Sept. 4, 1945. D. G. GRISWOLD 2,384,420

PUMP CONTROL MEANS

Filed Aug. 5, 1942

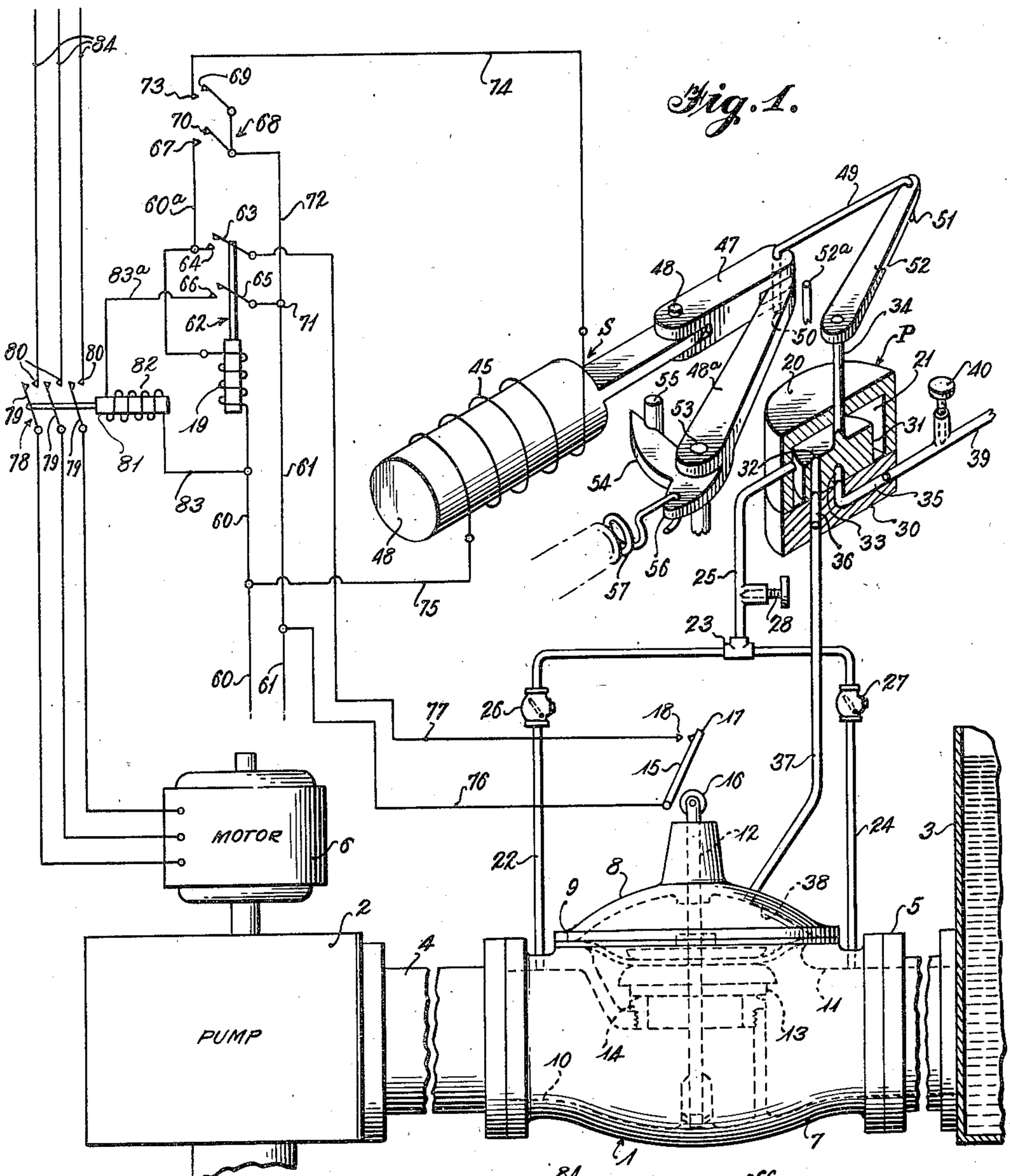

Fig. 1.

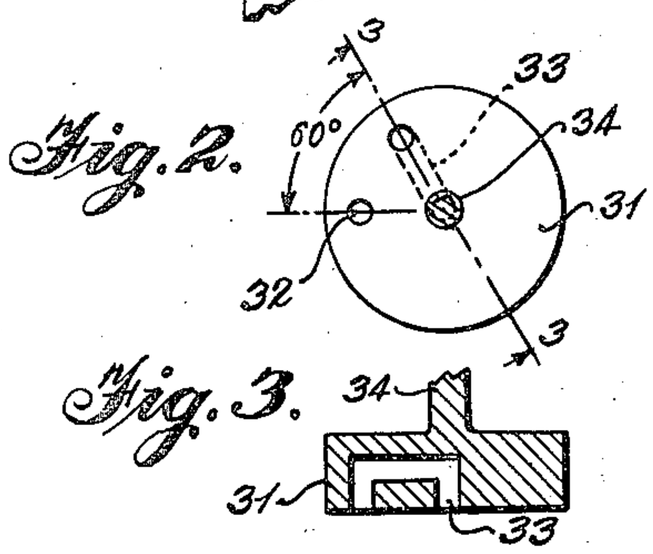

Fig. 2.

Fig. 3.

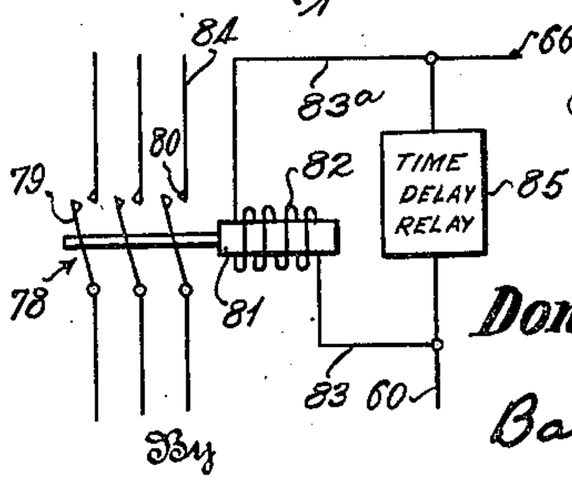

Fig. 4.

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Patented Sept. 4, 1945 2,384,420

UNITED STATES PATENT OFFICE

2,384,420

PUMP CONTROL MEANS

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Application August 5, 1942, Serial No. 453,709

15 Claims. (Cl. 103—40)

This invention relates broadly to pump control means.

The main object of the invention is to provide pump control means which will eliminate the line surges that usually occur during the starting and stopping of a pump.

Briefly, the invention comprises a valve connected in a pipe line on the discharge side of the pump, and control means for both the valve and pump arranged so that the valve will normally be closed but will start to open at about the same time that the pump is started (either slightly after or before the pump starts, depending upon the nature of the installation), and which valve will begin to close before the pump is stopped and will have reached approximately its completely closed position at the time that the pump is actually stopped.

Many water pumping and distribution systems now in use are unsatisfactory because of the surges which occur therein and impose severe shocks upon the system. These shocks are often of sufficient magnitude to break the pipe or cause irreparable damage to the valve controlling the line. Usually, the shocks are caused by a negative surge in the line due to the reduction of pressure when the pump is shut off, coupled with the momentum of the body of water in the line which tends to move to and fro until equilibrium is established. This negative surge when recorded on a pressure chart will take the form of a series of waves which indicate fluctuations in pressure that are bound to produce an objectionable hammering effect upon the entire system.

The present invention in one of its forms overcomes the above difficulties by requiring the valve in the line to be closed when the pump is started and to open gradually very shortly after the pump has been started. In this manner pressure is built up in the line against the resistance to flow offered by the gradually opening valve and, it is, therefore, impossible for surging to occur in the line at the time of the starting of the pump. Similarly, when it is desired to shut down or stop the pump, the valve is closed gradually and reaches its fully closed position at about the time that the pump is shut off. Again, no surges can occur in the line because the valve offers a restriction or resistance against which the pump must work so that a definite pressure is maintained in the line, whereby there can be no to and fro movement of the water in the line to produce the damaging effect attributed to surging.

The aforedescribed gradual opening and closing of the valve, while the pump is operating, can take place without any injury to the valve or line if a centrifugal pump, for example, is employed, which pump will permit a certain amount of "slip" so that no excessive pressures can be built up in the line. While it is preferable to use a centrifugal pump, nevertheless a positive displacement pump can be used by employing a conventional relief valve therewith which will relieve the pressure on the discharge side of the pump.

According to another embodiment of the invention, the valve is opened slightly before the pump is started in order to permit water to prime the pump, or to wet the bearings of certain types of pumps before any pumping is actually attempted. This embodiment employs a time delay relay in connection with the pump control.

Referring now to the drawing:

Fig. 1 diagrammatically illustrates a pump and valve installation including all of the controls necessary to practice the principles of the invention;

Fig. 2 is an enlarged plan view of a pilot disc that may be used to hydraulically control the opening and closing of the valve;

Fig. 3 is a sectional view through the pilot disc taken on the line 3—3 of Fig. 2, particularly illustrating the shape of the exhaust port;

Fig. 4 is a view of a fragment of the control circuit showing a time delay relay associated with the motor control switch.

In Fig. 1 the numeral 1 generally indicates a main valve connected between a centrifugal pump 2 and a storage tank 3, for example. Suitable piping 4 connects the discharge side of the pump 2 with the valve 1 and similar piping 5 connects said valve with the tank 3. The pump 2 is adapted to be driven by an electric motor 6, which is controlled in a manner explained more fully hereinafter.

The main valve 1 includes a body 7, a cover 8, and a flexible diaphragm 9 marginally secured between said body and cover. The body 7 contains an inlet chamber 10 and an outlet chamber 11. A valve stem 12 is conventionally secured to the diaphragm 9 and carries a closure member 13 arranged to engage a seat 14 for controlling the flow between chambers 10 and 11. It will be understood that the valve stem 12 is raised and lowered as the valve 1 is opened and closed, respectively. This movement of the valve stem is utilized in the present invention to actuate a conventional micro switch 15 preferably

arranged exteriorly of the main valve 1. The valve stem 12 projects outwardly of the cover 8 and carries a roller 16 adapted to engage the movable contact element 17 of the micro switch 15 as said stem moves upward. The movable contact 17 is arranged to engage a stationary contact 18 of the micro switch 15 to complete a circuit to a holding coil 19, the function of which will be described more fully later.

The opening and closing of the main valve 1 is controlled by a pilot valve P, which in turn is actuated by a solenoid mechanism generally indicated by the letter S. The pilot valve P includes a housing 20 containing a chamber 21 adapted to receive operating fluid under pressure. In the present construction, the chamber 21 is connected with both the inlet chamber 10 and the outlet chamber 11 of the main valve 1. Thus, a conduit 22 extends from the inlet chamber 10 to a pipe T 23, and a conduit 24 connects the outlet chamber 11 with said pipe T. A conduit 25 connects the stem of the T 23 with the pressure chamber 21. A check valve 26 is arranged in the conduit 22 and a check valve 27 is arranged in the conduit 24. The check valves 26 and 27, as will be obvious from the drawing, are arranged so that fluid can flow through the conduits 22 and 24 in only one direction, namely, toward the pressure chamber 21. An adjustable needle valve 28 is arranged in the conduit 25 to control the rate at which fluid can pass into the chamber 21 and thus control the rate at which the main valve 1 can gradually close.

The connection of the pressure chamber 21 with both the inlet and outlet chambers 10 and 11, respectively, assures the availability of operating fluid under pressure for closing the valve 1 when the pump 2 is idle as well as when the pump is operating. When the pump 2 is in operation the higher pressure will prevail in the inlet chamber 10, whereas, when the pump is stopped the higher pressure will be in the outlet chamber 11 so that the conduit arrangement 22—24—25 assures the supply of operating fluid to the pilot valve from whichever chamber contains the higher pressure. In either event the area of the diaphragm subject to the pressure of the operating fluid is greater than that exposed to the fluid in the body 7 of the valve 1 so that said valve will always close when desired.

The pilot valve P also includes a base 30 secured to the housing 20 in any conventional manner. The base 30 serves as a closure for the lower side of the pressure chamber 21 and also provides a seat for a pilot disc 31 received in said chamber. The pilot disc 31 is shown in plan in Fig. 2 and in cross-section in Fig. 3, and has a straight pressure port 32 and a U-shaped exhaust port 33 arranged upon an angle of 60° relative to each other. Obviously, more than one pressure port and exhaust port can be used if desired. A pilot valve shaft 34 is diagrammatically shown connected with the pilot disc 31 for turning said pilot disc.

One of the legs of the U-shaped port 33 is arranged axially of the pilot disc 31 and communicates with a drain passage 35 (Fig. 2) in the base 30. The other leg of said U-shaped port 33 communicates with a passage 36 which is connected by conduit 37 with the main diaphragm chamber 38 of the valve 1. A drain conduit 39 is connected with the passageway 35 and serves to conduct spent operating fluid from the pilot valve P. An adjustable needle valve 40 is arranged in the drain conduit 39 and is adapted to be regulated to control the rate of flow of spent operating fluid from the diaphragm chamber 38 and thus control the rate at which the main valve can gradually open.

The solenoid mechanism S for actuating the pilot valve P includes the usual coil 45 and armature 46. One end of the armature 46 is pivotally connected to a link 47 by a pin 48. The link 47 is also pivotally connected to a crank 48 by a rod 49 which has a portion 50 projecting through suitable openings in both the link and the crank. The rod 49 also has a portion 51 projecting through an opening in one end of an arm 52, the opposite end of said arm being fixedly secured to the pilot shaft 34, so that upon actuation of the arm 52, rotary movement will be transmitted through the pilot shaft 34 to the pilot disc 31.

The crank 48ª is pivotally mounted at one end upon a pin 53. A lug 54 projects laterally from the crank 48ª and is adapted to engage a stop pin 55 to limit the clockwise movement of the crank 48ª about the pin 53. The crank 48ª also has a longitudinal extension 56, which is connected to one end of a return tension spring 57. The spring 57 is arranged so as to hold the lug 54 in engagement with the stop pin 55 when the solenoid coil 45 is de-energized. The pilot disc 31 is shown in the position corresponding to the de-energized condition of the solenoid S, namely, with the pressure port 32 communicating with the passage 36 to maintain the main valve 1 in its closed position.

The stroke of the armature 46 is such as to cause the arm 52 to engage with a stop pin 52ª, whereby the angular rotation of the pilot disc 31 is limited to about 60°, the angle corresponding to the spacing of the pilot ports 32 and 33. Thus, the ports 32 and 33 are alternately connected with the passage 36 to successively effect closing and opening of the main valve 1. When more than one set of pilot ports 32—33 is used, a corresponding number of passages 36 will be needed, all connected with the conduit 37.

The motor 6, the micro switch 15, the holding coil 19, and the solenoid coil 45, all previously referred to, are interconnected in an electrical circuit which will now be described. The numerals 60 and 61 indicate two main leads for supplying current to the circuit. The lead 60 is connected to one side of the holding coil 19, which forms an element of a double contact relay 62. The relay 62 includes a first movable contact 63 adapted to engage a stationary contact 64 and a second movable contact 65 adapted to engage a stationary contact 66. The other side of the relay coil 19 is connected with a stationary contact 67 of a main switch 68 having movable contacts 69 and 70. The other main lead 61 is connected at 71 with the movable contact 65 of the relay 62 and is also connected with the stationary contact 70 of the switch 68 by a line 72. The switch 68 has a second stationary contact 73 which is connected by a line 74 with one side of the solenoid coil 45. The other side of said solenoid coil is connected by a line 75 with the lead 60.

One side of the micro switch 15 is connected by a line 76 with the main lead 61 and the other side of said micro switch is connected with the movable contact 63 of the relay 62 by a line 77.

The motor 6 is controlled by an electrically operated switch 78 including three movable contacts 79, three stationary contacts 80, an armature 81, and a coil 82 for effecting actuation of

the armature. One side of the coil 82 is connected with the main lead 60 by a line 83 and the other side of said coil is connected by a line 83a with the stationary contact 66 of the relay 62. Current is supplied to the motor 70 through three lines indicated at 84. It will be apparent that when the coil 82 is energized, the armature 81 will cause engagement of the movable contacts 79 with the stationary contacts 80 so that the circuit to the motor 6 will be completed.

The operation of the aforedescribed control apparatus is as follows: The main switch 68 is preferably manually operated, although it will be understood that it may be controlled by a float, (not shown), or any other suitable mechanism. The closing of the main switch 68 will complete the circuit to the solenoid S, for actuating the pilot valve P, and to the coil 82, for effecting actuation of the motor control switch 78. Simultaneously, the circuit will be completed to the relay 62 and its holding coil 19.

The circuit to the solenoid S will be completed as follows: Current from the main lead 61 will flow through the line 72, across the contacts 69 and 73 of the switch 68, through line 74 to one side of the solenoid coil 45, through said coil and back through the line 75 to the other main lead 60.

Likewise, the circuit to the holding coil 19 is completed through the main lead 61, line 72, contacts 67 and 70 of the switch 68, and line 60a to one side of the holding coil 19, the other side of said coil being directly connected with the main lead 60. Of course, energization of the relay holding coil 19 obviously will complete the circuit to the motor control switch 78, as follows: Current from the main lead 61 will flow through the relay contacts 65 and 66 and line 83a to one side of the coil 82, and from the other side of the coil 82 back to the other main lead 60 through the line 83.

As will be apparent from the foregoing, several functions occur simultaneously upon closing of the main switch 68. Thus, energization of the solenoid coil 45 will actuate the pilot valve P so that the arm 52 engages the stop 52a with the result that the exhaust port 33 is positioned to interconnect the passageways 35 and 36 to permit the exhaust of spent operating fluid from the diaphragm chamber 38 of the main valve through the drain line 39. This will allow the main valve 1 to open at a gradual rate controlled by the adjustment of the needle valve 40. The circuit to the motor switch 78 having been completed simultaneously with the actuation of the solenoid S, the motor 6 is started and the centrifugal pump 2 begins to pump water or other liquid into the pipe line 4. However, inasmuch as the main valve 1 only begins to open shortly after the pump 2 has started, the pipe line 4 will be maintained under pressure so that no surging can take place therein. The gradual opening of the main valve 1 will increase the rate at which water can flow through said valve, but the difference between the volume permitted to flow through said valve while opening and the capacity of the pump is taken care of by "slippage" in said pump in the case of a centrifugal pump, or through a relief valve in the case of a positive displacement pump. Continued pumping will gradually effect flexing of the diaphragm 9 upwardly and force the spent operating fluid out of the diaphragm chamber 38, eventually effecting full opening of the main valve. The upward flexing of the diaphragm 9 necessarily results in an upward movement of the valve stem 12 so that the roller 16 engages the movable contact 17 of the micro switch 15 causing said contact to engage the stationary contact 18 and thus complete a second circuit to the holding coil 19 of the relay 62. The completion of this circuit has no effect upon the circuits already completed. The roller 16 and movable contact 17 are preferably arranged so that the micro switch 15 is closed upon only a very slight upward movement of the valve stem 12, after the valve 1 starts to open. Hence, the micro switch 15 remains closed so long as the valve 1 is open, and said switch will open only when the main valve is about to completely close and cut off the flow between the chambers 10 and 11.

When it is desired to close the main valve 1, this can be effected by opening the switch 68, which will interrupt the circuit to the solenoid S and return the pilot disc 31 to its initial position under the action of the return spring 57. This will align the pressure port 32 with the passage 36 (see Fig. 1) so that operating fluid under pressure can flow from the chamber 21 through the conduit 37 into the diaphragm chamber 38 and effect gradual closing of the valve 1, or in other words, downward flexing of the diaphragm 9 with its incidental downward movement of the valve stem 12. It will be recalled that the micro switch 15 is closed and remains closed until the main valve 1 has substantially completely closed. This means that the holding coil 62 will remain energized and continue the maintenance of the circuit to the motor control switch 78, notwithstanding the fact that the main switch 68 has been opened. Thus, the micro switch 15 remains closed, after opening of the switch 68, and completes the circuit to the switch 78 as follows: Current will flow from the line 61 across the relay contacts 65 and 66 to one side of the coil 82 and from the other side of said coil through the line 83 to the other main lead 60. When the main valve 1 has almost completely closed the stem 12 will have moved downwardly a sufficient distance to permit the contact 17 of the micro switch 15 to disengage the contact 18, and thus effect opening of the micro switch 15. The opening of the micro switch 15 will, of course, break the circuit to the motor control switch 78 so that the circuit to the motor 6 will now be interrupted and the pump 2 will stop. Here again, it will be noted that the pump 2 has continued to operate against a gradual restriction of flow due to the closing action of the main valve 1 and that the pump 2 will continue to operate against such resistance until the said main valve has substantially completely closed, any "slippage" necessary to prevent excessive pressure in the line being automatically taken care of by the pump. In this manner all surging is avoided during the shutting down of the pump and the system operates quietly, free from vibrations and shocks.

The present invention, in addition to preventing line surges during both the starting and shutting down of the pump 2, affords the additional safeguard of being so arranged that the operator cannot ordinarily effect closing of the main valve 1, except under the conditions and in accordance with the procedure described herein. In actual practice, the solenoid S and the micro switch 15 are enclosed and are not accessible except by unwarranted tampering. The same is true of the relay 62 and the motor control switch 78, so that the only thing accessible to the operator for control is the main switch 68. When

this main switch is closed or opened, the starting and shutting down of the pump, respectively, takes place automatically and in the sequence described.

Fig. 4 illustrates a slight change that may be made in the circuit shown in Fig. 1 in order to provide certain additional advantages in practice. Here, a time delay relay 85 is shown connected across the coil 82 of the motor control switch 78. The time delay relay 85 provides means for delaying the actuation of the motor switch 78 so that said switch is not actuated until say 5 or 10 seconds after the solenoid S has been actuated to permit opening of the main valve 1. In this manner, the main valve 1 will be conditioned for opening slightly before the pump 2 starts. The advantage of this is that water can flow back through the valve while it is slightly open and prime the pump in installations where such priming is necessary, or in installations where it is highly desirable to wet the pump bearings before the pump is actually started.

It will be apparent that the principle of starting the pump and gradually opening the valve with the starting of the pump, and the gradual closing of the valve just prior to the stopping of the pump, may be effected by various other circuits, devices, and mechanisms different from that disclosed herein. Accordingly, it will be understood that the present invention is not limited to the particular circuits and apparatus disclosed herein, and that various alterations and changes may be made therein without departing from the spirit of the invention or the scope of the annexed claims.

I claim:

1. In combination, a pump; means for driving said pump; a valve upon the discharge side of said pump arranged to have fluid pumped therethrough by said pump; and control means operatively connected with said pump driving means and valve arranged to allow said valve to start opening before said pump driving means starts to drive said pump.

2. The combination defined in claim 1, in which the drive means for the pump is an electric motor and the control means includes a delayed action relay for delaying operation of the pump drive means until after the valve has started to open.

3. In combination, a pump; means for driving said pump; a valve upon the discharge side of said pump arranged to have fluid pumped therethrough by said pump; and control means operatively connected with said pump driving means and valve arranged to allow said valve to start opening before said pump starts, and to start closing of said valve while said pump is running and to stop said pump as said valve is about to completely close.

4. Control means for a motor driven pump, and a valve arranged on the discharge side of said pump, comprising: means for substantially simultaneously effecting starting of said pump and permitting the opening of said main valve, including a circuit containing electrically operated pilot valve means for controlling the opening of said main valve means including an electrically operated switch for completing a circuit to said motor; and means including a main switch connected in circuit with said electrically operated pilot valve means and said electrically operated switch for simultaneously completing the circuit to said electrically operated pilot valve means and said electrically operated motor switch.

5. In combination, a pump; means for driving said pump; a fluid pressure operable valve connected with said pump upon the discharge side thereof; a pilot valve controlling the exhaust and admission of operating fluid to said main valve to effect opening and closing of said main valve; and control means operatively connected with said pump driving means and said pilot valve arranged to actuate said pilot valve to permit opening of said main valve substantially simultaneously with the initiation of the drive of said pump.

6. In combination, a pump; means for driving said pump; a main diaphragm valve connected with said pump upon the discharge side thereof; a pilot valve controlling the exhaust and admission of operating fluid to the diaphragm chamber of said main valve to effect opening and closing of said main valve; means for controlling the rate of exhaust and admission of said operating fluid to determine the rate at which said main valve can operate; and control means operatively connected with said pump driving means and said pilot valve arranged to actuate said pilot valve to permit opening of said main valve substantially simultaneously with the initiation of the drive of said pump.

7. In combination, a pump; means for driving said pump; a fluid pressure operable main valve connected with the discharge of said pump; a pilot valve controlling the opening and closing of said main valve; and control means for said pump driving means and said pilot valve arranged to actuate said pilot valve to permit opening of said main valve substantially simultaneously with the initiation of the drive of said pump, and to effect actuation of said pilot valve to cause said main valve to close and to discontinue the drive of said pump at a time when said main valve has substantially completely closed.

8. In combination, a pump; means for driving said pump; a fluid pressure operable main valve connected with the discharge side of said pump; a pilot valve controlling the opening and closing of said main valve; means for controlling the rate at which said main valve can open and close, respectively; and control means for said pump driving means and said pilot valve arranged to actuate said pilot valve to permit opening of said main valve substantially simultaneously with the initiation of the drive of said pump, and to effect actuation of said pilot valve to cause said main valve to close and to discontinue the drive of said pump at a time when said main valve has substantially completely closed.

9. In combination, a motor driven pump; a main valve connected with the discharge side of said pump and including a reciprocable valve stem; a switch arranged to be operated upon slight upward movement of said valve stem; a motor switch arranged to complete a circuit to the motor for driving said pump; and a holding coil, said valve stem-operated switch being so connected in circuit with said holding coil and motor switch that when said valve stem operated switch is closed said holding coil maintains a circuit to said motor switch until said valve stem reaches substantially its lower limit of movement.

10. In combination, a pump; means for driving said pump; electrically operated means for controlling said pump drive means; a main valve connected with the discharge side of said pump; a relay coil in circuit with said electrically oper-

ated means for controlling said pump drive means; a pilot valve for controlling the opening and closing of said main valve; electrically operated means for actuating said pilot valve, said last-mentioned means being connected in circuit with said relay coil and pump drive control means; and a main switch in said circuit arranged so that upon closing thereof said pilot actuating means and relay coil are simultaneously actuated to effect initiation of operation of said pump drive means and opening of said main valve.

11. In combination, a motor driven pump; an electrically operated switch for controlling the operating of said motor; a main valve connected with the discharge side of said pump and including a reciprocable element movable coincidental with the opening and closing of said main valve; a switch arranged to be closed by said reciprocable element as said main valve is opened; a relay operably connected in circuit with the said last mentioned switch and said motor control switch, said relay being arranged to complete a circuit to said motor control switch when energized; a pilot valve controlling the opening and closing of said main valve; a solenoid for actuating said pilot valve, said solenoid being operably connected in circuit with said reciprocable element-operated switch, relay, and motor switch; and a main switch in said circuit arranged so that upon closing thereof said solenoid and holding coil are simultaneously actuated to effect opening of said main valve and the starting of said motor, said reciprocable-element operated switch serving to maintain a circuit to said relay after said main switch is opened and until said main valve is nearly completely closed.

12. In combination, a motor driven pump; an electrically operated switch for controlling the operation of said motor; a main valve connected with the discharge side of said pump and including a reciprocable element movable coincidental with the opening and closing of said main valve; a switch arranged to be closed by said reciprocable element as said main valve is opened; a relay operably connected in circuit with the said last-mentioned switch and said motor control switch, said relay being arranged to complete a circuit to said motor control switch when energized; a pilot valve controlling the opening and closing of said main valve; a solenoid for actuating said pilot valve, said solenoid being operably connected in circuit with said reciprocable element operated switch, relay, and motor switch; and a main switch in said circuit arranged so that upon closing thereof said solenoid and relay are simultaneously actuated to effect opening of said main valve and starting of said motor, said reciprocable element-operated switch being arranged to maintain a circuit to said motor switch through said relay after said main switch has been opened to de-energize said solenoid, and thereby effect operation of said pilot valve to permit opening of said main valve.

13. In combination, a pump; means for driving said pump; electrically operated means for controlling said pump drive means; a main valve connected with the discharge side of said pump; a relay in circuit with said electrically operated means for controlling said pump drive means; a pilot valve for controlling the opening and closing of said main valve; electrically operated means for actuating said pilot valve; a delayed action relay in the circuit between said relay coil and said pump drive control means, whereby said pump drive control means remains de-energized for a given time interval after said pilot valve actuating means is energized so that said pilot valve is actuated to permit said main valve to open before said pump is driven; and a main switch arranged in the circuit so that upon closing thereof, said pilot actuating means and relays are simultaneously actuated.

14. In combination, a motor driven centrifugal pump; a main valve connected with said pump upon the discharge side of said pump, said main valve including an inlet chamber, an outlet chamber, diaphragm operated means for controlling the flow between said chambers, and a reciprocable valve stem connected with said diaphragm; a pilot valve for controlling said diaphragm valve, said pilot valve including a pressure chamber connected by conduit means with the inlet and outlet chambers, respectively, of said main valve, said conduit means including check valves providing a one-way flow between said chambers in said main valve and the pressure chamber in said pilot valve and also including an adjustable needle valve between said check valves and pressure chamber for limiting the rate at which operating fluid can flow into said pressure chamber; a conduit connecting said pilot valve with the diaphragm chamber of said main valve and a drain conduit connecting said pilot valve with the atmosphere; a rotatable pilot disc in said pressure chamber having a through port for admitting operating fluid from said pressure chamber into the diaphragm chamber of said main valve when said pilot valve is in one position, and an exhaust port for exhausting spent operating fluid from said main diaphragm chamber through said drain conduit to the atmosphere when said pilot disc is in another position, said drain conduit having adjustable means therein for varying the rate at which said spent fluid can drain from said main diaphragm chamber, whereby to allow said main valve to open at a gradual rate; electrically operated means for actuating said pilot disc; electrically operated means for completing a circuit to said pump motor; a holding coil operably connected in circuit with both said electrically operated means; a micro switch arranged to be actuated by said valve stem, said micro switch being arranged so that it closes upon very slight upward movement of said valve stem corresponding to a slightly open position of the main valve; and a main switch connected in circuit with the micro switch, the holding coil, the electrically operated means for said pilot disc, and the electrically operated means for completing a circuit to said motor, the circuit arrangement being such that when said main switch is closed said electrically operated means for actuating said pilot disc is operated to rotate said pilot disc to permit opening of said main valve; and said electrically operated means for controlling said motor is actuated to complete the circuit to said motor so that said main valve starts to open substantially simultaneously with the starting of said pump, said circuit being further arranged so that when said main switch is opened, said electrically operated means for actuating said pilot disc is deenergized, thereby permitting said pilot disc to return to its initial position and effect closing of said main valve, said micro switch being arranged so that it now maintains said holding coil energized to continue the circuit to said motor so that said motor drives said pump until said main valve has substantially closed and said valve stem has assumed a position permitting said micro switch

to open and thus interrupt the circuit to said holding coil.

15. In combination, a centrifugal pump; an electric motor arranged to drive said pump; a pressure fluid operable main valve connected with said pump upon the discharge side of said pump, said main valve including an inlet chamber, an outlet chamber, a diaphragm for controlling the flow between said chamber and a reciprocable valve stem connected with said diaphragm; a pilot valve for controlling said main diaphragm valve, said pilot valve including a pressure chamber connected by conduit means with the inlet and outlet chambers, respectively, of said main valve, said conduit means including check valve means providing a one-way flow between said chambers in said main valve and said pressure chamber in said pilot valve; a conduit connecting said pilot valve with the diaphragm chamber of said main valve; a drain conduit for spent operating fluid connecting said pilot valve with the atmosphere; a rotatable, ported pilot disc in said pressure chamber for controlling the flow of operating fluid between said main valve and said pilot valve, whereby said main valve can be closed by fluid from the inlet or outlet chambers thereof depending upon which of said chambers is subject to the higher pressure; a circuit including electrically operated means for effecting rotation of said pilot disc; electrically operated means in said circuit for completing a circuit to said pump motor; and a main switch connected in said circuit with said electrically operated means for operating said pilot disc and said electrically operated means for completing a circuit to said pump motor for simultaneously effecting operation of said pump and pilot valve associated with said main valve.

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