July 13, 1943. P. C. SMITH 2,324,330

FIRE CONTROL APPARATUS

Filed July 20, 1940

FIG. 1.

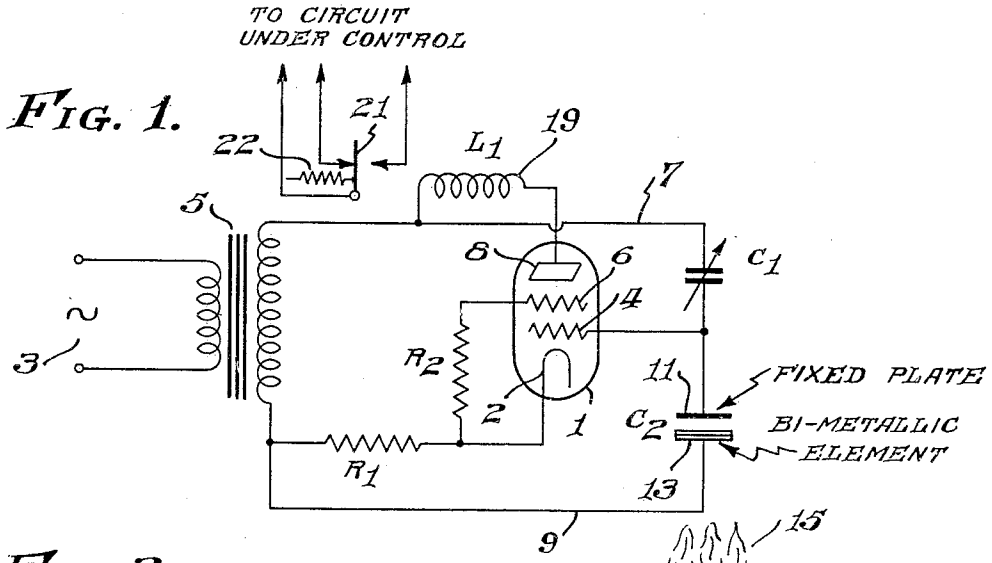


FIG. 2.

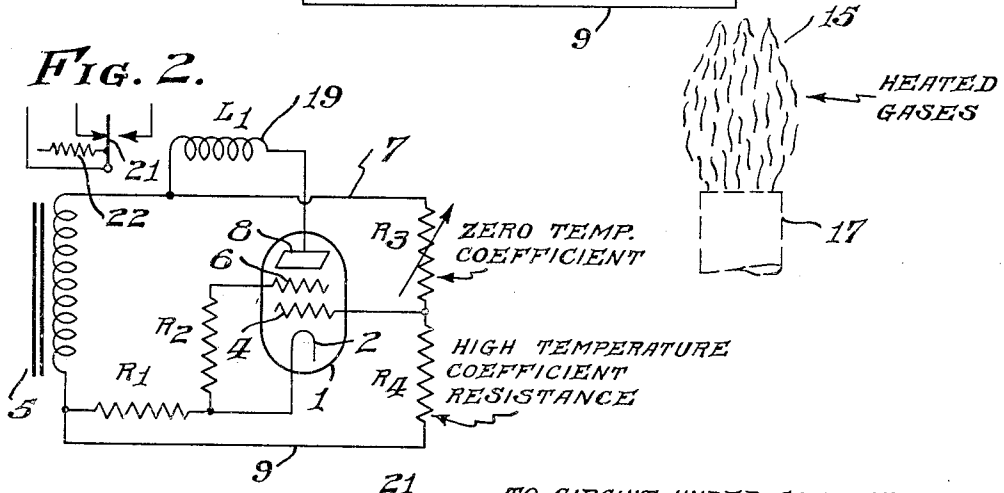


FIG. 3.

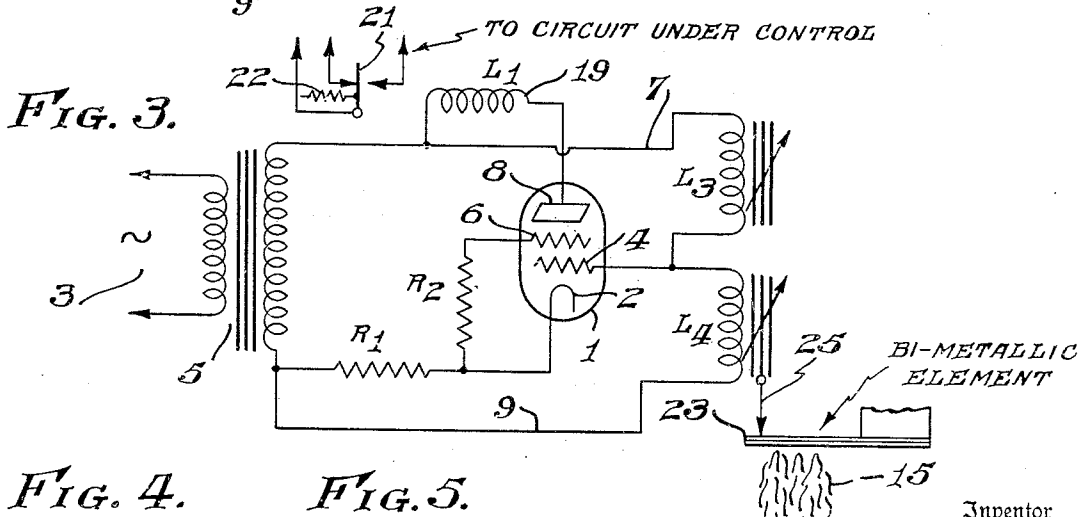


FIG. 4.

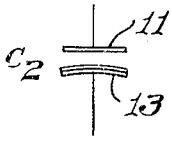
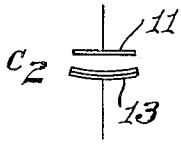


FIG. 5.



Inventor
Perry C. Smith
By
Attorney

Patented July 13, 1943 2,324,330

UNITED STATES PATENT OFFICE

2,324,330

FIRE CONTROL APPARATUS

Perry C. Smith, Brookline, Mass., assignor to Radio Corporation of America, a corporation of Delaware

Application July 20, 1940, Serial No. 346,484

10 Claims. (Cl. 158—28)

This invention relates to relay apparatus responsive to temperature changes, and more particularly to apparatus for controlling a heat source.

Among the fields of application of my present invention is that of controlling the fuel supply in oil-burning systems or other similar systems wherein fuel is supplied to a flame. In certain standard flame-control systems heretofore known, use has been made of a resistance bridge in connection with an electronic device to control the flame. In such systems, the flame is used as a part of the voltage divider which determines the potential of the control grid, the resistance of the flame usually being in the order of several megohms. Among the disadvantages of such an arrangement are (1) the element which is placed in the flame to obtain the resistance circuit is subject to disintegration from the flame, thereby shortening the life thereof, and (2) due to the carbon deposits which become an appreciable part of the total divider resistance, the device tends to drift in its control point.

The primary object of my present invention is to provide an improved system capable of acting as a supervisory means for various types of flames or other heat sources to shut down the fuel supply when certain conditions have been met, which system will not be subject to the disadvantages of similar systems heretofore known.

More particularly, it is an object of my present invention to provide an improved control system of the type set forth which will provide instantaneous fuel supply shut-off when the flame goes off.

Another object of my present invention is to provide an improved system of the type set forth which may be availed of as a thermostat or as a thermostat control.

A further object of my invention is to provide an improved system as aforesaid which is simple in construction, has a minimum number of parts, and is highly efficient in operation.

One system according to my present invention comprises a cold cathode gas discharge tube which is connected to a suitable source of E. M. F. and a variable impedance network in the input circuit thereof for controlling the grid of the gas discharge tube. One branch of the variable network is manually variable so that it can be set to balance against a predetermined value of the other branch in which a variable element responsive to temperature changes is employed, the latter element being arranged to cooperate with the flame or other heat source. Any variation in the impedance of the last-named, predetermined network will place the bridge out of balance and cause the gas discharge tube to fire or restore, dependent upon the polarity of the change, and thereby actuate a solenoid relay in the output circuit of the gas discharge tube to actuate suitable mechanism for shutting off the supply of fuel to the flame.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, as well as additional objects and advantages thereof, will best be understood from the following description of several embodiments thereof, when read in connection with the accompanying drawing, in which

Figure 1 is a wiring diagram showing a system according to one form of my invention,

Figure 2 is a wiring diagram showing a system according to a somewhat different form of my invention,

Figure 3 is a wiring diagram of a system of still another form of my invention; and

Figures 4 and 5 are views showing the variation that may take place in the heat controlled capacitor of the system of Fig. 1.

Referring more particularly to the drawing, wherein similar reference characters designate corresponding parts throughout, I have shown an amplifier comprising a cold cathode gas discharge device 1 which may be coupled to a suitable source of E. M. F. 2 through a transformer 5, a current limiting resistor R_1 being preferably connected to the cathode 2 thereof. The tube 1 may be a triode, a tetrode, or of any other suitable number of electrodes, that illustrated in the drawing being a tetrode provided with a grid electrode 4, a control grid electrode 6 and a plate or anode 8, in addition to the cathode 2. If desired, a resistor R_2 may be provided between the resistor R_1 and the control grid 6 to apply a biasing voltage on the control grid 6.

Connected to the grid 4, or in the input circuit of the amplifier 1, is a bridge constituted by the arms or branches 7 and 9, the arm 7 being provided with a manually variable capacitor C_1 and the arm 9 being provided with a variable capacitor C_2 which has a fixed plate or electrode 11 and a variable plate or electrode 13 constituted, for example, by a bimetallic element controlled by the heat of a flame 15 or other suitable heat source to which fuel may be supplied

through a pipe or conduit 17 under control of a suitable valve (not shown). Upon application of heat to the bimetallic element 13 of the capacitor C_2, the element 13 will warp in either direction to assume the position of either Fig. 4 or Fig. 5, depending upon the relative coefficients of expansion of the metals of which the element 13 is formed. In either case, it will be apparent that the capacity of the capacitor C_2 will have been changed.

Connected to the plate 3, or in the output circuit of the tube 1, is the winding L_1 of a solenoid relay 19 the armature of which is arranged to cooperate with the movable element 21 of a switch in a circuit to be controlled and which may be arranged to cooperate with the aforementioned valve in the conduit 17 or with other suitable mechanism for shutting off the supply of fuel to the flame 15. In operation, the capacitor C_1 is manually adjusted to balance the arm 7 of the bridge against the arm 9. When heat is applied to the bimetallic electrode 13 by the flame or other suitable heat source 15, it is obvious that the capacity of the capacitor C_2 will change, whereupon the arms 7 and 9 of the bridge will become unbalanced and the tube 1 will be fired to energize the relay 19 and operate the switch element 21. In the circuit of Fig. 1, if the capacitor C_2 is so arranged that its capacitance will decrease with a decrease in temperature, the resulting increase in impedance of the branch or arm 9 will make the grid 4 more positive and fire the tube. However, the reverse action is also possible, that is, the action can be reversed by making the capacitance of the capacitor C_2 increase in capacity with decrease in temperature. In any event, it will be obvious that, in my improved system, the tube 1 acts as a relay device with the bridge 7–9 constituting a voltage divider for impressing an operating voltage on the grid 4 to fire the tube 1 when the element 13 has reached a predetermined temperature. Should the flame go out, the drop in temperature of the element 13 will restore the balance between the arms 7 and 9, and the tube 1 will shut down to deenergize the relay 19, whereupon the switch element 21 will be returned to original position, as by a spring 22.

The arrangement of Fig. 2 is similar to that of Fig. 1, but in place of the capacitors C_1 and C_2, I substitute a manually variable resistor R_3 in the branch 7 and a heat responsive variable resistor R_4 in the branch 9. The resistor R_3 is preferably made of a material which has a zero temperature coefficient, while the resistor R_4 is made of a material having a high temperature coefficient so that, when heat is applied to the resistor R_4, its resistance will vary and the impedance of the branch 9 of the bridge will be altered. As in the case of the system of Fig. 1, that of Fig. 2 is initially set by adjusting the resistor R_3 to balance the branch 7 against the branch 9. When a predetermined temperature has been reached, the resistance of the resistor R_4 will have been sufficiently altered to cause the tube 1 to fire and operate the relay 19. When the heat source is removed from the resistor R_4, its temperature will drop, the original impedance of the branch 9 will be restored to balance it against the branch 7, and the tube 1 will go off.

The system of Fig. 3 is similar to those heretofore described, but in this system I employ a pair of inductances L_3 and L_4, respectively, in the arms 7 and 9. The inductances L_3 and L_4 are provided with magnetite cores or the equivalent, the inductance L_3 being manually adjustable, and the inductance L_4 being adjustable in response to a bimetallic element 23 which is connected to the core thereof by a suitable coupling 25 and which is responsive to the heat of the flame 15. Here, again, the system is originally set by manually adjusting the inductance L_3 to balance the arm 7 against the arm 9. When heat is applied to the bimetallic element 23, the inductance of the coil L_4 will be changed to alter the impedance of the arm 9, whereupon the tube 1 will be fired and the relay 19 energized. If the flame 15 goes out, the bimetallic element 23 is restored to its original position, the balance between the arms 7 and 9 is resumed, and the tube 1 becomes inoperative, whereupon the relay 19 is deenergized and the switch element 21 restored to normal position by the spring 22.

From the foregoing description, it will be apparent to those skilled in the art that I have provided a novel flame control system which operates instantaneously, when certain predetermined conditions have been met, to control the flame. Although I have shown and described several embodiments of my invention, it is apparent that various changes therein, as well as other modifications, are possible. For example, the grid voltage divider circuit, instead of being a capacitance, a resistance, or an inductance divider, may be a combination of resistance, capacitance and/or inductance, etc. Other changes will, no doubt, readily suggest themselves to those skilled in the art. I, therefore, desire that my invention shall not be limited except insofar as is made necessary by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. In flame responsive apparatus, the combination of an amplifier comprising an electron discharge device including a pair of bridge arms in the input circuit thereof, variable means in one of said arms associated with the flame and responsive to temperature changes induced thereby, and a relay in the output circuit of said device associated with the fuel supply to said flame for controlling the supply of fuel to said flame, a predetermined temperature change resulting from said flame causing a variation in said variable means sufficient to alter the balance of said bridge arms whereby to actuate said relay to alter the fuel supply to said flame.

2. In flame responsive apparatus, the combination of an amplifier comprising an electron discharge device including a pair of bridge arms in the input circuit thereof, variable means in each of said arms adapted to be varied to effect a balance of said arms, the variable means in one of said arms being manually adjustable and the variable means in the other of said arms being associated with the flame and responsive to temperature changes induced by said flame, and a relay in the output circuit of said device associated with the fuel supply to said flame for controlling the supply of fuel to said flame, a predetermined temperature change resulting from said flame causing a variation in said second-named variable means sufficient to alter the balance of said bridge arms whereby to actuate said relay to alter the fuel supply to said flame.

3. In flame responsive apparatus, the combination of an amplifier comprising a cold cathode gaseous discharge device, a bridge having a pair of arms in the input circuit of said discharge de-

vice, variable means in each of said arms for effecting a balance of said arms, the variable means in one of said arms being manually adjustable and the variable means in the other of said arms being associated with the flame and responsive to temperature changes induced thereby, and a relay in the output circuit of said device associated with the fuel supply to said flame for controlling the supply of fuel thereto, a predetermined temperature change resulting from said flame causing a variation in said second-named variable means sufficient to alter the balance of said bridge arms whereby to actuate said relay to alter the supply of fuel to said flame.

4. In flame responsive apparatus, the combination of an amplifier comprising a cold cathode gaseous discharge device, a bridge having a pair of arms in the input circuit of said discharge device, variable means in each of said arms for altering the impedance thereof, one of said means being manually adjustable for adjustment of its arm into balancing relation with the other of said arms, the variable means in said other arm being associated with the flame and responsive to temperature changes induced thereby, and a relay in the output circuit of said device associated with the fuel supply to said flame for controlling the supply of fuel thereto, a predetermined temperature change resulting from said flame causing a variation in said second-named means to alter the impedance of its arm and thereby alter the balance of said bridge whereby to actuate said relay to alter the supply of fuel to said flame.

5. The invention set forth in claim 4 characterized in that said variable means comprise variable impedance elements.

6. The invention set forth in claim 4 characterized in that said variable means comprise variable capacitances.

7. The invention set forth in claim 4 characterized in that said variable means comprise variable capacitances, and characterized further in that the second-named of said variable means comprises a capacitor one of the electrodes of which is constituted by a bimetallic element.

8. The invention set forth in claim 4 characterized in that said variable means comprise variable resistors.

9. The invention set forth in claim 4 characterized in that said first-named variable means comprises a variable resistor made of material having substantially zero temperature coefficient, and characterized further in that said second-named variable means comprises a resistor made of material having a relatively high temperature coefficient.

10. The invention set forth in claim 4 characterized in that said variable means include variable inductances.

PERRY C. SMITH.