July 10, 1962 M. CARLSON 3,043,277

HYDRAULIC DOOR OPERATOR SYSTEM AND CONTROL MEANS THEREFOR

Filed July 20, 1960

FIG. 1

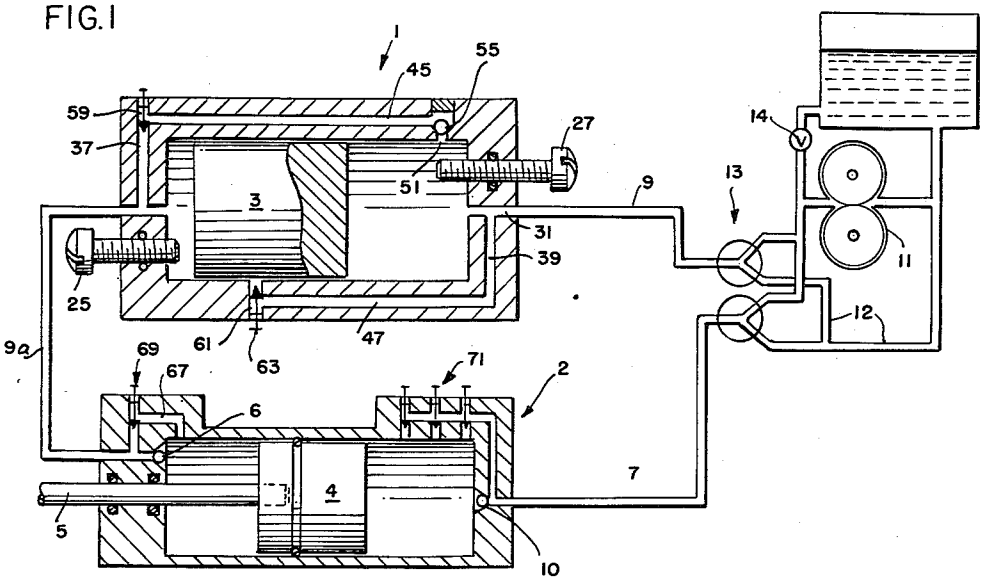


FIG. 2

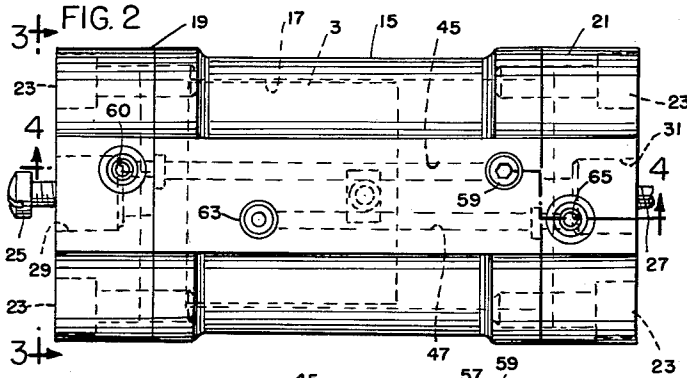


FIG. 3

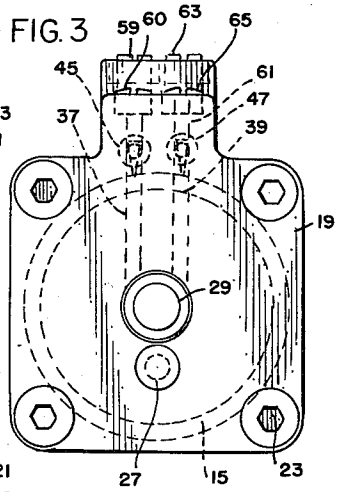


FIG. 4

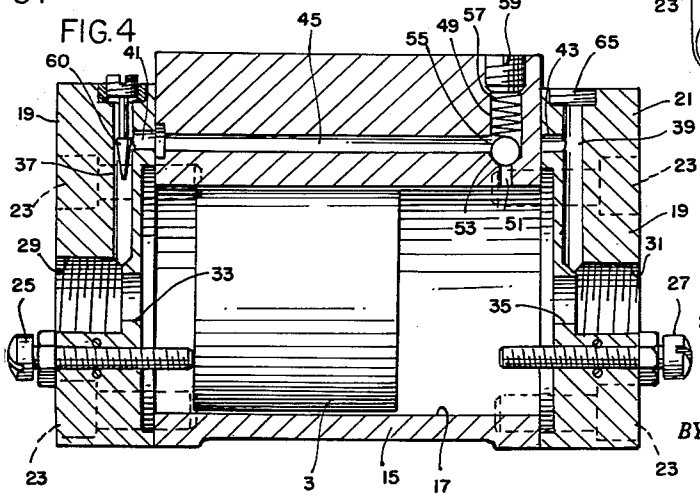
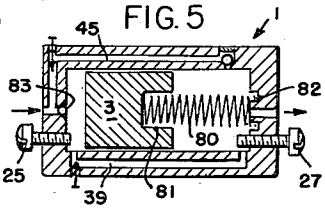


FIG. 5



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HYDRAULIC DOOR OPERATOR SYSTEM AND CONTROL MEANS THEREFOR

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12 Claims. (Cl. 121—44)

This invention relates to an improved hydraulic door operator system and an improved control device for such a system which permits positively powered movement of the door into the full opened position without racking, and which permits subsequent reactuation of the system to open the door without pause regardless of the phase of the normal door closing movement in which reactuation occurs.

This invention is particularly directed toward solving one of the more troublesome problems which has heretofore been believed to be a necessary incident of using automatic hydraulic door operator units. A typical example of such a unit is one which moves the door into the open position in response to stepping on an approach mat and which moves the door to the closed position in response to stepping off the usual safety mat on the other side of the door.

In such units, the control of door movement is often regulated to actuate a pump which exerts fluid pressure on the appropriate side of a power piston within a power cylinder. In the evolution of such door operators the positive hydraulic opening push was originally operative throughout the entire opening cycle of the door and until the door forcefully hit a suitable stop at the fully open position of the door, causing the door to be racked, often damaging the door and door mounting, as well as producing undesirable noise and strain on the operating mechanism.

One attempted solution of this problem was to provide an internal switch which would shut off the hydraulic power when the door was opened approximately sixty five degrees to permit the door to coast or decelerate into the fully open position, to obviate all racking and strain and yet provide for fast opening action. While this was quite effective in preventing racking, it was soon discovered that a heavy wind condition often opposed the terminal coasting movement of the door into the full open position, causing the door to come to a premature stop in a partially open position and providing an objectionably reduced door opening through which to pass.

Therefore, it is a primary object of the present invention to provide a hydraulic door operator system which permits the door to rapidly open and yet decelerate at the terminal portion of opening movement while under full power so as to effectively assure complete door opening at all times without shock or strain.

Further, in doorways subjected to heavy use, it quite frequently occurs that a second entrant will step upon the approach mat and reactivate the operator for opening movement of the door before the door has fully closed behind the first entrant. However, where no power is applied to the door during the terminal portion of door opening movement such reactuation frequently provides insufficient power to open the door completely due to the internal cut-off switch previously mentioned. Thus the second user is frustrated in his attempt to proceed through the door at his normal gait.

Therefore, it is a further object of this invention to provide a hydraulic door operating system which permits the door to rapidly open yet decelerate into the fully open position while under power to assure complete door opening at all times and which permits subsequent reactuation during any portion of the door closing cycle to positively move the door to the fully open position, thereby

permitting subsequent users to maintain their normal walking gait.

Further objects of this invention are to provide an improved buffer means for controlling fluid power actuation of the door and which includes adjustable control means for precisely controlling the speed of the door during the terminal portion of the opening movement; and further to provide a buffer control device adaptable for inexpensively modifying existing hydraulic door operator systems to achieve the aforementioned advantages, which device is inexpensive to manufacture, relatively simple in construction and which has a minimum number of moving parts.

Other objects and advantages of the instant invention will be apparent from the following description and the specific embodiment of the invention shown in the accompanying drawings in which:

FIGURE 1 is a schematic side elevational view in cross section of the improved hydraulic door operator system;

FIG. 2 is a plan view of the buffer device;

FIG. 3 is an end elevational view of the buffer device shown in FIG. 2, looking forwardly from the arrows indicated at 3—3 in FIG. 2;

FIG. 4 is a cross sectional view of the buffer device taken substantially on the plane of line 4—4 of FIG. 2; and

FIG. 5 is a schematic cross sectional view of a modification of the buffer device.

The hydraulic actuating system shown in FIGURE 1 is a conventional closed circuit, or fluid filled system with the exception of the inclusion of the buffer device shown generally at 1 which significantly modifies the operation of the system to achieve the desired purpose.

The system comprises a conventional fluid powered door operator 2 such as that shown in my Patent No. 2,869,861, or one which includes at least one reciprocating power actuated piston 4 having a connecting rod 5 for moving a pivoted door to and from the open and the closed positions. A first fluid line 7 and a second fluid line 9—9*a* are connected to opposing ends of the door control cylinder 2 and fluid under pressure is selectively forced through the appropriate line by means of a suitable pump 11 to move the door to the open or to the closed position. The pump 11 may be of the reversible type, such as that described in my Patent No. 2,927,-429, or a unidirectional type as shown in which case solenoid operated control valves 13 control the selection of the fluid line through which the pump is to effect pressure, to cause closing or opening of the door, as well as a suitable one of the return lines 12. These conventional control valves, as well as the pump 11, may be actuated by any appropriate well known door operator control system having means, such as a door mat or electric eye, adapted to complete a circuit automatically when a person approaches the door to pass through. It is to be noted from FIGURE 1 that, as shown, the pump, the fluid storage and expansion reservoir system, and the pressure relief valve 14 are conventional also.

Thus the conventional hydraulic door operator system operates as follows: When a person steps on an actuating mat when approaching the door the solenoid valve 13 causes the pump 11 to exert fluid pressure through line 7, causing piston 4 to move from right to left, connecting rod 5 being connected to an appropriate spindle mounted on the door to cause said door to swing to the open position. When the door reaches the open position, internal switching means, not shown, in the door operator (see Patent No. 2,869,861) stops the pump 11 and temporarily holds the door in that position until the user steps off the exit safety mat at which time the control means actuates solenoid valves 13 to permit the pump 11

to exert fluid pressure through fluid line 9—9*a* to move the piston 4 from left to right, to return the door to the closed position.

It is seen from this description, that the only control over the treminal portion of the door opening movement is provided by the limiting or stop switch included in the door operator mechanism. In other words, if the limiting switch is set to stop the pump, or cut-off flow of pressure fluid to the operator, when the door reaches the terminal position, then power is applied to the cylinder 4 throughout the entire opening movement stroke causing the door to bang into the open position. However, if the limiting switch is positioned so as to stop the pump 11 when the door reaches the sixty-five degree angle of opening, then, the momentum of the swinging door will carry it into full open position, unless, of course, the door is opposed in some manner.

However, if such a deceleraiton scheme is used, and a second entrant approaches the door at any time during movement of the door toward the closed position, the external actuating means will not complete the actuating circuit to the pump due to the open internal switch in the operator and the door will continue to move toward the closed position until it reaches the sixty-five degree open position. Thus, not only would the continued closing movement of the door necessitate the entrant's breaking his normal gait, but also, when the door had reached a position causing completion of the circuit, power would be applied for only a relatively short time in the opening direction, or until the door again passes the sixty-five degree open position. At that point the opening of the limit switch would terminate power actuation before sufficient momentum had been built up by the movement of the door to carry it to the fully open position.

It will now be seen from the foregoing description that a conventional hydraulic door operator system has two severe apparently conflicting problems; namely, providing positive power control of the opening movement of the door until it reaches the completely open position, and secondly, providing for the immediate ecective reactivation of the door operator, during the closing movement, whenever that may be required. In conventional systems it has previously been impossible to solve both problems, with the result that such systems either provide a door which will be subjected to racking at the completely opened position, or a door which will not achieve the fully opened condition when resisted by various forces or when reactivated prior to the door's achieving a substantially completely closed position.

In order to provide a hydraulic door operator system free from these defects, the instant invention teaches the use of a closed buffer, or control device 1, connected serially within the fluid line 9—9*a* leading between the pump 11 and the closing side of the door operator 2. It is to be noted that a buffer assembly may be installed in both fluid lines 9 and 7 if desired. However, in the embodiment shown in FIG. 1 the buffer assembly 1 is included only in the line 9 on the closing side of the operator 2. Further, the buffer means can be used with conventional two piston operators of the kind shown in FIG. 6 of my Patent No. 2,869,861.

Although shown diagrammatically in FIG. 1, FIGS. 3 to 4 inclusive, show a particular embodiment of the buffer device to be preferred for most installations where the device is employed as an accessory. In these figures it is seen that the buffer unit comprises a cylinder body 15 formed with a longitudinally extending bore 17 which is closed at each end by means of end plates or heads 19 and 21 which are bolted thereto by bolts 23. A piston 3 is mounted for free reciprocation within the bore 17. Longitudinally extending adjustment screws 25 and 27 threadably received in the end caps or heads 19 and 21, respectively and extending interiorly into bore 17, are provided to effectively terminate the free piston movement at each end of bore

travel and to adjustably determine the length or stroke of piston movement. Further, the end caps 19 and 21 are practically identical in construction and are provided with threaded bores 29 and 31 axially aligned with bore 17 and which receive the respective ends of the fluid pressure line in which the device is installed.

The threaded cap bores 29 and 31 terminate in counter bores 33 and 35 respectively leading to the interior of the cylinder 15. Further, each end cap is provided with an axially offset vertically extending bore 37 and 39 extending to the top of the cap and from which a communication bore 41 and 43 (see FIG. 4) extends perpendicularly toward the adjacent cylinder end.

The upper portion of the cylinder block 15 is formed with two longitudinally extending laterally spaced by-pass bores 45 and 47 respectively. Longitudinal by-pass bore 45 is aligned with and communicates with bore 41 in cap 19. Correspondingly, one end of bore 47 communicates with bore 43 in the cap 21.

In order to complete what we will hereafter call the second by-pass, a vertical bore 49 is provided in the cylinder block 15, which bore extends downwardly across the bore 45 to a counter bore 51 of smaller diameter communicating with the interior of the cylinder 17. It is to be noted that the counter bore 51 is provided near the end of the cylinder block adjacent end cap 21. Further, the juncture of counter bore 51 with longitudinal bore 45 is formed with a frustro-conical seat 53 for check valve ball 55 held in closing position thereagainst by spring member 57 which abuts a closure plug or cap 59 threaded into the outer end of the bore 49. A needle valve 60 inserted downwardly in bore 37, across its junction with communicating bore 41, serves to adjustably control the rate of flow of fluid through the second by-pass.

To complete what will hereafter be called the first by-pass, a second vertical bore 61 is provided extending downwardly in cylinder block 15 and across passage 47 into the interior of cylinder bore 17. The precise location of this bore 61 in relation to the ends of the cylinder bore 17 will be described hereafter in greater detail, since its location is essential to the proper functioning of the device. A needle valve 63 extends downwardly into bore 61 across its intersection of passage 47 and can be adjusted to control the rate of fluid flow through the first by-pass. As shown the cap bore 39, with which the passage 47 communicates, has its outer end closed by a plug 65.

The piston 3 may be described as a free piston inasmuch as it is not secured to piston rods nor is its motion utilized by anything external of the buffer cylinder 1 per se. Indeed the movement of the piston 3 is mainly for the purpose of controlling the passage of fluid through fluid line 9—9*a*, on the closing side of the operator 2, as will be described. The piston 3 is cylindrical and fairly elongated as is best seen in FIG. 4 in order to provide sufficient surface to effect efficiently its controlling function.

In operation, the subject hydraulic operator system functions as follows: The solenoid controlled valves 13 are appropriately actuated by external means, not shown, such, for example, as a person walking through an electric eye device or a person stepping upon a control mat, immediately before approaching a door. The solenoid controlled valves 13 connect the first fluide line 7 with the pump 11 and the second fluid line 9 with a return line 12, leading to the reservoir or suction side of the pump, so that the pressure of the pump forces fluid through line 7 and past ball check valve 10. It is to be noted that piston 4 will be at the right hand end of the operator cylinder 2, as seen in FIG. 1, when the door is in the closed position. Thus, the fluid entering into the cylinder 2 under pressure from the line 7 forces the piston 4 from right to left as viewed in FIG. 1 pushing the fluid normally in front of the forwardly moving piston out through outlet control passage 67, appropriately controlled, for the

desired initial door opening speed by a needle valve **69**, through fluid line **9***a* directly into the left end of the buffer unit cylinder **1**. As the fluid enters into the left end of buffer cylinder **1** the free piston **3** therein is moved from left to right as viewed in FIG. 1 in a manner producing relatively little impedance to the fluid flow and hence to the movement of the operator piston **4** toward the open door position. The buffer unit piston **3** is moved from left to right by the fluid displaced from the operator cylinder **2** by the piston **4** until it contacts the adjustment screw stop **27** when the door has been moved a predetermined distance, for example approximately forty-five degrees, from the closed piston. The length of the buffer piston **3** is made such that prior to its engaging stop **27** the vertical first by-pass bore **61** is exposed and thus, when piston **3** engages stop **27** the fluid is metered thereafter into the longitudinal bore **47** of the first by-pass, by the needle valve **63**, to retard the rate of fluid flow and thereby slow the movement of the operator piston **4** and of the door for the balance of movement to the fully opened position of the door.

During such movement of the piston **3**, from left to right in FIG. 1, no fluid can by-pass the piston **3** until the bore **61** is uncovered, the check valve **55** in by-pass **45** serving to keep the passage **45** closed against fluid pressure from the line **9***a*. The opening of the bore **61** into the buffer cylinder **15** thus must be located, relative to left hand end of the cylinder as shown in FIG. 1, so as to be within the area of the wall of piston **3** until the piston **3** has moved at least a major portion of its travel from its extreme left hand position toward its position at the 45° or half-open position of the door. The reason for this is that the by-pass **47** is intended to be effective only between the half-open and full open positions of the door and only during opening movement of the door.

This arrangement provides that, while full driving power will be applied to the door during its entire movement to the completely opened position, a materially decreased rate of movement will occur during the terminal portion of door opening action, thus preventing slamming and racking of the door at the fully opened position. Also, the adjustable stop **27** permits the speed control to be applied for any portion of door opening movement, between 45° and full open, that may be desired.

As the operator piston **4** moves to the end of the door opening stroke, a limit switch, not shown but previously mentioned, stops the motor driving pump **11** to terminate all application of pressure to fluid line **7**. The door is then held in the open position until the return or closing movement is appropriately actuated.

The actuation of the return movement is automatic, as described in my before mentioned Patent No. 2,869,861, limited only by a holding or safety means, such as an electric foot mat located on the other side of the door through which the person is passing. This safety feature is a commonly used expedient and forms no part of my present invention. Actuation of the return movement control means, not shown, will then cause solenoid controlled valves **13** to be reversed and cause the pump **11** to be actuated to provide the fluid pressure through fluid line **9**, line **7** then serving as a return line. The fluid is forced through fluid line **9** and into the right hand end, or passage **31**, of the buffer cylinder and the free piston **3** is pushed from right to left as viewed in FIG. 1. Simultaneously, this fluid pressure pushes upwardly on check valve ball **55** permitting relatively free fluid flow through the second by-pass bore **45**, bore **37**, line **9***a* and past ball check valve **6** and into the cylinder of the operator **2**. The rate of flow through the second by-pass **45** may be controlled by the needle valve **59**. However, under ordinary conditions such control is not needed.

Because of the relatively free flow of fluid through the second by-pass **45**, the movement of the buffer unit piston **3** from right to left, will be relatively slow as compared to the travel of the operator piston **4** on its door closing stroke. For this reason the piston **3** will not close off the first by-pass inlet **61** until the door has at least passed beyond the half open position in the closing direction. Thus, upon reactivation of the hydraulic operating system, for opening movement of the door, at any time prior to the time the door reaches the completely closed position, the buffer unit will permit immediate full application of power for movement of the door toward the full open position but at a positively controlled reduced speed during the terminal portion of opening movement, the piston **3** being again returned to the stop **27** permitting controlled by-pass of fluid through the first by-pass port **61** and passage **47** to pump **11**. Since the rate of flow through this by-pass is adjustably controlled by needle valve **63**, the door will continue moving under full driving power into the completely open position at a reduced rate of speed which may be determined to permit the user to continue his normal walking gait.

It is to be noted that most door operators, as for example, that operator shown diagrammatically in FIG. 1 at **2**, include adjustable control means **71** to control the speed of the movement of the door during the terminal portion of the closing cycle. This is to permit a rapid closing speed for a major portion of the closing movement and a controlled reduction of speed just prior to reaching the latching position so that the door will not slam shut.

The modified form of the buffer device shown in FIG. 5 is intended for use with door operators and door operator systems wherein the flow of fluid under pump pressure is in one direction, i.e. to drive the door operator in the door-opening direction only, the return of fluid to sump or reservoir being by way of a separate line. In such cases a separate means, other than the flow of pressure fluid, is needed to return the buffer unit piston to its starting position for driving fluid pressure regulation in the door opening operation.

As shown in FIG. 5 the return of the buffer unit piston, upon completion of the door opening operation and after driving pressure from the pump has been closed off, is accomplished by means of a compression spring **80** interposed between the forward end of the buffer piston and the forward end of the buffer cylinder, the buffer unit in such cases being located in the pressure supply line between the pump and the door operator piston. As shown the spring **80** is seated in a socket **81**, formed in the forward end of the buffer piston, and in an annular channel **82** surrounding the fluid outlet at the forward end of the buffer cylinder. Also, as shown in FIG. 5, a check valve **83** is located on the inlet side of the buffer cylinder and the first by-pass, which regulates the rate of fluid flow through the buffer unit, is arranged to extend from end to end of the buffer cylinder.

In the operation of this modified form of the buffer unit the hydraulic system, between the pump and the door operator piston, is always filled with hydraulic fluid and the driving flow of fluid under pressure enters the buffer unit from the left hand end, as viewed in FIG. 5, to drive the buffer piston to the right. The fluid thus displaced by the buffer piston acts directly on the piston of the door operator to drive it in the door opening direction under full pump pressure and at full speed until the buffer piston reaches the end of its forward stroke at which time further flow of pressure fluid from the buffer unit to the door operator is by way of the restricted first by-pass alone. Upon completion of the door opening operation, pressure flow from the pump is closed off in the usual way and as the door moves in the closing direction the spring **80** forces the buffer piston back to its initial position and the fluid on the driving side of the buffer piston is displaced from the rear to the front of the piston through the first by-pass **39**, the inlet to the buffer cylinder on the pump side being closed off by the check valve **83**. In this manner the buffer unit is kept filled with hydraulic fluid at all times and ready for reactivation at any time.

It will now be seen that an improved hydraulic door operator system and buffer means has been provided

which permits the door to be driven rapidly to the fully open position under constant fluid power and yet be decelerated near the end of its opening movement sufficiently to prevent racking of the door or slamming at the end of its opening movement; which permits the door operator to be reactivated, under full power, during any portion of the door closing cycle without loss of the speed control function in the terminal portion of the opening movement; which provides an improved buffer or terminal speed control means which is readily adjustable to accommodate substantially any operating condition or circumstance; which provides an improved terminal speed control device that can be readily embodied as an internal component in a door operator mechanism providing full power actuation during the entire door opening stroke; which provides a simple buffer device that can be utilized with a wide variety of conventional systems as an accessory and without modification of the installation of those systems; and which provides a simple buffer unit that can be economically manufactured and assembled, whether as a door operator component or as an accessory, and which has only one moving part.

Although but one specific embodiment of this invention has been herein shown and described it will be understood that numerous details of the construction and system arrangement shown may be altered or omitted without departing from the spirit of this invention as defined by the following claims.

I claim:

1. In an hydraulic door operator system, an hydraulic door operator comprising a double-ended cylinder, a piston in said cylinder, and a piston rod extending from said piston through one end of said cylinder, a source of fluid pressure for said operator, a fluid filled hydraulic circuit connecting said pressure source with the opposite ends of said cylinder for creating a pressure differential between opposite sides of said piston to drive said piston and rod in one direction, and means disposed serially in said hydraulic circuit on the low pressure side of said piston for automatically reducing said hydraulic pressure differential by control of fluid flow in said circuit during the terminal portion of the piston movement in said one direction and while said piston is under full driving pressure from said pressure source, and means for rendering the last named means inoperative during movement of said piston in the opposite direction.

2. In an hydraulic door operator system, an hydraulic door operator comprising a double-ended cylinder having a piston reciprocable therein and a connecting rod extending from said piston through one end of said cylinder, a source of fluid pressure for said operator, a fluid filled hydraulic circuit connecting said pressure source with the opposite ends of said cylinder for creating a pressure differential on opposite sides of said piston selectively to drive said piston and rod in either direction, and means connected serially within said hydraulic circuit for automatically reducing said hydraulic pressure differential by control of fluid flow in said circuit during the terminal portion of the piston movement in one direction and while said piston is under the full pressure from said pressure source, and means for rendering the last named means inoperative during movement of the piston in the opposite direction.

3. In an automatic door operator system comprising an hydraulic double-ended cylinder having a piston reciprocably mounted therein and operatively connected with a piston rod extending through one end of said cylinder, a pressure source for supplying fluid under pressure to said cylinder for driving said piston and including a fluid filled hydraulic circuit connecting said pressure source with each end of said cylinder for creating a pressure differential between opposite ends of the cylinder to move said piston in either direction, and means for controlling the direction of pressure actuation of said piston, a buffer means connected serially within said circuit for automatically reducing the pressure differential in said cylinder during the terminal portion of the movement of said piston in one direction.

4. In an automatic door operator system comprising a double-ended hydraulic cylinder having a piston reciprocably mounted therein and operatively connected with a piston rod extending through one end of said cylinder, a pressure source for supplying fluid under pressure to said cylinder for driving said piston and including an hydraulic circuit connecting said pressure source with each end of said cylinder for creating a pressure differential in the cylinder to drive said piston in either direction, and means for controlling the direction of fluid flow between said pressure source and said cylinder; a buffer means connected serially within said circuit for automatically reducing the pressure differential in said cylinder during the terminal portion of the movement of said piston in one direction, said buffer means having a unidirectional by-pass for permitting maximum pressure differential during any movement of said piston and spindle in the other direction.

5. In a door operator system comprising a double-ended hydraulic operator cylinder having a piston connected with a piston rod extending through one end of the cylinder, a pressure source for supplying pressure fluid to said operator cylinder and including a fluid filled hydraulic circuit connecting said pressure source with each end of said operator cylinder for creating a pressure therein to drive said piston in either direction, means for reversing the direction of fluid flow between said cylinder and said pressure source, a buffer means connected serially in said circuit and comprising a cylinder having a free piston mounted for reciprocation therein in response to the movement of pressure fluid to and from said operator cylinder, a first by-pass in said buffer means permitting controlled flow of pressure fluid in one direction past said free piston when said piston has moved to one end of its travel in said one direction in the buffer cylinder, and a second by-pass in said buffer means permitting relatively free flow of fluid in the other direction and past said free piston while said free piston is moving from said one end of its travel toward the opposite end of said buffer cylinder.

6. In a door operator system comprising an hydraulic door operator having a double-ended cylinder, a piston reciprocable therein, and a piston rod extending from said piston through one end of the cylinder, a source of hydraulic pressure fluid including a fluid filled reversible hydraulic circuit connecting said fluid source with each end of said operator cylinder for creating a driving pressure therein to move said piston, a buffer means connected serially in said circuit and comprising a cylinder having a free piston mounted for reciprocation therein in response to the movement of pressure fluid in said circuit to and from said operator, adjustable stop means at one end of the buffer cylinder for limiting the extent of movement of said free piston therein during movement of said operator piston in one direction, a first by-pass in said buffer means for permitting controlled flow of pressure fluid past said free piston when said free piston becomes engaged with said stop means, said first by-pass being normally closed by said free piston and open only when the free piston has traveled a predetermined distance toward said stop means, and a second by-pass in said buffer means permitting relatively free flow of fluid in the other direction past said free piston when said free piston is moving toward the other end of said buffer cylinder in response to a reverse flow of hydraulic pressure fluid to drive the operator piston in the other direction.

7. In an automatic door operator system, a door operator comprising a double-ended cylinder having a piston therein and a piston rod extending through one end of the cylinder, a source of pressure fluid, and a reversible hydraulic circuit connecting said source with each end of said cylinder for driving said piston in either direction,

a buffer means connected serially in said circuit and comprising a closed cylinder having a free piston mounted therein for movement in response to and in the direction of the flow of fluid in said circuit during operation of said operator, adjustable stop means at one end of the buffer cylinder for limiting the movement of said free piston in one direction during actuation of said operator piston in one direction, a first by-pass in said buffer means for permitting restricted flow of fluid in said one direction past said free piston when said free piston is engaged with said stop means, said free piston normally closing-off said first by-pass, a second by-pass in said buffer means permitting relatively free flow of fluid past said free piston in the other direction only when said free piston is moving from said one end toward the opposite end of said buffer cylinder during a reverse operation of the operator, adjustable means for externally regulating the rate of fluid flow through said first by-pass, and means for reversing the flow of pressure fluid in said hydraulic circuit.

8. In an automatic door operator system, a double-ended hydraulic door operator cylinder having a piston reciprocable therein and a piston rod fixed to said piston and extending through one end of the cylinder, a source of pressure fluid and a reversible hydraulic circuit connecting said source with each end of said operator cylinder for creating a pressure therein to drive said piston in either direction, a buffer means connected serially in said circuit and comprising a double-ended cylinder having a free piston mounted therein for axial movement in response to the flow of pressure fluid to and from said operator cylinder, adjustable stop means at one end of the buffer cylinder for limiting the extent of movement of said free piston therein during movement of said operator piston in one direction, a first by-pass in said buffer means opening in the side wall of the buffer cylinder and arranged to permit controlled flow of pressure fluid past said free piston when said free piston becomes engaged with said stop means, a second by-pass in said buffer means arranged to permit relatively free flow of fluid in the other direction past said free piston when said free piston is moving toward the other end of said buffer cylinder in response to a reverse flow of fluid in said hydraulic circuit to drive said operator piston in the direction opposite said one direction, and adjustable means for externally regulating the rate of fluid through said first by-pass.

9. A control device for automatically regulating the rate of fluid flow in one direction in a fluid filled reversible hydraulic system including a source of fluid pressure, comprising a cylinder connected serially with said source in said hydraulic system, a free piston slidably fitted in said cylinder for axial movement therein in response to the direction of fluid flow in said hydraulic system, a first by-pass on said cylinder for permitting restricted flow of fluid around said piston when said piston reaches one end of its stroke in the cylinder, and a second by-pass on said cylinder for providing relatively free flow of fluid around said piston in the other direction only and upon reversal of fluid flow in said hydraulic system.

10. A control device for automatically regulating the rate of fluid flow in a fluid filled reversible hydraulic system including a source of fluid pressure, comprising a cylinder block having a longitudinal bore forming a cylinder and having end means for closing each end of the cylinder, a free piston slidably fitted in said cylinder for axial reciprocation therein in response to fluid flow in said system, a port at each end of said cylinder block for connecting said cylinder serially with said pressure source in said system, a first by-pass in said cylinder block opening in the cylinder wall intermediate the ends of the cylinder for permitting restricted flow of fluid in one direction past said piston when said piston is at one end of its travel in said cylinder, said first by-pass being normally closed by the side wall of said piston, and a second by-pass including a check valve in said cylinder block for permitting relatively free flow of fluid in the opposite direction past said piston when said piston is moving from said one end toward the other end of said cylinder upon reversal of fluid flow in the hydraulic system.

11. In a reversible flow hydraulic system including a source of fluid pressure and a reversible hydraulic actuator driven thereby, a device for automatically changing the rate of flow in one direction in said system comprising a body having a longitudinal bore forming a cylinder, means at each end of said body closing said cylinder and having ports leading into the cylinder for connecting the cylinder serially with said actuator and pressure source in said hydraulic system, a free piston fitted in said cylinder for axial reciprocation therein in directional response to the flow of fluid in said system, adjustable stop means at one end of the cylinder for limiting the axial movement of said piston in the direction of said one end, a first by-pass in said cylinder block opening in the side wall of said cylinder intermediate the ends of said piston when the piston is at the cylinder end opposite said one end, said first by-pass including means for permitting restricted flow of fluid from end to end of said cylinder and past said piston when said piston is shifted to engage with said stop means, and a second by-pass including a check valve in said cylinder block for permitting relatively free fluid flow in the other direction past said piston upon reversal of fluid flow in said system and regardless of the position of said piston in said cylinder.

12. A control device for automatically regulating the rate of fluid flow in an hydraulic line, comprising a cylinder, means for connecting said cylinder serially in said hydraulic line, a free piston slidably fitted in said cylinder for axial movement therein in response to fluid flow in said hydraulic line, means normally urging said piston toward one end of said cylinder, a first by-pass on said cylinder for permitting restricted flow of fluid around said piston only when said piston is adjacent the other end of said cylinder, and a second by-pass on said cylinder for providing relatively free flow of fluid around said piston and from end to end of said cylinder in the direction of said one end only.

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