

May 12, 1964

W. T. RUDY ETAL
LEVEL CONTROLLED PUMPING SYSTEMS AND
SWITCH ASSEMBLIES THEREFOR

3,132,592

Filed Feb. 13, 1961

2 Sheets-Sheet 1

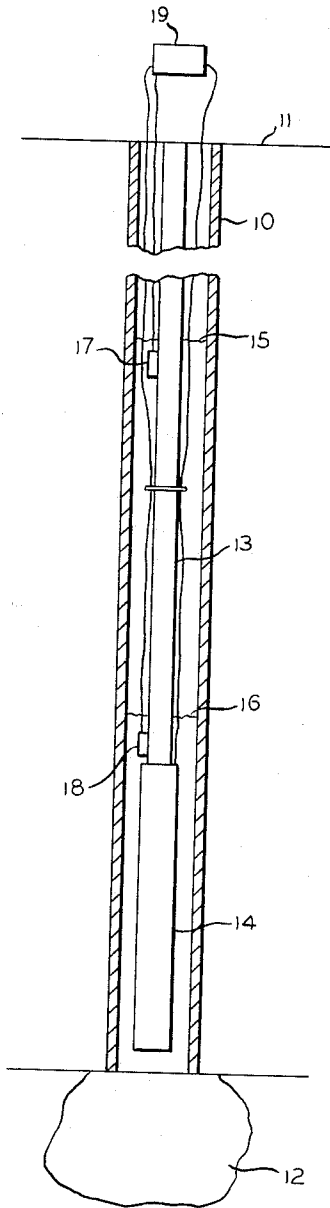


FIG. 1

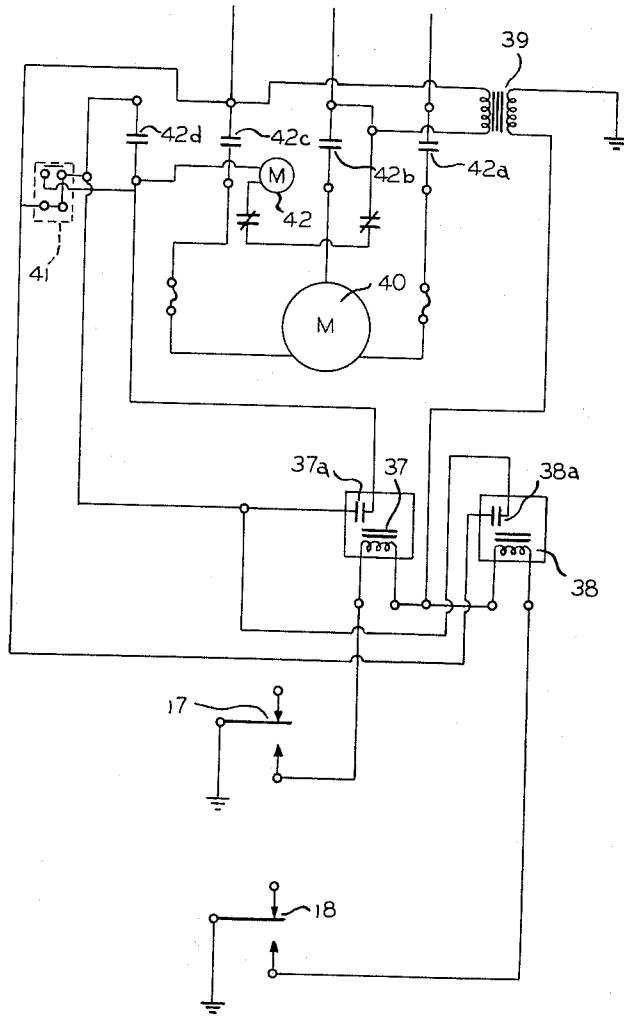


FIG. 6

INVENTORS
ALBERT L. POTTS
BY WILLIAM T. RUDY
NELSON W. WILLIAMS

ATTORNEYS

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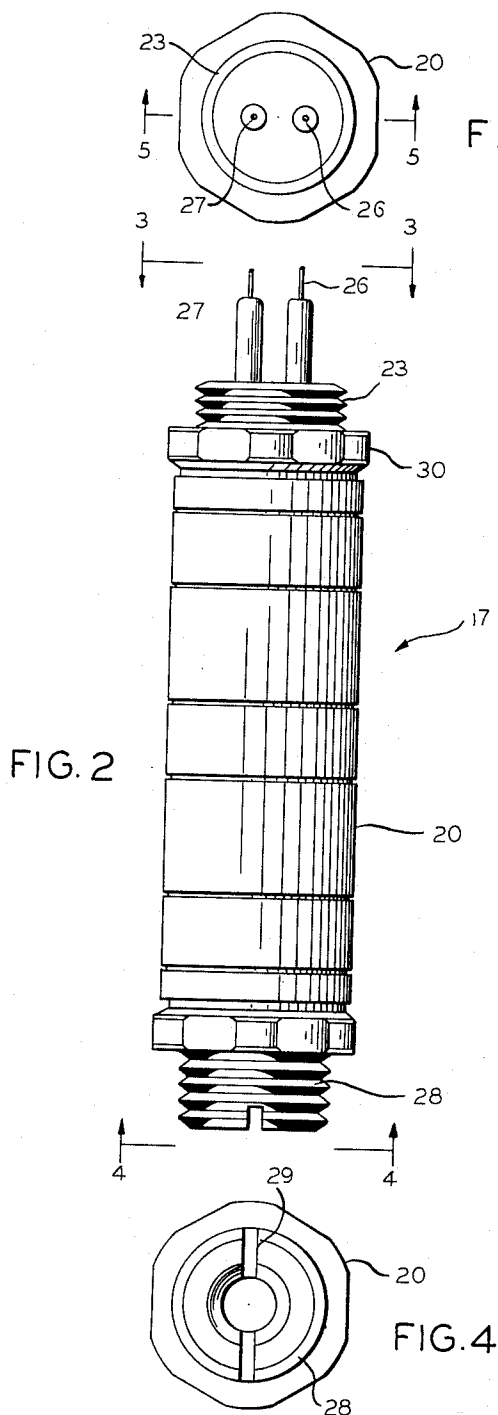


FIG. 3

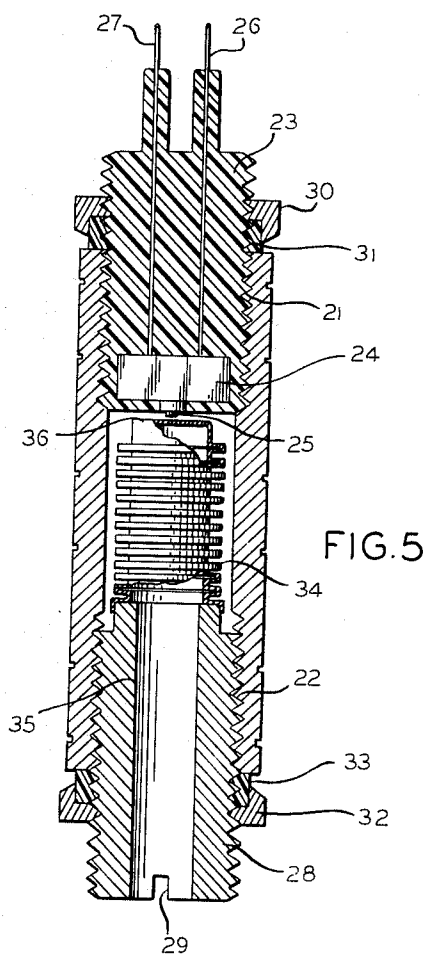


FIG. 5

INVENTORS
ALBERT L. POTTS
WILLIAM T. RUDY
BY NELSON W. WILLIAMS

ATTORNEYS

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LEVEL CONTROLLED PUMPING SYSTEMS AND SWITCH ASSEMBLIES THEREFOR

William T. Rudy, Henderson, Ky., and Nelson W. Williams and Albert L. Potts, Evansville, Ind., assignors to Albert Products, Inc., Henderson, Ky.

Filed Feb. 13, 1961, Ser. No. 88,858

5 Claims. (Cl. 103—25)

The present application is directed to control systems and is particularly concerned with improvements in the control of the motor drive for oil well pumps.

Pump actuators may take any one of several known forms. Pumps used for producing liquid from subterranean areas, for example, may be in the form of a reciprocating rod which is actuated by the customary walking beam which is, in turn, driven by a gasoline or electric motor. In some wells a pump and motor assembly may be immersed in the producing strata, while in other wells electric motor and pump assemblies may be positioned above ground so as to lift the fluid in the subterranean producing strata. In pumps of this type it is the common thing to find the subterranean pressure conditions such that a certain amount of oil or liquid flows into the cavity surrounding the intake facility of the pump, while the pump usually has sufficient capacity to remove this body of oil or liquid and empty the cavity before the pressure conditions replenish this cavity.

Since the operation of the pump should be terminated when the cavity within which the intake facility of the pump is working is empty, so as to avoid unnecessary wear and tear of the pumping facilities, some systems have been proposed which are responsive to the presence of liquid within the cavity to start operation of the pump and responsive to the lack of liquid for terminating operation of the pump. An example of this type of system is found in Urmann et al., U.S. Patent No. 2,690,713.

A number of problems arise in connection with systems of this type. In the first place the subterranean pressure conditions are at times extremely high and may be as high as one thousand pounds per square inch, which may adversely affect switch gear or other mechanisms. For this reason, any mechanisms disposed in the cavity must have the ability to withstand such pressures. In the second place, if an electrical system is used, the possibility of fire due to the electrical network is an ever present possibility so that any electrical system must be adequately safeguarded against such possibility. In the third place, the mechanism must be such that it does not disturb the normal operation of the well and is sufficiently compact and stable that it is not damaged by normal well operation.

The present invention has for its major purpose, the provision of control facilities of this class which adequately withstand pressures within the well, make adequate safeguard against fire, are easily disposed at any given level within a shaft of a well so as to enable easy use of the system at any level, are adequately safeguarded against interference with the pumping facilities, and which at the same time are compact, rugged and simple to manufacture.

An important and related purpose of the invention is the provision of a switch assembly which is "level" responsive and actuated by a column of liquid within the assembly, and formed in such a way as to fully protect the switch contact elements from high pressures imposed on the exterior of the assembly.

Other purposes will appear from time to time in the course of the ensuing specification and claims when taken with the accompanying drawings in which:

FIGURE 1 is a diagrammatic view of a typical well employing control facilities of the present invention;

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FIGURE 2 is a side view of one switch element utilized in the present invention;

FIGURE 3 is an end view of the switch illustrated in FIGURE 2;

FIGURE 4 is a bottom view of the switch assembly illustrated in FIGURE 2;

FIGURE 5 is a sectional view taken on the section lines 5—5 in FIGURE 3 and illustrating the switches of FIGURES 2, 3 and 4; and

FIGURE 6 is a diagrammatic view of the control circuit which is used in the present invention.

Like elements are designated by like characters throughout the specification and drawings.

Referring specifically now to the drawings and in the first instance to FIGURE 1, the numeral 10 designates an oil well shaft which extends from the ground level 11 down to the producing strata which is diagrammatically represented at 12. The customary tubing 13 extends downwardly within the shaft 10 and carries pumping facilities 14 at the lower end thereof. The pumping facility 14 and the actuator therefor may be any one of several forms. While the drawing represents a reciprocating type of pump it should be understood that this showing is merely representative of any one of many forms of pumps, as long as the intake of the pump is located at the producing level of the shaft as is illustrated in FIGURE 1.

In wells of this type fluid flows into the shaft and may reach an upper level 15 which may be assumed to be the maximum level desired in the shaft and a lower level 16, which may be assumed to be a minimum level at which time the operation of the pump should be discontinued to avoid damage to the pump and actuator.

A first switch assembly 17 is located near the upper level 15 and a second switch assembly 18 is located near the lower level 16. Each of the switch assemblies 17 and 18, will be described in greater detail in ensuing portions of this specification. Each includes control leads leading to control circuitry diagrammatically represented at 19 in FIGURE 1. The control circuitry 19 shown in FIGURE 1 should be taken as representative of controls for electric motors for pumps of varying classes as has been described previously.

Each of the switch assemblies 17 and 18 are identical and for this reason only one such assembly will be described in detail. Each assembly includes an elongated tubular body 20 which may be formed from metal such as brass. The tubular body 20 included threaded portions 21 and 22 at the upper and lower ends of the tubular opening within the body. A plastic plug, which may, for example, be made of nylon as shown at 23 and is threadably received by the threads 21 at the upper end of the body. The plug 23 has a microswitch 24 embedded within the body thereof. Microswitch 24 includes an actuating button 25 projecting downwardly beyond the lower end of the plug 23. Electrical lines 26 and 27 are adapted to be closed and opened by the operation of the switch 24 so as to actuate a relay and control the operation of the pump in a manner to be explained more fully hereafter.

The lower end of the body 20 has a threaded tubular plug 28 engaged with the threads on the lower portion of the body. The lower end of the plug 28 may include a slot 29 so as to receive a screwdriver blade for rotating the plug 28 within the body and adjusting the plug 28 longitudinally of the body.

The plug 23 at the upper end of the body is locked in position by a sealing nut 30 which is threaded onto the exterior of the plug 23 and in pressure engagement with a plastic seal 31. The lower end of the body is sealed by a nut 32 which is threaded onto the exterior of plug

28 and in pressure engagement with plastic seal 33 which bears against the lower end face of body 20.

The sealing rings 31 and 33 may be made of a plastic such as "Teflon."

The plug 28 has a metallic bellows 34 fixed on the inner end thereof and in communication with a passageway 35 extending longitudinally through the body of the plug. The bellows 34 is sealed onto the inner end of the plug 28 and is positioned so that the end face 36 thereof upon longitudinal flexing of the bellows, may contact the switch actuating member 25. The relative position of the bellows with respect to the switch actuating member 25 may be adjusted by simply turning the plug 28 so as to move the end face 36 of the bellows toward and away from the actuating member 25. The bellows, as thus formed, is adapted to receive a column of liquid from the exterior of the switch assembly and through the passageway 35 which opens through the lower end of the body and is in communication with the interior of the bellows. At the same time the interior of the body 20 is sealed from the exterior so as to prevent liquid from reaching the interior face of the body and the region adjacent to the microswitch 24.

The switch assemblies 17 and 18 are easily mounted in the positions illustrated in FIGURE 1 by simply strapping the bodies of the switch assemblies onto the pump delivery tube 13 which is disposed within the well shaft.

Each of the switch assemblies 17 and 18 are adapted, when closed, to energize low voltage relays 37 and 38, respectively, which receive energy from a stepdown transformer 39 which in turn receives energy from two lines of the three phase supply for motor 40 which drives the pump. Control switch 41 is in circuit with the switch 37a of the relay 37. When relay 37 is energized by the closing of switch 17, motor relay 42, which is placed across two of the three motor current supply lines, and in circuit with switch 37a, closes the contactor switches 42a, 42b and 42c so as to close the motor supply circuit and start the motor.

Switch 38a of relay 38 is in a parallel circuit with switch 37a, but this circuit includes a switch 42d which is closed by the energization of relay 42, so that this circuit is ineffective except when relay 42 has been energized by switch 37a.

When the level of fluid in the well is at the maximum point or that indicated at 15 in FIGURE 1 both switches 17 and 18 are closed with the result that the motor 40 is energized and the operation of the pump is started and continued. When the level of fluid in the well falls below the switch assembly 17, this switch opens but the closure of the switch 18 keeps the motor in operation, due to continued energization of relay 42 by the circuit of switch 37a. When the level of the fluid in the well has dropped down to the point approximately the level 16, the weight of this fluid is insufficient to force the bellows 34 of the switch assembly 18 against the actuating member 25 with the result that the end face 36 of the bellows moves away from the actuating member 25 and opens the switch assembly 18. When both switches 17 and 18 are open, the circuit to relay coil 42 is broken and the motor is stopped, thus stopping operation of the pump.

When the fluid in the well again fills up beyond the level designated at 16, switch assembly 18 will be closed but the switch 38a, which is closed as a result thereof, will not in and of itself cause the starting of motor 40. However, when the fluid builds up to a level generally designated at 15 in FIGURE 1, switch 17 is also closed and operation of the motor is then initiated.

Thus the system is such that the pump is never operated in a "dry" condition of the well, thus saving wear and tear on the pump and motor assembly. The operation of the pump is only commenced when there is sufficient fluid in the well to enable operation of the pump for a relatively long period of time.

Since the switch assemblies 17 and 18 operate on very

low voltage, the possibility of fire in the well is minimized. The switch assemblies are not adversely affected by pressure conditions in the well since the switches 24 are thoroughly sealed within the switch bodies 20.

The switch assemblies may be adjusted for different operating conditions merely by rotating the plugs 28 thereof so as to adjust the distance between the operating end face of bellows 34 and the switch actuator 25. The switches are responsive to the column of liquid which is forced upwardly within the passageway 35 and hence the switches are only actuated when the height of the liquid on the exterior of the switch is greater than the height of the end face 36. Since the resilient bellows offers resistance to the column of liquid therewithin, the switch may be adjusted so that it is actuated only when the level of fluid on the exterior of the assembly is at a predetermined point. For example, if it is desired to close the switches 24 when the level of fluid on the exterior of the switch approximates the level of the actuating member 25, then plug 28 is adjusted so that it is closely adjacent to the actuating member 25 as appears in FIGURE 5. If it is desired that the switch only be actuated when the level on the exterior of the assembly is at a much greater height then plug 28 is rotated to withdraw end face 36 from actuating member 25 and leave a much greater gap therebetween.

Whereas we have shown and described an operative form of the invention, it should be understood that this showing and description thereof should be taken in an illustrative or diagrammatic sense only. There are many modifications in and to the invention which will fall within the scope and spirit thereof and which will be apparent to those skilled in the art. The scope of the invention should be limited only by the scope of the hereinafter appended claims.

We claim:

1. A control system for pumps adapted to be submerged in a body of liquid including pumping means and conduit means leading therefrom to a position upwardly thereof, power actuating means for said pumping means and operatively associated therewith, and a switch assembly formed and adapted to cause actuation of said power means, said switch assembly including a tubular body positioned at the general level of the intake of said pumping means and a switch encased within an insulating body, said insulating body being positioned within said tubular member, said switch being connected to said actuating means, said switch having a downwardly disposed actuating member, said tubular body having an interior open ended tubular body disposed therewithin, said interior tubular body having a closed upper end disposed adjacent said switch actuating member and having an open end at the lower end of said tubular body whereby liquid may enter said inner tubular member, said inner tubular member having flexible portions adapted to flex with the movement of a body of liquid therewithin so as to move against said switch actuating member and cause actuation of said power means in accordance with the liquid condition within said inner tubular member, and at the general level of said pump intake.

2. A liquid level actuated switch assembly including an elongated tubular body having an insulating plug closing one end thereof and an inner tubular member threadably engaged with and within the other end of said body and closing said other end, a switch imbedded within said insulating plug and having an actuating member extending beyond the end of said plug and within said tubular body, said inner tubular member having a flexible portion within said tubular body and adapted to flex against said actuating member in accordance with pressure conditions within said inner tubular member, and sealing means between said other end of said tubular body and said inner tubular member to seal the space between said flexible portion and the inner portion of said tubular body which contains said switch actuating member from the

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exterior, said flexible portion being tubular and open to the exterior through said other end of said tubular body while having a closed end adjacent said switch actuating member.

3. The structure of claim 2 wherein said sealing means includes a nut threadably engaged with said inner tubular member at said other end of said outer tubular body and a Teflon washer carried by said nut and bearing against said other end of said outer tubular body. 5

4. The structure of claim 2 wherein said switch includes leads extending outwardly from the outer end of said insulating plug. 10

5. The structure of claim 2 wherein said insulating plug is threadably mounted in said tubular member and sealing means are provided between said plug and the first named end of said tubular body, said sealing means comprising a nut threadably mounted on said plug and a 15

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washer carried by said nut and engaged by said nut and said first named end of said tubular body.

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