March 25, 1958 R. P. SWEGER 2,828,373

CONDITION RESPONSIVE SWITCH APPARATUS

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Fig. 1.

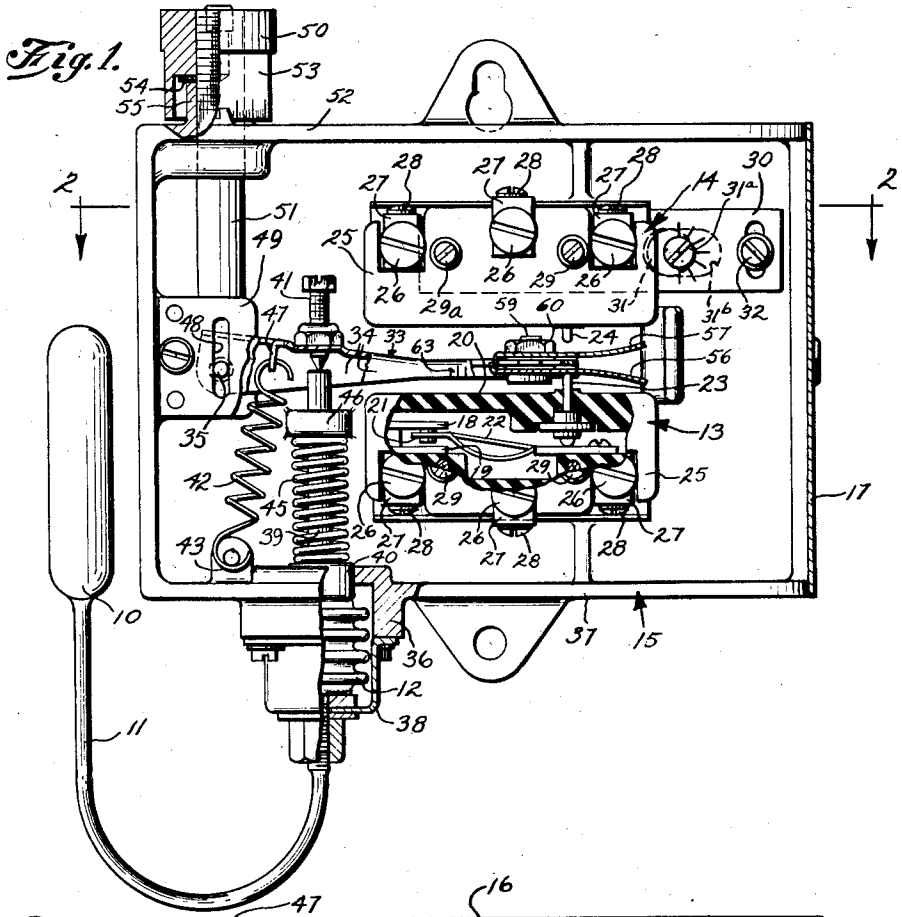


Fig. 2.

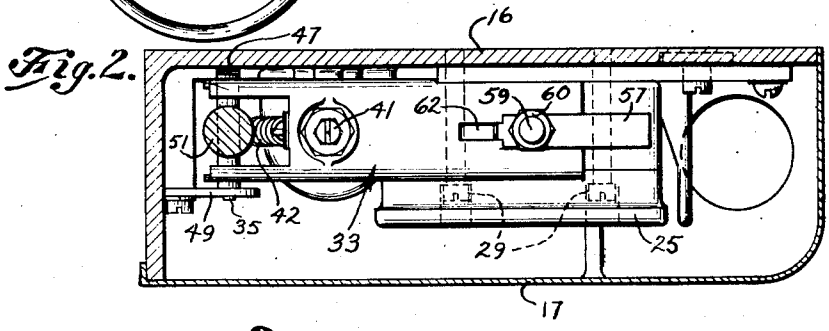
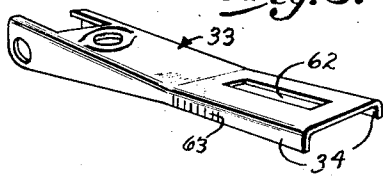


Fig. 3.



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Fig. 4.

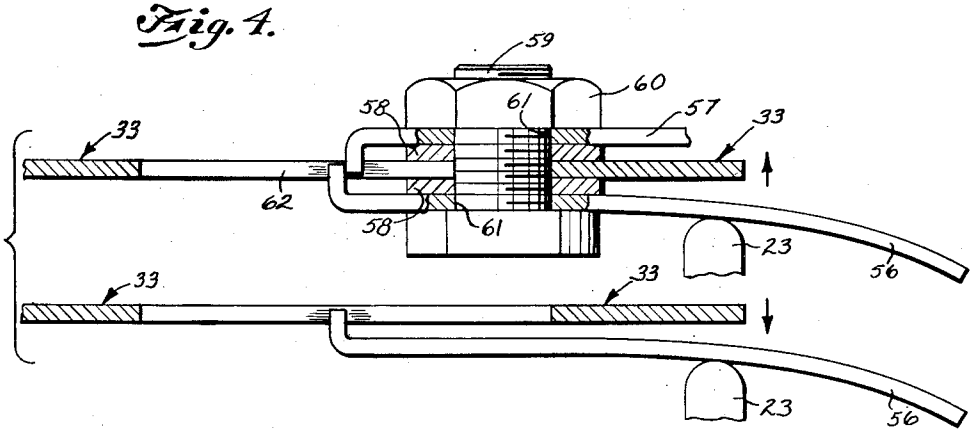
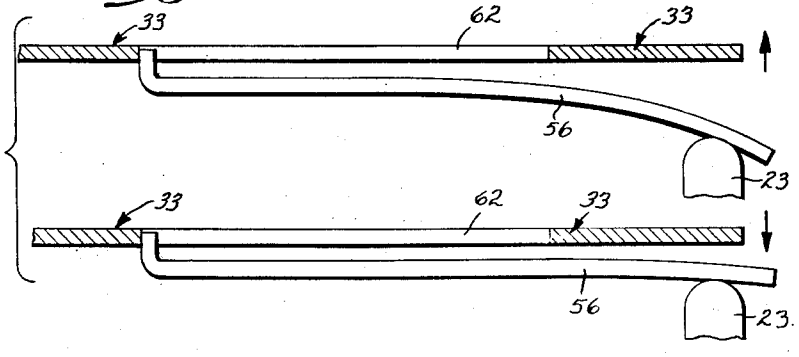


Fig. 5.



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CONDITION RESPONSIVE SWITCH APPARATUS

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Application October 25, 1954, Serial No. 464,402

10 Claims. (Cl. 200—18)

This invention relates to a condition responsive switch apparatus, such as one which responds to temperature changes, and has more particular reference to an over-center switch in which a movable contact is supported by a spring and moves between stationary contacts with a snap action of the spring. Such springs require a greater force to be shifted across center than to be held in the over-center position. This difference is utilized to obtain a differential in the magnitudes of the condition at which the switch responds upon an increase and a decrease in the condition.

One object of the invention is to employ two switches of the foregoing character in a novel manner to obtain a two-stage control of the condition.

A more detailed object is to obtain the two-stage control by arranging a movable member between the two switches and actuate the switches through the medium of springs carried by the member.

Another object is to vary the differential by springs which are arranged in such a manner that their spring rates may be adjusted whereby different amounts of movement of the movable member are required to actuate each switch.

Other objects and advantages of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings, in which:

Figure 1 is a front elevation view of a condition responsive switch apparatus constructed in accordance with the present invention, parts being broken away and shown in section.

Fig. 2 is a sectional view taken along the line 2—2 in Fig. 1.

Fig. 3 is a perspective view of the movable switch actuating member.

Fig. 4 is a view showing the actuating springs in two positions of movement with the parts arranged for a high spring rate.

Fig. 5 is a view similar to Fig. 4 but shows the parts arranged for a low spring rate.

While the invention is applicable to apparatus for sensing changes in various conditions, it is shown in the drawings, for purposes of illustration, as embodied in a thermostat responsive to temperature changes. Such changes are sensed by a fluid filled temperature bulb 10 connected by a tube 11 to a resilient metallic bellows 12. The latter thus is expanded and contracted in response to changes in temperature and this causes the actuation of one or more switches 13 and 14 which may be utilized to control heaters (not shown) for raising the temperature about the bulb 10.

The switches 13 and 14 are enclosed within a casing 15 composed of a flanged mounting plate 16 and an L-shaped cover 17 (Fig. 2). Preferably, the switches are of the snap action type and comprise two spaced stationary contacts 18 and 19 mounted within an insulated housing 20 with a third contact 21 movable between the two stationary contacts. The movable contact is carried on the end of a suitable leaf spring 22 which moves with an over-center action so that this contact is snapped from one of the stationary contacts to the other. Projecting through the housings of the two switches 13 and 14 are actuator pins 23 and 24 which engage the springs of the corresponding switches and which when depressed, shift these springs across center.

Disposed against the housing 20 of each of the switches 13 and 14 is a terminal plate 25 whose three terminals 26 are connected by rigid L-shaped conductors 27 to the terminals 28 of the switch, the latter terminals being connected respectively to the contacts 18, 19 and 21. Screws 29 projecting through the plate 25 are threaded into the housing 20 of the switch 13 and into the support plate 16 thereby securing this switch to the casing 15. Similar screws 29 and 29a fasten the switch 14 and the associated terminal plate to a bar 30 which is pivoted on the support plate 16 by means of the screw 29a and clamped in selected angular positions by a screw 32. The bar is turned by turning the head 31a of an eccentric 31 which is journaled on the bar and received in a slot 31b in the mounting plate 16. Mounting the switch 14 on the plate 30 permits the position of this switch to be adjusted to vary the spacing between the two switches.

In order to actuate the switches 13 and 14 in response to temperature changes, the switches are arranged with their actuators 23 and 24 projecting toward each other and an elongated horizontal lever 33, which is turned by the bellows 12, projects in between the actuators and depresses the latter as it swings up and down. Herein, the lever 33 is a sheet metal stamping formed with down-turned side flanges 34 through which a pin 35 projects at the inner end of the lever to form the fulcrum.

The bellows 12 is disposed within an annular boss 36 on the lower flange 37 of the plate 16 and is supported at its lower end by a cap 38 bolted to the boss. Connecting the upper end of the bellows and the lever 33 is a vertical pin 39 formed at its lower end with an enlarged head 40 which projects through the boss 36 and rests on top of the bellows. At its upper end, the pin abuts against the pointed lower end of a screw 41 threaded through the lever. A contractile spring 42 anchored at one end to a lug 43 on the flange 37 and at the other end to an ear 44 struck down from the lever 33 biases the latter to hold the screw 41 against the pin 39 downwardly so that the lever moves up and down as the bellows expands and contracts. The bellows is loaded by a compression spring 45 encircling the pin 39 and acting between the head 40 and a stationary lug 46 formed integrally with the plate and having a hole through which the pin projects.

In the present instance, one end of the fulcrum pin 35 projects into a vertical recess 47 (Fig. 2) formed in the plate 16 while the other end projects into a slot 48 paralleling the recess and formed in a bracket 49 which is bolted to the plate. This permits the pin 35 to slide up and down and such sliding is limited in the downward direction by a knob 50 (Fig. 1) threaded on the upper end of a rod 51 which carries the pin at its lower end and projects through the upper flange 52 on the plate 16. The knob 50 has a depending skirt 53 which forms an internal shoulder 54 and this shoulder abuts against an annular boss 55 upstanding from the flange 52 and encircling the rod 51. Thus, the spring 42, acting through the lever 33, the pin 35 and the rod 51, urges the shoulder 54 against the boss 55 and normally holds the fulcrum pin 35 in a fixed position. By threading the knob 50 up and down on the rod, the pin 51 is raised or lowered and this adjusts the temperatures at which the switch actuators 23 and 24 are depressed by the lever 33.

The sliding arrangement of the fulcrum pin **35** also protects the entire apparatus from damage when the bulb is subjected to abnormally high temperatures. Under such conditions, the bellows **12** expands swinging the lever **33** against the actuator **24** of the switch **14**. After this actuator has been depressed, the spring **42** yields and the fulcrum **35** is moved up so that the lever actually pivots about the actuator **24**. In this manner, neither the switch **14**, the lever **33** nor the bellows **12** are stressed to the point where they would be damaged.

In snap action switches of the type used herein, a greater force is required to shift the spring **22** across center than is needed to hold the spring in the over-center position. For example, an 11 ounce force may be required to shift the spring but a 7 ounce force will hold the spring. This difference may be utilized to obtain a differential between the temperatures at which the switch is actuated in each direction. For this purpose, the lever **33** depresses the actuators **23** and **24** of the switches **13** and **14** through the medium of springs **56** and **57**, so that, as the lever swings toward one actuator, the latter is engaged by the opposing spring which first is flexed a predetermined amount until it exerts a force great enough to shift the switch spring **22** across center. As the lever **33** swings away from the switch, the force of the actuating spring decreases but the switch spring remains over center due to the fact that a lesser force is required to hold it in this position. Eventually, the lever moves far enough that the force of the actuating spring decreases to a value below the minimum required to hold the switch spring and the latter moves back across center. In this manner, the switch is actuated at different temperatures in each direction.

According to one aspect of the invention, advantage is taken of the difference in the temperatures at which each of the two switches **13** and **14** operate to obtain a two stage control of the ambient temperature at the bulb. In such a case, the heater used to raise the temperature about the bulb would, as is well known in the art, be capable of producing a low heat and a high heat such as by using one or both of two heating units. With this arrangement, each switch controls one of the heater units so that, when the temperature at the bulb is substantially below the desired value, both units are energized while only one is energized when the temperature is only slightly below the set value. At the same time, the arrangement provides an accurately controlled differential between the temperatures at which the two heater units are energized and the temperatures at which the units are deenergized.

To achieve the foregoing ends, the switch **13** controls one unit of the heater and energizes this unit when the actuator pin **23** is depressed, that is, when the movable contact **21** of this switch is against the lower stationary contact **19**. When the pin **23** is released to permit the movable contact to snap up against the contact **18**, the heater unit is deenergized. The switch **14** operates in the opposite manner and functions to energize the second unit of the heater when the actuator pin **24** is released and deenergizes this unit when depressed. With this arrangement, a temperature at the bulb **10** substantially below the desired value causes the bellows **12** to contract to the extent that the lever **33** is swung down flexing the spring **56** sufficiently to overcome the force of the spring **22** of the switch **13**. This depresses the actuator pin **23** and snaps the contact **21** of the switch **13** down against the contact **19**. At this time, therefore, both units of the heater are energized.

As the temperature at the bulb **10** rises, the bellows **12** expands and swings the lever **33** up reducing the force of the actuating spring **56**. When the force of the spring is reduced below that required to hold the switch spring **22** down, below 7 ounces in the example given above, the switch spring snaps back across center deenergizing the first heater unit and leaving only the second unit energized. With only one unit of the heater in operation, the temperature at the bulb rises more slowly and gradually approaches the desired value and, during this time, the spring **57** is flexed until the spring of the switch **14** is overcome so that the lever **33** depresses the actuator **24** and deenergizes the second heater unit.

At this time, the spring **57** is exerting a force sufficient to move the switch spring across center, for example 11 ounces, and this is materially greater than the force required to hold the switch spring in the over-center position. Thus, as the temperature at the bulb **10** begins to fall and the resulting contraction of the bellows **12** permits the lever **33** to turn down, the actuator pin **24** remains depressed so that both heater units are deenergized. Continued downward swinging of the lever reduces the force of the actuator spring **57** below that required to hold the pin depressed and, when this occurs, the spring of the switch **14** overcomes the spring **57** and moves back across center to energize the heater unit controlled by this switch. This may cause the temperature at the bulb to rise again or, under some circumstances, the temperature may continue to fall but more gradually.

Should the bulb temperature continue to drop, the resulting further downward swinging of the lever **33** will cause the actuating spring **56** to flex until the force it exerts is sufficient to snap the spring **22** of the switch **13** over center. This energizes the associated heater unit so that both units then are again in operation.

It will be observed that the foregoing arrangement provides a two-stage control such as may be used to control the operation of a multiple unit heater. At the same time, the system maintains a differential between the temperatures at which each unit is energized and deenergized. Thus, in the present instance, both units are deenergized at predetermined temperatures as the bulb temeprature rises but are energized at lower temperatures upon a drop in temperature at the bulb.

The present invention also contemplates the provision of a novel construction and arrangement of the lever **33** and the actuating springs **56** and **57** so that the temperatures at which each spring actuates the associated switch **13** or **14** may be set selectively. For this purpose, the springs actuate the switches directly and are arranged to flex when moved against the corresponding switch actuator pin. Such flexing continues increasing the force exerted by the spring until the force is sufficient to overcome the force of the switch spring **22**. In accordance with the invention, the actuating spring is constructed so that its effective spring rate may be varied. By changing the spring rate, the amount of movement of the lever **33** required to flex the actuating spring enough to overcome the switch spring is varied. As a result the differential between temperatures at which the switch is actuated is adjusted selectively.

While the springs **56** and **57** may be constructed in various ways to effect a change in spring rate, herein such change is achieved by employing leaf or cantilever springs which are shiftable longitudinally so that the actuating pins **23** and **24** of the switches **13** and **14** engage the springs at selected distances from the anchored ends of the latter. The springs **56** and **57** are disposed respectively above and below the lever **33** and extend along and beyond the free end portion of the latter. Washers **58** (Fig. 4) are disposed between the inner ends of the springs and the lever and the springs are clamped against the washers by a bolt **59** and a nut **60**. The bolt projects through holes **61** in the springs, through the washers **58** and through an elongated slot **62** in the lever. The slot extends longitudinally of the lever and permits the bolt to be shifted back and forth along the lever.

With the foregoing arrangement, the nut **60** may be loosened and the bolt **59** slid along the lever **33** through the slot **62** to a selected position after which the nut is tightened clamping the bolt in this position. The springs

56 and 57 are shifted longitudinally of the lever with the bolt and assume adjusted positions relative to the switch actuators 23 and 24. As a result, the springs are engaged by the actuators at different selected distances from the spring ends. Thus, with the bolt disposed near the forward end of the slot 62 as shown in Fig. 4, the actuator 23 engages the spring 56 at a point comparatively far from the end of the spring. In this position of the parts, the spring has a relatively high spring rate so that the force of the spring increases rapidly upon downward swinging of the lever. Because of this, only a small movement of the lever is required to overcome the force of the switch spring 22 and actuate the switch 13.

By shifting the bolt 59 toward the inner end of the slot 62 so that the spring 56 is in the position shown in Fig. 5, the actuator 23 engages the spring near the outer end thereof. The effective rate of the spring is, therefore, reduced and a correspondingly greater movement of the lever is required to flex the spring sufficiently to actuate the switch 13. Thus, by shifting the springs 56 and 57 back and forth, their spring rates are adjusted and this varies the differential between the temperatures at which the switches 13 and 14 are actuated in each direction. If desired, a scale 63 (Fig. 1) may be marked on the flange 34 of the lever 33 to indicate the various positions of the springs and hence the differentials in the operating temperatures.

I claim as my invention:

1. Condition responsive apparatus having, in combination, a support, a lever fulcrumed on said support to swing back and forth in response to changes in the condition being sensed, two snap action switches mounted on said support on opposite sides of said lever and each having a movable contact carried by an over-center spring, two actuators, one for each of said switches and each operable to shift the corresponding switch spring across center, said actuators being spaced apart and opposing each other, and two leaf springs anchored at one end to said lever with their free ends projecting in between said actuators, each of said leaf springs opposing one of said actuators to engage the latter, then flex a predetermined amount and finally overcome the force of the corresponding switch spring upon swinging of said lever.

2. Condition responsive mechanism comprising a first support, two actuating springs mounted on opposite sides of said support and each having a spring rate that varies according to the point at which it is engaged, a second support movable relative to the first upon changes in the condition to be sensed, two snap action switches mounted on said second support on opposite sides of said first support and each having a movable contact carried by an over-center spring, and two actuators, one for each of said switches and each engaging one of said actuating springs whereby the switches are actuated upon relative movement of said supports and after a predetermined flexing of the actuating springs.

3. Condition responsive mechanism comprising a first support, two snap action switches spaced apart and each having a movable contact carried by an over-center spring, said spring requiring a greater force to be shifted across center than to be held in the over-center position, an actuator for each of said switches movable to shift the corresponding spring across center, said switches being mounted on said support with their actuators opposing each other, a second support movable relative to the first in response to changes in the condition to be sensed, and two spring elements mounted on said second member between said actuators and each opposing and engaging one of the actuators to cause the latter to move and thereby shift the corresponding switch spring back and forth across center upon relative movement of said supports, said spring elements yielding a predetermined amount when moved in each direction before effecting movement of said actuators.

4. Condition responsive apparatus having, in combination, a support, a lever fulcrumed on said support to swing back and forth in response to changes in the condition being sensed, two snap action switches mounted on said support on opposite sides of said lever and each having a movable contact carried by an over-center spring, two actuators, one for each of said switches and each operable to shift the corresponding switch spring across center, said actuators being spaced apart and opposing each other, two leaf springs anchored at one end to said lever with their free ends projecting in between said actuators, each of said leaf springs opposing one of said actuators to engage the latter, then flex and finally overcome the force of the corresponding switch spring upon swinging of said lever, and means for shifting said leaf springs on said lever to vary the points of engagement between said actuators and leaf springs thereby to change the effective spring rate of the leaf springs and adjust the amount of flexing of the same.

5. Condition responsive mechanism comprising a first support, two actuating springs mounted on opposite sides of said support and each having a spring rate that varies according to the point at which it is engaged, a second support movable relative to the first upon changes in the condition to be sensed, two snap action switches mounted on said second support on opposite sides of said first support and each having a movable contact carried by an over-center spring, two actuators, one for each of said switches and each engaging one of said actuating springs whereby the switches are actuated upon relative movement of said supports and after flexing of the actuating springs, and means for adjusting said actuating springs relative to said actuators to change the points of engagement thereby to change the effective rate of the actuating springs and vary the amount the latter flex before actuating said switches.

6. Condition responsive mechanism comprising a first support, two snap action switches spaced apart and each having a movable contact carried by an over-center spring, said spring requiring a greater force to be shifted across center than to be held in the over-center position, an actuator for each of said switches movable to shift the corresponding spring across center, said switches being mounted on said support with their actuators opposing each other, a second support movable relative to the first in response to changes in the condition to be sensed, two spring elements mounted on said second support between said actuators and each opposing and engaging one of the actuators to cause the latter to move and thereby shift the corresponding switch spring back and forth across center upon relative movement of said supports, said spring elements yielding when moved in each direction before effecting movement of said actuators, and means for varying the effective spring rates of said elements to change the amount the elements yield.

7. Condition responsive mechanism having, in combination, a first support, a leaf spring mounted on said support, a second support movable relative to said first support, a snap action switch mounted on said support and having a movable contact carried by a spring, said spring requiring a greater force to be moved across center than to be held in the over-center position, an actuator operable when moved to shift said switch spring over center and engaging said leaf spring, means to move said supports relatively together and apart in response to the condition being sensed whereby said leaf spring flexes upon initial movement of the supports together and then shifting said switch spring across center, said leaf spring flexing in the opposite direction upon separating movement of said supports and then permitting said switch spring to move back across center, and mechanism supporting said leaf spring on said first support for adjusting movement to change the point on the spring engaged by said actuator and thereby vary the effective rate of the spring.

8. Condition responsive mechanism having, in combination, a first support, a leaf spring mounted on said support, a second support movable relative to said first support, a snap action switch mounted on said support and having a movable contact carried by a spring, said spring requiring a greater force to be moved across center than to be held in the over-center position, an actuator operable when moved to shift said switch spring over center and engaging said leaf spring, means to move said supports relatively together and apart in response to the condition being sensed whereby said leaf spring flexes upon initial movement of the supports together and then shifting said switch spring across center, said leaf spring flexing in the opposite direction upon separating movement of said supports and then permitting said switch spring to move back across center, and mechanism for changing the point on said leaf spring engaged by said actuator thereby to change the effective rate of the spring.

9. A condition responsive mechanism comprising a first supporting member, a snap action switch mounted on said member and having a movable contact carried by an over-center spring, said spring requiring a greater force to be shifted across center than to be held in the over-center position, an actuator movable to shift said spring across center, a second supporting member movable relative to the first, a second spring mounted on said second member to engage said actuator and overcome the switch spring as said members move together, said second spring having a spring rate varying according to the point engaged by said actuator, means for changing the point of engagement between said actuator and said

second spring thereby to adjust the relative movement of said members required to shift said switch spring over center in each direction, and mechanism responsive to changes in the condition to be sensed and operable to move said members relatively together and apart.

10. A condition responsive apparatus having, in combination, first and second supporting members mounted to move together and apart relative to each other in response to changes in the condition to be sensed, a snap action switch mounted on said first member and having a movable contact supported by an over-center spring, said spring requiring a greater force to be moved across center than to be held in the over-center position, an actuator movable back and forth and operable to shift said spring over center, a second spring supported on said second member and yieldably engaging said actuator to oppose the spring of said switch, and means for varying the effective spring rate of said second spring thereby to adjust the relative movement of said members in each direction before one of said springs overcomes the other and causes shifting of the switch spring.

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