United States Patent

Einerson et al.

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[54] **SUBMERSIBLE PUMP AND CONTROL SYSTEM**

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[73] Assignee: **The Tait Manufacturing Company,** Dayton, Ohio

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[52] **U.S. Cl.**.....**417/40,** 417/44

[51] **Int. Cl.**.....**F04b 49/04**

[58] **Field of Search**...417/40, 44; 200/83 F; 335/205

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[57] **ABSTRACT**

A pump housing encloses an impeller driven by a motor which is operated by a control system including a reed switch in the gate circuit of a thyristor within the power supply lines to the motor. The reed switch is actuated by movement of a magnet mounted on a movable vertical rod having its upper end portion guided by a ferrous body which is effective to produce a flux path to the switch and to retain the magnet. The rod and magnet are moved by a float slidably mounted on the rod, and the assembly of the ferrous body, switch and thyristor are removable as a unit.

7 Claims, 5 Drawing Figures

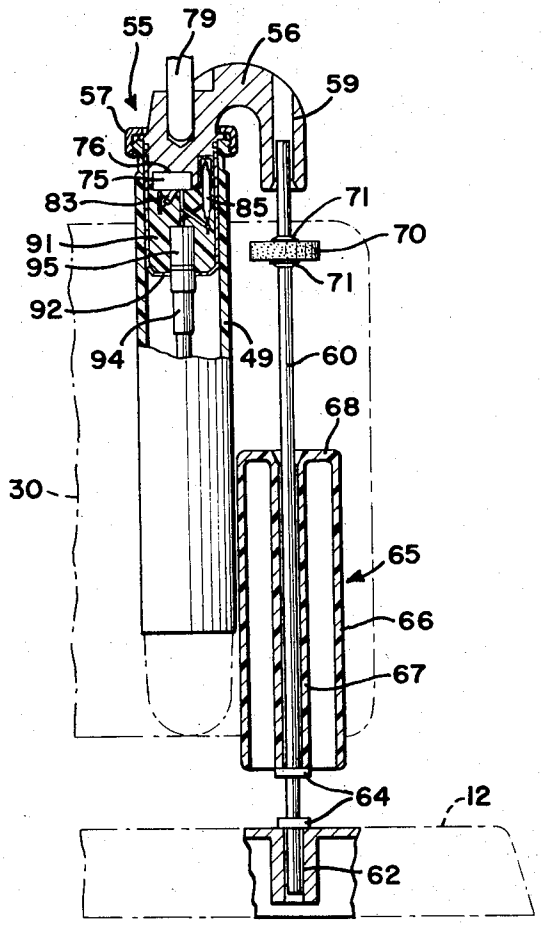


FIG-1

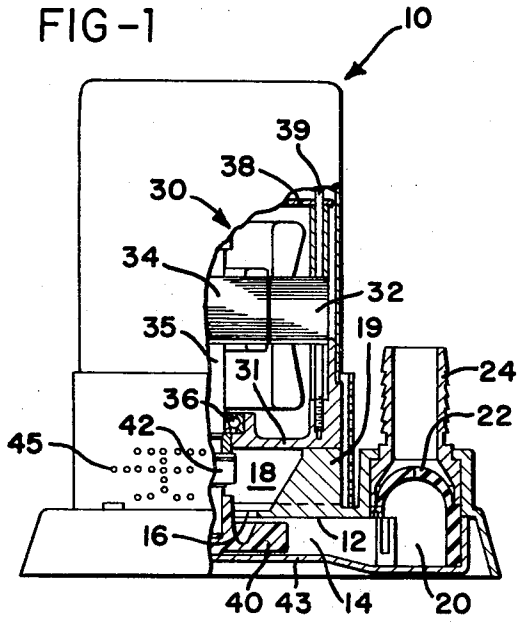


FIG-2

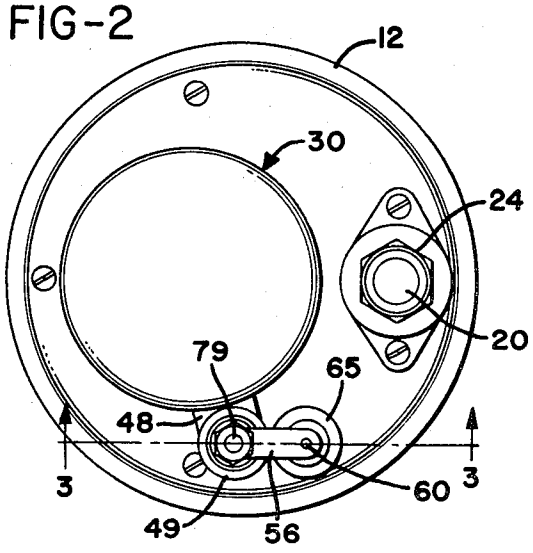


FIG-3

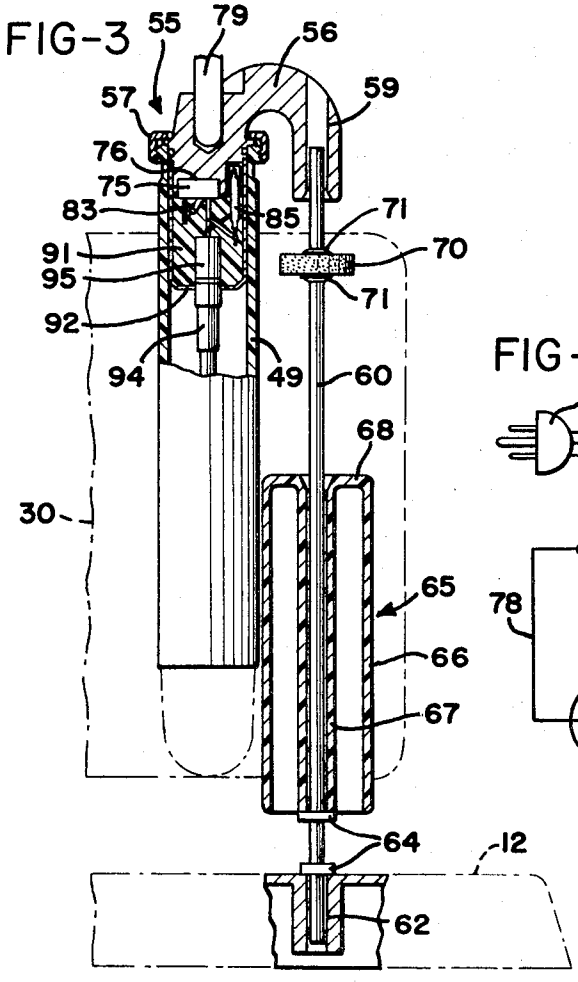


FIG-4

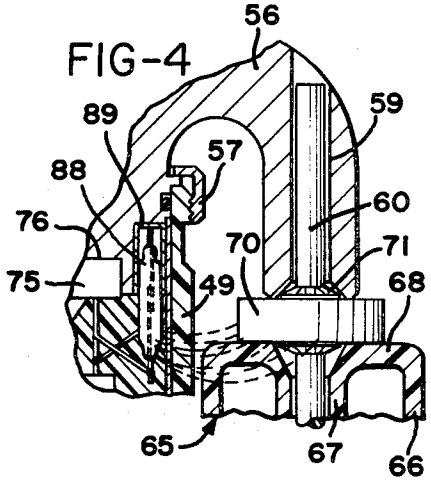
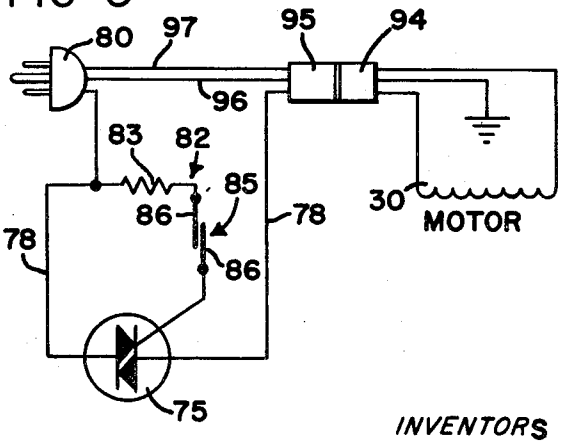


FIG-5



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SUBMERSIBLE PUMP AND CONTROL SYSTEM

BACKGROUND OF THE INVENTION

In a submersible drainer or pump such as disclosed in U.S. Pat. No. 3,216,361 which issued to the assignee of the present invention, usually a diaphragm switch is employed to control the operation of the pump motor in response to predetermined changes in the head or level of water above the pump.

Electrical power is supplied to the motor through the diaphragm pressure switch so that the switch usually operates with the full current load to the motor. When the switch is subjected to extended on-off cycling with this high current, the switch occasionally will fail. In some installations, this failure causes a substantial problem in that the water level will rise substantially above the pump unit causing significant damage to property. Furthermore, the replacement of the diaphragm switch is particularly undesirable in pumps which are installed in sumps, since the pump must be completely removed from the sump to replace the switch.

There are several patents disclosing devices for sensing the level of a liquid within a container and which do not employ a pressure actuated diaphragm switch. For example, U.S. Pats. No. 3,200,645, No. 3,419,695, No. 3,437,771 and No. 3,408,053 each disclose liquid level sensing systems including a reed switch which is actuated in response to movement of a magnet carried by a float. Each of the liquid sensing systems shown in the first three patents, employs a plurality of vertically spaced reed switches and an interconnecting control circuit for detecting a changing level in the liquid within a container. The system shown in the latter patent relies on a progressively decreasing magnetic flux to effect actuation of the reed switch.

SUMMARY OF THE INVENTION

The present invention is directed to an improved control system which is ideally suited for controlling a submersible pump unit. An important advantage of the controlling system of the invention is that only one magnetically actuated switch is required, and this switch is actuated to one position when the level of the liquid or water reaches an upper limit and is actuated to another position when the water level reaches a lower limit. The invention also provides for conveniently adjusting the upper and lower water level limits and provides for inexpensive construction as well as simplified assembly.

In accordance with a preferred embodiment of the invention, an inverted U-shaped ferrous body or member supports a reed switch which is connected in the gate circuit of a thyristor connected in series with the pump motor. The ferrous member is supported by the pump housing and also forms a guideway for the upper end portion of a vertically movable rod. The lower end portion of the rod is guided by an opening formed within the pump base, and a thickness oriented disk-like magnet is mounted on the rod so that it is adapted to contact the ferrous member when the magnet is raised to a position adjacent the reed switch.

A float is guided by the vertical rod and is adapted to engage the magnet and lift the magnet into contact with the ferrous member when the level of the surrounding body of water approaches an upper predetermined limit. When the magnet contacts the member, the reed switch closes triggering the thyristor so that the circuit to the motor is completed. As water is pumped from the chamber, the float descends while the magnet remains attached to the ferrous member. When the water level approaches a predetermined lower limit, the float engages a stop on the rod so that the magnet is pulled downwardly away from the ferrous member and reed switch thereby opening the reed switch to deenergize the thyristor and the circuit to the motor.

Other features and advantages of the invention will be apparent from the following description, the accompanying drawing and the appended claims.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is an elevational view of a submersible pump unit having a control system in accordance with the invention and with a portion broken away to show internal construction;

FIG. **2** is a top plan view of the pump unit shown in FIG. **1**;

FIG. **3** is a partial vertical section taken generally on the line **3—3** of FIG. **2** and with a portion of the pump unit shown in phantom;

FIG. **4** is an enlarged fragmentary section of a portion shown in FIG. **3**; and

FIG. **5** is a schematic circuit diagram of the pump unit control system constructed in accordance with the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. **1**, a submersible drainer or sump pump **10** includes a base housing **12** which defines a volute-shaped pumping chamber **14** having a circular inlet **16** connecting the pumping chamber **14** to an inlet chamber **18** interrupted by a plurality of upwardly projecting and radially extending ribs **19**. The pumping chamber **14** connects to an outlet chamber **20** which receives a resilient check valve **22** constructed and assembled as disclosed in U.S. Pat. No. 3,174,434 which issued to the assignee of the present invention. A tubular outlet fitting **24** has its lower end portion retained within the outlet chamber **20** and is adapted to receive a flexible discharge line (not shown).

An induction motor **30** includes a lower bearing bracket **31** which mounts on the pump housing **12**. A stator **32** seats on the lower bearing bracket **31** and surrounds a rotor **34** having a vertical shaft **35** which is rotatably supported on its lower end by an anti-friction ball bearing **36** retained within the hub of the bearing bracket **31**. The upper end portion of the shaft **35** is supported by a sleeve-type bearing (not shown) retained within the hub of an upper bearing plate **38** secured to the stator **32** by a series of bolts **39**. The rotor **34** may also be supported solely by one or more anti-friction bearings mounted on the lower end portion of the shaft **35**.

The shaft **35** extends downwardly through the inlet **16** to support an open face centrifugal impeller **40**. A rotary seal **42** forms a fluid tight seal between the shaft **35** and the lower bearing bracket **31**. The pumping chamber **14** and the outlet chamber **20** are covered along the bottom by a pan-like bottom plate **43**, and a cylindrical screen **45** surrounds the inlet chamber **18** to prevent undesirable foreign matter from entering the pump inlet **16**.

Referring to FIGS. 2 and 3, a fitting 48 is formed as an integral part of the housing 12 and projects outwardly to support a rigid tube 49 formed of a non-magnetic material such as brass or plastic. A control unit 55 is mounted on the upper end portion of the tube 49 and includes an inverted U-shaped ferrous body or guide member 56. One end portion of the guide member 56 extends into the upper end portion of the tube 49 and is releasably retained by a nut 57 which threads onto the upper end of the tube 49.

The opposite end portion of the guide member 56 has a vertical bore 59 which slidably supports the upper end portion of a vertical non-magnetic or rigid plastic rod 60. The lower end portion of the rod 60 is slidably supported within a bore 62 formed within the base of the housing 12 and a pair of vertically spaced stop members or washers 64 are retained by friction on the lower portion of the rod 60. A cylindrical plastic float member 65 is slidably supported by the rod 60 and includes an outer cylindrical wall 66 which is connected to a concentric inner wall or tube 67 by an integral upper end wall 68. The inner tube 67 of the float member 65 receives the guide rod 60 so that the float 65 is adapted to move on the rod 60 with changes in the level of the water surrounding the submersible pump unit 10.

A thickness oriented washer-like resilient magnet 70 is mounted on the upper end portion of the guide rod 60 and is retained by a pair of friction washers 71 which are pressed onto the rod 60. Normally, the float 65 rests upon the upper stop washer 64 as shown in FIG. 3, and the guide rod 60 is supported in its lower portion (FIG. 3) by the lower stop washer 64 which engages the upper surface of the housing 12 surrounding the bore 62.

When the submersible pump unit is installed within a chamber which is receiving a liquid such as water, the float 65 rises with a rise in the water level within the chamber. As the float 65 rises, it eventually engages the magnet 70 and lifts the magnet until the magnet engages the lower end surface of the ferrous body or member 56 as shown in FIG. 4.

Referring to FIGS. 4 and 5, a full wave or bi-directional gate control thyristor 75, generally referred to as a Triac, is recessed within a cavity 76 formed within the opposite end portion of the member 56 received within the upper end portion of the tube 49. The terminals of the thyristor 75 are connected by line 78 in series with the windings of the induction motor 30 supplied with power through a power cord 79 having a plug 80. The gate or trigger circuit 82 for the thyristor 75 includes a current limiting device or resistor 83 and a reed switch 85.

The leaf-like contacts 86 of the reed switch 85 are encased within a glass tube 88 (FIG. 4) which has its upper end portion recessed within a cavity 89 formed within the ferrous member 56. The lower end portion of the glass tube 88, the resistor 83 and the terminals of the thyristor 75 are encased within a waterproof potting compound 91 confined within a cylindrical tube 92. The power supply leads extending from the motor 30 are connected to a plug 94 (FIG. 5) which is inserted into a socket 95 connected to the line 78, a ground line 96 and the other power supply line 97 within the cord 79. As shown in FIG. 3, the socket 95 is recessed within the casing 92 and potting compound 91.

As mentioned above, when the float 65 rises on the guide rod 60 as the water level rises, the float moves the magnet 70 upwardly into contact with the ferrous member 56 which conducts the magnetic flux to the reed switch 85 causing the contacts 86 of the switch to close. Magnetic flux is also transmitted directly from opposite sides or poles of the magnet 70 to the contacts 86 of the reed switch 85 through the non-magnetic support tube 49 as indicated by the dotted lines in FIG. 4. When the reed switch contacts 86 close, the gate circuit for the thyristor 75 is completed so that a small current flows through the gate circuit to the thyristor. This current is sufficient to trigger the thyristor 75 so that it will shift to a closed condition and thereby complete the circuit to the motor 30.

As the motor driven pump removes water from the chamber, the water level and the float 65 drop while the magnet 70 is retained by the ferrous member 56 as shown in FIG. 4 as a result of the magnetic attraction. When the water level and float 65 approach a lower limit, as determined by the position of the upper stop washer 64 on the guide rod 60, the weight of the float 65 is sufficient to pull the magnet 70 away from the ferrous member 56 so that the magnet 70 and the rod 60 drop to their lower positions as shown in FIG. 3. The dropping of the magnet 70 breaks the magnetic flux path to the contacts 86 of the reed switch 85, causing the contacts to open and the thyristor 75 to return to its normally open condition thereby opening the circuit to the motor 30.

From the drawing and the above description, it is apparent that a pump incorporating a control system in accordance with the invention, provides desirable features and advantages. For example, the control system may be easily adapted for use on any form of pump such as the submersible drainer shown or a sump pump wherein the motor is supported above the upper water level. The control system may also be conveniently adjusted for changing either the lower and/or the upper water levels within the chamber. That is, the lower water level may be changed simply by adjusting the axial position of the upper stop washer 64 on the guide rod 60. While not shown, a similar stop washer may be adjustably mounted on the guide rod 60 above the float 65 to provide for adjusting the upper maximum level of the water within the chamber.

Another important advantage of the invention is provided by the relationship between the magnet 70, the ferrous guide member 56 and the magnetically actuated reed switch 85. That is, when the magnet 70 engages the ferrous member 56 as shown in FIG. 4, the member 56 not only functions to form a flux path from the magnet 70 to the reed switch contacts 86, but also functions to retain the magnet 70 and guide rod 60 in their upper positions while the float 65 is descending on the guide rod 60. The thickness oriented magnet 70 also provides for closing the contacts 86 of the reed switch 85 as a result of the direct magnetic flux path between the upper and lower surfaces of the magnet 70 to the corresponding contacts 86 of the reed switch 85 through the non-magnetic support tube 49 and the non-magnetic cylindrical tube 92.

The thyristor 75 within the circuit for the pump motor provides the advantage of limiting the current through the reed switch 85 to a low milliamp value so that the reed switch and pump unit have a long de-

pendable service life. Furthermore, by mounting the thyristor **75** within the ferrous guide member **56** which is normally surrounded by free air, the guide member serves as an effective heat sink to dissipate heat generated by the thyristor. This prevents the thyristor from overheating so that it will also provide a long dependable service life. It is also within the scope of the invention to add fins to the guide member **56** for aiding in the heat dissipation into the free air. Another feature is provided by the use of the retaining nut **57** in combination with the plug **94** and the socket **95**. If for some reason the reed switch **85** or thyristor **75** fail to function, the control unit **55** may be conveniently and quickly replaced by a new control unit.

While the form of apparatus herein described constitutes a preferred embodiment of the invention, it is to be understood that the invention is not limited to this precise form of apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. A submersible pump unit comprising a housing defining a pump chamber, means defining an inlet and an outlet for said chamber, a motor connected to said pump housing and having a rotor shaft, an impeller disposed within said chamber and connected to said shaft, a ferrous body, means connected to said housing and supporting one portion of said body, a magnetically actuated reed switch mounted on said body, means including a thyristor connecting said switch to said motor for controlling said motor in response to operation of said switch, a thickness oriented magnet, a vertical rod supporting said magnet, means on said body and connected to said housing for supporting said rod and said magnet for vertical movement between a first lower position and a second upper position with said magnet adjacent said body to effect actuation of said switch, a float slidably mounted on said rod for vertical movement between upper and lower predetermined positions, means for moving said rod and said magnet from said first position to said second position in response to rising of said float to said upper portion, stop means mounted on said rod and effective to cause movement of said rod and said magnet from said second position to said first position in response to engagement by said float moving downward toward said lower position, and said magnet being magnetically retained by said body in said second position while said float is descending to said lower position.

2. A submersible pump unit comprising a housing defining a pump chamber, means defining an inlet and an outlet for said chamber, a motor connected to said pump housing and having a rotor shaft, an impeller disposed within said chamber and connected to said shaft, a magnetically actuated switch, a gate circuit including said switch, a bi-directional thyristor actuatable by said gate circuit and connected to said motor for controlling said motor in response to operation of said switch, a magnet, means supporting said magnet for movement between first and second positions to effect actuation of said switch, a float, means supporting said float for movement independently of said magnet between upper and lower positions, means for moving said magnet from said first position to said second position in response to movement of said float to said upper position, means for moving said magnet from said second position to said first position in response to movement of said float to said lower position, and means for holding said magnet in at least one of said positions while said float is moving to one of said upper and lower positions.

3. A submersible pump unit as defined in claim **2** including a body supporting said thyristor and said switch, and means releasably supporting said body for removal of said thyristor and said switch as a unit.

4. A submersible pump unit comprising a housing defining a pump chamber, means defining an inlet and an outlet for said chamber, a motor connected to said pump housing and having a rotor shaft, an impeller disposed within said chamber and connected to said shaft, a magnetically actuated switch connected in controlling relation with said motor, a magnet, means supporting said magnet for movement between actuating and non-actuating positions with respect to said switch, a float, means supporting said float for movement independently of said magnet between upper and lower positions, means for moving said magnet from said non-actuating position to said actuating position in response to movement of said float from one of its said positions to the other, means for moving said magnet from said actuating position to said non-actuating position in response to substantially completed return movement of said float to said one position thereof, means for holding said magnet in said actuating position while said float is moving to said one position thereof, said holding means including a body of magnetic material engageable in magnetic flux conducting relation by said magnet in said actuating position thereof, and means mounting said switch in the path of said conducted flux for actuation thereby to control said motor.

5. A submersible pump unit as defined in claim **4** wherein said body is of a generally U-shaped configuration, said magnet is engageable against one end of said body, and said switch is mounted adjacent the other end of said body.

6. The submersible pump of claim **4** wherein said actuating position of said magnet corresponds to said upper position of said float.

7. A submersible pump unit as defined in claim **4** wherein said means supporting said float comprises a generally vertical guide member supported for generally vertical movement between predetermined limits, and said magnet being mounted on said guide member.

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