United States Patent [19]

Gritz

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[54] **PUMP SYSTEM AND VALVE ASSEMBLY THEREFOR**

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[73] Assignee: **Jacuzzi Bros. Incorporated,** Little Rock, Calif.

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[52] **U.S. Cl.** **417/38,** 137/116

[51] **Int. Cl.** **F04b 49/00**

[58] **Field of Search** 417/17, 38, 44; 137/614.21, 116

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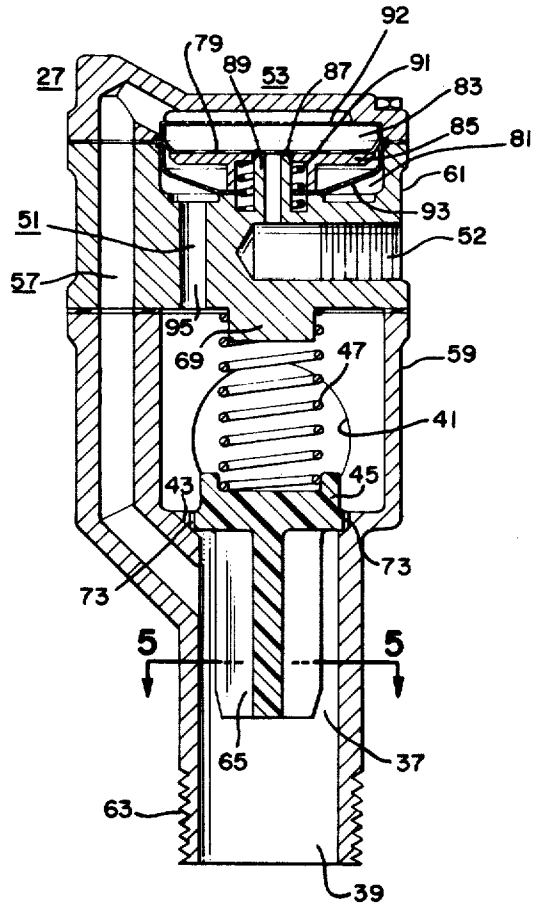
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Primary Examiner—William L. Freeh

[57] **ABSTRACT**

The invention relates to an automatic pump system, primarily for supplying water under constant pressure, wherein a valve which isolates the pressure switch following energization of the pump motor, is closed by application of hydraulic pressure directly thereto from the pump and a main valve in the system is by-passed to provide a sharp drop in differential pressure across said main valve to assure stable operation of the pressure switch isolating valve.

13 Claims, 6 Drawing Figures



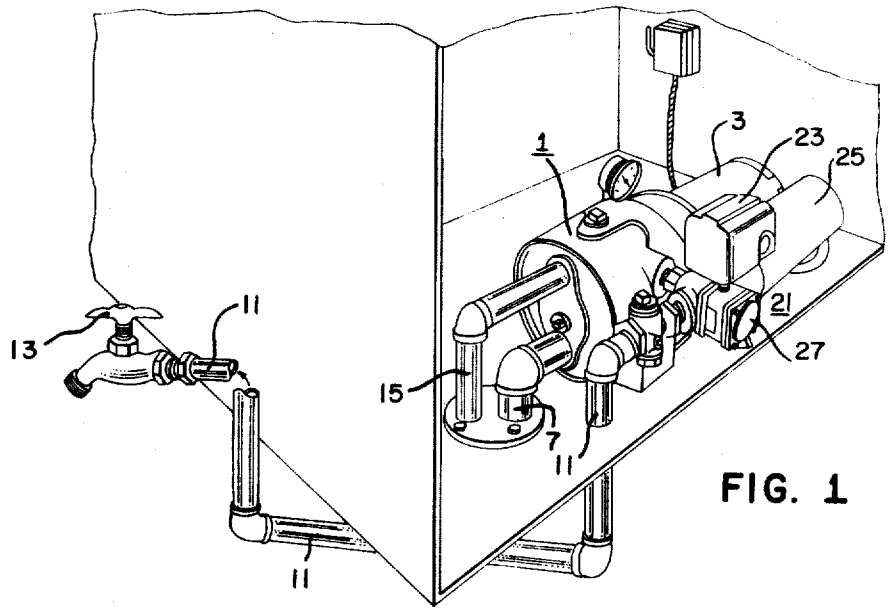


FIG. 1

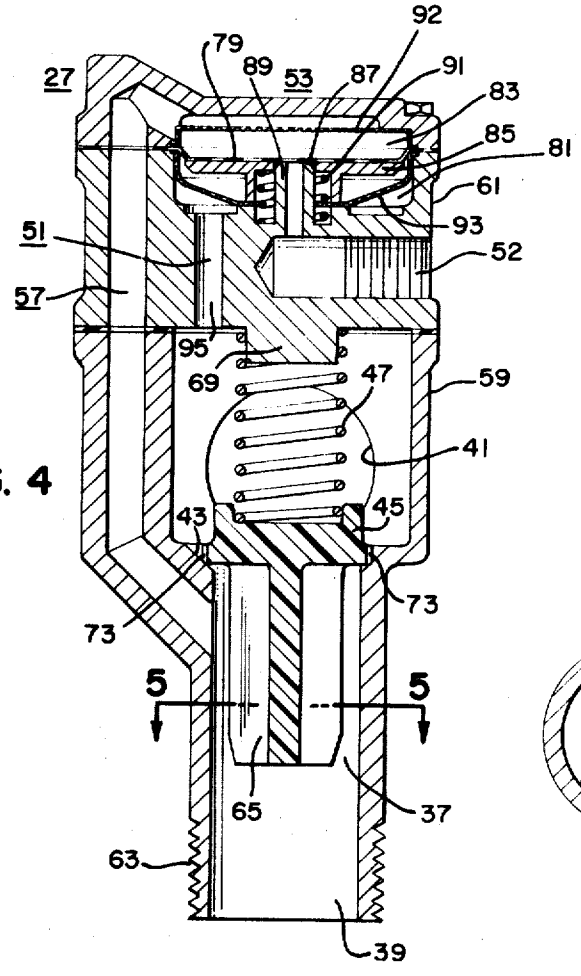


FIG. 4

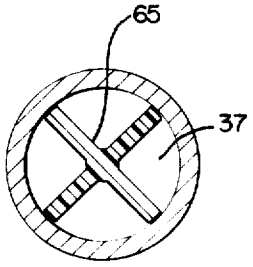


FIG. 5

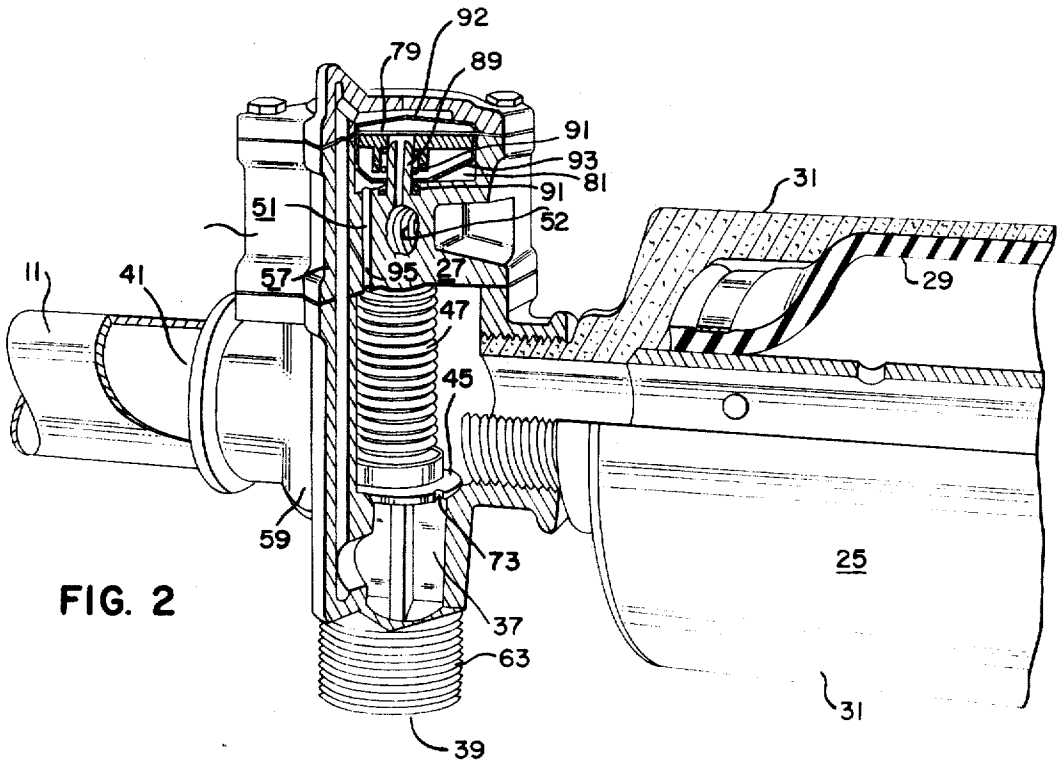

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FIG. 2

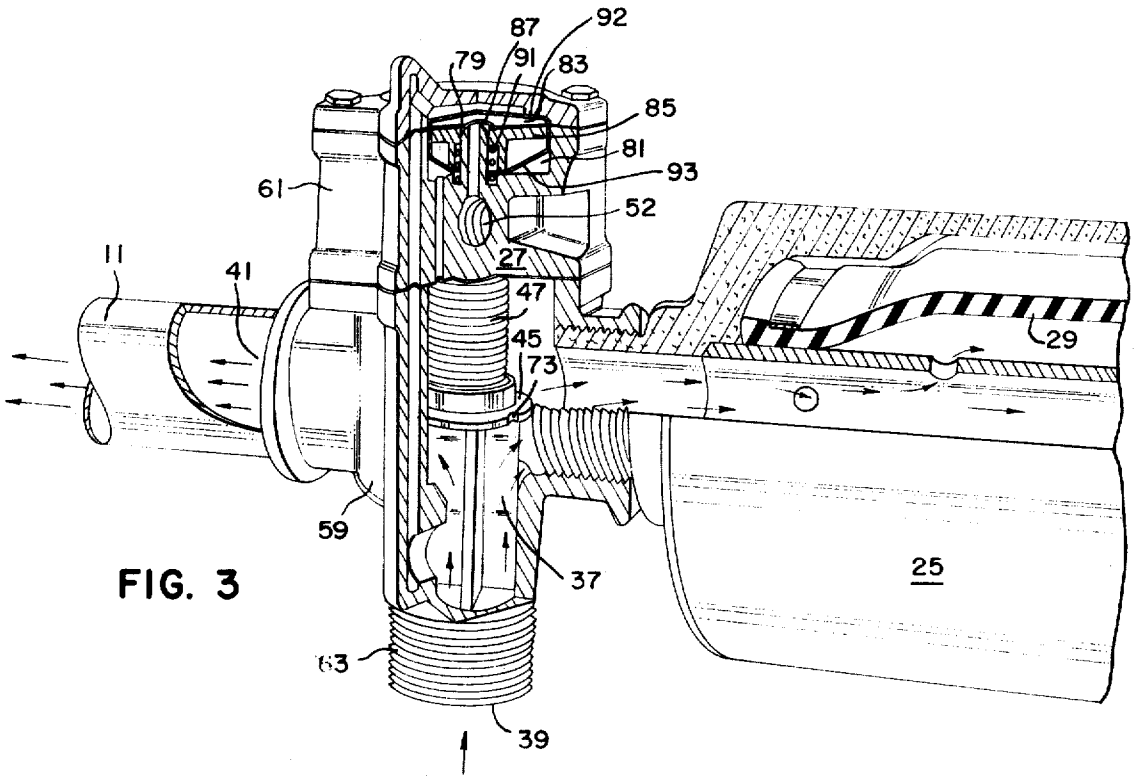

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FIG. 3

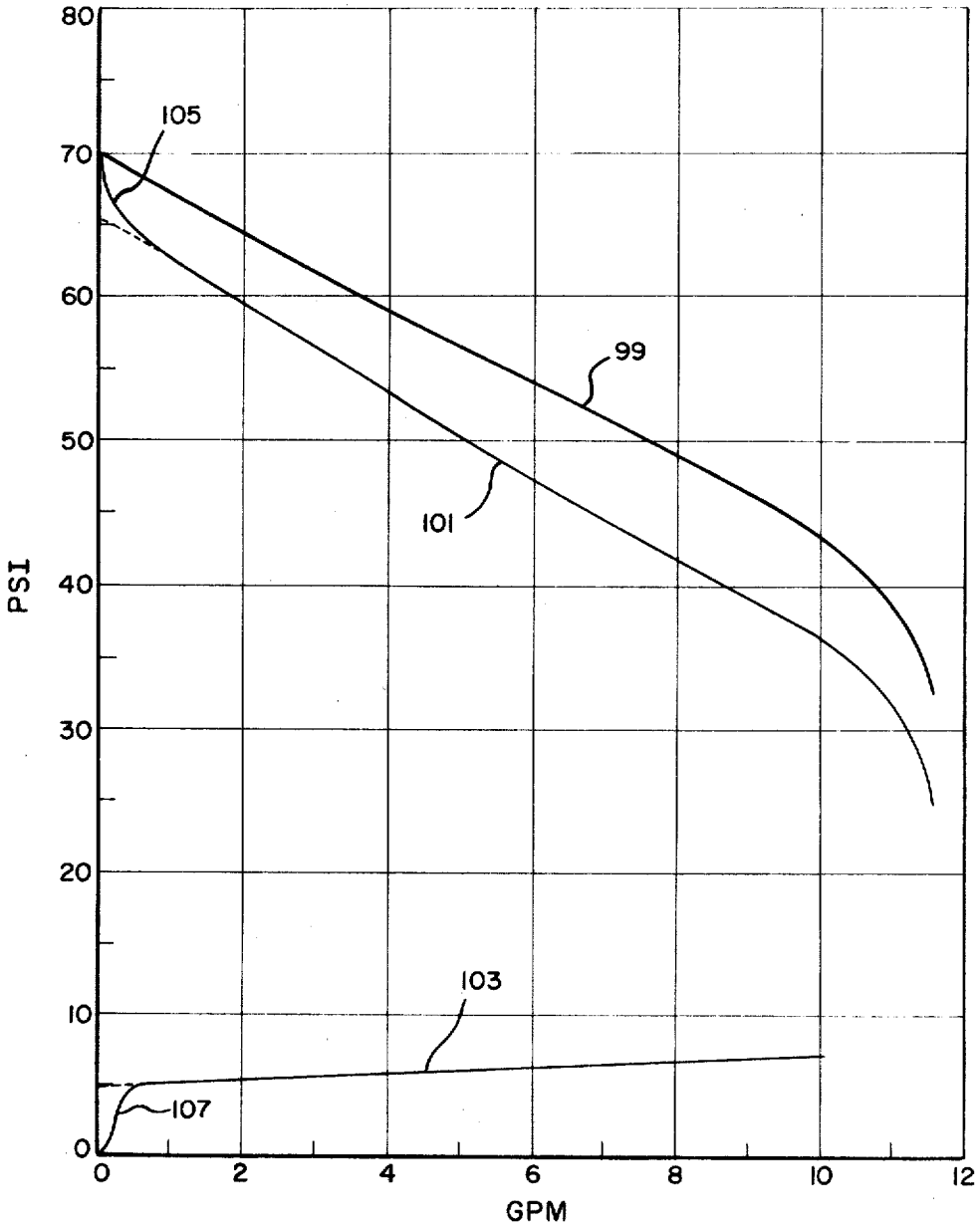


FIG. 6

PUMP SYSTEM AND VALVE ASSEMBLY THEREFOR

My invention relates to pump systems primarily for pumping water from a source, under pressure, and more particularly relates to a system of the automatic type for supplying water at substantially constant pressure for any demand from service.

Among the objects of my invention are:

1. To provide a novel and improved automatic pump system and control valve assembly therefor;
2. To provide a novel and improved automatic pump system which is more reliable in operation;
3. To provide a novel and improved valve assembly for an automatic pump system, which can be manufactured and assembled more economically, and which is more reliable in operation.

Additional objects of my invention will be brought out in the following description of a preferred embodiment of the same, taken in conjunction with the accompanying drawings wherein;

FIG. 1 is a view depicting an automatic pump system embodying the present invention and designed for supplying water at substantially constant pressure at the prevailing service demand;

FIG. 2 is a view through a valve assembly constituting an important component of the system of FIG. 1 depicting the same in a condition prevalent when the water system is in a quiescent state;

FIG. 3 is a view through the valve assembly of FIG. 2, depicting its condition when the system is in a condition of supplying a demand of service;

FIG. 4 is a view in section through the valve assembly of FIG. 2 and 3 to more clearly illustrate the relationship between the various component parts thereof;

FIG. 5 is a view in section taken in the plane 5—5 of FIG. 4; and

FIG. 6 depicts representative characteristic curves depicting the principle underlying the operation of the present invention.

Referring to the drawings for details of my invention in its preferred form, the system of FIG. 1 involves a pump 1, driven by a motor 3, which is drive coupled thereto in any appropriate manner.

The pump draws water from any suitable source such as a well by means of a suction line 7 connected at one end to the suction side of the pump, and extending down into the well, where it terminates below water level in a foot valve. The water thus drawn from the well is discharged through one or more service lines 11 extending from the discharge side of the pump to service, and includes a discharge valve 13. If the pump is of the deep well type, a pressure line 15 carries part of the pump discharge to an injector pump in the well, all in accordance with conventional practice.

In accordance with the present invention, there is incorporated into the system, switch means assembly 21 which is responsive to the opening of a service line, to cause the pump to start and promptly deliver water to service at substantially a constant pressure, in accordance with the prevailing service demand, and so long as there exists a service demand on the system. Upon shut-down of the service demand, the switch means assembly is promptly restored to its prior condition, in the course of which, the motor is de-energized to stop the pump, which remains ready to start again in response to a subsequent demand from service.

Such switch means assembly 21 involves a combination of a pressure switch 23, and a variable pressure device 25 which, in the quiescent condition of the system, is flow connected thereto.

The pressure switch may be of any conventional type adapted to close a circuit to a pump motor at a predetermined low pressure and open such circuit at a predetermined higher pressure.

The variable pressure device 25 may be of any type which can respond to the pressure in the service line and transmit such pressure to the pressure switch. In its preferred form, this variable pressure device involves an inflatable tube 29 in a housing 31, the inflatable tube being flow connected to the pump 1 and service line 11, and hydraulically pressure coupled to the pressure switch 23.

Structurally, the inflatable tube 29 is supported axially of its housing in spaced relationship thereto, to permit inflation thereof in response to admission of water under pressure.

Critical to the present invention, is a valve assembly 27 which functionally relates the various mentioned components of the system to one another. In its preferred embodiment, this valve assembly involves a housing 35 having a main flow passageway 37 therethrough, at the input end 39 of which passageway, the housing is provided for connection to the pump, and at its other end, the passageway terminates at an opening 41 in the housing for connection to service.

At an intermediate location, the wall of the main passageway is formed to provide a valve seat 43 for a valve 45 of the poppet type which is normally urged toward seating position against pump pressure, by a valve spring 47.

A first auxiliary or branch passageway 51 leads off from the main passageway, down stream of the poppet valve, to an external opening or port 52 in the housing for connection to the pressure switch. At an intermediate location along this auxiliary passageway, the passageway is spanned by pilot valve assembly 53 of the normally open type, in which the valve is capable of being hydraulically actuated directly from a normally open position to a closing position, to block or isolate the pressure switch from the system. Such hydraulic actuation is provided for a second auxiliary passageway 57 flow connecting the pump, upstream of the main poppet valve, to such pilot valve assembly.

The variable pressure device 25 is mounted on a wall of the housing where it will be in constant communication with the main flow passageway and thereby always exposed to pressure conditions in such main passageway, down stream of the poppet valve.

In the preferred embodiment of the overall valve assembly 27 as illustrated in the drawings, the housing 35 is formed, preferably, of three component parts, the first 59 being hollow and essentially closed off by the second or proximate section 61 and defining the main flow passageway, beginning with a threaded neck to which the pump may be flow coupled by suitable fittings, and terminating at the side opening 41 for connection to one or more service lines.

At the inner end of the neck portion of the main passageway, is the valve seat 43 which is spanned by the poppet valve 45, this valve having a guide stem 65 extending into the neck; the stem, preferably, being of X-section to provide for adequate flow to the valve 45 and the second auxiliary passageway 57.

This poppet valve is the main valve of the system, and is normally biased toward seating position by the spring **47** installed under compression between the poppet valve and the intermediate section **61** of the housing, which is formed with a protuberance **69** about which the spring seats for stability in its installed position.

The poppet valve is provided with by-pass means which preferably takes the form of one or more notches **73** in the valve periphery, whereby the main passageway is never blocked, the by-pass means functioning to generate a desired pressure drop characteristic during shutting down of the service line demand, as will subsequently be explained in more detail.

In the wall of this first section is another opening **75** intercepting the main passageway, such opening being threaded for coupling to the valve assembly housing, of the variable pressure device **25** of the type described, thus placing this variable pressure device in continuous flow communication with the service line or lines, all of which exist down stream of the main poppet valve.

The second and third sections of the housing are each recessed in their engaging walls to form a chamber which is partitioned by a diaphragm **79** clamped between the engaging walls of these two sections, such diaphragm being preferably of sheet rubber or rubberized fabric having some stretchable properties. This diaphragm forms a lower chamber **81** below the diaphragm and an upper shallow chamber **83** above the diaphragm, and preferably is backed up by a backing plate **85** having a central opening to expose the diaphragm to a valve seat **87** at the end of a hollow nipple **89** extending upwardly toward the diaphragm from the floor of the shallow chamber **81**. The diaphragm thus is adapted to function as a valve component in the pilot valve assembly. In the open condition of the pilot valve assembly, the nipple serves to connect this lower chamber to the pressure switch port **52**. A valve spring **91** about the nipple normally biases the diaphragm valve toward open position.

A screen **92** installed above the diaphragm and a screen **93** installed below the diaphragm, will serve to screen out sand or other debris which might otherwise gain access and adversely affect the functioning of the diaphragm.

As thus far described, and with the system in a quiescent state but pressurized by the variable pressure device **25**, opening of a service line valve will cause the variable pressure device to "collapse," thus dropping the prevailing pressure throughout the service line and the first auxiliary passageway to the pressure switch. The pressure switch, sensing this drop in pressure, will, at a preset low value of pressure, say of the order of 20 psi, electrically connect the pump motor in circuit and start the pump.

The lower shallow chamber **81** constitutes a portion of the auxiliary passageway **51**, such auxiliary passageway including also a section **95** connecting the main passageway to the shallow chamber, and the section through the nipple **89** to flow connect the shallow chamber to the port **52**, this port being threaded for coupling thereto of the pressure switch.

Hydraulic pressure applied to the upper side of the diaphragm during pumping, is derived directly from the pump, upstream of the main poppet valve, by way of the second auxiliary passageway **57** in the wall of the housing and which, in the specific embodiment illustrated, extends from the neck portion, upstream of the poppet valve, and terminates at the upper shallow chamber.

Immediately upon starting up, the pressure developed by the pump, opens the main poppet valve to supply service, and at the same time, by way of the second auxiliary passageway, applies hydraulic pressure directly to the upper side of the diaphragm. Thus a differential pressure, comparable to that across the main valve, will develop across the diaphragm, such differential pressure being sufficient, under the prevailing conditions, to overcome the resistance of the pilot valve spring and cause closing of said pilot valve. The pilot valve, when thus closed, isolates the pressure switch from the pressure in the system, thereby leaving the system free to supply service, uninterrupted by pressure changes that might result in pressure rising above the cut-off pressure setting of the pressure switch.

As the service valve is in the process of being turned off in the act of closing down a demand for service, flow across the main valve will be slowed down accordingly. The service pressure will rise, along with that developed by the pump in accordance with the characteristic curve of the particular pump. Thus a differential pressure developed across the main valve will follow a characteristic curve representing the differences between the pump pressure and service line pressure at different flow rates.

Referring to FIG. **6** of the drawings, the uppermost curve **99** is typical of a pump and depicts the pump pressure rising in response to restriction of its discharge as by turning down of a service valve.

The service line pressure, under comparable conditions, also rises as represented by the curve **101** next below the pump characteristic curve. Assuming no notches or other by-pass means about the main poppet valve, this second curve will, if permitted to continue without interruption by the pressure switch, gradually approach but never merge into the pump characteristic curve, the differences between the two curves being the differential pressure variations occuring across the main valve due to flow through this valve. When the calibration of the main valve spring **47** exceeds a prevailing differential pressure, the main valve will seat.

These differential pressures, if plotted, would follow a curve **103** of very shallow slope, thus necessitating extremely sensitive and impractical control means to distinguish between pressure valves along the curve. Since it is desired that the pilot valve respond to a value of differential pressure developed as the flow rate approaches zero, it becomes apparent that the pilot valve might not be capable of distinguishing pressure values along this portion of the curve and could respond to values anywhere along a substantial stretch of this curve where flow rate might be substantial instead of insignificant, insofar as normal service demands may be involved. Accordingly, the system is apt to shut down, or fail to supply service, when service is desired, as for example, at a flow rate even as low as a gallon per minute or so.

This drawback is overcome by the by-pass notches in the main poppet valve, or the equivalent of such notches, the function of such as previously indicated being to bring about a sharp drop in the flow across the main valve before service demand actually ceases, so as to introduce into the differential pressure curve as it approaches zero flow, a sharp drop in differential pressure, and by utilizing this narrow portion of the curve,

the pilot valve can then readily differentiate between a very narrow differential pressure range in which it is designed to open, and adjacent higher differential pressures along the curve. Thus the pilot valve can be designed to open, for example, at a diminished flow rate of the order of one-third gallon or less per minute, and the pump motor will then be disconnected when the flow rate in the system has been reduced to that value, which normally does not represent a normal service requirement. How the notches make this possible will be evident by again referring to the curves of FIG. 6.

In the presence of the notches, flow across the main valve continues after seating of the main valve and until the service valve is fully closed and terminates flow. At this point the service line pressure equals the pump pressure. Accordingly from the moment the main valve seats, the service line pressure curve swings upward along a section **105** to meet the pump pressure curve at zero flow. The pressure differential curve, following seating of the main valve, takes a sharp drop with further closing of the service valve, along a section **107** which drops the differential pressure from its prevailing value at say about three-fourths of a gallon per minute to zero. By designing the pilot valve spring so as to open the pilot valve at a differential pressure about half way down this section of the curve, which may be of the order of 3 psi representing a discharge flow rate of about one-third gallon per minute, the pilot valve, obviously need no longer be of extreme sensitivity, yet will, nevertheless, function repeatedly at substantially the same differential pressure and low discharge, thus assuring accurate shut down of the system.

Should a particular system incorporate water storage under pressure on the pump side of the main valve, or involve substantial piping from the pump to the main valve, which due to expansion under pump pressure, would exhibit similar storage characteristics during nonoperating periods of the pump, delay may be experienced in starting up the ppump in response to a service demand. This may be explained by the fact that upon opening a service valve, the initial demand will now be supplied, not only by the variable pressure device **25**, but also from such upstream storage facility, or piping in expanded condition.

Water from the upstream source must flow through the by-pass notches, thus creating a pressure differential which, when applied to the pilot valve diaphragm, will serve to close the pilot valve and hold it closed until the source of upstream flow has died off sufficiently. Such delay would be a function of magnitude of such storage of water under pressure and would be undersirable.

Such delay can be effectively reduced in the preferred embodiment of my invention, merely by the addition of a stop in the form of a skirt **111** depending from the back-up plate about the nipple and adapted to engage the screen immediately after closing of the pilot valve, to prevent extension tensioning of the diaphragm over the valve seat. Why this simple expedient should reduce the delay in question, may be explained as follows.

At the time of the prior shut down of the system, the pressure switch had reacted to a pressure in the system at least equal to the high pressure setting of the switch, and remains pressurized as it is in pressure communication with the variable pressure device.

Upon subsequently opening a service line valve to place a demand on the system, such pressure would drop in accordance with that of the variable pressure device. However, where upstream storage exists, the pilot valve will close before a substantial pressure drop can occur in the pressure switch, and the pressure switch will become isolated while still pressurized at a pressure substantially above its low pressure setting. Accordingly, as the pressure throughout the system decreases, it reaches a value sufficiently below that pressure in the pressure switch, when the difference in pressure will enable the minimally tensioned portion of the diaphragm across the valve seat to be lifted off the valve seat and permit the switch to drop its pressure and respond to the service line pressure when it drops to the lower pressure setting of the switch, to start the pump motor.

Inasmuch as different system installations may function at different pressure conditions, any pressure values indicated are merely for purposes of explanation and not of limitation.

It will be apparent from the foregoing description that the invention fulfills all the objects thereof, and while I have illustrated and described the same in its preferred form, the invention is subject to alteration and modification without departing from the underlying principles involved, and I accordingly do not desire to be limited in my protection to the specific details illustrated and described except as may be necessitated by the appended claims.

I claim:

1. A pump system comprising a pump, an electric motor in drive connection with said pump, a service line, a service valve in said service line, a pressure switch in electric circuit with said motor, and a control valve assembly comprising a valve housing having an input opening for flow connection thereto of said pump, a discharge opening for flow connection to said service line, and a main flow passageway interconnecting said input opening and said discharge opening, a main valve spanning said main passageway, means biasing said main valve toward closing position, a first auxiliary passageway flow connecting at one end with said main passageway on the downstream side of said main valve and terminating in an opening in said housing for hydraulic pressure connection to said pressure switch, means coupling said pressure switch to said valve housing at said last opening, a pilot valve assembly spanning said first auxiliary passageway and including a valve seat and a valve means normally biasing said pilot valve toward open condition, and a second auxiliary passageway, said second auxiliary passageway flow connecting at one end to said main passageway on the upstream side of said main valve and terminating at said pilot valve in pressure opposing relationship to said biasing means, whereby development of hydraulic pressure against said valve in excess of any opposing pressure against said valve will close said valve and block said first auxiliary passageway.

2. A pump system in accordance with claim **1**, characterized by by-pass flow means in by-pass relationship to said main valve to preclude blocking of said main passageway upon seating of said main valve and introduce a sharp drop in differential pressure across said main valve upon seating of said valve.

3. A pump system in accordance with claim 1, characterized by said by-pass means including at least one notch through said main valve.

4. A pump system in accordance with claim 1, characterized by said pilot valve comprising a diaphragm, with said biasing means exerting pressure against one side of said diaphragm valve in the direction of lifting the same from its seat and said second auxiliary passageway terminating at the opposite side of said diaphragm valve.

5. A pump system in accordance with claim 4, characterized by by-pass flow means in by-pass relationship to said main valve to preclude blocking of said main passageway upon seating of said main valve and introduce a sharp drop in differential pressure across said main valve upon such seating of said valve.

6. A pump system in accordance with claim 5, characterized by said biasing means being pressure calibrated to cause opening of said pilot valve assembly at a differential pressure generated following seating of said main valve.

7. A valve assembly for a pump system, comprising a housing having a main passageway therethrough, a main valve spanning said main passageway, means normally biasing said main valve toward closing position, a first auxiliary passageway in said housing extending from said main passageway on one side of said main valve, to an external opening in said housing adapted for coupling thereto of a pressure switch, a pilot valve assembly spanning said first auxiliary passageway and including a pilot valve, means normally biasing said pilot valve to open position, and means for transmitting pressure hydraulically from said main passageway on the other side of said main valve, to said pilot valve in opposition to said biasing means, to pressure said pilot valve toward closing.

8. A valve assembly for a pump system in accordance with claim 7 characterized by by-pass means in by-pass relationship to said main valve to preclude blocking of said main passageway upon seating of said main valve and introduce a sharp drop in differential pressure across said main valve upon seating of said valve.

9. A valve assembly for a pump system in accordance with claim 7, characterized by said by-pass means including at least one notch through said main valve.

10. A valve assembly for a pump system in accordance with claim 7, characterized by said pilot valve comprising a diaphragm, with said biasing means exerting pressure against one side of said diaphragm valve in the direction of lifting the same from its seat and said second auxiliary passagewy terminating at the opposite side of said diaphragm valve.

11. A valve assembly for a pump system in accordance with claim 10, characterized by means limiting tensioning of said diaphragm valve following seating thereof against its seta.

12. A valve assembly for a pump system in accordance with claim 10, characterized by by-pass flow means in by-pass relationship to said main valve to preclude blocking of said main passagewy upon seating of said main valve and introduce a sharp drop in differential pressure across said main valve upon such seating of said main valve.

13. A valve assembly for a pump system in accordance with claim 12, characterized by said biasing means being pressure calibrated to cause opening of said pilot valve assembly at a differential pressure generated following seating of said main valve.

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