Aug. 28, 1962 B. L. BINFORD 3,051,805

ELECTRIC SWITCH CONTROL MEANS

Filed March 9, 1959 2 Sheets-Sheet 1

Fig. 1

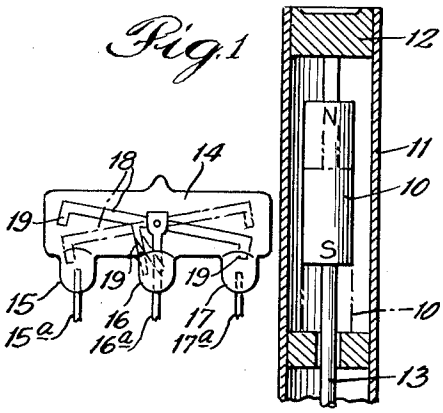


Fig. 2

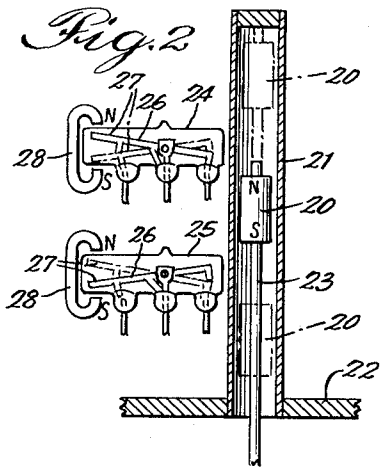


Fig. 3

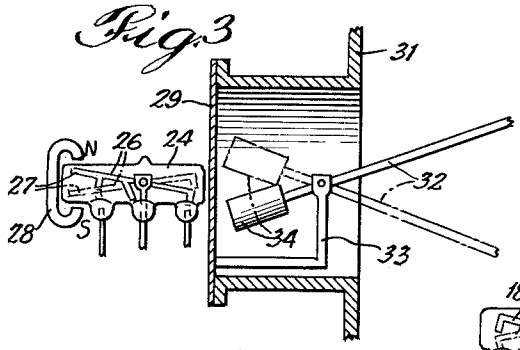


Fig. 4

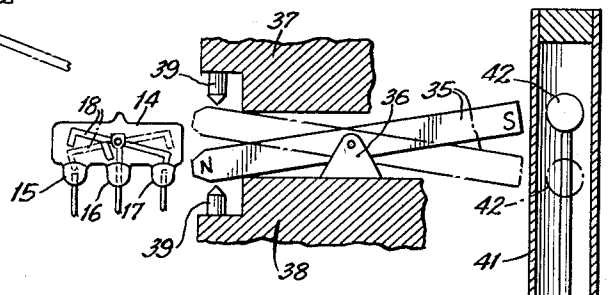
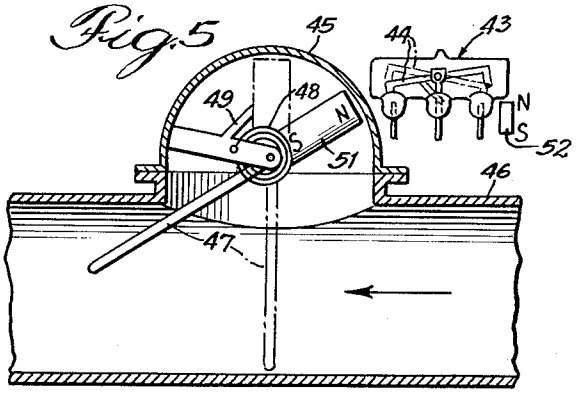


Fig. 5



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Fig. 6

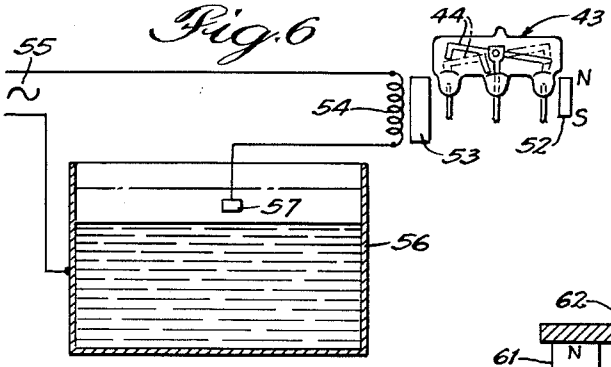


Fig. 7

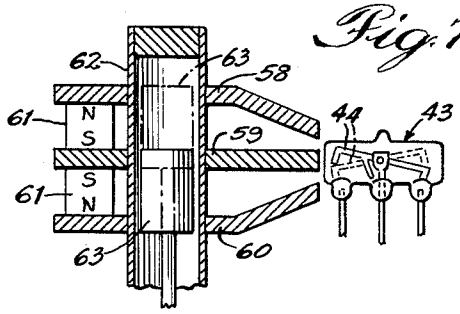


Fig. 8

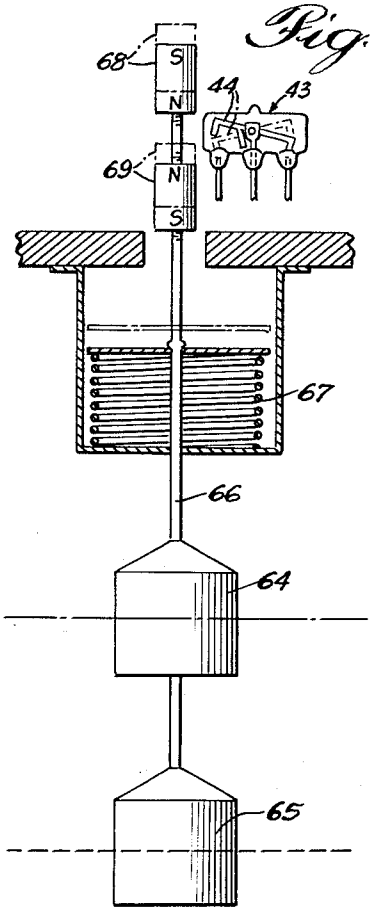
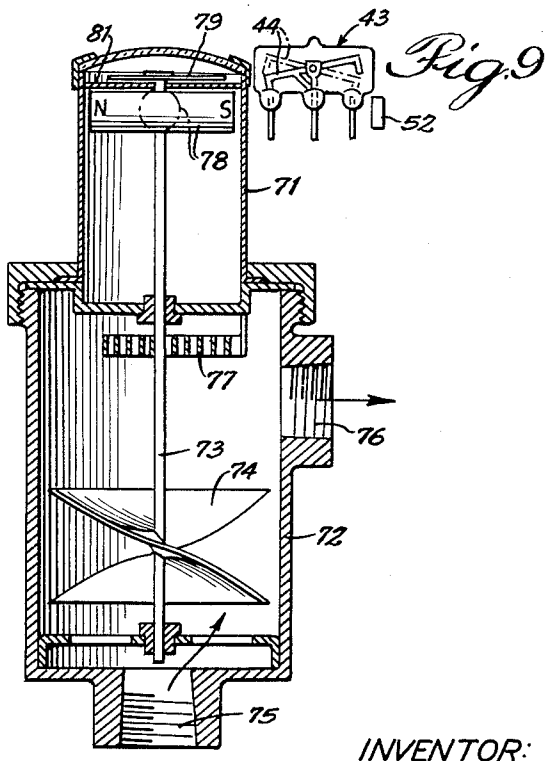


Fig. 9



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ELECTRIC SWITCH CONTROL MEANS

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1 Claim. (Cl. 200—87)

This invention relates to electric switch control means and more particularly to magnetic operating means for electrical switches and to a novel switch construction for magnetic operation.

Many different types of magnetically operated switches have heretofore been proposed and have found a relatively wide acceptance in industry. The present invention relates to improvements in magnetically operated switch mechanisms and has for one of its objects the provision of electric switch control means in which all of the moving parts of the switch are enclosed in a sealed envelope and are operated by varying magnetic forces outside of the envelope.

Another object is to provide electric switch control means in which the switch includes a contact pivoted on a horizontal axis in a sealed envelope and which is tilted to different positions about its axis to make and break control circuits by varying magnetic forces outside of the envelope.

According to a feature of the invention, the varying magnetic forces are produced by moving a permanent magnet vertically adjacent to one end of the envelope, by moving a magnetic pole toward and from one end of the envelope, by selectively shunting vertically spaced gaps adjacent to one end of the envelope or by energizing and de-energizing an electromagnet adjacent one end of the envelope.

A further object is to provide electric switch control means in which the switch contact is normally urged to one position by a permanent magnet adjacent to one end of the envelope and is moved to its other position by a variable magnetic force at the other end of the envelope.

According to another feature of the invention, permanent magnetic poles may be mounted above and below the horizontal center of the envelope at one end thereof to hold the contact in either position it occupies and to cause the contact to move with a snap action.

The above and other objects and features of the invention will be more readily apparent from the following description when read in connection with the accompanying drawings, in which:

FIGURE 1 is a side elevation with parts in section of a magnetic switch control means embodying the invention; and

FIGURES 2 through 9, inclusive, are similar views showing alternatives and variations in the switch control means.

As shown in FIGURE 1, an electric switch is moved to either of two different positions to complete either of two different circuits by movement of a magnet adjacent to the switch. In this apparatus a permanent magnet, as indicated at **10**, having a north pole at one end and a south pole at its opposite end, is movably mounted in a tube **11** of non-magnetic material which is closed at its upper end by a plug **12**. The tube may be sealed at its lower end to a tank or similar container in which a float or other moving means, such as a diaphragm, is mounted and is connected to the magnet through a rod **13**. In this way, the magnet is moved vertically in the tube in response to variations in conditions in the container such, for example, as liquid level, fluid pressure, density, flow, or the like.

The switch, as shown, comprises a sealed envelope **14** of non-magnetic material, such as glass, which is preferably evacuated. The envelope, as shown, is horizontally elongated and is provided at its lower surface with three spaced cupped depressions **15**, **16** and **17** adapted to contain a conducting material, such as mercury. Contacts **15***a*, **16***a* and **17***a* extend sealingly through the material of the envelope into the conducting liquid to complete circuits therewith.

Contact **16***a*, as shown, may extend to approximately the vertical center of the envelope and may provide a horizontal pivotal mounting for an elongated contact **18**. The contact **18** may have downwardly extending projections **19** at its ends and adjacent its center to project into the pools of conducting liquid in the cupped depressions **15**, **16** and **17**, as shown. The center projection **19** will extend at all times into the conducting liquid in the center cupped depression **16** while the end projections **19** will selectively make contact with the conducting liquid in the cupped depressions **15** and **17** as the contact **18** is tilted in one direction or the other.

In operation of the apparatus, when the magnet **10** is in its raised position, as shown in FIGURE 1, the lower or south pole thereof will be closely adjacent to the end of the switch structure and below the horizontal center thereof. This pole will attract the adjacent end of the contact **18**, which is formed of magnetic material and tilt it clockwise to the full line position illustrated to complete a circuit with the fixed contact **17***a*.

As the magnet **10** moves down the lower pole thereof will move farther away from the end of the switch structure and the upper pole will approach the switch structure. At some point in the movement the upper pole will exert a greater attraction on the adjacent end of the contact **18** than the lower pole and the contact **18** will tilt counterclockwise to the illustrated dot-dash line position to break the circuit with the fixed contact **17***a* and to complete a circuit with the fixed contact **15***a*. It will be noted that once the contact **18** starts to move, it will complete its movement to its extreme tilted position rapidly to produce a snap action effect providing positive switch opening or closing without chattering.

In the construction shown in FIGURE 2, a magnet **20** similar to the magnet **10** is mounted in a tube **21** of non-magnetic material which opens at its lower end into a tank or container indicated at **22**. A float, diaphragm, or the like, in the tank or container **22** is connected to the magnet through a rod **23** to move it vertically. It will be noted that the magnet **20** is short relative to the length of the tube so that it can have a substantial movement in the tube.

Two vertically spaced switches **24** and **25**, which may be of identical construction, are mounted adjacent to the tube **21**, as shown. The switches **24** and **25** may be identical with the switch as described in connection with FIGURE 1 and will not be further described in detail. The one difference which may be desirable is to extend the pivoted contacts **26** at the end remote from the tube **21**, as shown at **27**, to provide armature portions for a purpose to appear more fully hereinafter.

A permanent U-shaped magnet **28** is mounted adjacent to the end of each of the switch structures remote from the tube **21** with one of its poles above and the other below the switch envelope in registry with the armature portion **27** of the pivoted contact.

In operation of this construction, when the magnet is in the centered position shown in full, the upper pole will attract the adjacent end of the switch contact **26** to tilt it clockwise to the position shown and the lower pole will attract the adjacent end of the lower switch contact **26** to tilt it counterclockwise. At this time, the right-hand circuit of the upper switch and left-hand circuit of the lower switch will be completed. Should the magnet move up to the upper dot-dash line position shown, the upper contact **26** of the upper switch will be tilted counterclockwise so

that the left-hand circuits of both switches will be completed. It will be noted that the contact of the lower switch will remain in the illustrated full line position at this time since its armature 27 is more closely adjacent to the lower pole of the associated magnet 28 than it is to the upper pole so that the switch contact will be held in position regardless of vibrations or other external forces. Also due to the effect of the permanent magnet and to the effect of the controlling magnet, as described in FIGURE 1, movement of either of the switch contacts from one position to the other will occur with a snap action.

Upon movement of the magnet 20 to the lower position shown, both switch contacts 26 will be tilted clockwise to complete the right-hand circuits of both switches with the permanent magnet 28 of the upper switch holding it in its clockwise tilted position due to the greater proximity of the armature portion 27 to the upper magnet pole than to the lower magnet pole.

FIGURE 3 illustrates a further alternative construction embodying a switch identical to the switches of FIGURE 2 and in which corresponding parts are indicated by the same reference numerals. This switch is mounted with the end thereof remote from the magnet 28 adjacent to a non-magnetic plate or closure 29 in a tank, or the like, partially indicated at 31. A rod 32 is pivoted on a horizontal axis on a bracket 33 in the tank and may be tilted from the full line to the dotted line position shown by a float or the like in the tank. The rod carries a permanent magnet 34 adjacent the closure plate 29 and which will be moved between its full and dotted line positions as the rod swings about its pivot.

In this construction, when the magnet 34 is in the lower position shown in full lines, it will tilt the contact 26 clockwise to complete the right-hand switch circuit. As the magnet moves toward its dotted line position, and after it passes above the right end of the switch contact, it will tend to tilt the switch contact counterclockwise. However, the switch contact will not move until the upward force exerted on the right end thereof by the magnet 34 exceeds the holding forces exerted on the left end thereof by the upper pole of the permanent magnet 28. As soon as this occurs, the contact 26 will start to turn counterclockwise causing the attraction of the upper pole of magnet 28 to decrease as attraction of the lower pole increases. The switch contact will therefore move to its extreme tilted position rapidly with a snap action effect even though the magnet 34 may not have been moved to either of its extreme positions, as shown.

FIGURE 4 illustrates a further magnetic operating means which can be used with either of the two types of switches heretofore described. As shown, the switch corresponds to that of FIGURE 1 and parts thereof have been indicated by the same reference numerals as in FIGURE 1. In this construction, an elongated bar magnet 35 is pivoted intermediate its ends on a bracket 36 and extends between upper and lower stop structures 37 and 38 formed of non-magnetic material. Armature pins 39 are carried by the non-magnetic structures 37 and 38 adjacent to one end of the bar magnet 35 and are of such a length and so positioned that when the bar magnet is in engagement with one of the stop structures, it is spaced from the adjacent armature 39 by a small air gap so that there will be no tendency toward sticking.

One end of the bar magnet 35 is swingable vertically adjacent to one end of the switch structure, as shown, and the opposite end lies adjacent to a non-magnetic tube 41 in which an armature 42 of magnetic material may be moved vertically by a float, diaphragm, or the like. When the armature 42 is in the elevated position shown, it will attract the adjacent pole of the bar magnet 35 to tilt it counterclockwise so that its opposite end is below the horizontal center of the switch structure. At this time, the switch contact 18 will be tilted clockwise, as shown, to complete the right hand circuit of the switch.

As the armature 42 moves down it tends to swing the adjacent end of the magnet 35 down. However, the magnet 35 will not turn immediately due to the magnetic attraction between its left end pole and the armature member 39. When sufficient magnetic force is created between the armature 42 and the adjacent end of the magnet 35, the magnet 35 will turn rapidly clockwise to the position shown in dot-dash lines due to its inertia and to the increasing attraction of the upper armature member 39 for its left end pole. Upward movement of the left end of the magnet will tilt the contact 18 counterclockwise to the dotted position shown with a snap action.

FIGURE 5 illustrates an application of the invention to a flow control or flow indicator. For this purpose a switch, indicated generally at 43, which may be either as shown in FIGURE 1 or FIGURE 2 and which has a tilting contact 44 may be employed. The switch is mounted adjacent to a semi-cylindrical housing 45 of non-magnetic material which is mounted on a flow conduit 46 flow through which is to be indicated.

For the purpose of indicating flow a vane 47 is pivoted concentrically within the cylindrical portion 45 and is urged to a vertical position, as shown in dot-dash lines, by gravity or by gravity aided by a light spring 48 which may be calibrated according to the desired flow. Movement of the vane counterclockwise beyond the vertical position is limited by a non-magnetic stop 49. At its upper end the vane connects a straight bar magnet 51, one of whose poles moves closely adjacent to the inner surface of the cylindrical housing 45.

When there is no flow through the conduit 46 the vane will move to the vertical dot-dash line position shown in which the magnet 51 is remote from the adjacent end of the switch 43. At this time, the contact 44 of the switch may be urged clockwise to complete the right-hand circuit therethrough by a permanent magnet 52 mounted adjacent to the right-hand end of the switch and below the switch envelope. The magnet 52 will attract the right-hand end of the switch downward to tilt it to the dot-dash line position shown. When flow in a predetermined amount occurs in the conduit the vane 47 will be swung upward and to the left to the illustrated full line position, bringing the magnet 51 adjacent to and below the horizontal center of the switch. The magnet 51 is more powerful than the magnet 52 and will attract the adjacent end of the switch contact 44 to swing it clockwise to the full line position shown. Due to the effect of the magnets with the field of magnet 51 increasing as it approaches the full line position and with the field of magnet 52 decreasing as the contact 44 starts to move the movement will occur rapidly with a snap action.

FIGURE 6 illustrates an alternative means of operating a switch, as shown in FIGURE 5, and parts of the switch in FIGURE 6 corresponding to like parts in FIGURE 5 are indicated by the same reference numerals. In this case, an electromagnet, including a core 53 and a winding 54 is mounted adjacent to and below the left end of the switch structure opposite to the magnet 52. The winding 54 may be energized from any desired power source, indicated at 55, to indicate variations in a condition, such as the level of a conductive liquid in a container 56. For this purpose, one side of the source 55 is connected to the container 56 and the other side is connected through the winding 54 to a contact 57 at a predetermined level normally above the level of liquid in the container 56.

In operation of this construction, when the level of liquid in container 56 is below the contact 57, as shown, there will be no flow through the electromagnet winding 54 and this magnet will be de-energized. At this time, the magnet 52 will tilt the switch contact 44 clockwise to the position shown in full lines. When the liquid in the container 56 reaches a level to contact the contact 57, a circuit will be completed through the winding 54 and the electromagnet will be energized. The electromagnet is more powerful than the magnet 52 and will

therefore tilt the contact 44 counterclockwise to the position shown in dot-dash lines to break the right-hand switch circuit and complete the left-hand switch circuit. The embodiment shown in FIGURE 7 may employ a switch structure similar to that of FIGURES 5 and 6 with or without the permanent magnet 52 and switch parts in this figure are indicated by the same reference numerals as in FIGURES 5 and 6. In this construction there are three vertically spaced magnetic armatures 58, 59 and 60 terminating in a pair of magnetic gaps respectively above and below the horizontal center of the switch structure and adjacent to one end thereof. Magnets 61, which may be permanent magnets or electromagnets, are arranged between the armatures 58, 59 and 60 and are poled as shown so that there will normally be equal magnetic fields across each of the gaps. The armatures 58, 59 and 60 are spanned by a tube 62 of non-magnetic material in which a magnetic armature 63 may be moved vertically in response to variations in a condition to be indicated or controlled. The armature 63 is of a length to span the gap between adjacent armatures 58, 59 and 60.

When the armature 63 is in the lower position, as shown, registering with the gap between armatures 59 and 60, it will effectively shunt the magnetic field between these two armatures so that the effect of this field on the switch will be negligible. The magnetic field between armatures 58 and 59 however will produce an attraction for the switch contact 44 and will tilt it clockwise to the position shown in full lines. As the armature 63 moves up to the dot-dash line position illustrated, it will shunt the field between armatures 58 and 59 leaving the field between armatures 59 and 60 effective to tilt the switch contact 44 counterclockwise to the position shown in dot-dash lines. In this construction also it will be noted that the switch contact will not move until the field in the gap then remote from it becomes sufficiently powerful to overcome the remaining field in the gap to which it is then adjacent so that once the contact starts to move, it will move to the full limit with a rapid snap action effect.

FIGURE 8 illustrates still another switch operating mechanism which can be employed with any of the switches described above and which is illustrated as employing a switch 43 similar to that of FIGURES 5 to 7. In this case also, the magnet 52 may or may not be employed, or a magnet similar to the magnet 28 of FIGURES 2 and 3 could be employed. However, under normal conditions, no switch magnet is essential and it has been omitted in FIGURE 8.

The construction of FIGURE 8 is particularly adapted for the control of liquid level in devices subject to relatively wide variations in liquid level, such as sump pumps, and the like. The apparatus, as shown, includes a pair of vertically spaced displacers 64 and 65 to control variations in level between the dotted and dot-dash lines illustrated. The displacers are connected by vertical control rod 66 which is urged upwardly by a balancing spring 67 and which extends adjacent to one end of the switch 43 and carries a pair of vertically spaced magnets 68 and 69 which may be spaced any desired distance on the rod 66 to obtain the desired control action.

When the level of liquid in the tank is at the low point indicated by the dotted line in which the lower displacer 65 is partially uncovered, the displacers will move the rod 66 downwardly against the balancing spring 67 to the position shown in full lines. In this position the lower pole of the upper magnet 68 is more closely adjacent to the switch contact 44 than the upper pole of the lower magnet and will swing the contact clockwise to the full line position shown. This may complete a circuit through the right side of the switch to an indicator to indicate that the level is at the low position or the right-hand circuit of the switch could be left blank, if desired. As the level increases to submerge the lower displacer 65, the effective displacer weight still will be great enough to hold the upper magnet in a position low enough to maintain the switch contact tilted clockwise. However, as the level reaches the dot-dash line position in which it partially submerges the upper displacer, the spring 67 will elevate the rod 66 and raise the magnets to approximately the position shown in dot-dash lines. At this time, the upper pole of the lower magnet will attract the adjacent end of the contact 44 and tilt it counterclockwise to complete a circuit through the left-hand side of the switch. This circuit may start a sump pump, or the like, to reduce the liquid level. It will be noted that as the rod 66 moves the field of one of the magnets is gradually increasing while the field of the other magnet is gradually decreasing. Therefore, when the magnet whose field is increasing exerts sufficient force to start the switch contact 44 to move it will move rapidly with a snap action to its extreme position in one direction or the other to complete or break the circuit positively with no fluttering. A control of the type illustrated is highly desirable for controlling such devices as sump pumps since all of the switch parts are fully enclosed and are not subject to corrosion which might interfere with proper switch operation.

The apparatus of FIGURE 9 is adapted particularly to indicate fluid flow and may employ a switch 43 with a movable contact 44 and biasing magnet 52 identical to the switches shown in FIGURES 5 and 6. This switch is mounted with one end adjacent to a cylindrical housing 71 of non-magnetic material which is secured to one end of a housing 72 through which the fluid to be measured may flow. A shaft 73 is journalled in bearings in the housing 72 and in the lower end of the housing 71 and carries a helical vane 74 within the housing 72. Fluid is adapted to flow through this housing through a lower inlet opening 75 to an outlet opening 76 adjacent to the upper end thereof and will exert a turning force on the vane 74 proportional to the velocity of the fluid.

The vane 74 is biased in one direction by a spring 77 and at its upper end carries a horizontally elongated bar magnet 78 at a level slightly below the horizontal center of the switch 43. The shaft 73 may also carry a pointer 79 movable over a dial 81 in the upper part of the housing 71 to give a visual indication of the flow rate.

The magnet and switch may be so adjusted that the magnet will move into proximity of the switch to operate it at very low flow or high flow conditions. Assuming that the parts are adjusted to operate the switch at low flow conditions and that low flow conditions obtain, the spring 77 will turn the shaft 73 to a position shown in which one pole of the magnet is closely adjacent to the switch and attracts its contact 44 to turn it in a counterclockwise position, as shown in full lines. At this time, a circuit through the left-hand end of the switch will be completed and may indicate no flow or may effect control operations to increase the flow.

Upon an increase in flow, the force on the vane 74 will overpower the spring 77 and will turn the shaft 73 to move the magnet pole away from the switch 43. After the magnet has been moved far enough so that its magnetic field is less effective than the field of the biasing magnet 52, the biasing magnet will tilt the switch contact 44 clockwise to interrupt the left-hand circuit and to complete the right-hand circuit. This again may initiate an indicating or controlling operation. It will be noted that in this case also once the contact 44 starts to move from its existing position to its opposite tilted position, the movement will occur rapidly and the contact will swing to its extreme position in the other direction with a snap action effect.

While several embodiments of the invention have been shown and described herein, it will be understood that they are illustrative only and not to be taken as a definition of the scope of the invention, reference being had for this purpose to the appended claim.

What is claimed is:

Electric switch control means comprising an elongated sealed envelope having contact forming means adjacent to each of its ends, a movable contact of magnetic material pivoted on a horizontal axis intermediate the ends of the envelope and swingable to two different positions to establish circuits with the contact forming means respectively at each of said positions, a non-magnetic enclosure adjacent to one end of the envelope, a magnet movable in the enclosure for movement of one of its poles toward and away from the adjacent end of the envelope to cause the contact to swing about its pivotal axis, and a permanent magnet providing two poles respectively above and below the envelope at the opposite end thereof tending to hold the contact in either of its two positions which it then occupies.

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