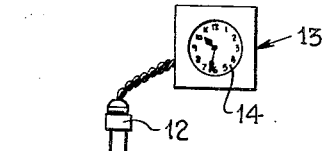
Sept. 5, 1944. W. A. RAY 2,357,609

CONTROL SYSTEM

Filed Oct. 30, 1942

Fig. 1



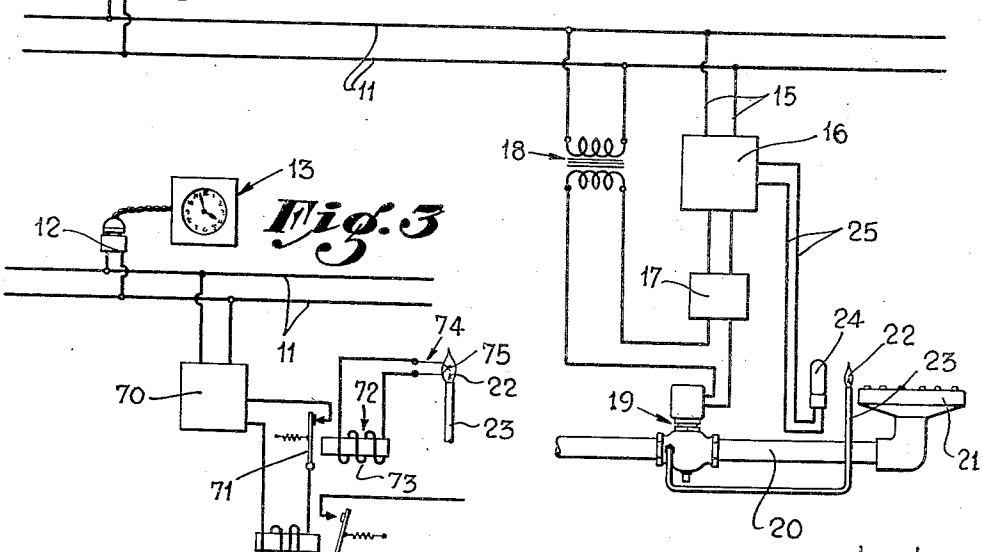
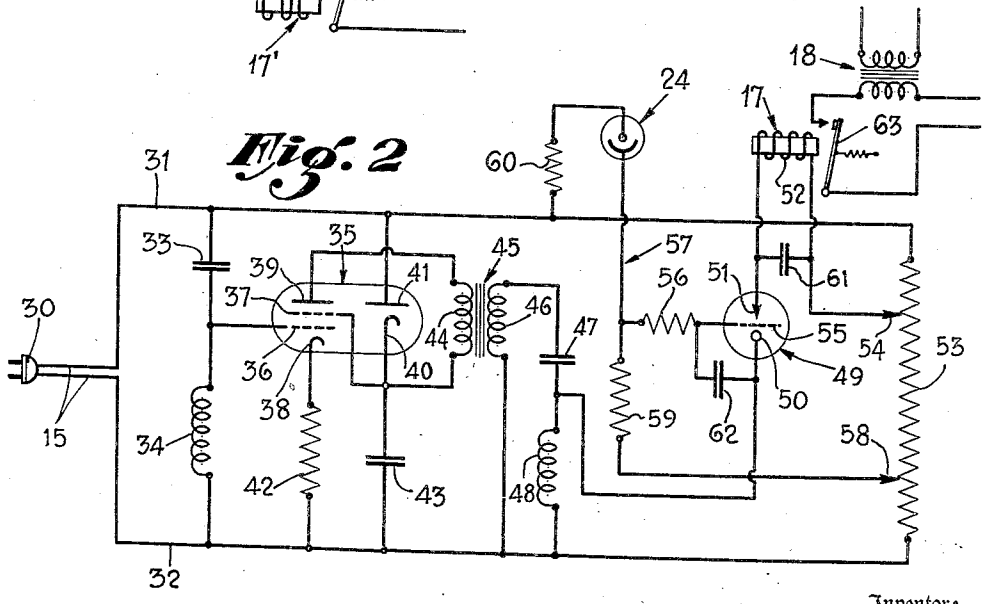


Fig. 3

Fig. 2



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Patented Sept. 5, 1944

2,357,609

UNITED STATES PATENT OFFICE

2,357,609

CONTROL SYSTEM

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Application October 30, 1942, Serial No. 463,919

6 Claims. (Cl. 158—28)

My present invention relates to systems for controlling the operation of fluid-fuel consuming burners, from a point remote therefrom, by the aid of carrier-frequency current conducted over the electrical service lines.

An object of this invention is to provide, in a system of the character described, means for rendering the system ineffective to pass fuel to the burner in the event of extinguishment of the pilot burner flame, or of the flame of the main burner when the same is of the normally-unextinguished type adapted to be controlled between low and high fire conditions.

A more specific object is to provide, adjacent the burner, means including an electronic circuit selectively responsive to the carrier-frequency and wherein flame responsive means forms an essential element; an electrically operated fuel-controlling valve energized, directly or indirectly, by the rectified carrier-frequency current; and, at the remote control point, a combination thermostat and carrier-frequency generator, operated by electricity derived from the service lines.

It will be apparent that, by the arrangement described, the thermostat and generator can be "plugged" into any convenient electric service receptacle, thereby eliminating additional wiring, and that waste of unburnt fuel and the attendant danger of explosion is also eliminated.

Other objects and advantages of the invention will be found in the description, the drawing, and in the claims; and for full understanding of the invention reference may be had to the following detailed description and accompanying drawing, wherein:

Figure 1 is a mainly-diagrammatic view of a burner control system embodying my invention;

Figure 2 is a wiring diagram of the carrier-frequency responsive control circuit; and

Figure 3 is a diagram of a modified form of the invention.

Referring first to Fig. 1 of the drawing, the numeral 11 indicates a pair of lines 11 which are assumed to be connected to the usual electrical service, and at the left-hand end of which is an outlet receptacle 12. Plugged into the receptacle is a control device 13 which comprises a high frequency generator (conveniently operated by energy derived from the service lines), a thermostat, and an electrically operated timer for changing the day and night temperature setting of the thermostat; a clock, operated by the timer motor, also being included, as is indicated by the clock dial 14. The generator, thermostat and timer may be of any of the well-known types and therefore are not shown in detail. Also connected to the service lines, by wires 15, is an electronic control device 16, shown in detail in Fig. 2, the output of which is connected to a relay 17 which controls the energization, by a transformer 18 connected to the lines 11, of a normally-closed solenoid-operated valve 19. This valve controls passage of fuel through a conduit 20 to a main burner 21, where it is ignited by the flame 22 of a normally constantly-burning pilot burner 23 connected to the valve 19 ahead of its closure. The flame 22, preferably of the semi-luminous type, serves also to illuminate a photocell 24 which is connected by wires 25 to the control device 16. It will be understood that the thermostat of device 13 serves to switch the high frequency current to the service lines in accordance with the heating requirements.

In Fig. 2 of the drawing, wherein the circuit diagram of the electronic control device 16 is illustrated, the numeral 30 indicates an attachment plug for connecting the circuit to the service lines 11 at any outlet receptacle convenient to the burner. In the example given, it is to be assumed that the electric service provides 60 cycle alternating current at approximately 115 volts, and that the frequency of the carrier current generated by the device 13 is 15 kilocycles. When the thermostat of device 13 is in circuit-closing condition, the 15 kc. carrier-frequency is applied to the top and bottom wires 31 and 32 of the diagram; these wires also being constantly at the voltage of the service lines. Connected across wires 31 and 32 is a tuned circuit, resonant at 15 kc., comprising a condenser 33 having a value of 0.05 mfd., in series with an inductance or choke coil 34 having a value of 2.5 mh. Indicated at 35 is a vacuum tube of the dual type, consisting of a screen-grid amplifier section and a rectifier section. The amplifier section of the tube comprises a control grid 36, a screen grid 37, a cathode 38, and an anode 39; the rectifier section comprising a cathode 40 and an anode 41. For the sake of simplicity, the necessary cathode heaters have not been shown. The control grid 36 is connected to the junction of condenser 33 and choke coil 34 and thus the 15 kc. carrier voltage is impressed across the control grid and the cathode 38. Due to the low impedance of the choke coil 34 at 60 cycles, the effect of the line voltage upon the control grid is negligible. In series with the cathode 38 is a resistor 42, of low value, which serves to provide the proper grid bias for the

amplifier section of the tube. The rectifier anode 41 is directly connected to the wire 31, and its cathode is indirectly connected to the other wire 32 through a coil 44, anode 39, and cathode 38, this part of the rectifier circuit being completed by the electron flow in the amplifier section. The rectifier section provides half-wave pulsating direct current for the amplifier anode 39, a condenser 43 of about 4 mfd. capacity serving to so smooth the pulsations that the effect is substantially that of uninterrupted direct current. As has been mentioned, in the circuit of anode 39 is the coil 44 which forms the primary of a coupling transformer 45; the secondary 46 of the transformer being connected to a tuned circuit comprising a condenser 47 and a choke coil 48, these elements having the same values, respectively, as those of the condenser 33 and choke coil 34. The characteristics of the transformer 45 should be such that the impedance of its input circuit and of its output or load circuit are substantially matched.

The amplified 15 kc. voltage is applied to a grid-glow rectifier tube 49, the cathode 50 of this tube being connected to the tuned load circuit at the junction of condenser 47 and choke coil 48. The anode 51 of the grid-glow tube is connected, through the coil winding 52 of relay 17, to a resistor or voltage divider 53, the opposite ends of which are joined to wires 31 and 32; the connection to the voltage divider being made by an adjustable tap 54. The resistance value of this voltage divider is conveniently about 25,000 ohms. The starter anode 55 of the tube is connected, through a current-limiting resistor 56 having a value of about 0.5 megohm, to another voltage divider, generally indicated at 57, which is connected at one end to the wire 31 and at the other, by a tap 58, to the voltage divider 53. The voltage divider 57 is composed of a series arrangement of a resistor 59, having a value of about 5 megohms, another resistor 60, having a value of about 2 megohms, and the photocell 24. Shunted across the relay coil winding 52 is the usual smoothing condenser 61; and across the cathode 50 and starter anode 55 is a small condenser 62 (0.0001 mfd.) which serves to stabilize the operation of the grid-glow tube.

It will be observed that, by the arrangement disclosed, the grid-glow tube is influenced both by the 60 cycle voltage and also by that of the 15 kc. carrier. In initial adjustment of the control circuits of this tube, flow of carrier-frequency current is interrupted, and the 60 cycle voltage across anode 51 and cathode 50 (through the relay coil 52 and choke coil 48) is adjusted by varying the position of the upper tap 54. Assuming that the photocell 24 is fully illuminated by the pilot-burner flame 22 and that consequently its effective resistance in the voltage divider 57 is quite low as compared with that of resistor 60, the other tap 58 is so adjusted that the voltage at the starter anode 55 is just below that at which the tube can fire. If the carrier-frequency current is now permitted to flow, the effect of the additional voltage provided by it (and amplified in tube 35) will cause the grid-glow tube to pass current and thereby so energize relay 17 that its contact-carrying armature 63 is attracted to connect the transformer 18 to the valve 19 and thus open the same to permit passage of fuel to the main burner 21 where it is ignited by the pilot-burner flame. If, upon establishment of the carrier-frequency current, the tube fails to function as described, the taps 54 and 58 are readjusted until the proper 60 cycle voltage conditions are obtained.

More specifically, the operation of the grid-glow control circuit is as follows: During that alternation of the 60 cycle current in which the anode 51 is positive with respect to cathode 50, the first 15 kc. alternation which causes the cathode to become more negative with respect to the anode and starter anode (thereby increasing the effect of the 60 cycle voltage) will start current flow through the tube, which flow will continue (regardless of succeeding alternations of the 15 kc. carrier) during the major portion of the positive 60 cycle alternation. During the following 60 cycle alternation, the anode will be negative with respect to the cathode and therefore no current will flow. However, during the next 60 cycle positive alternation, current flow will be reinitiated as described—a series of pulsations of direct current thus passing through the relay winding, the condenser 61 serving to so smooth the pulsations that the attractive force on the armature is relatively steady. If the carrier-frequency current is interrupted by the thermostat of device 13, starting of the grid-glow tube can no longer occur and the relay 17 is deenergized, thereby effecting closure of valve 19. If this valve is of the sensitive type, requiring only a small amount of electrical energy for operation, the relay can be eliminated and the valve energized directly. If the pilot-burner flame should become extinguished, the effective resistance of the photocell 24 in the voltage divider 57 becomes infinite and the 60 cycle voltage of the starter anode is therefore so reduced that firing of the tube is prevented, regardless of the existence of the 15 kc. voltage. It is to be noted that the photo-cell is so arranged that it can pass current during the 60 cycle alternation in which the anode 51 of the grid-glow tube is positive with respect to its cathode 50. Obviously, the carrier-frequencies employed in various control systems should be so chosen that they differ from each other to avoid the possibility of one system affecting the other when they operate over the same, or adjacent, portions of the service lines. Further, the amount of energy produced by the carrier-frequency generator should be so limited that it is ineffective at great distances.

In the modified form of the invention shown in Fig. 3, the numeral 70 indicates a carrier-frequency responsive control device which may be the same as that shown in the diagram of Fig. 2, except for the elimination of the photocell 24; the resistors 60 and 59 of voltage divider 57 thus being directly in series. The output of the control device is connected, in series with the contact arm 71 of an additional relay 72, to a relay 17' which serves to control the energization of the fuel valve in the same manner as relay 17 in the previously-described form of the invention. The coil winding 73 of relay 72 is connected to a thermoelectric generating device or thermocouple 74, the hot junction 75 of which is arranged to be heated by the pilot-burner flame 22. As long as this flame exists, the generated thermoelectric energy flowing in the coil 73 so energizes relay 72 that its contact-arm 71 is held in the closed position shown, thereby permitting operation of the burner control system in accordance with the demand of the thermostat of device 13. If the pilot-burner flame is extinguished, the control system is rendered inoperative by deenergization of relay 72; the thermoelectric generating device

thus serving in the same general manner as the photocell in the other form of the invention. If desired, the switching means of relay 72 could be connected in the voltage divider circuit 57 of Fig. 2 in place of the photocell, to serve a similar purpose.

While I have herein shown and described specific embodiments of my invention, I wish it to be understood that modifications may be made without departing from the spirit of the invention, and that I intend therefore to be limited only by the scope of the appended claims.

I claim as my invention:

1. In a system for controlling the operation of a fluid fuel burner by the aid of carrier-frequency current conducted between the control point and a point adjacent the burner by the electrical service lines: an electrically operated valve located adjacent the burner for controlling fuel supply thereto, means at said control point for generating said carrier-frequency current and including switching means for controlling the connection thereof to said service lines, electrical means connected to the service lines adjacent the valve for supplying electrical energy to the valve, said electrical means including an electronic circuit selectively responsive to said carrier-frequency, and means responsive to the existence of flame adjacent said burner for so controlling said circuit that the electrical means are rendered ineffective to supply energy to the valve when the flame is extinguished.

2. A control system, as defined in claim 1 wherein said flame responsive means is a photoelectric cell.

3. In a system for remotely controlling the operation of a fluid fuel burner by the aid of carrier-frequency current conducted between the control point and a point adjacent the burner by the electrical service lines: a normally-closed electrically operated valve located adjacent the burner for controlling fuel supply thereto; means at said control point and operated by electricity derived from said service lines for generating said carrier-frequency current, said last-named means including temperature responsive switching means for controlling the passage to said service lines of said carrier-frequency current; electrical means connected to the service lines adjacent the valve for supplying electrical energy to the valve, said electrical means including an electronic circuit selectively responsive to said carrier-frequency; and means responsive to the existence of flame adjacent said burner for so controlling said circuit that the electrical means are rendered ineffective to supply energy to the valve when the flame is extinguished.

4. A control system, as defined in claim 3, wherein said flame responsive means is a photoelectric cell.

5. In a system for remotely controlling the operation of a fluid fuel burner by the aid of carrier-frequency current conducted between the control point and a point adjacent the burner by the electrical service lines: a normally-closed electrically operated valve located adjacent the burner for controlling fuel supply thereto; means at said control point and operated by electricity derived from said service lines for generating said carrier-frequency current, said last-named means including temperature responsive switching means for controlling passage to said service lines of said carrier-frequency current; electrical means connected to the service lines adjacent the valve for supplying electrical energy to the valve, said electrical means including an electronic circuit selectively responsive to said carrier-frequency; a pilot-burner for said burner; and photoelectric means responsive to the flame of said pilot-burner for so controlling said electronic circuit that only while said flame exists is said electrical means capable of supplying energy to the valve to open the same in response to the demand of said temperature responsive switching means.

6. In a system for remotely controlling the operation of a gas-consuming main burner by the aid of carrier-frequency current conducted between the control point and a point adjacent the burner by the electrical service lines: a normally-closed electrically operated valve located adjacent the burner for controlling fuel supply thereto; means at said control point and operated by electricity derived from said service lines for generating said carrier-frequency current; said last-named means including temperature-responsive switching means for controlling passage to said service lines of said carrier-frequency current, and also including time-responsive means operated by electricity derived from the service lines for modifying the effect of said temperature-responsive switching means during predetermined periods; electrical means connected to the service lines adjacent the valve for supplying electrical energy to the valve, said electrical means including an electronic circuit selectively responsive to said carrier-frequency; a pilot burner for said main burner; and photoelectric means responsive to the flame of said pilot-burner for so controlling said electronic circuit that only while said flame exists is said electrical means capable of supplying energy to the valve to open the same in response to the demand of said temperature responsive switching means.

WILLIAM A. RAY.