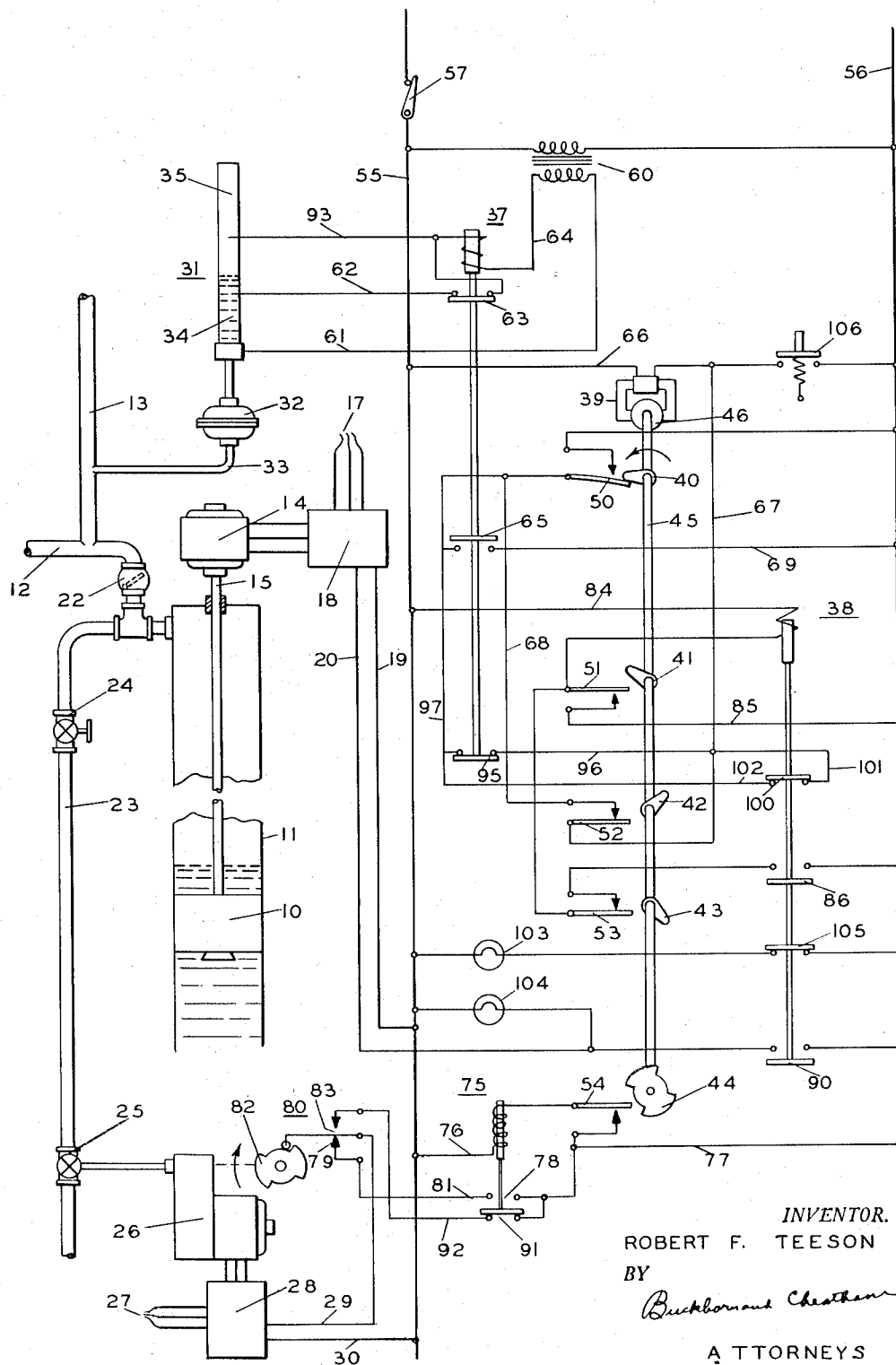


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SURGE CONTROL APPARATUS

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SURGE CONTROL APPARATUS

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8 Claims. (Cl. 103—41)

The present invention relates to an automatic control system, and more particularly to an arrangement for controlling the operation of various mechanical components of a liquid system.

The connection of supply pumps, or the like, to liquid systems under pressure is a sensitive matter. Considering, for example, a municipal water system supplied by deep well pumps the connection or disconnection of pumps supplying water to such a system is complicated by the fact that if the discharge of such a pump is suddenly added to the system or stopped suddenly, a pressure surge is created through the system which may have many undesirable effects. A surge may, for example, break pipes or mains in the system and may also cause audible pounding which may be disagreeable to the domestic user.

It is an object of the invention, therefore, to provide a new and improved means for connecting and disconnecting a supply pump to a pressurized liquid system so as to prevent creation of undesirable surges in the liquid system.

More particularly, it is an object of the present invention to provide new and improved means for effecting connection and disconnection of a deep well turbine pump to a municipal water system without the production of surges in said system.

A further difficulty in the operation of municipal water systems supplied directly from wells arises from the fact that sand and silt will accumulate in the wells during any inactive period thereof and the water may also become discolored. Obviously it is not desirable to pump such water directly into the system and some means should be provided for discharging the initial flow of water upon the starting of the pump, to some point remote from the water system itself.

It is, then, a further object of the present invention to provide means responsive to certain conditions within a water system for automatically starting a deep well turbine pump and diverting the initial discharge of a pump to a location remote from the water system to which the pump is arranged for connection, and after a predetermined period of operation of the pump, for effecting a surge-free connection thereof to the water system.

A still further problem involved in the operation of water systems supplied by deep well pumps, concerns the prevention of introduction of air into the water system. If upon starting, the pump is connected directly to the water system, an air column will be passed into the system and will, of course, be compressed. When such air reaches an outlet in the system, such as the water faucets in a home, it will be ejected therefrom with great violence, and utensils and glasses may be knocked from the hands of the user. As a matter of good public relations, therefore, the presence of air in the system should be eliminated as much as possible.

It is, then, another object of the present invention to provide an arrangement for accomplishing the connection

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of a deep well pump to a municipal water system whereby the addition of air to the system is precluded.

In accordance with an embodiment of the present invention, a control arrangement is provided for starting and stopping a deep well pump motor in response to conditions in a municipal water system, and for controlling the connection and disconnection thereof to the system in a manner so as to eliminate objectionable surges in the system.

10 The control arrangement is particularly adapted for use with a pump connected to a pressurized system through a check valve which prevents backflow of water from the system to the pump and includes a normally closed motor operated by-pass valve adapted to be connected between the pump and the check valve, which by-pass valve when open will permit discharge of the water from the pump to atmosphere rather than into the system. Control means are provided for connection to the system for deriving start and stop indications for the pump motor in response to minimum and maximum conditions therein and for effecting operation of the by-pass valve to slowly open the same a predetermined period of time prior to starting or stopping of the pump and to slowly close the by-pass valve a predetermined period of time after said pump has started or stopped, whereby a surge-free connection or disconnection of the pump to the system is obtained.

For a consideration of what is believed novel and inventive, attention is directed to the following description taken in connection with the accompanying drawings, while the features of novelty will be pointed out with greater particularity in the appended claims.

The drawing is a schematic diagram illustrating the preferred embodiment of the invention.

35 From the following description the invention will be described with particular regard to one specific application, namely, for controlling the driving motor connected to a deep well turbine pump and the valve arrangement provided for connecting such a pump to a municipal water system. It will become obvious as the description proceeds, that the control arrangement is not necessarily so limited and that it may be equally well adapted for other liquid systems. The particular control arrangement shown is, in one sense, an improvement upon the control arrangement shown in my Patent No. 2,430,257 issued November 4, 1947.

Referring now to the drawing, a deep well turbine pump 10 is shown schematically arranged within a well casing 11 for raising water up to a conduit means or header 12 and into a standpipe indicated by the vertically extending pipe section 13. The header 12 may be connected to a water system maintained under pressure as for example by a conventional pressure reservoir (not shown). An electric motor 14 mounted on top of the well 11 and connected to the pump 10 by a drive shaft 15 is adapted to receive electric energy from a source of supply through conductors 17 and a suitable relay actuated switch gear 18. The operation of the switch gear 18 is adapted to be controlled through a low voltage control circuit 19, 20 which, in turn, is controlled by an automatic control arrangement described hereinafter.

Liquid flow between the pump 10 and the high pressure system to which the header 12 is connected is controlled in part by a check valve 22 disposed in the header 12 and arranged to permit liquid flow from the pump to the system and to prevent liquid flow in the reverse direction. A by-pass line or conduit 23 is also connected to the header 12 between the check valve 22 and the pump 10 and is arranged to discharge to atmosphere. The conduit 23 is provided with a manual cut-off valve 24 and with a control valve 25 operated by a geared motor 26 which is adapted to receive electrical energy from a suitable source

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of supply through conductors 27 and a suitable relay actuated switch gear 28. The switch gear 28 is controlled through a low voltage circuit 29, 30, control of which will be subsequently described.

Since the by-pass line 23 discharges to atmosphere, the line will serve as a liquid escape means and water from pump 10 will discharge therethrough rather than through the check valve 22 so long as the control valve 25 is open. As the control valve is slowly closed, however, the water flow through line 23 will be restricted and the pressure therein will begin to rise. When the pressure in line 23 becomes greater than the pressure on the other side of the check valve 22, the water will begin to pass through the check valve 22, and the water flow will be gradually diverted into the header 12. Similarly, the rate of water flow through the check valve 22 will gradually diminish if the control valve 25 is opened gradually.

The control valve 25 may be of any suitable type, a freely rotating plug type valve being convenient inasmuch as the valve operating motor may be connected to rotate the valve plug in a single direction, the valve passing from completely open position to completely closed position or reversely with each quarter revolution of the valve plug. A plug type valve is also advantageous in the present instance since the increment of change in fluid flow over a given period of time is smallest immediately as the valve begins to open and immediately before the valve closes completely.

The advantage of this feature will become more apparent as the description proceeds. The rate at which the plug valve 25 should be closed depends upon the particular characteristics of the system in which the valve is incorporated, the pressure in the high pressure portion of the system, the size of the lines and the pump discharge capacity all affecting the valve operating rate. For purposes of illustration it will be assumed that the motor 26 drives the valve at a speed of one revolution per second so that the valve moves from a fully open position to a fully closed position in a period of time of fifteen seconds.

The motor 14 is adapted to be started and stopped in accordance with start and stop signals or indications provided by a condition responsive device such as a switch means responsive to variations in water level occurring within the standpipe 13 so as to maintain at least a predetermined pressure head upon the distribution system connected thereto. Any suitable condition responsive device may be used for indicating the variations in water level, such as a float switch or a pressure responsive switch 31. The pressure responsive switch shown includes a diaphragm device 32 which is connected to the standpipe 13 by a tube 33 and a movable contact illustrated in this instance as consisting of a mercury column 34 arranged within a glass tube 35 communicating with the device 32.

The control arrangement of the invention comprises a first relay 37, a second relay 38 and a motor driven cam or time switch indicated generally at 39. The cam switch 39 includes a plurality of cams, 40, 41, 42, 43 and 44 which are rotatable by the shaft 45 of the motor 46, the cams being radially displaced from each other upon the shaft 45 as will be more fully described hereinafter. The cams 40 to 44 are adapted to operate at spaced intervals of time, the corresponding switches 50 to 54 respectively, arranged adjacent thereto. The motor 46 may be of a geared "Telechron" type whereby the shaft 45 is driven relatively slowly in the direction of rotation indicated at a speed, for example, of one revolution per eight minutes.

The apparatus, connected in a manner to be described, is adapted to be energized through the supply conductors 55, 56, it being understood that these conductors are supplied from the same source as are the conductors 17, even though at a possibly lower voltage. A manual control switch 57 may be provided in one of the conductors, such as 55.

Assume first that the head of water in the standpipe 13 is at a normal level and that the pump driving motor 14

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is at rest. Under this condition of pressure head the mercury column 34 will stand at some intermediate position as indicated and the relay 37 will be energized and held in a lifted position as shown. In the specific embodiment shown, the relay 37 is adapted to be energized from the supply circuit 55, 56 through a step-down transformer 60, the secondary voltage of which may, for example, be 12 volts. The relay 37 is controlled by the water level responsive device 31 to which it is connected and under the conditions first assumed it is energized through the circuit extending from one side of the secondary of transformer 60, through the conductor 61 connected to the metal fitting at the lower end of the mercury column 34, through the mercury column, conductor 62, the raised holding contact 63 of relay 37, through the relay winding, the conductor 64 to the other side of the transformer secondary. In the raised position of the relay 37, the motor 46 of the time switch 39 is deenergized and the various switches will be in the relative positions as shown where they came to rest at the end of the preceding cycle of operation. In this condition of rest it will be observed that the cam 40 is in engagement with the corresponding switch 50, holding it in an open circuit position while the remaining cams are out of engagement with their respective switch elements. The relay 38 is also deenergized and the valve 25 is fully closed while the elements of the energizing circuit for the switch gear 28 are in the position shown.

Now assume that the pressure head in the standpipe 13 has fallen a predetermined amount making it desirable to start up the pump to replenish the water supply in the standpipe. Upon such a drop in the pressure head the mercury column 34 will fall, opening the circuit between the conductors 61 and 62, thereby deenergizing the relay 37 permitting it to drop out. Upon drop-out of the relay 37 the holding contact 63 moves to the open circuit position while contact 65 thereof moves to a closed circuit position establishing an energizing circuit for the time motor 46. This circuit may be traced from the supply line 55 through conductor 66, motor 46, conductor 67, the closed cam switch 52, conductor 68, closed contacts 65 and conductor 69 to the other supply line 56. Upon energization and rotation of the timer motor 46 the cam 40 will disengage the movable contact of the switch 50, permitting it to move to the normally closed condition, thereby establishing a by-pass circuit between the conductor 68 and the supply line 56 around the contact 65 of the relay 37.

A predetermined period of time after the initial energization of the timer motor 46, such as, for example, two minutes, the cam 44 will actuate the contacts of the normally open switch 54 to the closed circuit position, thereby effecting the energization of the relay 75. This circuit may be traced from the supply line 55 through the conductor 76, the winding of the relay 75, the closed contacts of the switch 54, and the conductor 77 to the other supply line 56. Upon the pickup of the relay 75 and the closure of its normally open contact 78, the valve motor switch gear 28 will be energized through a circuit which extends from the supply line 55, through the conductor 30, switch gear 28, the conductor 29, the normally closed contacts 79 of switch 80, conductor 81, closed contacts 78, and the conductor 77 to the supply line 56. Energization of the valve motor switch gear 28 will effect connection of the valve motor 26 to the power supply line 27 and the motor will slowly rotate the control valve 25 to its open position. Means are provided to effect deenergization of this valve motor when the control valve 25 reaches the fully open position. Connected to the motor 26 and adapted to rotate at the same speed as the plug of the valve 25 is the double cam 82 which is adapted to operate switch 80. The cam 82 is arranged so that when the control valve 25 reaches a fully open position the normally closed contacts 79 of switch 80 are opened and the normally open contacts 83 are closed. As will be seen, opening

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of the contacts 79 will open the energizing circuit to the valve motor switch gear described above, and the valve motor 26 will stop.

A predetermined period of time after the energization of the valve motor 26, and preferably after the valve 25 has become fully opened, the cam 41 will actuate the contacts of the normally open switch 51 to the closed circuit position, thereby effecting the energization of the relay 38. This circuit may be traced from the supply line 55 through the conductor 84, the winding of relay 38, the closed contacts of switch 51 and conductor 85 to the other supply line 56. Upon the pickup of the relay 38 and closure of its normally open contact 86, a holding circuit is established for the relay through the normally closed contacts of the cam switch 53, which by-passes the cam switch 51, to the supply line 56. It will be understood that the contacts of switch 51 are closed only momentarily in that they are reopened upon continued movement of the cam 41 thereafter.

Upon energization of the relay 38 and closure of its contact 90, the control circuit 19, 20 for the switch gear 18 is energized so as to effect connection of the motor 14 to the power supply 17.

With valve 25 open, water discharged by pump 10 will by-pass the check valve 22 and will be discharged through the conduit 23. A predetermined period of time after the pump motor 10 has been started, such as, for example, one minute, the cam 44 will disengage the movable contact of the switch 54 to open the circuit through the winding of the relay 75 and allow it to drop. When contacts 91 of the relay 75 are closed, a circuit through the switch gear 28 of the valve motor 26 will be closed to once again start the motor 26, this time in a valve closing movement. This circuit includes the supply line 55, the conductor 30, the switch gear 28, the conductor 29, the closed contacts 83, the conductor 92, the closed contacts 91, and the conductor 77 to the other supply line 56. The valve motor 26 will continue to rotate, closing the control valve 25 and rotating the cam 82 until the valve 25 is fully closed, at which time the cam 82 will disengage the contacts 83 to open the circuit through the valve motor switch gear 28 and stop motor 26 with valve 25 in the fully closed position. During the time the valve 25 is closing the pressure in the by-pass line 23 will gradually build up and will gradually cause the check valve 22 to open and the water to flow from the pump 10 into the header 12. Since this diversion takes place gradually over a relatively extended period of time, the introduction of water flow to the header 12 is accomplished with relatively little surge or pounding effects in the system to which the header 12 is connected.

As mentioned above, a delay is desired between the time the pump 10 is started and the time the valve motor 26 is energized to close the control valve 25. During such intervening period the air in the pump column may be expelled through the by-pass line 23, which air would create undesirable effects if introduced into the pressurized system. Also, as previously mentioned, the initial discharge of water from the pump may contain sand and silt and may also be slightly discolored if the pump has been shut down for any length of time and the delay prior to connecting the pump to the water supply system will enable the pump discharge to clarify.

The timer motor 46 will continue in operation until the cam 42 actuates the normally closed contacts of switch 52 to the open circuit position whereupon the motor 46 will be deenergized, contacts 52 being held open by the cam 42 in engagement therewith. This is the normal condition of rest for the time switch 39 during pumping operation.

A short time delay period, such as three minutes, is provided between the closing of the cam switch 41 and the opening of the cam switch 42 to assure ample time for any pump surges in the standpipe 13 to smooth out before the control of the system is transferred to the pressure

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responsive device 31. Though with the by-pass valve opening and closing arrangement of the present invention the probability of surges is very slight, the possibility of a surge occurring still remains and, as will subsequently appear, false fluctuations of the mercury column due to pumping surges might otherwise cause premature pickup of relay 37 which, in turn, would result in momentary energization of the timer motor 46 and deenergization of the pump motor 14.

Now assume that the motor 14 and the turbine pump 10 connected therewith have been in operation for such a time as to build up the pressure head within the standpipe 13 to such an extent that the mercury column 34 is raised within the tube 35 to close the circuit between conductors 61 and 93, thereby establishing an energizing circuit for the relay 37. This latter circuit extends through conductor 61, mercury column 34, conductor 93, winding of relay 37, conductor 64, to the other terminal of the transformer 94. Immediately upon the pickup of relay 37 the contact 63 thereof is closed, thereby establishing the previously described holding circuit for relay 37. Upon closure of the contact 95 of relay 37 an energizing circuit is established for the timer motor 46 extending from the conductor 67 through conductor 96, contact 95, conductor 97, the closed contacts of the cam switch 50 to the supply line 56. Upon rotation of the motor 46 the cam 42 will disengage the contacts of switch 52, permitting them to move to the closed circuit position, thereby establishing a by-pass circuit around contacts 95 of the relay 37.

After a predetermined period of time, which in this case may be a very short interval of a few seconds, the cam 44 will move normally open switch contacts 54 to the closed circuit position, thereby effecting energization of the relay 75. Upon pickup of the relay 75 and closure of its normally open contact 78, the energizing circuit through the switch gear and the closed contacts 79 will be closed as before and the valve motor 26 will be connected across the power supply line 27 and begin its rotation which, in this case, will cause control valve 25 to open gradually. As control valve 25 opens, the water from pump 10 will begin to pass through by-pass line 23 and the rate of flow of the water into the high pressure system will gradually diminish until all of the water is passing through the line 23 and the check valve 22 closes. The gradual reduction of water flow to the high pressure system will be accomplished with practically no surge whatsoever therewithin. As valve 25 attains the fully open position, in about fifteen seconds, the cam 82 will open the contacts 79 and close the contacts 83. Opening of contacts 79 will open the circuit through the switch gear 28 and valve motor 26 will stop with the control valve 25 in its fully open position. In this position of the control valve 25, the cam switch 43 will engage with the contacts of the normally closed switch 53, moving them to the open circuit position, thereby deenergizing the relay 38. Upon drop-out of relay 38 and opening of its contact 90 the control circuit 19, 20 for the pump motor switch gear 18 will be deenergized, disconnecting the pump motor 14 from the power supply. Immediately upon deenergization of the motor 14 the water column within the well will start to fall back through the pump, causing it and the motor to be driven in the reverse direction. The timer motor 46 will continue to rotate and after a predetermined period of time sufficient to permit the water to drop in the well column, for example, one minute, the cam 44 will disengage the movable contact of the switch 54, thereby deenergizing the relay 75 permitting it to drop out. Upon the drop-out of the relay 75 the contact 91 will be closed to close the energizing circuit for the valve motor switch gear 28 through the closed contacts 83, as previously described. This will energize the valve motor 26 and after a period of fifteen seconds the valve 25 will be closed, whereupon cam 82 will open contacts 83 and stop the valve motor 26 in the fully closed position of valve 25. The timer motor 46 will continue to rotate during the

preceding operations, and after the valve 25 is closed the cam 40 will open the contact switch 50, immediately breaking the timer motor circuit, stopping the motor and retaining the switch 50 in the open circuit position, thus completing the normal cycle of operation for the system. It is desirable as a sanitary precaution that the control valve 25 be closed when the pump 10 is shut down so foreign matter may not pass through line 23 to the well.

In the operation of the system as described the pump motor 14 is merely started and stopped in response to corresponding predetermined variations in pressure head in the standpipe 13 with certain time delay periods occurring between the start and stop indications of the pressure responsive device and the actual connection and disconnection of the pump motor for reasons stated and others which will be presently described.

Assume now that a momentary power failure occurs during a time when the motor 14 is in operation. It will be recalled that during the operation of motor 14 the relay 37 is deenergized, the relay 38 is energized and the timing device 39 is at rest with the cam 42 holding the contacts of switch 52 in the opened position. Immediately upon power failure the relay 38 will drop out, opening the control circuit 19, 20 for the switch gear 18, so that even though power should be restored shortly thereafter the switch gear 18 would not be immediately reclosed. Upon opening of the contacts 86 the holding circuit for the winding of relay 38 is broken so that the relay will not pick up upon restoration of power. On the other hand, an additional contact 100 of relay 38 is moved to the closed circuit position so that a circuit is closed for the timer motor 46 extending from the conductor 67 through conductor 101, contact 100, conductors 102 and 97 through the closed cam switch 50 to the supply line 56. Immediately upon restoration of power, the timer motor 46 will be energized through this circuit and will be maintained in operation until the relay 38 is ultimately picked up and the switch gear 18 for the pump motor 14 reclosed. This cannot occur, however, until after a considerable lapse of time and within which the column of water within the well 11 has had ample time to descend sufficiently through the pump 10 to a stationary level and the motor, which was spun by the descending column of water in the reverse direction of rotation, brought to rest. In the case assumed, the timer motor 46 is maintained in operation throughout one complete cycle starting from the position in which the cam 42 is holding the switch 52 open until it is again reopened. First the switch 52 is closed, then the switch 54 is closed and valve 25 will open and stop in the open position. Next switch 53 will open, then switch 54 will open and valve 25 will close and stop. It will be observed that the foregoing operations of the valve 25 are the same as would occur in the normal stopping operation of the pump. The timer motor 46 will continue to rotate and the switch 50 will open, but it will be observed that the switch 50 is by-passed by the closed contacts 65 of relay 37, maintaining an energizing circuit for the motor 46 through conductor 69. At this point the regular sequential operation of the pump starting will take place and the switch 54 will close to energize the circuits which cause valve 25 to open and stop. Then the contacts 51 will be closed to energize the pump, and after one minute the switch 54 will be opened and the valve 25 will start its closing operation and gradually force the water from the pump into the header 12. After a predetermined period of time the cam switch 52 will be opened, thereby stopping the motor 46. The operation of the pump motor 14 will continue until it is stopped by a rise in the mercury column 34 and pickup of relay 37.

It is obvious that if power failure occurs at any time when the mercury column 34 is below the contact of conductor 93, the pump motor will always be restarted following restoration of power irrespective of the exact position occupied by the cam switch device 39 at the instant of power failure. Thus the control arrangement

will not be locked out due to occurrence of power failure during some intermediate position of the cam switch unit. The features described in the preceding two paragraphs are covered by my Patent No. 2,430,257 and are only mentioned herein to amplify the possible application of the present invention. Obviously, the principal features of the present invention may be applied in environments totally dissimilar to that of the above patent.

While not necessary to the operation of the arrangement of the present invention, a pair of signal lamps 103 and 104 may be provided for indicating the energized and deenergized conditions, respectively, of the switch gear control circuit 19, 20. As shown, a red lamp 103 may be energized upon closure of the contacts 105 of relay 38 for indicating the deenergized condition, while a red lamp 104 may be connected for energization upon completion of the circuit through contact 90 upon pickup of relay 38.

A test switch 106 is also provided for manually effecting energization of the timer motor 46. The switch 106 need be depressed only for a time sufficient to permit disengagement of the cam 40 from the switch 50, whereupon the system will proceed throughout the entire cycle. During such testing the relay 37 will generally be in a picked up condition so that the time switch will not stop upon opening of the switch contacts 52 by cam 42 but will continue in operation. During such testing the relay 38 will pick up upon closure of the switch 51 and will remain in such condition until switch 53 is opened a short time thereafter.

The use of the step down transformer 60 for providing a low voltage for operating relay 37 is proposed in the embodiment herein described by reason of the particular form of pressure responsive device employed. In the arrangement as shown it will be observed that the conductor 61 is grounded so that a direct connection between it and the source of supply would not be desirable. However, if a condition responsive device having all contacts electrically insulated from ground is substituted for the device 31, then the use of the transformer 60 may be dispensed with.

Having described the invention in what is considered to be a preferred embodiment thereof, it is desired that it be understood that the invention is not necessarily so limited and that the various details shown are merely illustrative. It is intended in the following claims to cover all such obvious variations and modifications as will occur to one skilled in the art without departing from the true spirit and scope of the invention.

I claim:

1. A surge eliminating apparatus for use with a motor driven supply pump connected to a water main through a check valve, said apparatus comprising a control valve adapted to be operatively connected between said pump and said check valve for diverting flow of water from said pump to atmosphere, a motor connected to said control valve to effect gradual opening and closing thereof, a pressure responsive switch means adapted for connection to said main for producing minimum and maximum pressure indications corresponding to predetermined minimum and maximum pressure conditions within the main, a time switch including a driving motor connected to said switch means and energized in response to either maximum or minimum pressure indications of said switch means, a first means connected to said time switch responsive to operation of said time switch to a first position for effecting energization and valve opening movement of said valve motor, means connected to said control valve and valve motor for effecting deenergization of said valve motor when said control valve attains a fully open position, second means connected to said time switch and adapted for connection to said pump motor and responsive to operation of said time switch to a second position for effecting energization and deenergization of said pump motor in response to said minimum and maximum pressure indications, respectively, a predetermined period of time after energization of said valve motor, third means operatively connected to said time switch and re-

sponsive to operation of said time switch to a third position for effecting energization and valve closing movement of said valve motor a predetermined period of time after either energization or deenergization of said pump motor, and means connected to said control valve and valve motor for effecting deenergization of said valve motor when said control valve reaches a fully closed position.

2. Apparatus for eliminating surges in a liquid system under pressure having a pump means connected for supplying liquid thereto through a check valve, said apparatus comprising a control valve connected to said pump means in parallel with said check valve for permitting escape of the liquid from said pump means to atmosphere, a pressure responsive switch means connected to said system for deriving signals corresponding to minimum and maximum pressure conditions within said system, first means connected to said switch and pump means and responsive to a signal from said switch means of a minimum pressure condition for starting said pump means, second means connected to said control valve and said switch means and responsive to a signal from said switch means of a minimum pressure condition for slowly closing said control valve a predetermined period of time after starting of said pump means, third means connected to said control valve and switch means and responsive to a signal from said switch means of a maximum pressure condition for slowly opening said control valve, and fourth means connected to said pump and switch means and responsive to a signal from said switch means of a maximum pressure condition for stopping said pump means when said control valve is in the fully opened position.

3. Apparatus for eliminating surge in a relatively high pressure liquid system supplied by a liquid pump through a check valve, said apparatus comprising a normally closed valve means connected to said pump in parallel with said check valve for diverting the flow of liquid from said pump to atmosphere, pressure responsive switch means connected to said system and responsive to given pressures corresponding to a minimum or maximum pressure condition therein, means connected to said switch means and responsive to said maximum pressure condition thereof for slowly opening said valve means whereby liquid from said pump is gradually diverted through said valve means, and means connected to said switch means and responsive to said minimum pressure condition thereof for slowly closing said valve means whereby the liquid flow from said pump is slowly diverted through said check valve to said high pressure system.

4. A surge eliminating apparatus for use with a motor driven supply pump connected to a water main through a check valve, said apparatus comprising a control valve adapted to be operatively connected between said pump and said check valve for diverting flow of water from said pump to atmosphere, an electric valve driving motor connected to said control valve to effect gradual opening and closing thereof, switch means adapted for connection to said main for producing a signal upon occurrence of a predetermined minimum pressure therewithin, a time switch including an actuating means connected to said switch means for energization in response to said signal, first means connected to said time switch and said valve motor and responsive to actuation of said actuating means for effecting energization and control valve opening movement of said valve motor, means connected to said control valve and valve motor for effecting deenergization of said valve motor when said control valve attains a fully open position, second means connected to said time switch and adapted for connection to said pump motor and responsive to actuation of said actuating means for effecting energization of said pump motor a predetermined period of time after energization of said valve motor, third means connected to said switch and said valve motor and responsive to actuation of said actuating means for effecting energization and control valve closing movement of said valve motor a predetermined period of time after energiza-

tion of said pump motor, and means connected to said control valve and valve motor for effecting deenergization of said valve motor when said control valve reaches a fully closed position.

5. The combination comprising an electric pump driving motor, a deep well pump driven by said pump motor and arranged for supplying water to a pressure reservoir, a check valve operatively arranged with said pump for preventing flow of water from said reservoir to said pump, a normally closed control valve operatively connected between said pump and said check valve for diverting flow of water from said pump to atmosphere, an electric valve driving motor connected to said control valve to effect gradual opening and closing thereof, switch means operatively connected to said reservoir and responsive to a maximum pressure condition in said reservoir for giving a corresponding signal, a time switch including a driving motor having circuit connections through said switch means and adapted to be energized in response to said signal of said switch means, first means operatively connected to said time switch and said valve motor and responsive to operation of said time switch for effecting energization and control valve opening movement of said valve motor, means connected to said control valve and valve motor for effecting deenergization of said valve motor when said control valve attains a fully open position, second means operatively connected to said time switch and said pump motor and responsive to operation of said time switch for effecting deenergization of said pump motor a predetermined period of time after energization of said valve motor, third means operatively connected to said time switch and said valve motor and responsive to operation of said time switch for effecting energization and control valve closing movement of said valve motor a predetermined period of time after stopping of said pump, and means connected to said control valve and valve motor for effecting deenergization of said valve motor when said control valve attains a fully closed position.

6. In a surge eliminating apparatus for use with liquid pump means connected to supply liquid to a liquid system under pressure through a check valve, said surge eliminating apparatus comprising a control valve adapted to be connected between said pump means and said check valve for diverting the flow of liquid to atmosphere, a motor connected to said control valve for slowly opening and closing the same, a pressure responsive switch means adapted for connection to said system and responsive to a maximum pressure condition therein, means operatively connected to and controlled by said switch means for effecting stopping of said pump means, further means operatively connected to and controlled by said switch means for effecting energization of said valve motor and opening movement of said valve a predetermined period of time preceding stopping of said pump means, means connected to said control valve and valve motor for effecting deenergization of said valve motor when said control valve attains a fully open position, means operatively connected to and controlled by said switch means for effecting energization of said valve motor and closing movement of said control valve after stopping of said pump means, and means connected to said control valve and said valve motor for effecting deenergization of said valve motor when said control valve attains a fully closed position.

7. A surge eliminating apparatus for use with a motor driven pump connected to supply liquid to a pressure reservoir through a check valve, said apparatus comprising a control valve connected between said pump and said reservoir for diverting the flow of liquid to atmosphere, a motor connected to said control valve for slowly opening and closing the same, switch means connected to said reservoir and operable in response to a minimum pressure condition therein, motor control means operatively connected to said switch means and said motor and responsive to operation of said switch means for effecting start-

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ing of said pump motor, valve motor control means operatively connected to said valve motor and said switch means and responsive to operation of said switch means for effecting energization of said valve motor and opening movement of said control valve a predetermined period of time preceding operation of said pump means, motor connected to said control valve and valve motor for effecting deenergization of said valve motor when said control valve attains a fully open position, said valve motor control means being responsive to operation of said switch means to energize said valve motor and effect closing movement of said control valve a predetermined period of time after beginning operation of said pump means, and means connected to said control valve and valve motor for effecting deenergization of said valve motor when said control valve reattains a fully closed position.

8. In a control apparatus for a pump adapted to supply liquid to a pressure system, a check valve arranged to prevent liquid flow from the system to the pump, a normally closed control valve connected to said pump and by-passing said check valve, switch means connected to said system and responsive to a maximum pressure

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condition therein for giving a control signal, valve control means operatively connected to said switch means and to said control valve and responsive to said signal for slowly opening said control valve whereby the liquid flow is gradually diverted from said system and through said control valve, pump control means operatively connected to said switch means and said pump and responsive to said signal for stopping said pump when said check valve is fully closed, said valve control means being further responsive to said signal to close said control valve when said pump has stopped.

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