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GAS FURNACE CONTROL SYSTEM

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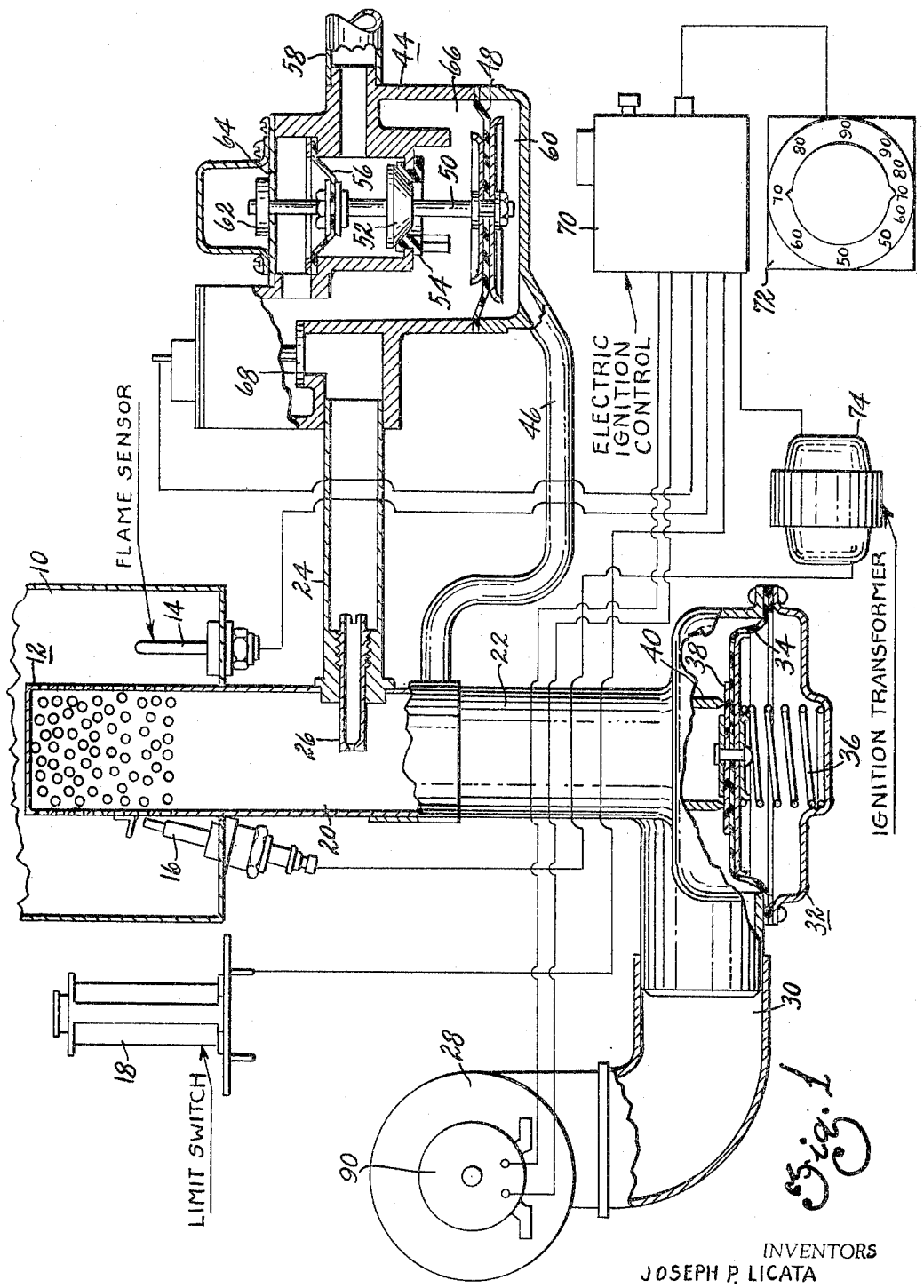



Fig. 1

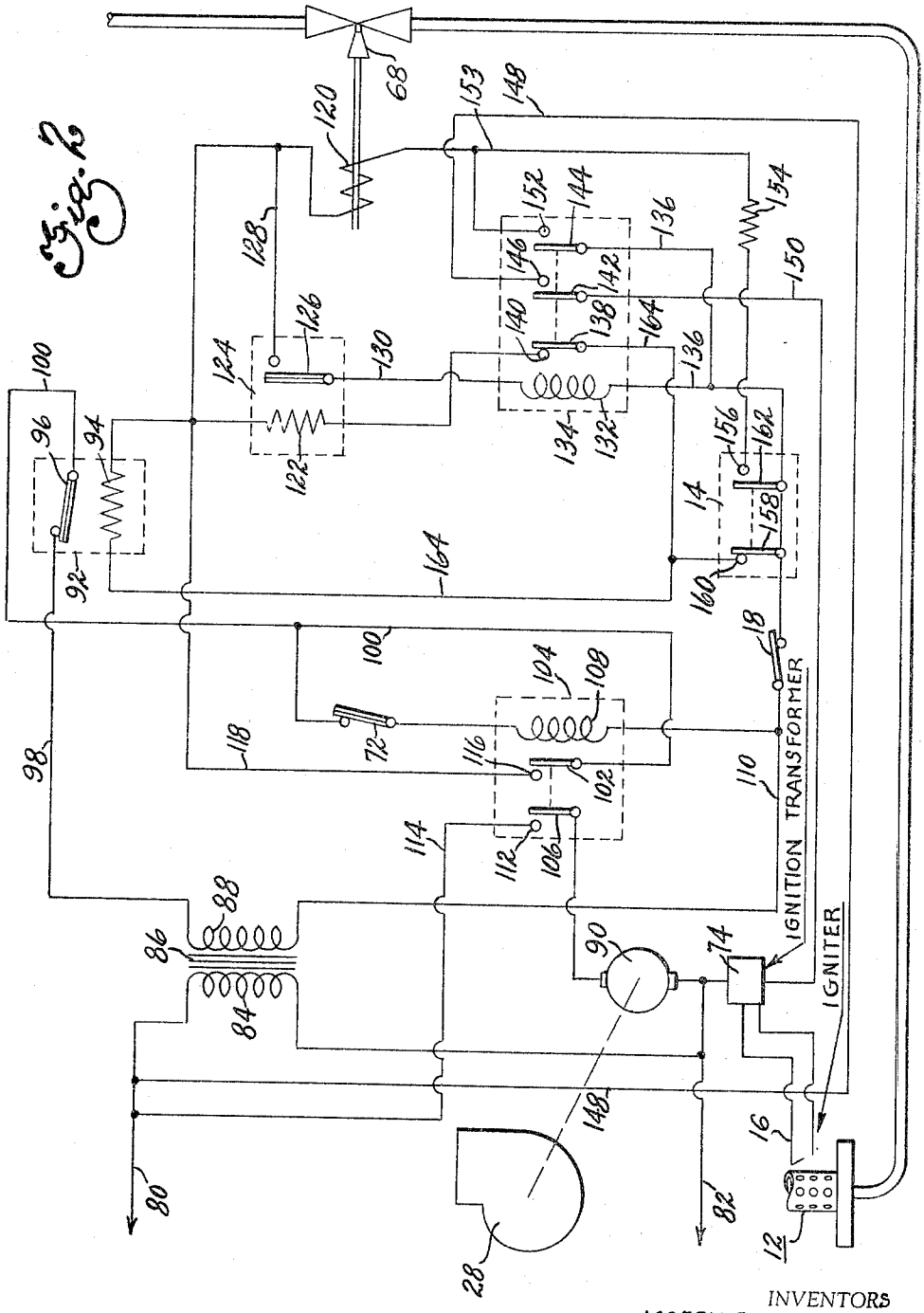

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Fig. 2




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# GAS FURNACE CONTROL SYSTEM

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This invention pertains to gas furnace control systems, and particularly to an improved control system for a pressurized gaseous fuel burner.

Heretofore, pressurized gaseous fuel burners have been manufactured for use in domestic heating systems wherein gaseous fuel is mixed with pressurized combustion air and supplied to a burner whereat it is ignited. In systems of this type it is essential to supply sufficient air to assure complete combustion, and accordingly the control system must include means for maintaining a substantially constant fuel-air ratio. In addition, it is desirable to purge the burner of any gaseous fuel by initiating operation of the combustion air blower prior to opening the gas valve when the unit is started up in response to a demand for heat. The present invention is primarily directed to an improved control system including means for precluding the flow of gaseous fuel into the blower compartment during the off cycle, purging the furnace on start-up, automatically controlling the fuel-air ratio during furnace operation and improving the reliability and safety of a pressurized gaseous fuel burner.

Accordingly, among our objects are the provision of a control system for a pressurized gaseous fuel burner including means for regulating the gas pressure in accordance with combustion air pressure; the further provision of a control system of the aforesaid type including means for precluding the flow of gaseous fuel to the blower compartment during downdraft conditions; the further provision of means for purging the furnace on start-up; the further provision of safety means for precluding the flow of gaseous fuel to the burner in the event the solenoid operated fuel valve fails to close; and the still further provision of an improved spark ignition control system for a pressurized gaseous fuel burner.

The aforementioned and other objects are accomplished in the present invention by embodying a check valve between the combustion air blower and the burner tube and by utilizing a control diaphragm responsive to combustion air and gas pressures to automatically maintain a substantially constant fuel-air ratio. When the combustion air blower is not operating a safety gas valve precludes the flow of gaseous fuel, this valve being urged towards the closed position by a safety magnet and gas pressure. On start-up the burner is purged of any gaseous fuel by timed operation of the combustion air blower prior to engagement of the spark ignition system and opening of the gas valve.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

FIGURE 1 is a schematic layout, partly in section and partly in elevation, of the improved control system for a pressurized gaseous fuel burner showing only the input conductors to all electrically controlled elements except the blower motor.

FIGURE 2 is an electrical schematic of the burner control system.

With reference to FIGURE 1, the improved control system is designed for use with a forced warm air furnace



having a combustion chamber 10 with a distributed port burner tube 12 projecting thereinto. It is to be understood, of course, that the combustion chamber 10 is located in a suitable furnace casing and is connected to heat exchanger means through which the hot flue gases flow. A conventional flame sensor 14 is located within the combustion chamber 10 proximate the burner tube 12, as is a spark igniter 16. A conventional limit switch 18 is located within the furnace casing, not shown, in accordance with usual practice.

The burner tube 12 includes a mixing chamber 20 wherein combustion air and gaseous fuel are mixed. To this end the mixing chamber 20 and the burner tube are connected to combustion air supply conduit 22 and a gaseous fuel supply conduit 24 through a gas orifice tube 26. Combustion air is supplied from a motor driven blower 28 through a conduit 30 to a check valve 32. The check valve includes a pressure responsive diaphragm 34 normally urged by a spring 36 so that valve disc 38 thereof engages valve seat 40. When the check valve disc 38 is closed, communication between the burner tube and the blower 28 is blocked and accordingly gaseous fuel from the combustion chamber 10 cannot flow under downdraft conditions into the blower compartment. However, by virtue of the large annular area of the diaphragm 34 subjected to combustion air pressure upon operation of the blower 28, the valve disc 38 will be unseated whenever the blower 28 is operating.

The static pressure in the conduit 22 is communicated to a combination gas valve and pressure regulator 44 through a tube 46. The static air pressure in chamber 60 acts on the lower surface of a control diaphragm 48 which is connected to a valve stem 50 having a valve element 52 cooperable with a relatively soft valve seat 54. A balancing diaphragm 56 is attached to the valve stem 50 and closes the upper end of the throttle valve housing. Gaseous fuel is supplied through conduit 58 to the throttling disc housing. The valve stem 50 carries a permanent disc magnet 62 which coacts with a steel plate 64. In the absence of static air pressure in chamber 60, the gas acting on diaphragm 48 will tend to close the valve 52 and the permanent magnet 62 provides a seating force for the valve 52 on its seat 54. Thus, the valve 52 constitutes a safety valve to prevent gas flow when the combustion air blower is not operating. The magnet 62 does not impose any appreciable load on the control diaphragm 48 when the valve is open due to the fact that it is spaced from the steel plate 64.

When the combustion air blower 28 is operating, the static pressure developed in chamber 60 on the lower side of the control diaphragm 48 is sufficient to open the valve 52. The control diaphragm 48 has substantially equal areas exposed to air chamber 60 and gas chamber 66. Accordingly, supply gas from the conduit 58 will flow into the regulating chamber 66 and act on the control diaphragm 48 in opposition to the static air pressure in chamber 47. Thus, the gas is throttled by the valve 52 to obtain a regulated gas pressure in accordance with the static air pressure in chamber 60. A rise in the static air pressure in chamber 60 will result in a further opening of the valve 52, whereas a drop in the static air pressure will result in a further throttling of the gas flow into the regulating chamber 66. It is in this manner that a substantially constant fuel-air ratio is maintained in the mixing chamber 20 with variations in the pressure of the combustion air supplied by the blower 28.

The combination valve assembly 44 also includes a solenoid operated shutoff valve 68 which controls the flow of regulated gas from the chamber 66 to the conduit 24 during burner operation. The solenoid operated valve 68 is controlled by the electric ignition control system 70

which includes a room thermostat 72, an ignition transformer 74, the flame sensor 14, the limit switch 18 and other components to be described.

Referring to FIGURE 2, the electric ignition control system comprise input wires 80 and 82 connected to a 115 volt alternating current power supply which energizes the primary winding 84 of a transformer 86. The transformer 86 includes a secondary winding 88 which supplies 24 volt alternating current power to a secondary circuit. The primary circuit includes a motor 90 for driving the air circulating blower, not shown, and the combustion air blower 28, and the ignition transformer 74. The secondary low voltage circuit includes a conventional manual reset safety switch 92 having a heater 94 and a bimetallic switch element 96, the bimetallic switch element being connected by wire 98 to one side of the secondary transformer winding 88. The bimetallic switch 96 is also connected by wire 100 to movable switch contact 102 of a motor relay 104. The motor relay 104 includes a second movable switch contact 106 and an operating coil 108. The operating coil of the motor relay switch 104 is connected to the wire 100 through the room thermostat switch 72, and is also connected to wire 110. Wire 110 is connected to the secondary transformer winding 88.

Movable switch contact 106 is engageable with a stationary contact 112 connected to a wire 114 for completing the energizing circuit for the blower motor 90. Movable switch contact 102 is engageable with a fixed contact 116 connected to a wire 118. Wire 118 is connected to solenoid coil 120 for operating the gas shutoff valve 68 and is also connected to heater 94 of the safety switch 92 and heater 122 of the time delay relay 124. The time delay relay 124 includes a bimetal switch 126 connected between wires 128 and 130. Wire 128 is connected to wire 118, and wire 130 is connected to an operating coil 132 of an ignition relay 134. The coil 132 is also connected by wire 136 through limit switch 18 to the wire 110. The limit switch 18 remains closed at all times except upon overheating of the furnace.

The ignition relay includes a normally closed switch comprising movable switch contact 138 and fixed contact 140, and two normally open switches having movable switch contacts 142 and 144. Movable switch contact 142 is engageable with stationary contact 146 which is connected by wire 148 to wire 80 of the primary circuit. The movable switch contact 142 is connected by wire 150 to the ignition transformer 74. Movable switch contact 144 is connected to the wire 136, and is engageable with stationary contact 152 connected to wire 153. A resistor 154 is connected between the solenoid coil 120 of the gas valve and a stationary contact 156 of the flame sensor 14. The flame sensor 14 includes a normally closed switch comprising movable contact 158 and stationary contact 160, and a normally open switch comprising movable contact 162 and stationary contact 156. The resistor 154 reduces the current flow in solenoid coil 120 to a level sufficient to maintain the gas valve 68 open, but insufficient to open the gas valve if the flame sensor 14 should fail with its normally open switch 162 closed. The flame sensor 14 operates in response to heat within the combustion chamber 10 during burner operation to open switch 158 and close switch 162 in a manner to be described hereinafter. The ignition relay switch 138 is connected by wire 164 to flame sensor switch 160, and its stationary contact 140 is connected to the time delay heater 122.

## OPERATION

In response to a demand for heat, the thermostat switch 72 closes thereby energizing the secondary circuit from the secondary winding 88 through the normally closed safety switch 96, the wire 100, the thermostat switch 72, the motor relay operating coil 108 and the wire 110. Accordingly, switches 102 and 106 will be closed, with switch 106 energizing the motor 90 to operate the circulating air blower as well as the combustion blower 28. When the combustion blower 28 is operating the valve disc 38 of check valve 32 is unseated thereby supplying combustion air to the burner tube 20 and the combustion chamber 22 so as to purge the unit of any combustible mixture. In addition, a static pressure head is developed in the air chamber 60 of the combination control valve. Gaseous fuel will not be admitted to the mixing chamber 20 since the shutoff valve 68 remains closed. Moreover, valve disc 52 will remain seated due to the pressure which builds up between the regulator valve and the shutoff valve.

The duration of the purging cycle is determined by time delay relay 124. As is apparent when the room thermostat switch 72 is closed, the heater 122 for the time delay relay 124 is energized through motor relay switch 102, wire 118, normally closed ignition relay switch 138, normally closed flame sensor switch 158 and normally closed limit switch 18. Likewise, the safety switch heater 94 is energized from wire 118 through wire 164, switch 158 and the limit switch 18. The time delay 124 will close its switch 126 is approximately 10 seconds. When the time delay relay switch 126 is closed, the ignition relay coil 132 is energized from the secondary winding 88 through wire 110, limit switch 18, wire 136, switch 126, wires 128 and 118, motor relay switch 102, wire 100, safety switch 96 and wire 98.

Upon energization of the ignition relay operating coil 132 switch 138 opens thereby deenergizing the time delay heater 122 to initiate its cooling cycle of 10–15 seconds, and switches 142 and 144 close. Closure of switch 142 energizes ignition transformer 74 and the igniter 16 in the primary circuit through wires 148 and 150. Closure of the ignition relay switch 144 results in energization of the gas valve solenoid coil 120 from wire 110, limit switch 18, wire 136 through the switch 144, coil 120, wire 118, motor relay switch 102, wire 100, safety switch 96 and wire 98. Accordingly, the ignition transformer 74 will provide a spark at the igniter 16 for ignition, and the solenoid coil 120 will open the shutoff valve 68 thus enabling the static pressure head in chamber 60 to unseat valve disc 52 to supply regulated gas through the conduit 24 and the orifice 26 to the mixing chamber 20. The gaseous fuel and combustion air will be mixed in the chamber 20, it being understood that air in excess of that required for complete combustion is supplied by the blower 28. The combustible mixture is supplied to the distributed port burner 12 within the combustion chamber 10. Upon the successful establishment of combustion, the flame sensor 14 will operate its switches so as to open switch 158 and close switch 162. The opening of switch 158 will deenergize the safety switch heater 94. The closure of switch 162 will shunt, or bridge, ignition relay switch 144 in the circuit of the gas valve solenoid coil 120 through current limiting resistor 154. Thereafter, the time delay relay switch 126, which begins its cooling cycle upon energization of the ignition relay coil 132, will reset to its normally open position thus deenergizing the ignition relay coil 132 and terminating electric ignition by closing switch 138 and opening switches 142 and 144.

When the demand for heat has been satisfied by the furnace, the thermostat switch 72 opens. Opening of the thermostat switch 72 will deenergize the motor relay coil 108 whereby switches 102 and 106 will be opened. Opening of switch 106 deenergized the blower motor 90, opening of switch 102 deenergizes the gas valve solenoid coil 120.

If there is a failure to ignite the combustible mixture in response to a demand for heat in accordance with the aforedescribed operation, the flame sensor 14 will not operate its switches 158 and 162. Accordingly, at the end of the normal cycle when the time delay relay switch 126 opens to deenergize the ignition coil 132, the gas valve solenoid coil 120 will be deenergized concurrently with interruption of the ignition circuit. In this event the control system will recycle to again energize the igniter and open the gas valve until such time has elapsed that the

safety switch heater **94** causes opening of switch **96**. In the normal operating sequence, successful ignition must be established within 40 to 90 seconds or the safety switch **96** will open thus deenergizing the entire secondary circuit.

In the event of a flame failure during burner operation, the flame sensor will open switch **162** and close switch **158** thus interrupting energization of the gas valve solenoid coil **120**. Closure of switch **158** by the flame sensor will restrict the time delay relay and safety switch heating cycles as aforedescribed. In the event of a failure of combustion air, the control diaphragm **48** of the combination control valve will immediately respond to movement of the valve disc **52** towards its seat **54** under pressure, and the safety magnet **62** will provide a seating force for the valve disc **52** so as to extinguish the flame.

While the embodiment of the invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

**1.** A control system in a pressurized gaseous fuel burner wherein combustion air is supplied under pressure and mixed with gaseous fuel to form a combustible mixing including a blower for supplying combustion air under pressure, a conduit connecting said blower and said burner, a fuel shut-off valve, pressure regulating means for the gaseous fuel having a connection with said conduit and including a throttling valve and means responsive to pressure of the gaseous fuel and combustion air for controlling said throttling valve to maintain a substantially constant fuel-gas ratio with variations in the pressure of combustion air, said throttling valve comprising a valve disc and a cooperable seat, said valve disc being attached to a valve stem, a safety magnet attached to said valve stem and magnetizable means coacting with said safety magnet to move said valve disc into engagement with its seat upon a loss of combustion air pressure, ignition means for said combustible mixture, means operable to energize said blower in response to a demand for heat to purge the burner of combustible mixture, means operable after a predetermined time delay to energize the ignition means and open the fuel shut-off valve, and means operable to deenergize the ignition means upon successful establishment of combustion.

**2.** A control system in a pressurized gaseous fuel burner wherein combustion air is supplied under pressure and mixed with gaseous fuel to form a combustible mixture including, a blower for supplying combustion air under pressure, a conduit connecting said blower and said burner, a fuel shut-off valve, pressure regulating means for the gaseous fuel having connection with said conduit and responsive to the static pressure therein for maintaining a substantially constant fuel-air ratio with variations in said static pressure, an electric igniter for said combustible mixture, means operable to energize said blower in response to a demand for heat to purge the system of combustible mixture, a time delay relay comprising a heater and a normally open switch, a circuit for energizing said heater simultaneously with said blower in response to a demand for heat so as to continue operation of said blower for a predetermined time interval, means operable to energize the electric igniter after said predetermined time interval comprising a relay operated switch means having an operating coil connected with said time delay relay switch, means operable to open said fuel shut-off valve comprising a solenoid coil having a connection with said relay operated switch means whereby closure of said time delay relay switch effects energization of said ignition relay operating coil to operate said relay operated switch means, and flame responsive means for deenergizing said electric igniter upon successful establishment of combustion comprising a normally closed switch and a normally open switch, said normally closed switch being connected in circuit with the operating coil of said ignition relay switch means and said normally open switch being connected in circuit with said solenoid coil and shunting said relay operated switch means whereby successful establishment of combustion results in opening the normally closed switch and closes the normally open switch to deenergize said electric igniter and continue energization of said solenoid coil.

**3.** The control system set forth in claim **2** wherein a current limiting resistor is connected in the circuit between the solenoid coil and the normally open switch of said flame responsive means to reduce the current flow through the solenoid coil to a level sufficient only to maintain the fuel shut-off valve open.




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