Oct. 14, 1958 G. N. MILES ET AL 2,855,861

PUMPS

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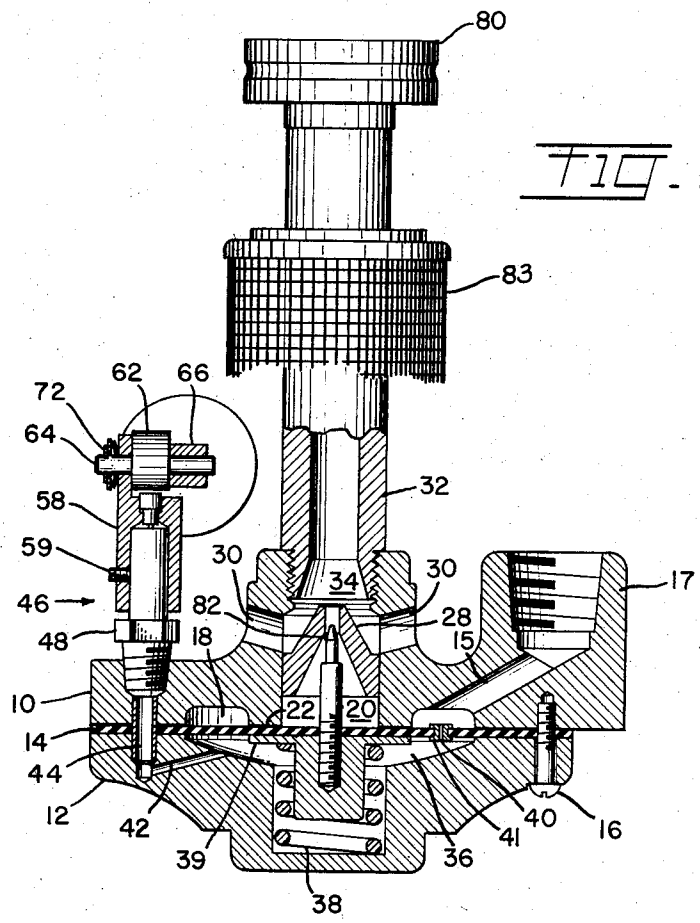


FIG. 1.

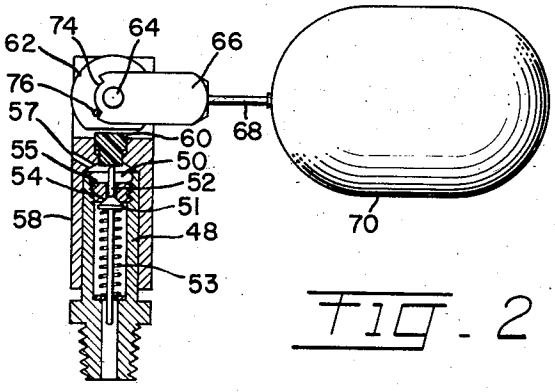


FIG. 2.

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PUMPS

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8 Claims. (Cl. 103—276)

This invention relates to improvements in pumps, and particularly to an improved pump of the type commonly utilized for cellar drainage, removal of condensate water from air conditioners, drain tank disposal and the like.

One of the most familiar applications for a pump of the type with which the present invention is concerned is in removing water from a basement which does not have a floor drain. Conventional practice in such situations is to dig a pit or sump at a low point in the basement, and to place a pump with a liquid-level responsive control in the sump so that water collecting therein will be pumped out automatically to a drain when it reaches a certain level in the sump.

The improved pump provided by the present invention operates on the Venturi principle. Water under pressure from any suitable source is piped into the pump and ejected through a Venturi jet which discharges into an outlet pipe. The water passing through the jet is utilized to aspirate drainage water from the sump through suitable intake openings around the jet. The present improved pump has the advantage over electrically operated motor-driven pumps in that it has a minimum number of moving parts subject to failure, and the even greater advantage that failure of the electrical supply, which often occurs during a storm when the sump pump is most badly needed, will not affect the operation of the pump. The present improved pump has the additional advantage that it is not readily subject to clogging with dirt or relatively viscous fluids. Furthermore, no priming is necessary in the operation of this pump. Moreover, the pump of the present invention has the additional advantage over electrically operated pumps that there is no shock hazard around the pump in a flooded area.

It is among the objects of the present invention to provide an improved Venturi-type pump which is operable over a relatively wide range of water supply pressures, which is simple and economical to manufacture, and which has numerous other advantages both in constructional and operational characteristics as explained hereinafter.

A more complete analysis of the invention and of specific features and advantages thereof is given in the following description of an illustrative embodiment, which is to be read in connection with the accompanying drawing, wherein

Figure 1 is an elevation view, partly in section, of a pump assembly embodying the invention, and

Figure 2 is an enlarged side view, partly in section, of the valve and float portion of the pump shown in Figure 1.

Referring to Figure 1 of the drawing, a water-level controlled pump embodying the invention is shown to comprise a two-part body portion **10**, **12** which may conveniently be circular in shape. The upper and lower body sections **10**, **12** are clamped tightly together by means of screws **16** or the like, with the peripheral portion of a diaphragm **14** being pinched tightly between the sections **10**, **12** to form a liquid-tight seal.

As previously mentioned, the present improved pump is liquid actuated. An inlet for the actuating liquid comprises a passage **15** formed in an internally threaded boss **17** on the upper body section **10**. The threaded boss **17** provides a convenient connection point for any suitable water inlet fitting (not shown).

The passage **15** communicates with an annular cavity **18** in the upper body portion **10**. This annular cavity **18** is separated from a central bore **20** by a circular lip **22** which is adapted to be contacted by the movable diaphragm **14**. Thus, the actuating liquid flow path extends from the passage **15** through the cavity **18** into the central bore **20**, and is adapted to be opened and closed by the diaphragm **14** in cooperation with the circular lip **22**.

Within the central bore **20** is located a tapered nozzle **28**. Adjacent to the tip of the nozzle **28**, a plurality of radial openings **30** are formed in the body section **10**. These openings **30** extend into the bore **20** and constitute inlet openings through which water to be pumped can enter the unit under the aspirating action of liquid flowing through the nozzle **28**. Immediately above the nozzle **28**, the bore **20** is threaded to receive a fitting **32** having a tapered bore **34** therein which cooperates with the nozzle **28** to form a Venturi throat in the usual fashion. If desired, of course, the fitting **32** can be formed integral with the upper body section **10**.

Flow of actuating liquid to the Venturi nozzle **28** is controlled by the diaphragm **14**. The diaphragm, in turn, is controlled by the pressure on opposite faces thereof.

The lower body section **12** has a shallow cavity **36** formed therein which is covered by the diaphragm **14**. A spring **38** extends between the bottom of the cavity **36** and a pressure disc **39** which is adapted to contact the underside of the diaphragm **14**. The spring **38** urges the diaphragm upwardly toward a position contacting the circular lip **22** of the upper body section **10**.

The diaphragm **14** has a small opening **40** therein defined by a protective washer assembly **41** and communicating between the lower body section cavity **36** and the upper body section annular cavity **18**. Thus, liquid entering the unit through the inlet passage **15** can seep through the opening **40** into the lower cavity **36**. As long as this liquid is trapped in the lower cavity **36**, the hydraulic pressure per unit area on the upper and lower sides of the diaphragm will equalize. Hence, by proper selection of the force of the spring **38** relative to the comparative active areas on the upper and lower surfaces of the diaphragm **14**, the diaphragm can be made to close tightly against the circular lip **22** when water is trapped in the lower cavity **36**. It is also seen that operation of the pump can be controlled by a valved outlet from the cavity **36** which will regulate the hydraulic pressure on the diaphragm.

In accordance with the invention, an outlet is provided from the lower body section cavity **36** through a passageway **42**. This passageway **42** communicates with a connecting passageway **44** which extends from the lower body portion **10** through the clamped peripheral portion of the diaphragm and into the upper body portion **12**, where the passageway **44** leads to a valve assembly **46**.

The valve assembly **46** (Figure 2) comprises a housing **48** which is threaded into the upper body section **10**. The housing **48** has a central bore **50** which communicates with the passage **44**. The bore **50** contains a valve mechanism including a valving element **51** which is fixed to a longitudinally movable stem **52** in the housing **48**. A spring **53** presses against the underside of the valving element **51**, normally urging the element **51** tightly against a tapered seat **54** formed in the underside of a plug **55** which is threaded into the upper end of the bore **50**. Thus, when the element **51** contacts the seat **54**, it separates the passage **44** from an outlet port **57** in an outer housing **58** which surrounds the valve housing **48**. The inner and outer housings **48**, **58** are held together by a set screw **59** (Figure 1).

In the present illustrative embodiment of the invention, the valve mechanism is float actuated so that the pump will operate in response to changes in level of the liquid being pumped. The valve stem **52** projects through the plug **55**, making contact with an actuating pin **60** which is movable axially in the outer housing **58**. Accordingly, the actuating pin **60** is urged upwardly by the force of the valve spring **53** acting through the valve stem **52**. The upper surface of the actuating pin **60** is adapted to engage a camming member **62** which is formed integral with a shaft **64** journalled above the pin **60**. The shaft **64** carries a rotatable member **66** which is drilled and threaded to receive the lever arm **68** of a float element **70**.

The float mounting **66** is held on the shaft **64** by a retaining ring **72** or the like, and has an arcuate cutaway section **74** in the end wall adjacent to the cam **62**. A pin **76** extends from the cam **62** into the cutaway **74**, to be engaged by the end walls of the cutaway **74** upon rotation of the float mounting **66**.

Thus, as the float rises and falls with changes in liquid level, the float mount **66** will rotate on the shaft **64** until the pin **76** engages the cutaway end walls at approximately ninety degree displaced points of float mount rotation. After the float mount **66** engages the pin **76**, continued float movement will rotate the cam **62** and actuate the valve stem **52**. It will be seen that the cutaway **74** allows for lost motion in the movement of the float arm, thereby providing for a difference in liquid level between the valve open and the valve closed positions.

The discharge tube **32** leading from the Venturi assembly preferably is provided with a suitable fitting **80** at the upper end thereof for convenient assembly to a length of pipe, garden hose or the like for carrying away the water discharged from the pump. Also, a screen element **83** preferably is provided around the water inlet holes **30** to prevent clogging the holes **30** with debris.

In operation of the pump as thus far described, when the level in the sump is high enough to raise the float **70** and actuate the cam **62** to open the valve **51**, the water in the cavity **36** in the lower housing section **12** will escape through the outlet opening **57** in the housing **58**, because this outlet opening **57** is much larger than the diaphragm hole **40**. This will reduce the pressure on the underside of the diaphragm **14** and cause the diaphragm to move downwardly in response to the pressure of the water contained in the upper housing section annular cavity **18**. As the diaphragm moves away from the circular lip **22**, water will flow from the annular cavity **18** into the central bore **20** and out through the Venturi nozzle **28**, drawing with it liquid sucked in through the inlet holes **30** in the sides of the upper housing section **10**.

As the water level around the pump drops, the float will move downwardly, eventually closing the valve **51** and thereby permitting water pressure to build up on the underside of the diaphragm by flow through the diaphragm hole **40**.

It can be seen that the relatively small opening **40** in the diaphragm will have a substantial pressure drop thereacross until the cavity **36** in the lower housing section is practically full of water, and that there will be a similar pressure drop between the annular cavity **18** and the central bore **20** in the upper housing section as the diaphragm approaches the lip **22**. It has been found that this may result in a condition whereby the diaphragm remains slightly displaced from the lip **22** until sufficient pressure has been built up on the underside of the diaphragm to cause the diaphragm to suddenly contact the lip and shut off water flow from the annular cavity **18** to the central bore **20**. Under such conditions, the abrupt stoppage of water flow may cause an objectionable "water hammer" sound in the supply line.

In accordance with one of the features of the present invention, this situation is alleviated by mounting a tapered pin **82** on the upperside of the diaphragm **14** to

project into the Venturi nozzle **28**. This tapered pin does not fit tightly in the nozzle, but only acts to restrict the flow therethrough as the diaphragm moves upwardly, thereby tending to build up a back pressure within the central bore **20** and at the same time reduce the pressure drop across the circular lip **22**. As a result, the diaphragm tends to seat against the lip smoothly, rather than suddenly ramming home with an objectionable water hammer.

It can be seen that the hydraulic forces acting on the diaphragm **14** constitute the water pressure in the cavity **36** in the lower housing chamber acting on the underside of the diaphragm, as opposed by the water pressure in the annular cavity **18** plus the water pressure in the central bore **20** of the upper housing section. As the diaphragm approaches the lip **22**, the pressure drop across this lip begins to rise and the pressure in the central bore **20** begins to drop. Without the pressure reducing pin **82**, the pressure on the upperside of the diaphragm would change rapidly, with a cumulative action taken place as the drop across the lip **22** increases. This sudden change in pressure would cause the diaphragm to seat with a very abrupt motion, abruptly cutting off the water flow through the inlet passage **26**. However, by utilizing the tapered pin **82** to effect a gradually increasing back pressure in the central bore **20** upstream of the nozzle, the rate of change of pressure drop across the circular lip **22** can be reduced sufficiently to result in a gradual, rather than an abrupt change in the forces acting on the diaphragm. Accordingly, the diaphragm will come to its closed position slowly rather than abruptly, and thereby avoid the water hammer problem. While the rate of change of pressure drop can be controlled in some instances by careful selection of the dimensions of the lip **22** or by reducing the bleed orifice **40** in the diaphragm, the tapered pin **82** is found to be advantageous as being operable over a wide range of conditions, as well as being simpler and less expensive than a dash-pot drag for slowing the diaphragm motion.

What is claimed is:

1. A pump comprising a housing having a liquid passage extending therethrough and including an inlet portion and an outlet portion, a Venturi nozzle in said outlet portion of said passage, secondary inlet openings in said housing adjacent to said nozzle through which to aspirate liquid to be pumped in response to liquid flow through said nozzle, a partition extending into said passage between said inlet portion and said outlet portion, a diaphragm within said housing and forming one wall of said passage opposite said partition, said diaphragm having a portion movable into and out of engagement with said partition whereby to close and open said passage, means including said diaphragm defining a chamber in said housing on the opposite side of said diaphragm from said passage, means defining a passageway extending from said passage inlet portion through said chamber and out of said housing, valve means in said passageway for controlling liquid flow through said passageway whereby to control the liquid pressure in said chamber as a means of controlling the position of said diaphragm, and means coupled to said diaphragm and responsive to movement of said diaphragm portion for regulating the liquid pressure in said passage outlet portion whereby to regulate the movement of said diaphragm portion.

2. A pump comprising a housing having a liquid passage extending therethrough, said passage including a central outlet portion and an inlet portion including an annular chamber surrounding said central outlet portion and an inlet duct leading to said chamber, a Venturi nozzle in said outlet portion of said passage, secondary inlet openings in said housing adjacent to said nozzle through which to aspirate the liquid to be pumped in response to liquid flow through said nozzle, a circular partition extending into said passage and separating said outlet portion

from said annular chamber, a diaphragm within said housing forming one wall of said passage opposite said partition, said diaphragm having a portion movable into and out of engagement with said partition whereby to close and open said passage, means including said diaphragm defining a second chamber in said housing on the opposite side of said diaphragm from said passage, means defining a passageway extending from said annular chamber through said second chamber and out of said housing, valve means in said passageway for controlling liquid flow through said passageway whereby to control the liquid pressure in said chamber as a means of controlling the position of said diaphragm, and means coupled to said diaphragm and responsive to movement of said diaphragm portion for regulating the liquid pressure in said passage outlet portion whereby to regulate the movement of said diaphragm portion.

3. A pump comprising a Venturi nozzle through which to force liquid under pressure for operating said pump, inlet-orifice defining means adjacent to said nozzle through which to aspirate liquid to be pumped in response to liquid flow through said nozzle, said pump having therein a liquid supply passage leading to said nozzle, said passage being defined in part by fixed wall means and in part by movable wall means, said movable wall means comprising a flexible diaphragm having a portion which is movable between first and second positions, said diaphragm portion in said first position being in contact with a portion of said fixed wall means and thereby interrupting said passage, said diaphragm portion in said second position being out of contact with said portion of said fixed wall means and thereby opening said passage, and a tapered pin carried by said diaphragm and projecting restrictively into said nozzle in said shut-off position of said diaphragm for increasing the pressure drop across said nozzle upon movement of said diaphragm into said shut-off position, whereby to develop a back pressure in said passage for retarding the movement of said diaphragm toward said shut-off position.

4. A pump comprising a body having a cavity therein, a diaphragm extending across said cavity and dividing said cavity into first and second chambers, circular partition means dividing said first chamber into a central portion and an annular portion, an inlet passageway leading into said annular portion, an outlet passageway leading from said central portion, a tapered nozzle disposed in said outlet passageway, secondary inlet openings leading into said second passageway adjacent to the tip of said nozzle, said diaphragm having an orifice therein communicating between said annular portion and said second chamber, an outlet passage leading from said second chamber, a valve in said outlet passage for opening and closing said passage, a float element, means linking said float element to said valve for opening and closing said valve upon raising and lowering said float, said diaphragm orifice having a substantially smaller flow area than the flow area of said passage and said valve, and a tapered pin carried by said diaphragm and projecting from said diaphragm into said nozzle upon movement of said diaphragm into engagement with said partition whereby to restrict the flow area through said nozzle and thereby build up a back pressure in said central portion to oppose the motion of said diaphragm toward said partition means.

5. A pump comprising a housing having a liquid passage extending therethrough and including an inlet portion and an outlet portion, a Venturi nozzle in said outlet portion of said passage, secondary inlet openings in said housing adjacent to said nozzle through which to aspirate liquid to be pumped in response to liquid flow through said nozzle, a partition extending into said passage between said inlet portion and said outlet portion, a diaphragm within said housing forming one wall of said passage opposite said partition, said diaphragm having a portion movable into and out of engagement with said partition whereby to close and open said passage, means including said diaphragm defining a chamber in said housing on the opposite side of said diaphragm from said passage, said diaphragm having a restricted flow area opening therein communicating between said passage inlet portion and said chamber, an outlet passageway extending from said chamber out of said housing, a valve in said passageway for controlling the liquid flow through said passageway whereby to control the liquid pressure in said chamber as a means of controlling the position of said diaphragm, and means connected to said diaphragm and movable in response to diaphragm movement for restricting liquid flow through said nozzle upon movement of said diaphragm into passage closing position.

6. A pump comprising a housing having a liquid passage extending therethrough, said passage including a central outlet portion and an inlet portion including an annular chamber surrounding said central outlet portion and an inlet duct leading to said chamber, a Venturi nozzle in said outlet portion of said passage, secondary inlet openings in said housing adjacent to said nozzle through which to aspirate liquid to be pumped in response to liquid flow through said nozzle, a circular partition extending into said passage and separating said outlet portion from said annular chamber, a diaphargm within said housing forming one wall of said passage opposite said partition, said diaphragm having a portion movable into and out of engagement with said partition whereby to close and open said passage, means including said diaphragm defining a second chamber in said housing on the opposite side of said diaphragm from said passage, said diaphragm having a restricted flow area opening therethrough communicating between said passage inlet portion and said chamber, an outlet passageway extending from said chamber out of said housing, a valve in said passageway for controlling liquid flow through said passageway whereby to control the liquid pressure in said chamber as a means of controlling the position of said diaphragm, and a tapered pin carried by said diaphragm and projecting restrictively into said nozzle in the passage closing position of said diaphragm for increasing the pressure drop across said nozzle upon movement of said diaphragm into said passage closing position, whereby to develop a back pressure in said passage for retarding the movement of said diaphragm towards said passage closing position.

7. The invention defined in claim 6, wherein a float element is connected to said valve to actuate said valve in response to changes in liquid level adjacent to said pump.

8. A pump comprising a Venturi nozzle through which to force liquid under pressure for operating said pump, inlet-orifice defining means adjacent to said nozzle through which to aspirate liquid to be pumped in response to liquid flow through said nozzle, said pump having therein a liquid supply passage leading to said nozzle, said passage being defined in part by fixed wall means and in part by movable wall means, said movable wall means comprising a flexible diaphragm having a portion which is movable between first and second positions, said diaphragm portion in said first position being in contact with a portion of said fixed wall means and thereby interrupting said passage, said diaphragm portion in said second position being out of contact with said portion of said fixed wall means and thereby opening said passage, means including said diaphragm defining a chamber in said pump on the opposite side of said diaphragm from said passage, and means in said pump for controlling the pressure in said chamber in response to the level of liquid surrounding said pump whereby to control the position of said diaphragm portion relative to said fixed wall means and thereby control liquid flow through said passage as a function of the level of liquid surrounding said pump.

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