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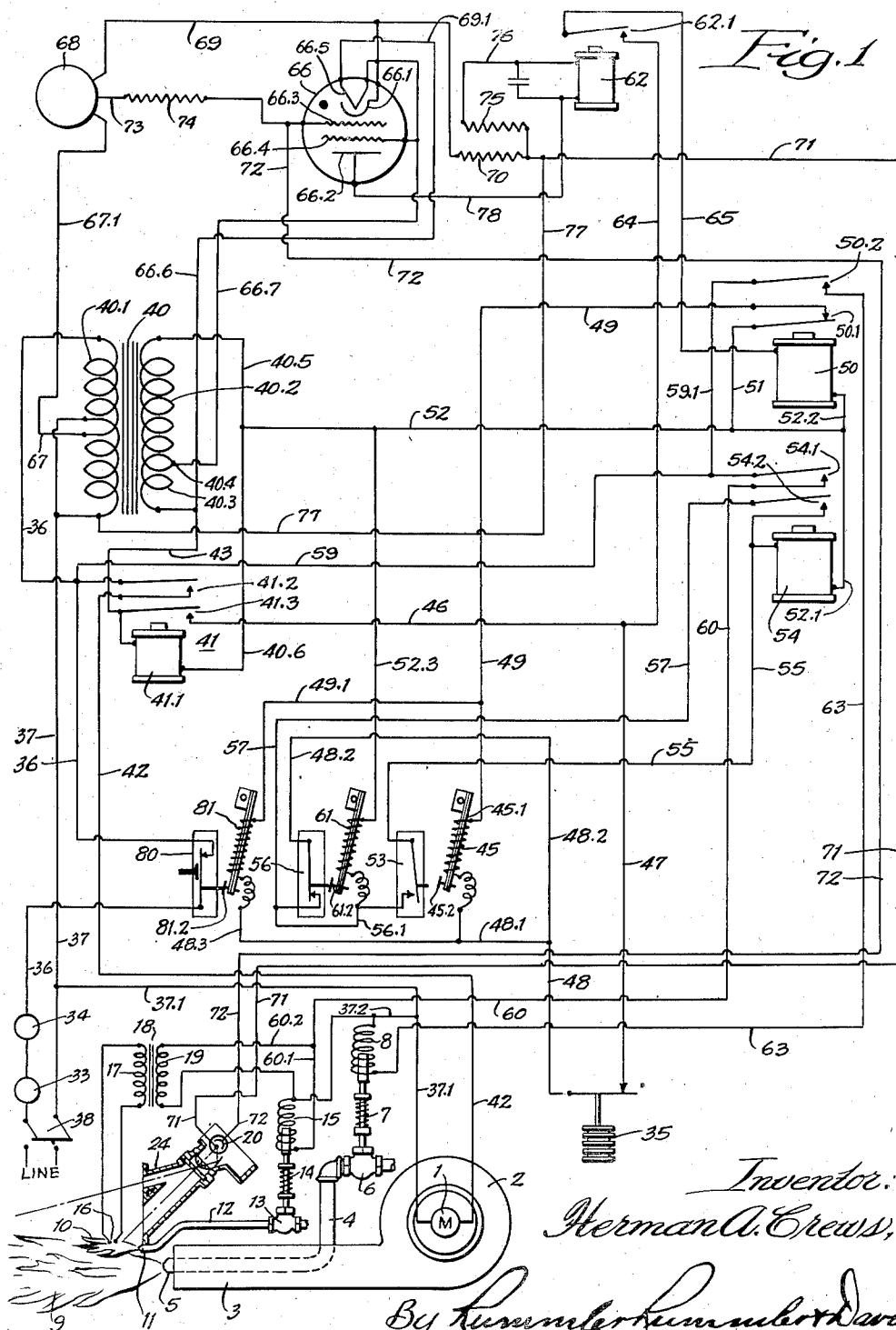
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BURNER CONTROL

Filed Nov. 19, 1942

2 Sheets-Sheet 1



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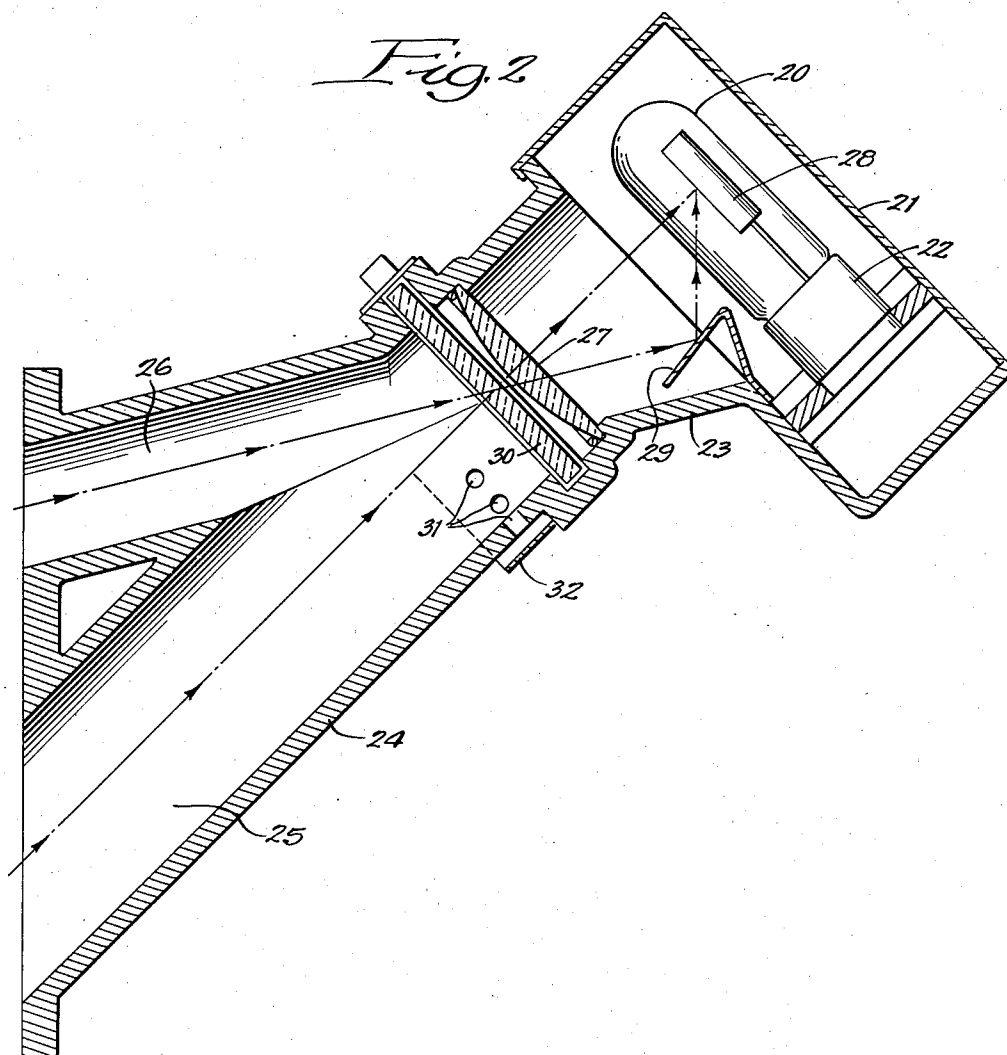
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BURNER CONTROL

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8 Claims. (Cl. 158—28)

This invention relates to electric control systems particularly suitable for burners using fluid fuel, including gas, liquid and powdered solids.

The main objects of this invention are to provide an improved electrically operated system for controlling the operation of a fluid fuel burner more or less automatically and for assuring safe operation under all operating conditions; to provide a burner control in which the sequence of operations is such that first, a draft will be established to scavenge the apparatus of residual gases, then a pilot flame will be established, and then the fuel will be fed to the burner only during periods when a light sensitive control device responds to light from either the pilot or the burner flame; to provide a control system of this kind in which the pilot flame is extinguished automatically at the expiration of a predetermined interval of time and the feeding of fuel is thereafter instantly cut off upon failure of the burner to emit sufficient light to maintain the responsive condition of the light sensitive cell; and to provide an improved arrangement of the light sensitive cell and light-directing means whereby the power circuit is controlled by a unitary light sensitive device responsive to light, either from the pilot flame, from the burner flame, or both, or from the light of a torch in installations designed for starting without a pilot flame.

A specific embodiment of this invention is shown in the accompanying drawings in which:

Figure 1 illustrates diagrammatically an arrangement of apparatus and electrical circuits as the same might be employed in an oil burning installation.

Fig. 2 is a sectional detail of an appropriate control head for housing the light sensitive cell or photo tube of the control apparatus.

The details of construction and circuit arrangements of this invention will best be understood if it is kept in mind that the device has its burner control devices arranged to operate successively in the following sequence:

The blower creates a draft of air through the combustion chamber, removing any residual fuel vapors and gases; then the pilot light is turned on and ignited and runs for a short measured interval of time. The light from the pilot flame causes a photo cell to operate a relay system which supplies fuel to the burner. The photo cell is thereafter controlled by the light of the fuel burner flame to maintain the fuel supply. The pilot flame and its supply of gas are automatically cut off after the expiration of sufficient time to normally establish the burner flame. If for any rea-

son the burner flame is extinguished, the photo cell instantly responds so as to cut off the supply of fuel to the burner. If conditions are normal, all operation of moving parts of the apparatus will thereupon cease and be in readiness for resumption of operation when heat is called for. If the burner flame fails to ignite when called for by the presence of the pilot flame, the pilot will be extinguished automatically by its timing devices and the foregoing starting operations will be repeated. If, however, the burner fails to have a proper flame established within a predetermined period of time for which the safety lock-out circuit breaker is set, then that circuit breaker will operate and lock out any further energizing current from the system.

In the form shown in the drawings, the burner mechanism includes a motor 1, a blower 2, and a duct 3 which conducts air from the blower to the combustion chamber of the furnace and through which the fuel inlet duct 4 leads to a nozzle 5. The supply of fuel is controlled by a valve 6 normally closed by spring 7 and held open for operation of the burner by a solenoid 8, or the like.

The flame issuing from the burner is indicated at 9. Similarly a pilot flame is indicated at 10 issuing from a nozzle 11 of the gas supply pipe 12 controlled by a valve 13 which is held closed by a spring 14 and held open for operation by a solenoid 15, or the like. The pilot light is also equipped with ignition electrodes 16 energized by a secondary winding 17 of a transformer 18 whose primary 19 is in parallel connection with the winding of the solenoid 15.

The light sensitive cell here shown as an electronic photo tube 20 is mounted in position to receive light from the pilot flame and burner flame and is placed in such position and so screened by the walls of the housing that the photo tube will not receive light from other sources that might be more or less incandescent from the operation of the furnace.

It is not necessary that the light ducts 25 and 26 gather all of the light issuing from the burner flame and pilot but these ducts are so proportioned that each respectively will conduct to the cathode of the light sensitive cell a beam of light of sufficient intensity to activate the photo cell. To this end the beams from these two sources of light should be proportioned according to the normal intensity of the light of these sources and accordingly the beam that is collected from the pilot is of larger sectional area than the beam collected from the burner flame. Roughly the areas of

the ducts 25 and 26 are approximately inversely proportional to the luminosity of their respective light sources.

The housing for the photo tube, as illustrated in Fig. 2, is shaped to form a head chamber 21 in which the tube is mounted in a suitable socket 22, a neck 23 and a flared throat 24 which has a passage 25 of relatively large cross-sectional area for the beam of light from the pilot flame and a passage 26 of relatively smaller cross-sectional area for a beam of light from the burner flame. It will be understood that in practice this relation of the flames to the photo tube head is more pronounced than it appears in Fig. 1 where for clearness the pilot flame is shown of exaggerated size and the burner flame is cut off by the limits of the drawing. Also the light of the burner flame is more intense than that of the pilot flame.

A lens 27 concentrates the beams of light upon the cathode 28 of the photo tube 3. Preferably the beam of light from the pilot flame is directed straight to the cathode while the light beam from the burner flame which comes in at an angle is reflected by a mirror 29 to the cathode. Interposed between the lens and the throat 24 is a color screen 30 which is arranged to be readily removable for cleaning and is preferably of blue color so as to screen out red light that might be emitted by the furnace walls.

The walls of the throat 24 are perforated at 31 for ventilation adjacent the screen 30 and the zone of the perforations is surrounded by a shield 32 to prevent stray light from entering and reaching the photo tube.

The electrical control system may include any of the usual limit controls, such as a temperature or pressure limiting device represented diagrammatically at 33 in Figure 1, a low water limiting device 34, shown in the power circuit, and an oil temperature responsive device 35, shown in the control circuit, the latter being of a form that will prevent the operation of the fuel burning devices if the entering fuel oil is not sufficiently warm to insure its ignition on issuance from the burner nozzle.

The power line from the source of alternating current is represented by conductors 36 and 37 and when the main switch 38 is closed, this line circuit energizes transformer 40 of which the primary winding is designated 40.1. This transformer may, for example, be adapted for either a 220 volt or 110 volt source and is arranged to provide two secondary circuits of different voltage. The first secondary winding 40.2 may, for example, provide a potential of 24 volts; whereas the second secondary designated 40.3 controlled by the tap 40.4 would give a potential of lower voltage, as for example 6 volts for heating the filament of the electronic valve 66, shown in the form of a hot-cathode gas tetrode arranged for control by a light sensitive photocell.

The secondary 40.2 is connected in series with the winding 41.1 of a start relay 41 which when energized closes the normally open contacts 41.2 and thus completes the circuit to the burner motor 1 which circuit comprises line conductor 36, contacts 41.2, conductor 42, motor 1, conductor 37.1 and line conductor 37.

When the start relay 41 is energized, normally open contacts 41.3 close and complete a circuit to a thermal timing element 45 for the pilot device which circuit can be traced as follows:

Secondary winding 40.2; conductor 43; contacts 41.3; conductors 46, 47; oil temperature responsive device 35; conductors 48, 48.1; thermal

pilot-timing element 45; conductor 49, normally closed contacts 50.1 of a fuel feed control relay 50; conductors 51 and 52 back to secondary 40.2.

The thermal timing element 45 includes a bi-metallic strip 45.1 and an adjusting pin 45.2. After the lapse of the time for which the pin 45.2 is adjusted, said thermal timing element closes the normally open micro-switch contacts 53 and closes the energizing circuit for the winding of the pilot light relay 54. This circuit can be traced from secondary winding 40.2, through conductor 43, contacts 41.3, conductors 46, 47, oil temperature responsive device 35, conductors 48 and 48.2, normally closed switch 56, conductor 56.1, switch 53, conductor 55, winding of pilot light relay 54 and conductors 52.1 and 52 to secondary 40.2.

When the pilot light control relay 54 is thus energized, normally open switch contacts 54.1 are closed, closing an energizing circuit for the pilot light fuel valve and ignition. This circuit can be traced from line conductor 36, conductor 59, contacts 54.1, conductors 60 and 60.1, pilot light valve solenoid 15 and leads 37.2 and 37.1 to line conductor 37. Pilot light ignition primary 19 is energized by obvious shunt connections 60.2 of the circuit that energizes solenoid 15.

Energizing of the pilot light control relay 54 also closes switch contacts 54.2 closing a holding circuit for the pilot light relay 54 after switch 53, which initiates energization of relay 54, has re-opened after energization of the fuel relay 50 has opened normally closed contacts 50.1 and de-energized the thermal timing element 45 of switch 53. This holding circuit can be traced as follows:

Secondary winding 40.2, conductor 43, contacts 41.3, conductors 46, 47, oil temperature device 35, conductors 48, 48.2, switch contacts 56, conductor 57, contacts 54.2, relay winding 54 and conductors 52.1, 52 and 40.5 to secondary.

The thermal timing element 61 is energized independently of pilot relay 54 and opens the circuit of that relay by opening switch 56 after an interval of time for which its adjustment 61.2 is set.

The pilot light is thus permitted to remain burning only for the time interval for which the element 61 is set, regardless of whether the burner flame is present or not.

The energizing circuit of thermal element 61 can be traced from secondary coil 40.2 through conductor 43, contacts 41.3, conductors 46, 47, oil temperature responsive device 35, conductors 48, 48.2, switch 56 and conductors 56.1, 61, 52.3, 52 and 40.5 to secondary 40.2.

The fuel supply valve 6 is normally closed by spring 7 and is provided with a solenoid 8 by means of which it is opened when the fuel is to be admitted to the burner. Solenoid 8 receives its energy from the main power circuit under the control of the fuel valve relay 50, and the tube relay 62 as will be described below.

The light-operated tube relay 62 is energized by current from a 110 volt tap 67 on primary winding of the main transformer 40 under the control of the electronic valve 66 which in turn is controlled by the photo tube 20.

The electronic valve 66 is of the tetrode type having an indirectly heated cathode 66.1 connected to the primary winding of transformer 40 by conductor 67.1, potentiometer 68 and conductor 69. The anode 66.2 is connected by conductor 78 to winding of tube relay 62. The control grid 66.3 is connected by conductor 72 to

the cathode of the photo tube 20 and is connected through high resistance 74 to the tap 73 on the grid bias potentiometer 68. The screen grid 66.4 is connected to the low potential heating circuit of the cathode filament 66.5. This heating circuit is shown connected by conductors 66.6 and 66.7 to the low voltage secondary winding 40.3. The anode of photo cell 20 is connected by conductors 71 and 77 to conductor 37.

The tube relay 62 is energized when current is supplied by the electronic valve 66 under the action of the photo cell 20 when its cathode 28 receives light from either the pilot flame or the burner flame.

The winding of the relay 62, as shown, is connected on one side through conductor 76 and anode current resistor 75 to the power line 77 and on the other side by conductor 78 to the anode 66.2.

Energization of the winding of tube relay 62 closes contact 62.1 and thus energizes winding of fuel relay 50. This energizing circuit can be traced from secondary winding 40.2 through conductor 43, start relay contacts 41.3, conductors 46, 64, tube relay contact 62.1, conductor 65, winding of fuel relay 50 and conductors 52.2, 52, 40.5 to secondary 40.2.

Energization of fuel relay 50 opens normally closed contacts 50.1 of the energizing circuit of the thermal timing unit 45 and closes the normally open contacts 50.2 of the energizing circuit for the fuel valve solenoid 8 and thus admits fuel to the burner. This fuel valve circuit can be traced from line conductor 36, through conductors 59, 59.1, contacts 50.2, conductor 63, solenoid 8, conductors 37.2, 37.1 to line conductor 37.

The safety cut-out switch 80 is interposed in the line conductor 36 and is of an appropriate form to remain open until manually closed by an attendant. The safety switch 80 is controlled by an adjustable thermal timing element 81 similar to the element 45, and the element 81 is connected by means of leads 48.3 and 49.1 as a shunt of the circuit hereinbefore described as controlling the time control element 45. The adjustable pin 81.2 of the element 81 is preferably set for sufficient time to permit one or more repetitions of the operations of igniting the pilot flame before the switch 80 automatically breaks the circuit.

The operation of the device shown is as follows: When the main switch 38 is closed transformer 40 is energized and the secondary current from that transformer energizes the motor control or start relay 41 closing contacts 41.2, starting the motor 1 and causing the pump 2 to establish a draft in the combustion chamber of the furnace so as to scavenge it of residual explosive gases, if any are present. Energization of motor control relay 41 also closes contacts 41.3 energizing the pilot timing element 45 which, after a desired interval of time, closes switch 53 energizing pilot relay 54. This relay closes contacts 54.1 energizing solenoid 15, opening the gas valve 13 of the pilot and simultaneously energizing transformer 18 to generate a spark at the pilot ignition electrodes 16, and after the pilot flame has been thus properly established light therefrom will cause the photo tube and electronic valve 66 to energize the tube relay 62 closing contacts 62.1 and energizing the fuel control relay 50. The fuel control relay 50 in turn closes contacts 50.2 energizing solenoid 8 to open the fuel valve 6. The vaporized fuel issuing from the burner nozzle 5 is ignited by the pilot flame

10 and light from this flame then serves to activate the photocell to maintain the fuel supply. The switch 56 under the action of the thermal timing device 61 automatically opens the circuit of the pilot gas valve and ignition electrodes at a predetermined time regardless of whether the burner flame is established or not. If the burner flame is not established the sequence of operations of turning on the pilot light and cutting it off will be repeated.

If the burner flame is properly established then, when the pilot flame is extinguished as aforesaid, the burner flame itself will be the sole source of light for the photo tube and upon failure of that flame the tube relay 62 will be deenergized and the normally open contact 62.1 will break the circuit of the fuel valve relay 50 which in turn will release contact 50.2 of power circuit to solenoid 8 and instantly cut off the fuel supply.

Although but one specific embodiment of this invention is herein described, it will be understood that numerous details of the construction shown may be altered or omitted without departing from the spirit of this invention as defined by the following claims.

I claim:

1. In a fluid fuel burner, means for producing a burner flame, means for producing a luminous pilot for such flame, a light sensitive cell controlling the feeding of fuel to the flame producing means, a housing shaped to enclose said light sensitive cell, said housing having separate light beam ducts directed at the burner flame and pilot respectively, and lens means positioned to concentrate said light beams on said light sensitive means, said ducts being of different transverse areas for collecting beams of sizes approximately inversely proportional to the relative intensities of light issuing from said burner and pilot respectively.

2. In a furnace, the combination of draft-producing means, a fuel burner, fuel feeding means for said burner, a fuel ignition device normally inactive, a normally closed fuel supply valve for said fuel feeding means, electrical control circuit means for said fuel supply valve and ignition device, comprising a photo cell positioned to be sensitive to light from both the ignition device and the flame of said burner, fuel control relay mechanism actuated by said photo cell for holding said fuel supply valve open only when said photo cell is activated by light, and ignition control relay mechanism having a thermal timing switch for energizing said ignition device, and having a thermal timing switch for deenergizing said ignition device independent of said photo cell.

3. In a fluid fuel burner, draft-producing means, pilot means for igniting the fuel, a fuel feeding means, power circuits and control circuits for separately actuating each said means, said power circuits having normally open contacts respectively, individual relays energized by the respective said control circuits for closing said normally open contacts in the respective power circuits of said fuel feeding means and pilot means, a start relay in the control circuit of said draft producing means having normally open contacts in the power circuit of said draft producing means and having normally open contacts in the control circuits of said fuel feeding means and said pilot means, a light sensitive cell housed to receive light from said pilot means and the flame fed by said fuel feeding means, an electric valve tube controlled by said light sensitive means, and a relay energized by said valve tube, and normally

open contacts in the control circuit of said fuel feeding relay and positioned to be closed through energization of said valve energized relay.

4. In a fluid fuel burner, draft-producing means, pilot means for igniting the fuel, a fuel feeding means, power circuits and control circuits for separately actuating each said means, said power circuits having normally open contacts respectively, individual relays energized by the respective said control circuits for closing said normally open contacts in the respective power circuits of said fuel feeding means and pilot means, a light sensitive cell housed to receive light from said pilot means and the flame fed by said fuel feeding means, an electric valve tube controlled by said light sensitive means, a relay in circuit with said valve tube, normally open contacts in the control circuit of said fuel feeding relay and positioned to be closed by said valve energized relay, normally open contacts in said pilot relay control circuit, an electrical timing device for automatically closing said last-named contacts, and an energizing circuit for said timing device having normally closed contacts positioned to be opened when said fuel feed relay is energized.

5. In a fluid fuel burner, draft-producing means pilot means for igniting the fuel, a fuel feeding means, power circuits and control circuits for separately actuating each said means, said power circuits having normally open contacts respectively, individual relays energized by the respective said control circuits for closing said normally open contacts in the respective power circuits of said fuel feeding means and pilot means, a light sensitive cell housed to receive light from said pilot means and the flame fed by said fuel feeding means, an electric valve tube controlled by said light sensitive means, a relay in circuit with said valve tube, normally open contacts in the control circuit of said fuel feeding relay and positioned to be closed by said valve energized relay, normally open contacts in said pilot relay control circuit, an electrical timing device for automatically closing said last-named contacts, and an energizing circuit for said timing device having normally closed contacts positioned to be opened when said fuel feed relay is energized, a pair of normally closed contacts in series with the normally open contacts in the pilot relay control circuit, and means including an electrical timing device for opening said last named normally closed contacts for deenergizing the pilot control relay.

6. In a fluid fuel burner, draft-producing means, pilot means for igniting the fuel, a fuel feeding means, power circuits and control circuits for separately actuating each said means, said power circuits having normally open contacts respectively, individual relays energized by the respective said control circuits for closing said normally open contacts in the respective power circuits of said fuel feeding means and pilot means, a light sensitive cell housed to receive light from said pilot means and the flame fed by said fuel feeding means, an electric valve tube controlled by said light sensitive means, a relay in circuit with said valve tube, normally open contacts in the control circuit of said fuel feeding relay and positioned to be closed by said valve energized relay, normally open contacts in said pilot relay control circuit, an electrical timing device for automatically closing said last-named contacts, and an energizing circuit for said tim-

ing device having normally closed contacts positioned to be opened when said fuel feed relay is energized, a pair of normally closed contacts in series with the normally open contacts in the pilot relay control circuit, and means including an electrical timing device for opening said last-named normally closed contacts for deenergizing the pilot control relay, and a holding shunt bridging the normally open contacts in said pilot control relay circuit and having normally open contacts positioned to be closed on energization of said pilot control relay for holding the same energized until said normally closed pilot relay circuit contacts are opened by their respective timing device.

7. In a fluid fuel burner, draft-producing means, pilot means for igniting the fuel, a fuel feeding means, power circuits and control circuits for separately actuating each said means, said power circuits having normally open contacts respectively, individual relays energized by the respective said control circuits for closing said normally open contacts in the respective power circuits of said fuel feeding means and pilot means, a light sensitive cell housed to receive light from said pilot means and the flame fed by said fuel feeding means, an electric valve tube controlled by said light sensitive means, a relay in circuit with said valve tube, normally open contacts in the control circuit of said fuel feeding relay and positioned to be closed by said valve energized relay, normally open contacts in said pilot relay control circuit, an electrical timing device for automatically closing said last-named contacts, and an energizing circuit for said timing device having normally closed contacts positioned to be opened when said fuel feed relay is energized, a circuit breaker in series with said power circuits, and means including a timing device for opening said circuit breaker connected in shunt with said first-named timing device and in series with its said normally closed contacts at the fuel feed relay.

8. In a fluid fuel burner, draft producing means, pilot means for igniting the fuel, a fuel feeding means, power circuit means for operating said draft producing means, separate branch leads from said power circuit means for said pilot means and said fuel feeding means, normally open contacts in each said branch lead, a pilot control relay for closing said normally open contacts of said pilot branch lead, a fuel control relay for closing said normally open contacts of said fuel feed branch lead, control circuit means for energizing said pilot control relay comprising a normally open switch and a normally closed switch in series with each other, a thermal timing device for closing said last-named normally open switch, circuit means for said timing device having normally closed contacts positioned and arranged to be opened when said fuel control relay is energized, a thermal timing device for opening said normally closed switch, and a holding circuit bridging said normally open switch and having normally open contacts positioned to be closed by said pilot control relay through said normally closed switch, whereby said pilot control relay will be held energized for a predetermined time while said last-named normally open switch is open.

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