Oct. 23, 1962 C. HOTCHKISS 3,059,693

CONTROL SYSTEM

Filed July 20, 1959 2 Sheets-Sheet 1

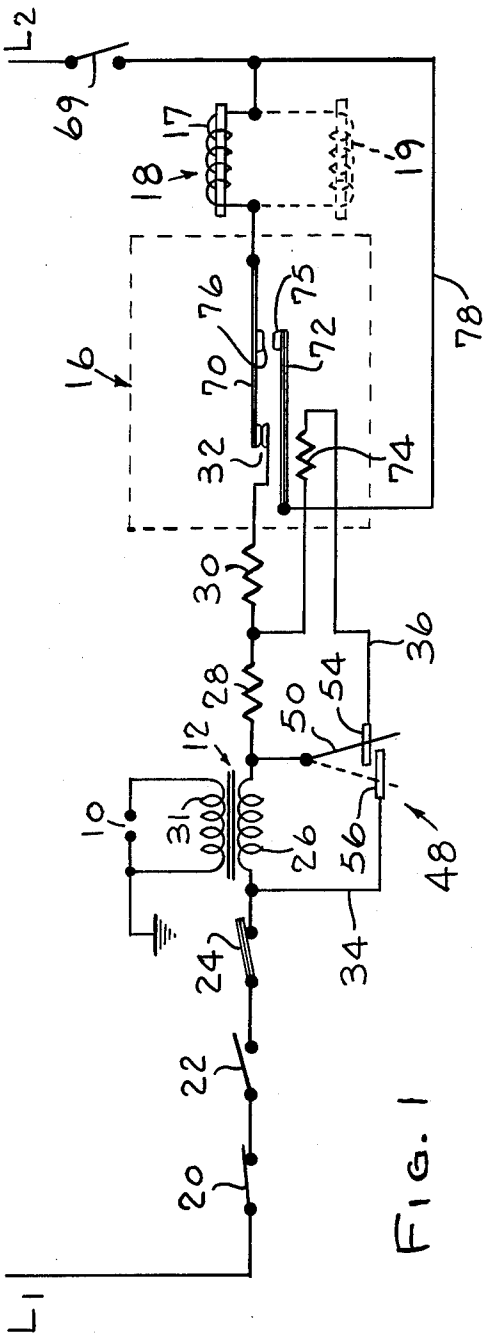


FIG. 1

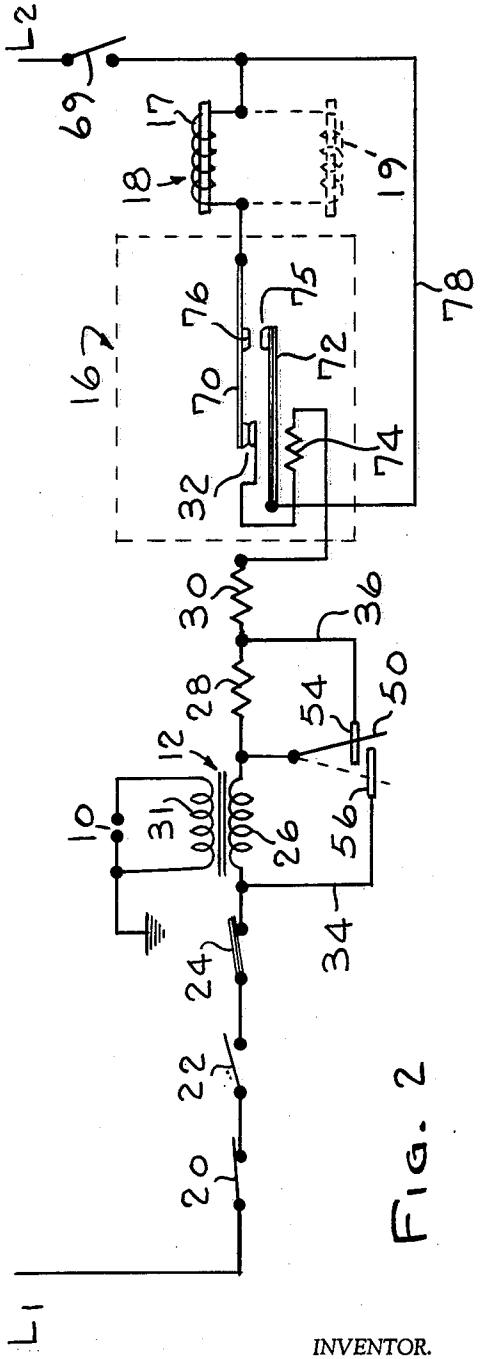


FIG. 2

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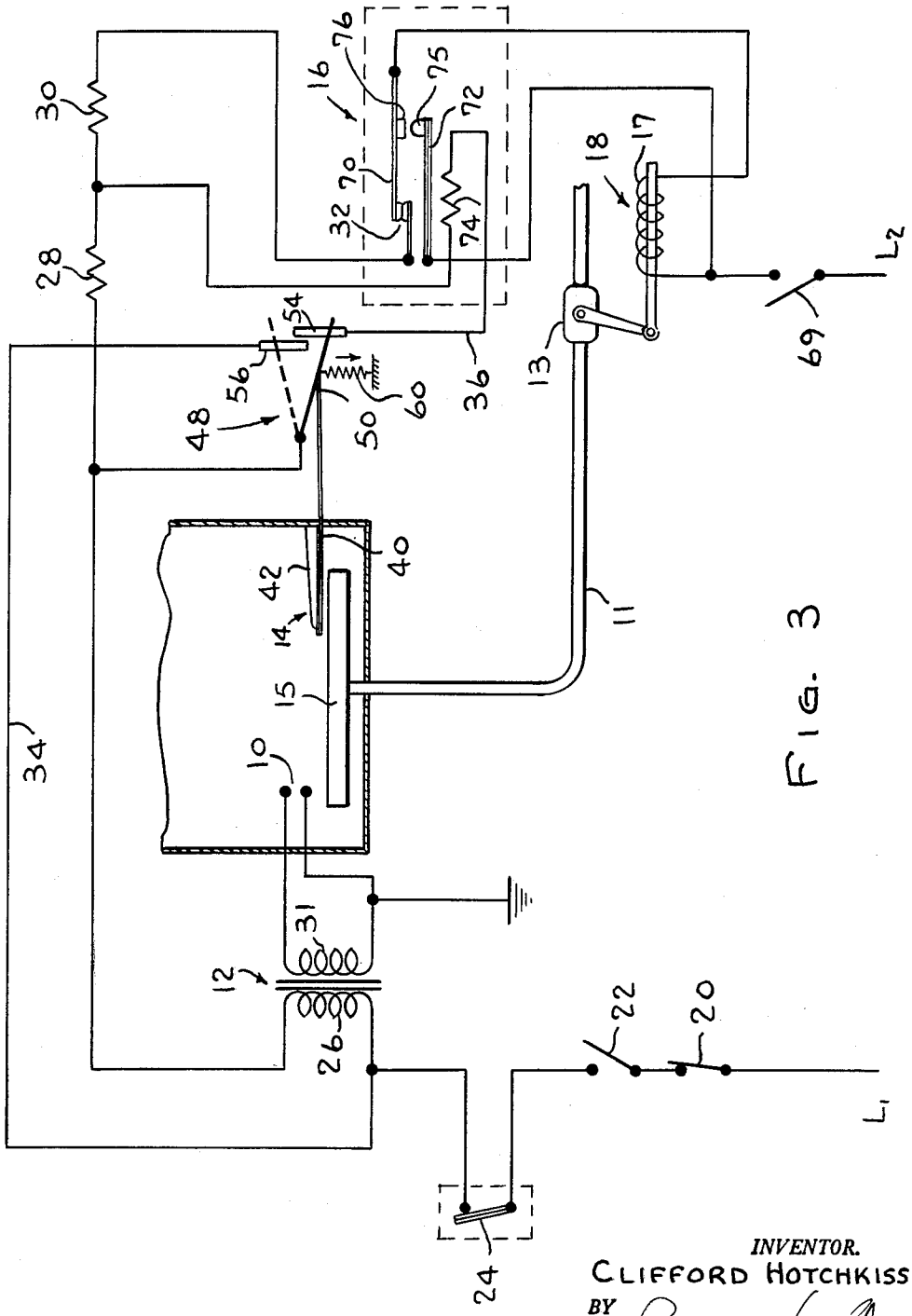


FIG. 3

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CONTROL SYSTEM

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18 Claims. (Cl. 158—125)

This invention relates to an improved ignition means for gas burners and particularly to an automatic direct spark ignitor combined with a safety control system.

Conventional ignition systems for gas burners depend upon a standing pilot for the ignition of the main burner gas and may be provided with an electric hot wire or glow coil as the ignition means for the pilot flame. These systems are subject to failure due to the closing of primary air openings by lint, plugging of the orifice, low and erratic gas pressure, variable draft, etc. These problems have existed in the gas burner industry for a long period of time, with the most aggravated problems existing in clothes dryers and the like.

Service records show that the pilot burner and its companion igniter account for a disproportionate share of service complaints. The performance and life of the latter element being adversely effected by variations in supply line voltage, an often encountered service condition. Since the clothes dryer provides the most aggravated problems, the present system will be described as used on a clothes dryer but is applicable to any device.

The present system provides an intense electric spark as an ignition means to directly ignite the main burner gas, thereby eliminating the need of a standing pilot. It incorporates all the necessary safeguards against ignition failure and provides fail safe operation in a unique and simple manner.

The primary object of this invention is to provide a spark ignition means for a gas burner.

Another object of this invention is to provide a spark ignition means for a gas burner with safety interlocks to assure safe operation under all conditions.

A further object of this invention is to provide a direct spark igniter for a gas burner which utilizes a power type transformer. Previous efforts in a spark ignition means have used impedance type transformers which immediately prices the product out of the market.

Other objects and advantages will be pointed out in, or be apparent from, the specification and claims, as will obvious modifications of the two embodiments shown in the drawings, in which:

FIGURE 1 is a schematic view of the circuit arrangement for the present invention.

FIGURE 2 is a schematic view of a modified circuit for the present invention.

FIGURE 3 is a schematic view of the ignition circuit and a gas burner assembly.

FIGURES 1 and 2 show slight modifications of the same essential circuit for the ignition system as applied to a clothes dryer control. In order to facilitate understanding the essentials of the ignition system, the control components of the circuits will be left out of the first description, and will be brought out later.

Referring first to FIGURE 1, it will be noticed that the spark electrodes **10** are on secondary **31** of a power type ignition transformer **12**, the primary **26** of which is across the line L1, L2 and in series with resistances **28** and **30**. The primary is also in series with safety lock-out switch **16** and with coil **17** of electro-magnetic valve operator **18** which controls the flow of gas to the burner. An optional dual valve operator arrangement **19** shown dotted could be added to the present system if desired. In the solid line position shown in FIGURE 1,

it will be noted that flame detector switch **48** acts to shunt resistance **28**. This switch is operated by flame detector **14** and the solid line position denotes the cold position of the switch. Therefore, starting from a cold start, the line voltage will be impressed across the primary of the ignition transformer and will shunt resistance **28** and pass through resistance **30**, safety lockout switch **16** and valve coil **17**.

A power type transformer is characterized by the fact that if the secondary is open (that is, if there is no spark) the current flow in the primary will be very low. This feature is utilized in combination with resistance **30** to limit the current in the coil **17** so that there is insufficient power developed to actuate valve operator **18**. Now, however, if a spark occurs at the electrodes the current in the primary of the power transformer will go up appreciably, and under these circumstances, the current flow in the coil will be sufficient to actuate the valve operator whereupon the spark can ignite the gas. The operation of the electro-magnetic valve operator will not be effected by the intermittent action of the electrodes and will hold the valve open once a spark has been initiated by the transformer.

Thus it will be seen that the characterics of a power type transformer are utilized in this circuit to insure actuation of valve operator **18** only when there is a spark at the electrodes. It will be appreciated that a power type transformer is much less costly than the impedance type transformer heretofore utilized in spark ignition systems.

As noted above, switch **48** is operated by flame detector **14**, the details of which will be pointed out hereinafter. When the flame impinges on the flame detector, it will move transfer switch **48** to the hot contact position shown dotted on the wiring diagram. When the switch transfers from the cold to the hot contact position, the primary of the transformer will be shunted and the resistance **28** will be placed into the circuit. It will be noted that both the transformer and the resistance are momentarily shunted when the switch moves from the cold to the hot position. This, of course, de-energizes the transformer and stops the spark while the subsequent addition of resistance **28** limits the current flow in the valve coil to a value insufficient to open the valve but sufficient to hold the valve open. This feature can assume importance in the event of a momentary power failure. Valve **18** would close but if the power came back on before the flame detector had moved the transfer switch to the cold contact position, there would be sufficient current in the coil **17** to open the valve (to pour raw gas past the inoperative igniter) if resistance **28** were not in the circuit. Resistance **28** will reduce the current in the coil to a value insufficient to open the valve. Thus, when there is a momentary power failure, the valve operator cannot reopen until the flame detector moves the transfer switch back to the cold contact position so that the transformer will be ready to produce a spark on the electrodes.

The flame detector is mounted in a position adjacent the flame in the main burner. The detector includes thermal element **40** which is a low mass stainless steel strip having one end secured to shield **42** and the other end attached to switch blade **50**, by way of example only since a snap type switch will normally be employed to accomplish the switch function. This type strip is used since it reacts quickly to variations in heat providing a reliable indication of the presence of flame at the burner. The arm multiplies the expansion and contraction of the strip actuating transfer switch **48** mounted within the housing.

Blade **50** of switch **48** is connected to the main circuit between the transformer and the resistance **28** and is mounted so that it can be moved to engage cold contact **54** and close resistance shunt circuit **36** or hot contact

56 and close transformer shunt circuit 34. As the thermal element of the flame detector expands under the influence of the heat from the flame on the burner, it will move the switch blade against the bias of spring 60. Contacts 54 and 56 are mounted in an overlying relation so that the blade will momentarily engage both contacts in the transfer from the lower to the upper position. The transfer switch thus provides a means for shunting resistor 28 and the transformer separately or both simultaneously but never allowing both shunt circuits to be opened simultaneously.

It is essential that both the hot and cold contacts be engaged monemtarily after ignition occurs on the burner to insure holding the gas valve open while the spark is cut off. In the present circuit arrangement resistance 28 is in the order of 230 ohms while resistance 30 is in the order of 60 ohms. If resistance shunt circuit 36 is opened before the transformer shunt circuit 34 is closed, the addition of the high resistance may reduce the line current momentarily below that required to hold the valve operator open. Even though this may be only momentary, the valve operator may start to close the main burner gas supply and on closing the transformer shunt circuit there will only be sufficient current in the main circuit to hold the valve in position and not to reopen the valve.

The safety lock-out switch connected in series with the primary of the power transformer and the valve operator acts as a timer to cut off the flow of current to the coil 17 after a predetermined time interval if the burner fails to ignite. The switch includes bimetal 72 having contact 75 at one end which will engage contact 76 on downwardly biased arm 70 when the bimetal warps upwardly in response to heat from heater 74. When this occurs, current passing through arm 70 will be shunted through the bimetal to line 78 around coil 17 and back to line L2 so that the valve operator closes. With the impedance of coil 17 out of the circuit, the line current will increase to the heater causing it to warp the bimetal faster to further lift arm 70 until it opens normally closed switch 32. This will break the main circuit cutting off the line current to the heater whereupon the heater and bimetal will start to cool. The bimetal will start to return to its normal position closing switch 32 and allowing current to flow to the heater reheating the bimetal to again open switch 32. This cyclic action will continue until the dryer timer or door switch is opened and acts to limit the buildup of heat in the heater during the lock-out period. This action also reduces the time required for the lock-out switch to cool off and reset for the next ignition cycle. The time delay for shunting the circut may be adjusted by varying the gap between contacts 75 and 76.

In FIGURE 1, heater 74 is in resistance shunt circuit 36 and will be de-energized when the flame detector actuates switch 48 to engage the hot contact. In FIGURE 2, heater 74 is in the main circuit and will remain in the main circuit when switch 48 moves to the hot contact position. The latter circuit arrangement provides a safety feature not found in the first arrangement in that the lock-out switch will respond to any excessive line current, such as shorting resistance 28, to open the main circuit and close the valve operator.

In operation of FIGURE 1 or 2 the primary of the transformer, the resistance shunt circuit, the lock-out switch and the coil for the valve operator are energized simultaneously starting an ignition cycle. If a spark is initiated across the electrodes, the line current will be increased to a value sufficient to open the valve operator. If the main burner gas ignites in the normal manner, the flame detector will react to the presence of the flame and in approximately five seconds will move the switch to the "hot" contact closing the transformer shunt circuit and de-energizing the transformer so that the spark is discontinued. The resistance shunt circuit will then be opened adding the high resistance to the circuit to reduce the line current to a value below that required to open the valve but high enough to hold the valve open.

If the main burner gas fails to ignite, the flame detector will not actuate the transfer switch, leaving it in the cold contact position, continuing the spark and shunting the high resistance. The safety lock-out switch heater is energized with the main circuit and if energized continually for approximately twenty seconds, the bimetal will warp far enough to close the valve operator shunt circuit allowing the valve operator to close stopping the ignition cycle. The bimetal will start to cycle between opening and closing of the main circuit thus reducing the time required for the unit to be automatically reset for the next ignition cycle.

The ignition system has a number of inherent safety features which make it particularly suitable for gas burner appliances. If there is no spark on the electrodes when the system is energized, the valve operator will not open the main gas supply valve since the coil of the valve operator requires the increase in line current caused by the spark on the secondary in order to function. If the spark electrode has been shorted, the valve operator will open the gas supply valve but the line current will be at a maximum causing the safety lock-out switch to act in less time, approximately ten seconds, to close the valve operator shunt circuit shutting off the gas. A similar action will result whenever the line current becomes excessive. If there is a flame failure after ignition the flame detector will move the transfer switch to the cold contact position (in about 5 sec.) opening the transformer shunt circuit and restoring a spark on the electrode for prompt re-ignition.

For clothes dryer application the circuit is provided with the usual door switch 20, timer 22, and thermostat 24. Since these are convenient components for a dryer their operation is self-explanatory. The spark electrodes can be of any conventional design, including the automotive type.

This circuit will operate a clothes dryer or other appliance without the use of a pressure regulator where forced draft conditions quickly remove unburned gas. It is possible to get unburned gas in a gas burner if the supply is stopped momentarily extinguishing the flame and turned back on again while the burner is operating but before a spark has been started on the electrodes. Under forced draft conditions the explosive mixture will be quickly dissipated. The flame detector (when it cools) will not shut off the gas but will turn on the ignition spark which in a furnace with forced draft will not cause an explosion. It is generally recognized that the only thing that can extinguish the flame in a modern furnace is to shut off the gas. Under natural draft conditions, a variation in the gas pressure could conceivably result in too low a pressure to sustain a flame and then build up again creating an explosive mixture in the burner. Therefore, pressure switch 69 could be added to the present system to open the electrical circuit supplying the control switch to positively shut off the gas in the event of too low a gas pressure and providing a means for preventing the control switch from opening the supply valve before the flame detector has returned the switch blade to the cold contact.

The system of both FIGURES 1 and 2 provide the following safety features for unusual operating conditions:

(1) No Spark.—Due to an open circuit in the secondary circuit of the ignition transformer or too wide a spark gap.

Action: Valve operator will not open gas supply valve. If the supply valve was open when failure occurred, it will immediately close.

(2) No Spark.—Due to a shorted secondary circuit in the ignition transformer or shorted spark gap.

Action: Safety Lock-out Switch will act to close the valve operator shunt circuit in shorter time than normal ignition failure timing due to increased current in the line.

(3) No Spark.—Due to shorted ignition transformer primary.

Action: Safety Lock-out Switch will act to close the valve operator shunt circuit in greatly accelerated time.

(4) Shorted Resistors (FIGURE 2 only).

Action: Safety Lock-out Switch will act to close valve operator shunt circuit in shorter than normal timing.

(5) Open Circuit.—In either the ignition transformer primary, resistors, or Safety Lock-out Switch heater. (FIGURE 2.)

Action: Valve cannot open. (Will close if already open.)

(6) Normally Open Contact of Safety Lock-Out Switch Fails to Make Due to Lint or Other Material Accumulation.

Action: Lock-out Switch heater being energized through normally closed contact continues to heat and bimetal continues movement and ultimately opens normally closed contact de-energizing valve operator.

(7) Normally Closed Contact of Safety Lock-Out Switch Fails to Open.

Action: Valve operator is de-energized by normally open contact. Bimetal continues under heat until timer period expires. During this period great force is developed by bimetal which should ultimately break normally closed contact.

(8) Flame Detector Fails to Open Cold Contact.

Action: Safety Lock-Out Switch heater continues to be fully energized and within approximately 20 seconds (at normal line voltage) will close the normally open contact to close the valve.

(9) Flame Detector Fails to Make Hot Contact.

Action: Valve might close after cold contact opens (especially at low voltage) which shuts off gas allowing flame detector to return to cold position restarting the cycle. If hot contact fails to close on subsequent operations and valve falls closed each time, the series of starting operations will eventually cause a lockout. If valve remains open normal action ensues except for a reduced spark at spark gap.

(10) Flame Detector Fails to Make Cold Contact.

Action: Valve will not open on next cycle.

(11) Ignition Failure (Main Burner Flame).

Action: Flame Detector remains in "cold" position continuing to fully energize Safety Lock-out Switch heater. Switch acts to close valve within 20 seconds (at normal line voltage).

(12) Flame Failure—After Initial Ignition.

Action: Flame Detector responds to restore spark for prompt re-ignition.

(13) Power Interruption—Due to opening door, timer operation, power failure, etc.

Action: Valve operator closes gas supply valve immediately and cannot reopen until Flame Detector returns to "cold" position and restores spark.

The maximum period of time which this system holds the gas supply valve open allowing raw gas to flow into the burner is twenty (20) seconds. This is quite satisfactory for low B.t.u. units. If the ignition system is used with a large capacity unit, this time period would be excessive. Under these conditions, the ignitor could be used with a pilot burner of approximately 10,000 B.t.u. The flame detector could be modified to open the main burner only when there is a flame on the pilot burner.

Although but one embodiment of the present invention has been illustrated and described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

I claim:

1. A spark ignition and fuel control system comprising an electric circuit, a transformer in the circuit, a spark igniter actuated by the transformer, an electrically operated fuel valve operator connected in the circuit with the transformer, said transformer limiting current flow to the valve operator to a value insufficient to actuate the valve operator in absence of a spark at the igniter, the occurrence of the spark at the igniter increasing current flow to a value sufficient to actuate the valve operator, and means responsive to heat of combustion of the fuel for de-energizing the transformer, current limiting means allowing only sufficient current flow to hold the valve operator open, said current limiting means being rendered effective when the heat responsive means de-energizes the transformer.

2. An igniter according to claim 1 including means operable in absence of ignition within a predetermined period of time to de-energize the valve operator.

3. An igniter according to claim 2 including means operable in absence of ignition for a period of time greater than said predetermined period to de-energize the circuit.

4. A spark ignition system for a gas burner comprising, an electric circuit, a power transformer having a primary winding and a secondary winding with said primary winding being connected in the circuit, an electrically responsive control valve in said circuit for a gas supply line to a burner, a spark igniter connected to the secondary winding of the transformer, said primary winding limiting the current in the circuit to a value insufficient to operate the control valve in the absence of a spark on the igniter, said control valve opening in response to a spark at the igniter, timing means for opening the circuit after a predetermined period of time in the absence of ignition at the burner, said timing means including a normally closed switch connected in the circuit, a normally open contact mounted on the switch, a bimetal positioned to engage the open contact, a shunt circuit by passing the control valve and including the bimetal and the normally open contact, a heater connected in the electric circuit and means for energizing the heater so that the heat from the heater will warp the bimetal to engage and close the open contact thereby shunting the control valve.

5. A system according to claim 4 including means for rendering the timing means heater ineffective after ignition occurs in the burner.

6. A system according to claim 4 in which the bimetal is operative to open the normally closed switch after closing the shunt circuit.

7. A spark ignition and fuel control system for a gas burner comprising, an electric circuit, a transformer having primary and secondary windings with the primary in the circuit, an electrically responsive control for a gas supply line connected in circuit with the primary of the transformer, spark electrodes connected to the secondary of the transformer, said primary limiting the current in the circuit in the absence of current flow in the secondary of the transformer to a value insufficient to open the control, said control opening in response to the presence of a spark at the electrodes, a resistance member connected to the circuit and means for substituting the resistance member in the circuit for the primary of the transformer after ignition occurs in the burner to limit the current in the circuit to a value sufficient to hold the control open but insufficient to open the control.

8. An electric ignition and fuel control system for a gas burner comprising, a circuit including a control valve to a gas supply for the gas burner and spark ignition means, an initially open shunt circuit connected to bypass the ignition means, a resistance means connected in the circuit to limit current in the circuit to a value sufficient to hold the valve open but insufficient to open the valve, an initially closed shunt circuit for the resistance means, switch means to open the initially closed shunt circuit and close the initially open ignition means shunt circuit, and heat responsive flame detecting means for actuating the switch means after ignition occurs.

9. A system according to claim 7 including a shunt circuit connected across the control and a timing means, said timing means operatively engaging the shunt circuit

to shunt the control a predetermined time interval after energizing the primary.

10. A spark ignition system for a gas burner comprising, a first electric circuit, a power transformer having a primary winding and a secondary winding with said primary winding connected in the first circuit, a control in said first circuit for a gas supply to a main burner, a spark igniter connected to the secondary winding of the transformer, said primary limiting the current in the circuit in the absence of a spark on the igniter, said control opening in response to a spark at the igniter, timing means for opening the circuit after a predetermined period of time in the absence of ignition, said timing means including a normally open switch and an electrically energized means positioned to operate the switch, said electrically energized means being connected in the first circuit, a shunt circuit by-passing the control and including the switch, electrical means for energizing the first circuit, said electrically energized means acting to close said switch a predetermined period of time after energization of the first circuit to close the control in the absence of ignition at the burner.

11. A system according to claim 10 including means for rendering the electrically energized means ineffective after ignition occurs in the burner.

12. A system according to claim 11 including a normally closed switch in the first circuit, said electrically energized means acting to open the normally closed switch a predetermined period of time after closing said shunt circuit to the first circuit.

13. A spark ignition system for a gas burner comprising, an electric circuit, a power transformer having a primary winding and a secondary winding with said primary winding connected in the circuit, a control valve for a gas supply to a main burner connected in the circuit, a spark igniter connected to the secondary winding of the transformer, said primary limiting current in the circuit in the absence of a spark on the electrodes, said control valve opening in response to a spark at the igniter, timing means for intermittently opening and closing the circuit after a predetermined period of time in the absence of ignition, said timing means including shunt circuit means for limiting current flow to the control valve to a value insufficient to hold the valve open when the electric circuit is closed after it has been initially opened.

14. A system according to claim 8 wherein the spark ignition means includes a power type transformer having a primary winding and a secondary winding, and a pair of spark electrodes, said primary winding being connected to the circuit and said secondary winding being connected to the spark electrodes.

15. A system according to claim 8 including an electromagnetic valve operator for a burner gas supply connected in series with the spark ignition means, said valve operator opening in response to a spark at the ignition means, an initially open shunt circuit for the valve operator, and a timing device for closing the valve operator shunt circuit in the absence of a spark on the ignition means.

16. A system according to claim 15 wherein the timing device includes a heat responsive member and a heater connected to the main circuit, said heater being effective on the heat responsive device only while the ignition means shunt circuit remains open.

17. A system according to claim 15 wherein the timing device includes a heat responsive member and an electrically energized heater connected in the initially closed resistance shunt circuit.

18. A device according to claim 15 wherein the timing device includes a first switch for closing the valve operator shunt circuit, and a second switch for opening the main circuit, means energized when the transformer shunt circuit is open to close the first switch, said energized means opening the second switch after the first switch has been closed to de-energize the energized means until the second switch closes so that the energized means cycles between opening and closing of the second switch.

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