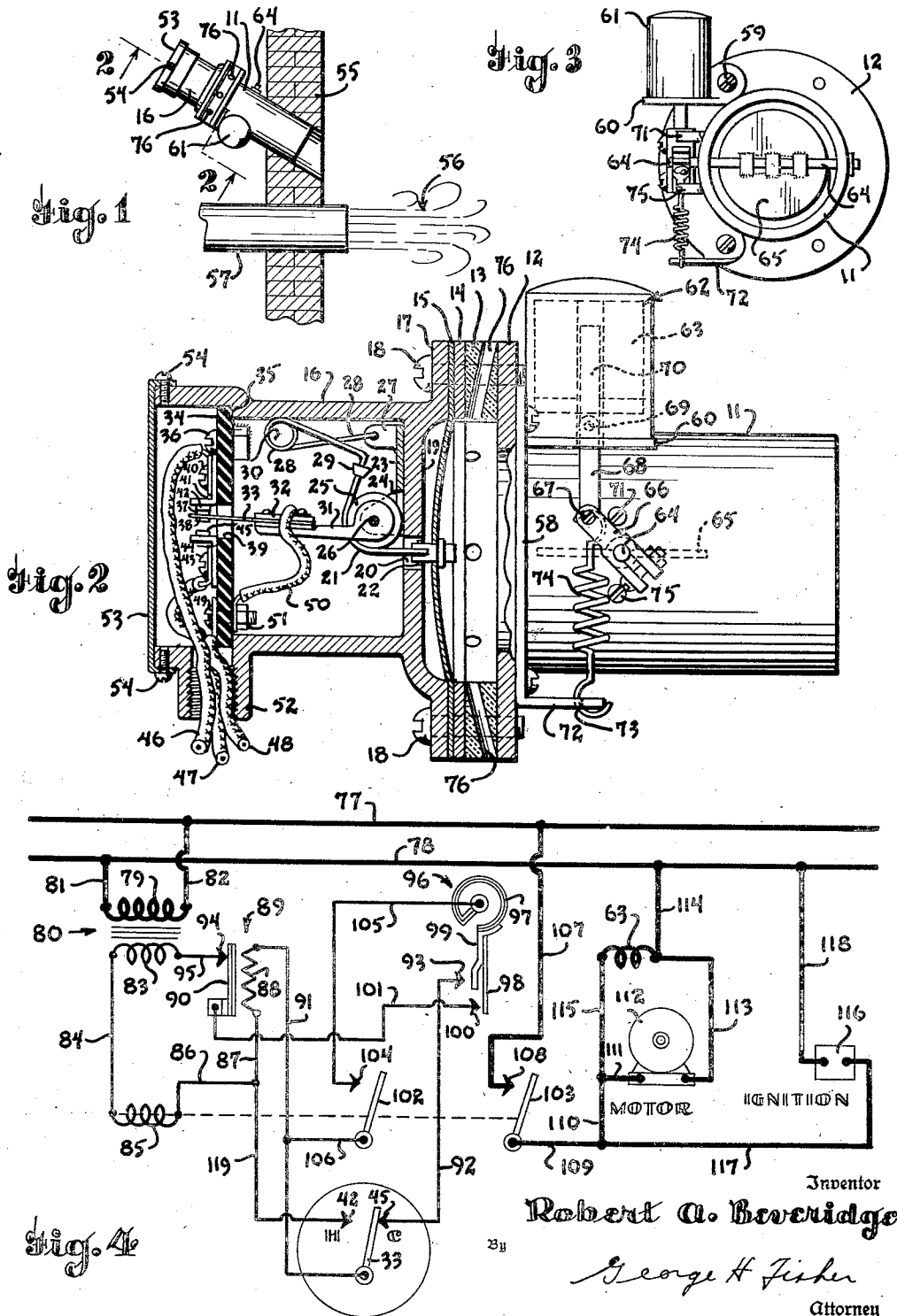


Feb. 27, 1940.

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2,191,640

RADIANT HEAT SENSITIVE DEVICE
Filed Dec. 22, 1937



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UNITED STATES PATENT OFFICE

2,191,640

RADIANT HEAT SENSITIVE DEVICE

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Application December 22, 1937, Serial No. 181,122

8 Claims. (Cl. 158—28)

This invention relates generally to a heat sensitive switch, and more particularly to that type of switch which responds to the radiant heat of combustion, and opens and closes depending upon whether or not there is combustion within the furnace.

In devices of this character it is customary to provide a tube which is inserted through the furnace wall and positioned to look directly at the fire. A heat responsive device is located at the end of the tube outside of the furnace and this heat responsive device will be subjected to considerable radiant heat from the fire, but as it is situated well back in the tube it will get very little heat by conduction or convection. As combustion takes place the radiant heat from the fire is absorbed by the heat responsive device which responds and actuates a switch through the medium of a slip friction connection. When the fire is extinguished the heat radiated to the heat sensitive device will be greatly decreased and the heat already absorbed by it will be dissipated outwardly through its casing causing it to again respond and immediately actuate its switch due to the slip friction connection.

It is an object of this invention to provide a means for rendering devices of the above character more sensitive to the starting up and shutting down of a fire within a furnace.

Another object of the invention is to provide a damper between the heat sensitive device and the fire which is opened when the fire producing means is energized so that if combustion occurs the radiant heat from the fire can heat the heat sensitive device, and is closed when the fire producing means is deenergized so that radiant heat from the walls of the furnace cannot reach the heat sensitive device and retard its cooling.

In the case where a fire has burned for a while and the furnace and stack have become heated, there is a natural draft through the furnace and up the stack. If now the fire is extinguished there will be a temporary reduction in pressure within the combustion chamber below atmospheric pressure. Advantage is taken of this fact in the present invention by taking a device of the character described above and cutting holes in the casing by the heat sensitive device so that when the fire is extinguished and the lowered pressure occurs in the combustion space, room air will be sucked into the casing, over the heat sensitive device, into the furnace and up the stack. This passage of room air over the heat sensitive device helps to carry

away its heat after the fire is extinguished and therefore makes the device more sensitive. The damper, referred to above, is a loose fit in the tube so that the air has plenty of opportunity to be drawn through the tube and into the furnace.

These and other objects will become apparent as the following specification is read with reference to the accompanying drawing, in which—

Figure 1 is a view showing the manner in which the device of this invention is mounted in the wall of a furnace;

Figure 2 is a side view of the invention, partly in elevation and partly in a section taken along the line 2—2 of Figure 1;

Figure 3 is an end view looking into the tube at the damper and heat sensitive diaphragm; and

Figure 4 is a diagram of an oil burner control circuit in which the present invention may be used.

Referring first to Figure 2, a tube 11 is provided with an annular flange 12 against which is placed annular heat insulator 13 and an annular gasket. Against the gasket is placed a thin metal disc 15 which is blackened on one side so that its absorption of radiant heat will be accelerated. A casing 16 is provided with an annular flange 17 which abuts the disc 15 and through bolts 18 are provided for integrally connecting the casing and the tube along with the other members recited. The casing 16 is provided with a partition 19 having a hole 20 therein through which passes a ribbon 21, one end of which is connected to the center of the diaphragm 15 by a suitable connecting means 22. Bracket 23 is fastened to the partition 19 by a suitable means, not shown, and this bracket is provided with a pair of ears 24 between which a wheel 25 rotates on an axis 26. The bracket 23 is provided with a second ear 27 to which is connected a spring 28. The ribbon 21 engages the surface of the wheel 25 for a portion of its circumference and is connected to one end of the spring 28 by some suitable connecting means 29. The center portion 30 of the spring 28 is wound several times about a member 31 and exerts an upward pull on the ribbon 21 as viewed in Figure 2. Mounted on the axis 26 and rigidly connected with the wheel 25 is an arm 31 to the free end of which is connected as at 32 a flexible contact carrying member 33. A partition 34 of insulating material is held adjacent to a shoulder 35 of casing 16 by means of screws 36. The flexible arm 33 which carries contacts

37 and 38 extends through hole 39 in the partition 34. Mounted immediately above the hole 39 by means of screw 40 is a bracket 41 carrying stationary contact 42, and located immediately below the hole 39 and fastened to partition 34 by means of screw 43 is a bracket 44 carrying the stationary contact 45. Conductor 46 is connected to bracket 41 by means of screw 40 and conductor 47 is connected to the bracket 44 by means of screw 43. Conductor 48 is connected to a screw 49 extending through the insulating partition 34 and conductor 50 is connected to the screw 49 on the other side of the partition 34 by means of nut 51 and in turn is connected through the connecting means 32 to the flexible contact arm 33. A nipple 52 is provided at the lower part of the casing 16 through which the conductors 46, 47 and 48 extend. A cap 53 closes the open end of the casing 16 and is fastened thereto by means of screws 54.

The device so far described is old and forms no part of the present invention. It is intended to be applied to a furnace so that it may respond to the radiant heat of the fire. The manner of mounting this instrument is shown in Figure 1, wherein the tube 11 is shown mounted in the wall 55 of a furnace and directed so that the open end of the tube looks directly at the flame 56 produced by the oil burner 57.

When there is no fire in the furnace and the device is in its cold position, the diaphragm 15 will be more or less straight and the contacts 38 and 45 will be in engagement. When the oil burner is put into operation and combustion occurs the radiant heat from the fire will pass through the tube 11 and be absorbed by the blackened surface of the diaphragm 15 which will commence to heat up very rapidly. The central portion of the diaphragm which absorbs the radiant heat will become considerably hotter than its periphery, which will cause it to expand and buckle. A constant pull is exerted on the center of the diaphragm through the medium of the ribbon 21 and the spring 28 which will cause movement of the diaphragm to the left as viewed in Figure 2 when it expands. This movement will cause a consequent movement of the ribbon 21 which will rotate the roller 25 in a clockwise direction and carry with it arm 31 and the resilient contact carrying arm 33, which will cause disengagement of the contacts 38 and 45 and engagement of the contacts 37 and 42. Further movement of the arm 31 is prevented by the engagement of these contacts but any further movement of the diaphragm 15 will be taken care of by the ribbon 21 slipping over the surface of the wheel 25. As the fire continues to burn the diaphragm 15 will continue to absorb more and more heat, the central part of the diaphragm will remain hotter than the periphery due to the fact that the heat will be conducted along the diaphragm to the periphery and dissipated to the air in the room. This insures that the periphery of the diaphragm will always remain comparatively cold so that the diaphragm will remain buckled as long as a fire exists in the furnace.

When the fire becomes extinguished there will be a very great reduction in the amount of radiant heat which will strike the diaphragm 15 so that it will commence to cool rapidly. This cooling will cause it to straighten out and as it does so it will pull the ribbon 21 toward the right as viewed in Figure 2, thereby rotating

the wheel 25 in a counterclockwise direction, which will carry with it arms 31 and 33. This will cause disengagement of the contacts 37 and 42 and engagement of contacts 38 and 45. The device will then be in its cold position again. It is understood of course that any excess movement of diaphragm 15 to the right after the contacts 38 and 45 have been closed will be absorbed by the ribbon 21 slipping with respect to the wheel 25.

The present invention involves an addition to this structure for the purpose of rendering the diaphragm 15 more sensitive to combustion within the furnace and particularly more sensitive to the extinguishment of the fire. A bracket 58 is fastened to flange 12 by means of the screw 59. This bracket has a shelf 60 on which is mounted a casing 61 which uses a solenoid 62 having a winding 63. Mounted on a transverse shaft 64 extending diametrically through the tube 11 is a butterfly damper 65. The shaft 64 is pivotally connected by means of a crank arm 66 as at 67 to a link 68 which is in turn pivotally connected at 69 to a plunger 70 for the solenoid 62. Energization of the solenoid winding 63 causes a rotation of the crank 66 in a clockwise direction until it strikes the stop 71 which is fastened to the tube 11, at which time the damper 65 will be in a horizontal position longitudinally of the tube 11 so that it will permit radiant heat to enter the tube 11 and strike the diaphragm 15. Bracket 58 is provided with an ear 72 having a small hole 73 through which one end of a coil spring 74 is inserted. The other end of spring 74 is hooked under the pin 67 which pivotally connects the arm 66 with the link 68. Thus when the winding 63 is deenergized the spring 74 will pull the crank arm 66 downwardly to rotate it in a counter-clockwise direction through an angle of 90° until it strikes the stop 75, at which time the damper 65 will extend transversely across the opening through the tube 11. This will prevent radiant heat from passing through the tube and striking the diaphragm 15.

The reason for providing the damper 65 is that when the fire is extinguished in the furnace, although there can be no radiant heat from the flame which will pass to the diaphragm 15, yet there is a considerable amount of radiant heat which passes from the walls of the furnace to the diaphragm and such radiant heat has a material effect on the cooling down process of the diaphragm. With the addition of the damper 65 to this control device, it will be seen that where the winding 63 is wired in parallel with the burner motor that when the motor is deenergized the winding 63 will be deenergized, which will allow the spring 74 to rotate the damper 65 to the position where it extends across the tube 11 so that any radiated heat from the walls of the furnace cannot strike the diaphragm 15 and delay its cooling action.

Where the burner has been operating and the furnace and stack has become heated up there is a natural draft through the furnace and up the stack due to the heating of the elements. If now the burner motor is deenergized or the fire becomes extinguished for some other reason the natural draft due to the heated stack will then lower the pressure in the combustion chamber to a value where it is lower than atmospheric. Advantage may be taken of this fact by boring holes such as shown at 76 through the annular heat insulator 13. These holes are placed at an

angle so that the reduced pressure within the furnace will cause room air to pass through the holes directly onto the diaphragm 15 and thence out through the tube 11 and around the damper 65, which it will be noted from Figure 3 fits very loosely within the tube 11 and into the furnace and up the stack. These holes while not necessary for a proper functioning of the device will, however, assist in cooling the diaphragm 15 thereby making its response quicker when the burner motor is shut down.

Referring now to Figure 4, an oil burner control circuit in which this invention may be used to advantage will now be described. Supply conductors 77 and 78 feed the primary winding 79 of the transformer 80 through conductors 81 and 82. The secondary 83 of this transformer is connected by means of conductor 84 to one end of relay coil 85, the other end of which is connected by conductor 86 to a conductor 87 leading to one end of a heating element 88 for the safety switch 89. This safety switch is operated by means of a bimetallic element 90 and is of the type which breaks the circuit after its heater has been energized for a predetermined time and then must be manually reset. This safety switch forms no part of the present invention and may be of the type disclosed in the Denison Patent No. 1,958,081. The other end of the heater 88 is connected by means of the conductor 91 to the switch arm 33 of the combustion responsive switch. The cold contact 45 of this switch is connected by means of conductor 92 to stationary contact 93. Stationary contact 94 which is engaged by the bimetallic element 90 is connected by conductor 95 to the secondary 83 of the transformer 80. A room thermostat 96 is provided which comprises a bimetal coil 97 to which is attached a flexible switch arm 98 and a rigid switch arm 99. Flexible switch arm 98 is adapted to engage stationary contact 100 which is connected by means of conductor 101 with bimetallic element 90. Relay coil 85 is adapted to operate two switch arms 102 and 103. The switch arm 102 engages stationary contact 104 which is connected by means of conductor 105 with the bimetallic coil 97 of the room thermostat 96. Conductor 106 connects the switch arm 102 with the conductor 91. A conductor 107 connects stationary contact 108 with the supply line 77. Switch arm 103 is adapted to cooperate with the contact 108 and this switch arm is connected by means of conductors 109, 110 and 111 to the burner motor 112. The burner motor is connected to the supply line 78 by means of conductors 113 and 114. Connected in parallel with the motor 112 is the solenoid winding 63 by means of the conductor 115. Also connected in parallel with the motor is an ignition means 116 by means of the conductors 117 and 118.

Considering the operation of the system as a whole, we will first assume that the room thermostat is satisfied, that the combustion switch is in its cold position and the burner motor is shut down. Assume now that the room temperature decreases. The flexible switch arm 98 will first engage the stationary contact 100, but as the circuit is opened at contact 104 nothing will happen at this time. A further cooling of the room thermostat will cause the rigid switch arm 99 to engage its contact 93 at which time the following circuit will be closed: from secondary 83, conductor 95, contact 94, thermostat 90, conductor 101, contact 100, switch arms 98 and 99, contact 93, conductor 92, cold combustion switch

45, switch arm 33, conductor 91, heater 88, conductors 87 and 86, relay winding 85 and conductor 84 back to the other side of the secondary winding 83. This circuit will energize the relay winding 85 which will pull in its switch arms 102 and 103. Engagement of switch arms 102 and 104 will set up a holding circuit comprising the conductor 106, switch arm 102, contact 104, conductor 105, bimetallic element 97, a flexible switch arm 98, contact 100, conductor 101, bimetallic element 90, contact 94, conductor 95, secondary 83, conductor 84, relay coil 85, conductors 86 and 87, heating winding 88, conductor 91 back to conductor 106. This means that the relay 85 will be held in as the contacts 93 and 99 are separated and until the flexible arm 98 separates from its contact 100. As the switch arm 103 closes its contact 108 upon energization of the relay winding 85, a circuit is set up for the burner motor as follows: supply line 77, conductor 107, contact 108, switch arm 103, conductors 109, 110 and 111 to the burner motor 112 and conductors 113 and 114 back to the other supply line 78. At the same time the solenoid winding 63 is energized in parallel with the motor 112 by the conductor 115. The ignition means 116 will also be energized if it is connected in parallel with the burner motor 112 by the conductors 117 and 118.

As explained above, the energization of the burner motor and the consequent energization of the solenoid winding 63 will cause the damper 65 in the combustion responsive device to assume a horizontal position in the tube 11 so that the diaphragm 15 can absorb the radiant heat from the burner the moment that combustion takes place. If combustion should fail to take place, it is understood of course that the heater 88 for the safety switch will heat the bimetallic element 90 to the point where it will break its contact with the contact 94 and therefore the relay 85 will be deenergized and the system will shut down. After the safety switch has shut the system down it must be manually reset. Assuming, however, that combustion does take place, the diaphragm 15 will commence to warm up which will cause it to buckle and separate the contacts 38 and 45. The separation of these contacts will have no effect on the circuit because of the holding circuit for the relay coil 85 which passes through switch arm 102 and contact 104 independently of the switch arm 33 and contact 45. Continued heating of the diaphragm 15 will cause engagement of the arm 33 with its contact 42. A shunt circuit is now set up around the heater 88 which circuit comprises the conductor 91, switch arm 33, contact 42 and conductor 119. The heater 88 will therefore be deenergized and the safety switch will remain closed.

Due to the operation of the burner, the room will now heat up and eventually the room thermostat will cause separation of its switch arm 98 with the stationary contact 100, which will cause deenergization of the relay 85 which will in turn drop out its relay contacts 102 and 103. As the switch arm 103 disengages its contact 108 the burner motor, ignition means and solenoid coil 63 will be deenergized. This means that the fire will go out and the return spring 74 will operate to rotate the damper 65 through an angle of 90° so that it is placed directly across the opening through the tube 11. This will prevent any further radiant heat from striking the diaphragm 15 which might interfere with its cooling process. The extinguishment of the fire will, as

explained above, create a partial vacuum within the combustion chamber and if the holes 76 have been provided in the annular heat insulator 13 room air will now be caused to flow across the diaphragm 15 through the tube 11 around the damper 55 and into the furnace. This passage of room air over the diaphragm will materially aid it in its cooling thereby making it more sensitive to the extinguishment of the fire. The cooling of the diaphragm will cause it to straighten out when it will break the contact between arm 33 and contact 42 and make contact between arm 33 and contact 45. The device will now be in its cold position and the above cycle may be repeated.

It should be noted also that if the system is in its running or hot position and the fire should be extinguished while the burner motor is still energized, due to a temporary stoppage in the oil line for example, the diaphragm 15 will immediately start to cool because of the sudden decrease in radiant heat from the furnace. This will cause the diaphragm to open the hot contact at 42 which will deenergize the relay 85 and hence the burner motor and cause the damper 65 to assume the position where it prevents any radiant heat from striking diaphragm 15 which will continue to cool as explained above. The extinguishment of the fire will cause a decrease in pressure in the combustion chamber even before the burner motor is shut down so that the room air blowing against the diaphragm will help cool it immediately the fire is extinguished.

It will therefore be seen that in this invention I have provided a device which will aid in making a radiant heat responsive thermostat more sensitive to the extinguishment of the fire in that it will not only prevent the further absorption of heat from the furnace but will also cause a more rapid dissipation of heat from the heat responsive device.

Certain changes and modifications of this invention may occur to those who are skilled in the art and it is therefore to be understood that I am to be limited not by the embodiment disclosed herein but rather by the scope of the appended claims.

I claim as my invention:

1. In a burner control system in combination, a furnace, a fuel burner for producing a fire in said furnace, a heat responsive device located in the wall of said furnace in a position to absorb radiant heat from the fire produced by said fuel burner, control means for energizing and deenergizing said fuel burner, said control means including means operated by said heat responsive device, and means permitting radiant heat from said fire to pass to said heat responsive device when said burner is energized and preventing radiant heat from passing to said heat responsive device when said burner is deenergized.

2. In a burner control system in combination, a furnace, a fuel burner for producing a fire in said furnace, a heat responsive device comprising an elongated tube, a thermostat located at one end of said tube, the other end of said tube being open, means for mounting said device in the wall of said furnace so that the open end of the tube confronts the fire thereby permitting radiant heat passing directly to the thermostat, control means for energizing and deenergizing said fuel burner, said control means including means operated by said heat responsive device, and means for deenergizing the fuel burner and preventing radiant heat from passing from the

furnace to said thermostat when the fire is extinguished.

3. In a burner control system in combination, a furnace, a fuel burner for producing a fire in said furnace, a heat responsive device comprising an elongated tube, a thermostat located at one end of said tube, the other end of said tube being open, means for mounting said device in the wall of said furnace so that the open end of the tube confronts the fire thereby permitting radiant heat passing directly to the thermostat, control means for energizing and deenergizing said fuel burner, said control means including means operated by said heat responsive device, a damper mounted within said tube on an axis extending transversely of said tube, a solenoid connected to said damper for rotating said damper to a position where it does not interfere substantially with the radiant heat passing from the furnace to the thermostat, a spring for rotating the damper to a position directly across the tube when said solenoid is deenergized, and means for energizing said solenoid simultaneously with said fuel burner.

4. In a burner control system in combination, a furnace, a fuel burner for producing a fire in said furnace, a heat responsive device comprising an elongated tube, a heat sensitive diaphragm clamped at its periphery closing one end of said tube, the other end of said tube being open, means for mounting said device in the wall of said furnace so that the open end of the tube confronts the fire thereby permitting radiant heat passing directly to said diaphragm from said fire, switch means operated by said diaphragm, control means including said switch means for energizing said fuel burner, so that when the burner is energized the diaphragm will heat up and operate the switch means in one direction, and when the burner is deenergized the diaphragm will cool off and operate the switch means in the opposite direction, a damper mounted within said tube on an axis extending transversely of said tube, a solenoid connected to said damper for rotating to a position where it does not interfere substantially with the radiant heat passing from the furnace to the thermostat, a spring for rotating the damper to a position directly across the tube when said solenoid is deenergized, and means for energizing said solenoid simultaneously with said fuel burner, and holes cut in the tube near the diaphragm so that upon deenergization of the burner the natural draft through the furnace will draw room air over the diaphragm and into the furnace, said damper being a loose fit within said tube to permit such passage of air.

5. A heat responsive device comprising in combination, a furnace, a fuel burner for producing a flame within said furnace, an elongated tube, a heat sensitive diaphragm clamped at its periphery closing one end of said tube, control means for said fuel burner operated by said diaphragm, the other end of said tube being open and being adapted to be positioned so that radiant heat from said flame can pass through said tube and onto said diaphragm, a damper pivoted within said tube, an electric motor for moving said damper to one position so that it will have substantially no effect on the radiant heat passing through said tube, and means for moving said damper to a position directly across said tube when said motor and fuel burner are deenergized.

6. A heat responsive device comprising in combination, a furnace, a fuel burner for producing

a flame within said furnace, an elongated tube, a heat sensitive diaphragm clamped at its periphery closing one end of said tube, control means for said fuel burner operated by said diaphragm, the other end of said tube being open and being adapted to be positioned so that radiant heat from said flame can pass through said tube and onto said diaphragm, a damper pivoted within said tube, an electric motor for moving said damper to one position so that it will have substantially no effect on the radiant heat passing through said tube, means for moving said damper to a position directly across said tube when said motor and fuel burner are deenergized, and holes cut through the tube near the diaphragm so that when said damper is located across said tube air from outside said tube may pass over said diaphragm and help cool it.

7. A heat responsive device comprising in combination, an elongated tube having an open end and a closed end, a heat sensitive device located at the closed end of said tube, a furnace, means for producing a fire in said furnace, control means for said fire producing means including said heat sensitive device, means for mounting

said device in a wall of said furnace so that the open end of the tube confronts the fire, the heat sensitive device being located outside of the furnace and responding to the radiant heat passing from the furnace through the tube, holes cut in the tube for directing room air against the heat sensitive device when the furnace pressure is below atmospheric due to fire extinguishment, and means operated by the heat sensitive device upon a response due to the extinguishment of the fire for preventing radiant heat from passing to the heat sensitive device from the furnace.

8. A burner control system comprising in combination, a combustion chamber, a burner for producing a fire in said chamber, a combustion responsive device positioned in the path of radiant heat from said combustion chamber, control means for said burner including said combustion responsive device, and means normally preventing radiant heat from said combustion chamber striking said combustion responsive device, but permitting such action whenever said burner is energized.

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