Sept. 19, 1944. W. F. WOLFNER, 2D 2,358,372

THERMAL SWITCH

Filed Oct. 16, 1941

Fig. 1

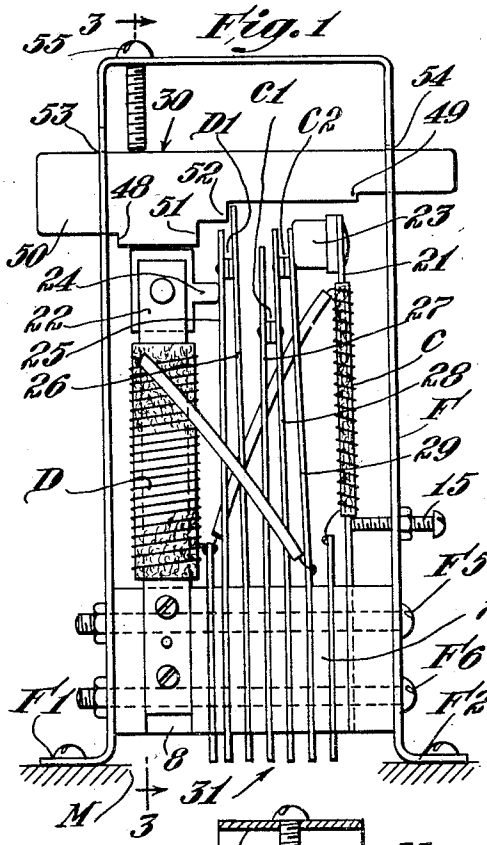
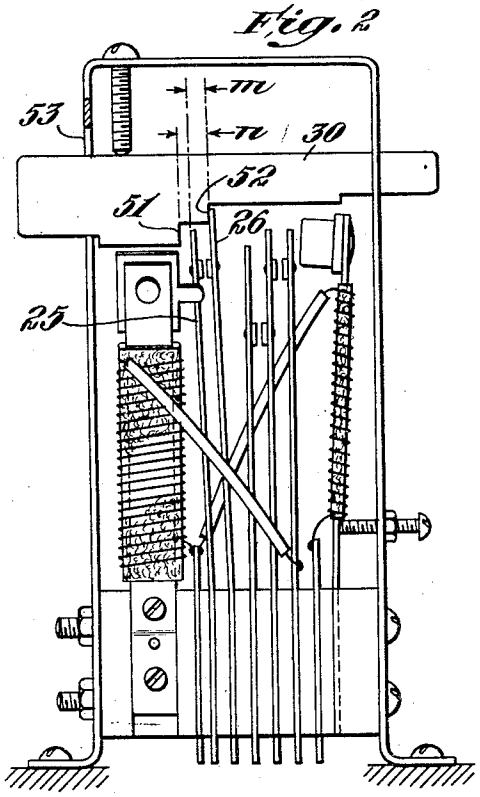


Fig. 2



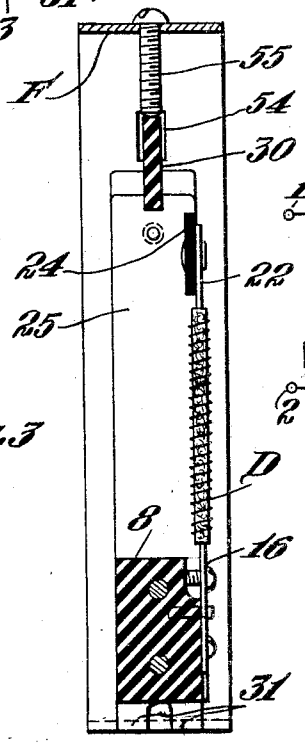


Fig. 3

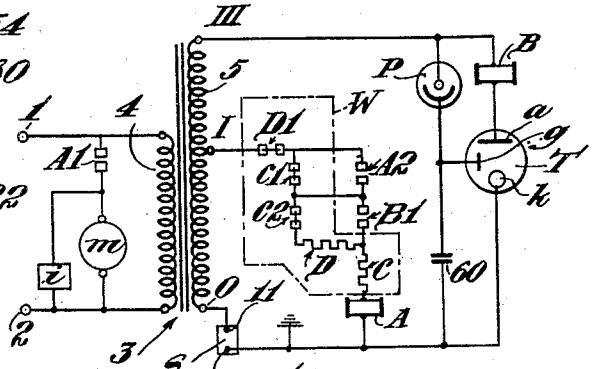


Fig. 4

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THERMAL SWITCH

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Application October 16, 1941, Serial No. 415,259

14 Claims. (Cl. 200—122)

This invention relates to electric switches and especially to switches with thermally controlled actuators.

It is one of the main objects of the invention to provide a simple, rugged and reliable switch unit of this type which can be easily assembled, checked and cleaned, which permits manual or relay control of switching elements in addition to thermal control, and is especially suited as a delayed action safety switch for burner installations.

In one aspect, the invention provides a switch which locks itself as well as its actuator in the position, for example open, attained after operation of the actuator; in another aspect, it provides a switch of this type which opens rapidly with snap action. In a further aspect the switch according to the invention has an actuation arrangement which, depending upon certain easily effected modifications in construction, provides for resetting with or without changing the switch position and with or without changing the actuator position; in a preferred embodiment the resetting initiating movement does not affect the switch position but permits resetting of the actuator if it is in readiness therefor, whereas only complete resetting movement such as release of an initially depressed button, is able to operate the switch proper. In still another aspect, the invention provides a thermally controlled switch which can not be reclosed before the thermal element has regained its initial condition, which prevents restarting during a predetermined period.

These and other objects, aspects and features of the invention will be apparent from the description of a specific embodiment illustrating the genus of the invention and referring to a drawing in which:

Figs. 1 and 2 are elevations of a switch according to the invention, with the thermal elements in normal and heated positions, respectively;

Fig. 3 is a section on line 3—3 of Fig. 1; and

Fig. 4 is a control circuit incorporating the switch according to Figs. 1 to 3.

Referring to Figs. 1, 2 and 3, a suitable holding or frame element as for example a U-shaped metal strip or bail F, having flanges F1, F2 for mounting the switch on an appropriate support M, holds between its arms by means of screws F3, F4 a series of blocks 7 of insulating material. Between these blocks and insulated from the screws are clamped switch spring strips 25, 26, 27, 28, 29 constituting switch contact elements, and a bimetallic actuator strip 21. Screwed to end block 8 is a second bimetal strip 22 which can move only in planes normal to the bail plane in which strips 21 and 25 to 29 are moving.

Strips 21 and 22 are provided with heating resistors C and D, respectively; in normal, unheated condition, the thermal strips 21, 22 assume the position shown in Fig. 1, whereas when heated they bend as indicated in Fig. 2. Screws 15 (Fig. 1) and 16 (Fig. 3) are provided for adjusting the movement of the thermal strips 21 and 22.

The switch springs 25 to 29 are provided with contacts and constitute switches C1, C2 and D1; under normal conditions, with bimetal strips 21 and 22 unheated, an insulating head 23 of strip 21 retains switches C1 and C2 closed (Fig. 1) and insulating finger 24 of strip 22, constituting a stop element, closes switch D1. The lower ends of the switch springs are extended into tails for connection with lead wires, as indicated at 31.

A resetting mechanism consists of block or bar 30 of insulating material which has two retaining shoulders 48, 49 and two control faces or shoulders 51, 52 and runs in two openings or slots 53, 54 of frame strip F. Slot 53 is high enough to permit insertion of block 30 (Fig. 2), but screw 55, if placed as indicated in Figs. 1 to 3, after insertion of the block, retains the block 30 in the frame without, however, hindering its sliding movement in slots 53, 54.

The control faces 51, 52 are preferably so spaced that their distance n (Fig. 2) is greater than the distance m of the stop faces of switch springs 25, 26 in open position. Therefore, pushing in of block 30 by means of resetting push button extension 50 will not close switch D1, whereas release of the button will permit this closing

As mentioned before, and shown in Fig. 1, all three switches C1, C2, D1 are closed when the thermal strips 21, 22 are cold. When resistor C heats up strip 21, switches C1 and C2 are permitted to open, as shown in Fig. 2, switch C1 opening before C2. If resistor D heats strip 22, the latter bends laterally (to the right in Fig. 3) and permits switch D1 to open as likewise shown in Fig. 2.

Cooling of strip 21 will reclose switches C1 and C2, the contacts being so arranged that switch C2 closes before switch C1.

Cooling of strip 22 in itself does not affect the position of switch D1, since spring blade 25 retains the strip in bent position (Fig. 2). This arrangement locks switch D1 in open position after it has once opened due to heating of strip

22, and also locks thermal element 22 in "hot" position. Further, the mechanical correlation of finger 24 and switch spring 25 effects instantaneous opening, or snap action of switch D1 as soon as the finger has reached the edge of spring strip 25.

Upon pressing button 50 towards the frame, shoulder 51 will move spring 26 towards the right (Fig. 2) and release thermal strip 22, provided it is cold, in the position of Fig. 3; D1 will not yet close due to the above-mentioned spacing of faces 51, 52. If the button is now released it is urged towards the left of Fig. 2 by spring 26 and the latter makes contact with 25 which is now retained by finger 24 in the closing position shown in Fig. 1. If strip 22 should be warm when the button is pressed, spring 25 is not stopped by finger 24 and releasing of push button 50 will have no effect.

It will now be apparent that a switch as above described does not permit the locking of contacts C1, C2 by securing the push button in depressed position, this position having only the effect of releasing actuator strip 22 provided it is cool.

It will be further apparent that the distances between the actuating shoulders and the corresponding switch spring faces may be correlated in different manner; for example, dimension *n* could be made smaller than *m*, in which case switch D1 would close immediately upon pressing button 50. Also, dimension *n* and the length of finger 24 can be so chosen that initial actuation of switch C1 may or may not release strip 22.

Although a switch of this type has many uses, its operation will be described with reference to a burner control circuit described in detail in my copending application Serial No. 415,257 filed on even date, and indicated in Fig. 4, which shows the essential circuit elements of Figs. 1 to 3 within frame W.

In Fig. 4, a source of alternating current 1, 2 supplies a burner motor *m* and an ignition device *i* through normally open switch A1, and primary 4 of transformer 3, whose secondary 5 has three taps O, I and III. Connected to taps O and III are anode *a* and cathode *k* of cold cathode tube T, in series with relay magnet B and room thermostat S with contacts 11, 12, respectively. The control electrode *g* of tube T is connected between a phototube P and a condenser 60 which are in series between taps O and III. Phototube P is so arranged that it can receive light from the burner flame.

Connected between tap 1 and contact 12 of the thermostat is a device of the present type with switches D1, C1 and C2, and heaters D and C; a relay magnet A is in series with heater C. In parallel to switch C1 is connected a normally open switch A2, and in parallel to C2 a normally open switch B1. Switches A1 and A2 are actuated by magnet A, and switch B1 is actuated by magnet B.

The operation of a switch according to the present invention, in a circuit of this type, is as follows:

Under normal idling conditions with the burner cold and the controlling temperature above the critical value, the circuit elements are conditioned as indicated in Figs. 1 and 3.

If the thermostat contacts 11, 12 are now closed either by hand or due to the controlling temperature falling below the desired level, magnet A is energized through circuit I—D1—C1—C2—D—C—A—12—11—O. Magnet A closes switches A1 and A2, starting motor and ignition through circuit 1—A1—*m*—2 and 1—A1—*i*—B2—2, and preparing a circuit directly including heater C, through I—D1—A2—B1—C—A—S—O. Heaters C and D are now heating up, and if D is of higher resistance than C, it will heat up faster than C.

The ignition being effective, the burner flame starts and the phototube receives light from the burner flame so that its impedance is considerably lowered, which causes the potential at the electrode *g* to rise above the starting value; tube T becomes conductive and magnet B is energized.

Magnet B now closes switch B1, shunting out heater D which normally will not yet have reached a position permitting opening of switch D1, and therefore causing heater C to heat up more rapidly.

Heater C quickly continues to heat its bimetallic strip which, after a predetermined time, opens first switch C1 and then switch C2.

The burner is now in normal operating condition, with phototube P illuminated, with control tube T conducting and magnet B energized, and with magnet A and heater C energized in the direct circuit I—D1—A2—B1—C—A—S—O.

If thermostat shut off is effected by the rise of room temperature during normal operation of the burner, the opening of contacts 11, 12 deenergizes magnet A and stops the motor, and darkening of the phototube restores the entire circuit to normal idling condition.

If ignition failure should occur, that is if the burner flame should fail to start although the ignition device is effective, the photocell will fail to render tube T conductive and magnet B will not be energized, so that B1 fails to shunt out heater D. Heater strip 22, after a predetermined time, will permit switch D1 to open, which deenergizes the circuit of magnet A and opens switch A1, stopping motor and ignition. Both heater coils C and D will now cool off, since their circuits are interrupted at D1; switches C1 and C2 will close, but switch D1 will remain open due to the above-described mechanical correlation of heater strip 22 and switch spring 25. Therefore all elements excepting D1 are in position for starting, so that the burner can now be restarted by releasing starter button 50 after it has been depressed. It will be noted that the burner cannot be started or kept running by keeping button 50 in depressed position; only release of the button initiates the starting cycle.

If flame failure should occur, that is if the flame should become extinguished after having been properly ignited, phototube P becomes dark, magnet B is deenergized, and switch B1 opens. Switch B2, if provided, closes. Switch B1 opens the energizing circuit of magnet A and coil C under "normal operating conditions," namely, I—D1—A2—B1—C—A—S—O and magnet A releases switches A1 and A2; switch A1 stops the motor. Heater coil C cools and, after a predetermined time, closes switches C1 and C2. Switch D1 being still closed since D was cool because C2 was open, magnet A becomes again energized and starts ignition and motor so that normal operation may begin, provided proper combustion is possible; if the fuel should fail to ignite, the condition explained above under "ignition failure" prevails and the circuit will perform the operations described under that heading.

It will now be evident that the thermal switch according to the invention provides simple and reliable operation of systems such as the burner control installation above described, and it will

also be apparent that it can be easily adapted for analogous operation in other circuits, either in the form herein described or modified as for example to include only one, or more than two thermal actuators arranged to fit a particular circuit in question.

It should be understood that the present disclosure is for the purpose of illustration only and that this invention includes all modifications and equivalents which fall within the scope of the appended claims.

I claim:

1. An electric switch comprising a contact element adapted for movement in a given plane between two circuit defining locations, an actuator for said contact element adapted for movement between two operative positions having a stop element extending parallel to said plane towards said contact element and adapted to move at an angle to said plane, which stop element in one of the actuator positions holds said contact element in one of said locations and which in the other actuator position releases said contact element to assume its other location and is in that location locked by the contact element with the actuator in its other position, and means constructed and arranged to engage said contact element so as to move it to said first location thereby unlocking the actuator.

2. An electric switch comprising two contact springs tending to separate from each other in a given plane, an actuator adapted to move adjacent to one of said springs at an angle to said plane, a stop element projecting from said actuator pressing against the adjacent spring and bringing the springs into contact when said actuator is in one position, said actuator being locked by engagement with said adjacent spring to retain the actuator in another position, and means adapted to effect disengagement of said adjacent spring from said stop element to permit the springs to separate and the actuator to return into said first position.

3. An electric switch comprising two contact springs tending to separate from each other in a given plane, an actuator adjacent to one of said springs adapted to bend normally to said plane, a stop element projecting from said actuator so as to engage said springs when said actuator is in unbent position and to be locked by the adjacent spring to retain the actuator in bent position, and means adapted to effect disengagement of said adjacent spring from said stop element to permit the springs to separate and the actuator to return into unbent position.

4. An electric switch comprising two contact springs tending to separate from each other in a given plane, a bimetallic actuator strip movable in a plane at right angles to said contact spring plane and adapted to press said springs together if at a certain temperature, and a heating element on said strip for bending said strip to a position disengaged from said springs, thereby permitting the springs suddenly to separate during movement of said strip into said disengaged position upon change of temperature.

5. An electric switch comprising two contact members tending to assume one of two circuit-defining relations and having stop faces assuming a certain distance with the contact members in one of said relations, an actuator movable between two positions relatively to said contact members and adapted to engage them in one of said relations when in one of said positions and to be engaged by one of said contact members in the other position, and a movable control element having at a certain distance from each other two control faces adapted to engage said stop faces upon movement relatively thereto, said two distances being selected to determine the circuit-defining relation of said contact members and to disengage said actuator from said contact member, when said control element is moved relatively to said contact members.

6. An electric switch comprising two contact members tending to assume a circuit-opening relation and having stop faces assuming a certain distance with the contact members in said opening relation, an actuator movable between two positions relatively to said contact members and adapted to engage them in closed relation when in one of said positions and to be engaged by one of the opened contact members in the other position, and a movable control element having at a distance greater than said stop face distance two control faces adapted to engage said stop faces upon movement relatively thereto, engagement of said faces retaining the contact members open while disengaging them from said actuator.

7. A thermal switch comprising two contact spring blades tending to separate in a given plane, an actuator mounted adjacent to said blades including a bimetallic strip which bends upon change of temperature substantially normally to said plane, said actuator having a stop member extending in said plane and retaining one of said blades in contact with the other by pressing against it while said strip is at comparatively low temperature but permitting the blades to separate when said strip bends upon warming, said extension being arranged to be engaged by said blade upon bending of said strip to retain it in bent position regardless of temperature, and means for moving said blade into closing position thereby permitting said strip to return into the position corresponding to the lower temperature.

8. An electric switch comprising a U-shaped mounting bail having a long and a short slot extending in the bail plane adjacent to and on either side, respectively, of the bail top portion, a plurality of switch springs fastened to the arms of said bail and arranged to move in the bail plane, insulating means separating said springs from each other, a control bar slidingly inserted in said slots having control faces adapted to contact said springs and retaining shoulders adjacent said bail slots, and an adjustable retainer extending from said bail towards said bar, said retainer holding said bar in said slots after it has been passed through said longer slot.

9. An electric switch comprising a mounting bail having two slots extending in the bail plane adjacent to and on either side of the bail top portion, a plurality of switch springs fastened to the arms of said bail and arranged to move in the bail plane, insulating means separating said springs from each other, a control bar slidably inserted in said slots having control faces adapted to contact said springs, switch actuator strips fastened to said insulators and movably extending in intersecting planes, and means for controlling said springs by moving said strips.

10. A thermal switch comprising an insulating mounting base, a protective frame element fastened to said base, spring leaves extending from said base and constructed and arranged so as to constitute the elements of two switches adapted to move in a given plane within said frame ele-

ment, a bimetal strip adjacent to the blades of one switch and movable in said plane so as normally to hold the blades of said first switch in contacting relation, a second bimetal strip adjacent to the blades of the second switch and movable at an angle to said plane, said second bimetal strip having an extension constructed and arranged normally to hold the blades of said second switch in contacting relation, but which permits them to open when said second bimetal strip bends and then locks the bimetal strip in bent position, and a resetting element slidably mounted in said frame element, said resetting element having shoulders for engaging the blades of said second switch to effect disengagement of said second switch from said extension and permitting said second strip to bend back into normal position.

11. An electric switch comprising a contact element adapted freely to be moved by mechanical means in a certain plane between two circuit defining locations; and a thermally actuated locking bar carrying a heating element and being adapted for movement, through the effect of said heating element, between two positions, and having a stop element moving adjacent said contact element at an angle to said plane; said stop element being constructed and arranged to release in one of said positions said contact element leaving it free to assume one of said locations, and to be retained in said position through engagement by said contact element.

12. An electric switch comprising a contact element adapted freely to be moved by mechanical means in a certain plane between two circuit defining locations; and a thermally actuated locking bar carrying a heating element and being adapted for movement, through the effect of said heating element, between two positions, and having a stop element moving adjacent said contact element at an angle to said plane; said stop element being constructed and arranged to hold, with said locking bar in one of said positions, said contact element in one of said locations, and to release, with said locking bar in the other position, said contact element to assume its other location.

13. An electric switch comprising a mounting frame having an opening extending in the frame plane adjacent to the frame top portion, a plurality of switch springs fastened to said frame and arranged to move in the frame plane, insulating means separating said springs from each other, and a control bar slidably inserted in said opening having control faces adapted to contact said springs and retaining means adjacent to said opening.

14. An electric switch comprising a mounting frame having two openings in the frame sides adjacent to and on either side of the frame top portion, two groups of switch springs fastened between the lower ends of said frame sides and arranged to move in the frame plane, insulating means separating said springs from each other and from said frame, a control bar slidably inserted in said openings and having control faces adapted to contact said springs, switch actuator strips fastened to said insulators alongside said switch springs and adapted to move in said frame plane and in a plane normal thereto, respectively, and means for controlling said springs by moving said strips.

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