

[54] **BURNER IGNITION SYSTEM HAVING
SAFETY SWITCH WITH REMOTE RESET**

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[51] Int. Cl.² **F23N 5/00**

[58] Field of Search 431/68, 71, 27; 337/56

[56] **References Cited**

UNITED STATES PATENTS

3,378,658 4/1968 Arlin et al. 337/56 X

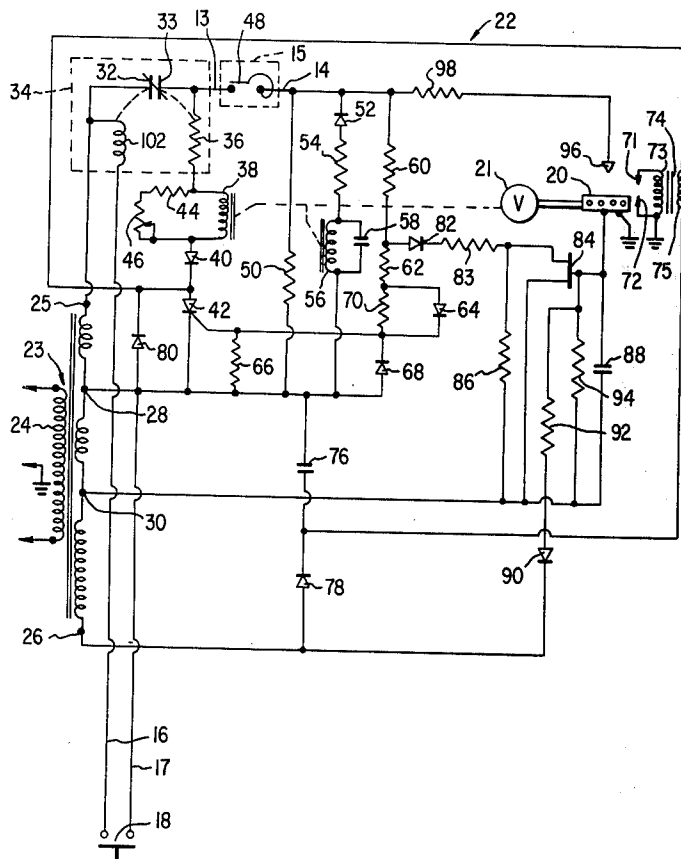
3,380,796 4/1968 Kompelien 431/68
3,422,384 1/1969 Filchak et al. 337/56 X
3,767,354 10/1973 Wright 431/71 X

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[57] **ABSTRACT**

A safety switch for an ignition system, or the like, has condition responsive means for opening a pair of contacts and retaining the pair of contacts in the open condition until they are reset. The safety switch is reset by the normal manual pushbutton or by a solenoid energized by a remote switch.

3 Claims, 8 Drawing Figures



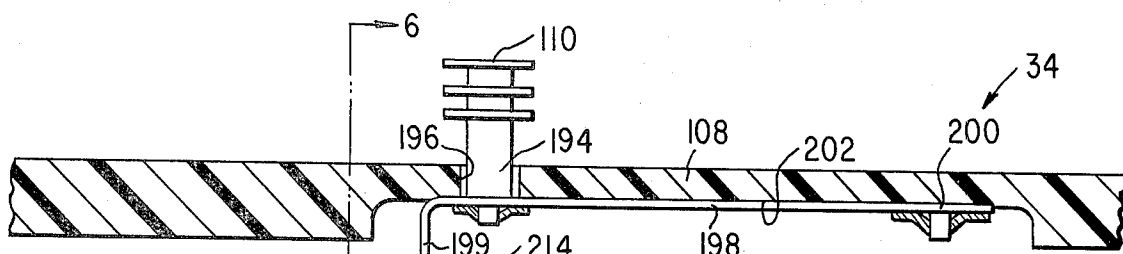


FIG 5

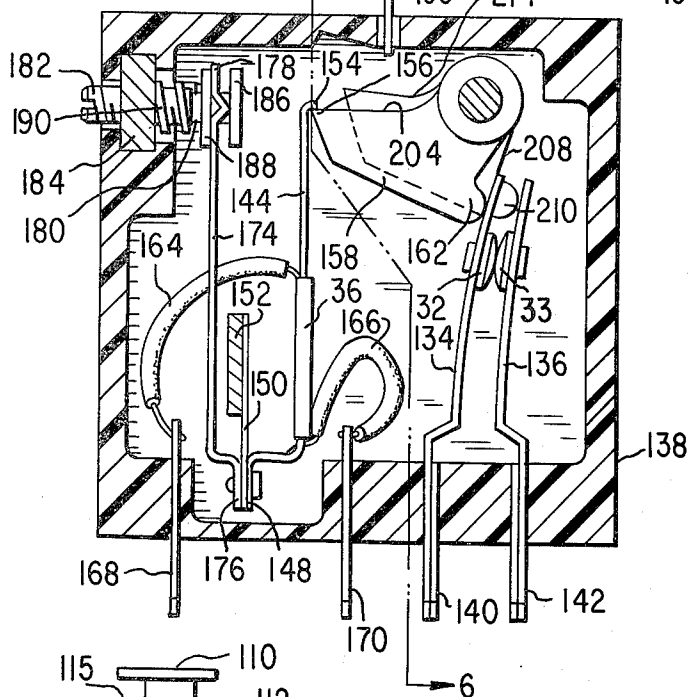


FIG 6

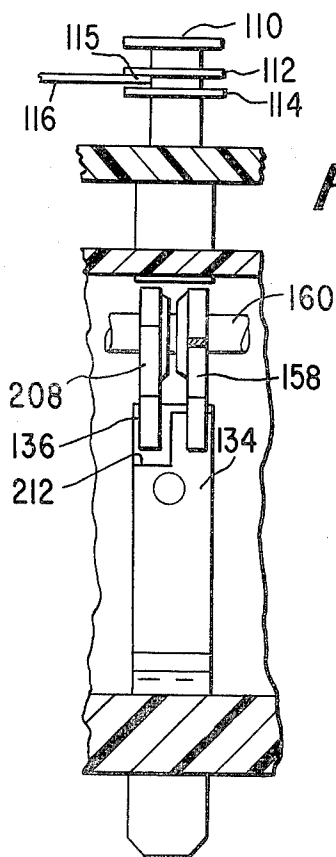


FIG 3

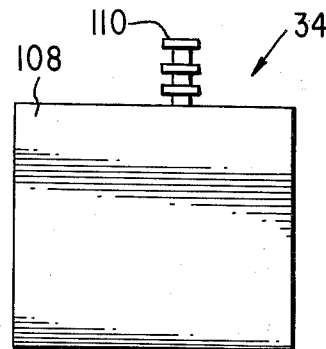
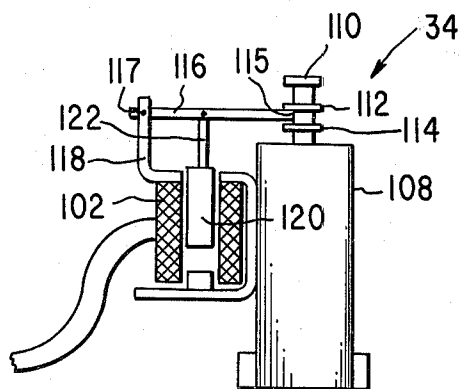


FIG 4



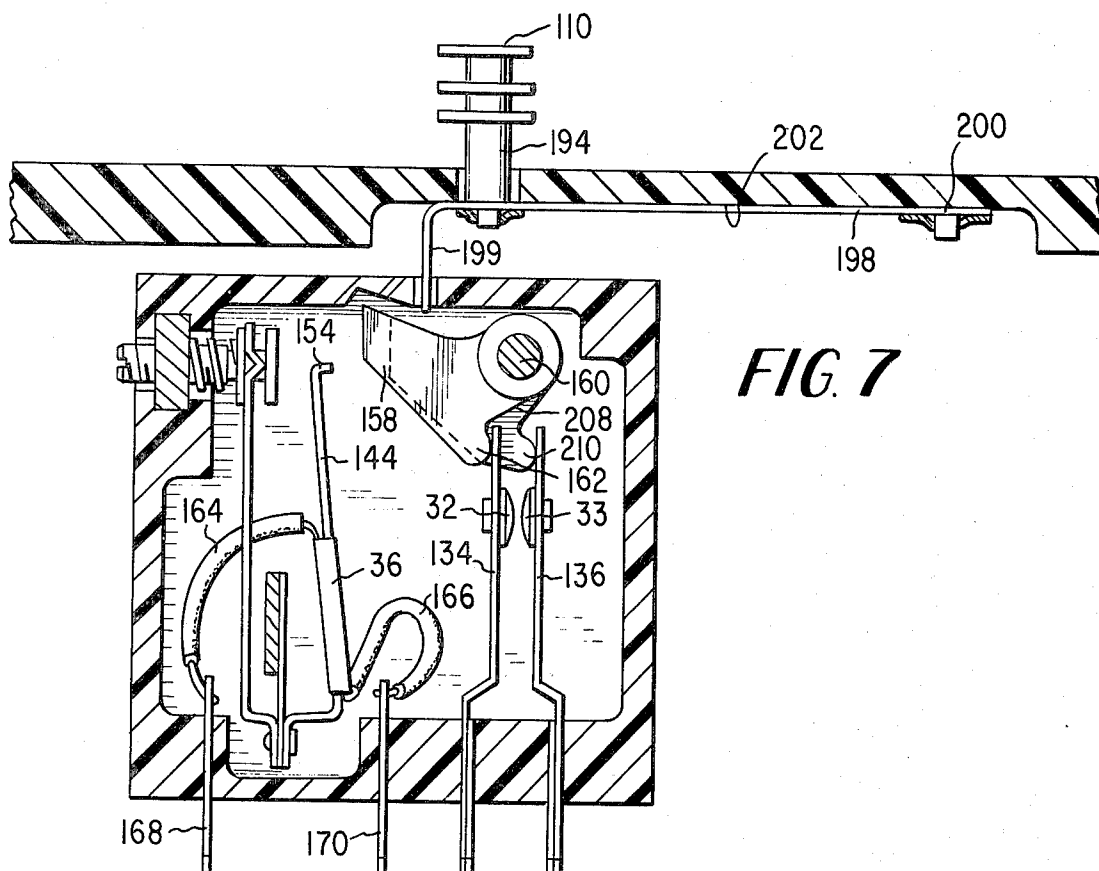


FIG. 7

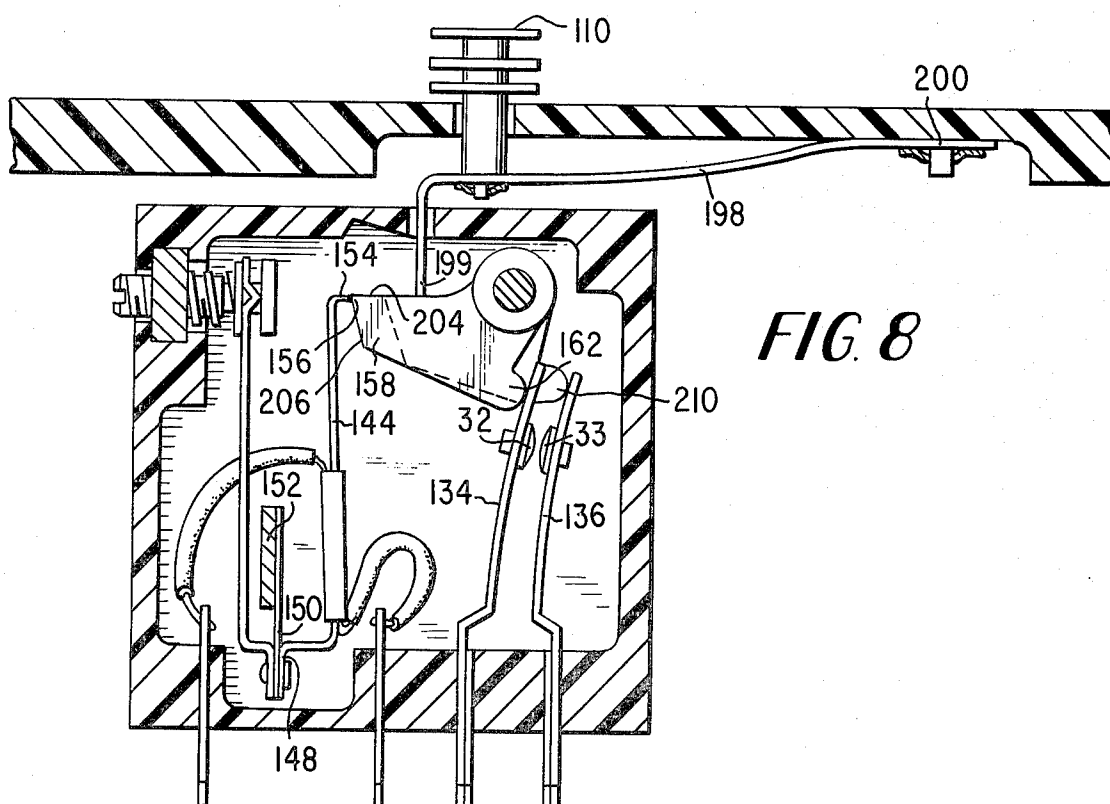


FIG. 8

BURNER IGNITION SYSTEM HAVING SAFETY SWITCH WITH REMOTE RESET

BACKGROUND OF THE INVENTION

The invention relates to burner systems, and in particular, to burner systems employing safety switches which when operated must be reset.

DESCRIPTION OF THE PRIOR ART

The prior art, as exemplified in U.S. Pat. Nos. 985,943, 3,422,384 and 3,536,427, contains a number of safety switches and a number of electromechanically or manually operated switch devices. Common safety switches employed in burner ignition systems have contacts which are opened by electrical resistance operated delay heat motors. These safety switches open after a time delay when the ignition circuit senses a condition such as flame outage, failure to ignite, etc., to terminate operation of the burner system. The safety switches have latching facilities, or the like, for holding the contacts open, and are provided with manual reset facilities for releasing the latching facilities to reset the safety switch. Usually the manual reset facilities include a pushbutton directly mounted on the switch and which must be depressed to reset the switch. Typically the ignition system including the safety switch is mounted with the burner in a unitary furnace structure by the manufacturer. Flame outage, failure to ignite, loss of electrical power, and the like, causing termination of burner system operations can all be due to transient conditions which do not require repair or correction of the burner system. For heating systems employing a furnace structure installed in a relatively inconvenient location, such as in a roof top installation, or the like, the requirement for gaining access to the furnace structure to depress the manual pushbutton reset is a major inconvenience. The prior art electromechanically operated switch devices which can be remotely operated are not sufficiently reliable or do not have the same mode of operation or safety features required in burner systems.

SUMMARY OF THE INVENTION

The invention is summarized in that a safety switch includes a pair of contacts, closing means for normally holding the pair of contacts closed, opening means for holding the pair of contacts open, condition responsive means for operating the opening means to open the pair of contacts, manual pushbutton means for operating the closing means to close the pair of contacts, and electrically energizable means for depressing the pushbutton means.

An object of the invention is to construct a safety switch device, which is opened and latched by the sensing of a condition, with reset means which can be remotely operated.

Another object of the invention is to provide a safety switch with both a manually operated pushbutton reset and with electrically energizable reset facilities.

It is also an object of the invention to construct a modified safety switch with remotely energizable reset facilities wherein the conventional manual reset, operation, and safety features of prior safety switches are not substantially changed.

A further object of the invention is to construct an electrical ignition system including a remotely reset-

table safety switch wherein the structural arrangement and operation of prior ignition systems is retained.

An advantage of the invention is that an electric ignition system may be reset after termination by the sensing of a condition such as a flame outage, failure to ignite, and loss of electric power due to transient conditions without the necessity of gaining access to the reset pushbutton mounted on a safety switch.

Additional features of the invention include the provision of a solenoid with an armature for pivoting a lever engaging a reset pushbutton at one end; and the provision of a pushbutton reset having a pair of flanges for engaging the end of an electromagnetically operated lever which can be remotely operated for depressing the pushbutton.

Other objects, advantages and features of the invention will become apparent from the following description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sketch of a heating system in accordance with the invention.

FIG. 2 is a diagram of an electrical ignition system for the heating system of FIG. 1.

FIG. 3 is a front view of a safety switch in the circuit of FIG. 2.

FIG. 4 is a side view, partially in cross section of the safety switch of FIG. 3.

FIG. 5 is a detailed cross sectional elevation view of a portion of the safety switch of FIG. 2 and 3.

FIG. 6 is a cross section view taken along lines 6-6 of FIG. 5.

FIG. 7 is a view similar to FIG. 5 but illustrating a second position of the safety switch.

FIG. 8 is a view similar to FIGS. 5 and 7 but illustrating a still further position of the safety switch.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As illustrated in FIG. 1, the invention is embodied in a heating system having a furnace structure or unit 10 mounted in a relatively inaccessible location, such as on a rooftop 11 of a building 12. Electrical lines 13 and 14 connect the furnace unit 10 with a conventional control device, such as a thermostat switch 15, located remotely from the furnace unit 10, such as within the building 12. Also electrical lines 16 and 17 connect the unit 10 to a reset switch, such as a normally open pushbutton switch 18, located remotely from the furnace unit 10, for example in the building 12 in easy access to maintenance personnel.

The furnace unit 10 contains, as shown in FIG. 2, a burner, such as a gaseous fuel burner 20, with fuel control facilities, such as a gas valve 21 for controlling the flow of gaseous fuel to the burner 20. An ignition and control circuit, indicated generally at 22 and also contained in the furnace unit 10, controls the operation of the valve 21, ignites fuel from the burner 20, and terminates operation of the heating system after a delay in the event there is a failure of burner ignition or flame outage. The circuit 22 is controlled by the remote thermostat switch 15, and upon termination of heating system operation, may be reset by the remote reset switch 18.

The circuit 22 includes a transformer indicated generally at 23 having a primary winding 24 connected across a suitable voltage source, such as a 120 volt 60 herz alternating current source. The secondary winding

of the transformer 23 has end taps 25 and 26 with intermediate taps 28 and 30 dividing the secondary winding into three sections. Tap 25 is connected to one side or a contact 32 of a pair of normally closed contacts 32 and 33 of a safety switch 34 which has a resistance heat operator or motor 36 connected in series with the contacts 32 and 33, a first gas valve winding 38 of the valve 21, a diode 40, and the anode and cathode electrodes of a silicon control rectifier (SCR) 42 to the tap 28. A resistance 44 and a variable resistance 46 are connected in series across the winding 38.

The control device 15 has a thermostatically controlled contacts 48 interposed between the lines 13 and 14. The line 13 is connected to the contact 33 and the line 14 is connected to one end of a resistance 50 which has its other end connected to the tap 28. A series circuit including a diode 52, a resistance 54 and a second winding 56 for the gas valve 21 is connected across the resistance 50. The diode has a polarity for passing positive current from tap 28 to tap 25. A capacitor 58 is connected across the terminals of the winding 56. A triggering circuit for the SCR 42 includes a series circuit having resistances 60 and 62, a diode 64 and a resistance 66 connected across the resistance 50. The gate electrode of the SCR 42 is connected to the junction of the resistance 66 to the diode 64 which has a polarity to pass positive current from the tap 25 to the gate electrode of the SCR 42. A diode 68 is connected across the resistance 66 with the anode connected to the tap 28 and the cathode connected to the junction of the resistance 66 to the diode 64. A resistance 70 is connected across the diode 64.

The value of the resistance 54 and the characteristics of the second winding 56 of the valve are selected to produce sufficient electromagnetic flux to hold the valve 21 open but to produce insufficient electromagnetic flux to change the valve 21 from a closed condition to the open condition. The characteristics of the first winding 38 of the valve 21 and the values of the resistances 44 and the variable resistance 46 are selected to allow the magnetic flux produced by the winding 38 to supplement the flux from the winding 56 sufficiently to change the valve 21 from the closed condition to the open condition.

In a spark generator portion of the circuit 22, spark electrodes 71 and 72 are connected to respective opposite ends of a secondary winding 73 of a spark transformer 74 which has its primary winding 75 connected at one end to the anode of the SCR 42. The other end of the primary winding is connected to the junction of a capacitor 76 and a diode 78 serially connected between the taps 26 and 28. The diode 78 has a polarity selected to pass positive current to the side of the capacitor 76 connected to the primary winding 75 when the tap 26 is positive with respect to the tap 28. A diode 80 is connected across SCR 42 with the cathode electrode of the diode 80 connected to the anode electrode of the SCR 42. Similarly, the diode 40 has a polarity passing positive current from tap 25 to the SCR 42 and through the winding 75 to the capacitor 76.

In a flame detection portion of the circuit 22, a diode 82 and a resistance 83 are serially connected from the junction between the resistances 60 and 62 to the source electrode of a field effect transistor (FET) 84 which has its drain electrode connected to the tap 30. A resistance 86 is connected across the source and drain electrodes of the FET 84. The gate electrode of the FET 84 is electrically connected to the burner 20

which is connected to one side of a capacitance 88 which has its other side connected to the tap 30. A negative biasing circuit for the gate electrode of the FET 84 includes a diode 90 and a resistance 92 connected to the tap 26 for supplying a negative current to the capacitor 88. A resistance 94 is connected from the gate electrode of the FET 84 to the tap 30. A flame sensing rod or probe 96 is mounted in a position to be impinged upon by a flame from the burner 12 and is electrically connected by a resistance 98 to the lead 14.

The safety switch 34 has an electromagnetic reset winding or coil 102 connected at one end to the lead 16 and at its other end to the tap 25. The lead 17 is connected to the tap 28.

As shown in FIGS. 3 and 4, the safety switch 34 has an insulation housing 108 and a reset pushbutton 110 which may be depressed to reset the safety switch. The pushbutton 110 has a pair of flanges 112 and 114 forming a channel therebetween for containing a free end 115 of a lever 116. The other end 117 of the lever 116 is pivotally mounted on a bracket 118 secured to the housing 108 and which supports the electromagnetic coil 102. A ferromagnetic armature 120 slidable within the coil 102 has a linkage 122 pivotally connected to an intermediate point of the lever 116. The armature 120 is held in a spaced position from the magnetic center of the coil 102 when the pushbutton 110 is normally extended so that when the coil 102 is energized the armature 120 will be attracted by electromagnetic flux to pivot the lever 116 and depress the pushbutton 110.

As illustrated in FIGS. 5, 6, 7 and 8, the contacts 32 and 33 are mounted on respective resilient arms 134 and 136 secured within a portion 138 of the housing 108. Ends 140 and 142 of the arms 134 and 136 extend externally from the housing 108 for connection by appropriate leads between the tap 25 and the resistance 36 of FIG. 1. The normal bias of the resilient arms 134 and 136 is such as to urge the contacts 32 and 33 out of electrical contact with each other in the manner as illustrated in FIG. 7 so as to open the electrical circuit therebetween.

A bimetallic latch member 144 has an offset bent end 148 secured to a flexure member 150 that is fixed to the housing 108 by fixed support 152. The other end 154 of the bimetallic latch member 114 is bent into an "L" shape or hook shape such that it is adapted to engage or latch a projecting point 156 of a first cam member 158 rotatably mounted in the housing 108 on a shaft 160. The cam 158 has an abutment or lobe 162 adapted to engage against the spring blade 134 and bias the spring blade to the right in the manner illustrated in FIG. 5 when the cam member 158 is locked by the bimetal member 144 so as to maintain the contact 32 on the arm 134 in electrical engagement with the contact 33 on the resilient arm 136. The resilient force of the spring arms 134 and 136 normally urge the cam 158 to rotate about the shaft 160 to engage the projection point 156 upward against the hooked end 154 of the bimetal element 144.

The bimetal element 144 is designed to be warped to the left to move the hooked end 154 away from the cam 158 when the resistance element 36 is heated to a predetermined temperature. Opposite ends of the resistance element 36 are electrically connected by respective leads 164 and 166 to terminals 168 and 170 extending externally from the housing 108.

An ambient temperature compensating bimetal member 174 has an offset bent lower end 176 secured

to the same portion of the flexure 150 as the end 148 of the member 144. The upper end 178 of the bimetal member 174 has a suitable opening (not shown) for receiving a shank 180 of a thread adjusting member 182. The threaded adjusting member 182 extends through a threaded bore (not shown) in a nut 184 suitably secured in an opening in the housing 108. The shank 180 of the threaded adjusting member 182 has a head 186 on the internal end thereof and a washer-like member 188 biased by a compression spring 190 to normally urge the end 178 of the bimetal compensating member 174 against the head 186.

The reset button 110 has a shank portion 194 which extends through an opening 196 in the housing where it is mounted towards one end 199 of an elongated spring member 198 fastened at its other end 200 to an interior surface 202 of the housing 108. The end 199 of the spring member 198 is bent downward to extend above an upper surface 204 of the cam member 158 extending along a radius from its axis of rotation to the point 156. The end 199 has a length designed to engage the surface 204 when the pushbutton 110 is depressed to rotate the cam 158 sufficiently counterclockwise to allow the projecting point 156 to be latched by the hooked end 154 of the bimetal 144.

The cam 158 has a surface 206 extending downward and at an angle to the surface 204 for camming the hooked end 154 to the left when the cam 158 is rotated counterclockwise.

Another cam member 208 is also rotatably mounted on the housing by the shaft 160 in side by side relationship to the cam 158. The cam 208 has an abutment or lobe 210 extending through a cutout 212 in the arm 134 for engaging against the spring arm 136 in the manner as illustrated in FIG. 6. The cam member 208 has a surface 214 extending radially from its axis of rotation and that is adapted to be engaged by the end 199 of the reset spring member 198 when the pushbutton 110 is depressed downwardly. As illustrated in FIG. 8, the cam member 208 has an arcuate width between the surface 214 and the abutment 210 which is sufficiently greater than the arcuate width between the surface 204 and the abutment 162 of the cam member 158 to hold the arm 136 and the contact 33 spaced from the contact 32 and the arm 134 when the pushbutton 110 is depressed.

In operation of the heating system shown in FIG. 1, furnace unit 10 is operated in accordance with the demand of the control device 15 through leads 13 and 14 to control the temperature in the building 12. In the event that the operation of the heating system is terminated by a transient condition in the unit 10, the unit 10 may be reset through electrical leads 16 and 17 by depressing the pushbutton switch 18. The unit 10 will then continue to be operated in accordance with the demand of the control device 15. If the system operation is terminated by a defective condition in the unit 10, depressing the pushbutton switch will not enable the operation of the unit 10 until proper maintenance or repair has been completed. With the pushbutton switch 18 mounted at a location of easy access, it is unnecessary to obtain access to the unit 10 which is in a relatively inaccessible location in order to reset the unit 10 in the event of termination by a transient condition.

Referring to FIG. 2, the closing of the thermostat contacts 48 signals a demand for operation of the burner 20 by energizing the control circuit 22. The control circuit 22 simultaneously opens the valve 21

and produces sparks across the spark electrodes 71 and 72 igniting fuel passing from the burner 20. After combustion is sensed at the burner 20, the generation of sparks across the electrodes 71 and 72 is terminated.

More specifically, the closing of the thermostat contacts 48 initiates conduction through the diode 52, the resistance 54 to charge the capacitor 58 which then produces current through the winding 56 of the valve 21. Also, the closing of the contacts 48 passes current through resistances 60 and 62, diode 64 and resistance 66 producing a positive voltage on the gate electrode of the SCR 42 rendering the SCR 42 conductive. When the SCR 42 is rendered conductive, a path is completed through resistance 36, the winding 38, the diode 40, and the SCR 42. The winding 38 and the winding 56, both energized together, open the valve 21 passing gas to the burner 20.

Positive current from the tap 26 of the secondary of the transformer 23 flows through the diode 78 and positive current from tap 25 flows through diode 40 and winding 75 charging the capacitor 76. When the SCR 42 is rendered conductive, the capacitance rapidly discharges through the primary winding 75 of the spark transformer 74 and the SCR 42 thus creating a spark across the spark electrodes 71 and 72.

When ignition of flame from the burner is completed, the probe 96 is emersed in the flame. The flame acts as a rectifier passing positive current from the probe 96 to the burner 20 and blocking positive current from the burner 20 to the probe 96. Thus, when the tap 25 is positive with respect to the tap 30, current flows through the contacts 32 and 33, the thermostat switch 48, the resistance 98, probe 96, the flame, the burner 20 and resistance 94 to charge the capacitance 88. The gate electrode of the FET 84 becomes positive rendering the FET 84 conductive which completes an electrical path through diode 82, resistance 83 and the FET 84 to the tap 30. This renders the junction of the resistances 60 and 62 negative with respect to the tap 28 preventing the gate electrode of the SCR 42 from becoming positive during half cycles when the tap 25 is positive with respect to the tap 28, and thus maintaining the SCR 42 non-conductive. With SCR 42 non-conductive, the sparking ceases through the spark electrodes 71 and 72 and the current stops through the winding 38 of the gas valve 21. Since the winding 56 has a value designed to maintain the valve in the open position, the gas valve 24 will remain open and supply gas to the burner 20.

In the event that the probe 96 does not sense a flame within a predetermined duration, the resistance heater 36 of the safety switch 34 opens the contacts 34 and 33 terminating operation of the burner ignition circuit and closing the valve 21 to the burner 20. The safety switch 34 must then be reset before the burner can be operated.

The safety switch may be reset by depressing either the remote pushbutton switch 18 or the normal reset pushbutton 110, FIGS. 3 and 4, on the safety switch 34. Depressing the pushbutton switch 18 energizes an electromagnetic reset coil 102 of the safety switch.

Referring to FIG. 4, when the electromagnetic winding 102 is energized, the armature 120 is attracted pivoting the lever 116 about its pivot end 117 causing the free end 115 of the lever 116 to engage the flange 114 of the pushbutton 110 and move the pushbutton 110 downward thus resetting the safety switch 34. Referring to FIGS. 5, 6, 7 and 8, when the pushbutton 110 is de-

pressed, either manually or by the lever 116, the spring member 198 is pushed downward engaging the bent end 199 of the spring member 198 against the surfaces 204 and 214 of the respective cam members 158 and 208, which rotates the cam members 158 and 208 counterclockwise. The rotation of the cam members 158 and 208 engages the abutments 162 and 210 against the respective spring arms 134 and 136 as shown in FIG. 8 to move the spring arms 134 and 136 to the right while maintaining the contacts 32 and 33 spaced apart. The hooked end 154 of the bimetal member 144 is cammed to the left by the camming surface 206 of the cam member 158 until the hooked end 154 drops over the point 156 to latch the cam 158 in the counterclockwise position. Subsequently, the release of the pushbutton 110 allows the cam member 208 to rotate back clockwise under the force of the spring arm 136 thus engaging the contacts 33 and 32 to reset the safety switch 34.

When the current through the terminals 168 and 170 leads 164 and 163, and the resistance heating element 36 continues for an excessive duration, i.e. exceeding a predetermined duration, the bimetal member 144 will be warped with sufficient force to disengage the hooked end 154 from the point 156 of the cam 158. This releases the cam member 158 allowing the cam member 158 to be rotated clockwise under the force of the spring arm 134 until the contact 32 disengages the contact 33, thus opening the circuit between terminals 140 and 142 through the contacts 130 and 132.

The temperature response of the safety switch may be adjusted by adjusting the threaded member 182 to bias the temperature compensating bimetal arm 174 to the right or left which urges the bimetal member 144 also to the right or left. The bimetal temperature compensating element 174 also warps with changes in ambient temperature which compensates for warpage in the bimetal member 144 due to ambient temperature changes.

It is particularly advantageous that the safety switch 34 is provided with a solenoid having an armature for moving a lever to engage the reset pushbutton of the safety switch. This allows the safety switch to both be reset at the location of the unit 10 as well as from the remote location of the pushbutton switch 18. The particular construction of the lever 116 pivotally mounted on bracket 118 and which is rotated by the armature 120 of the solenoid for engaging the pushbutton 110 results in a simplified construction which is reliable in operation without changing or necessitating any change in the safety switch, which change would degrade the operation and reliability of the safety switch with respect to prior art conventional safety switches employing solely a manual pushbutton reset.

Further, it is noted that the spring 198 which normally urges the pushbutton 110 outward from the housing 108 also urges the armature 120 to a position spaced from the attracted center position in the coil 102. Also, the function of the safety switch 34 cannot be bypassed by tying or taping either the pushbutton 110 or the pushbutton switch 102 depressed; the cam member 162 will hold the contacts 32 and 33 apart.

Since many variations, modifications and changes in detail may be made to the present embodiment, it is intended that all matter in the foregoing description or in the accompanying drawings be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. An electric ignition system comprising means for generating sparks, flame sensing means for terminating operation of the spark generating means when a flame is sensed, a safety switch having a pair of normally closed contacts and a resistance heat motor serially connected with the spark generating means, said resistance heat motor capable of opening the closed contacts when the flame sensing means fails to sense a flame after a predetermined duration of operation of the spark generating means, said safety switch including electromagnetic means for resetting the contacts in a closed position, switch means disposed at a location remote from the ignition circuit for energizing the electromagnetic means, a transformer having a secondary winding, said spark generating means being energized by the secondary winding of the transformer, and said electromagnetic means being in series with the switch means across the secondary winding of the transformer.
2. An electric ignition system comprising means for generating sparks, flame sensing means for terminating operation of the spark generating means when a flame is sensed, a safety switch having a pair of normally closed contacts and a resistance heat motor serially connected with the spark generating means, said resistance heat motor capable of opening the closed contacts when the flame sensing means fails to sense a flame after a predetermined duration of operation of the spark generating means, said safety switch including electromagnetic means for resetting the contacts in a closed position, switch means disposed at a location remote from the ignition circuit for energizing the electromagnetic means, said safety switch including a pushbutton manually depressible for resetting the safety switch, and said electromagnetic means including a lever engaging the pushbutton, an armature connected to the lever, and an electric coil which is energized by the switch means to attract the armature to move the lever to depress the pushbutton.
3. An electric ignition system for a burner comprising a first transformer having a first primary winding and a first secondary winding; a safety switch having a resistance heat motor and first and second normally closed contacts which are opened when the resistance heat motor senses a current for an excessive duration; said safety switch having means for holding the first and second contacts open after the resistance heat motor has operated and pushbutton means for resetting the first and second contacts closed when the pushbutton means is depressed; said first contact connected to a first tap of the first secondary winding; a first coil; an ignition circuit including the resistance heat motor and a silicon controlled rectifier serially connected with the first coil and the anode and cathode electrodes of the silicon controlled rectifier between the second contact and a second tap of the first secondary winding; a thermostat switch connected at one side to the second contact;

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a trigger circuit connected between the other side of the thermostat switch and a gate electrode of the silicon controlled rectifier;
 flame sensing means for disabling the trigger circuit when the presence of a flame from the burner is sensed;
 a second coil connected in a circuit between the other side of the thermostat switch and the second tap;
 fuel control means for the burner;
 said fuel control means capable of being changed from an unoperated condition to an operated condition when both the first and second coils are energized;

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said fuel control means capable of being maintained in an operated condition when only the second coil is energized;
 said fuel control means being returned to the unoperated condition in the absence of energization of both the first and second coils;
 said safety switch having a third coil, an armature, a pivotally mounted lever for engaging the pushbutton means, and linkage means connecting the lever to the armature;
 a push button switch mounted in a location remote from the safety switch; and
 circuit means connecting the pushbutton switch in series with the third coil across at least a portion of the first secondary winding.

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