Oct. 27, 1959 D. H. ELLIS ET AL 2,909,801

DOOR CLOSER

Filed July 1, 1957 2 Sheets-Sheet 1

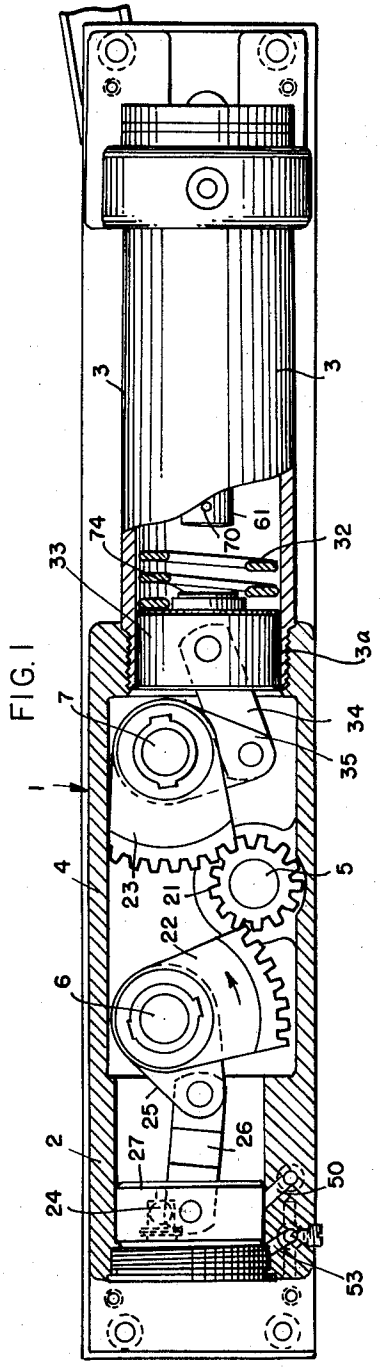

FIG. 1

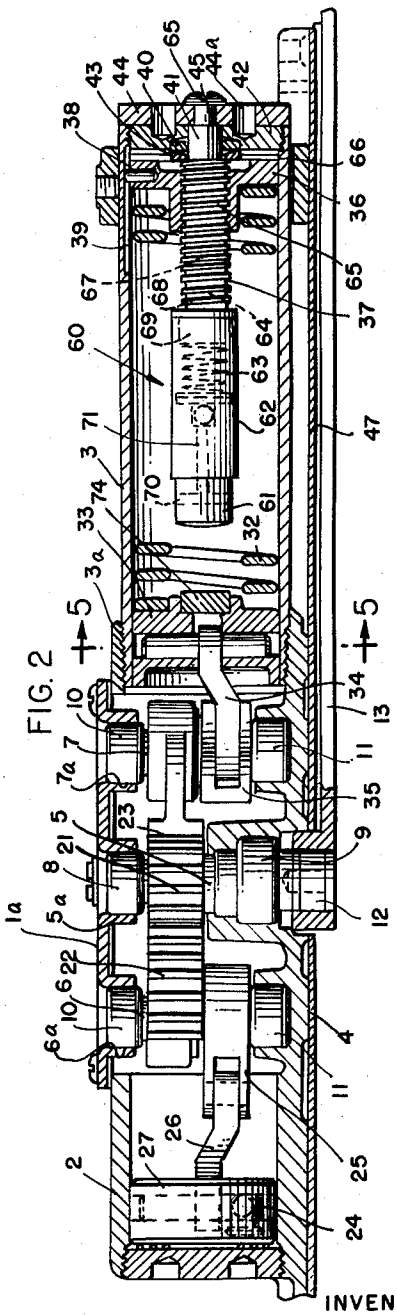

FIG. 2

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Oct. 27, 1959 D. H. ELLIS ET AL 2,909,801

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FIG. 3

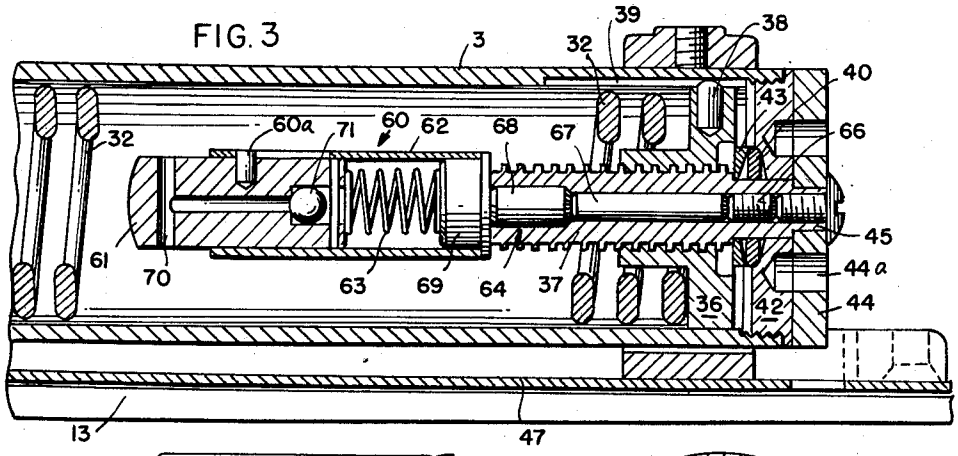


FIG. 4

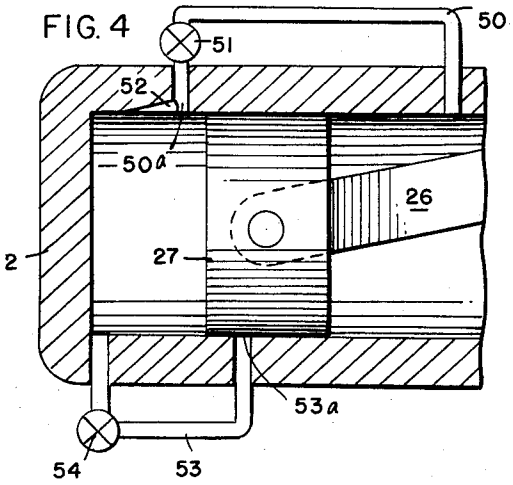


FIG. 5

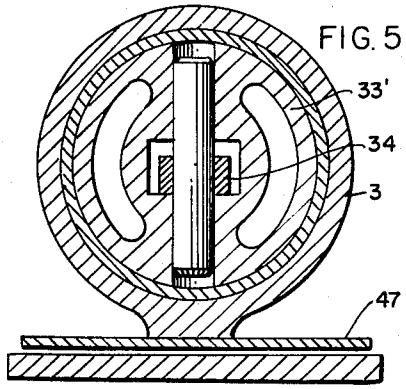
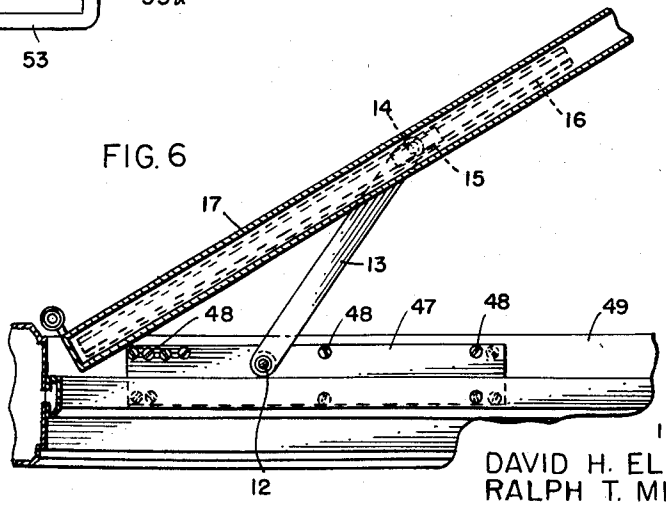


FIG. 6



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DOOR CLOSER

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Application July 1, 1957, Serial No. 669,092

11 Claims. (Cl. 16—62)

The present invention relates to door checks and closers in which the operating mechanism is compactly arranged in a single housing and located flush with the head jamb above the door where it is partially concealed by the door stop molding with only an operating arm exposed to engage slidably in a guide rail countersunk in the top of the door. The invention is an improvement upon that disclosed in the Garrison U.S. Patent No. 2,045,076, reference to which is hereby made.

With increased use of air conditioning in office buildings and homes, fast closing doors are in demand. Moreover, with the drafts and pressure differentials incurred between rooms which tend to open or hold doors open, or prevent their closing, work loads are imposed upon checks and closers, and performance results are required, that are not met by conventional devices.

Strengthening closer springs to provide faster closings and to overcome increased work loads imposes a greater burden upon persons using the door. This is not required with the present invention but it may feel like it exists since the relative initial opening and the continued opening pressures are different for ease of operation and there may exist a tendency to over push the door after initial opening and cause it to strike objects and walls at the end of its opening excursion. Door stops designed to safeguard against this, only place additional strains upon the door closers, the hinges and jambs and also are apt to cause damage to the doors themselves. Furthermore even with heavier springs, when an open door is released for closing, the door is accelerated in its closing motion much faster only to be followed by a relatively heavy slamming action as it reaches its closed position. Conventional door checks which retard the closing of the door only cause undesirable air conditioning loss and still do not permit the door to latch where latches are used.

The present invention contemplates two opening efforts to be exerted in opening a door without requiring additional effort of a person using the door; a firm one to start with that is rapidly reduced to a light one over the major portion of the opening movement, yet requires some exertion substantially all the way; and a second that is constant in its resistance to fast movement only during the last small portion of the door opening movement.

The invention further contemplates two separate closing speeds, a fast movement over the major portion of its closing movement followed by a quick deceleration as it nears latching position, whereafter all restraint upon the closing movement is removed just prior to the latching portion of its movement so that the full force of the closing spring is available to carry the load of the latching operation with the assistance of some inertial movement of the door.

A further object of the invention is to provide a device characterized as mentioned which can be readily adjusted to handle doors of various weights and inertias; doors of various areas and various air pressure differentials effective thereon; and, doors installed in various locations requiring various opening angles.

Another object of the invention is to provide a sealed housing filled with hydraulic fluid for lubricating and controlling the devices employed in the various operations already indicated, which housing is of little height throughout its length, is easily assembled, installed, adjusted and serviced.

These being among the objects of the invention, which also include the provision of a rugged construction with improved operating characteristics and capable of mass production at reduced cost, other and further objects will appear from the drawings, the description relating thereto and the appended claims.

In the accompanying drawings illustrating a preferred embodiment of the invention:

Figure 1 is a plan view partly in section of the door check and closer embodying the invention;

Fig. 2 is a longitudinal section of the embodiment illustrated in Fig. 1;

Fig. 3 is an enlarged view of one end of the device shown in section in Fig. 2;

Fig. 4 is an enlarged partially schematic view of the other end of the device shown in section in Fig. 2;

Fig. 5 is an enlarged section taken upon line 5—5 in Fig. 2; and

Fig. 6 is a sectional view looking upwardly at the top door jamb with the embodiment illustrated in place and the door partly open.

In the present invention a multiplying leverage advantage is provided in which two crank elements are operated in series as moved from a starting position disposed at substantially 90° to their direction of resultant drive to compress a rectilineally acting spring. Both end in a toggle closing action with the spring compressed. The drive of the second crank is one derived from a spur gear that is rotated by the first crank as driven by a door being pushed open. Thus, the greatest load in the door opening movement is at the opening, and from there diminishes as the door reaches its fully open position. The spring which opposes the opening is compressed during opening to store energy that is then utilized to close the door. With the leverage system employed, the greatest closing force occurs near the end of the closing movement. Consequently the results are such that the maximum transmission of energy with respect to door movement occurs near or at its closed position whether it is being opened or closed.

The present invention contemplates a door check and closer of novel construction and operation which applies an added load on the door opening during the last portion of the opening movement. This load is a one way expenditure of energy and leaves the compressed spring free to expend its full energy during its closing effort. However, near the end of the closing movement a hydraulic dash-pot rapidly decelerates the door closing movement until just before the door closes completely then releases the spring from further restraint. This permits rapid closure of the door through its major portion of closing movement at an accelerated rate and, after momentary deceleration just prior to full closing, liberates the main spring from any retarding control so that the spring at the time of its least stored-up force is free to operate the latch by which the door is kept closed as well as overcome any expected drafts or pressure differences present at the door.

In the drawings a casing 1 for the operating mechanism comprises a casting having a cylinder 2 at one end and an intermediate rectangular frame part 4 formed to support the lower ends of a main operating spindle 5 and crank spindles 6 and 7. Threaded at the other

end, as at 3*a*, is a second cylinder 3 supported on the frame 4. A cover 1*a* closes the top of the frame 4 and has therein sockets 5*a*, 6*a* and 7*a* for supporting the upper ends of the respective spindles. The main spindle 5 is carried by needle bearings 8 and 9 and the spindles 6 and 7 have similar mountings with needle bearings 10 and 11.

Attached to the lower squared end 12 of spindle 5 is an arm 13 which carries at its outer end on a ball pivot 14 (Fig. 6) a slide 15 fitting a guide rail 16 which is countersunk in the upper edge of the door 17 as indicated in Fig. 6. By the act of opening the door, the arm 13 swings out with the door while the slide 15 moves along the guide 16.

During an opening movement of the door, the spindle 5 turns in its bearings and through a pinion 21, secured to the spindle, transmits motion through gearing sectors 22 and 23 to the spindles 6 and 7. Spindle 6 rigidly carries a crank arm 25, by means of which motion is transmitted through a connecting rod 26 to a piston 27 operating in the cylinder 2.

As shown in Fig. 2, the piston 27 has a back flow check valve 24 therethrough which opens when the piston moves to the right as viewed in Fig. 2 and closes when the piston is moved to the left. With the check valve 24 closed and the piston moving to the left as when the door is moving to closed position, the movement of the piston is hydraulically controlled through a system of passages, adjustable valves and a graduated bleed groove in the side of the cylinder wall.

Referring to Fig. 4 the closing check system comprises a passage 50 by-passing the piston when the piston is in its outermost position. A valve 51 controls the movement of fluid through the passage 50 and the passageway terminates at 50*a* in a graduated groove 52 tapering in the direction of the head of the cylinder 2 beginning at a point in the cylinder where the piston closes the passage 50 on its inward movement at the time the door approaches its closed position. The valve, passage and tapered groove are dimensioned and adjusted to permit rapid closing of the door until the piston closes passage 50 at 50*a* at approximately the time the door nears its closed position. Thereupon the passage of fluid is gradually restricted by the tapered groove 52 until the door is just about to close, at which time a second passage 53 and valve 54 are brought into operation.

As the head of the piston progresses along the tapered groove 52, the port 53*a* is opened beyond the skirt of the piston and the valve 54 takes over the control of the flow of fluid from the cylinder head. This valve is set to relieve the closing effort just enough for the door movement to operate the latch and overcome any adverse pressure differential existing on opposite sides of the door. Thus there is a rapid closing, a rapid deceleration near the end of the closing stroke and a release of the door for latching operation.

The cylinder 3 has the main spring 32 therein which is compressed by the door opening to store energy for closing the door when free to do so under the controls just described. The spring receives energy on the opening movement of the door through the piston 33 which slides in the cylinder 3 because of its link connection 34 to crank arm 35 on the spindle 7. When the door is released, the spring closes the door by returning its energy through these same connections.

On its right-hand end (Fig. 2) spring 32 bears against a flanged nut 36 threaded on a hollow screw 37 and may be adjusted along the screw by rotating the latter during which time any turning of nut 36 is prevented by a pin 38 which projects from the side of the nut into a groove 39 in the inner wall surface of the cylinder 3.

The pressure of the spring is, through the nut, exerted axially on screw 37 and this thrust is utilized to keep packing 40 tightly fitting against a round shank 41 of the screw which passes through the cylinder end cap 42. The screw carries a washer 43 which bears against the packing.

There is a spring adjuster disc 44 fast to the flattened end 45 (Fig. 2) of the shank of the screw. Disc 44 has axial holes 44*a* therein for rotation by means of a spanner wrench.

Access to the disc may be had after installation of the construction by releasing finishing plate 47 at the bottom of the casting through removal of screws 48 which hold the plate in place. The casting is attached to the frame structure of head 49 (Fig. 6) by suitably located screws which are normally covered by the plate 47.

The screw 37 is hollow at 64 throughout its length and is threaded adjacent its rearward end to receive a screw 65, which holds the adjuster plate 44, and a set screw 66 which drives a spacer rod 67 endwise through the hollow screw 37. The free end of the screw 37 receives therein in telescoping sliding relationship a shank 68 of a head member 69 upon which is mounted a hydraulic dash-pot 60 comprising a loosely telescoping piston 61 and cylinder 62 urged in a direction of separation by a spring 63 but prevented from complete separation as, for example, by a slot and guide pin arrangement 60*a*. The piston 61 has a suitable passage 70 therein leading from its free end and terminating within the cylinder in a back flow check valve 71. Thus when free to do so, the dash-pot 60 is elongated by the effort of the spring 63 with free flow of fluid into the cylinder being permitted through the passage 70 and valve 71. However, when the valve 71 is closed, as on opposite movement of piston 61, the dash-pot 60 may not be collapsed except as fluid within the cylinder escapes around the piston between the piston and cylinder walls. For this purpose, an anvil member or wear plate 74 is provided upon the piston 33 where it engages the exposed end of the piston 61 when the door approaches is fully open position. Thereafter, continued opening of the door is opposed by the dash-pot effect of the piston and cylinder collapsing against trapped and gradually expelled fluid.

In the operation of this door closing and checking construction, the door is manually swung outwardly on its hinges, as illustrated by Fig. 6. This motion causes the arm 13 to swing outwardly from the position parallel with the closed door and as the angular relationship changes, the slide 15 travels along guide rail 16. Near the end of this movement the dash-pot 60 is brought into operation to prevent sudden over pushing of the door.

Upon the opening movement, the rotation of spindle 5 which is secured to the arm 13, is such as to move sector gear 22 in the direction of the arrow marked thereon in Fig. 1. This causes the piston 27 to move to the right. The oil which nearly fills the casting goes past the check valve 24 to the opposite side of the piston. At the same time, through the sector gear 23 and connections with piston 33, the spring 32 is compressed to store up power for closing the door.

Spring 32 is at all times under compression and there is no chance for free play to occur in the construction.

Should it be desirable to increase or decrease the tension of spring 32, the spring stop nut 36 is shifted lengthwise of the casing in either direction by turning the adjuster 44 which serves to rotate the screw 37 to drive the nut 36. Rotation of the nut 36 on the screw 37 is prevented by the pin guide 38.

It will be observed in Fig. 3 that the back check adjustment pin 67, which is slidable in the hollow screw 37, is engaged endwise by the shank 68 of the dash-pot head member 69 and the set screw 66 so that the dash-pot 60 may be located at various points axially of the screw 37 according to the angle of door opening desired and even though the shank 68 may be pushed considerably out of the hollow screw 37, the inner edges of the coil turns of spring 32 will serve as a guideway to maintain alignment of the parts. The set screw 66, by which

the pin 67 is operated, may be of the Allen head type, and access thereto is had from the outer end of the cylinder 3 by first removing the adjuster securing screw 65.

The main advantages of this invention reside in the improved and simplified arrangement of the operating parts of door closer mechanism whereby a smaller and more compact arrangement of the housing can be had; and in the improved construction and arrangement of both the back check means and the closing check control means.

Other principal advantages of this invention reside in the ready adjustability of the back check means with respect to its point of operation for checking the final swinging movement of the door in the opening direction; in the improved and more uniform checking and cushioning action of the back check means afforded by the simplified construction and operation of the dash-pot elements; in the novel combination of the separately adjustable back check elements with the means for adjusting the tension of the main closer spring; in the novel construction of the improved back check means whereby it is readily adjustable from the outside of the door closer unit and without any removal or dismantling of the same; and in the improved arrangement of the door closing check and adjustable control therefor whereby positive and yet relatively quiet latching of the door may be had for substantially any pressure conditions and latch operating characteristics.

Although but one specific embodiment of this invention is herein shown and described, it is to be understood that details as set forth may be altered or omitted without departing from the spirit of the invention as defined by the following claims:

We claim:

1. An overhead door checking and closing mechanism comprising a housing having opposed cylinders and plungers therein, a transmission intermediate said plungers including a spur gear rotated by door movement, sector gears in mesh with said spur gear and cranks driven by said sector gears for actuating said plungers, resilient means disposed in one of the cylinders placed under increased tension by inward movement of the plunger in said one cylinder, and means mounted axially in said one cylinder for retarding inward movement of the said plunger beyond a predetermined point including axially telescoping elements for trapping fluid between them and a resilient element urging their axial separation, said telescoping elements having a bleed passage between them for restricted escape of the trapped fluid, and one of the telescoping elements having a fluid inlet passage and a check valve therein for closing the inlet passage under pressure of the trapped fluid.

2. An overhead door checking and closing mechanism comprising a housing having opposed cylinders and plungers therein, a transmission intermediate said plungers including a spur gear rotated by door movement, sector gears in mesh with the spur gear and cranks driven by said sector gears actuating said plungers, normally tensioned spirally coiled resilient means disposed in one of the cylinders to be placed under increased tension by inward movement of the plunger in said one cylinder, means for adjusting the normal tension upon said resilient means including a rotatable screw extending axially of and terminating within said resilient means, and means supported on said screw for axial adjustment with respect thereto to engage said one plunger for retarding inward movement of the plunger beyond a predetermined point, the last named means including axially telescoping elements for trapping fluid between them and having a bleed passage for restricted escape of the trapped fluid, and a resilient element urging axial separation of said elements.

3. An overhead door checking and closing mechanism comprising a housing having opposed cylinders and plungers therein, a transmission intermediate said plungers

including a spur gear rotated by door movement, sector gears in mesh with the spur gear and cranks driven by said sector gears for actuating said plungers, normally tensioned spirally coiled resilient means disposed in one of the cylinders to be placed under increased tension by inward movement of the plunger in said one cylinder, means for adjusting the normal tension upon said resilient means including a rotatable screw extending axially of and terminating within said resilient means, and means comprising an axial extension of said screw to engage said one plunger for retarding inward movement of the plunger beyond a predetermined point, the last named means including axially telescoping elements for trapping fluid between them and having a bleed passage for restricted release of the trapped fluid, and a resilient element normally urging axial separation of said elements, one of said telescoping elements having a passage for admitting fluid between said elements and a check valve for closing said passage when the last named means is engaged by said one plunger.

4. An overhead door checking and closing mechanism comprising a housing containing fluid and having oppositely acting cylinders and plungers therein, transmission means connected to said plungers for driving said plungers into their respective cylinders and including a lever arm for actuation by a door, resilient means in one of the cylinders normally urging the respective plunger outwardly therefrom, and means on the other cylinder for retarding the inward movement of the plunger therein; said last named means including a first fluid conduit by-passing the said plunger and terminating upon the wall of said other cylinder in an inwardly tapered groove adjacent the inner end of said other cylinder, and a second fluid conduit independent of the first conduit and having openings in the wall of said other cylinder spaced from each other a distance greater than the axial length of the plunger in said other cylinder, one of said openings being disposed at the end of said other cylinder beyond the maximum inward movement of the plunger therein and the other of said openings being exposed as said plunger approaches the limit of its inward movement.

5. An overhead door checking and closing mechanism comprising a housing containing fluid and having oppositely acting cylinders and plungers therein, transmission means connected to said plungers for driving said plungers into their respective cylinders and including a lever arm for actuation by a door, resilient means in one of the cylinders normally urging the respective plunger outwardly therefrom, and means on the other cylinder for retarding the inward movement of the plunger therein; said last named means including a first fluid conduit by-passing the said plunger and terminating upon the wall of said other cylinder in an inwardly tapered groove adjacent the inner end of said other cylinder, a second fluid conduit independent of the first conduit and having openings in the wall of said other cylinder spaced from each other a distance greater than the axial length of the plunger in said other cylinder, one of said openings being disposed at the end of said other cylinder beyond the maximum inward movement of the plunger therein and the other of said openings being exposed as said plunger approaches the limit of its inward movement, and valve means in each of said conduits for independently regulating the rate of fluid flow therethrough.

6. An overhead door checking and closing mechanism comprising a housing containing fluid and having oppositely acting cylinders and plungers therein, transmission means connected to said plungers for driving the plungers into their respective cylinders alternately and including a lever arm for actuation by a door, spring means in one of the cylinders urging the respective plunger outwardly therefrom, and means on the other cylinder for retarding said inward movement of its plunger including a first conduit by-passing the said plunger and terminating upon the wall of said other cylinder in an inwardly

tapered groove near the inner end of the plunger stroke and a second conduit independent of the first conduit and having openings in the wall of said other cylinder spaced from each other a distance greater than the axial length of the plunger in said other cylinder with one of said openings disposed at the inner end of the cylinder, the other of said openings being disposed in position for communication with said cylinder when the plunger approaches the limit of its inward movement, and adjustable means in said second conduit for restricting fluid flow therethrough.

7. In a door checking and closing mechanism comprising a housing having a main cylinder and a plunger reciprocable in said main cylinder, means adapted for actuation by a door for operating said plunger, and spring means normally tensioned to resist inward movement of said piston into the main cylinder and to urge the piston outwardly from the said cylinder; a back-check means comprising a cylinder having a piston axially slidable therein and a spring normally urging the piston in the outward direction, means for limiting the outward movement of the piston from the cylinder, said piston normally projecting a predetermined distance from said cylinder and having a passage for admitting fluid therethrough to the interior of said cylinder, a check valve for closing said passage upon inward movement of the piston into said cylinder, and means for supporting said back-check means axially in said main cylinder for engagement of said piston by said plunger at a predetermined point in the inward stroke movement of said plunger.

8. In a door checking and closing mechanism having a main cylinder, a head at one end of said cylinder, a plunger reciprocable in said cylinder, means adapted for actuation by a door for operating the plunger, and a spring disposed in said cylinder between said plunger and said head for normally urging the plunger outwardly from the cylinder; a back-check comprising a support member mounted in the main cylinder head and projecting axially into the main cylinder, said support member having an axial bore therethrough, a dash-pot cylinder closed at one end and having a shank extending axially therefrom into the inner end of the bore of said support member, said dash-pot cylinder having a piston therein projecting axially from its other end for engagement by said plunger upon inward movement of the plunger in said main cylinder, and means in the bore of said support member for adjusting the axial position of said dash-pot shank therein.

9. In a door checking and closing mechanism having a main cylinder, a head at one end of said cylinder, a plunger reciprocable in said cylinder, means adapted for actuation by a door for operating the plunger, and a spring disposed in said cylinder between said plunger and said head for normally urging the plunger outwardly from the cylinder; a back-check comprising a support member mounted in the main cylinder head and projecting axially into the main cylinder, and means comprising an axial extension of said support member to engage said plunger for retarding the inward movement of the plunger beyond a predetermined point, the last named means including axially telescoping elements for trapping fluid between them and having a bleed passage for restricted escape of the trapped fluid, a resilient element normally urging axial separation of said telescoping elements, and one of said telescoping elements having an inlet passage for admitting fluid between the telescoping elements and a check valve for closing said passage when the last named means is engaged by said plunger.

10. In a door checking and closing mechanism having a main cylinder, a head at one end of said cylinder, a plunger reciprocable in said cylinder, means adapted for actuation by a door for operating the plunger, and a spring disposed in said cylinder between said plunger and said head for normally urging the plunger outward from the cylinder; a back-check comprising a support member mounted in the main cylinder head and projecting axially into the main cylinder, means comprising an axial extension of said support member to engage said plunger for retarding inward movement of the plunger beyond a predetermined point, and means for adjusting the retarding means axially of said cylinder to vary the point of engagement of the retarding means by said plunger, said retarding means including axially telescoping elements for trapping fluid between them and having a bleed passage for restricted escape of the trapped fluid.

11. In a door checking and closing mechanism having a cylinder and a plunger reciprocable in said cylinder, means adapted for actuation by a door for operating the plunger, and spring means for normally urging the plunger into the cylinder upon closing action of the door, and means for retarding the inward movement of the plunger in said cylinder and then releasing said plunger for substantially free movement under the actuation of said spring for the balance of its stroke; the last named means including a first fluid conduit by-passing the plunger and terminating upon the wall of said cylinder in an inwardly tapered groove adjacent the inner end of said cylinder, and a second fluid conduit independent of the first conduit and having openings in the wall of said cylinder spaced from each other a distance greater than the axial length of the plunger, one of said openings of said second conduit being disposed at the end of said cylinder beyond the maximum inward movement of the plunger therein and the other of said openings being exposed as said plunger approaches the limit of its inward movement, and valve means in each of said conduits for independently regulating the rate of fluid flow therethrough.

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