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BURNER CONTROL APPARATUS WITH TIMING MEANS

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Fig. 1.

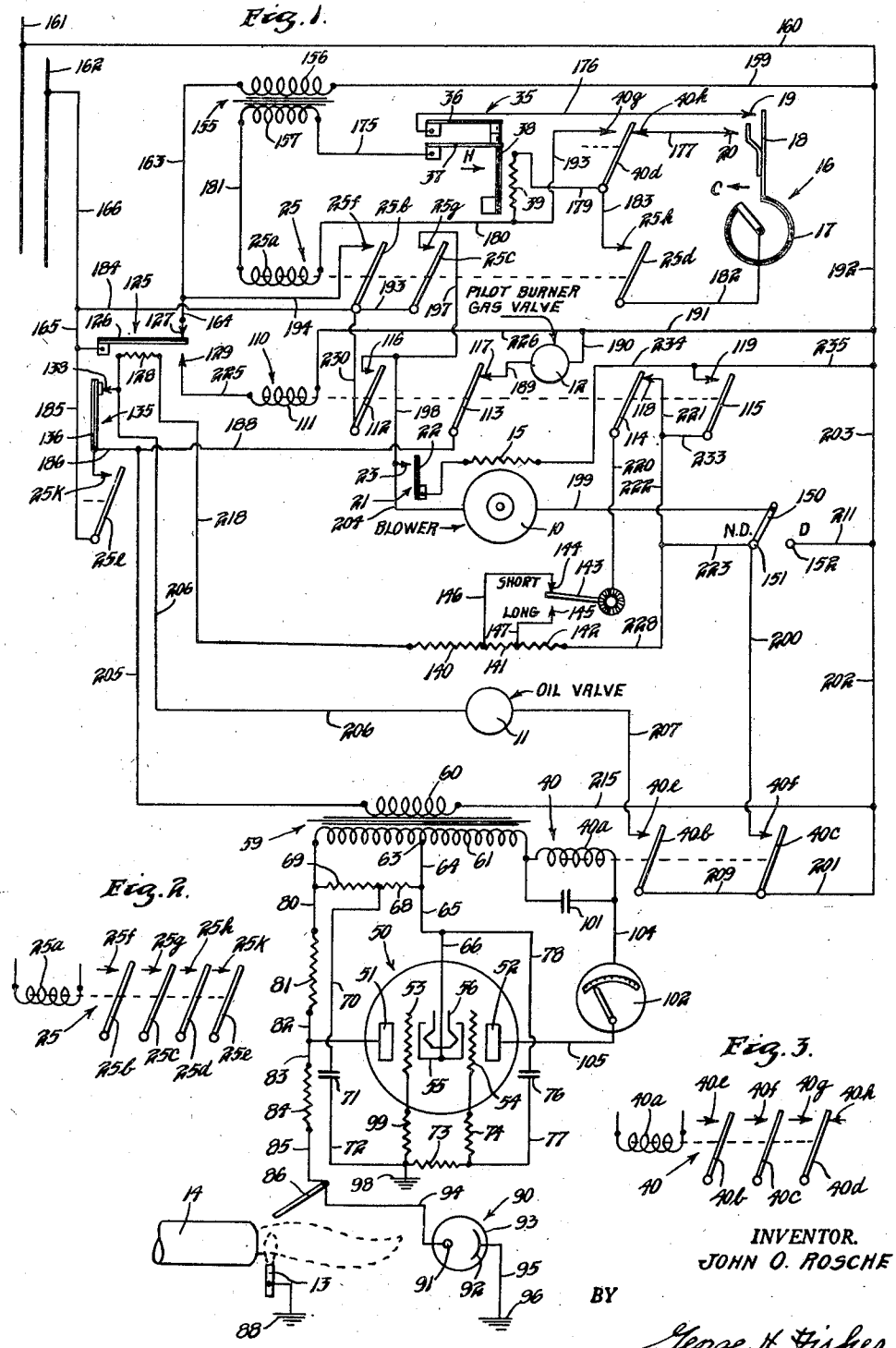


Fig. 2.

Fig. 3.

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BURNER CONTROL APPARATUS WITH TIMING MEANS

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16 Claims. (Cl. 158—28)

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The present invention is concerned with improvements in burner control apparatus and more particularly with apparatus particularly designed for the control of oil burners.

An object of the present invention is to provide a burner control system employing a timer which is effective to interrupt operation of the ignition after a timed period and which also is effective to maintain the burner blower in operation a predetermined period of time after the supply of fuel to the burner has been interrupted.

A further object of the invention is to provide apparatus such as set out in the preceding object in which the timer is caused to have a shorter timing period when maintaining the blower in operation following the interruption of fuel than when timing the ignition means.

A further object of the present invention is to provide a system such as set out in the last object in which the timer is a thermal timer and in which the cooling time of the thermal timer is reduced by reducing the energization of the timer heater when the timer reaches its hot position.

A still further object of the present invention is to provide an arrangement in which the timing period of the thermal timer when controlling the ignition may be varied without affecting the length of the timing period for the operation of the blower following fuel interruption.

A further object of the present invention is to provide an improved burner control system of the type in which upon a flame failure during operation, the supply of fuel to the burner is immediately interrupted and in which following a predetermined period of time the complete system is shut down in such a manner as to require manual intervention before it can be restarted.

A further object of the present invention is to provide an improved burner control system of the type set out in the preceding object in which provision is made for preheating the oil to a predetermined temperature.

A further object of the present invention is to provide a system in which the motor is operated for a longer time following the termination of oil delivery if there is an abnormal combustion failure than if the thermostat has merely become satisfied.

A further object of the invention is to provide an arrangement in which the fuel valve may be energized either simultaneously with the blower of the oil burner or at the end of a short time period after the energization of the blower.

Other objects of the invention will become apparent from a consideration of the accompanying specification, claims, and drawing, of which

Figure 1 is a schematic showing of the improved burner control apparatus associated with portions of the burner apparatus being controlled,

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Figure 2 is a schematic view of one relay employed in the apparatus, and

Figure 3 is a schematic view of another relay employed in my apparatus.

Referring to Figure 1, the burner apparatus to be controlled comprises a blower 10 employed to supply air under pressure to an atomizing type of oil burner, the nozzle of which is shown in the lower part of the figure and designated by the numeral 14. The numeral 11 is employed to indicate an oil valve which controls the flow of fuel to the burner. This valve may, for example, be of a solenoid type which is open whenever energized and closed when deenergized. Also included in the burner apparatus being controlled is a pilot burner gas valve 12 which controls flow of fuel to a pilot burner 13. Provided with the pilot burner is some means for igniting the pilot burner whenever gas is supplied thereto. This means might well be an electrical ignition means which is energized simultaneously with the pilot burner gas valve. For purposes of simplicity, this ignition means is not shown. An electrical heater 15 is employed for preheating the oil before it is delivered to the burner. The operation of this heater is controlled by a thermostat 21 having a bimetallic element 22 exposed to the oil and adapted upon a drop in temperature to move into engagement with a fixed contact 23.

The main control for the system in which my apparatus is employed is a thermostat 16. This thermostat may, for example, be a room thermostat located in the space whose temperature is to be controlled or it may be a boiler water thermostat responsive to the temperature of the boiler water. The thermostat is shown as comprising a bimetallic element 17 to which is attached a contact arm 18 adapted to sequentially engage with two contacts 19 and 20. As indicated by the legend adjacent the thermostat, the bimetallic element 17 moves contact arm 18 to the left upon a drop in temperature. The contact arm 18 is so spaced from contacts 19 and 20 that it first engages contact 19 and then upon a further drop in temperature engages contact 20.

The thermostat 16 controls the energization of a relay indicated in its entirety by the reference numeral 25. This relay comprises a relay coil 25*a* and a plurality of switch blades 25*b*, 25*c*, 25*d*, and 25*e*. In order to simplify the showing of the circuit, switch blade 25*e* has been shown in a different portion of the drawing than switch blades 25*b*, 25*c*, and 25*d*. In order to illustrate the normal relationship between the units of relay 25, the relay has been shown with the elements in their normal relation in Figure 2. The relay switch blades 25*b*, 25*c*, 25*d*, and 25*e* are biased out of engagement with contacts 25*f*, 25*g*, 25*h*, and 25*k*, respectively. Upon energization of the relay coil 25*a*, the switch blades 25*b* to 25*e*

are moved against the bias into engagement with contacts 25*f* to 25*k*, respectively.

A thermal safety switch 35 also controls the energization of relay 25. This safety switch may be of any type which at the end of a period of time moves to a circuit interrupting position and remains in that position until manually reset. A typical switch of this type which may be employed is that shown in the patent to John M. Wilson, 2,290,399. As shown schematically in the drawing, the switch consists of a pair of switch blades 36 and 37, the switch blade 37 being held in engagement with the switch blade 36 against its bias by a bimetallic element 38. An electric heater 39 is located adjacent bimetallic element 38 and is effective when energized to heat bimetallic element 38 to cause it to warp to the right, as indicated by the legend adjacent the element 38. Upon continued energization of heater 39 beyond a predetermined period of time the bimetallic element 38 moves out from under switch blade 37, permitting switch blade 37 to drop away from switch blade 36. When this happens, the switch blades 36 and 37 must be manually reengaged.

The reference numeral 40 is employed to generally designate a further relay. This relay comprises a coil 40*a* and three switch blades 40*b*, 40*c*, and 40*d*. The latter switch blade is shown in the upper portion of the drawing to simplify the showing of the circuit. The relay is shown with the elements thereof in their normal relationship in Figure 3. The switch blades 40*b*, 40*c*, and 40*d* cooperate with fixed contacts 40*e*, 40*f*, 40*g*, and 40*h*. Switch blades 40*b* and 40*c* are normally biased out of engagement with contacts 40*e* and 40*f*, respectively, being moved into engagement therewith upon energization of relay coil 40*a*. The switch blade 40*d* is normally biased into engagement with contact 40*h*, and is moved out of engagement with contact 40*h* and into engagement with contact 40*g* upon energization of relay coil 40*a*.

The relay 40 is controlled by flame responsive apparatus including an electronic discharge tube 50. This tube is of the twin triode type having two anodes 51 and 52, two grids 53 and 54, and a cathode 55. The cathode 55 is associated with both anodes 51 and 52. The anode 51, grid 53, and cathode 55 constitute a first triode, while the cathode 55, the grid 54, and the anode 52 constitute a second triode. The cathode heater 56 can be connected with any suitable source of power. Since such connections are conventional, they have been omitted for the purpose of simplicity. The tube 50 is supplied with power by a transformer 59, this transformer comprising a primary winding 60 and a center tapped secondary winding 61. The right hand half of secondary 61 is employed as a source of anode potential for the second triode including anode 52. The left hand half is employed in connection with the first triode including anode 51 and the flame detecting elements of the apparatus. The center tap 63 is connected by conductors 64, 65, and 66 to the cathode 55. The pair of resistors 68 and 69 are connected in series across the left hand half of secondary 61. The resistor 68 is relatively small as compared with resistor 69. In one particular application, the resistor 68 was a 25,000 ohm resistor while the resistor 69 was a 300,000 ohm resistor. The junction of resistors 68 and 69 is connected by conductor 70, a condenser 71, a conductor 72, and resistors 73 and 74 to grid 54. This connection, as will be more apparent from the subsequent description, serves to apply to grid 54 an alternating voltage which is out of phase with respect to the anode voltage and hence serves to bias the grid 54 negatively during the positive half cycles of the second triode including anode 52. A condenser 76 is connected between grid 54 and cathode 55 by resistor 74 and conductors 77, 78, and 66. The condenser 76 serves to act as the filter for the voltage applied between the grid 54 and the cathode of the second triode and also to delay the response of the tube to the establishment of flame. The left hand terminal of resistor 69 which is at the same potential as the left hand terminal of secondary 61 is connected by conductor 80, resistor 81, conductors 82 and 83, resistor 84, and conductor 85 to a flame electrode 86. This flame electrode is adapted to project into the path of the flame from pilot burner 13, the pilot burner 13 being grounded at 88. Also connected to the left hand terminal of resistor 69 is a photoelectric cell 90. This cell is of any suitable type comprising an anode 91 and cathode 92 located within an envelope 93. The anode 91 is connected by conductor 94 to the flame electrode 86 and hence to the left hand terminal of resistor 69. The cathode 92 is connected by a conductor 95 to a ground connection 96. It will be apparent that the flame gap of the pilot flame and the photoelectric cell 90 are connected in parallel between the left hand terminal of the transformer 61 and ground. The conductor 72 connected to the lower plate of condenser 71 is connected to ground at 98. The condenser 71 is also connected to the grid 53 by conductor 72 and a resistor 99.

The relay 40 is in the output circuit of the second triode. Since it is a relay designed to be operated on direct current, a condenser 101 is connected in parallel with relay 40 to filter out the alternating component of the pulsating current supplied by the triode to the relay 40. A meter 102 is connected in series with relay 40 to indicate the current supplied by the triode to relay 40.

A third relay is designated by the reference numeral 110. This relay comprises a relay coil 111, a plurality of switch blades 112, 113, 114, and 115. The switch blades 112, 113, and 114 are designed to cooperate with fixed contacts 116, 117, 118, and 119, respectively. Switch blades 112 and 115 are biased out of engagement with contacts 116 and 119 and are moved into engagement with their respective contacts upon energizing of relay coil 111. The switch blades 113 and 114 are biased into engagement with contacts 117 and 118, being moved out of engagement therewith upon energization of relay coil 111.

A thermal timer 125 is employed to terminate the operation of the pilot burner as well as to maintain the blower in operation after the oil valve has closed following a normal operation of the burner. This timer 125, as shown schematically in the drawing, comprises a bimetallic element 126 which normally engages a contact 127, this contact being the "cold contact." Associated with the bimetal element 126 is a heater 128. Upon energization of the heater, the bimetal element 126 warps downwardly into engagement with another fixed contact 129, which may be referred to as the "hot contact."

Among the switches controlling the energization of heater 128 is a thermostat 135 adapted to respond to the temperature of the oil. This thermostat comprises a bimetallic element 136 adapted to engage with a fixed contact 138. As long as the oil is at the proper temperature, the

contacts 137 and 138 are held in engagement. If the oil assumes too cold a temperature for proper operation of the system, contact 137 is moved by bimetallic element 136 to the left out of engagement with contact 138 until the preheater controlled by thermostat 21 has heated the oil to the desired temperature.

Connected in series with heater 128 are three series connected resistors 140, 141, and 142. A manually operated switch blade 143 is adapted to engage with either of two contacts 144 or 145 both of which are connected to the series connected resistors 140, 141, and 142. Contact 144 is connected by a conductor 146 to the junction of resistors 140 and 141 while the contact 145 is connected by a conductor 147 to the junction of resistors 141 and 142. Thus, depending upon the position of switch blade 143, it is connected to either the junction of resistors 140 and 141 or the junction of resistors 131 and 142. The switch blade 143 is employed to control the length of the ignition timing and is manually moved between contacts 144 and 145 depending upon the length of ignition timing which is desired. When switch blade 143 is in engagement with contact 144 the timing is short and when in engagement with contact 145, the timing is long, as indicated by legends on the drawing and as is explained in more detail later.

A manually operable switch blade 150 is adapted to be moved into engagement with either of two fixed contacts 151 and 152. This switch is employed to control whether the oil valve and blower are energized simultaneously or whether there is a delay following the energization of the oil burner blower, in the energization of the fuel oil valve. As shown, the switch blade 150 is in engagement with the contact 151 identified by the legend ND. In this position, as will be more clear from the subsequent explanation, the blower and oil valve are energized simultaneously; in other words, there is no delay in the energization of the oil valve after the energization of the blower. With the switch blade 150 in engagement with contact 152, the blower is energized before the fuel valve so that there is some delay in the energization of the oil valve following that of the blower. This contact is identified with the legend D standing for "delay."

Power is supplied for energization of the relay 25 by a transformer 155. This transformer consists of a primary winding 156 and a low voltage secondary winding 157. The right hand terminal of the primary winding 156 is connected by conductors 159 and 160 to a line wire 161. The left hand terminal of primary 156 is connected by conductors 163 and 164, contact 127, bimetallic element 126, and conductors 165 and 166 to the other line wire 162.

While the values of the various elements employed in the apparatus described are not critical, and in many cases a wide range of values may be employed, I have found in one particular embodiment the following values to give satisfactory operation. Resistors having resistances of 1500 ohms, 1000 ohms, and 3500 ohms were employed for resistors 140, 141, and 142, respectively. The heater 128 had a resistance of 2650 ohms. The secondary 157 had an output of 24 volts. Referring to the flame detecting apparatus, resistors 69 and 68 had, as previously mentioned, resistances of 300,000 ohms and 25,000 ohms, respectively. Resistors having resistances of 10,000 ohms and one megohm were employed for resistors 91 and 84. A 7 megohm and a 2 megohm resistor were employed for resistances 99 and 74, respectively. The resistor 73 was a 1 megohm resistor. A .02 microfarad condenser was employed for condenser 71 and a .25 microfarad condenser for condenser 76. A .5 microfarad condenser was employed for condenser 101.

Operation

Before starting with the operation of the system in general, the operation of the flame detecting apparatus will be briefly described.

While the operation of this flame detecting apparatus will be briefly given in the present specification, it is fully set out in the copending application of Vilynn O. Beam, Serial No. 450,613, filed July 11, 1942, now Patent No. 2,455,350, granted December 7, 1948, and for a more detailed understanding of the operation of this portion of the apparatus, reference is made to that application.

It will be assumed at first that neither the pilot burner nor main burner are ignited. Under these conditions, the grid 54 is biased negatively by reason of their connection through condenser 71 to the left hand terminal of resistor 68. As previously noted, the right hand terminal of this resistor is connected to cathode 55. The right hand terminal of the secondary 61 is connected through relay coil 40*a*, conductor 104, meter 102, and conductor 105 to the anode 52. Hence, during those half cycles in which the right hand terminal of secondary 61 is positive with respect to the center tap, which are the half cycles during which the second triode including anode 52 may be conductive, the left hand terminal of secondary 68 is negative with respect to the cathode so that the voltage impressed by reason of the connection of grid 54 to the left hand terminal of resistor 68 is such as to cause grid 54 to be biased negatively during the conductive half cycles. Also, the condenser 71 tends to assume a negative charge by reason of its inclusion in two grid cathode rectifying circuits. Thus, a circuit may be traced during the half cycle in which the left hand terminal of grid 68 is positive with respect to the right hand terminal (the opposite cycle to the one just considered) as follows: from the left hand terminal of resistor 68 through conductor 70, condenser 71, conductor 72, resistor 99, grid 53, cathode 55, and conductors 66 and 65 to the right hand terminal of resistor 68. The effect of current flow through this path is to cause condenser 71 to become charged with a voltage of such polarity that the lower plate of condenser 71 is negative with respect to the upper plate. Due to the rectifying characteristic of the grid 53, current cannot flow in the opposite half cycle. During the same half cycle, current can also flow between grid 54 and cathode 55 through the following circuit: from the left hand end of resistor 68 through conductor 70, condenser 71, conductor 72, resistors 73 and 74, grid 54, cathode 55, and conductors 66 and 65 to the right hand terminal of resistor 68. Again, this current flow can take place only during the half cycle now being considered. As a result of the two circuits just traced, the condenser 71 tends to acquire a charge of such polarity as to cause the lower plate of condenser 71 to be negative with respect to the upper plate. Since grid 54 is connected to the lower terminal of condenser 71, grid 54 tends to assume a negative potential with respect to cathode 55. As previously noted, the fluctuations in the charge across the condenser tend to be filtered out by the bypass condenser 76.

As a result of this negative bias on grid 54, the

triode including anode 52 is substantially non-conductive.

Upon the establishment of either the pilot flame or the main burner flame, a change in the charge of the condenser results. Let it be assumed at first that the pilot burner is ignited so that the gap between the pilot burner 13 and the flame electrode 85 is bridged. A conductive path will then be established from the left hand terminal of resistor 69, through conductor 80, resistor 81, conductors 82 and 83, resistor 84, conductor 85, flame electrode 86, burner 13, ground connections 88 and 98, conductor 72, condenser 71, and conductor 70 to the right hand terminal of resistor 69. The current flowing through this circuit flows in such a direction as to cause the lower plate of condenser 71 to become charged positively with respect to the upper plate. During the next half cycle, when the polarity of the voltage across resistor 69 is reversed, current can still flow through the circuit traced but in the opposite direction. Due, however, to the fact that current tends to flow through a flame better in a direction opposite to that of flame propagation, the current flow through the circuit in the direction traced is greater than that in the opposite direction. Consequently, the net effect of the current flowing through the flame through condenser 71 is to tend to charge the condenser in such a manner that the lower plate tends to become positive with respect to the upper plate. It will be noticed that this charge is opposite to that produced by reason of the flow between the grids 53 and 54 and the cathode 55. In other words, the effect of the establishment of the pilot flame is to tend to raise the potential of the lower plate of the condenser 71 in a positive direction with respect to the upper plate. Since it is the lower plate that is connected to grid 54, the potential of grid 54 with respect to cathode 55 is raised. The apparatus is so designed that the rise in potential of grid 54 is such as to cause energization of relay 40 through the following circuit: from the left hand terminal of secondary 61 through conductor 102, relay coil 40*a*, conductor 104, meter 102, conductor 105, anode 52, cathode 55, and conductors 66, 65, and 64 to the left hand terminal of resistor 61. The resultant energization of relay coil 40*a* causes switch blades 40*b*, 40*c*, and 40*d* to move into engagement with fixed contacts 40*e*, 40*f*, and 40*g*, respectively, switch blade 40*d* moving out of engagement with contact 40*h*.

The photoelectric cell 90, as previously noted, is connected in parallel with the gap between flame electrode 86 and ground. Such a photoelectric cell is conductive only to current flowing from the anode 91 to cathode 92 and is so conductive only when exposed to a source of light. The cell 90 is so located as to be exposed to the light of the main burner flame. Thus when the main burner is ignited, the photoelectric cell 90 is asymmetrically conductive in the same direction as the flame gap. Thus, again, a charge is impressed upon condenser 71 which is of such polarity as to cause the grid 54 to assume a potential sufficiently high as to cause the second triode to be conductive.

As more fully explained in the copending Beam application, the apparatus is designed so as not to be responsive to the presence across either the flame gap or the terminals of the photoelectric cell of an impedance which is not rectifying in character. If such an impedance is connected across the flame gap, the effect of the circuit through condenser 71 including the flame gap of the photoelectric cell is to impress upon condenser 71 an alternating voltage. Since the left hand terminal of condenser 69 is opposite in phase with respect to the cathode potential to that of anode 52, it will be apparent that this alternating voltage across condenser 71 is opposite in phase with respect to the anode voltage applied to the second triode including anode 52. Hence, the tendency of this voltage is to drive grid 54 even more negative during the conductive half cycle. When a rectifying impedance is connected across this gap, such as the flame or the photoelectric cell, the flow of current during the half cycle in which the applied voltage would be out of phase with the anode voltage is blocked so that the voltage impressed on condenser 71 tends to drive grid 54 more positive rather than more negative.

As will be more apparent from the subsequent description of the operation of the apparatus, it is necessary to check both the pilot flame and the main burner flame. Since a flame electrode is ideally adapted to check the presence of a pilot burner flame, the flame is employed as a rectifying impedance in the case of the pilot burner. A flame electrode, however, is not satisfactory in connection with the main burner flame due to the fluctuations of that flame. By using a photoelectric cell, this objection is overcome. Since a photoelectric cell is likewise asymmetrically conductive, it is possible to obtain the same effect from a photoelectric cell as with the flame electrode. In other words, I employ two flame detecting arrangements, one responsive to the pilot flame, one to the main burner flame and both of which result in the presence of an asymmetrically conductive impedance in the circuit upon being exposed to the respective conditions to which they are designed to respond. Thus, the flame detecting apparatus functions to cause energization of relay 40 whenever either the pilot burner flame or the main burner flame is present.

Referring now to the operation of the system as a whole, the various elements are in the position shown when the controlling thermostat 16 is in its satisfied position, that is, when the temperature to which bimetallic element 17 is subjected is at or above the desired value. Under these conditions, none of the control apparatus, with the exception of transformer 155, is energized. Now let it be assumed that the temperature adjacent bimetallic element 17 drops to cause engagement of contact blade 18 first with contact 19 and then with contact 20. Nothing happens until both sets of contacts are made. When this happens, an energizing circuit is established for relay coil 25*a* as follows: from the right hand terminal of secondary 157 through conductor 175, safety switch blades 37 and 36, conductor 176, thermostat contact 19, contact blade 18, thermostat 20, conductor 117, contact 40*h*, switch blade 40*d*, conductor 179, safety switch heater 39, conductor 180, relay coil 25*a*, and conductor 181 to the left hand terminal of secondary 157. The establishment of the circuit just traced causes energization of relay coil 25*a* with a resultant movement of switch blades 25*b*, 25*c*, 25*d*, and 25*e* into engagement with contacts 25*f*, 25*g*, 25*h*, and 25*k*, respectively, as previously explained.

The movement of switch blade 25*d* into engagement with contact 25*h* establishes a holding circuit for relay coil 25*a* independent of thermostat contact 20, this holding circuit being as follows: from the right hand terminal of secondary

157, through conductor 175, safety switch blades 37 and 36, conductor 176, thermostat contact 19, switch blade 18, bimetallic element 17, conductor 182, switch blade 25d, contact 25h, conductors 183 and 179, safety switch heater 39, conductor 180, relay coil 25a, and conductor 181 back to the other terminal of secondary 157. It is to be noted that the new circuit does not include thermostat contact 20. It will be recalled that this was the last to be engaged of the contacts. Thus, upon a subsequent temperature rise, the relay 25a will remain energized until the temperature has risen sufficiently to cause contact blade 18 to separate from contact 19. In this way, a temperature differential must occur between the energization and the de-energization of relay 25.

The engagement of switch blade 25b with contact 25f results in the following circuit being established to primary winding 156: from line wire 162 through conductors 166 and 184, switch blade 25b, contact 25f, conductors 194 and 163, transformer winding 156 and conductors 159 and 160 to the other line wire 161. It will be noted that this circuit does not include the "cold contact" 127 of the timer, so that when the timer is subsequently energized to separate from the cold contact, transformer 155 remains energized. The purpose of originally including the cold contact was to prevent initiation of the operation of the apparatus if the timer was not in its cold or starting position.

The movement of switch blade 25e into engagement with the fixed contact 25k results in the following circuit being established to the pilot burner gas valve 12. From line wire 162 through conductors 166, 165, and 185, switch blade 25e, contact 25k, conductors 186 and 188, switch blade 113, contact 117, conductor 189, gas valve 12, and conductors 190, 191, 192, and 160 to the other line wire 161. The energization of the pilot burner gas valve 12 results in gas being supplied to the pilot burner. As previously explained, suitable means are provided to ignite this gas so that under normal conditions the pilot burner is ignited as a result of the establishment of the circuit just traced.

The transformer 59 is initially deenergized so that the flame responsive apparatus is incapable of responding to the presence of the pilot burner flame. At the same time, however, as the circuit to the pilot burner gas valve is established, a circuit is established to the primary 64 of transformer 59 as follows: from line wire 162 through conductors 166, 165, and 185, relay switch blade 25e, contact 25k, conductors 186 and 205, primary 60, and conductors 215, 202, 203, 192, and 160 to the other line wire 161. As a result of the energization of primary winding 60, the electronic apparatus is energized. The cathode heater 56 is heated up so as to render tube 50 effective after a predetermined period. As soon as the tube is so heated, the apparatus responds to the presence of the pilot burner flame to cause energization of relay 40 and the subsequent movement of switch blades 40b, 40c, and 40d, to their energized position, as previously explained.

The separation of switch blade 40d from contact 40h interrupts the energizing circuit for relay 25a previously traced. Since a holding circuit through switch blade 25d has already been established, this does not affect the operation of relay 25a. The purpose of requiring the energizing circuit for relay 25 to proceed through contact 40h initially is to insure that relay 40 is in its deenergized condition before the apparatus is started. If relay 40 were accidentally maintained in its energized position with no pilot flame or main burner flame, no checking of the flame would result. By requiring that the energizing circuit to relay 25a include a contact of relay 40 which is made only when the relay is deenergized, this possibility is prevented.

The movement of switch blade 40d into engagement with contact 40g establishes a shunt around the safety switch heater 39 as follows: from the lower terminal of heater 39 through conductor 193, contact 40g, switch blade 40d, and conductor 179 to the upper terminal of heater 39. As a result of this shunt circuit being established, heater 39 is no longer energized. The establishment of a pilot flame has already been checked so that presumably it is now possible to establish a main burner flame without difficulty. Moreover, as will be apparent later, provision is made for reenergizing heater 39 if the main burner flame is not established.

The engagement of switch blade 40c with contact 40f causes energization of the burner blower 10 through the following circuit: from line wire 162 through conductors 166, 184, and 193, switch blade 25c, contact 25g, conductors 197, 198, and 204, blower 10, conductor 199, switch blade 150, contact 151, conductor 200, contact 40f, switch blade 40c, and conductors 201, 202, 203, 192, and 160 back to line wire 161. At the same time as blower 10 is energized, if the temperature of the oil is sufficiently high to cause closure of oil thermostat 135 the fuel oil valve 11 is likewise energized as a result of engagement of relay switch blade 40b with contact 40e, the circuit to oil valve 11 being as fololws: from line wire 162 through conductors 166, 165, and 185, relay switch blade 25e, contact 25k, bimetallic element 136, contact 138, conductor 206, oil valve 11, conductor 207, contact 40e, switch blade 40b, and conductors 209, 201, 202, 203, 192, and 160 back to the line wire 161. The oil valve and blower are now thus both in operation. Since the operation of the pilot burner has been checked prior to the opening of the fuel oil valve and the energization of the blower, it is assured that all of the conditions necessary to the operation of the burner have been established.

In the operation just described, the oil valve and blower are brought on simultaneously. If the switch 150 were in engagement with contact 152, a circuit would have been established to the blower motor 10 as soon as relay 25 was energized, this circuit being as follows: from line wire 162, through conductors 166, 184 and 193, relay switch blade 25c, contact 25g, conductors 197, 198 and 204, blower 10, conductor 199, switch blade 150, contact 152, and conductors 211, 203, 192, and 160 to the other line wire 161. Under such conditions, there would have been a delay between the time that the blower was first energized and the fuel oil valve was energized equivalent to the time required for the cathode heater 56 to warm up and for the apparatus to respond to the presence of the pilot burner flame.

In the above paragraphs, it has been assumed that the oil has been sufficiently warm that the preheater thermostat 135 is closed. If it is not, the circuit traced above to the fuel oil valve cannot be established until the oil has had an opportunity to heat up. If the oil is not warm enough, as soon as the circuit is established to the blower motor, a circuit is also established to the preheater 15. For example, if the switch 150 is in the delay position, which is the position normally

assumed when it is necessary to employ a preheater, a circuit is established to preheater 15 following the energization of relay 25 as follows: from line wire 162 through conductors 166, 184, and 193, switch blade 25c, contact 25g, conductors 197 and 198, oil thermostat contact 23, bimetallic element 22, preheater 15, and conductors 234, 235, 192, and 160, back to the other line wire 161. This energization of the preheater continues until thermostat 21 is satisfied. Shortly before this temperature is reached, the contacts of thermostat 135 are closed so as to make possible the establishment of the circuit to the oil valve. The oil thermostat 135 also controls the energization of the timer heater 128. The reason for this is that the time required for preheating the oil may be quite substantial and during this period it is not desirable for the timer to be heating. It is also to be noted that during the period required for preheating, the safety switch heater is shunted by the circuit traced above.

Assuming the oil thermostat 135 to be closed, the energization of relay 40 results in the energization the heater 128 of the thermal timer 125. The energizing circuit for this heater is as follows: from line wire 162 through conductors 166, 165, and 185, switch blade 25e, contact 25k, bimetallic element 136, contact 138, heater 128, conductor 218, resistor 140, conductor 146, contact 144, switch blade 143, conductor 220, switch blade 114, contact 118, conductors 221, 222, 223, and 200, contact 40f, switch blade 40c, and conductors 201, 202, 203, 192, and 160 to the other line wire 161. In tracing the above circuit, it has been assumed that switch blade 143 is in engagement wtih contact 144 to give a short ignition timing period. If switch blade 143 were in engagement with contact 145, the above circuit would have included both resistors 140 and 141 which would, of course, reduce the energization of heater 128. As a result of the energization of heater 128, the timer 125 is effective at the end of a predetermined period of time, dependent in length upon the position of switch 143, to move from engagement with contact 127 into engagement with contact 129.

The movement of the bimetallic element 126 of thermal timer 125 into engagement with the "hot contact" 129 results in the establishment of the following circuit to relay winding 111 of relay 110: from line wire 162 through conductors 166 and 165, bimetallic element 126, contact 129, conductor 225, relay coil 111, and conductors 226, 191, 192, and 160 to the other line wire 161. The energization of relay 110 as a result of the circuit just described causes switch blades 112 and 115 to move into engagement with contacts 116 and 119 and switch blades 113 and 114 to separate from contacts 117 and 118.

The separation of switch blade 113 from contact 117 results in the interruption of the circuit to the pilot burner gas valve previously traced. This causes interruption of the operation of the pilot burner so that there no longer is a flame between electrode 86 and the pilot burner 13. Since, however, both oil and air have been supplied for a period of time equivalent to the timing period of the thermal timer, the ignition of the main burner has presumably taken place. Under these conditions, the photoelectric cell 90 responds to the presence of the burner flame and maintains relay 40 energized despite the termination of the ignition. For the present, it will be assumed that the apparatus operates in this manner.

The separation of switch blade contact 114 from contact 118 interrupts that portion of the previously traced circuit to timer heater 128 which acted as a shunt around either both resistors 141 and 142 or resistor 142 alone, depending upon the position of switch blade 143. Proceeding from the right hand terminal of resistor 140, the circuit to heater element 128 is now completed through resistors 141 and 142, conductors 228, 223, and 200, contact 40f, switch blade 40c, and conductors 201, 202, 203, 192 and 160 to the other line wire 161. It will be noted that the circuit to heater 128 now includes all three resistors 140, 141, and 142 so that the energization of heater 128 is less than that which was the case when the timer blade 126 was moved from the cold to the hot contacts. The purpose of this reduction in the energization of heater 128 is to reduce the time required for cooling. As will be more apparent later, this cooling time is employed to provide for continued energization of the blower a predetermined period of time following closure of the oil valve. If the energization of heater 128 were continued at the level employed to move the bimetal blade 126 from engagement with contact 127 to engagement with contact 129, this cooling time would be excessively long.

The movement of switch blade 112 into engagement with contact 116 results in the establishment of a new circuit to blower motor 10, independent of relay 25, this circuit being as follows: from line wire 162 through conductors 166, 184, and 230, switch blade 112, contact 116, conductors 198 and 204, blower 10, conductor 199, switch blade 150, contact 151, conductor 200, contact 40f, switch blade 40c, and conductors 201, 202, 203, 192, and 160 to the other line wire 161. The purpose of establishing this circuit is to permit operation of the blower under the control of relay 110 and timer 125 following the deenergization of relay 25 as a result of the termination of the call for heat, as will be more apparent later.

The movement of switch blade 115 into engagement with contact 119 results in the establishment of the following circuit for timer heater 128 which is independent of the relay 40 controlled by the flame responsive means: from line wire 162 through conductors 166, 165, and 185, switch blade 25e, contact 25k, oil thermostat 135, heater 128, conductor 218, resistors 140, 141, and 142, conductors 228, 222, and 233, switch blade 115, contact 119, and conductors 235, 192, and 160 to the other line wire 161. The purpose of this circuit is to insure continued energization of heater 128 in the event of a flame failure so as to prevent ignition from being reestablished following such a flame failure.

The system is now in normal operation and has gone through a normal starting sequence. Presumably, it will continue in operation until such time as the controlling thermostat 16 becomes satisfied so as to cause separation of contact blade 18 from both contacts 19 and 20. When this happens, the maintaining circuit for relay coil 25a will be interrupted so as to cause deenergization of relay 25. This in turn will result in deenergization of all of the elements connected in series with relay switch blade 25e, namely, the transformer 59 of the flame detecting apparatus, the oil valve 11, and the heater 128 of the thermal timer 125. The delivery of oil to the furnace will be stopped immediately and the timer 125 will start to cool. In the meantime, the blower 10

continues in operation due to the circuit for it previously traced through switch blade 112, which circuit is independent of any of the switch blades of relay 25. This operation of the blower will continue until the bimetal element 126 has cooled sufficiently to cause its separation from "hot contact" 129. When this happens, the relay 110 is deenergized to cause interruption of the only remaining circuit for the blower. The various elements of the apparatus are now in the position they assumed at the start so that upon a subsequent call for heat by the room thermostat, the apparatus can again be placed into operation.

It was originally assumed that the pilot burner ignited properly so that as soon as the cathode heater of tube 50 warmed up, the relay 40 became energized. If the pilot burner is not properly lighted, relay 40 is not energized. As as result, switch blade 40*d* is never moved into engagement with contact 40*g* to shunt the safety switch heater 39. Consequently, the safety switch heater 39 remains energized until the bimetallic blade 38 moves out from underneath switch blade 37 to complete separation of switch blades 36 and 37. This in turn causes deenergization of relay 25 to terminate operation of the entire system. As previously explained, the system cannot again be placed into operation until the safety switch 35 is manually reclosed.

It was also assumed during the description of the operation that the main burner flame was properly established so as to continue the energization of relay 40. If this does not occur, the relay 40 becomes deenergized as soon as relay 110 is effective to deenergize the pilot burner gas valve. It will be obvious that this is the case since as soon as the pilot burner is extinguished, no rectifying path is established between conductor 85 and ground. The energization of relay 110, it will be recalled, not only resulted in the interruption of ignition but also established a holding circuit for heater 128 through switch blade 115 controlled by the relay 110. Thus, despite the deenergization of relay 40 and the resultant interruption of the first traced energizing circuits for heater 128, the heater continues to remain energized to maintain timer 125 in its hot position which in turn results in the continued energization of relay 110. In the meantime, the deenergization of relay 40 has caused switch blade 40*d* to move out of engagement with contact 40*g* to interrupt the shunt circuit around safety switch heater 39. The safety switch thus begins to heat up again. During this time, the oil valve 11 is deenergized so that no oil flows to the burner. The blower 10 is maintained energized through one or the other of two circuits. If the switch blade 150 is in the position shown, the conductor 199 leading from blower 10 is connected to line wire 161 through switch blade 150, contact 151, conductors 223, 222, and 233, switch blade 115, contact 119, and conductors 235, 192, and 160. If, on the other hand, the switch blade 150 is in engagement with contact 152, the conductor 199 leading from blower 10 is connected to line wire 161 by switch blade 150, contact 152, and conductors 211, 203, 192, and 160. Thus, regardless of the position of the switch blade 150, the blower continues to operate during this period while the safety switch heater 39 is again heating the bimetallic element 38. This provides for a purging of any oil from the burner before the system is shut down. After a predetermined period of time corresponding to the timing of the safety switch heater, the bimetallic element 38 is

deflected to the right to cause separation of switch blades 36 and 37 as previously described. This will in turn cause deenergization of relay 25. As a result, the heater 128 of the thermal timer 125 is deenergized. The blower 10 will continue in operation until the timer 125 has cooled sufficiently to cause separation of bimetal element 126 from contact 129 to cause deenergization of relay 110. Thus, when there is a flame failure under these conditions, the system provides for a "blow out" cycle equivalent in length to that of the timing of the safety switch plus the timing of the thermal timer.

If the system is placed into operation satisfactorily but a flame failure occurs during the normal operation, the sequence leading to a safety shut down is substantially the same as that occurring when the main burner flame was not initially established in spite of a successful establishment of the pilot burner flame. Under these conditions, relay 40 is immediately deenergized to cause immediate deenergization of the oil valve. Relay 110 does, however, remain energized under the control of the time switch which in turn continues to be energized by reason of the engagement of switch blade 115 with contact 119. The remaining operation is otherwise exactly the same as described in the previous paragraph. It will be recalled from the previous paragraph that the "blow out" cycle was considerably longer in the event of a shut down following a flame failure than after a normal operation of the burner. This is a very desirable feature of my apparatus since if combustion has not been established or has failed following a successful establishment of it, there is more likelihood of unburned oil remaining in the burner. By operating the blower motor for a longer period of time, provision is made for blowing out this extra accumulation of oil. Moreover, by having the thermal safety switch 35 and thermal timer 125 proceed through their cycles in sequence, the relative length of their timing periods is not critical.

It will be seen that I have provided an improved burner control system in which the utmost of safety is obtained. A check is made of the establishment of ignition before fuel is supplied to the main burner. A check is then made of the establishment of the main burner flame. In each case, the check is done by electronic apparatus which is capable of distinguishing between the condition actually being checked and a false condition having similar characteristics. The ignition is turned off at the end of a time period and the timer which serves to time the ignition also provides for a purging operation of the blower to remove any unburned oil before the control apparatus is completely deenergized. If there is a safety shut down because of a failure of the main burner to become ignited, a blow out cycle of extra length is provided.

It will further be seen that my apparatus provides for an extreme flexibility of operation. By a simple switching operation, either one of two lengths of ignition timing can be secured. Furthermore, provision can be made for either opening the oil valve at the same time as the blower or a predetermined period of time thereafter.

While I have described a specific embodiment of my invention for the purposes of illustration, it is to be understood that the invention is limited only by the scope of the appended claims.

I claim as my invention:

1. Burner control apparatus including, a fuel control, a burner blower, a burner ignition

means, a timer, means to initiate operation of said ignition means, said fuel control, said blower, and said timer, means controlled by said timer for deenergizing said ignition means a predetermined period of time after initiation of operation of said timer and for decreasing the time required for said timer to return to its starting position, means to cause said fuel control to assume a fuel interrupting condition when burner operation is not desired, and means controlled by said timer effective after said fuel control has been caused to assume said fuel interrupting condition to maintain said blower in operation while said timer is returning to its starting position so as to give a purging period.

2. Burner control apparatus including, a fuel control, a burner blower, a burner ignition means, a timer, means to initiate operation of said timer upon said fuel control, said blower, and said ignition means being effective, means controlled by said timer for deenergizing said ignition means a predetermined period of time after initiation of operation of said timer, means to cause said fuel control to assume a fuel interrupting condition when burner operation is not desired, means controlled by said timer effective after said fuel control has been caused to assume said fuel interrupting condition to maintain said blower in operation while said timer is returning to its starting position, and manually positioned means selectively operable upon change in position thereof to vary the length of said predetermined period of time prior to termination of ignition without varying the length of said purging period.

3. Burner control apparatus comprising a fuel control, a burner blower, a burner ignition means, a thermal timer including means for heating the same, means operative to initiate operation of said ignition means upon said fuel control, said blower, and said timer, means controlled by said timer for deenergizing said ignition means a predetermined period of time after energization of said timer heating means and for decreasing the energization of said timer heating means so as to reduce the cooling time of said timer, and means controlled by said timer effective after said fuel control has been caused to assume a fuel interrupting condition to maintain said burner blower in operation while said timer is cooling.

4. In control apparatus for controlling a burner fuel control device, a combustion air supplying device, and a burner ignition means; said control apparatus comprising a main switch; a thermal timer having a hot position and an electrical heating element for causing it to move to said hot position from a normal cold position; means including said main switch and adapted upon closure thereof to cause energization of such a burner control device, combustion air supplying device, and burner ignition means; means controlled by said last named means for causing energization of the heating element of said thermal timer; means controlled by said timer and adapted upon the same moving to said hot position to interrupt the operation of said ignition means and to decrease the energization of the heating element of said timer; and further means controlled by said timer and adapted to maintain said combustion air supplying device in operation after deenergization of said fuel control device as a result of opening of said main switch and until said timer moves from said hot position.

5. Burner control apparatus comprising a fuel control for a burner; a burner blower; burner ignition means; combustion responsive apparatus adapted to respond to the establishment of combustion at the burner being controlled; means including a main control device for initiating operation of said fuel control, said burner blower, and said burner ignition means, and for maintaining said fuel control and said burner blower in operation; means controlled by said main control device effective when said control device assumes a condition in which burner operation is not demanded to cause said fuel control to interrupt the delivery of fuel; timing means to cause said blower to continue its operation a first predetermined period of time after interruption of the fuel; means controlled by said combustion responsive apparatus effective when said combustion responsive device indicates a failure in combustion also to cause said fuel control to interrupt the delivery of fuel; and means including said timing means for maintaining said blower in operation for a second predetermined period of time after such a combustion failure, said second period of time being greater than said first predetermined period of time.

6. Burner control apparatus comprising a fuel control for a burner; a burner blower; burner ignition means; combustion responsive apparatus adapted to respond to the establishment of combustion at the burner being controlled; means including a main control device for initiating operation of said fuel control, said burner blower, and said burner ignition means, and for maintaining said fuel control and said burner blower in operation; means controlled by said main control device effective when said control device assumes a condition in which burner operation is not demanded to cause said fuel control to interrupt the delivery of fuel; timing means to cause said blower to continue its operation a first predetermined period of time after interruption of the fuel, means controlled by said combustion responsive apparatus effective when said combustion responsive device indicates a failure in combustion also to cause said fuel control to interrupt the delivery of fuel; and means to delay the timing operation of said timing means after such a combustion failure so as to maintain said blower in operation for a longer predetermined period of time than after a fuel interruption under the control of said main control device.

7. Burner control apparatus comprising a fuel control for a burner; a burner blower; burner ignition means; combustion responsive apparatus adapted to respond to the establishment of combustion at the burner being controlled; means including a main control device for initiating operation of said fuel control, said burner blower, and said burner ignition means, and for maintaining said fuel control and said burner blower in operation; means controlled by said main control device effective when said control device assumes a condition in which burner operation is not demanded to cause said fuel control to interrupt the delivery of fuel; first timing means to cause said blower to continue its operation a first predetermined period of time after interruption of the fuel; means controlled by said combustion responsive apparatus effective when said combustion responsive device indicates a failure in combustion also to cause said fuel control to interrupt the delivery of fuel;

a second timing means; and means including said second timing means for delaying the initiation of the timing operation of said first timing means for a second predetermined period of time after such a combustion failure so that said blower continues in operation for a period of time equal in length to the sum of said first and second periods of time.

8. Burner control apparatus comprising a fuel control for a burner; a burner blower; burner ignition means; combustion responsive apparatus adapted to respond to the establishment of combustion at the burner being controlled; means including a main control switch for initiating operation of said fuel control, said burner blower, and said burner ignition means, and for maintaining said fuel control and said burner blower in operation; means controlled by said main control device effective when said control device assumes a condition in which burner operation is not demanded to cause said fuel control to interrupt the delivery of fuel; timing means to cause said blower to continue its operation a first predetermined period of time after such interruption of the fuel; means controlled by said combustion responsive apparatus effective when said combustion responsive device indicates a failure in combustion also to cause said fuel control to interrupt the delivery of fuel; means including a thermal safety switch in series with said main control switch effective after a second predetermined period of time to move to open position and at the same time to initiate the timing cycle of said timing means so that the blower is maintained in operation following a combustion failure over both said second and said first predetermined periods of time.

9. Burner control apparatus comprising a fuel control for a burner; a heater for the fuel; a burner blower; burner ignition means; means including a main control device for initiating operation of said burner ignition means, said fuel heater, and said burner blower; means including a device responsive to the operation of said ignition means and a device responsive to the temperature of the fuel for energizing said fuel control when said ignition means is operative and said fuel is at a predetermined temperature; means including a timer for rendering said ignition means inoperative at the end of a timing period of said timer; and means for initiating the operation of said timer simultaneously with said fuel control.

10. Burner control apparatus comprising a fuel control for a burner; a heater for the fuel; a burner blower; burner ignition means; means including a main control device for initiating operation of said burner ignition means, said fuel heater, and said burner blower; means including a device responsive to the operation of said ignition means and a device responsive to the temperature of the fuel for energizing said fuel control when said ignition means is operative and said oil is at a predetermined temperature; means including a timer for rendering said ignition means inoperative at the end of a timing period of said timer; means for initiating the operation of said timer simultaneously with said fuel control; a safety shutdown device effective after a timed period of operation to render said control device inoperative to continue or again to initiate operation of said ignition means; means including said device responsive to the operation of said ignition means for interrupting the operation of said safety shutdown device upon said ignition means being operative; and means including a device responsive to the establishment of combustion for maintaining said safety shutdown device inoperative.

11. Burner control apparatus for controlling a fuel control, a burner blower, and a burner ignition means; said apparatus comprising: a first relay adapted to be connected to a main control switch and a source of power so as to be energized whenever said main control switch is closed; a second relay; means adapted to be associated with a burner and with the ignition means therefor and to energize said second relay whenever either said ignition means is operative or there is combustion at the main burner; a thermal timer having an electrical heater; means for energizing said heater when said first and second relays are energized; a third relay; means for energizing said third relay when said thermal timer is in its hot position; first circuit means controlled by said first and third relays and adapted to be connected to a burner ignition means to energize the latter when said first relay is energized and said third relay is deenergized; second circuit means controlled by said first and second relays and adapted to be connected to a burner fuel control to cause operative energization of the latter when both said first and second relays are energized; and third circuit means controlled by said first and third relays and adapted to be connected to a burner blower to cause operation of the latter whenever either of said first or third relay is energized so that following the deenergization of said first relay, said third circuit means is adapted to maintain said blower in operation while said timer is in its hot position.

12. Burner control apparatus for controlling a fuel control, a burner blower, and a burner ignition means; said apparatus comprising: a first relay adapted to be connected to a main control switch and a source of power so as to be energized whenever said main control switch is closed; a second relay; means adapted to be associated with a burner and with the ignition means therefor and to energize said second relay whenever either said ignition means is operative or there is combustion at the main burner; a thermal timer having an electrical heater; means for energizing said heater when said first and second relays are energized; a third relay; means for energizing said third relay when said thermal timer is in its hot position; first circuit means controlled by said first and third relays and adapted to be connected to a burner ignition means to energize the latter when said first relay is energized and said third relay is deenergized; second circuit means controlled by said first and second relays and adapted to be connected to a burner fuel control to cause operative energization of the latter when both said first and second relays are energized; third circuit means controlled by said first and third relays and adapted to be connected to a burner blower to cause operation of the latter whenever either said first or third relay is energized, and fourth circuit means controlled by said second and third relays and adapted to be connected to said burner blower to cause operation of the latter whenever either said second or third relay is energized; and switching means for selectively rendering either said third or fourth circuit means effective to cause blower operation to be initiated either when said first or when said second relay is energized.

13. Burner control apparatus for controlling

a fuel control, a burner blower, and a burner ignition means; said apparatus comprising: a first relay adapted to be connected to a main control switch and a source of power so as to be energized when said main control switch is closed; a second relay; means adapted to be associated with a burner and with the ignition means therefor and to energize said second relay whenever either said ignition means is operative or there is combustion at the main burner; a thermal timer having an electrical heater; means controlled by said first and second relays for energizing said heater; a third relay; means for energizing said third relay when said thermal timer is in its hot position; first circuit means controlled by said first and third relays and adapted to be connected to a burner ignition means to energize the latter when said first relay is energized and said third relay is deenergized; second circuit means controlled by said first and second relays and adapted to be connected to a burner fuel control to cause operative energization of the latter when both said first and second relays are energized; and third circuit means controlled by said second and third relays and adapted to be connected to a burner blower to cause operation of the latter when either said second or third relay is energized so that following the deenergization of said first relay with the resultant interruption of the energization of said second relay, said third circuit means is adapted to maintain said blower in operation while said timer is in its hot position.

14. Burner control apparatus for controlling a fuel control, a burner blower, and a burner ignition means; said apparatus comprising: a first relay adapted to be connected to a main control switch and a source of power so as to be energized when said main control switch is closed; a second relay; means adapted to be associated with a burner and with the ignition means therefore and to energize said second relay whenever either said ignition means is operative or there is combustion at the main burner; a thermal timer having an electrical heater; means controlled by said first and second relays for energizing said heater; a safety switch connected in series with said first relay and tending to deenergize said first relay at the end of a predetermined period of time; means operative upon energization of said second relay to render said safety switch inoperable; a third relay; means for energizing said third relay when said thermal timer is in its hot position; first circuit means controlled by said first and third relays and adapted to be connected to a burner ignition means to energize the latter when said first relay is energized and said third relay is deenergized; second circuit means controlled by said first and second relays and adapted to be connected to a burner fuel control to cause operative energization of the latter when both said first and second relays are energized; and third circuit means controlled by said first and third relays and adapted to be connected to a burner blower to cause operation of the latter when either said first or third relay is energized so that following the deenergization of said first relay, said third circuit means is adapted to maintain said blower in operation while said timer is in its hot position.

15. Burner control apparatus for controlling a fuel control, a burner blower, and a burner ignition means; said apparatus comprising: a first relay adapted to be connected to a main control switch and a source of power so as to be energized when said main control switch is closed; a second relay; means adapted to be associated with a burner and to energize said second relay when there is combustion at the main burner; a thermal timer having an electrical heater; means controlled by said first relay for energizing said heater; a third relay; means for energizing said third relay when said thermal timer is in its hot position and for decreasing the energization of the electrical heater of said timer; first circuit means controlled by said first and third relays and adapted to be connected to a burner ignition means to energize the latter when said first relay is energized and said third relay is deenergized; second circuit means controlled by said first relay and adapted to be connected to a burner fuel control to cause operative energization of the latter only when said first relay is energized; third circuit means controlled by said first and third relays and adapted to be connected to a burner blower to cause operation of the latter when either said first or third relay is energized so that following the deenergization of said first relay, said third circuit means is adapted to maintain said blower in operation while said timer is in its hot position.

16. Burner control apparatus for controlling a fuel control, a burner blower, and a burner ignition means; said apparatus comprising: a first relay adapted to be connected to a main control switch and a source of power so as to be energized when said main control switch is closed; a second relay; means adapted to be associated with a burner and with the ignition means therefor and to energize said second relay whenever either said ignition means is operative or there is combustion at the main burner; a thermal timer having an electrical heater; means for energizing said heater when said first and second relays are energized; a third relay; means for energizing said third relay when said thermal timer is in its hot position; first circuit means controlled by said first and third relays and adapted to be connected to a burner ignition means to energize the latter when said first relay is energized and said third relay is deenergized; second circuit means controlled by said first and second relays and adapted to be connected to a burner fuel control to cause operative energization of the latter when both said first and second relays are energized; and third circuit means controlled by said first relay and adapted to be connected to a burner blower to cause operation of the latter when said first relay is energized.

JOHN O. ROSCHE.

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Certificate of Correction

Patent No. 2,490,095 December 6, 1949

JOHN O. ROSCHE

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows:

Column 7, line 8, for "electrode 85" read *electrode 86*; column 8, lines 61 and 62, for "thermostat 20, conductor 117," read *thermostat contact 20, conductor 177*,; column 10, line 36, for "fololws" read *follows*; column 11, line 25, before "the", first occurrence, insert *of*;

and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 23rd day of May, A. D. 1950.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.