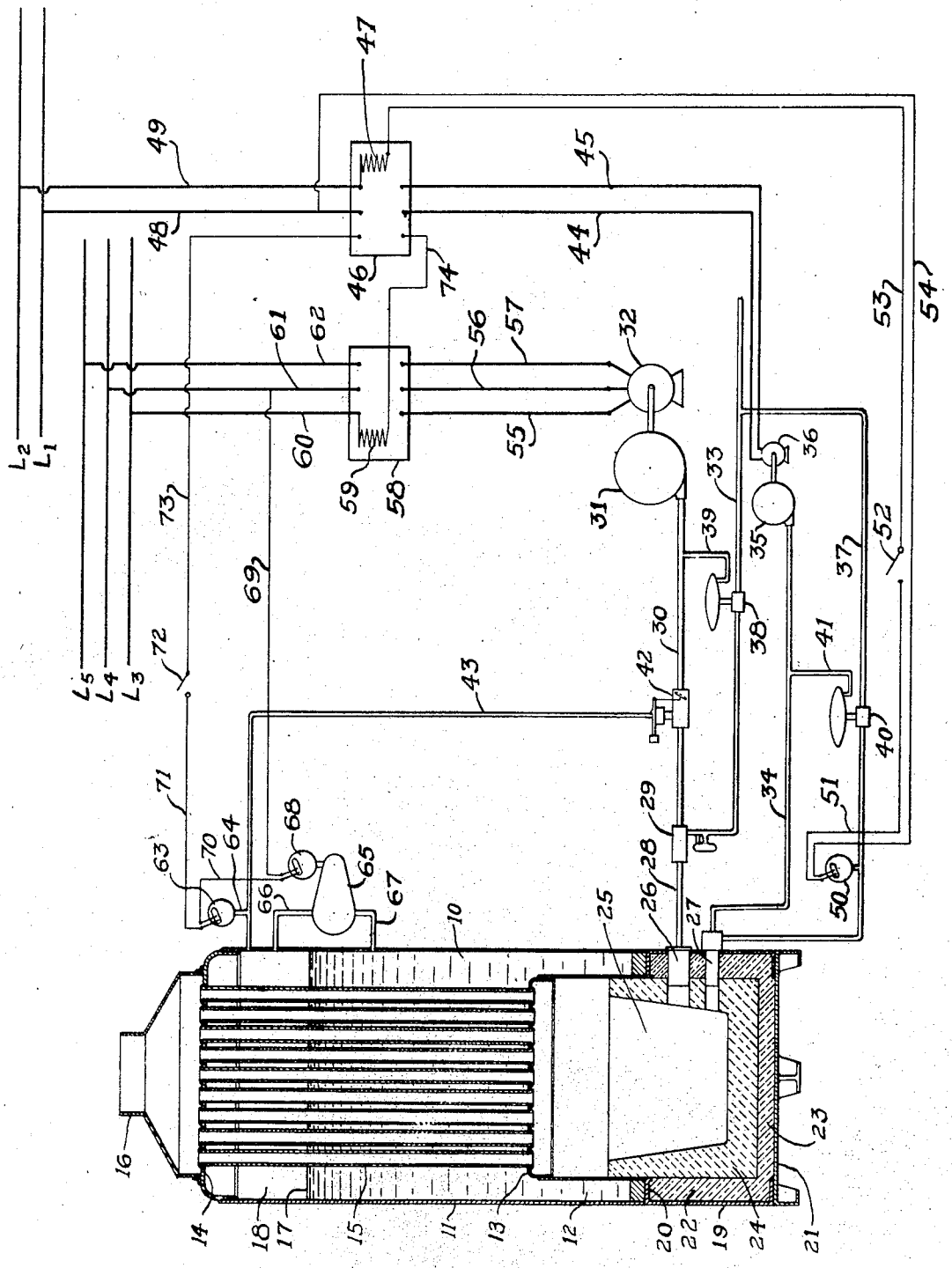
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BOILER CONTROL SYSTEM

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BOILER CONTROL SYSTEM

Application filed August 9, 1929. Serial No. 384,764.

The present invention relates to improvements in control systems for gas-fired boilers and water heaters.

An important object of the present invention resides in the provision of a novel control system in which the supply of gas to both a main burner and a pilot burner is automatically controlled by the supply of air to said burners.

A more specific object of the invention resides in the provision of a control system comprising a main burner, a pilot burner, a proportional air and gas mixer for supplying a combustible mixture to the main burner, means for supplying air under pressure to the mixer, a line for supplying gas to the mixer, means for supplying air under pressure to the pilot burner, a line for supplying gas to the pilot burner, an automatic valve in the gas line to the mixer responsive to the supply of air to the mixer for controlling the supply of gas, an automatic valve in the gas line to the pilot burner responsive to the supply of air to the pilot burner for controlling the supply of gas.

A further object resides in the provision in a control system of the foregoing character of automatic means responsive to the pressure in the boiler for regulating the supply of air to the mixer.

Still another object resides in the general combination making up the control system, said combination including various safety devices individually operable to stop the supply of air and gas to the main burner, for example, when the pressure exceeds a predetermined value, when the water lever falls below a predetermined minimum, and operable to stop completely the supply of air and gas both to the main burner and pilot burner should there be a sufficient drop in the gas main pressure or failure of gas supply which would endanger extinguishing the pilot burner.

Further objects and advantages will become apparent as the description proceeds.

In the accompanying drawing, the figure is a diagrammatic representation of a control system embodying the features of our invention.

While the invention is susceptible of various modifications and alternative constructions, we have shown in the drawing, and will herein describe in detail the preferred embodiment, but it is to be understood that we do not thereby intend to limit the invention to the specific form disclosed, but intend to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

Referring more particularly to the drawing, the control system may be applied to any suitable type of gas-fired boiler or water heater. In the present instance, we have shown diagrammatically a vertical fire tube boiler 10, having an outer shell 11, an annular water leg 12, a bottom tube sheet 13, a top tube sheet 14, vertical fire tubes 15 extending between and fastened to the top and bottom tube sheets, and a flue gas outlet 16. Normally the water level is maintained at the aproximate level of the line 17, the space above this level constituting a steam space 18.

The boiler 10 is mounted on a suitable base structure having a casing consisting of a side wall 19, an inwardly extending top flange 20, and a bottom wall 21. The top flange 20 conforms in size and shape to the annular water leg 12 of the boiler 10 and constitutes a rigid support for the boiler. The side wall 19 has a heat insulating lining 22, and the bottom wall 21 has a heat insulating lining 23. The side wall 19 and the bottom wall 21 are further lined with a refractory lining 24, the refractory lining at the sides extending above the top flange 20 and lining the inside of the annular water leg 12 for a substantial distance above the top flange 20 of the casing of the base structure.

The refractory lining 24, the water legs 12 and the bottom tube sheet 13 form a closed combustion chamber 25. A suitable main burner 26 is inserted in an opening through the side wall 19 of the casing and through the heat insulating lining 22 and refractory lining 24. Only one main burner 26 is shown but any number of main burners may be used.

A pilot burner 27 for igniting the main burner 26 is inserted through an opening in the side wall 19 and the heat insulating lining 22 and refractory lining 24.

The main burner 26 is connected through a fuel line 28 to a suitable proportional mixer 29. Preferably, this mixer is of the type in which a jet of air, adjustable in volume, serves to induce a proportionate flow of gas to form a mixture of predetermined air-gas ratio over a substantial range of supply. The specific construction of this mixer forms no part of the present invention, and therefore is not disclosed herein, but a suitable mixer is disclosed in U. S. Letters Patent No. 1,684,500 granted to G. W. McKee. The mixer 29 is connected through a line 30 to a suitable source of air under pressure, such as a blower 31, adapted to be driven by an electric motor 32. Gas is adapted to be supplied from a suitable source (not shown) through a line 33 to the mixer 29.

The pilot burner 27 is connected through a line 34 to a suitable source of air under pressure. To accomplish an object of this invention the source of air under pressure for the pilot burner 27 is entirely separate from the source supplying air to the main burner 26, and is adapted to be driven by means separate from the means for driving the source of air for the main burner. In the present instance, the source of air for the pilot burner 27 consists of a blower 35 driven by an electric motor 36. The pilot burner 27 is connected through a branch line 37 to the main gas line 33.

In order that no gas will be delivered to the mixer 29 unless there is also a sufficient supply of air being delivered to the mixer, means is provided which is responsive to the supply of air for controlling the supply of gas. This means comprises a diaphragm valve 38 interposed in the gas line 33 between the line 37 and the mixer 29. It will be evident that the valve 38 does not control the supply of gas to the pilot burner 27. One side of the diaphragm chamber of the valve 38 is connected through a line 39 to the line 30 at the outlet side of the blower 31. When the blower is put into operation, and air is supplied to the line 30, air pressure in the line 39 will open the gas valve 38 and conversely, when the supply of air to the line 30 is stopped, the valve will close. Thus, no gas will be supplied to the burner 26 unless a supply of air to the burner is available.

In the same manner, means responsive to the supply of air to the pilot burner 27 for controlling the supply of gas to the pilot burner is provided. This means comprises a diaphragm valve 40 interposed in the gas line 37. One side of the diaphragm chamber of the valve 40 is connected through a line 41 to the line 34 supplying air to the pilot burner 27. When the blower 35 is put into operation, and air is supplied to the line 34, air pressure in the line 41 will open the gas valve 40. When no air is being delivered to the pilot burner, the valve 40 will remain closed.

Interposed in the line 30, between the mixer and the line 39, is an automatic air regulating valve 42. The specific construction of this valve forms no part of the present invention, and therefore is not disclosed herein, but a suitable valve is disclosed in our co-pending application for U. S. Letters Patent Serial No. 348,793 filed March 21, 1929. Preferably, this valve comprises a valve member in the line 30 and operatively connected to an expansible diaphragm. The interior of the latter is connected through a line 43 to the steam space 18 of the boiler 10. On a rising pressure in the steam space 18, the diaphragm expands serving to close the valve proportionately, but the diaphragm does not permit the valve to close completely. Thus, the supply of air to the burner 26, and hence the supply of fuel mixture, is automatically regulated in accordance with pressure conditions in the steam space 18.

Suitable control means is provided for operating the motor 36 which drives the pilot blower 35, said control means being effectual to stop the operation of the motor if the pressure in the gas line 37 to the pilot burner 27 falls below a predetermined minimum. This means comprises a suitable pressure operated switch 50, interposed in the pilot gas conduit 37 between the diaphragm valve 40 and the pilot burner 27. The switch 50 is adapted to remain closed as long as the pressure in the conduit 37 is above a predetermined minimum but should the pressure in said conduit fall below this predetermined minimum then the switch will open automatically. Reclosing of the switch is accomplished by manual means.

Electric current for operating the motor 36 is supplied through two leads 44 and 45 connected to a suitable starting box 46. The starting box 46 is under the control of a suitable electromagnet coil 47. Electric current is supplied to the starting box through two leads 48 and 49 connected respectively to current means L_1 and L_2.

One end of the electromagnet coil 47 is connected to the lead 49. The other end of the electromagnet coil is connected through a lead 53 to one terminal of a manually operated switch 52, the other terminal of said switch being connected through a lead 51 to one terminal of the switch 50. The other terminal of the switch 50 is connected through a lead 54 to the lead 48. Thus it is seen that when the switches 50 and 52 are closed there is a complete circuit between the current main L_1, lead 48, lead 54, switch 50, lead 51, switch 52, lead 53, electromagnet

coil 47, lead 49 and the current main L_2. As long as this circuit remains complete the electromagnet coil 47 operates to maintain the starting box 46 in the closed position permitting current to flow from the mains L_1, and L_2 to the motor 36. In case the switch 52 should be opened manually or if the switch 50 should open due to a fall in gas pressure in the conduit 37, then the circuit through the electromagnet coil 47 would be broken and consequently the starting box would open, breaking the circuit between the current mains L_1 and L_2 thus stopping the operation of the motor 36.

Switch 50 is semi-automatic in its operation and is adapted to be manually reset when it is desired to close the circuit controlling the motor 36 after the switch has been opened automatically due to a fall in gas pressure in the conduit 37. In order to start the pilot motor 36 it is necessary first to manually reset switch 50 and close the manually operated switch 52 in order to complete the circuit controlling the pilot motor. Switch 50 must be held manually in the closed position until sufficient air pressure from the blower 35 has been built up in the conduit 34 and conduit 41 thus opening the diaphragm valve 40 admitting gas to the pilot burner and operating to maintain the switch 50 in the closed position until the gas pressure in the conduit 37 should once again fall below a predetermined value.

Suitable control means also is provided for controlling the motor 32 driving the main blower 31, said control means being effectual to stop the operation of the motor if the pressure in the steam space 18 exceeds a predetermined maximum, if the water level in the boiler 10 falls below a predetermined minimum, if the starting box switch 46 controlling the pilot blower 36 operates to stop the pilot motor or if it is desired to control the motor 32 manually. In the present instance this motor is represented as a three phase motor and it is connected through leads 55, 56 and 57 to a suitable starting box 58 under the control of a suitable electromagnet coil 59. The starting box is connected through leads 60, 61 and 62 to current mains L_3, L_4, and L_5.

A suitable pressure operated switch 63 is provided in communication with the steam space 18 through the line 43 and a branch line 64. The switch 63 operates in such a manner that when the pressure within the steam space is below a predetermined value the switch is closed but if the pressure within the steam space should rise above this predetermined value then the switch will open and when the pressure within the steam space again falls below the predetermined value the switch will close.

Suitable means is provided to control motor 32 in accordance with the water level in the boiler 10. In the present instance a chamber 65 in communication with the steam space 18 through the conduit 66 and with the water space through the conduit 67 is provided. Electric switch means 68 is provided which remains closed as long as the water level in the chamber 65 is above a predetermined level. If the water level in the chamber 65 should fall below this predetermined level then the switch 68 will automatically open and when the water level in said chamber again rises above the predetermined level the switch will close. Devices for operating electric switches in accordance with water level within chambers are well known in the art and the specific construction forms no part of the present invention and hence it is not disclosed.

The starting box 46 is adapted to control the circuit through three leads and is generally known as a three pole starting box, the three poles being under the control of the electromagnet coil 47. In the present instance two poles of this starting box are used across the power leads 44 and 48, 45 and 49, these leads transmitting electric current from the current mains L_1 and L_2 to the motor 36. The third pole of this starting box is used in the circuit controlling the motor 32.

One end of the electromagnet coil 59 is connected to the power lead 60. The other end of the coil being connected through a lead 74 to one terminal of the third pole of the starting box 46. The other terminal of the third pole of the starting box 46 is connected through a lead 73 to a manually operated switch 72. The switch 72 is connected through a lead 71 to one terminal of the pressure operated switch 63. The other terminal of the pressure operated switch 63 is connected through a lead 70 to one terminal of the switch 68 and the other terminal of the switch 68 is connected through a lead 69 to the power lead 61. Thus there is a complete circuit from the power main L_3 through lead 60, electromagnet coil 59, lead 74, the third pole of the starting box switch 46, lead 73, switch 72, lead 71, switch 63, lead 70, switch 68, lead 69, lead 61 and power main L_4. When the switches 72, 63 and 68 are in the closed position and the starting box 46 is closed then the circuit is complete permitting electric current to pass through the electromagnet coil 59 thus maintaining starting box switch 58 in the closed position, and hence supplying current from the mains L_3, L_4, and L_5 to the motor 32.

To start the system from a cold boiler, delivery of gas and air to the pilot burner 27 is started by starting the motor 36 as herein previously described. The pilot burner is lighted by means not shown. Since there is then no pressure in the steam space 18 and consequently no pressure in the conduit 43 the switch 63 will be in the closed position and the air regulating valve 42 will be in the fully

open position. If the water level in the boiler is above a predetermined minimum the water level in the chamber 65 will also be above a predetermined minimum and consequently the switch 68 will be in the closed position. Then to start the motor 32 it is only necessary to close the manually operated switch 72 and thus complete the control circuit through the electromagnet coil 59. Completing the circuit through the electromagnet coil 59 causes the starting box 58 to close and thus the motor 32 and the blower 31 are started.

The blower 31 causes air under pressure to be delivered through the conduit 30 to the mixer 29. Air pressure from the conduit 30 is transmitted through the conduit 39 to the pressure responsive valve 38 causing said valve to open, thus admitting gas to the mixer 29. The mixture of gas and air is delivered through the conduit 28 to the burner 26 and ignited by the burner 27. As the pressure in the steam space 18 increases the pressure in the conduit 43 also increases causing the air regulating valve 42 to partially close thus reducing the amount of air being delivered to the mixer 29 and consequently reducing the amount of mixture of gas and air to the burner 26. If the pressure in the steam space 18 should rise above a predetermined maximum then the switch 63 will open breaking the circuit through the electromagnet coil 59 causing the starting box switch 58 to open, thus the motor 32 and the blower 31 are stopped.

As soon as the blower 31 is stopped there will then be no air pressure in the conduit 30 and consequently no air pressure in the conduit 39 thus the valve 38 will close preventing any further supply of gas to the mixer 29. When the pressure in the steam space 18 again falls below the predetermined minimum the switch 63 will again close starting the motor 32. If the pressure in the steam space continues to fall then the air regulating valve 42 will be caused to open in proportion to the drop in pressure, thus increasing the amount of mixture of air and gas being delivered to the burner 26.

In case the water level in the boiler 10 falls below a predetermined minimum the water level in the chamber 65 will also fall below the predetermined minimum thus causing the switch 68 to open stopping the motor 32. When the water level in the chamber 65 again rises above the predetermined minimum the switch 68 will close and hence start the motor 32. If it is desired to manually stop the motor 32 it is only necessary to open the switch 72. If it is desired to manually stop both motors 32 and 36, it is only necessary to open the switch 52 thus breaking the circuit through the electromagnet coil 47 causing the starting box switch 46 to open, breaking the circuit between the current mains L_1 and L_2 and the motor 36. Opening of the starting box switch 46 breaks the circuit through the electromagnet coil 59, causing the starting box switch 58 to open, breaking the circuit between the current mains L_3, L_4, and L_5 and the motor 32.

It is seen that a failure of electric supply to the motor 32 would cause the blower 31 to stop and thus there would be no air pressure to act on the diaphragm of the valve 38 and it would close preventing any gas from flowing to the main burners 26. In case of a failure of electric supply to the motor 36 there would be no air pressure in the conduit 41 and consequently the valve 40 would close shutting off the gas to the pilot burner 27 and operating to open the switch 50 thus shutting down the entire system until it is manually restarted by resetting switch 50. In any case of failure of gas supply to the conduit 33 the entire system is shut down by means of the switch 50 and even if gas should again be supplied to the conduit 33 no gas would be delivered to the burners 26 or 27 because of the automatic closing of the diaphragm valves 38 and 40 due to the stoppage of the blowers 31 and 35 and motors 32 and 36 which cannot be restarted automatically if the switch 50 is open.

We claim as our invention:

1. A control system for boilers comprising, in combination, a main burner, means for supplying air under pressure to said main burner, means for supplying fuel to said main burner, a valve means interposed in said last mentioned means and operatively connected to said first mentioned means to control the supply of fuel, said valve means being operable to prevent the supply of fuel when said first mentioned means is inoperable, a pilot burner, means for supplying air under pressure to said pilot burner, means for supplying fuel to said pilot burner, and a valve means interposed in said last mentioned means and operatively connected to said pilot burner air supply means to control the supply of fuel, said last mentioned valve means being operable to prevent the supply of fuel when said pilot burner air supply means is inoperable.

2. A control system for boilers comprising, in combination, a burner, a source of air under pressure, a line connecting said source to said burner, a proportional air and gas mixer interposed in said line, a gas supply line connected to said mixer, a pressure responsive valve in said gas line, means for transmitting the pressure of said source to said valve to open the latter, a pilot burner, a second source of air under pressure, a line connecting said second source to said pilot burner, a gas supply line connected to said pilot burner, a pressure responsive valve in said last mentioned gas supply line, means for transmitting the pressure of said second source to said last mentioned valve to open

the latter, and pressure-operated means controlled by the supply of gas to said pilot burner operable to prevent the supply of air to both burners when the pressure of the gas flowing to said pilot burner falls below a predetermined amount.

3. A control system for boilers comprising, in combination with a boiler adapted to generate steam under pressure, a burner, a source of air under pressure, a line connecting said source to said burner, a pressure responsive valve interposed in said line, means for transmitting the pressure of said boiler to said valve to vary the flow of air through said line in accordance with the pressure in said boiler, a proportional air and gas mixer interposed in said line between said burner and said valve, means for supplying gas to said mixer, a pressure responsive valve in said gas line, means for transmitting the pressure from said source to said last mentioned valve to open the latter, a pilot burner, a second source of air under pressure, a line connecting said second source to said pilot burner, means for supplying gas to said pilot burner, a pressure responsive valve in said last mentioned means, and means for transmitting the pressure from said second source to said last mentioned valve to open the latter.

4. A control system for boilers comprising, in combination, a main burner, means for supplying air under pressure to said main burner, an electric motor driving said means, a pilot burner, means for supplying air under pressure to said pilot burner, an electric motor driving said last mentioned means, means for supplying gas to said main burner, means for supplying gas to said pilot burner, and means operable to prevent the operation of said first mentioned motor when said second mentioned motor is inoperable.

5. A control system for boilers comprising, in combination, a burner, means for supplying air to said burner, means regulated by the flow of air to said burner to admit gas to said burner, a pilot burner, means for supplying air to said pilot burner, means regulated by the flow of air to said pilot burner to admit gas to said pilot burner, and means regulated by the flow of gas to said pilot burner to cut off the flow of air to both burners when the flow of gas to the pilot burner is cut off.

6. A control system for boilers comprising, in combination with a water level boiler, a burner, a proportional air and gas mixer, a line connecting said burner with said mixer, a source of air under pressure, a line connecting said source with said mixer, a pressure responsive valve interposed in said last mentioned line adapted to vary the flow of air through said line in accordance with the pressure in the steam space of said boiler, means for supplying gas to said mixer, a pressure responsive valve interposed in said means, means for transmitting the pressure of said source to said valve adapted to open the latter, an electric motor driving said source, means responsive to the pressure in said boiler adapted to control said motor, means responsive to the water level in said boiler adapted to control said motor, a pilot burner, a second source of air under pressure, a line connecting said second source to said pilot burner, means for supplying gas to said pilot burner, a pressure responsive valve interposed in said last mentioned means, means for transmitting the pressure of said second source to said last mentioned valve to open the latter, an electric motor driving said second source, means to cause said last mentioned motor to be inoperative when said last mentioned gas supply means is inoperative, and means to cause said first mentioned motor to be inoperative when said second mentioned motor is inoperative.

7. A control system for boilers comprising, in combination with a water level boiler, a burner adapted to burn a mixture of air and gas, means for supplying air under pressure to said burner, means for supplying gas to said burner, an electric motor driving said first mentioned means, means for supplying electric current to said motor, a switch interposed in said last mentioned means, a pilot burner, means for supplying air under pressure to said pilot burner, means for supplying gas to said pilot burner, means for opening said switch when said air supply to said pilot burner is inoperative, means for opening said switch when the pressure in said boiler rises above a predetermined maximum, and means for opening said switch when the water level in said boiler falls below a predetermined minimum.

8. A control system for boilers comprising, in combination, a burner, a source of air under pressure, a line connecting said source to said burner, a proportional air and gas mixer interposed in said line, a gas supply line connected to said mixer, means operable to open said gas line only when air is being supplied to said mixer, a pilot burner, a second source of air under pressure, a line connecting said second source to said pilot burner, a gas supply line connected to said pilot burner, means operable to open said last mentioned gas supply line only when air is being supplied to said pilot burner, and means to cause both sources of air under pressure to be inoperable when said pilot burner is inoperable.

In testimony whereof we have hereunto affixed our signatures.

CHARLES B. PAGE.
ERNEST W. REDDERSON.