April 16, 1968 E. S. ARLIN ET AL 3,378,658

MAGNETICALLY CONTROLLED RESETTABLE SWITCH

Filed April 4, 1966

Fig. 1

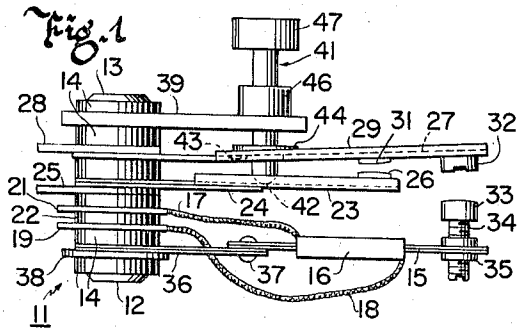


Fig. 2

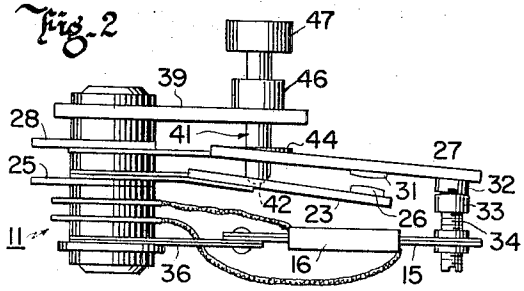


Fig. 3

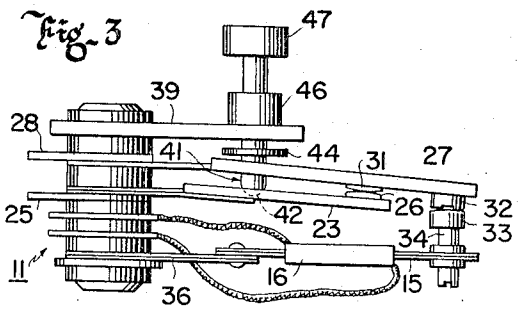


Fig. 4

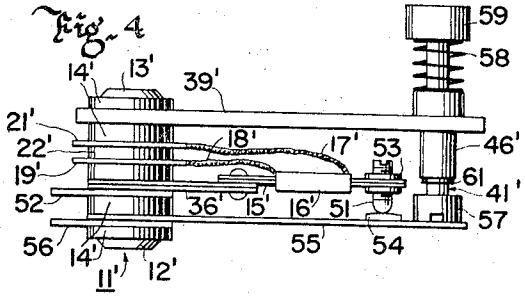


Fig. 5

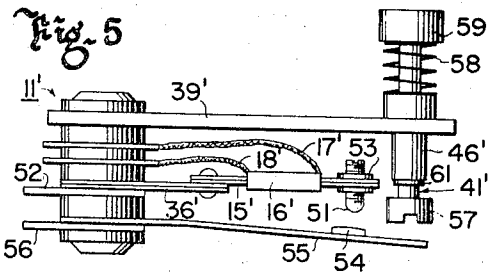


Fig. 6

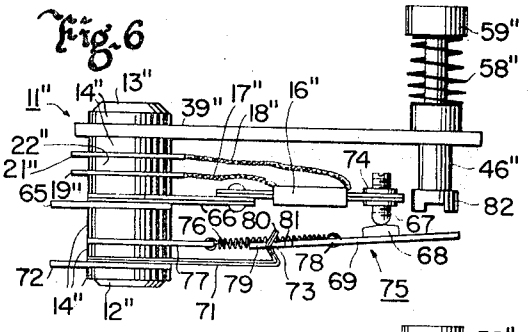
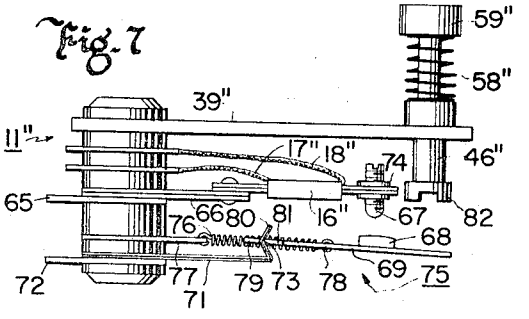


Fig. 7



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MAGNETICALLY CONTROLLED RESETTABLE SWITCH

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This invention relates to electrical switches and more particularly to switches which are tripped under given conditions and resettable only following elimination of said predetermined conditions.

A number of utilizations of electrical controls are known in which a circuit control is actuated from one stable state to another upon the persistance of a given condition for a predetermined interval. Frequently, the return of the control to its first condition is restricted to a reset operation which is calculated to assure the restoration of safe conditions in the system prior to the reactivation of the controls. For example, gas and oil fired burners utilize safety devices which disable their controls in response to conditions indicative of a malfunction and which require manual resetting. It is desirable that such devices be arranged so that the resetting function is effective only when the conditions which triggered the device no longer prevail. Since such devices when improperly reset are often capable of creating dangerous conditions, it is desirable to positively assure that an improper reset cannot be accomplished. This has required the utilization of multiple interlocking controls and equipment of substantial complexity.

An object of the present invention is to improve resettable electrical switches.

A second object is to simplify resettable electrical switches.

A third object is to interlock the reset functions and control functions of electrical switches to avoid actuation of the controls during a resetting operation.

A fourth object is to avoid mechanical constraints such as catches and detents on the motion of a switch blade to its tripped condition.

Another object is to reset switches utilizing magnetic force to limit the constraints imposed upon the retripping of the switch.

A further object is to critically relate magnetic reset and latch forces to actuating conditions in simple switch structures:

In accordance with the above objects, one feature of this invention is a reset mechanism for a switch contact and its movable support resiliently biased to a tripped condition comprising a magnetic pickup which is extended into the range of influence of the contact and its movable support to attract the contact and its movable support.

Another feature is a manual movement of a magnet to a position to overcome resilient forces on a switch blade to reset the switch blade. This can be accomplished by moving the blade manually into the range of magnetic influence where magnetic forces oppose and overcome the resilient forces.

A third feature as applied to a switch blade having two stable positions separated by a region of instability across which it shifts rapidly is to provide a reset mechanism which includes a magnetic element cooperating with a magnetic element on the blade such that the reset mechanism can be positioned in the vicinity of the tripped blade with the respective magnetic elements within effective range of influence of each other. The magnetic forces between the reset machnism and blade to be effective must overcome the forces biasing the blade in its tripped position. The magnetic forces are effective upon the blade while the reset mechanism transfers it into the region of blade instability and at least to a position from which it will advance to its stable reset position.

A further feature is a magnetic latch working against resilient bias and thermally actuated forces to retain a switch in a reset condition until the thermally actuated component exceeds a predetermined tripping level.

The above and additional objects and features will be more fully appreciated from the following detailed description when read with reference to the accompanying drawing in which:

FIG. 1 is a side elevation in the tripped condition of a switch including one embodiment of the invention wherein magnetic attraction is employed for both resetting and latching a switch blade;

FIGS. 2 and 3 are side elevations of the switch of FIG. 1 respectively showing the switch as it is being reset and in the reset condition;

FIG. 4 is a side elevation in the reset condition of another form of a magnetically reset and latched switch according to this invention including a thermal time delay tripping mechanism;

FIG. 5 is the switch of FIG. 4 in the tripped condition;

FIG. 6 is a side elevation in the reset condition of a magnetically reset overcenter snap action switch according to this invention; and

FIG. 7 is the switch of FIG. 6 in the tripped condition.

Each of the illustrated embodiments of the invention includes a stack 11 of elements assembled upon a rivet 12 having a head 13. The elements making up the stack are assembled in a generally conventional manner by utilizing insulating bushings 14 which have shanks (not shown) fitting within the apertures (not shown) of the adjacent conductive elements in the stack to electrically insulate those elements from the rivet 12 and each other.

The switch of each embodiment is of the thermal time delay variety wherein a bimetallic blade 15 upon which is mounted in intimate heat transfer relationship an electrical heater 16 is shifted in position by the warping of the bimetal in some predetermined relationship to the current flowing in the heater. This current is fed to the heater over leads 17 and 18 from suitable heater terminals 19 and 21 in stack 11. An insulating washer 22 separates the terminals 19 and 21 which are otherwise isolated from the elements of the stack by the centering shanks (not shown) on adjacent bushings 14. Heater 16 is electrically insulated from bimetal blade 15 to complete the electrical isolation of the heater from the primary circuit of the switch.

Magnet latching is employed to maintain the switch of FIGS. 1, 2 and 3 reset. The switch is tripped by separating the magnetically attracting elements sufficiently so that a mechanical bias exceeds the magnetic attraction and the contact blades separate to break the switch's primary circuit. It is reset by moving the released blade from its second stable position into the range of magnetic attraction of sufficient force to overcome the mechanical bias. During the reset operation the other blade of the switch is displaced to prevent completion of the circuit.

In particular, in FIGS. 1, 2 and 3, the switch comprises a first blade 23 arranged with longitudinal stiffening ribs to concentrate its flexure adjacent stack 11. This blade is further stiffened by a stiffening blade 24. A main terminal 25 is in electrical communication with blade 23 and its switch contact 26 through blade 24. A second blade 27 and its main terminal 28 is located in the stack above blade 23 as viewed in the drawings. Both of blades 23 and 27 are resiliently biased upward in the drawings.

Blade 27 has longitudinal stiffening flanges 29 and carries a contact 31 arranged to engage contact 26 when the

switch is reset as shown in FIG. 3. It also carries a magnet 32 for latching it in its reset position by its magnetic attraction to ferromagnetic slug 33 carried on the bimetal blade 15. Slug 33 is adjustably positioned on blade 15 by its supporting threaded shank 34 fitting into threaded bushing 35 swaged in a suitable aperture of blade 15. If it is desired to electrically isolate the bimetal blade from the main circuit of the switch, the magnet 32 can be secured to blade 27 by a non-conductive coupling or bushing 35 can be made non-conductive.

When no heat is developed in heater 16, slug 33 is positioned as shown in FIGS 1 and 3 such that when the switch has been tripped, as in FIG. 1, the magnet 32 and slug 33 are separated beyond the range of magnetic attraction and when it has been reset blade 27 is magnetically held as shown in FIG. 3. Ambient temperature compensation of the position of slug 33 is provided by the opposed flexure with temperature changes which occurs in bimetal blades 36 and 15. These blades are joined at their overlapped ends as by rivets 37 to provide an effective length of blade 36 from the edge of abutting washer 38 to the rivets 37 which flexes upward at its rivet end with increased temperature. This compensates the downward flexure of the free end of blade 15 with temperature increases over the length from rivet 37 to bushing 35. Thus in the range of ambient temperature changes for which the switch is designed, the slug 33 is maintained at its adjusted latching level.

The switch when reset is maintained in the condition shown in FIG. 3. It is tripped when a predetermined amount of heat is applied to bimetal blade 15 to flex the blade downward and move slug 33 out of the region in which the magnetic attraction between the slug 33 and magnet 32 is sufficient to overcome the spring bias formed in blade 27 which tends to move it upward at its outer end. Current flowing in heater 16 in an amount and over an interval sufficient to develop the flexing temperature releases the magnet from the slug to the position shown in FIG. 1.

A rigid blade 39 adjacent the end of stack 11 supports the reset actuator, an insulating plunger 41 having an end 42 abutting the upper face of blade 23, a shank passing freely through an aperture 43 in blade 27 and a flange 44 engaging the upper face of blade 27 adjacent aperture 43. Plunger 41 is guided for reciprocal motion within sleeve 46 which is swaged through an opening in blade 39. The motion of the plunger is generally perpendicular to the major face of the blades 27 and 23 and in the plane of motion of blade 27 between its latched and tripped positions. The upper shank 45 of plunger 41 is capped by a button 47 adapted to receive finger pressure when the switch is reset manually. Plunger 41 is biased to position by the resilience of blade 23 when manual pressure is relieved.

Resetting of the switch is illustrated in FIG. 2. In resetting, blade 27 is displaced to bring magnet 27 into effective range of slug 33 so that a magnetic latch is established to hold blade 27. The lower face of flange 44 on plunger 41 causes this displacement of blade 27 when button 47 is depressed. Throughout the resetting, contacts 31 and 26 are held apart by the spaced relationship maintained between blades 27 and 23 by plunger 41. This relationship is determined by the spacing of those portions of plunger 41 abutting blades 27 and 23, particularly the lower face of flange 44 and the plunger end 42. Thus depression of plunger 41 moves blade 23 downward as it moves blade 27 to the reset position as shown in FIG. 2. During reset the travel of plunger 41 is restricted by blade 24 so that blade 27 cannot be displaced to magnetically latch if bimetal blade 15 has been displaced from its normal latching position. This avoids a false closing of the circuit through contacts 31 and 26 if resetting conditions have not been properly restored.

The magnetic forces of the switch of FIGS. 1, 2 and 3 are utilized for latching the actuated blade in its reset condition in opposition to a continuously effective spring bias tending to move the blade toward its tripped position. The opening of the switch contacts in this arrangement where both blades are resiliently biased in the same direction is insured upon tripping the switch by the restriction imposed upon the motion of blade 23 in its biased direction by the end 42 of plunger 41 as the upper face of flange 44 integral therewith abuts rigid support blade 39. Further, in this arrangement continuous resetting force must be imposed to carry the magnetic latch elements 32 and 33 into effective range of each other and until the latch is made up. While this force is imposed end 42 of plunger 41 remains effective to maintain the relative positions of blades 27 and 23 and contacts 31 and 26 open. Release of the reset force permits the resilience of blade 23 to displace the plunger 41 and close the contacts without augmenting the upward bias of blade 27 to a degree sufficient to overcome the magnetic latching forces between slug 33 and magnet 32.

In the structure of FIGS. 4 and 5 the reset and latching of the contact blade also is effected against a continuously applied resilient bias toward the tripped position of the blade. However, reset is accomplished by moving the magnetic element of the reset and latch mechanism to the blade rather than the blade to the latch.

Since the embodiments of FIGS. 4 and 5 and FIGS. 6 and 7 include many elements corresponding to those of FIGS. 1 to 3 like elements will be identified with like references characters. These reference characters will be identified by a single prime as applied to the embodiment of FIGS. 4 and 5 and a double prime for the embodiment of FIGS. 6 and 7.

In FIGS. 4 and 5 a stack assembly 11' comprises a rivet 12' on which is mounted conductive elements and, where appropriate for insulating purposes, insulating bushings 14'. The composite bimetal blade 36', 15, is arranged for ambient temperature compensation in the manner of FIG. 1. Its heater 16' when carrying current to raise the temperature of blade 15' causes the outer end of the blade to flex downward. In the unheated and compensated position the actuator 51 on blade 15' is adjusted as shown in FIG. 4.

Composite bimetal blade 36', 15' is in the main circuit of the switch. It has a terminal 52 and its actuator 51 is a conductive contact button threadedly mounted in tapped bushing 53 secured in the outer end of blade 15'. Contact 54 cooperating with button 51 in the main circuit of the switch is secured on resilient blade 55. Main terminal 56 abuts blade 55 in the stack 11'.

Mechanically, blade 55 is resiliently biased downward so that when unconstrained it assumes the position shown in FIG. 5 whereby the contact 54 is separated from contact 51 for all ranges of heating of blade 15' by heater 16'. The upward travel of blade 55 is constrained by contact 54 abutting contact 51. Forces are imposed on blade 55 to move it upward by the attraction of magnet 57, blade 55 either being of ferromagnetic material or having a ferromagnetic section (not shown) in the region abutted by magnet 57. Magnet 57 is supported on plunger 41' mounted for reciprocation in the plane of motion of blade 55 and generally perpendicular thereto by rigid supporting blade 39' and its integral plunger guide sleeve 46'. A retracting spring 58 is arranged to bias the magnet 57 toward blade 39'. Spring 58 is shown as a coil spring in compression between the underside of the button 59 on the head of plunger 41' and the upper end of sleeve 46' where it passes through and is secured in blade 39'.

In one application of the switches of this invention they are to be tripped with a dissipation in their heater of 0.4 watt. This requires a balance between the flexure forces of the thermally responsive tripping element, bimetal 15' in FIG. 4, the resilient forces imposed on the spring biased element for the switch contact, the resilience of contact blade 55 aiding the thermally induced forces of blade 15' in FIG. 4, and the magnetic latching forces

between blade 55 and magnet 57, such that the continuous dissipation of 0.4 watt in heater 16' is sufficient to warp blade 15' and produce a force which when combined with the bias on blade 55 will move blade 55 out of the latching range of attraction of magnet 57. Plunger spring 58 is therefore arranged to retain plunger 41' at the position shown in FIG. 4 as the blade 55 is deflected downward to separate the blade 55 from magnet 57. One means of insuring the proper position of retracted magnet 57 is a stop flange 61 on the plunger 41' to abut its upper face against the lower end of sleeve 46'.

Once the blade 55 is freed from its magnet 57 it snaps to the position shown in FIG. 5. It can be reset by depressing plunger 41' to extend magnet 57 into the range of attraction of blade 55 so that the blade is drawn to the magnet and, when the magnet is permitted to retract under the influence of spring 58, the blade is drawn toward the position shown in FIG. 4. If blade 15' has cooled and returned to the position shown in FIG. 4 at the time blade 55 is reset, the magnetic latch remains effective. If the blade 15' is in its stripping position at the time of reset the switch will again be tripped as the magnet is retracted since the blade will be forced out of the latching range of magnet 57.

The utilization of a magnet to attract the blade of a switch in its tripped position and the retraction of that magnet to draw the blade to its reset position can be advantageous even in those switch structures in which no latch function is required of the magnet. FIGS. 6 and 7 show a switch of this type having an activated contact of the over center snap action variety.

The primary circuit of the switch of FIGS. 6 and 7 is from terminal 65 through bimetal blade 66 to contact 67 on blade 66 and engageable with contact 68 on pivotally mounted blade 69 fulcrummed on blade 71 abutting terminal 72. Ambient temperature compensation is provided by the bimetal of blade 71 which causes the fulcrum 73 for the snap action to move with ambient temperature changes an amount to compensate for the shift of actuating contact 67 due to ambient temperature changes. Actuating temperature changes are imposed upon blade 66 by heater 16" to cause contact 67 to move blade 69 over center with respect to fulcrum 73 in response to the imposition of the triggering level of current in 16". In order to adjust for this trigger point actuating contact 67 is screw mounted in tapped bushing 74 secured in the blade 66.

The snap action assembly 75 includes a tension spring 76 coupled at its fixed end to a blade 77 secured in stack 11" and at its opposite end to pivoted blade 69 in the region 78 adjacent its contact 68. Blade 69 is bifurcated with a pair of legs 79 extending toward stack 11" from the region 78 to straddle spring 76. The blade 71 is also bifurcated to straddle spring 76 at its upturned ends 80 from which opposed sockets for the fulcrums 73 are formed. The fulcrums 73 are formed on ears 81 protruding outwardly from each leg 79 of blade 69.

Snap action of blade 69 occurs to the two limits shown in FIGS. 6 and 7. As shown in FIG. 6 in the reset or switch closed condition, the axis of tension along spring 76 is above the fulcrum or pivot mounting 73 for blade 69 so that the contact 68 is biased against contact 67. When the abutting face of contact 67 moves contact 68 and blade 69 downward to shift the tension axis of spring 76 below fulcrum 73, the blade 69 snaps downward until the lower face of spring 76 rests against the portion of the blade 71 intermediate upturned ends 80. Alternatively the motion of the ends of legs 79 can be limited as by arranging them to engage stops (not shown) on blade 77 or a stop (not shown) can be provided for the outer end of blade 69 in order to prevent excessive travel of blade 69 in the tripped direction.

In the tripped position as shown in FIG. 7, blade 69 reaches a stable position within the range of travel of magnet 82. This range is established by the stroke of plunger 41" in the plane of motion of blade 69 and generally perpendicular thereto as defined by sleeve 46". Rigid support blade 39" extends from stack 11" and retains sleeve 46" in a suitable aperture. A retraction spring 58" embraces plunger 41" between button 59" and the upper end of sleeve 46". When button 59 is depressed, it moves magnet 82 into its range of attraction for blade 69. Upon its release the plunger 41" and magnet are retracted by spring 58" to carry blade 69 around its pivot at 73 so that the tension axis of spring 76 is above the pivot and the over center snap action carries contact 68 against contact 67. Blade 66 is sufficiently stiff so that it does not flex upward appreciably even though the resilience of spring 58" causes the continued retraction of plunger 41" and magnet 82. Thus, the magnet 82 is carried out of the effective range of blade 69 and the switch is reset to a condition in which the only constraining force holding contact 68 against contact 67 is that of spring 76. In this condition the switch is readily tripped by application of a small tripping force.

It is to be understood that the magnetic attraction utilized in resetting switches as illustrated above together with switch constructions set forth lend themselves to many variations. For example, the magnets can be located on the actuated switch blades and slugs to which the magnets are attracted mounted on the resetting mechanism. Other forms of thermally responsive elements can be substituted for the bimetal blades. A number of snap actions are known which might be utilized. Therefore the present disclosure is to be read as illustrative and not in a limiting sense.

Having described the invention, we claim:

1. A resettable electric switch comprising a first contact; a second contact; a first contact support assembly for said first contact having a first stable position, a second stable position and a region intermediate said first and second positions; a displaceable contact support for said second contact; means resiliently biasing said second contact to a position engaging said first contact when said first contact support is in its first stable position; means to trip said first contact support to said second stable position; a first magnetic element included in said first contact support assembly and movable therewith; a second magnetic element engageable with said first magnetic element to develop a mutual magnetic attraction therewith; reset means for said first contact support assembly to move said support from said second to said first position, said reset means moving one of said magnetic elements into a range of magnetic attraction of said other magnetic element during said resetting function.

2. A resettable electric switch comprising a first contact; a second contact; a first contact support assembly for said first contact having a first stable position, a second stable position and a region intermediate said first and second positions; a displaceable contact support for said second contact; means resiliently biasing said second contact to a position engaging said first contact when said first contact support is in its first stable position; means to trip said first contact support to said second stable position; a reset means; a first magnetic element carried by said reset means; a second magnetic element included in said first contact support assembly and movable therewith; said reset means extending said first magnetic element into the range of magnetic attraction for said second magnetic element while said first support assembly is in said second positon; and means to retract said reset means to a position drawing said magnetically attracted second magnetic element and said first support assembly to said first position.

3. A combination according to claim 1 including a support for movably mounting said second magnetic element.

4. A combination according to claim 3 including means to position said second magnetic element to retain said first magnetic element by magnetic attraction to maintain said first contact support assembly in said first position.

5. A combination in accordance with claim 3 including

a thermally responsive means for shifting the position of said support for said second magnetic element.

6. A combination according to claim 5 including a control heater for controlling the temperature of said thermally responsive means.

7. A combination according to claim 1 including a thermally responsive means for shifting the position of said first contact support assembly from said first position to said second position.

8. A combination according to claim 7 including a control heater for controlling the temperature of said thermally responsive means.

9. A combination according to claim 1 including a thermally responsive means for shifting the position of said displaceable contact support, said second contact when displaced to a given position causing the displacement of said first contact support assembly to said second position.

10. A combination according to claim 2 wherein said displaceable contact support is a resilient blade movable in a plane normal to its major face; said first contact support is movable between its first and second positions in the plane of motion and along a path generally normal to the major face of said resilient blade; and said first magnetic element is movable by said reset means in the plane of motion and generally normal to the major face of said resilient blade.

11. A combination according to claim 10 including means to position said first magnetic element to retain said second magnetic element and said support assembly in said first position.

12. A combination according to claim 10 wherein said first contact support is a snap action assembly.

13. A combination according to claim 12 including means to bias said first magnetic element to a position spaced out of the range of effective magnetic attraction for said second magnetic element when said first contact support is in said first position.

14. A combination according to claim 10 wherein said first magnetic element and said displaceable contact support are located on a common side of said first contact support whereby said first magnetic element abuts and restricts the motion of said first contact support toward said displaceable contact support during the actuation of said reset means.

15. A combination according to claim 10 including means for resiliently biasing said first contact support toward said second position, and means for resiliently biasing said reset means to draw said magnetically attracted first contact suport toward said first position.

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