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P. GIUFFRIDA ET AL

3,489,500

FUEL BURNER RECYCLING CONTROL

Filed March 18, 1968

2 Sheets-Sheet 1

FIG 1

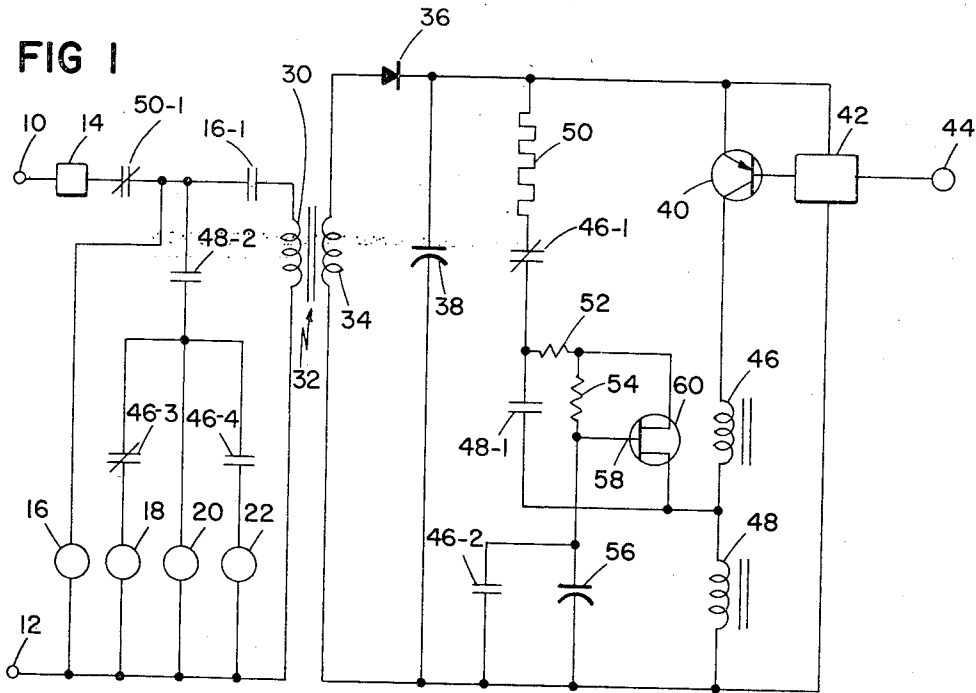
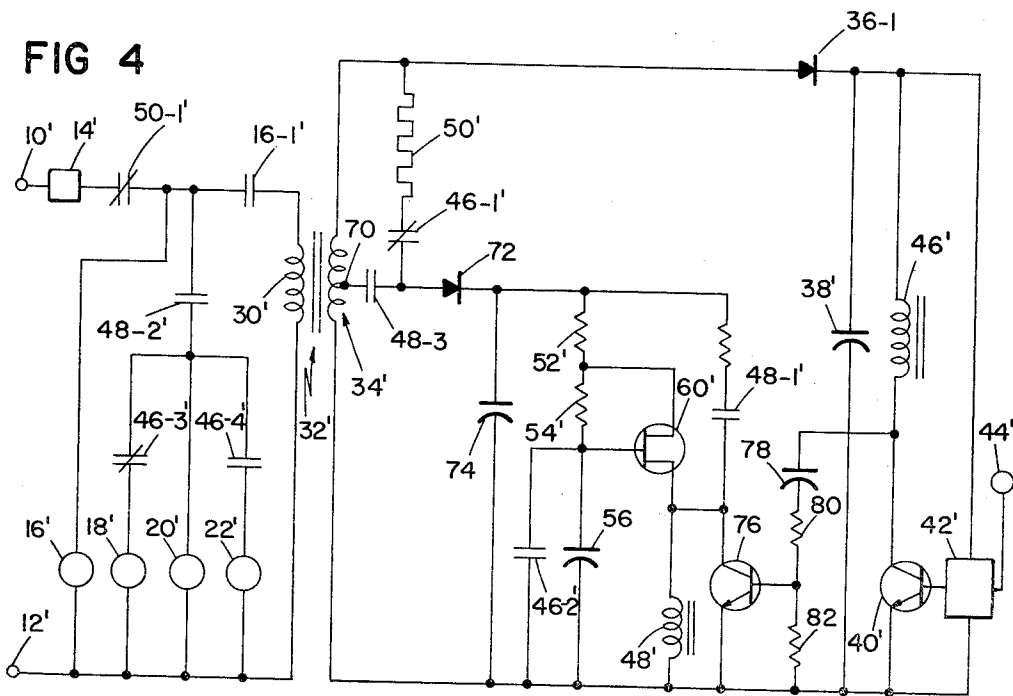


FIG 4



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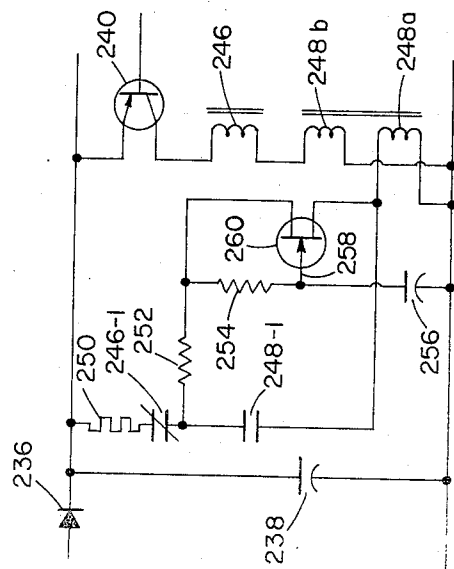
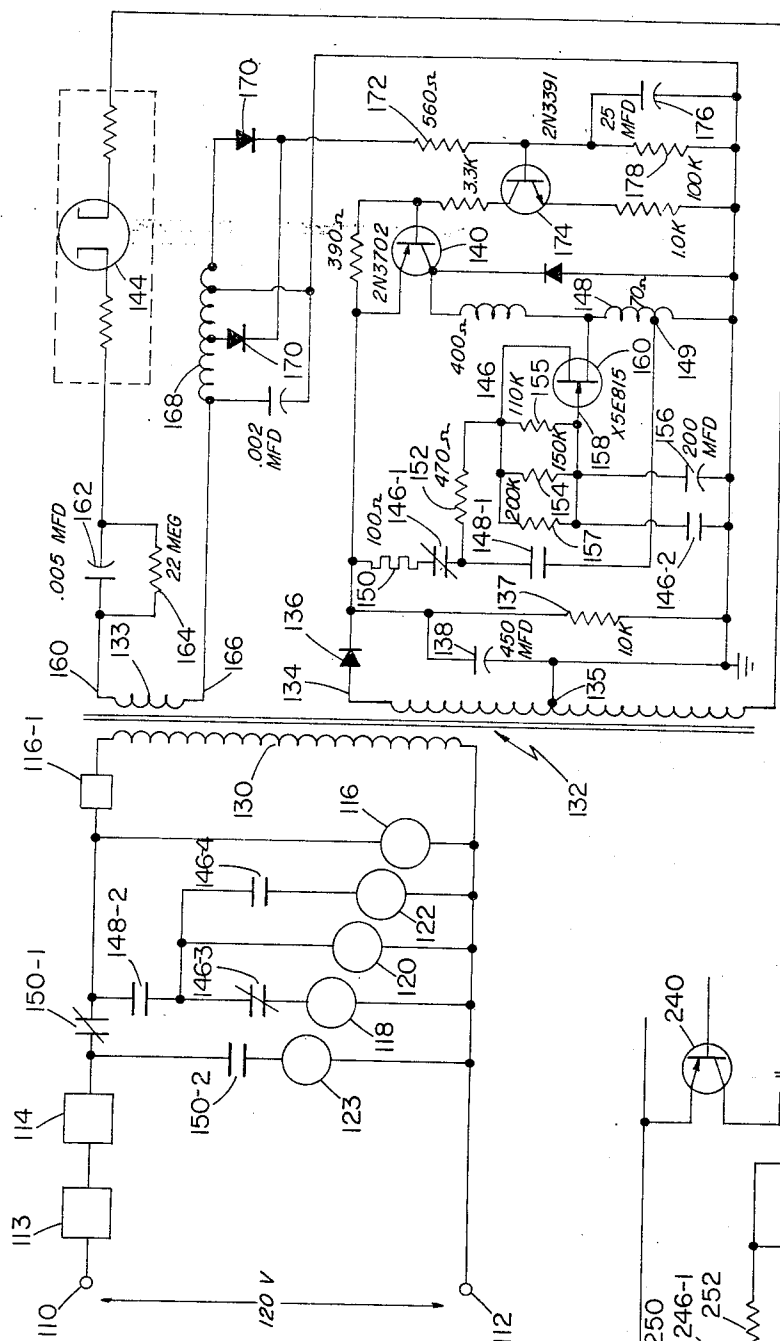
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2 Sheets-Sheet 2



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FUEL BURNER RECYCLING CONTROL

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U.S. Cl. 431-26

17 Claims

ABSTRACT OF THE DISCLOSURE

A combustion control system, in response to a flame failure signal, de-energizes both the flame relay and the control relay in a sequence which insures a purge cycle before an attempt to re-ignite flame is made. In one group of embodiments, after flame is established, the only circuit maintaining the flame relay and the control relay energized is a series circuit of those two coils with a flame signal responsive switch and removal of the flame present signal causes both relays to drop out. In another embodiment, removal of the flame present signal causes the flame relay to drop out and creates a shunt path across the control relay coil, causing it to drop out also.

Summary of invention

This application is a continuation-in-part of our co-pending application Ser. No. 601,955, filed Dec. 15, 1966.

This invention relates to electrical control circuitry and more particularly to control circuitry particularly adapted for use in combustion supervision systems.

In some types of gas burning equipment, it is desirable to attempt to relight the pilot in case it becomes extinguished by some phenomenon that does not require a permanent shut-down of the combustion system. An attempt to relight the pilot at the instant flame failure is detected may be hazardous because unburned fuel can accumulate in the combustion chamber between the actual flame failure and is detected by the flame sensing circuitry. Because of this hazard some combustion controls are designed for extremely short flame failure response time but such controls may be unreliable due to too short an averaging period. This hazard can be avoided if the control is designed to insure a preignition purge period before the trial for ignition so that unburned gases that have collected in the combustion chamber are removed before an attempt is made to relight the burner.

Accordingly, it is an object of the invention to provide a novel and improved fuel burner control which provides a purge cycle for ventilating the combustion chamber prior to initiation of a flame initiation sequence after a flame failure signal.

Another object of this invention is to provide novel and improved apparatus for the supervision of combustion condition established in a combustion chamber.

Another object of the invention is to provide a combustion control system having improved correlation between the coils of the main control relay and the flame relay.

Another object of the invention is to provide novel and improved apparatus which reduces the complexity of combustion system control and which increases the safety of combustion system operation.

Still another object of the invention is to provide novel and improved system for sequencing a fuel burner coordinated with lockout arrangement which terminates the operation of the system in the event of improper opera-

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tion but which permits a recycle including a purge interval, after a flame failure signal.

Still another object of the invention is to provide a novel and improved combustion control apparatus which is compact, economical, and meets stringent requirements established by supervising agencies for said combustion control apparatus.

In accordance with the invention, there is provided control apparatus for use with a fuel burner installation that includes a fuel control, an ignition control, and preferably a blower which forces air through the supervised combustion chamber. The control apparatus includes a main control relay that controls a normally open switch connected in the energizing circuits of fuel control and the ignition control and a flame relay that controls a normally open switch connected in the energizing circuit of the fuel control and a normally closed switch connected in the energizing circuit of the ignition control. After a combustion condition is established in the combustion chamber in response to a request for heat, a circuit is established which in response to failure of a flame signal from the flame sensor causes the control relay to become de-energized effectively before the flame relay is de-energized.

In a first form of the invention, the control relay and flame relay coils are connected in a series circuit with a flame sensor switch, which series circuit becomes the exclusive energizing circuit after flame is established and can be maintained only as long as the flame sensor switch is closed. Both coils are de-energized on opening of the flame sensor switch due to flame failure for example. Through timing of the switch contacts it is insured that the control relay contacts open before the flame relay contact controlling ignition closes, thus preventing a transient ignition condition. In a second form of the invention the flame sensor switch is connected in series with the flame relay coil and arranged to actuate a control relay coil shunting circuit, which shunting circuit causes de-energization of the control relay. In each form the control apparatus initiates a purge cycle before ignition is attempted after flame failure.

In a particular embodiment of the series circuit arrangement, a tapped main control relay coil is used, the full coil being energized after a time delay to place the control relay in the picked up condition but only a small portion of the control relay being used to maintain the control relay in picked up condition. This specific arrangement allows a larger voltage to be placed across the flame relay to better insure proper operation of the flame relay over a wide range of operating conditions. In another particular embodiment of the series circuit arrangement, the control relay has two energizing coils, one employed for initial pickup in response to a request for burner operation and a second connected in series with the flame relay coil. Energization of the first control relay coil does not reduce the voltage across the flame relay coil so that the desired wide range of operating margins of the flame relay is provided. The first control relay coil is de-energized after flame is detected so that both the control relay and flame relay are maintained in picked up condition only so long as the flame sensor switch is closed.

The invention provides simple and compact, yet extremely reliable fuel burner control system, which prevents a transient ignition condition after flame failure and which insures a purge interval prior to attempted relighting after a flame failure signal if such is desired. Other objects, features, and advantages of the invention will be seen as the following description of particular embodiments thereof progresses, in conjunction with the drawings in which:

FIG. 1 is a schematic diagram of a first embodiment of a combustion control system constructed in accordance with the invention;

FIG. 2 is a schematic diagram of a second form of system constructed in accordance with the invention;

FIG. 3 is a schematic diagram of still another form; and

FIG. 4 is a schematic diagram of a further embodiment of a combustion control system constructed in accordance with the invention.

Description of particular embodiments

With reference to FIG. 1, control power is applied to the circuit at terminals 10, 12. Connected in series with terminal 10 is an operating control 14 such as a thermostat. The system further includes a blower control 16, an ignition control 18, a pilot fuel control 20 and a main fuel control 22. In addition there is a switch 16-1 that is responsive to air flow produced by blower 16 connected in series between operating control 14 and primary winding 30 of transformer 32.

The secondary winding 34 of transformer 32 has a rectifying diode 36 connected to it and a shunt capacitor 38 which smoothes the rectified signal from the diode 36. Connected across the output of the rectifier is a series circuit of a transistor switch 40 that is responsive to signal from flame sensor electronics 42 actuated by flame sensor 44, the solenoid coil 46 of flame relay, and the solenoid coil 48 of control relay. The impedances of the coils 46 and 48 are selected so that the current required to energize coil 46 is sufficient only to hold relay coil 48 energized and never enough to energize it. In a particular embodiment, this may be accomplished by requiring substantial armature travel for the pickup (energization) of control relay 48 so that at least three times the holding current is required to initially energize it.

Also connected across the rectifier output is a series circuit of lockout actuator 50, normally closed flame relay contacts 46-1, and a resistive capacitive timer network that includes resistors 52, 54 and capacitor 56. The junction between resistor 54 and capacitor 56 is connected to control electrode 58 of unijunction transistor 60 which has an output electrode connected to the solenoid coil of control relay 48. A normally open contact 48-1 of the control relay is connected to bridge the unijunction transistor and provide a holding circuit for control relay 48 once that relay has been energized. A normally open flame relay contact 46-2 is connected in shunt with capacitor 56 to provide a discharge path for that capacitor whenever flame relay 46 has been energized.

In addition, in the transformer primary section of the circuitry there is provided normally closed contacts 50-1 which are opened by lockout switch heater 50, normally open contacts 48-2 which are closed by the energization of the control relay 48, and two sets of contacts operated by the flame relay, normally closed contacts 46-3 and normally open contacts 46-4.

In operation, terminals 10 and 12 are normally continuously energized. In response to a call for heat as signalled by control 14, blower 16 is energized through the normally closed lockout switch contacts 50-1. As soon as air flow is produced by blower 16, switch contacts 16-1 close and the primary winding 30 of transformer 32 is energized. The scanner electronics 42 are energized from the secondary winding 34 of transformer 32, and if the proper conditions (e.g. no flame) exist and the circuitry is otherwise operating properly, flame relay 46 remains de-energized. In this event a circuit is completed through lockout switch actuator 50, closed flame relay contacts 46-1, and the resistive capacitive timer network of components 52, 54, and 56 so that a charging signal is applied to capacitor 56, and a biasing signal is applied to unijunction transistor 60 so that a bias is imposed on control electrode 58 of transistor 60. After the time interval necessary for capacitor 56 to charge sufficiently to exceed

the control electrode bias potential, the transistor conducts and a capacitor discharge path is provided through that transistor to the coil of relay 48, discharging capacitor 56 in approximately ten milliseconds and energizing coil 48. With the energization of relay coil 48, its contacts 48-1 close, completing a holding circuit bypassing transistor 60. (Further details of this type of control circuit may be had with reference to co-pending patent application Ser. No. 599,885 entitled "Combustion Control System" filed in the names of Giuffrida and Cade on Dec. 7, 1966.)

Contacts 48-2 in the primary circuit also close, energizing pilot fuel control 20 directly and ignition control 18 through normally closed flame relay contacts 46-3. Fuel starts to flow to the pilot burner and is ignited. When scanner 44 senses the pilot flame, the scanner electronics 42 operate switch 40 to complete a circuit to energize flame relay coil 46. (During this interval the lockout switch actuator 50 is also heated through the low impedance path completed by contacts 48-1 that bypasses the higher resistance network of components 52 and 54 and transistor 60.)

On detection of flame and energization of coil 46, a second holding circuit for control relay coil 48 is completed through switch 40 and flame relay coil 46. The first holding circuit (including the lockout actuator) is interrupted by the opening of contacts 46-1. Also, contacts 46-4 close (to permit fuel to flow to the main burner) and contacts 46-3 open (terminating the ignition). Thus a normal combustion condition has been established in the combustion chamber.

Should flame fail after it has been established in the combustion chamber, switch 40 will open and both relay coils 46 and 48 will be immediately de-energized. The relays are designed so that contacts 48-2 open before contacts 46-3 close, thereby insuring that even momentary energization of the ignition control 18 is avoided. The circuit immediately commences a purge operation via blower 16 and the switch contact 16-1 which remain closed. The circuit through lockout heater 50 is completed with the closing of contacts 46-1 to initiate charging of capacitor 56, to provide a timed purge interval. When that interval is complete, transistor 60 conducts to energize control relay 48 and initiate an ignition cycle. Should flame not be established within a predetermined time, the lockout heater, which is operatively energized during this ignition cycle, will operate to open contacts 50-1 and lockout the combustion apparatus in safe condition.

A circuit arrangement similar to FIG. 1 is shown in FIG. 2. In that circuit, control power is applied at terminals 110, 112. Connected in series with terminal 110 are operating controls such as a limit switch 113 and a thermostat 114. The system further includes a blower control 116, an ignition control 118, a pilot fuel control 120, a main fuel control 122 and an alarm 123. In addition, switch 116-1, responsive to air flow produced by blower 116, is connected in series between the operating controls and the primary winding 130 of transformer 132.

Transformer 132 has two secondary windings 133 and 134. A rectifying diode 136 and a shunt capacitor 138 are connected between the upper terminal of secondary winding 134 and tap 135 across a 15.5 volt section of the secondary winding 134. The lower section of the secondary winding 134 provides 280 volts. Connected across the output of the rectifier circuit is a series circuit of a transistor switch 140 that is responsive to a signal from electronic amplifier circuitry actuated by flame sensor 144, the solenoid coil 146 of flame relay and the solenoid coil 148 of the control relay. The flame relay coil 146 has an impedance of four hundred ohms and the control relay coil 148 has a total impedance of seventy ohms and a tap 149 at ten ohms.

Also connected across the rectifier output is a series circuit of lockout actuator 150, normally closed flame relay contacts 146-1, and a resistive capacitive timer network

that includes resistors 152, 153, 154, 155, and capacitor 156. The junction between resistor 155 and capacitor 156 is connected to the control electrode 158 of unijunction transistor 160. A normally open contact 148-1 is connected in a circuit between flame relay contact 146-1 and tap 149 to bypass the unijunction transistor 160 and the resistive capacitor timer network to provide a holding circuit for control relay 148 once that relay has been energized. A normally open flame relay contact 146-2 is connected in shunt with capacitor 156 to provide a discharge path for that capacitor whenever flame relay 146 has been energized.

In addition, in the transformer primary section of the circuitry there is provided normally closed contacts 150-1 which are opened by lockout switch heater 150; normally open lockout switch contact 150-2 which are closed by the lockout switch heater 150 to energize alarm 123; normally open contacts 148-2 which are closed by energization of the control relay 148; and two sets of contacts operated by the flame relay, normally closed contacts 146-3 and normally open contacts 146-4.

The flame sensor 144 is connected to terminal 160 of 280 volt secondary winding 133 through a parallel circuit of capacitor 162 and resistor 164. The other terminal 166 of winding 133 is connected to a tapped readout inductor 168 which, via two diodes 170 and resistor 172, is connected to the input of the scanner electronics. The scanner electronics includes amplifier transistor 174 which controls operation of the switch transistor 140 and has connected in its control circuit an integrating network including capacitor 176 and resistor 178.

In operation, terminals 110 and 112 are normally continuously energized. In response to a call for heat signalled by control 114 blower 116 is energized through the normally closed lockout switch contacts 150-1. As soon as air flow is produced by blower 116, switch contacts 116-1 close and the primary winding 130 of transformer 132 is energized. The scanner 144 is energized from the secondary winding 133 of transformer 132 and the scanner electronics and control circuitry energized from the secondary winding 144. If the proper conditions exist in the supervised system and the circuitry is otherwise operating properly, flame relay 146 remains de-energized. In this event a circuit is completed through the lockout switch actuator 150, closed flame relay contacts 146-1 and the resistive capacitive timer network of components 152-156 so that a charging signal is applied to capacitor 156 and a biasing signal is applied to the unijunction transistor 160 so that a bias is imposed on its control electrode 158. After the time interval necessary for capacitor 156 to charge sufficiently to exceed the control electrode bias potential, transistor 160 conducts and a capacitor discharge path is provided through that transistor across the entire coil 148. This current flow through coil 148 places the control relay in picked up condition and causes contacts 148-1 to close. Those contacts complete a holding circuit bypassing transistor 160, from the lockout switch heater 150 through the normally closed flame relay contacts 146-1, the now closed control relay contacts 148-1 and the ten ohms section of control relay winding 148. (This ten ohm section of coil 148 may be wound near the pole piece so that it represents a larger percent of the total turns of the coil and therefore greater flux per ohm of coil resistance.)

Contacts 148-2 in the primary circuit also close, energizing pilot fuel control 120 directly and ignition control 118 through the normally closed flame relay contacts 146-3. Fuel starts to flow to the pilot burner and is ignited. When scanner 144 senses the pilot flame, a signal is applied to transistor 174 and that transistor operates switch 140 to complete a circuit to energize the flame relay coil 146. With the energization of coil 146, current also flows through the entire winding of control relay coil 148 in a maintaining circuit. The first holding circuit (including the lockout switch actuator 150) is interrupted by the opening of contacts 146-1. Also, contacts 146-4 close (to permit

fuel to flow to the main burner) and contacts 146-3 open (terminating ignition). Thus a normal combustion condition has been established in the supervised combustion chamber.

Should flame fail after it has been established in the combustion chamber, switch 140 will open and both relay coils 146 and 148 will be immediately de-energized. The relays may be designed so that contacts 148-2 open before contacts 146-3 close, thereby insuring that there will not be even momentary energization of the ignition control 118 in this event. The circuit immediately commences a purge operation via blower 116 and the switch contact 116-1 which has remained closed. The circuit through lockout heater 150 is completed with the closing of contacts 106-1 to initiate the charging of capacitor 156, to provide a timed purge interval. When that interval is complete, transistor 160 conducts to energize control relay 148 once again and initiate an ignition cycle. Should flame not be established in the combustion chamber within the predetermined time, the lockout heater, which is operatively energized during the ignition cycle as indicated above, operates to open contacts 150-1 and lock out the combustion apparatus in safe condition.

Another embodiment is shown in FIG. 3 in which the control relay coil has two independent sections 248a and 248b, section 248a being connected in series with the output circuit of transistor 260 and section 248b being connected in series with flame relay coil 246. In this arrangement, in response to a request for burner operation, capacitor 256 starts to charge. When that capacitor is charged sufficiently to exceed the bias on the control electrode 258, transistor 260 conducts and capacitor 256 discharges through the coil 248a, providing sufficient current to pick up relay 248 and close contacts 248-1. With the completion of that circuit, a low impedance circuit for heater 250 is established and ignition is initiated. When flame is sensed, transistor 240 conducts and the resulting current flow through coils 246 and 248b picks up flame relay 246 and the current flow through heater 250 is terminated upon the opening of contacts 246-1. Coil 248a then becomes de-energized but coil 248b maintains the control relay in picked up condition until flame in the combustion chamber terminates at which time both the flame relay and the control relay drop out in response to the opening of switch 240.

Another embodiment of the invention is shown in FIG. 4 in which components similar to those employed in FIG. 1 are indicated by a primed reference numeral. Thus, terminals 10', 12' are normally energized from a suitable source of power. Operating control 14' has connected in series with it lockout contacts 50-1' and air flow switch contacts 16-1' to energize the primary 30' is connected through diode rectifier 36' to energize scanner electronics 42' which respond to scanner 44' and operate transistor switch 40', which, when closed, energizes the coil of flame relay coil 46'. The combustion control elements in the primary circuit are connected in identical arrangement to those shown in FIG. 1.

The transformer 34 has a center tap 70 to which is connected control relay contacts 48-3. A second diode 72 and capacitor 74 provides a rectifier source for the timing network, which includes resistors 52', 54', capacitor 56' and transistor 60', and the control relay 48'.

There is also connected between flame relay coil 46' and control relay coil 48' a control circuit that includes transistor 76 which has its output circuit connected in shunt with coil 48' and its base electrode connected to a network includes capacitor 78 and resistors 80 and 82.

It will be seen that the sequence of operation is similar to that of FIG. 1. In response to a request for heat from operating control 14', blower 16' is energized and switch contacts 16-1' close to energize transformer 32'. The scanner electronics 42' are energized and if the circuitry is operating properly transistor switch 40' does not conduct. The timer is energized through lockout switch

heater 50' and closed flame relay contacts 40-1 and rectifier 72 to delay energization of control relay 48' for a predetermined interval. Upon energization of control relay 48', contacts 48-2' close, energizing ignition 18' and pilot fuel control 20'. Contacts 48-3 close to complete a low impedance path for heating of lockout actuator 50 until flame is detected and at the same time provide a low voltage signal for maintaining the control relay energized. When flame is established in the combustion chamber, the scanner 44' provides an indication of this fact to operate switch 40' and energize flame relay 46'. Capacitor 78 which has charged during the timing interval discharges through transistor 40' Should a flame failure signal occur transistor 40' ceases conducting and a positive voltage transition is applied via capacitor 78 to cause transistor 76 to conduct and shunt control relay coil 48' so that the control relay is de-energized and contacts 48-2 open, terminating the flow of fuel to the combustion chamber. Through selection of suitable relay configurations the opening of contacts 48-2' is insured before contacts 46-3' close so that ignition after flame failure is prevented until a purge cycle has been completed.

While particular embodiments of the invention have been shown and described, various modifications will be apparent to those skilled in the art. Therefore, it is not intended that the invention be limited to the disclosed embodiments or to details thereof and departures may be made therefrom within the spirit and scope of the invention as defined in the claims.

What is claimed is:

1. Burner control apparatus for use with a fuel burner installation having a combustion chamber, comprising an ignition control, a fuel control for controlling the flow of fuel to said combustion chamber,

- a control relay having a normally open switch which is closed upon energization of the relay in response to a request for initiation of flame in the combustion chamber,
- a flame relay having a normally open switch and a normally closed switch, which switches are operated upon energization of the flame relay in response to detection of flame in the combustion chamber,
- a flame sensor for providing an output signal in response to the sensing of flame in the combustion chamber,
- a first circuit including said control relay switch and said normally open flame relay switch for energizing said fuel control,
- a second circuit including said control relay switch and said normally closed flame relay switch for energizing said ignition control,
- a third circuit including an electronic timing device connected to energize said control relay a predetermined time interval after it has been energized, and means to maintain said timing device in reset condition while flame is detected in said combustion chamber,
- and means including a fourth circuit for de-energizing both said flame relay and said control relay substantially simultaneously on failure of said output signal from said flame sensor so that said ignition control is not immediately reenergized upon flame failure.

2. The apparatus as claimed in claim 1 and further including a blower control and a circuit responsive to said blower control for energizing said control relay only after a predetermined time interval has expired after failure of said flame signal.

3. Burner control apparatus for use with a fuel burner installation having a combustion chamber, comprising an ignition control, a fuel control for controlling the flow of fuel to said combustion chamber,

- a control relay having a normally open switch which is closed upon energization of the relay in response to a request for initiation of flame in the combustion chamber,

a flame relay having a normally open switch and a normally closed switch, which switches are operated upon energization of the flame relay in response to detection of flame in the combustion chamber,

a flame sensor for providing an output signal in response to the sensing of flame in the combustion chamber,

a first circuit including said control relay switch and said normally open flame relay switch for energizing said fuel control,

a second circuit including said control relay switch and said normally closed flame relay switch for energizing said ignition control.

a third circuit operable by a demand signal to energize said control relay,

a fourth circuit including a series circuit connection of a flame responsive switch which is closed upon response to said output signal from said flame sensor, the coil of said flame relay and the coil of said control relay,

and means responsive to said output signal to render said third circuit inoperative whereby de-energization of both said flame relay and said control relay occurs substantially simultaneously on failure of flame indication from said flame sensor so that said ignition control is not immediately re-energized upon flame failure.

4. The apparatus as claimed in claim 3 wherein the coil of said control relay has a tap and further including a circuit for delaying the pickup of said control relay after a request for heat to provide a purge interval and a holding circuit connected to said tap so that only a small portion of said control relay coil holds said control relay in picked up condition prior to energization of said flame relay coil, and means to open said holding circuit upon pickup of said flame relay.

5. The apparatus as claimed in claim 3 wherein said control relay has two coils, one of said coils being connected in series with said flame relay coil and further including a circuit connected to the other of said control relay coils for delaying the pickup of said control relay after a request for heat to provide a purge interval and a holding circuit connected to said other coil so that said other control relay coil holds said control relay in picked up condition prior to energization of said flame relay coil, and means to open said holding circuit upon pickup of said flame relay.

6. Burner control apparatus for use with a fuel burner installation having a combustion chamber, comprising an ignition control, a fuel control for controlling the flow of fuel to said combustion chamber,

- a control relay having a normally open switch which is closed upon energization of the relay in response to a request for initiation of flame in the combustion chamber,

- a flame relay having a normally open switch and a normally closed switch, which switches are operated upon energization of the flame relay in response to detection of flame in the combustion chamber,

- a flame sensor for providing an output signal in response to the sensing of flame in the combustion chamber,

- a first circuit including said control relay switch and said normally open flame relay switch for energizing said fuel control,

- a second circuit including said control relay switch and said normally closed flame relay switch for energizing said ignition control,

- and a third circuit including a switch element connected in shunt with said control relay coil and circuit means responsive to failure of said output signal for closing said switch element to de-energize said control relay coil whereby de-energization of both said flame relay and said control relay occurs substantially simultaneously on failure of said output signal

from said flame sensor so that said ignition control is not immediately reenergized upon flame failure.

7. The apparatus as claimed in claim 6 wherein said switch element is a solid state device having an output circuit connected in shunt with said control relay coil and a control electrode, and said third circuit further includes a capacitor coupled between said control electrode and said flame relay coil.

8. Burner control apparatus for use with a fuel burner installation having a combustion chamber, comprising an ignition control, a fuel control for controlling the flow of fuel to said combustion chamber,

a control relay having a normally open switch which is closed upon energization of the relay in response to a request for initiation of flame in the combustion chamber,

a flame relay having a normally open switch and first and second normally closed switches, which switches are operated upon energization of the flame relay in response to detection of flame in the combustion chamber,

a flame sensor for providing an output signal in response to the sensing of flame in the combustion chamber,

a first circuit including said control relay switch and said normally open flame relay switch for energizing said fuel control,

a second circuit including said control relay switch and said first normally closed flame relay switch for energizing said ignition control,

a third circuit for energizing both said flame relay and said control relay responsive to said output signal, and a fourth circuit including a lockout switch actuator, said second normally closed flame relay switch and a timing device connected to energize said control relay a predetermined time interval after it has been energized, said lockout switch actuator and said timing device being connected in series with said second normally closed flame relay switch so that said fourth circuit is disabled upon detection of flame in said combustion chamber whereby said ignition control is not immediately re-energized in response to the loss of said output signal upon flame failure.

9. The apparatus as claimed in claim 8 wherein the coil of said control relay has a tap and said fourth circuit is connected to delay the pickup of said control relay after a request for heat to provide a purge interval and further including a holding circuit connected to said tap so that a portion of said control relay coil holds said control relay in picked up condition prior to energization of said flame relay coil, and means to open said holding circuit upon pickup of said flame relay.

10. The apparatus as claimed in claim 9 wherein said holding circuit includes a normally open switch operated by said control relay for bypassing said timing device upon energization of said control relay.

11. The apparatus as claimed in claim 10 and further including a blower control and a circuit responsive to said blower control for energizing said fourth circuit to pick up said control relay only after a predetermined time interval has expired after failure of said flame signal.

12. The apparatus as claimed in claim 11 wherein said blower control responsive circuit includes a switch responsive to air flow in said combustion chamber.

13. The apparatus as claimed in claim 12 wherein said third circuit includes a series circuit connection of a flame responsive switch which is closed upon response to a flame signal from said scanner, the coil of said flame relay and the coil of said control relay,

and circuitry responsive to the detection of flame in said combustion chamber to render said series circuit the only energizing circuit for said control relay and flame relay coils.

14. The apparatus as claimed in claim 12 wherein said third circuit includes a switch element connected in shunt with said control relay coil and circuit responsive to a flame failure signal for closing said switch element to de-energize said control relay coil.

15. Apparatus for use with a fuel burner installation having a combustion chamber, comprising an ignition control, a fuel control for controlling the flow of fuel to said combustion chamber, a control relay effective to operate a switch in said controls and having coil means, a flame relay effective to operate another switch in said controls and having coil means, a flame sensor for providing an output signal in response to the sensing of flame in the combustion chamber,

a first circuit for energizing said control relay coil means to place said control relay in picked up condition,

a second circuit including at least a portion of said control relay coil means for holding said control relay in picked up condition, and

a third circuit connecting at least a portion of said control relay coil means and said flame relay coil means in series with a switch closed in response to said flame sensor output signal for maintaining both said control relay and said flame relay in picked up condition when said flame sensor is producing an output signal indicative of the presence of flame in the combustion chamber and such that the switch passes the entire current flowing through said portions of the control and flame relay coil means when closed.

16. The apparatus as claimed in claim 15 wherein the coil means of said control relay has a tap and further including a circuit for delaying the pickup of said control relay after a request for heat to provide a purge interval and a holding circuit connected to said tap so that only a small portion of said control relay coil means holds said control relay in picked up condition prior to energization of said flame relay coil means, and means to open said holding circuit upon pickup of said flame relay.

17. The apparatus as claimed in claim 15 wherein said control relay has two coils, one of said coils being connected in series with said flame relay coil means and further including circuit connected to the other of said control relay coils for delaying the pickup of said control relay after a request for heat to provide a purge interval and a holding circuit connected to said other coil so that said other control relay coil holds said control relay in picked up condition prior to energization of said flame relay coil, and means to open said holding circuit upon pickup of said flame relay.

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