April 23, 1957 M. CARLSON 2,789,814

POWER ACTUATING MEANS FOR SWINGING DOOR

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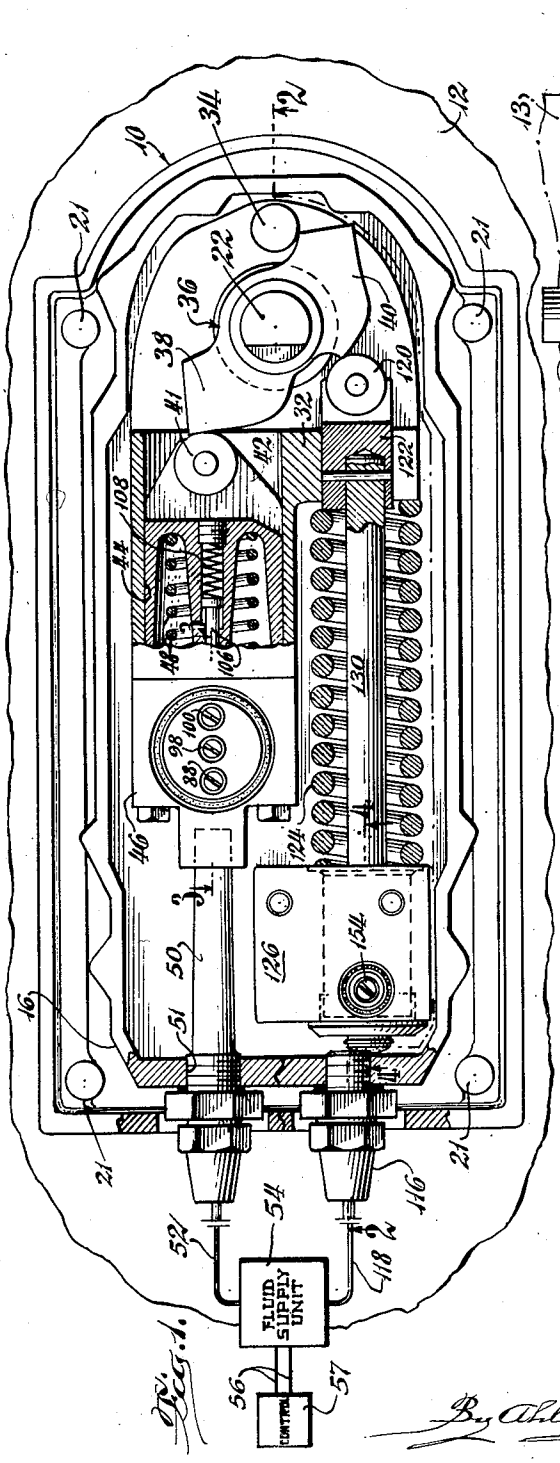

Fig. 1.

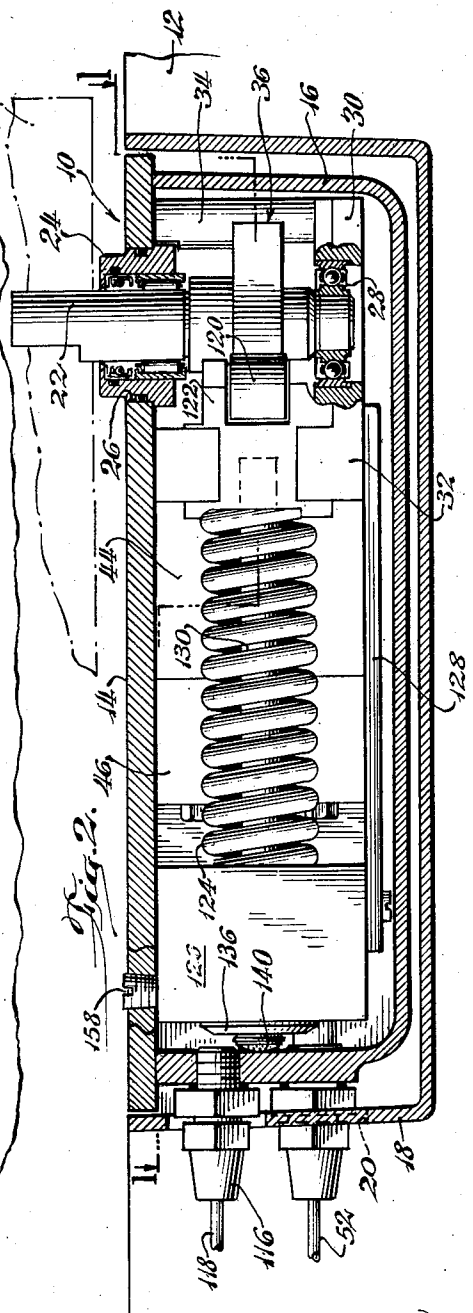

Fig. 2.

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Fig. 3.

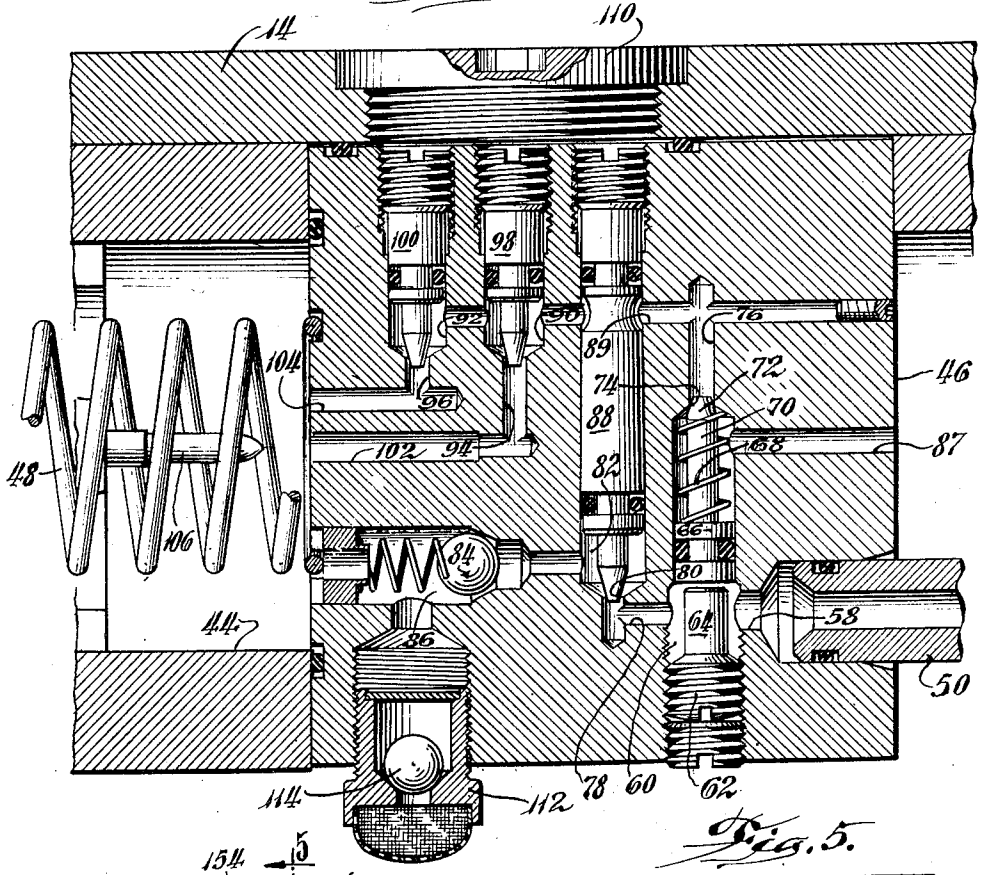


Fig. 4.

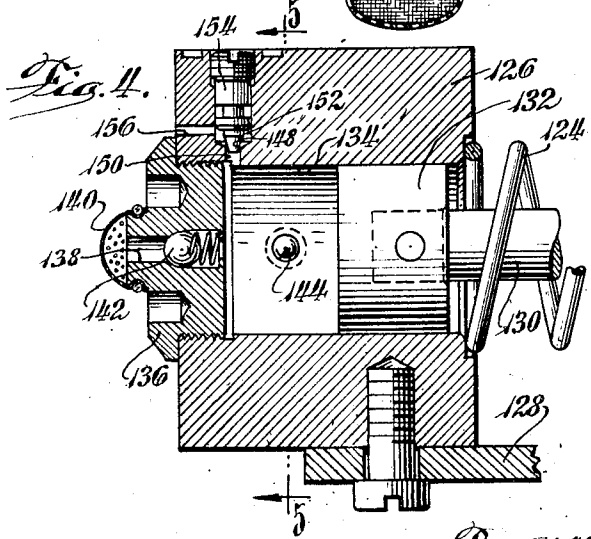
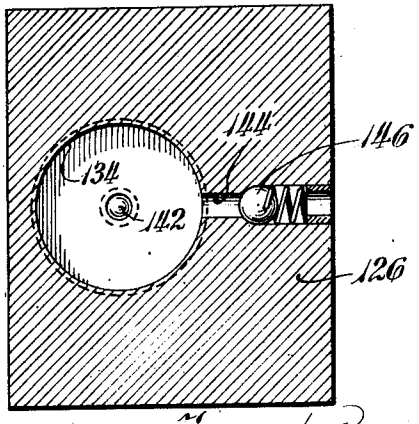


Fig. 5.



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United States Patent Office 2,789,814 Patented Apr. 23, 1957

2,789,814

POWER ACTUATING MEANS FOR SWINGING DOOR

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Application October 12, 1955, Serial No. 540,023

4 Claims. (Cl. 268—66)

The present invention relates to power actuating systems for swinging doors and more particularly to hydraulically energized door actuating units adapted to be mounted adjacent and connected to a swinging door to open the door by power supplied through the actuating fluid and then close the door mechanically. Door actuating means of this character is disclosed in the patent application of Martin Carlson on Automatic Door Operator, Serial No. 327,835, filed in the United States Patent Office December 24, 1952, now Patent 2,739,808 issued March 27, 1956.

One object of the invention is to provide an improved door actuating unit of the above character which utilizes the mechanical door closing structure of the unit and fluid of the hydraulic actuating system to check hydraulically the hydraulically energized door opening movement of the unit as it approaches an extreme open-door position.

Another object is to provide an improved door actuating unit, as recited above, which is strikingly economical and compact in construction and which provides for ready adjustment of the degree to which door opening movement is checked hydraulically as it approaches a predetermined open-door position.

Other objects and advantages will become apparent from the following description of the exemplary form of the invention shown in the drawings, in which:

Fig. 1 is a plan view of one embodiment of the invention, illustrating certain standard components diagrammatically and showing a horizontal section, taken generally along the irregular line 1—1 with reference to Fig. 2 of the door actuating unit;

Fig. 2 is a vertical sectional view of the actuating unit taken generally along the irregular line 2—2 of Fig. 1;

Fig. 3 is a fragmentary sectional view on an enlarged scale taken along the line 3—3 of Fig. 1;

Fig. 4 is a fragmentary sectional view on an enlarged scale taken along the line 4—4 of Fig. 1; and

Fig. 5 is a fragmentary vertical sectional view taken along the line 5—5 of Fig. 4.

As shown, the exemplary embodiment of the invention comprises a hydraulically energized, door actuating unit 10, Figs. 1 and 2, mounted substantially flush with the floor 12 in underlying relation to the pivotally supported vertical edge of a swinging door 13 (shown only in phantom, Fig. 2). In general the working parts of the actuating unit are mounted on base means including support structure attached to the underside of a flat horizontal top plate 14. The top plate 14 together with a sump pan 16 secured to the underside of the plate forms an enclosure for the working structure, which will be presently described in greater detail.

As shown, the sump pan 16 depends from the plate 14 into an upwardly open metal casing 18 set into a recess 20 in the floor 12. Suitable supports 21, Fig. 1, in the casing 18 extend upwardly into engagement with the lower marginal edge of the plate 14 to support the plate flush with the floor 12.

The upper end of a vertical door actuating shaft 22 extending through one end of the plate 14 is conventionally shaped to form a nonrotatable, supporting connection with a standard fitting (not shown) attached to the lower edge of the pivoted door to locate the shaft 22 concentrically with the pivotal axis of the door.

The portion of the shaft 22 passing through the upper plate 14 is journaled in a combined bearing and seal fitting 24 of a standard construction inserted upwardly into an aperture 26 in the plate.

The extreme lower end of the shaft 22 is journaled and supported by an antifriction bearing 28 capable of carrying both thrust and radial loads. Support for the bearing 28 is provided by a horizontal foot portion 30 of a support block 32 attached to the underside of the plate 14. Additional support for the free end of the support block foot 30, which extends toward the adjacent end of the sump pan 16, is provided by a vertical standard 34, Figs. 1 and 2, extending downwardly from the plate 14 and providing, as will presently appear, a convenient stop for positively terminating door opening movement of the shaft 22.

The shaft 22 is rotated in opposite directions by a butterfly cam 36 attached to the shaft 22 between the upper and lower bearings 24 and 28 and having a door opening lobe 38 and a door closing lobe 40 extending generally in opposite directions from each other.

The door opening lobe 38 of the cam 36 is engaged by a cam actuating roller 41, Fig. 1, journaled on the adjacent projecting end of a piston 42 slidably mounted in a cylinder 44. Integral with the previously mentioned support block 32, the cylinder 44 projects generally away from the cam lobe 38. The end of the cylinder 44 adjacent the cam lobe 38 is open thus permitting the piston 42 to project freely from the cylinder to hold the roller 41 in engagement with the cam lobe.

The opposite end of the cylinder 44 is closed, Figs. 1 and 3, by a ported head 46 bolted to the support block 32 defining the cylinder. A helical compression spring 48 mounted in the cylinder 44 between the head 46 and the piston 42 biases the latter to hold the roller 41, Fig. 1, continuously against the door opening cam lobe 38. The piston 42 as energized hydraulically through the head 46 and connected to the shaft 22 through the cam 36 forms a hydraulic actuator for the unit.

Operating fluid is supplied under pressure to the head 46 through a hollow stem 50 connected into the head, as shown in Fig. 3, and extending horizontally out through a threaded hole 51, Fig. 1, in the sump pan 16.

As shown schematically in Fig. 1, the outer end of the hollow stem 50 is connected by a conduit 52 to the outlet of a power operated unit 54 of conventional construction capable of supplying operating fluid under pressure. As indicated, the pressure fluid supply unit 54 is controlled electrically through wires 56 from a conventional door control 57. For a complete description of pressure fluid supply means 54 and electrical control means 56 suitable for this purpose, reference may be made to the previously mentioned patent application Serial No. 327,835. It is sufficient here to note that upon operation of the control 57 the pressure fluid supply unit 54 responds to force fluid under pressure through the conduit 52 and the stem 50 into a horizontal bore 58, Fig. 3, in the ported cylinder head 46.

From the bore 58 the operating fluid flows into a vertical bore 60 closed at the lower end by a plug 62 having an upwardly extending stem portion 64, which forms a lower stop for a piston 66 vertically slidable within the upper end of the bore 60. Normally the piston 66 is held downwardly against the stop 64 by a helical spring 68 coiled around a stem 70 extending upwardly from the piston.

The admission of fluid under pressure into the lower end of the bore 60 forces the piston 66 upwardly to engage the tapered upper end 72 of the stem 70 with an exhaust valve orifice 74 formed by the juncture of the upper end of the bore 60 with the lower end of a vertical exhaust bore 76 of smaller diameter.

Fluid in the bore 60 below the piston 66 flows through a horizontal bore 78 and an orifice 80 into a bore 82 which communicates through a one-way ball check valve 84 and a bore 86 with the chamber defined in the cylinder 44 between head 46 and the piston 42. The rate at which fluid enters the cylinder 44 and hence the speed with which the shaft 22 rotates by extension of the piston 42 is regulated by a needle valve member 88, Fig. 3, extending down through the bore 82 to coact with and vary the effective flow area of the orifice 80.

After supplying fluid under pressure to turn the shaft 22 to open-door position and hold it in that position for a predetermined period the fluid supply unit 54, operated by the control 57 as described in the previously mentioned application, Serial Number 327,835, now Patent 2,739,808, releases the pressure on the fluid supplied through the stem 50 into the lower end of the bore 60, Fig. 3. This allows the spring 68 to force the piston 66 and stem 70 downwardly to unblock the outlet orifice 74 in the lower end of the bore 76. This establishes communication between the bore 76 through the upper end of the bore 60 with an exhaust bore 87 opening out through the head 46 into the sump pan 16.

The upper end of the bore 76 connects with a horizontal bore 89 which crosses the upper end of the bore 82 around a necked down portion of the valve member 88 to connect with the lower ends of two parallel bores 90 and 92 extending downwardly into the head 46 in parallel relation to the bore 82.

The lower ends of the bores 90, 92, communicate respectively with the upper ends of vertical bores 94, 96 of smaller diameter. The effective flow area connecting the bore 94 with the bore 90 is controlled by a needle valve member 98 threadedly supported in the upper end of the bore 90. Similarly, the effective flow area of the juncture between the bore 96 and the bore 92 is controlled by a needle valve member 100 threadedly supported in the upper end of the bore 92.

The lower ends of the bores 94 and 96 join, respectively, with horizontal bores 102 and 104 which communicate with the cylinder 44. The bore 102 is disposed in coaxial relation to the cylinder 44 to receive the adjacent end of a throttling pin 106, Figs. 1 and 3. The pin 106 is slidably supported in the piston 42 in coaxial relation to the piston in such a manner that the pin is fully retracted from the bore 102, as shown in Fig. 3, when the piston is extended away from the head 46 to turn the shaft 22 to open door position. A spring 108 in the piston 42 urges the pin 106 yieldably toward the head 46 to engage the bore 102 after the piston 42 has progressed part-way from open door position toward closed door position in the cylinder 44.

During a first phase of movement of the piston 42 toward the head 46, as produced by turning movement of the shaft 22 from open door toward closed door position, fluid is expelled from the cylinder 44 through both the bores 102 and 104 to escape through the exhaust bore 87 into the oil sump pan 16. Hence, the speed at which the shaft 22 can turn toward closed door position during this first phase of its movement is controlled by the setting of the valve members 98 and 100. After movement of the piston 42 has progressed sufficiently by door closing movement of the shaft 22 to engage the pin 106 with the bore 102, fluid is exhausted from the cylinder 44 only through the bore 104 at a rate determined by the setting of the valve member 100. The result is to check door closing movement of the shaft 22 as it approaches closed-door position.

Access for adjusting the valve members 88, 98, and 100 to regulate the speed at which the shaft 22 is turned toward open-door position and at which it may be returned first at a higher speed and then at a lower speed to closed-door position is provided through a covering plug 110 threaded into the plate 14 in overlying relation to the valve members. See Fig. 3.

In the event the shaft 22 is turned toward open-door position by manual actuation of the attached door 13 fluid from the pool in the sump pan 16 enters the cylinder 44 through a screened plug 112, Fig. 3, in the lower side of the head 46 containing a check valve 114 and communicating with the fluid supply bore 86 at the downstream side of the one-way valve 84.

Fluid discharged from the cylinder head 46 maintains a pool of liquid in the sump pan 16 at a substantial level, predetermined by the vertical position of an overflow connection 116 to the pan, Figs. 1 and 2. A conduit 118 connects the overflow 116 to the fluid supply unit 54, where it is pressurized as needed to turn the shaft 22 toward open-door position as described.

In accordance with the present invention, hydraulic fluid of the system used for turning the shaft 22 by power toward open-door position and for controlling the return movement of the shaft toward closed-door position is used in conjunction with means in the unit which mechanically rotates the shaft back to closed-door position to check hydraulically the door-opening movement of the shaft as it approaches open-door position.

Structurally, the means incorporated into the door actuating unit to mechanically return the shaft 22 to closed-door position comprises a rotary cam actuator 120, Figs. 1 and 2, supported for engagement with the door closing cam lobe 40 by a reciprocable actuator guide block 122 slidably mounted in the previously mentioned support 32 for translation in parallel spaced relation to the piston 42.

The actuating roller 120 is urged hard against the door-closing cam lobe 40 by a helical compression spring 124 acting between the slidable block 122 and a cylinder block 126, Figs. 1, 2, 4, and 5 in the opposite end of the pan 16. The cylinder block 126 is attached to the plate 14 and reinforced against the spring 124 by a horizontal plate 128 fastened to both the lower side of the cylinder block and the previously mentioned support 32.

Door-opening movement of the shaft 22 works the cam lobe 40 against the roller 120 to compress the spring 124 which operates, upon relaxation of the hydraulically produced force of the roller 40 against the cam lobe 38, to turn the shaft 22 in the reverse direction back to closed-door position.

A guide stem 130 connected at one end to the slidable door-closing block 122, Fig. 1, extends through the spring 124 to actuate means within the cylinder block 126, Fig. 4, which hydraulically checks door-opening movement of the shaft 22 as it approaches open-door position. As shown in Fig. 4, the end of the guide stem 130 opposite the block 122 is pinned to a piston 132 slidably disposed within a horizontal cylinder 134 defined in the block 126.

The end of the cylinder 134 opposite the piston 132 is covered by a plug 136, Fig. 4, threaded into the block 126. A fluid inlet, axial bore 138 extending through the plug 136 is covered at its outer end by a screen 140 and shaped internally to coact with a ball check valve 142 which prevents a reverse flow of fluid from the cylinder 134 out through the inlet bore.

As shown in Fig. 2, the inlet bore 138 covered by the screen 140 is below the level of the drain connection 116 and hence covered by the pool of liquid of the actuating system contained in the sump pan 16.

In turning the shaft 22 toward closed-door position in the manner described, the spring 124 operates through the block 122 and the stem 130 to move the piston 132 away from the plug 136 thus enlarging the chamber defined by the piston and cylinder 134. Enlargement of the chamber within the cylinder 134 in this manner draws

fluid from within the sump pan **16** through the bore **138** and past the valve **142** into the cylinder.

Hydraulically energized turning movement of the shaft **22** toward open-door position in the manner described operates through the cam lobe **40** and the roller **120** to force the piston **132** toward the plug **136** to produce an outflow of liquid from the cylinder **134**. Until the shaft **22** approaches its open door position, fluid in the cylinder **134** escapes largely through an exhaust bore **144**, Figs. 4 and 5, extending from the cylinder through the block **126** at a position along the axis of the cylinder aligned with a medial portion of the overall stroke of the piston **132**. It will be noted that a ball check valve **146** in the exhaust bore **144** prevents the inflow of fluid through the bore **144** into the cylinder **134** to bypass the screen **140** during subsequent retraction of the piston **132** from the plug **136**.

As the shaft **22** approaches its open-door position, the piston **132** moves across the inner end of the exhaust bore **144** closing off this escape passage. The size of the outlet bore **144** is such that movement of the piston **132** in the cylinder **134** does not restrict, as a practical matter, the speed of door-opening movement of the shaft **22** until the bore **144** is cut off by the piston as recited.

As the piston **132** crosses the bore **144** the speed of the piston is progressively slowed hydraulically to a greatly reduced value corresponding to the rate at which fluid can escape from the cylinder **134** through a slow speed orifice **148**, Fig. 4, formed at the juncture of the upper end of a bore **150** with the lower end of a larger bore **152**. The lower end of the bore **150** communicates with the cylinder **134** immediately adjacent the plug **136**. The effective flow area of the slow speed orifice **148** is regulated by an adjustable needle valve member **154** threadedly mounted in the bore **152**. Fluid escaping through the orifice **148** into the lower end of the bore **152** is discharged through an exhaust bore **156** back into the sump pan **16**. Access for adjusting the valve member **154** is provided through an opening in the plate **14** normally closed by a plug **158**, Fig. 2.

Hence, the final phase of the door opening movement of the shaft **22** continues at a very slow speed, as determined by the rate at which fluid can escape from the cylinder **134** through the orifice **148**, until the door opening cam lobe **38** engages the standard **34**, Fig. 1, which forms a positive stop determining the extreme open-door position of the shaft **22**.

Thus, in an extremely simple, economical manner the hydraulic fluid of the hydraulic door-opening system is used in conjunction with the mechanical door closing structure of the unit to check the door-opening movement of the shaft **22** as it approaches its extreme open-door position. As a consequence, the unit is capable of swinging a door quickly between closed and open positions and checking the door in open position with no significant impact or jar on either the door actuating unit or the attached door.

While I have shown and described a preferred embodiment of my invention, it will be apparent that numerous variations and modifications thereof may be made without departing from the underlying principles and scope of the invention. I therefore desire, by the following claims, to include all such variations and modifications by which substantially the results of my invention may be obtained through the use of substantially the same or equivalent means.

I claim:

1. A hydraulically energized actuating unit for a swinging door, comprising, in combination, base means, a shaft rotatably mounted on said base means and adapted for connection with a swinging door for turning movement therewith, a power-operated hydraulic actuator connected to said shaft to turn the latter in a given door-opening direction, a reciprocable door-closing member, spring means biasing said member in one direction, means connecting said door-closing member to said shaft to transmit thereto the force of said spring means as a moment tending to turn said shaft in a door-closing direction opposite to said door-opening direction thereof and to move said door-closing member in a direction opposite said one direction upon turning movement of said shaft in said door-opening direction, a piston connected to said door-closing member, cylinder means connected to said base means and receiving said piston; said cylinder means including means coacting therewith to define with said piston a fluid chamber expandable and contractible, respectively, upon movement of said door-closing member and the attached piston in said one direction and in said direction opposite thereto; one-way valve means connected to said chamber to provide for unidirectional flow of fluid thereinto, means defining a slow-speed escape orifice connected to the end of said chamber opposite said one direction of movement of said door-closing member, an adjustable needle valve coacting with said slow-speed escape orifice to vary the effective flow area thereof, and means defining a high speed escape orifice communicating with said chamber through the side of said cylinder along the medial portion of the stroke of said piston therethrough.

2. A hydraulically energized actuating device for swinging doors, comprising, in combination, base means, a shaft rotatably mounted on said base means and adapted for connection to a swinging door, a hydraulic actuator connected to said shaft to turn the latter in a predetermined door-opening direction, door-closing means supported for movement in opposite directions, spring means biasing said door-closing means in a door-closing direction, means connecting said door-closing means to said shaft to transmit thereto force of said spring means as a moment tending to turn the shaft in a door-closing direction opposite to said door-opening direction thereof and to move said door-closing means in a direction opposite to said door-closing direction thereof upon turning movement of said shaft in said door-opening direction thereof, first hydraulic means constituting a piston, second hydraulic means constituting a cylinder receiving said piston and including means coacting therewith to define with said piston a fluid chamber expandable and contractible upon movement of the piston within the cylinder, one of said hydraulic means being connected to said base means and the other of said hydraulic means being connected to said door-closing means to expand and contract said chamber respectively upon movement of said door-closing means in said door-closing direction thereof and in said opposite direction thereof, one-way valve means connected to provide a unidirectional flow of fluid to the end of said cylinder toward which said piston moves to contract the chamber, means defining a restricted fluid escape outlet from the end of said chamber adjacent the connection therewith of said one-way valve means, and means defining a high speed fluid escape passage communicating with said chamber through the side of said cylinder along the medial portion of the stroke of said piston therein.

3. Hydraulic actuating means for a swinging door, comprising, in combination, base means adapted to be mounted below a swinging door and including means defining a sump for hydraulic fluid, a vertical shaft rotatably mounted on said base means and adapted for connection with a swinging door along the axis thereof, a door opening cam on said shaft, a hydraulic door opening actuator including a hydraulically operated cam actuator engaging said door opening cam for imparting door-opening turning movement to said shaft, means defining a fluid exhaust from said hydraulic actuator into said sump, fluid supply means connected to supply fluid under pressure controllably to said actuator, drain means connected to said sump means to return fluid from a predetermined upper level therein to said fluid supply means, a door-closing cam on said shaft, a door-closing cam follower engaging said door-closing cam, spring means

mounted to urge said door-closing cam follower hard against said door-closing cam to apply a door-closing moment to said shaft opposite to the direction of door opening movement thereof, a piston connected to said door-closing cam follower, cylinder means connected to said base means and receiving said piston to define therewith a chamber expandable and contractible respectively upon movement of said door-closing cam follower and said piston by said spring means and upon movement of said door-closing cam follower and said piston in opposition to said spring means, means defining a fluid inlet passage extending from within said sump means below said predetermined upper level into the end of said cylinder toward which said piston moves to contract said chamber, said inlet passage defining means including a one-way valve for preventing the flow of fluid out through the passage from the cylinder, means defining a slow speed exhaust orifice connected between the interior of said sump means and the end of said cylinder adjacent the cylinder end of said inlet passage, an adjustable valve member extending into proximity to said orifice to regulate the effective size thereof, and means defining a high speed exhaust passage opening into the interior of said sump means and communicating with said chamber through a portion of said cylinder traversed by said piston during a medial portion of the stroke thereof.

4. A hydraulically energized actuating device for swinging doors, comprising, in combination, base means including means defining a sump for hydraulic fluid, a shaft rotatably mounted on said base means and adapted to be connected to a swinging door, a hydraulic actuator con-

nected to said shaft to turn the latter in a predetermined door-opening direction, means defining a hydraulic exhaust from said actuator into said sump, door-closing means supported for movement in opposite directions, spring means biasing said door-closing means in a door-closing direction, means connecting said door-closing means to said shaft to transmit thereto force of said spring means as a moment tending to turn the shaft in a door-closing direction opposite to said door-opening direction thereof and to move said door-closing means in a direction opposite to said door-closing direction thereof upon turning of said shaft in said door-opening direction thereof, first hydraulic means constituting a piston, second hydraulic means constituting a cylinder receiving said piston and including means coacting therewith to define with said piston a chamber expandable and contractable upon movement of the piston within the cylinder, one of said hydraulic means being connected to said base means and the other of said hydraulic means being connected to said door-closing means to expand said chamber upon movement of said door-closing means and said piston by said spring means and to contract said chamber upon movement of said door-closing means and said piston in opposition to said spring means, one-way valve means connected to provide a unidirectional flow of fluid from within said sump into the end of said cylinder toward which said piston moves to contract said chamber, and means defining a restricted fluid escape passage into said sump from said last mentioned end of said cylinder.

No references cited.