

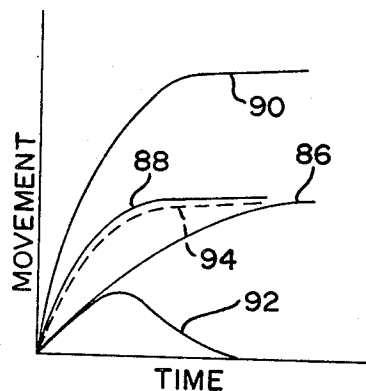
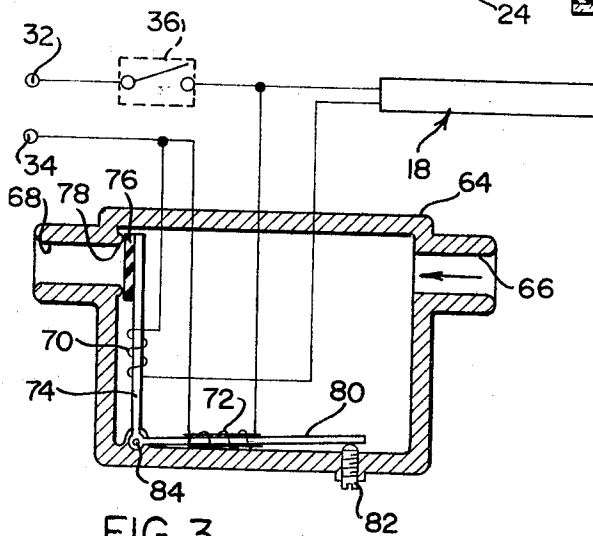
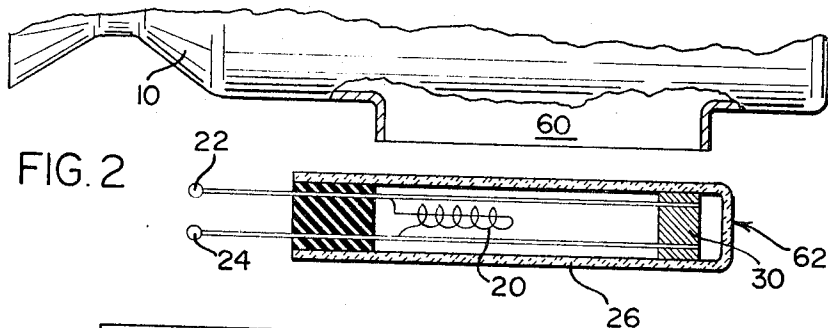
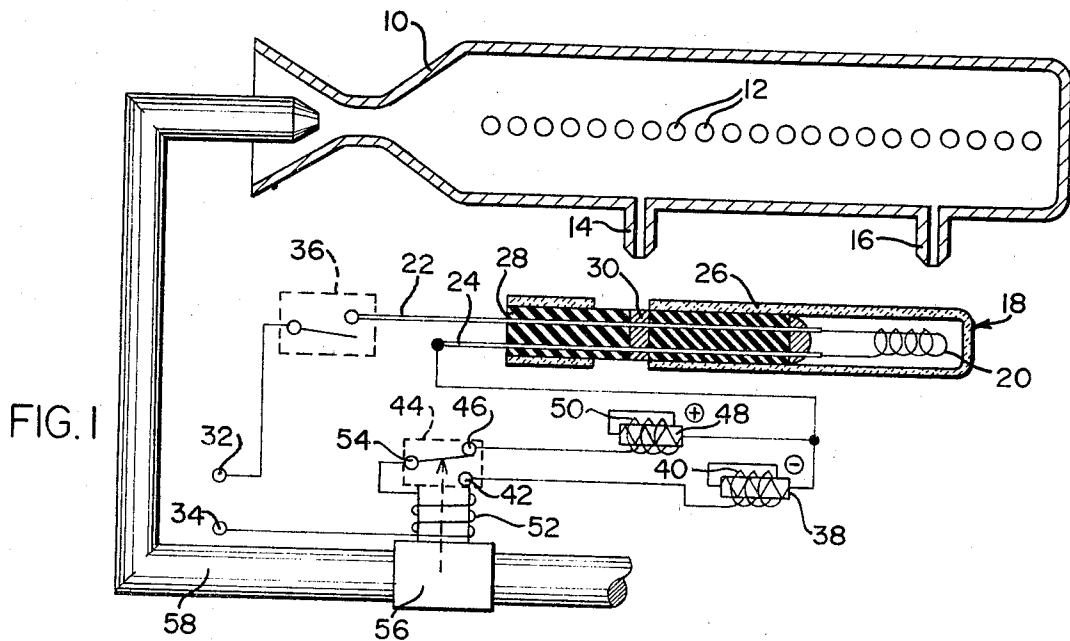
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ELECTRIC IGNITION SYSTEM

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ELECTRIC IGNITION SYSTEM

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ABSTRACT OF THE DISCLOSURE

Electric ignition systems utilizing an igniter having a glow-wire and a negative temperature coefficient resistor in parallel therein and a fuel valve adapted to control a flow of fuel to a burner wherein the igniter controls the operation of the fuel valve via the varying resistance of the parallel combination of the glow-wire and the negative temperature coefficient resistor.

BACKGROUND OF THE INVENTION

The present invention pertains to electrical ignition systems, and more particularly, to such systems having flame proving means associated with an electric igniter to control a flow of fuel to a burner.

It is conventional to utilize a pilot flame to ignite a burner and after ignition to assure fuel continuity to the burner. Such pilot flames have a disadvantage in that they are subject to outage for reasons other than fuel or burner failure, such as drafts or dust and lint clogging the pilot fuel line. Electric igniters are more desirable than flame igniters due to their reliability and immunity from the conditions that may cause undesired outage of flame igniters; however, in the past electrical igniters have not been commonly utilized since they have involved the use of relatively complex timing and electrical relay systems in order to obtain maximum life from the igniters and also to provide the safety function which is obtained by monitoring the standing flame in flame igniter systems. Spark-type electrical igniters require complex circuitry to obtain the high voltage necessary to obtain the spark, and glow-wire igniters require circuitry to minimize the time they remain at igniting temperatures because they are subject to oxidation and must be frequently replaced.

SUMMARY OF THE INVENTION

An object of the present invention is to utilize an electric igniter exhibiting a varying resistance in an electric ignition system to control a valve.

Another object of the present invention is to utilize an electric igniter having a temperature responsive resistor and a glow-wire in parallel therein in an electric ignition system.

A further object of the present invention is to construct an electric ignition system utilizing a variable resistance igniter and a valve operating in response to the varying resistance of the igniter.

The present invention has another object in that an igniter includes a flame sensing resistor and a glow-wire to ignite a burner and prove the flame in the burner.

An advantage of the present invention is the relatively simple circuitry necessary to provide electrical ignition of a burner and flame proving means for the burner.

The present invention is generally characterized in that an electric ignition system comprises a valve adapted to control a flow of fuel to a burner and an igniter having a varying resistance for controlling the valve.

Other objects and advantages of the present invention will become apparent from the following description of the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partially sectioned schematic diagram of an embodiment of an electric ignition system according to the present invention;

FIG. 2 is a partially sectioned diagram of a modification of the igniter-burner relationship of FIG. 1;

FIG. 3 is a partially sectioned schematic diagram of another embodiment of an electric ignition system according to the present invention; and

FIG. 4 is a plot graph showing the movement of the bimetal arms of FIG. 3 plotted against time.

DESCRIPTION OF PREFERRED EMBODIMENTS

A first embodiment of an electrical ignition system according to the present invention is shown in FIG. 1 which includes a burner 10 having a plurality of heating ports 12 and spaced pilot ports 14 and 16. The igniter components are embodied in an assembly 18 which is located within igniting proximity of pilot ports 14 and 16 of burner 10 and includes a heating element such as a glow-wire 20 which is connected to two conductors 22 and 24 that extend through igniter 18. Igniter 18 is encapsulated by a ceramic sheath 26, and an electrical insulating material 28 secures the positioning of conductors 22 and 24 within igniter 18. A resistor 30 having a negative temperature coefficient of resistance seals conductors 22 and 24 together and may be made of a material such as zirconium oxide and vapor deposited in igniter 18. Ceramic sheath 26 and insulating material 28 completely seal the chamber in which glow-wire 20 is disposed.

Terminals 32 and 34 are adapted to be connected to a suitable source of electrical power, and terminal 32 is connected to a switch 36 which may be manually or automatically controlled to supply electrical power selectively to igniter 18 and the remainder of the circuit. Conductor 24 of igniter 18 is connected through a resistor 38 having a negative temperature coefficient of resistance and a heating coil 40 to a contact 42 of a switch 44. Conductor 24 is also connected to switch 44 at a contact 46 through a resistor 48 having a positive temperature coefficient of resistance and a heating coil 50. A solenoid coil 52 is connected between terminal 34 and a pole 54 of switch 44 and controls the operation of switch 44 and a valve 56 which controls a flow from a fuel supply (not shown) through a conduit 58 having a nozzle 60 to burner 10. Solenoid 52 is shown in FIG. 1 in its energized state thereby connecting pole 54 to contact 46 and opening valve 56. When solenoid 52 is in its normal or de-energized state, valve 56 is closed and pole 54 is connected to contact 42.

Operation of the electric ignition system of FIG. 1 is commenced by closing switch 36 which completes a circuit from terminal 32 through switch 36, igniter 18, resistor 38, heating coil 40, contact 42, pole 54 and solenoid 52 to terminal 34. Due to its negative temperature coefficient, resistor 30 has a resistance many times greater than the resistance of glow-wire 20, and consequently the resistance of the parallel combination of resistor 30 and glow-wire 20 is approximately that of glow-wire 20. Since resistor 38 also has a negative temperature coefficient its resistance will be very high, and the voltage drop across igniter 18 and resistor 38 prevent the application of sufficient energizing voltage to solenoid 52. However, as current passes through heating coil 40 it begins to heat, and this heat causes the resistance of resistor 38 to decrease until there is sufficient voltage to energize solenoid 52. The time delay provided by resistor 38 and heating coil 40 allows glow-wire 20 to be heated to ignition temperature before valve 56 is opened to supply fuel to burner 10.

The energization of solenoid 52 opens valve 56 and connects pole 54 of switch 44 to contact 46 which disconnects resistor 38 and heating coil 40 from the circuit and replaces them with resistor 48 and heating coil 50. Since resistor 48 has a positive temperature coefficient, its resistance is small when first placed in the circuit and increases as heating coil 50 starts to heat to initially maintain solenoid 52 energized. The opening of valve 56 allows fuel to be supplied to burner 10 where it will be ignited by igniter 18. After ignition, a flame at port 14 will be sensed by resistor 30 which will decrease its resistance due to its negative temperature coefficient. The resistance of glow-wire 20 is higher at ignition temperature than when cold, and the resistance of resistor 30 is lower at ignition temperature than when cold. The resistance of the parallel combination of resistor 30 and glow-wire 20 after burner 10 is ignited, is approximately equal to the resistance of resistor 30 since the resistance of glow-wire 20 is much greater than the resistance of resistor 30. Consequently, solenoid 52 will remain energized after the resistance of resistor 48 reaches a maximum due to the low resistance of igniter 18.

If proper ignition does not occur there will be no flame at port 14 and the resistance of resistor 30 will remain high and consequently, the resistance of igniter 18 will be high which causes the voltage drop across resistor 48 and igniter 18 to be great enough to deenergize solenoid 52. The deenergization of solenoid 52 closes valve 56 to prevent further fuel flow to burner 10 and also disconnects resistor 48 and heating coil 50 and connects resistor 38 and heating coil 40 in the circuit. Resistor 38 will have cooled to the extent that its resistance is high when it is again connected in the circuit and therefore solenoid 52 will remain deenergized. The system will then recycle; that is, after heating coil 40 heats resistor 38, solenoid 52 will be energized and will remain energized if burner 10 is ignited. If it is desired to limit the number of times the system recycles, a timing mechanism may be placed in series with power control switch 36 to permit ignition during a predetermined time period after switch 36 is initially closed and to lock out the system if ignition is not achieved during the predetermined time period. When it is desired to stop the heating of burner 10, switch 36 is opened which deenergizes solenoid 52 and closes valve 56.

In one tested embodiment of the system of FIG. 1, a glow-wire was used having a resistance when cold of 25 ohms and a resistance of 150 ohms when at igniting temperature. The shunt resistor 30 used, had a resistance much greater than 25 ohms when the igniter was cold and a resistance of 10 ohms when sensing a flame at port 14. Consequently, when switch 36 was closed the resistance of igniter 18 was approximately 25 ohms and after ignition the resistance of igniter 18 was approximately 10 ohms.

FIG. 2 illustrates a modification of the igniter-burner relationship shown in FIG. 1. Identical reference numerals are used to designate identical components in the description of FIGS. 2 and 3. In FIG. 2, a burner 10 is partially shown having a long, narrow port 60 which serves to ignite burner 10 and also as part of means to prove the burner flame. An igniter 62 is located within igniting and flame proving proximity of port 60 of burner 10 and includes electrodes 22 and 24, insulating material 28, a glow-wire 20, a ceramic sheath 26 and resistor 30 having a negative temperature coefficient. Igniter 62 of FIG. 2 differs from igniter 18 of FIG. 1 in that, although glow-wire 20 and resistor 30 are in parallel in both FIGS. 1 and 2, in FIG. 2 resistor 30 is located at the end of igniter 62 farthest away from conductors 22 and 24. Igniter 62 operates in the same manner as igniter 18 when placed in the ignition system of FIG. 1; however, it is necessary to have only one pilot port with igniter 62 whereas igniter 18 is associated with two pilot ports.

FIG. 3 illustrates an ignition system similar to that

described in FIG. 1; however, a heat motor operated valve 64 having an inlet 66 and an outlet 68 is utilized in place of solenoid operated valve 56 of FIG. 1. An igniter 18 is not shown in detail since either igniter 18 of FIG. 1 or igniter 62 of FIG. 2 may be utilized in the ignition system of FIG. 3 and their operations are the same as previously described. Terminals 32 and 34 are adapted to be connected to a suitable source of electric power, and terminal 32 is connected to a power control switch 36 which may be either manually or automatically controlled. Igniter 18 is in series with a heating coil 70 between switch 36 and terminal 34, and a heating coil 72 is also connected between switch 36 and terminal 34. Heating coil 70 is disposed in heating proximity to a bimetal arm 74 which is attached to a valve member 76 that sealably engages a valve seat 78. Heating coil 72 is thermally lagged from a bimetal arm 80 which abuts an adjustable screw 82 at its free end and is attached at its other end to a pin 84 to which arm 74 is also attached.

The operation of the ignition system of FIG. 3 is described with reference to FIG. 4 which is a plot of the movement of arms 74 and 80 against time. When arm 74 is heated it deflects clockwise around pin 84 whereas arm 80 deflects counterclockwise around pin 84 when it is heated; however, both deflections are plotted as positive movements in FIG. 4. The closure of switch 36, either manually or automatically, completes a first circuit from terminal 32 through switch 36 and heating coil 72 to terminal 34 which energizes heating coil 72 to begin heating arm 80 and a second circuit from terminal 32 through switch 36, igniter 18 and heating coil 70 to terminal 34 which energizes heating coil 70 to begin heating arm 74. The movement of arm 80 is shown in curve 86 of FIG. 4, and at time zero, when switch 36 is closed, there is no movement of arm 80 or arm 74. As heating coil 72 heats arm 80, it deflects gradually until it reaches a point of maximum deflection as shown by curve 86. The deflection of arm 80 tends to maintain valve 64 closed due to its counterclockwise motion around pin 84 which maintains valve member 76 in contact with valve seat 78.

As previously pointed out in the description of FIG. 1, igniter 18 has a higher resistance when cold than when at ignition temperature, and consequently, the amount of deflection of arm 74 is dependent upon the ignition of the burner (not shown). Curve 88 of FIG. 4 illustrates the movement of arm 74 when the burner fails to ignite, and curve 90 of FIG. 4 illustrates the movement of arm 74 when there is ignition. Since arms 74 and 80 deflect in opposing directions, in order to determine the movement of valve member 76 it is necessary to subtract the movement of arm 80 from the movement of arm 74 as shown in curves 92 and 94. Curve 92 is a composite of curve 86 subtracted from curve 88 and curve 94 is a composite of curve 86 subtracted from curve 90.

After switch 36 is closed, arms 74 and 80 begin to deflect however, due to the thermal lag of heating coil 72, arm 80 deflects at a slower rate than arm 74 and valve member 76 gradually opens to permit fuel to be supplied to the burner. If the burner fails to ignite, the negative temperature coefficient resistor 30 in igniter 18 will maintain a high resistance which maintains the resistance of igniter 18 high. Thus, the current supplied to heating coil 70 is limited, and arm 74 deflects as shown in curve 88. The movement of arm 80 equals the movement of arm 74 at a later time, and therefore closes valve 64 as shown by curve 92 which descends to zero after arm 80 obtains its maximum deflection. Consequently, valve 64 opens to supply fuel to the burner after igniter 18 has been energized, and if the burner fails to ignite valve 64 closes due to the interaction of arms 74 and 80.

If there is ignition, resistor 30 senses the flame and lowers the resistance of igniter 18 to allow more current to be supplied to heating coil 70 which causes a greater deflection of arm 74 as shown by curve 90. Valve 64 will remain open after arm 80 obtains maximum deflection

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as shown by curve 94. Should the burner fail at some time after ignition, the resistance of resistor 30 will increase which increases the resistance of igniter 18 and reduces the current supplied to heating coil 70. Thus, arm 74 cools to equal the deflection of arm 80 and valve 64 closes to prevent further fuel being supplied to the burner. To stop the heating of the burner, switch 36 is opened which deenergizes igniter 18 and permits arms 80 and 74 to cool to close valve 64.

Screw 82 may be adjusted to assure closure of valve 64 upon ignition or burner failure by making certain that the deflection of arm 80 at least equals the deflection of arm 74 when igniter 18 has a high resistance.

The embodiments of FIGS. 1 and 3 may be combined by replacing solenoid operated valve 56 in FIG. 1 with heat motor operated valve 64 and retaining switch 44 and positive temperature coefficient resistor 48 to perform the safety cutoff function by balancing the power input and the bimetal response.

Inasmuch as the present invention is subject to many modifications, variations and changes in detail, it is intended that all matter contained in the foregoing description and shown in the accompanying drawings, shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In an electric ignition system, the combination comprising

an input circuit,

electric ignition means including a heating element adapted to ignite fuel at a burner and a temperature responsive resistor connected in parallel with said heating element and adapted to sense a flame from the burner, said electric ignition means exhibiting a varying resistance dependent upon temperature sensed by said electric ignition means,

valve means adapted to control a flow of fuel to the burner,

first means for controlling said valve means, and

second means connecting said first means and said electric ignition means with said input circuit, said valve means being controlled by said first means in accordance with the varying resistance of said electric ignition means.

2. The invention as recited in claim 1 wherein said temperature responsive resistor has a negative temperature coefficient of resistance.

3. The invention as recited in claim 5 wherein said second means includes a switch connected to and controlled by said first means and a first resistor having a negative temperature coefficient of resistance connected with said switch and said electric ignition means whereby said valve means opens a predetermined time after said electric ignition means is energized.

4. The invention as recited in claim 3 wherein said second means further includes a second resistor having a positive temperature coefficient of resistance connected between said switch and said electric ignition means and said switch means has a first state in which said second resistor is connected to said first mean and a second state in which said first resistor is connected to said first means.

5. The invention as recited in claim 4 wherein said temperature responsive resistor in said electric ignition means has a negative temperature coefficient of resistance whereby said electric ignition means exhibits a high resistance when said temperature responsive resistor does not sense a flame.

6. The invention as recited in claim 1 wherein said first means includes a first bimetal arm and a first heating element therefor and said second means includes means for connecting said first heating element and said electrical ignition means in series with said input circuit.

7. The invention as recited in claim 6 wherein said first means further includes a second bimetal arm and a second heating element therefor and said second means includes means connecting said second heating element with said input means.

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8. The invention as recited in claim 7 wherein said first means includes means for causing said first and second bimetal arms to deflect in opposing directions.

9. The invention as recited in claim 8 wherein said temperature responsive resistor in said electric ignition means has a negative temperature coefficient of resistance whereby said valve means is open when said temperature responsive resistor senses a flame and said valve means closes when said temperature responsive resistor fails to sense a flame.

10. In an electric ignition system, the combination comprising

an electric igniter having first and second conductors, a first resistor having a negative temperature coefficient of resistance connected with said first and second conductors and a glow-wire connected in parallel with said resistor,

an input circuit,

valve means,

first means for controlling said valve means,

second means connecting the first conductor of said igniter with said input circuit, and

third means connecting the second conductor of said igniter with said first means.

11. The invention as recited in claim 10 wherein said third means includes a switch connected with said first means, a second resistor having a positive temperature coefficient of resistance connected with said switch and the second conductor of said igniter and a third resistor having a negative coefficient of resistance connected with the second conductor and said switch.

12. The invention as recited in claim 10 wherein said first means includes a first bimetal arm, a first heating element located within heating proximity of said first bimetal arm, a second bimetal arm and a second heating element located within heating proximity of said second bimetal arm, means for connecting said first heating element to the second conductor of said igniter and means for connecting said second heating element to the second conductor of said igniter whereby said valve means is controlled by the resistance of said igniter.

13. Electric ignition apparatus for a fuel burner comprising an electric igniter assembly including a heating element adapted to ignite fuel at the burner and a temperature responsive resistor connected with said heating element, said igniter assembly including a sheath having a closed end and an open end, and electrical conductor means disposed in said sheath and extending through said open end of said sheath, said temperature responsive resistor being connected with said conductor means and disposed adjacent said open end of said sheath and said heating element being connected with said conductor means and disposed adjacent said closed end of said sheath, said igniter assembly having a resistance varying with temperature in accordance with the resistance of said heating element and the resistance of said temperature responsive resistor; and valve means adapted to supply fuel to the burner, said valve means being connected with said igniter assembly and controlled in accordance with the varying resistance of said igniter assembly.

14. Electric ignition apparatus for a fuel burner comprising an electric igniter assembly including a heating element adapted to ignite fuel at the burner and a temperature responsive resistor connected with said heating element, said igniter assembly including a sheath having a closed end and an open end, and electrical conductor means disposed in said sheath and extending through said open end of said sheath, said temperature responsive resistor being connected with said conductor means and disposed adjacent said closed end of said sheath and said heating element being connected with said conductor means and disposed adjacent said open end of said sheath, said igniter assembly having a resistance varying with temperature in accordance with the resistance

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of said heating element and the resistance of said temperature responsive resistor, and valve means adapted to supply fuel to the burner, said valve means being connected with said igniter assembly and controlled in accordance with the varying resistance of said igniter assembly.

15. Electric ignition apparatus for a fuel burner comprising an electric igniter assembly including a heating element adapted to ignite fuel at the burner and a temperature responsive resistor connected in parallel with said heating element, said igniter assembly having a resistance varying with temperature in accordance with the resistance of said heating element and the resistance of said temperature responsive resistor; and valve means adapted to supply fuel to the burner, said valve means being connected with said igniter assembly and controlled in accordance with the varying resistance of said igniter assembly.

16. The invention as recited in claim 15 wherein said heating element includes a glow-wire, and said tem-

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perature responsive resistor has a negative temperature coefficient of resistance.

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