March 5, 1940. V. O. BEAM 2,192,631

AUTOMATIC FUEL IGNITION

Filed April 14, 1937 2 Sheets-Sheet 1

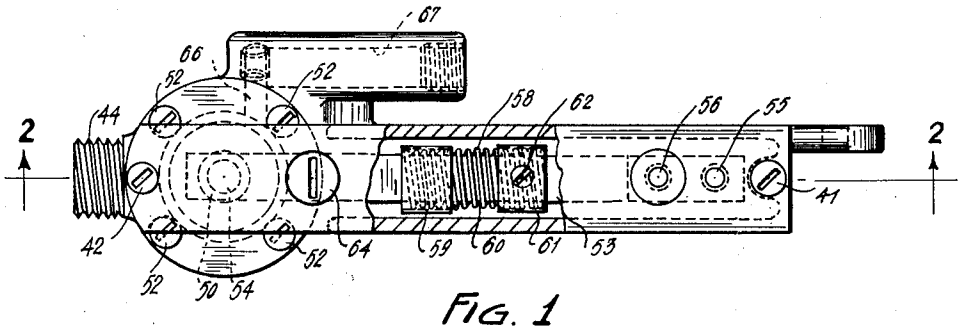


FIG. 1

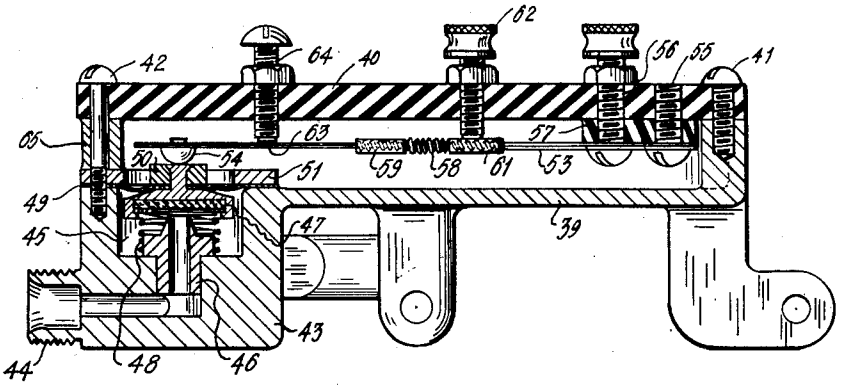


FIG. 2

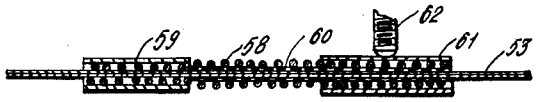


FIG. 3

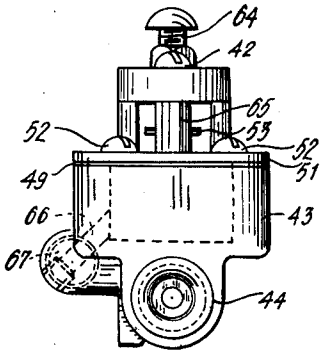


FIG. 4

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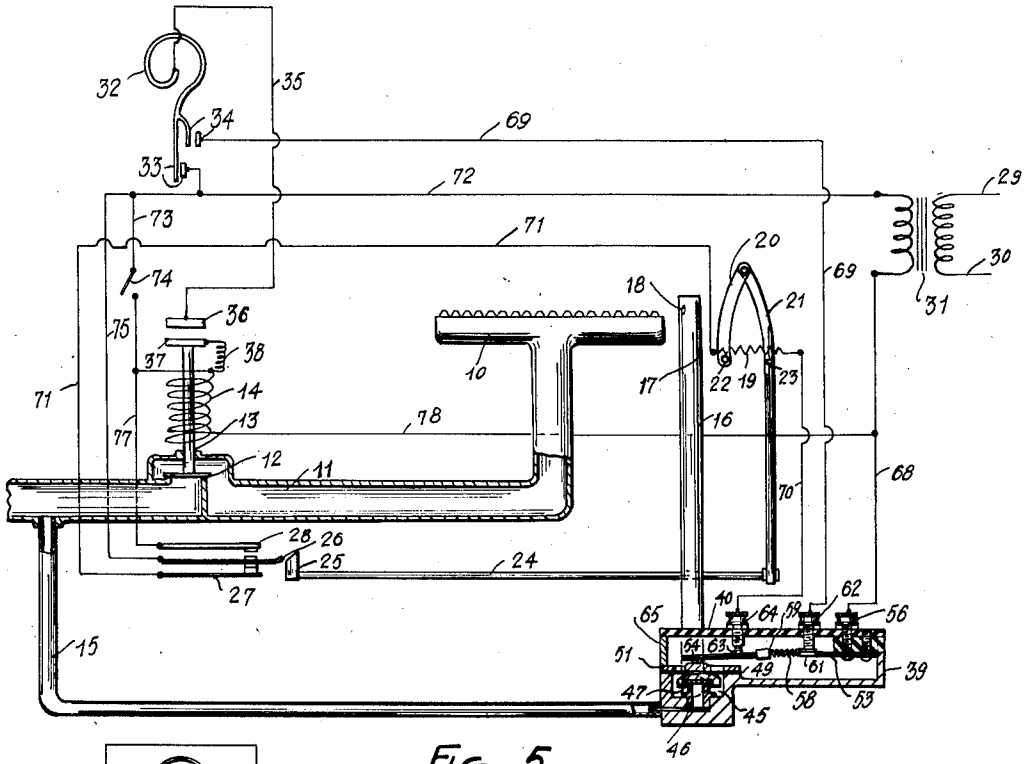


FIG. 5

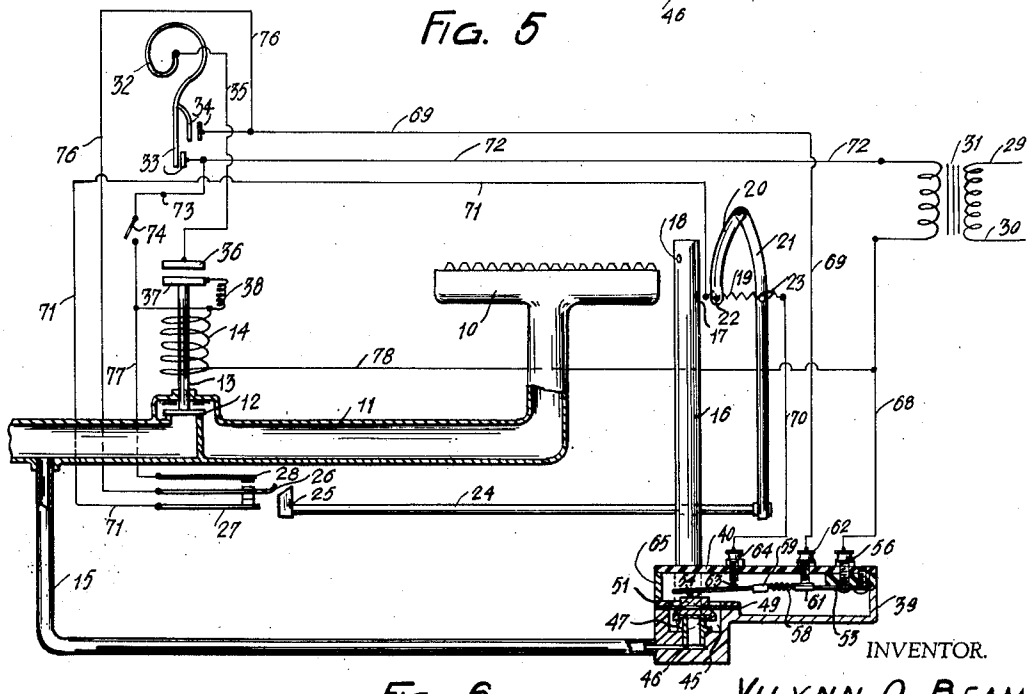


FIG. 6

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AUTOMATIC FUEL IGNITION

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Application April 14, 1937, Serial No. 136,847

12 Claims. (Cl. 158—28)

This invention relates to improvements in automatic fuel ignition, and has to do particularly with apparatus and electrical controls for normally shutting off the pilot burner, for turning it on and igniting it automatically when a room thermostat calls for heat, and for turning it off prior to the time when the room thermostat causes the main burner to be extinguished.

In modern systems for the control of burners in domestic heating plants utilizing liquid or gas fuel, where the pilot is designed to burn continuously, it is common to provide a fuel cut-off which becomes effective in the event that the pilot burner goes out. In such a system the main fuel valve cannot again be opened until the pilot is again lighted manually, and the fact that the burner is out may not be discovered until the premises are chilled. In my system this interruption to service is avoided. The pilot, when burning, acts through a thermal element to control the solenoid or motor which operates the valve for the main burner, so that if the pilot goes out at a time when the room thermostat is calling for heat, the fuel supply to the main burner is cut off. Then, as soon as the thermal element has cooled sufficiently, if the room thermostat is still calling for heat, the ignition cycle begins over again. If the fuel supply remains off, the ignition cycle may be repeated a number of times without effect, but when the fuel supply is resumed the burner automatically starts again.

Amongst the objects of the invention is the provision of a simple and dependable system for controlling the operation of a fuel burner embodying automatic ignition.

Another object is the provision of means for lengthening the life of the igniter by making its operation intermittent rather than continuous.

A further object is the provision of novel apparatus for electrically controlling the pilot fuel valve and for causing intermittent energization of the igniter coil.

Still another object is the provision of means for cutting off the igniter at the same time that the main fuel valve is opened.

Other objects and features of novelty will appear as I proceed with the description of those embodiments of the invention which, for the purposes of the present application, I have illustrated in the accompanying drawings, in which

Fig. 1 is a plan view of a combined pilot fuel valve and ignition interrupter which may be employed in carrying out the invention;

Fig. 2 is a vertical sectional view of the same taken substantially on the line 2—2 of Fig. 1;

Fig. 3 is a fragmental vertical sectional view, corresponding to a portion of Fig. 2, showing the parts on a larger scale;

Fig. 4 is an end view of the apparatus of Figs. 1 and 2;

Fig. 5 is a diagram of my system showing the electrical controls and conductors; and

Fig. 6 is a view similar to Fig. 5, illustrating a modification.

Referring particularly to Fig. 5, in which the preferred form of the invention is illustrated diagrammatically, a main gas burner is shown at 10. It will be understood that the invention is applicable to a burner using a fluid fuel, but I have illustrated it herein as applied to a gas burner and it will be so described hereinafter. In the gas line 11, leading to burner 10, there is a valve 12 which is electrically operated. This valve may be a diaphragm valve controlled by a solenoid or it may be motor operated, but for the sake of simplicity it is herein shown as attached directly to the armature 13 of a solenoid 14, so as to be open when the solenoid is energized.

A tube 15 is connected with gas line 11 to the rear of valve 12 and serves as a conductor for gas flowing toward the pilot, which is represented at 16. The pilot is supplied with two gas exit ports, shown at 17 and 18. When gas flows out of port 17 it envelopes an electric igniter coil 19, and if that coil is sufficiently hot the gas will be ignited. The heat of the flame will then cause the stream of gas to take an upward course and the flame will heat the shorter one of two interconnected thermal members 20 and 21, which are pivotally joined at their upper ends and pivotally connected with some suitable support at the pivot points 22 and 23. Member 21 is relatively long and, at its lower extremity, is attached to a substantially horizontal rod 24 carrying a beveled head 25.

The heat of the flame from the pilot port 17 causes the thermal member 20 to expand and lengthen, whereupon member 21 is tilted on its pivot 23 and the rod 24 is pushed toward the left. The beveled head 25 is adapted to engage the middle blade 26 of a double-throw switch, and thereby raise that blade out of contact with the lower blade 27 and into contact with the upper blade 28. This switch and the thermal element actuating means therefor are described more at length in my copending application, Serial No. 86,381, filed June 20, 1936.

Line wires 29 and 30 supply current to the primary coil of a step-down transformer 31, from the secondary coil of which low voltage current is taken for the operation of the system. This transformer is preferably one of the constant current, high impedance type, although other transformers of the proper power rating may be used provided they are not of the constant voltage type. A room thermostat, indicated at 32, has two sets of contacts 33 and 34 so mounted that when the thermostat calls for heat contacts 33 close first and contacts 34 follow when

the temperature is lowered approximately two degrees further. Conversely, when the temperature of the premises again rises toward the desired level, contacts 34 are broken first and contacts 33 follow after a further rise of approximately two degrees.

The fixed end of the thermostat is connected by a conductor 35 with a stationary contact 36 that is adapted to be engaged by a contact 37 carried by armature 13 when the solenoid 14 is energized. The solenoid is also connected with the contact 37 by a flexible conductor 38.

In carrying out the invention I employ a novel pilot control which is illustrated somewhat in detail in Figs. 1 to 4 inclusive. This piece of apparatus comprises a casing 39 with a cover 40 of insulating material, removably attached thereto by screws 41 and 42, and a depending extension 43 with a nipple 44 for the reception of one end of the tube or pipe 15. The extension 43 has a pocket 45 formed therein, connected with the bore of nipple 44 by suitable passages. In the pocket 45 I mount a valve seat 46, the upper surface of which is adapted to be engaged by a disk valve 47, the contacting portion of which may be formed of leather or the like. A light spiral spring 48 tends to hold the valve piece in its upper open position. A central post on the valve piece projects upwardly through a central opening in a flexible diaphragm 49, a collar 50 surrounding the post and the latter being peened or riveted over to clamp the diaphragm and provide a fluid tight joint. A flat ring 51 is superimposed upon the rim of the diaphragm and is fastened down tightly by screws 52, thereby forming a seal around the upper, outer edge of the pocket 45.

53 is a bi-metal thermal element, having a knob 54 on its free extremity, adapted to contact the top of valve piece 47 and depress the valve against the action of spring 48. This condition obtains when the bi-metal strip is not heated. The right hand end of strip 53 is fixed to the cover 40 by means of a screw 55 and a bolt 56, the latter projecting upwardly above the cover and serving as a binding post. A spacing block 57 of insulation is interposed between the strip and the cover. For a portion of its length, the bi-metal strip has wound thereon a heating coil 58, which is electrically connected at one extremity to the strip by means of a clamp 59, and at other points is insulated from the strip by an insulating envelope 60. The opposite extremity of the coil is clamped in position over the insulation by means of a metal clamping band 61. An adjustable binding post 62, mounted in the cover, engages clamping band 61. Toward the free end of the strip there is a small projection or contact point 63 which is positioned beneath and adapted to engage the lower extremity of a screw 64, by means of which the movement of the bi-metal strip, when heated, may be limited and controlled. The screw 64 also serves as a binding post.

The casing 39 is open at the valve end so as to make it possible to observe the valve movements. The cover at this point is supported by a spacer block 65, through which the screw 42 extends. A gas exit passage 66 connects pocket 45 with a further passage 67 in an arm of the casing, and to this exit passage is connected the pilot pipe 16.

When the heating coil 58 is deenergized and has been permitted to cool, the bi-metal strip 53 assumes its natural position, that is with its free extremity deflected downwardly to an extent sufficient to cause knob 54 to press valve piece 47 down into close contact with the valve seat 46. Now, when the current is turned into coil 58 and that coil heats up accordingly, the thermal element 53 is warped, causing its free extremity to be deflected upwardly, thereby opening the pilot gas valve. Shortly thereafter the contact 63 on the thermal element engages screw 64 and a circuit is set up through igniter coil 19, as will presently appear.

Binding post 56, on the cover of the pilot control apparatus, is connected by a conductor 68 with one end of the secondary coil of the transformer 31. From the binding post 62, a conductor 69 leads to the stationary part of the pair of thermostat contacts 34. The third binding post 64 is connected by a conductor 70 with one end of the igniter coil 19. From the opposite end of that coil a conductor 71 leads to the lower blade 27 of the double-throw switch. The transformer secondary is also connected by a conductor 72 with the stationary member of the thermostat contacts 33, while a branch conductor 73, with a hand switch 74 therein, is connected with the upper end of solenoid 14. In Fig. 5, the middle blade 26 of the double-throw switch is connected by a conductor 75 with the stationary part of thermostat contacts 33 and the conductor 72, whereas in Fig. 6 the middle blade 26 of the switch is connected by a conductor 76 with the stationary thermostat contact 34 and the conductor 69. The upper blade 28 of the switch in both instances is connected with the upper end of solenoid 14 by a conductor 77. The lower end of the solenoid is connected by conductor 78 to conductor 68.

Operation

Looking first at Fig. 5, and assuming that the system has been quiescent for a period and that the temperature has fallen to a point where the thermostat 32 calls for heat, that is to say, the contacts 33 become engaged, the contact 36 above solenoid 14 then is made alive, that is, it is connected with one end of the transformer secondary by way of conductor 72, contacts 33, thermostat 32 and conductor 35. The circuit is not completed however. Sometime later, when the temperature falls a little further, say two degrees, the contacts 34 also come together. Now, a circuit is set up from the transformer through conductor 72, contacts 33 and 34 and conductor 69 to binding post 62, and then through clamping band 61 and heating coil 58 to bi-metal thermal strip 53, through that strip to binding post 56 and back through conductor 68 to the transformer. Current traversing this circuit gradually heats up the coil 58 which warps the bi-metal strip 53, causing the free end thereof to swing upwardly. The pressure of knob 54 upon the valve piece 47 is thus relieved and the spring 48 opens the valve, enabling gas to flow through tube 15 into pocket 45 and thence out through passages 66 and 67 to pilot pipe 16, from which it flows through ports 17 and 18. The stream of gas emerging from port 17 envelopes the igniter coil 19. The heating effect of heating coil 58 continues and increases the warping of element 53 until the contact 63 on the bi-metal strip engages with screw 64. When this latter contact is made a circuit is set up from the transformer, through conductors 72 and 75 to the middle blade 26 of the double-throw switch, which is then in its down position in contact with

the lower blade 27, and out through that blade and through conductor 71 to one end of igniter coil 19, through that coil and down through conductor 70 to binding post 64 and contact 63 on bi-metal strip 53, through that strip to binding post 56 and back through conductor 68 to the transformer. Igniter coil 19 is thus brought up to a high heat, and if sufficient gas from the pilot burner port 17 is present the gas is ignited. The electrical energy consumed in the heating of igniter coil 19, lowers the voltage in the circuits fed by the transformer. Assuming that the normal voltage through heating coil 58 is twenty volts, then when the igniter coil is thrown on the line this voltage is reduced to some value less than twenty volts depending on the output voltage characteristic of the transformer used. This drop in voltage reduces the heating effect of heating coil 58 sufficiently to cause the contact 63 to leave the screw 64, which breaks the circuit through igniter coil 19, thereby permitting the voltage to rise again to normal and causing the coil 58 to heat up once more sufficiently to warp the bi-metal member so as to close the circuit through the igniter coil. This intermittent energizing of the igniter coil continues as long as the switch blades 26 and 27 are in contact. The pilot gas valve, however, remains open continuously, the movement of the bi-metal thermal member for making and breaking the igniter circuit being very slight, and not sufficient to affect the valve.

As soon as the stream of gas flowing from port 17 in the pilot pipe becomes ignited, its heat causes the flame to rise away from the coil 19 and into the vicinity of the thermal member 20, over which it plays. Also the flame travels around and ignites the stream of gas emerging from port 18, adjacent the main burner 10. The thermal member 20 is therefore heated up, and as it expands the member 21 is swung upon its pivot 23. The long lower arm of member 21 thus communicates a pushing effort to rod 24, the beveled head of which lifts intermediate blade 26 of the double-throw switch away from contact with lower blade 27 and into contact with upper blade 28. The circuit through the igniter coil is thereby broken and a circuit is set up through solenoid 14 as follows: From the transformer through conductors 72 and 75 to switch blade 26, from that blade to blade 28 and conductor 77, through solenoid 14 and back by way of conductors 78 and 68 to the transformer. The armature 13 of the solenoid then rises and opens the main gas valve 12, permitting gas to flow to the burner and to be ignited by the pilot flame issuing from port 18. When the solenoid 14 is energized the contact 37 is carried up into engagement with fixed contact 36, which establishes a holding circuit through the solenoid from the transformer, through conductor 72, thermostat contacts 33, through the thermostat to conductor 35, through contacts 36 and 37, flexible conductor 38 to solenoid 14, and conductors 78 and 68 back to the transformer.

The above conditions are then maintained, the main burner and the pilot burner continuing to operate as long as the thermostat calls for heat. When the temperature of the premises approaches the desired warmth, the thermostat contacts 34 are the first to separate. This breaks the circuit through the heating coil 58 and permits the pilot gas valve 47 to close. The thermal members 20 and 21 then cool off and the rod 24 is retracted, breaking the connection across switch blades 26 and 28 and again establishing connection between switch blades 26 and 27. The solenoid 14 continues to be energized, however, by reason of the holding circuit previously described, which is under control of the thermostat contacts 33 only. The main burner continues to function thereafter until the temperature of the premises rises a further predetermined small amount, say two degrees, when the thermostat contacts 33 separate, breaking the holding circuit and permitting the main gas valve 12 to drop to closed position, causing the main burner to go out.

The system illustrated in Fig. 6 operates in the same manner as that above described, except that the igniter circuit traverses the two sets of thermostat contacts instead of by-passing them, as in Fig. 5. This circuit in Fig. 6 is from the transformer through conductor 72, thermostat contacts 33 and 34, conductor 76 to switch blade 26, through switch blade 27 and conductor 71 to igniter coil 19, and thence through conductor 70, binding post 64, bi-metal strip 53, binding post 56 and conductor 68 back to the transformer. In the system of Fig. 5, which is preferred, the main burner cannot be turned out so long as the pilot is burning, because the solenoid 14 remains energized through closed switch blades 26 and 28 regardless of whether or not thermostat contacts 33 are closed. In Fig. 6, on the other hand, the solenoid circuit through blades 26 and 28 also extends through the thermostat, and it can be broken by the thermostat whether or not the cooling of the thermal members 20 and 21 causes the switch blades 26 and 28 to open.

Definite time factors are involved in the operation of the various parts of the apparatus. After the thermostat contacts 34 are made, it takes the heating coil 58 with its interrupting action approximately thirty-five seconds to open the pilot gas valve and energize the igniter coil, thus lighting the pilot. After this operation another sixty seconds is required for the thermal member 20 to heat up sufficiently to change the position of the double-throw switch and thus open the solenoid valve. Hence, approximately ninety-five seconds are required for the complete operation of the on-cycle or starting cycle. On the off-cycle approximately the same amount of time is required for the cooling of the thermal member 20 sufficiently to cause the separation of switch blades 26 and 28. In the case of the system of Fig. 5, any interruption of the normal room thermostat operation of less than sixty seconds duration will have no effect on the solenoid valve, because the pilot thermal element 20 will not have cooled sufficiently to separate the blades 26 and 28. Any interruption longer than sixty seconds will open the switch blades 26 and 28 and will close the solenoid valve. Thereafter, a complete recycle must take place before the burner can again be lighted. In the case of Fig. 6, any short interruption of the normal room thermostat action will close the solenoid valve, but if that interruption is less than sixty seconds long the valve will again open because the switch blades 26 and 28 are maintained in engagement by the still warm thermal element 20. Such rapid on and off movements of the main burner are generally undesirable, and it is on that account that I prefer the system of Fig. 5.

Having thus described my invention, I claim:

1. In fuel burning equipment, a pilot burner, a fuel valve for said burner, a hot wire coil ig-

niter operatively associated with said burner, means adapted to be connected to a room thermostat, to be responsive thereto for opening said valve and intermittently energizing said igniter, and means functioning in response to the operation of the pilot burner for deenergizing said igniter.

2. In fuel burning equipment, a main burner, a pilot therefor, a hot wire coil igniter for said pilot, a valve for the fuel supply to said pilot, means adapted to be connected to a room thermostat, to be responsive thereto for opening said valve and for intermittently heating said igniter to the point of fuel ignition while the valve remains open.

3. In fuel burning equipment, a main burner, a pilot therefor, an electric igniter for said pilot, a valve for the fuel supply to said pilot, a room thermostat, and a member movable in one direction under control of the room thermostat for opening said valve and energizing said igniter and movable a lesser distance in the opposite direction for disconnecting said igniter without closing said valve.

4. In fuel burning equipment, a main burner, a pilot therefor, a thermal element arranged to be actuated by said pilot, a switch operated by said thermal element, an electric igniter for said pilot, a valve for the fuel supply to said pilot, a room thermostat, and means embodying a heating coil under control of the room thermostat for opening said valve and energizing said igniter, and under the control of said switch independently of said thermostat for deenergizing said igniter.

5. In fuel burning equipment, a main burner, a pilot therefor, a thermal element arranged to be actuated by said pilot, a switch operated by said thermal element, an electric igniter for said pilot, a circuit for said igniter including said switch, a valve for the fuel supply to said pilot, a room thermostat, a member under control of said thermostat movable in one direction for opening said valve and closing said igniter circuit and movable a lesser distance in the opposite direction for opening said igniter circuit, whereby when the thermostat calls for heat said valve is opened and said igniter circuit is closed, and when the thermal element becomes heated through operation of the pilot said switch opens to break the igniter circuit.

6. In fuel burning equipment, a pilot, an igniter therefor, an electric circuit including said igniter, a control circuit for said igniter circuit, said circuits being in shunt with each other, a transformer of variable voltage type for supplying current to both circuits, said control circuit embodying means responsive to changes in electrical energy applied thereto for making and breaking said igniter circuit whereby the current flow in the control circuit is varied intermittently, and the igniter circuit is alternately opened and closed.

7. In fuel burning equipment, a pilot, an igniter therefor, an electric circuit including said igniter, a control circuit for said igniter circuit, said control circuit embodying a heating coil, said circuits being in shunt with each other, a transformer of variable voltage type for supplying current to both circuits, and means operated by the heating coil for opening the igniter circuit when said heating coil is fully energized, whereby the current flowing through the heating coil varies as the igniter circuit is opened and closed so as to cause intermittent energizing of the igniter.

8. The combination with a gas burner and a room thermostat, of a normally out pilot, a normally deenergized electric igniter for said pilot, heat responsive means associated with said pilot, a switch adapted to be operated by said heat responsive means, said igniter and said switch being in circuit with said thermostat, a fuel supply for the pilot, a valve therein, means comprising an electric heating coil for controlling said valve and said igniter, a circuit including said means and said thermostat, whereby the valve opens and the igniter circuit closes when the thermostat calls for heat and the valve closes and the igniter circuit opens when the thermostat moves to the no-call-for-heat position, said pilot when ignited causing said heat responsive means to actuate said switch to open said igniter circuit, whereby when the pilot is out and the thermostat again calls for heat and turns on the ignition and the gas to the pilot, the pilot cannot be again ignited until the heat responsive means has cooled sufficiently to operate said switch.

9. In fuel burning equipment, a pilot burner, a fuel valve for said burner, a hot wire hollow coil igniter operatively associated with said burner and having an energizing circuit, a common controller for both opening said valves and energizing said igniter circuit, means for intermittently interrupting the operation of the igniter while said valve remains open, and means functioning in response to the operation of the pilot burner for deenergizing said igniter circuit.

10. In fuel burning equipment, a pilot burner, a fuel valve for said burner, a hot wire coil igniter operatively associated with said burner, an electric circuit for said igniter, a common controller for both said fuel valve and said igniter circuit and including a member adapted to occupy three positions in the first of which said fuel valve is closed while said igniter circuit is open, in the second of which said fuel valve is open while said igniter circuit is closed, and in the third of which said fuel valve is open and said igniter circuit is open, and means functioning in response to the operation of the pilot burner for deenergizing said igniter circuit.

11. In fuel burning esuipment, a pilot, a fuel valve for said pilot, a hot wire hollow coil igniter therefor, an electric circuit including said igniter, a control circuit for said igniter circuit, said circuits being in shunt wth each other, and means for supplying current to both circuits, said control circuit embodying means responsive to energization of the igniter, for breaking said igniter circuit while maintaining said valve open, whereby the current flow in said circuits is varied intermittently, and the igniter circuit is alternately opened and closed.

12. In fuel burning equipment, a pilot, an electric igniter therefor, a switch for said igniter, a valve for the fuel supply to said pilot, a room thermostat, electrical timing means embodying a movable member under the control of the room thermostat, which member acts first to open said valve and thereafter to energize said igniter, and means following by a short time interval the lighting of the pilot and made effective by operation of the pilot for operating said switch to deenergize the igniter independently of said thermostat.

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