claim 1, wherein the second and third hydraulic passage (11, 15) are formed independently of each other in a wall of a main piston cylinder for accommodating slidably the main piston (3).

4. A floor hinge according to claim 3, wherein the second hydraulic passage (11) comprises first, second, third and fourth branch passages (11b, 11c, 11d, 11e) which are disposed, in this order, from the piston front chamber (4), the first branch passage (11b) having a first speed adjusting valve (9), the fourth branch passage (11e) having a delayed action adjusting valve (10).

5. A floor hinge according to claim 3, wherein the third hydraulic passage (15) comprises first, sec-

ond, third and fourth branch passages (15b, 11c, 15d, 15e) which are disposed, in this order, from the piston front chamber (4), the first branch passage (15b) having a latching action adjusting valve (14), the fourth branch passage (15e) having a second speed adjusting valve (13).

6. A floor hinge according to claim 3, wherein the third hydraulic passage (15) is offset from the second hydraulic passage (11) toward a cylinder head (20) of the main piston cylinder (19a).

7. A floor hinge having an output shaft (1) connected to a door and serving as a rotary shaft of said door, a rotational motion-linear motion converting mechanism (A) for converting a rotational motion of said output shaft (1) into a linear motion, a main piston (3) connected to said output shaft (1) through the rotational motion-linear motion converting mechanism (A) for controlling the rotational motion of the output shaft (1), a return spring (2) for being deformed by the rotational motion of the output shaft (1) caused by a door opening action and for accumulating a spring force, in response to movement the main piston, the spring force returns the main piston to a door closing position, and a back check mechanism for decelerate opening speed of the door in a range from a predetermined door opening angle to a maximum door opening angle, characterized in that said back check mechanism comprises a back check cylinder (19b) provided at a position opposite to the piston (3) with respect to the rotational motion-linear motion converting mechanism (A), a back check cylinder (19b), an elastic member (17) for urging the back check piston (16) toward the output shaft (1), a back check hydraulic passage (33) formed in the back check piston (16) in which a check valve (34) is provided to close the back check hydraulic passage (33) when the door is rapidly opened to cause the rotational motion-linear motion converting mechanism (A) to contact the back check piston (16) to thereby retract the back check piston (16), a back check bypass passage (35) for communicating the back check cylinder (16) with the piston rear chamber (5), and a back check throttle means (35) for controlling the working oil in the back check bypass passage (35).

8. A floor hinge according to claim 7, wherein the back check throttle means (35) comprises a safety valve (36) or an adjusting valve.

9. A floor hinge having an output shaft (1) connected to a door and serving as a rotary shaft of said door, a rotational motion-linear motion converting mechanism (A) for converting a rotational motion of said output shaft (1) into a linear motion, a main piston (3) connected to said output shaft (1) through the rotational motion-linear motion converting mechanism (A) for controlling the rotational motion of the output shaft (1), a return spring (2) for being deformed by the rotational motion of the output shaft (1) caused by a door opening action and for accumulating a spring force, in response to movement the main piston, the spring force returns the main piston to a door closing position, a hydraulic control circuit for a delayed action for opening the door at an extremely low speed in a range from a maximum door opening angle to a predetermined door closing angle, a first speed door closing action for closing the door at a high speed, a second speed door closing action for closing the door at a low speed, and a latching action for closing the door at an extremely low speed near the full-closed condition for latching the door, and a back check mechanism for decelerate opening speed of the door in a range from a predetermined door opening angle to the maximum door opening angle, characterized in that said hydraulic control circuit comprises:

a first hydraulic passage (7) formed in said piston (3) for communicating a piston front chamber (4) and a piston rear chamber (5) with each other and having a check valve (6) for allowing working oil within the piston rear chamber (5) to flow into the piston front chamber (4) during a door opening action but preventing the working oil from moving in a reverse direction during a door closing action;

a second hydraulic passage (11) formed in a predetermined branch shape for switching communication between the piston front chamber (4) and a piston rear chamber (5) with each other by using ports which are selectively opened and closed by said piston (3) in response to movement of the piston (3) during said delayed action and said first speed door closing action, said second hydraulic passage (11) having a delayed action adjusting valve (9) and a first speed adjusting valve (10); and

a third hydraulic passage (15) formed in a predetermined branch shape for switching communication between the piston front chamber (4) and a piston rear chamber (5) with each other by using ports which are selectively opened and closed by said piston (3) in response to movement of the piston (3) during said second speed door closing action and said latching action, said third hydraulic passage (15) having a second speed adjusting valve (13) and a latching action adjusting valve (14),

and that said back check mechanism comprises:

a back check cylinder (19b) provided at a position opposite to the piston (3) with respect to the rotational motion-linear motion converting mechanism (A);

a back check cylinder (19b);

an elastic member (17) for urging the back check piston (16) toward the output shaft (1);

a back check hydraulic passage (33) formed in the back check piston (16) in which a check valve (34) is provided to close the back check hydraulic passage (33) when the door is rapidly opened to cause the rotational motion-linear motion converting mechanism (A) to contact the back check piston (16) to thereby retract the back check piston (16);

a back check bypass passage (35) for communicating the back check cylinder (16) with the piston rear chamber (5); and

a back check throttle means (35) for controlling the working oil in the back check bypass passage (35).

10. A floor hinge according to claim 9, wherein the back check throttle means (35) comprises a safety valve (36) or an adjusting valve.

FIG. 1A

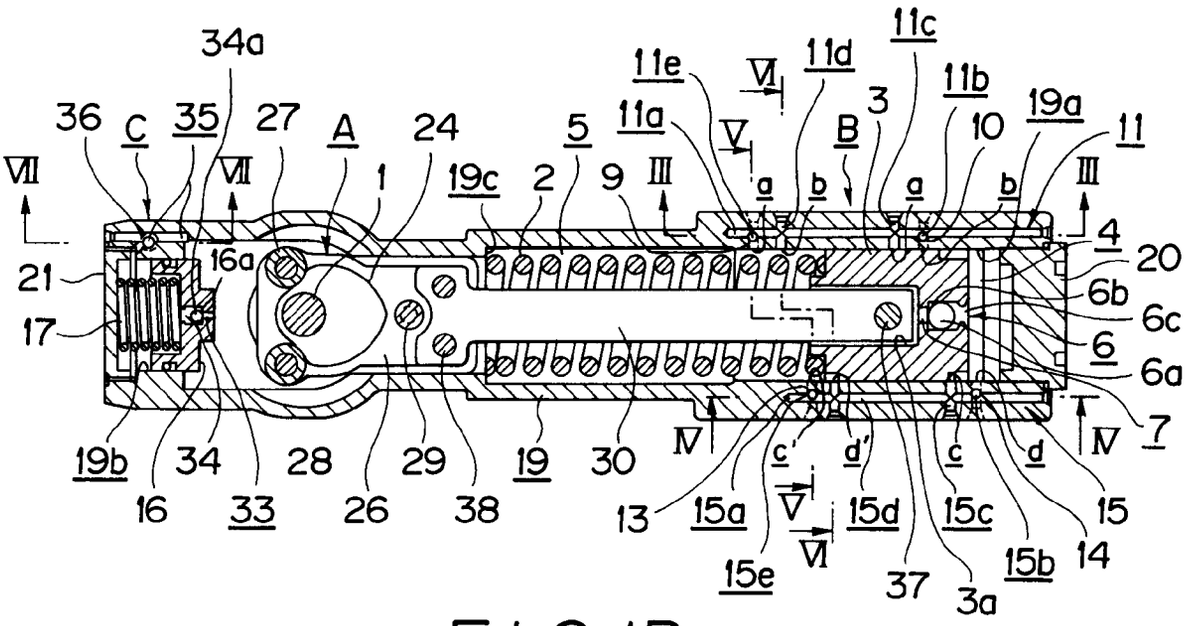

34a
36
C
35
27
A
24
5
11e
VI
11d
11c
11b
19a
11
11a
V
B
3
10
VII
VII
1
19c
2
9
III
a
b
a
b
III
4
20
21
16a
6b
6c
17
6
6a
7
IV
IV
19b
34
28
29
19
30
c'
d'
c
d
16
33
26
38
13
15a
V
15d
15c
15
VI
15e
37
3a
15b
14

FIG. 1B

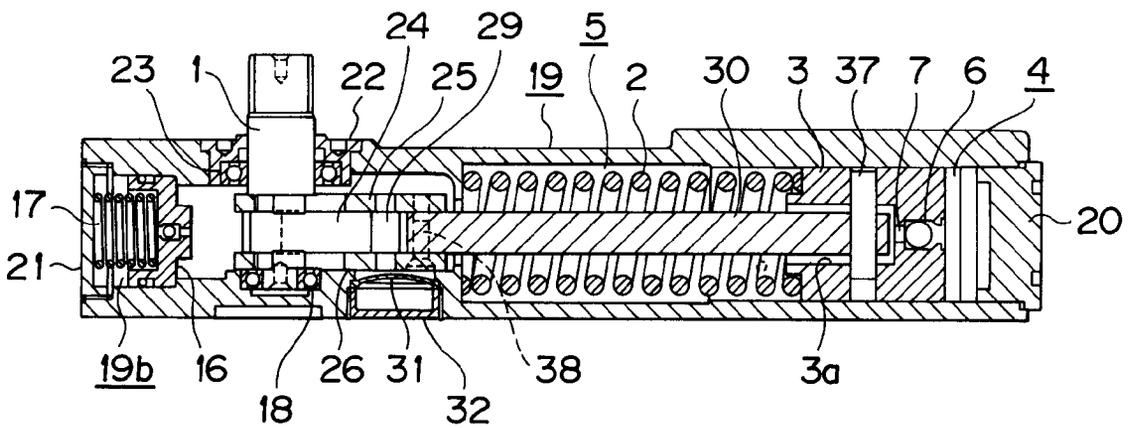

24
29
5
23
1
22
25
19
2
30
3
37
7
6
4
17
20
21
19b
16
26
31
38
3a
18
32

FIG. 2A

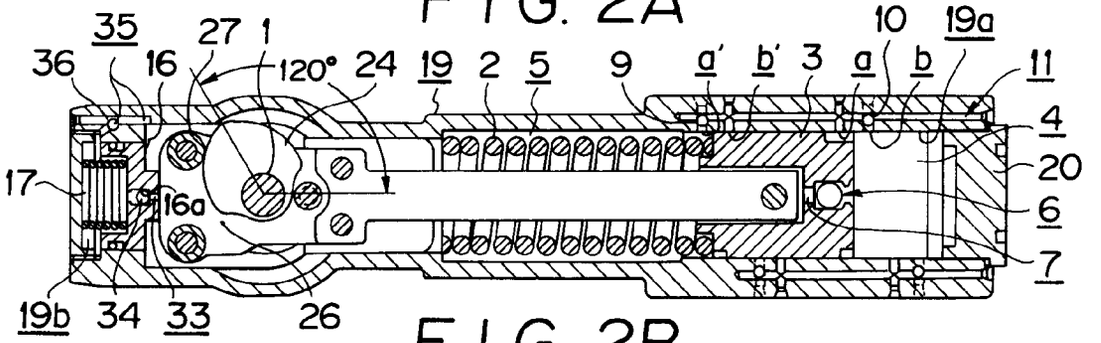


FIG. 2B

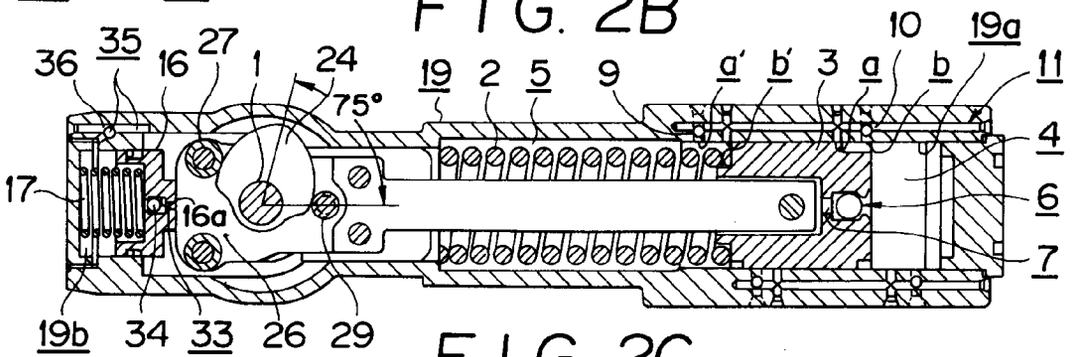


FIG. 2C

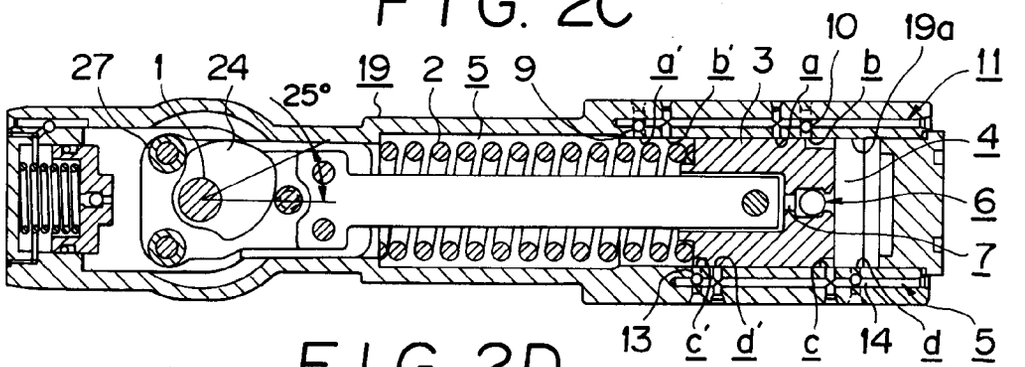


FIG. 2D

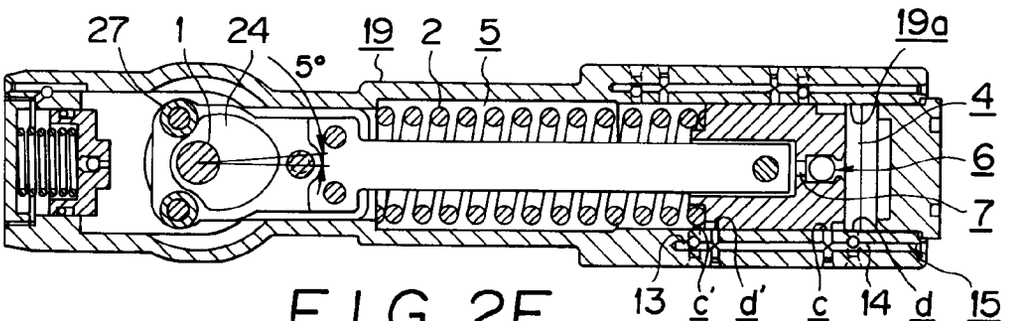


FIG. 2E

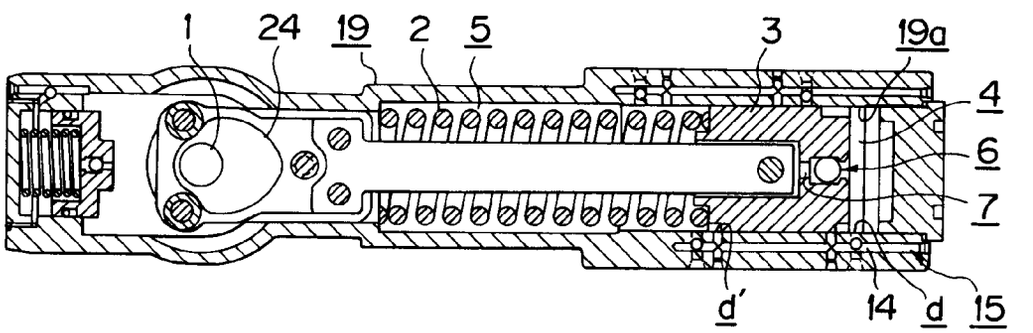


FIG. 3

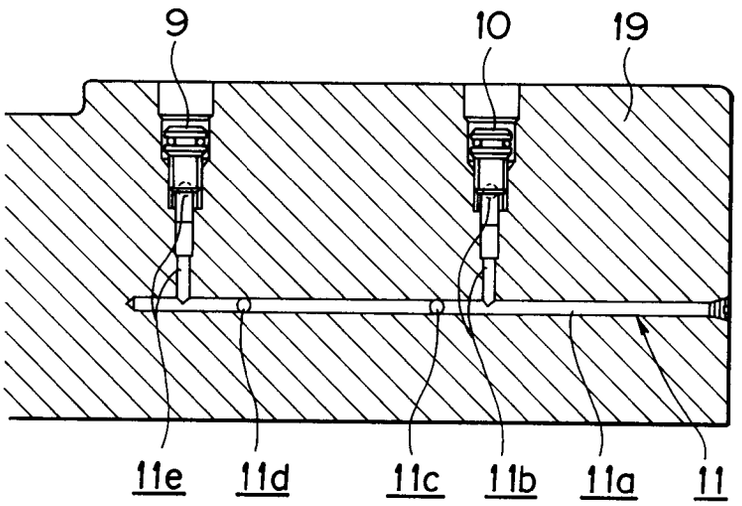


FIG. 4

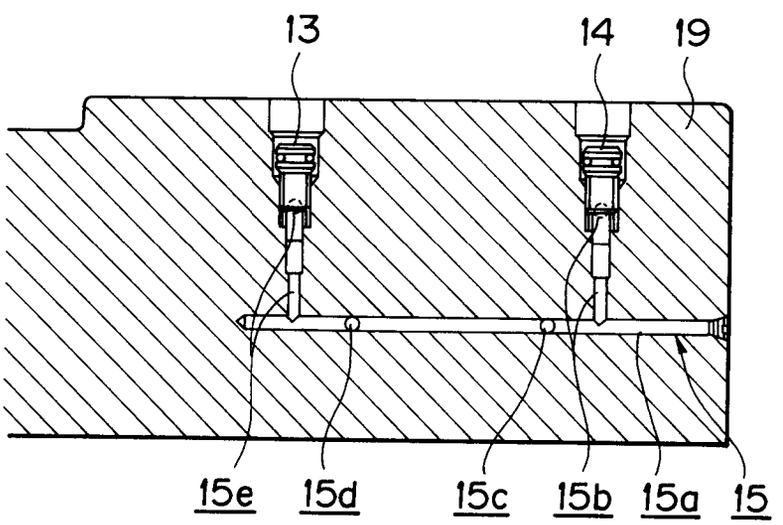


FIG. 5

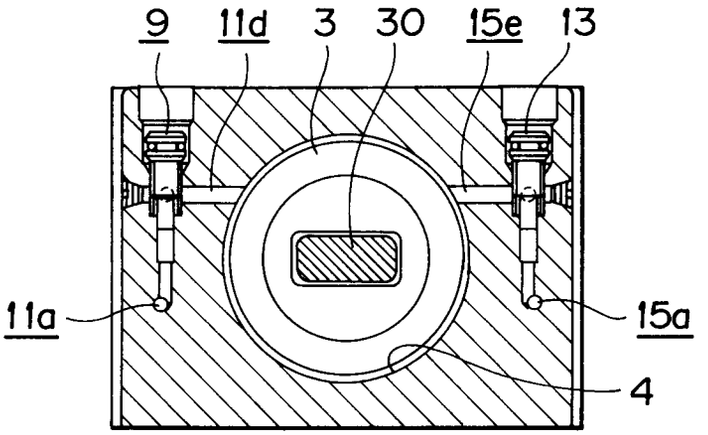


FIG. 6

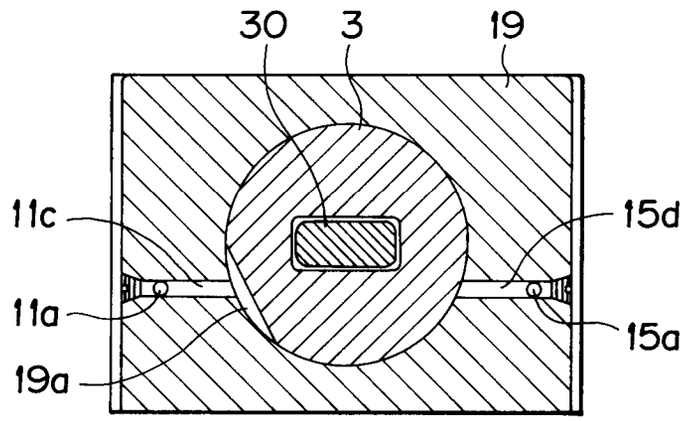


FIG. 7