

[54] DOOR CONTROL DEVICE

[75] Inventor: Edward J. Poitras, Holliston, Mass.

[73] Assignee: Walter Kidde & Company, Inc., Clifton, N.J.

[22] Filed: Oct. 5, 1972

[21] Appl. No.: 295,174

[52] U.S. Cl. 16/48.5; 16/51; 16/62; 251/138

[51] Int. Cl. E05f 3/22

[58] Field of Search 16/48.5, 49, 51, 52, 55, 16/66; 292/201, 144; 249/334; 251/138, 140

[56] References Cited

UNITED STATES PATENTS

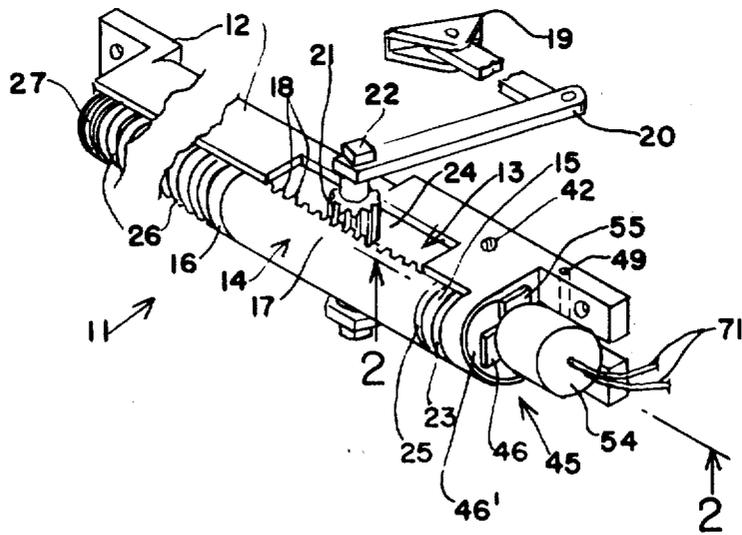
1,430,192	9/1922	Schloss	16/49
1,735,511	11/1929	Shrode	251/138
1,782,040	11/1930	Hill	16/66
2,169,656	8/1939	McNeely	292/144 X
2,996,928	8/1961	Watson	251/138 X
3,176,516	4/1965	Guenther	251/138 X
3,528,639	9/1970	Grayson	251/140 X
3,648,326	3/1972	Gaysowski	16/48.5
3,696,462	10/1972	Martin	16/49

Primary Examiner—Roy D. Frazier
 Assistant Examiner—Peter A. Aschenbrenner
 Attorney, Agent, or Firm—John E. Toupal

[57] ABSTRACT

Disclosed is a control mechanism having a spring that urges a piston in a closing direction. In response to movement of the piston in the opening direction, a check valve allows flow of hydraulic fluid from a reservoir volume into a hold volume where it is retained to prevent return movement of the piston in the closing direction under the influence of the spring bias. A door coupled to the piston can be urged into any open position and is retained there by the fluid in the hold volume. Disposed within another passage between the reservoir and hold volumes is a control valve that is biased in a closed position by a valve biasing leaf spring. A control surface on a stem of the valve is subjected to the fluid pressure in the hold volume and exerts a force in opposition to the control valve bias. In response to exertion on the piston of a force complementing the closure force provided by the spring bias, increased fluid pressure in the hold volume overcomes the control valve bias allowing the valve to open and permitting hydraulic fluid flow from the hold volume into the reservoir volume. Consequently, a door connected to the closure device can be manually moved from any retained position in a closing direction. A second control mechanism responds to a predetermined condition by reducing the valve control valve bias also resulting in fluid flow between the hold and reservoir volumes and enabling the coil spring to force the piston and associated door in a closing direction.

13 Claims, 7 Drawing Figures



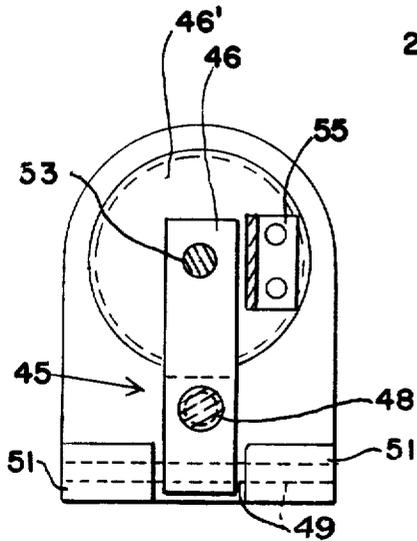


Fig. 3.

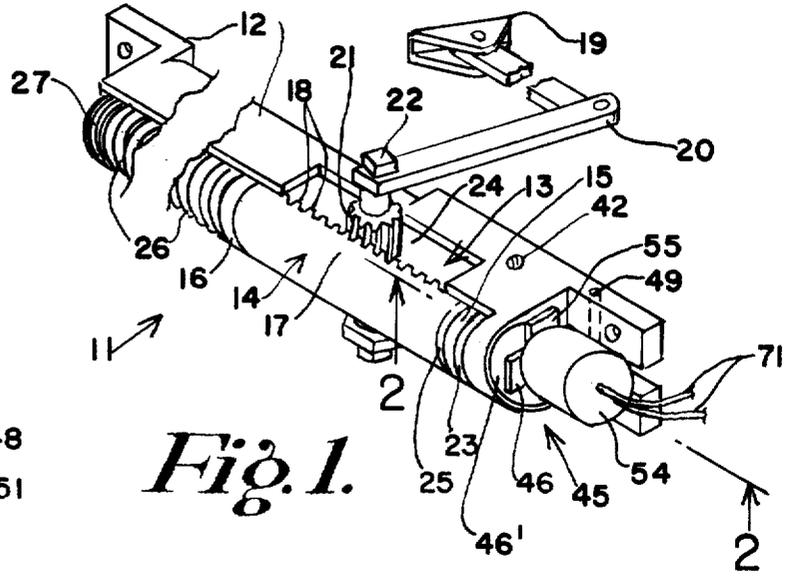


Fig. 1.

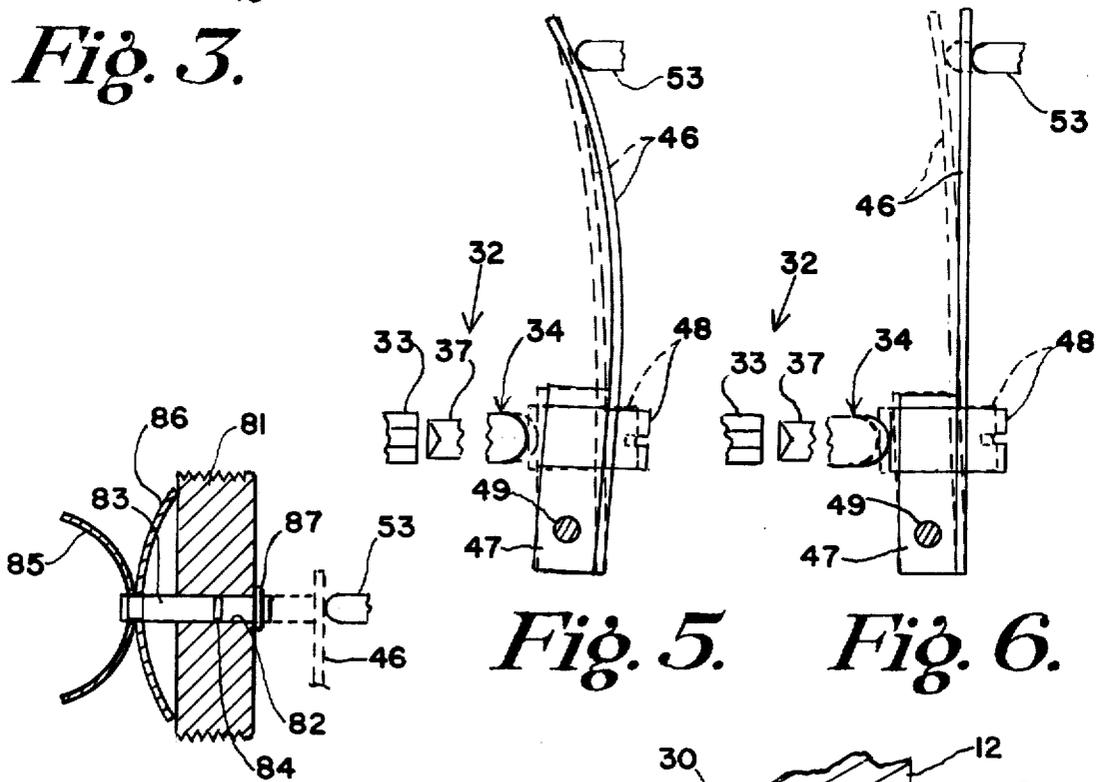


Fig. 5.

Fig. 6.

Fig. 7.

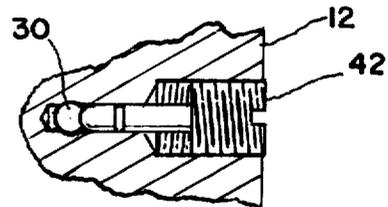


Fig. 4.

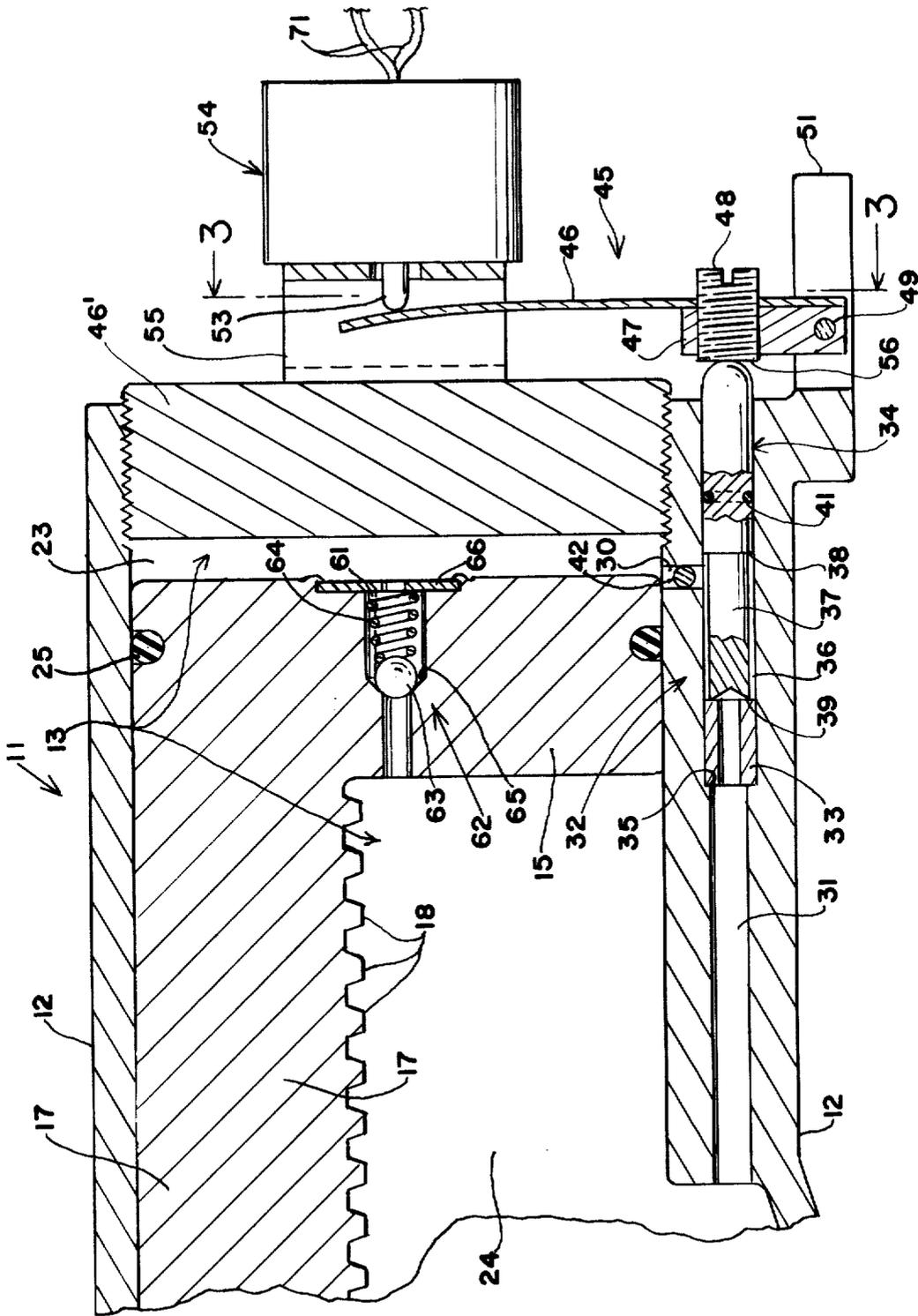


Fig. 2.

DOOR CONTROL DEVICE

BACKGROUND OF THE INVENTION

This invention relates generally to combination door closer and positioner, and more particularly, to a door positioner that automatically closes a door in response to a predetermined condition.

Devices for automatically closing doors in response to the occurrence of a predetermined dangerous condition are well known. For example, doors that close automatically to prevent the spread of fire are used in many building structures. Typically, a suitable door closing mechanism is activated by opening of a fusible link that melts in response to the occurrence of a given ambient temperature. In certain applications, however, it is highly desirable that doors be automatically closed in the initial stages of a fire before excessive temperatures are generated. Typical examples of such applications include hospitals, nursing and convalescent homes, etc. in which incapacitated individuals cannot escape themselves or be easily and expeditiously removed by attendants in the event of fire. Personal injury in such facilities resulting from smoke inhalation is common even in instances wherein uncontrolled fire conditions fail to materialize.

Because of the problem described above, there have been proposed various types of door closers that can be actuated to automatically close a door in response to detection of initial products of combustion such as smoke. These prior devices have not been practical, however, for a variety of reasons. Some have failed to provide other operational features required for a device of this type such as the ability to retain a door in intermediate positions between open and closed. Others have been too mechanically cumbersome and costly to warrant their use in the extensive numbers required to provide protection for each occupant of facilities having a large number of individual rooms.

The object of this invention, therefore, is to provide an improved and relatively low cost device that will retain a door in any selected position between open and closed and can be automatically actuated to induce complete closing of the door in response to detection of a predetermined condition such as the presence of combustion products.

SUMMARY OF THE INVENTION

The invention is characterized by the provision of an hydraulic door closer including a housing that retains a piston reciprocable in opening and closing directions. The housing defines an hydraulic fluid retaining chamber that is divided into reservoir and hold volumes by the piston. A coil spring exerts a closure force on the piston, movement of which is coupled to a door by a conventional connecting linkage. In response to movement of the piston in the opening direction, a check valve allows flow of hydraulic fluid from the reservoir volume into the hold volume where it is retained to prevent return movement of the piston in the closing direction under the influence of the spring bias. Thus, a door coupled to the piston can be urged into any open position and is retained there by the fluid pressure in the hold volume. Disposed within another passage between the reservoir and hold volumes is a control valve that is biased in a closed position by a valve biasing leaf spring. A control surface on a stem of the valve is sub-

jected to the fluid pressure in the hold volume and exerts a force in opposition to the control valve bias. In response to exertion on the piston of a force complementing the closure force provided by the spring bias, increased fluid pressure in the hold volume overcomes the control valve bias allowing the valve to open and permitting hydraulic fluid flow from the hold volume into the reservoir volume. Thus, a door connected to the closure device can be manually moved from any retained position in a closing direction. A second control mechanism responds to a predetermined condition by reducing the control valve bias also resulting in fluid flow between the hold and reservoir volumes and enabling the coil spring to force the piston and associated door in a closing direction.

In a preferred embodiment, the second control mechanism includes a solenoid having an armature that retains the bias force applied to the control valve. De-energization of the solenoid releases its armature to reduce the bias on the control valve which opens to induce closing movement of the piston. In a typical application the solenoid would be controlled by a detector that senses combustion products such as smoke or heat.

One feature of the invention is the provision of a fluid flow restriction between the control valve and the hold volume. Because of this restriction, the opened control valve is subjected only to the fluid pressure in the reservoir volume rather than the higher pressure in the hold volume. Consequently, the force required to reclose the control valve and stop movement of a door is reduced. This feature facilitates automatic positioning of a door by remote actuation of the valve controlling solenoid.

Another feature of the invention is the provision of a trip means that prevents closure of the control valve with the piston located in a predetermined range of positions within the chamber. The predetermined range of positions preferably entail the positions of the piston corresponding to positions of an associated door within a few inches of its closed position. This feature prevents retention of the door in a nearly closed position.

DESCRIPTION OF THE DRAWINGS

These and other objects and features of the present invention will become more apparent upon a perusal of the following description taken in conjunction with the accompanying drawings wherein:

FIG. 1 is a schematic, perspective view of a preferred door control device according to the present invention;

FIG. 2 is an enlarged cross sectional view taken along lines 2—2 of FIG. 1;

FIG. 3 is an end view of the device shown in FIGS. 1 and 2;

FIG. 4 is an enlarged partial view illustrating an adjustable flow restricting valve utilized in the device of FIGS. 1 and 2;

FIG. 5 is a partial view illustrating a different operating position of the valve bias mechanism shown in FIG. 2;

FIG. 6 is a partial view illustrating another operating position of the valve bias mechanism shown in FIG. 5; and

FIG. 7 is a cross sectional view of a modified end plug for use in the device shown in FIGS. 1 and 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIGS. 1-3 there are shown schematic views of a door control device 11 according to the present invention. Shown specifically in FIG. 1 are components typically utilized in conventional hydraulic door closers. A housing 12 defines a cylindrical fluid sealed chamber 13 to be filled with a suitable hydraulic fluid. Disposed within the chamber 13 is a piston 14 reciprocable in opening (toward the left as shown in FIG. 1) and closing (to the right as shown in FIG. 1) directions. The piston member 14 is formed by a front end wall 15 and a rear end wall 16 that straddle a mid portion 17 cutaway to provide rack gear teeth 18. A pinion gear 21 extends into the housing 12 and is operatively engaged with the rack gear teeth 18. Terminating the pinion gear 21 outside the housing 12 is a square section nut 22 operatively connected to a bracket 19 by a conventional linkage mechanism 20. The linkage 20 couples motion of the piston 12 with relative motion between a door and a support surface (neither shown) either of which is attached to either the device 11 or the bracket 19 in the conventional manner. Dividing the chamber 13 into a hold volume 23 and a reservoir volume 24 is an O-ring gasket mounted on the piston front wall 15. A coiled spring 26 is retained between the piston back wall 16 and an end plug 27. It will be understood that half of the housing 12 is not shown for clarity and that conventional seals are utilized to fluid tightly seal the chamber 13.

Referring now to FIG. 2 there is shown in greater detail a control portion of the device 11 shown in FIG. 1. Formed in the housing 12 and extending between the hold volume 23 and the reservoir volume 24 are fluid flow passages 30 and 31. A control valve 32 for controlling hydraulic fluid flow between the volumes 23 and 24 is positioned between the passages 30 and 31. Included in the valve 32 is a seat member 33 and a stem 34 movable in the passage 31 between open and closed positions. The seat member 33 is a centrally orificed cylindrical plug pressed against a circular shoulder 35 in the passage 31. An annular recess 36 on one end of the stem 34 provides a valve head portion 37 and establishes an annular fluid pressure responsive surface 38 that is transverse the longitudinal axis of the stem 34. The end of the head portion 37 is conically recessed to provide a circular sealing edge 39 that seats against the plug 33 around the central opening therein. Providing a fluid seal between the stem 34 and the cylindrical wall of the passage 31 is an O-ring 41. As shown more clearly in FIG. 4, a manually adjustable valve stem 42 extends through the housing into the passage 30 and allows adjustment in the fluid conductance between the hold volume 32 and the passage 31.

A control valve bias mechanism 45 is mounted outside the housing 12 on an end plug 46' thereof. The bias mechanism 45 includes a leaf spring 46 and a support plate 47 having a surface integrally secured, for example by welding, to a mating surface of the leaf spring 46. Also included in the bias mechanism 45 is an adjustment screw 48 extending through and threadedly engaging the support plate 47. One end of the bias mechanism 45 is secured by a pivot pin 49 between spaced ears 51 extending from the housing 12. One side of the opposite end of the bias mechanism 45 engages an armature 53 of a solenoid 54 mounted on the end

plug 46' by a bracket 55. An end 56 of the adjustment screw 48 opposite the armature 53 engages an end of the valve stem 34 projecting out of the housing 12.

Positioned within a passage 61 through the front end piston wall 15 is a check valve assembly 62 that provides single directional fluid flow from the reservoir volume 24 into the hold volume 23. The check valve 62 includes a spherical ball 63 that is urged by a spring 64 into engagement with a seat 65 formed in the passage 61. Retaining the spring 64 is a washer 66 secured along its periphery to the piston 14, for example by riveting over of the adjacent portions of the piston end wall 15.

The door control device 11 is installed in the same manner as a conventional door closer with the linkage 20 extending between a door and a suitable support surface. Depending upon the linkage arrangement employed, the housing 12 is mounted on either the door or on the support surface and the bracket 19 is attached in either case to the opposite member. With the device 11 suitably mounted, the piston 14 will be in the position shown in FIG. 2 when the attached door (not shown) is in a fully closed position. Opening movement of the door is transmitted by the linkage 20 to the pinion gear 21 producing rotation thereof and resultant movement of the piston 14 in the opening direction which is toward the left as shown in FIG. 2. The resultant differential fluid pressure on opposite sides of the piston end wall 15 forces open the check valve 62 allowing fluid flow from the reservoir volume 24 into the hold volume 23. Once opening movement of the door and accordingly of the piston 14 stops, however, pressures on opposite sides of the end wall 15 are equalized allowing the spring 64 to seat the ball valve 63 and thereby trap the fluid retained in the hold volume 23. This trapping of fluid in the hold volume 23 is complete in that the control valve 32 is also maintained in a closed position as will be described in greater detail below. The fluid trapped in the volume 23 prevents the coil spring 26 from forcing the piston 14 and associated door in the closing direction. Thus, the device 11 retains the door in any position to which it is opened.

The control valve 32 is held in the closed position by the force applied by the biasing mechanism 45 to the valve stem 34. This closure force is produced by the leaf spring 46 which is retained by the armature 53 of the energized solenoid 54 in the slightly flexed position shown in FIG. 2. During installation of the device 11, the adjustment screw 48 is screwed into a position that provides on the valve stem 34 a closure force slightly greater than the oppositely directed fluid pressure generated force on the annular area 38. Therefore, assuming energization of the solenoid 54 and a stationary position for the door coupled to the piston 14, the control valve 32 is retained in closed position preventing hydraulic fluid flow through the passage 31.

Assume, however, that the previously opened door is urged in a closing direction producing on the piston 14 an auxiliary force in addition to the closure force normally produced by the coil spring 26. The additional force generates in the hold volume 23 an increased fluid pressure that is transmitted by the passage 30 into the valve recess 36. The resultant increased force exerted on the surface area 38 overcomes the spring force of the bias mechanism 45 and moves the valve 32 into the open position shown by solid lines in FIG. 5. Hydraulic fluid then flows from the hold volume 23

through the passage 30, the valve recess 36, the central opening in the valve seat 33 and the passage 31 into the reservoir volume 24. This release of fluid from the hold volume 23 permits movement of the piston and the operatively coupled door in a closing direction in response to manual urging thereof.

Assume next that with a door associated with the device 11 in a stationary open position, the solenoid 54 is deenergized. Resultant movement of the armature 53 to a retracted position as shown by solid lines in FIG. 6 reduces the spring bias applied by the mechanism 45 to the control valve 32. Accordingly, the existing fluid pressure in the valve recess 36 is able to move the valve into open position as shown. Opening of the valve 32 allows fluid flow from the hold volume 23 into the reservoir volume 24 as described above and thereby allows the coil spring 26 to move the piston 12 and associated door into a fully closed position.

In preferred applications of the device 11, the electrical leads 71 from a coil of the solenoid 54 are connected to a conventional detector for sensing combustion products such as smoke or heat. Such detectors as shown for example in U.S. Pat. Nos. 3,462,752 and 2,698,367. Upon detection of the combustion product, the associated detector deenergizes the solenoid 54 resulting in automatic closure of a door coupled to the device 11 in the manner described above. Thus, an incapacitated occupant of a room equipped with the device 11 would be automatically protected by an automatically closed door from heat or smoke being generated in other parts of a building.

According to another intended use of the device 11, the solenoid 54 could also be coupled for remote operation by a switch manually actuated by an occupant of the protected room. In that case the occupant can remotely control movement of an opened door into any more closed position by merely deenergizing the solenoid 54 until the door moves to the desired position. For this application, location of the fluid flow restriction passage 30 between the hold volume 23 and the control valve 32 is important. Upon opening of the valve 32, the valve recess 36 is opened to the atmospheric pressure in the reservoir volume 24 and the pressure drop in the system exists at the restricted orifice passage 30. Consequently, reclosure of the valve 32 merely requires that the biasing mechanism 45 overcome atmospheric pressure on the surface 48 rather than the higher fluid pressure existing in the hold volume 23. For this reason, the power required of the solenoid 54 to stop closing movement of a door by forcing the leaf spring 46 into the active position shown in FIG. 2 is minimized.

Referring now to FIG. 7 there is shown a modified end plug 81 that can be substituted for the end plug 46' shown in FIG. 2. Extending through a central aperture 82 and reciprocable therein is a trip rod 83. A fluid seal between the rod 83 and plug 81 is provided by an O-ring 84. Attached to an end of the rod 83 are a pair of oppositely facing spring leaves 85 and 86. A split ring 87 is fitted in a groove at the opposite end of the rod 83 to limit movement thereof into the plug 81.

The modified plug 81 is employed in the device 11 when it is desired that a controlled door will always automatically close from any of a range of positions near its fully closed position. When the door reaches a nearly closed position, the end wall 15 (FIG. 2) engages the spring 85 and compresses the lighter spring

86 forcing the rod 83 out of the plug 81. As shown by dotted lines in FIG. 7, the ejected rod 83 engages the leaf spring 46 forcing the armature 53 toward the non-energized position shown in FIG. 6. This results in opening of the control valve 32 and insures full closure of the door as described above. Upon reopening of the door, the spring 86 returns the rod 83 to the position shown by solid lines in FIG. 7. With the door in an open position the spring 86 is sufficiently strong to overcome the force exerted on the rod 83 by the trapped fluid pressure in the hold volume 23. The additional spring 85 is used merely to provide for overtravel of the piston 14 where desired.

Obviously, many modifications and variations of the present invention are possible in light of the above teachings. It is to be understood, therefore, that the invention can be practiced otherwise than as specifically described.

What is claimed is:

1. An hydraulic door closer comprising
 - a housing defining a chamber for hydraulic fluid;
 - a piston mounted within said housing and dividing said chamber into reservoir and hold volumes, said piston adapted for reciprocating movement through said chamber in opening and closing directions;
 - connecting means for coupling movement of said piston with a door;
 - piston bias means exerting a closure force tending to move said piston in said closing direction;
 - check valve means which opens to allow flow of the hydraulic fluid from said reservoir volume to said hold volume in response to movement of said piston in said opening direction and closes in the absence of movement in said opening direction to trap hydraulic fluid in said hold volume;
 - a control valve disposed within a fluid flow passage extending between said reservoir and hold volume;
 - valve bias means biasing said control valve in a closed position to prevent fluid flow through said passage and thereby prevent closing movement of the door;
 - first control means for overcoming said valve bias means to open said control valve to effect closing movement of the door in response to exertion on said piston of an auxiliary force aiding said closure force;
 - second control means actuatable to reduce said valve bias means and open said control valve to effect closing movement of the door in response to a predetermined condition; and
 - trip means for automatically reducing said valve bias independently of actuation of said second control means to maintain said control valve in an open condition with said piston located in a predetermined range of positions within said chamber so as to prevent retention of the door in a range of open positions corresponding to said predetermined range of positions of said piston.
2. An hydraulic door closer according to claim 1 wherein said predetermined range of positions of said piston correspond only to positions of the door within a few degrees of fully closed.
3. An hydraulic door closer according to claim 1 wherein said first control means comprises relief means for overcoming said valve bias in response to a greater fluid pressure in said hold volume than that normally provided by said piston bias means.

7

8

4. An hydraulic door closer according to claim 3 wherein said relief means comprises a surface exposed to the fluid pressure in said hold volume and coupled for movement with said control valve, said surface being disposed to provide a fluid pressure induced force in opposition to said valve bias means.

5. An hydraulic door closer according to claim 4 including fluid flow restriction means between said hold volume and said control valve.

6. An hydraulic door closer according to claim 5 wherein said restriction means comprises adjustable restriction means for adjusting the fluid conductance between said hold volume and said control valve.

7. An hydraulic door closer according to claim 1 wherein said second control means comprises actuator means coupled to said valve bias means and adapted to reduce the biasing force applied thereby to said control valve in response to said predetermined condition.

8. An hydraulic door closer according to claim 7 wherein said actuator means comprises an electrical solenoid having a coil and an armature and said predetermined condition is deenergization thereof.

9. An hydraulic door closer according to claim 8 wherein said control valve comprises a valve seat de-

fined by said passage, a valve stem movable in said passage and including a head portion disposed to seat against said valve seat.

10. An hydraulic door closer according to claim 9 wherein said valve bias means comprises a leaf spring having one end fixed to said housing, an opposite end engaged on one side by said armature, and an intermediate portion with a side opposite said one side exerting said biasing force on said control valve.

11. An hydraulic door closer according to claim 10 including adjustment means for adjusting the biasing force applied to said control valve by said leaf spring.

12. An hydraulic door closer according to claim 11 wherein said adjustment means comprises a screw threaded through said intermediate portion and having an end engaging said valve stem.

13. An hydraulic door closer according to claim 12 wherein said trip means comprises trip actuator means for automatically reducing the biasing force applied by said valve bias means in response to location of said piston in said predetermined range of positions within said chamber.

* * * * *

25

30

35

40

45

50

55

60

65