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FURNACE CONTROL SYSTEM

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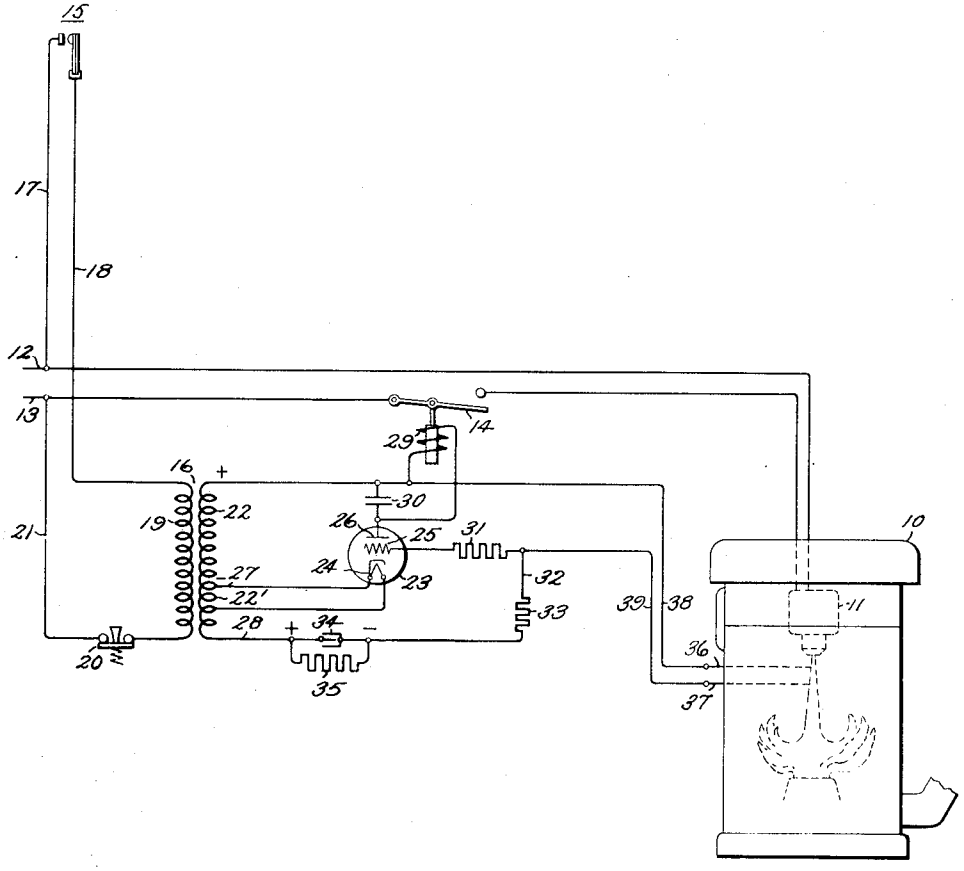

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FURNACE CONTROL SYSTEM

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5 Claims. (Cl. 158—28)

This invention relates to control systems and, though it is not necessarily limited thereto, it is particularly adaptable for controlling a furnace which is adapted to be periodically operated in accordance with temperature conditions of an enclosure.

Furnaces such as those designed for domestic heating are generally supplied with fuel, such as oil or gas, by an electrically operated burner mechanism. The circuit controlling the burner is normally controlled by a thermostat device located within the enclosure to be heated and, upon a call for heat, the circuit to the burner is energized to supply fuel to the combustion chamber until the enclosure temperature is raised to the point where the thermostat is returned to the open circuit position. If the fuel fails to ignite within a predetermined interval after the initiation of the operation of the burner, or should the flame during the operation of the furnace for any reason become extinguished, it is desirable that the burner be shut down independently of the condition of the thermostat.

It is an object of this invention to provide a new and improved electrical control system for a load device, which system is of the type that is responsive to a predetermined function of operation of the device for maintaining the operation thereof or upon a predetermined time after the failure of said function effects the deenergization of the device, the system comprising a relatively small number of working parts and is reliable and efficient in operation.

It is a further object of this invention to provide a new and improved furnace control arrangement which upon the occurrence of a predetermined condition initiates the operation of the furnace and in response to a predetermined functional failure of the furnace terminates the operation thereof independently of the initiating control, which arrangement is simple in construction, efficient in operation, and low in manufacturing cost.

In the embodiment illustrated a load device, such as a furnace burner motor is adapted to be energized from an alternating current source, the motor circuit switch being controlled through an electric discharge device energized through a transformer controlled by a room thermostat. During the proper functioning of the furnace it remains under the control of the thermostat by the maintenance of conductivity of the discharge device but upon failure of the furnace properly to function, the discharge device is rendered non-conductive with a predetermined time delay to deenergize the furnace burner motor circuit.

For a consideration of what I believe to be novel and my invention, attention is directed to the following description and the claims appended thereto taken in connection with the accompanying drawing.

In the drawing the figure is a diagrammatic sketch illustrating one form of the invention.

Referring to the drawing, a furnace **10** is shown which, for example, may be of the oil burning type, combustibles being supplied through a suitable motor driven burner means **11**. The burner motor is adapted to be supplied with electric energy from a suitable source, such as the alternating current leads **12** and **13**. The operation of the burner motor is controlled by means of a suitable switch **14** in one of the leads, such as **13**, which switch is in turn normally controlled in accordance with the temperature variations within the enclosure receiving heat from the furnace. The thermostat **15**, suitably mounted within the enclosure, not shown, is arranged for controlling an energizing circuit of a suitable transformer **16**, one contact of the thermostat being connected by conductor **17** to the lead **12** while the other thermostat contact is connected by the conductor **18** to one terminal of the transformer primary winding **19**. The other terminal of the transformer primary winding is connected through a normally closed switch **20** and conductor **21** to the other alternating current supply lead **13**. Connected in the circuit of the transformer secondary winding **22** is a suitable electric discharge device **23** of the three-element type having a cathode **24**, a control electrode or grid **25**, and an anode **26**. The cathode **24** may be energized from any suitable source and is connected to an intermediate point of the transformer winding **22**. As indicated, the cathode may be energized from an intermediate portion **22'** of the transformer secondary winding **22** through connections **27** and **28**. The anode is connected through the operating winding **29** of switch **14** to one terminal of the transformer winding **22**, a suitable capacitor **30** being provided in parallel with winding **29** for the purpose of smoothing out the pulsations of direct current during the conductive condition of the discharge device. The control electrode **25** is connected through the resistance **31**, connection **32**, resistance **33**, the parallel connected capacitor **34**, and leakage resistance **35** to the opposite terminal of the transformer secondary winding **22**. Electrodes

36 and 37 suitably arranged within the furnace in the path of the flame thereof are connected to the anode and control electrodes, respectively, of the discharge device through the connections 38 and 39. When these spaced electrodes are energized, a current will flow between them in the presence of a flame as is well known in the art, the phenomenon being fully described in Patent No. 2,112,736 Cockrell, issued March 29, 1938, and assigned to the General Electric Company, the assignee of the present application. It is obvious, however, that in place of the specific type of flame detector shown, any other suitable flame detector or other means responsive to a predetermined function of the operation of the load device, in this instance, the furnace burner motor, may be substituted therefor.

The operation of the arrangement will now be described. Upon a predetermined decrease in temperature within the enclosure to be supplied with heat by the furnace 10, the thermostat 15 closes the energizing circuit for the transformer primary winding 19. The cathode 24 of the electric discharge device will be energized and during those half cycles when the anode is positive the device will be conductive, resulting in a flow of current therethrough sufficient for energizing the winding 29 and closing switch 14. It is understood that the control electrode 25 is initially at a potential more positive than the cut-off value, due to the initially discharged condition of the capacitor 34. Assume for the moment that the fuel fails to ignite in the furnace upon the energization of the burner means. After a predetermined time following the closure of switch 14 and depending upon the value of the resistances 31, 33, and 35, the charge of the condenser will be built up by grid rectification during the negative half cycles, and correspondingly increase gradually the negative bias on the control electrode 25. As the negative bias is increased, the conduction of the electric discharge device 23 will be decreased to such a value that switch 14 will drop out and the furnace burner motor will be disconnected from the source of supply.

Now assume that the fuel is promptly ignited within the predetermined time interval following the energization of the burner motor and that the flame is maintained. The flame then will form a relatively low resistance conductive path between the electrodes 36 and 37, as is well known in the art, thus effectively connecting the control grid 25 of the electric discharge device 23 to anode potential. The capacitor 34 will be discharged, the conductivity of the electric discharge device maintained, and the switch 14 retained in the closed position as long as the flame continues in the furnace under the control, however, of the thermostat 15. Should the furnace flame become extinguished for any reason while the thermostat is in the circuit closing condition, the conductive path between the electrodes 36 and 37 is disrupted effectively disconnecting the control electrode 25 from the anode circuit. The capacitor 34 will, as explained above, gradually be charged, the plate connected to the control grid assuming a negative potential. After a predetermined time, this charge will become such that the negative bias impressed upon the control electrode will reduce the conductivity of the tube and the current flow therethrough to such a value that the switch 14 will drop to the open circuit position. The electric discharge device 23 will be maintained non-conductive and the switch 14 deenergized as long as the thermostat 15 is in the closed circuit condition. It is obvious that means may be provided so that an appropriate alarm or signal will be given to indicate the lock-out of the furnace control system upon flame failure so that the defective condition may be promptly corrected. When the furnace is again in condition for operation, the circuit may be reset by depressing the switch 20 momentarily opening the energizing circuit of the transformer primary winding 19. This will give the capacitor 34 an opportunity to discharge through the resistance 35. Upon the release of the switch 20, the transformer will again be energized and the electric discharge device 23 will be rendered conductive for effecting the closure of switch 14 as described above.

Having described the principle of operation of my invention together with the apparatus which I now consider to represent the best embodiment thereof, I desire to have it understood that the apparatus shown is only illustrative and that the invention may be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In combination, a furnace, electrically operable motor means for supplying combustibles thereto, an electrically operable switch for controlling the energization of said motor means, means responsive to the temperature variations within an enclosure to be heated by said furnace, a transformer adapted to be controlled by the operation of said temperature responsive means, means for controlling said switch including an electric discharge device connected to said transformer and adapted to be energized thereby, said electric discharge device being initially conductive to cause closure of said switch, a control electrode in said discharge device, a capacitor connected between said control electrode and said transformer, a leakage resistance connected across said capacitor, said capacitor being initially discharged and adapted to be charged so as to disrupt the conductivity of said tube a predetermined time following the closure of said switch, and means responsive to the presence of flame within the furnace within said predetermined time for discharging said capacitor and maintaining the conductivity of said electric discharge device.

2. In combination, a furnace having an electrically operated burner means, a source of electric current, connections including an electrically operable switch between said burner means and said source, an electric discharge device adapted to be energized from said source, said device having an anode, a cathode and a control electrode, energizing means for said switch connected in the anode-cathode circuit of said device, said device being normally conductive when energized, the current flow therethrough being normally sufficient for maintaining said switch in the closed circuit position, a capacitor connected to said control electrode and said source of current adapted to be gradually charged with such polarity and to such a potential that said discharge device is rendered non-conductive a predetermined time following the initial energization of said discharge device, means responsive to a predetermined condition of operation of said furnace within said predetermined time for discharging said capacitor and maintaining the conductivity of said discharge device, and means re-

sponsive to a condition influenced by the heating action of said furnace for controlling the energization of said discharge device.

3. In combination, a furnace having an electrically operable motor means for supplying combustibles to the combustion chamber thereof, a source of alternating current, an electrically operable switch for controlling the energization of said motor means from said source, temperature responsive means, a transformer adapted to be energized upon the predetermined operation of said temperature responsive means, an electric discharge device having an anode, a cathode and a control electrode, a circuit including an operating winding for said switch connecting said anode to one terminal of said transformer, a circuit connecting the cathode to an intermediate point of said transformer, a circuit including current limiting means and a capacitor connecting said control electrode to the opposite terminal of said transformer, a leakage resistance connected across said capacitor, said capacitor being initially discharged and adapted to be gradually charged following the energization of said transformer by said temperature responsive means whereby said electric discharge device may be rendered non-conductive a predetermined time following the initial energization thereof, and means responsive to the presence of flame within said furnace within said predetermined time for discharging said capacitor and maintaining said electric discharge device conductive.

4. In combination, a furnace having an electrically operated burner means for heating an enclosure, an alternating current source of supply, connections including an electrically operable switch between said burner means and said source of supply, an electric discharge device having an anode, a cathode and a control electrode, a transformer, a circuit including an energizing winding for said switch connecting said anode to one terminal of said transformer, said cathode connected to an intermediate point of said transformer whereby said discharge device is rendered conductive and said switch closed upon the energization of said transformer, means responsive to a predetermined normal condition of operation of said burner means for maintaining the conductivity of said discharge device, a circuit including a capacitor and a leakage resistance unit bridging said capacitor connecting said control electrode to the opposite terminal of said transformer whereby said control electrode is rendered sufficiently negative with respect to said cathode a predetermined time following failure of said burner operating condition to decrease the conductivity of said discharge device below the drop out value of said switch, and means responsive to the temperature within the enclosure to be heated by said furnace for controlling the energization of said transformer from said source of supply.

5. In combination, a furnace, electrically operable motor means for supplying combustibles thereto, an electrically operable switch for controlling the energization of said motor means, means responsive to the temperature variations within an enclosure to be heated by said furnace, a transformer adapted to be energized by the operation of said temperature responsive means, an electric discharge device connected to said transformer and adapted to be energized thereby, said electric discharge device being initially conductive to cause closure of said switch, a control electrode in said electric discharge device, a capacitor connected between said control electrode and said transformer, a leakage resistance connected across said capacitor, said capacitor being adapted to be charged with such a polarity and such potential as to disrupt the conductivity of said tube a predetermined time following closure of said switch, and means responsive to the occurrence of flame within the furnace for maintaining the conductivity of said electric discharge device and the closed condition of said switch.

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