Dec. 2, 1969 P. E. NAPOLITANO 3,481,274

DIFFERENTIAL PRESSURE SENSITIVE VALVE SYSTEM FOR SELF-PRIMING LIQUID-TYPE PUMPS

Filed Dec. 18, 1967 4 Sheets-Sheet 1

FIG. 1.

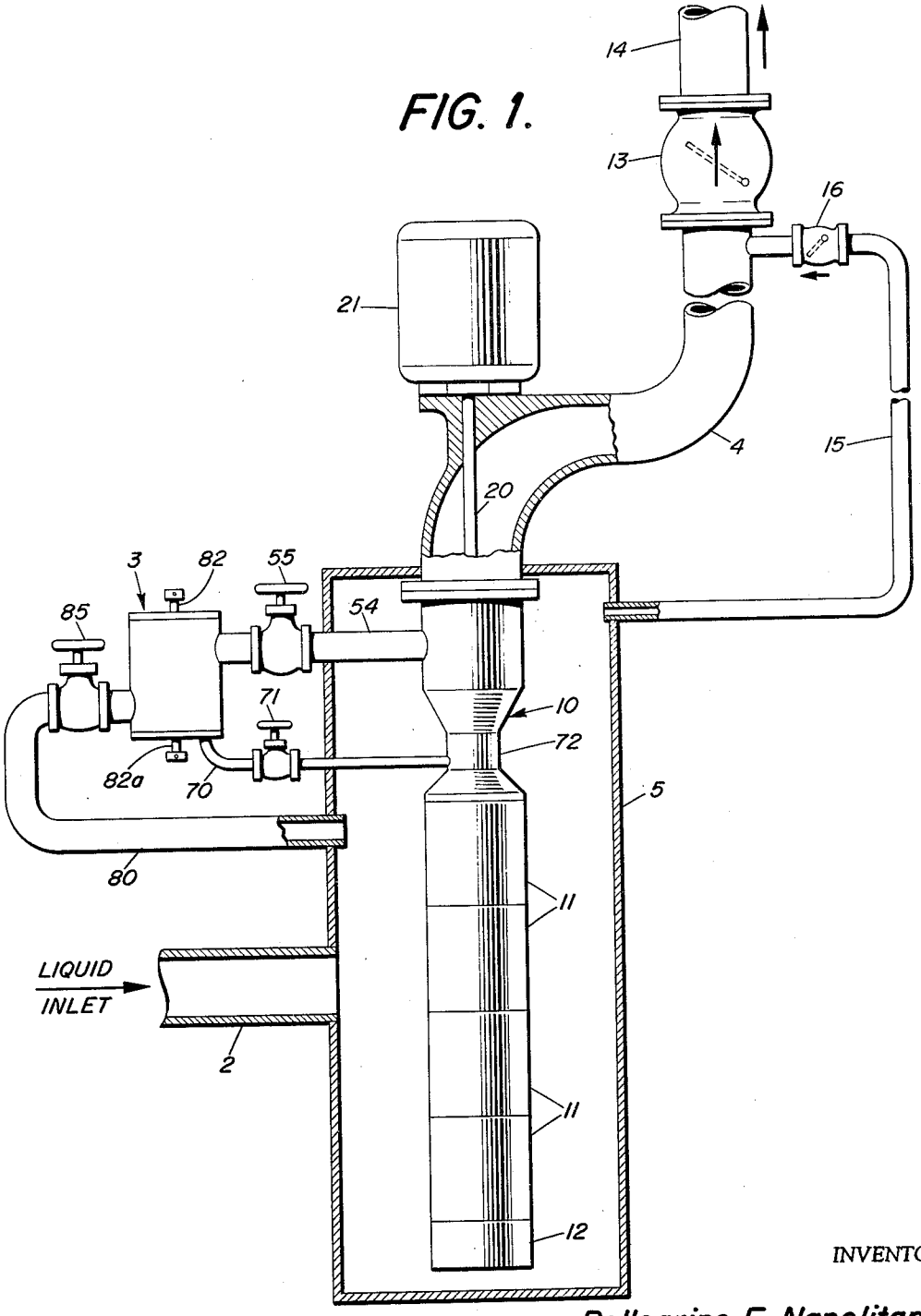

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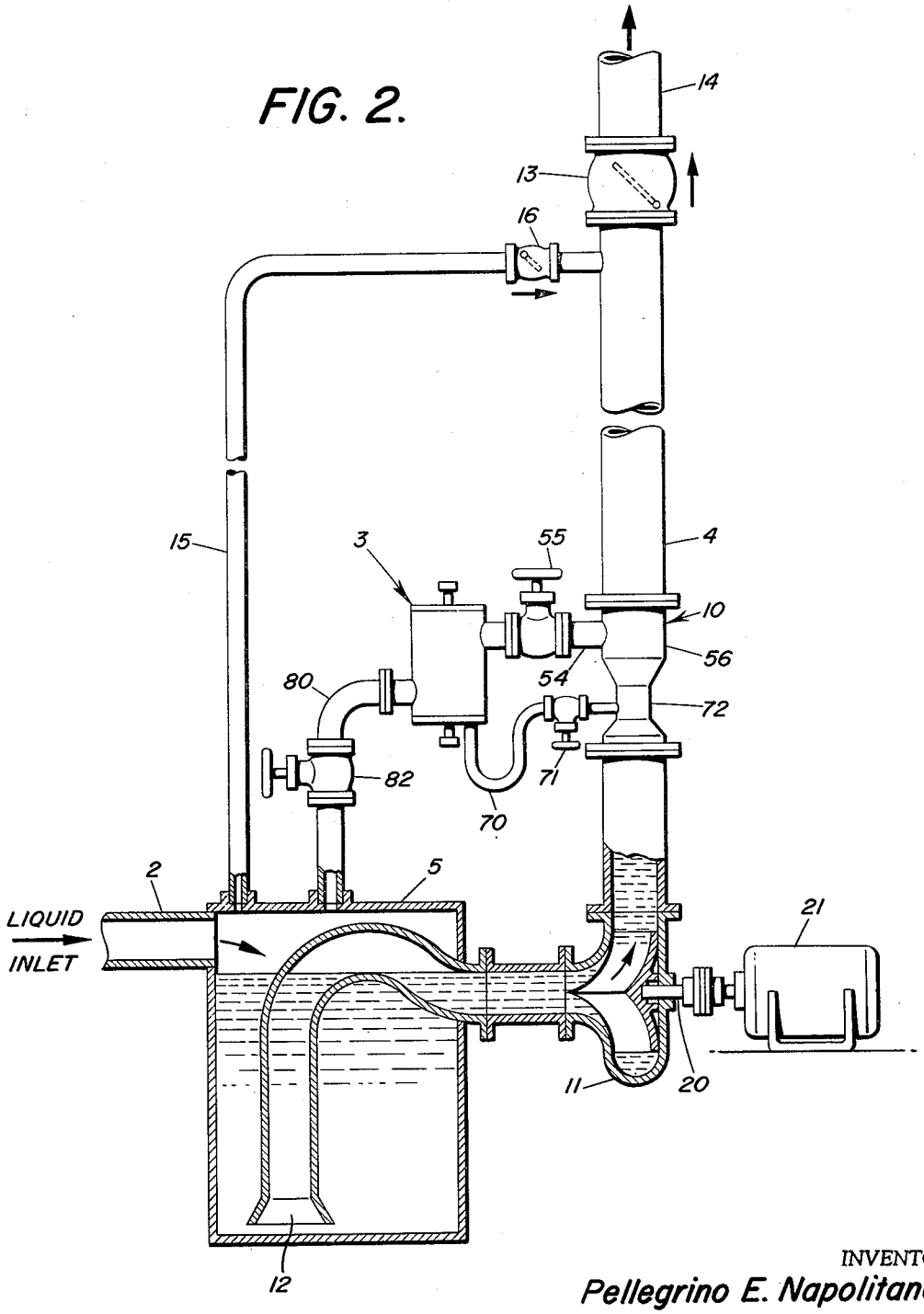
FIG. 2.



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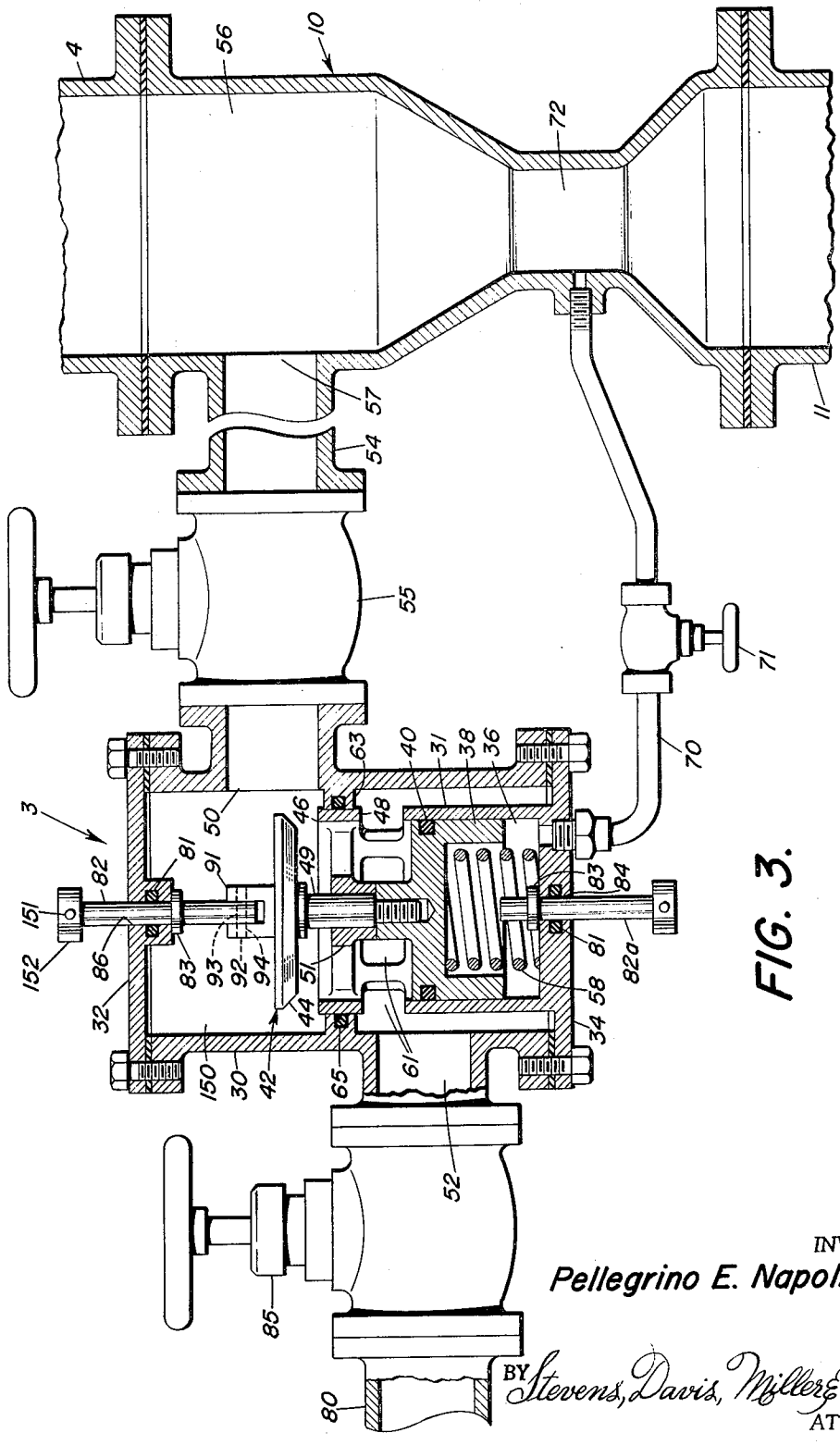

FIG. 3.

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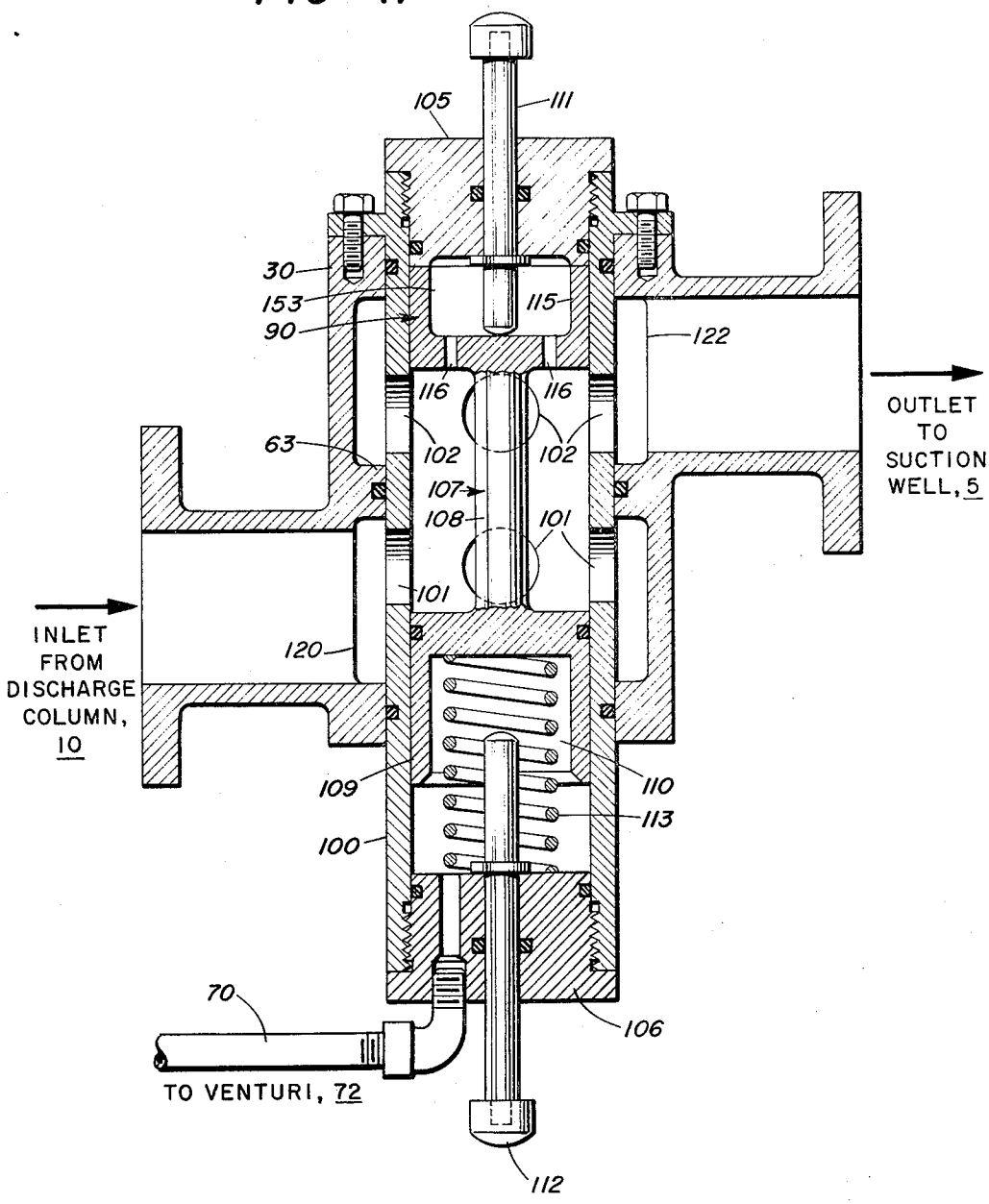
FIG. 4.



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3,481,274

DIFFERENTIAL PRESSURE SENSITIVE VALVE SYSTEM FOR SELF-PRIMING LIQUID-TYPE PUMPS

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U.S. Cl. 103—113 11 Claims

ABSTRACT OF THE DISCLOSURE

A primer valve system for a liquid pump which provides automatic self-priming of the pump without interference in the normal operation thereof. The system includes a primer valve that is readily accesible for maintenance without dismantling of the pump.

The present invention relates to self-priming liquid pumping systems and, more particularly, to an improved primer valve system which may be adapted to any type liquid pump for effecting automatic self-priming of the pump without interfering with the normal operation of the pump or complicating its maintenance.

In the past, there have been many different devices developed which automatically prime a liquid pump to prevent air from being introduced to the suction side of the pump when the pump runs dry due to an insufficient amount of liquid being present in the pump inlet. These devices are essential to the efficient operation of the pumping system since, as is well known, once air is admitted to the suction passage in sufficient quantities to allow the pump to exhaust its supply of liquid within the suction well, the pump no longer is able to maintain suction to pump the liquid. Consequently the pumping operation stops, and the attention of an operator is required if no automatic means for priming the system is provided.

In one type of device for accomplishing repriming, self-priming of the pump is effected by a primer valve located in the discharge passage of the pump, which closes the discharge passage and opens a port communicating the discharge passage with the well surrounding the pump, whereby a quantity of previously pumped and stored liquid flows back to the suction well and pump inlet. The recycled liquid is pumped, forcing the primer valve to assume a position which opens the discharge passage and closes the port. If the pump is not fully reprimed, the primer valve again closes the discharge passage and opens the port for another recycle. This recycling through the pump unit continues in this fashion until the suction inlet is once again submerged in liquid and the normal pumping cycle is restored. An example of an apparatus operating on this principle of self-priming is described in the Meyer et al. Patent No. 2,902,940, issued Sept. 8, 1959.

The heart of the recycle type of self-priming described is the primer valve which closes the discharge passage and opens a port to the suction well of the pump unit to allow the stored liquid to once again be pumped and restore normal suction at the pump inlet. In this type of prior art system, the primer valve is located inside the discharge passage and includes a sliding valve element mounted for movement along or relative to the central axis of the pump unit. While this arrangement is proven to be generally satisfactory for purposes indicated, there has been a long-felt need in the art for an improved primer valve arrangement for this type of pumping system because maintenance of the valve in such systems requires removal of the pump shaft, and the otherwise

simple replacement of the valve necessitates the dismantling of the pump.

In my copending U.S. patent application entitled Self-Priming Liquid Pumping System and Primer Valve, Ser. No. 418,707, filed Dec. 16, 1964, now Patent 3,370,604, I have disclosed a system having an improved primer valve arrangement in which the primer valve is easily accessible for service or replacement, and the disassembly of the pump and shaft for removal or installation of the primer valve is not required. This system provided a significant step forward in the art, as the replacing of a primer valve can be accomplished in a matter of minutes, and the pump can be quickly put back in operation.

The present invention is directed generally to the type of self-priming system described and, particularly, to a novel primer valve and associated actuator construction providing for continuous operation of the pump even during the mechanical servicing or replacement of the primer valve.

According to another and related aspect of this invention, a valve system for self-priming pumps is provided that is simple in construction, has improved operating characteristics for the purpose indicated and can be adapted to any type liquid pump.

It is still another object of the present invention to provide a valve system for self-priming pumps wherein a primer valve is provided which is easily accessible for service or replacement and does not require that the pump be shut down while it is being serviced or replaced.

Another object of the present invention is to provide a primer valve system characterized by auxiliary means for actuating the primer valve in the event it becomes clogged by chemicals or other foreign matter contained in the liquid in which it operates.

Another object of the present invention is to provide a valve system wherein the primer valve is in the form of a cartridge which may be easily and quickly replaced.

Another object of the present invention is to provide a primer valve system in which the primer valve does not have to be in the discharge flow, or positioned immediately adjacent thereto, and may be a distance away as long as it is connected to the discharge by a conduit through which the liquid will flow when returning to be recycled, and a pressure tube connected to the throat of the venturi, thus enabling the adaptation of this system to liquid pumps in environments where space around the discharge pipe is limited and access thereto is difficult.

A still further object of the present invention is to provide a primer valve system containing a primer valve assembly which may be selectively isolated from the pumping system.

The above and still further objects, features and advantages of the present invention will become apparent upon consideration of the following detailed description, especially when taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a sectional view of the present invention in conjunction with a conventional center-shaft centrifugal pump.

FIG. 2 is a sectional view of the present invention in conjunction with a horizontal pump.

FIG. 3 is an enlarged sectional view illustrating the structure of the valve assembly of this invention.

FIG. 4 is another embodiment of the valve assembly constructed in accordance with the present invention.

The device of the invention may be associated with a conventional center-shaft centrifugal pump as shown in FIG. 1, a horizontal pump 2 as shown in FIG. 2, or any other liquid-type pump desired.

These pumping systems raise the liquid to the desired

location by suction and reprime themselves automatically. That is, upon the entrance of air into the system via inlet or suction pipe **2** and the resilient discontinuance of the normal flow of liquid through said pipe **2**, the primer valve, generally represented by reference numeral **3** in the accompanying drawings, opens discharge pipe **4** to suction well **5** so that the system is primed with previously pumped liquid stored in upper portions of the discharge passage of the pipe **4**, whereby normal pumping operations can be resumed. If the suction pipe **2** continues to admit air to the suction well **5** in sufficient quantities to prevent normal pump operation after the liquid from the upper portions of the discharge pipe **4** has been recycled to the suction well **5** by gravity and the priming cycle is incomplete, the same priming liquid will be recycled until liquid completely fills pipe **2** and is drawn into well **5** to establish a continuous pumping operation.

In accordance with the present invention, a conduit **10** formed in the shape of a venturi is interposed between the uppermost pump stage and the discharge pipe or column **4**. The primer valve assembly **3** is connected to said conduit **10** and mounted adjacent to the discharge pipe.

Continuing now with a more detailed description of those parts of the pumping system illustrated in FIGS. 1 and 2 to which this invention applies, and similar parts of which are referred to by the same numeral, a motor **21** is provided to turn the pump **11**, it being understood that any number of pump elements **11** can be interconnected with said motor **21** through a suitable drive shaft **20** as shown in FIG. 1. The motor **21** drives the pump element **11** continuously. An intake skirt **12** is provided to supply the pump element **11** with the liquid contained in the bottom of the suction well **5**. As liquid is pumped from the suction well **5** and discharged through the discharge pipe **4**, it passes through check valve **13** which prevents liquid in delivery conduit **14** from flowing by gravity back into the pumping system if the pumping operation is discontinued. An air line **15** interconnects the upper portion of the suction well **5** and the upper portion of the discharge pipe **4**, permitting the repriming liquid moving back through primer valve **3** to displace air in well **5** and feeding the displaced air to the top of discharge pipe **4** to simultaneously equalize pressure. A check valve **16** is provided in the air line **15** to prevent feedback of the liquid to the suction well during the pumping operation. In the manner just described, the pumping system will pump liquid until the admission of air into the system causes a discontinuance of normal suction, whereupon the system will reprime itself until normal operation is resumed.

The valve assembly **3** as shown in FIG. 3 has a housing **30** which may be fabricated in tubular or any other convenient configuration suitable for housing a cartridge-type valve assembly. A top cover **32** bolted to one end of the housing **30** and the bottom **34** of cartridge **3** bolted to the other end of the housing **30** may be removed to provide access to the valve assembly **3**.

A sleeve **31** extends up from said bottom **34** providing a cylindrical control chamber **36** in which is mounted a piston **38** adapted for reciprocation having a conventional O-ring **40** for sealing purposes. The piston **38** carries a poppet-type valve element, generally represented by reference numeral **42**, having a poppet portion **44** for cooperation with a seat **46** formed on a ring **48** formed at the top of said sleeve **31**, and a stem portion **49**. Openings **61** are formed in the sleeve **31** to permit fluid passage through said sleeve. The stem portion **49** of the valve element is threaded into an aperture in the top of piston **38** and guided by a member **51** supported by said sleeve and through which the stem portion **49** extends. Ports **50** and **52** formed in the housing provide an inlet and outlet, respectively, for the flow of liquid through the valve housing **30**.

As seen in FIG. 3, when the cartridge-type valve assembly **3** is bolted in the housing, the sleeve **31** extends up the housing **30** and forms a liquid-tight seal with a shoulder **63** in the housing having an O-ring **65** mounted therein. The lower portion of the sleeve **31** is spaced from the circular wall of the housing **30** so as to provide a fluid flow path from openings **61** in the sleeve **31** to the outlet **52** in the valve housing. A pipe **54**, having a cutoff valve **55** therein, connects port **50** with the discharge section **56** of the conduit **10** through a port **57**.

Acting on the piston **38** and urging the poppet valve **42** to its open position is a spring **58**. The force acting on piston **38** against the spring **58** to effect closing of the valve is developed by the pressure in chamber **150** being greater than the pressure in chamber **36**. Tube **70** extends through the bottom of the cartridge **3** and communicates with the throat **72** in the venturi-formed conduit **10**. In this way, the static pressure at the throat **72** of the venturi is conveyed to chamber **36**. A cutoff valve **71** is provided in tube **70** between chamber **36** and the throat **72**.

The disposition of the valve **42** (whether it is open or closed) is determined by the velocity of the liquid flowing through the conduit **10**. When liquid is being discharged through conduit **10**, the flow of liquid through the throat section **72** produces a change in pressure relative to the pressure in the divergent section **56** of the venturi, thus producing a reduction of pressure in chamber **36** sufficient to overcome the force of the spring **58** and hold the valve **42** in its closed position. When liquid ceases to flow through the conduit **10**, there is no difference in pressure between the throat **72** in the venturi and the discharge section **56**, thus the force of the spring **58** opens the valve **42**, passing priming fluid from inlet port **50** to outlet port **52** and through the drain pipe **80** and its associated cutoff valve **85** to the well **5**. When liquid is again pumped through the discharge pipe and its associated venturi, pressure at the throat **72** of the venturi decreases, decreasing the pressure in the chamber **36**, and closing valve **42** in the manner described.

Auxiliary means for actuating valve **42** is provided by a rod **82** extending through an aperture **86** in the top cover **32** of the valve housing connected to a U or slotted member **91** mounted on the top of the valve element **42**, by a pin **92** extending through an aperture **93** in the bottom of rod **82** and apertures **94** in member **91**. A conventional sealing O-ring **81** is provided around rod **82** at the aperture **86**. The rod may be manually operated or may be actuated by any type of external power desirable. Should the valve **42** become encrusted or clogged by chemicals or other foreign matter and not respond to the change in velocity of the liquid in the venturi, the rod **82** can be used to position the valve in its proper position.

If desired, instead of connecting rod **82** to the member **91** by means of the pin **92**, the rod **82** may be used to merely contact member **91** or valve element **42** so that the rod **82** may be actuated to seat valve **42**, and a rod, extending through an aperture **84** in the bottom of the valve assembly cartridge **3** at the opposite end of the housing **30** in contact with the piston **38**, be used to move the valve into an open position. Another conventional sealing O-ring **81** is provided around rod **82***a* at aperture **84**. In this case, each of the rods is also provided with a shoulder **83** which will engage the interior or the top cover or the bottom of the cartridge through which it extends to prevent it from becoming dislocated from the assembly. The rods may be manually operated or may be actuated by any type of external power desirable and operated in response to the same conditions as would a single rod.

By closing the valves **55**, **71** and **85**, the valve assembly **3** can be isolated from the rest of the pumping system, and maintenance can be performed on the valve assembly, or the valve assembly cartridge can be swiftly removed and replaced by merely removing the bolts ex-

tending through the bottom of the cartridge into the housing, removing pipe **70** from the cartridge, and sliding the cartridge-type valve assembly out of the housing and replacing it with another one.

In the case where the auxiliary means for opening and closing the valve includes only one rod connected to the valve member by means of a pin, a pin **151** connecting the rod to a handle **152** or some other control means must first be removed so that the rod **82** may slide out of the top cover when the valve assembly is removed.

In either case, however, the maintenance or removal of the cartridge-type valve assembly does not interfere with the normal operation of the pump.

As illustrated in FIG. 4, a slide valve **90** may also be utilized as a primer valve in the same manner as the poppet valve **42** illustrated in FIG. 3. The slide valve **90** is provided with a sleeve **100** having inlet ports **101** positioned so as to communicate with the inlet port **120** of housing **130**, and outlet ports **102** positioned so as to communicate with the outlet port **122** of housing **130**. The sleeve **100** is provided with a flange **103** having apertures therein through which the cartridge-type valve assembly is bolted to the top of the housing **30**.

Conventional O-rings are provided between sleeve **100** and the housing **130** at the bottom and top of the housing and at shoulder **163** of the housing, providing a fluid-tight seal therebetween. Caps **105** and **106** are threadedly mounted in sleeve **100** providing the sleeve with a top and bottom. Mounted within sleeve **100** is a spool **107** having a shaft **108** connected to a piston **109**, forming a chamber **110** in the bottom portion of the sleeve and biased by spring **113**, in the same manner as piston **56**, chamber **36**, and spring **58** of FIG. 3. Openings **116** are provided in spool **107** adjacent to shaft **108** to allow free passage into chamber **153**.

Rods **111** and **112** extend through caps **105** and **106** in the same manner as rods **82** and **82***a* of FIG. 3. Otherwise, note that the view of FIG. 4 is from the opposite side as compared with the view of FIG. 3.

The tube **70**, for the reason just explained, appears to the left of FIG. 4 and extends through the cap **106** conveying a pressure reduction to chamber **110** when liquid is flowing through conduit **10** in the same manner as in chamber **36** of FIG. 3, causing the circular projection **115** of the spool to close ports **102**. When liquid ceases to flow through the conduit **10**, there is no difference in pressure between the throat in the venturi and the divergent section **56**, and there is then a pressure balance in chambers **110** and **153**. Thus, the force of spring **113** pushes the spool out of contact with ports **102** and priming fluid flows from inlet port **120** to outlet **122**, through ports **101** and **102** in the sleeve **100**.

With my present invention, I thus provide an improved primer valve system which may be easily adapted to any type liquid pump system and, once installed, allow the continuous operation of the pumping system even while the primer valve is being serviced or replaced.

Although the present invention has been described in conjunction with preferred embodiments, it is to be understood that modifications and variations may be resorted to without departing from the spirit and scope of the invention, as those skilled in the art will readily understand. Such modifications and variations are considered to be within the purview and scope of the invention and appended claims.

What is claimed is:

1. A primer valve and actuator assembly for a liquid pumping system having a well and a conduit defining an upwardly directed flow path for said liquid comprising a valve housing having an inlet port and an outlet port, a pipe connected to said inlet port, a port in the side of said conduit communicating with the interior of said housing through said pipe and said well, valve means in said housing including a cartridge-type valve assembly which may be removed and replaced in said housing as a unit and a valve element for controlling liquid flow between said inlet and outlet ports, sensor means positioned in said flow path capable of detecting the flow condition within said conduit, actuator means in communication with said sensor means to operate said valve means in response to a predetermined flow condition in said flow path, and isolation means for selectively isolating said primer valve from said pumping system.

2. A primer valve and actuator system as defined in claim **1** wherein said sensor means includes a venturi having its divergent end upstream in said flow path, said actuator means including a closed chamber in said housing, a piston forming one end of said chamber and connected to move said valve element in response to a predetermined change in pressure conducted through a duct to said chamber from the throat of said venturi, and said isolating means including a cutoff valve in said pipe, a cutoff valve in said drain, and a cutoff valve in said duct.

3. A primer valve and actuator assembly as defined in claim **2** including auxiliary actuator means for operating said valve means.

4. A primer valve and actuator assembly as defined in claim **1** wherein said auxiliary actuator means includes mechanical means connected to said valve means to open and close said valve element.

5. A primer valve and actuator assembly as defined in claim **2** wherein said auxiliary actuator means includes structural means for contacting and exerting a force on said valve element to close it.

6. A primer valve and actuator assembly as defined in claim **2** wherein said auxiliary actuator means includes a pair of structural means, one of said pair for contacting and exerting a force on said piston to open said valve element, and the other of said pair for contacting and exerting a force on said valve element to close it.

7. A primer valve and actuator assembly as defined in claim **4** wherein said structural means includes a rod extending through an aperture in the valve housing.

8. A primer valve and actuator assembly as defined in claim **7** wherein said valve element is a poppet valve.

9. A primer valve and actuator assembly as defined in claim **7** wherein said valve element is a sliding valve.

10. A differential pressure sensitive valve system for use with a liquid pump, comprising a closed suction well arranged to hold a quantity of priming liquid and from which said pump can draw liquid, an inlet suction connection in said well, a conduit defining an upwardly directed flow path from said pump, a delivery pipe communicating with the top of said conduit, means to prevent back flow from said delivery pipe to said conduit, a valve housing having an inlet port and an outlet port, a pipe connected to said inlet port, a port in the side of said conduit communicating with the interior of said housing through said pipe and said inlet port, a drain connecting said outlet port and said well, valve means in said housing controlling communication between said inlet and outlet, sensor means positioned within said conduit capable of detecting the flow condition within said conduit, actuator means in communication with said sensor means to operate said valve means so as to prevent flow through said housing in response to a predetermined flow condition within said conduit, said actuator means operating said valve means to allow flow through said housing upon the detection by sensing means of the cessation of said predetermined flow condition within said conduit, the flow through said housing passing liquid from said conduit to said well, an air supply pipe for said chamber connected to said well, means to prevent back flow through said air supply pipe to said well, and isolating means including at least one cutoff valve for selectively isolating said primer valve from said pumping system.

11. A differential pressure sensitive valve system for use with a liquid pump as defined in claim **10** including auxiliary actuator means for operating said valve means

in the event of a breakdown in the actuator means responsive to a predetermined flow condition.

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137—117; 251—14