Dec. 11, 1962 H. J. STRETTON 3,067,993

MEANS FOR AUTOMATICALLY OPERATING DOORS AND OTHER DEVICES

Filed Nov. 25, 1960 3 Sheets-Sheet 1

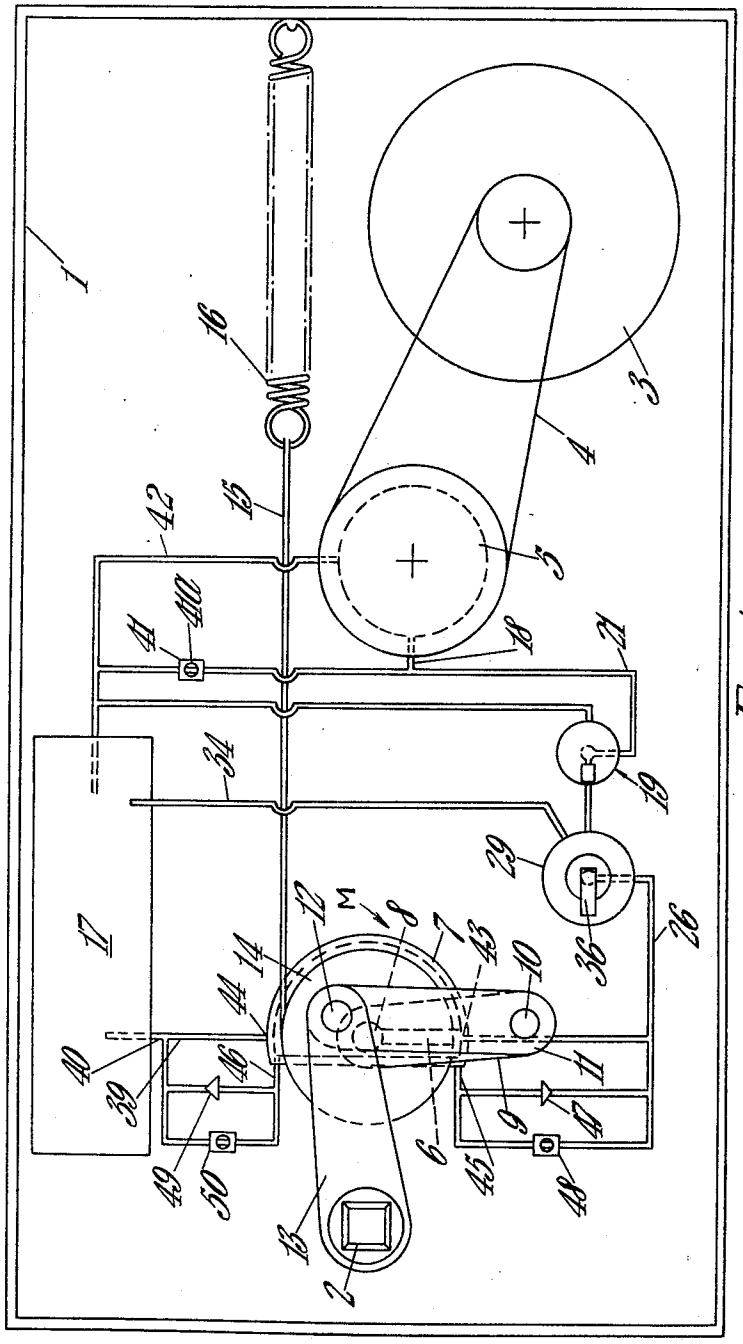


Fig. 1.

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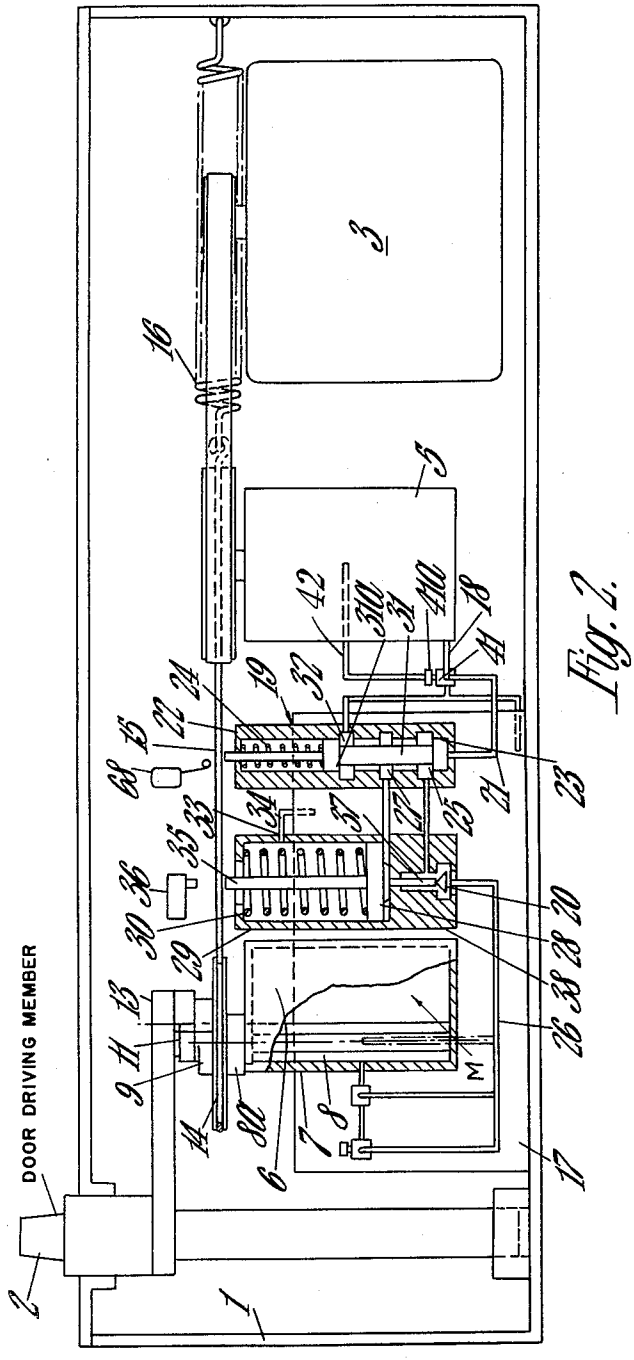


Fig. 2.

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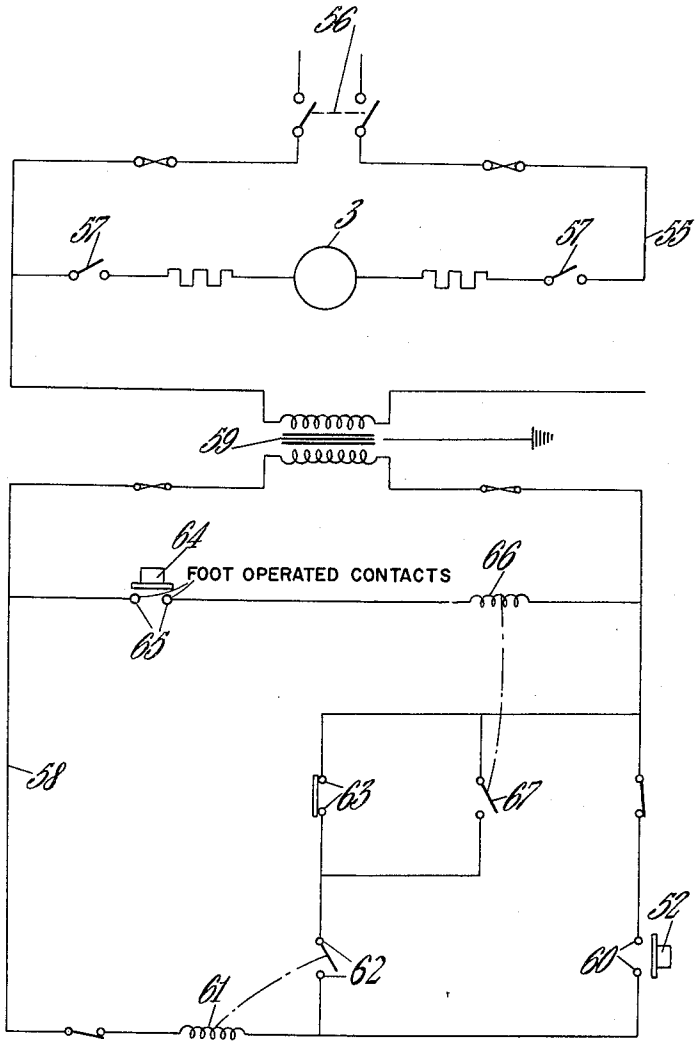


Fig. 3.

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MEANS FOR AUTOMATICALLY OPERATING DOORS AND OTHER DEVICES

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10 Claims. (Cl. 268—34)

This invention relates to means for automatically operating doors and other devices where a controlled time sequence is required, and has for its object to provide a relatively simple and reliable form of equipment for this purpose. The invention can be employed with equipment in which initiation of the operation is effected by any convenient means such as a push button or switch, or by means such as a photo-electric device or mat-operated contacts which opens a door for example upon the approach of a user thereto, and subsequently closes the door after a desired time interval.

According to the invention, means for automatically operating doors or other devices comprises a hydraulic pump and a hydraulic motor in a circuit which includes a control valve responsive to pump pressure and a non-return valve for preventing back flow from the hydraulic motor when the pump stops, and means for opening the non-return valve and permitting return movement of the hydraulic motor after a predetermined time interval.

The invention also consists in means according to the preceding paragraph in which opening of the non-return valve is effected by a loaded timing piston or hydraulic accumulator, displacement of which is initiated by the said control valve when the hydraulic motor has operated, and which actuates the said non-return valve on its return movement.

The invention also consists in operating means according to either of the two preceding paragraphs in which stopping of the pump is effected by the means for opening the non-return valve after said time interval.

According to a further feature of the invention, means is provided for damping the hydraulic motor at the end points of its travel. The hydraulic motor preferably comprises an angularly movable vane in an arcuate chamber, and including spring means for returning the vane after operation thereof.

In a preferred construction of the control valve said valve is displaceable under pressure of the hydraulic medium, supplied by the pump, to open ports communicating respectively with the non-return valve and with a timing piston or hydraulic accumulator. The control valve also includes a communication between the timing piston and a reservoir in the hydraulic circuit which communication is opened when the valve returns after stopping of the pump.

Other features of the invention will be defined in the appended claims.

In the accompanying drawings,

FIGURE 1 is a plan view of a door operating mechanism constructed in accordance with one form of the invention;

FIGURE 2 is a side elevation partly in section of FIGURE 1;

FIGURE 3 is a diagram showing the electrical connections.

In carrying the invention into effect according to one convenient mode illustrated in the drawings as applied by way of example to mechanism for automatically opening a door in response to operation of a switch by a user approaching the door, and for subsequently closing the door after an appropriate time interval there is provided a casing 1 mounted in a recess beneath the door

and having a rotary door driving member 2 for the door hinge. Housed within the casing 1 is an electric motor 3 driving through a belt 4 a pump 5 for supplying hydraulic medium to a hydraulic motor M for opening the door. The hydraulic motor comprises an angularly displaceable vane 6 in a sector-shaped chamber 7. The vane is carried by an operator 8 which is connected to the door driving member 2 by an arm 9 pivoted at 10 to a link 11 the opposite end of which is pivoted at 12 to an arm 13 secured to the drive member 2. A pulley 14 secured to the shaft 8*a* of the operator 8 has attached thereto a cable 15 connected to an anchored spring 16 which acts to close the door. The arm 9 on the motor shaft is positioned so as to be slightly in advance of the connecting link 11 and the door. The longer arm 13 on the door hinge is more or less parallel to the door, and the connecting link 11 is substantially perpendicular to the door and parallel to the motor vane 6. The arrangement is such that the longer arm 13 lies more or less perpendicular to the motor vane 6.

When the door is fully open, i.e. at 90° to its closed position, the arm 13 is more or less parallel both to the door and to the motor vane 6, and the connecting link 11 is perpendicular to the door and to the motor vane 6. Hence the return spring 16 which acts on the motor shaft 8*a* is afforded a greater mechanical advantage when the door is closed than when it is open, so that the door is not so easily opened by external pressure, as for example by draughts.

The pump 5 is connected in a hydraulic circuit including the hydraulic motor M and a reservoir 17, and between the pump outlet 18 and the hydraulic motor there are provided in sequence a pressure operated control valve 19 of the double piston or spool type, and a non-return valve 20 associated with a timing device. Referring to FIGURES 1 and 2, a conduit 21 from the pump outlet 18 leads to one end of a cylindrical control valve casing 22 so that pressure from the pump displaces the valve piston 23 against a loading spring 24 and opens a lateral port 25 communicating through the non-return valve 20 and a conduit 26 with the inlet side of the hydraulic motor M so that oil is pumped through the non-return valve to actuate the motor vane 6 and open the door. Further upward movement of the control valve piston 23 opens a second lateral port 27 which affords communication between the inlet 21 of the valve casing 22 and the underside of a timing or accumulator piston 28 which is slidable vertically in a cylinder 29 and is loaded by a spring 30. When the valve occupies the position shown, the second port 27 can also communicate through the space around the valve neck 31 with a third port 32 leading to the reservoir 17. When the door has been driven to its fully open position, the pump oil pressure rises and displaces the control valve piston 23 against its loading spring to open the aforesaid second port 27 and admit oil to the underside of the timing piston 28 which is thereby progressively displaced upwards, the non-return valve 20 meanwhile preventing back flow of oil from the hydraulic motor M. A leak-off port 33 with a communicating conduit 34 leads from the upper side of the timing piston 28 to the reservoir 17 which is at atmospheric pressure and is located mainly below the level of the conduit 34. A rod 35 on the timing piston 28 is arranged to actuate switch means indicated at 36 for stopping the pump driving motor 3 after a predetermined piston travel. As a result of the consequent loss of oil pressure in the system the control valve 23 returns to its lowest position, oil escaping through conduit 21 and bleed valve 41. Oil also escapes from beneath the timing piston 28 through the ports 27 and 32 of the control valve and returns to the reservoir 17, entering the latter below oil

level, the timing piston **28** being driven downwardly by its loading spring **30**. When the timing piston **28** reaches the end of its downward travel, the lower face thereof engages and displaces downwardly a slidable rod **37** extending into the casing **38** of the non-return valve **20** to open the said valve so that oil flows back from the inlet of the hydraulic motor M under the force provided by the door return spring **16** until the door has closed. This oil escapes through the space between the two piston elements **31** and **31***a* of the control valve and the third lateral port **2** leading to the reservoir **17**. During the operation of the pump, oil leaving the hydraulic motor M is returned to the reservoir **17** by way of ducts **39**, **40** as shown in FIGURE 1.

The upper part of the timing cylinder **29** contains air. The previously mentioned port **33** near the upper end of said cylinder is uncovered by the piston **28** when near the end of its upward travel and thereby provides a leak-off connection to the reservoir **17**. This arrangement affords pressure relief should the pump not stop when required, and also drains away any oil which may have leaked upwardly past the piston **28**.

As shown in FIGURES 1 and 2 an adjustable orifice bleed valve **41** having a head **41***a* is included in a by-pass connection between the pump inlet **42** and its outlet **18** for controlling the rate of oil flow in the system.

The construction of the hydraulic motor M is such that the vane **6** just before each of its end positions closes the main inlet port **43** and the main outlet port **44** respectively. To ensure correct operation there are therefore provided an additional inlet passage **45** and an additional outlet passage **46**. The inlet passage **45** communicates with the main supply conduit **26** through a non-return valve **47** which is by-passed by an adjustable orifice bleed valve **48**. The outlet passage **46** communicates with the oil return conduit **40** through a non-return valve **49** which is by-passed by an adjustable orifice bleed valve **50**. Thus on the inlet side of the hydraulic motor a starting impulse is given to the vane **6** by way of fluid passing through the non-return valve **47**. As soon as the initial movement of the vane has uncovered the inlet port **43**, oil will be supplied through the latter and the valve **47** closes. When the vane subsequently returns to its initial position, the terminal portion of its movement is damped by the bleed valve **48**. On the outlet side, as the vane approaches its end position the main outlet **44** is cut off and a damping effect is afforded by the bleed valve **50**, the non-return valve **49** being closed. On the return movement of the vane, the non-return valve **49** opens to admit oil to the vane cylinder to enable the vane to start.

Initiation of a door opening is effected by the closing of an electrical contact or switch, e.g. a push button, or by contacts closed by a mat or by a photo-electric device when a user approaches the door, and operating through the usual relay or contactor means to start up the pump motor. Referring to FIGURE 3, a push button **52** closes contacts **60** for opening the door. The motor **3** is in a circuit **55** supplied through a main switch **56**, the motor being started by the closing of contactors **57**. A control circuit **58** fed by a transformer **59** includes contacts **60** which are closed by operation of the push button aforesaid. This action energizes a relay coil **61** to close contacts **62** and also closes the contactors **57** to start the motor. The closure of the contacts **62** causes the coil **61** to act as a holding coil so that the motor continues to run after a momentary closing of the contacts **60**. The circuit also includes contacts **63** of the micro switch **36** shown in FIGURE 1. These contacts are normally closed but are opened by the rod **35** shown in FIGURE 2 after a pre-determined travel of the timing piston **28**. Opening of the contacts **63** by operation of the micro switch **36** de-energizes the holding coil **61** so that the control circuit is interrupted, the motor stops, and the door returns to closed position as previously described.

Means is also provided for delaying the closing of the door if a user remains in the vicinity thereof, and comprises safety mat-operated member **64** (FIGURE 3) located on the far side of the door in conjunction with a suitable mat (not shown). Foot pressure on this mat closes contacts **65** to energize a relay coil **66** to close contacts **67** in parallel with the contacts **63** of the micro switch **36**. Thereby the control circuit **58** remains closed and the motor **3** continues to operate the pump so that the door will not close until the user has left the safety mat and thereby opened contacts **65**. This arrangement deals with the possibility of a user passing through the door but not leaving the vicinity of the far side thereof, in which circumstances closing of the door against the user is prevented. So long as the safety mat remains depressed, the timing piston **28** will continue to rise until the relief port **33** opens.

The above described control circuit may be modified, if desired, by omitting the hold-on relay **61** and its contacts **63**, and substituting a hold-on switch. Referring to FIGURE 2, there is provided a micro switch **68** actuated by the initial opening movement of the control valve piston element **31***a* to actuate contacts **62** and maintain the motor circuit closed until the said control valve returns to its closed position.

The micro switch indicated generally at **36** in FIGURES 1 and 2 is adjustably mounted such that it can be slidably engaged by the rod **35** of the timing piston **28** to actuate the switch.

In the example and modifications described above it will be appreciated that in the event of a failure of the electrical power supply to the pump motor the door can be operated by hand.

It will be understood that whilst the invention is intended particularly for door operating mechanism it can be applied to other devices where an initial operation followed by a return movement after a predetermined time is desired. Also whilst the vane type of hydraulic motor is preferred, other types of motor could be employed as the actuating means.

I claim:

1. Hydraulic door operating equipment comprising in combination with a door, an hydraulic circuit with a motor for opening the door, an hydraulic pump for driving the hydraulic motor, an electric motor for driving the hydraulic pump, a control valve responsive to pump pressure, an hydraulic accumulator timing device disposed between said control valve and said hydraulic motor and a non-return valve adapted to be operably coupled with said hydraulic accumulator timing device for preventing back flow from the hydraulic motor when the pump stops and operation of said timing device being initiated by means of said control valve when the door has been fully opened by the hydraulic motor.

2. Hydraulic door operating equipment comprising in combination with a door, an hydraulic circuit with a motor for operating the door, an hydraulic pump for driving the hydraulic motor, an electric motor for driving the hydraulic pump, a displaceable plunger control valve responsive to pump pressure, a loaded timing piston disposed between said control valve and said hydraulic motor, a non-return valve adapted to be operably coupled with said loaded timing piston for preventing back flow from the hydraulic motor when the pump stops and displacement of said piston being initiated by said control valve when the hydraulic motor has operated, and said piston actuating said non-return valve on its return movement.

3. Hydraulic equipment as claimed in claim 2 in which stopping of said hydraulic pump is effected by return movement of part of said timing device after a time interval.

4. Hydraulic door operating equipment as set forth in claim 1 including means for damping the hydraulic motor at the beginning and end of its travel.

5. Hydraulic door operating equipment as set forth

in claim 2 in which the plunger of said control valve is displaceable under pressure of the hydraulic medium to open ports communicating respectively with the non-return valve and with said timing piston.

6. Hydraulic door operating equipment as set forth in claim 2 in which the plunger of said control valve is displaceable under pressure of the hydraulic medium to open ports communicating respectively with the non-return valve and with said timing piston, the control valve including a communication between said timing piston and a reservoir in said hydraulic circuit, said communication being opened when the said valve returns after stopping of said pump.

7. Hydraulic door operating equipment as set forth in claim 2 in which said timing piston is spring loaded and said non-return valve is arranged to be opened by displacement of a member which is engaged and displaced by said timing piston when said timing piston completes its return stroke.

8. Hydraulic door operating equipment as set forth in claim 1 and further including an adjustable orifice bleed valve included in a by-pass between the inlet and outlet of said pump.

9. Hydraulic door operating equipment as set forth in claim 1 in which said hydraulic motor comprises a vane angularly displaceable within a chamber and a connection between said vane and a door linkage comprises a linkage such that the travel of the door is less than the travel of the vane.

10. Hydraulic door operating equipment as set forth in claim 1 including a control circuit for said electric motor, door closing delaying means comprising foot operated contacts for energising a relay to close a switch in the control circuit of said electric motor, the closing of said door being thereby delayed until the user has left the vicinity of the door and opened said foot operated contacts.

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