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BURNER SAFETY CONTROL SYSTEM

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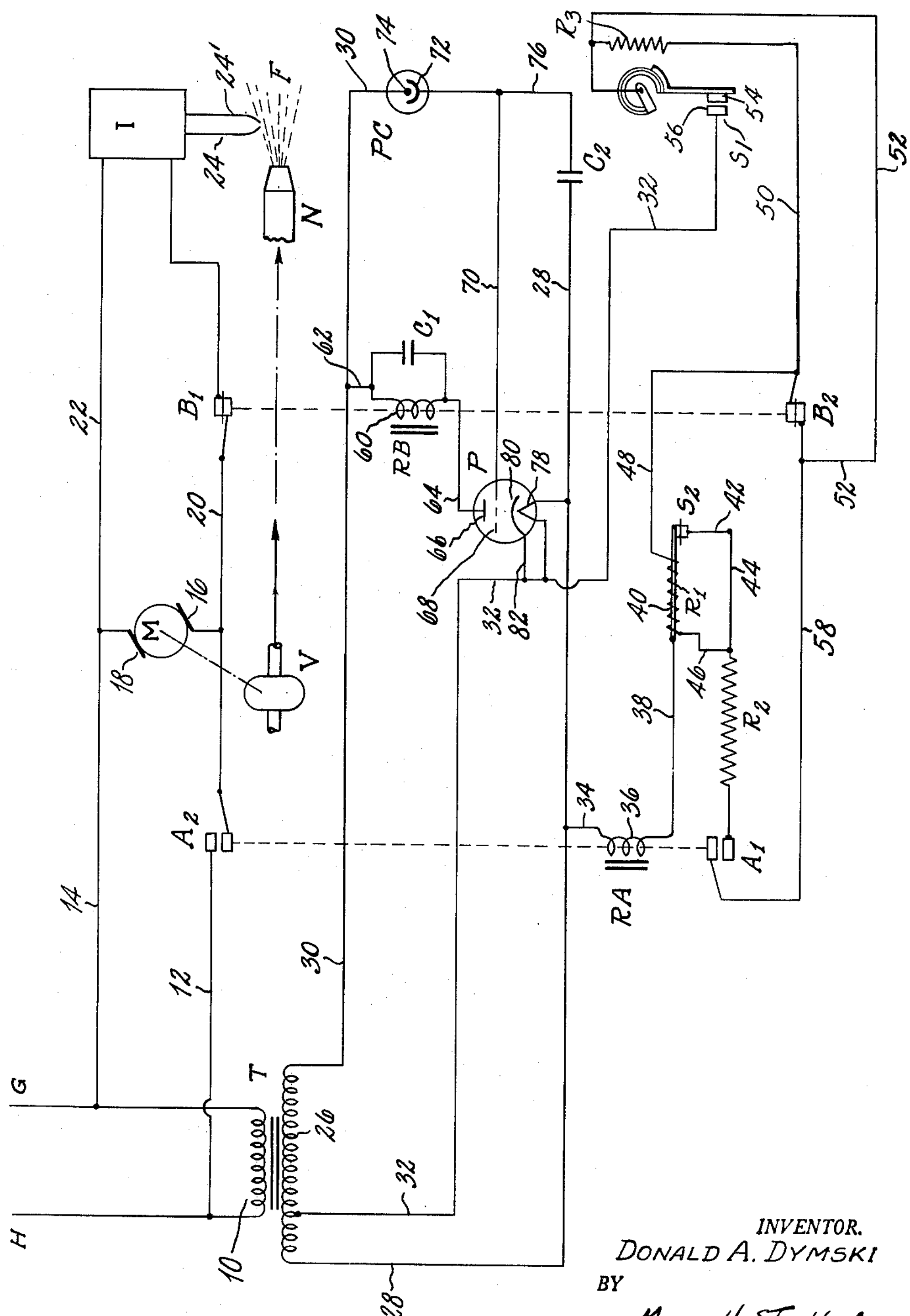

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BURNER SAFETY CONTROL SYSTEM

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This invention pertains to control systems, and more particularly to an electric control system for an intermittently operated burner.

Among my objects are the provision of a control system for an intermittently operated burner including means responsive to the light emitted from the combustion of fuel for deenergizing an ignition device, and the further provision of a control system including a low voltage room thermostat control circuit.

The aforementioned and other objects are accomplished in the present invention by providing motor operated means for controlling the delivery of combustible fuel to a nozzle where it is ignited by electrical ignition device under the control of a room thermostat. Specifically, the control system includes separate relays for controlling the operation of the fuel delivery means and the ignition device. The control system also includes a transformer, the primary of which is connected to a suitable source of alternating current, and the secondary of which is tapped to provide a low voltage circuit in which the condition responsive device, or room thermostat, is connected. When the room thermostat responds to a demand for heat, the low voltage circuit is completed, and inasmuch as the winding for the fuel delivery relay is connected in this circuit, the relay contacts are closed and fuel is delivered to the nozzle. An ignition relay winding is included in a high voltage circuit connected to the transformer secondary, energization of the ignition relay being under the control of combustion responsive, light sensing means.

The fuel delivery means and the ignition device are connected in parallel across the source of power, contacts of the motor relay and the ignition relay being arranged so that energization of the ignition relay is dependent upon closure of a pair of motor relay contacts. Accordingly, energization of the motor relay due to a demand for heat, will result in concurrent energization of the motor and the ignition device. Thus, the fuel delivered to the burner nozzle by the fuel delivery means is ignited by the ignition device. Upon the successful establishment of combustion, the light sensing means will permit the flow of current in the high voltage secondary circuit, thereby energizing the ignition relay winding to open the ignition relay contacts and deenergize the ignition device.

The control system also includes safety means for preventing the continued delivery of fuel to the nozzle if combustion is not established by the ignition device within a predetermined time period after energization of the fuel delivery means and the ignition device. The safety means comprise a thermosensitive switch connected in the low voltage secondary circuit, which switch is operable to open the low voltage secondary circuit and deenergize the fuel delivery relay if starting current flows through its heater for the predetermined time period. However, if combustion is successfully established within this time period, the opening of the ignition relay contacts will modify the low voltage circuit so as to reduce the current flow through the safety switch heater to a value insufficient to effect opening of the safety switch.

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Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing wherein a preferred embodiment of the present invention is clearly shown, and wherein the drawing represents a circuit diagram of a control system constructed according to this invention together with a schematic showing of some elements of a domestic furnace.

With particular reference to the drawing, a control system for a domestic furnace which burns fluid fuel, such as oil or gas, is depicted. In a conventional fashion the burner arrangement for the furnace includes an electric motor M for operating fuel delivery means V, which take the form of a compressor and pump in an oil burning installation, and a valve in a gas burning installation. The burner also includes an ignition transformer I which is connected to energize electrodes **24** and **24'**, the latter being placed adjacent a nozzle N in order to ignite the combustible mixture F as it passes therethrough.

The control system includes a circuit for energizing the fuel feeding device M, which circuit includes conductors **12** and **14**, contacts A2 of a relay RA, and brushes **16** and **18**. The conductors **12** and **14** are connected to lines H and G, which, in turn, are connected to a suitable source of alternating current, not shown. A circuit for the ignition device is connected in parallel with the circuit for the fuel feeding device and includes conductors **20** and **22** having connection with conductors **12** and **14** and with the ignition transformer I. The ignition circuit also includes a pair of relay contacts B1 of relay RB. The construction of relay RA is such that the contacts A2 are closed during energization thereof and open during deenergization thereof, while the opposite is true of contacts B1 of relay RB, that is, contacts B1 are closed during deenergization of relay RB and open during energization thereof.

Lines H and G also connect with a primary winding **10** of a transformer T. The transformer T in the usual manner includes a secondary winding **26**, which has an intermediate tap to provide a low voltage circuit between conductors **28** and **32**. A high voltage secondary circuit is provided between conductors **28** and **30**, which are connected to opposite ends of the secondary winding **26**.

The low voltage secondary circuit includes a condition responsive device, or room thermostat, S1, which includes a pair of cooperable elements **54** and **56**. Element **56** is connected to the conductor **32**, and element **54** is connected to a conductor **52**. The condition responsive switch S1, as shown, includes an anticipator resistor R3, one end of which is connected to the conductor **52** and the other end of which is connected by a conductor **50** to a conductor **48**. A second set of relay contacts B2 of the relay RB are situated between the conductors **48** and **52** such that when the relay RB is deenergized, the closed contacts B2 will interconnect conductors **48** and **52**, thereby shunting the resistor R3. The conductor **48** is connected to a resistor R1, which is disposed in contiguous relation to a thermostatic arm **40** of a thermosensitive switch S2. The arm **40** of the thermosensitive, or safety switch, S2 normally engages a contact **42**, which is connected to a conductor **44** having connection with a resistor R2 and a second conductor **46**, which is connected to the other end of resistor R1. Current flow of a predetermined magnitude through the resistor R1 for a predetermined period of time will cause the arm **40** to warp upwardly, as is viewed in the drawing, thereby moving the arm **40** out of contact with the element **42**. The arm **40** is connected by a conductor **38** to a winding **36** of the alternating current relay RA, which is, in turn, connected by the conductor 34 to the conductor 28. The relay RA also includes a second set of contacts A1, which connect the resistor R2 in parallel with the resistor R1 upon energization of the relay RA. One of the pair of contacts, designated by A1, is connected to a conductor 58, which has connection with conductor 52; and the other of the relay contacts, designated by A1, is connected to resistor R2.

The high voltage secondary circuit includes a suitable electric discharge device, or electronic tube, P. The electronic tube P includes a filament 78, a cathode 80, a control grid 68, and a plate element 66. The filament 78 is connected across the wires 28 and 32. Thus, the filament 78 is always energized. The cathode 80 is connected by a conductor 82 to the conductor 32 of the low voltage secondary circuit. The plate 66 is connected by a conductor 64 to one side of a relay winding 60 of the relay RB. Since the electronic tube P is a half-wave unidirectional rectifier, a suitable capacitor C1 is connected in shunt relationship with the coil 60 in order to prevent erratic vibratory action of the direct current relay RB. The other side of the winding 60 is connected by a conductor 62 to the conductor 30. The grid 68 is connected by a wire 70 to a conductor 76. One end of conductor 76 is connected to a plate of a capacitor C2, the other plate of capacitor C2 being connected to conductor 28. Inasmuch as the capacitor C2 is connected to conductor 28, while cathode 80 is connected to conductor 32, it will be apparent that upon completion of the low voltage secondary circuit the grid 68 will be at a negative potential relative to the cathode 80. The electronic tube P is of such a character that the negative potential supplied by capacitor C2 will bias the tube P to the cut-off point.

Conductor 76 also connects with a cathode 72 of a photoelectric cell PC. The photoelectric cell PC includes a plate 74, which is connected to the conductor 30. In order that the negative bias on the control grid 68 of the electronic tube P may be reduced to render the tube P conductive, the photoelectric cell PC is disposed with its cathode 72 in alignment with the flame of the fuel mixture so that the light thereof may shine on the cathode and render the photoelectric cell conductive. Thus, if the combustible mixture F is ignited, the photoelectric cell is rendered conductive and current may flow from conductor 28 through the capacitor C2 and conductor 76 to conductor 30 and back to the secondary winding 26 of the transformer. In this manner the bias on the control grid 68 of the tube P is changed to render the tube P conductive. Thereafter, current flow from the cathode 80 to the plate 66 of tube P, and through the winding 60 of the relay RB will energize this relay to open relay contacts B1 and B2.

Operation

With lines H and G connected to a suitable source of alternating current, when the room thermostat S1 responds to a demand for heat and effects contact between elements 56 and 54, the low voltage secondary circuit is completed and current will flow from the tapped secondary winding 26 through conductor 32, elements 56 and 54, conductor 52, closed contacts B2, conductor 48, resistor R1, conductors 46 and 44, engaged elements 40 and 42 of the safety switch S2, conductor 38, winding 36, and conductors 34 and 28 back to the tapped secondary winding 26. The flow of current through winding 36 will energize the relay RA and thereby close contacts A2 and A1. Closure of contacts A1 will place resistor R2 in parallel with resistor R1. Thus, the magnitude of current flow through resistor R1 will be reduced by the closing of contacts A1 inasmuch as the resistor R2 is connected in parallel therewith which reduces the total circuit resistance and increases the voltage drop across the relay winding 36. The circuit including the low voltage tap, conductor 32, closed contacts of the thermostat S1, conductors 52 and 58, contacts A1, resistor R2, conductor 44, the closed contacts of switch S2, element 40, conductor 38, coil 36 and conductors 34 and 28 constitute a holding circuit for relay RA when the resistor R3 is connected in series with the resistor R1 by the opening of contacts B2. Closure of contacts A2 will energize the motor M, thereby effecting the delivery of fuel by the device V to the nozzle N. Inasmuch as the contacts B1 and B2 of relay RB are normally closed, contacts B1 will close the ignition circuit, thereby energizing ignition transformer I. Contact B2 will provide a shunt circuit around resistor R3.

The filament 78 of tube P is always heated if the transformer is energized, placing the tube P in condition for conductance when the negative grid bias is reduced. If combustion is established within a predetermined period of time, that period of time being determined by the time constant of safety switch S2, photoelectric cell PC will be rendered conductive, thereby reducing the negative bias on control grid 68. Thus, the tube P is rendered conductive, thereby energizing winding 60 of relay RB, which, in turn, will open contacts B1 and B2. Opening of contacts B1 will deenergize the ignition device, and opening of contacts B2 will connect the resistor R3 in series with the resistor R1, thereby reducing the current flow through resistor R1 to a value insufficient to produce enough heat to warp the arm 40 out of engagement with contact 42. The holding circuit for the relay RA is completed through resistor R2 at this time.

When the room thermostat S1 is satisfied, contacts 54 and 56 will separate, thereby opening the low voltage secondary circuit and deenergizing relay RA. Deenergization of relay RA will cause contacts A1 and A2 to open, contacts A2 opening the circuit to the fuel feeding device. Accordingly, the flame caused by the combustion of the fuel mixture F will be extinguished and photoelectric cell PC will no longer be conductive, so that the capacitor C2 will again be effective to bias the tube P to the cutoff point. Thus, the control system is placed in condition for another demand for heat by the room thermostat S1.

In the event the room thermostat S1 responds to a demand for heat, thereby energizing relay RA to complete the circuits to the fuel delivery device and the ignition device, and no ignition occurs, the following sequence of events will transpire. Inasmuch as no combustion occurs, the photoelectric cell PC will not be rendered conductive and, accordingly, the tube P will remain non-conductive, and relay RB will not be energized within the predetermined time constant of the safety switch S2. Accordingly, starting current will continue to flow through the safety switch heater R1 and after the elapse of the predetermined time period, the arm 40 will warp outwardly, thereby opening the low voltage secondary circuit and deenergizing relay RA to shut down the burner. The aforegoing sequence of events will also transpire if either of tubes PC or P become faulty and fail to operate properly.

If, after combustion has been established after a demand for heat by the room thermostat S1, a power failure occurs in the supply to lines H and G, the entire control will be deenergized, thereby shutting down the unit. When power is restored, and if the thermostat S1 is still calling for heat, the control system may go into safety, as described in the preceding paragraph, if the filament 78 of tube P fails to heat up sufficiently to render tube P conductive within the predetermined time constant of the safety switch S2. However, if the filament of tube 78 heats up before the elapse of the predetermined time period, and combustion is established in the furnace, the control system will function normally.

If after combustion has once been established and tubes PC and P have been rendered conductive, thereby energizing relay RB, the following sequence of events will transpire upon flame failure. As soon as the flame is extinguished, the photoelectric cell PC will be rendered non-conductive, thereby permitting capacitor C2 to bias the tube P to the cut-off point. Accordingly, the relay

RB will be deenergized and contacts B1 and B2 will be moved to the closed position. Closure of contact B1 will result in energization of the ignition device, and if combustion is reestablished, the tubes PC and P will again be rendered conductive and energize relay RB. However, if for some reason combustion is not reestablished by the ignition device I within the time constant period of the safety switch S2, closure of contact B2 will cause the unit to go into safety, inasmuch as starting current through safety switch heater R1 will cause the arm 40 to warp out of engagement with element 42, thereby opening the low voltage secondary circuit and shutting down the unit.

From the foregoing, it is manifest that the present invention provides a control system which is extremely simple in construction and design. Moreover, the control system is so designed that in the event the electronic components fail to operate properly, the control system will go into safety. In addition the control system herein described provides a low voltage room thermostat control circuit, thereby minimizing the possibility of arcing at the switch contacts thereof.

While the embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. A control system for fluid fuel burners including in combination, a source of alternating current electric power, a transformer having a primary winding connected with said source and a secondary high voltage winding, a low voltage secondary circuit energized by a portion of said transformer secondary winding and having two branches, an electrical fuel feeding device, an electrical ignition device for the fuel, a circuit for energizing said electrical fuel feeding device, a circuit for said ignition device, a relay having an actuating coil connected in series with both branches of said low voltage circuit, said relay including a plurality of switches operated thereby, one of said relay operated switches being connected in the circuits for the fuel feeding device and the ignition device whereby when the relay is energized, the circuits to the fuel feeding and ignition devices are closed, another of said relay operated switches being connected in one branch of said low voltage circuit, first switch means in series with both branches of said low voltage circuit and responsive to a demand for heat to control the energization of said relay actuating coil, second switch means in series with both branches of said low voltage circuit, means in the other branch of said low voltage circuit for opening said second switch means to deenergize said low voltage circuit if starting current flows through said other branch for a predetermined time interval after said first switch means closes in response to a demand for heat, a resistor in said one branch of the low voltage circuit, said relay actuating coil, when energized, energizing said one branch to establish a holding circuit for said relay through said first and second switch means, said resistor, and the other relay operated switch, third switch means in the other branch of said low voltage circuit, a resistor shunting said third switch means, and means including said high voltage winding for opening said third switch means so as to insert said resistor in said other branch and thereby reduce the current flow through said other branch upon the successful establishment of combustion within said predetermined time interval.

2. A control system for fluid fuel burners including in combination, a source of alternating current electric power, a transformer having a primary winding connected with said source and a secondary high voltage winding, a low voltage secondary circuit energized by a portion of said transformer secondary winding and having two branches, an electrical fuel feeding device, an electrical ignition device for the fuel, a circuit for energizing said electrical fuel feeding device, a circuit for said ignition device, a relay having an actuating coil connected in series with both branches of said low voltage circuit, said relay including a plurality of switches operated thereby, one of said relay operated switches being connected in the circuits for the fuel feeding device and the ignition device whereby when the relay is energized, the circuits to the fuel feeding and ignition devices are closed, another of said relay operated switches being connected in one branch of said low voltage circuit, room thermostat actuated switch means in series with both branches of said low voltage circuit and responsive to a demand for heat to control the energization of said relay actuating coil, safety switch means in series with both branches of said low voltage circuit, means in the other branch of said low voltage circuit for opening said safety switch means to deenergize the low voltage circuit if starting current flows through said other branch for a predetermined time interval after said room thermostat actuated switch means closes in response to a demand for heat, a resistor in said one branch, said relay actuating coil, when energized, energizing said one branch to establish a holding circuit for said relay through said room thermostat actuated switch means, said safety switch means, said resistor, and said other relay operated switch, combustion responsive switch means in said other branch of the low voltage circuit, an anticipating resistor for said room thermostat shunting said combustion responsive switch means, and means including said high voltage winding for opening said combustion responsive switch means so as to insert said anticipating resistor and reduce the current flow through said other branch upon the successful establishment of combustion within said predetermined time interval.

References Cited in the file of this patent

UNITED STATES PATENTS

2,086,823	Shaw	July 13, 1937
2,102,091	Persons	Dec. 14, 1937
2,175,720	Miller	Oct. 10, 1939
2,243,200	Fisher	May 27, 1941
2,448,504	Beam	Aug. 31, 1948
2,681,101	Mosely	June 15, 1954