March 13, 1945. I. E. McCABE 2,371,455

ELECTRIC SWITCH MECHANISM

Original Filed March 19, 1940 3 Sheets-Sheet 1

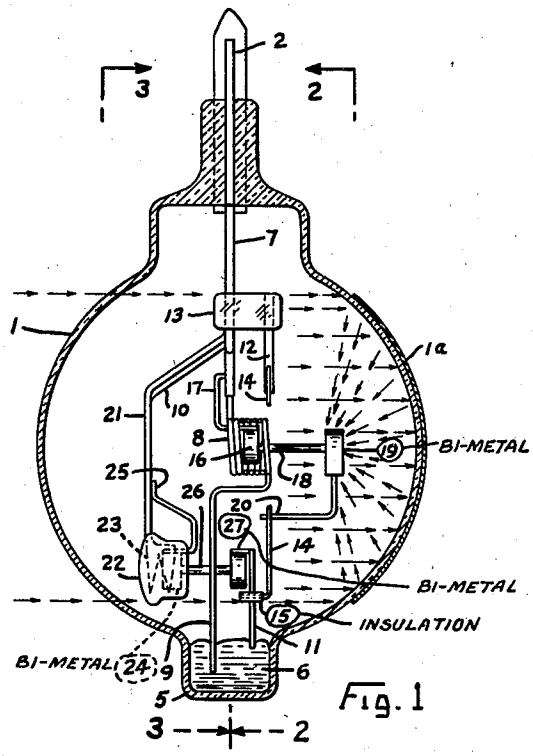


Fig. 1

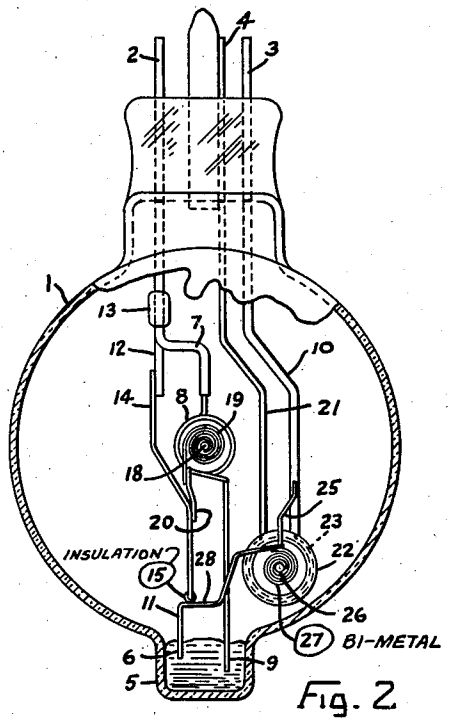


Fig. 2

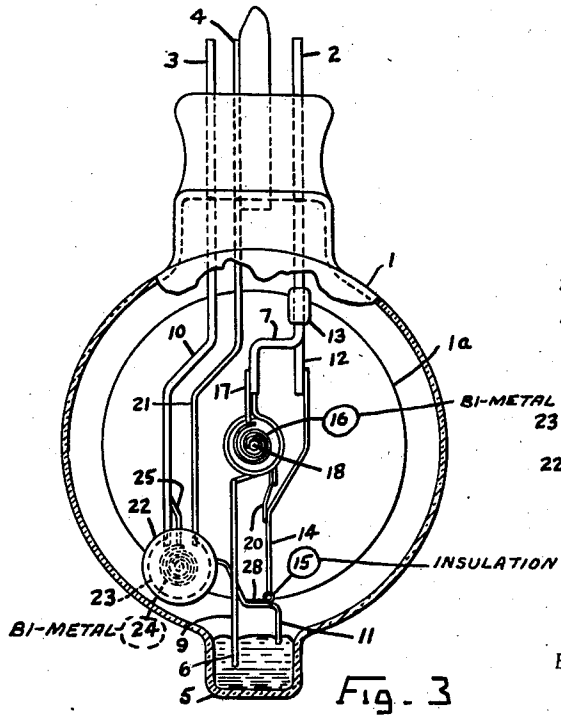


Fig. 3

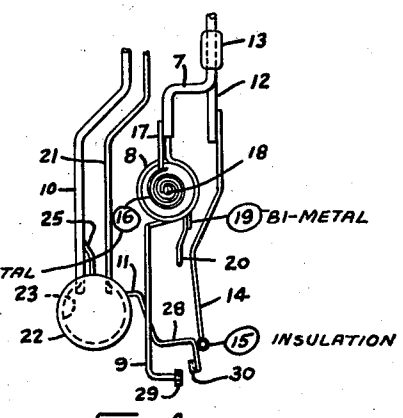


Fig. 4

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ELECTRIC SWITCH MECHANISM

Original Filed March 19, 1940 3 Sheets-Sheet 2

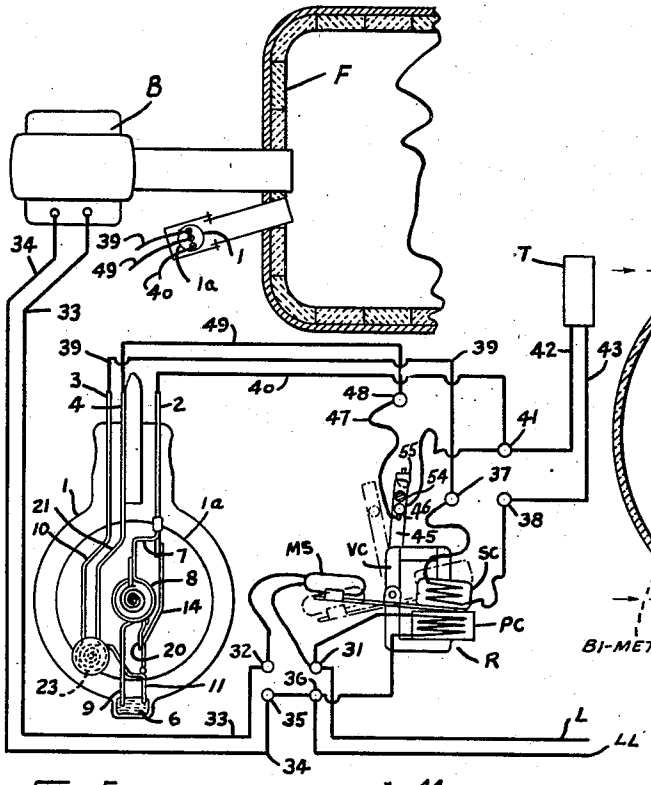


Fig. 5

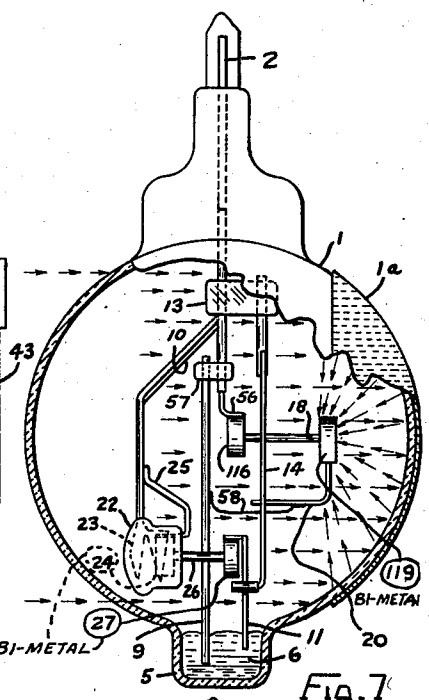


Fig. 7

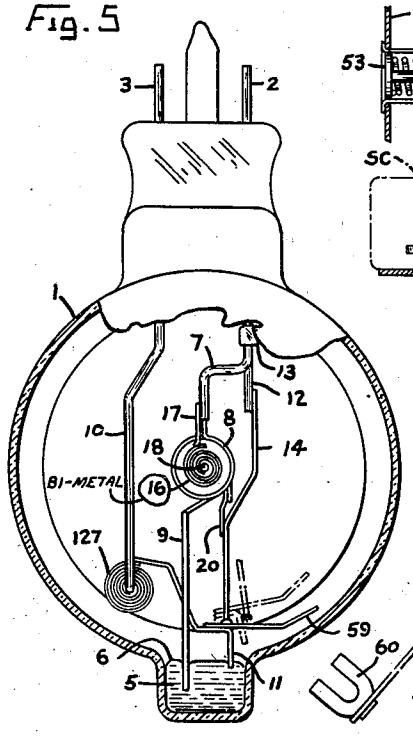


Fig. 8

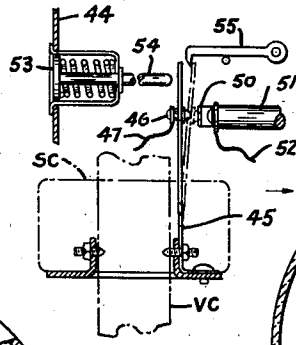


Fig. 6

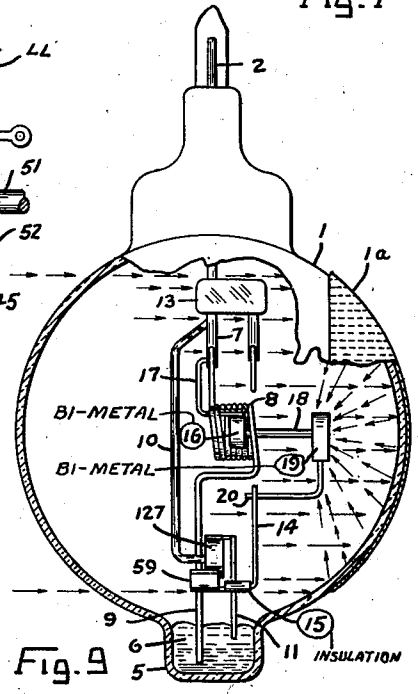


Fig. 9

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ELECTRIC SWITCH MECHANISM

Original Filed March 19, 1940 3 Sheets-Sheet 3

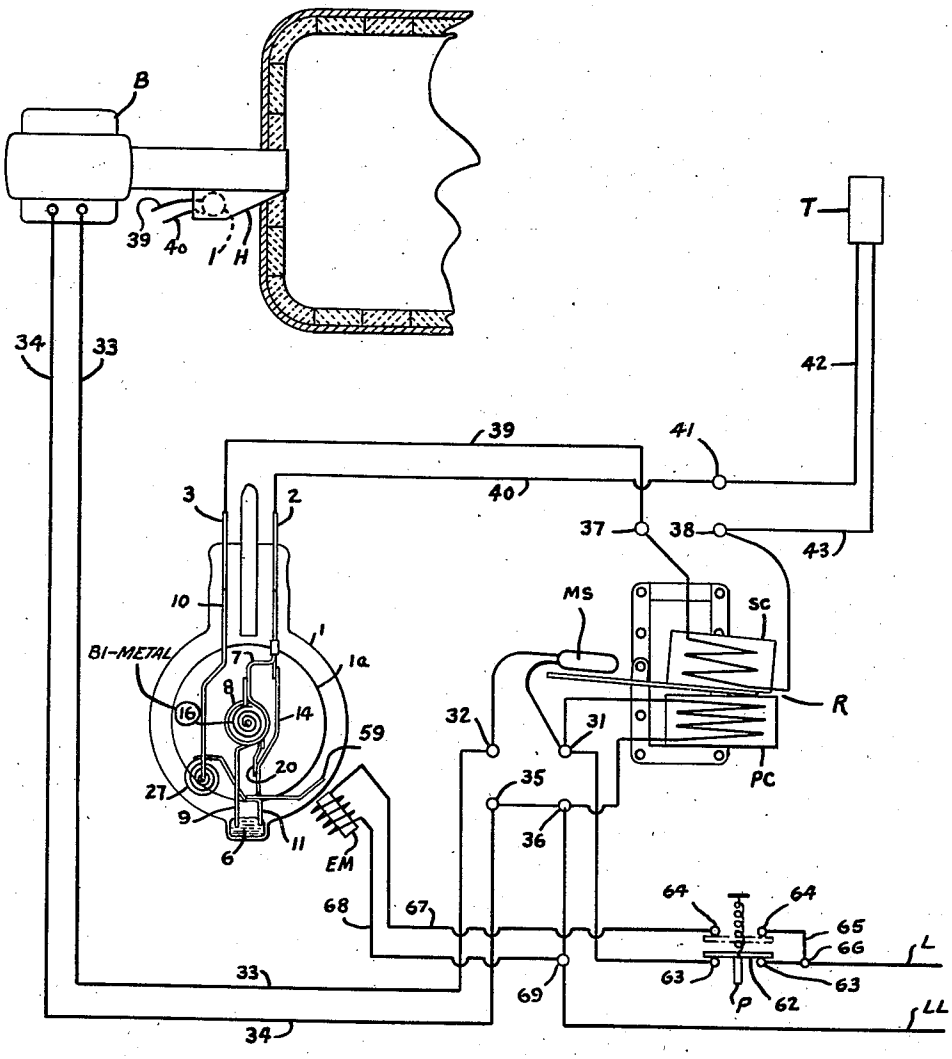


Fig. 10

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Patented Mar. 13, 1945

2,371,455

UNITED STATES PATENT OFFICE

2,371,455

ELECTRIC SWITCH MECHANISM

Ira E. McCabe, Chicago, Ill.

Original application March 19, 1940, Serial No. 324,795. Divided and this application October 5, 1942, Serial No. 460,923

7 Claims. (Cl. 158—28)

This invention relates to improvements in electric controls adaptable for controlling the operation of an electrically operated fluid fuel burner mechanism, although it may be used for other purposes, and more particularly to an electric switching mechanism responsive to radiant energy emanating from rays of visible light.

During the past twenty years or more since the introduction of fluid fuel and particularly oil, gas or powdered coal as a fuel for heating houses, hotels, office and other buildings, the burners for such fuel have been developed to such an extent as to substantially supersede the demand for coal furnaces wherever electricity is available. It was recognized early in this industry that the burner mechanisms must be automatic in operation and so controlled as to furnish fuel when heat was desired and to shut off the delivery of fuel when the demand for heat was satisfied as a normal operation, and at the same time, to provide safety means to cut off the supply of fuel upon an abnormal occurrence, such as initial failure of the fuel to ignite or failure of combustion during normal operation.

The popular demand for such heating systems has been enhanced by the developments of the fluid fuel burner manufacturers in reducing the cost of the burner mechanism to be within the reach of the general public. The reduction of cost was a mechanical problem to the burner manufacturers, but, as the burner mechanisms were operated by electricity, the problem of automatic safety control was an electrical problem. A control industry grew up separate and distinct from the burner manufacturers which encountered a much more difficult problem. So that today while the fluid fuel burners are advertised by a large number of the mail order houses, the controls for the burners are complicated, costly and require especially trained personnel to install them in connection with the burner. The accepted type of safety controls of this character is usually responsive to the presence or absence of the heat of combustion within the heater or furnace and usually requires a member of thermostatic metal mounted in the stack leading from the heater to the chimney or in a position otherwise adjacent to the combustion chamber disassociated with the burner mechanism and is in addition to the room thermostat for controlling the normal operation.

It is an object of this invention to provide a safety control for an electrically operated and controlled fluid fuel burner mechanism which will provide the safety mechanism within a small enclosed space, so constructed at the factory as to require no further adjustment, preventing the user from tampering with it, and may be supplied to the burner manufacturer to incorporate as a part of the burner mechanism, if so desired. It is a further object of this invention to so construct this improved safety control mechanism that it will operate in response to the presence or absence of visible light emanating from the burner flame, thereby avoiding the use of thermostatic metal being subjected to the heat of combustion. When delivered as a part of the burner mechanism, it is only necessary to connect the improved safety control in circuit with the other controls of the system, usually including a room thermostat for controlling the normal operation of the burner and a switch in the circuit to the burner motor, thereby avoiding the necessity of employing highly trained electricians to adjust and install the heating system. This improved control not only reduces the size of the safety unit, but reduces the number of switches now necessary to safety controls.

This invention is a continuation of the development of light responsive switches disclosed in this applicant's prior patents, No. 2,159,392, May 23, 1939; No. 2,149,853, March 7, 1939; and No. 2,162,098, June 13, 1939, listed in accordance with the filing dates of the respective applications for patent, and includes all the advantages and uses of the switches so disclosed. As an additional advantage thereover, it provides the arrangement within the single bulb or sealed container of the fluid connector having one electrode immersed at its end in the connecting fluid and mechanism for normally maintaining the other electrode in locked engagement with the connector, whereby flame failure at any time releases said electrode to open the circuit therethrough. This invention also provides a manually controlled circuit or other means for resetting the switch. This application is a division of this applicant's co-pending application Serial No. 324,795, filed March 19, 1940 which became Patent No. 2,318,698, May 11, 1943.

With these and other objects in view reference is made to the accompanying sheets of drawings which illustrates preferred embodiments of this invention, with the understanding that minor changes may be made without departing from the scope thereof.

In the drawings:

Figure 1 is a view in vertical section of one form of this improved switch, showing the operating parts in side elevation.

Figure 2 is a view partly in section, taken on the line 2—2, Figure 1, looking in the direction of the arrows.

Figure 3 is a view partly in section, taken on the line 3—3, Figure 1, looking in the direction of the arrows.

Figure 4 is a detail view of the operating parts shown in Figure 3, modified to illustrate the use of solid metal contacts in place of the fluid connector or mercury, showing the contact members in the released open circuit position.

Figure 5 is a wiring diagram illustrating the application of this improved switch, shown in Figures 1 to 3, to a control circuit of an automatic fluid fuel burner.

Figure 6 is a detail view partly in elevation and partly in section of a switch re-set mechanism, comprising a form of push button switch incorporated in the control system, as disclosed in Figure 5.

Figure 7 is a view similar to Figure 1 of a modified form of this invention.

Figure 8 is a view similar to Figure 3 of another modified form of this invention, including an automatic magnetic re-set device.

Figure 9 is a view partly in section, taken on the line 9—9, Figure 8.

Figure 10 is a modified wiring diagram similar to that disclosed in Figure 5 and wherein the improved switch is mounted upon the air pipe of the burner and a modified form of manually operated magnetic re-set device is employed.

In carrying out the present invention it is preferable to enclose the moving parts of this safety control in a spherical transparent bulb or casing 1, similar to that disclosed in Figure 8 of the applicant's prior Patent No. 2,162,098, June 13, 1939. The bulb 1 is preferably of glass provided with a radial extension through which the leading in wires 2, 3 and 4 are sealed and the bulb diametrically opposite the seal is provided with a radial well 5 for containing mercury or other fluid electrical connecting material 6. Since the circuit is made and broken through the mercury connector the switching mechanism is of the mercury tube switch type and therefore the casing is evacuated and the air is replaced by an inert gas. The conductivity of such gas affects the operating characteristics of the device and it has been found that the use of argon permits a smaller size bulb to be used. As shown in Figures 1, 2 and 3, the leading in wires 2, 3 and 4 extend beyond the end of the seal and the projecting ends of leads 2 and 3 are adapted to be connected to the conductors of the circuit to be controlled by the safety switch mechanism, while the projecting end of lead 4 is adapted to be connected to the conductor of the circuit for manually resetting the switching mechanism. The leading in wire 2 upon the interior of the bulb 1 is connected to an electrode 7 which includes intermediate its length a coil 8 of resistance wire arranged concentric with the horizontal axis of the bulb and the end 9 of the electrode is extended in a vertical position to approximately the bottom of the well 5 so that its lower end will be immersed in the mercury 6. When the circuit is completed and the current flows through the resistance coil 8 the coil will become heated.

The leading in wire 3 upon the interior of the bulb 1 is connected to an electrode 10 which terminates in an extension 11, the free end of which is adapted to enter and engage the mercury 6 to complete the circuit therethrough and is normally urged out of engagement with the mercury 6, as hereinafter described.

The electrode 7 supports a member 12, preferably by a bracket of insulating material or glass bead 13 mounting a spring latch 14 terminating in a glass bead or cylinder of insulating material 15 normally urged in the direction of the rotatable extension 11 of the electrode 10 to ride over and hold the extension 11 when rotated to engage the mercury 6, as shown in Figure 2. The electrode 7 also supports a coil 16 of bi-metallic metal within the heating coil 8 by a bracket 17 secured to the outer free end of the coil 16, as shown in Figures 1 and 3. The inner end of the coil 16 is secured to the end of a shaft 18 and supports the shaft in a horizontal plane. The other end of the shaft 18 is secured to the inner end of another coil 19 of bi-metallic metal, which responds oppositely and moves in an opposite direction to coil 16. The outer end of coil 19 carries a latch release 20 normally touching the latch 14 when the circuit to the leads 2 and 3 is closed and the electrode extension 11 is immersed in the mercury. When the circuit is closed through the leading in wires 2 and 3, as by the room thermostat as hereinafter described, the relation of the resistance wire coil 8 and the thermal coil 16 enclosed thereby is such that the predetermined time allowed for the ignition of the burner flame may lapse before the coil 16 responds to the heat of the coil 8 to rotate the shaft 18 sufficiently to cause the latch release 20 to trip the latch 14 to release the terminal extension 11 to be moved out of engagement with the mercury 6 and open the circuit through the safety switch bulb 1.

In accordance with this invention the safety control bulb 1 is so located that in the event the ignition of the combustible mixture of the burner takes place within the predetermined time, the flame of the burning fuel will fall upon the bulb 1. As disclosed in this applicant's prior Patent No. 2,162,098, June 13, 1939, the bulb 1 is provided with a reflector 1a to concentrate the rays of light from the burner flame upon the thermostatic coil 19, as shown in Figure 1, to increase its temperature and cause its response thereto to counteract the effect of the rotation of the shaft 18 imparted by the coil 16 and cause the latch release 20 to remain in neutral position. Likewise the thermal coils 16 and 19 will compensate for changes in ambient temperature to prevent the latch 14 being abnormally released.

This invention also contemplates a means for resetting the switch mechanism within the bulb 1 when the latch 14 has been released by initial failure of the combustible mixture to ignite and provide a burner flame or upon failure of the combustible mixture during normal operation. A preferred form of this re-setting mechanism is illustrated in Figures 1, 2 and 3. As shown in Figures 2 and 3, the electrode 21, attached to the end of the leading in wire 4 within the bulb 1, is arranged to extend in parallel and spaced apart relation to the electrode 10 so that the lower ends may support between them a cup-shaped shell 22 of refractory material. A coil 23 of resistance wire is wound about the shell, embedded in the walls of the shell or arranged upon the inner walls of the shell, as may be desired, and is shown in dotted lines in Figure 1 as embedded within the walls of the shell. The opposite ends of the coil 23 are connected to the lower ends of the electrodes 10 and 21 so that when the circuit is open through the

mercury connector 6, the closing of a circuit between leading in wires 3 and 4 exterior of the bulb 1 will cause the current to pass through the coil 23 of resistance wire to produce heat within the cup-shaped shell 22. A coil of bi-metallic metal 24 is supported concentrically within the cup-shaped shell 22 by a bracket 25 secured at its upper end to the electrode 10, as shown in Figures 1 and 2, and secured to the outer end of the coil 24 at its lower end. The inner end of the coil 24 is secured to a shaft 26 and holds the shaft in a horizontal position. A bi-metallic coil 27 mounting the extension 11 of the electrode 10 at its outer free end is secured at its inner end to the opposite end of the shaft 26. The coils 27 and 24 respond oppositely to changes in ambient temperature so that no movement of the extension 11 will take place upon changes in ambient temperature. When the extension 11 is out of engagement with the mercury, the closing of the circuit through leading in wires 3 and 4 will heat the coil of resistance wire 23 and the heat will be transmitted to the bi-metallic coil 24 within the cup-shaped shell 22 and in response thereto will rotate the shaft 26 and coil 27 to move the extension 11 to cause its end to enter and be submerged within the mercury 6. The extension 11 is provided with a shoulder 28 which will allow the insulated end 15 of the latch 14 to engage the shoulder 28 and hold the extension 11 of the electrode 10 immersed in the mercury to establish the circuit through leading in wires 2 and 3 within the bulb 1.

After the latch 14 locks the extension 11 in the closed position and current passes through the leading in wires 2 and 3, the current through the heating coil 23 is short-circuited and the cooling of the coil 24 places coil 27 under sufficient tension to snap the extension 11, when released, to open the circuit through the mercury 6.

A modification of this form of switch mechanism is illustrated in Figure 4 in which the circuit is closed through metal contacts 29 and 30 carried by the extremities of the portion 9 of the electrode 7 and the extension 11 of the electrode 10. In this figure the parts are illustrated in the position assumed after the latch 14 has been moved by the latch release 20 to ride out of engagement with the shoulder 28 of the electrode extension 11 so that the coil 27 has separated the contacts 29 and 30. In this position the latch 14 is held inoperative by the insulating cylinder 15 engaging the portion of the extension 11 below the shoulder 28, as shown.

To illustrate a preferred means for operating the re-setting mechanism, Figure 5 shows a schematic diagram of a typical installation of a commercial fluid fuel burning system and a wiring diagram thereof in which F indicates the combustion chamber of a heater or furnace to which is installed an electrically operated oil burner B the operation of which is controlled by room thermostat T. All commercial oil burners include a recognized means for igniting the fuel. One of the wires of the commercial electric current L is connected to the binding post 31. The current passes from there through a motor switch MS, preferably a mercury tube switch, and from there through binding post 32, through wire 33 to one side of the motor of the burner B. The other side of the motor is connected by the wire 34 to the binding post 35 and from thence to the other wire LL of the commercial current. The motor switch MS is preferably controlled by a room thermostat through a repulsion relay which is a commercial product such as shown in this applicant's prior Patent No. 2,024,697, December 17, 1935. One end of the stationary primary coil PC is connected to binding post 31 and the other end to the binding post 36. One end of the windings of the secondary coil SC is connected to the binding post 37 and the other end to the binding post 38. The binding post 37 is connected by the wire 39 to the leading in wire 3 of the safety switch bulb 1. The leading in wire 2 of the safety switch bulb 1 is connected by the wire 40 to a binding post 41 which in turn is connected by the wire 42 to one side of the room thermostat T, the other side of which is connected by wire 43 to the binding post 38 so that when the circuit is normally closed through the fluid connector 6 within the safety bulb 1, as hereinabove described, the circuit through the secondary coil SC will be controlled by the room thermostat T. The motor switch MS is mounted on an arm pivoted to the vertical core VC at the side opposite the movable secondary coil of the relay R which is secured to the other end of the arm and so arranged that when the secondary coil is de-energized it will tilt the mercury tube motor switch MS into the open position. When the circuit, through the secondary coil SC, is closed by the room thermostat it is repelled and will tilt the motor switch into closed position, as shown in dotted lines, to close the circuit to the motor. If combustion fails either initially or during normal operation the burner flame becomes extinguished and the safety switch mechanism within the bulb 1 will open the secondary circuit, if closed by the room thermostat, through the mercury 6 and cause the secondary coil to fall and open the motor switch. In order to re-set the safety switch mechanism within the bulb 1 it is preferable to mount a manually operable switch actuator upon the casing 44 which covers the commercial relay R and is shown in the detailed view in Figure 6. An arm 45 is mounted at the pivotal point of the arm carrying the secondary coil SC and motor switch MS to extend upwardly above the core of the relay R, the free end of which will be moved from the position shown in full lines in Figure 5 when the relay is de-energized to open the motor switch to the position shown in dotted lines in Figure 5 when the relay has been energized to close the motor switch. This arm mounts a binding post and contact 46 adjacent its free end, as shown in Figure 6. This binding post and contact is connected by wire 47 to binding post 48 and from thence by wire 49 to the leading in wire 4 of the safety switch bulb 1. A contact 50 is mounted upon a binding post 51 to be engaged by the contact 46 when the arm 45 is in the position shown in dotted lines in Figure 6 and the relay R is de-energized and the motor switch MS open. The contacts 46 and 50 are normally held in spaced apart relation by constructing the arm 45 of resilient material. The binding post 51 is connected by the wire 52 to the binding post 41. The manual re-set actuator includes a spring-pressed plunger 53 including a reciprocating pin 54 so located that when the arm 45 is in position with the contacts 46 and 50 in alignment the manual depression of the plunger 53 will cause the end of the pin 54 to engage the upper free end of the arm 45 and move the contact 46 into engagement with the contact 50 and thereby complete the circuit from the contact 46 through wires 47, 49, leading in wire 4, through electrode 21,

heating coil 23, electrode 10, leading in wire 3, wire 39 and through the secondary coil of the relay to binding post 38 and from thence through wire 43, room thermostat when closed, wire 42 to binding post 41, and to contact 50. In order to maintain this circuit closed a sufficient length of time for the heating coil 23 to return the extension 11 of electrode 10 into engagement with the mercury 6 a pivoted latch 55 is provided having a hooked end adapted to ride over the free end of the arm 45 as it is bringing contact 46 into engagement with contact 50 and to hold it with the contacts in engagement until the movement of the secondary coil SC carries the end of the arm 45 out of engagement with the latch 55. It is necessary that the resistance of the heating coil 23 is such that although the secondary circuit is closed therethrough, sufficient current will not pass through the secondary coil to repel it. As the latch 14 would not release the extension 11 of the electrode 10 to open the circuit within the safety switch bulb 1 unless there was a flame failure, the secondary circuit would be closed through the room thermostat so that as soon as the coil of resistance wire 23 produced sufficient heat to return the extension 11 into contact with the mercury to close the normal circuit through the room thermostat, safety switch mechanism within the bulb 1, and secondary coil SC, the coil SC will be repelled by the full secondary current to move contact 46 out of engagement with contact 50. As soon as the secondary coil has been repelled the free end of the arm 45 will be released from the latch 55 and thereafter when the secondary coil is de-energized by the opening of the room thermostat the end of the arm 45 will return with the contacts 46 and 50 in spaced apart alignment with each other and the free end of the arm 45 will be aligned with but spaced apart from the end of the latch 55.

The manual re-set mechanism just described is such that a momentary depression of the push button 53 is all that is required to set the mechanism in operation because as soon as the rod or shaft 54 closes the circuit the latch 55 holds the contacts 46 and 50 in engagement until the repulsion of the coil SC moves the arm 45 out of engagement therewith. Should the push button 53 fail to return after being depressed, the next time the secondary circuit is opened the edge of the arm 45 will engage the rod 54 as the coil SC falls and will prevent the contacts 46 and 50 being aligned with each other and render the re-set mechanism inoperative until the push button 53 is released to return it to its normal position.

Figure 7 illustrates a modification of the safety switch mechanism shown in Figures 1, 2 and 3 wherein it is possible to dispense with the coil of resistance wire 8 connected in the electrode 7. In this form the electrode 7 is connected by a bracket 56 directly to the outer free end of the thermal coil 116 and the portion 9 of the electrode 7 entering the mercury 6 and submerged therein is supported by a bracket of insulation or glass bead 57 upon the electrode 7 and the latch release 20 is connected by wire 58 to the portion 9 of the electrode 7. By so constructing the parts when the circuit is normally closed through the mercury 6 and the room thermostat closes the circuit through the leading in wires 2 and 3, the current passes through electrode 7, thermal coil 116, shaft 18, thermal coil 119, latch release 20 and wire 58 to the portion 9 of the electrode 7. In this case the thermal coils 116 and 119 are so constructed that they respond alike to changes in ambient temperature, but differ in electric resistance whereby the passage of an electric current through both will cause coil 116 to deform more rapidly than coil 119, as disclosed in this applicant's prior Patent No. 2,149,853, March 7, 1939, but the reflected rays of light from the flame concentrating upon coil 119 will cause coil 119 to deform at the same rate but in the opposite direction to the coil 116 so that the movement of the two coils balance each other.

Another modification is shown in Figures 8 and 9 whereby the re-setting mechanism may be constructed to dispense with the leading in wire 4, electrode 21, heating coil 23, thermal coil 24, and shaft 26, as well as the circuit opened and closed manually through contacts 46 and 50, shown in Figures 5 and 6. In this form the inner end of the coil spring 127 is carried by the lower end of the electrode 10 and the shoulder portion 28 of the extension 11 is provided with an extension 59 of magnetic material. The free end of this extension or armature 59 is formed to follow the general contour of the wall of the bulb 1 and be adjacent thereto when the electrode extension 11 is in engagement with the mercury 6. When the latch 14 has released the extension 11 to open the circuit by being moved out of the mercury 6, the position assumed by the armature 59 is shown in dotted lines in Figure 8.

One means for re-setting the switching means so constructed is to provide a fixed magnet 60 mounted on the free end of a fixed spring 61 so mounted that the magnet will be normally held a sufficient distance from the bulb 1 so that the magnetic field of the magnet will not attract the armature 59 when the circuit through the mercury 6 is open. The free end of the spring 61 may be readily advanced to move the magnet 60 to bring the armature 59 within its magnetic field to return the extension 11 to its latched closed position.

Another means to re-set the switch mechanism of this type is by the use of an electro-magnet which will allow the re-setting of the switch mechanism to be actuated at a point remote from the burner mechanism. Such a means is shown in Figure 10 in a schematic diagram of a heating system and wiring diagram including another form of installation.

In Figure 10 the furnace or heater F is provided with an electrically operated oil burner B controlled by a room thermostat T through a repulsion relay R and safety switch bulb 1 of the type shown in Figures 8 and 9. An electro-magnetic means is employed to re-set the switching mechanism with the bulb 1 by arranging an electro-magnet EM adjacent the wall of the bulb 1 aligned with the armature 59 of the re-set mechanism. The electric current for energizing the electro-magnet EM is preferably derived from the commercial source by interposing in the wire L a manually operable switch which normally completes the circuit from the source through wire L to binding post 31 connected to the motor switch MS and primary coil PC of the repulsion relay R. This switch preferably includes a manually depressible plunger P having a bridge 62 normally held in engagement with spaced apart contacts 63 and connected to the wire L to complete the circuit during normal operations of the system and corresponding contacts 64 spaced apart from each other and from contacts 63 adapted to be engaged by the bridge 62 when the plunger P is depressed. One of the contacts 64 is connected

by wire 65 to binding post 66 to connect it to wire L on the side adjacent the source. The other is connected by wire 67 to the coil of the electro-magnet EM, the other end of which is connected by wire 68 to the binding post 69 to connect it to the commercial wire LL. When the latch 14 has been actuated to open the circuit through the mercury 6 in the bulb 1 by failure of combustion, and the operation of the burner mechanism ceases, the safety switch mechanism within the bulb 1 may be re-set by manually depressing the plunger P to cause the bridge 62 to connect the contacts 64, as shown in dotted lines in Figure 10. A circuit from wire L is then established through the electro-magnet EM to wire LL to energize the electro-magnet EM which in turn attracts the armature 59 to immerse the end of electrode extension 11 in the mercury 6 and allow the latch 14 to maintain the circuit through the mercury 6 by riding over the shoulder 28. Releasing the plunger P causes the commercial circuit to be again closed through bridge 62 and contacts 63 to the binding post 31. In the event that the plunger P fails to return to its normal position after manual operation, the circuit to the relay R and motor switch MS will remain open and the burner mechanism will not be able to operate while the electro-magnet remains energized.

In the form shown in Figure 10 the safety switch bulb 1 is mounted in a housing H forming a part of the air pipe of the burner B in such a manner that the rays of light emanating from the burning fuel will enter the open end of the air pipe and fall upon the reflector 1a of the bulb 1.

It can readily be understood that in a switch constructed in accordance with the above description the coil responsive to electrically generated heat and the coil responsive to light rays may be so co-ordinated at the factory that in response to their respective sources of heat the movement of one normally neutralizes the movement of the other. Any appreciable variation in the current value in the electrically heated element will vary the heating of that element and the movement thereof so that the movement of the other element responsive to light will fail to provide the compensating movement necessary to maintain the circuit closed during normal operation.

When this switch is used as a safety control in a fluid fuel burner system it is desirable that the operation of the safety switch be uniform irrespective of variations in line voltage within at least 25% above or below the normal voltage. In the installation illustrated in Figures 5 and 10 the relay controlling the operation of the motor switch may be arranged to provide a constant current in the secondary throughout the operative voltage range in the line, and as the electrically heated element of the switch is connected in secondary circuit the current will be constant. If it is not desirable to utilize the relay itself to regulate the current or another type relay is employed, a ballast in the form of electrical resistance may be interposed in the circuit of the electrically heated switch element as shown in Figure 10. It is preferable to use nickel wire for the ballast as it possesses the characteristic of increasing its resistance as its temperature increases and may serve to regulate the current passing through the safety switch, or any other well-known resistance may be used to allow more current to flow through the safety switch as the normal voltage decreases during a fluctuation, or vice versa. If resistance wire is employed in the form of a coil it may be attached as an integral part of the switch structure at the factory to eliminate any possible omission of the ballast when the switch is installed.

From the drawings and descriptions of the various forms of switches disclosed herein, it is apparent that these switches may be employed as control devices depending upon the existence of light upon which the switch is focused to maintain the switch in closed circuit position while the circuit to the switch is closed, whereby when the source of light is removed, the continued passage of the circuit through the switch will open it. It is also seen that the switch contains additional mechanism, which may be actuated from a point exterior of the switch, to reclose the switch circuit and that the switch mechanism is unaffected by changes in ambient temperature.

It is also to be noted that the normal position of the switch is in closed position, whereby the operating parts are in effect, braced and stabilized by each other to render the structure capable of withstanding the jars and rough handling, to which it might be subjected, without distortion and disarrangement of the parts. This arrangement is particularly advantageous when the parts are necessarily constructed of thin and light weight materials in order to control and be responsive to small current such as may exist in the low voltage circuit disclosed in Figure 5.

It is also to be noted that the movable electrode 11 does not just engage the surface but is immersed in the body of mercury 6 contained in the well. This arrangement permits the switch to be tilted considerably in various directions from the vertical without displacing the mercury in the well sufficiently to prevent contact therewith by the movable electrode.

This particular switch construction is especially advantageous for use in connection with electrically operated and controlled fluid fuel burners in railway locomotives or in any other place where there is a considerable vibration and pitching or rolling motion, such as occurs with marine apparatus.

What I claim is:

1. In an electrically operated and controlled fluid fuel burner heating system including a burner motor, a circuit therefor, an electrically actuated motor switch in the burner circuit, actuating mechanism including a controlling circuit for the electrically actuated motor switch, a safety switch responsive to the light of the burner flame in the controlling circuit, said safety switch including a thermally actuated mechanism normally maintaining a closed circuit through the switch and operating, upon the closure of the controlling circuit, to open said circuit upon initial or subsequent failure of the burner flame, but upon establishment of the burner flame to continue to maintain said closed circuit and a remote-controlled mechanism cooperating with said thermal mechanism and associated with the motor switch actuating mechanism to be operable to reset the safety switch when the motor switch circuit is open.

2. In an electrically operated and controlled fluid fuel burner heating system including a burner motor, a circuit therefor, an electrically actuated motor switch in the burner circuit actuating mechanism including, a controlling circuit for the electrically actuated motor switch, a safety switch responsive to the light of the burner flame in the controlling circuit, said safety switch including a thermally actuated mechanism nor-

mally maintaining a closed circuit through the switch and operating, upon the closure of the controlling circuit, to open said circuit upon initial or subsequent failure of the burner flame, but upon establishment of the burner flame to continue to maintain said closed circuit and wherein the safety switch thermal mechanism is electrically responsive to reset the switch to its normal closed position after it has been opened, a remote controlled mechanism for electrically energizing said thermal mechanism to reset the switch and associated with the motor switch actuating mechanism to be operable when the motor switch is open and inoperable when the motor switch is closed.

3. The structure of claim 1 wherein said remote controlled mechanism includes a plunger operated switch to close a circuit through the last named thermal mechanism.

4. In an electrically operated and controlled fluid fuel burner heating system including a burner motor, a circuit therefor, an electrically actuated motor switch in the burner circuit, actuating mechanism including a controlling circuit for the electrically actuated motor switch, a safety switch responsive to the light of the burner flame in the controlling circuit, said safety switch including a thermally actuated mechanism normally maintaining a circuit closed through the switch and operating, upon the closure of the controlling circuit, to effect the opening of said circuit upon initial or subsequent failure of the burner flame, but upon establishment of the burner flame to continue to maintain said circuit closed, said safety switch thermally actuated mechanism including an electrically actuated reset member to reset the switch to its normal closed position after it has been opend, a remote controlled mechanism for energizing said reset member and associated with the operation of the motor switch actuating mechanism to allow energization of the reset member upon opening the motor switch.

5. The structure of claim 4, wherein the actuated reset member includes an armature, an electro-magnet to cooperate therewith, said electromagnet being in a circuit controlled by said remote control mechanism, the latter being a manually operated switch adapted in one position to close a circuit to the electro-magnet and in another the circuit to the motor switch mechanism.

6. The structure of claim 4, wherein the thermally actuated mechanism is contained within an enclosed transparent bulb, a body of mercury therein, two electrodes one of which is normally movable and adapted to enter into and be withdrawn from the mercury to close and open the circuit therethrough, resilient means normally withdrawing the movable electrode from the mercury to open the switch, electrical means for actuating the movable electrode to enter into the mercury to close the switch, a releasable latch for engaging and holding the movable electrode when the switch is closed, a latch release for operating the latch to release the movable electrode, a thermally actuated mechanism for operating the latch release, said mechanism being responsive to two sources of heat which, when both prevail, render said mechanism inoperative, one of said sources being the light of the burner flame and the other the resistance of a part of the switch to the passage of current therethrough, the latter, upon failure of the burner flame, acting to operate the mechanism to cause the releasable means to release the movable electrode to open the switch.

7. The structure of claim 4, wherein the electrically actuated reset member comprises an ambient temperature compensated thermal reset actuator interposed in the switch structure to place a movable portion thereof in closed or open circuit position, an electric heater therefor energized through the remote controlled mechanism, said thermal reset actuator when heated establishing a closed switch circuit and when cold an open circuit and wherein the thermally actuated mechanism, in normally maintaining the circuit closed through the switch, effects the same by opposing the action of the thermal reset actuator to open the switch circuit when cold, after the closure thereof.

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