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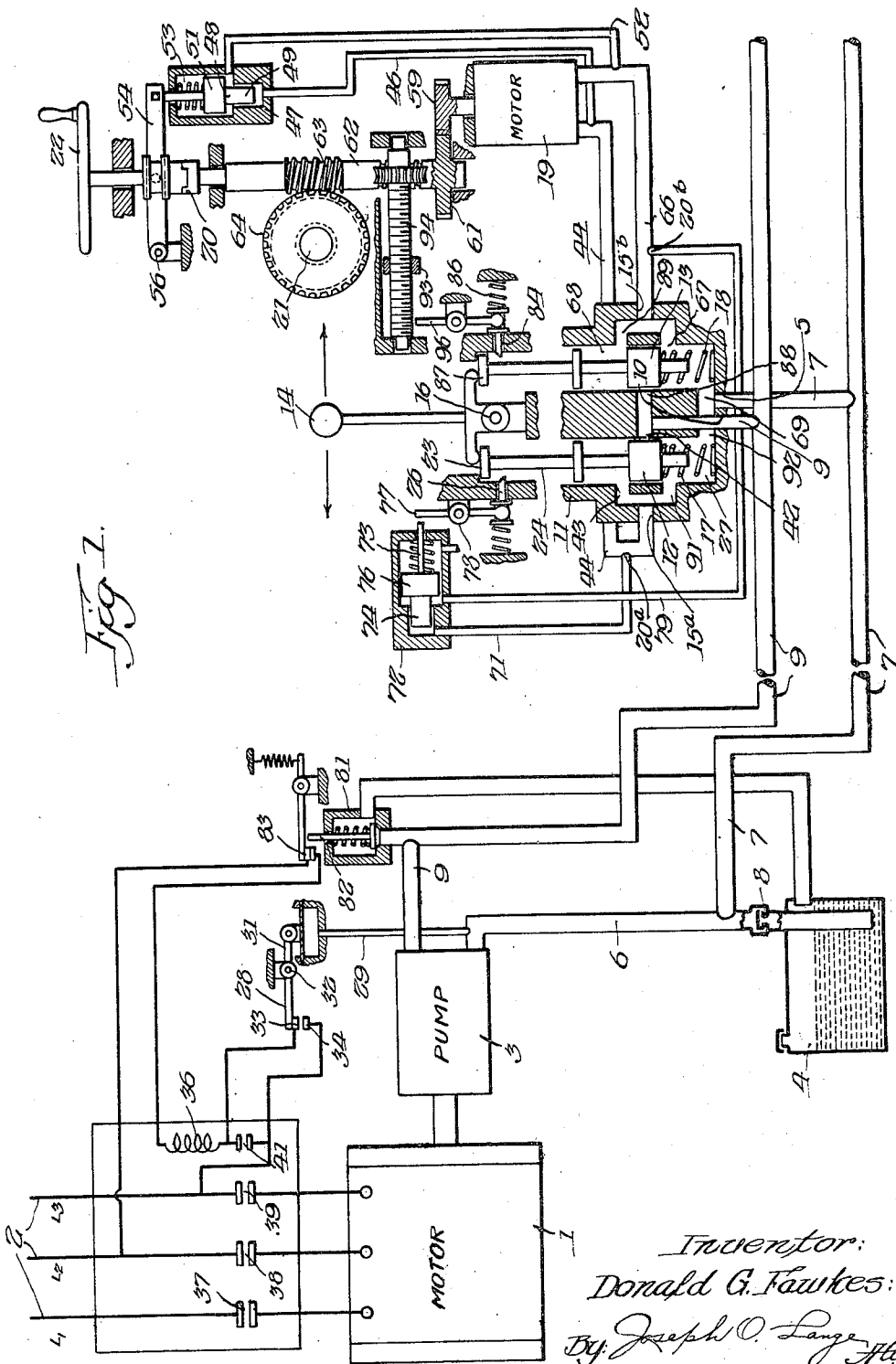
D. G. FAWKES

2,387,215

VALVE-OPERATING SYSTEM

Filed Feb. 5, 1943

4 Sheets-Sheet 1



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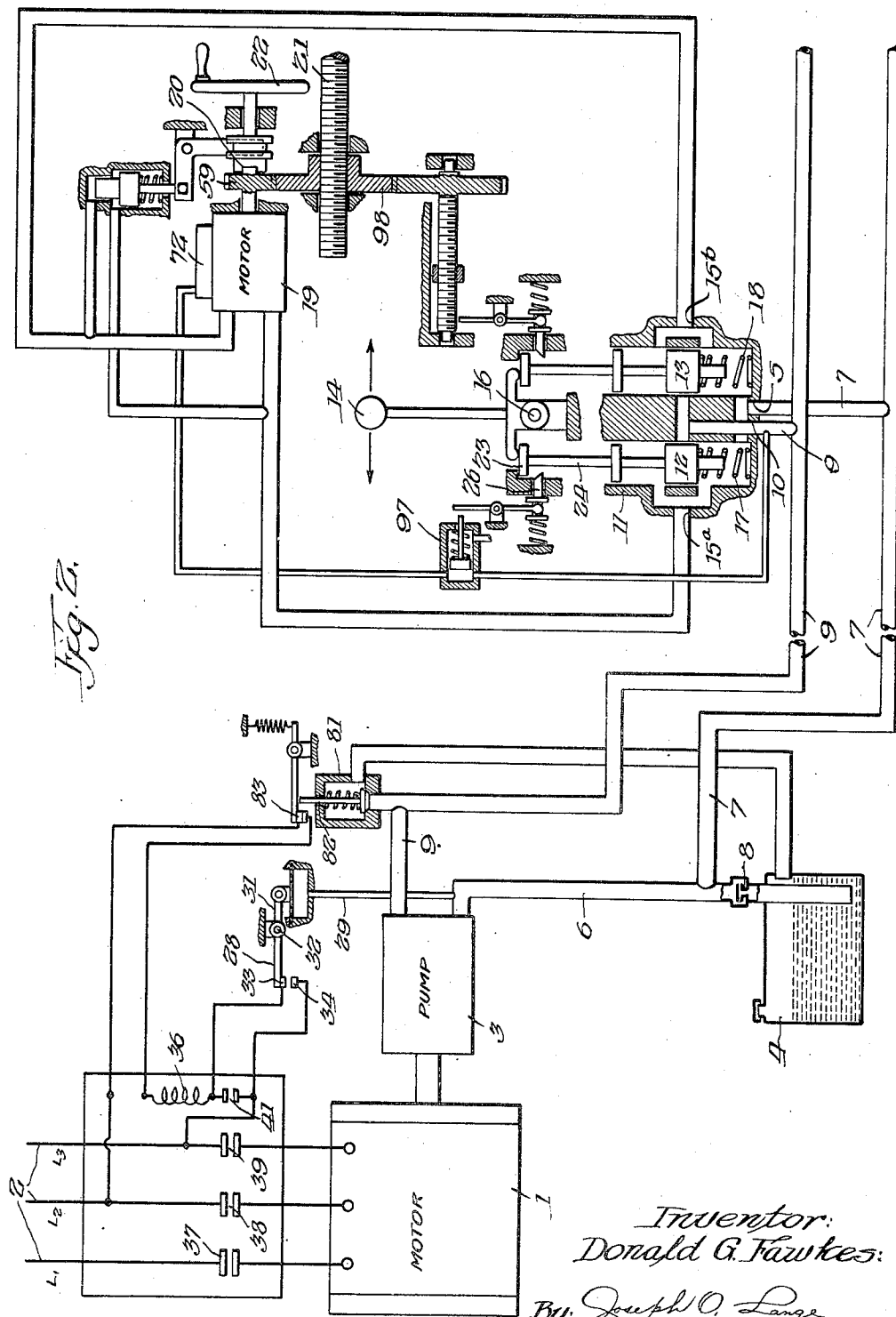
D. G. FAWKES

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VALVE-OPERATING SYSTEM

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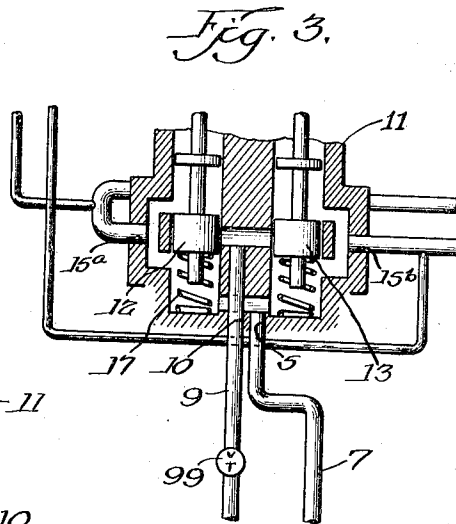
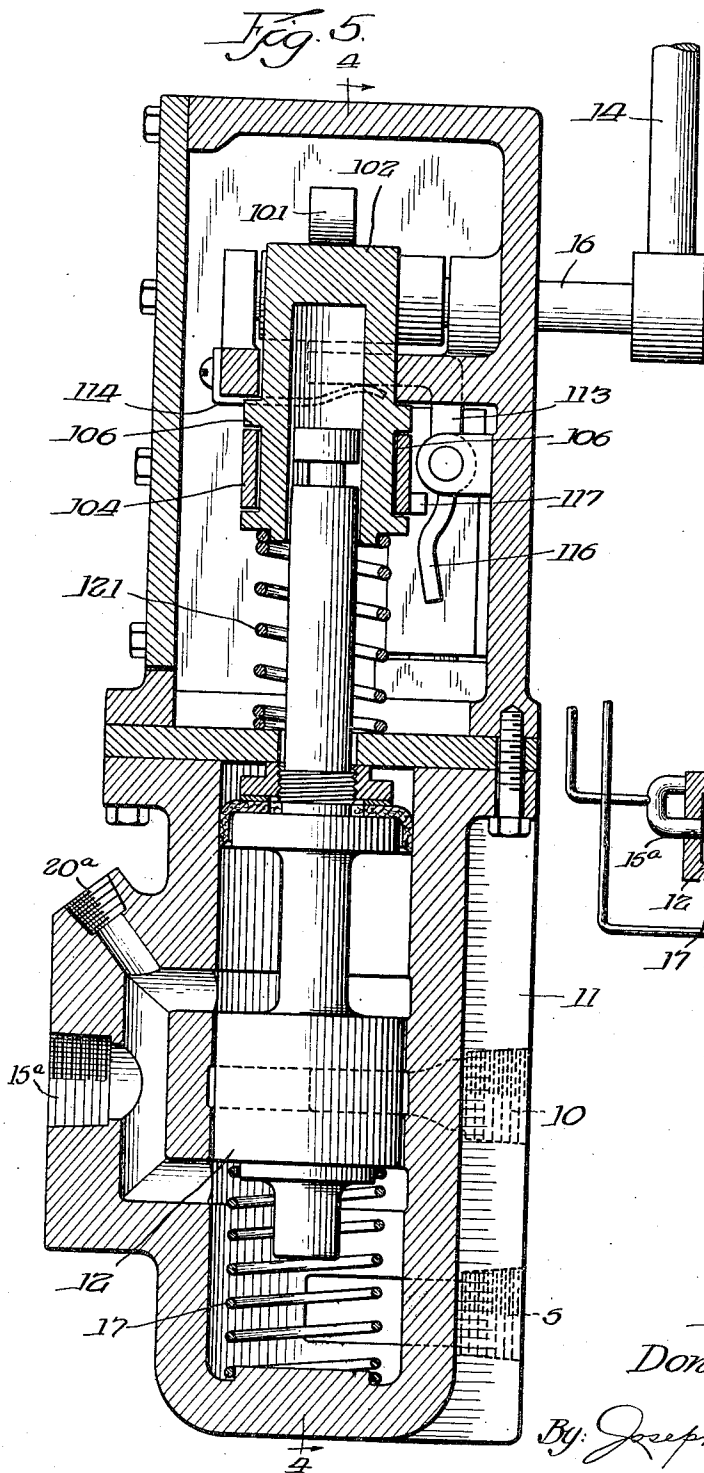
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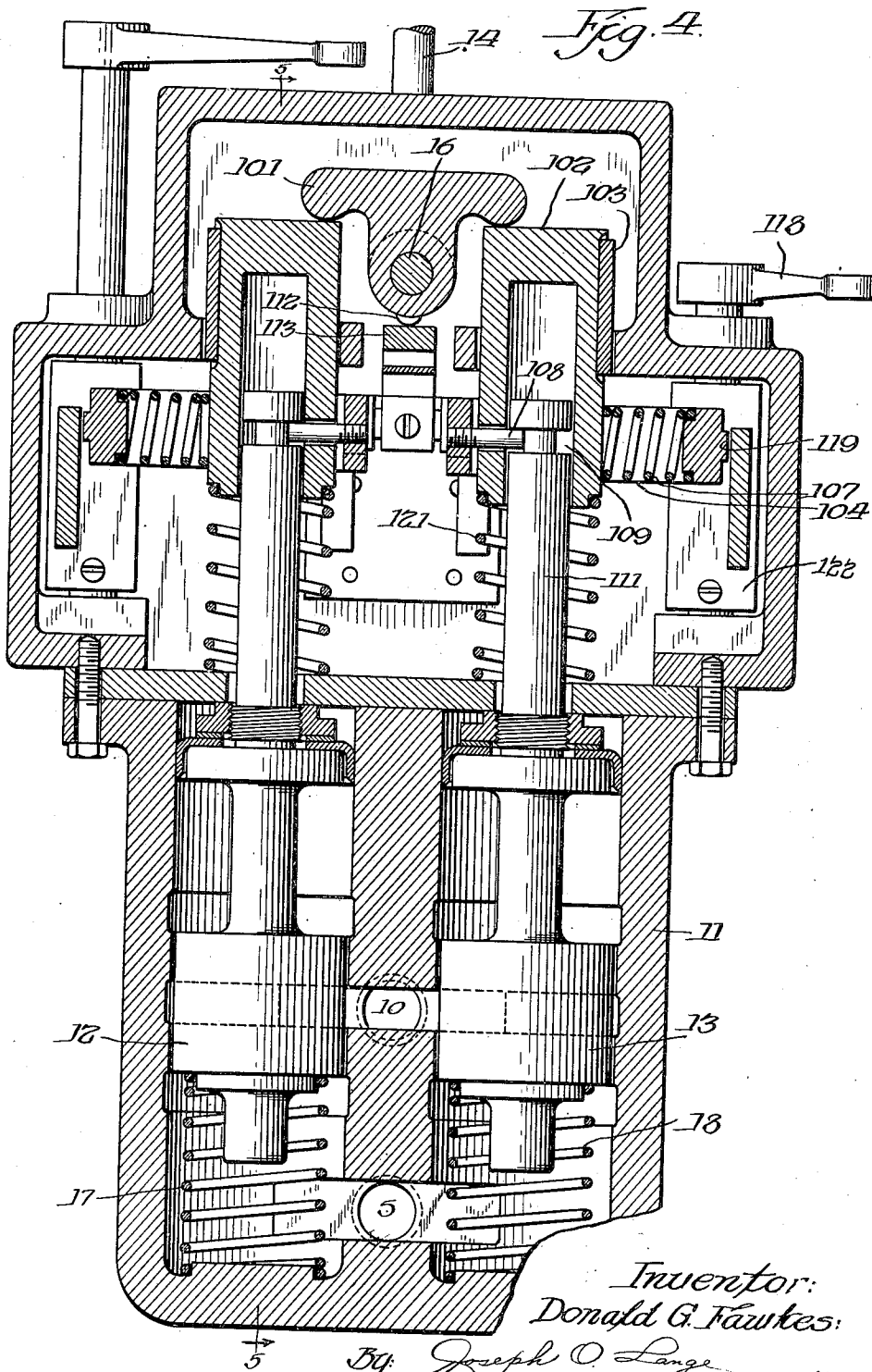
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VALVE-OPERATING SYSTEM

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UNITED STATES PATENT OFFICE

2,387,215

VALVE-OPERATING SYSTEM

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Application February 5, 1943, Serial No. 474,897

6 Claims. (Cl. 74-407)

This invention relates to a new and improved valve operating system or the like. More specifically, it has for one of its principal objects means for providing electrical operation therefor with the added feature of supplying a variable amount of torque output as determined by the resistance offered by the valve being thus operated particularly when the valve is in its final seating cycle and again when it is being lifted from its seat.

An important object of this invention is to provide a hydraulic valve operator electrically actuated and employing variable displacement pumps and fluid motors in which the latter are so arranged as to automatically vary the torque necessary in operating the valve satisfactorily. By my invention the speed of motor operated valves generally may be increased without impairing the efficiency of the valve operator employed.

Another purpose of this invention is to provide means whereby any number of separately actuable, hydraulically powered valve operating units may be supplied with operating fluid from a single remotely located electric motor driven hydraulic pump through a pair of supply and return lines.

A further object is to provide means whereby the electric motor driven pump is automatically started or stopped in response to the operation of the control valve of any of the individual operating units, without employing intervening electrical, mechanical or other impulse transmitting devices other than the supply and return lines.

As shown and hereinafter described, the individual operating units are not shown operable from a remote position, since the control valves must be located in the operating units proper in order that the open limit latches can be mechanically connected to the mechanism. It should be apparent, however, that either auxiliary hydraulic, electric or mechanical remote controls can be employed to operate the control valves from some remote position, if desired.

A still further object of this invention is to provide a duplex operated valve consisting of a hydraulic power actuator and a conventional manual actuator, the novel system having an automatic manual declutching means so that when the valve is being power driven the manually operated handwheel will not be rotated thereby avoiding injury to the operator thereof should both means of operation be attempted simultaneously. The valve operating mechanism of my invention preferably employs a variable displacement type of rotary fluid motor in which the displacement of the said motor is controlled by a

hydraulic plunger which is connected to the same source of fluid pressure supply as the fluid motor. It should be understood that various types of variable displacement fluid motors with plunger actuated stroke varying mechanisms are available, including radial piston, axial piston, vane and diaphragm types, and all of these motors are similar in that they are directly reversible merely by the act of interchanging the fluid supply and fluid return connections.

It is a further object to provide in this apparatus a stroke shifting cylinder on the fluid motor which is arranged to increase the displacement of the motor when the supply pressure is increased, whereby when the fluid motor encounters greater resistance to rotation the fluid pressure increases and the stroke shifter increases the displacement of the motor correspondingly. Such beneficial function by the stroke shifter accordingly provides for lowering the motor speed and raising the torque output. It will therefore become apparent that if the plunger within the stroke shifting cylinder is caused to move from the minimum motor displacement position to the maximum motor displacement position by a relatively small increase in the fluid pressure, the fluid horse power will remain practically constant even though the torque demand varies over a wide range. The latter characteristic is highly desirable for valve operator application because of the great difference that exists between the torque or thrust required to move a valve disc or closure member from its open to the closed position and the torque or thrust required to seat or to unseat the valve or closure member.

Other and further important objects will become apparent from the disclosures in the following specification and accompanying drawings, in which

Fig. 1 is a diagrammatic view of the electro-hydraulic valve operating system of this invention.

Fig. 2 is another diagrammatic view showing a modified form of valve operating system embodying this invention.

Fig. 3 is a fragmentary diagrammatic view of the hydraulic operating system of this invention similar to a portion of that structure shown in Fig. 1 but employing a modified means of actuation as hereinafter described.

Fig. 4 is a vertical sectional view of the novel control valve on the line 4-4 of Fig. 5 and as employed in the above hydraulic valve operating system.

Fig. 5 is a sectional view of the control valve taken on the line 5—5 of Fig. 4.

Similar reference numerals apply to similar parts throughout the various views of the drawings.

As shown in the drawings and referring particularly to Fig. 1, the reference numeral 1 indicates generally an electric motor or like prime mover connected to a line source of E. M. F. as indicated at 2, and mechanically connected with a pump 3 by any suitable means for the purpose of driving the said pump. In order to simplify the description of the system shown in Fig. 1, some of the details of the control valve shown in Figs. 4 and 5 have been omitted. Accordingly, the operators shown in Figs. 1 and 2 cannot be stopped at intermediate positions and do not function properly if the control valve handle is inadvertently held in the depressed position at the moment that either of the limit latches is disengaged from its associated plunger stem flange. The improved construction shown in detail in Figs. 4 and 5 obviates these faults. The suction side of the pump 3 is suitably connected, as indicated, to a conventional reservoir 4 containing the hydraulic fluid for circulation within the system; a conduit 6 interconnects the pump and the reservoir while an intercepting conduit 7 acts as the medium for return of the hydraulic fluid in the system via connection 5 after or during its course of operation to joint with the conduit 6. Immediately below the juncture of the pipe 7 with the pipe 6 and preferably at a location above the reservoir 4, the check valve 8 diagrammatically indicated is provided to prevent the displaced fluid in the valve operating system from flowing into the reservoir and thereby permitting in the operation of the valve system the use of the same circulating fluid over and over. The discharge side of the pump is provided with the conduit 9 which extends to the most remotely located valve operating unit in the system, as does also the fluid return conduit 7. Any number of other operating units are connected to the conduits 7 and 9 in the manner indicated in Fig. 1 at any point between the pump and the farthest end of the conduits. Each such operator is provided with its own control valve such as designated generally at 11 in Fig. 1. As indicated, the control valve 11 consists of two piston plungers respectively at 12 and 13 which are operable singly or one at a time by means of the control handle 14, the latter member being capable of rotating the shaft 16. It will be apparent depending upon which direction the control handle 14 is actuated, that such movement correspondingly depresses either of the plungers 12 or 13 against the action of the springs 17 and 18 below the said plungers 12 and 13 as hereinafter explained in greater detail. The circulating line fluid under pressure from the pump 3 is directed by means of the control valve 11 to the fluid motor 19 which is of the combined wobbler-reciprocating type and which acts through the gearing arrangement shown to rotate the stem 21 of the valve to be operated (not shown). The handwheel 22 is provided to engage the valve stem 21 through means of the clutch 20 and gear arrangement illustrated, functioning when the fluid motor 19 is not being used to actuate the valve stem.

The control valve 11 is operated by actuating movement of the control handle 14. For purposes of explanation, let it be assumed that the valve to be operated is to be closed. Such clos-

ing operation is normally effected by a movement to the left or counter-clockwise movement of the control handle 14, which latter movement of the control handle 14 causes the plunger 12 to move downwardly until the flange 23 on the end of the plunger stem 24 passes the latch pin 26. The control handle 14 is then released and the latch pin 26 holds the plunger 12 in a depressed position. In order to move the valve plunger 12 downward, the fluid in the lower end of the plunger cylinder 27 must be displaced. Since all the fluid lines connected to the lower end of the valve cylinder 27 are either dead-ended or lead to other components which present considerable resistance to the outward flow of the fluid, the downward movement of the plunger 12 provides for the accumulation of pressure in the fluid return line 7. The latter line communicates with the pressure switch 28 at the inlet side of the pump 3 through the conduit 29 which permits such pressure to move the lever arm 31 pivoted at 32 upwardly at its right end and downwardly at its left end to engage the contact points 33 and 34. The check valve 8 in the suction line 6 extending from the reservoir 4 prevents the displaced fluid from flowing into the reservoir 4. When the contacts 33 and 34 of the pressure switch 28 are closed, the contactor solenoid 36 is energized, which closes the respective motor contacts 37, 38 and 39 and also the holding contacts 41. The holding contacts 41, being connected in parallel with the pressure switch 28, maintain the solenoid 36 energized after the pump begins to operate, which latter operation results in relieving the pressure in the suction line 6 and the consequent opening of the contacts of the pressure switch 28.

As soon as the pump 3 begins to operate, the pressure in the return line 7 is reduced and the control valve plunger can be moved downward until it latches. The fluid discharged from the pump flows into the supply line to the control valve 11 through the port 42 via connection 10 into the valve cylinder 27, through the port 43 into the line 44 via connection 15a to the fluid motor 19. Adjoining the conduit 44 is the conduit 46 leading to the handwheel declutching cylinder 47. The declutching cylinder 47 contains a differential or double piston 48, the smaller diameter cylinder 49 being connected to one side of the fluid motor 19, and the larger diameter cylinder 51 to the other side of the fluid motor 19 via the conduit 52. The latter construction provides the assurance that the handwheel will be declutched when the motor is started in either direction, and results in a minimum of fluid leakage from the supply side to the suction side of the circuit. Only a relatively small pressure is required to move the declutching piston 48 so that the motor 19 does not begin to operate until the declutching piston 48 has reached the upper limit of its travel against the action of the spring 53. The latter movement of the declutching piston serves to lift the lever arm 54 which is pivoted at 55 and causes the clutch 20 to become disengaged. The pinion 59 on the motor shaft meshes with and rotates the gear 61 and the shaft 62, upon which is mounted the worm 63. The latter member meshes with the worm gear 64 keyed to the valve stem 21, as indicated. It is apparent that this movement causes the valve stem 21 to rotate in a clockwise or closing direction. Continuing with the description of the circulation of the fluid through the operating system, the fluid flows

through the motor 19 into the line conduit 66 to the control valve 11 at the connection 15b through the port 67 into the right hand valve cylinder 68, and through the port 69 via the connection 5 to the return line 7.

When the disc of the valve being operated (not shown) reaches its seat, that is to say, is closed, it is well known that the torque required to turn the valve stem 21 in the closing direction increases, and therefore the motor 19 offers increased resistance to the flow of fluid through it. Thus as the pressure in the supply line 9 increases, the latter increased pressure is communicated to the stroke shifting cylinder 72 on the motor through the conduit 71 at the connection 20a to the valve 11. The stroke shifting cylinder 72, in addition to serving to vary the motor displacement, also functions to unlatch or release the closing valve plunger when a predetermined fluid pressure within the system is attained. The releasing action referred to is accomplished by means of the rod 73 which is fixedly attached to the differential piston, the latter member having the usual portion comprising a small diameter 74 and a large diameter 76. Accordingly, axial movement of the differential piston results in similar movement of the rod 73 so as to permit the latter to strike the pivotally mounted arm 77, positioned as at 78, which causes the latch 26 to be withdrawn and to thereupon permit the plunger 12 and the flange 23 thereof to rise to its normal upward position. The differential piston 74-76 is preferably used in the stroke shifter 72 in order that the motor 19 will have its variable torque characteristic regardless of the direction in which the motor 19 is rotated. Thus if the power operator is being employed to open the valve, pressure will be brought to the stroke shifting cylinder 72 through the conduit 79 from the line 66 at the connection 20b. The conduits 71 and 79 are not interconnected and therefore are not capable of by-passing fluid. However, each is independently responsive to the piston 74-76 to vary the displacement of the motor and also to act as a valve seat thrust limiting means and to thereby disengage the latch 26 so as to permit movement upward of the control valve plunger 12. The latter movement of the control valve plunger 12 disconnects the motor from the source of fluid supply. When the port 42 is shut off by the plunger 12, pressure in the fluid supply line thereupon increases rapidly until at the set or predetermined pressure the relief valve 81 diagrammatically illustrated at the pump discharge opens. In opening, the relief valve stem 82 opens a pair of controls 83 which interrupt the electrical circuit through the main contactor solenoid 36, thus allowing the motor contactors 37, 38 and 39 to open.

To operate the main valve (not shown) in the opening direction, the control handle 14 is moved to the right, which movement accordingly causes the right-hand plunger 13 of the control valve 11 to move in a downward direction until the latch 84 under pressure of a spring 86, and which is similar in its operation to the latch pin 26 engages the plunger stem flange 87. The described movement of the plunger 13 thereby creates pressure in the return line 7, operating the pressure switch 28 and starting the pump 3 in motion as described above in connection with the closing of the main valve. Fluid then flows into the control valve 11 through the port 88 into the valve cylinder 68, thence through the port 89 at the connection 15b into the line conduit 66 and to the motor 19. It will be apparent that simultaneously there-

with the fluid under pressure in the line 66 is partially diverted or bypassed through the conduit 52 to the handwheel declutching cylinder 47 which thereby causes the handwheel 22 immediately to become disengaged from the main valve stem 21. When the handwheel has thus been declutched, line fluid actuating pressure increases within the system until the motor starts to rotate and to operate the valve. Line fluid is then discharged from the motor into the conduit 44, passing from the latter line via the valve port 91 into the left-hand cylinder 27 of the control valve 11. Thence it moves through the cylinder 27 into the valve port 92 and past the connection 5 into the fluid return line 7. If the main valve is being initially closed, it is well known that a relatively high torque is required to accomplish such operation. Thus the high resistance offered to the flow of fluid through the motor causes the supply pressure to rise and the effort behind the motor stroke is accordingly increased by means of the pressure acting through the conduit 79 to the stroke shifting cylinder 72 and subsequently against the large diameter of the piston 76 to produce a relatively large displacement by the motor. As distinguished from the seating operation when the unseating of the main valve disc (not shown) continues, the torque required to operate the valve is reduced and the operating fluid pressure is accordingly decreased. Thus as the motor displacement is decreased by the stroke shifting cylinder 72 in the manner previously described, the motor speed increases. Under these conditions, as the valve disc reaches its near full open position the nut 93 threadedly mounted on the open position limit screw 94 moves axially forward to strike the latch lever 96, thereby disengaging the latch 84 from the stem flange 87 and allowing the valve plunger 13 to be moved to its normal upper position by means of the plunger spring 18. Immediately upon the occurrence of such latter movement, the relief valve 81 opens and stops the pump 3 in the manner previously described in connection with the main valve closing operation.

Directing attention now to Fig. 2, the modified valve operator therein shown is substantially the same as that described in connection with Fig. 1, but features a special seating construction and also a novel arrangement of the operating system with relation to the main valve stem. Specifically, a separate seat thrust limiting cylinder 97 is employed in place of the construction wherein the seat thrust limiting arrangement constituted a part of the stroke shifting cylinder 72 superposed on the motor 19 as shown in Fig. 1. Under certain installation conditions, this modification possesses advantages in its simplicity of application. Also a novel gearing arrangement is employed in the modified form shown in Fig. 2 whereby the pinion 59 in cooperation with the motor 19 effects rotative movement of the gear 98 which accordingly serves to move the valve stem 21 reciprocally as described in detail in connection with Fig. 1.

A further modified form of the present valve operating system is shown in Fig. 3 in which the valve operator of Fig. 1 is provided with an independent supply of fluid of sufficiently high pressure in place of the pump 3 and wherein a conventional throttling valve or orifice 99 is positioned in the line 9 connecting such fluid supply source with the control valve 11. Thus it will be seen that in Fig. 3 the pump may be dispensed with and the drain line 7 then simply discharges to a

location which may be removed from the valve operator system without necessarily returning to a reservoir 4 as illustrated in Figs. 1 and 2. It will be apparent that whenever the motor torque decreases, the motor speed is increased and the rate of flow through the motor increases; similarly the increased flow through the throttle valve 99 results in increased pressure drop and the pressure at the motor is therefore decreased, thereby causing the stroke shifter 72 to decrease the displacement of the motor 19. The throttle valve 99 is preferably adjustable so that the actuating pressure at the motor when the valve operating system is relatively lightly loaded (for example, when the valve is being operated from the closed or from the open position but without being actually seated or unseated) will be somewhat below the supply pressure. Subsequently when the main valve disc or closure member reaches its seat or is back-seated in the wide open position, the motor 19 encounters increased resistance and slows down, decreasing the flow therethrough. Accordingly, the pressure at the motor is increased and the stroke shifter 72 increases the motor displacement, thus enabling it to supply the increased torque required under the main valve operating conditions referred to.

The novel control valve of my invention is shown in detail in Figs. 4 and 5 which show a preferred form of construction for the control valve 11, comprising the spring-loaded plungers together with their actuating means. Thus when the control handle 14 is turned clockwise, as seen in the plan view in Fig. 4, the cam 101 mounted on the shaft 16 moves the sleeve 102 downwardly toward the interior body portion of the control valve 11. The sleeve 102 is prevented from rotating about its axis by means of the key 103. The slidable member 104, as better shown in Fig. 5, is positioned on the sleeve 102 and is slidably mounted in the grooves 106 on the top and bottom sides of the sleeve 102. The member 104 is urged outwardly by means of its spring 107 which maintains the pin 108 in engaged position with the groove 109 provided in the end of the plunger stem 111. Accordingly the plunger 13 is further moved downwardly with the sleeve 102 as the control handle 14 is further rotated in a clockwise direction. When the control cam 101 is rotated from its neutral or ineffective position by means of the control handle 14, the lobe 112 on the underside of the hub of the cam 101 recedes from the latch shaft lever 113, thus allowing the latch shaft spring 114 to rotate the latch 116 in a clockwise direction as seen in Fig. 5, until it rests against the catch 117 on the slidable member 104. Then, as the sleeve 102 is moved downwardly, the catch 117 rides against the latch 116 until, at its fully depressed position, the catch 117 passes the end portion of the latch 116, thereby enabling the latch to rise behind the catch and to hold the slidable member 104, the sleeve 102 and the plunger 13 in like depressed position.

When the trip lever 118 is rotated in a clockwise direction as viewed from the upper end of Fig. 4, the trip 122 strikes the boss 119 on the end of the slidable member 104 and moves the latter member to the left as seen in the top view (Fig. 4), until the catch 117 moves over the end of the latch 116, thereby allowing the sleeve spring 121 to effect movement of the sleeve 102, the plunger 13, the control cam 101 and the control handle 14 to the neutral position.

It will be apparent that if the control handle 14 is inadvertently held in the operating position,

the sleeve 102 cannot return to the neutral position when the trip lever 118 is operated. In this event the pin 108 in the end of the slidable member 104 disengages the groove 109 in the end of the plunger stem 111, thereby allowing the plunger 13 to move upwardly by the action of the spring 18 until it reaches its stop. Subsequently, when the control handle 14 is released, the sleeve spring 121 forces the sleeve 102 upwardly until the pin 108 again engages the groove 109 in the plunger stem 111.

If it is desired to stop the valve operator at any intermediate position, the control handle 14 is rotated to the central or neutral position where the latch lobe 112 on the control cam 101 pushes the latch shaft lever 113 downwardly, disengaging the latch 116 and permitting the depressed plunger 13 to return to its neutral position.

In summary, it is evident that I have developed a flexible and efficient valve operator or the like and that numerous details of construction may be varied over a wide range. It is therefore not proposed to limit the patent granted hereon otherwise than as necessitated by the prior art.

I claim:

1. A valve operating fluid system or the like comprising, in combination, a fluid motor, a fluid supply line therefor, combined manual means and an electrically operated hydraulic means; the said manual means comprising a handwheel, a clutch; a declutching cylinder, the said handwheel being declutched when the said declutching cylinder reaches the limit of its travel in one direction, the said electrically operated hydraulic means comprising a source of E. M. F., an electric motor, a fluid pump, a fluid reservoir in communication with the said pump, a control valve connected to the pressure side of the said pump, a pressure switch cooperating with the said control valve to actuate the said pump, a relief valve connected to the pressure side of said pump and to the fluid reservoir, solenoid actuated means cooperating with the said relief valve, switch means operable by the actuation of the said relief valve whereby when the pressure in the system reaches a predetermined maximum the relief valve will jointly open and permit fluid in the system to return to the reservoir and provide for disengagement of the source of E. M. F. from the said electric motor, the said solenoid actuated means interrupting the E. M. F. circuit through the relief valve upon actuation of the latter at a predetermined pressure within the said fluid supply line of the system.

2. In combination, a valve operating fluid system comprising a fluid motor, a fluid supply line therefor, manual means and an electrically operated hydraulic means; the said manual means comprising a handwheel, a clutch; fluid actuated means for the said clutch, the said manual means being selectively disengageable from the hydraulic means, the said electrically operated hydraulic means comprising a source of E. M. F., an electric motor, a fluid pump, a fluid reservoir in communication with the said pump, a control valve connected to the pressure side of the said pump, the said control valve having a plurality of plungers, movement of one of said plungers disconnecting the said fluid motor from the fluid supply line, a relief valve connected to the pressure side of said pump and to the fluid reservoir, the said relief valve cooperating with the movement of the plungers of the said control valve and electrical means cooperating with the said relief valve whereby when the pressure in the

system reaches a predetermined maximum the relief valve opens to permit line fluid from the fluid motor to return to the reservoir and provide for disengagement of the source of E. M. F. from the said electric motor, the said control valve having a bypass connection with the fluid actuated means for the said clutch whereby simultaneous with the application of fluid pressure to the said fluid supply line the said handwheel is disengaged so as to be freely rotatable independent of the electrically operated hydraulic means.

3. A combined fluid and manual operating system comprising, in combination, a fluid motor, a handwheel alternatively usable with the fluid motor, a hydraulic system comprising a source of E. M. F., an electric motor therefor, a fluid pump cooperating with said electric motor, a fluid reservoir for the pump, a control valve having its inlet connected to the pressure side of said pump and its exhaust to the suction side of said pump, an electrical pressure switch normally open and connected to the suction side of the said pump so that when the said control valve is being actuated residual fluid in the hydraulic system is caused to reverse its flow to actuate the said pressure switch, a solenoid, the said pressure switch cooperating with the said solenoid to hold the latter member energized at a predetermined stage of operation of the said pump, a series of electric motor holding contacts connected in parallel with the said pressure switch whereby when the pressure switch closes the solenoid is actuated and causes the motor holding contacts to close and the said electric motor to begin operation.

4. A fluid operated system of the character described comprising, in combination, a fluid motor, a handwheel selectively disengageable from the fluid motor drive, a hydraulic system comprising a source of E. M. F., an electric motor therefor, a fluid pump in communication with said electric motor, a fluid reservoir connected to the pump, a control valve having its inlet connected to the pressure side of said pump and its exhaust to the suction side of said pump, an actuating handle for the said control valve, the latter member having a plurality of plungers operable singly upon predetermined movement of the said actuating handle, an electrical pressure switch normally open and connected to the suction side of the said pump, at least one of the control valve plungers being in communication with the said pressure switch whereby when the control valve is actuated residual fluid in the hydraulic system is caused to reverse its flow to actuate the said pressure switch, a solenoid cooperating with the said pressure switch, a series of electric motor holding contacts for the said pressure switch, the motor holding contacts energizing the said solenoid whereby when the pres-

sure switch is closed the solenoid is actuated, a stroke shifting cylinder communicating with the said control valve whereby one of the plungers of the said control valve may be released when a predetermined fluid pressure within the hydraulic system is attained.

5. The combination of fluid operated means for independently operating a plurality of valves or the like, a system comprising combined manual means and electrically operated hydraulic means; a fluid motor, said manual means including a handwheel independently operable from the said hydraulic means, a clutch therefor, driven means intermediate the handwheel and the means to be operated; means operating the said clutch in communication with the said hydraulic means, the said electrically operated hydraulic means comprising a source of E. M. F., an electric motor, a pump cooperating with said electric motor, a fluid reservoir connected with said pump having an outlet and a return conduit, a control valve communicating with said fluid motor, connecting conduits between the said pump and the said control valve whereby the independently actuatable hydraulically powered operating units may be supplied with operating fluid from the said pump, the said control valve including means movable to create pressure in the said return conduit of the pump, a pressure actuated switch movable in response to the pressure created in the return conduit to initiate operation of the said pump, the said means to render the clutch operable being pressure responsive to provide for operation of the said handwheel, the said latter means being simultaneously actuated with the movement of line fluid under pressure through the said control valve to the said fluid motor.

6. Actuating means in combination for operating one or more valves or the like, the combination including manual means and electrically operated hydraulic means including a fluid motor therefor; each of said manual means including a handwheel and a clutch both of which are movable independently of the said hydraulic means, fluid means for actuating the said clutch, the said electrically operated hydraulic means comprising a source of E. M. F., an electric motor, a pump cooperating with said electric motor, relief means associated with the said pump, a source of fluid supply communicating with the said pump and said fluid motor, a control valve communicating with said fluid motor and the said means for actuating the clutch, connecting conduits between the said pump, the said control valve and clutch actuating means, whereby the control valve, the fluid motor and the clutch actuating means may be simultaneously supplied with operating fluid from the said pump.

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