

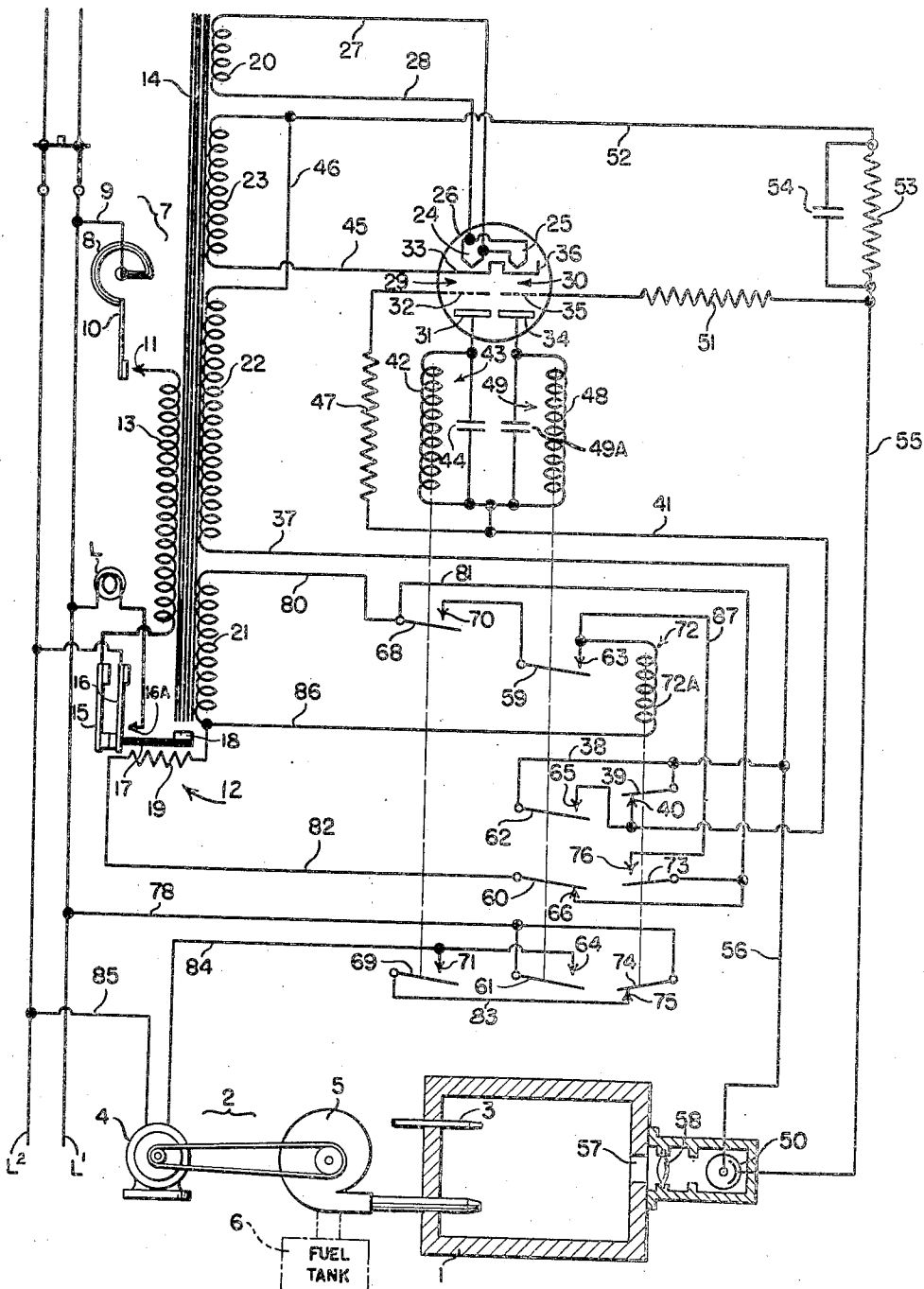
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H. S. JONES

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CONTROL SYSTEM

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INVENTOR.

HARRY S. JONES

BY

E. B. Spangenberg

ATTORNEY

UNITED STATES PATENT OFFICE

2,345,399

CONTROL SYSTEM

Harry S. Jones, Washington, D. C., assignor to
The Brown Instrument Company, Philadelphia,
Pa., a corporation of Pennsylvania

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The present invention relates to new and useful improvements in light sensitive control systems, and more particularly, to new and useful improvements in such systems arranged for controlling the operation of fuel burners.

It is a general object of the present invention to provide an improved safety control system for a fuel burner which responds in one sense to the presence of a flame at said burner and responds in another sense to the absence of a flame at said burner.

A more specific object of the present invention is to provide an improved safety control system for a fuel burner which utilizes a light sensitive device as the flame responsive element, and operates on failure of the burner flame to ignite when the burner is initially placed in operation or on failure of the flame while the burner is in operation, to shut off the supply of fuel to the burner.

In furnaces or fuel burners of the type which operate on liquid or gaseous fuels, the flame often fails to ignite upon initially placing the burner in operation or becomes extinguished while the burner is in operation for various reasons, and unless some provisions are made for immediately detecting such initial failure of ignition or flame failure and for shutting off the supply of fuel to the burner, a highly explosive mixture of fuel will be permitted to accumulate in the combustion chamber. Permitting such a combustible mixture of fuel to accumulate not only results in a waste of fuel, but also gives rise to a hazardous condition in that the combustible mixture is apt to explode, particularly if an attempt is made to relight the fuel before the combustion chamber has been purged of the explosive mixture.

It is a particular object of the present invention to provide an improved and simplified safety control system which operates in a positive manner to quickly shut off the supply of fuel to the burner when, for any reason, the fuel burner flame fails to ignite within a predetermined time upon initial placing of the burner into operation, or the burner flame becomes extinguished while the burner is in operation, and also to provide a signal for calling the attention of an attendant to the abnormal shut down of the burner.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages and specific objects obtained with its use, reference should be made to the accompanying

drawing and descriptive matter in which I have illustrated and described a preferred embodiment of the invention.

The single figure of the drawing shows a fuel oil burner having a combustion chamber 1 in which a spray of oil supplied by an oil pumping arrangement indicated generally by the reference character 2 is burned upon being ignited by a gas or other pilot light 3 which usually is continuously burning. The oil pumping equipment 2 is electrically driven from alternating current supply lines L¹ and L² which may be ordinary 110 volt lighting mains, and comprises a unidirectional electrical motor 4 which is adapted to be electrically connected to the supply lines L¹ and L², and a fuel pump 5 which is driven through the medium of belt means by the motor 4. When the motor 4 is energized, a spray of fuel will be supplied by the fuel pump 5 from a fuel tank indicated in dotted lines and designated by the reference numeral 6 to the combustion chamber 1.

The oil pumping equipment 2 is controlled by means of a thermostat 7 which may be located in a room or space to be heated. The thermostat 7 may be of any suitable construction and includes a bimetallic element 8 connected by means of a conductor 9 to the alternating current supply line L¹ and a contact blade 10 adapted to engage a relatively stationary contact 11 which is connected to the supply line L² through a thermal switch 12 and the primary winding 13 of a transformer 14.

The thermal safety switch 12 may desirably be of the general type disclosed in Patent 1,958,081, issued to F. S. Denison on May 8, 1934. As illustrated, this switch comprises a stationary arm 15 and a movable arm 16 biased for movement away from arm 15 but normally held in engagement with the latter by means of a bimetallic element 17. Element 17 is rigidly secured at one end to a block 18 and is arranged to be heated by a coil 19 when the latter is energized through a circuit described hereinafter. Upon energization of coil 19 for a predetermined period of time, element 17 will be warped sufficiently in the counterclockwise direction to permit arm 16 acting under spring or other bias to separate from switch arm 15 thereby interrupting the circuit including thermostat 7. The switch 12 will remain locked in this position until manually returned to its normal closed position. When the movable arm 16 is thus released by element 17 it moves into engagement with a relatively fixed contact 16A and thereby closes an energiz-

ing circuit to a signalling lamp L from the supply lines L¹ and L².

The transformer 14 supplies power to a circuit arrangement to be described which controls the operation of the oil pumping equipment 2 under control of the thermostat 7 and also in accordance with the conditions of combustion of the spray of fuel oil supplied to the chamber 1 by the pumping equipment 2. The transformer 14 is a combination step-up and step-down transformer and comprises the line voltage primary winding 13, low voltage secondary windings 20, 21 and 23 and a high voltage winding 22. Low voltage secondary winding 20 is used to energize the heater filaments 24 and 25 of an electric discharge device 26, and, as shown, is connected to the filaments 24 and 25, which are connected in parallel, by conductors 27 and 28.

The electric discharge device 26 comprises two sections designated by the reference numerals 29 and 30, respectively, within one envelope. The section 29 includes an anode 31, a control electrode 32, a cathode 33 and the heater filament 24, and the section 30 includes an anode 34, a control electrode 35, a cathode 36 and the heater filament 25. As shown, the cathodes 33 and 36 are directly connected within the envelope 26. The section 29 is utilized as a half wave rectifier while the section 30 is utilized as a triode.

The output circuit of rectifier 29 is energized by the transformer secondary winding 22 through a circuit which may be traced from the lower end of winding 22 through a conductor 37, a conductor 38, a switch arm 39, a contact 40, a conductor 41, a winding 42 of a relay 43 across which a condenser 44 is connected, anode 31, cathode 33, a conductor 45, transformer secondary winding 23, and a conductor 46 to the upper end of winding 22. As illustrated, control electrode 32 is connected by means of a resistor 47 to the point of connection of conductor 41 and relay winding 42. Consequently, section 29 is normally fully conductive and relay 43 is normally energized whenever the transformer 14 is energized, which action is effected by closure of the thermostat switch arm 10 with the contact 11.

The output circuit of triode 30 is energized by the transformer secondary winding 22 through a circuit which may be traced from the lower end of winding 22 through conductors 37 and 38, switch arm 39, contact 40, conductor 41, a winding 48 of a relay 49, which is shunted by a condenser 49A, anode 34, cathode 36, conductor 45, transformer secondary winding 23, and conductor 46 to the upper end of winding 22.

The input circuit of triode 30 includes the transformer secondary winding 23 in one branch and in another branch includes the anode to cathode resistance of a photoelectric cell 50. The first mentioned branch may be traced from the control electrode 35 through a resistance 51, a conductor 52 in which a resistance 53 shunted by a condenser 54 is inserted, transformer secondary winding 23 and conductor 45 to cathode 36. The winding 23 is so wound on transformer 14 as to tend to apply a potential on the control electrode 35 which is negative with respect to the cathode 36 during the half cycles when the anode 34 is positive. This branch of the input circuit of triode 30, thus, tends to render the triode non-conductive.

The second branch of the input circuit of triode 30 may be traced from the upper terminal of transformer secondary winding 22, conductor 46, conductor 52, resistance 53 shunted by condenser

54, a conductor 55, the cathode of photoelectric cell 50, the anode of cell 50, a conductor 56, and the conductor 37 to the lower terminal of winding 22. The control electrode 35 of triode 30, as previously noted, is connected through resistance 51 to the common terminal of resistance 53 and conductor 55. The flow of electric current through this circuit is controlled in accordance with the illumination of photoelectric cell 50 and produce a potential drop across resistance 53 and condenser 54 which is of the proper polarity to tend to impress a potential on the control electrode 35 which is positive with respect to the potential of cathode 36, and thereby tends to render the triode 30 conductive. This potential drop produced across resistance 53 and condenser 54 thus is opposed to the potential impressed between the control electrode 35 and cathode 36 by the transformer secondary winding 23. With this arrangement, therefore, the conductivity of the triode 30 and thereby the energization of relay 49 is adapted to be controlled in accordance with the illumination of photoelectric cell 50.

The photoelectric cell 50 is mounted in any convenient manner outside an opening 57 in the wall of combustion chamber 1, so as to be exposed to light emanating therefrom. A lens 58 may desirably be provided, as shown, so as to concentrate the rays from a large area within the chamber 1 upon the photoelectric cell 50. Preferably light from the flame of the main burner 2 is focused upon the cell 50 so that the latter is rendered conductive when there is a flame at the main burner but is non-conductive when there is no flame present at the main burner.

Summarizing, when a flame is not present at the main burner the conductivity of photoelectric cell 50 is relatively low and as a result the triode 30 is substantially non-conductive since the potential drop produced across resistance 53 by the flow of current from the photoelectric cell there-through is then insufficient to offset the effect of the negative potential applied to the control electrode 35 by the transformer secondary winding 23. When a flame is burning at the main burner 2, however, the conductivity of photoelectric cell 50 is increased and consequently the potential drop across resistance 53 is increased. This increased potential drop across resistance 53 operates to render the triode 30 conductive and thereby effects energization of the relay 49.

For convenience of illustration, the sections 29 and 30 will be referred to as conductive hereinafter when their output current is sufficient to actuate the respective relays 43 and 49 associated therewith, and as non-conductive when their output current is insufficient for that purpose. For further convenience, a contact through which a circuit is completed when a relay is actuated will be designated a front contact of the relay, and a contact through which a circuit is completed when the relay is deenergized will be designated a back contact.

As illustrated in the drawing, the relay 49 comprises the winding 48 and switch arms 59, 60, 61 and 62. Switch arms 59, 61 and 62 cooperate with front contacts 63, 64, and 65, respectively, and switch arm 60 cooperates with a back contact 66. The relay 43 comprises the winding 42 and switch arms 68 and 69 which cooperate with front contacts 70 and 71, respectively. There is also provided a relay 72 the energization of which is controlled by the relays 43 and 49 and which is utilized for a purpose explained hereinafter. Relay 72 comprises a

winding 72A and switch arms 73 and 74 in addition to the switch arm 39 already mentioned. Switch arms 39 and 74 cooperate with back contacts 40 and 75, respectively, and switch arm 73 cooperates with a front contact 76.

When the temperature of the space to be heated is higher than the desired value, all parts of the system are in the positions shown in Fig. 1, and the supply of fuel to the combustion chamber 1 is then cut off. If the temperature of the room or space to be heated falls below the value it is desired to maintain, the thermostat 7 operates to move the switch blade 10 into engagement with the contact 11. This results in closure of the energizing circuit to the transformer primary winding 13 and thereby effects energization of the transformer secondary windings. Immediately upon energization of the transformer secondary winding, energizing current is supplied the heater 19 of the thermal safety switch through a circuit which may be traced from the upper terminal of winding 21, through a conductor 80, a conductor 81, contact 66, switch arm 60, a conductor 82, and resistance 19 to the lower terminal of winding 21.

After the cathodes 33 and 36 of the sections 29 and 30 have been heated to their operating temperatures, the rectifier 29 is immediately rendered conductive and energizes the relay 43. The relay 43 then operates switch arm 69 into engagement with contact 71 to complete an energizing circuit to the pump motor 4. This energizing circuit to motor 4 may be traced from the supply line L¹ to a conductor 78, switch arm 74, contact 75, conductor 83, switch arm 69, contact 71, a conductor 84, motor 4, and a conductor 85 to the supply line L².

Operation of motor 4 causes a spray of oil to be supplied to the combustion chamber 1 from the fuel supply tank 6, which spray of oil under normal combustion conditions will be ignited by the flame of the continuously burning pilot light 3. It is noted relay 43 when energized also actuates switch arm 68 into engagement with contact 70.

If the spray of oil supplied to combustion chamber 1 fails to ignite within a predetermined time, the energizing circuit to the transformer primary winding 13 is opened at the switch 15, 16, the relay 43 is deenergized, and consequently the burner motor 4 is deenergized. This effect is obtained by virtue of the action of the thermal safety switch 12, the heater 19 of which, as noted hereinbefore, is energized immediately upon closure of switch blade 10 upon contact 11, and causes opening of the switch 15, 16 when energized for a predetermined time.

If the main burner ignites properly, the appearance of a flame thereat operates to increase the conductivity of photoelectric cell 50, and thereby operates to render the triode 30 conductive and effects energization of the relay 49 in the manner explained hereinbefore. Relay 49 when energized actuates switch arm 61 into engagement with contact 64 to close an energizing circuit to the pump motor 4 which is independent of the switch arms 69 and 74, moves switch arm 60 out of engagement with contact 66 to deenergize the heater 19 of the thermal safety switch 12, moves switch arm 59 into engagement with contact 63 to close an energizing circuit to the winding 72A of relay 72, and moves switch arm 62 into engagement with the contact 65 to close an energizing circuit from 75

the transformer secondary winding 22 to the sections 29 and 30 and the relay windings 42 and 48 which is independent of the switch arm 39 and contact 40.

5 The energizing circuit to the motor 4 closed upon energization of the relay 49 may be traced from the supply line L¹ to conductor 78, switch arm 61, contact 64, conductor 84, motor 4, and conductor 85 to the supply line L².

10 The energizing circuit to the winding 72A of relay 72 which is closed upon energization of relay 49 may be traced from the upper end of winding 21 to conductor 80, switch arm 68, contact 70, switch arm 59, contact 63, winding 72A, and a conductor 86 to the lower terminal of winding 21.

The auxiliary energizing circuit to the sections 29 and 30 and the relay windings 42 and 48 which is closed upon energization of relay 49 is effected by closure of the switch arm 62 on the contact 65, which switch arm and contact shunt the switch arm 39 and contact 40. Subsequent movement of switch arm 39 out of engagement with contact 40, therefore, does not result in opening of the energizing circuit from the transformer secondary winding 22 to the triodes 29 and 30 and the relay windings 42 and 48. To this end the relay 72 is preferably so designed as to be slower in operation than the relay 49 to thereby guard against the switch arm 39 being moved out of engagement with contact 40 before the contact 62 is moved into engagement with the contact 65.

35 Relay 72 when energized closes a holding circuit for itself, moves the switch arm 39 out of engagement with the contact 40, and moves the switch arm 74 out of engagement with the contact 75. The holding circuit which is closed upon energization of relay 72 may be traced from the upper terminal of winding 21 to conductor 80, conductor 81, switch arm 73, contact 76, a conductor 87, winding 72A and conductor 86 to the lower terminal of winding 21.

45 The fuel burner system is now in full operation and normally a spray of fuel will continue to be supplied to the chamber 1 as long as the thermostat 7 calls for heat, or more specifically, as long as the switch arm 10 and contact 11 are held in engagement.

50 If the flame at the main burner should become extinguished for any reason the relay 49 will be deenergized immediately, or after any desired time delay which can be predetermined by properly choosing the value of condenser 54. Deenergization of relay 49 causes the switch arms 59, 62 and 61 to separate from contacts 63, 65 and 64, respectively, and causes switch arm 59 to move into engagement with contact 66. Separation of switch arm 62 and contact 65 opens the energizing circuit from the transformer secondary winding 22 to the tube sections 29 and 30 and the relay windings 42 and 48. Separation of switch arm 61 from contact 64 deenergizes the pump motor 4 which cannot again become energized because the relay 49 is locked out by separation of its own switch arm 62 from the contact 65 and the switch arm 39 is held away from the contact 40 by the then energized relay 72. Engagement of the switch arm 60 with the contact 66 closes an energizing circuit to the heater 19 of the thermal safety switch and after a predetermined time the thermal safety switch 12 locks out and completely deenergizes the system. The thermal safety switch 12 must be manually

reset after the abnormal condition causing the flame to become extinguished has become corrected before the burner can again become ignited.

Such energization of the heater 19 of the thermal safety switch 12 not only causes deenergization of the system but also effects energization of the signalling lamp L to thereby visually indicate to an attendant the abnormal burner shut down. The circuit through which lamp L is energized may be traced from supply line L¹ to lamp L, contact 16A of the thermal safety switch, and switch arm 16 to the supply line L².

Recapitulating, when the burner operates normally, the thermostat 7 controls the operation of the burner automatically at all times. Each time the thermostat 7 calls for heat there is a delay in energizing the burner motor 4, which delay is determined by the time required for the heaters 24 and 25 of the electronic discharge device 26 to come to their normal operating temperature. The entire system is shut down and permanently locked out as described above if the burner is not ignited within a predetermined time after the burner motor 4 is energized. In addition, the entire system is shut down and permanently locked out if the flame should become extinguished while the burner is in operation. In either case the system cannot again be started until the abnormal condition at the burner is corrected and the thermal safety switch 12 is manually reset.

Upon shut-down of the burner either during the starting operation or due to flame failure after the system has been in operation, the signalling lamp L is energized and thereby visually indicates to an attendant the abnormal shut-down of the burner. If desired, audible signalling means may also be provided for indicating the abnormal burner shut-down.

While in accordance with the provisions of the statutes, I have illustrated and described the best form of my invention now known to me, it will be apparent to those skilled in the form of the apparatus disclosed without departing from the art that changes may be made in the spirit of my invention as set forth in the appended claims, and that certain features of my invention may sometimes be used to advantage without a corresponding use of other features.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In an oil burning system, electrically operated means for projecting fuel into a zone of ignition, means for igniting the fuel, means for controlling said electrically operated means including a source of electrical current, a connection between said source of current and said electrically operated means, said connection having a normally closed contact and a normally open contact connected in series therein and a normally open contact connected in shunt to said first and second mentioned contacts, a relay coil associated with said first mentioned contact and adapted when energized to open said contact, a second normally closed contact and a normally open contact associated with said relay coil, said last mentioned normally closed contact being adapted to be opened and said last mentioned normally open contact being adapted to be closed when said relay coil is energized, a transformer having a primary winding and a plurality of secondary windings, switching means responsive to the temperature of a space heated by the burn-

ing fuel, a connection between said source of current and said transformer primary winding including said switching means, a connection including one of said transformer secondary windings and said relay coil and having two normally open contacts connected in series therein and the normally open contact associated with said relay coil connected in shunt to said series connected contacts, a relay coil associated with said second mentioned contact and with one of the normally open series connected contacts in said last mentioned connection and adapted when energized to close both of said contacts, a connection between said second mentioned relay coil and another of said transformer secondary windings to energize said second mentioned relay coil to thereby close said second mentioned contact to effect energization of said electrically operated means when the temperature of said space is lower than the desired value, a third relay coil associated with said third mentioned contact and with the second normally open series contact in the connection including the first mentioned relay and adapted when energized to close both of said contacts, a third normally open contact associated with said third mentioned relay coil and adapted to be closed when said relay is energized, a light sensitive device responsive to the burning of the fuel, an electronic discharge device having an input circuit controlled by said light sensitive device and an output circuit, a connection including one of said transformer secondary windings, said last mentioned contact and the second mentioned normally closed contact associated with said first mentioned relay in parallel, said third mentioned relay, and the output circuit of said electronic discharge device whereby energization of said third relay coil effects energization of said first mentioned relay coil, and additional means controlled by said third mentioned relay coil and disposed in the connection between said source and the transformer primary winding to deenergize the latter and thereby the entire system upon the occurrence of said third mentioned relay coil being deenergized a predetermined time while said transformer primary winding is energized.

2. In an oil burning system, electrically operated means for projecting fuel into a zone of ignition, means for igniting the fuel, means for controlling said electrically operated means including a source of electrical current, a connection between said source of current and said electrically operated means, said connection having a normally closed contact and a normally open contact connected in series therein and a normally open contact connected in shunt to said first and second mentioned contacts, a relay coil associated with said first mentioned contact and adapted when energized to open said contact, a second normally closed contact and a normally open contact associated with said relay coil, said last mentioned normally closed contact being adapted to be open and said last mentioned normally open contact being adapted to be closed when said relay coil is energized, a transformer having a primary winding and a plurality of secondary windings, switching means responsive to the temperature of a space heated by the burning fuel, a connection between said source of current and said transformer primary winding including said switching means, a connection including one of said transformer secondary windings and said relay coil and having two normally open contacts connected in series therein and the normally

open contact associated with said relay coil connected in shunt to said series connected contacts, a relay coil associated with said second mentioned contact and with one of the normally open series connected contacts in said last mentioned connection and adapted when energized to close both of said contacts, a connection between said second mentioned relay coil and another of said transformer secondary windings to energize said second mentioned relay coil, a third relay coil associated with said third mentioned contact and with the second normally open series connected contact in the connection including the first mentioned relay and adapted when energized to close both of said contacts, a third normally open contact associated with said third relay coil and adapted to be closed when said relay is energized, a light sensitive device responsive to the burning of the fuel, an electronic discharge device having an input circuit controlled by said light sensitive device and an output circuit, and a connection including one of said transformer secondary windings, said last mentioned contact and the second mentioned normally closed contact associated with said first mentioned relay in parallel, said third mentioned relay, and the output circuit of said electronic discharge device.

3. In an oil burning system, electrically operated means for projecting fuel into a zone of ignition, means for igniting the fuel, means for controlling said electrically operated means including a source of electrical current, a connection between said source of current and said electrically operated means, said connection having a normally closed contact and a normally open contact connected in series therein and a normally open contact connected in shunt to said first and second mentioned contacts, a relay coil associated with said first mentioned contact and adapted when energized to open said contact, a second normally closed contact and a second normally open contact associated with said relay coil, said last mentioned normally closed contact being adapted to be opened and said last mentioned normally open contact being adapted to be closed when said relay coil is energized, a transformer having a primary winding and a plurality of secondary windings, switching means responsive to the temperature of a space heated by the burning fuel, a connection between said source of current and said transformer primary winding including said switching means, a connection including one of said transformer secondary windings and said relay coil and having two normally open contacts connected in series therein and the normally open contact associated with said relay coil connected in shunt to said series connected contacts, a relay coil associated with said second mentioned contact and with one of the normally open series connected contacts in said last mentioned connection and adapted when energized to close both of said contacts, a connection between said second mentioned relay coil and another of said transformer secondary windings to energize said second mentioned relay coil, a third relay coil associated with said third mentioned contact and with the second normally open series connected contact in the connection including the first mentioned relay and adapted when energized to close both of said contacts, a third normally open contact associated with said third relay coil and adapted to be closed when said relay is energized, a device responsive to the burning of the fuel, an electronic discharge device having an input circuit controlled by said device and

an output circuit, a circuit connection including one of said transformer secondary windings, said last mentioned contact and the second mentioned normally closed contact associated with said first mentioned relay in parallel, said third mentioned relay, and the output circuit of said electronic discharge device.

4. In an oil burning system, electrically operated means for projecting fuel into a zone of ignition, means for igniting the fuel, means for controlling said electrically operated means including a source of electrical current, a connection between said source of current and said electrically operated means, said connection having a normally closed contact and a normally open contact connected in series therein and a normally open contact connected in shunt to said first and second mentioned contacts, a relay coil associated with said first mentioned contact and adapted when energized to open said contact, a second normally closed contact and a second normally open contact associated with said relay coil, said last mentioned normally closed contact being adapted to be opened and said last mentioned normally open contact being adapted to be closed when said relay coil is energized, a transformer having a primary winding and a plurality of secondary windings, switching means responsive to the temperature of a space heated by the burning fuel, a connection between said source of current and said transformer primary winding including said switching means, a connection including one of said transformer secondary windings and said relay coil and having two normally open contacts connected in series therein and the normally open contact associated with said relay coil connected in shunt to said series connected contacts, a relay coil associated with said second mentioned contact and with one of the normally open series connected contacts in said last mentioned circuit connection and adapted when energized to close both of said contacts, a connection between said second mentioned relay coil and another of said transformer secondary windings to energize said second mentioned relay coil, a third relay coil associated with said third mentioned contact and with the second normally open series connected contact in the connection including the first mentioned relay and adapted when energized to close both of said contacts, a third normally open contact associated with said third relay coil and adapted to be closed when said relay is energized, and a circuit connection including one of said transformer secondary windings, said last mentioned contact and the second mentioned normally closed contact in parallel, said third mentioned relay, and means including a device responsive to burning of the fuel to control the conductivity of said last mentioned connection.

5. In an oil burning system, electrically operated means for projecting fuel into a zone of ignition, means for igniting the fuel, means for controlling said electrically operated means including a source of electrical current, a circuit connection between said source of current and said electrically operated means, said circuit connection having a normally closed contact and a normally open contact connected in series therein and a normally open contact connected in shunt to said first and second mentioned contacts, means responsive to the temperature of a space heated by the burning fuel to close said second mentioned contact to effect energization of said electrically operated means when the temperature of said space is lower than the

desired value, means actuated in response to burning of the fuel, and means controlled jointly by said last mentioned means and by said temperature responsive means to open said first mentioned contact and to close said third mentioned contact and operative upon abnormal extinguishment of the burning fuel to open said third mentioned contact and to maintain said first mentioned contact open to thereby deenergize said electrically operated means.

6. In an oil burning system, electrically operated means for projecting fuel into a zone of ignition, means for igniting the fuel, means for controlling said electrically operated means including a source of electrical current, a circuit connection between said source of current and said electrically operated means, said circuit connection having a normally closed contact and a normally open contact connected in series therein and a normally open contact connected in shunt to said first and second mentioned contacts, means responsive to the temperature of a space heated by the burning fuel to close said second mentioned contact to effect energization of said electrically operated means when the temperature of said space is lower than the desired value, light sensitive means actuated in response to burning of the fuel, means jointly controlled by said light sensitive means and by said temperature responsive means to open said first mentioned contact and to close said third mentioned contact, said last mentioned means being operative upon abnormal extinguishment of the burning fuel to open said third mentioned contact and to maintain said first mentioned contact open to thereby deenergize said electrically operated means and operative thereafter to open said second mentioned contact irrespective of the condition of said temperature responsive means and to close said first mentioned contact.

7. In an oil burning system, electrically operated means for projecting fuel into a zone of ignition, means for igniting the fuel, means for controlling said electrically operated means including a source of electrical current, a circuit connection between said source of current and said electrically operated means, said circuit connection having a normally closed contact and a normally open contact connected in series therein and a normally open contact connected in shunt to said first and second mentioned contacts, means responsive to the temperature of a space heated by the burning fuel to close said second mentioned contact to effect energization of said electrically operated means when the temperature of said space is lower than the desired value, means actuated in response to burning of the fuel, means jointly controlled by said last mentioned means and by said temperature responsive means to open said first mentioned contact and to close said third mentioned con-

tact, said last mentioned means being operative upon abnormal extinguishment of the burning fuel to open said third mentioned contact and to maintain said first mentioned contact open to thereby deenergize said electrically operated means and operative thereafter to open said second mentioned contact irrespective of the condition of said temperature responsive means and to close said first mentioned contact.

8. In an oil burning system, electrically operated means for projecting fuel into a zone of ignition, means for igniting the fuel, means for controlling said electrically operated means including a source of electrical current, a circuit connection between said source of current and said electrically operated means, said circuit connection having a normally closed contact and a normally open contact connected in series therein and a normally open contact connected in shunt to said first and second mentioned contacts, means responsive to the temperature of a space heated by the burning fuel to close said second mentioned contact to effect energization of said electrically operated means when the temperature of said space is lower than the desired value, means responsive to burning of the fuel, and means controlled by said last mentioned means to close said normally opened contact and to open said normally closed contact and operative to hold the latter in said opened position independently of said responsive means and operative upon failure of the fuel to burn to open both of said normally open contacts to deenergize said electrically operated means.

9. In an oil burning system, electrically operated means for projecting fuel into a zone of ignition, means for igniting the fuel, means for controlling said electrically operated means including a source of electrical current, a circuit connection between said source of current and said electrically operated means, said circuit connection having a normally closed contact and a normally open contact connected in series therein and a normally open contact connected in shunt to said first and second mentioned contacts, means responsive to the temperature of a space heated by the burning fuel to close said second mentioned contact to effect energization of said electrically operated means when the temperature of said space is lower than the desired value, light sensitive means responsive to burning of the fuel, and means controlled by said light sensitive means and by said temperature responsive means to close said normally opened contact and to open said normally closed contact and operative to hold the latter in said opened position independently of said responsive means and operative upon failure of the fuel to burn to open both of said normally open contacts to deenergize said electrically operated means.

HARRY S. JONES.