July 12, 1960 L. K. SMITH 2,945,102

ACTUATING LINKAGE FOR A SWITCH

Filed Nov. 6, 1958 2 Sheets-Sheet 1

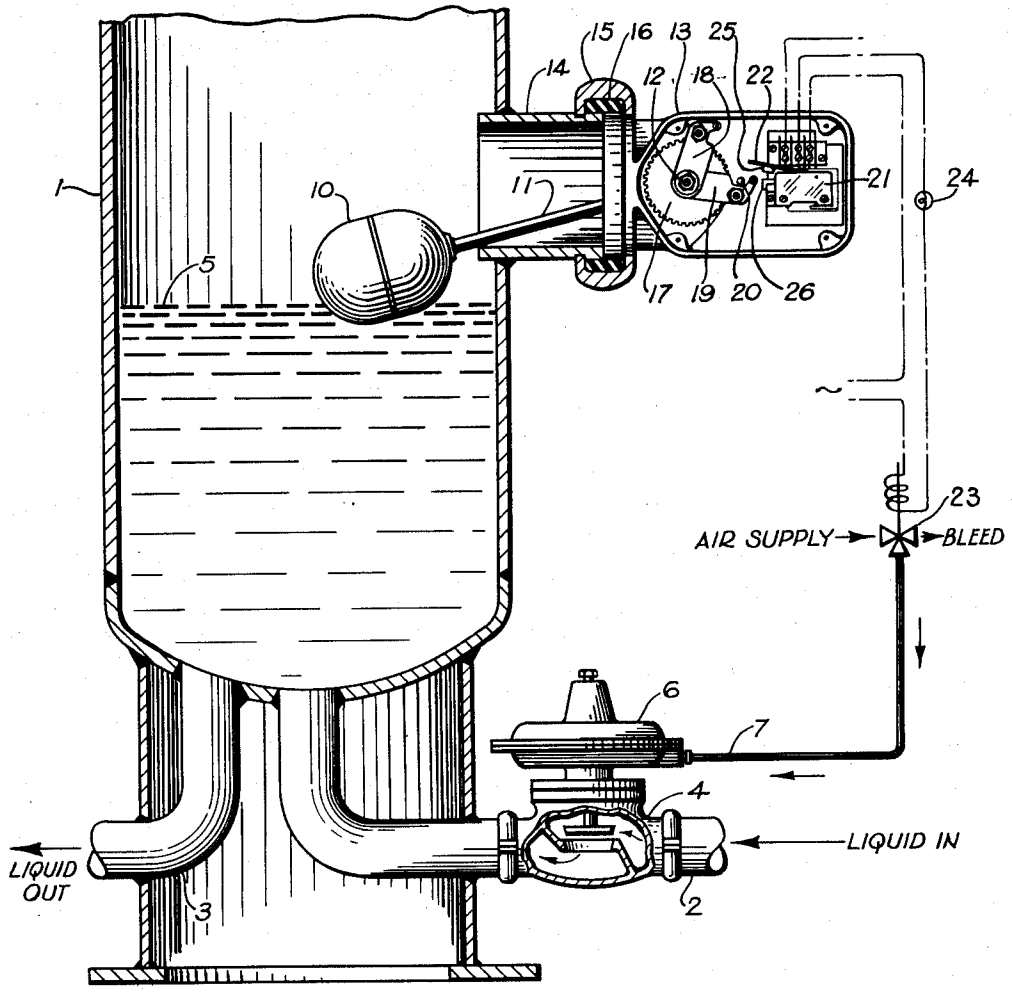


Fig. 1.

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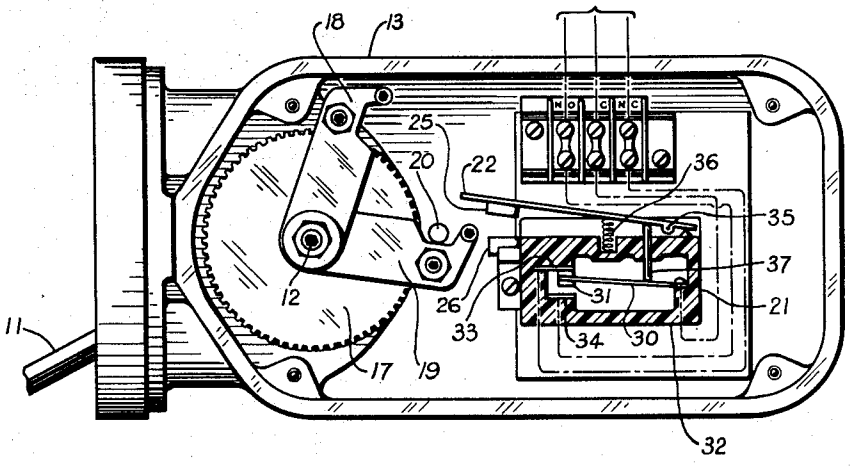


Fig. 2.

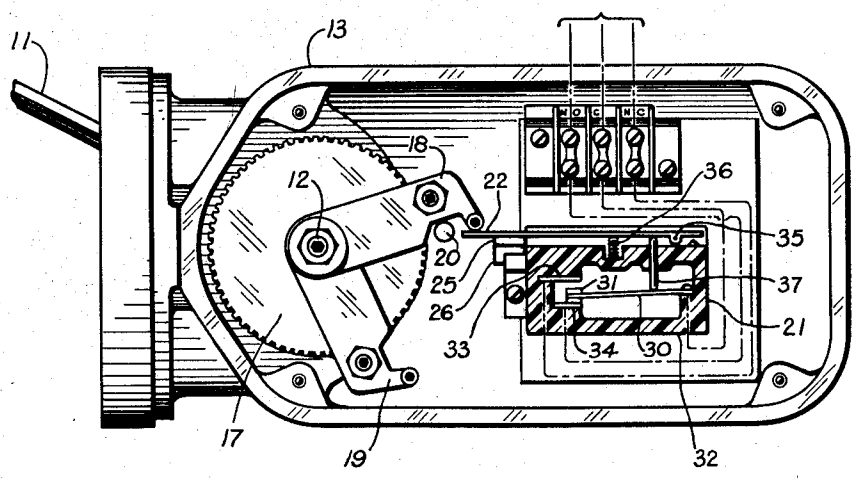


Fig. 3.

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ACTUATING LINKAGE FOR A SWITCH

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7 Claims. (Cl. 200—84)

The present invention relates to the actuating linkage between an element moved in space by a variable and a switch manifesting and/or controlling the variable.

Two-position switches, spring-urged to one of their positions, are inexpensive, yet dependable, means of actuating electric circuits. The contact-carrying actuating arm is readily bowed to create a spring force closing one set of contacts and snapped to its alternate position by a relatively light force moving a short distance. The transfer rate from one set of contacts to the other is high enough to keep arcing problems to a minimum.

These two-position, spring-urged, switches are rugged and inexpensive due at least partially to the simplicity of their actuating mechanism. However, they are limited to being actuated to the position alternate to their spring-urged position by movement of an element, by a variable, in one direction. Therefore, only one value of the variable, positioning the element in space, will transfer the contacts of the switch. There is need for a simple, inexpensive actuating linkage with which to positively transfer the switch contacts at different values of the variable positioning the element in space.

A primary object of the invention is to positively actuate a two-position, spring-urged, switch at different values of a variable.

Another object is to develop a force which will overcome the spring force of a two-position, spring-urged, switch at one value of a variable and eliminate the spring-opposing force at a second value of the variable.

Another object is to readily adjust the actuation of a two-position, spring-urged, switch between its alternate positions to predetermined differences between two values of a variable at which the switch is actuated.

The present invention contemplates linkage between an element positioned in space by a variable and a two-position, spring-urged, switch which will positively maintain the switch in the position in which the spring-force of the switch is overcome for a finite, predetermined, change in value of the variable.

The invention further contemplates the development of the magnetic force of a magnetic body on the arm carrying the spring-urged contacts of the switch at a first value of the variable to hold the contacts in one position and elimination of the magnetic force at a second value of the variable to enable the spring force to transfer the contacts to their second position.

The invention further contemplates the element moved in space by the variable having two adjustable contact arm members mounted on it with which to alternatively position a magnetic body so the magnetic force of the body will overcome the spring force of the switch and so the magnetic force overcoming spring force of the switch will be rendered ineffective.

Other objects, advantages and features of this invention will become apparent to one skilled in the art upon consideration of the written specification, appended claims and attached drawing wherein;

Fig. 1 is a diagrammatic elevation of a complete control system embodying the present invention;

Fig. 2 is a partially sectioned elevation of linkage between the element of the system positioned in space and the switch in a first position embodying the invention; and

Fig. 3 is the structure of Fig. 2 with the switch in its alternate position.

Fig. 1 illustrates a simple control system in which the present invention is embodied. The invention can be used by more complicated systems. However, the system illustrated was selected as having the degree of simplicity which would strongly emphasize the novel features of the invention.

More specifically, Fig. 1 illustrates how the invention is used to manifest and control the level of liquid in a container. The purposes served by holding a predetermined amount of liquid in the tank is of no present concern in illustrating this invention. Tank **1** is shown as supplied liquid through conduit **2**. The liquid is removed from tank **1** through conduit **3**.

The system capacity is sized so liquid will be withdrawn through conduit **3** at a lower rate than liquid is supplied through conduit **2**. Therefore, valve **4**, in conduit **2**, can be opened and closed to control the height of liquid level **5**.

Valve **4** is illustrated as a spring-closed, diaphragm-operated, two-positioned valve. Housing **6** carries the diaphragm on top of the valve. Control fluid pressure applied under the diaphragm, through pipe **7**, overcomes the spring force to open the valve. If desired, the valve spring can be arranged under the diaphragm to open the valve. The control fluid pressure developed in pipe **7** would then be applied to the top of the diaphragm to close the valve.

Level **5**, of the liquid in tank **1**, is shown at its minimum value. This predetermined minimum value of the variable level is caused to develop a control fluid pressure in pipe **7** which will open valve **4**. With valve **4** open, the liquid supplied through conduit **2** will raise level **5** to a predetermined maximum value. The predetermined maximum value is caused to develop a control fluid pressure in pipe **7** which will enable the spring of valve **4** to close valve **4**. With valve **4** closed, liquid will be withdrawn through conduit **3**, for a use not illustrated, and level **5** will return to the height shown in Fig. 1. Thus, the control fluid pressure developed in pipe **7** maintains level **5** between predetermined minimum and maximum values in tank **1**.

Level **5**, as a variable, positions an element in space to develop the control fluid pressure in pipe **7**. The structure actuated by this element develops the control fluid pressure and embodies the present invention. The system between the element positioned in space and pipe **7** includes many conventional components. However, a novel structure is included in the combination of components to produce an entirely new result.

Float **10** represents the element positioned in space by the fluid level **5**. Float **10** is buoyed by the liquid level in tank **1** and moved vertically as level **5** varies in height. Float arm **11** is attached to float **10**, and as float **10** rises and falls float arm **11** pivots a shaft **12**. The pivot shaft for arm **11** is journalled through the walls of housing **13**. Linkage in housing **13** is more directly utilized to develop the fluid pressure control signal positioning valve **4**.

Housing **13** is mounted in a fixed position on the side of tank **1**. A pipe-collar **14** is welded into an opening of tank **1** and a coupling **15** clamps the pipe-collar **14** and housing **13** together in a firm union. A gasket **16** is included in the coupling to seal the junction between the

pipe-collar 14 and housing 13 to prevent escape of fluid from tank 1.

The shaft 12, journalled through the walls of housing 13, is also sealed thereto to prevent escape of the tank 1 fluid. However, the shaft 12 is mechanically connected to arm 11 in order that it will be rotated as float 10 rises and falls. Further, a wheel 17 is mounted on the shaft so it will rotate with shaft 12.

Wheel 17 positions switch-actuating arms 18 and 19. Specifically, actuating arms 18 and 19 are pivoted about the shaft 12 axis and are fixed to the wheel 17 at predetermined points along its periphery. Pinion gears are mounted on arms 18 and 19 so they will mesh with teeth formed on the wheel 17 periphery. When the pinion gears are clamped to their respective arms, the arms are coupled through these gears to the wheel 17, extending from the center of rotation of wheel 17 at a predetermined angle.

A stop-pin 20 is placed just beyond the periphery of wheel 17. Stop-pin 20 is mounted on housing 13 and thereby limits the rotation of actuating arms 18 and 19 and their attached structure. The result of this arrangement is to establish the range of movement for float 10 with the angle subtended by arms 18 and 19 extending from the center of wheel 12.

As the engaging surfaces at the tips of arms 18 and 19 describe arcs with the rise and fall of float 10, they mechanically contact and move the actuating arm of a switch. Actuation of switch 21 develops an electrical signal which is transduced into the fluid pressure control signal in pipe 7. Therefore, the mechanical motion of float 10 can be traced as it is transduced into an electrical value which is in turn transduced into a fluid pressure value which controls valve 4 to cause level 5 to vary between two predetermined maximum and minimum values.

It is desirable to utilize a form for switch 21 which is dependable, yet inexpensive. Further, the switch should be rugged and simple in structure. A two-position spring-urged type of switch is preferred. The basic switch manufactured by the Micro-Switch division of Minneapolis-Honeywell Regulator Co., Freeport, Illinois, and having various forms, illustrated in Catalog 62C, has been found as satisfactory.

The micro-switch device, actuated by float 10, meets many of the requirements of the control system disclosed in 1. The switch has two sets of contacts, one set of which is normally closed, being spring-urged into this position. A very light force, moving through a very short distance, will overcome the spring force to open the normally closed contacts and make the normally open contacts. After the force is applied, from the float 10, to overcome the spring force, removal of this external force causes the contacts to assume their original position.

The present control system is representative of many simple control systems with which it is desired to have a variable controlled over a range rather than at a single, predetermined, value. Where there is more or less continual withdrawal of liquid through conduit 3, from tank 1, a single-point control of level 5 with valve 4 will cause rapid on-off cycling. Obviously, the mechanical wear of equipment rapidly cycled is very high. On the other hand, where it is desired to use a very simple two-position, spring-urged, form for switch 21, a means must be developed to overcome the spring force at one value of the variable and remove the spring-opposing force at the second value of the variable.

In specific terms, as float 10 rises to its predetermined maximum value, actuating arm 18 will mechanically contact and carry switch arm 22 downward. The normally closed contacts of switch 21 will be broken and the control fluid pressure in pipe 7 will be reduced in value. The spring of valve housing 6 will close valve 4 and level 5 will be lowered as liquid is withdrawn through conduit 3. However, as float 10 lowers with descending level 5, contact arm 18 will be lifted from actuating arm 22 and allow the normally closed contacts to again make if no force is maintained on arm 22 to keep it depressed. The control fluid pressure in conduit 7 will be increased to the value which will overcome the valve spring to supply liquid through conduit 2 and return float 10 to its maximum height. The result of having no force to hold the switch 21 in the position to which it was carried by actuating arm 18 is single-point control of level 5 at a predetermined height.

The present invention was developed to solve the problem of keeping the spring force of switch 21 overcome after actuating arm 18 has been removed by the fall of float 10 a finite distance. The present invention provides a force which will oppose the spring force of switch 21 until removed by actuating arm 19 engaging arm 22 of switch 21. The result is a combination of linkage including the desirable two-position, spring-urged, type of switch with its mechanical actuation of the switch by the float 10 adjustable between predetermined differences between two values of the variable level 5 moving the float.

The elements added to the combination to effect this new result are magnetic bodies attached to switch arm 22 and to housing 13. When actuating arm 18 depresses switch arm 22 the force of attraction between the magnetic bodies will overcome the force of the spring of switch 21, holding the switch in its alternate position. This magnetic force remains effective during the period float 10 lowers and actuating arm 18 is pivoted upward, away from switch arm 22. Float 10 continues to lower until actuating arm 19 pivots upward, engages switch arm 22, and moves arm 22 upward far enough to separate the magnetic bodies until their force of attraction is removed from arm 22. With the magnetic force removed, the spring force constantly applied to the contacts carry the contacts to their normally closed, spring-urged position.

Figs. 2 and 3 have been established to carefully show the two positions of the contacts of the micro-switch device. Obviously the relation of switch contact position to the float position can be reversed. Also the contact position which will energize the circuit including the switch 21 can be changed.

Three-way, two-position, solenoid valve 23, in Fig. 1 is used to illustrate how the electrical signal developed by switch 21 can be transduced into the control fluid pressure in pipe 7. Pipe 7 is connected, through valve 23, to either a supply of fluid pressure, or is bled to atmosphere. Valve 23 is normally in one position, carried to, and held in, that position by a spring. When a line supply of electrical power is applied to the circuit of the valve 23 solenoid, the spring force is overcome and the valve is carried to its alternate position. Valve 23 is shown as connected to pipe 7 so supply pressure will be developed in pipe 7 when the circuit of the valve solenoid is energized. The alternate relation between energization of valve 23 and control fluid pressure development in pipe 7 could be easily provided by reversing the connection to valve 23.

A light 24 is shown as included in the circuit of valve 23. When the circuit is energized, the illumination of light 24 serves as an indication of that fact. It is also possible to manifest the position of float 10 by mechanical linkage to an indicator or recorder. These components are too well known, and obviously feasible, to need specific illustration.

The overall function of the system embodying the invention is shown with Fig. 1. The magnetic bodies 25 and 26 are shown attached to switch arm 22 and housing 13. The switch 21 is shown on its normal, or spring-urged, position. Float 10 is at its minimum value. Actuating arm 19 is shown as having applied its contacting surface to switch arm 22 to separate the bodies 25

and 26 so their magnetic force on arm 22 is removed. The circuit of the solenoid of valve 23 is energized when the contacts of switch 21 are in their normal, spring-urged, position. The supply pressure is connected to pipe 7 to develop the control fluid pressure therein to its maximum value. The spring of valve 4 is overcome by the control fluid pressure and valve 4 is opened to supply liquid to tank 1 and raise level 5.

Fig. 2 shows the mechanism within case 13 in greater detail. The switch 21 is sectioned to show the contacts and spring which urges them into their normal position. The actual construction of a micro-swith unit is more complex than shown here. Figs. 2 and 3 show the internal arrangement somewhat diagrammatically to maintain simplicity.

Switch 21 has a contact-supporting arm 30 with an electric contact structure 31 mounted on one end. The other end of arm 30 is mounted on the housing 32 in a manner which will develop the spring force of flexure of the arm 30 to carry the contact structure upward. Contact structure 31 is carried upward, against contact 33, by the spring force of arm 30. This "making" of contacts 31 and 33 is termed the normal, or spring-urged position of the switch contacts. The alternate position of arm 30 carries contact 31 against contact 34.

Arm 30 is carried to its alternate position by applying a force in opposition to that of the spring force of arm 30. This alternate position is illustrated by Fig. 3. The force to overcome the spring force is applied by float 10, linked as shown to the contacting surface of actuating arm 18. This contacting surface is pivoted downwardly with shaft 12 to depress switch arm 22. Switch arm 22 is rotated counter clockwise about shaft 35, against the force of a spring 36. Pin 37 transmits the motion of switch arm 22 to switch arm 30 to resist the flexure force of arm 30 and transfer contact 31 from engagement with contact 33 to engagement with contact 34.

As switch arm 22 is rotated counter clockwise about shaft 35, magnetic bodies 25 and 26 are brought together. The magnetic force of attraction between the bodies develops until the force of spring 36 and the force of arm 30 flexure is suddenly overcome and the position of Fig. 3 is completed. Stop pin 20 sets the maximum travel of arm 18 and relieves switch arm 22 of the stress produced by further elevation of level 5 before the closing of valve 4 enables it to be stopped and lowered.

As valve 4 is closed by the control action resulting from breaking the circuit of the solenoid of valve 23 by separating contacts 33 and 31, level 5 starts to lower with usage of the liquid in tank 1. Float 10 lowers and arm 18 raises, rotating with shaft 12. If magnetic bodies 25 and 26 were not included in the combination, the spring-urged position of contacts 31 and 33 would be immediately re-assumed. The valve 4 would open and the cycle of raising and lowering level 5 at a single control point would continue. However, switch 21 will maintain the position of Fig. 3 until the contacting surface of arm 19 is raised, engages switch arm 22 and removes the magnetic force.

The invention provides an adjustable span of level 5 values at which magnetic bodies 25 and 26 are brought together and separated. Arms 18 and 19 can be clamped to wheel 17 at any number of desired points. The contacting surfaces of these arms then establish the values of level 5 which will develop the force on switch arm 22 and remove the force from switch arm 22. The provision of this force by magnetic bodies 25 and 26 is simple, efficient and inexpensive. Obviously, the arrangement is far superior to any mechanical retaining mechanism actuated by arms 18 and 19.

The preferred embodiment of the invention is disclosed as utilizing magnetic bodies 25 and 26 to develop a force of attraction on switch arm 22 to overcome the spring force of the switch. This magnetic force may also be described as a bonding force. Adhesive forces are also regarded as bonding forces. Therefore, it is well within the scope of this invention to use an adhesive material attached to the switch arm 22 which will serve the same function of magnetic bodies 25 and 26.

Also, although not specifically illustrated, electromagnetic bodies could be used to develop the force of attraction required on switch arm 22. A separate circuit could be energized through a switch actuated by arms 18 and 19 at the same time switch arm 22 is engaged. The resulting magnetic force developed by energizing the electromagnets could be applied and removed at the same time the magnetic force of bodies 25 and 26 is applied and removed as shown in the drawings.

From the foregoing it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the apparatus.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

The invention having been described, what is claimed is:

1. A device for manifesting two different values of a variable including, an element moved in space by a variable, a switch mounted at a location whereby its spring-urged actuating arm is mechanically engaged from two different directions by the element as the element moves under the influence of the variable to position the switch contacts in manifestation of different values of the variable, and a magnetic body which is first positioned by the element to develop a magnetic force on the actuating arm to overcome the spring force and hold the contacts of the switch in one position against the spring force and secondly positioned to eliminate the magnetic force on the actuating arm to permit its spring to return the contacts of the switch to their alternate position.

2. The device of claim 1 in which the variable is the level of a fluid in a container and the element is a float on the liquid.

3. The device of claim 2 in which the float is attached to two arms pivoted about a common center by the float to mechanically engage and position the magnetic body.

4. A linkage system including, an element variably positioned in space, a two-position spring-urged switch, a first magnetic body mounted in a fixed relation to the switch, a second magnetic body attached to the actuating arm of the switch, a first arm mounted on the variably positioned element in such manner as to mechanically engage the actuating arm of the switch and move it against the spring force to make a first set of contacts and position the second magnetic body to develop sufficient attractive force between it and the first magnetic body as to overcome the spring force, and a second arm mounted on the variably positioned element in such manner as to mechanically engage the actuating arm of the switch and position the second magnetic body to remove the attractive force between the bodies to enable the spring force to make a second set of contacts and break the first set of contacts.

5. The linkage system of claim 4 in which, the variably positioned element is a float moved by the level of the fluid, and the first and second arms are pivotally mounted for movement by the float so as to alternately engage the actuating arm of the switch and the first magnetic body as the float is moved up and down by the level of the fluid.

6. A control system for fluid level in a container having a float moved by the fluid level and a valve con-

trolling the elevel of fluid including; a linkage system actuated by the float including, a wheel in the plane of the float arm movement, and actuating arms attached to the wheel at predetermined points; a two-position spring-urged switch having its contact-actuating arm moved between two positions by mechanical engagement with the actuating arms attached to the wheel; an electric circuit completed through the switch contacts; a solenoid operated valve energized by the electric circuit to establish control fluid pressures on the valve for control of the fluid level in the container; and magnetic bodies of which, a first of the bodies is attached to the contact-actuating arm of the switch which is moved by one of the actuating arms attached to the wheel to be attracted to a second of the bodies to oppose the spring force of the switch and hold the contact-actuating arm in one position and the contact-actuating arm is moved by the other of the actuating arms attached to the wheel to separate the bodies and remove the magnetic force of the bodies from the contact-actuating arm so the contact-actuating arm will be spring-urged to its other position.

7. A device for manifesting two different values of a variable including, an element moved in space by a variable, a switch mounted at a location whereby its spring-urged actuating arm is mechanically engaged from two different directions by the element as the element moves under the influence of the variable to position the switch contacts in manifestation of different values of the variable, and a means which is first positioned by the element to develop a bonding force on the actuating arm of the switch to overcome the spring force of the switch and which is secondly positioned by the element to remove the bonding force from the actuating arm of the switch to enable the spring of the switch to return the switch contacts to their alternate position.

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