Aug. 29, 1967 E. C. WEBB ETAL 3,337,902

DOOR ACTUATOR AND CHECK

Original Filed Nov. 23, 1962

3 Sheets-Sheet 1

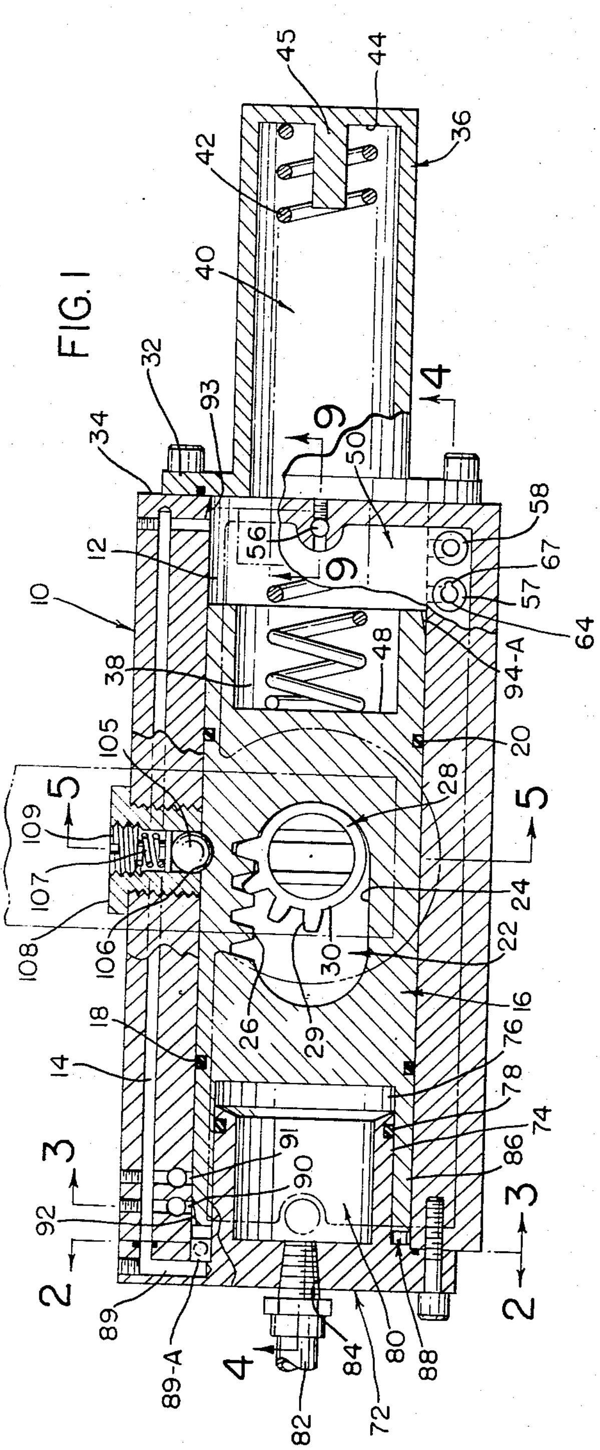

FIG. 1

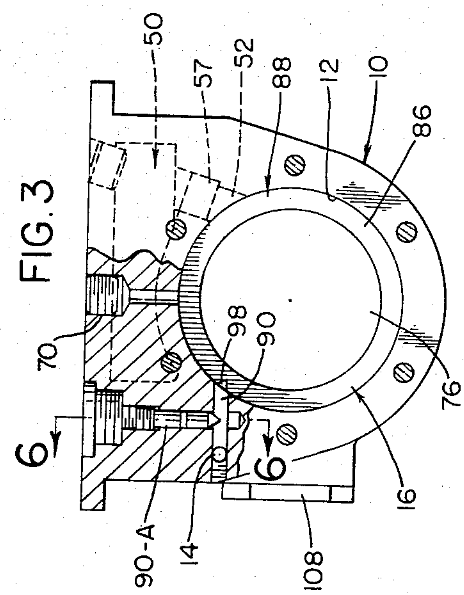

FIG. 3

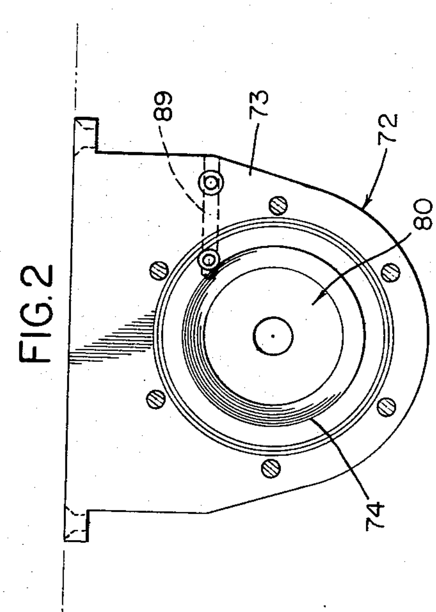

FIG. 2

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FIG. 4

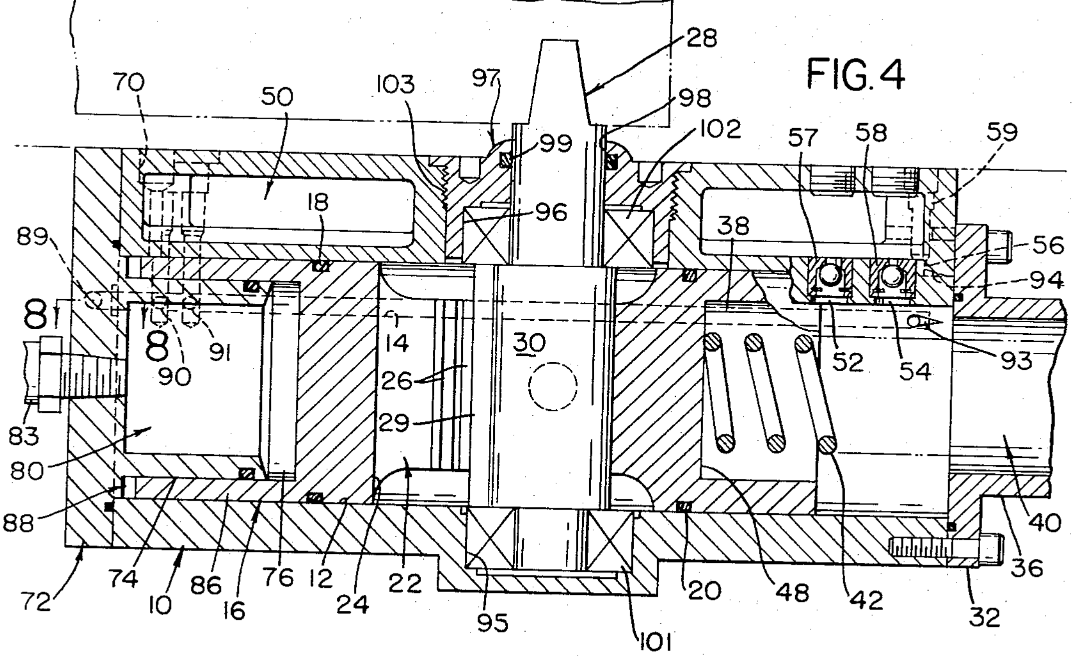


FIG. 5

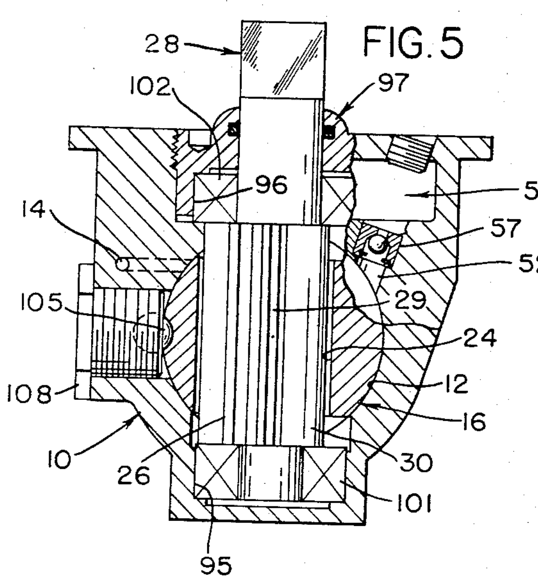


FIG. 6

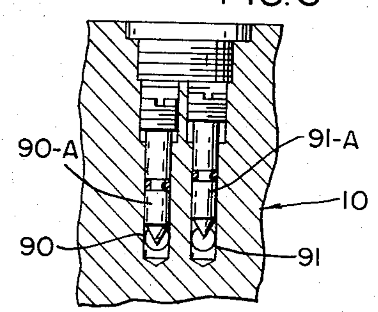


FIG. 7

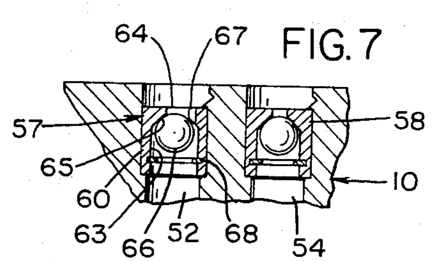
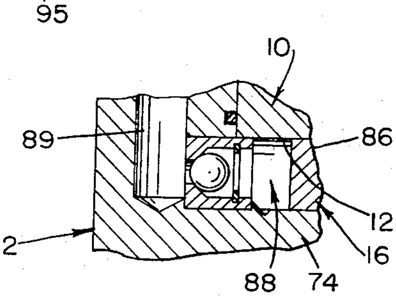


FIG. 8



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3 Sheets-Sheet 3

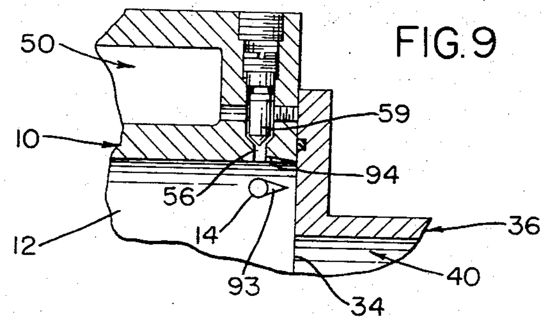

FIG.9

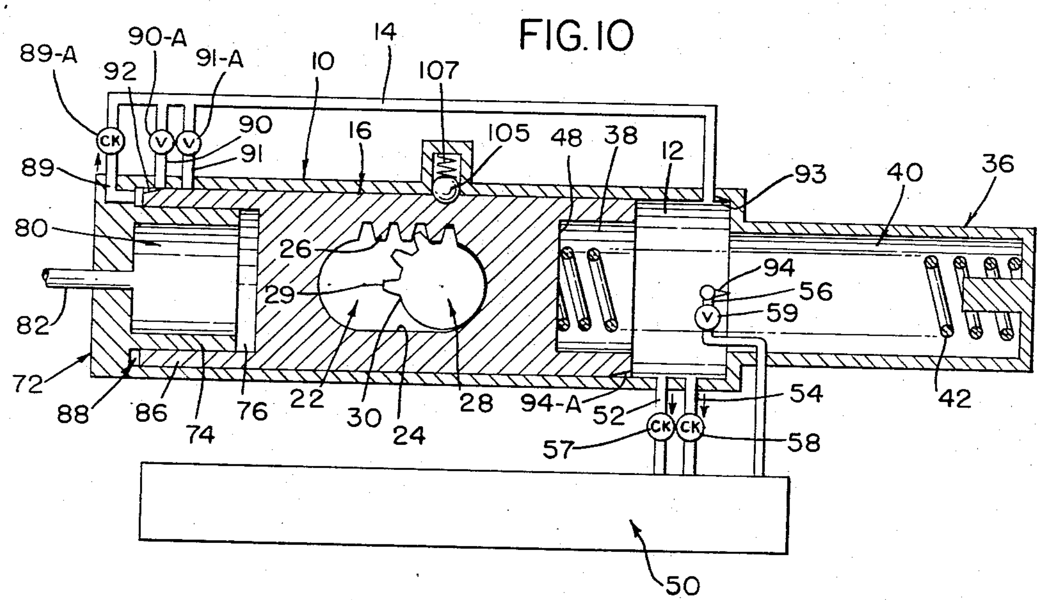

FIG.10

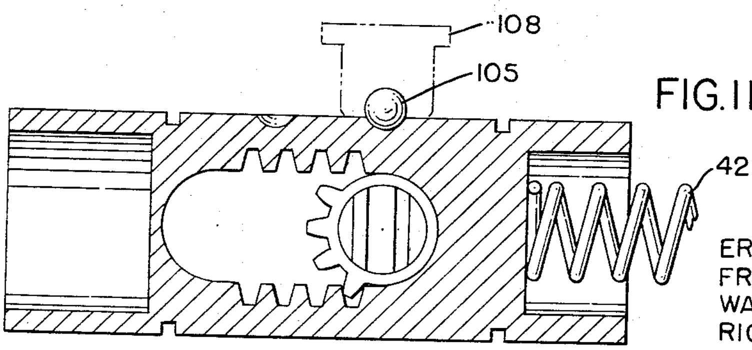

FIG.11

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Patented Aug. 29, 1967

3,337,902
DOOR ACTUATOR AND CHECK

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Continuation of application Ser. No. 239,468, Nov. 23, 1962. This application May 5, 1966, Ser. No. 554,259
17 Claims. (Cl. 16—62)

This invention relates to an improved door actuator and check for use in automatic door operator systems of the type disclosed in the United States patent application, Ser. No. 190,167, filed Apr. 25, 1962, by Frank Bond, Wallace S. Kegg, and Richard F. Moranz, now United States Letters Patent No. 3,195,879; the instant application being an improvement of said application and a continuation of United States patent application, Ser. No. 239,468, filed Nov. 23, 1962, now abandoned. In addition to being adapted for use in automatic systems, the door actuator of the invention also may be converted easily for use as a manual door check where more elaborate automatic door operator systems are not economically feasible or desirable.

The structure of the instant invention is particularly adapted for use as indicated, in view of its provision of a relatively dry spindle area which minimizes objectionable oil leaks and affords low maintenance costs.

The hydraulic actuator and check of this invention includes a metal housing having a bore in which a rack is slidably received and sealed adjacent its ends in order to provide a relatively dry central area. A pinion gear is drivingly connected to the rack between the seals in the central area and projects outwardly from the housing to provide a spindle or shaft for driving engagement with a door. A secondary or outer safety seal on the spindle is provided to prevent leakage out of the central area if an appreciable amount of fluid should leak past the rack seals into said area.

Within the housing of the door actuator is a first chamber defined by a first end of the bore and a first end of the rack adjacent thereto and a second chamber smaller than the first chamber defined by a portion of the second end of the bore and a portion of the second end of the rack adjacent thereto. A suitable flow passage is provided to communicate the first and second chambers. A third chamber, having a fixed volume, is communicated with the first chamber by means of flow passages which provide the checking action and permit adjustable rates of flow. This third chamber is an auxiliary reservoir or surge chamber which helps to maintain the proper fluid pressure in the system, in a manner to be explained, and which further acts to simplify inspection and servicing operations. A captive hydraulic fluid is provided in the said three housing chambers for flow through the various passages as the volume of the first and second chambers is varied by reciprocation of the rack.

When used as a door actuator for a system of the type disclosed in the said United States Patent No. 3,195,879, the portion of the second end of the bore not defining the second chamber and the remaining portion of the second end of the rack adjacent thereto define a fourth chamber for providing selectively controlled hydraulic pressure from the single hydraulic line of the automatic system such that flow from the system into said fourth chamber acts on the rack to move it toward the first chamber and against the force of a spring seated therein. This movement of the rack drives the pinion in engagement therewith and moves the door from closed position to open position. A ball detent arrangement is provided to hold the door in closed position against inadvertent opening by forces such as might be encountered by a strong wind against the door in a novel manner which does not interfere with the ability of the single line hydraulic system to open the door for reasons that will become apparent from the description to follow.

Upon removal of the pressure from the fourth chamber, the spring in the first chamber returns to its normal position and drives the rack and pinion in engagement therewith to move the door back to the closed position. By maintenance of the pressure in the fourth chamber, the door may be held open for a predetermined period of time as set in the automatic single line hydraulic system controls and then upon opening of the single hydraulic line to reverse flow, the spring in the first chamber forces the fluid out of the fourth chamber as the rack returns to its original door closed position while simultaneously turning the pinion to close the door.

Since the second chamber is smaller than the first chamber and communicated in the captive fluid system therewith, the fluid displaced from the first chamber is greater than that which enters the second chamber. The balance of this fluid is taken up by the third chamber which is a surge chamber or auxiliary reservoir communicated with the first chamber through check valves therebetween. These check valves permit a more rapid flow into the second chamber during door opening than the rate of flow from the second chamber which occurs during door closing. Thus, the actuator is adapted to provide faster opening and greater checking action during closing of the door. Suitable adjusting valves provide for regulating the flow through the passages and means for decreasing the speed of the movement of the rack at either end of the stroke to dampen the abrupt shock on the actuator when the door reaches the fully open or fully closed position are also provided.

One of the advantages of the actuator and check unit of this invention is that the same basic unit may be used either as a component of an automatic door operator system, as explained, or as a manual door check where more elaborate systems are not desired. Moreover, the unit may be reversed 180° for use with either right or left handed doors.

A further advantage of the invention is found to result from the use of seals on the end of the rack in a manner not heretofore known in a door operator or door check field.

In general, hydraulic door actuators have previously been designed with large areas of metal-to-metal contact between the piston and the bore such that the clearances between the wear parts have been extremely critical. These large area wear surfaces have accordingly been subject to much wear and have created oil leakage and pressure loss which has required high maintenance costs in the form of frequent adjustment of the hydraulic fluid control valves to insure maintenance of adequate pressures in the system for proper door actuating and checking action.

The present invention is specifically designed to minimize the maintenance requirements of hydraulic door checks and actuators by the novel use of O-ring seals on the rack to provide a relatively dry spindle area with a secondary safety seal beyond that to prevent fluid which may inadvertently get into the central area from leaking out and onto the adjacent floors or carpet. Moreover, the device is provided with an auxiliary reservoir of fluid to automatically compensate for small losses of fluid which may occur from slight leakage into the central area.

An additional feature of the auxiliary reservoir is that it provides for easier inspection and detection of leakage or other malfunction of the actuator because it is easy to detect from the level of the fluid in the auxiliary or surge chamber whether any appreciable amount of fluid has leaked past the rack seals into the normally dry spindle area. If such leakage has occurred, the surge chamber or auxiliary reservoir can be refilled and the actuator continue to serve without replacement for an additional period of time such as while awaiting repairs, it being noted that the secondary safety seal on the spindle is adequate for keeping any fluid which does get into the normally dry central area from leaking along the shaft and out onto the adjacent floor and carpet.

The present type of unit, when used in an automatic door operator system, may make effective use of a single line system because of the minimum leakage which occurs past the rack seals into the dry central area, thus eliminating the necessity of having two hydraulic lines to take up any leakage which might otherwise occur in the area of the spindle if it were not adequately sealed at this point.

A further significant advantage provided by the relatively dry central area is the fact that the adjustment of the checking action may be set at the factory without the necessity of extensive trial and error adjustments to obtain a proper setting during normal installation and use of the unit.

Of further importance to the accomplishment of lower maintenance costs is the fact that heavy tapered roller bearings are provided to hold the spindle firmly and prevent wobble and leaks at the secondary seal point on the spindle if any leaks through the O-ring seals on the rack should occur which permit oil to enter the dry central area. This insures that the secondary seal will remain effective during long use to prevent damage and leakage outside of the housing and prevent water from entering the housing.

The prior art door actuators and door checks have not been satisfactory because of their costly maintenance requirements due to leakage which results in a flow of oil out of the actuator along the spindle to the adjacent floor area. This leakage is both damaging to the floor or carpets in the area and requires regular adjustment to the check setting to compensate for the reduced amount of hydraulic fluid in the system.

Another disadvantage which has been inherent in the devices of the prior art has been the multitude of parts which wear and contribute to the oil leakage. Moreover, as the wearing of the parts increases, the oil leakage increases until the unit often becomes permanently damaged.

With the problems of the prior art devices in mind, it is an object of this invention to provide a door actuator and check which is of versatile design and which drastically reduces the maintenance costs which have heretofore been associated with this type of unit.

It is a further object of this invention to provide a door operator and door check having a substantially dry spindle area which minimizes oil leakage and damage to the adjacent carpets and floors.

It is a further object of this invention to provide a door actuator and door check for use in a simplified one-line hydraulic system which has an easily accessible mechanical system located in a relatively dry central area for easy inspection and replacement of the principal wearing parts.

It is a further object of the invention to provide a simple hydraulic unit which may be utilized either as an actuator in an automatic door operator system or as a manual door check with a minor conversion of the unit.

It is a further object of the invention to provide a novel door actuator and door check having an auxiliary reserve of oil to automatically fill voids in the hydraulic fluid system if minor leakage should occur by the sealing elements to thereby eliminate the necessity of frequent fluid system adjustment or replacement.

It is a further object of the invention to provide a door actuator and door check which eliminate the necessity for frequent adjustment of the checking rate of the door.

Other and more specific objects of the invention will be apparent from the description to follow.

FIG. 1 is a plan sectional view of the door actuator of this invention as used in an automatic door operator system;

FIG. 2 is a cross-section taken along the line 2—2 of FIG. 1;

FIG. 3 is a cross-section taken along line 3—3 of FIG. 1 with parts broken away;

FIG. 4 is a fragmentary section of the door actuator taken on the line 4—4 of FIG. 1;

FIG. 5 is a cross-sectional view taken along the line 5—5 of FIG. 1; with certain of the parts shown in full for clarity;

FIG. 6 is an enlarged fragmentary cross-sectional view taken along the line 6—6 of FIG. 3;

FIG. 7 is an enlarged area of FIG. 4;

FIG. 8 is a section on line 8—8 of FIG. 4;

FIG. 9 is a section on line 9—9 of FIG. 1;

FIG. 10 is a schematic flow diagram illustrating the door actuator of the invention as used in an automatic system;

FIG. 11 is a modification of the rack and pinion arrangement of the unit of the invention when used in a two-way opening door as a manual door check;

Like numerals are used to designate like parts throughout the several views of the drawing.

In FIG. 1, a hydraulic actuator for use in an automatic door operator system is illustrated which comprises a cylinder block **10** having a straight-through central bore **12** and a longitudinal flow passage **14** therein. A hydraulically driven rack **16** is slidably received in the bore **12** and sealed by means of spaced O-rings **18** and **20** mounted on the periphery of the rack **16** to provide a dry central area **22** within the bore **12**. The rack **16** is provided with a central opening **24** having a plurality of rack teeth **26** along one elongated side thereof.

A spindle member **28** is mounted in the opening **24** of the rack and has as an integral part thereof a pinion gear sector **30** for co-operative engagement with the rack teeth **26**, such that movement of the rack along the bore **12** of the housing **10** causes a rotation of the spindle **28** through the driving connection between the rack teeth **26** and the teeth of the pinion **30**. The cylinder block or housing **10** has an end **34** such that an end cap **36** having a flange **32** and an appropriate diameter to co-operate with the bore **12** may be mounted on the end **34** of the cylinder block **10**, thereby to provide a closure for the bore **12** at that end and to define in co-operation with a recessed end **38** in the rack **16** adjacent thereto a first cavity or chamber **40**.

A coil spring means **42** is provided in the chamber **40** between the end **44** of the end cap **36** and the opposing end **48** of the chamber **40** provided by the base of the recessed end or cavity **38** in the end of the rack **16**. The spring **42** acts to normally urge the rack **16** to door closed position as will be seen hereinafter and is maintained in position by the inner bore of end cap **36** or by a projection **45** extending inwardly from the end **44** coaxially with the bore **12** and the interior of the coil spring **42**.

The cavity **40** is communicated with the hydraulic system by a passage **14** which intersects the bore **12** of the cylinder block **10**. The cavity **40** also is communicated with an elongated surge chamber **50** provided in the cylinder block **10** at a location above the bore **12** when the door actuator is in its operative position. The communication between the chamber **40** and the chamber **50** is through passageways **52**, **54**, and **56** having check valves **57** and **58** and flow adjustment needle **59**, respectively, therein as shown in FIGS. 7 and 9, for instance.

The check valve frame structure **60** is seated in a counterbore and retained in said counterbore by staking or some other appropriate means. Within the check valve **57** is an elongated bore having an enlarged diameter portion **63** and a smaller diameter portion **64** joined by a tapered seat **65** upon which a valving ball **66** is seated to substantially stop flow through the passageway portion **64**. A bleed-by passage **67** is provided in communication with the bore portions **63** and **64**, however, which is not closed by the ball 66, and which permits a constant bleed-by action through the check valve 57 when needed. A suitable retaining ring or other conventional means, such as retaining ring 68, is seated in the bore portion 63 of the frame 60 adjacent the end thereof to retain the ball 66 in operative position therein for limited axial movement into and out of engagement with the tapered seat 65. The other check valves of the device are similar to check valve 57 but do not have the bleed-by passage 67.

The chamber 50 is available for filling and inspection purposes in that within the top of the cylinder block 10, when it is mounted in its operative position, is a suitable threaded and capped passage 70 which provides access to the chamber 50. The cylinder is filled and bled with the door in open position with check valves 57 and 58 and needle valve 59 in the passages to chamber 50 removed.

In the embodiment illustrated in FIGURES 1–10 of the instant application for use in automatic door operator systems of the type disclosed in U.S. Letters Patent No. 3,195,879 the end of the cylinder block or housing 10 opposite the end 34, has secured thereon an end cap 72, having on its inner face an annular flange 74 concentric with the bore 12. The flange 74 is spaced from the bore 12 radially by a distance sufficient for a portion 86 of the rack 16 to be telescopically received around the flange 74 as the flange enters an end recess 76 in the rack 16 similar to the end recess or cavity 38 on the opposite end of the rack 16. Appropriate O-ring seals 78 on the periphery of the flange 74 adjacent the inwardmost end thereof provide a sliding fluid seal with the extending portion 76 of the rack 16 telescoped thereover, thus to form a substantially leakproof hydraulic fluid retaining chamber 80 in communication with the valves and manifold (not shown) of the hydraulic door operator system by means of a single hydraulic fluid line 82 threadedly connected to the end cap 72 by means of an appropriate fitting 83 threaded in a bore 84 in the end cap 72.

It will be noted then, that the chamber 80 for receiving the hydraulic fluid from the automatic system through the line 82 occupies only the inner portion of the end of the rack 16 and that the outer portion 86 of the rack which is telescoped over the flange 74 also defines with the end cap 74 an annular chamber 88. The annular chamber 88 is communicated with the longitudinal flow passage 14 which extends through the housing 10 by means of passageways 90 and 91 having a check valve 89–A, a fine flow adjustment 90–A, and a coarse flow adjustment 91–A, respectively therein. The relative axial location of passageways 90 and 91 are such that when chamber 88 is diminished by movement of the rack 16 away from the end 34 of the cylindrical block, a deceleration movement for the rack at the final stage of the door closing stroke occurs in a manner which is explained in connection with the operation of the door actuator system of U.S. Letters Patent No. 3,195,879. Thus, a damping action is provided by the location of passages 90 and 91 during the final stages of the door closing stroke.

A like damping action is provided at the opposite end of the opening stroke by the relative locations of passages 52, 54, and 56 which also provide for increased and decreased speed of piston movement by appropriate control of the rate of flow between the chambers as the operating cycle progresses.

The passage 90 and its fine flow adjustment 90–A are continually in effect in the system by means of bleeder notch 92 in the end of the piston adjacent thereto, when the door is in closed position with the chamber 88 in its condition of smallest capacity. A bleeder notch 93 in the bore 12 intercepting the port formed by the entrance of passage 14 into said bore insures a continual communication between chamber 88 and chamber 40.

The chamber 50 and the chamber 40 are kept in slight continual communication by means of bleeder notch 94 which is on the bore 12 at the end of passage 56 adjacent chamber 40. The bleeder 94 keeps pasage 56 and its fine flow adjustment continually of effect in the system even at the extreme door open position of the piston 16 and even if check valves 57 and 58 are closed.

The bleeder notch 94–A on the piston 16 adjacent chamber 40 and aligned with passage 54, upon opening of check valve 58 during initial stages of the closing stroke, provides for an effective connection of passage 54 into the system for bleed-by of fluid from chamber 50 to the expanding chamber 40, with a resulting reduction in vacuum created in said chamber 40 by said action.

As will be seen in FIGS. 4 and 5, the dry spindle area, as provided in the illustrated embodiment, includes top and bottom bearing mounting means in the form of an annular bearing seat 95 in the opening of the cylindrical block 10 and an annular bearing seat 96 in a spindle cap provided in the top of the cylindrical block 10. Accordingly, the spindle cap 97 has in coaxial alignment therewith and in addition to the bearing seat cup 96, an annular bore 98 extending upwardly to the top of the cylinder block 10. The spindle is in tight rotatable engagement with the bore 98, and an annular seal 99 received in an appropriate groove within the bore 98 provides a secondary rotatable seal to prevent leakage of any excess fluid along the spindle which inadvertently may have entered the dry spindle area 22. The rotatable seal also prevents foreign materials from entering this chamber.

Within the bearing seats 95 and 96 are the annular tapered roller bearings 101 and 102 which preferably are of the heavy-duty type and able effectively to prevent wobble or other damaging lateral movement of the spindle 28. The provision of these heavy-duty bearings insures that the seal 99 will remain in firm engagement with the spindle 28 to form an effective secondary seal to prevent any leakage of oil which might get past the O-rings 18 and 20 into the dry central area 22.

As will be seen clearly in the drawings, the spindle cap 97 is provided in the cylinder block 10 by means of an appropriate threaded connection 103 which enables the cap 97 to be removed from the top of the cylinder block 10 so that the entire spindle and bearing structure may be inspected or removed for replacement or maintenance of the various elements. This provision is extremely significant in that inspection and replacement of the parts most exposed to wear without disturbing the hydraulic system is possible.

It will be seen that a special provision of a detent 105 in the form of a ball seated in a socket 106 in the side of the piston 16 holds the door in proper closed condition. The spring load on this detent is adjustable to provide the holding force desired. This provision insures that inadvertent forces such as might be found from wind acting on the door will not open the door even though the spring 42 is a relatively low pressure spring.

The ball detent 105 is spring biased by means of a suitable spring 107 and is held in a cap type housing or some other suitable means 108 so that it may be removed or replaced. Behind the spring 107 a pressure adjustment in the form of a threaded screw adjustment means 109 is provided so that the force of the spring may be varied to provide suitable resistance to removal of the ball 105 from the detent cavity 106 on the piston.

It has been found that by this arrangement a slow build up of relatively high wind pressure will not open the door due to the latent spring pressure of the spring 107 behind the ball 105. However, the slack in the gear teeth, upon initial actuation of the door operator by the application of pressure in the chamber 80 through the hydraulic line 82 from the manifold, acts to move the door out of the closed position by snapping the detent ball 105 out of its pocket 106 in the piston. This effect, of course, is extremely desirable in insuring tight closure of the door at all times when not in use.

Describing now the operation of the door operator when in the automatic system with the door closed and the cylinder in static position. The piston is under the forces of compression from spring **42** and seated with the surface of the central opening **24** against the pinion **30** with the ball detent **105** urged into its seat **106** by the spring **107**. As the fluid pressure increases in the line **82** from the manifold or other control unit of the system, the fluid enters the chamber **80** through end cap **72**. The captive hydraulic fluid is immediately displaced from chamber **40** through line **14**, passageway **89**, the check valve therein, and through passage **90** and bleeder **92** to chamber **88**.

Simultaneously with this flow and because the chamber **40** is also in communication with the chamber **50**, flow to the chamber **50** occurs through the passageway **52** and the bleed-by channel **67** of the check valve **57** therein and the passageway **56** at a rate which may be finely adjusted by needle valve **59** therein. When the piston approaches the limit of travel as defined by the movement of the pinion **30** within the opening **24** of the rack on this opening stroke, the passage **52** is closed and the piston movement and door movement is partially damped.

During the opening action, the check valve **58**, under the pressure within chamber **40**, keeps the passageway **54** closed. In the final stages of opening, the damping action is further increased by substantial closing of the passageway **56** except for its bleed-by passage **94** and adjacent bleed screw **59**. As the piston comes to rest with the surface of the opening **24** against the pinion **30**, the bleeder **93** is open to communicate the chamber **40** and the passage **14** and bleeder **94–A** maintains passageway **54** open slightly to communicate chambers **40** and **50** therethrough. The door actuator is maintained in this condition until the closing cycle begins.

The door closing operation begins when pressure is released from line **82** and the chamber **80** such that the compressed spring **42** may return the piston to its original static position. As the closing stroke starts, the fluid is displaced through lines **90** and **91** into passage **14** and back to the chamber **40**. The check in passageway **89** is closed during this portion of the cycle.

At the opposite end of the device the passageway **56** permits flow from the reservoir **50** into the chamber **40** through the bleeder **94**. Also permitting flow from the reservoir or chamber **50** is the bleeder **94–A**, since the check **58** opens and connects passageway **54** to the chamber **40** therethrough. Further opening of the door, as the cycle continues, opens the check **57** so that flow through the passageway **52** can occur. The function of the passageway **54** and check valve **58** in the device is apparent only in the closing cycle and will be seen to provide for the elimination or reduction of a vacuum in the chamber **40** as the piston advances toward the closed position.

As the piston opening **24** approaches the pinion **30** and the door is almost closed, the passageway **91** is closed off damping partially the piston movement and the door closing action. As the end of the piston then passes the mouth of the passageway **90**, the piston movement is further damped; and the piston comes to rest against the spindle with only the bleeder notch **92** in the piston leaving communication between the chamber **88** and the chamber **40** through the adjustable needle valve **90–A** in passage **90**. At this time, the ball detent **105** seats in its pocket **106** in the piston and the entire actuator or mechanism is static until the force required to release it is again exerted, in a manner previously explained.

FIG. 11 illustrates schematically how the described door actuator may be converted for use as a manual door check. The spring **42** holds the door with the detent **105** in one of two detent pockets, one for the open position and one for the closed position. The detent action is similar to that described in connection with the automatic door actuator embodiment; however, in this instance, the snapping force which takes up the slack in the gear teeth is accomplished by a quick push on the door picking up

the slack. It has been found that by adjustment of the spring pressure, the required opening force may be varied as desired, for particular applications of the manual check. The entire checking action and hydraulic fluid system of the manual door check acts as described in connection with the automatic device except that there is no fluid other than the captive fluid in the system, and there is no connection via a line **82** to a manifold or pressure supply system. The flange **74** of end cap **72** is omitted and cavity **88** is thus enlarged to include cavity **80** and the space occupied in the automatic arrangement by flange **74**. The force exerted by the increase of pressure in the chamber **80** in the automatic device is provided in this embodiment manually by pushing the door when the check is used in this manner.

The illustrated check of FIG. 11 is for use where the manual single piston door check is to be swung in either direction although when a rack such as illustrated in connection with the automatic door actuator is used with teeth on only one side of the opening **24**, the device may be utilized for a manual door check to swing in one direction only by merely increasing the clearance at the opening end of piston cut out **24** to permit a door opening of approximately 105°, instead of 90°.

It has been found that this manual use of the device is extremely efficient because the spring pressure acts to close the door completely and the detent mechanism acts as a latch to hold the door closed until the door has a rapidly applied force thereagainst to snap it open and to thereby pop the detent ball **105** out of its seat **106** on the piston. A slowly applied load such as would be occasioned by wind pressure against the door would need to be several times the magnitude of the load which, if applied by a sudden push on the door, would open the door against the spring biased detent therein. This is true because of the use of the inertia of the door and slack in the gear teeth to create the snapping action to move the detent.

For ease of description, the principles of the invention have been set forth with but a single illustrated embodiment showing one convenient form the invention might take. It is not our intention that the illustrated embodiment, nor the terminology used in describing it be limiting inasmuch as variations may be made without departing from the spirit of the invention. Rather, we desire to be restricted only by the scope of the presented claims.

The invention claimed is:

1. A hydraulic device which includes:

a housing having a bore,

an elongated piston having a portion defining a rack slidably received in said bore and sealed by means of seals located adjacent each end of said rack to define a substantially dry central area intermediate the limits of movement of said piston within said bore,

a pinion gear drivingly connected by interengaged teeth to said rack between said seals in said substantially dry central area,

a first chamber defined by a first end of said bore and a first end of said piston adjacent thereto,

a second chamber defined by a portion of a second end of said bore and a portion of the second end of said piston adjacent thereto,

a flow passage exterior of said bore communicating said first and second chambers,

a surge chamber having a fixed volume communicated with said first chamber and located above said first chamber,

a captive fluid in said chambers which flows through said passage as the volume of said first and second chambers is varied by reciprocation of said piston,

said piston being maintained in an initial position of rest at one of said limits of movement by a detent means in engagement with said piston at a location within said substantially dry central area,

said pinion gear drivingly connected to a shaft projecting out of said substantially dry central area such that when a rotational force is applied suddenly to said shaft initially, slack in the engaged teeth will act on the piston to snap the detent means out of the piston retaining position, but when a rotational force is applied gradually to said shaft initially, the slack is slowly taken up and a greater force is required to move the detent means out of the piston retaining position.

2. The device of claim 1 in which said portion of the second end of said piston is the entire end.

3. A hydraulic device which includes:

a housing having a bore,

an elongated piston slidably received in said bore for reciprocation between two limits of movement,

a rack longitudinally disposed on said piston,

a pinion gear drivingly connected by interengaged teeth to said rack between the ends of said piston,

a first chamber defined by a first end of said bore and a first end of said piston adjacent thereto,

a second chamber defined by a portion of a second end of said bore and a portion of the second end of said piston adjacent thereto,

a flow passage exterior of said bore communicating said first and second chambers,

a surge chamber having a fixed volume communicated with said first chamber and located above said first chamber,

a captive fluid in said chambers which flows through said passage as the volume of said first and second chambers is varied by reciprocation of said piston,

said piston being maintained in an initial position of rest at one of said limits of movement by a detent means in engagement with said piston,

said pinion gear drivingly connected to a shaft rotationally mounted transversely to said bore such that when a rotational force is applied suddenly to said shaft initially, slack in the engaged teeth will act on the piston to snap the detent means out of the piston retaining position, but when a rotational force is applied gradually to said shaft initially, the slack is slowly taken up and a greater force is required to move the detent means out of the piston retaining position.

4. The hydraulic device of claim 3 in which said piston is maintained in a position of rest at a second one of said limits of movement by said detent means when said piston is at said second limit of movement.

5. The hydraulic device of claim 3 in which the second chamber is smaller than said first chamber.

6. The hydraulic device of claim 3 in which the shaft has its projecting end drivingly connected to a door and a sealing means prevents flow of fluid along said shaft between the ends thereof.

7. A door check which includes:

a housing having a bore,

a piston having at least one closed end slidably received in said bore and defining therewith a substantially dry spindle area,

spindle means drivingly connected to a door and mounted in said spindle area for rotatable motion in response to the motion of said piston,

a first fluid chamber adjacent a first end of said piston,

a second and smaller chamber adjacent a second end of said piston,

a third chamber located above said first chamber,

passages exterior of said bore interconnecting said first chamber with said second and third chambers such that captive fluid flows through said passages as the volume of said first and second chambers varies and the chambers are so connected that the fluid level in said third chamber will vary with different positioning of said piston.

8. A door check which includes:

a housing having a bore,

a piston slidably received in said bore and defining therewith a spindle area,

spindle means drivingly connected to a door and mounted in said spindle area for rotatable motion in response to the motion of said piston,

a first fluid chamber adjacent a first end of said piston,

a second and smaller chamber adjacent a second end of said piston,

a third chamber located above said first chamber,

passages exterior of said bore interconnecting said first chamber with said second and third chambers such that captive fluid flows through said passages as the volume of said first and second chambers varies and the chambers are so connected that the fluid level in said third chamber will vary with different positioning of said piston.

9. The door check of claim 8 in which branch passages are included in communication with the bore and the interconnecting passages in locations to insure that the piston motion is damped in the final stages of motion in either direction by means of automatic changes in the capacity of the flow passages utilized for flow of the captive fluid between the chambers.

10. The door check of claim 8 in which detent means are included in said bore for engagement with said piston which act to require a greater force to initially move said piston than is required to keep it in motion once it is moved past the detent.

11. The door check of claim 8 in which the capacity of said flow passages utilized for flow of captive fluid between the chambers may be adjusted manually to vary the rate of flow between the chambers.

12. The door check of claim 8 in which the piston has a spring normally biasing it into door closed position.

13. The door check of claim 12 which is also a door operator because said check includes a fourth chamber located adjacent said second end of said piston and sealed from said interconnecting passages and said other chambers such that the motion of the piston is in response to pressure changes created in said fourth chamber.

14. A hydraulic device which includes:

a housing having a cylinder,

a piston having at least one closed end mounted for reciprocating movement within said cylinder,

and said piston having two distinct fluid systems acting on said closed end one of which fluid systems includes a chamber which is located adjacent said one end of said piston such that the piston moves in response to an externally created increase in pressure in said chamber against a spring abutting the opposite end of said piston the other of which fluid systems is in communication with the cylinder on the opposite end of said piston.

15. The device of claim 14 in which a single fluid conduit is in communication with said chamber to transmit said externally created pressure.

16. The device of claim 14 in which said cylinder has a substantially dry central area intermediate the limits of movement of said piston within said cylinder.

17. The device of claim 16 in which a single fluid conduit is in communication with said chamber to transmit said externally created pressure.

References Cited

UNITED STATES PATENTS

810,634	1/1906	Flather	279—76 X
1,500,277	7/1924	Selker	188—88
2,491,375	12/1949	Hardy	92—68
2,790,991	5/1957	Schlage	16—62
2,893,725	7/1959	Katz	60—52
3,087,720	4/1963	Catlett	16—62 X

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