United States Patent [19]

Hantack

[11] **3,862,820**

[45] **Jan. 28, 1975**

[54] **DIRECT BURNER IGNITION SYSTEM**

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[73] Assignee: **Eaton Corporation,** Cleveland, Ohio

[22] Filed: **Jan. 16, 1974**

[21] Appl. No.: **433,939**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 281,067, Aug. 16, 1972.

[52] **U.S. Cl.** **431/66,** 317/98, 431/254

[51] **Int. Cl.** **F23n 5/24**

[58] **Field of Search** 431/66, 67, 254; 317/98

[56] **References Cited**

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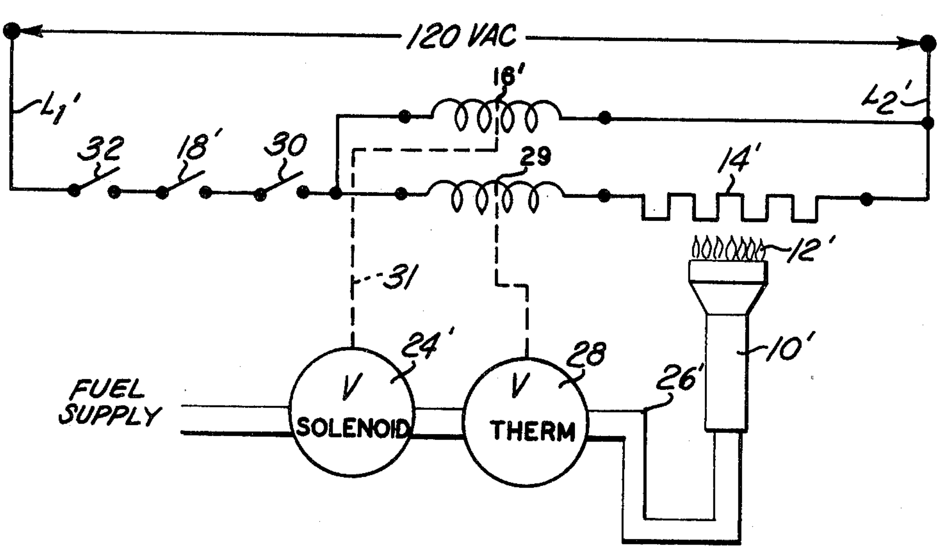
Attorney, Agent, or Firm—Teagno & Toddy

[57] **ABSTRACT**

A direction ignition system is provided for a valve controlled ignition system. The system utilizes an electrically actuated electromagnetic valve means connected between the fuel burner and a fuel supply. The valve means has an armature and includes means for biasing the armature in a normally closed position. The biasing means is adjustable and force-calibrated to prevent actuation of the valve means at less than a minimum voltage drop thereacross. The system also includes a fuel ignition element, electrically in series with the electromagnetic valve means, which reaches fuel ignition temperature in response to a predetermined current flow. Alternatively, there may be provided an electrically actuated thermal valve, fluidically in series with the electromagnetic valve means, and electrically in series with the fuel ignition element. The electromagnetic valve means is then in parallel electrically with the thermal valve and ignition element.

13 Claims, 7 Drawing Figures



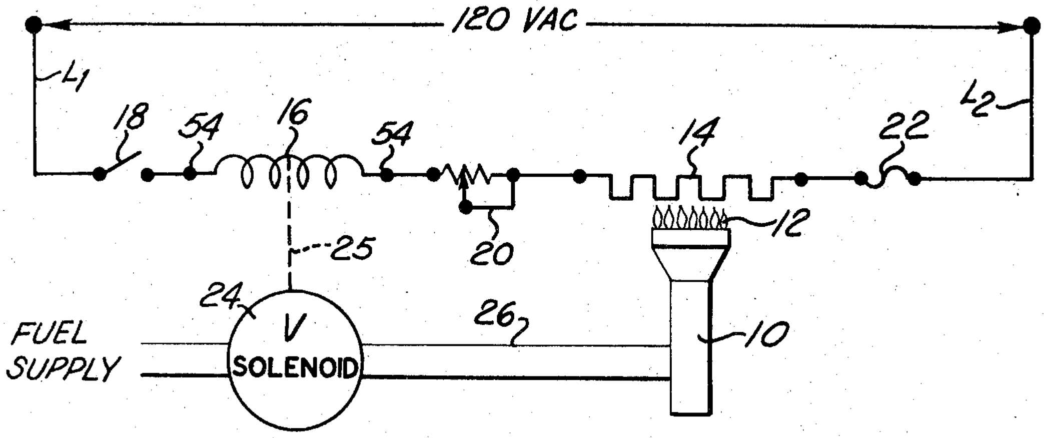
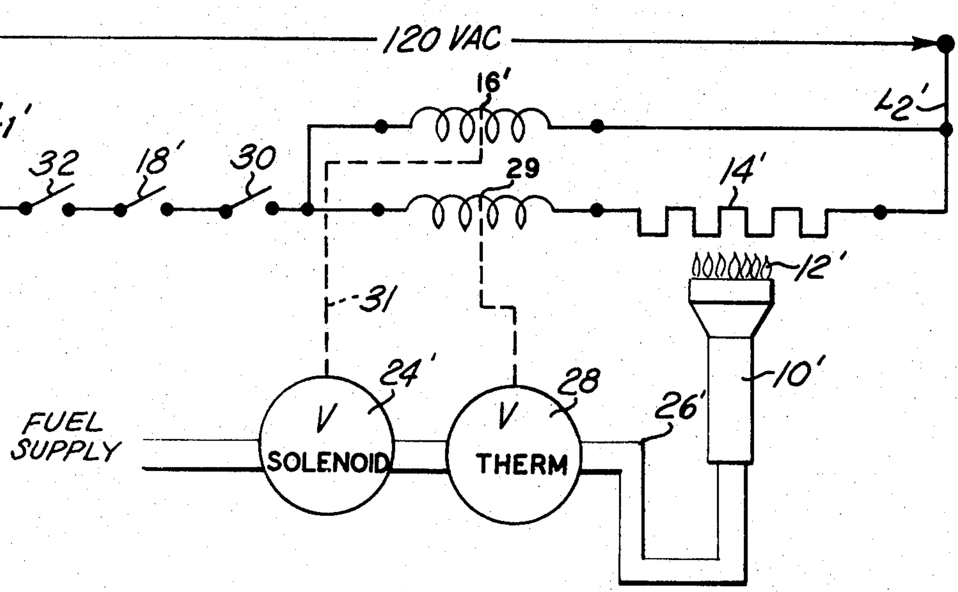

120 VAC
L_1
L_2
18
54
16
54
14
22
12
20
25
24
FUEL
SUPPLY
V
SOLENOID
26
10

FIG. 1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V
THERM

FIG. 2

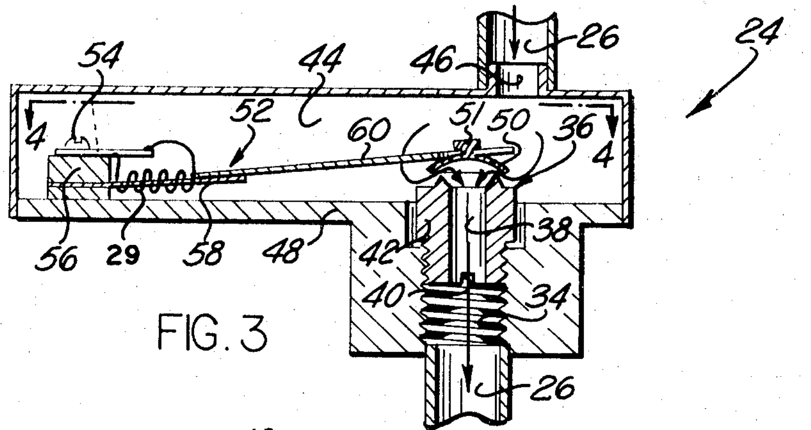

FIG. 3

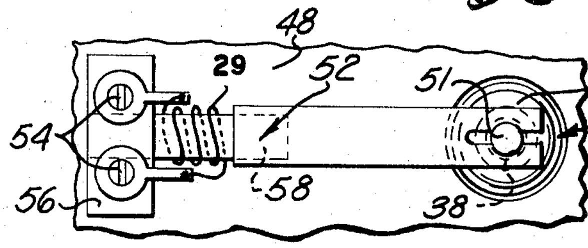

FIG. 4

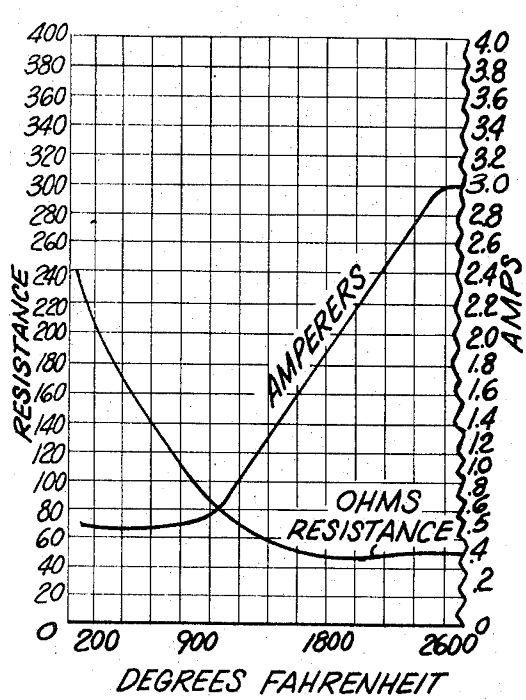

FIG. 5

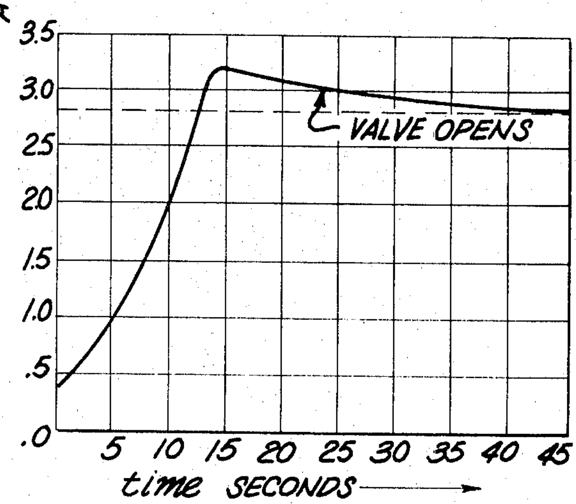

FIG. 6

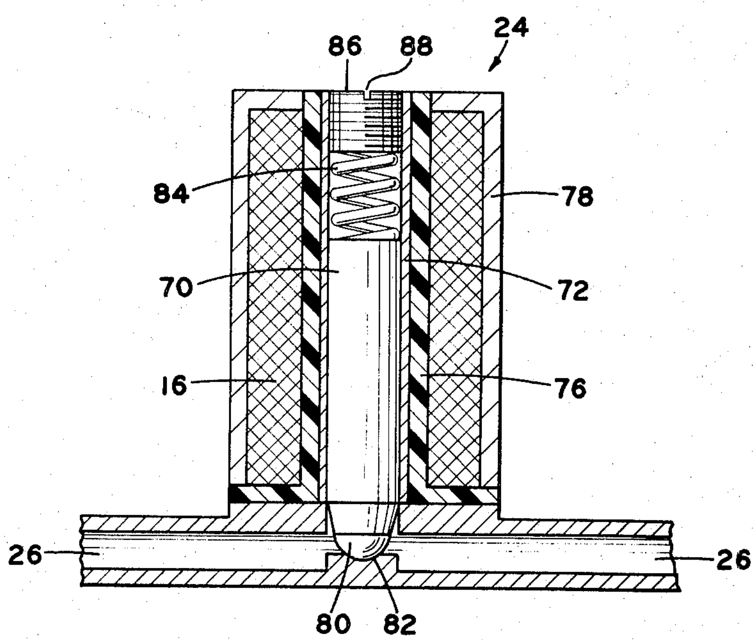

FIG. 7

DIRECT BURNER IGNITION SYSTEM

This application is a continuation-in-part of my copending application Ser. No. 281,067, filed Aug. 16, 1972.

BACKGROUND OF THE INVENTION

This invention relates generally to fuel ignition systems for valve controlled burners and particularly to direct ignition systems using an igniter element which allows an increased current flow to actuate a valve upon reaching an ignition temperature.

Prior art burner ignition devices generally fall into two categories, namely, indirect and direct ignition devices.

The indirect ignition devices generally comprise pilot flame ignited burner systems wherein a fluid filled thermoresponsive device is continuously heated by the pilot flame to a predetermined temperature at which the expanded fluid of the thermocouple allows the main valve to be opened to provide fuel flow to the burner which is then ignited by the pilot flame. One drawback of such devices is that the positioning of the thermocouple to the pilot flame is quite critical. Improper placement of the thermocouple either too far from the flame or too near to the cold part of the flame will not heat the thermocouple sufficiently to open the main valve. Another drawback is that the pilot flame may be shifted from the thermocouple by an air draft or completely extinguished thereby preventing the main valve from opening in either case. Because the pilot flame is burning continuously, a waste of fuel results during any period of time when the main burner is not actuated. The waste is especially great during relatively mild parts of the winter when heat is needed only periodically, but the pilot flame burns constantly.

Direct ignition systems are known which utilize electrical means for producing sparks to directly ignite fuel flowing from a burner. A timing circuit is used in conjunction with the spark ignition means to terminate fuel flow to the burner if the fuel is not ignited within a predetermined time. Some flame detection means are also required for indicating to the timing circuit whether the fuel has been ignited or not. As such these systems are complicated and expensive and require extensive troubleshooting to determine the cause of any failure occurring therein.

Direct ignition systems are also known which utilize a glow coil or heater element which is heated to the fuel ignition temperature and which are operable to ignite the fuel flowing from the burner. In these systems, some type of flame detecting means is required to terminate fuel flow should the heater element fail to ignite the fuel. The detecting means may comprise infra-red sensors or flame conductivity sensors along with their associated circuitry. Such a system is disclosed in U.S. Pat. No. 3,649,156 issued to Leonard E. Conner. It will be appreciated that such a system requiring separate flame igniting and flame sensing elements is complicated and expensive since extensive circuitry is required to coordinate the igniting and sensing functions into an operative system.

SUMMARY OF THE INVENTION

The present invention provides a new and improved direct burner ignition system which is simple in construction and inexpensive to manufacture and operate.

The system requires no separate flame sensing means to maintain operation since it is capable of providing electrical failsafe operation.

In one embodiment of the invention a variable resistance means provides a first resistance value when at ambient temperature and a second resistance value when heated by connection to an electrical power source. Valve actuating means are electrically series connected to this variable resistance means and are operable to allow fuel to flow to a burner only after the variable resistance means achieves the second resistance value.

In another embodiment of the invention an electromagnetic valve is connected between a fuel supply and a burner to provide a flow of fuel to the burner in response to a predetermined current. Ignition means, having a resistance which decreases with increased temperature is mounted proximate to the burner to provide an element which attains the ignition temperature of the fuel in response to the same predetermined current. Series circuit means connect the valve and the ignition means to a power source whereby current flow from the power source is operable to increase the temperature of the ignition means thereby decreasing the resistance of the series circuit and allowing the predetermined current value to be obtained in the circuit.

In yet another embodiment of the invention a parallel electric circuit means is series connected with the ignition means to control a heat valve and an electromagnetic valve in response to the ignition means attaining fuel ignition temperature. The electromagnetic valve has an armature and includes means for biasing the armature in a normally closed position. The biasing means is adjustable to prevent actuation of the valve at less than a minimum voltage drop across the electromagnetic valve.

The series connection of the temperature ignition means with the valve or valves which control fuel flow to the burner in the above described embodiments provides a simple and inexpensive direct fuel ignition apparatus which assures that fuel flow will occur only when the ignition element is at the fuel ignition temperature. Therefore, there is no requirement for any separate flame sensing devices or delay circuitry as the present invention automatically provides electrical fail-safe operation.

It is, therefore, an object of this invention to provide a simple and inexpensive direct ignition system which is electrically fail-safe.

It is a more specific object of the present invention to provide a system which insures that no fuel can flow when the ignition element is below the ignition temperature, even under extreme circumstances, such as a low voltage condition.

Another object of this invention is to provide a fuel valve actuating system which is operable to actuate a fuel valve in response to a predetermined resistance of a variable resistance means which is electrically connected to the fuel valve.

Another object of this invention is to provide a direct ignition system which allows fuel flow to a burner only upon an ignition element attaining a fuel ignition temperature.

Another object of the invention is to provide a direct fuel ignition system which is operable to actuate a plurality of valves to provide fuel flow to a burner in response to an ignition element attaining a fuel ignition temperature.

These and other objects of the invention will become more apparent from the description of the drawings and the detailed description of the preferred embodiment, which follows hereinafter.

BREIF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic drawing of one series connected direct ignition system.

FIG. **2** is a schematic drawing of a series-parallel connected direct ignition system.

FIG. **3** is a sectional side view of a thermally actuated bimetal valve which may be used in conjunction with the circuit of FIG. **2.**

FIG. **4** is a top view of the bimetal portion of the thermally actuated valve of FIG. **3.**

FIG. **5** is a graph of resistance of, and current flow through the igniter element versus temperature of the igniter element.

FIG. **6** is a graph of current in the series circuit of FIG. **1** versus time after connection to a 120 Volt A.C. power source.

FIG. **7** is a semi-schematic sectional side view of a calibrated solenoid valve of the type which may be used in the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings wherein FIG. **1** shows a 120 Volt A.C. power source connected across a pair of lines L_1 and L_2 with a thermostat switch **18,** a coil **16,** a trim resistor potentiometer **20,** an igniter **14** and a fuse **22** all electrically connected in a series circuit associated therewith. This series circuit provides a direct ignition system for a burner **10.** Fuel flow to the burner **10** is controlled by a solenoid valve **24** positioned in a conduit **26** between the burner **10** and a fuel supply.

The solenoid valve **24** is positioned to be actuated by the coil **16** as is indicated by the dotted line **25** in a manner that will be described later. The igniter **14** is mounted proximately to the outlet of the burner **10** to allow the fuel from the burner **10** to flow directly onto the igniter **14** upon actuation of the valve **24.**

The operation of the circuit of FIG. **1** is best understood with reference to the graphs of FIGS. **5** and **6.** A master control thermostat (not shown) is used to set a reference temperature to which the thermostat switch **18** controls the burner flame to maintain the reference temperature setting. However, since this part of the circuit is conventional in the art it need not be illustrated for purposes of understanding the invention. The thermostat switch **18** closes and allows the voltage across line L_1, L_2 to be applied to the series circuit connected therebetween. The resistances of the trim resistor **20,** the fuse **22** and the coil **16** are selected to be negligible as compared to the initial resistance of the igniter.

The igniter **14** is preferably a negative slope thermistor which is composed of silicon carbide materials and exhibits a decreased electrical resistance with increased temperature. A typical resistance v. temperature curve for such an igniter is disclosed at FIG. **5.** Such igniters are readily available from the Carborundum Company of Niagara Falls, New York.

As is seen in FIG. **5** the igniter **14** has a resistance of 240 ohms at the initial ambient temperature of 80°F. when the series circuit between L_1 and L_2 is first connected to the 120 Volt A.C. power source. The initial current flowing through the igniter **14** is approximately 0.45 amps and the line voltage is proportioned therefore between the igniter and remaining elements with a 108 VAC drop across the igniter **14** and 12 VAC drop across the remaining elements. The igniter **14** is heated by the current flowing therethrough and rises in temperature while exhibiting a corresponding decrease in resistance until the resistance starts leveling off, at approximately 1,600°F., to an approximate value of 38 ohms. Of course, as the igniter **14** resistance decreases, the current in the series circuit between L_1 and L_2 increases, due to a decrease in total circuit resistance, until it also levels out to an approximate value of 3 amps.

The solenoid valve **24** is preselected to allow fuel flow to the burner **10** whenever a current of approximately 2.8 amps flows through the heater coil associated therewith. Because this current flow is possible only when the resistance of the igniter **14** is approximately 38 ohms and this igniter resistance is possible only when the igniter **14** is at 2,200°F. or greater, ignition of the fuel flowing from the burner **10** is thereby assured since fuels such as natural gas have an ignition temperature of approximately 1,600°F.

Once the fuel flowing from the burner is ignited, the burner **10** will heat the surroundings until the thermostat senses that the preselected temperature has been attained and will then open the switch **18** to terminate current flow and close the valve **24** preventing further fuel flow to the burner **10.** The igniter **14** is also disconnected from the power source by the switch **18** and cools down to its initial temperature.

The trim resistor **20** is a manually adjustable potentiometer by which resistance may be added to the circuit and the maximum current flowing therein minimized thereby. The circuit is protected by a fuse **22** which will open circuit in situations of excessive current flow in the circuit.

The circuit outlined above is electrically failsafe in that any malfunction of the component parts will not cause a hazardous condition by allowing fuel to flow without it being ignited by the igniter **14.** Should an open circuit develop in either the igniter **14** or the coil **16** current flow to the solenoid valve **24** would stop and the valve **24** would close to shut off fuel flow to the burner. If a short circuit develops in the igniter **14,** the fuse **22** would open the circuit due to excessive current flow and prevent current flow to the valve **24** shutting off fuel flow. If the coil **16** is short circuited, current flow therein would stop and the valve **24** would shut off fuel flow even though the igniter was on.

FIG. **7** illustrates semi-schematically a preferred form of the solenoid valve **24** for use in the subject embodiment. The valve **24** is "force-calibrated," i.e., the biasing means which maintains the armature in a normally-closed position is precisely set to be overcome by a predetermined, minimum voltage drop across the solenoid valve. The valve **24** includes an armature **70** positioned within an armature guide **72.** The solenoid coil **16** is wound on a bobbin **76,** which is fitted over the guide **72** and the entire assembly is encased within the solenoid cover **78.** In the subject embodiment, the armature **70** terminates at its lower end in a generally hemispherical armature head **80,** which is held against valve seat **82,** by biasing means in the form of helical compression spring **84.** The force exerted by the spring **84** against armature 70 is precisely controlled by a calibration means, shown herein as a threaded compression-adjusting member 86, which may be adjusted by means of slot 88. It should be clearly understood, of course, that the biasing of the armature may be accomplished by other means, such as an accurately calibrated biasing spring, and the important feature of the preferred embodiment of FIG. 7 is the ability to precisely control the voltage drop across the solenoid valve which is required to actuate the armature, lifting the head 80 out of the seat 82 and opening supply line 26'. It should also be noted that other head and seat arrangements may be utilized and the present invention is in no way dependent upon any particular such arrangement.

The time within which specific circuit actions take place are seen in the graph of FIG. 6. When the circuit is first connected to the 120 VAC power supply at time 0 seconds a current of approximately 0.45 amps initially flows in the circuit and rises to approximately 2.8 amps within the next 13 seconds. This is the minimal current which when maintained for a brief period of time will cause sufficient voltage (1R) drop in the coil to cause the force-calibrated solenoid valve 24 to be actuated.

Referring now to FIG. 2, wherein like parts are similarly designated, but with a prime added, the circuit shown therein is an alternative embodiment of the direct ignition system of FIG. 1, and is particularly adaptable to the direct ignition of burners in clothes dryer applications. A timer switch 32 is electrically series connected with a thermostat switch 18' and a dryer door actuated motor switch 30. A two branch parallel circuit is connected between line L_2' and the motor switch 30. An electromagnetic coil 16' is located on one branch and a heater coil 29 is series connected to an igniter 14' located in the second branch. The electromagnetic coil 16' activates the solenoid valve 24' as is indicated by dotted line 31.

Thermal valve 28 and the solenoid valve 24' are both connected in line with the supply line 26' and fuel flow to the burner 10 occurs only when both valves 24' and 28 are open.

In operation, when the timer (not shown) is set for a certain time interval, the timer switch 32 closes. If the thermostat (not shown) senses the dryer temperature is lower than the preselected temperature the thermostat switch 18' will also close. If the door is closed the dryer motor will operate and close the switch 30 to apply power to the two parallel branches to complete the circuit. Power applied through the heater coil 29 and igniter 14' will open the thermal valve 28 after a period of time when the igniter is at the fuel ignition temperature, similar to the manner which was explained previously with respect to FIG. 1. Power applied through the electromagnetic coil 16' will immediately open the solenoid valve 24'. When the igniter 14 is at the full ignition temperature, the valve 28 being open, fuel will flow to the burner 10' and will be ignited by the igniter 14'.

Fuel will continue to flow to the burner 10' until any one of the switches 32,18', or 30 are opened. When either of the switches 32,18', or 30 opens it stops current flow to heater coil 29 and coil 16 to immediately shut off valve 24' to stop fuel flow. Thus when the thermostat (not shown) senses that the preselected temperature has been attained in the dryer, the thermostat switch 18' opens and terminates current flow to the solenoid coil 16' shutting off valve 29' to terminate fuel flow. When the dryer door is opened, the dryer motor (not shown) is stopped and it in turn opens the switch 30 and terminates current flow to the coil 16' shutting off valve 24' to terminate fuel flow. Similarly when the timing cycle of the dryer ends, switch 32 opens and terminates current flow to the coil 16' shutting off valve 24' to terminate fuel flow.

This circuit is also electrically fail-safe because the added elements of the coil 29 and valve 28 fail only in a non-hazardous manner. A short circuit of the coil 29 will prevent development of the requisite heat therein and the valve 28 will remain closed. Conversely, an open circuit of the coil 28 will prevent the requisite current flow and the valve 28 will likewise remain closed.

The thermal valve 28, as shown in FIGS. 3 and 4, has an inlet 46 connected to the fuel supply side of line 26. The fuel is communicated therethrough to a chamber 44 wherein it exerts its supply line pressure on a valve plug 50 to seal a passageway 38 extending through a seat body 42 of an adjustable seat assembly 36 threaded into a valve plate 48. An ambient compensated bimetal assembly 52 is connected to the plug 50 by having the top portion 51 of the plug slide into a keyway formed in a bimetal element 60. The bimetal 60 has one end joined to a compensating bimetal element 58 by means known to those familiar with the art. The other end of the element 58 is joined to an electrically insulating terminal block 56 by means also known to those skilled in the art. The heater coil 29 is wrapped around the element 58 with its ends connected to electrical connecting terminals 54. The bimetal elements 58,60 are preselected to provide a constant force on the valve plug 50 throughout a range of temperatures as long as both elements are at the same temperature. However, when the heater coil is activated by current flow therethrough, it raises the temperature of the element 58 above that of the element 60 to unbalance the force on the plug 50 and cause it to be lifted from the seat assembly 36. This lifting occurs at the preselected current flow of 2.8 amps through the heater coil 29, at which time the added force from element 58 is sufficient to overcome the compensating force of element 60 as well as that of the fuel line pressure acting on the plug 50. The seat assembly 36 may be adjusted up or down by appropriately threading the assembly 36 in the plate 48. An adjustment slot 40 is provided to facilitate this action. When the plug 50 is lifted from the seat assembly 36 fuel flows through the passageway 38 into an outlet 34 which communicates with the burner 10 side of the supply line 26 to supply fuel to the burner 10 thereby.

It will be apparent to one skilled in the art that the various current, resistance and time values recited herein are merely for purposes of illustrating the operation of one preferred embodiment of the invention, which is in no way dependent upon any particular value.

Certain modifications and improvements will become obvious to those skilled in the art upon reading this specification. One of such obvious modifications and improvements would be to incorporate a flame loss override circuit to shut off the power to the direct ignition circuit upon loss of flame from the burner. This would function as a secondary mechanical fail-safe circuit. It is the Applicant's intention, therefore, that all such obvious modifications and improvements be included within the scope of his invention.

Having described the invention so as to enable one skilled in the art to practice it, I claim:

1. A direct ignition system for a valve controlled fuel burner comprising:
  a. an electrically actuated thermal valve connected between said fuel burner and a fuel supply;
  b. electromagnetic valve means fluidically in series with said thermal valve, said valve means having an armature and including means for biasing said armature in a normally closed position, said biasing means preventing actuation of said valve means at less than a minimum voltage drop across said valve means;
  c. means providing a fuel ignition element proximate to the outlet of said burner, said fuel ignition element reaching fuel ignition temperature in response to a predetermined current flow therethrough; and
  d. parallel electric circuit means operating
    i. said thermal valve in response to a fuel ignition temperature being present in said fuel ignition element, and
    ii. said electromagnetic valve means.

2. A direct ignition system as set forth in claim 1 wherein said electromagnetic valve means is a solenoid valve and said biasing means includes a helical compression spring.

3. A direct ignition system as set forth in claim 2 wherein said biasing means includes means to adjust the voltage drop required to actuate said valve means.

4. A direct ignition system as set forth in claim 3 wherein said adjustment means includes an adjustable threaded member providing a seat for said spring, said threaded member being oppositely disposed from said armature.

5. A direct ignition system as set forth in claim 1 wherein said fuel ignition element is a variable resistance means electrically in series with said thermal valve and electrically in parallel with said electromagnetic valve means.

6. A direct ignition system as set forth in claim 5 wherein said ignition element is a negative slope thermistor.

7. A direct ignition system as set forth in claim 1 including:
  an electrical power source; and
  a manual switch series connected to said parallel circuit means to control the connection of said electrical power source to said parallel circuit means and said fuel ignition element.

8. A direct ignition system as set forth in claim 1 wherein said fuel ignition element includes a negative resistance thermistor having a fuel ignition temperature when a predetermined current flows therethrough.

9. A direct ignition system as set forth in claim 1 wherein said parallel circuit means includes a substantially constant resistance heater mounted to said thermal valve to control the opening of said thermal valve in response to said predetermined current flowing through said resistance heater.

10. A system for igniting a fuel burner comprising:
  a. electromagnetic valve means connected between said fuel burner and a fuel supply, said valve means including an armature selectively movable between a position opening said valve means and a position closing said valve means, said valve means further including means for biasing said armature to prevent opening of said valve means at less than a minimum voltage drop across said valve means;
  b. means providing a fuel ignition element proximate to the outlet of said burner, said fuel ignition element reaching fuel ignition temperature in response to a predetermined current flow therethrough; and
  c. said biasing means includes a helical compression spring and means to adjust the voltage drop required to actuate said electromagnetic valve means.

11. A system as set forth in claim 10 wherein said ignition element includes variable resistance means electrically in series with said valve means.

12. A system as set forth in claim 11 wherein said ignition element is a negative slope thermistor.

13. A system as set forth in claim 10 wherein said adjustment means includes an adjustable threaded member providing a seat for said spring, said threaded member being oppositely disposed from said armature.

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