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BURNER SAFETY CONTROL SYSTEM

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Fig. 1

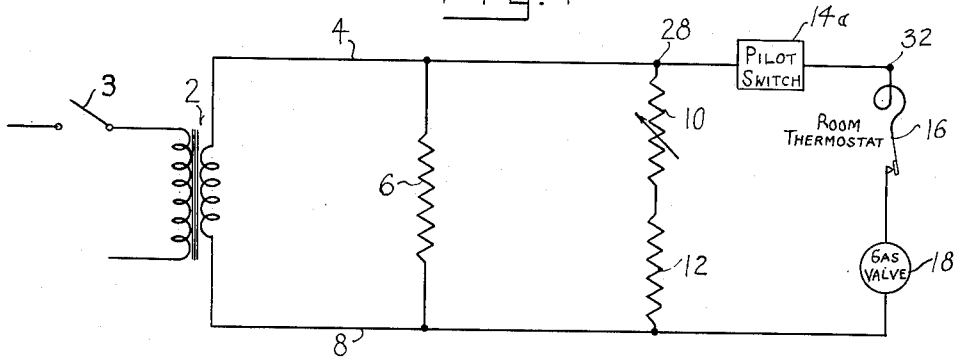


Fig. 2

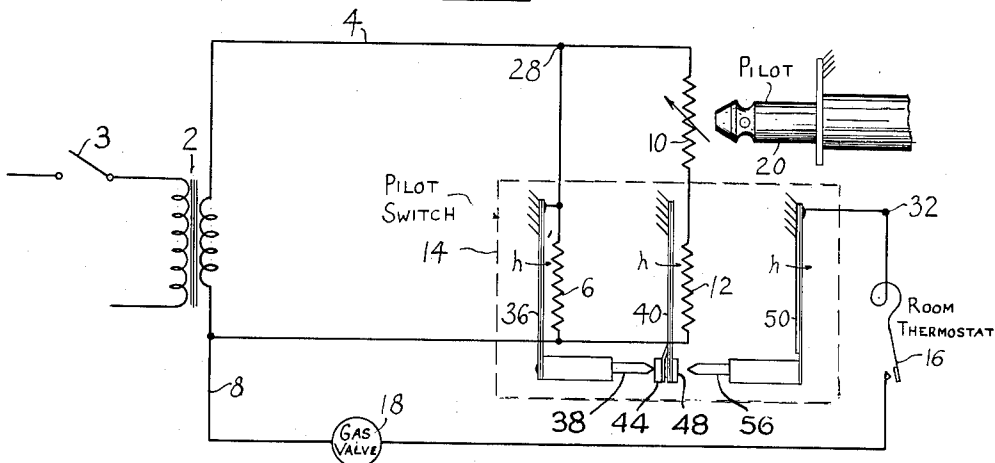


Fig. 3

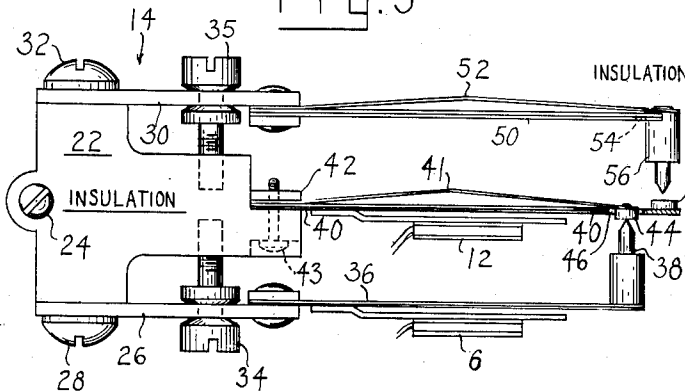
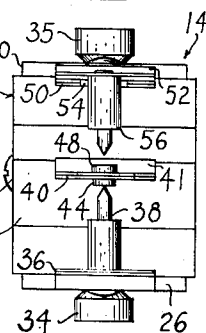


Fig. 4



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ATTORNEYS

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BURNER SAFETY CONTROL SYSTEM

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2 Claims. (Cl. 158—123)

This invention relates to control systems and more particularly to combined safety and condition controlling means for fuel burners and the like.

Electrically operated fuel control apparatus has been arranged to permit supply of fuel to the main burner if a flame sensitive portion of the apparatus has previously been heated by a pilot burner. This condition is indicative of a proper preparatory state which is required prior to ignition of the main burner. The flame sensitive device may take the form of an electrical resistance element which changes its resistance when heated and thus may be utilized to affect the current in a controlling circuit. This invention utilizes a type of resistance element that is wound with "Hytemco" wire, an alloy of nickel and iron, having a relatively large positive temperature coefficient of resistance, i. e., the resistance is a function of temperature and varies proportionally therewith. It is this characteristic that is utilized to perform a novel switching function in this invention.

It is one of the objects of this invention to provide a novel type of temperature responsive resistance pilot which may be used in a gas burner control system to effect operation of the main gas burner under desirable safety conditions.

It is one of the objects of this invention to provide a novel thermostatic pilot switch and accompanying circuit components to prevent operation of the gas burner until satisfactory ignition of the pilot burner has been realized.

In essence, the invention consists of a novel thermostatically controlled switch operated by a parallel circuit to effect operation of a main gas valve. The parallel circuit includes as one of its components, a temperature responsive resistor, located in proximity to the pilot flame and responsive thereto to effect a wattage balance or unbalance in the parallel circuit, depending upon the presence or absence of flame.

In the drawings Fig. 1 represents an across-the-line type of wiring diagram showing the invention as applied to a gas burner control system; Fig. 2 represents a semi-schematic type of wiring diagram showing the pilot and the thermostatic pilot switch in their functional relationship to the control circuit; Fig. 3 represents a plan view of the thermostatic pilot switch; and Fig. 4 represents a right side view of the switch of Fig. 3.

Referring now to Fig. 1, a conventional step-down transformer 2 is shown, having its primary connected to a source of voltage through a manual switch 3 and its secondary connected to the branch lines 4 and 8. A resistance type heater 6 is connected between the lines 4 and 8 to be subjected to the full voltage of the secondary of transformer 2. One side of a temperature responsive resistor 10 is connected to branch line 4 and the other side to one side of a resistance type heater 12, similar to heater 6. The other side of heater 12 is connected to the line 8.

A thermostatic pilot switch 14 is indicated in Fig. 1 by the character 14a because the heaters 6 and 12, which are a functional part of the switch 14, are located in

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other portions of the circuit. The switch 14a represents only the contact switch portion of the assembly in its relationship to the controlling circuit of Fig. 1. This may be further explained by reference to Fig. 2, in which the boxed area is indicated as the pilot switch 14 and includes heaters 6 and 12.

In the wiring diagram of Fig. 1, one side of switch 14a is shown connected to the line 4 and the other side to one side of a room thermostat 16. The thermostat 16 is operated to a closed contact position upon a demand for heat in a room or other enclosure and is operated to an open contact position upon the satisfaction of the heat demand. The other side of thermostat 16 connects with one side of the energizing portion of a control device such as a main gas valve 18 controlling the flow of gas to a main burner, not shown. The other side of valve 18 is connected to the branch line 8. The valve 18 may be a solenoid valve in which the energizing portion is a solenoid coil which actuates the valve to open position when energized and closes the valve when deenergized. Both the thermostat 16 and the valve 18 are conventional types of apparatus utilized in gas burner control systems and their functions are well understood in the art.

Referring now to Fig. 2 in which is shown a semi-schematic diagram, a fragmentary view of a typical gas pilot burner 20 is shown in thermal proximity to the temperature responsive resistor 10. The resistor 10 may be enclosed in a bulb or capsule (not shown) to prevent damage from the pilot flame. The main requirement for the resistor 10 is that it be exposed to the heat of the flame at the pilot burner. Thus, with the successful ignition of the pilot 20, by any suitable ignition means, the pilot flame will impinge on the bulb containing the resistor 10 to thereby heat the resistor 10 and change its resistance. The temperature responsive resistor 10 has a positive temperature coefficient of resistance, which means that upon a temperature increase, the value of electrical resistance will increase and conversely upon a temperature decrease the value of electrical resistance will decrease. A resistor having a negative temperature coefficient of resistance, such as a thermistor, could be used as will be pointed out hereinafter, but for purposes of explanation, this invention is shown utilizing a resistor having a positive temperature coefficient of resistance. Thus the resistor 10, for example, may have a resistance of approximately 20 ohms when cold (that is at ordinary room temperatures), and a resistance of approximately 90 ohms when hot (that is at high temperatures occasioned by the pilot flame).

The pilot switch 14 is illustrated schematically in Fig. 2 to show its function in the control circuit, but reference is now to be had to Figures 3 and 4 in which the construction details are shown. An insulation block 22 provides a means for mounting or supporting the switch components and for fastening the switch assembly to a panel, etc. by means of a screw 24. A relatively stiff strip 26 of electrical conducting material is secured to one face of the block 22 by means of a screw 28. A similar strip 30 is secured to the opposite face of block 22 by means of a screw 32. The screws 28 and 32 also serve as electrical terminals for connecting the switch 14 in the control circuit (Figs. 1 and 2). Set screws 34 and 35, threaded into block 22, are provided to position the strips 26 and 30, respectively, relative to the block 22 and to each other. This provides adjustments for different ranges of operation and for calibration of the pilot switch 14.

The free end of strip 26 has a temperature responsive element, such as a bimetallic blade 36 riveted thereto. The heater 6, previously described as to its electrical connections in the circuit, is mounted on bimetal 36 in thermal proximity thereto, as shown in Fig. 3. A contact structure 38 is affixed to the free end of bimetal 36. The

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contact 38 may be moved by adjustment of screw 34 or by flexure of bimetal 36.

A second temperature responsive element, such as a bimetallic blade 40 and a co-extensive leaf spring 41, are secured to a mid point on block 22 by means of a retaining strip 42 and a screw 43. The bimetal 40 is similar in construction and characteristics to the bimetal 36 and deflects similarly with the same amount of applied heat. The spring 41 carries at its free end a contact 44, which co-acts with contact 38. The spring 41 is biased in a downward direction against the bimetal 40 (Fig. 3). An opening 46 in bimetal 40 permits upward movement of contact 44 and spring 41, independently of bimetal 40. The heater 12, heretofore described in its electrical position in the circuit, is mounted on the bimetal 40 in thermal proximity, as shown. A contact 48, similar to contact 44, is secured to the free end of bimetal 40 and moveable therewith.

A third temperature responsive element, such as a bimetallic blade 50 and a co-extensive leaf spring 52 (similar to spring 41) are riveted to the free end of strip 30. The free end of bimetal 50 has a semi-circular aperture 54 therein which allows a contact structure 56, attached to the free end of spring 52, to protrude there-through. The spring 52 and contact 56 are biased in a downward direction against the bimetal 50. Note that downward travel of both contacts 44 and 56 is limited by the bimetals 40 and 50 respectively, and the upward travel is resisted by the bias of springs 41 and 52, respectively.

The current-carrying path through the switch 14 is as follows: from the secondary of transformer 2, branch line 4, terminal 23, strip 26, bimetal 36, contact 38, contact 44, spring 41, bimetal 40, contact 48, contact 56, spring 52, strip 30, terminal 32, thermostat 16, valve 18, branch line 3 and back to the secondary of transformer 2. Thus the switch contacts are in series relationship and separation of either contacts 38—44 or contacts 48—56 will interrupt the switch circuit. As shown in Figs. 2, 3, and 4, the switch 14 is in open-circuit position, because contacts 48—56 are separated even though contacts 38—44 are closed. This is the cold position of the switch, that is, when no current is flowing in the circuit.

In the wiring diagram shown in Figs. 1 and 2, three branch parallel circuits are utilized to control the gas supply and demand system. The heater 6 with its connections to branch lines 4 and 8 forms a first parallel circuit. The temperature responsive resistor 10 and heater 12 with their connections to branch lines 4 and 8 forms a second parallel circuit. The first and second parallel circuits comprise a parallel system which is designated as the controlling system. A third parallel circuit is formed by the switch 14a, thermostat 16, gas valve 18 and their connections to branch lines 4 and 8. The third parallel circuit is the circuit controlled or the demand circuit because it contains the thermostat 16 which responds to a heat demand and it contains the pilot switch 14a which is controlled by the parallel system, above mentioned.

For the purposes of illustration, the following is a description of the parallel system components and their resistance values under "balanced" and "unbalanced" conditions. The heater 6 has a fixed resistance of 360 ohms under all conditions of operation. The heater 12 has a fixed resistance of 90 ohms under all conditions of operation. The temperature responsive resistor 10 has a resistance of 20 ohms when cold, that is, in the absence of flame at the pilot 20, and a resistance of 90 ohms when hot, that is, in the presence of flame at the pilot 20. The hot condition of resistor 10 creates a balance between heaters 6 and 12 because they both consume the same wattage. This is further explained by comparing the wattage in the components 6, 10 and 12 under an applied voltage of 19 volts and a unity power factor, for example. At this voltage and with resistor 10 in the hot condition,

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the heater 6 will consume approximately 1 watt, the heater 12 will consume approximately 1 watt, and the resistor 10 will consume approximately 1 watt. The same wattage in heaters 6 and 12 create a balanced condition in switch 14. At the same voltage and with resistor 10 in the cold condition, the heater 6 will still consume approximately 1 watt, but the resistor 10 will now consume approximately .6 watt and the heater 12 will now consume approximately 2.685 watts. Thus the heaters 6 and 12 consume different wattages and are in an unbalanced state in switch 14, when the resistor 10 is cold. It is to be noted that the cold or unbalanced condition referred to is dependent upon the condition of resistor 10 and its relation to pilot 20 and not due to lack of current flow. The current flowing through resistor 10 produces a negligible amount of heat, not enough to keep it hot when the flame is out.

Operation

With no current flow from the secondary of transformer 2 the switch 14 is in the position shown in Figs. 2, 3, and 4. Note, that contacts 38—44 are in engagement and contacts 48—56 are out of engagement, due to an adjustment of screw 35. With the application of 19 volts from the secondary of transformer 2 and assuming a unity power factor in the system the heaters 6 and 12 and resistor 10 consume unequal wattage as in the cold or unbalanced condition. This means that heater 12, consuming 2.685 watts will provide more heat to bimetal 40, than will heater 6, consuming 1 watt, provide to bimetal 36. Thus, the bimetal 40 will flex a greater distance upwardly (Fig. 3), separating contact 44 from contact 38 and carrying contact 48 into engagement with contact 56, and carrying the contacts 44 and spring 41 upwardly. The bimetal 36 having less heat supplied by heater 6 will follow bimetal 40 a certain distance but not sufficiently to maintain contact 38 in engagement with contact 44. Therefore the series switch circuit remains broken during the cold condition of resistor 10 which causes an unbalance between heaters 6 and 12.

Upon ignition of pilot 20, manually or by other suitable means, the resistor 10, being exposed to the pilot flame, heats up, changing its resistance from 20 ohms to 90 ohms. This changes the current drawn in the second parallel circuit, which causes heater 12 to decrease its wattage consumption from 2.685 watts to 1 watt. The heater 6 is unaffected because its wattage consumption remains 1 watt with the same applied voltage. The equal amounts of heat transmitted by heaters 6 and 12 will affect the corresponding bimetals 36 and 40 similarly. Both bimetals 36 and 40 will flex upwardly the same distance, carrying contact 38 already in engagement with contact 44 upwardly the same distance as contact 48. The bimetal 50 is unaffected by the heaters and responds only to ambient changes. It is to be noted that bimetal 50 is constructed of bimetallic material only for ambient compensation. Thus, the bimetal 50 remains stationary and the contact 48 engages contact 56 to complete the circuit through pilot switch 14. Continued travel of the bimetals 36 and 40 after the contacts have engaged, is provided for by the strain relief springs 41 and 52 which prevent distortion of the components.

Upon a demand for heat, with the closing of the contacts of thermostat 16, the solenoid coil of the gas valve 18 is energized. This results in fuel flowing to the main burner where it is ignited by the pilot flame. The heating system is now in operation and subsequent de-energization and energization of the valve 18 is under the control of thermostat 16 for as long a period as the pilot remains ignited. In the event that for some reason the pilot flame is extinguished, the resistor 10 will cool, reducing its resistance from 90 ohms back to 20 ohms. This again creates an unbalance between heaters 6 and 12. With the heater 12 providing a larger amount of heat to the bimetal 40, the contacts 44 and 38 will separate, opening

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the switch circuit. Therefore, no operation of the system is possible without a successful and uninterrupted pilot flame. Any interruption of the pilot flame, due to clogging, wind blasts, etc., will result in the cooling of resistor 10 causing the unbalance and subsequent lockout of switch 14. This feature is obtainable at all periods of the operating cycle.

In cases of component failures the following actions occur. If heater 12 burns out, the sole heating of heater 6 causes bimetal 36 to flex upwardly while bimetal 40 remains stationary and contact 48 remains out of engagement with contact 56. The strain relief spring 41 permits the contact 38 to push the contact 44 through the aperture 46 in bimetal 40 without affecting the action of bimetal 40. The bimetal 40 remains inactive due to the failure of heater 12.

In the event that heater 6 burns out, the bimetal 36 remains inactive and the bimetal 40 flexes upwardly carrying the contact 44 out of engagement with the contact 38. Even though subsequently contact 48 engages contact 56, the series switch remains in the open circuit position.

In the event resistor 10 burns out, it creates an open circuit through heater 12 and the system reacts in the same manner as when heater 12 burns out.

In the event both heaters 6 and 12 burn out, the switch remains in the position shown in Fig. 3.

Note, that the system is substantially independent of voltage fluctuations because of the proportional change in the parallel circuits.

As previously mentioned, a thermistor or a resistor having a negative temperature coefficient of resistance may be used in place of the resistor 10. In this event the unbalance is created by selecting the hot value of resistance of the thermistor at 90 ohms or equal to the resistance of heater 12 and the cold value of resistance of the thermistor at some high resistance, such as 1000 ohms, thereby causing the heating effect or heat output of heater 12 to be negligible. Then the balanced condition after successful ignition of pilot 20 will result in the closing of switch 14 in the same manner as with the use of resistor 10 and the unbalanced condition after a flame failure at pilot 20 will result in movement of bimetal 40 and contact 48 downwardly, separating contact 48 from contact 56, while contact 38 remains in engagement with contact 44, this latter condition being due to the negligible heat output of heater 12 and the continued heating of heater 6.

In the event that an increase in ambient temperature causes the bimetal blades 36 and 40 to flex upwardly, a corresponding deflection by the bimetal 50 retains the contact 56 out of engagement with the contact 48. Obviously, where conditions warrant it, the substitution of a metal strip for the bimetal 50 is possible without departing from the scope of the invention. This would not provide ambient compensation but would be feasible in an application where the ambient temperatures remain stable.

This invention is subject to these and other modifications but it is intended to be limited only by the scope of the appended claims.

What is claimed is:

1. A safety control for a fuel burner of the type which breaks a control circuit upon the cessation of combustion at the burner comprising, a source of voltage, electrically energized fuel control means controlling the flow of fuel to the burner, a first branch circuit connected across said voltage source and including a first electrical heater, a

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second parallel branch circuit connected across said source and including a second electrical heater, a third parallel branch circuit connected across said source and including in series said fuel control means and a safety switch means, first and second thermally responsive members moveable in unison from cold to normal hot positions in response to the application of heat thereto and mounted in thermally conductive relation to said first and second heaters respectively, said members being operatively connected to said safety switch means to close said safety switch means only upon movement of both said members to their respective normal hot positions and to open said switch means by movement of said second member beyond its normal hot position, a temperature responsive resistance adapted to be heated by combustion at said burner and connected in said second branch circuit, the thermal output of said first and second heaters being balanced to move both said members to their normal hot positions when the thermally responsive resistance is heated by combustion at said burner, the change in resistance of the thermally responsive resistance upon the cessation of combustion increasing the heat output of said second heater and thereby moving said second member beyond its normal hot position to open said safety switch means.

2. A gas pilot safety control of the type which breaks a control circuit upon the extinction of the pilot flame comprising, a source of voltage, electrically energized means for controlling the flow of gas to a main burner, a first branch circuit connected across said voltage source and including a first electrical heater, a second parallel branch circuit connected across said source and including a second electrical heater, a third parallel branch circuit connected across said source including in series said electrically energized means and a safety switch means, first and second bimetal members moveable in unison from cold to normal hot positions in response to the application of heat thereto and mounted in thermally conductive relation to said first and second heaters respectively, said bimetal members being operatively connected to said safety switch means to close said safety switch means only upon movement of both said members to their respective normal hot positions and to open said switch means by movement of said second member beyond its normal hot position, a thermally responsive resistance having a relatively high positive temperature coefficient of resistance adapted to be heated by the pilot flame and connected in said second branch circuit, the thermal output of said first and second heaters being balanced to move both said members to their normal hot positions when said resistance is heated by the pilot flame, the change in resistance of said thermally responsive resistance upon extinction of the pilot flame increasing the heat output of said second heater and thereby moving said second member beyond its normal hot position to open said safety switch means.

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