

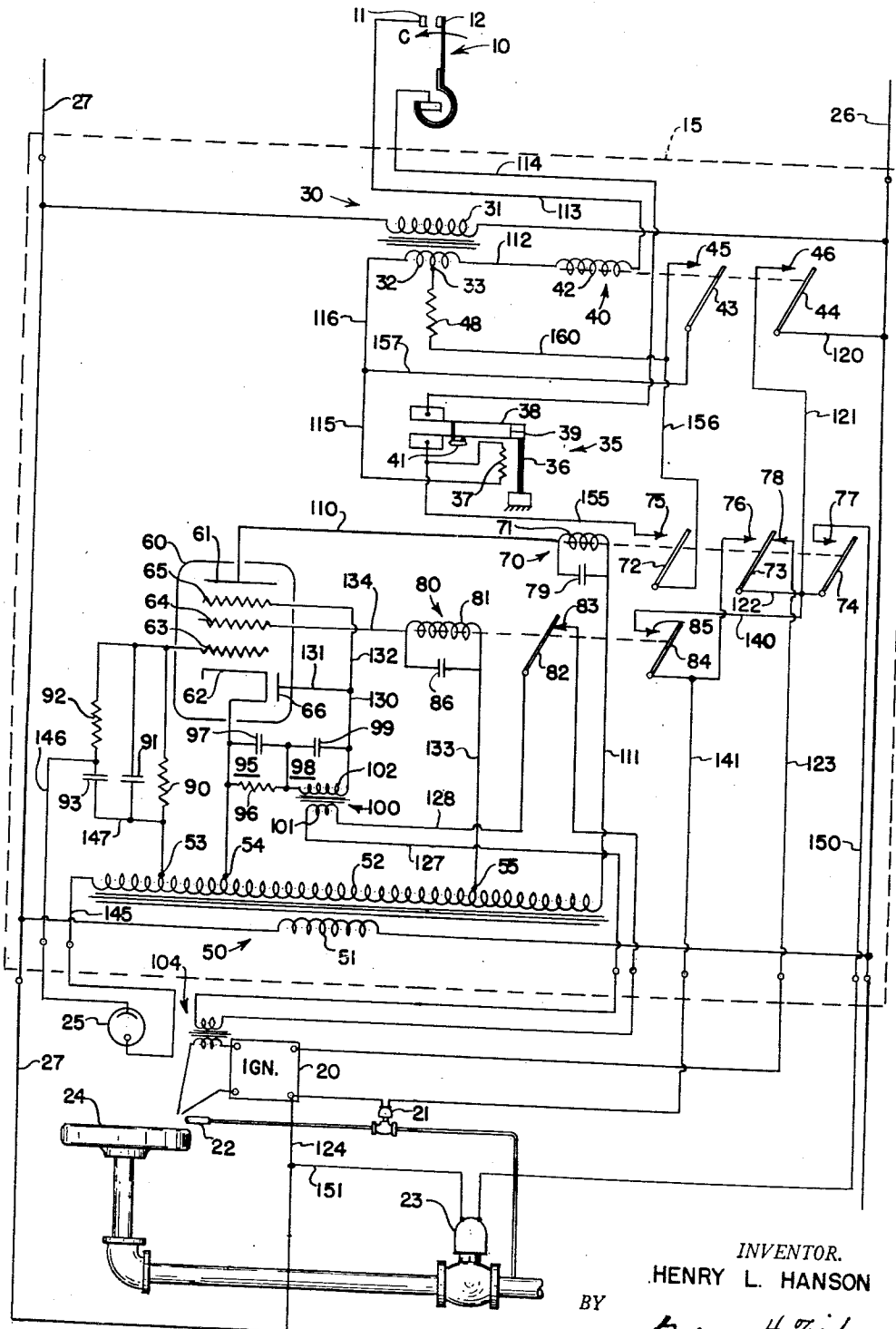
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BURNER CONTROL APPARATUS

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BURNER CONTROL APPARATUS

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The present invention is concerned with a new and improved burner control apparatus. More particularly this invention is directed to the provision of a combined burner ignition and flame detection apparatus arranged to insure maximum safety of operation of a controlled fuel burner.

In present day burner controls used with burners having igniting means and fuel flow controlling means it is often necessary that there be provided a control apparatus for checking separately each function of the fuel burner and its flame initiating means. It is also desirable to check the control apparatus itself to see that the burner is not brought into operation unless the control apparatus is functioning in the desired manner.

It is therefore an object of the present invention to provide a new and improved burner control apparatus for checking ignition and flame at a controlled fuel burner.

Another object of the present invention is to provide a new and improved burner control apparatus having ignition and flame detecting means combined in a single unit.

Still another object of the present invention is to provide a burner control apparatus having an ignition checking means which is effective in the absence of the detection of flame to periodically check the presence of ignition.

A further object of the present invention is to provide an electronic control circuit with an electron discharge device having a plurality of anode, cathode and grid electrodes with relays in circuit with at least two of those electrodes and each controlled by different signal voltages applied to two other of said electrodes.

A still further object of the present invention is to provide a burner control apparatus having ignition checking means which periodically checks the presence of ignition in the absence of a burner flame and then shuts down completely the controlled burner if after the ignition check has been made a number of times no flame is detected.

These and other objects of the present invention will be understood upon considering the following specification, the attached drawing, and the appended claims.

Referring to the single figure, which is a wiring diagram of the apparatus, the numeral 10 represents a thermostatic device of any desired type which will indicate when there is a need for burner operation. This thermostatic device 10 comprises a pair of switch contacts 11 and 12

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which are adapted to complete appropriate electrical circuits in the control apparatus of the present invention which is located within the housing indicated generally by the numeral 15.

The control circuits within the housing 15 are effective to energize an ignition device 20, a pilot valve 21 which controls the flow of fuel to a pilot burner 22 and a main valve 23 which controls the flow of fuel to a main burner 24. For detecting the presence of a flame at the pilot burner and at the main burner a photoelectric device 25 is provided although it is to be understood that other types of flame responsive means can be employed, such as flame rods.

Supplying power to the low voltage circuits controlled by the thermostatic device 10 within the housing 15 is a transformer 30 having a primary 31 and a secondary 32 tapped at 33. In circuit with the secondary 32 is a safety switch device 35 and a control relay 40. Safety switch device 35 comprises a bimetallic element 36, a heater 37 therefor, a pair of switch contacts 38 and 39 normally held in engagement by bimetal 36, and a reset actuator 41. The relay 40 comprises a relay winding 42, and a pair of switch blades 43 and 44 normally biased out of engagement with a pair of associated contacts 45 and 46. Connected to the tap 33 of secondary 32 is a current limiting resistor 48.

Supplying power to the detecting portion of the apparatus is a transformer 50 having a primary winding 51 and a secondary winding 52 which is tapped at 53, 54 and 55. Connected in energizing relation to this secondary winding 52 is an electron discharge device 60 having an anode 61, cathode 62, and grid elements or electrodes 63, 64 and 65. Also associated with the cathode 62 is an anode 66 which cooperates with the cathode 62 to form a diode rectifier. Connected in circuit with the anode 61 is a control relay 70 having a relay winding 71, and switch blades 72, 73 and 74 which are normally biased out of engagement with associated switch contacts 75, 76, and 77. The switch blade 73 is normally biased into engagement with a further contact 78. A condenser 79 is connected in parallel with the relay winding 71 to function in the normal manner to bypass alternating current flowing in the relay circuit. Connected in circuit with the grid electrode 64 is a further relay 80 having a relay winding 81, a switch blade 82 normally biased into engagement with a contact 83 and a switch blade 84 normally biased out of an engagement with a contact 85. A condenser 86 is connected in parallel with the relay winding 81

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and functions to by-pass alternating current flowing in the relay circuit.

Connected to the grid 63 is a grid resistor 90 having a filter condenser 91 connected in parallel therewith. A grid current limiting resistor 92 is also connected to the grid 63 and this resistor 92 with a further condenser 93 are connected in series parallel relationship with condenser 91. A filter network 95 is associated with the anode 66 and comprises a resistor 96 and a condenser 97. Also associated with this anode 66 is a tuned resonant circuit 98 comprising a condenser 99 and a transformer 100 having a primary 101, which is energized by a selected harmonic frequency arising in ignition device 20, and a secondary 102. The harmonics may, for example, be coupled from the ignition device 20 by means of a current type of pickup transformer 104 which has one winding in series with one of the ignition electrodes.

Operation

The apparatus as shown in the drawing is in the completely shut down position. When in this condition the thermostatic device 10 will be open circuited and the control relays 40, 70, and 80, will all be deenergized. With the control relays deenergized the burner apparatus including the ignition device 20, pilot valve 21, and main valve 23 will also be deenergized so that there will be no flame present at the pilot burner 22 or at the main burner 24. When there is no flame present at either of the two burners the control discharge device 60 will have a bias thereon which will maintain the current flow through the discharge device sufficiently low that neither of the relays 70 nor 80 can become energized. The source of biasing voltage for the discharge device 60 is obtained from the secondary winding 52. With the control grid 63 connected through resistor 90 to tap 53, with the cathode 62 connected to tap 54 of secondary 52 and with the anode 61 connected to the right-hand terminal of secondary 52 through conductor 110, relay 71, and conductor 111, there will be an A. C. bias which is negatively phased applied to the control grid whenever the right-hand terminal of secondary 52 is phased positive with respect to the left-hand terminal. While the current that does flow is insufficient to energize either of the relays 70 or 80, there will be some current flow in the circuit when the anode is phased positive with respect to the cathode.

As soon as there is a demand for operation of the burner due to a drop in space temperature to some predetermined value, the thermostatic device 10 will operate to close the contacts 11 and 12. The closing of these contacts will effect the energization of the relay 40 in a circuit that may be traced from the right-hand terminal of secondary 32 through conductor 112, relay winding 42, conductor 113, switch contacts 11 and 12, conductor 114, safety switch contacts 38 and 39, safety switch heater 37, and conductors 115 and 116 back to the left-hand terminal of secondary 32. With this energizing circuit for relay 40 completed the relay winding will move the switch blades 43 and 44 into engagement with their associated switch contacts 45 and 45 respectively. When switch blade 43 engages contact 45 a circuit is completed from the lower end of resistor 43 through the switch contact 45, switch blade 43, and conductor 113 to the left-hand terminal of secondary 32. This connection will have no immediate effect upon the operation of the ap-

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paratus. When switch blade 44 engages switch contact 46 an energizing circuit is completed to the ignition device 20. This circuit may be traced from the input power line 26 through conductor 120, switch blade 44, switch contact 46, conductor 121, conductor 122, switch blade 73, switch contact 76, conductor 123, ignition device 20, and conductor 124 to the other input power line 27.

If the ignition device 20 is operating properly there will be considerable harmonics present at the device and these harmonics are coupled to the tank circuit 98 by a pair of conductors 127 and 128. With the tank circuit 98 tuned to a pre-selected harmonic of the ignition frequency there will be a relatively high voltage across the terminals thereof and this voltage will be rectified by the action of anode 66 cooperating with cathode 62 in a circuit that may be traced from the right-hand end of the tank circuit 98 through the conductors 130 and 131, anode 66, cathode 62, resistor 96, back to the left-hand end of the tank circuit 98. With the voltage on the tank circuit rectified there will be a relatively high negative voltage appearing on the right-hand terminal of the tank circuit 98 and this negative voltage will also be applied to the grid 65 through the conductors 130 and 132. With a negative voltage applied to the grid 65 there will be an increase in the current which normally flows in the circuit which includes the grid 64. This current flow circuit may be traced from the secondary 52, assuming the right-hand terminal thereof is positive with respect to the left-hand terminal, from tap 55, through conductor 133, relay coil 81, conductor 134, grid 64, cathode 62, to tap 54 on secondary 52. If the voltage on grid 65 is sufficiently negative the electrons which were previously flowing to the anode 61 are effectively driven back toward the cathode and are collected by the grid 64 so that the grid current will increase to a point where the relay 80 will be energized.

When the relay 80 becomes energized the switch blade 82 will move out of engagement with the associated switch contact 83 so that the circuit to the harmonic tank circuit 98 will be broken. This will have no immediate effect upon the apparatus because of the fact that the condenser 97 will have been charged at the same time that the current was flowing through the resistor 96 and the charge on this condenser 97 will remain for a length of time dependent upon the size of the condenser and the resistor 96. Also actuated when the relay 80 becomes energized is a switch blade 84 which moves into engagement with the switch contact 85. This latter switching operation effects energization of the pilot valve 21 and this energizing circuit may be traced from the input power line 26 through conductor 120, switch blade 44, switch contact 46, conductor 121, conductor 143, switch contact 85, switch blade 84, conductor 141, pilot valve 21, and conductor 124 back to the other input power line 27. When the pilot valve 21 becomes energized fuel will flow to the pilot burner 22 and will be ignited by spark electrodes of the ignition device 25.

As soon as a flame appears at the pilot burner 22 this flame will be detected by the photocell 25 which will be effective to place a direct current charge on the condenser 53. The charging circuit for condenser 53 may be traced from the left-hand terminal of secondary 52 through conductor 145, photocell 25, conductor 143, condenser

93, and conductor 147 back to the tap 53 on secondary 52. The photocell or photoelectric device 25 is of the type which passes current in only one direction and therefore the current flow will be effective to charge the condenser 93. The charge on the condenser 93 will be such that its upper terminal will be positive and its lower terminal negative. Inasmuch as the upper terminal is positive the positive voltage will be applied to the control grid 63 by way of resistor 92. This positive voltage on the condenser 93 at its upper terminal will be sufficient to overcome the negative bias applied to the control grid 63 by reason of the connection of the control grid to tap 53 and the cathode 62 connected to tap 54. With this positive voltage applied to the control grid 63 the current flow in the tube 60 will be increased sufficiently to a point where the control relay 70 is energized. As soon as the control relay 70 becomes energized the switch blades 72, 73 and 74 move into engagement with the respective switch contacts 75, 76, and 77. When the contact 74 engages contact 77 an energizing circuit is completed to the main valve 23. This circuit may be traced from the input power line 26 through conductor 120, switch blade 44, switch contact 46, conductor 121, switch blade 74, switch contact 77, conductor 150, main valve 23, and conductor 151 to the other input power line 27. As soon as the main valve becomes energized the valve will open and fuel will flow to the main burner 24.

Upon the switch blade 73 engaging contact 76 a holding circuit is established to the pilot valve 21 which is independent of the operation of the relay 80. This holding circuit may be traced from the input power line 26 through conductor 120, switch blade 44, switch contact 46, conductor 121, conductor 122, switch blade 73, switch contact 76, conductor 141, pilot valve 21, and conductor 124 back to the other input power line 27. When the blade 73 engages the contact 76 it broke the circuit through the contact 78 and this caused the deenergization of the ignition device 20. With the ignition device no longer energized there is no possibility of any harmonic frequencies appearing in the resonant network 98 and so there will be no effective biasing voltage applied to the grid 65. However, inasmuch as there is a positive voltage applied to the control grid 63 there will be a relatively large amount of current flowing through the tube and there will be current flowing in the circuit which includes the grid 64 and relay 80. This current is normally sufficient to maintain the relay energized. However, in view of the fact that this operation is marginal it is necessary that the pilot valve circuit, first completed through the circuits of the relay 80, be maintained energized by the flame detection relay 70.

When the switch blade 72 engages contact 75 a holding circuit is established for the control relay 40 which is independent of the safety switch device 35. This holding circuit may be traced from the right-hand terminal of the secondary 32 through conductor 112, relay winding 42, conductor 113, switch contacts 11 and 12, conductor 114, switch contacts 38 and 39, conductor 155, switch contact 75, switch blade 72, conductor 156, switch contact 45, switch blade 43 and conductors 157 and 116 back to the left-hand terminal of secondary 32. With this holding circuit completed independent of the heater 37 of the safety switch device 35 the heater will no longer be energized and will not attempt to warp the bimetal

from its normal position where it holds the contacts 38 and 39 in engagement.

The apparatus as described thus far is now in the normally operative position with the thermostatic device 10 still indicating a need for burner operation, the ignition device 20 deenergized and the main and pilot valves 23 and 21 both energized to supply fuel to their respective burners. The apparatus will stay in this condition until such time as there is no longer a demand for burner operation.

As soon as the thermostatic device 10 is satisfied the contacts 11 and 12 will be open circuited. This will cause the immediate deenergization of the relay 40. When the relay 40 becomes deenergized the switch blade 44 moves out of engagement with associated contact 46 and this will effect the deenergization of both the main and pilot valves 23 and 21 as the energizing circuits for these valves is completed through this switch blade and contact. As soon as flame is no longer present at the pilot burner 22 and the main burner 24, there is no longer a flame to be detected by the photoelectric device 25 and the charge on the condenser 93 will leak off. The discharge circuit which may be traced from the upper terminal of condenser 93 through resistor 92, resistor 90 and conductor 147 back to the lower terminal of condenser 93. When the condenser has discharged sufficiently the control electrode 63 will have a potential which will maintain the current flow through the discharge device 60 below that value necessary to maintain either of the relays 70 or 80 energized. Thus, both relays 70 and 80 are moved to the deenergized position as they are shown upon the drawing and the apparatus will be in the completely shut down position ready for another operation when the need is indicated by the thermostatic device 10.

Operation upon ignition failure

In the event that there should be a failure of operation of ignition device 20 it is desired that the present apparatus not cause any fuel to flow to either the pilot or main burners and that if ignition is not established within a predetermined time that the apparatus shut down. Assume that the thermostatic device 10 has just indicated a need for burner operation and the control relay 40 is energized to complete an energizing circuit to the ignition device 20 through the switch blade 44 and contact 46. If the ignition device is not operating properly there will be no harmonics arising in the ignition circuit and this will result in no voltage being applied to the resonant circuit 98 associated with the ignition checking circuit. When there is no voltage applied to the resonant circuit and the control electrode 63 has only the alternating current from secondary 62 applied thereto the current flow to the discharge device 60 will be insufficient to energize relay 80.

It will be noted that the energizing circuit for the relay 40 is still being completed through the safety switch heater 37 in a circuit that may be traced from the right-hand terminal of secondary 32 through conductor 112, relay winding 42, conductor 113, switch contacts 11 and 12, conductor 114, switch contacts 38 and 39, safety switch heater 37, and conductor 115 and 116 back to the left-hand terminal of secondary 32. If this last traced circuit remains in tact for a sufficient length of time the heater 37 will warp the bimetal 36 to the right and the contacts 38 and 39 will separate to break the energizing circuit

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for the control relay 40. When the relay 40 becomes deenergized the switch blade 44 will move out of engagement with contact 46 and the ignition device 20 will become deenergized. The apparatus will remain deenergized until such time as the safety switch device 35 is manually reset by pressing the reset button 41 to effect a closing of the contacts 38 and 39. As soon as this is done the apparatus will attempt to start in the normal manner by first checking the operation of the ignition device 20. If the fault has still not been removed the apparatus will again be shut down by the safety switch heater 37 warping the bimetal 36 to the right and again opening the energizing circuit to the relay 40.

Operation upon failure to establish combustion

If the ignition device 20 should be operating properly but flame is not established at the pilot burner 22 the present apparatus will periodically check the ignition operation a number of times and if combustion is not established the apparatus will be completely shut down. Assume again that the thermostatic device 10 has just closed to indicate a need for burner operation. As under starting conditions with normal operation the relay 40 will become energized and the contacts 44 and 46 will close to complete the energizing circuit to the ignition device 20. Assume that there is proper ignition and that the harmonics therefrom are coupled into the resonant tank circuit 98 and a voltage is developed across this tank circuit and across the condenser 97 which is effective to apply a negative voltage to the grid 65. With this negative voltage appearing on grid 65 the current flow in the grid circuit 64 and relay 80 will increase sufficiently to energize the relay 80. When the relay 80 becomes energized the energizing circuit to the pilot valve is completed by the closing of the switch blade 84 with contact 85. If there should be no flame established at the pilot burner 22 within a predetermined time the apparatus will shut off the pilot valve 21 and again check to see if the ignition device 20 is operating properly. This operation will be understood when it is noted that when the relay 80 becomes energized, the switch blade 82 moves out of engagement with contact 83 to open the energizing circuit to the harmonic tank circuit 98. When no signal is applied to the tank circuit 98, the condenser 99 will discharge effectively immediately through secondary 102 and the condenser 97 will discharge through the resistor 96. The length of time that it takes for the condenser 97 to discharge through the resistor 96 will determine the length of time that the relay 80 will be energized without a further voltage being applied to the harmonic network 98. Thus, after the condenser 97 has discharged the potential on grid 65 will drop and the relay 80 will become deenergized. When the relay becomes deenergized the switch blade 84 will move out of engagement with contact 85 and will deenergize the pilot valve, and the switch blade 82 will engage contact 83 to again complete the energizing circuit to the tank circuit 98. When the energizing circuit to the tank 98 is again completed a check will be made to see if the ignition device 20 is operating properly and if it is a voltage will be built up across the tank circuit and the condenser 97 which will again bias the electrode 65 in a negative direction to effect energization of the relay 80. When the relay again becomes energized the pilot valve 21 will again

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be energized and a further attempt will be made to establish combustion at the pilot burner 22.

If flame is still not established at the pilot burner 22 the apparatus will again shut down to check the operation of the ignition device and this process will continue for a number of times until such time as the heater 37 associated with the safety switch device 35 warps the bimetal 36 toward the right and opens the contacts 38 and 39. The opening of the contacts 38 and 39 will cause deenergization of the control relay 40 and a complete shut down of the apparatus will result until such time as the reset device 41 is again actuated.

Thus it will be seen that the apparatus will check the ignition and if there is ignition the pilot valve will be opened. If no flame is established the apparatus will again check the ignition and if still operating properly a further attempt will be made to establish combustion at the pilot burner with this checking and igniting attempt being carried on until the safety switch device 35 opens to the energizing circuit to the main control relay 40. This arrangement has the advantage of maintaining the amount of unburned fuel injected into a combustion chamber at a minimum when there is no flame present to consume this fuel.

As soon as the fault causing the failure of combustion at the pilot burner has been cleared the apparatus will start in the normal manner as described above.

If there should be a failure of combustion during normal operation, the flame detection relay 70 will become deenergized and will reconnect the ignition device 20 into an energizing circuit. If combustion is not established within a predetermined time the safety cut off device will be effective to shut down the apparatus. During the period between the flame failure and the shut down by the safety switch 35 the apparatus will periodically check the operation of the ignition device 20 as explained above and if the ignition device 20 fails for any reason the pilot valve will be retained in the deenergized position so that no further fuel can be fed into the combustion chamber.

Component checking features

In the operation considered thus far the apparatus within the housing 15 has been considered to be operating properly. If, for any reason, the apparatus was not operating properly, and such lack of operation is apt to create an unsafe condition, it is desired that the apparatus be shut down.

One function where it would be desirable to maintain the apparatus inoperative would be where there is an open or a short circuit condition existing at the photoelectric device 25. In the event there is an open or a short circuit in the photocell circuit there will be no rectification present and it will be impossible for the condenser 93 to charge to attempt to establish an effective control signal on the grid 63 for causing energization of the relay 70. Further, with a short circuit condition existing at the photoelectric device 25 the grid 63 would be effectively connected to the left-hand terminal of the secondary 52 by a connection through the resistor 92, conductor 146, photo-electric device 25, and conductor 145. This would have the effect of applying a further negatively phased biasing voltage to the control grid 63 which would limit even more the flow of current

through the discharge device 60. With the relay 70 deenergized for a predetermined length of time, with the relay 40 energized, the safety switch device 35 will become effective to shut the entire apparatus down.

In the event that the flame detection relay should stick in the operating position with the switch blade 72 engaging contact 75 an energizing circuit will be completed to the safety switch heater 37 whenever the main control relay 40 is deenergized. This circuit may be traced from the tap 33 on secondary 32 through resistor 48, conductor 160, conductor 156, switch blade 72, contact 75, conductor 155, heater 37, and conductors 115 and 116 back to the left-hand terminal of secondary 32. As soon as the heater has warped the bimetal 36 toward the right the contacts 38 and 39 will open to make it impossible to energize the relay 40 upon a subsequent closing of the thermostatic device 10.

Under these conditions it will be impossible to reset the safety switch device until such time as the fault causing energization of the heater 37 is removed. This will be understood when it is noted that the heater 37, under the assumed circumstances, is energized independently of any relay contacts of relay 40 and the opening of the contacts 38 and 39 does not effect the deenergization of the relay 70. Thus, heater 37 holds bimetal 36 in the warped position. Such an arrangement as this enables the operator to determine whether or not the control apparatus is not functioning properly or whether the controlled burner is not functioning properly. When the apparatus is not functioning the apparatus cannot be put back into operation but when the burner fails the apparatus can be put back into operation by the actuation of the reset actuator 41.

Conclusion

In conclusion it will be noted there has been provided a burner control apparatus with a new and improved circuit which checks the presence of ignition, introduces a minimum of fuel into the burner in the absence of combustion, and which shuts down in the absence of ignition or combustion or upon a component failure within the apparatus. While many modifications will be apparent to those skilled in the art it is to be understood the invention is limited solely by the scope of the appended claims.

I claim as my invention:

1. Burner control apparatus for use with a burner having igniting means, a pilot valve and a main control valve, the combination comprising, a first control relay, a source of power, an energizing circuit for said relay including said source adapted to be completed by means indicating a need for burner operation, means controlled by said first relay arranged to connect the igniting means to said source of power, control means comprising a second relay adapted to respond to the proper operation of said igniting means, said control means arranged to effect operation of the pilot valve, flame responsive means comprising a third relay adapted to respond to a burner and pilot flame, means including said flame responsive means rendering said main valve operative and maintaining the pilot valve operative upon the presence of a pilot flame, timing means connected to said control means for energizing the pilot valve for a number of relatively short periods in the absence of a flame, and further timing means connected in control-

ling relation with respect to said control relay for rendering said relay ineffective after said first named timing means has operated a number of times.

2. Control apparatus, comprising in combination, a source of power, an electron discharge device having an anode, cathode and a plurality of grid electrodes, means connecting said cathode and anode and one of said grid electrodes to said source, a first relay connected in circuit with said anode, a second relay connected in circuit with said one grid electrode, a source of biasing voltage connected to another of said grid electrodes, said last named source when of a predetermined magnitude effecting operation of said second relay, and a control signal source connected to a further of said grid electrodes and effective when of a predetermined magnitude to effect operation of said first relay.

3. Control apparatus, comprising in combination, a source of power, an electron discharge device having an anode, cathode, control grid, screen grid and suppressor grid, means connecting said cathode, said screen grid and said anode to said source, a first relay in the anode connection, a second relay in the screen grid connection, a source of biasing voltage connected to said suppressor grid and effective when of a predetermined magnitude to effect operation of said second relay, and a source of control signal connected to said control grid, said control signal when of a predetermined magnitude effecting operation of said first relay.

4. Control apparatus, comprising in combination, a source of power, an electron discharge device having an anode, cathode, control grid, screen grid and suppressor grid, means connecting said cathode, said screen grid and said anode to said source, a first relay in the anode connection, a second relay in the screen grid connection, a source of biasing voltage connected to said suppressor grid and effective when of a predetermined magnitude to effect operation of said second relay, a source of control signal connected to said control grid, said control signal when of a predetermined magnitude effecting operation of said first relay, and means actuated by said first relay for rendering ineffective said source of biasing voltage.

5. Burner control apparatus for use with a burner having electrical ignition; a relay, electronic means for checking the presence of proper ignition, said means comprising an electrical circuit adapted to be coupled by said relay to an ignition device, rectifying means connected thereto and adapted to produce an output voltage indicative of the presence of electrical ignition, an electron discharge device having a plurality of grid electrodes, means connecting said relay in circuit with one of said grid electrodes, and means connecting another of said electrodes to said rectifying means to control the current flow through said relay; said relay thereby normally controlling said electrical circuit in accordance with the presence or absence of electrical ignition, and flame responsive means connected to render said relay ineffective to respond to the presence or absence of electrical ignition when a burner flame is present.

6. Control apparatus, comprising in combination, a source of power, an electron discharge device having an anode, cathode, control grid, screen grid and suppressor grid, means connecting said cathode, said screen grid and anode to said source, a first relay in the anode connection,

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a second relay in the screen grid connection, a source of biasing voltage connected to said suppressor grid and effective when of a predetermined magnitude to effect operation of said second relay, a source of control signal connected to said control grid, said control signal when of a predetermined magnitude effecting operation of said first relay, and means actuated by said second relay for rendering ineffective said source of biasing voltage.

7. Burner control apparatus, comprising, an electron discharge device having an anode, cathode and a plurality of grid electrodes, a source of power, a first relay connected to said anode, a second relay connected to one of said grid electrodes, means connecting said device to said source of power so that normally the current flowing therethrough is insufficient to operate said first or second relays, a first electrical circuit connected to a second of said grid electrodes and including means effective to apply a voltage thereto upon exposure to a properly operating ignition means, said circuit effecting operation of said second relay when said last named voltage is present, and a second electrical circuit connected to a third of said grid electrodes and including means to apply a voltage thereon indicative of the presence or absence of a burner flame, said second electrical circuit effecting operation of said first relay upon said voltage indicating the presence of flame.

8. Control apparatus, comprising, a source of power, an electron discharge device having an anode, cathode and three grid electrodes, means connecting said device in energizing relation to said source, a first relay connected in circuit with said anode, a second relay connected in circuit with one of said grid electrodes, a first control signal source connected to said device at a second of said grid electrodes to effect operation of said second relay, a second control signal source connected to said device at a third of said grid electrodes to effect operation of said first relay, and circuit means controlled by said second relay for rendering said first source ineffective and said second source effective.

9. Control apparatus, comprising, a source of power, an electron discharge device having an anode, cathode and three grid electrodes, means connecting said device in energizing relation to said source, a first relay connected in circuit with said anode, a second relay connected in circuit with said one of said grid electrodes, a first control signal source connected to said device at a second of said grid electrodes to effect operation of said second relay, a second control signal source connected to said device at a third of said grid electrodes to effect operation of said first relay, and circuit means controlled by said first relay for rendering ineffective said first source.

10. Burner control apparatus, comprising, an electron discharge device having an anode, cathode and a plurality of grid electrodes, a source of power, a first relay connected to said anode, a second relay connected to one of said grid electrodes, means connecting said device to said source of power so that normally the current flowing therethrough is insufficient to operate said first or second relays, a first electrical circuit connected to a second of said grid electrodes and including means effective to apply a voltage thereto upon exposure to a properly operating ignition means, said circuit effecting operation of said second relay when said last named voltage is present, a second electrical circuit con-

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nected to a third of said electrodes and including means to apply a voltage thereon indicative of the presence or absence of a burner flame, said second electrical circuit effecting operation of said first relay upon said voltage indicating the presence of flame, and means connecting said second circuit to said source at a point where said device will be rendered inoperative upon an open or short circuit condition occurring in said second circuit.

11. Burner control apparatus for use with a burner having electrical ignition means, a pilot burner, and fuel flow control means, comprising in combination, an electron discharge device having an anode, cathode, control grid, screen grid and suppressor grid, a source of power, means connecting said cathode, said screen grid and said anode to said source, a first relay in the anode connection adapted when energized to actuate the fuel flow control means, a second relay in the screen grid connection arranged when energized to indicate the presence of electrical ignition, a first control signal source connected to said suppressor grid and having a signal indicative of the presence or absence of electrical ignition, said suppressor grid when a predetermined signal is applied thereto effecting energization of said second relay, means including said second relay for initiating operation of the pilot burner, and a second control signal source connected to said control grid and having a signal thereon indicative of the presence or absence of a burner flame, said control grid effecting operation of said first relay when said second source indicates a burner flame.

12. Burner control apparatus for use with the burner having electrical ignition; a relay, electronic means for checking the presence of proper ignition, said means comprising an electrical circuit adapted to be coupled by said relay to an ignition device, rectifying means connected in said electrical circuit and adapted to produce a direct current output voltage indicative of the establishment of ignition, a capacitor associated with said rectifying means to be charged by the direct current output of said rectifying means, a resistor forming a discharge path for said capacitor, and an electronic discharge device having said relay in circuit therewith and connected to said capacitor to be controlled by the direct current output of said rectifying means so long as said capacitor remains charged; said relay thereby normally controlling said electrical circuit in accordance with the presence or absence of ignition, and flame responsive means connected to render said relay ineffective to respond to the presence or absence of ignition when a burner flame is present.

13. Burner control apparatus for use with a burner having electrical ignition and fuel flow controlling means, comprising; a source of power; a control relay having a first and second position; electrical means, first circuit means controlled by said relay connecting said electrical means to respond to the establishment of electrical ignition when said relay is in said first position, said electrical means adapted to energize said relay by said source when said relay is in said first position and electrical ignition is established to cause said relay to move to said second position and hence to disconnect said electrical means so that said electrical means no longer responds to the establishment of electrical ignition and said relay tends to return to said first position; electrical timing means

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connected in controlling relation to said electrical means to maintain said relay in said second position for a predetermined length of time after the establishment of electrical ignition; second circuit means adapted to control fuel flow controlling means, means including said relay for energizing said second circuit; and combustion responsive means connected to said electrical means and operative upon the establishment of combustion to render said electrical means ineffective to respond to the establishment of electrical ignition.

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