March 24, 1953 J. A. SENN 2,632,825

TEMPERATURE RESPONSIVE SWITCH

Filed Nov. 21, 1949

FIG. 1

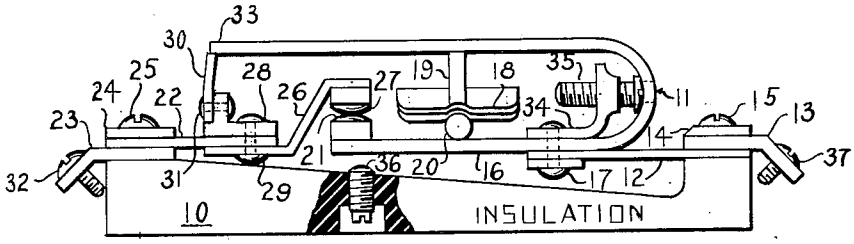


FIG. 2

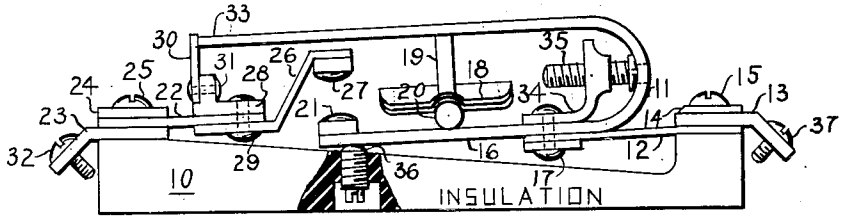


FIG. 3

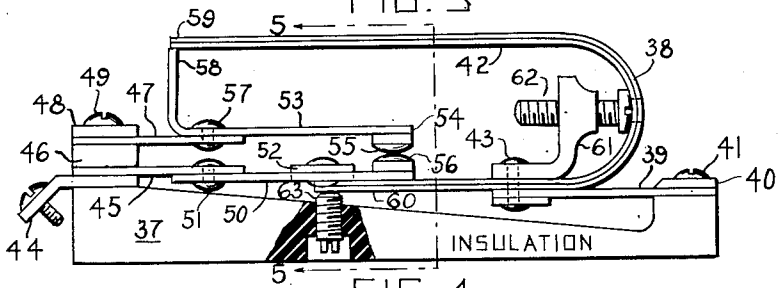


FIG. 4

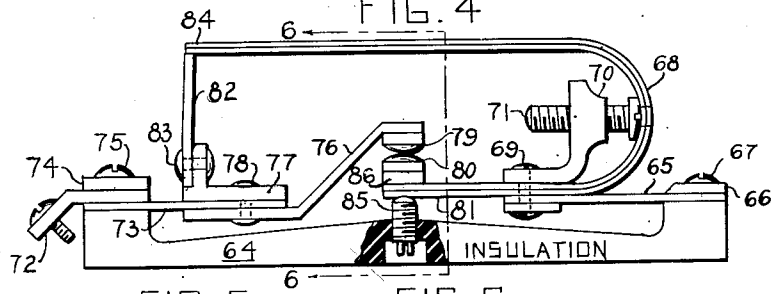


FIG. 5

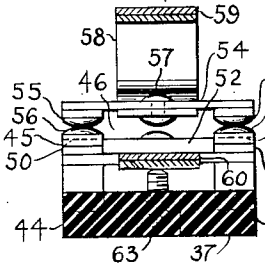
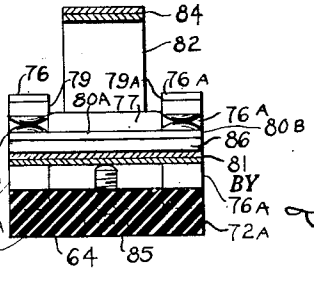


FIG. 6



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TEMPERATURE RESPONSIVE SWITCH

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11 Claims. (Cl. 200—139)

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This invention concerns a type of temperature or pressure responsive switch which has for its main object the elimination of destructive arcing or "frying" of the contacts thru the utilization of a novel latching arrangement.

In the past there has been developed many arrangements for coping with the destructive arcing resulting from slow "make" and "break" of contacts. Primarily, the defect is remedied by creating a swift or snap action to converge and separate the contacts. The over-center spring switch action has proven somewhat successful but is characterized by the requirement that the cut-in and cut-out points be set relatively widely apart, i. e. that the differential setting be relatively large to insure proper contact pressure, also these arrangements have a range of vanishing contact pressure, for as the over-center spring is carried over center, the contact pressure is momentarily reduced to zero. For purposes of precise and sensitive control some form of latching arrangement has been found to be more satisfactory.

Contact arcing on contact separation as such has no relation to the contact pressure preceding this event. But persistent high contact pressure up to the point of contact separation keeps the resistance of the junction low and therefore also the voltage drop. Thus less wattage is developed at this junction and a colder contact is the result, which in turn has the effect of reducing the thermal gradient induced by the subsequent arc on the contacts.

This invention concerns a type of switch latching mechanism that both effects a switch open and switch closed latching arrangement but at the same time increases the contact pressure just prior to attaining these changed positions.

It is a further object of this invention to illustrate a latching arrangement that is adaptable to many types of actuating mechanisms to provide a versatile and economical control under varied conditions and requirements.

For a more complete understanding of the invention reference should now be had to the drawing in which,

Fig. 1 is a side view of one embodiment of the device shown in switch closed position just prior to being latched open;

Fig. 2 is a side view of the device of Fig. 1 with the switch shown in open position;

Fig. 3 is a side view of a modification of Figs. 1 and 2;

Fig. 4 is a side view of a modification of Figs. 1, 2 and 3;

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Fig. 5 is a sectional view taken along lines 5—5 of Fig. 3;

Fig. 6 is a sectional view taken along lines 6—6 of Fig. 4.

In Figs. 1 and 2 the actuating or power element of the device is shown as consisting of a diaphragm assembly and a U-shaped spring, the device itself is of the reverse acting type, i. e. it closes its contacts on a temperature rise. In Figs. 3, 4, 5 and 6 the actuating element of the device consists of a U-shaped bimetal.

Referring now to Figs. 1 and 2, the device shown comprises an insulation base 10 having attached thereto a U-shaped structure 11 by means of a flat spring hinge 12. The spring hinge 12 is held to the base 10 by a connector plate 13, washer 14 and screw 15. The spring hinge 12 is biased in a downward direction to move the U-shaped structure 11 in a counterclockwise direction about the screw 15. The structure 11 consists of a U-shaped spring 16 attached to spring hinge 12 by rivet 17. The U-shaped spring 16 is biased to converge its ends. Between the legs of the U-shaped spring 16 is placed a sealed diaphragm 18, having an upper connecting rod 19 secured to the upper leg of spring 16 and a ball joint 20 secured to the lower leg of spring 16, to control the position of the legs of U-shaped spring 16. This diaphragm structure is a sealed unit having a fluid fill subject to temperature changes to effect movement of the arm 19 and ball 20. This diaphragm unit is explained in detail in application Serial Number 600,862, filed June 22, 1945, now Patent Number 2,487,947.

At the left side of the base 10 another flat spring hinge 22 is fastened to the base and to a connector plate 23 by a washer 24 and a screw 25. The opposite end of spring hinge 22 is fastened to a contact arm 26 having a contact 27 for engagement with contact 21 which is fastened to the lower leg of spring 16. Spring hinge 22 is biased downwardly to pivot contact arm 26 in a clockwise direction about the screw 25. Also fastened to spring 22 is an insulation piece 28. The spring 22, contact arm 26 and insulation piece 28 are secured together by rivet 29. Extending upwardly from the piece 28 is a latch 30 fastened by rivet 31. The insulation piece 28 electrically insulates the U-shaped spring 16 from the contact circuit. The upper end of latch 30 engages with the end 33 of U-shaped spring 16 to maintain the U-shaped spring 16 in the position shown in Fig. 1, holding against the bias of spring hinge 12.

Fastened to the U-shaped spring 16 by rivet

17 is a bracket 34 which supports a range adjusting screw 35. The function of screw 35 is to spread and converge the projecting legs of U-shaped spring 16 and thereby vary the operating or cut-in point of the device. There is also added in the base 10 a stop adjusting screw 36 to permit varying of the differential setting between the cut-in and cut-out points of the device. Two connecting screws 32 and 37 permit circuit connections to be made for a circuit to be controlled.

In the operation as shown in Fig. 1, a temperature decrease affecting the diaphragm 18 is reflected in a converging action of the legs of U-shaped spring 16 thru the force exerted by the spring bias of spring 16. The leg 33, however, is restrained by the latch 30 from moving in a downward direction. The contact end 21 is free, however, and starts moving upwardly away from the stop 36. The end 21, which is already in engagement with contact 27, will thereby move contact 27 and contact arm 26 upwardly. Fig. 1 shows this movement after a period of time has elapsed and the movement of contact end 21 has progressed from a point of rest on the stop 36 to the position shown. The quiescent position when contacts are closed has the portion of member 16 carrying contact 21 abutting the stop 36. Note, that as contact arm 26 moves upwardly, the spring 22 resists this movement thereby causing increased contact pressure between contacts 27 and 21. The downward bias of spring 12 is a somewhat negligible factor at this time because it acts on the whole U-shaped structure 11 which is not movable downwardly as a unit until the latch 30 releases the end 33. This is effected after a predetermined distance has been traversed by arm 26 and latch 30 is kicked out from under end 33 of spring 16. Then the U-shaped structure 11 moving as a unit under the bias of spring hinge 12 snaps downward until arm 16 engages the stop 36. The contacts 21 and 27 snap open because latch arm 30 and arm 26 remain in their raised positions, held by end 33 abutting latch arm 30. Note that the action of breaking contact is accomplished at a point when contact pressure is at a maximum.

With the switch now in the position as shown in Fig. 2 the reverse operation will now be described. In this position (Fig. 2) end 33 acts as the latch to hold the latch arm 30 against clockwise movement under the bias of spring 22. An increase in temperature will now result in an expansion of the diaphragm 18 and the resulting spreading of the legs 33 and 16 by the rod 19 and ball 20. But leg 16 and contact 21 are now abutting the stop 36, therefore movement of leg 16 downward is blocked. Thus the spreading action of the diaphragm 18, arm 19 and ball 20 is reflected only in the upward movement of end 33. As end 33 moves upwardly the contact arm 26 and arm 30 are moved slightly in a counterclockwise direction since arm 30 is inclined slightly to the right as viewed in Figs. 1 and 2, this further increases the tension of spring 22. This action increases the bias of spring 22 in the clockwise direction but is not released until the latch 33 clears the latch arm 30 and the contacts 27 and 21 snap closed.

In Figs. 3 and 5 is shown a modification of Figs. 1 and 2 whereby a U-shaped bimetal is substituted as the actuating mechanism for the diaphragm 18 and spring 11 of Figs. 1 and 2 and the device itself has the conventional sequence of operation, i. e. it opens its contacts on a temperature rise. In Figs. 3 and 5 the insulation base 37 has a U-shaped structure 38 pivotally attached thereto by a flat spring 39. The spring 39 is attached to the base 37 by a washer 40 and a screw 41. The bimetal 42 of the U-shaped structure 38 is secured to the spring 39 by a rivet 43. The spring 39, like its counterpart in Figs. 1 and 2, spring 12, is biased in a downward direction.

At the left end of the base 37, two connector plates 44 and 44A (Fig. 5), two flat springs 45 and 45A (Fig. 5), an insulation piece 46, flat spring 47, and washer 48 are secured by screws 49 and 49A (not shown).

Note, that in Figs. 3, 4, 5 and 6 a contact bridge arrangement is used to eliminate current flow thru the bimetals. This is necessary because, as is well known, current flow and the resulting generation of heat affects the operation of thermostatic bimetal.

As shown in Figs. 3 and 5, the lower contact arms 50 and 50A are attached to flat springs 45 and 45A respectively by rivets 51 (one of which is shown). The lower contact arms 50 and 50A are electrically separated but mechanically connected by an insulation bridge 52 which allows for their synchronous movement. The upper contact arms 53 (one of which is shown) are attached to flat spring 47. A conductor bridge 54 electrically and mechanically connects contacts 55 and 55A of contact arms 53. The contact bridge 55—54—55A, engages with contacts 56 and 56A to complete the circuit traced as follows: connector 44, spring 45, contact arm 50, contact 56, contact 55, conductor 54, contact 55A, contact 56A, contact arm 50A, spring 45A and connector 44A. The contact arms 53 and 53A are joined and fastened to spring 47 by rivets 57. Extending upwardly from the rivet 57 is an extended portion 58 of arms 53. This portion 58 constitutes the latch for the end 59 of bimetal 42.

As can be seen in Fig. 5, the lower leg 60 of bimetal 42 coacts with the insulation bridge 52 to move the lower contact arms 50 and 50A in accordance with temperature changes affecting bimetal 42.

Attached to bimetal 42 by rivet 43 is a bracket 61 which serves as a support for a range or operating point adjusting screw 62. The screw 62 adjusts the operating point of the device by varying the distance between the bimetal legs 59 and 60 as does screw 35 in Figs. 1 and 2.

A stop adjusting screw 63 is provided to regulate the extremity of travel of leg 60 and thereby provides a differential adjustment.

In operation, ambient temperature changes affecting the bimetal 42 cause the legs 59 and 60 to flex in opposite directions for any given temperature change. By way of example, assuming the fast expanding metal component of member 38 is located on the outside an increase in the temperature will cause leg 59 to flex downwardly and leg 60 to flex upwardly. Leg 59 is restrained against downward movement by latch 58 but leg 60 will move upwardly engaging insulation bridge 52. Further movement of leg 60 will carry bridge 52 and contacts 56 and 56A upwardly pushing contacts 55 and 55A and their contact arms 53 upwardly. This movement will cause arms 53, and latch 58 to pivot counterclockwise around the point 49 which after a predetermined distance will disengage latch 58 from leg 59 causing the contacts to open with a snap. This operation of the latch mechanism is the same as that previously described in connection with Figs. 1 and 2 except that in Figs. 3 and 5

a temperature increase causes the contacts to open while in Figs. 1 and 2 a temperature decrease causes the contacts to open. Note that in the modification shown in Figs. 3 and 5 no part of the current will flow thru the bimetal 38 because no contacts are mounted on the bimetal.

In the modification shown in Figs. 4 and 6 a bimetal is again utilized as the actuating element but the insulation and conduction bridges are reversed. The insulation base 64 has a flat spring 65 attached by a washer 66 and screw 67. A U-shaped bimetal 68 is fastened to the spring 65 by a rivet 69. Also attached to the bimetal 68 by rivet 69 is a bracket 70 supporting a range adjusting screw 71 similar to screws 35 and 62 of Figs. 1, 2 and 3.

The left side of insulation base 64 has two connectors 72 and 72A (Fig. 6), two flat springs 73 (one of which is shown) and two washers 74 (one of which is shown) held by screws 75 (one of which is shown). To the spring 73 is fastened contact arm 76. To one of the springs 73 is fastened contact arm 76A (Fig. 6). Attached across springs 73 is an insulation piece 77 held by rivets 78. Contact arms 76 and 76A are fastened to contacts 79 and 79A (Fig. 6) respectively. These contacts, 79 and 79A, are located physically adjacent to a contact bridge comprised of contact 80, conductor 80A and contact 80B (Fig. 6). This contact bridge is insulated from the bimetal leg 81 by an insulation strip 86.

Attached to the insulation piece 77 by rivet 83 is a latch 82. The latch 82, as shown, engages the bimetal leg 84. A stop adjusting screw 85 performs the same function as in Figs. 1, 2, 3 and 5.

The operation of this modification (Figs. 4 and 6) is the same as in Figs. 3 and 5 and therefore requires no further explanation. The contact structure 80 in this modification is physically mounted on the bimetal 81 but electrically insulated therefrom. The circuit to be controlled can be connected across terminals 72 and 72A. The circuit through the device can be traced as follows: terminal 72, spring 73, contact arm 76, contact 79, contact 80, conductor 80A, contact 80B, contact 79A, contact arm 76A, other spring 73 and terminal 72A.

From the foregoing description it will be readily apparent that many modifications of this invention are possible and I wish to be limited only by the scope of the appended claims.

What is claimed is:

1. A condition responsive switching mechanism including a base, a U-shaped member in spaced overlying relation to said base, the legs of said member being moveable relative to each other upon a condition change, a stop mounted on said base adjacent one leg of said U-shaped member, first biasing means biasing said U-shaped member against said stop, a first contact mounted for movement by said one leg, moveable means including a second contact engageable with said first contact and a latch member, said moveable means being moveable by said one leg from a first position wherein said latch member is in latching engagement with the other leg of said U-shaped member and said contacts are closed to a second position wherein said contacts are open and said latching engagement is released, said other leg retaining said latch member in said second position, second biasing means biasing said moveable means into said first position, said one leg being moveable toward said other leg upon a change in said condition in one sense to move said moveable means from said first position to said second position against the force exerted by said second biasing means, said other leg being moveable upon a condition change in another sense to permit said second biasing means to move said moveable means back to said first position, and adjusting means for manually adjusting the relative position of the legs of said U-shaped member.

2. A temperature responsive switching mechanism including a base, a U-shaped member in spaced overlying relation to said base, an expansible temperature responsive element mounted within the bight of said U-shaped member to provide relative movement between the legs of said member, an adjustable stop mounted on said base adjacent one leg of said U-shaped member, first biasing means biasing said U-shaped member against said stop, a first contact mounted for movement by said one leg, moveable means including a second contact engageable with said first contact and a latch member, said moveable means being moveable by said one leg from a first position wherein said latch member is in latching engagement with the other leg of said U-shaped member and said contacts are closed to a second position wherein said contacts are open and said latching engagement is reelased, said other leg retaining said latch member in said second position, second biasing means biasing said moveable means into said first position, said one leg being moveable toward said other leg upon a decrease in the temperature affecting said temperature responsive element to thereby move said moveable means from said first position to said second position against the force exerted by said second biasing means, said other leg being moveable upon an increase in said temperature to permit said second biasing means to move said moveable means back to said first position and adjusting means for manually adjusting the relative position of the legs of said U-shaped member.

3. A temperature responsive switching mechanism including a base, a U-shaped bimetal member in spaced overlying relation to said base, an adjustable stop mounted on said base adjacent one leg of said member, first biasing means biasing said member against said stop, a first contact mounted for movement by said one leg, movable means including a second contact engageable with said first contact and a latch member, said movable means being moveable by said one leg from a first position wherein said latch member is in latching engagement with the other leg of said member and said contacts are closed to a second position wherein said contacts are open and said latching engagement is released, said other leg retaining said latch member in said second position, second biasing means biasing said moveable means into said first position, said one leg being movable toward said other leg upon a decrease in the temperature affecting said bimetal member to thereby move said moveable means from said first position to said second position against the force exerted by said second biasing means, said other leg being movable upon an increase in said temperature to permit said second biasing means to move said moveable means back to said first position.

4. A temperature responsive switching mechanism including a base, a U-shaped bimetal member in spaced overlying relation to said base, an adjustable stop mounted on said base adjacent one leg of said member, first biasing means biasing said member against said stop, a first con-

tact mounted for movement by said one leg, moveable means including a second contact engageable with said first contact and a latch member, said moveable means being moveable by said one leg from a first position wherein said latch member is in latching engagement with the other leg of said member and said contacts are closed to a second position wherein said contacts are open and said latching engagement is released, said other leg retaining said latch member in said second position, second biasing means biasing said moveable means into said first position, said one leg being moveable toward said other leg upon a decrease in the temperature affecting said bimetal member to thereby move said movable means from said first position to said second position against the force exerted by said second biasing mean, said other leg being movable upon an increase in said temperature to permit said second biasing means to move said moveable means back to said first position, and adjusting means for manually moving said legs relative to each other.

5. In a condition responsive switch, an insulation base having mounted thereon at one end a first spring member, a U-shaped spring biased to converge its extremities mounted on said first spring member and biased thereby in one direction, a stop on said base adjacent the lower leg of said U-shaped spring, a second spring member mounted on the other end of said base, a latch lever mounted on said second spring member biased thereby in one direction and abutting the upper leg of said U-shaped spring, a movable contact arm mounted on said second spring member, adjusting means for manually adjusting the relative position of the legs of said U-shaped spring, a diaphragm assembly supported between the upper and lower legs of said U-shaped spring to move said legs relative to each other, a first contact mounted on the lower leg of said U-shaped spring for engagement with a second contact on said contact arm whereby converging movement of said diaphragm assembly causes said lower leg to move upwardly carrying said contact and said contact arm upwardly until said lever slips out from under said upper leg causing said contacts to open, and whereby diverging movement of said diaphragm assembly causes said upper leg to move upwardly until said upper leg releases said lever allowing the contact arm to spring downwardly closing the contacts.

6. In a condition responsive switch, an insulation base supporting a switch structure comprising, a first spring member biased in one direction, a second spring member biased in said one direction, a U-shaped spring member biased to converge its ends, a lever attached to said second spring member having a latch member abutting one end of said U-shaped spring member, adjusting means for manually adjusting the relative position of the ends of said U-shaped spring member, a contact arm attached to said second spring member, a diaphragm structure operatively connected to said U-shaped spring member to diverge its ends under the influence of condition changes, a stop on said base adjacent one of the legs of said U-shaped spring member, a contact mounted on said U-shaped spring member for engagement with said contact arm whereby converging action of said U-shaped spring results in an upward movement of said contact and a pivotal movement of said contact arm and said lever, whereby said latch member disengages said U-shaped spring member to snap open said contact and said contact arm, and whereby diverging action of said U-shaped spring results in releasing said latch member to snap closed said contact and said contact arm.

7. A temperature responsive switching mechanism including a base, a U-shaped bimetal member in spaced overlying relation to said base, an adjustable stop mounted on said base adjacent one leg of said member, first biasing means biasing said member against said stop, a first contact movable by said one leg, movable means on said base including a second contact engageable with said first contact and a latch member, said movable means being movable by said one leg from a first position wherein said latch member is in latching engagement with the other leg of said member and said contacts are closed to a second position wherein said contacts are open and said latching engagement is released, said other leg retaining said latch member in said second position, second biasing means biasing said movable means into said first position, third biasing means biasing said first contact against said one leg, said one leg being movable toward said other leg upon a decrease in the temperature affecting said bimetal member to thereby move said movable means from said first position to said second position against the force exerted by said second and third biasing means, said other leg being movable upon an increase in said temperature to permit said second biasing means to move said movable means back to said first position.

8. A temperature responsive switching mechanism including a base, a U-shaped bimetal member pivotally mounted on said base and biased in one direction, a first contact pivotally mounted on said base, movable means pivotally mounted on said base and biased in one direction, said movable means including a second contact engageable with said first contact and a latch member, said latch member engageable with one leg of said U-shaped bimetal member, said contacts movable by the other leg of said U-shaped bimetal to effect contact action to a first latching position, and said contacts movable to a second position by reversed action of said U-shaped bimetal to effect contact action to a second latching position.

9. In a temperature responsive device, an insulation base having mounted thereon a U-shaped bimetal in spaced overlying relation to said base, a first biasing means biasing said bimetal against said base, a first contact mounted on said one leg and movable therewith, movable means carrying a second contact, second biasing means biasing said movable means against said first contact, a latch member mounted on said movable means and engageable with the other leg of said U-shaped bimetal, and adjusting means for manually adjusting the relative position of the legs of said U-shaped bimetal.

10. A condition responsive switching mechanism including a base, a U-shaped member in spaced overlying relation to said base, the legs of said member being movable relative to each other upon a condition change, first biasing means biasing said U-shaped member against said base, a first contact mounted for movement by one leg of said U-shaped member, movable means including a second contact engageable with said first contact and a latch member, said movable means being movable by said one leg from a first position wherein said latch member is in latching engagement with the other leg of said U-

shaped member and said contacts are closed to a second position wherein said contacts are open and said latching engagement is released, said other leg retaining said latch member in said second position, second biasing means biasing said movable means into said first position, said one leg being movable toward said other leg upon a change in said condition in one sense to move said movable means from said first position to said second position against the force exerted by said second biasing means, said other leg being movable upon a condition change in another sense to permit said second biasing means to move said movable means back to said first position, and adjusting means for manually adjusting the relative position of the legs of said U-shaped member.

11. A condition responsive switching mechanism comprising a base, means including a condition responsive element mounted in spaced overlying relation to said base, a spring biasing said means toward said base, a contact-carrying lever pivotally mounted on said base, a member carried by said lever in engagement with a portion of said means when said lever is in a first

position and held in latching engagement by said spring, said means, upon a change in the condition moving said lever to a second position and into latching relation with said member for retaining said lever in said second position, and contacts one of which is moved by said lever another being moved by said means, said contacts being closed when said lever is in said first position and open when said lever is in said second position, and adjusting means for adjusting the magnitude of the condition change required to move said lever from said first to said second position.

JURG A. SENN.

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