Nov. 15, 1966 O. O. HEMBREE ETAL 3,285,183

CONTROL ASSEMBLY FOR OIL WELL PUMP

Filed Dec. 1, 1964

2 Sheets-Sheet 1

Fig. 1

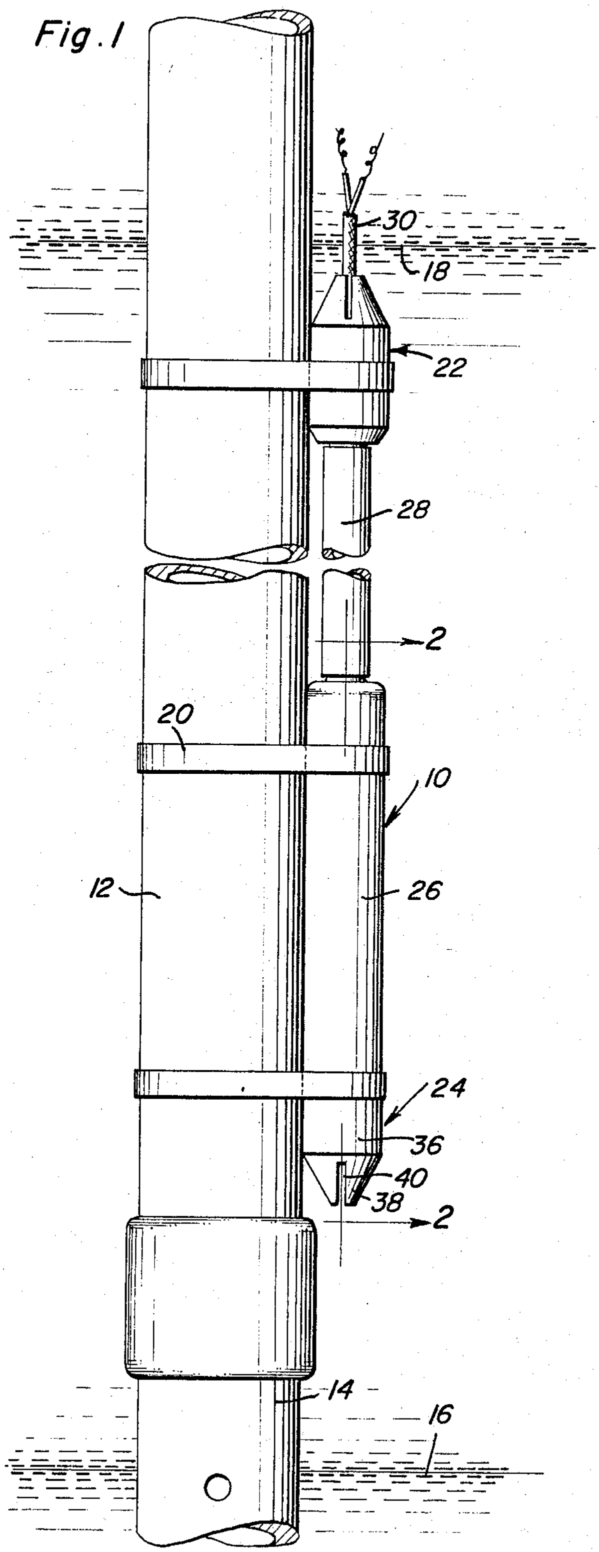


Fig. 4

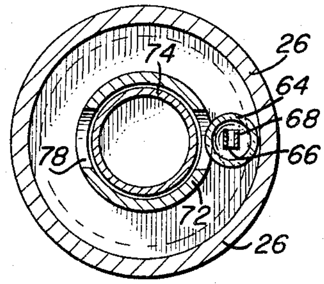


Fig. 5

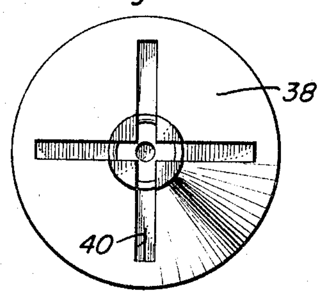
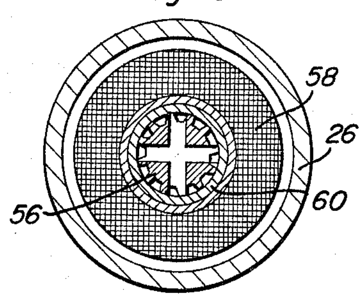


Fig. 6



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2 Sheets-Sheet 2

Fig. 2

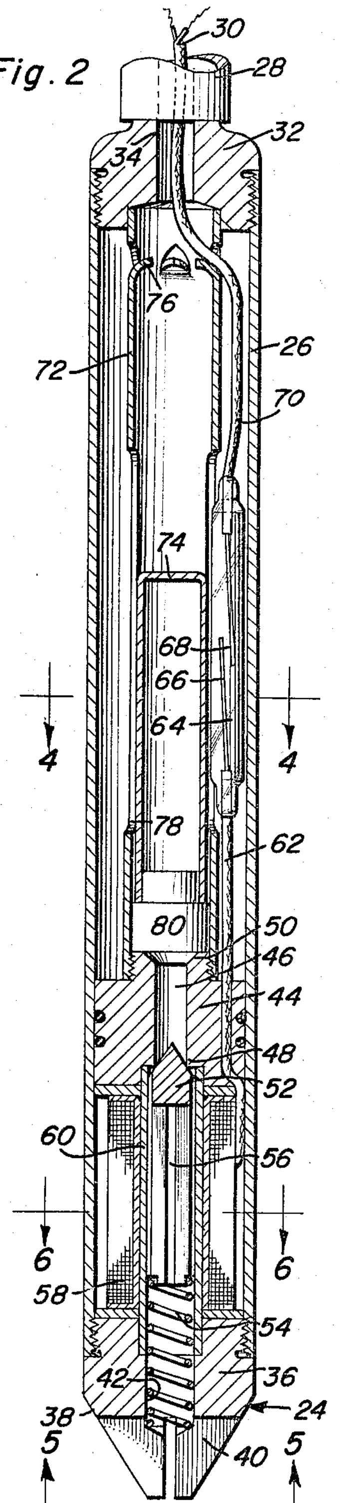


Fig. 3

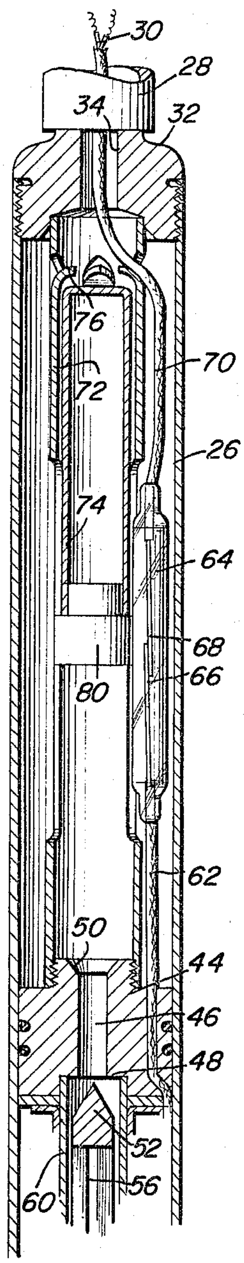
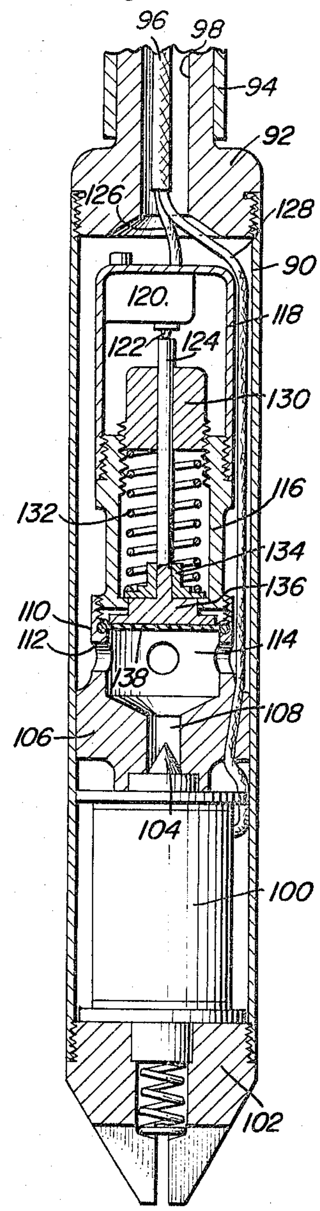


Fig. 7



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CONTROL ASSEMBLY FOR OIL WELL PUMP
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9 Claims. (Cl. 103—25)

The present invention relates to a device for automatically controlling the pumping of fluid such as oil from an oil well by means of utilizing the force and flow characteristics of the fluid being pumped to activate or deactivate the pump motor when the fluid level has reached a desired high and low level respectively for automatically actuating the pump motor for pumping the fluid when the fluid level reaches a predetermined high point and automatically stopping the pump motor when the fluid level reaches a predetermined low point.

Various installations facilitate the application and adaptation of the present invention. For example, in storage tanks for fluids, in transfer operations where amounts of fluid are to be moved, in blind pumping of fluid from one tank to another tank at remote distances, exhausting of fluids from remote pits or holes deep in the ground and many others. In this particular application, the invention is disclosed for use in an oil well with it being pointed out that the invention is not limited to such use but encompasses many uses such as those mentioned above as exemplary.

In the particular use of the invention as disclosed, it is normal practice when an oil well has been completed to install pumping equipment with the pump being operated by an electric motor or a gasoline engine. The present invention may be incorporated into the pumping system to control both types of motors with the gasoline motor either being started by an automatically controlled starting mechanism or manually started after it has been automatically stopped.

Also, in normal oil well pumping systems, control of the pumping mechanism requires the services of a person called a "pumper" who is engaged solely to observe the pumping of the well. His duties requires that he watch the flow of the fluid being pumped from the well and when the pump "pumps-off" (the term indicating the fluid has been exhausted from the hole) he shuts off the pump to allow the fluid to recover in the hole. The "pumper's" job is complicated by the fact that well locations are usually widely dispersed and sometimes are inaccessible. Also, bad weather conditions and the total number of wells to be watched further complicates the job of the "pumper." Also, all formations do not surrender the fluid at the same rate and the human element injects a degree of uncertainty in controlling the pumping apparatuses. In some instances, an electric timing clock has been used to time the pumping cycle and this type of operation continues to operate the pump for a given length of time even though the fluid has been exhausted from the hole. When the pump mechanism continues to operate when the fluid has been exhausted from the hole, damage is done to the downhole equipment in the form of undue wear on the cups and working barrel surface of the pump. This operation also causes a condition referred to as "cut oil" and this damage is costly inasmuch as it requires pulling of the equipment to repair the damage and also results in inefficient pumping inasmuch as the down time required to repair the pump is lost.

The problems described above are eliminated by the present invention inasmuch as it eliminates the need for the time clock and also reduces considerably the need

for a "pumper." In using the present invention, when the fluid in the hole reaches a predetermined high level, the pump automatically starts to pump the fluid. When the fluid in the hole is pumped out and the lowest level as predetermined is reached, the pump automatically stops. The lowest desired level of the fluid can be accurately controlled so that the formation will not be exposed which is desirable inasmuch as this will prevent the formation from drying out or otherwise being coated by contact with normal bottom hole atmosphere thus maintaining the free surrender of the fluid from the formation.

Thus, basically, the present invention serves to activate the pump when it is needed and subsequently deactivate the pump when it is not needed. It is always ready to control the pump and thus eliminates the need for a "pumper" to do this work and releases him for other duties.

The present invention incorporates two methods of accomplishing this purpose one of which may be considered a float and flow method and the other a pressure and flow method with both methods involving apparatuses which are relatively simple in construction, dependable in operation, efficient, long lasting and relatively inexpensive to manufacture.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout, and in which:

FIGURE 1 is a side view illustrating the float and flow method of the present invention installed on an oil well flow pipe;

FIGURE 2 is a longitudinal, vertical sectional view, on an enlarged scale, taken substantially upon a plane passing along section line 2—2 of FIGURE 1;

FIGURE 3 is a partial sectional view similar to FIGURE 2 but illustrating the structure in pump actuating condition;

FIGURE 4 is a transverse, sectional view taken substantially upon a plane passing along section line 4—4 of FIGURE 2 illustrating further structural details of the form of the invention;

FIGURE 5 is a bottom plan view taken generally upon reference line 5—5 of FIGURE 2 illustrating further structural details of this form of the invention;

FIGURE 6 is a transverse, sectional view taken substantially upon a plane passing along section line 6—6 of FIGURE 2; and

FIGURE 7 is a sectional view illustrating the pressure and flow apparatus.

The present invention, as illustrated in FIGURE 1, is designated by the numeral **10** and it attached to the working barrel or bottom hole pump **12** having a perforated nipple **14** attached to the lower end thereof. The lowest desired fluid level is designated by numeral **16** and the highest desired fluid level is designated by numeral **18**. The control device **10** is secured to the working barrel or tubing **12** by a plurality of suitable straps **20** and includes a top inlet fitting **22** and a bottom inlet or outlet fitting **24** which is carried by the lower end of a tubular casing **26**. The upper end of the tubular casing is connected to the top inlet fitting **22** by an elongated flexible tube **28** which may be of any desired length depending upon the installation requirements. For example, the plastic tube or pipe may be from five feet to fifteen feet in length with it being understood that any suitable length may be employed with the plastic tube **28** not only forming a passage for fluid entering the top inlet fitting **22** so that it can proceed into the casing **26** but also provides a passage for a multiple conductor conduit **30**.

As illustrated in FIGURE 2, the tubular casing **26** has a screw-threaded fitting **32** at the upper end thereof in sealed relation thereto with the fitting **32** having a bore **34** therethrough communicating with the interior of the plastic tube **28**, the tube being secured to the fitting **32** in any suitable manner. The lower end of the casing **26** has the lower inlet fitting **24** screw-threaded thereto with the lower inlet fitting **24** being in the form of a screw-threaded plug **36** having a conical lower end **38** which has four radial slots or grooves **40** formed therein which communicate with a central longitudinal bore **42** which communicates with the interior of the casing **26**.

Disposed in the casing **26** is a valve seat member **44** having a longitudinal passageway **46** therethrough provided with a valve seat **48** at the lower end thereof and a valve seat **50** at the upper end thereof. A solenoid controlled valve member **52** engages the lower valve seat **48** and is retained against the valve seat by a compression spring **54** engaging the bottom end of an elongated shank **56** on the valve member **52**. An electromagnetic coil **58** encircles a sleeve **60** forming a guide for the valve member so that when the coil **58** is energized, the valve **52** will be retracted downwardly into the interior of the coil inasmuch as the valve member **52** including the stem or shank **56** serves as the movable armature of the electromagnet. Connected electrically to the coil **58** is a conductor **62** which extends through the valve member **44** and into the interior of a sealed housing **64** having a pair of contact elements **66** and **68** therein in the form of spring wires which are normally spaced apart as illustrated in FIGURE 2. The contact element **68** is connected to a conductor **70** forming a continuation of the conduit **30** for completing a circuit to the solenoid and completing a circuit to a pump motor in a conventional manner when the switch contacts **66** and **68** are in contact and breaking the circuit to the motor for stopping the pump motor and stopping the pump and also deenergizing the solenoid for permitting the valve **52** to close.

Disposed interiorly and concentrically of the casing **26** is a tubular member **72** in the form of a guide for an elongated hollow float member **74** which moves longitudinally in the guides or tubular member **72**. The upper end of the tubular member **72** is provided with inwardly struck lugs **76**, one of which forms a passageway for the conductor **70** and all of which form a limit stop for the movement of the float **74**. The tubular member **72** is provided with a plurality of longitudinally extending slots **78** for enabling fluid to flow into the space between the tubular members **72** and the casing **26** so that fluid may substantially completely enclose the float so that the fluid which is liquid or the like will cause the float **74** to move longitudinally in the tubular guide member **72**.

At the lower end of the float **74**, there is provided a permanent magnet **80** in the form of a valve member which rests against the valve seat **50** and which is movable off the valve seat when the float **74** floats upwardly to its uppermost position as illustrated in FIGURE 3.

As illustrated in FIGURES 2 and 3, the switch contacts **66** and **68** are orientated so that the permanent magnet **80** will be closedly adjacent thereto when the float **74** reaches its upper limit of movement as illustrated in FIGURE 3. The permanent magnet **80** will close the contacts **66** and **68** thus actuating a switch due to the magnetic field produced by the permanent magnet when the float **74** is raised so that the magnet is generally centrally disposed in relation to the switch as illustrated in FIGURE 3.

In use, the slots **40** are orientated at or slightly above the top performation in the perforated tube **14** through which the fluid is pumped. The plastic tube **28** is of a sufficient length to locate the top inlet fitting **22** at the desired highest level of the fluid as at **18**. The top inlet fitting **22** is substantially the same in configuration and shape as the bottom inlet or outlet fitting and also has

radial grooves therein. A one or two wire cable **30** extends upwardly and outwardly from the top of the hole above ground where the transformer or resistor and relay system are conveniently located. When the fluid in the hole rises to the level of the top inlet fitting, the fluid spills in through the fitting and is directed down through the plastic tube **28** and collects in the float chamber in the casing **26** above the valve member **44**. When sufficient fluid has collected above the valve, it will raise the float **74** to its uppermost position which will close the switch contacts **66** and **68** which connects the circuit in a low voltage system which then will energize the solenoid thus opening the solenoid valve and also activate a relay for causing the pump motor to be started. The solenoid valve **52** stays in open position until the fluid is pumped down to the lowest level **16** so that the float will fall to its lowermost position and the switch contacts will separate thus deenergizing the solenoid and enabling the solenoid valve to close for preparation of the next cycle.

FIGURE 7 illustrates the pressure and flow method which has the same over-all characteristics as the first form of the invention including a tubular casing **90** having an upper end plug or fitting **92** attached to the plastic tube **94** corresponding to the tube **28** which has an inlet fitting at the upper end thereof corresponding to the inlet fitting **22** in FIGURE 1. A conductor **96** passes through a passageway **98** in the fitting **92** and the plastic tube to control the pump motor and connect with a suitable transformer or power source for providing a low voltage source of electrical energy for energizing a solenoid **100** mounted on the lower end of the casing **90** with the solenoid **100** corresponding with the solenoid **58** in FIGURE 2. A bottom inlet or outlet fitting **102** is screwthreaded into the lower end of the casing **90** and the inlet fitting **102** corresponds to the inlet fitting **24** in FIGURE 2 for controlling the valve **104** in the same manner. The valve **104** is associated with a valve seat member **106** which has a passage **108** extending therethrough for selectively closing and opening by the valve member **104**. The upper end of the valve member **106** is provided with an internally threaded axial extension **110** spaced concentrically from the casing **90** and provided with a plurality of inlet openings **112** therein for communicating the hollow interior **114** of the extension **110** with the interior of the casing **90**. Screw-threadedly attached to the extension **110** is an adapter **116** having an externally and internally screw-threaded upper end portion. The externally threaded end of the adapter **116** is engaged with a cylindrical cap **118** having a microswitch **120** mounted therein and provided with an actuating button **122** engageable by a reciprocating plunger **124**. An electrical conductor **126** is connected to the microswitch and a similar conductor **128** extends downwardly to the solenoid **100** to energize the solenoid when the microswitch **120** is closed which also actuates the pump motor.

The internally threaded upper end of the adapter **116** is provided with a guide plug **130** screwthreaded thereto which has a bore slidably receiving the plunger **124** for guiding reciprocation of the plunger. A compression coil spring **132** encircles that part of the plunger disposed below the guide plug **130** and the other end thereof engages a spring follower **134** connected to the plunger **124** thereby spring biasing the plunger **124** to a lowered position away from the microswitch **120**.

The lower end of the plunger **124** is provided with an enlarged head **136** engaging a resilient diaphragm **138** extending across the upper end portion of the extension **110** and secured thereto in sealing relation so that the interior of the cap **118**, adapter **116**, and extension **110** above the diaphragm **138** will be sealed against entry of pressurized fluid which engages the undersurface of the diaphragm **138**. Thus, when the fluid in the hole rises to the level of the top inlet fitting, the fluid spills in through the fitting and is directed down through the plastic tubing and collects at the bottom of the casing above the valve **104** which is in closed condition. When sufficient fluid is connected above the valve, the static pressure generated will act on the diaphragm and cause the plunger to move upwardly thereby causing a contact to be made in the microswitch. This contact connects the circuit in the low voltage system, such as a 24-volt system which then opens the solenoid valve and activates the relay causing the pump to be started. The solenoid valve **104** stays in valve open position until the fluid is pumped down to the lowest level where the pressure is relieved on the pressure switch and the circuit is broken and the pump stops. At this point, the solenoid valve closes in preparation for the next cycle.

To compensate for the increased atmospheric pressure encountered at greater distance below sea level, an adjustment is provided by turning the plug **130** which varies the tension on the spring **132**. Such adjustment may be marked to indicate the depth and this adjustment is made prior to installation of the device in the hole. The diaphragm **138** may be sealed in place by a suitable O-ring or the like and there is a relatively small space provided above the head **136** of the plunger **124** before it seats solidly but this distance is enough to enable contact to be made within the microswitch. The solid seating of the head of the plunger prevents the diaphragm from rupturing due to the pressure exerted thereon.

In addition to the structure disclosed, a suitable transformer to supply 24 volts or some other low voltage for the system is provided above ground together with a relay to convert the impulse received from this system to activate the line voltage required for the pump circuit. The various electrical components and details conform to conventional electrical practices. Also, a rheostat or the like may be provided to regulate the current to compensate for resistance in the cable to enable proper current to reach the control unit which may be located at varying depths in order to insure proper operation of the solenoid valve and the switch. The solenoid valve is especially designed in that it has longitudinal slots therein and the dimension thereof is slightly less than the tubular guide **60** to provide a flow passage therethrough when the valve is open. The flexible plastic tubing is sufficiently rigid to maintain a tubular passage which collects the fluid when a high level is reached and allows the fluid to flow or spill down through the tube and come to rest above the solenoid valve at the bottom of the control unit. When the suitable amount of fluid is collected to operate the switch, the well pump is activated and the reverse action is accomplished when the fluid is exhausted. The particular orientation of the actual high and low levels to be attained may be determined by the specific construction and configuration of the various components. For example, the permanent magnet may be such as to be retained in either of its initial positions until the force of the fluid has built up or reduced sufficiently that it will be moved from its extreme positions to close or open the switch contacts completely during its movement thus assuring that quick and positive operation of the switch contacts will be attained.

In practical operation a system has been provided wherein the required amount of current is fed in to operate the solenoid valve, the relay and overcome the cable wire resistance wherein the cable wire is the varying factor due to variable lengths or depth of holes. A standard hook-up or a standard design of a system is being provided to meet conditions for all holes to 3,000 feet deep. Resistors from 2 to 10 watts are incorporated in the system for this standard hook-up and no transformer is used. With this method no adjustment is required at installation time. Another advantage of the resistor system assures proper setting of the electrical characteristics at installation. The device is located in the power line between the incoming 110 volt source and the pump motor. Two terminals are provided for the incoming 110 current in the control box and two terminals for the line to the pump motor. Between these two sets of terminals are two more to which the cable from the device in the well are attached. The control box contains all instrumentation wired and ready to make the three simple connections.

In cases of deeper depths, if required, only a change in the resistors built into the system would be required, within reason.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention as claimed.

What is claimed as new is as follows:

1. A device for controlling operation of a pump motor for automatically activating a pump when a fluid level reaches a predetermined high point and automatically deactivating the pump when the fluid level reaches a low point comprising a tubular casing having a passageway in the bottom thereof for communicating with a fluid supply, the upper end of said casing being communicated with upper inlet means for communication with fluid when the fluid reaches a predetermined high level, a normally closed valve in said passageway in the casing to preclude inlet of fluid through the passageway so that fluid will have to enter the inlet means, and switch means in said casing responsive to inflow of fluid into the upper inlet means for closing a circuit to operate a pump motor for pumping the fluid, and means opening said valve in the passageway in the casing in response to operation of the pump motor for opening the valve in the casing whereby fluid in the casing will drain out through the passageway as the fluid level lowers to a predetermined point thereby opening the switch means for stopping the pump motor and closing the valve in the passageway in the casing.

2. The structure as defined in claim **1** wherein said switch means includes an actuator responsive to introduction of fluid into the casing.

3. The structure as defined in claim **2** wherein said actuator is in the form of a float, guide means in the casing for said float, said float having a permanent magnet thereon, and a proximity switch means orientated at a position alongside of the permanent magnet when to float raises the permanent magnet in response to inflow of fluid into the casing for closing the switch to actuate the pump motor and open the valve in the passageway in the casing.

4. The structure as defined in claim **2** wherein said actuator includes a plunger, a microswitch having an actuating button in the path of movement of the plunger, said plunger having a head theron, a diaphragm attached to the head, an adapter sealingly engaged with said diaphragm and having fluid inlet means below the diaphragm whereby inflow of fluid into the casing will exert pressure on the diaphragm for moving the plunger thereby actuating the switch for operating the pump motor and opening the valve in the passageway in the casing.

5. The structure as defined in claim **1** wherein said valve in the passageway in the casing is a solenoid operated valve for opening upon completion of a circuit to start the pump motor thus communicating the interior of the casing with the fluid supply whereby the means in the casing will automatically deactivate the pump when the fluid level drops to a predetermined point.

6. The structure as defined in claim **5** wherein said casing includes a plug having a conical end and a longitudinal bore therethrough forming a portion of said passageway, said conical end having transversely extending slots communicating with the bore for facilitating exit of fluid.

7. The structure as defined in claim 6 wherein said upper inlet means includes an elongated plastic tube, an inlet fitting mounted on the upper end of said plastic tube, said inlet fitting having a conical tapered upper end portion with transverse grooves therein communicating with the longitudinal bore in the fitting and communicating with the plastic tube.

8. A control assembly for controlling operation of a pump for removing liquid from a reservoir in which the supply therein is being replenished so that the pump will be activated when the level in the reservoir reaches a predetermined level and become deactivated when the pump lowers the level in the reservoir to a predetermined lower level comprising a vertically orientated casing having a passageway in the bottom thereof communicated with the reservoir, valve means in said passageway for selectively closing the same, inlet means communicated with the casing for admitting fluid into the casing when the level in the reservoir reaches a predetermined high point, means in said casing responsive to inflow of fluid for actuating a pump when the level in the reservoir reaches the predetermined high point and falls into the casing, said means in said casing also actuating the valve means for opening the valve means in the passageway thereby communicating the passageway in the bottom of the casing with the reservoir so that the pump will remain actuated until the level in the reservoir

reaches a predetermined low point at which time the means in the casing will deactivate the pump.

9. The structure as defined in claim 8 wherein said casing is elongated with the passageway in the bottom being longitudinal and the upper end of the casing a longitudinal inlet, and means adapted to mount the casing longitudinally on a well tubing disposed in an underground reservoir.

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