United States Patent [19]

Hartley

[11] **3,867,071**

[45] **Feb. 18, 1975**

[54] **PUMPING SYSTEM WITH AIR VENT**

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[22] Filed: **Sept. 22, 1972**

[21] Appl. No.: **291,284**

[52] **U.S. Cl.**..... **417/211.5,** 55/170, 137/202, 417/306, 417/435

[51] **Int. Cl.**..... **F04b 49/00,** B01d 19/00

[58] **Field of Search**..... 417/211.5, 306, 435; 55/170; 137/202

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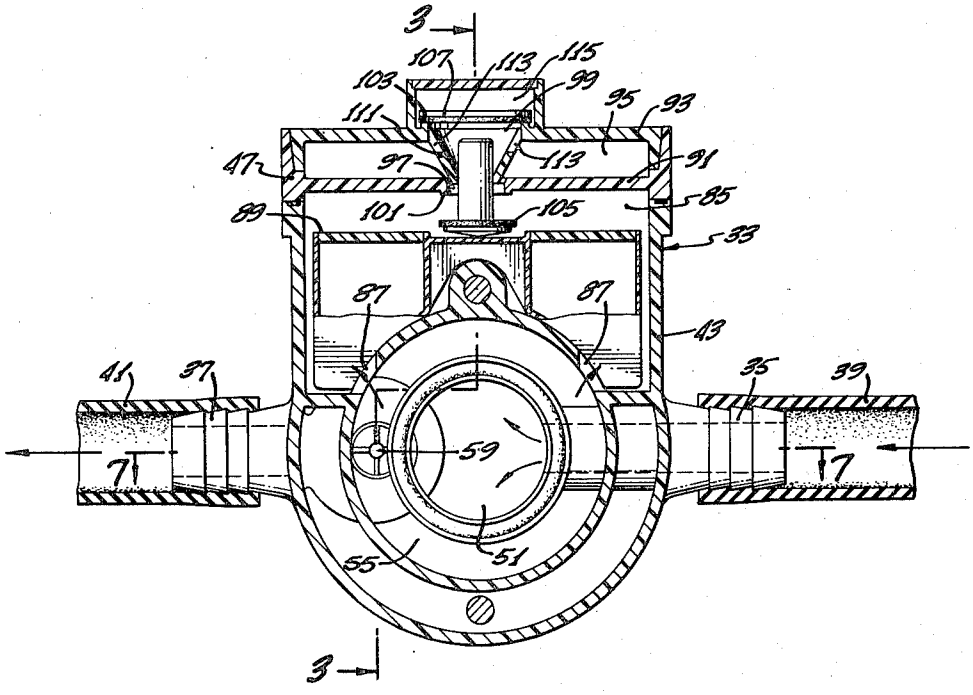
Assistant Examiner—Richard E. Gluck
Attorney, Agent, or Firm—Gordon L. Peterson

[57] **ABSTRACT**

A pumping system for pumping a liquid comprising a pump, a check valve on the discharge side of the pump, a vent in communication with the discharge side of the pump and with the upstream side of the check valve, and a valve for opening and closing the vent.

4 Claims, 9 Drawing Figures



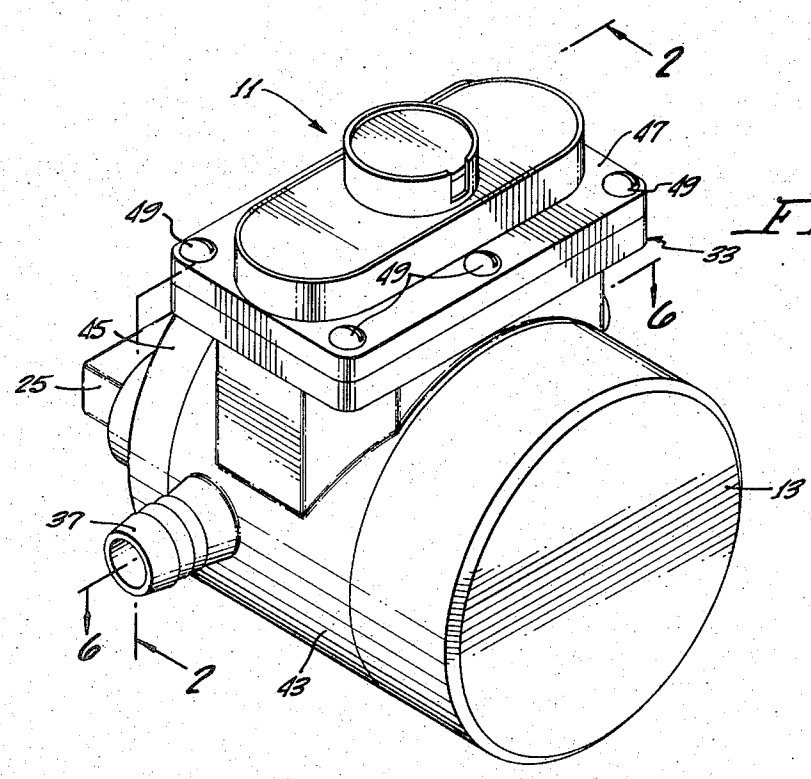

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FIG. 1

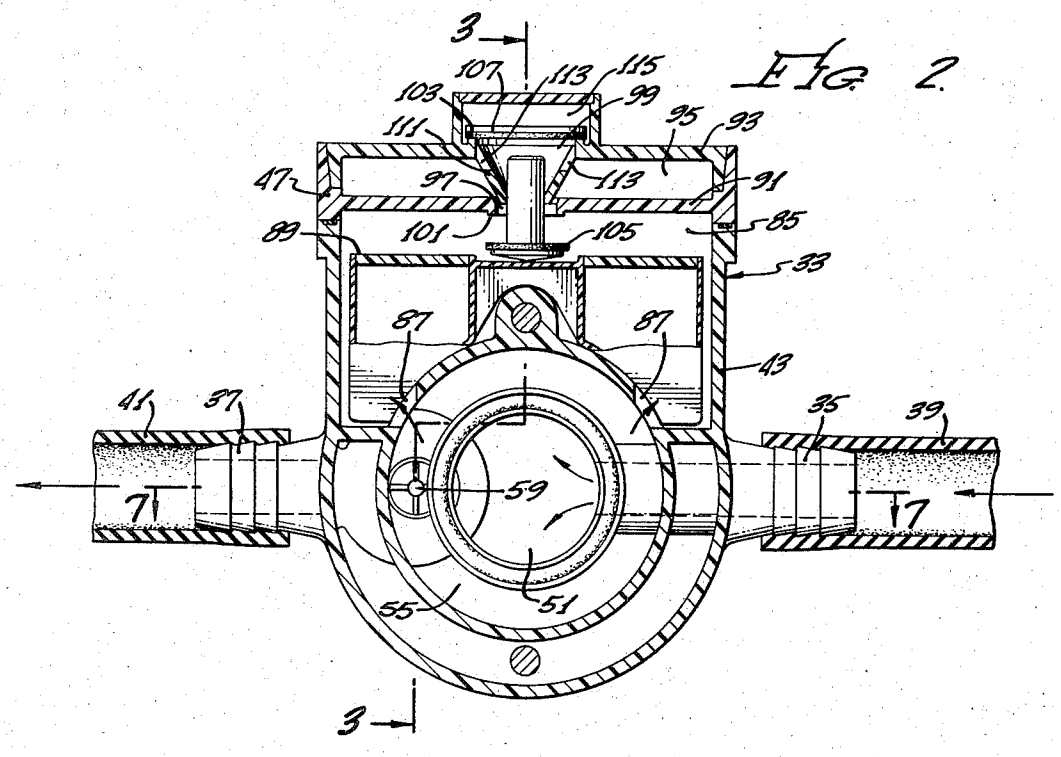
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FIG. 2

FIG. 3.

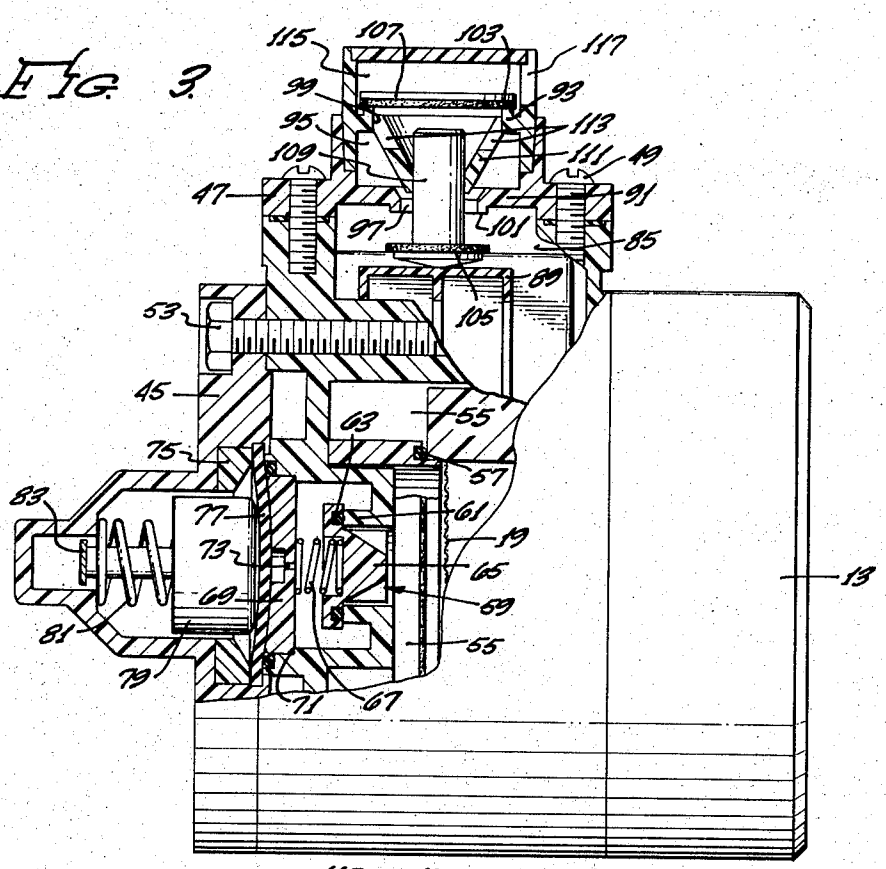
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FIG. 4.

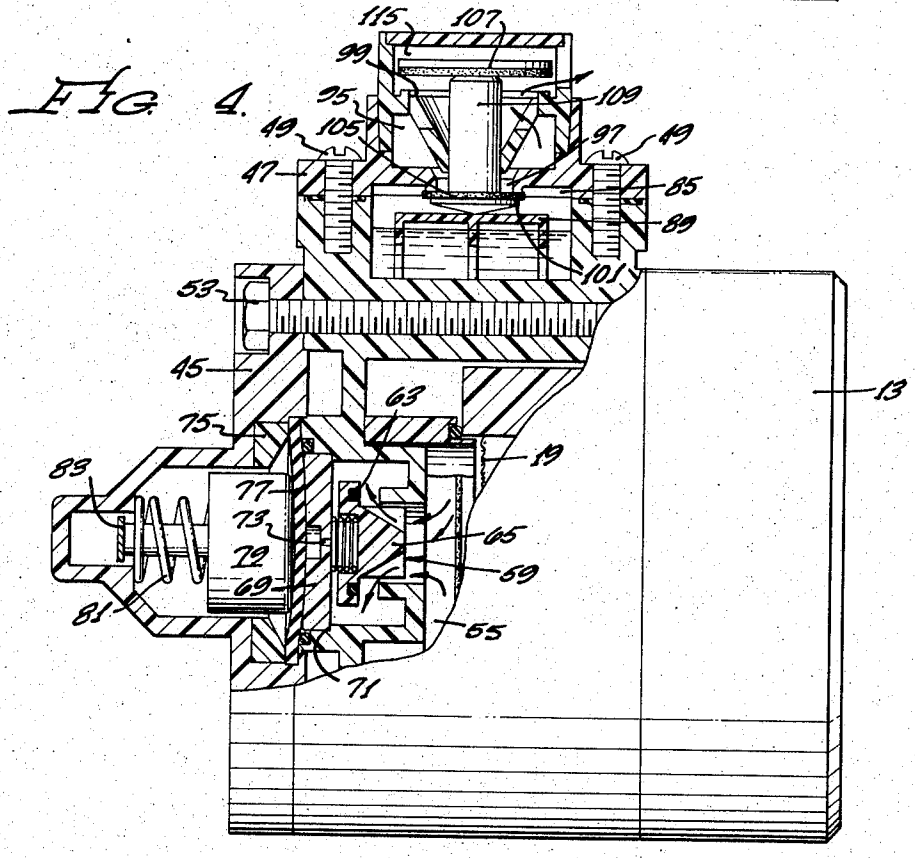
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FIG. 5.

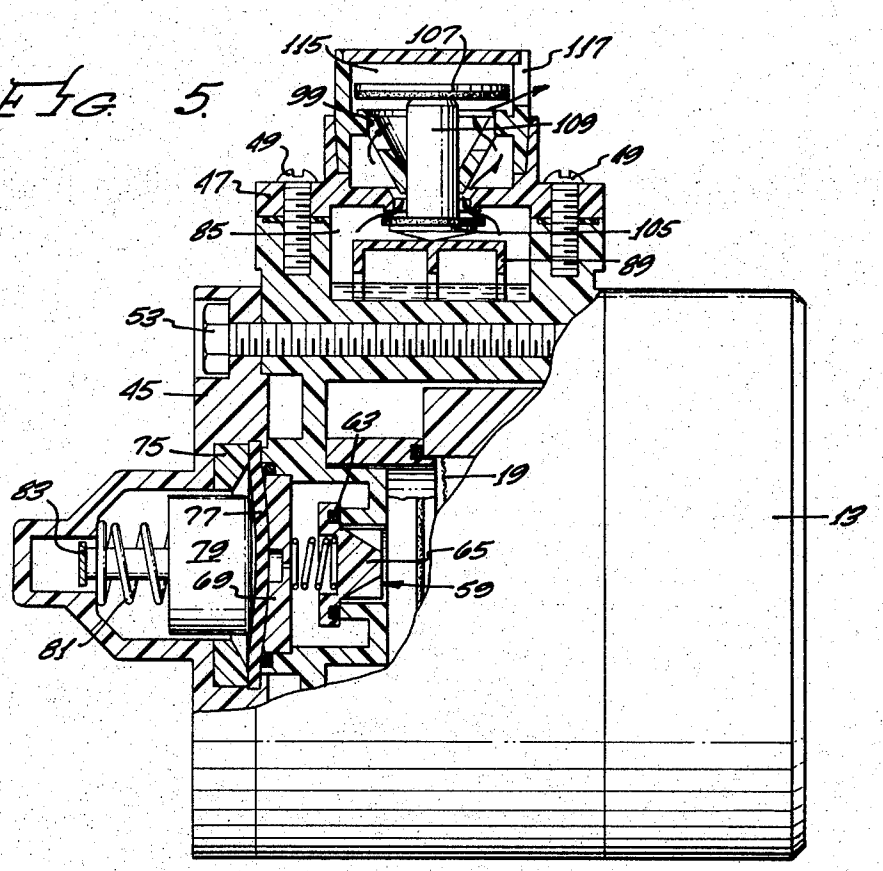
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FIG. 6.

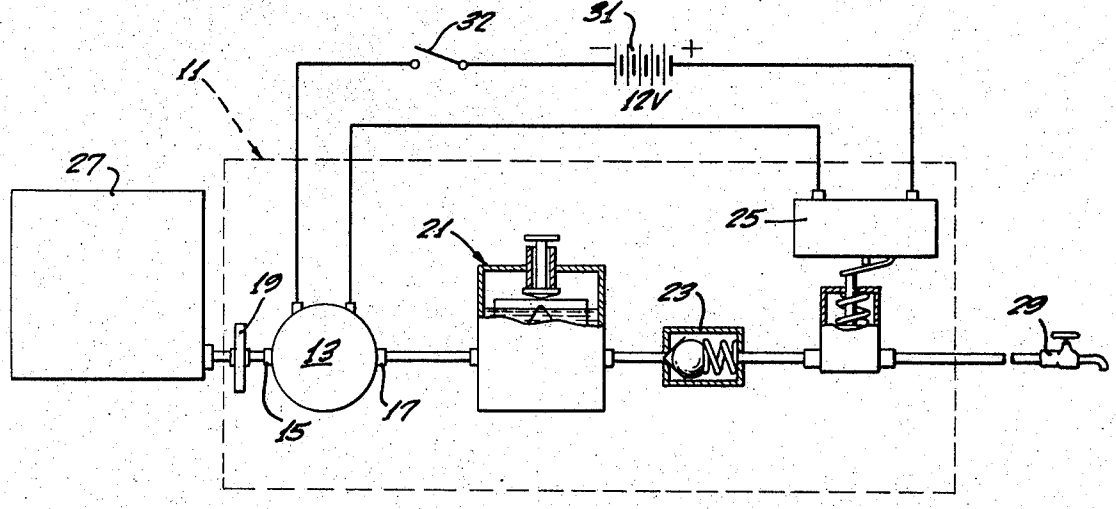
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FIG. 7.

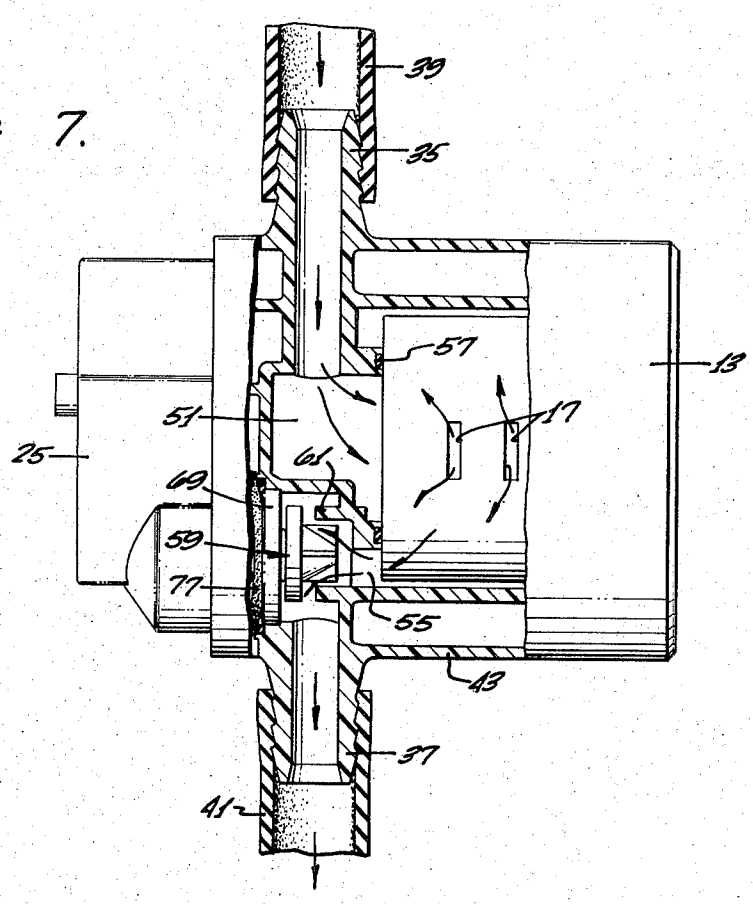


FIG. 9.

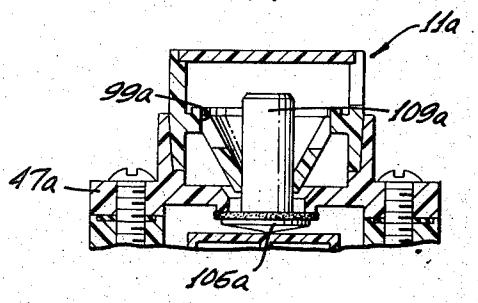
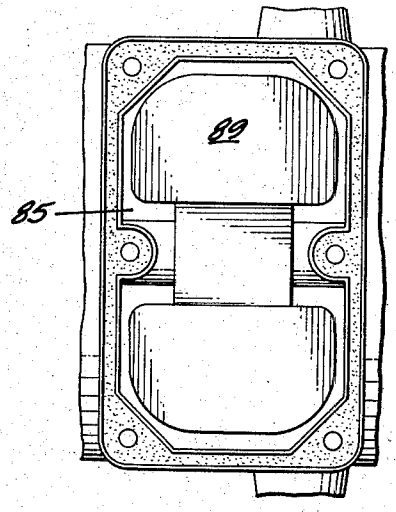


FIG. 8.



PUMPING SYSTEM WITH AIR VENT

BACKGROUND OF THE INVENTION

Many liquid pumping systems employ a pump which draws a liquid from an exhaustible supply of the liquid such as a storage tank. One example of such a pumping system is the water system for a vehicle such as recreational vehicles and boats. A water system includes a spring biased check valve downstream of the pump which is used to prevent backflow of water through the pump.

When the water in the storage tank is depleted, the pump draws some air into the system. When the tank is refilled with water, air in the system is trapped between the water in the tank and the check valve. Accordingly, the pump must pump air rather than water. Under these conditions, centrifugal pumps and many positive displacement pumps will not develop adequate pressure to open the check valve, and consequently, the pump cannot deliver water.

SUMMARY OF THE INVENTION

The present invention provides a pumping system which eliminates the air lock problem regardless of the type of pump which is used. The user need not open any valves or faucets to accomplish this.

The present invention provides vent means in communication with the pump discharge on the upstream side of the check valve. The vent means may include a vent opening. A valve is provided to open and close the vent opening. The valve is controlled so that it substantially prevents the escape of water from the system and so that air which would ordinarily be trapped within the system can escape. The valve is open under conditions when air lock would ordinarily occur and is closed when water adjacent to the vent opening rises to a level where it might escape through the vent opening.

Although the valve could be manually controlled, it is preferred to employ automatic control means for the valve. This can be simply and advantageously accomplished by means such as a float responsive to the liquid level in a float chamber adjacent the vent opening. The valve includes a valve element, the position of which is controlled by the float. When the water level in the float chamber is high, the float rises and closes the valve to substantially prevent the escape of water. When the water level in the chamber is lower, the float lowers and opens the valve.

More specifically, in one form the of the invention which is particularly adapted for pumping systems where the pump is below the water level in the tank, only a single valve opening and valve element are used. In this event there is water in the float chamber as long as there is water in the tank. Accordingly, the float is normally held in an upper position so long as there is water in the tank, and consequently, the valve opening is normally closed. However, when the water in the tank is depleted, the float lowers, and the vent opening is opened by the valve. Upon refilling of the tank, water flows to and through the pump and forces the air out through the vent opening thereby avoiding air lock. As there is water at the pump, any air trapped downstream of the check valve can be easily forced out of the system by the water delivered by the pump.

In a second embodiment of the invention, which is adapted for use with pumps above or below the water level in the tank, the vent means includes a pair of vent

openings in series. A valve is provided for each of the vent openings. The second valve can be opened by the air pressure developed by the pump when the latter is pumping air. The second valve can also be opened by the float as the water level in the float chamber rises. Thus, the second valve does not prevent the air from being removed from the system.

One important function of the second valve element is that it adapts the pumping system to a situation in which the pump is located above the water tank. In the typical water system, the pump is cycled off and on as required to maintain the water pressure in a predetermined range. With the pump above the tank and shut off, the water in the pump would run back into the tank if the vent opening were open and a loss of prime would occur. The second valve, however, closes when the pump is shut off and the water in the float chamber drops to a predetermined level with the result that no additional water can drain from the pump under the influence of gravity back into the storage tank. Another function of the second valve which is applicable regardless of pump location is that it closes the system under certain operating conditions to thereby exclude dirt.

Another feature of the invention is that both of the valves are of very simple construction and neither of them employs springs or biasing members. The valve elements are movable to one of the positions thereof under the influence of gravity.

The vent opening should be on the discharge side of the pump so that all air between the tank and the pump discharge can be forced out of the system. If the vent were on the intake side of the pump, it would draw air into the system when the pump was running. The vent opening should be on the upstream side of the check valve so that water can readily flow to the vent and force the air in the system out the vent. The vent opening should be above the float chamber because the air which is to be expelled, being lighter than water, will inherently seek an upper level in the system.

Upon restarting of the pump after refilling of the water tank, the air in the system may tend to cause some foaming. The foam will seek a high elevation in the system and some of it may escape through the first of the vent openings prior to the closing thereof by the first valve. In order to prevent the water component of this foam from being discharged from the system, the present invention provides a foam chamber immediately downstream of the float chamber. The foam can collect in the foam chamber. The second vent opening is provided in the foam chamber and provides communication with the atmosphere outside of the system. To help separate the gaseous and liquid components of the foam, the present invention provides for a tortuous path between the float chamber and the second vent opening.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a pumping system constructed in accordance with the teachings of this invention.

FIG. 2 is a sectional view taken generally along line 2—2 of FIG. 1 showing the pumping unit with no water being supplied thereto and with the pump removed.

FIG. 3 is an enlarged sectional view taken generally along line 3—3 of FIG. 2 with the pump turned off and no water in the tank.

FIG. 4 is a sectional view similar to FIG. 3 with the pump running under normal operating conditions.

FIG. 5 is a sectional view similar to FIG. 3 showing how air is removed from the system.

FIG. 6 is a schematic view of a pumping system constructed in accordance with the teachings of this invention.

FIG. 7 is a partial sectional view taken generally along line 7—7 of FIG. 2 with the pump running under normal operating conditions.

FIG. 8 is a top plan view of the float and float chamber.

FIG. 9 is a fragmentary sectional view showing a modified form of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 6 shows a pumping system **11** constructed in accordance with the teachings of this invention. The pumping system **11** generally includes a pump **13** having an intake port **15**, a discharge port **17**, and a filter **19** immediately upstream of the intake port. The pumping system **11** also includes a vent unit **21** intermediate the discharge port **17** and a check valve **23**, and a pressure responsive switch **25**. The check valve **23** prevents back flow therethrough in a direction toward the pump **13** and is normally biased to a closed position. If desired an accumulator (not shown) may also be used in a manner well known in the art.

The pumping system **11** is adapted for connection to a tank **27** of liquid such as water with such liquid being supplied to the intake port **15** of the pump **13**. The pumping system **11** at its discharge side is adapted for connection to a water distribution system which may include one or more faucets **29**.

The pump system **11** is also connectible to a source of power such as a battery **31** which supplies electrical energy to the motor of the pump **13** to operate the pump. The pressure switch **25** opens and closes a circuit to the pump **13** to cycle the pump on and off. The pressure switch **25** is responsive to the pressure downstream of the check valve **23** reaching a predetermined level for turning the pump off and is responsive to the pressure downstream of the check valve **23** dropping to a predetermined level to turn the pump on. A manual switch **32** allows the pump **13** to be shut down regardless of the condition of the pressure switch **25**.

During normal operation of the pumping system **11**, the vent unit **21** does not effect the operation of the system. However, if the tank **27** runs dry, air will accumulate in the pumping system **11** upstream of the check valve **23**. When the tank **27** is refilled, the water forces the air to the vent unit **21** which allows the latter to escape with the result that the air will not interfere with pump operation.

A preferred form of the pumping system **11** is shown in FIGS. 1–7. The pumping system **11** (FIGS. 1 and 2) includes a housing **33** of molded plastic material having an inlet **35** and an outlet **37**. Conduits **39** and **41** connect the inlet **35** and the outlet **37** to the storage tank **27** (FIG. 6) and to the water distribution system respectively.

The housing **33** includes a main housing section **43** having open ends which are closed by the pump **13** and a rear cover plate **45** (FIG. 3). The upper end of the main housing section **43** is closed by a cover plate **47** which is attached to the main housing section by a plurality of screws **49**.

As shown in FIGS. **2** and **7**, the main housing section **43** defines a central inlet chamber **51** which communicates with the inlet **35**. The pump **13** is mounted on the main housing section **43** by screws **53** (FIG. 3). The filter **19** (FIG. 3) is carried by the pump **13** and the intake ports **15** are behind the filter. The discharge ports **17** of the pump **13** deliver water under pressure to discharge chamber **55** which surrounds the central chamber **51**. The pump **13** may be a centrifugal pump or a positive displacement pump, and in the embodiment illustrated is in the form of a positive displacement roller pump. An annular seal **57** bears against the pump to thereby provide a seal between the chambers **51** and **55**.

A check valve **59** (FIGS. 2–6) is in communication with the discharge chamber **55**. The check valve **59** includes annular boss **61** formed integrally with the main housing section **43** and defining a valve seat **63**. A valve element **65** is urged by a spring **67** toward a closed position shown in FIG. 3 in which the valve element **65** engages the valve seat **63**. The spring **67** bears against a disc **69** which is seated on a shoulder **71** and which has a central passage **73** extending therethrough.

An annular retainer **75** holds a resilient diaphragm **77** in position adjacent the disc **69**. A plunger **79** is urged against the diaphragm **77** by a spring **81**. An arm **83** which is pivotally mounted in the cover plate **45** bears against the outer end of the plunger **79**. The pressure switch **25**, which may be of conventional design, is also carried by the rear cover plate **45** and is arranged to be actuated by predetermined pivotal movement of the arm **83**.

When the pump **13** is not operating, the check valve **59** will ordinarily be closed as shown in FIG. **3**. When the pump **13** operates to pump water, the pressure in the discharge chamber **55** increases sufficiently to force the valve element **65** off the seat **63** to allow fluid flow through the boss **61** and into the outlet **37** as best shown in FIG. **7**. When the check valve **59** opens, fluid also flows through the passage **73** and against the diaphragm **77** to force the plunger **79** upwardly against the biasing action of the spring **81**. The passage **73** is of small diameter and forms a restriction to provide some time delay between a pressure change on the check valve side of the passage and a corresponding pressure change on the diaphragm side of the passage. This pivots the arm **83** to actuate the pressure switch **25** to turn off the pump **13**. This occurs when the pressure downstream of the check **59** reaches a preset magnitude. Similarly, when the pressure downstream of the check valve **59** drops below a predetermined level, the spring **81** urges the plunger **79** downwardly to thereby allow the arm **83** to pivot in the opposite direction to actuate the pressure switch **25** and energize the pump.

The main housing section **43** also defines a float chamber **85** (FIGS. 2 and 3) which is closed by the upper cover plate **47**. In a preferred orientation of the pumping system **11**, the float chamber **85** is at an upper level in the pumping system. A pair of apertures **87** provide communication between the annular chamber **55** and the float chamber **85**. Thus, the float chamber **85** communicates with the discharge side of the pump **13** and with the upstream side of the chcek valve **59**.

A hollow float **89** which may be constructed of plastic material is mounted in the float chamber **85**. The

float **89** is of sufficiently light weight so as to float in the liquid which is being pumped by the pump **13.**

The upper cover plate **45** has an inner wall **91** and an outer wall **93** defining a foam chamber **95** therebetween. A first vent opening **97** provides communication between the float chamber **85** and the foam chamber **95,** and a second vent opening **99** provides communication between the foam chamber **95** and the atmosphere or the exterior of the pumping system **11.** Annular valve seats **101** and **103** are provided around the vent openings **97** and **99,** respectively.

A first valve element **105** is movable between an open position (FIGS. **2, 3** and **5**) and a closed position (FIG. **4**). The valve element **105** is movable upwardly or to the closed position thereof by the float **89.**

A disc-like valve element **107** rests on the valve seat **103** (as shown in FIGS. **2** and **3**) to close the vent opening **99.** The valve element **107** is movable off of the seat **103** to an open position (FIGS. **4** and **5**) by air pressure when the pump is pumping air and/or by a stem section **109** of the valve element **105.** The stem section **109** projects through the vent opening **109** and is slidably received in a conical boss **111.**

A serpentine passage is provided between the flaot chamber **89** and the exterior of the cover plate **45.** To this end, the lower end of the boss **111** extends to a location slightly within the vent opening **97.** Accordingly, the vent opening **97** is substantially annular. In addition, the conical boss **111** has a plurality of radical apertures **113.** The cover plate **45** defines a circular chamber **115** immediately above the valve element **107** from which the only exit is a relatively small radical aperture **117.**

The pumping system **11** can be connected to the tank **27** so that the pump **13** is either above or below the tank **27.** Assuming first that the pump **13** is below the tank **27,** then during normal operation of the pump, water under pressure is discharged from the pump discharge port **17** and passes through the discharge chamber **55** and the apertures **87** to the float chamber **89.** As the water is under pressure, it will accumulate to a substantial height in the float chamber **89** and float the float **89** as shown in FIG. **4.** With the water level in the float chamber **85** relatively high, the float **89** urges the valve element **105** to a closed position. In addition, the stem section **109** lifts the valve element **107** off of its seat so that the vent opening **97** is closed and the vent opening **99** is open. If the pump **13** is shut off, the water level in the chamber **85** remains high because the pump **13** is below the tank **27** so drainage back to the tank will not occur. Accordingly, with the pump **13** below the tank **27,** the valve elements **105** and **107** do not effect normal operation of the pump.

If the tank **27** runs dry, then pressure downstream of the check valve **59** is lost and the pressure switch **25** turns the pump **13** on with the result that the pump draws in some air. Accordingly, the space between the tank **27** and the check valve **59** is filled at least partly with air. The pump **13** may then be shut down by opening the manual switch **32** and the tank **27** is then filled. Because the pump **13** is mounted below the tank **27,** water can flow under the influence of gravity from the tank toward the pump **13.** The air between the tank **27** and the check valve **59** is forced by the water through the apertures **87** and into the float chamber **85.** The head of water in the tank **27** is sufficient to cause the air in the float chamber **85** to pass through the vent opening **97** and to force the valve element **107** off of its seat **103** to allow the air to escape. As the air escapes from the system **11,** the water level in the float chamber **85** increases. This causes the float **89** to float and drives the valve element **105** through an intermediate position (FIG. **5**) in which the stem section **109** is positioned to prevent closure of the valve element **107** and is operative to hold the latter open if the air pressure in the chamber **85** is insufficient to do so. Ultimately, the valve element **105** reaches the closed position (FIG. **4**), and in this position, there is no air at the pump **13.**

If the pump **13** is mounted above the tank **27,** then the pump **13** should be a self priming pump. With the pump **13** above the tank **27,** then upon termination of pump operation water in the float chamber **85** tends to flow under the influence of gravity back toward the tank **27.** However, as soon as the water in the float chamber **85** is dropped only slightly, the stem section **109** allows the valve element **107** to return under the influence of gravity to the closed position as shown in FIGS. **2** and **3.** With the vent opening **99** closed, continued flow of water back into the tank **27** is prevented. Accordingly, the valve element **107** prevents the pump **13** from losing its prime each time the pump is turned off.

If the tank **27** runs dry, the pump **13** draws some air into the system. When the tank **27** is refilled, air is trapped between the water in the tank **27** and the check valve **59.** However, the air in the system is not under any head or pressure because the pump **13** is above the tank.

When the pump is started, it will pump the air through the apertures **87,** the float chamber **85,** the vent opening **97** and force the valve element **107** off of its seat **103** to open the vent opening **99.** As the air has an escape path upstream of the check valve **59,** the pump **13** can then, employing its self priming feature, draw water up to its level and in so doing close the vent opening **97** as shown in FIG. **4.**

FIG. **9** shows a pumping system **11***a* which is a second embodiment of this invention. The pumping system **11***a* is identical to the pumping system **11** in all respects except that the valve element **107** has been eliminated. Parts of the pumping system **11***a* corresponding to parts of the pumping system **11** are designated by corresponding reference numerals followed by the letter *a.*

With the valve element **107** eliminated, the pumping system **11***a* is fully adapted for use in systems in which the pump **13** is below the level of the liquid in the tank **27.** However, the pumping system **11***a* is not adapted for use in systems in which the pump **13** above the level of liquid in the tank **27** because without the valve element **107,** the pump would lose its prime each time the pump is turned off.

Although exemplary embodiments of the invention have been shown and described, many changes, modifications and substitutions may be made by one having ordinary skill in the art without necessarily departing from the spirit and scope of this invention.

I claim:

1. A pumping system for pumping liquid comprising:

a housing having an inlet and an outlet, said inlet being connectible to a source of liquid;

a pump having a suction opening and a discharge opening, said pump being mounted in said housing for pumping liquid through said housing from said inlet to said outlet;

wall means on said housing defining a float chamber in communication with the discharge opening of said pump, said wall means having a vent opening therein in communication with the exterior of said housing;

means for blocking said float chamber from direct communication with the suction opening of said pump whereby the only flow path between said float chamber and the suction opening is through the discharge opening;

a float in said float chamber movable in response to the liquid level in said float chamber;

a valve including a valve element movable between a closed position in which the valve element closes the vent opening and an open position in which the valve element allows flow through the vent opening;

said valve element being drivable toward at least one of said positions thereof by said float, said valve element closing said vent opening in response to a relatively high liquid level in said chamber and opening said vent opening in response to a lower liquid level in said chamber; and

said vent opening being a first vent opening, said valve including a first valve element and a stem, said stem projecting through said first vent opening in both the open and closed positions, means defining a second vent opening in series with the first vent opening, a second valve element disconnected from said stem for closing the second vent opening, said second valve element including a disc.

2. A pumping system for pumping liquid comprising:

a housing having an inlet and an outlet, said inlet being connectible to a source of liquid;

a pump having a suction opening and a discharge opening, said pump being mounted in said housing for pumping liquid through said housing from said inlet to said outlet;

means defining a discharge chamber in said housing communicating with said discharge opening whereby said discharge chamber receives fluid from said pump;

means defining a float chamber in said housing, said chambers having a common wall with an aperture therein to provide communication between said chambers;

said float chamber having a vent opening;

a float in said float chamber movable in response to the liquid level in said float chamber;

a valve including a valve element movable between a closed position in which the valve element closes the vent opening and an open position in which the valve element allows flow through the vent opening;

said valve element being drivable toward at least one of said positions thereof by said float, said valve element closing said vent opening in response to a relatively high liquid level in said chamber and opening said vent opening in response to a lower liquid level in said chamber;

a check valve in said housing in communication with said discharge chamber; and

said float chamber and said discharge chamber being above and below said common wall, respectively.

3. A pumping system as defined in claim **2** wherein said discharge chamber has a second wall, said check valve including means on said second wall defining a valve seat and a valve element engageable with said valve seat.

4. A pumping system as defined in claim **3** wherein said vent opening is a first vent opening, said first mention valve includes a first valve element and a stem, said stem projecting through said first vent opening in both the open and closed positions, means defining a second vent opening in series with the first vent opening, a second valve element disconnected from said stem for closing the second vent opening, said second valve element including a disc, said aperture being in a lower portion of said common wall, and means for blocking said float chamber from direct communication with the suction opening of said pump whereby the only flow path between said float chamber and the suction opening is through the discharge opening.

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