Feb. 7, 1967 R. M. LOFTUS 3,302,330

AUTOMATIC DOOR OPERATOR

Filed May 20, 1964

FIG. 1

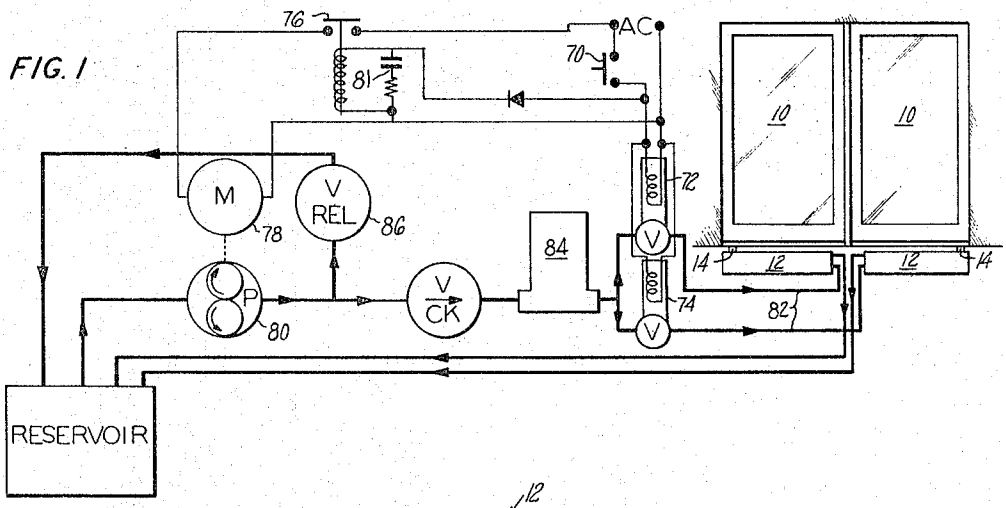


FIG. 2

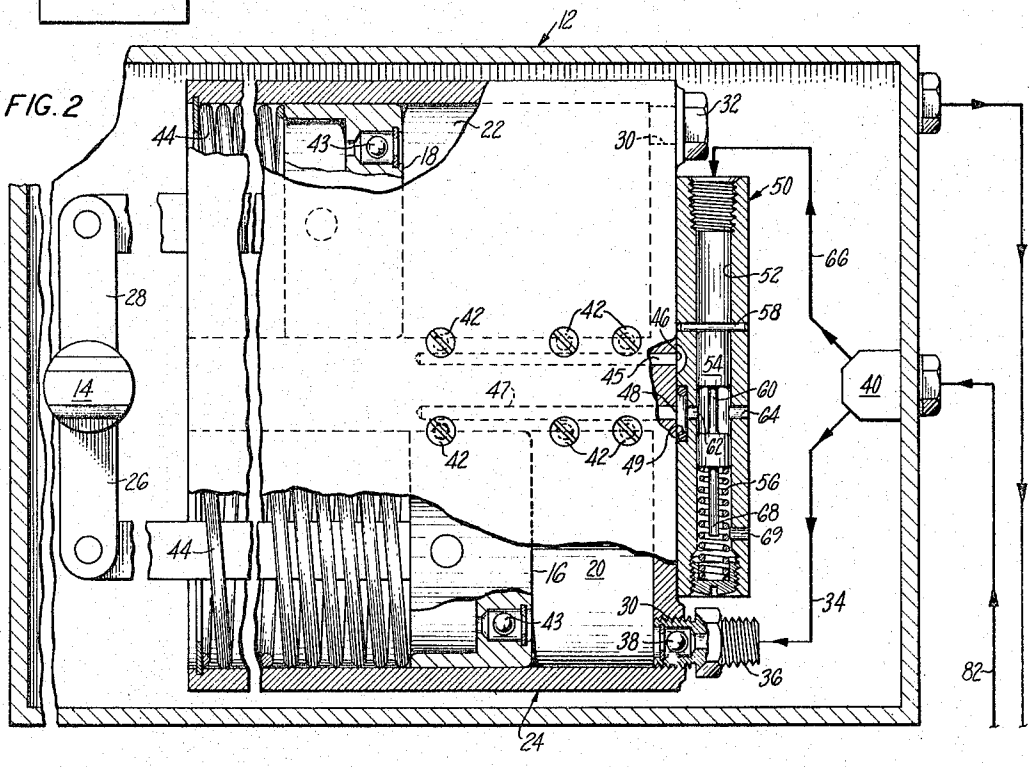
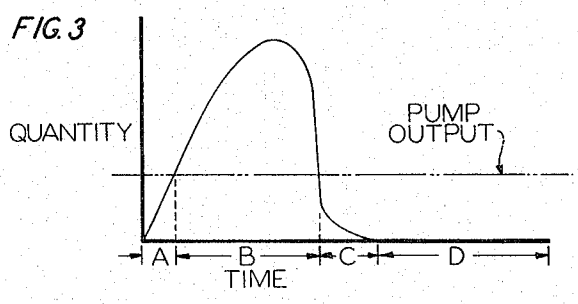


FIG. 3



INVENTOR.
ROBERT M. LOFTUS

BY Lindsey, Prutzman and Hayes

ATTORNEYS

United States Patent Office

3,302,330
Patented Feb. 7, 1967

3,302,330

AUTOMATIC DOOR OPERATOR

Robert M. Loftus, Farmington, Conn., assignor to The Stanley Works, New Britain, Conn., a corporation of Connecticut

Filed May 20, 1964, Ser. No. 368,817
10 Claims. (Cl. 49—30)

This invention relates to a fluid operator system and particularly to such a system for use in the powering of doors in the door opening and closing cycle. The invention is especially applicable to swinging doors and as one of its objects aims to provide a fluid operator system having compact size and minimum heat generation.

It is a further object of this invention to provide a novel fluid operator system for automatic doors incorporating a fluid supply pump which cooperates with an automatically replenished auxiliary fluid supply source for powering the doors.

Another object of this invention is to provide an improved hydraulic operator system providing for the hydraulic damping of the door during its return to closed position and for minimizing the hydraulic fluid leakage during the power stroke of the operator.

Other objects will be in part obvious and in part pointed out more in detail hereinafter.

The invention accordingly consists in the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction hereafter set forth and the scope of the application which will be indicated in the appended claims.

In the drawings:

FIG. 1 is a schematic representation of a hydraulic door operator system depicting this invention;

FIG. 2 is a fragmentary and diagrammatic view of a hydraulic power operator illustrating the unique bypass control valve of this invention; and

FIG. 3 is a graph illustrating the fluid requirements of the system during its typical operation.

Referring now to the drawings, in which like numerals indicate like parts throughout the several views, a pair of swinging doors of the type for which the fluid operator system of this invention is particularly designed are denoted generally by the numerals **10** and are hung for pivotable movement adjacent their remote edges in a conventional manner.

Each of the doors **10** is provided with a fluid power operator **12** for powering the door during its opening and closing movement and, as shown in FIG. 1, the power operator for each door is mounted in a recess in the threshold of the door with the output spindle **14** of each operator forming the bottom pivot of the door.

Referring now particularly to FIG. 2, each of the operators **12** is provided with a pair of pistons **16** and **18** which are mounted in separate cylinders **20** and **22**, respectively, in cylinder block **24**. Each of the pistons **16**, **18** are connected to the spindle **14** through crank arms **26**, **28**, respectively, so that the movement of one of the pistons automatically causes the movement of the other. Each of the cylinders **20**, **22** is provided with an inlet port **30**, with the port **30** for the cylinder **22** shown as being closed by a plug **32** and the port **30** for the cylinder **20** being connected by a coupling nipple **36** and tubing **34** to a manifold **40**. Coupling nipple **36** is provided with a one-way valve **38** which prevents the discharge of hydraulic fluid from the interior of the cylinder **20**.

Each of the pistons **16**, **18** is provided with a biasing or closing spring **44** which opposes the movement of pistons **16**, **18**, respectively, during the power stroke of the pistons and returns the pistons to a neutral position after the power stroke at which time the door is in its normal or closed position.

With the operator connected, as shown in FIG. 2, the piston **16** serves as a power piston during the power stroke of the operator and moves to the left as viewed in FIG. 2 against the bias of its associated spring **44**; it being understood that the one-way valve **43** in the piston **16** is closed by the pressurized fluid entering the cylinder **20**. In such operation, piston **18** moves to the right and serves as a checking piston to hydraulically damp the movement of the spindle **14**. Because of the hydraulic fluid trapped in the cylinder **22**, the one-way check valve **43** of piston **18** is also seated.

To provide for the discharge of hydraulic fluid trapped in checking cylinder **22** under such conditions, there are provided bypass needle valves **42** which are adjustable to accommodate the desired rates of movement of the spindle **14** during different portions of door opening movement. The needle valve **42** provides communication between the interior of the cylinder **22** and the passageway **45** in the cylinder block, the end of which discharges through a port **46** into the interior of the housing of the operator **12**.

Cylinder **20** is likewise provided with bypass needle valves **42** so that the piston **16** may serve as the checking piston during the closing of the door under the influence of the spring **44**. The presence of these needle valves **42** in cylinder **20**, however, normally results in undesired leakage of pressurized fluid during the power stroke of the piston **16** and one of the important features of this invention is to provide a bypass control valve arrangement which is automatically operable to substantially eliminate such leakage through the bypass needle valves **42** during the power stroke of piston **16**.

As indicated above, the power operator **12** illustrated in FIG. 2 is diagrammatical in nature. For a more complete description of such a power operator **12**, reference is made to U.S. Patent 2,911,210 which issued on November 3, 1959, on an invention of Harold W. Ferguson and is entitled "Hydraulic Door Operators."

The bypass control valve **50** utilized in this invention is shown as being mounted on cylinder block **24** to receive the fluid discharge from the outlet port **48** of passageway **47** through needle valve **42** of cylinder **20**. Bypass control valve **50** is preferably sealed to the outlet port **48** by a resilient O-ring **49**.

The bypass control valve **50** is a tubular member having an axial bore **52** of uniform diameter which receives a spool valve **54** for reciprocable movement therein. A biasing spring **56** urges the spool valve in one direction against the stop **58** which positions the spool valve so that the necked portion **60** thereof is aligned with inlet opening **62** and outlet opening **64** in the side walls of the valve **50**. The inlet opening **62** communicates with the outlet port **48** of the passageway **47** of cylinder **20** so that when the spool valve **54** is in the position shown (as when the piston **16** is moving in the door closing direction under the influence of its spring **44**) the fluid trapped in the cylinder **20** is discharged past the needle valves **42** directly into the housing of the operator to damp the movement of the piston.

However, when pressurized fluid is admitted to manifold **40** to initiate the power stroke of piston **16** it is also fed into the end of bypass control valve **50** through tube **66** to urge the spool valve **54** against the bias of spring **56**. Because the areas of the two enlarged ends of spool valve **54** are equal, any leakage past bypass valves **42** of cylinder **20** entering the bypass control valve **50** through opening **62** produces equal and oppositely directed forces on the spool valve **54** and thus does not affect the biasing forces on the spool valve **54**.

The spool valve 54 is provided with a downwardly depending stop 68 for limiting the movement of the spool valve so that the enlarged end of the spool valve 54 is positioned to seal off the inlet and outlet ports 62, 64, respectively, to prevent leakage past the bypass valves 42 during the power stroke. A drain port 69 is provided in the wall of the bypass control valve so that fluid is not trapped in the cavity for spring 56.

It will be readily apparent that while FIG. 2 diagrammatically illustrates the operator connected for right-hand operation, it could be readily adapted for left-hand operation by connecting supply tube 34 to inlet port 30 of cylinder 22 and applying the plug 32 to the inlet port 30 of cylinder 20 and reversing the bypass control valve 50 so that inlet port 62 thereof is in communication with exhaust port 46 of passageway 45 for cylinder 22.

For an understanding of the operation of the power operator system of this invention refer to FIG. 1. A control switch, which may be any conventional switch such as a pedestrian-operated carpet switch, is indicated by numeral 70. Closing the control switch 70 energizes the solenoid valves 72, 74 and relay switch 76 to energize the drive motor 78 for the positive displacement gear-type pump 80 to deliver pressurized fluid through tubing 82 to the operators 12 thereby initiating the power stroke of the two power operators. The delivery of pressurized fluid to tubing 82 also operates the bypass control valves 50 for each of the operators as hereinbefore described. So long as the switch is closed, solenoid valves will be actuated and power supplied to the operators 12 to hold the doors in an open position.

When the switch is released, the solenoid valves 72, 74 are de-energized and the normal leakage past the spool valve 54 of the bypass control valve 50 permits the biasing spring 56 to slowly return the spool upwardly against the stop 58. The three bypass needle valves 42 of the power cylinder 20 can then discharge the liquid trapped in the cylinder 20 so that the piston 16 can move to the right under the influence of spring 44 and the damping provided by the limited rate of discharge of the fluid past the needle valves 42 to return the door to its closed position.

The time for the fuel to leak past the spool valve 54 of the bypass control valve 50 may be adjusted by adjusting the fit of the spool 54 in the bore 52 of the control valve but is normally in the order of one to two seconds to cause the door to "dwell" briefly after the control switch 70 is opened. It will be further observed that as the control switch 70 is opened, the power to the motor relay 76 is also interrupted. However, by the provision of a suitable time delay 81, the power continues to be applied to the motor for a short period of time for the reason hereinafter more fully described.

In accordance with one aspect of this invention, the size and capacity of the positive displacement supply pump 80 selected for use in the system illustrated herein is less than that required to power the two doors 10, and in practice, it has been found that the use of a pump 80 having three-fourths the required capacity results in satisfactory performance of the system.

In order to provide sufficient additional power to operate the doors, there is provided in accordance with this invention, an automatically replenished accumulator, or reservoir of pressurized fluid 84, to aid the pump 80 during peak load periods of the power strokes of the operators. Another characteristic of this design is that time delay means 81 is provided to operate the motor 78 over a sufficiently long period of time at the end of each power stroke of the system to recharge the accumulator to its full pressure and to discharge a small amount of fluid through the pressure regulating valve 86 of the system. However, since the hydraulic fluid available for recirculation is quite limited in quantity, it will heat up quickly so that the time delay means 81 is adjusted

to minimize the amount of recirculated fluid during each door opening cycle but to assure that some fluid is recirculated.

Reference to FIG. 3 will indicate the conventional requirements for pressurized hydraulic fluid during the normal operation of the doors 10. During the first portion A of the cycle, the pump 80, which begins to pump as the cycle is initiated, has sufficient capacity to provide all the needs of both operators 12 of the system operating simultaneously. Thereafter, and for a second portion B of the cycle, the fluid which has previously been stored under pressure in the accumulator 84, aids the pump 80 in supplying the required fluid. Thereafter during the final portion of the cycle, the pump 80 again has sufficient capacity to provide all the fluid required to operate the doors and additionally to deliver a portion of its output to the accumulator to begin to recharge the accumulator. After the pedestrian leaves the doorway and control switch 70 opens, the pump motor 78 continues to be energized briefly because of the time delay provided by the time delay circuit 81 for a further sufficient period of time D to recharge the accumulator 84 to its full pressure and to recirculate a small quantity of fluid through the pressure regulating valve 86 so that the system is fully conditioned for the next operating cycle.

It is readily apparent that it is essential that the pressure in the accumulator be automatically and fully replenished during each cycle since, otherwise, the pressure of the system, after repeated cycles, may become insufficient to close bypass control valves 50. The result would be that the operators could not deliver sufficient fluid to open the doors. Moreover, the recirculating fluid through the pressure regulating valve 86, also rapidly heats the limited quantity of hydraulic fluid in the system, the amount of fluid recirculated must be minimized particularly under conditions of heavy use. Finally, the use of a bypass control valve 50 which minimizes the leakage during the power stroke while retaining the advantage of damped door closing by permitting the power piston to be used as a checking piston having bypass needle valves during the closing movement of the door, is particularly advantageous in the system.

While the invention has been described in connection with an automatic operator system having doors installed in a single doorway, it is readily apparent that it can also be utilized with doors installed in separate doorways or with an operator system for a single door in which the pump capacity is less than that which is required for the pump stroke of the operator.

As will be apparent to persons skilled in the art, various modifications and adaptations of the structure above described will become readily apparent without departure from the spirit and scope of the invention, the scope of which is defined in the appended claims.

I claim:

1. An automatic door operator system comprising a pedestrian responsive switch for opening and closing a fluid valve, a positive displacement fluid supply pump and a power cylinder connected to the output thereof with the valve connected therebetween, with the power cylinder having a power piston therein, an auxiliary source of pressurized fluid connected to the output of said pump and operable only during an intermediate portion of the power stroke of the power cylinder to assist the pump in delivering pressurized fluid to the power cylinder, and electric circuit means operable at the end of each power stroke of the power piston to replenish the fluid pressure of the auxiliary fluid source to its original level prior to the de-energization of the fluid pump.

2. The automatic door operator system of claim 1 wherein the supply pump is powered by an electric motor and the electric circuit means includes a time delay circuit to continue the energization of the electric motor after the pedestrian responsive switch is opened.

3. A fluid operator for moving an object along an established travel path comprising a pump for supplying pressurized fluid, a power cylinder having a piston therein, means connecting the piston and the object to move the object along said travel path by movement of the piston in one direction under the impetus of the pressurized fluid entering one end of the cylinder, means connecting the output of the pump to the power cylinder including a normally closed valve, means for opening said valve to provide communication between said pump and the power cylinder, said valve opening means further activating said pump to deliver its output to said power cylinder, and an automatically replenished accumulator containing pressurized fluid connected to the pump output to assist the pump by providing pressurized fluid to the power cylinder during only a portion of the power stroke of the piston, and means for continuing the operation of the pump after each power stroke is completed to build up the pressure in the accumulator to a preset level.

4. A fluid operator as recited in claim 3 wherein the means for continuing the operation of the pump includes a time delay means operable after the valve returns to its closed position.

5. The device as set forth in claim 4 wherein the pump is provided with a fluid supply reservoir and a pressure regulating valve and said time delay means is adapted to continue the operation of the pump to recirculate a small quantity of the output of said pump through the pressure regulating valve to the supply reservoir.

6. An automatic door operator system including a hydraulic cylinder having a piston therein and source of pressurized hydraulic fluid for powering the piston in response to pedestrian traffic through the associated doorway, said source comprising a pump of limited capacity relative to the requirements of the system and an auxiliary accumulator, power means for returning the door to its closed position, bypass valve means in the cylinder through which trapped hydraulic fluid in the power cylinder is discharged to damp the operator during the return stroke of the piston, and a hydraulically operated bypass control valve responsive to the pressure of the hydraulic fluid at the inlet of the power cylinder for preventing the leakage

of hydraulic fluid past the bypass valve means during the power stroke and to delay the initiation of the return stroke of the piston until after the bypass valve means is opened to discharge the trapped hydraulic fluid.

7. An automatic door operator system as recited in claim 6 wherein the bypass control valve includes a spool valve spring-biased in a direction to hold the reduced center portion thereof in alignment with the discharge port of the bypass valves whereby any hydraulic fluid tending to leak past the bypass valves during the power stroke produces equal and opposite forces on the bypass shuttle valve.

8. An operator as recited in claim 7 wherein the spool valve includes a stop projection at one end thereof for limiting the movement of the bypass control valve under the influence of the inlet pressure thereby closing the outlet port of the bypass valves.

9. The automatic door operator system recited in claim 7 wherein valve means are provided to trap the pressurized fluid in the power cylinder and in the bypass control valve after the power stroke of the piston until controlled leakage past the valve spool enables the biasing spring thereof to align the reduced center portion of the spool valve to discharge the trapped fluid thereby to regulate the time the door remains open prior to initiating its closing movement.

10. An automatic door operating system as defined in claim 7 wherein automatic time delay means are provided for causing the door to dwell in its open position for a predetermined time after the end of the power stroke and for continuing the operation of the pump until the accumulator pressure is returned to its original level.

References Cited by the Examiner

UNITED STATES PATENTS

2,900,791	8/1959	Kinsey	60—52
2,911,210	11/1959	Ferguson	268—66
2,918,085	12/1959	Govan et al.	60—52
3,084,927	4/1963	Linder	268—34

HARRISON R. MOSELEY, *Primary Examiner.*

J. K. BELL, *Assistant Examiner.*