

[54] **CONTROL METHOD AND APPARATUS FOR BURNERS**

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431/66; 431/60; 431/63

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431/66; 126/351, 374; 122/448 R

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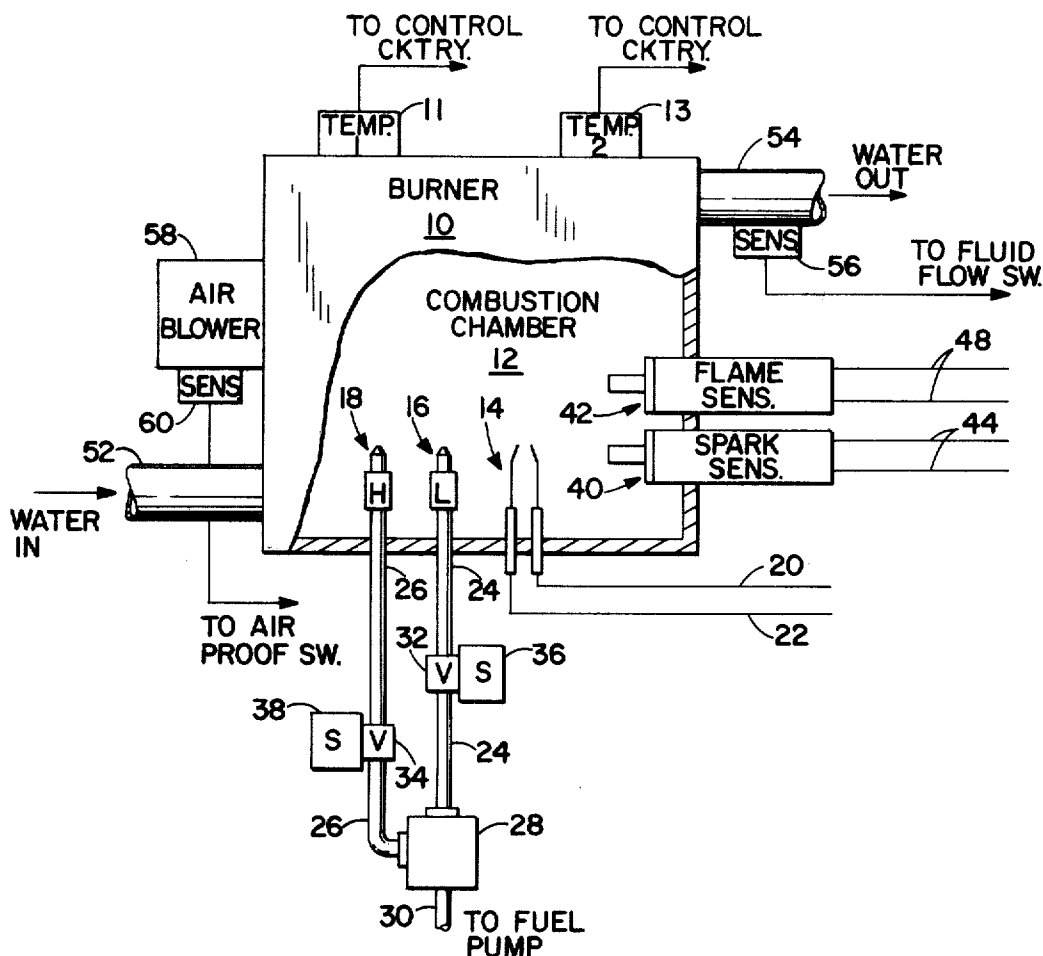
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[57] **ABSTRACT**

Control apparatus for burners having independent spark and flame sensors which control turn-on in three phases. A spark is produced in the first phase, a low flame in the second, and a high flame in the third. Fuel for the low and high flame is supplied through independent lines and valving. The control apparatus prevents the burner from being turned on unless certain operating conditions are present.

3 Claims, 3 Drawing Figures



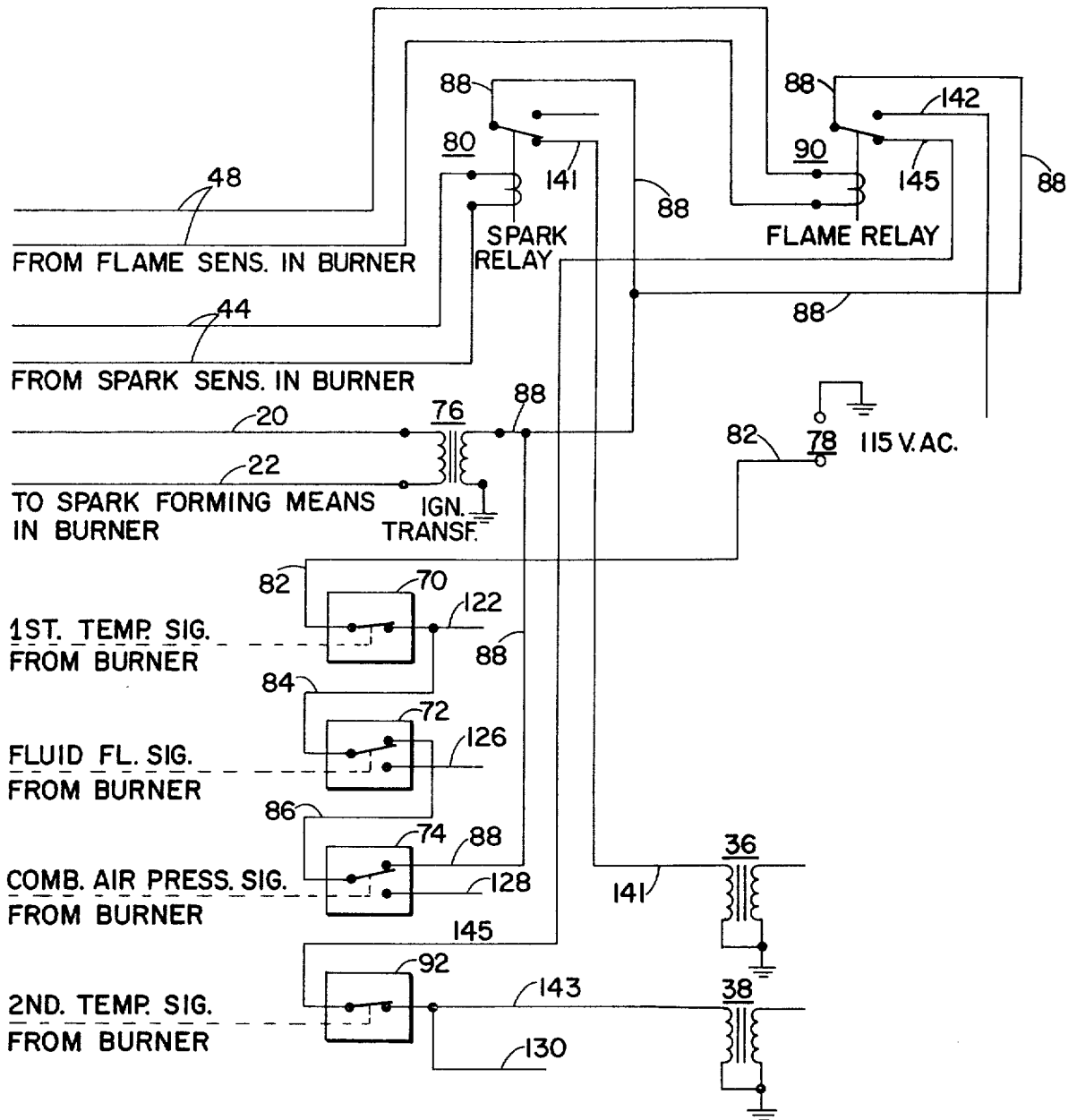
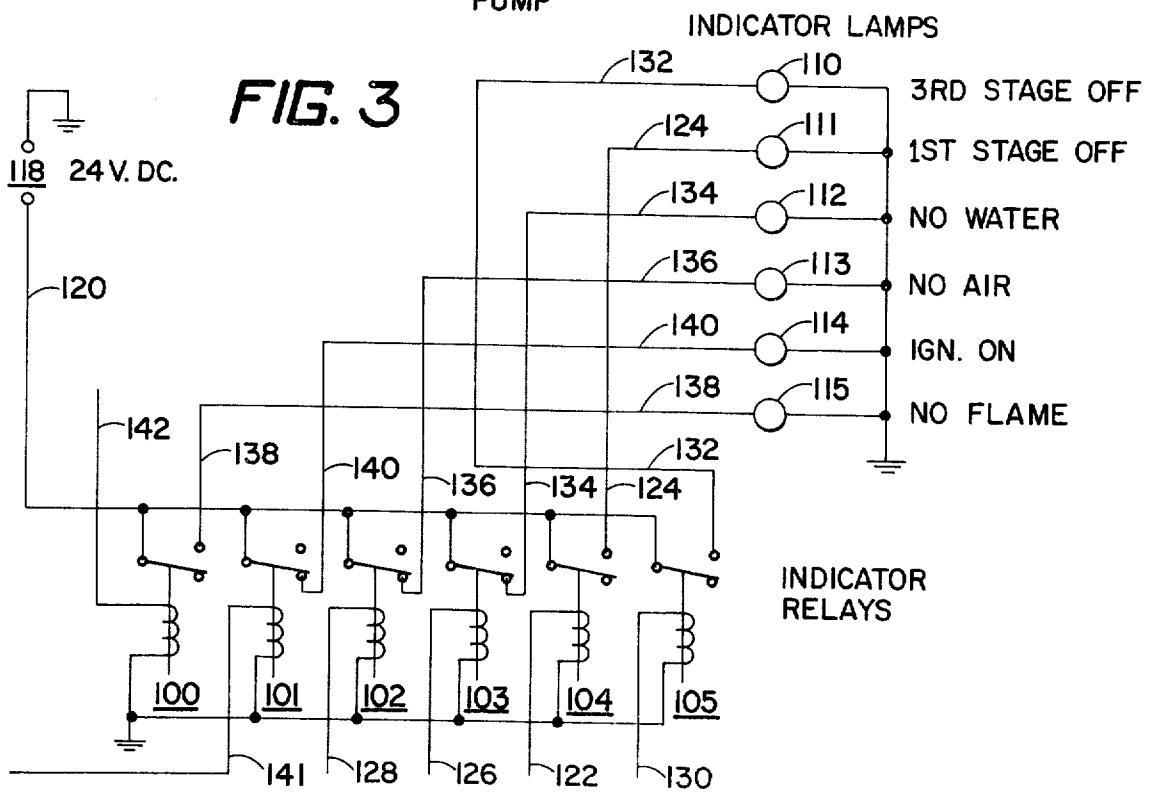
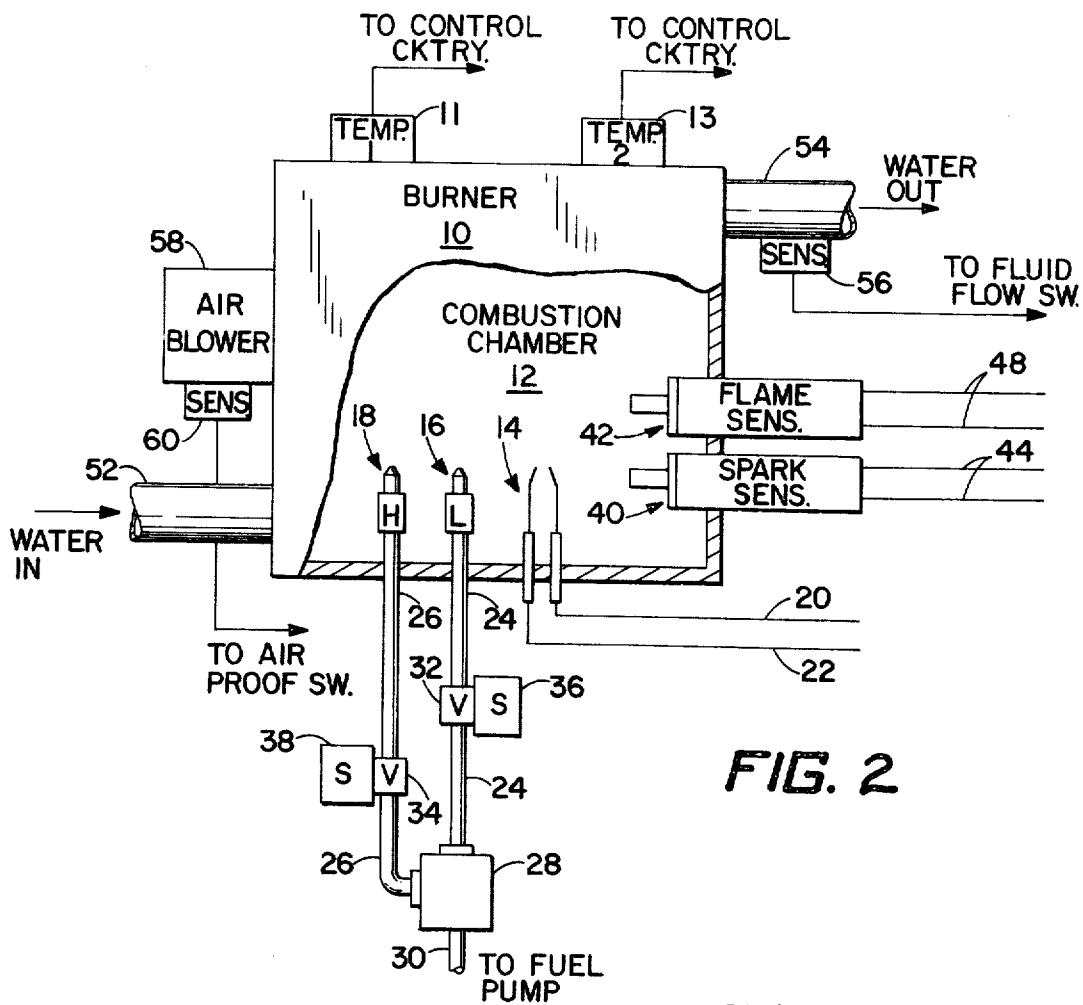


FIG. 1



CONTROL METHOD AND APPARATUS FOR BURNERS

BACKGROUND OF THE INVENTION

The invention pertains to burners such as those in hot washers used for deicing airplanes, more specifically to controls for such a burner.

In the prior art, the spark is initiated and the fuel is injected at the same time and a timer on the exhaust of the system waits a set period to sense the heat of combustion. The dwell time permits quantities of unburned fuel to accumulate in the combustion chamber if ignition does not take place, therefore presenting a dangerous situation. In these burners the flame is either off or high. A burner that operates in two steps is relatively unsafe, especially when fuels like gasoline and jet fuel are being burned.

SUMMARY OF THE INVENTION

In the present invention a spark is generated only if certain conditions exist in the burner system. These conditions involve a first temperature, water flow, and air pressure. After the spark is formed and sensed, a small amount of fuel is injected into the combustion chamber of the burner. The spark ignites the fuel which in burning forms a flame that is low. If the low flame is sensed and a second temperature exists in the burner system, a large amount of fuel is injected into the combustion chamber. The low flame ignites the large amount of fuel, which in burning forms a flame that is high.

It is an object of the invention to provide control apparatus for a burner wherein the burner is turned on in three phases. In the first phase a spark is generated, in the second phase a low flame is produced, and in the third phase a high flame is produced. It is another object of the invention to provide control circuitry for a burner such that the spark is not formed unless certain conditions exist in the burner system. Another object of the invention is to provide a burner system having separate fuel jets, fuel lines, valving, and control circuitry for producing the low and high flames. A further object of the invention is to provide control apparatus for a burner wherein separate spark and flame sensors are used for generating control signals.

Other objects, advantages and features of the invention will appear below.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram of the control circuitry for the apparatus;

FIG. 2 is a simplified diagram of the burner; and

FIG. 3 is a schematic diagram of indicator circuitry associated with the control apparatus.

Detailed Description

FIG. 2 includes a burner 10 with a combustion chamber 12. A spark forming means or ignitor 14, low flame fuel jet 16, and a high flame fuel jet 18 are mounted in the bottom of chamber 12. Electrical energy is supplied to ignitor 14 by leads 20 and 22. Fuel lines 24 and 26 supply fuel to jets 16 and 18. The lower ends of lines 24 and 26 are connected to a tee fitting 28. Fuel from a fuel pump (not shown) supplies fuel to tee 28 by means of a line 30. The flow of fuel in lines 24 and 26 is controlled by valves 32 and 34 which are opened and closed by solenoids 36 and 38.

A spark sensor 40 and a flame sensor 42 are mounted in the wall of chamber 12. Sensor 40 is sighted on the tip of ignitor 14 and sensor 42 is sighted on a low flame which is produced by jet 16. Although flame sensor 42 is sighted on the low flame produced by jet 16, it will also be incidentally sighted on a high flame which is produced by jet 18. Spark sensor 40 develops an output signal on lines 44 when a spark is detected and flame sensor 42 develops an output signal on lines 48 when a low flame or high flame from jet 16 or jet 18 respectively is detected.

A fluid to be heated, such as water, enters burner 10 through a pipe 52 and exits through a pipe 54. Sensor 56 mounted in pipe 54 senses fluid flow. The flow must be within a predetermined operating range before burner 10 can be turned on.

Air blower 58 mounted on burner 10 supplies air for combustion to chamber 12. A sensor 60 mounted on air blower 58 senses the combustion air pressure which must be within a predetermined operating range before burner 10 can be turned on.

FIG. 1 shows circuitry for controlling the operation of burner 10 and includes switches 70, 72 and 74 and ignition transformer 76. Switches 70, 72 and 74 control the application of electrical energy to the primary winding of transformer 76. When the primary winding is energized, the secondary winding provides energy to ignitor 14 through leads 20 and 22.

Source 78 provides 115 volts AC for the system and is returned to ground. Switch 70 is connected to the 115 VAC by a lead 82. Switch 70 is closed if the fluid being heated is less than a first predetermined temperature (Temp. 1), e.g., 205°F. Therefore if Temp. 1 is greater than about 205°F., switch 70 is opened, shutting the burner off. The Temp. 1 signal is developed by a sensor 11 mounted on burner 10. With switch 70 closed, 115 VAC is applied to switch 72 by a lead 84. Switch 72 is responsive to the output of sensor 56 which detects the flow of water in pipe 54. If the flow is in the operating range, switch 72 moves to its upper position and 115 VAC is applied to switch 74 by a lead 86. Switch 74 is responsive to the signal generated by sensor 60 which is indicative of the combustion chamber air pressure created by air blower 58. If the air pressure is in the operating range, switch 74 is moved to the upper position and 115 VAC is applied to the primary winding of ignition transformer 76 by a lead 88. In this way, ignition transformer 76 is energized only if certain operating conditions exist in burner 10. With the primary winding of transformer 76 energized, energy from the secondary is applied to ignitor 14 which establishes a spark.

After the spark is established, the next control phase involves proving or sensing the spark and opening the valve to the low flame jet 16 if the spark is proved. When a spark of sufficient intensity is produced by ignitor 14, it is detected by sensor 40 which develops an output signal on leads 44. Leads 44 are connected to the winding of a spark relay 80. When the spark is detected relay 80 is energized and moves to its lower position and the 115 VAC is applied to the primary winding of solenoid 36 by a lead 141. Solenoid 36 opens valve 32 and jet 16 receives fuel through line 24. The spark produced by ignitor 14 causes the fuel coming from jet 16 to be ignited and a low flame is formed. This completes the second control phase in which valve 32 is opened only after a spark is formed and detected.

In the third and last phase of control, valve 34 is opened, supplying fuel to the high flame jet 18 only after the low flame from jet 16 is detected. When a low flame is present it is detected by flame sensor 42 which develops an output signal on leads 48. Leads 48 conduct the signal to a winding of relay 90. When a low flame is detected, relay 90 is energized and moves to its lower position and 115 VAC is applied to a switch 92 by a lead 145. Switch 92 is responsive to a second predetermined temperature (Temp. 2) of the fluid being heated in burner 10. For example, Temp. 2 may be about 195°F. If the temperature of the fluid is greater than 195°F., the third phase of control is not activated and the flame remains low. The Temp. 2 signal is developed by a sensor 13 mounted on burner 10. If the fluid is less than 195°F., switch 92 is closed and 115 VAC is applied to the primary winding of solenoid 38 by a lead 143. Solenoid 38 opens valve 34 and jet 18 receives fuel through line 26. The low flame of jet 16 ignites the fuel issuing from jet 18 and a high flame is produced. Valve 32 allows only a small amount of fuel to be supplied to jet 16, whereas valve 34 allows a large amount of fuel to be supplied to jet 18. This completes the third and last phase of the operating cycle.

The indicator circuitry shown in FIG. 3 includes a set of six relays 100-105 and a set of six indicator lights 110-115. A source 118 provides 24 volts DC for the indicator circuitry and is returned to ground. The 24 VDC is connected to each of the relays 100-105 by a lead 120.

When a spark is being sensed and relay 80 is energized and moves to its lower position, 115 VAC is applied to the winding of relay 101 by lead 141, moving the relay to its lower position. This causes 24 VDC to be applied to light 114 by a lead 140. Energization of light 114 indicates that ignition is on.

When a flame is not being sensed and relay 90 is deenergized and moves to its upper position, 115 VAC is applied to the winding of relay 100 by a lead 142. This causes the 24 VDC being applied to light 115 by lead 138 to be removed, deenergizing light 115. An energized light 115 indicates that the flame is off, therefore a deenergized light 115 indicates that the flame is on.

When there is insufficient combustion chamber air pressure and switch 74 is in its lower position, 115 VAC is applied to the winding of relay 102 by a lead 128, moving the relay to its lower position. This causes the 24 VDC to be applied to light 113 by lead 136. Energization of light 113 indicates insufficient combustion chamber air pressure.

When there is insufficient fluid flow and switch 72 moves to its lower position, 115 VAC is applied to the winding of relay 103 by a lead 126 and it moves to its lower position. This causes 24 VDC to be applied to light 112 by a lead 134. Energization of light 112 indicates an insufficient fluid flow.

When Temp. 1 is less than about 205°F. and switch 70 is closed, 115 VAC is applied to the winding of relay 104 by a lead 122, moving the relay to its lower position. This causes the 24 VDC being applied to light 111 by lead 124 to be removed, deenergizing light 111. An energized light 111 indicates that the first phase of control is not taking place, therefore a deenergized light 111 indicates that the first phase is taking place.

When Temp. 2 is less than about 195°F. and switch 92 is closed, 115 VAC is applied to the winding of relay 105 by a lead 130 and relay 105 moves to its lower po-

sition. This causes the 24 VDC being applied to light 110 by lead 132 to be removed, deenergizing light 110. An energized light 110 indicates that the third phase of control is not taking place, therefore a deenergized light 110 indicates that the third phase is taking place.

A specific embodiment of the invention has been described. Modifications of this embodiment and other embodiments within the spirit and scope of the invention will occur to those skilled in the art, therefore the invention is to be limited only by the following claims.

What is claimed is:

1. A method of operating a burner for heating a flowing fluid, the burner having first and second operating temperatures associated therewith, and a combustion chamber for highly volatile explosive fuel requiring an operating combustion air pressure, the method including the following steps:
 - a. sensing the first operating temperature;
 - b. sensing the fluid flow;
 - c. sensing the air pressure;
 - d. forming a spark only if the sensed first operating temperature, fluid flow, and air pressure are within predetermined operating ranges;
 - e. directly visually sensing the spark;
 - f. providing a small amount of said volatile fuel to the combustion chamber only if the spark is visually sensed, the spark igniting the fuel, which in burning forms a flame that is low;
 - g. sensing the flame;
 - h. sensing the second operating temperature; and
 - i. providing a large amount of said volatile fuel to the combustion chamber only if the flame is sensed and the second operating temperature is within a predetermined operating range, the low flame igniting the large amount of fuel which in burning forms a flame that is high.
2. A failsafe burner control apparatus for controlling the supply and ignition of highly volatile and explosive fuel such as gasoline or jet fuel in a burner used within a larger system having a plurality of measurable operating quantities, comprising:
 - a. first sensing means for sensing a plurality of said operating quantities and for respectively providing a plurality of control signals indicative thereof;
 - b. means for forming a spark when energized;
 - c. control means responsive to said plurality of operating quantity control signals and operatively connected to said spark forming means for energizing said spark forming means only when each of said plurality of operating quantities is within a predetermined range;
 - d. a spark sensor mounted to directly visually sight the presence or absence of said spark for providing a sensed spark output signal in response thereto;
 - e. first fuel control means operatively connected to receive and responsive to said sensed spark output signal for providing a small amount of said volatile fuel for ignition by said spark, thereby forming a low flame;
 - f. a flame sensor, operatively independent of said spark sensor, connected to sense the presence or absence of said flame for providing a sensed flame output signal in response thereto;
 - g. second sensing means for sensing a single one of said plurality of operating quantities and for providing a single control signal indicative thereof; and

h. second fuel control means operatively connected to receive and responsive to said sensed flame output signal and said single operating quantity control signal for providing a large amount of said volatile fuel for ignition by said low flame, thereby forming a high flame. 5

3. Burner control apparatus for deicing systems, of the type having a circulating fluid, a combustion chamber for burning highly explosive fuel and designed for operation at a combustion air pressure within a predetermined range, and being designed to operate with first and second temperatures of said fluid in predetermined ranges and with a flow rate within a predetermined range of said fluid, said burner control apparatus comprising: 10

- a. means for sensing said first operating temperature and for providing a first control signal indicative thereof; 15
- b. means for sensing said fluid flow rate and for providing a second control signal indicative thereof; 20
- c. means for sensing said combustion chamber air pressure and for providing a third control signal indicative thereof;
- d. ignition means mounted in said combustion chamber for forming a spark when energized, to ignite said fuel within the combustion chamber; 25
- e. means responsive to said first, said second and said third control signals for energizing said ignition means only when said first, said second and said third control signals indicate that said first temperature, said fluid flow rate and said combustion air pressure are simultaneously within their respective said predetermined operating ranges; 30

f. spark sensing means mounted to operatively sight said formed spark for sensing the presence or absence of said spark and for generating first and second spark control signals indicative thereof, said sensing means operative to generate said first spark control signal when the presence of said spark is sensed, and to generate said second spark control signal when the absence of said formed spark is sensed;

g. means operatively connected to receive said spark control signals for providing a small amount of said fuel to said combustion chamber for ignition by said spark upon receipt of said first spark control signal, thereby forming a flame that is low;

h. flame sensing means mounted to sight said flame and operatively independent of said spark sensing means, for sensing the presence or absence of said flame and for providing a flame control signal indicative thereof; 15

i. means for sensing said second operative temperature and for providing a fourth control signal indicative thereof; and 20

j. means connected to receive said flame control and said fourth control signals and operatively responsive thereto for providing a large amount of said fuel to said combustion chamber when said flame control and said fourth control signals respectively indicate the presence of said flame and the presence of said second operative temperature within its said predetermined range, thereby forming a flame that is high. 25

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