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SAFETY SWITCH

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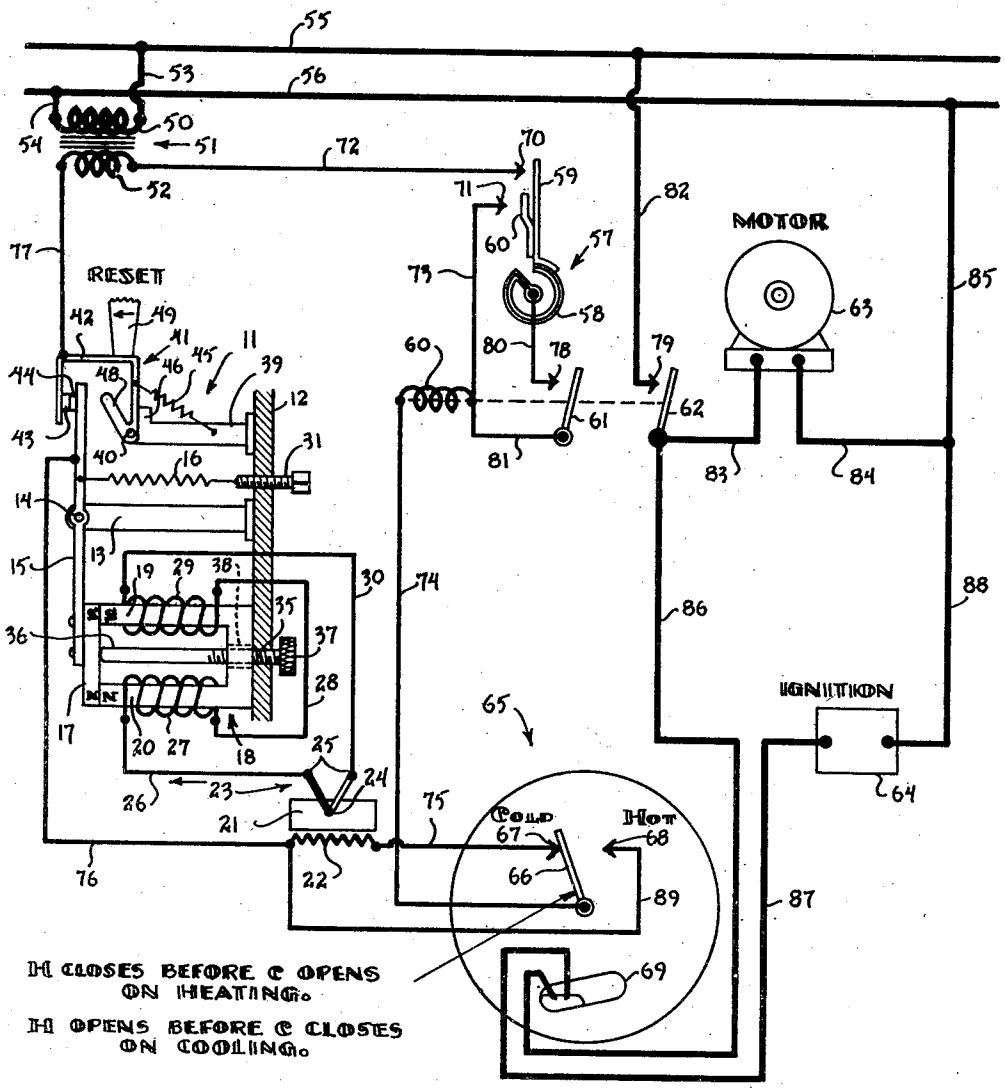

Inventor

Hubert T. Sparrow

By George H. Fisher

Attorney

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SAFETY SWITCH

Hubert T. Sparrow, Minneapolis, Minn., assignor to Minneapolis-Honeywell Regulator Company, Minneapolis, Minn., a corporation of Delaware

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This invention relates generally to the art of switching, and more particularly to that type of switch which is operated by a heat responsive timer and which must be manually reset.

Such a switch has particular utility in the automatic control of oil burners and will be described in this connection although it is clear that it may be used in many different combinations requiring a thermally timed switch.

In the control of an oil burner it is common practice, on a call for heat by the main control instrument to energize the burner motor for delivering oil to the combustion chamber of the furnace and also to energize the ignition means for producing a spark or flashing a gas pilot to ignite the oil so delivered. If combustion occurs the system will remain in running position until the main control instrument is satisfied, at which time it will shut the system down. If for some reason, however, the oil does not ignite, it is not desirable to continue to deliver raw fuel to the furnace. Therefore a timer is employed to shut the system down a predetermined time after it has started, unless combustion has taken place in the meantime. When combustion occurs a switch is operated which stops operation of the timer, but if combustion does not occur the timer opens a switch, shutting the system down, and it is required that this switch be manually reset, at which time the trouble causing failure of combustion may be corrected.

It is therefore an object of this invention to provide a thermally timed switch which will open a circuit a predetermined time after it has been closed, providing the action of the timer has not been stopped in the meantime.

A further object is to provide a magnet for holding a switch in one position and a time controlled means for overcoming the effect of the magnet on the switch so that a biasing means can actuate the switch.

Another object is to provide a magnet for holding a switch in one position and a thermocouple for neutralizing the effect of said magnet to permit a biasing means to actuate the switch.

Another object is to provide a manual means for resetting the lever but which is incapable of actuating the switch unless the magnet can hold the lever.

Still another object is to provide a pivoted switch operating lever which carries a permanent magnet at one end and which cooperates with a core to normally hold the switch in closed position, but which is released for actuation by a spring when a thermocouple neutralizes the effect of the magnet.

Still another object is to provide an adjustable means in a device of the above type for limiting the movement of the magnet toward the core, and also a means for adjusting the biasing spring.

These and other objects will readily become apparent to those skilled in the art as the following specification is read in the light of the accompanying drawing, in the single figure of which my invention is shown as applied to a simple control system for an oil burner.

Referring to the safety switch of this invention, it will be seen that the entire structure is carried by means of a base 12. Suitably connected to the base 12 is a supporting arm 13 to which is pivoted as indicated at 14 a lever 15. A tension spring 16 is connected to the lever 15 just above the pivot 14 and also to the base 12 by means of the adjustable screw 31 for the purpose of biasing the lever 15 for rotation in a clockwise direction. Suitably connected to the lower end of the lever 15 is a bar magnet 17 having two poles indicated as N and S. Also supported on the base 12 is a U-shaped core generally indicated at 18 and having two legs 19 and 20. The end of leg 20 is adapted to lie adjacent the N pole of the bar magnet 17 and the leg 19 is adapted to lie adjacent the S pole of the bar magnet 17.

Suitably located in the general proximity of the above mechanism is a metallic block 21 with which is associated an electric heater 22 for the purpose of heating the block. A thermocouple generally indicated at 23 and having a hot junction 24 and a cold junction 25 is positioned to respond to the temperature of the metallic block 21. One end of the cold junction 25 is electrically connected by means of a conductor 26 to one end of a winding 27 which surrounds the leg 20 of the core 18. The other end of the winding 27 is connected by means of the conductor 28 to one end of a second winding 29 which is located around the leg 19 of the core 18. The other end of the winding 29 is connected by means of a conductor 30 to the other side of the cold junction 25 of thermocouple 23.

The core 18 is not permanently magnetized and there is a magnetic attraction between the legs 19 and 20 of core 18 and the bar magnet 17. When the metallic block 21 is cold, both the cold and hot junctions of the thermocouple 23 will be at the same temperature and no current will be flowing in the circuit connected to the thermocouple. If the heater 22 is now energized, it will

begin to raise the temperature of the block 21 and hence the hot junction 24 of the thermocouple 23, which will develop an electromotive force causing a flow of current in the direction indicated by the arrow. It will be noted that with the current flow in this direction the winding 27 is so applied to the leg 20 as to magnetize the leg in such a manner that a north pole is produced adjacent the N pole of the bar magnet 17, and the winding 29 is so applied to the leg 19 as to produce a south pole adjacent the S pole of the bar magnet 17. As the temperature of the metallic block 21 increases, the temperature difference between the hot and cold junctions of the thermocouple 23 will increase and hence the current flow in the thermocouple circuit will increase and will eventually attain a value wherein the magnetic flux produced by the windings 27 and 29 is substantially equal and opposite to the magnetic flux produced by the bar magnet 17. At this time there will be insufficient attraction between the core 18 and the magnet 17 to keep the biasing spring 16 from rotating the lever 15 in a clockwise direction. The extent of this rotation under the influence of the spring 16 is such that even though the metallic block 21 should now cool to low temperature and the current flow through the windings 27 and 29 be reduced to zero, the distance between the core 18 and bar magnet 17 will be so great that the magnetic attraction at that distance cannot rotate the lever 15 against the action of the spring 16. However, if the lever 15 were to be manually returned to its original position, the gap between the core 18 and magnet 17 would be reduced to the point where the magnetic attraction between the two would be sufficient to hold the lever 15 in that position.

The base 12 is provided with a screw-threaded hole 35 in which is screwed the stem 36. The stem 36 is provided with a knurled head 37 and extends through an oversized hole 38 in the core 18. Rotation of the head 37 will move the stem 36 in and out of the core 18 in order that the air gap between the permanent magnet 17 and the core 18 may be readily adjusted. Such an adjustment will vary the maximum attractive force between the permanent magnet 17 and the core 18 and hence will vary the point at which the biasing spring 16 will open the switch. Another way to vary this point is to adjust the screw 31 to vary the force exerted by the spring 16 on the lever 15.

Also connected to the base 12 is a support 39 to which is pivoted as at 40 a reset member generally indicated at 41. The reset member 41 is provided with a resilient member 42 which is in the general form of a U and which carries at its free end a stationary contact 43 which is adapted to cooperate with a movable contact 44 located at the upper end of the lever 15. A tension spring 45 is connected between the reset member 41 and the support 39 for the purpose of normally holding the member 41 adjacent a stop 46 on the support 39. With the lever 15 in the position shown in the drawing, wherein the bar magnet 17 is adjacent the core 18, the contacts 43 and 44 will be in engagement. The arm 42 of the reset member 41 is resilient and regardless of the air gap between the bar magnet and the core 18 as determined by the adjustable stem 36, will always maintain its contact 43 in engagement with the movable contact 44. As the bar magnet 17 is released by the current flowing through the windings 27 and 29 as described above, the spring 16 will rotate the lever 15 in a clockwise direction until the upper end of the lever 15 engages an arm 48 on the reset member 41, at which time the contacts 43 and 44 will be separated. As explained above, the lever cannot now be moved automatically by the action of the magnet 17 but must be manually reset. For this purpose a handle 49 is provided on the reset member 41 to rotate it in a counter-clockwise direction, causing the arm 48 to cam the lever 15 to its original position wherein the bar magnet 17 lies adjacent the core 18. If at this time the temperature of the block 21 has been reduced to the point where the current flow through the windings 27 and 29 is so low that the flux produced thereby cannot overcome the effect of the magnet 17, the lever 15 will remain in its set position. If, however, the current is still of sufficient strength to nullify the effect of magnet 17, the spring 16 will return the lever 15 to its clockwise position as soon as the reset handle 49 is released. It will be noted that as the reset handle 49 is moved to the left the stationary contact 43 is moved to the left also so that the contacts 43 and 44 cannot be closed unless the magnet 17 is holding the lever 15 in its vertical position and until the handle 49 is released to move the stationary contact 43 again to the right and into engagement with the movable contact 44. The purpose of this arrangement is to provide a device wherein it will be impossible to manually maintain the circuit closed when the safety device is calling for an open circuit condition.

Although the above mechanism may be readily adapted for various different uses, one of the most obvious being an overload cut-out, it will be described in connection with a simple automatic control system for an oil burner. The primary winding 50 of a step-down transformer generally indicated at 51 and having a secondary winding 52 is fed by means of conductors 53 and 54 from line wires 55 and 56. The usual room thermostat is indicated generally at 57 and comprises a bimetallic element 58 operating a resilient contact blade 59 and a rigid contact blade 60. Controlled by the thermostat 57 is a relay winding 60 which operates two switch arms 61 and 62. The usual oil burner motor is indicated at 63 and the ignition means at 64. The combustion responsive switches are indicated generally at 65 and are of usual form wherein a thermally responsive element is positioned to respond to the existence or non-existence of combustion within the furnace combustion chamber. The thermal element is connected by means of a slip friction connection to the switch arm 66 so that the arm 66 will be actuated not upon the attainment of any predetermined temperature but rather upon a change in direction of temperature variation. The switch is shown in its cold position engaging the contact 67 and as the temperature at the thermally responsive element increases the arm 66 will first engage the hot contact 68 and then break the cold contact 67. As the thermally responsive element continues to heat it will also rotate the mercury switch 69 to break the circuit therethrough. On a decrease in temperature at the thermal element the switch arm 66 will first be actuated to disengage the contact 68 and then engage the contact 67, and rotate the mercury switch 69 to reclose the circuit therethrough.

In describing the operation of this system as a whole, it will be assumed that the parts are in

the position shown in the single figure of the drawing. This is the cold position in which the room thermostat 57 is satisfied and the oil burner is deenergized. The room temperature will now begin to decrease until the resilient arm 59 engages contact 70, at which time no circuit will be closed. The room temperature will continue to decrease until the arm 60 engages contact 71 at which time a circuit will be established from the secondary winding 52 of the transformer 51, conductor 72, contact 70, flexible arm 59, rigid arm 60, contact 71, conductor 73, relay coil 60, conductor 74, switch arm 66, cold contact 67, conductor 75, electric heater 22, conductor 76 to the lever 15 and thence through the contacts 44 and 43 to the arm 42 on the reset member 41, and thence by means of conductor 77 back to the secondary winding 52. This will cause the relay 60 to pull in the switch arms 61 and 62 to engage their contacts 78 and 79. Closure of the contact 78 by the switch arm 61 will set up a holding circuit from contact 70, resilient arm 59, bimetallic element 58, conductor 80, contact 78, switch arm 61 and conductor 81 to the relay coil 60 so that on a rise in temperature the relay will not be dropped out when the arm 60 leaves the contact 71 but will remain energized until the resilient arm 59 leaves the contact 70. Engagement of the switch arm 62 with contact 79 will set up a circuit for the burner motor as follows: line wire 55, conductor 82, contact 79, switch arm 62, conductor 83, burner motor 63, conductors 84 and 85 back to the line 56. At the same time a circuit is established for the ignition means from the switch arm 62, conductor 86, mercury switch 69 which is in closed position, conductor 87, ignition means 64 and conductors 88 and 85 back to the line 56. This will simultaneously energize the burner motor and the ignition means.

At this time it will be seen that on a call for heat by the room thermostat the burner motor, ignition means and electric heater 22 are simultaneously energized. Under normal conditions the fuel pumped to the furnace by the burner motor will be ignited and combustion will take place. The heat of combustion will be felt by the thermal element of the combustion switch 65, which will first cause the switch arm 66 to engage contact 68. This will establish a circuit from the secondary 52 through the room thermostat 57, relay coil 60 to the switch arm 66 as traced above, and then to contact 68 and conductor 89 to the conductor 76 and thence back to the secondary 52 as traced above. It will be noted that this circuit does not pass through the electric heater 22 and hence the block 21 will not be heated to the point where the bar magnet will be released through the effect of the thermocouple 23 and windings 27 and 29. Through the response of the thermal element of the combustion device 65, switch arm 66 will next leave the contact 67 and the mercury switch 69 will then be moved to open circuit position to deenergize the ignition means 64. The burner motor will remain energized through the switch arm 62 and the system will now be in running position.

If the room thermostat later becomes satisfied, it breaks the circuit to the relay coil 60 and the switch arms 61 and 62 drop out to break all electric circuits and the parts will return to the position as shown in the drawing.

Assume now that the room thermostat has energized the relay 60 and the burner motor 63, the ignition means 64, and the electric heater 22 are energized as described above. If for some reason combustion should not take place, the switch arm 66 will remain in engagement with the contact 67 and hence the circuit will continue to pass through the electric heater 22 which will, after a predetermined period of time determined by the size of the metallic block 21, the size of the heater 22 and the current flow therethrough, raise the temperature of the block 21 to the point where the windings 27 and 29 reduce the effect of the permanent magnet 17 and the tension spring 16 will rotate the lever 15 in a clockwise direction, breaking the circuit through the contacts 43 and 44. This will break the circuit to the relay coil 60 and the burner motor 63 and ignition means 64 will be deenergized. The parts will remain in this position until the safety switch mechanism is manually reset. As noted above, the contacts 43 and 44 cannot be closed until the block 21 has been given a chance to cool to the point where the magnet 17 is capable of holding the lever 15 in its contact closing position. If the trouble which caused the failure of combustion has been remedied the system will not start up as originally described, but if combustion again fails to occur the safety switch mechanism will again open the contacts 43 and 44 and require a manual reset.

This mechanism will also shut the system down in case combustion should fail while the system is in running position. Assume for example that the room thermostat is calling for heat and that the system has been started as described above with the switch arm 66 engaging contact 68, the mercury switch 69 in open position and the burner motor 63 energized through the switch arm 62. If at this time combustion should fail, the thermal element of the combustion device 65 will start to cool and immediately open the contact 68 which will drop out the relay 60 and shut the system down. The room thermostat 57 will still be calling for heat and as soon as the switch arm 66 engages the cold contact 67, the relay 60 will again be energized and the system will attempt to start. However, if the trouble is still present which caused the failure of combustion from running position, then combustion will not occur when the attempt is made to start and the electric heater 22 will remain energized and after a predetermined length of time bring the temperature of the metallic block 21 up to the point where the windings 27 and 29 will overcome the effect of the magnet 17, permitting the spring 16 to break the circuit at the contacts 43 and 44 and shut down the system as before.

Certain modifications and changes in the present construction will doubtless occur to those skilled in the art and it is thereby to be understood that I intend to be limited by the scope of appended claims and not by the specific embodiment shown in the drawing and described in the specification.

I claim as my invention:

1. In a device of the character described comprising in combination, a pivoted lever, a movable contact mounted on said lever, a stationary contact positioned for cooperation therewith, a spring tending to rotate said lever in a direction to open said contacts, a normally unmagnetized core, a permanent magnet carried by said lever and lying adjacent said core to hold said contacts in closed position against the action of said spring, a thermocouple having a hot junction

and a cold junction, lagging for said said hot junction, an electrical conductor in circuit with said thermocouple and wound around said core, and a heater for said hot junction, said cold junction responding to ambient temperature, said thermocouple producing a current flow through said winding which will reduce the effect of said permanent magnet to a point where said spring can open the contacts when the heater has raised the temperature of said hot junction to a predetermined degree.

2. In a device of the character described comprising in combination, a pivoted lever, a movable contact mounted on said lever, a stationary contact positioned for cooperation therewith, a spring tending to rotate said lever in a direction to open said contacts, a normally unmagnetized core, a permanent magnet carried by said lever and lying adjacent said core to hold said contacts in closed position against the action of said spring, a thermocouple having a hot junction and a cold junction, lagging for said hot junction, an electrical conductor in circuit with said thermocouple and wound around said core, a heater for said hot junction, said cold junction responding to ambient temperature, said thermocouple producing a current flow through said winding which will reduce the effect of said permanent magnet to a point where said spring can open the contacts when the heater has raised the temperature of said hot junction to a predetermined degree, and means for manually returning said lever to its original position, said means being incapable of closing said contacts unless said permanent magnet is capable of preventing said spring from rotating said lever.

3. In a device of the character described comprising in combination, a pivoted lever, a movable contact mounted on said lever, a stationary contact positioned for cooperation therewith, a spring tending to rotate said lever in a direction to open said contacts, a normally unmagnetized core, a permanent magnet carried by said lever and lying adjacent said core to hold said contacts in closed position against the action of said spring, a thermocouple having a hot junction and a cold junction, lagging for said hot junction, an electrical conductor in circuit with said thermocouple and wound around said core, a heater for said hot junction, said cold junction responding to ambient temperature, said thermocouple producing a current flow through said winding which will reduce the effect of said permanent magnet to a point where said spring can open the contacts when the heater has raised the temperature of said hot junction to a predetermined degree, and means for manually returning said lever to its original position, said means being incapable of closing said contacts unless said permanent magnet is capable of preventing said spring from rotating said lever, and adjustable means for limiting the movement of said permanent magnet toward said core.

4. In a device of the character described, a lever pivoted intermediate its ends, a stationary contact, a movable contact mounted on one end of said lever for cooperation with said stationary contact, a first member mounted on the other end of said lever, a second stationary member, said members being magnetically attracted toward each other to hold said contacts in closed position, spring means tending to rotate said lever in a direction to open said contacts, a heat absorbing block, a heater for said block, a thermocouple whose hot junction is responsive to the temperature of said block and whose cold junction is responsive to ambient temperature, and an electric winding in series with said thermocouple, said winding being adapted to neutralize said magnetic attraction between said members when said block is heated to a predetermined temperature.

5. In a device of the character described comprising in combination, a switch biased to one position of operation, a polarized relay normally retaining said switch in its other position of operation, a heat absorbent mass, a thermocouple having a hot junction and a cold junction, said hot junction being responsive to the temperature of said mass, a winding associated with said relay and in series with said thermocouple, and means for heating said mass to a temperature sufficient to cause said thermocouple to develop a flow of electricity through said winding to overcome the effect of said relay and permit said switch to move to its said one position under the influence of its bias.

6. In a device of the character described comprising in combination, a switch, a switch operating member biased to switch open position, magnetic means normally retaining said member in switch closed position, a thermocouple having hot and cold junctions, said hot junction being lagged and said cold junction responding to ambient temperature, a winding in series with said thermocouple and associated with said magnetic means in such a manner that a predetermined flow of electricity through said winding will overcome the holding effect of said magnetic means, and means for heating said lagged hot junction whereby said thermocouple will produce said predetermined flow of electricity and said switch operating member will be released to open said switch.

7. In a device of the character described comprising in combination, a switch, a switch operating member biased to switch open position, magnetic means normally retaining said member in switch closed position, a thermocouple having hot and cold junctions, said hot junction being lagged and said cold junction responding to ambient temperature, a winding in series with said thermocouple and associated with said magnetic means in such a manner that a predetermined flow of electricity through said winding will overcome the holding effect of said magnetic means, means for heating said lagged hot junction whereby said thermocouple will produce said predetermined flow of electricity and said switch operating member will be released to open said switch, and a trip-free manual reset for said switch whereby said switch can be closed manually only if the hot junction of said thermocouple is sufficiently cool so that said magnetic means retains said switch operating member in switch closed position.

HUBERT T. SPARROW.