Aug. 4, 1964 W. M. HUMMEL 3,143,619

RADIATION SENSITIVE THERMALLY RESPONSIVE SWITCH

Filed June 6, 1961

Fig. 1.

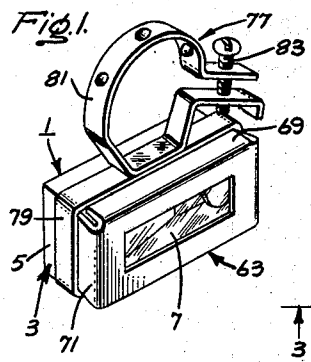


Fig. 2.

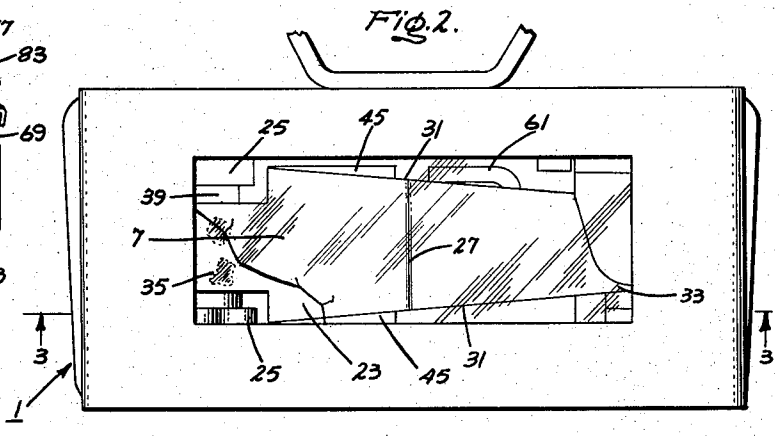


Fig. 3.

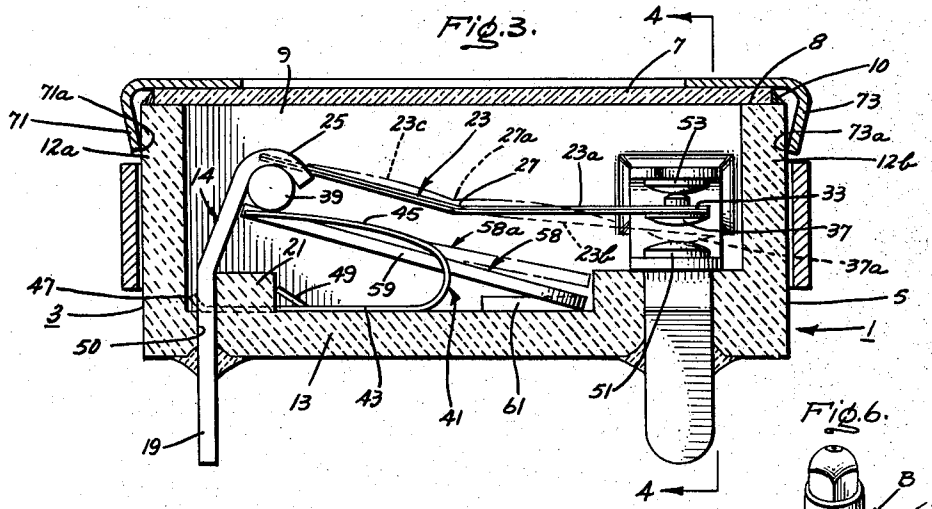


Fig. 4.

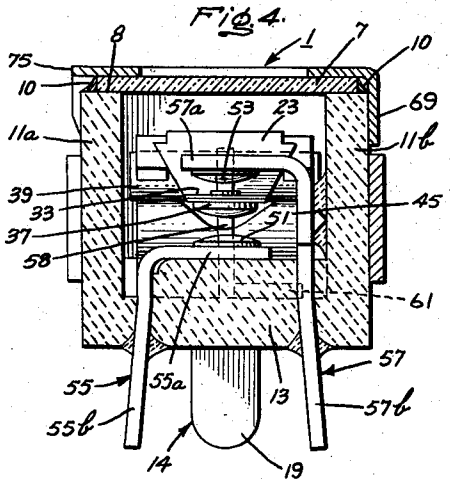


Fig. 5.

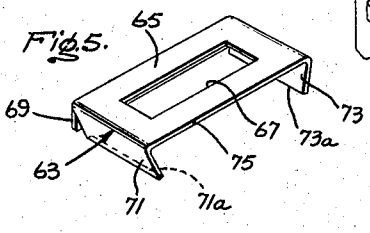
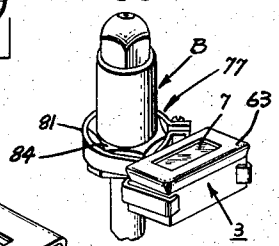


Fig. 6.



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RADIATION SENSITIVE THERMALLY RESPONSIVE SWITCH

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4 Claims. (Cl. 200—138)

My invention relates to radiation sensitive thermally responsive switches and more particularly to such switches of the type used as flame detectors and mounted in close proximity to the flame of fluid fuel burning systems and the like.

To obtain efficient response in radiation sensitive flame detecting switches of the prior art, it has been found worthwhile to mount the switch structures in close proximity to the flame, such as, for example, upon the burner itself. When the switches are mounted in such a manner, relatively high thermal conditions ensue, which have a deleterious effect upon the switch. More particularly, one type of radiation sensitive flame detecting switch of the prior art includes a translucent portion or window which is attached to an insulating casing by some suitable sealant material. When switches of this type are installed close enough to the flame to produce a desirable response, the sealant materials deteriorate due to the increased temperature, thereby loosening the window from the casing and allowing the entry of extraneous materials, such as oil, into the switch housing. These extraneous materials may and often do result in the contamination of the switch contacts. It has therefore been found desirable to provide an improved flame detecting switch which includes such structure that it is not adversely effected by relatively high temperatures incident to the disposition of the switch in close proximity to a flame. Such a flame detector, as previously set forth, may be mounted close enough to the flame to provide an efficient response.

Accordingly, it is the general object of my invention to provide a new and improved radiation sensitive flame detecting switch which will operate efficiently in close proximity to a flame while substantially minimizing any adverse effects.

Another object of my invention is to provide an improved radiation sensitive flame detecting switch which includes a simplified means for restricting the impingement of radiant energy to the switch.

An additional object of my invention is to provide an improved radiation responsive flame detecting switch which is simple in construction and relatively inexpensive to manufacture.

In carrying out my invention, in one form thereof, I apply it to a flame detecting switch including a switch mechanism substantially enclosed in a cavity of an insulating base. A translucent wall portion attached to the base for admitting radiant energy into the cavity. A thermally responsive member is mounted within the cavity together with contacts operated by the movement of the thermally responsive member. With this switch arrangement, in order to obtain a very rapid response to the presence of the flame, a reflective shield is fastened to the switch housing. This shield protects various parts of the switch housing and switch from the impingement of radiant energy by reflection of radiant energy directed thereto, but at the same time allows radiant energy to impinge upon the thermally responsive member. By using this protective reflective shield upon the switch, the switch may be operated in close proximity to a burner flame to obtain an efficient response to the presence of the flame without deleteriously affecting the longevity of the switch structure.

By further aspects of my invention, additional desirable features may be included in the switch, and the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which I regard as my invention. The invention, however, as to organization and method of operation, together with further objects and advantages thereof, may best be understood with reference to the following description when taken in conjunction with the accompany drawing, in which:

FIG. 1 is a perspective view of an improved thermally responsive switch embodying my invention, in one form thereof;

FIG. 2 is a plan view of the improved thermally responsive switch, with part of the mounting bracket broken away;

FIG. 3 is a cross-sectional view taken substantially along the line 3—3 of FIG. 2;

FIG. 4 is a cross-sectional view taken substantially along the line 4—4 of FIG. 3;

FIG. 5 is a perspective view of the protective shield embodying my invention; and

FIG. 6 is a perspective view of the switch positioned on a burner.

Referring now in detail to the drawings, and in particular to FIGS. 1–3, there is shown a thermally responsive flame detecting switch 1, wherein my invention has been advantageously employed. The switch housing 3 includes hollow insulating base 5 and translucent cover or window 7. Window 7 is fastened to the open side 8 of base 5 and also sealed thereto by some suitable sealant material 10, such as silicone rubber, to provide a translucent cover for the switch 1. To make the manufacturing operation simple, base 5 of switch 1 is box shaped, including elongated side walls 11*a* and 11*b* (FIG. 4), end walls 12*a*, and 12*b* (FIG. 3), and bottom wall 13 (FIG. 3). The base 5 is manufactured from some suitable insulating material, such as the ceramic steatite. Within hollow portion 9 of the base 5, the operating components of flame detecting switch 1 are sealed.

To keep the cost of switch 1 to a minimum, and also provide a switch which is very small in over-all size, as shown in FIGS. 3 and 4, the operating components of switch 1 are very simple in construction. More particularly, bearing terminal 14 is extended through bottom wall 13 near end wall 12*a*. As shown in FIGS. 3 and 4, terminal 14 includes tab 19 which extends outwardly through a slot in bottom wall 13 of base 5 for electrical connection to a lead wire. Boss 21 is extended inwardly from bottom wall 13 of base 5. Boss 21 serves to furnish additional support for terminal 14 within cavity 9 by engaging an intermediate portion of the terminal 14 (See FIG. 3.) After tab 19 of the terminal 14 has been extended through the bottom wall 13 and fastened in position on the outside of base 5 (as shown in FIGS. 3 and 4) by some suitable sealant, such as the aforementioned silicone rubber, a pair of terminal shoulders (not shown) are held in secure engagement with the inner surface of bottom wall 13.

For rotatably supporting a thermally responsive arm 23 within base 5, bearing terminal 14 is bent over transversely within cavity 9, as shown in FIG. 3, and it includes a pair of curved bearing fingers 25 at its inner end (FIG. 2). The manner of rotatably mounting arm 23 within base 5 of the flame detecting switch shall be described in detail hereinafter. Bimetallic arm 23 is constructed to expand and contract in response to thermal change and thus detect the presence of a flame via radiation and/or temperature change. In particular, arm 23 is made from a flat strip of suitable thin bimetallic material which is bent angularly intermediate its ends along line 27 so that the high expansion side 23*a* has an intermediate angle in the order of 163°. In order to provide clearance for one of the fixed contact terminals,

as shall become apparent hereinafter, and also to facilitate a relatively high bimetal energy output per weight of bimetallic material used, the side edges 31 of bimetal 23 (FIG. 2) are convergent towards its free end 33. Bimetal arm 23 has an appropriate aperture formed in its free end 33 for receiving a riveted silver contact 37. Contact 37 extends outwardly from both sides of the bimetal to provide single pole double throw action in the well-known manner.

To provide a clutch arrangement for rotatably supporting arm 23 within base 5, supported end 35 of the arm is stepped inwardly from side edges 31 and fastened to a smooth rotatable cylindrical member or pin 39. (See FIG. 3.) To be more specific, bimetal end 35 is welded tangentially to pin 39 and spaced equidistant from the ends of the pin. Portions of the smooth pin 39 adjacent its ends then extend outwardly in a transverse manner from underneath the stepped sides of the bimetal to fit into or underneath the curved bearing fingers 25 of the terminnal 14. (See FIGS. 2 and 3.) To continuously bias bearing pin 39 into engagement with the curved fingers 25 and thus furnish the desired clutching action in the flame detecting switch 1, a U-shaped clutch spring 41 is provided (FIG. 3). Spring 41 includes a generally flat supporting portion 43 and is bifurcated to provide a pair of spaced spring arms 45 (FIG. 4). Near the end edge 47 of the supporting portion 43, there is formed a slot (not shown) with an inwardly and angularly turned tongue 49 extending toward end wall 12*a*. For securing spring 41 to bottom wall 13 of base 5, the aforementioned slot of portion 43 is first slipped around boss 21 of the base. Then tab 19 of terminal 14 is pushed through base slot 50 from the inside of the hollow portion 9. Tab 19 engages a transverse side of the slot of spring 41, and it wedges the spring into a secure position when terminal 14 is sealed outside of base 5. The free end of the tongue 49 frictionally engages an adjacent wall of boss 21 (as shown in FIG. 3) to restrain the spring supporting portion 43 from any longitudinal movement within base 5.

With clutch spring 41 securely mounted in position on bottom wall 13 of base 5 (as shown in FIG. 3), the bifurcated resilient arms 45 each compressively engage the underside of pin 39 tangentially near its respective ends to bias the pin into frictional engagement with bearing fingers 25 of terminal 14. A very simplified slip-type clutching arrangement for rotatably supporting movable contact 37 within base 5 is thus achieved. Such a clutching arrangement provides overtravel or slip-clutching action upon continuous flexure of the bimetal in the same direction after movable contact 43 has already engaged the "hot" or "cold" side contacts 51 and 53.

The "hot" and "cold" side contacts 51 and 53, respectively, represent the fixed contacts of switch 1. As shown in FIG. 4, "hot" side contact 51 is attached to L-shaped terminal 55 at contact supporting section 55*a* inside of base 5. Tab 55*b* of terminal 55 is extended through a longitudinally extending slot of base wall 13 and bent outwardly, being sealed to the outer surface of wall 13 by the aforementioned sealant, silicone rubber. "Hot" side contact 51 thus faces upwardly (as seen in FIG. 4) for engaging movable contact 37 upon downward movement thereof. "Cold" side contact 53 is attached to the elongated L-shaped terminal 57 at contact supporting section 57*a*. Tab 57*b* of terminal 57 is extended through a longitudinally extending slot and bent outwardly, being sealed to the outer surface of wall 13 in the same manner as terminal 55. "Cold" side contact 53 thus faces downwardly to engage movable contact 37 upon upward movement thereof (viewing FIGS. 3 and 4).

To insure that switch 1 will normally maintain its movable contact 37 in engagement with the "cold" contact 53 for properly starting the burner, a positioning rod 58 is connected to the supported end 35 of the bimetallic arm by attachment to an opposite side of clutch pin 39. More particularly, as shown in FIG. 3, rod 58 includes an elongated portion 59 which has its upper end welded to pin 39 and a support section 61 formed on its lower end. Elongated portion 59 of rod 58 extends longitudinally underneath the bimetallic arm 23 and is centrally disposed so that it has freedom to rotate with pin 39 between the spaced arms 45 of clutch spring 41. Pin 39 of my switch, with bimetallic arm 23 and biasing rod 58 attached thereto, as shown in FIG. 3, provides a switch sub-assembly. When this sub-assembly is mounted in the assembled switch 1, if the temperature of the switch is under 100° F., support section 61 of positioning rod 58 engages the inner surface of bottom wall 13 of base 5 to bias bimetallic arm 23 to its uppermost position (as shown in FIG. 3). Movable contact 37 is thus normally biased into engagement with "cold" side fixed contact 53 by rod 58. Such an arrangement provides switch 1 with a built-in self-starting feature.

Turning now to a very important aspect of my invention, which provides a simplified means for restricting the impingement of radiant energy to the switch and thereby facilitates the efficient operation and utilization of the switch in close proximity to a burner flame, as shown in FIG. 1, the switch 1 also includes protective shield 63. (See also FIG. 5.) Shield 63 is made from a thin sheet of rigid material which reflects light, such as, for example, stainless steel having a thickness of 0.02 inch. Structurally, shield 63 includes rectangular section 65 with an elongated slot 67 formed therein, and flanges 68, 71, and 73 which extend downwardly (viewing FIG. 5) from three peripheral sides of section 65. Flange 69 is disposed in generally perpendicular relationship to the plane of section 65 and when shield 63 is positioned upon switch housing 3, an adjacent outer and upper surface of wall 11*b* is engaged by the inner surface of flange 69 (as shown in FIG. 4). To securely fasten protective shield 63 to the switch housing 3, flanges 71 and 73 are oppositely disposed and then are bent downwardly and inwardly from the outer ends of frame section 65, as shown in FIG. 5. The flanges 71 and 73 bracket end walls 12*a* and 12*b* of base 5, with their inner transverse edges 71*a* and 73*a* grippingly engaging adjacent outer surfaces of the end walls 12*a* and 12*b* to thus efficiently fasten shield 63 to base 5. (See FIG. 3.)

To facilitate convenient attachment of the shield 63 to switch housing 3 after the switch 1 has been otherwise assembled, forward edge 75 of section 65 is not flanged, but instead is coplanar to slot 67. As shown in FIG. 5, forward edge 75, together with adjacent front edges of flanges 71 and 73, combine to provide a substantially U-shaped mouth for slipping the shield into engagement with switch housing 3. When shield 63 is seated on base 3, forward edge 75 of the shield protrudes outwardly, as shown in FIG. 4, from above longitudinal side wall 11*a*.

It will thus be seen that shield 63 of switch 1 is positioned on the switch so that it brackets three sides of window 7 and protrudes laterally outwardly over the other side of the window. By using shield 63 on switch 1 in such a manner, the switch may be mounted in extremely close proximity to the flame of a burner. (See FIG. 6.) Since the surfaces of shield 63 are capable of reflecting light, they reflect radiant energy impinging thereupon. Thus, due to the positioning of shield 63 around the outer periphery of window 7 and in shielding relationship with adjacent surfaces of base 5, radiant energy which would otherwise impinge upon various parts of the switch housing and internal parts of the switch itself in the absence of the sheild, becomes efficiently restricted. Window 67 of the frame-like section 65 of protective shield 63 permits radiant energy to impinge upon bimetal 63 within cavity 9; but substantially all of the emitted radiant energy from the flame which is directed toward other parts of the switch (such as the periphery of translucent cover 7, and sealant 10 which attaches cover 7 to base 5) is reflected. Shield 63 therefore serves to keep all of the various parts

of switch **1**, with the exception of bimetallic arm **23**, at a relatively cool temperature, by its reflection of radiant energy emanating from the burner flame. It will thus be seen by those skilled in the art that by utilizing the reflective protective shield **63** in my improved radiant responsive flame detecting switch **1**, an efficient means has thereby been obtained for obviating the deleterious effects experienced when prior art flame detecting switches of this type are disposed in close proximity to a flame.

Turning now to an explanation of the operation of my improved flame detector switch **1**, due to the disposition of the switch relative to the burner B (FIG. 6), window **7** provides a translucent medium for the entry of radiant energy into hollow portion **9** of base **5**. Bimetallic arm **23** will thus respond to the presence of a burner flame via radiation and/or temperature change. When the ambient temperature of the switch is under approximately 100 F., rod **58** is in the position shown in full in FIG. 3. Biasing section **61** of rod **58** engages base wall **13** and serves as a rigid support for rotatable bimetal arm **23** to normally maintain movable contact **37** in engagement with "cold" side contact **53** (as shown in full in FIG. 3). In this manner, after switch **1** has been stored in a cold warehouse, or when it has been severely jarred or shaken during shipment, biasing rod **58** will always assure that movable contact **37** is in engagement with the "cold" side fixed contact **53** when the flame detector switch is placed in operation. As an example, if flame detector switch **1** is cooled to —40 F. and then brought back to room temperature, movable contact **37** will remain in continuous engagement wtih the "cold" side fixed contact **53** until the ambient temperature has reached approximately 100 F.

When switch **1** has been connected in a "master" furnace controlling circuit for controlling a burner B (FIG. 6), it will then immediately start the burner B because the "cold" side contacts are engaged. As the burner B starts, the bimetal **23** will then flex downwardly to the dotted position **23b** shown in FIG. 3. Movable contact **37** will thus move from the "cold" side to the "hot" side fixed contact, its position then being represented by the dotted contact **37***a* of FIG. 3. This action signals the condition of the flame to a primary relay (not shown) of the master control circuit in the well-known manner. The burner B will then, of course, gradually heat up the bimetal. As the temperature increases, with the movable contact **37** engaging "hot" side contact **51**, bimetal **23** tends to straighten itself out and open the angle between its ends. More specifically, since the bimetal is fixed at the movable contact end by closure with the "hot" side contact **51**, bimetal **23** flexes to position **23***c* of FIG. 3, and bent portion **27** of bimetal **23** moves to position **27***a*. With an increase of temperature of about 30 F., bimetal **23** will then turn rotatable pin **39** in a counterclockwise direction (viewing FIG. 3) to slip the frictional clutch provided by the engagement of pin **39** with the curved fingers **25**. The biasing force provided by clutch spring **41** require about a 30 F. rise in temperature to slip the clutch and rotate the pin **39**. When this clutch slippage occurs, biasing rod **58** moves upwardly to the position **58***a* (as shown in FIG. 3) to free supporting section **61** from the bottom wall **13** of the base. Rod **58** then no longer has any biasing effect upon bimetal **23**.

In the event that the flame which is being detected by my switch **1** should fail, the bimetal contact **37** moves from the "hot" side contact toward the "cold" side contact. As soon as the movable contact **37** leaves the "hot" side contact, this immediately shuts off the fuel supply. The frictional clutch is arranged to prevent slippage of the pin **39** of the rotatable bimetal until at least a 30 F. temperature drop is affected and the movable contact **37** has moved from the "hot" side contact and touches the "cold" side contact. Another 30 F. temperature drop wipes the movable contact into the "cold" side contact, building up a torque equal to, and opposite to the clutch torque. With further cooling, the clutch then slips and the biasing rod **58** is thus returned to its original biasing position (with supporting section **61** in engagement with bottom wall **13** of the base).

My improved flame detecting switch **1** has been designed principally for mounting in the blast tube of a domestic gun-type oil burner. For this purpose, I have illustrated it with one form of a mounting bracket assembly **77**. This assembly (as shown in FIG. 1) includes a U-shaped clip **79** which surrounds three sides of base **5** and partially brackets the fourth side (FIG. 6). Clamp **81** is welded to a portion of clip **79** and includes a threaded clamp screw **83** for attaching the assembly to a suitable support within the blast tube of a burner, such as nut-shaped annulus **84** of burner B in FIG. 6. Various other types of supporting bracket assemblies can, of course, be utilized for my improved flame detector switch, in accordance with the requirements of the application.

It will thus be understood that my new and improved flame detecting switch, such as herein illustrated, provides a simple end efficient means for detecting the presence of flame via radiation and/or temperature change in close proximity to a flame. With flame detecting switches incorporating my invention, it is no longer necessary to limit the proximity to the flame because of deleterious thermal effects of this proximity upon the switch structure. It should be realized that certain aspects of my invention may be incorporated efficiency and beneficially in other various types of thermally responsive switches.

While in accordance with the patent statutes, I have described what at present is considered to be the preferred embodiment of my invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from my invention, and I, therefore, aim in the following claims to cover all such equivalent variations as fall within the true spirit and scope of this invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A thermally responsive flame detecting switch useable in close proximity to a flame, said switch comprising a housing including at least one translucent wall portion for transmitting radiant energy into said housing, a thermally responsive member positioned within said housing, contact means disposed within said housing and operable in response to thermally responsive movement of said member, and a single thin metal reflective shield engaged on said housing directly in the path of radiant energy emission between said flame and said switch, said shield directly overlying the edge of said translucent wall in close juxtaposition to said translucent wall to protectively shield parts of said switch from radiant energy and having a central window allowing the impingement of radiant energy upon said thermally responsive member through said translucent wall thereby to enhance the efficiency and durability of said switch.

2. A thermally responsive flame detecting switch useable in close proximity to a flame, said switch comprising a housing, said housing including a base with a hollow cavity therein an a translucent wall portion attached to said base for admitting radiant energy into said cavity, a thermally responsive member positioned within said cavity, a contact means disposed within said cavity and operable in response to thermally responsive movement of said member, and a single sheet reflective shield engaged on said base directly in the path of radiant energy emission between said flame and said switch, said shield directly overlying the edges of said translucent wall to protect parts of said switch from radiant energy and having a window allowing the impingement of radiant energy upon said thermally responsive member through said translucent wall thereby to enhance the efficiency and durability of said switch.

3. A thermally responsive flame detecting switch useable in close proximity to a flame, said switch comprising a box-shaped housing, said housing including a base with a hollow cavity therein and a translucent wall portion having a peripheral area sealed into engagement with an open end of said base and covering said base for admitting radiant energy into said cavity, a thermally responsive member positioned within said cavity, contact means disposed within said cavity and operable in response to thermally responsive movement of said member, and a single plate having a reflective face perimetrically framing said translucent wall portion and arranged for disposition directly in the path of radiant energy emission between said flame and said switch, said face serving to protect parts of said switch from radiant energy while allowing the unrestricted impingement of radiant energy upon said thermally responsive member, thereby to enhance the efficiency and durability of the switch.

4. A burner mounted flame detecting switch useable in close proximity to a flame, said switch comprising a box-shaped housing, said housing including an insulating base with a hollow cavity therein and a rectangularly configured translucent wall portion attached to an open end of said base and serving as a wall thereof for admitting radiant energy into said cavity, a thermally responsive member positioned within said cavity, said member carrying a movable contact on the free end thereof, fixed contact means disposed within said cavity and cooperable with said movable contact in response to thermally responsive movement of said member, and a reflective shield of rectangular configuration engaged on said base and extending over said translucent wall, said shield having a flat frame-like section including a window, and at least two oppositely disposed flanges turned downwardly and inwardly from ends of said section, said flanges frictionally engaging oppositely disposed walls of said base for attachment of said shield to said switch housing, the window of said shield being disposed in generally overlying relationship to the thermally responsive member, said shield serving to protect parts of said switch from radiant energy while allowing unrestricted impingement of radiant energy upon said thermally responsive member thereby to enhance the efficiency and durability of the switch.

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