Nov. 24, 1953 J. A. DEUBEL 2,660,645

FLAME DETECTOR

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Fig. 1

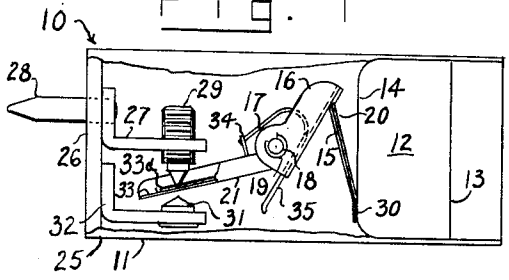


Fig. 2

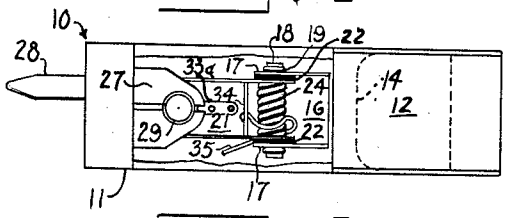


Fig. 3

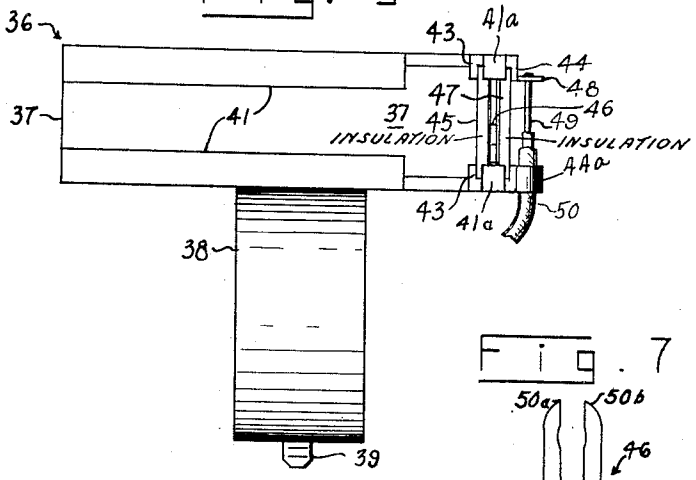
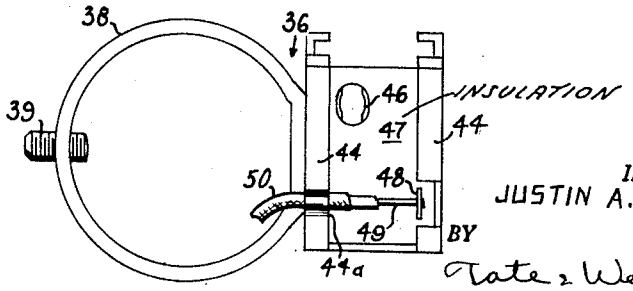


Fig. 7

Fig. 4



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Fig. 5

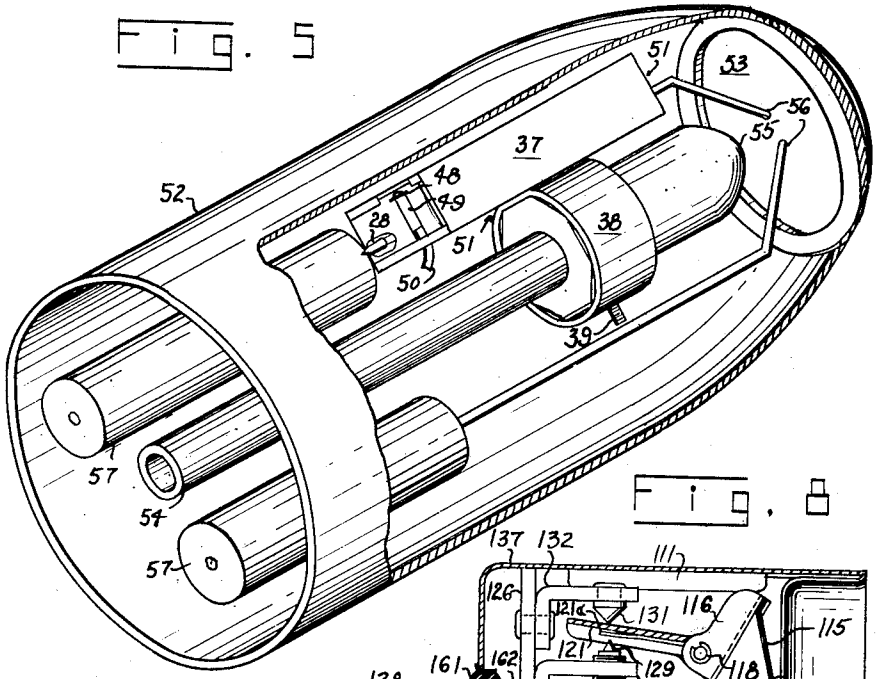
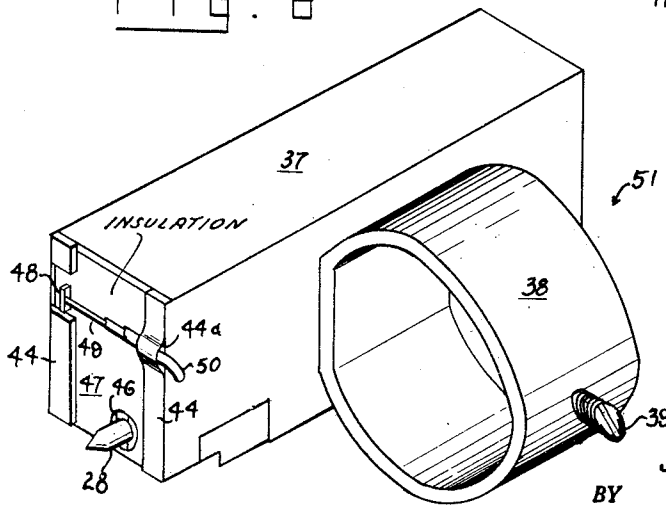


Fig. 8

Fig. 6



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FLAME DETECTOR

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Fig. 9

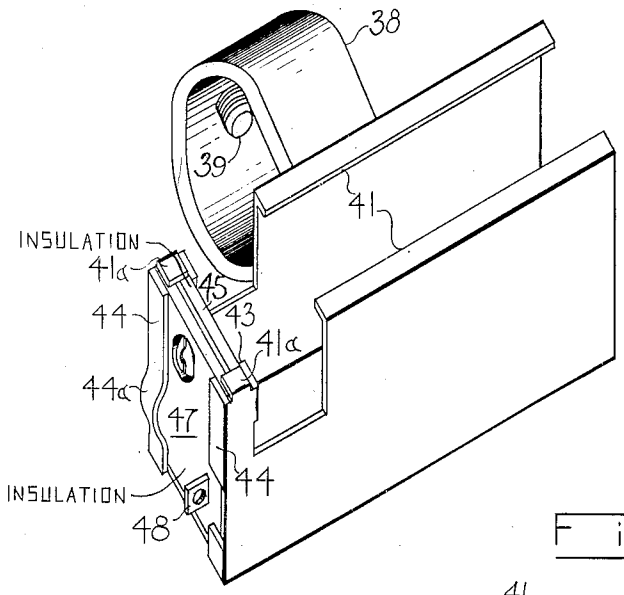


Fig. 10

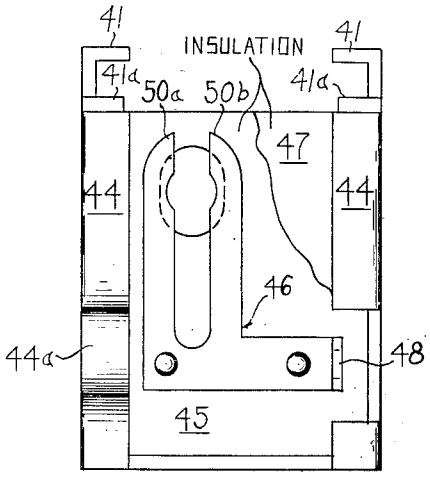
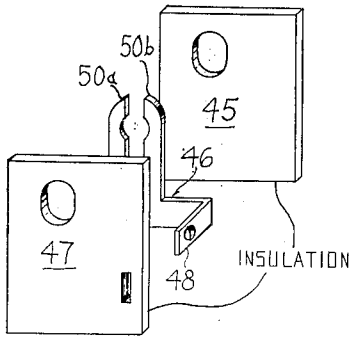


Fig. 11



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FLAME DETECTOR

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8 Claims. (Cl. 200—136.5)

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This invention relates to a control mechanism that serves to open and close an associated electric circuit in accordance with external conditions which influence the operating mechanism.

More particularly this invention concerns a novel type of switch that operates in response to temperature changes which has application as a flame responsive switch in an oil burner control apparatus.

In an oil burner operation it is of prime importance to provide sufficient and adequate safety devices to prevent burner operation under abnormal conditions. One of these safety requirements necessitates the use of a control that will stop burner operation upon failure to initiate combustion. Generally some type of flame responsive device has in the past been used to determine the presence or absence of flame, and these devices are usually located remotely from the burner and burner primary control. However, many of these devices now in use are subject to limitations in rapidity of response and length of useful life. Many factors contribute to cause these limitations but the most important one is the necessity of positioning the flame responsive device in proximity to the flame. The deteriorating effects of the flame, the temperature and pressure of the air stream, vibration etc. require a construction that will be relatively unaffected by these factors. This invention embodies a type of construction that effectively shields the moving parts from the flame and products of combustion, provides positive and immediate response to reversals in temperature change, and permits ease of adjustment and repair, and is located within the burner blast tube and therefore can be assembled with the burner and primary control as a unit.

A further feature of the invention resides in the slip-friction element which permits over travel of the actuating member in both directions and provides immediate response upon reversal of the direction of temperature changes.

Further objects will become apparent as this description proceeds and will be particularly pointed out in the appended claims.

In the following description like reference characters indicate like parts in the several drawings:

Figure 1 represents a side view of the flame or heat responsive switch with a portion of the side plate removed.

Figure 2 represents a top view of the flame or heat responsive switch with a portion of the top plate removed.

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Figure 3 represents a top view of the switch mounting.

Figure 4 represents an end view of the switch mounting.

Figure 5 represents a perspective view of the end portion of an oil burner tube assembly with the flame detector mounted in a preferred location.

Figure 6 represents a perspective view of the assembled switch and mounting.

Figure 7 represents a front view of the switch contact fork.

Figure 8 is a view, similar to Fig. 1, showing a modification of the device of Fig. 1.

Fig. 9 is a perspective view of the switch mounting.

Fig. 10 is an enlarged end view of the switch mounting, similar to Fig. 4.

Fig. 11 is a composite view of the prong-receiving end assembly.

In respect to comparative sizes in the several figures, the Figs. 1, 2, 3, 4, 6, 7, and 8 are drawn to approximately twice actual size and the flame responsive device of Fig. 5 is drawn to actual size.

Referring now to Figs. 1 and 2 in which is shown the flame or heat responsive switch unit 10 having a casing 11 substantially rectangular in shape, encompassing the side, top and bottom with the ends left open. A rectangular cup-shaped closure member 12 is securely fastened within the open end of casing 11. The member 12 has an open end 13 and a closed end 14 sealing off the opening 13 from the remainder of casing 11. The member 12 is formed of metal or other heat conductive material and is the primary recipient of heat radiation from the flame. A heat responsive member comprising a bimetallic strip 15, serving as an actuating member, is secured by welding or other suitable means to the closed end 14. This arrangement places the bimetal 15 in heat conductive relationship with the cup member 12. In this arrangement, the free end 20 of bimetal 15 is securely fastened to a channelled lever 16. The lower ends 17 of the flanges of channel-shaped lever 16 are perforated to receive a pivot pin 18 secured in position by lock rings 19. A channel-shaped contact lever 21 is similarly supported on the pivot pin 18 but separated from lever 16 by friction washers such as carbon washers 22. A flexible contact blade 33a is fastened by any suitable means to the web-portion 33 of lever 21. Circumferentially surrounding the pin 18 and interposed between the flanges of contact lever 21 is a compression

spring 24. The spring 24 serves to spread the channel flanges against the carbon washers 22 which are confined by the ends 17 and lock rings 19. The result of this arrangement permits unitary movement of levers 16 and 21 when such movement is unobstructed and also provides for slip frictional movement between levers 16 and 21 when the movement of lever 21 is obstructed.

Within the open end 25 of casing 11 is securely fastened an insulation piece 26 which effectively seals this end of casing 11. Fastened to the piece 26 by rivets or other suitable means is an L-shaped, electrically conductive bracket 27. A contact prong 28 is secured to the bracket 27 and projects through a hole in insulation piece 26. A threaded aperture in the bracket 27 serves as a means of support and adjustment for a threaded contact member 29. A stop 31, supported by a bracket 32 which is riveted to the piece 26, limits the counterclockwise movement of lever 21. The contact 29 cooperates with the web-portion 33 of channel 21 to constitute a switch which may be integrated into the oil burner control system. Flexible blade 33*a* has a slight upward bias and therefore there is a small clearance between blade 33*a* and the portion 33 when the contacts are open, the blade 33*a* being flexed slightly downward when the contacts are closed. The amount of this press-back flexure of blade 33*a* determines the magnitude of the temperature increase necessary to open the contacts. The position of contact 29 with relation to the stop 31 is adjustable. This adjustment determines the amount of unobstructed clockwise movement of lever 21 which may take place upon a decrease in temperature of the strip 15 and consequently determines the magnitude of the temperature decrease necessary to reclose the switch contacts 29—33. As shown in the drawings, the stop 31 is not connected to any electrical circuit and serves solely as a stop, however, it could be utilized as an electrical contact. This could be accomplished by providing the bracket 32 with a prong similar to the prong 28 and an exterior connection to complete a circuit. The contact lever 21 would provide a common lead for both circuits. The device would then act as a double throw switch.

An upturned portion of the contact lever 21 provides an electrical terminal 34 to which a flexible conductor lead 35 is soldered or otherwise fastened. The lead 35 is passed over the spring 24, led along the base of channel 16 and fastened to the casing 11 by soldering. This arrangement electrically grounds the lever 21 to the casing 11 to provide one path for current flow from the switch. Essentially a high resistance ground exists from lever 21, through carbon washers 22, channel 16, bimetal 15, cup member 21, and casing 11 but this path is undesirable for this application of the invention, in that current through the bimetal will generate heat and affect operation of the switch.

Referring now to Figs. 3–6 and 9 there is shown the switch mounting 36, comprising a mounting socket 37 and a mounting clamp 38. The clamp 38 is threaded to provide a tightening screw 39 which enables the mounting 36 to be secured to an oil tube 54 as shown in Fig. 5. The mounting socket 37, formed of conductive metal, has an open flanged top 41 allowing insertion of flame responsive switch unit 10 into the mounting socket 37. An open end 42 of mounting socket 37 has inturned edges 43 and 44 which form a slotted receptacle in the mounting socket end. An inner insulation piece 45, a contact fork or receptacle 46 (Fig. 7), and an insulation piece 47 are assembled within this slotted portion, after which the edges 43 and 44 are squeezed together and bent over to form tabs 41*a* to secure this assembly within the mounting socket 37. The insulation pieces 45 and 47 are made the same size as the end of the mounting socket 37. This assembly is more clearly illustrated in Figs. 9, 10, and 11 wherein the contact fork 46 is shown in relation to the insulation pieces 45 and 47. In Fig. 11 the insulation pieces 45 and 47 and the contact fork or receptacle 46 are shown in their aligned relationship prior to assembly in the slotted end of the mounting socket 37. The contact fork 46 (Figs. 7 and 11) adjacent its ends 50*a* and 50*b* provides an opening into which the contact prong 28 may be inserted upon assembling of the detector 10 and mounting 36. An L-shaped extension 48 of the fork 46 is attached to the central wire 49 of a metal sheathed conductor lead. This type of lead has the central hot wire separated from the grounded sheath 50 by insulation. The grounded sheath 50 is soldered to a projection 44*a* of edge 44 of mounting socket 37 (Fig. 6). Thus, when the unit 10 is assembled within the mounting socket 37, the wire 49 is electrically connected to the extension 48, fork 46, prong 28, bracket 27 and contact 29. The grounded sheath 50 is electrically connected to the projection 44*a*, mounting socket 37, casing 11, lead 35, terminal 34, and contact lever 21. Fig. 6 shows the assembled flame detector 51 with the unit 10 inserted into the mounting socket 37.

Referring now to Fig. 5 in which is shown the blast-tube portion of a gun type oil burner having the flame detector 51 mounted on the oil tube 54. The blast tube 52 has an opening 53 through which the atomized mixture of oil and air is expelled into the combustion chamber of an oil-fired furnace. The oil tube 54 is provided with an orifice 55 from which the oil under pressure is injected into the air stream which flows inside the tube 52. Typical means provided for ignition purposes are the electrodes 56 with their corresponding insulators 57.

Note that the detector unit 51 is mounted on the oil tube 54 in such a position that the end 13 of cup member 12 is in proximity to the opening 53 to receive a maximum of radiated heat from the burner flame.

In operation, when the oil burner is shut down the strip 15 will be in its cold position and portion 33 will be in electrical contact with the contact 29, as shown in Fig 1. After the oil burner is placed in operation, heat from the flame will be radiated to the member 12, at its end 14. By conduction and radiation, heat will be transmitted to strip 15. Assuming the higher expansive side of the bimetal strip 15 is adjacent the member 12, the strip 15 will flex away from member 12 at its free end as its temperature increases. Upon the initial movement of the free end of strip 15, the member 16 and lever 21 will move as a unit, pivoting lever 21 counterclockwise about the pin 18. This movement, depending on the amount of press-back of blade 33*a*, soon separates contacts 29—33 indicating to the burner control apparatus to which the flame detector is connected that combustion is taking place within the furnace combustion-chamber.

Continued increase in temperature of strip 15 moves the lever 21 into engagement with the stop 31, which obstructs further counterclockwise

movement of lever 21. Further movement of strip 15 produces slippage at the carbon washers 22.

After the burner has operated for the required period and the burner flame has been extinguished, the strip 15 will cool causing it to move its free end toward member 12. This movement will immediately result in lever 21 leaving the stop 31 and moving into engagement with contact 29. This closure of contacts 29—33 indicates to the burner control apparatus that the burner flame has been extinguished and the combustion chamber is cooling. Further cooling of strip 15 will result in slippage at the carbon washers 22. Lever 21 will be held in a position such that an increase in temperature of strip 15 will immediately open the contacts 29—33.

Figure 8 shows a modification of the device previously described. In this modification, the switch is arranged so as to be closed when the bimetal strip 115 (comparable to strip 15 of Fig. 1) is in its hot position. This form of the flame detector has the contact assembly and the heat responsive element hermetically sealed within an outer casing 137.

The casing 137 has a contact prong 128 mounted on its closed end. The prong 128 is sealed to an eyelet 160 by means of a globule 161 of fused glass, or similar material, and the eyelet 160 is fastened, by any suitable means such as solder, into an opening in the closed end of the casing 137. The inner end of prong 128 has a central, axial opening or recess in which is seated a compression spring 162.

The switch unit is composed of a frame or housing 111 including a plate 126, formed of suitable electrical insulating material. Plate 126 has riveted to it a bracket 132 carrying a stop 131. An electrically conductive rivet 163 fastens a contact carrying bracket 127 to the plate 126. When the flame detector is assembled the outer end of rivet 163 bears against the spring 162 which serves as an electrically conductive path between the contact 129, mounted on the bracket 127, and prong 128. A contact carrying blade 121a is fastened by any suitable means to a channel-shaped lever 121, the lever 121 and a member 116 being assembled on a pin 118 by means of the slip-friction mechanism previously described. Member 116 is mounted on the free end of strip 115, which, in turn, is secured, by any suitable means to a cup-shaped member 112. In assembling the flame detector, the housing 111 including plate 126, upon which are mounted brackets 127 and 132, is inserted into casing 137, the head of rivet 163 seating against the end of spring 162, compressing it slightly. Member 112 is then inserted into the casing 137, which in turn is inserted into a mounting socket 37 shown in Fig. 4. The flanged edges of member 112 resting against the edges of casing 137, to which they may be soldered thereby hermetically sealing the assembly. It will be noted that because of the flexibility of spring 162, the position of plate 126 with reference to the closed end of casing 137 is not critical, the compression of spring 162 permitting slight variations in the length dimensions of the casing 137, frame 111, and member 112. The resulting advantage in utilizing components which need not be manufactured to extremely close dimensional tolerances is obvious. Additionally, spring 162 insures that good electrical contact is maintained between prong 128 and contact 129. The operation of the modification of Fig. 8 is identical to that previously described, except that the switch contacts are closed upon an increase in temperature and opened upon a decrease in temperature.

There have been illustrated preferred embodiments of the invention, but its scope is to be limited only by the appended claims.

What is claimed is:

1. A thermally responsive switch comprising switching means, a casing enclosing said switching means, a connector prong extending from one face of the casing and connected to said switching means within the casing, a mounting socket into which the casing may be removably inserted, the wall of the mounting socket adjacent said prong being formed of insulating material and having an opening therein accommodating said prong, an electrically conductive member mounted within said wall and having portions engaged by said prong when said casing is inserted into said mounting socket, said conductive member having a part extending outside said wall to provide an external lead-in connection for said switching means.

2. A switch assembly comprising an outer casing, an inner switch housing insertable into the casing, switching elements mounted within said housing, an electrically conductive member extending through a wall of said housing and electrically connected to said switch elements within said housing, electrical terminal means extending through a wall of said casing adjacent said conductive member, and flexible means extending between said terminal means and said conductive member and flexed an amount proportional to the depth of insertion of said housing into said casing, said flexible means also serving as an electrical connection between said terminal means and said conductive member.

3. A switch assembly comprising an outer casing, an inner switch housing insertable into the casing, switching elements mounted within said housing, an electrically conductive member extending through a wall of said housing and electrically connected to said switch elements within said housing, electrical terminal means extending through a wall of said casing adjacent said conductive member, and a compression spring extending between said terminal means and said conductive member and compressed an amount proportional to the depth of insertion of said housing into said casing, said compression spring also serving as an electrical connection between said terminal means and said conductive member.

4. A switch assembly comprising an outer casing, an inner switch housing insertable into the casing, switching elements mounted within said housing, an electrically conductive member extending through a wall of said housing and electrically connected to said switch elements within said housing, an electrical connector prong extending through a wall of said casing adjacent said conductive member, the outer end of said prong being adapted for connection to an external lead-in wire, the inner end of said prong having an axial recess therein, a compression spring bottomed within said recess and contacting said conductive member when said housing is inserted into said casing, said spring being compressed an amount proportional to the depth of insertion of said housing into said casing, said spring also serving as an electrical connection between said prong and said conductive member.

5. A hermetically sealed switch assembly adapted for mounting within the blast tube of

an oil burner comprising: an open-ended outer casing, switch elements mounted within said casing, a closure member for the open end of said casing adapted to receive radiant heat from the burner flame, and external terminal means extending through the wall of said casing opposite said closure member, and fusible means hermetically sealing the opening in said casing through which the terminal means extends.

6. An hermetically sealed switch assembly adapted for mounting within the blast tube of an oil burner comprising: an outer casing, an inner switch housing insertable into the casing, switching elements mounted within said housing, an electrically conductive member extending through a wall of said housing and electrically connected to said switch elements within said housing, electrical terminal means extending through a wall of said casing adjacent said conductive member, and a flexible member extending between said terminal means and said conductive member and flexed an amount proportional to the depth of insertion of said housing into said casing, said flexible member forming an electrically conductive path between said terminal means and said conductive member which is independent of the insertion of said housing into said casing to a precise given depth.

7. An hermetically sealed switch assembly adapted for mounting within the blast tube of an oil burner comprising: an outer casing, an inner switch housing insertable into the casing, switching elements mounted within said housing, an electrically conductive member extending through a wall of said housing and electrically connected to said switch elements within said housing, electrical terminal means extending through a wall of said casing adjacent said conductive member, and a flexible member extending between said terminal means and said conductive member and flexed an amount proportional to the depth of insertion of said housing into said

casing, said flexible member forming an electrically conductive path between said terminal means and said conductive member which is independent of the insertion of said housing into said casing to a precise given depth, and a mounting socket into which said casing is insertable, said mounting socket having receptacle means for accommodating said terminal means.

8. An hermetically sealed switch assembly adapted for mounting within the blast tube of an oil burner comprising: an outer casing, an inner switch housing insertable into the casing, switching elements mounted within said housing, an electrically conductive member extending through a wall of said housing and electrically connected to said switch elements within said housing, an electrical connector prong extending through a wall of said casing adjacent said conductive member, the inner end of said prong having an axial recess therein, a compression spring bottomed within said recess and contacting said conductive member when said housing is inserted into said casing, said spring being compressed an amount proportional to the depth of insertion of said housing into said casing and forming an electrically conductive path between said prong and said conductive member which is independent of the insertion of said housing into said casing to a precise given depth, and a mounting socket into which said casing is insertable, said mounting socket having receptacle means for accommodating said prong.

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