

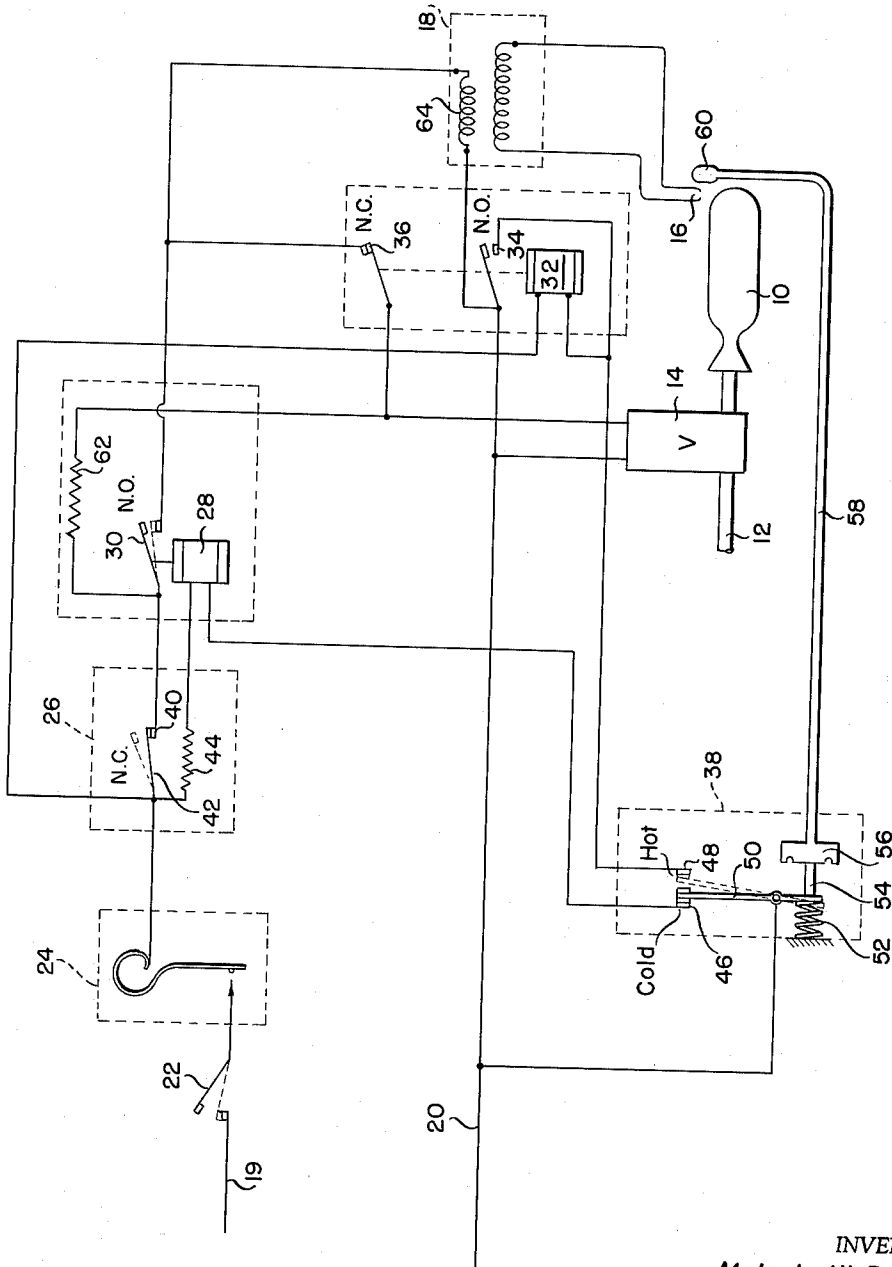
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BURNER IGNITION AND CONTROL SYSTEM

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**BURNER IGNITION AND CONTROL SYSTEM**  
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This invention relates to control and ignition systems for fluid fuel burners and more particularly to such systems which open and close a fuel valve and time the operation of a spark ignitor.

While the present invention has particular utility in connection with the control of gas burners installed in domestic heating systems, the invention may also be used to control other types of fluid fuel burners, for example, oil burners, and may be used for other types of heating plants such as those installed in commercial and industrial establishments.

In general, of the ignition and control circuits available in the past, those which have provided for safe operation have been expensive, complicated and difficult to service. Simplicity and low cost have been achieved only at the expense of the elimination of one or more necessary safety features.

Certain prior systems, such as those which utilize a continuously burning gas pilot which burns throughout the heating season require expensive safety controls and in most areas involve a high cost of operation. Other prior systems, in which a gas is ignited by an electric ignitor when heat is required, waste less gas than the continuous pilot but require more complicated controls to time the spark, control the gas to the pilot, and to guard against unsafe conditions. Possibilities for ignition failure in such a system are substantial.

It has also been proposed to ignite the main gas flame directly by a hot wire resistance coil. This system, however, has been found to be unreliable since low voltage causes ignition failure while high voltage burns out the ignitors in a short time. If the system includes apparatus to discontinue the flow of gas to the ignitor after ignition has occurred the cost of the system becomes relatively high.

Prior systems in which the main burner is ignited directly by a continuous spark require a heavy duty spark transformer, which is relatively expensive, and means to prevent radio interference as well as the usual relatively complex, expensive safety controls.

It has also been proposed to ignite the main burner by a spark which is cut off after ignition. While this system has many advantages it has not come into widespread use because the control systems heretofor provided have been costly, complicated and difficult to service. In such a system it is necessary to insure a spark at the time the gas is turned on, that successful ignition is effected, that the gas flow stops in the event the burner is not ignited or if the gas flow is momentarily discontinued, that if the burner shuts off the ignitor does not become operative again until there has been time for the accumulated gas to be cleared from the furnace, and finally in case of failure of any component of the control system a dangerous condition will not be produced.

Many prior control systems have incorporated electronic devices such as photoelectric cells, amplifiers, rectifiers, and other devices incorporating vacuum tubes and/or transistors. All of these systems have been expensive and complicated and have involved serious service problems. With these considerations in mind it is a principal purpose and object of the present invention to provide improved control and ignition systems particularly adapted for use with gas fired home heating plants which are simple, compact and inexpensive and yet which provide completely safe operation under all

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operating conditions even when a component of the system fails to operate.

It is also an object of the invention to provide improved ignition and control systems for fuel burners which control the energization of an electrically operated gas valve and a high voltage circuit across the spark gap, the system functioning so that upon closing a switch or a thermostat, gas will flow to the main burner to be ignited by a spark which is discontinued after ignition is effected, the system also incorporating means to discontinue the flow of gas and the spark if the burner fails to ignite within a predetermined time as well as means to discontinue the flow of gas if the burner flame is extinguished after it has once been established, and means to prevent re-establishment of the spark or gas flow until sufficient time has elapsed to allow the heating plant to be purged of any accumulated unburned gas.

It is also an object to the present invention to provide a relatively simple, inexpensive ignition and control system for a gas burner which employs only standard, low cost, relays, transformers, resistance units, and switches, which is trouble free and inexpensive and which is simple, compact and provides for completely safe operation.

It is an additional object of the present invention to provide improved control and ignition systems for gas burners of the type referred to above, which, in case of failure of any of its components, will maintain the main fuel valve in closed position.

Additional objects and advantages of the present invention will become apparent as the description proceeds in connection with the accompanying drawing which is a schematic diagram showing the components of the system in a typical installation.

In this figure the ignition and control system of the present invention is shown in connection with a conventional gas burner 10 of the type which may be employed in a domestic heating plant. The burner is supplied with gas from a main gas conduit 12, the flow of gas being controlled by a solenoid valve 14 of conventional construction, which is spring biased to the closed position and is opened by actuation of its associated solenoid coil. The burner 10 is ignited by a spark 16 in series with the secondary coil of a transformer 18.

The control circuit of the present invention which is connected to power lines 19 and 20 as described in detail below, includes a master switch 22, a room thermostat 24, a warp switch assembly 26, a relay 28 having normally open contacts 30, a relay 32 having normally open contacts with 34 and normally closed contacts 36 and a temperature sensitive switch assembly often termed a flame switch indicated generally at 38. All of these components, as well as the spark 16 and the transformer 18, are relatively low cost items which are available through a number of commercial sources.

The warp switch assembly 26 includes a bi-metallic blade 42 which maintains the contact 40 normally closed and opens the contact 40 when the blade 42 is heated by a resistor unit 44.

The flame switch assembly 38 includes contacts 46 and 48 which are adapted to be opened and closed by a swinging blade 50 biased by a spring 52 to maintain a circuit through the contact 46 and is moved to the dotted line position to close contact 48 by a plunger 54 carried by a diaphragm 56 connected by a capillary tube 58 to a bulb 60 positioned close to the burner 10. As is well known in the art the bulb 60 may be filled with a fluid such as mercury which expands when heated to displace the diaphragm 56 and move the switch blade 50 from its full line or cold position to its dotted line or hot position. Thus the switch assembly 38 is effective to maintain a circuit through control 46 when the burner 10 is out of operation and to maintain a circuit through con-

tact 48 when the burner 10 is in operation. The many electrical leads connecting the various components will not be described individually since they are clearly disclosed in the drawing and the following description of the operation of the system.

The control system is shown in its completely deenergized position with the burner 10 and the spark 16 out of operation, the main circuit being open at the master switch 22. The system may be readied for operation by closing master switch 22 and setting the thermostat 24 as desired. Until the thermostat closes the system will remain in the condition shown in the drawing.

When the thermostat 24 closes, a circuit is completed from the main power line 19 through the switch 22 to the thermostat 24 and the warp switch contacts 40, a resistor 62 connected in parallel with the relay contact 30, and through valve 14 to main power line 20. Because of the size of the resistor 62 the current flow is not sufficient to open the valve 14.

Simultaneously, a circuit is made through the resistance heater 44, the relay 28, the cold contacts 46 of the flame switch 38 to the power line 20. Contacts 30 are then closed shorting out the resistance 62 to open valve 14 and completing a circuit through primary 64 to energize the spark 16. Normally this will result in prompt ignition of the flame at the burner 10.

The initiation of combustion heats bulb 60 to open cold contact 46 and close hot contact 48 on the switch assembly 38. When contact 46 is opened the circuit through the resistance heater 44 and the relay 28 is opened. This action takes place before the resistance heater 44 has imparted sufficient heat to the bi-metal arm 42 to open contact 40 which thus remains closed. The deenergization of relay 28 opens contacts 30 so that the circuit through the solenoid valve 14 is made only through the resistance 62. The current flow in this circuit is sufficient to hold valve 14 open but not sufficient to open the valve from its closed position. When the hot contact 48 closes, a circuit is completed to the relay 32 which opens contact 36 and closes contact 34. The opening of contact 36 deenergizes the spark 16. The closing of contact 34 completes a shunt circuit around the hot contact 48.

The system will continue in this manner with the burner in operation and the spark 16 deenergized until the thermostat 24 is opened by an increase in temperature in the space served by the burner 10. When the thermostat opens, the circuit to the valve 14 is opened and the valve will immediately move to its fully closed position thus discontinuing combustion, while contact 36 will close and contact 34 will open. The system will remain completely deenergized until the thermostat again closes repeating the operation described above.

In the event ignition of the main burner 10 is not effected, the warp switch heater 44 will continue in operation since the cold contact 46 of the flame switch 38 remains closed. After a predetermined time, which can be set as desired, the resistance heater 44 will cause switch contact 40 to open thus immediately deenergizing the spark 16 and closing the valve 14.

Similarly, in the event the main burner 10 becomes extinguished after ignition, the flame switch 38 will move to close contact 46 and open contact 48. The closing of the contact 46 will energize the warp switch heater 44 to open the circuit through the valve 14. In either event, that is where the burner initially fails to ignite or there is a failure of combustion after ignition, the circuit cannot be restored to its original condition for reignition without first opening the main switch 22 to deenergize the heater 44 and permit the switch blade 42 to cool. Since the cooling of the switch blade 42 requires several minutes, ample time is permitted to permit the dissipation of any gas accumulated in the furnace.

It is a feature of particular importance of the present invention that failure of one or more of the electrical

components of the system does not produce an unsafe condition, i.e., that the entire system in all respects "fail safe."

For example, in case of any type of failure of the flame switch assembly 38, the contact 46 will remain closed keeping the warp switch heater 44 in the circuit to open the contact 40 to thereby close the main gas valve 14 and deenergize the spark 16. In the event of failure of the resistance element 44 or the relay 28, contacts 30 remain open, preventing opening of the valve 14. In the event that the resistor 62 burned out, valve 14 would close as soon as ignition were effected and contact 36 were opened.

Finally, in the event of failure of the transformer 18 there would be no burner ignition; and, after a brief period of time, switch contact 40 would open, closing the main gas valve 14.

Thus it is apparent that failure of any of the components or open circuits in this system result in a fail safe condition.

It is also apparent from the foregoing that the present invention provides an unusually simple and safe control system in accordance with the objects set forth above.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, 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 Letters Patent is:

1. An ignition and control system for a fluid fuel burner comprising a normally closed solenoid operated valve for controlling the supply of fuel to said burner; spark ignition means for said burner; power circuit means for said valve and said ignition means; a normally closed warp switch in said circuit; normally open relay contacts and a resistor connected in parallel in said circuit, said relay contacts and said resistor each being in series with said warp switch and said valve, said relay contacts being in series with said spark ignition means, the resistance of said resistor being such that the current flow through said resistor is sufficient to hold said valve open but insufficient to open said valve; main switch means for connecting said circuit to a power source; a combustion sensor including a pair of normally closed contacts and a pair of normally open contacts, said normally closed contacts being open and said normally open contacts being closed when said combustion sensor is heated by combustion of said burner; means including said normally closed contacts of said combustion sensor operative when said main switch means is closed and said valve is closed to close said relay contact to open said valve and to energize said spark ignition; said combustion sensor opening said normally closed contacts and thereby opening said relay contacts upon initiation of combustion at said burner whereby the circuit to said solenoid valve is maintained through said resistor and said spark means is deenergized, and a heater in series with said normally closed contacts and operable to open said warp switch a predetermined time after said main switch means is closed.

2. An ignition and control system for a fluid fuel burner, said system comprising circuit means between first and second power lines of opposite polarity and incorporating switch means controlling flow of current in said circuits, a warpswitch including a resistance heater and a normally closed pair of contacts connected in parallel with said heater, said contacts being adapted to open after current flows through said heater for a predetermined time, a first relay incorporating a normally open pair of contacts which close when said relay is energized, a second relay incorporating a normally closed pair of contacts

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and a normally open pair of contacts, said normally closed contacts opening and said normally open contacts closing when said second relay is energized, a normally closed electrically energized fuel valve which permits fuel to flow to said burner when energized, an electric ignitor adapted to ignite fuel at said burner when energized, a combustion sensor incorporating a normally closed pair of contacts and a normally open pair of contacts, said normally closed contacts opening and said normally open contacts closing when said combustion sensor is heated by combustion at said burner, a resistor in series with said fuel valve and having a resistance allowing sufficient power input to said valve when energized to maintain said valve in open condition but less than required to open it when closed, said circuit means between said power lines including circuits

- (1) through said resistance heater, said first relay and the normally closed contacts of said combustion sensor,
  - (2) through the normally closed contacts of said warp switch, said resistor and said fuel valve,
  - (3) through the normally closed contacts of said warp switch, the normally open contacts of said first relay when closed, and said ignitor,
  - (4) through the normally closed contacts of said warp switch, the normally open contacts of said first relay when closed, the normally closed contacts of said second relay and through said valve,
  - (5) through said second relay and the normally open contacts of the combustion sensor when closed,
  - (6) through said second relay and its normally open contacts when closed; whereby
- when said switch means is closed, circuits (1) and (2) are completed, causing the normally open contacts of

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said first relay to close, completing circuits (3) and (4) thus energizing said valve and said ignitor; when combustion is established the normally open contacts of the combustion sensor will close and the normally closed contacts will open, breaking circuit (1) which opens the contacts of said first relay breaking circuits (3) and (4), and completing circuit (5) which energizes the second relay to complete circuit (6), thus maintaining the valve open and deenergizing the ignitor; while if combustion fails, continued energization of circuit (1) will cause the normally closed contacts of the warp switch to open, breaking circuits (2), (3) and (4), which will deenergize said valve and ignitor.

3. An ignition and control system according to claim 2, wherein said ignitor incorporates a transformer having its primary winding in said third circuit and its secondary winding in series with a spark plug which has its spark gap adjacent to said burner.

4. An ignition and control system according to claim 2, wherein said switch means incorporates a manual switch and a thermostat connected in series.

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