July 27, 1965 J. L. LA POINTE ETAL 3,196,928

IGNITION SYSTEM AND CONTROL FOR FUEL BURNER

Filed Sept. 28, 1961

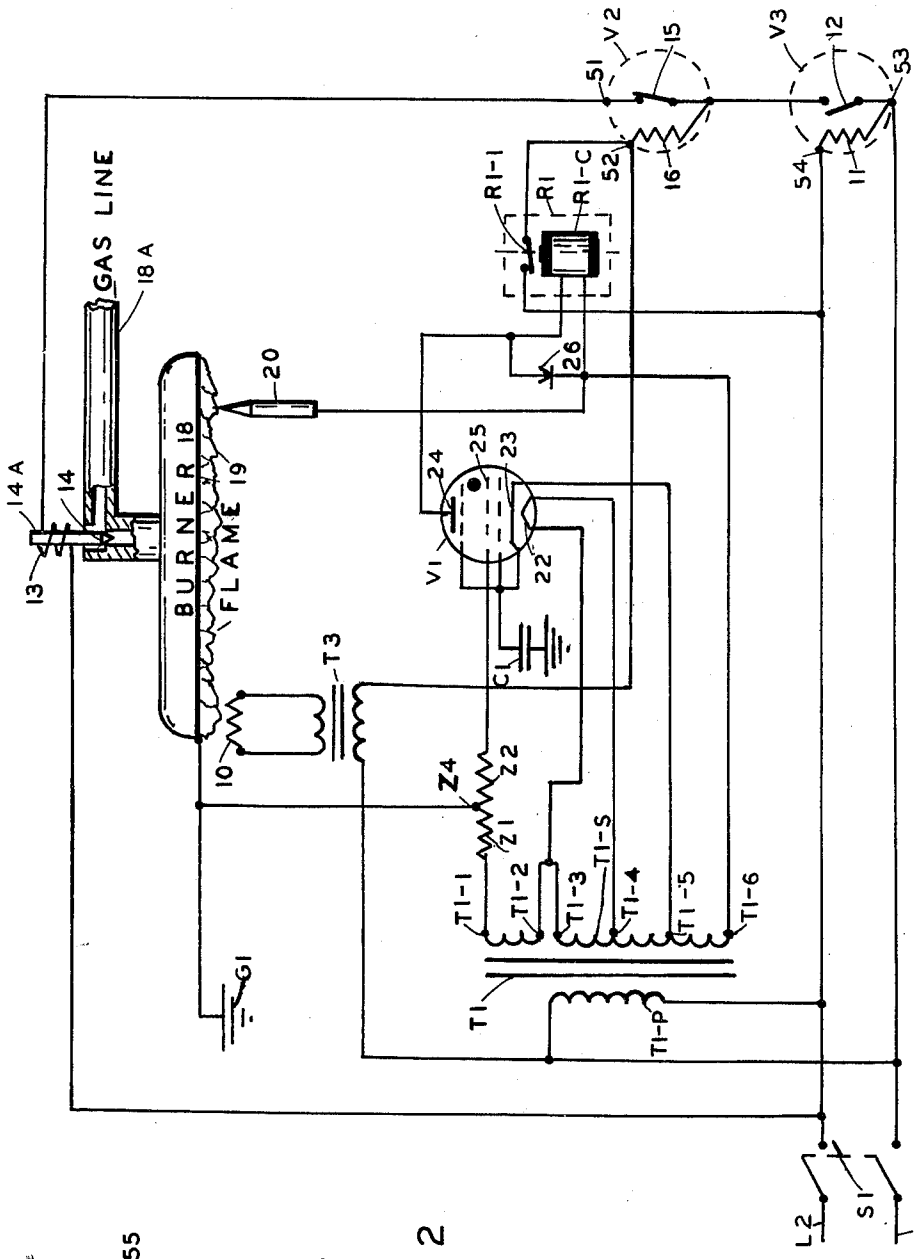


FIG. 1

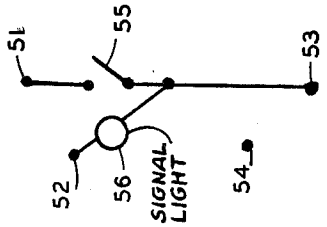


FIG. 2

INVENTORS
JOSEPH LEO LaPOINTE
JOHN J. FANNON, JR.
BY
Jack M. Young
ATTORNEY

United States Patent Office

3,196,928

Patented July 27, 1965

3,196,928

IGNITION SYSTEM AND CONTROL FOR FUEL BURNER

Joseph Leo La Pointe, Detroit, and John J. Fannon, Jr., Grosse Pointe Park, Mich., assignors to Hupp Corporation, Cleveland, Ohio, a corporation of Virginia

Filed Sept. 28, 1961, Ser. No. 141,479
6 Claims. (Cl. 158—122)

This invention relates to an ignition system or control circuit for a burner, and especially to an automatic ignition system for a gas burner operative to initiate fuel flow, ignite the fuel, and discontinue fuel flow in the event that combustion does not take place.

This application is a continuation-in-part application of our co-pending United States patent application Serial No. 844,387, filed October 5, 1959, now Patent No. 3,155,-145 granted November 3, 1964, and entitled "Control Circuit for Gas Burner."

An object of the present invention is to provide a control circuit or ignition system which minimizes the danger of escape of gas in explosive quantities or quantities sufficent to be poisonous to human beings.

A further object of the present invention is to provide a control circuit or ignition system for a gas burner.

A further object of the present invention is to provide an ignition system, especially for a gas burner, to automatically ignite the burner.

A further object of the present invention is to provide an ignition system having electronic means responsive to the combustion of gas in a burner to turn off the gas igniter.

A further object of the present invention is to provide an ignition system that rapidly senses and responds without delay to the presence or absence of a flame at the burner.

A further object of the present invention is to provide an ignition system wherein the flow of fuel will be shut off if the burner fails to ignite.

A further object of the present invention is to provide an ignition system that will automatically re-ignite the burner after the flame has been blown out.

A further object of the present invention is to provide an igintion system having means responsive to failure of combustion of fuel in a burner to actuate relay means and shut off a solenoid operated valve to discontinue flow of fuel to the burner.

A further object of the present invention is to provide an ignition system characterized by its compact construction; minimum number of component parts; low manufacturing cost; fail safe operation; ease of use; and long trouble-free wear life.

These and other objects of the present invention will become more fully apparent by reference to the appended claims as the following detailed description proceeds in reference to the accompanying drawings wherein:

FIG. 1 is a schematic representation of a first form of the present invention; and

FIG. 2 is a schematic representation of a portion of a second form of the present invention.

FIG. 1 shows the first form of the invention. FIG. 2 shows a circuit component adapted to be substituted in FIG. 1, for the component shown therein at the correspondingly numbered terminals, to provide said second form to the invention with the remainder of FIG. 1. The first form of the invention in FIG. 1 will be described in complete detail first before later describing the second form of the invention in FIG. 2.

The control circuits, ignition systems, and methods of controlling ignition of a burner in the present invention may be utilized in such appliances as gas dryers, broilers, refrigerators, roasters, grills, ranges and furnaces; and in

a variety of industrial applications, such as industrial ovens, furnaces, die heaters, paint and baking ovens, and infrared space-heating units. Each is especially adapted for use on infra red radiant heater burners of the type shown in the G. Schwank United States patents, Nos. 2,775,294 and 2,870,830. When used in industrial applications, each may be readily cycled for repetitive production processes.

FIG. 1 discloses a conventional solenoid operated gas valve **14** for supplying and controlling the flow of combustible fluid fuel, such as gas, from supply line **18A** to fluid fuel burner means **18**. Air is aspirated into burner **18** by the gas and burned adjacent one surface of the burner to form flame **19**. Burner housing **18** is made of metal or other electrically conductive material. Gas or fuel valve **14** is a conventional shut-off valve having valve element **14A** to open or close a port to contol the flow of gas. Valve element **14A** is urged to the valve closed position by a spring (not shown). Solenoid **13**, upon energization, is effective to open valve element **14A** in valve **14** against the action of the spring into the valve open position, while de-energization of solenoid **13** permits the spring to move valve element **14A** to the valve closed position.

Time delay relays V2 and V3 are of a conventional type in which heater elements **16** and **11** therein respectively are provided to heat to a pre-selected temperature in a pre-selected time so as to open or close associated respective contacts or switches **15** and **12** at the pre-selected time and temperature.

Although any suitable circuit components may be used, it has been found in one suitable installation that a proper mode of operation is achieved by using components of the following sizes: transformer T1 has a 115 volt, 60 cycle primary winding or coil T1–P, 190 volt A.C. across secondary terminals T1–1 and T1–2 at no currents conditions, 6.3 volts 2 amps across secondary terminals T1–3 and T1–4, 24 volts across secondary terminals T1–4 and T1–5, 100 ma. across terminals T1–4 and T1–6, 160 volts across terminals T1–5 and T1–6, and a secondary coil T1–5 having terminals T1–1, T1–2, T1–3, T1–4, T1–5, and T1–6; glow coil igniter transformer T3 has a 115 volts, 2.5 amps primary coil and a 2.5 volts, 11 amps secondary coil; high resistance Z1 is a 4.7 megohm ½ watt resistor; grid protector resistance Z2 is a 240K ohms ½ watt resistor; capacitance C1 is 0.1 mfd., 400 v. D.C.: igniter coil **10** is a Nichrome heater element glow coil; thyratron tube V1 is a 2D21 thyratron, or any equivalent electronic valve; and probe **20** is a metal probe constructed of Inconel or other suitable material.

The mode of operation should be readily apparent after considering the following description.

Closing main switch S1 energizes the primary and secondary coils of transformer T1 and igniter glow coil **10**, positioned adjacent burner **18** for causing flame **19**. Alternating current power is supplied through A.C. power lines L1, L2 to primary coil T1–P and secondary coil T1–S of transformer T1 after closing main switch S1 for supplying power to tube V1. Closing switch S1 also energizes or supplies alternating current power to igniter glow coil or igniter **10** by forming Circuit No. 1 through line L1, transformer T3, igniter glow coil **10**, normally closed contact R1–1 of relay R1 as a switch means in igniter energizing circuit, and line L2.

Since tube V1 disclosed herein requires approximately 10 to 15 seconds warmup time before it can operate, a suitable time delay is provided in the circuit by keeping open contact **12** of time delay relay tube V3 to prevent power being applied to gas valve solenoid **13** until after warmup has occurred. Closing main switch S1 energizes time delay relay tube V3 by forming Circuit No. 2 through

line L1, heater element 11 of time delay relay tube V3, and line L2. After the 10 to 15 seconds time delay has elapsed, heater element 11 of tube V3 closes its normally open contact 12: (1) to energize solenoid 13 to open gas control valve 14 to permit gas to flow from gas line 18A into burner 18 by forming Circuit No. 3 electrically connected in parallel with primary coil T1–P of transformer T1 through line L1, normally open contact 12 now closed, normally closed contact 15, valve solenoid 13, and line L2; and (2) to energize time delay relay tube V2 by forming Circuit No. 4 through line L1, normally open contact 12 now closed, heater element 16 of tube V2, normally closed contact R1–1 of relay R1, and line L2.

Now, energized igniter 10 will ignite the gas mixture now permitted to flow from burner 18 through open valve 14 and will produce flame 19.

After the gas is ignited, flame 19 completes an electrical path causing thyratron tube V1 to conduct, relay R1 to be energized, and igniter 10 and time delay relay heater element 16 to be de-energized. Tube V1 has cathode heater 22 energized by a circuit from transformer secondary winding terminals T1–3 and T1–4. Flame 19 forms Circuit No. 5 through series connected transformer tap T1–1, resistance Z1, junction Z4, burner housing 18, flame 19, flame sensing element means or probe 20 located adjacent burner 18 contiguous to or in flame 19 from burner 18, and transformer secondary tap T1–6. Circuit No. 5 is energized by secondary coil T1–S and electrically connected to grid 25 at junction Z4. The voltage pulse or the potential at junction Z4 produced by Circuit No. 5 is now sufficiently positive relative to cathode 23, because of the IR drop across resistance Z1, so that a glow discharge takes place between cathode 23 and starter anode or grid 25 so the gas is ionized in thyratron tube V1 and the tube conducts, during each half cycle that anode 24 is positive, so electronic valve V1 is actuated to energize relay R1 by forming Circuit No. 6 energized by secondary coil T1–S through transformer secondary terminal T1–5, cathode 23 of thyratron tube V1, anode 24 of tube V1, relay coil R1–C of relay R1, and transformer secondary terminal T1–6. Sensing element 20, electrically connected to grid 25, thus senses the presence of flame 19 by conduction of an electrical current along a path through flame 19 to control the conduction action of tube V1 by grid 25. Rectifier or diode 26, located in series with thyratron V1, is in parallel with relay coil R1–C to prevent relay chatter because tube V1 conducts only during the positive half cycles, but any suitable unidirectional electronic valve, such as a condenser, may be so placed in parallel with relay coil R1–C for this same purpose. Energizing relay coil R1–C opens switch means or normally closed relay contact R1–1 now: (1) to break Circuit No. 1 to de-energize and cut off power to igniter 10 for conservation purposes when a flame 19 is present and thyratron V1 is energized, and (2) to break Circuit No. 4 to de-energize heater element 16 of time delay relay tube V2. Gas valve 14 is open, igniter 10 is de-energized, heater element 16 of time delay tube V2 is de-energized, and flame 19 maintains this condition of operation.

Here, two electrode elements are provided in Circuit No. 5, including burner housing element means 18 and probe element means 20. If desired, a second probe, electrode or structural element means, similar to probe 20, can be located in flame 19 and directly electrically connected to junction Z4 and ground G1 with burner 18 eliminated from Circuit No. 5.

If flame 19 goes out, tube V1 stops conducting, relay R1 is de-energized, igniter 10 is re-energized, and heater element 16 of time delay relay tube V2 is re-energized. If flame 19 goes out, lack of flame 19 causes sensing element 20 to control the action of tube V1 by breaking Circuit No. 5 so that the positive potential at junction Z4 is reduced to reduce the positive bias on grid 25 of tube V1 to prevent tube V1 from conducting. Since tube V1 stops conducting, Circuit No. 6 is broken to de-energize relay coil R1–C and close its normally closed contact R1–1. Closing switch means or relay contact R1–1 now: (1) energizes or applies power to igniter 10 by reforming Circuit No. 1 when flame 19 is absent, and (2) energizes heater element 16 of time delay relay tube V2 by reforming heater element energizing Circuit No. 4.

If flame 19 is absent, burner 18 does not re-ignite, or flame 19 is not restored within a predetermined period of time established by thermal time delay switch means or relay tube V2, gas valve 14 is closed. After time delay relay tube V2 times out, its energized and heated heater element 16 opens its normally closed bimetal switch or contact 15 located in valve energizing Circuit No. 3 to break Circuit No. 3 to de-energize solenoid 13 and thus to close gas valve 14 to cut off the supply of fuel to burner 18.

It should also be readily apparent that if, when Circuit No. 4 was first formed as first described heretofore, flame 19 was not produced within the predetermined period of time established by heater element 16 of time delay relay tube V2, heater element 16 opens normally closed contact 15 to break Circuit No. 3 to de-energize solenoid coil 13 to close valve 14 in the same manner to shut off the supply of gas to burner 18.

The second form of the invention is shown in FIG. 2. It is exactly the same as the FIG. 1 form except that the circuitry in FIG. 2 between terminals 51, 52, 53 and 54 (including manually operated switch 55 and neon glow lamp 56 or other suitable warning light) is substituted for tubes V2 and V3 in FIG. 1 at terminals 51, 52, 53 and 54. The sequence of operation and of circuit forming and breaking occurs the same as before described but with the following exceptions. First, tube warmup Circuit No. 2 is not used to close switch 12, and Circuit No. 3 is now not formed until after switch 55 is manually closed so that the gas valve and ignition are manually operated, such as on a domestic oven or boiler igniter. Second, if any of these conditions: (1) flame 19 goes out after once lit, or (2) flame 19 is not originally produced have occurred so as to break sequentially Circuits Nos. 5 and 6 to de-energize relay coil R1–C, normally closed relay contact R1–1 will close to reform: (1) Circuit No. 4 so lamp 56 will now be energized, instead of heater element 16 of tube V2, to indicate lack of flame 19 and to indicate "ignition on" to the apparatus operator, and (2) Circuit No. 1 to re-energize igniter 10. After lamp 56 has been lit for a predetermined period of time, the operator may manually open switch 55 to break Circuit No. 3 to de-energize solenoid 13 to close gas valve 14 in the same manner as heating of element 16 in FIG. 1 automatically opened switch 15 in tube V2 to break Circuit No. 3 after the time delay.

It may now be readily appreciated that the control circuits and ignition systems in FIGS. 1 and 2 invention forms are effective as safeguards to assure that gas burner 18 is operating properly when gas valve 14 is open, and to automatically ignite and re-ignite burner 18. The apparatus is simple in construction, requires a minimum number of operating parts, is compact, operates quickly without undue delay, is fail-safe in that failure of substantially any of the component parts will operate to discontinue the flow of gas to burner 18 and require trouble-shooting of the circuit to locate and repair the fault, and has a substantially long, trouble-free wear life.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive with the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by U.S. Letters Patent is:

1. An ignition and control for a burner system, comprising a transformer having a primary coil and a secondary coil, an igniter positioned adjacent said burner and adapted to be supplied with current to ignite said burner, a thyratron, said secondary coil providing power by a circuit means to said thyratron, a solenoid operated fuel valve for controlling flow of fuel to said burner, a valve energizing circuit in parallel with said primary coil electrically connected to and controlling the solenoid of said fuel valve, a sensing element adapted to be positioned adjacent the burner to sense the presence of a flame, said sensing element being electrically connected to the grid of said thyratron for controlling the conduction of said thyratron, a relay, circuit means for energizing said relay by said thyratron when the sensing element responsive to the presence of a flame causes said thyratron to conduct, switch means in said igniter circuit opened by said relay when said relay is energized to thereby de-energize the igniter upon the thyratron becoming energized by said sensing element, and closed by said relay when said relay is de-energized for applying power to said igniter when the thyratron is de-energized in the absence of a flame thermal time delay switch means including a heater element and a normally closed switch adapted to be opened by energizing said heater element for a predetermined period of time, said normally closed switch being in the valve energizing circuit, and switch means in the energizing circuit of said heater element closed by said relay when said relay is de-energized so that the normally closed switch is opened to de-energize the solenoid and to close said fuel valve in the event that the burner either does not initially ignite or does not re-ignite within a predetermined period of time.

2. An ignition and control for a burner system, comprising a transformer having a primary coil and a secondary coil, an igniter positioned adjacent said burner and adapted to be supplied with current to ignite said burner, a thyratron, said secondary coil providing power by a circuit means to said thyratron, a solenoid operated fuel valve for controlling flow of fuel to said burner, a valve energizing circuit in parallel with said primary coil electrically connected to and controlling the solenoid of said fuel valve, a sensing element adapted to be positioned adjacent the burner to sense the presence of a flame, said sensing element being electrically connected to the grid of said thyratron for controlling the conduction of said thyratron, a relay, circuit means for energizing said relay by said thyratron when the sensing element responsive to the presence of a flame causes said thyratron to conduct, switch means in said igniter circuit opened by said relay when said relay is energized to thereby de-energize the igniter upon the thyratron becoming energized by said sensing element and closed by said relay when said relay is de-energized for applying power to said igniter when the thyratron is de-energized in the absence of a flame, thermal time delay switch means including a heater element and a normally closed switch adapted to be opened by energizing said heater element for a predetermined period of time, said normally closed switch being in the valve energizing circuit, switch means in the energizing circuit of said heater element closed by said relay when said relay is de-energized so that the normally closed switch is opened to de-energize the solenoid and to close said fuel valve in the event that the burner either does not initially ignite or does not re-ignite within a predetermined period of time, a unidirectional electronic valve in parallel with said relay and in series with said thyratron in the relay energizing circuit from said thyratron.

3. A system, as set forth in claim 2, with said sensing element comprising a probe adapted to be located in said flame; and a resistance in series with said probe and flame forming a circuit energized by said secondary coil and electrically connected to the grid of said thyratron for controlling the conduction of said thyratron.

4. An ignition and control for a burner system, comprising a transformer having a primary coil and a secondary coil, an igniter positioned adjacent said burner and adapted to be supplied with current to ignite said burner, a thyratron, said secondary coil providing power by a circuit means to said thyratron, a solenoid operated fuel valve for controlling flow of fuel to said burner, a valve energizing circuit in parallel with said primary coil electrically connected to and controlling the solenoid of said fuel valve, a sensing element adapted to be positioned adjacent the burner to sense the presence of a flame, said sensing element being electrically connected to the grid of said thyratron for controlling the conduction of said thyratron, a relay, circuit means for energizing said relay by said thyratron when the sensing element responsive to the presence of a flame causes said thyratron to conduct, switch means in said igniter circuit opened by said relay when said relay is energized to thereby de-energize the igniter upon the thyratron becoming energized by said sensing element and closed by said relay when said relay is de-energized for applying power to said igniter when the thyratron is de-energized in the absence of a flame, thermal time delay switch means including a heater element and a normally closed switch adapted to be opened by energizing said heater element for a predetermined period of time, said normally closed switch being in the valve energizing circuit, switch means in the energizing circuit of said heater element closed by said relay when said relay is de-energized so that the normally closed switch is opened to de-energize the solenoid and to close said fuel valve in the event that the burner either does not initially ignite or does not re-ignite within a predetermined period of time, said sensing element sensing the presence of a flame by an electrical path through said flame to provide the sole means to control the conductive action of said thyratron.

5. An ignition and control apparatus for a burner producing a flame, comprising a transformer having a primary coil and a secondary coil, an ignitor positioned adjacent to said burner and adapted to be supplied with current to ignite said burner, a thyratron supplied with power by a circuit means from said secondary coil, a fuel control means for controlling flow of fuel to said burner, fuel control means energizing circuit in parallel with said primary coil electrically connected to and controlling the fuel control means, a flame probe adjacent to but separated from said burner and positioned to contact said flame when said burner is in operation, said probe being electrically connected to the grid of said thyratron for controlling the conduction of said thyratron, a relay, circuit means for first energizing said relay by said thyratron after flame at the burner completes a circuit through said probe to cause said thyratron to conduct, switch means in said ignitor circuit first opened by said relay when the relay is energized, a thermal time delay means including a heater element in a normally-closed switch adapted to be opened by energizing said heater element for a predetermined period of time, said normally-closed switch being in the circuit including said fuel control means, means for energizing said heater element with said ignitor so that the normally-closed switch is opened to de-energize and close said fuel control means in the event that the burner either does not initially ignite or does not reignite after a pre-determined period of time, a second thermal time delay means including a second heater and a normally open switch adapted to be closed by energizing said second heater for a predetermined period of time, said normally open switch being in the circuit including the first-mentioned thermal time delay means, said second heater being in said energizing circuit in parallel with said primary coil.

6. An ignition and control apparatus for a burner

producing a flame, comprising a transformer having a primary coil and a secondary coil, an ignitor positioned adjacent to said burner and adapted to be supplied with current to ignite said burner, a thyratron supplied with power by a circuit means from said secondary coil, a fuel control means for controlling flow of fuel to said burner, fuel control means energizing circuit in parallel with said primary coil electrically connected to and controlling the fuel control means, a flame probe adjacent to but separated from said burner and positioned to contact said flame when said burner is in operation, said probe being electrically connected to the grid of said thyratron for controlling the conduction of said thyratron, a relay, circuit means for first energizing said relay by said thyratron after flame at the burner completes a circuit through said probe to cause said thyratron to conduct, switch means in said ignitor circuit first opened by said relay when the relay is energized, a manually-operated switch in said circuit through said fuel control

means, a pilot lamp, and means energizing said pilot lamp with said ignitor.

References Cited by the Examiner

UNITED STATES PATENTS

1,899,744	2/33	Breisky, et al.	158—28
1,936,784	11/33	Diamond	158—28
2,162,501	6/39	Draper	158—28
2,243,071	5/41	Crago	158—28
2,388,124	10/45	Crews	158—28
2,720,614	10/55	Cairns	158—130 X
2,761,625	9/56	Dymski	158—28 X
2,870,329	1/59	Aubert	158—123
2,964,102	12/60	Cassell, et al.	158—125
2,981,324	4/61	Deziel	158—125

JAMES W. WESTHAVER, *Primary Examiner.*

MEYER PERLIN, *Examiner.*