

[72] Inventor **William R. Landis**
 Richfield, Minn.
 [21] Appl. No. **884,154**
 [22] Filed **Dec. 11, 1969**
 [45] Patented **Apr. 13, 1971**
 [73] Assignee **Honeywell Inc.**
 Minneapolis, Minn.

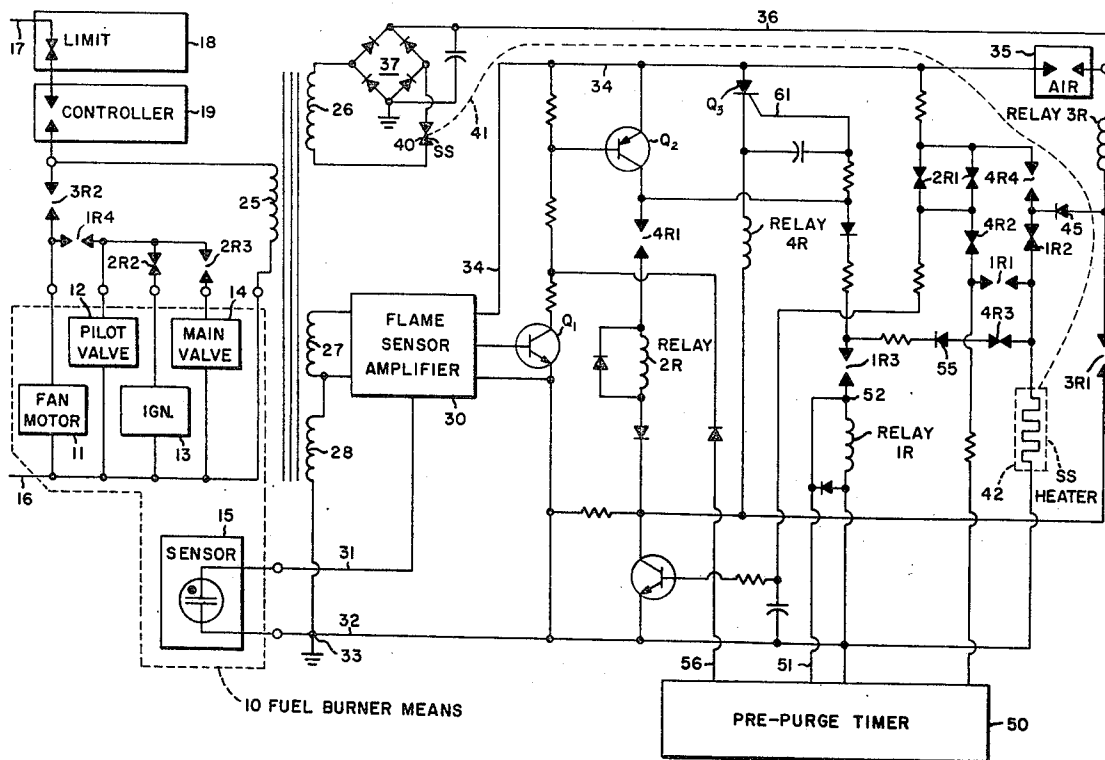
3,433,572 3/1969 Giuffrida 431/31
 3,449,055 6/1969 Blackett 431/31
 3,482,922 12/1969 Blackett 431/26

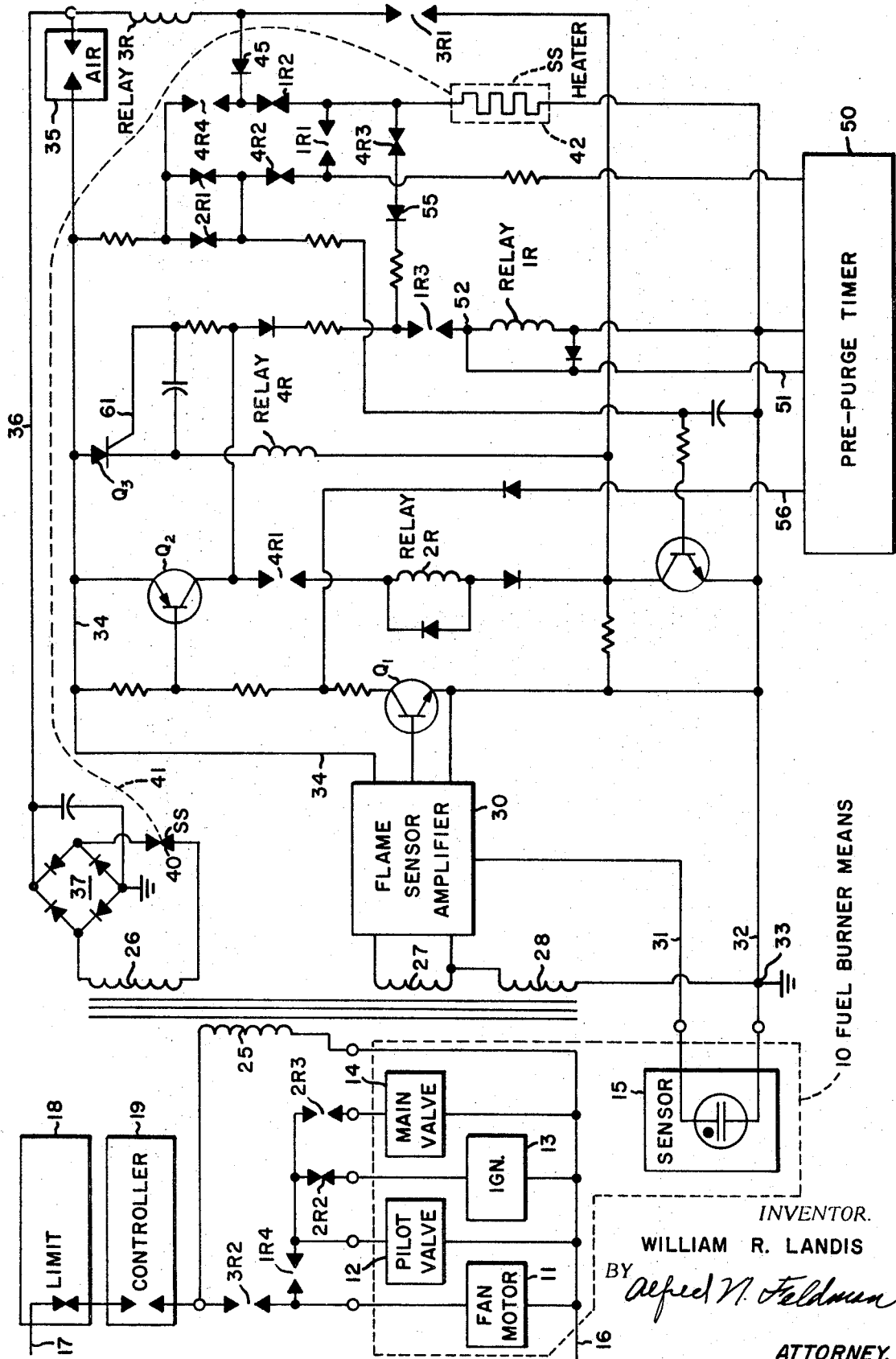
Primary Examiner—Carroll B. Dority, Jr
Attorneys—Lamont B. Koontz and Alfred N. Feldman

[54] **BURNER CONTROL SYSTEM**
 8 Claims, 1 Drawing Fig.
 [52] U.S. Cl. 431/26,
 431/31
 [51] Int. Cl. **F23n**
 [50] Field of Search 431/26, 31

[56] **References Cited**
 UNITED STATES PATENTS
 3,393,037 7/1968 Giuffrida et al. 431/31

ABSTRACT: A fuel burner control system which includes a flame detecting unit and an electrically heated safety switch for safely starting and operating a fuel burner. The burner control system utilizes a time delay circuit for purging a combustion chamber prior to a trial for ignition. The system includes a conventional fan relay, ignition relay, and flame relay, but also includes a fourth relay and series connected silicon-controlled rectifier connected to lock the system out or cause the safety switch to heat in the event of a loss of flame signal after the system has properly been started, or in the case of a false flame signal occurring during the purge timing period.





INVENTOR.

WILLIAM R. LANDIS

BY *Alfred N. Feldman*

ATTORNEY.

BURNER CONTROL SYSTEM**CROSS REFERENCE TO RELATED APPLICATIONS**

The present system is an improvement of a system disclosed in the James C. Blackett application, Ser. No. 731,554 filed on May 23, 1968 in the United States and entitled SOLID STATE CONTROL SYSTEM. The subject matter also related to a U.S. Pat. No. 3,449,055 issued on Jun. 10, 1969 to James C. Blackett and which is entitled BURNER CONTROL APPARATUS WITH PREPURGE TIMING.

BACKGROUND OF THE INVENTION

The present invention is directed to an improved burner control system that is capable of overcoming safety deficiencies that now exist in conventional burner control systems and is accomplished by the addition of a nominal amount of additional circuitry and components. The present addition to the previously mentioned systems provides for a nonrecycling type of operation in the event of a flame failure, or in the event of a flame signal large enough to pull in a flame relay during the purge timing period. Both of the additional functions are accomplished by the addition of a single relay and associated circuitry.

SUMMARY OF THE INVENTION

The previously mentioned U.S. Pat. No. 3,449,055 and the pending application, Ser. No. 731,554 both disclose various aspects of a burner control system utilizing solid state components for safe startup and operation of a fuel burner. The present invention adds one additional circuit to the system disclosed in the Blackett application, Ser. No. 731,554. This single additional circuit encompasses a silicon-controlled rectifier and series connected relay. The single additional circuit provides two separate and distinct safety functions not previously found in a single similar type of apparatus. The additional circuit provides for a non recycling type of operation in the event of a flame failure after a burner has been put into normal operation, and this same circuit provides for shutdown of the burner in the event of the generation of a flame signal large enough to pull in a flame relay during the purge timing period in the startup of the burner system.

BRIEF DESCRIPTION OF THE DRAWING

The single FIGURE of the present application is a circuit diagram of a fuel burner control system incorporating the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A fuel burner means 10 is schematically shown and includes such items as a fan motor 11, a pilot valve 12, an ignition means 13, a main valve 14, and a flame sensor 15. The flame sensor 15 may be an ultraviolet radiation sensor, a pair of flame rods, or any other well known flame sensor. Electrical power is supplied to the fuel burner means 10 via conductors 16 and 17 through a normally closed limit control 18, a normally open controller 19, and a plurality of relay contacts 3R2, 1R4, 2R2 and 2R3. The relay contacts are sequenced by the appropriate operation of three relays that will be described later in the description so as to provide energy for the fan motor 11 to purge the fuel burner means 10 of any unburnt fuel before the pilot valve 12 and ignition 13 are energized to provide a pilot flame to in turn light fuel from the main valve 14 which is controlled by contact 2R3. When the controller 19 is closed, in addition to supplying power to the fuel burner means 10, electrical energy is supplied to the transformer winding 25 so that energy can be supplied to the balance of the control system.

Transformer winding 25 is coupled to three further transformer secondary windings 26, 27 and 28. Secondary windings 27 and 28 supply alternating current energy to a flame sensor amplifier 30 of a conventional form. The flame sensor amplifier 30 is connected by conductors 31 and 32 to

the flame or radiation sensor 15. Conductor 32 is grounded at 33 and forms a ground for the entire system. The flame sensor amplifier 30 has direct current energization supplied on conductor 34 through an air switch 35 that closes when the fan motor 11 provides adequate air flow to insure purging of the fuel burner means 10 during purge timer period. Air switch 35 is further connected by conductor 36 to a rectifier bridge 37 of a conventional design which is energized from the transformer secondary 26 to supply direct current on conductor 36 for the control system. Connected between the transformer secondary 26 and the bridge 37 is a safety switch contact 40 that is mechanically coupled at 41 to a safety switch heater 42. The safety switch heater functions in the control system, as is well known in the art, and its energization over a sufficient period of time causes the safety switch contacts 40 to open thereby removing the direct current on conductor 36 from the control system and causing the system to close down the fuel burner means 10 in a safe fashion.

Directly connected to conductor 36 and energized thereby is a relay 3R and a locking contact 3R1 for relay 3R. The relay 3R is also connected through a diode 45 and a normally closed contact 1R2 to the safety switch heater 42 to the ground circuit for the system. As soon as energy is supplied on conductor 36 to relay 3R, current flows through the diode 45 and the normally closed contact 1R2 through the safety switch heater 42 checking the continuity of the safety switch heater and pulling in the relay 3R. As soon as the relay 3R pulls in its locking contact 3R1 closes the relay in until such time as the energy on conductor 36 is removed. The closing of relay 3R also immediately closes the contact 3R2 which starts the fan motor 11 which in turn operates the air switch 35. As soon as the air switch 35 closes, direct current energy is supplied on conductor 34 to the flame sensor amplifier 30 along with a number of other circuits that will be outlined below.

As soon as the air switch 35 closes and energy is supplied on conductor 34, current flows through a pair of normally closed redundant contacts 2R1 and a normally closed contact 4R2 to a prepurge timer 50. The prepurge timer 50 is an electronic timing device that has an output current on conductor 51 that flows to a junction 52 between a normally open relay contact 1R3 and a relay 1R. The relay 1R is the ignition relay and current flows through the relay 1R from the junction 52 to ground. The flow of current through relay 1R occurs after the purge timing function of the prepurge timer 50 has occurred and pulls the relay 1R in along with its associated contact 1R4 in the energizing circuit for the fuel burner means 10. The closing of contact 1R4 supplies electrical energy to the pilot valve 12 and ignition means 13 thereby starting the ignition of the burner means 10.

The operation of relay 1R also closes an additional relay contact 1R1 that connects the safety switch heater 42 to a source of potential through the normally closed contact 4R2 and the normally closed contacts 2R1. The closing of 1R1 and subsequent energization of the safety switch heater 42 is proved because relay 1R's holding current flows through contacts 1R1, 4R3, diode 55, contact 1R3 into junction 52 and relay 1R. The ignition relay will drop out and purge timing will begin if relay 1R fails to hold in. If the circuit established by the closing of contact 1R1 is not interrupted within a set period of time, the safety switch heater 42 will function to turn "off" the system in a safe fashion. In a normal startup, however, this will not occur as will be noted in the subsequent description of the function of the relay contacts 2R1, and 4R2.

As soon as the pilot valve 12 and ignition means 13 are energized, ignition radiation is generated and sensed by sensor 15. The ignition radiation causes the flame sensor amplifier 30 to become active thereby causing a pair of transistors Q1 and Q2 to conduct. The conduction of transistor Q2 can occur through three different paths that will be outlined below. In a normal startup sequence current flows from the conductor 34 through the transistor Q2 and through a gate circuit 61 of a silicon-controlled rectifier Q3 which is connected between the conductor 34 and a circuit which eventually reaches the

ground conductor 33. Current flowing in the gate circuit 61 of the silicon-controlled rectifier Q3 causes the silicon-controlled rectifier Q3 to conduct through a relay 4R which is the safety circuit relay of the present invention. The conduction of the silicon-controlled rectifier Q3, once started, does not cease until the direct current supplied on conductor 34 is interrupted and the silicon-controlled rectifier Q3 and relay 4R becomes a form of latching type switch means. As such, the relay 4R is continuously energized as long as the silicon-controlled rectifier Q3 conducts. The relay 4R has contacts 4R1, 4R4, and 4R3 along with the previously mentioned contact 4R2. The operation of the relay 4R causes the contact 4R2 to open thereby removing heating current from the safety switch heater 42 and disabling the prepurge timer 50. The contact 4R3 also opens to disable the relay 1R holding circuit used during a normal startup. Contact 4R4 is closed to provide a latched safety circuit that remains in a standby condition as long as the relay 1R and its associated contact 1R2 remains operated.

As soon as the relay 4R becomes operative and the contact 4R1 closes, a final relay 2R is energized and relay 2R is commonly referred to as the flame relay. Relay 2R has associated with it the contacts 2R2 and 2R3. Contact 2R2 opens the ignition circuit and 2R3 closes the circuit to the main valve 14. As soon as the relay 2R has operated to open the contact 2R2 and close contact 2R3, the burner means 10 is in normal full operation and the flame sensor 15 senses the flame of the pilot and main burner. At this time also, contacts 2R1 have opened thereby removing one of the possible paths of current to the safety switch heater 42.

While the operation of the individual circuits were brought out above, a brief summary of the operation of the system in normal startup will be again noted. At normal startup, the controller 19 closes its contacts to supply alternating current energy to the flame sensor amplifier 30 and direct current energy on conductor 36 to the air switch 35. As soon as energy is supplied on conductor 36, the fan motor 11 is started by the relay 3R pulling in through the safety switch heater 42 to check the continuity of the safety switch heater and to lock the relay 3R in by means of contact 3R1. As soon as sufficient air flow has been proved, the air switch 35 closes supplying direct current potential to the balance of the circuit. As soon as this energy is supplied on conductor 34, current flows through the relay contacts 2R1 along with contact 4R2 to the prepurge timer 50 to start a purge timing interval. As soon as the timing interval has been appropriately timed out, current flows in conductor 51 to the junction 52 to operate the relay 1R along with the contacts 1R3 and 1R4. The relay contact 1R3 provides a holding circuit through the normally closed contact 4R3 and the contact 1R1. Also operated at this time is the contact 1R4 which energizes the pilot valve 12 and ignition means 13. As soon as ignition is started, the sensor 15 operates the flame sensor amplifier 30 to cause the transistors Q1 and Q2 to conduct. The conduction of current through the transistor Q2 starts through the gate circuit 61 of the silicon-controlled rectifier Q3 and this operates relay 4R, contact 4R1, and relay 2R which opens the ignition contact 2R2 and closes the main valve contact 2R3. At this same time, the parallel contacts 2R1 operate to an "open" position leaving the system in a normal "run" condition until such time as the controller 19 is opened. At any time that controller 19 opens, all of the alternating and direct current is removed from the system and the system turns "off" the fuel burner means 10 in a normal and safe fashion.

The control system disclosed operates in substantially the same fashion as that disclosed in the Blackett application Ser. No. 731,554 except that the silicon-controlled rectifier Q3 and the relay 4R along with the contacts 4R1, 4R3, 4R4, and 4R2 have been added along with some minor additional components to provide two safety functions. The two safety functions are a nonrecycling shutdown of the entire system in the event of (1) a loss of flame signal to the sensor 15, and (2) a flame signal large enough to pull in the flame relay 2R

through operation of Q2 from the sensor 15 during the purge timer portion of the operation of the system. These two functions will be described below.

If during the normal operation of the system the sensor 15 loses the sense of radiation, the flame sensor amplifier 30 operates to run turn "off" the conduction through transistor Q2. The loss of conduction through transistor Q2 causes the relays 1R and 2R to be deenergized. The loss of the conduction through Q2, however, does not cause the silicon-controlled rectifier Q3 to cease conduction. The silicon-controlled rectifier Q3 can only be brought out of conduction by removing the direct current potential on conductor 34. The loss of the holding currents for the relays 1R and 2R operate their associated contacts 1R4, 2R2, and 2R3, which turn "off" the pilot valve 12, ignition means 13, and main valve 14. The operation of relays 1R and 2R also causes the normally closed contact 1R2 which is associated with the relay 1R to close completing a circuit through the safety switch heater 42. The safety switch heater current is prevented from being shorted to ground by diode 45. During the safety switch heating period, the prepurge and 1R holding circuit is disabled by 4R2 and 4R3 contacts. As soon as the safety switch heater 42 has been energized for its timing period, the safety switch contact 40 opens removing the direct current potential on conductor 36 thereby shutting down the system. This type of a shutdown requires manual resetting of the safety switch 40 and a normal restart of the system.

The second safety function added by the present invention utilizes basically the same components but at a different portion of the operating cycle of the overall control system. The function now described occurs during the purge timer operation at which time the transistors Q1 and Q2 have not yet normally been brought into operation. As long as transistors Q1 and Q2 have not been brought into operation, the silicon-controlled rectifier Q3 and the relay 4R also are not in operation. A spurious or false signal from sensor 15, causes the flame sensor amplifier 30 to operate. The operation of the flame sensor amplifier 30 causes the transistors Q1 and Q2 to conduct through the silicon-controlled rectifier Q3 pulling in relay 4R. Since this occurs during the purge timer operation, the relay 1R and its associated contacts have not been energized. The purge timer and associated circuits prevent false operation of 1R by opening 4R2 contacts before purge timing is completed. No current pulses to the 1R relay are caused by the deenergization of the purge timer 50 because its timer capacitor (not shown) discharges through conductor 56 and transistor Q1 to ground before relay 4R pulls in. The operation of relay 4R during the purge time causes a completed circuit through the contact 4R4 and the normally closed contact 1R2 to the safety switch heater 42 thereby starting the safety switch heating. The relay 4R once having been pulled in by the operation of the silicon-controlled rectifier Q3 does not drop out until the safety switch heater 42 has caused the safety switch 40 to open removing the direct current from the conductor 34. It is thus apparent that whenever a false signal large enough to pull in 2R occurs at the sensor 15 prior to the operation of the relay 1R, the relay 4R becomes energized and stays energized to cause the safety switch heater 42 to operate the safety switch contact 40 to shutdown the system.

It is thus apparent that the addition of a silicon-controlled rectifier and relay form a latching switch means. The placing of the relay contacts in such a manner as to require their operation in proper sequence with the balance of the relay contacts add safety functions that can be obtained at two different points of operation in the normal control system operation. The simple addition of these nominal components provides for two different safety functions that are not normally found in a single normal fuel burner control system. The individual safety functions provided by the addition of the silicon-controlled rectifier Q3 and the relay 4R can individually be found in fuel burner control systems but are not available in a single device and further are not available

through the function of a single set of components. The dual safety function from a single set of components forms the present invention and has been described in a preferred configuration in a known embodiment of a fuel burner control system. This specific example in no way is intended to be a limitation of the scope of the present invention but is merely an example of a preferred embodiment. As such, the applicant wishes to be limited in the scope of his invention solely by the scope of the appended claims.

I claim:

1. A control system adapted to operate fuel burner means having flame sensor means to sense the presence or absence of flame at said burner means, and safety switch means to shutdown said fuel burner means in the event of a malfunction of said system or said burner means, including: control voltage supply means responsive to a demand for operation of said burner means to energize said control system; purge timer means energized by said voltage supply means and including switch means to time a purge period prior to ignition of said burner means and said switch means initiating the ignition of said burner means; sensor means responsive to flame connected to latching switch means; and flame responsive switch means; said latching switch means normally energizing said flame responsive switch means in response to flame at said sensor means with operation of said latching switch means and the subsequent operation of said flame responsive switching means providing operation of said burner means in normal operation until said control voltage supply means is removed at the end of said demand for operation of said burner means; said sensor means and latching switch means operating in response to flame occurring during the purge period to in turn disable said purge timer means to prevent ignition at said burner means and to energize said safety switch means; said sensor means and latching switch means operating said safety switch means to lockout the operation of said system in the event said sensor means indicates the absence of flame after the initial sensing of flame subsequent

to the purge period.

2. A control system adapted to operate fuel burner means as described in claim 1 wherein said latching switch means includes a silicon-controlled rectifier and series connected relay means; said silicon controlled rectifier upon conducting energizing said relay means and maintaining said relay means energized until said control voltage supply means is deenergized.

3. A control system adapted to operate fuel burner means as described in claim 2 wherein said relay means is an electromagnetic relay with at least one normally open contact connected to control said flame responsive switch means.

4. A control system adapted to operate fuel burner means as described in claim 3 wherein said control voltage supply means includes a controller and bridge means adapted to be connected to an alternating current source and having a direct current potential output to energize said control system.

5. A control system adapted to operate fuel burner means as described in claim 1 wherein said flame at said burner means to which said sensor means responds generates an ultraviolet output.

6. A control system adapted to operate fuel burner means as described in claim 5 wherein said latching switch means includes a silicon-controlled rectifier and series connected relay means; said silicon-controlled rectifier upon conducting energizing said relay means and maintaining said relay means energized until said control voltage supply means is deenergized.

7. A control system adapted to operate fuel burner means as described in claim 6 wherein said relay means is an electromagnetic relay with at least one normally open contact connected to control said flame responsive switch means.

8. A control system adapted to operate fuel burner means as described in claim 7 wherein said control voltage supply means includes a controller and bridge means adapted to be connected to an alternating current source and having a direct current potential output to energize said control system.

40

45

50

55

60

65

70

75