April 11, 1961 T. C. JOHNSON, SR 2,979,583

FLOAT OPERATED SWITCH

Filed May 14, 1959

Fig. 1.

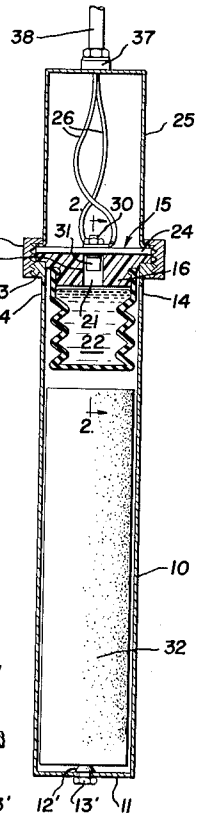


Fig. 2.

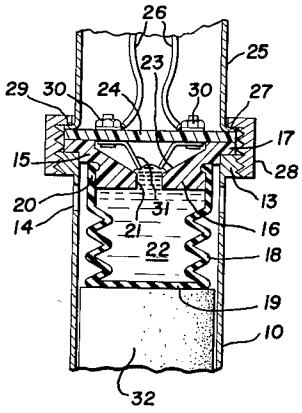


Fig. 3.

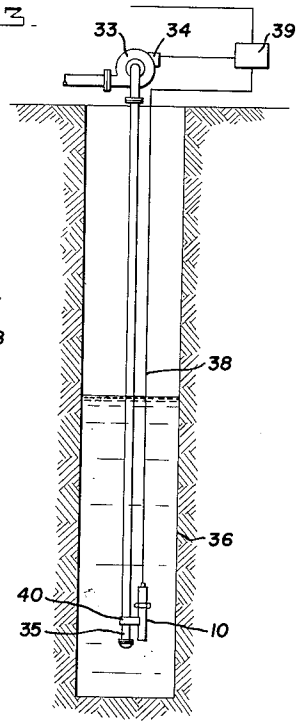
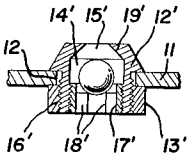


Fig. 7.



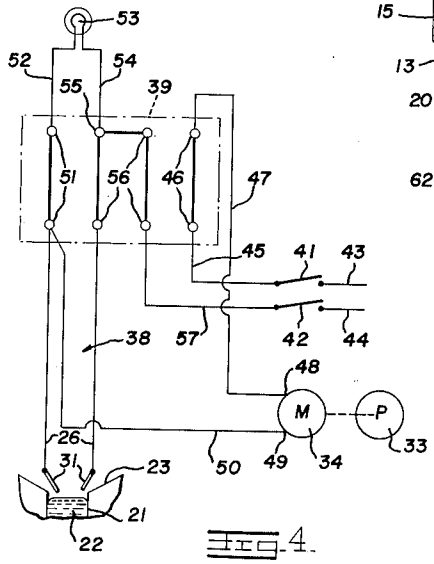


Fig. 4.

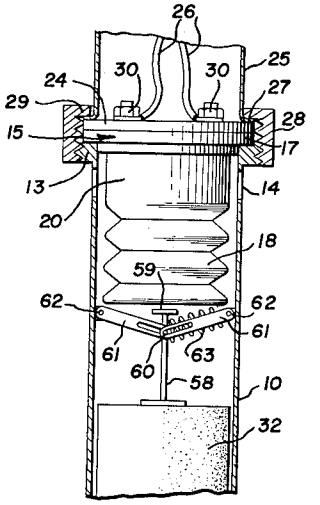


Fig. 5.

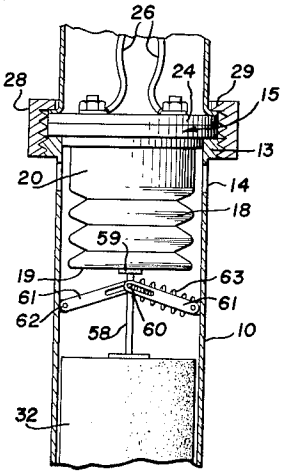


Fig. 6.

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FLOAT OPERATED SWITCH

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The present invention relates to float operated switches, and more particularly to a float operated mercury switch for controlling and protecting well pumps and the motors of pumps and the like.

A primary object of the invention is to provide a float operated mercury switch which is highly simplified in construction, compact, reliable and efficient in operation, and economical to manufacture.

A further object of the invention is to provide a float operated switch which may be attached directly to the foot valve of a well pump or suspended at the desired elevation in the well independently of the foot valve.

A further object is to provide a float operated mercury switch which is adapted to a wide variety of applications other than the preferred application or use of the switch in conjunction with a well pump and motor.

Other objects and advantages of the invention will be apparent during the course of the following description.

In the accompanying drawings forming a part of this application and in which like numerals are employed to designate like parts throughout the same,

Figure 1 is a central vertical longitudinal section through a float operated mercury switch according to the invention.

Figure 2 is an enlarged fragmentary central vertical section taken on line 2—2 of Figure 1.

Figure 3 is a side elevation, partly diagrammatic, showing the float operated switch mounted upon the foot valve of a well pump.

Figure 4 is an electrical wiring diagram showing a possible circuit which includes the float operated switch.

Figure 5 is an enlarged fragmentary vertical section through a modified form of float operated mercury switch having a snap action device.

Figure 6 is a view similar to Figure 5 with the snap action device shown in the active position for compressing the bellows containing the mercury.

Figure 7 is an enlarged fragmentary vertical section through a float check valve at the bottom of the casing.

In the drawings, wherein for the purpose of illustration is shown a preferred embodiment of the invention, the numeral **10** designates an elongated casing or cylinder formed of metal, plastics material or the like and having a bottom wall **11** provided with a central opening **12**, Figure 7. The upper end of the cylinder **10** is formed open, and adjacent to such upper end the cylinder has an integral screwthreaded external flange **13**, as shown. The cylinder **10** is provided near and below its upper end with two or more ports **14** for a purpose to be described.

A float check valve casing **12'**, Figure 7, is secured within the opening **12** of bottom wall **11** by means of a lock nut **13'** or the like. The check valve casing has a chamber **14'** with a restricted opening **15'** at its upper end and communicating with the interior of cylinder **10**. A float ball check valve element **16'** of lightweight material adapted to float in water is arranged captively within the chamber **14**, and an insert **17'** within the lower tubular portion of the casing **12'** has a plurality of spaced internal ribs **18'** which engage the ball check valve element **16'** to prevent it from falling out of the casing **12'** but allow the passage of water through the casing **12'** when the ball is engaging the ribs **18'** as in Figure 7. When the ball **16'** floats upwardly in the chamber **14'** and engages the conical seat **19'** afforded by the restricted opening **15'**, the ball will seal the opening **15'** so that water cannot flow through the casing **12'**.

A cap **15** of insulating material rests upon the upper end of the cylinder **10** and has a reduced body portion **16** projecting downwardly into the cylinder and terminating adjacent the ports **14**, as shown. The cap **15** has an upper marginal flange **17** which engages the top of the screw-threaded flange **13** of cylinder **10**. A resilient accordion-pleated bellows **18** formed of insulating rubber-like material is provided within the upper portion of the cylinder **10**, and this bellows has its lower end closed by a wall **19** formed integral therewith. The upper cylindrical neck portion **20** of the bellows is firmly secured around the cylindrical body portion **16** in any preferred manner, so as to form a fluid tight joint therewith.

The body portion **16** of cap **15** has a central opening **21** formed through its lower end, communicating directly with the interior of bellows **18**, which contains a body of mercury **22**. Above the opening **21**, the cap **15** has an enlarged upwardly flaring cavity **23** extending through the top of the cap **15** and extending upon opposite sides of the opening **21** in two directions, as shown in Figure 2. As shown in Figure 1, the cavity **23** may have the same width as the opening **21** in the direction at right angles to Figure 2. The diameter of the opening **21** is considerably smaller than the internal diameter of the bellows **18**, so that upward compression of the bellows for a slight amount will cause the mercury **22** to rise rapidly through the opening **21** and enter the cavity **23**.

Mounted upon the top of the insulating cap **15** and covering the cavity **23** is a circular flat insulating plate **24**, preferably of the same diameter as the flange **17**. A metallic cylindrical shell or cover **25** for wires **26** is mounted upon the insulating plate **24** and extends above the cylinder **10** as shown in Figure 1. The shell **25** has an integral marginal flange **27** at its lower end, preferably having the same diameter as the insulating plate **24** and abutting the latter. A tubular coupling nut **28** is provided for rigidly connecting the flange **27**, plate **24** and the flanges **17** and **13** in abutting relation, Figure 2, and the nut **28** has screw-threaded engagement with cylinder flange **13**. The top of nut **28** has an inwardly directed annular flange **29** which engages the flange **27** in clamping relation, as shown. A fluid tight connection is thus provided between the insulating plate **24** and the flange **17**.

A pair of spaced electrical terminals **30** are bodily mounted upon the insulating plate **24** in alignment with the underlying cavity **23**, and a pair of depending switch contact elements **31** are electrically connected with the terminals **30** at the bottom side of the plate **24**, as shown in the drawings. The contact elements **31** are of strip-like formation, and project downwardly in the recess **23** and have their lower ends terminating near the slightly above the reduced opening **21**. The contact elements **31** preferably extend across a major portion of the width of cavity **23** as shown clearly in Figure 1. The arrangement is such that when the bellows **18** is compressed upwardly as in Figure 2, the mercury **22** will rise through the opening **21** and bridge the contacts **31** near the bottom of the cavity **23**, Figure 2.

An elongated cylindrical float **32** is disposed within the cylinder **10**, below the bellows **18**, and this float has a guided fit within the cylinder so that it may rise and fall with the water level in a well or the like. The upper end of the float **32** is adapted to directly contact the bottom

wall 19 of bellows 18 to compress the bellows as the water level rises. When the float moves downwardly as in Figure 1, its top end becomes spaced from the bellows and the bellows returns to its normal expanded condition and the mercury 22 falls below the opening 21 so that the contacts 31 are no longer bridged by the mercury.

Figures 3 and 4 of the drawings illustrate the use of the float operated switch in connection with a well pump 33, having a motor 34 and the usual foot valve 35, located within the well bore 36, Figure 3. The wires 26 leading from terminals 30 extend through an opening in the top wall of shell 25 and have a fluid tight connection with the shell at 37. Above the shell 25, the wires 26 constitute a two wire cable 38 having a water-proof sheathing of rubber or the like. The cable 38 leads upwardly to and is electrically connected with pump motor control means 39, Figure 3. The cylinder 10 of the float operated switch is directly secured to the foot valve means 35, as at 40 in Figure 3. If preferred, the float-operated switch may be supported independently of the foot valve by suspending the same upon its water-proof cable 38 at the desired elevation.

As shown in Figure 4, the control circuit for the pump motor 34 may comprise a fused disconnect switch, having switch contacts 41 and 42, connectable across a power line having wires 43 and 44. The contact 41 is connected through a wire 45 with terminals 46 of control box 39, and a further wire 47 leads from the control box to one terminal of the motor 34 as at 48. The other terminal 49 of the pump motor is connected through a wire 50 with terminals 51 of the control box 39, and a wire 52 leading from one of the terminals 51 is connected in series with the filament of a pilot light bulb 53. Another wire 54 leads from the light bulb filament to another terminal 55 of the control box 39, which control box has additional terminals 56 electrically connected as shown. The wires 26 of cable 38 leading from the float switch contacts 31 are electrically connected with a pair of the terminals 51 and 56, as shown in Figure 4.

The float switch contacts 31 are thus connected in series with the filament of pilot light bulb 53. When the water level in the well bore 36 is above the elevation of the foot valve 35 and float operated switch, the latter is entirely submerged and the water may enter the ports 14 and fill the cylinder 10, causing the float 32 to rise and contact the bellows 18. This will compress the bellows upwardly, Figure 2, and the mercury 22 will rise into the cavity 23 and bridge the contacts 31. The disconnect switch 41—42 is now closed and the motor 34 is energized to operate the pump 33, and water is being pumped from the well 36. Current flows from the wire 43 through the wires 45 and 47 to the electric motor 34, and from the motor through the wire 50 to contact 51, and from this contact through one of the wires 26, and across the switch contacts 31 which are bridged by the mercury 22. The current now flows through the other wire 26 and through the contacts 55 and 56 and a further wire 57 back to the other wire 44 of the power line. While the float switch contacts 31 are thus closed or in circuit with the motor, the pilot light bulb 53 is off, and the operator knows that the water level in the well is adequately high to allow the pump to run without losing its prime or without damaging the pump or its electric motor.

When the water level in the well 36 becomes lowered to a level where it is unsafe to continue pumping water, the float 32 will descend in the cylinder 10 until the float is free of the mercury filled bellows 18, and the bellows will expand downwardly so that the mercury 22 will fall below the level of the cavity 23 and open the circuit through the float switch contacts 31. When this occurs, the pump motor 34 is shut off, and current will now flow through the filament of the pilot light bulb 53 to indicate that the water level is too low for safe pumping and that the pump has been shut off. When the water level in the well again rises sufficiently, the pump motor willl begin to operate and the pilot light bulb 53 will again be off.

With reference to the float check valve shown particularly in Figure 7, when the water level in the well is lowered and drops below the upper end of float cylinder 10, the pressure of the water inside of the cylinder 10 forces the ball check valve element 16' downwardly or away from the seat 19', allowing the water level in the cylinder 10 to drop approximately with the outer water level until the float operated switch stops the pump in the manner previously described. This allows the water level in the well to rise again, but as the water levels within and exteriorly of the cylinder 10 are substantially equalized, the float ball check valve element 16' rises and engages the conical seat 19' for sealing the passage 15'. This prevents further water from entering the lower end of cylinder 10. When the water level of the well now rises to the level of the ports 14, it will enter these ports and quickly fill the cylinder 10 for starting the pump again.

The described arrangement furnishes a differential between the pump stopping and starting water levels in the well. This differential may also be varied by making the cylinder 10 longer or shorter. It is evident that in a dug or bored well due to its relatively greater diameter this differential action above described need not be as great as for a smaller diameter drilled well. The desired differential is also governed to some extent by the flow of the well and the rate of pumping.

The feature of the float check valve at the bottom of the cylinder 10 is optional and may be omitted in some cases, if preferred, and in such cases, the opening 12 of bottom wall 11 will still be provided.

In Figures 5 and 6 there is shown a slight modification of the float operated switch for imparting to the same as quick or snappy action. To this end, the top of the float 32 is rigidly connected with a vertical bellows-actuating pin 58, having a head 59 for direct contact with the bottom wall of bellows 18. The pin 58 carries a transverse extension 60, slidably connected with a pair of slotted links 61 having their outer ends pivoted at 62 to the side wall of cylinder 10. A coil spring 63 is connected with one pivot 62 and with the pin extension 60 for causing the actuating pin 58 to move upwardly rapidly toward contact with the bellows, when the links 61 pass the horizontal dead center position while the float is rising. When this occurs, the bellows 18 will be compressed upwardly with a quick or snappy action, and the switch contacts 31 will be bridged by the mercury 22 much more quickly than would be the case where the bellows is compressed by the natural rising of the float 32 without any snap action means. All other parts of the float operated switch, Figures 5 and 6, are identical in construction and operation to the corresponding parts shown and described in the prior form of the invention, Figures 1 and 2.

When the water level in the well is falling, and the float 32 is descending in the cylinder 10, Figures 5 and 6, the operating pin 58 will move downwardly and disengage the bellows with a snappy action, once the links 61 have moved by horizontal dead center. This will disconnect or open the switch contacts 31 with a quick action.

It is to be understood that the forms of the invention herewith shown and described are to be taken as preferred examples of the same, and that various changes in the shape, size and arrangement of parts may be resorted to, without departing from the spirit of the invention or the scope of the subjoined claims.

Having thus described my invention, I claim:

1. A float operated mercury switch comprising an elongated tubular body portion having opening means near its upper and lower ends, a cap element mounted upon the upper end of the body portion and having a recess formed in its top and an opening communicating with said recess and extending through the bottom of said cap, a bellows secured to said cap and depending therefrom

and having a bottom wall, said bellows disposed within the upper portion of the tubular body portion and having its interior communicating with said opening of the cap, a body of mercury within said bellows and adapted to rise through said opening of the cap when the bellows is compressed upwardly, a float arranged within said body portion below the bellows and adapted to rise and fall relative to the bellows and to compress the bellows upwardly while rising, a cover plate for the top of said cap extending over said recess, a pair of electrical terminals secured to the cover plate, a pair of electrical contacts connected with said terminals and depending from the cover plate and disposed within said recess above the opening of the cap to be bridged by the mercury when the mercury rises through said opening of the cap, and wires connected with the leading from said terminals of the cover plate.

2. A float operated switch comprising an elongated cylinder having a bottom wall provided with an opening, said cylinder having a side opening near its upper end, a cap formed of insulating material mounted upon the upper end of said cylinder and having a recess in its top and a central opening formed through its bottom communicating with said recess, a bellows dependingly secured to said cap within the upper portion of said cylinder and having a bottom wall, the interior of the bellows communicating with said opening of the cap, a body of conducting fluid within said bellows adapted to rise through said opening of the cap and to enter said recess when the bellows is compressed upwardly, a float disposed within said cylinder below said bellows and adapted to compress the bellows when rising, an insulating cover plate mounted upon said cap and covering the top of said recess, a pair of electrical terminals secured to said cover plate, a pair of contact elements connected with said terminals and depending from the cover plate and disposed within the recess of the cap and above the opening of the cap, wires connected with said terminals and extending above the cover plate, a cylindrical shell mounted upon said cover late and enclosing said wires, and detachable clamping means connected with the upper end of said cylinder and engaging said shell and serving to clamp the shell against the cover plate and to also clamp the cover plate to said cap and the cap to the upper end of said cylinder.

3. A float operated switch comprising a tubular guide to be supported vertically during use and having opening means near its upper end, means forming a chamber for an electrical conducting fluid upon the top of said tubular guide, a bellows containing a body of said conducting fluid dependingly secured to said means within the upper portion of the tubular guide and communicating with the chamber of said means, a float mounted within the tubular guide below said bellows and adapted to move vertically and to contact the lower end of said bellows to compress the same upwardly, switch contact means mounted upon said means and projecting into said chamber for contact with the conducting fluid when such fluid rises into said chamber, conductor means connected with and leading from the switch contact means, and an upwardly closing float check valve for the lower end of the tubular guide to provide a differential in the operation of power-operated means to be controlled by the float operated switch.

4. A float operated switch according to claim 3, wherein said tubular guide includes a bottom wall having an opening, and wherein said check valve comprises a sleeve secured within said opening and defining a chamber having a restricted opening at its uper end communicating with the interior of the tubular guide, said restricted opening forming a tapered valve seat, a buoyant check valve element arranged within the chamber of said sleeve and adapted to float into sealing engagement with said tapered valve seat, and projection means on said sleeve engageable with said check valve element to prevent the same from dropping out of said sleeve and allowing the passage of fluid upwardly through said sleeve and around the check valve element.

5. A float operated switch comprising, a generally vertical guide device, means forming a chamber mounted upon the guide device, a bellows mounted within the guide device and having its interior in communication with said chamber, a body of conducting fluid mounted within the bellows, a float mounted within the guide device below the bellows and adapted to bear against the bellows to compress it when the float rises, a snap action device connected with the float to move it in either direction when the snap action device is shifted past dead center, contact elements extending into said chamber, and conductors connected with the contact elements.

6. A float operated switch comprising, a generally vertical guide device, means mounted upon the upper portion of the generally vertical guide device and having a chamber and a relatively large opening leading into the bottom of the chamber, a generally vertical bellows mounted within the upper portion of the generally vertical guide device and having its interior in communication with the relatively large opening, a generally vertical float mounted within the generally vertical guide device and serving to compress the generally vertical bellows when the float rises, a body of conducting fluid mounted within the bellows and adapted to be moved through said opening in the chamber upon the upward movement of the bellows and to move out of the chamber when the bellows moves downwardly, and spaced contacts arranged within the chamber to be electrically connected by the body of conducting fluid when said body moves into the chamber.

7. A float operated switch comprising, a generally vertical guide device, a cap formed of insulating material mounted upon the upper end of the generally vertical guide device, said cap having a generally vertical chamber and a relatively large opening leading into the bottom of the chamber, said cap including a lower reduced portion, a generally vertical bellows having its lower end closed and its upper end open and receiving the reduced extension and secured thereto, said bellows surrounding said opening and being in communication therewith, a body of conducting fluid held within the bellows and forced through the relatively large opening into the chamber when the bellows is vertically compressed, a float arranged within the generally vertical guide device to engage and compress the bellows, spaced contacts arranged within the chamber, and means to mount the contacts upon the cap.

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