ABSTRACT OF THE DISCLOSURE

A simple ignition system for a space heater or the like is provided wherein gas or similar fuel flow is controlled by a solenoid valve. A heat sensitive switch and an air flow sensitive switch are serially connected to the solenoid valve for preventing gas flow in the absence of ignition or air flow respectively. An electric glow igniter adjacent the heat sensitive switch initiates combustion, and is disconnected after ignition for prolonged life. If desired, a time delay for disabling the heater in the absence of ignition can be employed if, for example, the heater is a nonsealed system.

BACKGROUND

In small inexpensive space heaters such as may be employed, for example, in mobile homes, small apartments, or individual rooms, it is desirable to employ a small low-cost, highly reliable control system. Such a system must provide full safety for room occupants under all conditions and still be inexpensive.

BRIEF SUMMARY OF THE INVENTION

Thus, in practice of this invention according to a presently preferred embodiment there is provided a heater control combination for a fuel operated space heater or the like having a blower, a burner, and a solenoid valve for controlling fuel flow. The control combination includes an electric igniter for the fuel burner, a heat sensitive switch adjacent the igniter and the burner and in series with the solenoid valve, plus an air flow responsive switch in the blower air flow path and in series with the solenoid valve. Means may be provided for disconnecting the igniter after fuel ignition occurs. A time delay relay may be used to turn off fuel flow in case there is a failure to ignite.

DRAWINGS

These and other features and advantages of the present invention will be appreciated as the same becomes better understood by reference to the following detailed description of a presently preferred embodiment when considered in connection with the accompanying drawings wherein:

FIG. 1 illustrates in block diagram form a control system suitable for a nonsealed heating system; and

FIG. 2 illustrates in block form a control system suitable for a sealed system.

DESCRIPTION

FIG. 1 illustrates in block form a control system constructed according to principles of this invention. As illustrated in this embodiment, the heater, which may, for example, be a small space heater for a mobile home or the like, includes a fan 10 for distributing heated air into the space to be heated. The fan or blower 10 may also supply a pressure head to the air intake of the combustion system of the heater for combustion with a fuel, such as, natural gas. A conventional burner 11 is provided for heating the air.

In a so-called sealed space heater, the air inlet flowing to the burner 11 and the exhaust for the combustion products are completely separate and remote from the air flow path through the heater to the space to be heated. In a sealed system there is thus no opportunity for depleting air from the space nor for discharging the exhaust products into the space, either of which could be hazardous to the occupants. In a nonsealed system, on the other hand, the combustion product exhaust is separate but the air intake to the combustion system is in parallel with the air intake for heating, and typically a fraction of the air intake is recirculated from the space to be heated and another fraction is "make-up" air from the external environment. In a nonsealed system, the occupant's safety is protected by a reliable, safe control system that effectively prevents depletion of a room's air or discharge of combustion products into a room.

In a space heater, as provided in practice of this invention, the flow of gas from a gas supply 12, such as the main or a storage tank, is controlled by a conventional solenoid valve 13, and control of the solenoid valve provides the principal safety features of the heater.

The electrical control system comprises a single pole switch 14 controlling the input power to the system. At least one line of the input power is controlled by a conventional thermostat 16 sensitive to temperature of the air in the space to be heated, and located either in an inlet line to the space heater or remote therefrom at some other location in the room. Input power is also applied to one contact of a normally open relay 17 that controls operation of the fan 10. From the thermostat 16 when it is turned on, power is applied to a conventional normally closed time-delay relay 18, and thence to the coil 19 of the fan relay 17. Thus, when the thermostat turns on, power is immediately applied to the relay coil 19 closing the relay 17 and causing the fan 10 to immediately start operation.

Operation of the fan 10 causes air to commence flowing in the ducts of the heater, and the moving air acts on the sail 21 of a normally open sail switch 22. The sail switch 22 is merely a sensitive switch actuated by a gas bulb or a solid heat sensitive switch 24 that is closed by a thermally responsive member 26 when that member has been sufficiently heated. Such a device is commercially available and often known as a flame switch. The thermally responsive member 26 that causes the switch 24 to operate may be, for example, a small glass bulb, a mechanical expansion material or may include material having a substantial volume change upon melting so as to cause mechanical motion and close the switch 24 when a pre-selected temperature has been attained. In one embodiment, the heat responsive member 26 is arranged concentrically with the igniter 23 for very rapid thermal response.

The flame switch 24 and sail switch 22 are in series with the normally closed solenoid valve 13 so that the valve
is open only when both the normally open flame switch and normally open sail switch are closed in response to proper operation of the igniter and fan, respectively. That is, when the burner is closed, power is applied to the fan to close the sail switch 22, and power is also applied to the igniter 23 for closing the flame switch 24, thereby opening the solenoid valve 13 with a time delay that is only that time required to operate the two switches 22 and 24, and in effect it is assumed that this time delay is quite small.

Connected in series with the igniter 23 and the delay operating coil 27 of the time-delay relay 18 is a normally closed thermally responsive igniter cut out switch 28. The heat sensitive cut out switch 28 is sufficiently remote from the igniter 23 that it is not heated thereby to the point that it leaves its normally closed condition. The heat responsive switch 28 is, however, located in the region of the heater heated by the burner 11, and hence when the burner 11 operates, the cut out switch 28 is heated and opens in response thereto.

Opening of the heat responsive switch 28 cuts off the power to the igniter 23 so that it is no longer electrically heated. It, and the flame switch actuator 26, are in the region heated by the burner 11 so that even if the igniter is off the flame switch 24 remains closed while combustion continues. The igniter cut out switch 28 is desirable since the temperature of the region of the heater where the burner 11 is less than its temperature in response to electrical heating, and hence the operating lifetime of the igniter is greatly increased.

The igniter cut out switch 28 also disables the time-delay relay 18, which is normally closed, so that it remains closed. In the absence of such disabling, the time-delay relay after a selected time would open and remove power from the fan relay coil 19 and from the solenoid valve 13, thereby shutting down the entire heater unit. Normally a time delay of about 90 seconds is appropriate for safety. The time-delay relay 18 provides an additional back-up safety factor in a nonsealed heater so that if the solenoid valve 13 should open and the burner 11 shut off, more than a small amount of unburned gas could be discharged from the heater before the solenoid valve was closed due to operation of the time-delay relay. When the burner 11 operates properly, the cut out switch 28 disables the time-delay relay 18 and permits the solenoid valve 13 to remain open.

A normally open heat responsive switch 29 is provided in parallel with the contacts of the fan relay 17 for providing an alternative way of applying power to the fan 10, whether or not the thermostat 16 is closed. When the temperature in the portion of the heater where the heat responsive switch 29 is located is above a preselected value, the normally open switch is closed, thereby applying power to the fan 10 whether or not the relay 17 is closed. Thus, any time the heater is hot, the fan 10 will operate. An example of such operation is when the thermostat 16 turns off, thereby turning off the burner 11. In such a situation there is a short time delay before all parts have cooled sufficiently due to the sensible heat of the various parts of the heater. During this time, the heat responsive switch 29 keeps the fan 10 operating for cooling the heater, and as soon as it is sufficiently cool, the fan turns off.

FIG. 2 illustrates in block form a somewhat simplified control system such as may be employed with a sealed space heater. As illustrated in this embodiment, power is applied to the control system by way of a double pole switch 36 which applies power to a conventional thermostat 37. Closing of the thermostat switch when, for example, a room is too cool, applies power to an igniter 38 in the form of an electrical heater which is heated to a temperature in excess of the ignition temperature of a gas-air mixture.

The thermostat also applies power to a fan 39 for circulating air through the heater. Movement of air through the heater operates a sail switch 41 in the same manner as hereinabove described in relation to FIG. 1. The igniter 38 heats the thermally responsive member 42 of the conventional flame switch 43, also in the same manner as hereinabove described. The closing of the normally open sail switch 41 and normally open flame switch 43 enables operation of a solenoid valve 44 which opens to permit gas to flow from a gas supply 46 to a burner 47. Ignition of gas from the burner 47 by the igniter 38 results in opening of a normally closed thermal cut off switch 48 connected in series with the igniter 38 so that power is removed from the igniter to enhance its lifetime.

A high limit cut out switch 49 is also provided in series with the solenoid valve 44. The cut out switch 49 is normally closed and in response to a temperature in excess of a preselected limit, the switch 49 opens, thereby cutting off the flow of gas through the solenoid valve 44. Such a high limit switch 49 is conventionally employed for preventing overheating of space heaters and other appliances, and although not specifically described in relation to the embodiment of FIG. 1, can also be incorporated therein.

A normally open thermally responsive switch 51 is provided between the source of power and the fan 39 so that if the temperature in the heater is above some preselected limit the fan is operated in order to cool the heater. This, for example, in the case of the thermostat is turned off to cool the heater to a safe temperature.

Although only two embodiments of space heater control arrangements have been described and illustrated herein, many modifications and variations can be provided by one skilled in the art. It is, therefore, to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:
1. A fuel operated heating apparatus comprising:
   a fuel burner;
   a fan;
   an electrically operated igniter for the burner;
   an electrically operated valve for controlling the flow of fuel to the burner;
   a heat responsive switch adjacent the igniter and in series with the valve for operating the valve only in response to a temperature in excess of a preselected limit;
   a sail switch in series with the valve and operably mounted in the air flow path of the fan for operating the valve only in response to air flow in the heater;
   a second heat responsive cut out switch in series with the igniter for disabling the igniter in response to operation of the burner;
   a time-delay relay having normally closed contacts in series with the valve and the igniter and operable in response to the second heat responsive cut out switch for remaining closed when the burner is operating and opening after a selected time delay when the burner is inoperative.
2. A heating apparatus as defined in claim 1 wherein the igniter comprises an electrically heated resistor.
3. A heating apparatus as defined in claim 2 wherein the heat responsive element of the first heat responsive switch is concentric with the igniter resistor.
4. A space heater comprising:
   a fuel burner, an electric blower, and an electrically operated fuel flow valve, the improvement comprising:
   an electrically heated igniter;
   a heat responsive switch responsive to the igniter and in series with the valve;
   an air movement responsive switch responsive to blower air flow and in series with the valve, whereby the valve is enabled only when both the heat responsive switch and the air movement responsive switch are closed; and
5. In an improved fuel operated heating apparatus as defined in claim 4 the further improvement of: a second heat responsive switch in series with the igniter for disabling the igniter when a temperature in the heater is in excess of a selected limit.

5. a time-delay relay having normally closed contacts in series with the valve and igniter and operable in response to the second heat responsive cut out switch for remaining closed when the burner is operating and opening a selected time delay when the burner is inoperative.

References Cited

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