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WITH OBSTRUCTION DETECTING MEANS

Original Filed Aug. 13, 1953

2 Sheets-Sheet 1

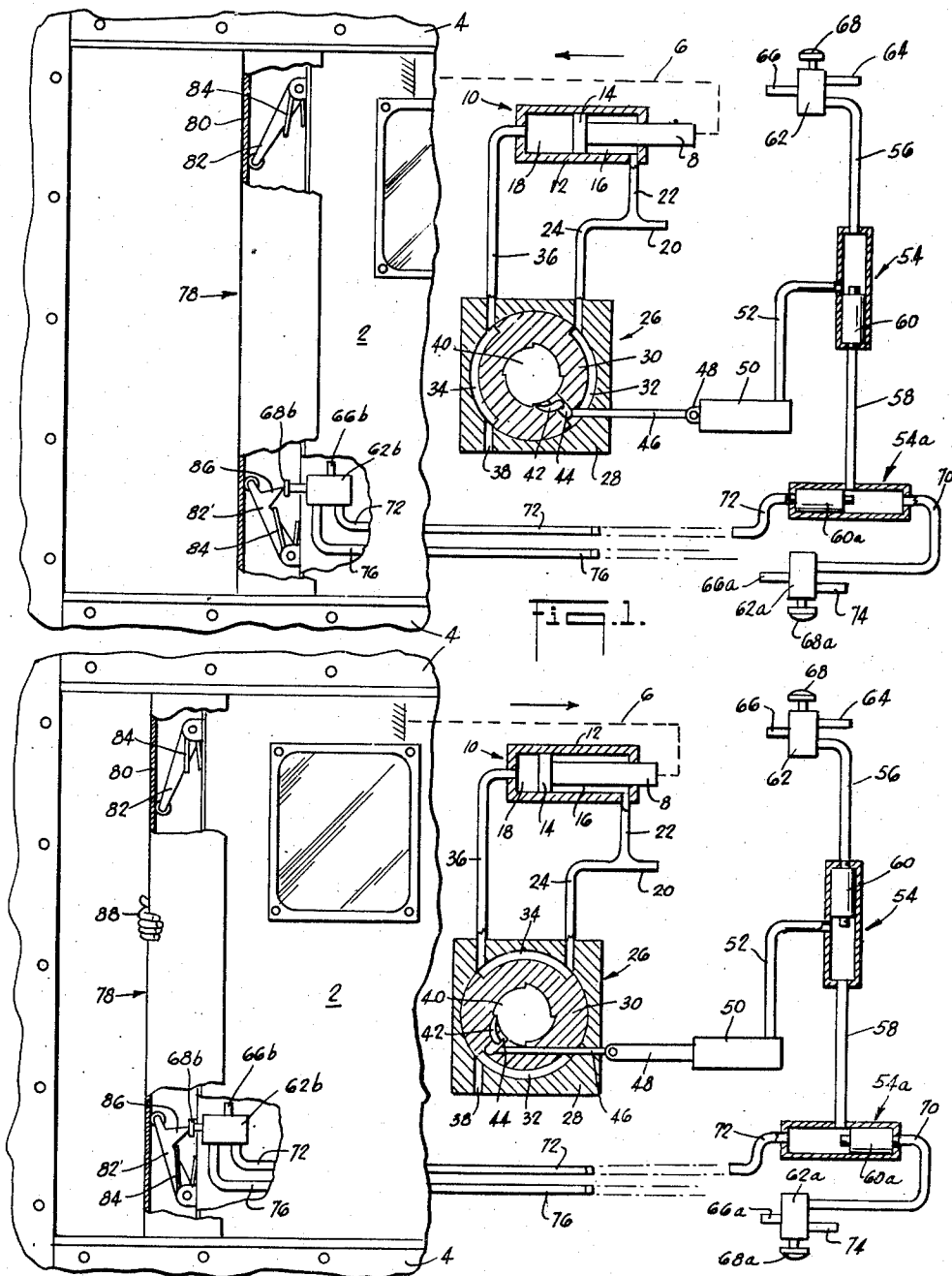


Fig. 2.

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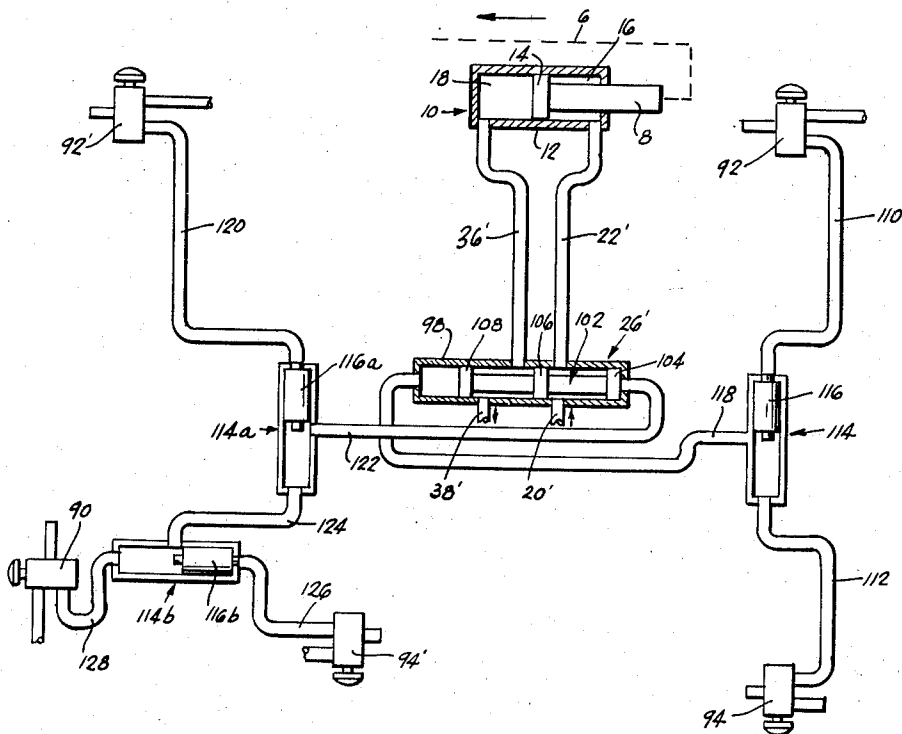


FIG. 3.

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**CONTROL SYSTEM FOR POWER OPERATED
DOORS EQUIPPED WITH OBSTRUCTION
DETECTING MEANS**

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Continuation of abandoned application Serial No.
373,958, August 13, 1953. This application November
19, 1954, Serial No. 470,007

15 Claims. (Cl. 268—50)

The present invention relates to a simplified control system for use with power operated doors having "sensitive edges" or the like capable of detecting an obstruction in the path of doors and reversing the direction of movement of the doors when such an obstruction is met. As specifically disclosed, the invention is particularly applicable to use in non-electric systems utilizing only pneumatic or hydraulic pressure or a combination of the two for the performance of all of the desired functions. Such systems are of importance in locations where the menace of explosions is so great that the possibility of electric sparking must be completely eliminated, for example in powder plants.

The employment of "sensitive edges" or other obstruction detecting means in connection with power operated doors is almost a necessity from a practical point of view. This is particularly the case where heavy doors are involved, requiring force for movement thereof, of such a magnitude that it cannot be manually resisted. The "sensitive edges" or other obstruction-detecting means have assumed a variety of forms, most of which have become more or less standardized. The specific nature of the obstruction detecting means is not of the essence of this invention. Most such means are incorporated into a system for controlling the operation of the door so that movement of the door, usually in a closing direction, is completely reversed when an obstruction is sensed. However, in most of these systems the door, when it has reached the limit of its reversed movement, will again resume its closing movement, and until the obstruction is removed from its path the door will shuttle back and forth, hitting the obstruction in each shuttling cycle. This not only places undue stress upon the door and the operating system therefor, but also materially hinders removal of the obstruction from the path of the door, particularly if that obstruction is fairly massive.

On the other hand, when the obstruction is easily removed, a system in which a door, when once reversed in direction through detection of an obstruction, must move all the way to its initial position before it can again resume its interrupted movement involves an unnecessary and undesirable time delay, particularly when heavy doors, which can only be moved slowly, are involved.

In addition, and particularly in non-electric systems, it has generally been necessary to utilize separate high pressure valves active on the prime mover and controlled by the obstruction-detecting means. This makes for complexity and expense of installation.

The system of the present invention is designed to overcome all of these drawbacks, and to do so in a way which materially simplifies the installation and reduces the cost thereof, at the same time increasing the flexibility of the system and its applicability to different specific environments. According to the present invention, when an obstruction is sensed the direction of movement of the door will be reversed and the door will move to its initial position, where it will remain until a subsequent

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manual actuation causes it to resume its previously interrupted movement. Hence heavy obstructions may be removed from the path of the door without interference by repeated cycling of the door. The system is further so designed that if the manual actuation to cause the door to resume its interrupted direction of movement should be applied before the door has completed its reverse movement, said subsequent manual actuation will be immediately effective to cause the door to re-reverse its direction and resume its interrupted movement even before the reversal cycle has been completed. Hence, for example, if the door, in closing, should strike an individual and, in response to sensing his presence, start to return to open position, the individual, once he has moved out of the path of the door, can cause the door to resume its closing movement at once, and without waiting until the door has returned to its fully open position. Indeed, in one embodiment here illustrated, the "sensitive edge" or obstruction detecting means itself may be manually actuated to produce such a re-reversal of movement, so that practically no time is lost insofar as door operation is concerned.

The above objectives are accomplished by utilizing a single two-position valve to control the operation of the motor, usually hydraulically powered, which operates the door. This valve, the sole direction control means for that motor, may be the same as would be employed even in the absence of an obstruction-detecting means, and may be used without modification in conjunction with any desired number of manually actuated control elements. The valve is preferably controlled by a system other than the high pressure system which actuates the motor, for reasons of simplicity of installation, but that high pressure system could be used to control the position of the valve if so desired. As here specifically disclosed a low pressure pneumatic system is employed to control the valve. This pneumatic system includes a plurality of valves, some placed for manual actuation either at remote points or at points close to the door, and another valve preferably being mounted on the door and adapted to be actuated by the "sensitive edge" or other obstruction-detecting means. The construction of the first mentioned valve is such that it will assume one or the other of its operative positions, causing the motor to open or close the door respectively, depending upon the actuation of the valves in the pneumatic system, each individual pneumatic valve actuation being effective to cause the valve to change from one operative position to the other, thus reversing the direction of movement of the door independently of the actuation position of the door. Hence control of the movement of the door is instantaneous and may be exercised at any point in its range of movement.

In one illustrated embodiment the same pneumatic valves, both manually actuated and "sensitive-edge" actuated, are employed to control operation of the door in both directions, but another embodiment is disclosed in which separate pneumatic valves are utilized to cause the door to open or close respectively, the "sensitive-edge" actuated pneumatic valve being effective only to cause the door to open. The pneumatic system is capable of wide variation to meet desired control characteristics without requiring any modification of the hydraulic system which actually provides the force for moving the door. Thus simplicity, compactness, in expensiveness and flexibility of adaptation to different installation requirements are all achieved, while at the same time greater control over the door operation is attained than has heretofore been possible.

To the accomplishment of the above, and to such other objects as may hereinafter appear, the present invention relates to a control system for a powered door or

the like as defined in the appended claims and as described in this specification, taken together with the accompanying drawings in which:

Fig. 1 is a schematic view of one embodiment of the present invention, the door being shown at an intermediate position and moving toward its closed position;

Fig. 2 is a view of the system of Fig. 1 showing the operation of that system when an obstruction is detected by the "sensitive edge" while the door is closing; and

Fig. 3 is a schematic view of another modification of the control system of the present invention, the door being omitted.

In the embodiment of Figs. 1 and 2, a door generally designated 2 is slidably mounted in upper and lower rails 4 so as to be movable between a closed position all the way to the left and an open position all the way to the right as viewed in the drawings. The door 2 is mechanically operatively connected in any appropriate manner, as indicated by the broken line 6, to the piston rod 8 of a hydraulic motor generally designated 10, the piston rod 8 being slidable through an end wall of the cylinder 12 and being secured to a piston 14 slidable within that cylinder. The motor 10 is here shown as of the well known differential type, the area on the left hand end of the piston 14 against which pressure may be exerted being greater than the area at the right hand end thereof. The piston 14 will be seen to divide the interior of the cylinder 12 into two chambers 16 and 18 to the right and left of the piston 14 respectively. Pressure, and in this specific instance, hydraulic pressure, is constantly applied within the chamber 16 and hence on the right hand end of the piston 14, via pipes 20 and 22. Pipe 24 connects the pressure pipe 20 to a ratchet valve generally designated 26, that valve comprising a housing 28 within which a rotor 30 is mounted, the rotor being provided with arcuate passages 32 and 34 at its periphery and adapted to register with the pipe 24, a pipe 36 which communicates with the chamber 18 of the cylinder 12, and a passage 38 which exhausts.

The rotor 30 is capable of assuming either of two operative positions, one being shown in Fig. 1 and the other being shown in Fig. 2. In the position of Fig. 1 the rotor passage 34 connects the pipe 36 with the exhaust passage 38, pressure is therefore applied through pipes 20 and 22 only within the chamber 16, the piston 14 is moved to the left, and the door 2 is moved toward closed position. In the operative position of Fig. 2, which represents a rotation of the rotor 30 ninety degrees in a clockwise direction from the position of Fig. 1, the rotor passage 34 connects the pipes 24 and 36, the exhaust passage 38 being blanked off. As a result the same pressure is exerted in the chambers 16 and 18 and, because of the differential area of the piston surface exposed to that pressure, the piston 14 will be forced to the right, thus causing the door 2 to move toward its open position.

The valve rotor 30 is moved by a ratchet element 40 having steps thereon each of approximately 90 degrees in extent, the ratchet 40 being engaged by pawl 42 mounted on arm 44 which is in turn pivotally mounted on link 46, both the arm 44 and pawl 42 being resiliently urged toward the ratchet 40 so that, when the link 46 is moved to the left (compare Fig. 2 with Fig. 1) the ratchet 40 and hence the rotor 30 are rotated through 90 degrees, movement of the link 46 back to its original position causing the pawl 42 to ride ineffectually over the surface of the ratchet 40 and then snap in behind the next step. The link 46 is connected to a plunger 48 movable with the cylinder 50 and spring urged to its retracted position shown in Fig. 1. The plunger 48 is adapted to be moved to its extended position shown in Fig. 2 upon the application of pressure, here specifically shown as pneumatic pressure, within the cylinder 50 and against the inner end of the plunger 48, that pressure being led to the cylinder 50 by pipe 52 which communicates with double check valve 54.

The double check valve 54, while it has but a single outlet 52, has a pair of oppositely disposed inlets 56 and 58, a shuttle element 60 being slidable within the valve 54 and movable between the positions shown in Figs. 1 and 2, in one of which positions it connects the pipe 56 to the outlet pipe 52 and in the other of which positions it connects the pipe 58 to the outlet pipe 52. When pressure is applied in the pipe 56 the shuttle 60 will be moved by that pressure to its position shown in Fig. 1, in which it blocks off the tube 58. When pressure is applied in the tube 58 the shuttle 60 will be moved by that pressure to its position shown in Fig. 2, in which it blocks off the pipe 56. The pipe 56 communicates with a source of pneumatic pressure by means of the pin valve 62 and pipe 64, the pin valve 62 being located at any desired position, such as adjacent to one side of the door. The valve 62 is provided with an exhaust port 66 and with an actuating button 68. When the button is in its normal extended position, to which it may be urged by a spring, the pipe 56 is connected to the exhaust port 66, and when the button 68 is depressed the pipe 56 is disconnected from the exhaust port 66 and is connected to the pressure source via the pipe 64. The pipe 58 leads to a second double check valve 54a and constitutes the outlet therefrom, the valve 54a having a pair of oppositely disposed inlet pipes 70 and 72 and containing a slidable shuttle 60a which functions in the same manner as the shuttle 60 of valve 54. The pipe 70 communicates with a source of pneumatic pressure via a pin valve 62a and pipe 74, the valve 62a being constructed similarly to the pin valve 62 and being positioned at any appropriate place for manual actuation, for example, on the other side of the door from the pin valve 62. The pipe 72 communicates with a source of pneumatic pressure via the pin valve 62b and the pipe 76. The pin valve 62b is constructed similarly to the pin valves 62 and 62a and is mounted on the door 2, its projecting button 68b being adapted to be depressed to open the pin valve 62b whenever the obstruction-detecting means, generally designated 78 and here shown in the form of a "sensitive edge," detects the presence of obstruction in the path of the door. The "sensitive edge" 78 is shown in a typical form, comprising a hollow housing 80, slidably mounted on the front edge of a door and urged forwardly by means of pivotally mounted arms 82, 82' spring urged outwardly through the action of springs 84. The arm 82' is provided with a lug 86 engageable with the button 68b and active to move the button 68b into the pin valve 62b whenever the door 2, by meeting an obstruction, causes the housing 80 to telescope over the door itself.

To describe the operation of this system, let us first assume that the door is fully closed, the ratchet valve 26 having an operative position comparable to that shown in Fig. 1. If now the button 68 is depressed pneumatic pressure will pass through the pin valve 62 into the double check valve 54 via the pipe 56, the shuttle 60 moving to close off the pipe 58, pressure thus entering the cylinder 50 via the pipe 52 and causing the plunger 48 to be projected out from the cylinder 50. This will cause ratchet valve 26 to assume an operative position similar to that shown in Fig. 2, and the door will open. If the button 68a had been depressed instead of the button 68, the same end result would obtain, pressure from the pipe 74 passing through the pin valve 62a and the pipe 70 into the double check valve 54a, the shuttle 60a of which is moved to the left to close off the pipe 72 if it is not already in that position, pressure then continuing along the pipe 58 into the double check valve 54, the shuttle 60 of which is moved to close off the pipe 56 if it is not already in that position. Whichever button is actuated, when it is released the pipe 56 or 70, as the case may be, will be connected to the exhaust port 66 or 66a respectively, the pressure within the cylinder 50 will be released, and the plunger 48 will be returned to its with-

drawn position by the spring active thereon, thus restoring the ratchet mechanism to its initial position and rendering the system ready for a subsequent actuation. Any subsequent actuation of either of the pin valves 62 or 62a will cause the ratchet valve 26 to assume the operative position shown in Fig. 1, and the door will move to closed position. Note that the same pin valve 62 or 62a can be used to initiate both the opening and closing movement of the door.

If now, while the door is closing, it meets an obstruction, as represented by the hand 88 in Fig. 2, the sensitive edge 78 will be actuated, the button 68b will be depressed, and pressure will be conveyed to the cylinder 50 along the following path: From pipe 76 through pin valve 62b and pipe 72 to double check valve 54a, where the shuttle 60a will be moved to the right to block pipe 70 if it is not already in that position, pressure passing through pipe 58 into double check valve 54, the shuttle 60 of which is moved to block pipe 56 if it is not already in that position, the pressure entering cylinder 50 through pipe 52. As a result the plunger 48 will be extended, the ratchet valve 26 will assume its operative position shown in Fig. 2, and the door will reverse its direction of movement and move toward its open position. If nothing further should be done, the door will reach its open position and remain there. When the obstruction has been moved from the door path, subsequent actuation of either of the pin valves 62 or 62a will again cause the door to move toward closed position.

In addition, if either of the pin valves 62 or 62a should be actuated while the door is moving toward open position and before it has reached that position, but after the door has moved away from the obstruction, thus permitting the pin valve 62b to close and causing the plunger 48 to be withdrawn within the cylinder 50, the ratchet valve 26 will be caused to again change its operative position, and the door will then immediately be moved toward closed position. In addition, movement of the door toward closed position can also be initiated through manual pressure against the sensitive edge 78 to reactuate the pin valve 62b. This facet of operation is most significant. If the door should close on an individual, thus actuating the sensitive edge 78 and causing the door to reverse its direction of movement, the individual can immediately step out of the path of the door and, by pressing against the still adjacent sensitive edge 78, cause the door to resume its closing movement without any appreciable delay.

It will, of course, be apparent that any number of manually actuated valves similar to the pin valves 62 and 62a could be employed, some such valves being placed at remote stations while others are placed near the door. It is noteworthy that no modification of the high pressure hydraulic system is required thereby, and the only modification of the pneumatic system is the provision of an additional number of double check valves 54.

Fig. 3 discloses another embodiment of the control system of the present invention in which the pin valve 90 controlled by the sensitive edge 78 is effective when actuated only to cause the door to move toward its open position, and in which separate pairs of pin valves 92, 92' and 94, 94' are positioned on opposite sides of the door for manual control of the operation thereof, all of the pin valves 90-94' being constructed similarly to the pin valves 62 of Figs. 1 and 2. The pin valves 92 and 94, when actuated, cause the door to move to closed position and the pin valves 92', 94' cause the door to move to open position. Actuation of pin valves 92 or 94 while the door is closing will have no effect, and action of pin valves 92' or 94', or the pin valve 90 controlled by the sensitive edge 78, will have no effect while the door is opening. However, each of these valves, when actuated, will be effective to cause the door to move toward one position or the other so long as the door is not already in or moving toward that position. To this end a hydraulic

valve 26' of the "pilot" type is employed, that valve including a cylinder 98 within which slide 102 is movable from one end to the other thereof, the slide 102 having three piston like portions 104, 106, 108 thereon. Hydraulic pressure enters the cylinder 98 via the pipe 20'. The pipe 38' exhausts. The pipes 22' and 36' communicate respectively with the chambers 16 and 18 in the cylinder 12 of the motor 10. When the slide 102 is in one of its operative positions, as illustrated in Fig. 3, the piston 106 separates the pipes 22' and 36' and the piston 108 permits the pipe 36' to communicate with the exhaust 38', the space between the pistons 104 and 106 permitting the pipe 22' to communicate with the pipe 20'. This corresponds to the operative position of the ratchet valve 26 shown in Fig. 1, pressure is applied within chamber 16, the chamber 18 exhausts, and the door is caused to move to closed position. When the slide 102 is in its extreme left hand position, the piston 108 engaging against the left hand end wall of the cylinder 98, the piston 106 will be interposed between the pipes 36' and 38', and the space between the pistons 104 and 106 is such that the pipe 20' will communicate with both of pipes 22' and 36'. This corresponds to the operative position of the ratchet valve 26 shown in Fig. 2, pressure will be exerted in both chambers 16 and 18, and the door will be caused to open.

In order to move the slide 102 from one operative position to the other the closing pin valves 92 and 94 are connected by pipes 110 and 112 respectively to double check valve 114 having a shuttle 116 and an outlet pipe 118 which communicates with the left hand end of the cylinder 98, so that pneumatic pressure may be exerted against the outer face of the piston 108. Correspondingly, the opening pin valves 92' and 94', together with the pin valve 90 controlled by the sensitive edge 78, are connected to communicate with the right hand end of the cylinder 98, so that pneumatic pressure may be exerted against the outer face of the piston 104, as follows: The pin valve 92' is connected by pipe 120 to double check valve 114a the outlet of which is connected by pipe 122 to the right hand side of the cylinder 98. The other inlet to the double check valve 114a is defined by pipe 124 which also represents the outlet from double check valve 114b. The pin valve 94' is connected to one inlet of the double check valve 114b by means of pipe 126 and the pin valve 90 on the door is connected to the other inlet of the double check valve 114b by pipe 128.

With the slide 102 in its position shown in Fig. 3, manual closing of either of the pin valves 92' or 94', or closing of the pin valve 90, will cause pneumatic pressure to be exerted against the outer face of the piston 104, and this will force the slide 102 to its left hand operative position, thus causing the direction of operation of the motor 10 to reverse. With the slide 102 in its position illustrated in Fig. 3, closing of either of the valves 92 or 94 will have no effect, since they tend to urge the slide 102 to the position which it already assumes. Conversely, with the slide 102 in its other operative position, the piston 108 being against the left hand end of the cylinder 98, closing of either of the valves 92 or 94 will cause pressure to be applied to the outer face of the piston 108, the slide 102 will be caused to return to the position illustrated in Fig. 3, and the direction of movement of the door will be reversed.

The present invention has been here illustrated in conjunction with the operation of a sliding door, and in conjunction with the use of a hydraulic system for moving the door and a pneumatic system for actuating the hydraulic valve. Only one specific type of obstruction-detecting means and only a limited number of modifications of the pneumatic control system have been here disclosed. It will be appreciated, however, that numerous variations can be made from these specific details without departing from the spirit of the invention as defined in the following claims, and without essential sacrifice

of any of the extremely advantageous features of operation and design which are inherent in the instant invention.

This application is a continuation of my previous application Serial Number 373,958, filed August 13, 1953, now abandoned, having the same title as this application and assigned to the same assignee.

I claim:

1. A control system for a fluid operated door equipped with an obstruction-detecting means, said system comprising a fluid-pressure-operated motor operatively connected to a door for moving the same between open and closed positions, a source of fluid pressure, a first valve between said source and said motor, having two operative positions and effective to cause said motor to open and close said door depending on its position, a second source of fluid pressure operatively connected to said first valve so that successive applications of pressure to said first valve will cause it to move alternately from one operative position to the other, and a second valve operative between said second source and said first valve, operatively connected to said obstruction-detecting means, actuated thereby whenever said means is actuated, and providing for each actuation an individual application of pressure to said first valve, thereby causing it to shift from one operative position to the other.

2. The control system of claim 1, in which said first source provides hydraulic pressure and said second source provides pneumatic pressure.

3. In the system of claim 2, additional and manually actuatable valves operatively connected between said second source and said first valve in parallel with said second valve, said additional valves being positioned to be manually actuatable for control of the operation of said door, and when actuated providing an individual application of pressure to said first valve.

4. In the system of claim 1, additional and manually actuatable valves operatively connected between said second source and said first valve in parallel with said second valve, said additional valves being positioned to be manually actuatable for control of the operation of said door, and when actuated providing an individual application of pressure to said first valve.

5. The control system of claim 1, in which said first valve is operatively connected to an actuating mechanism therefor comprising a ratchet element which moves said valve alternately from one operative position to the other, a pawl active on said ratchet element, and moving mechanism for said pawl operatively connected thereto and comprising a piston movable within a cylinder, spring urged to one position, and fluid-pressure moved to another position, said second source being connected to said cylinder via said second valve.

6. The control system of claim 5, in which said first source provides hydraulic pressure and said second source provides pneumatic pressure.

7. In the system of claim 5, additional and manually actuatable valves operatively connected between said second source and said first valve in parallel with said second valve, said additional valves being positioned to be manually actuatable for control of the operation of said door, and when actuated providing an individual application of pressure to said first valve.

8. A control system for a fluid operated door equipped with an obstruction-detection means, said system comprising a fluid-pressure-operated motor operatively connected to a door for moving the same between open and closed positions, a source of fluid pressure, a first valve between said source and said motor, having two operative positions and effective to cause said motor to open and close said door depending on its position, and being movable from one operative position to the other by the application of pressure thereto at one side or the other thereof respectively, a second source of fluid pressure,

and means for operatively connecting said second source to that side of said first valve at which the application of pressure causes said first valve to move to a position to open said door, said means including a second valve operative between said second source and said side of said first valve and operatively connected to said obstruction-detection means so as to be actuated thereby when said obstruction-detection means is actuated, actuation of said second valve permitting the pressure from said second source to be applied at said side of said first valve.

9. The system of claim 8, in which an additional and manually actuatable valve is connected between said second source and said first valve in parallel with said second valve, said additional valve being positioned to be manually accessible for manual initiation for opening said door.

10. The system of claim 9, in which another manually actuatable valve is connected between said second source and that side of said first valve at which the application of pressure causes said first valve to move to a position to close said door, said other valve being positioned to be manually accessible for manual initiation of closing said door.

11. A control system for a powered door or the like equipped with an obstruction-detecting means, said system comprising a motor operatively connected to said door for moving the same between open and closed positions, manual control means actuatable in a single sense and operatively connected to said motor for causing it to operate in one direction or the other, an auxiliary control means actuatable in a single sense and operatively connected to said obstruction-detecting means for actuation thereby, each individual actuation of said manual control means in said sense being effective to cause the motor to reverse its previous direction of operation and to tend to operate until the door has reached its final position in its new direction of motion, the door thereafter remaining stationary, each actuation of said auxiliary control means in said sense being similarly effective.

12. A control system for a fluid-pressure-operated door or the like equipped with an obstruction-detecting means, said system comprising a fluid-pressure-operated motor operatively connected to said door for moving the same between open and closed positions, a valve operatively connected to said motor and having two operative positions, one for causing the motor to operate to close the door and the other for causing the motor to operate to open the door, manual control means actuatable in a single sense and operatively connected to said valve and effective, on each actuation thereof in said sense, to cause said valve to move from its existing operative position to its other operative position, and an auxiliary control means actuated in a single sense by said obstruction-detecting means, operatively connected to said valve and effective, on each actuation thereof in said sense, to cause said valve to move from its existing operative position to its other operative position.

13. A control system for a fluid-pressure-operated door or the like equipped with an obstruction-detecting means, said system comprising a fluid-pressure-operated motor operatively connected to said door for moving the same between open and closed positions, a valve operatively connected to said motor and having two operative positions, one for causing the motor to operate to close the door and the other for causing the motor to operate to open the door, manual control means actuatable in a single sense and operatively connected to said valve and effective, on each actuation thereof in said sense, to cause said valve to move from its existing operative position to its other operative position, and an auxiliary control means actuated in a single sense by said obstruction-detecting means, operatively connected to said valve and effective, on each actuation thereof in said sense, to cause said valve to assume said other operative position.

14. A control system for a powered door or the like, said system comprising a motor operatively connected to said door for moving the same between open and closed positions, a control element actuatable in a single sense, operatively connected to said door, and effective when actuated in said sense to cause the motor to move said door in the direction opposite to that in which said door has previously moved, said door being equipped with an obstruction-detecting means operatively connected to said control element and effective to actuate it in said sense whenever said obstruction detecting means is actuated.

15. A control system for a powered door or the like, said system comprising a motor operatively connected to said door for moving the same between open and closed positions, and a pair of control elements each actuatable

in a single sense, operatively connected to said door, and independently effective when actuated in said sense to cause the motor to move said door in the direction opposite to that in which said door has previously moved, said door being equipped with an obstruction-detecting means operatively connected to one of said control elements and effective to actuate it in said sense whenever said obstruction-detecting means is actuated, the other of said control elements being exposed for manual actuation.

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