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BURNER CONTROL SYSTEM

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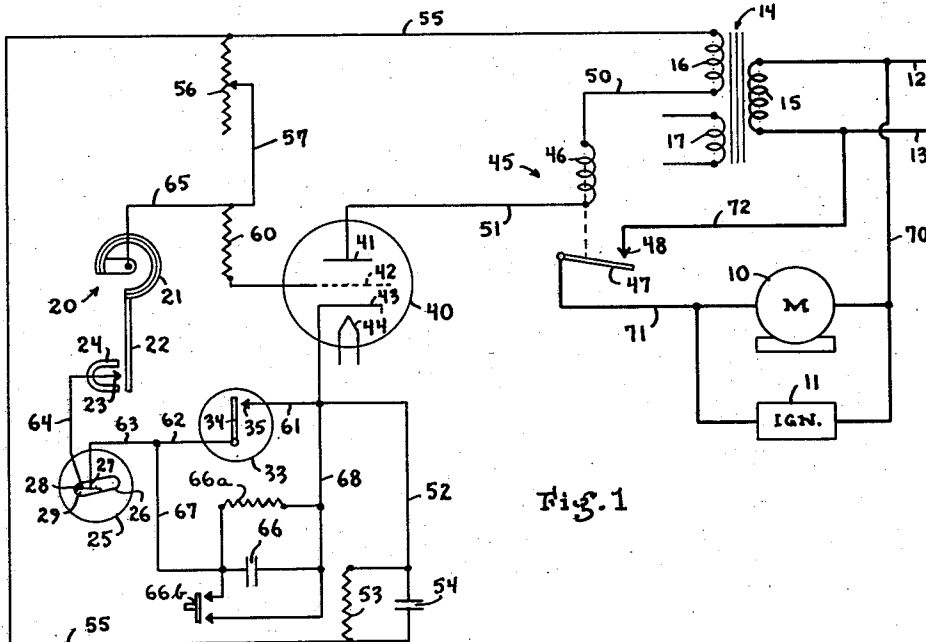


Fig. 1

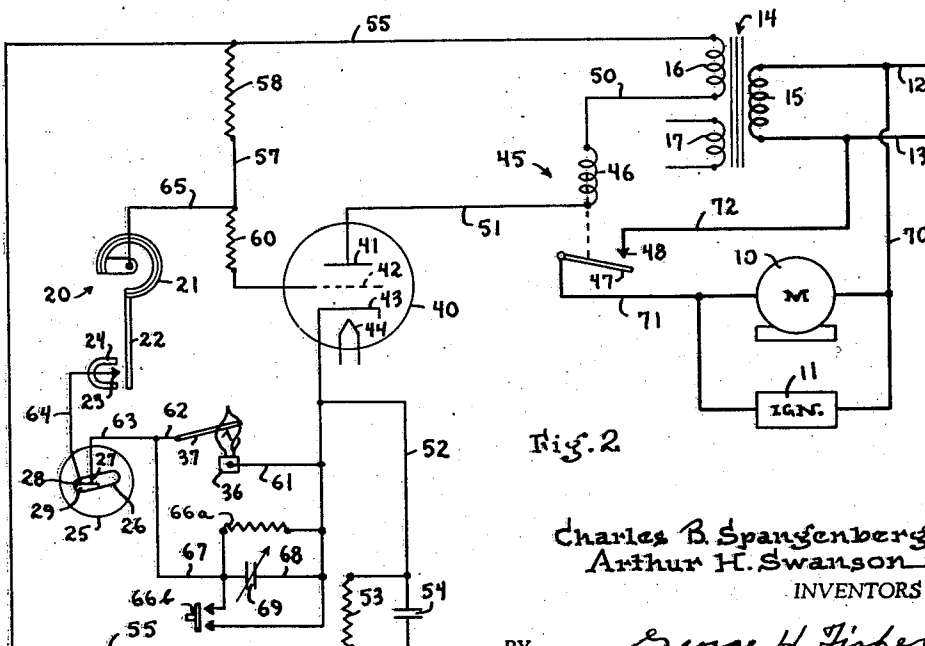


Fig. 2

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BURNER CONTROL SYSTEM

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This invention relates generally to fluid fuel burner control systems.

In a conventional oil burner control system, there is customarily provided some means responsive to the presence of flame at the burner, which means must be maintained in an operative condition in order to permit the supply of fuel to the burner. Many types of flame responsive means are well known in the art, for example, temperature responsive stack switches, photocells, flame electrodes which provide a conductive path through the flame, etc. These flame responsive devices are ordinarily maintained conductive due to the heat of the flame, the light produced by the flame, or the conductivity of the flame itself. In conventional systems, when the flame responsive device is conductive, indicating the presence of flame at the burner, the feeding of fuel to the burner is allowed to continue if demanded by the room thermostat, or other main control device.

In order to start a burner with a control system employing such a flame responsive device, some means must be provided for permitting the supply of fuel during the starting period when there is no flame at the burner. Such means ordinarily consists of a timing device, which allows the feeding of fuel to the burner after a call for heat by the main control, regardless of the flame responsive device. If the flame responsive means does not respond during the starting period, the supply of fuel to the burner is cut off by the timing device at the end of a predetermined time.

An object of the present invention is to provide an improved and simplified burner control system, including a novel means of timing the duration of the starting period.

Another object of the present invention is to provide an improved burner control system including an electric discharge device, wherein the controlling devices are connected in the input circuit of the discharge device, so that the current carried by the controlling devices is at a minimum.

A further object of the present invention is to construct a burner control system wherein the timing of the starting period is regulated by a condenser connected in the input circuit of an electric discharge device.

A still further object is to provide, in such a circuit, means for varying the duration of the starting period.

Other objects and advantages of my invention will become apparent from a consideration of

the appended claims, specification, and drawing, in which,

Figure 1 represents a circuit diagram of a control system embodying our invention, and

Figure 2 is a modification of the control system of Figure 1, embodying our invention in a somewhat different form.

Figure 1

Referring to Figure 1, 10 represents a motor driving means for supplying fuel to a fluid fuel burner (not shown). An ignition device 11 is provided for igniting the fuel as it issues from the burner. Motor 10 and igniter 11 are adapted to be energized from a pair of power supply lines 12 and 13. Also connected to the power lines 12 and 13 is a transformer 14 having a primary winding 15 and a pair of secondary windings 16 and 17.

Operation of the burner motor 10 is controlled by a thermostatic device 20 which may be a room thermostat mounted in the space to be heated by the burner. The thermostat 20 comprises a bimetallic element 21, which carries on its free end a contact arm 22, which on a decrease in temperature to a predetermined point is adapted to engage a stationary contact 23. A permanent magnet 24 is mounted adjacent the stationary contact 23 to provide a snap action of the contact arm 22 in a manner well known in the art.

A limit switch 25 responsive to bonnet temperature or some other limiting condition of the heating system, is provided to shut down the system in case the said limiting condition exceeds a predetermined value. The switch 25 comprises a glass tube 26 having a pair of electrodes 27 and 28 in one end thereof, and a pool of mercury 29 which is adapted to roll along the bottom of the tube and make and break the circuit between the electrodes as the tube is shifted back and forth by a suitable condition responsive element (not shown).

A combustion responsive switch 33 comprises a movable contact arm 34 and a stationary contact 35. This switch may be of the usual slip friction type which is actuated by means of a thermal element responsive to the stack temperature or the temperature in the combustion chamber of the furnace. Due to the slip friction action between the thermal element and the switch arm, the switch is responsive to a change in temperature rather than to any predetermined temperature.

The thermostat 20, the limit switch 25, and the

combustion responsive switch 33 cooperate to control the conductivity of an electric discharge device 40, having an anode 41, a control electrode 42, a cathode 43, and a heater element 44.

Connected in the output circuit of the discharge device 40 is a relay 45 having a winding 46 whose energization controls the operation of a switch arm 47 into and out of engagement with the stationary switch contact 48.

The output circuit of the discharge device 20 is conductive only during the half cycles when the lower end of transformer secondary winding 16 is positive with respect to its upper end. The output circuit may be traced from the lower end of secondary winding 16 through a conductor 50, relay winding 46, a conductor 51, anode 41, cathode 43, a conductor 52, biasing resistor 53 and its associated parallel by-pass condenser 54, and a conductor 55 to the upper terminal of transformer secondary winding 16.

The input circuit of discharge device 40 comprises various branch circuits which connect cathode 43 and control electrode 42. One of these branches is effective to maintain control electrode 42 at a potential sufficiently negative with respect to that of cathode 43 that the current flowing in the output circuit of discharge device 40 is too small to energize relay 45 enough to make contact between switch arm 47 and contact 48. This branch circuit, hereinafter referred to as the negative biasing branch may be traced from cathode 43 through conductor 52, biasing resistor 53 and its associated parallel by-pass condenser 54, conductor 55, variable resistance 56, a conductor 57, and resistor 60 to control electrode 42. In this negative biasing branch, control electrode 42 is at substantially the same potential as the negative (upper) terminal of transformer secondary 16 during the half-cycles when the discharge device 40 is conductive, while cathode 43 is at a substantially more positive potential, due to the drop across biasing resistor 53.

A second branch of the input circuit is provided which shunts the major portion of the negative biasing branch just traced, and when completed maintains the control electrode 42 at substantially the same potential as the cathode 43. When the second branch is complete, the discharge device 40 conducts sufficient current to energize relay 45 and cause engagement of switch arm 47 with contact 48. This second branch may be traced from cathode 43 through a conductor 61, combustion responsive switch 33, conductors 62 and 63, limit switch 25, a conductor 64, thermostat 20, a conductor 65 and resistor 60 to control electrode 42.

In this second branch of the input circuit, the combustion responsive switch 33 is connected in parallel with a timing condenser 66 by means of a pair of conductors 67 and 68.

The heater element 44 of discharge device 40 may be supplied with energy from any suitable source. For example, in the system shown, it may be connected to the terminals of transformer secondary winding 17. These connections have been omitted from the drawing for the sake of clarity.

Operation of Figure 1

When the parts are in the position shown in the drawing, the thermostat 20 is satisfied. In other words, it is not calling for operation of the burner motor 10. The bonnet temperature or other limiting condition is below the predetermined limiting value, so that the switch 25 is

closed. No combustion is taking place in the burner. Hence, the last change affecting the combustion responsive switch 33 was a drop in temperature, and the switch arm 34 is therefore separated from the contact 35. Let it be assumed that the system has been energized for a length of time sufficient for the heater element 44 to heat the cathode 43 to its operating temperature.

Under these conditions, the discharge device 40 is substantially non-conductive, since the control electrode 42 is biased negatively by means of the negative biasing branch of the input circuit, previously traced. The statement that the discharge device 40 is substantially non-conductive means merely that the current flowing in its output circuit is insufficient to operatively energize relay 45.

Let it be assumed that the temperature to which the thermostat 20 is exposed now falls, causing switch arm 22 to move into engagement with contact 23. This completes the second branch of the input circuit and shunts biasing resistor 53 and its associated parallel by-pass condenser 54 from the output circuit of the discharge device 40. This shunt connection may be traced from the cathode 43 through conductor 68, condenser 66, conductors 67 and 63, limit switch 25, conductor 64, contact 23, switch arm 22, bimetallic element 21, conductors 65 and 57, and variable resistance 56 to conductor 55. When this connection is first completed, the condenser 66 is substantially uncharged so that no potential difference exists across its terminals. To this end the condenser 66 may desirably be shunted by a resistance 66a of suitably high value. Therefore, the potential of control electrode 42 is almost the same as that of cathode 43 and the discharge device 40 becomes conductive. Current flowing through the output circuit of discharge device 40 energizes relay 45, thereby moving the switch arm 47 into engagement with stationary contact 48.

This operation of relay 45 completes an energizing circuit for burner motor 10 and igniter 11, which may be traced from power supply line 12 through a conductor 70, burner motor 10 and igniter 11 in parallel, a conductor 71, switch arm 47, contact 48, and a conductor 72 to power supply line 13.

As soon as the connection through condenser 66 is completed, the intermittent unidirectional flow of current through it tends to build up a potential on its plates. The polarity of this potential is such that the plate connected to the cathode is positive with respect to the plate connected to the control electrode 42. Each half cycle during which the discharge device 40 is conductive adds a small amount to the charge of the plates of condenser 66. The charge on condenser 66 therefore gradually increases, and as it increases the potential of control electrode 42 becomes more and more negative with respect to the potential of cathode 43. As the potential of control electrode 42 becomes more negative, the current flow in the output circuit of discharge device 40 becomes less, due to the well known characteristics of such discharge devices. When the potential across condenser 66 reaches a critical value, depending upon the characteristic of the discharge device 40, the output current of the device 40 is reduced to a point where it is no longer sufficient to maintain the energization of relay 45. When the current through winding 46 falls to this low value, switch arm 47 drops away from contact 48, thereby deenergizing motor 10.

The period of time necessary to charge condenser 66 to its critical value, and thereby cut off operation of the burner motor 10, may be determined by adjustment of the variable resistor 56. During the alternate half cycles when the condenser 66 is not being charged by the flow of current through the discharge device 40, the charge on its plates is slowly leaking off through a circuit which may be traced from the right-hand terminal of condenser 66 through conductors 68 and 52, resistance 53, conductor 55, variable resistor 56, conductors 57 and 65, thermostat 20, conductor 64, limit switch 25, and conductors 63 and 67 to the left-hand terminal of condenser 66. It may be seen, that as the value of variable resistance 56 is reduced, a greater proportion of the charge on the condenser 66 leaks off during the alternate half cycle when it is not being charged. Therefore, as the value of variable resistance 56 is reduced, the period of time necessary to build the charge on condenser 66 up to the point where it will cause deenergization of relay 25, is increased.

The variable resistance 56 is adjusted so that the period of time needed to charge condenser 66 is somewhat longer than the time required by the combustion responsive switch 33 to close its contacts following the appearance of a flame at the burner. Therefore, under normal conditions, combustion responsive switch 33 will close due to the presence of the burner flame before the condenser 66 has charged sufficiently to cause deenergization of relay 45. As soon as the combustion responsive switch closes, it shunts the condenser 66, thereby removing the condenser from any further control of the discharge device 40. The burner motor 10 and the igniter 11 will therefore remain energized until the thermostat 20 again becomes satisfied and opens its contacts. Opening of the limit switch 25 or of the combustion responsive switch 33 will also cause deenergization of the system.

The resistance 66a is provided to insure that the condenser 66 will be in a completely discharged condition when the thermostat 20 closes its contacts. If the condenser 66 had an initial charge when the thermostat 20 called for heat, it can readily be seen that the charging time of the condenser would be affected thereby. If the polarity of the charge was such that the left hand plate of condenser 66 was negative, the charging time would be shortened, and the relay 45 might be deenergized before the combustion responsive switch 33 closed. This would effectively prevent the burner from operating. The resistance 66a may desirably be made ten times as large as resistance 56, in order that its effect on the charging time of condenser 66 will be small as compared with that of resistance 56.

An initial negative charge having the undesirable effect mentioned might occur, if resistance 66a were not used, in various ways. For example, if, shortly after a call for heat by thermostat 20, and before closure of switch 33, the thermostat should be manually adjusted to operate at a lower temperature, the charge on the plates of condenser 66 might remain there until the next call for heat, thereby shortening the starting period.

A switch 66b is provided which may shunt the condenser 66. This switch 66b is normally open and may be manually closed, for example, by means of a push button. The switch 66b is provided in order that the burner may be started after it has shut down due to charging of condenser 66 during an attempt to start automati-

cally. It is only necessary to close the switch 66b momentarily in order to discharge condenser 66 completely. This returns the circuit to its normal condition, and allows a new starting period to begin.

A normally closed push button switch might be placed in conductor 63 or 64 in lieu of switch 66b. It would be necessary, in using such a switch, to hold it open long enough for condenser 66 to discharge through resistor 66a.

Figure 2

Figure 2 discloses a modification of our invention wherein a different type of combustion responsive device is employed, and wherein a different arrangement is used for adjusting the length of the starting period of the system. All elements in the circuit of Figure 2 which correspond exactly to elements in the circuit of Figure 1 have been given the same reference numerals, and will not be further described.

In Figure 2, the combustion responsive switch 33 of Figure 1 has been removed. In its place, conductor 61 is connected to the metallic structure of the burner 36, and the conductor 62 has been connected to an electrode 37 mounted in a position so that it operatively engages the flame of the burner 36. Since it is well known that flames are electrically conductive, it will be apparent that as soon as a flame appears at the burner, the timing condenser will be shunted sufficiently so that it cannot charge to a point where it will cause deenergization of relay 45.

The variable resistance 56 of Figure 1 has been replaced by a fixed resistance 58 in Figure 2, and the condenser 66 of Figure 1 has been replaced by a variable condenser 69 in Figure 2. It will be readily understood that the time necessary to charge condenser 69 may be controlled by varying its capacitance just as easily as it may be controlled by varying a resistance connected in circuit with it.

The operation of the circuit shown in Figure 2 is entirely analogous to the operation of the circuit in Figure 1. It will not therefore be further described.

It should be apparent from the preceding description that we have provided a burner control circuit in which the timing arrangement is considerably simplified over the devices of the prior art. Furthermore, since all the condition responsive controls are connected in the input circuit of an electrical discharge device, the current flowing through their contacts is substantially negligible. There is therefore no possibility of arcing or corrosion at the contacts such as is sometimes encountered in burner control circuits of the prior art.

While we have shown and described preferred embodiments of our invention, it will be readily understood that various modifications will suggest themselves to those skilled in the art. It is therefore our intention that the scope of our invention is to be limited only by the appended claims.

We claim as our invention:

1. A control system for a fluid fuel burner comprising in combination, a relay controlling the operation of said burner, an electric discharge device having an input circuit and an output circuit, a source of electrical energy, means connecting said output circuit, said source, and said relay, means for biasing said input circuit so as to hold the current in said output circuit below the value necessary to energize said relay, a con-

trol device for initiating operation of said burner, a condenser, means including said control device for connecting said condenser in said input circuit so that the charging current of said condenser opposes said biasing means for a predetermined time, thereby permitting the current in the output circuit to rise above the value necessary to energize said relay, and means responsive only to the presence of a flame at said burner for shunting said condenser so as to maintain said output current above said value.

2. In a control system for a fluid fuel burner, in combination, means for supplying fuel to said burner, an electrical network including a condenser in a branch thereof, means including a device responsive to a condition indicative of the need for operation of said burner for completing a circuit in said network, said circuit including said condenser in series, means responsive to a flame at said burner for shunting said condenser in said circuit, and means in said network responsive to the flow of current in said circuit for operatively energizing said fuel supply means.

3. In a control system for a fluid fuel burner, in combination, means for supplying fuel to said burner, control means for said fuel supply means including an electric discharge device having an input circuit and an output circuit, said control means being effective to operate said fuel supply means when said discharge device is conductive and to stop operation of said fuel supply means when said discharge device is substantially non-conductive, said input circuit including a first connection for maintaining said discharge device substantially non-conductive and a second connection adapted, upon the occurrence of a current flow therethrough, to overcome the effect of said first connection and maintain said discharge device conductive, switch means in said second connection for permitting a current flow therethrough, said switch means being responsive to a condition indicative of the need for operation of said burner, a condenser connected in series with said switch means so as to permit a flow of charging current to said condenser through said second connection for a predetermined time after closure of said switch, and means responsive to the presence of a flame at said burner for shunting said condenser.

4. In a control system for a fluid fuel burner, in combination, means for supplying fuel to said burner, control means for said fuel supply means including an electric discharge device having an input circuit and an output circuit, said control means being effective to operate said fuel supply means when said discharge device is conductive and to stop operation of said fuel supply means when said discharge device is substantially non-conductive, and means for controlling the conductivity of said discharge device, comprising a sensitive switching device responsive to a condition indicative of the need for operation of said burner connected in series with a parallel group including a condenser and a device for completing a shunt circuit around said condenser in response to the presence of flame at said burner.

5. A system for controlling the temperature in a space, comprising in combination, a fluid fuel burner, means for supplying fuel to said burner, control means for said fuel supply means including an electric discharge device having an input circuit and an output circuit, said control means being effective to operate said fuel supply means when said discharge device is conductive and to stop operation of said fuel supply means when

said discharge device is substantially non-conductive, and means in said input circuit for controlling the conductivity of said discharge device including a thermostatic switch responsive to the temperature in said space connected in series with a parallel group comprising a condenser and a device for completing a shunt circuit around said condenser in response to the presence of a flame at said burner.

6. A system for controlling the temperature in a space comprising in combination, a fluid fuel burner, means for supplying fuel to said burner, control means for said fuel supply means including an electric discharge device having an input circuit and an output circuit, said control means being effective to operate said fuel supply means when said discharge device is conductive and to stop operation of said fuel supply means when said discharge device is substantially non-conductive, and means in said input circuit for controlling the conductivity of said discharge device including a thermostatic switch responsive to the temperature in said space and a switch responsive to a limiting condition connected in series with a parallel group comprising a condenser and a device for completing a shunt circuit around said condenser in response to the presence of a flame at said burner.

7. A safety control system for apparatus normally operable when energized to establish a predetermined condition, comprising in combination, an electric discharge device having an input circuit and an output circuit, a source of electrical energy, means connecting said output circuit, said source, and said apparatus, means for biasing said input circuit so as to hold the current in said output circuit below the value necessary to energize said apparatus, control means for initiating operation of said apparatus, a condenser, means including said control means for connecting said condenser in said input circuit so that the charging current of said condenser opposes said biasing means for a predetermined time, thereby permitting the current in the output circuit to rise above the value necessary to energize said apparatus, and means responsive to the establishment of said predetermined condition for shunting said condenser so as to maintain said output current above said value.

8. In a safety control system for apparatus normally operable when energized to establish a predetermined condition, in combination, means including an electric discharge device for controlling said apparatus so that said apparatus is energized only when said device is conductive, means responsive to a condition indicative of the need for operation of said device in its active sense for operating said control means, means including a condenser in the input circuit of said discharge device for maintaining conductivity thereof for a predetermined time following a call for operation by said condition responsive means, and means responsive to the establishment of said predetermined condition for shunting said condenser so as to maintain conductivity of said discharge device.

9. A control system for an electrically operated device including an electric discharge device having an anode, a cathode and a control electrode, means for maintaining said cathode in a continually heated condition, means for continually impressing a voltage across said anode and cathode, a relay responsive to the current flow through said discharge device for initiating operation of said electrically operated device, means

for normally biasing said control electrode so that the current flow through said relay is inadequate to energize said relay, means including a condition responsive device for rendering said previously named biasing means ineffective and for producing a further biasing voltage on said control electrode at a predetermined rate so that after a predetermined time delay a lowering of current flowing through said discharge device to a predetermined value will cause said electrically operated device to be deenergized, and means responsive to a predetermined normal condition of operation of said electrically operated device for overcoming said further biasing voltage so that said electrically operated device will remain energized when said predetermined normal condition of operation obtains before the expiration of said predetermined time delay.

10. In a burner control system, a relay for controlling the flow of fuel to a burner, means for controlling the energization of said relay, said means including an electric discharge device having an anode, a cathode and a control electrode, means for impressing a voltage across said anode and cathode, means including a condition responsive device for controlling said electric discharge device to effect current flow therethrough and through said relay, a condenser connected in series with said condition responsive device for producing a biasing voltage on said control electrode at a predetermined rate so that after a predetermined time delay a lowering of current flowing through said discharge device to a predetermined value will cause said relay to be deenergized, and means responsive to the establishment of combustion for discharging said condenser so that said relay will remain energized when combustion occurs before the expiration of said predetermined time delay.

11. In apparatus for controlling a fluid fuel burner, a relay adapted to be employed for controlling a burner, an electronic discharge device having input and output terminals, means for employing electrical energy to said apparatus, an output circuit for said discharge device including said energy supplying means, said relay, and

said output terminals of said discharge device, means for applying to said input terminals a biasing voltage of such magnitude as to hold the current in said output circuit below the value necessary to energize said relay, a condenser, and connections between said condenser and said input terminals adapted to include a control switch, said connections being effective when completed by said control switch to cause charging of said condenser and to oppose said biasing voltage during the time said condenser is charging, thereby permitting the current in the output circuit to rise above the value necessary to energize said relay, and connections adapted when completed to include means responsive to the presence of a burner flame and effective when completed and upon the occurrence of a flame to shunt said condenser so as to maintain said output current above said value.

12. In apparatus for controlling a fluid fuel burner, a relay adapted to be employed for controlling a burner, an electronic discharge device for controlling the energization of said relay, said device having an anode, a cathode and a control electrode, means for impressing a voltage across said anode and cathode, means for controlling said electric discharge device to effect current flow therethrough and through said relay, a condenser, connections from said condenser adapted to be connected to a condition responsive device and being effective when connected to such a condition responsive device to produce a biasing voltage on said control electrode at a predetermined rate so that after a predetermined time delay a lowering of current flowing through said discharge device to a predetermined value will cause said relay to be deenergized, and further connections adapted when completed to include means responsive to the presence of combustion and effective when completed and upon the occurrence of a flame to discharge said condenser so that said relay will remain energized when combustion occurs before the expiration of said predetermined time delay.

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