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Metcalf et al.

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[54] **FUEL BURNER SUPERVISORY SYSTEM**

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[52] **U.S. Cl.** **340/228,** 328/6, 431/32, 431/79

[51] **Int. Cl.** **F23n 5/08,** G08b 17/12

[58] **Field of Search** ..... 340/227, 228, 228 S; 431/79, 32, 24; 328/6

[56] **References Cited**

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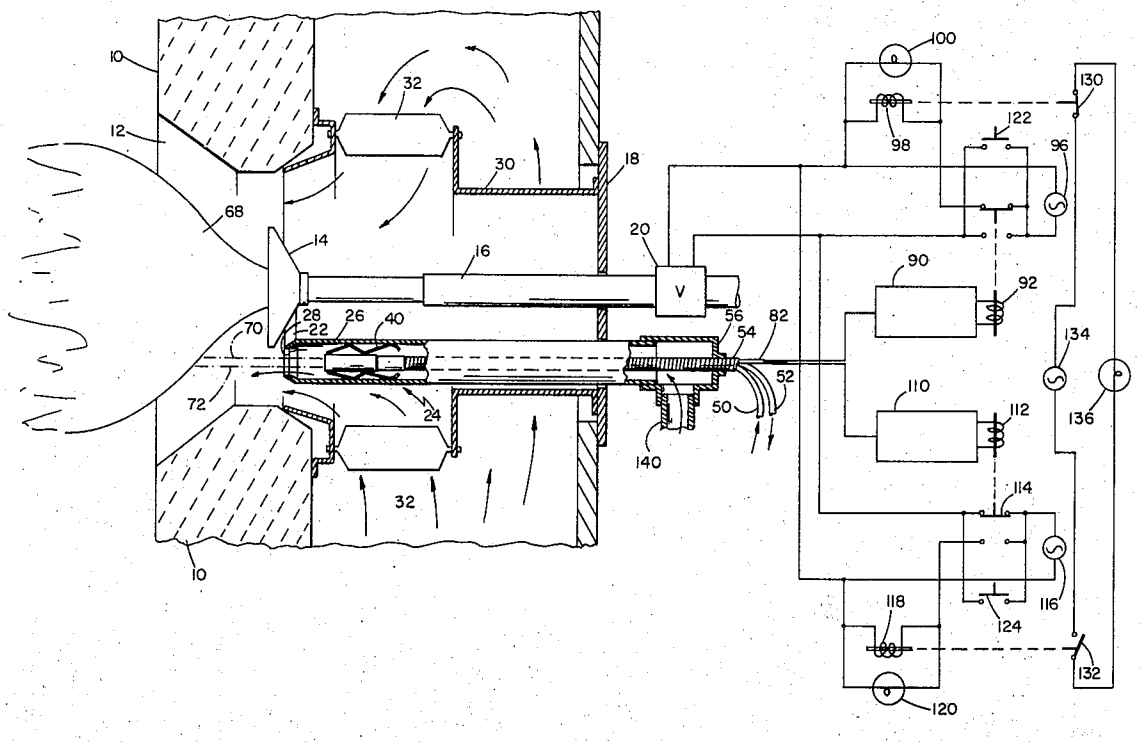
[57] **ABSTRACT**

Fuel burner supervisory system wherein a pair of flame sensors are located close to the flame being supervised, periods of flame absence are simulated for each sensor, elements are respectively responsive to the sensors to assume a trouble state when an associated sensor indicates the absence of flame other than during a period of simulated flame absence, or when the sensor indicates the presence of flame during a period of simulated flame absence, and a flame failure alarm is connected to signal when both elements are in their trouble states, thus indicating a likely absence of flame.

15 Claims, 2 Drawing Figures



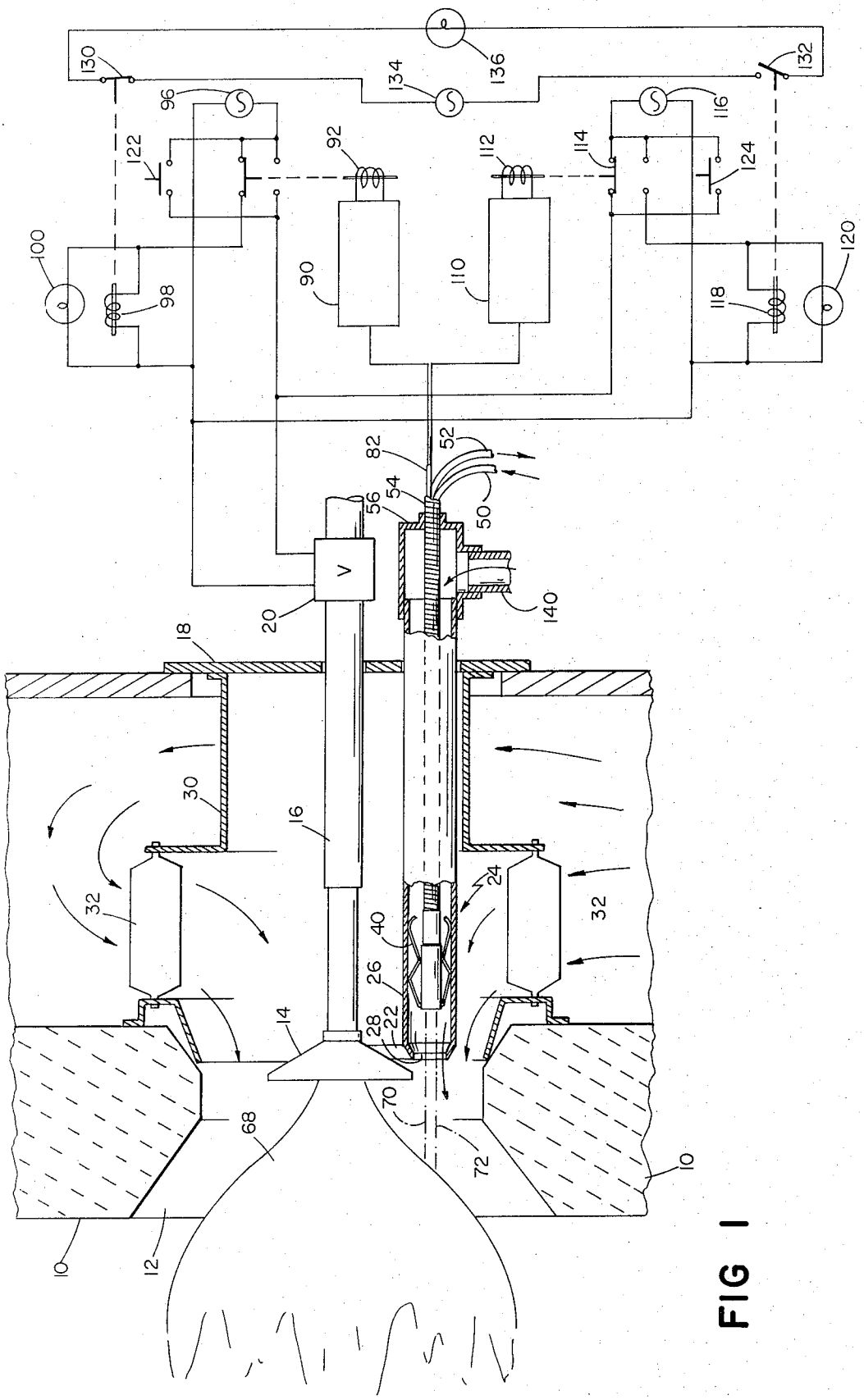

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FIG 1

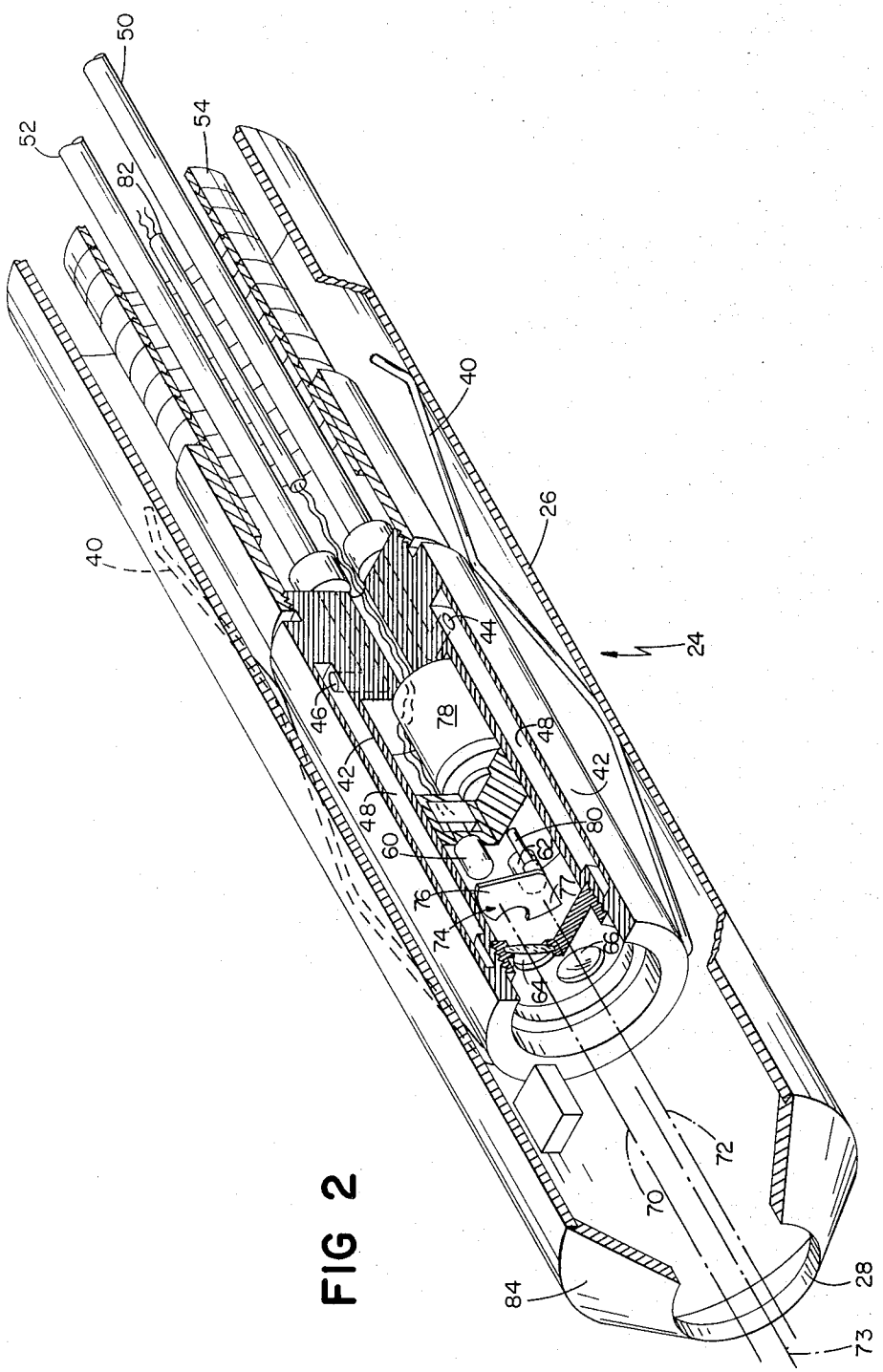

FIG 2

FUEL BURNER SUPERVISORY SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to sensor and control systems for supervising fuel burners.

SUMMARY OF THE INVENTION

The invention makes possible improved use of ultraviolet sensitive, avalanche breakdown type, photoelectric flame sensors, by allowing for their location close to the flame being supervised and by monitoring sensor operability with fail-safe circuitry in a manner that minimizes unnecessary shutdown of the burner.

In particular, the invention allows for mounting of the sensor unit directly on the burner, thus permitting improved angular field of view coordination with the supervised burner, ensuring continued sensor alignment with a selected flame being monitored even upon adjustment of the burner orientation, increasing signal strength, improviding optical penetration of the coal shround when used in a coal burning system and improving discrimination among multiple flames. These advantages are provided despite the extremely hot and hostile environment present near the burner nozzle.

In general the invention features a pair of flame sensors with associated circuitry for simulating periods of flame absence for each sensor, a pair of elements respectively electrically responsive to the sensors to assume a trouble state when an associated sensor indicates the absence of flame other than during a period of simulated flame absence, or when the sensor indicates the presence of flame during a period of simulated flame absence, and a flame failure alarm connected to signal when both elements are in their trouble states, thus indicating a likely absence of flame. In preferred embodiments the elements are flame relays each connected to actuate an alarm when in its trouble state; both sensors are mounted in a liquid cooling jacket in turn mounted in a tube the inner wall of which is spaced from the outer wall of the jacket to permit passage of air past the sensors to prevent ash and the like from masking the sensors, thus making possible the mounting of the sensors closely adjacent the flame being supervised; the end of the tube nearest the flame has an air deflector and radiation suppressor; and two electrical power sources are connected in parallel to a fuel valve for the burner, the connections being through contacts under respective control of the flame relays, the sources also being connected to their alarms through contacts under respective control of the flame relays, each flame relay also being in effective control of contacts connected in series with a third power source and the flame failure alarm.

Other advantages and features of the invention will be apparent from the description and drawings herein of a preferred embodiment thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view partially sectioned and partially schematic showing a fuel burner supervision system embodying the invention; and

FIG. 2 is an enlarged isometric view partially broken away showing the ultra-violet sensors and associated hardware illustrated generally in FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, FIG. 1 shows a fragment of a furnace fire wall **10** with an opening **12** in which is supported oil burner nozzle **14** having a fuel supply conduit **16** extending through front boiler plate **18** and provided with a solenoid operated fuel valve **20** outside plate **18.**

Suspended from nozzle **14** by bracket **22** is scanner assembly **24** including an outer generally cylindrical guide tube **26** which has an axial opening **28** at one end closely adjacent burner **14** at fire wall opening **12** and extends parallel to conduit **16** through plate **18.**

Surrounding conduit **16** and tube **26** between plate **18** and fire wall **10** is a windbox **30** with adjustable vanes **32** for admitting air into the windbox to burner **14,** as shown by the arrows.

Scanner assembly **24** is shown in detail in FIG. **2.** Supported concentrically within tube **26** by centering spring **40** is a double-walled water cooling jacket **42.** Water inlet and outlet passages **44** and **46,** respectively, communicate with annular zone **48** between the two jacket walls, and connect with water pipes **50** and **52** which, surrounded by strip wound flexible protective hose **54,** extend through an opening in the back wall **56** of assembly **24.** An internal baffle in zone **48** prevents flow of water directly from inlet to outlet.

Within jacket **42** are mounted two ultra-voilet sensitive, avalanche breakdown type, photoelectric flame sensors **60** and **62** (e.g. as described in U.S. Pat. No. 3,416,041), respectively aligned with optical lenses **64** and **66** mounted at the front of jacket **42.** Sensors **60** and **62** are thus arranged for optical communication with burner flame **68** through lenses **64** and **66** and opening **28** along respective optical axes **70** and **72** parallel to the longitudinal axis **73** of tube **26.** Since the sensors are rigidly mounted with respect to the burner nozzle, their alignment with the flame is preserved even in the event the burner position is shifted. Interposed between the sensors and the lenses is a shutter **74** having opaque tongues **76** and **77** spaced apart by an angle (between their radial center-lines) equal to the angle between axes **70** and **72.** The shutter is mounted for angular movement in its own plane about axis **73,** driven by drive **78** through shaft **80,** back and forth between a first position in which tongues **76** and **77** are aligned with axes **70** and **72** to mask the sensors from flame **68,** and a second position in which the sensors are exposed to the flame. Electrical wiring **82** connected to the sensors and drive **78** extends through wall **56** to the control circuitry shown in FIG. **1.** If desired, a baffle (not shown) can be placed between sensors **60** and **62** to prevent interference between the sensors.

Opening **28** is defined by a frusto-conical air deflector and radiation suppressor **84** secured to the front end of tube **26.**

Referring to FIG. **1,** sensor **60** is connected through fail-safe circuitry **90** to a flame relay **92** which operates a set of contacts **94** having a first position (when relay **92** is energized) closing a circuit between electrical power source **96** and valve **20,** and a second position (when relay **92** is deenergized, as shown in FIG. **1**) closing a circuit between source **96** and relay **98** and alarm light **100** wired in parallel. Circuitry **90** provides conventional signal modification and amplification, causes relay **92** to be energized whenever flame **68** is

sensed by sensor **60**, and is synchronized with the cycling frequency of shutter **74** to keep relay **92** energized during the periods of simulated flame absence which occur whenever the shutter tongues are in alignment with axes **70** and **72**. Relay **92** will drop out if flame **68** should go out, or if sensor **60** should signal the presence of flame during an expected period of simulated flame absence, or if sensor **60** should otherwise fail. One possible example of circuitry **90** is disclosed in U.S. Pat. No. 3,288,195.

Similarly, sensor **62** is connected through fail-safe circuitry **110** to flame relay **112** which operates a set of contacts **114** having a first position (when relay **112** is energized, as shown in FIG. **1**) closing a circuit between electrical power source **116** and valve **20**, and a second position (when relay **112** is deenergized) closing a circuit between source **116** and relay **118** and alarm light **120** wired in parallel. Circuitry **110** controls relay **112** in the same manner as circuitry **90** controls relay **92**.

Thus, whenever either or both of relays **92** and **112** are energized, valve **20** will be open, allowing the supply of fuel to burner nozzle **14**. Should one flame relay be energized and the other deenergized, the cause of the deenergization will most likely be a sensor or circuit component failure, rather than a true absence of flame, and valve **20** will remain open while light **100** or **120** will signal the need for repair. Should both flame relays be deenergized, power sources **96** and **116** will both be isolated from valve **20** and the valve will close, shutting off the fuel supply; in this condition contacts **130** and **132** respectively operated by relays **98** and **118** will both close, completing a circuit between power source **134** and flame failure alarm light **136**, thus signalling the likelihood that flame **68** is extinguished.

Sensors **60** and **62** are cooled by the water circulating through jacket **42**. Air is supplied through inlet **140** at the outside end of tube **26** and circulated through the tube to exit at opening **28**, providing a positive pressure to clear ash or other debris from in front of the sensors. Thus, the sensors can be located very close to flame **68** despite the high temperatures present there, increasing their ability to respond selectively and accurately to ultra-violet light in the flame being monitored. In the event of sensor failure, the provision of two sensors and the circuitry described above minimizes unnecessary closure of valve **20**.

Other embodiments are within the following claims:

1. A fuel burner supervisory system comprising first and second flame sensors, each said flame sensor adapted to be individually responsive to flame in the supervised fuel burner and to produce a flame signal output as a result of sensing flame in the supervised fuel burner,

cyclically operative means associated with said first and second flame sensors for periodically simulating flame absence for each sensor, the interval of simulated flame absence for each sensor being less than a predetermined interval of time,

first circuitry responsive to the flame signal output of said first sensor and having a first state indicative of the absence of a flame signal output from said first sensor for interval greater than said predetermined interval of time and a second state indicative of the presence of a flame signal output from said first flame sensor,

second circuitry responsive to the flame signal output of said second sensor and having a first state indicative of the absence of a flame signal output from said second flame sensor for an interval of time greater than said predetermined time interval and a second state indicative of the presence of a flame signal output from said second flame sensor,

first and second switching means,

said first switching means enabling flow of fuel to said fuel burner in response to said first circuitry in said second state independently of said second switching means,

second switching means enabling flow of fuel to said fuel burner in response to said second circuitry in said second state independently of said first switching means,

and third circuitry responsive to said first and second circuitries, said third circuitry including a flame failure alarm connected to signal when both said first circuitry and said second circuitry are in their first states, thus indicating a likely absence of flame.

2. The system of claim **1** wherein said first and second switching means are flame relays, an alarm associated with each said relay, and each said relay is connected to actuate its associated alarm when in its second state.

3. The system of claim **2** further comprising

two electrical power sources,

contacts, under the respective control of said relays, through which said sources are adapted to be connected in parallel to a fuel valve to control the position thereof,

contacts, under the respective control of said relays, through which said sources are adapted to be connected to their associated alarms, and

contacts, under the effective respective control of said relays, connected in series in said third circuitry with said flame failure alarm.

4. The system of claim **3** wherein said last mentioned contacts are in series with a third power source.

5. The system of claim **1** wherein said sensors and said cyclically operative means are mounted in a sealed housing and liquid cooling jacket surrounds said housing.

6. The system of claim **5** wherein said jacket is mounted in a guide tube to provide a space within said tube surrounding said jacket for the flow of air past said housing to clear debris from in front of said sensors.

7. The system of claim **6** wherein said guide tube includes at its forward end air deflector and radiation suppressor structure defining an optical aperutre for said sensors.

8. The system of claim **1** wherein said sensors are of the ulta-violet sensitive, avalanche-breakdown type.

9. The system of claim **6** mounted in a combustion chamber having a burner nozzle, said guide tube being mounted directly adjacent said nozzle and being rigidly fixed to said nozzle for movement with said nozzle.

10. A fuel burner supervisory system comprising

an elongated tubular member, air deflector and radiation suppressor means at one end of said tubular member, said air deflector and radiation suppressor means defining an outlet port,

means for supporting said tubular member with said outlet port adjacent the fuel nozzle of the supervised burner,

a sensor assembly disposed in said tubular member, said sensor assembly comprising a sealed housing, jacket structure spaced rom said housing to define a chamber to which cooling liquid may be supplied for flow around said housing, optical window structure in the front wall of said housing, first and second photoelectric flame sensors in said housing in fixed optical alignment with said optical window structure and said outlet port, shutter means in said housing interposed between said sensors and said optical window means, and means to operate said shutter means for simulating at periodic intervals flame absence for each sensor,

inelt passage means extending through said tubular member from a point remote from said outlet port to said jacket structure for supplying cooling liquid to said chamber to cool components mounted in said housing,

outlet passage means extending through said tubular member from said jacket structure to a point remote from said outlet port for receiving cooling liquid after said cooling liquid has circulated through said chamber,

means mounting said sensor assembly in spaced relation to said tubular member, and port means in said tubular member at a point remote from said outlet port through which air may be introduced for flow past said sensor assembly and out said outlet port to clear debris from in front of the front wall of said housing.

11. A fuel burner supervisory system comprising

an elongated tubular member, air deflector and radiation suppressor means at one end of said tubular member, said air deflector and radiation supressor means defining an outlet port,

means for supporting said tubular member with said outlet port adjacent the fuel nozzle of the supervised burner,

a sensor assembly disposed in said tubular member, said sensor assembly comprising a sealed housing, jacket structure spaced from said housing to define a chamber through which cooling liquid may be supplied, optical window structure in the front wall of said housing, first and second photoelectric flame sensors in said housing in fixed optical alignment with said optical window structure and said outlet port, shutter means in said housing interposed between said sensors and said optical window means, and means to operate said shutter for simulating periods of flame absence for each sensor,

inlet passage means extending through said tubular member from a point remote to said outlet port to said jacket structure for supplying cooling liquid to said chamber to cool components mounted in said housing,

outlet passage means extending through said tubular member from said jacket structure to a point remote from said outlet port for receiving cooling liquid after said cooling liquid has circulated through said chamber,

means mounting said sensor assembly in spaced relation to said tubular member, port means in said tubular member at a point remote from said outlet port through which air may be introduced for flow past said sensor assembly and out said outlet port to clear debris from in front of the front wall of said housing,

first circuitry responsive to the flame signal output of said first sensor and having a first state indicative of the absence of a flame signal output from said first sensor and a second state indicative of the presence of a flame signal output from said first flame sensor,

second circuitry responsive to the flame signal output of said second sensor and having a first state indicative of the absence of a flame signal output from said second flame sensor and a second state indicative of the presence of a flame signal output from said second flame sensor,

first and second switching means,

said first switching means enabling flow of fuel to said fuel burner in response to said first circuitry in said second state independently of said second switching means,

second switching means enabling flow of fuel to said fuel burner in response to said second circuitry in said second state independently of said first switching means,

and third circuitry responsive to said first and second circuitries, said third circuitry including a flame failure alarm connected to signal when both said first circuitry and said second circuitry are in their first states, thus indicating a likely absence of flame.

12. The system of claim **11** wherein said first and second switching means are flame relays, an alarm associated with each said relay, and each said relay is connected to actuate its associated alarm when in its second state.

13. The system of claim **12** further comprising

two electrical power sources,

contacts, under the respective control of said relays, through which said sources are adapted to be connected in parallel to a fuel valve to control the position thereof,

contacts, under the respective control of said relays, through which said sources are adapted to be connected to their associated alarms, and

contacts, under the effective respective control of said relays, connected in series in said third circuitry with said flame failure alarm.

14. The system as claimed in claim **13** wherein said last mentioned contacts are in series with a third power source.

15. The system as claimed in claim **14** wherein said sensors are of the ultra-voilet sensitive, avalanche-breakdown type.

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