

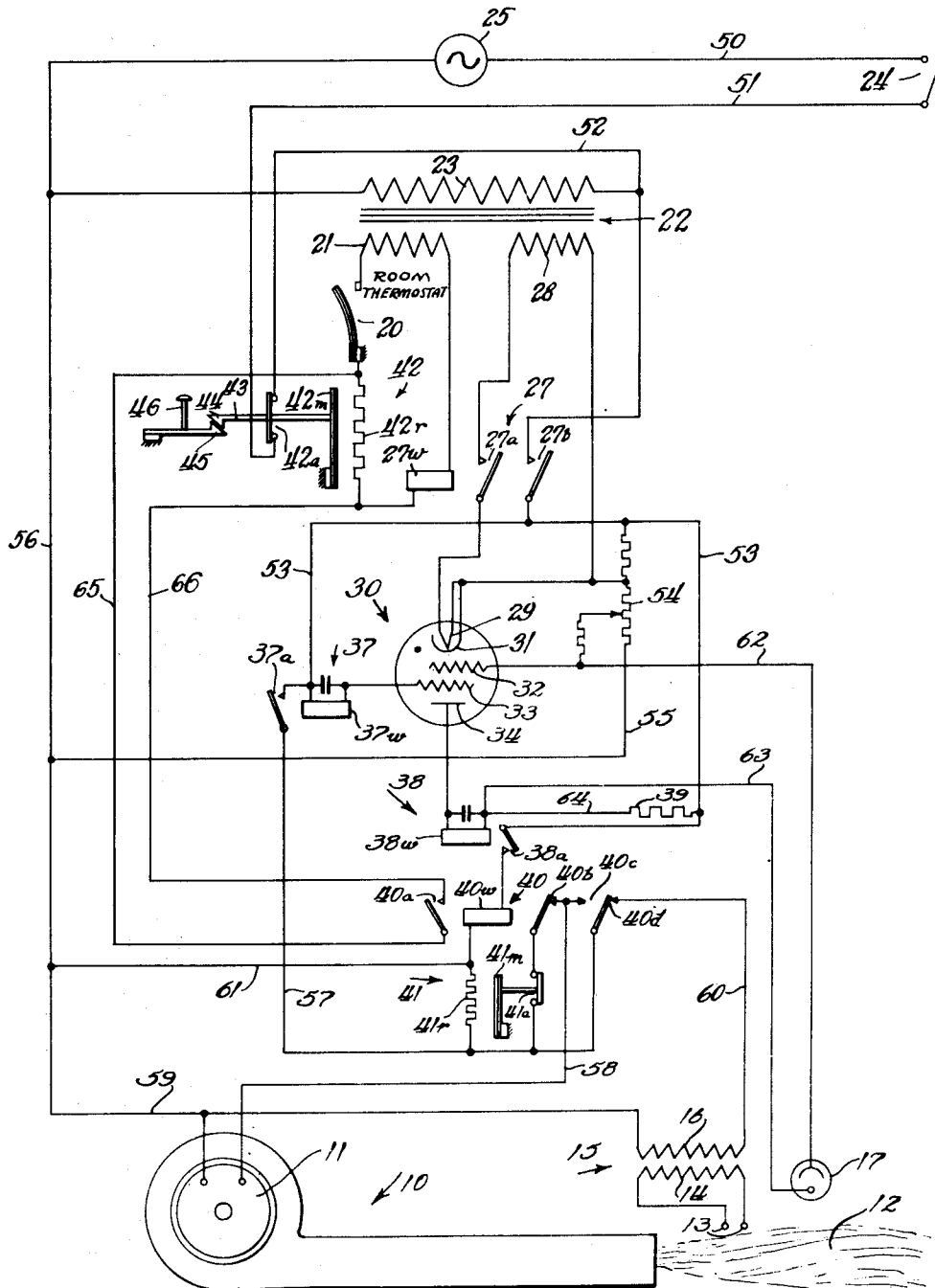
Feb. 24, 1942.

W. F. SCANLAN

2,274,384

CONTROL SYSTEM

Filed March 26, 1941



Inventor:
Warren F. Scanlan
By Brown, Jackson, Battelle & Quincy
Attys.

UNITED STATES PATENT OFFICE

2,274,384

CONTROL SYSTEM

Warren F. Scanlan, Chicago, Ill., assignor to
Charles P. Peirce, Chicago, Ill.

Application March 26, 1941, Serial No. 385,226

4 Claims. (Cl. 158—28)

My invention relates, generally, to electric control systems and it has particular relation to burner control systems in which a burner in heating apparatus is initiated in operation and is controlled.

My invention is intended for use in controlling liquid fuel burners, commonly known as oil burners, vapor type burners and also gas type burners. The present invention will be described particularly in conjunction with an oil burner, but it will be understood that it can be used with other types of burners.

In the prior art of burner control a series of relays was used together with mercury switches and various thermal units. Because of the characteristics and dependency of thermal metals on changing temperature, instantaneous control was not feasible due to the fact that these metals require for their actuation substantial changes in temperature, and, therefore, they are subject to considerable time delay. In many instances this time delay is variable and often extends over a period of several minutes. Even with the finest adjustments that are allowable a five second time delay is required before the control can become effective.

In burner control systems of the prior art employing light sensitive cells or photo cells for detecting the presence or absence of flame on the burner there has been the serious objection that if the photo cell circuit becomes short circuited fuel continues to be supplied to the burner even though the flame may have been extinguished. One of the objects of my invention is to prevent the further supply of fuel to a burner in the event that the photo cell circuit becomes short circuited.

Another object of my invention is to permit the supply of fuel to a burner on which the flame burns intermittently for a predetermined interval and which will prevent the further supply of fuel to the burner if the intermittent operation of the flame does not cease before the end of the interval.

A further object of my invention is to provide for locking out a burner control system in the event that the flame is not established a predetermined time after a cycle of operations intended to result in establishment of the flame is initiated.

A still further object of my invention is to provide for locking out the burner control system if the electric valve employed in the system fails or is removed, if the photo cell control circuit therefor becomes short circuited or if

the flame burns intermittently for a predetermined interval as above set forth.

Other objects of my invention will, in part, be obvious and in part appear hereinafter.

For a more complete understanding of the nature and scope of my invention reference can be had to the following detailed description taken in connection with the accompanying drawing in which the single figure illustrates diagrammatically a concrete embodiment of my invention.

Referring now particularly to the drawing it will be observed that the reference character 10 designates, generally, a unit which may include an electro-responsive device or motor 11. The particular burner unit 10 illustrated diagrammatically is one of the oil type but it will be understood that the present invention is not limited to this particular type of burner. The motor 11, as is well known, forces the oil through the guns and nozzles of the burner. In a gas type of burner the electro-responsive means might be in the form of a solenoid operated valve or other similar means. The fuel is supplied from the burner 10 for combustion in a flame as indicated at 12. For igniting the flame igniter electrodes 13 are provided which are connected across a high voltage winding 14 of a transformer, shown generally at 15, having a primary winding 16 that is arranged to be energized as will be hereinafter set forth.

If the burner had been one of the gas type there would be provision for a pilot flame for igniting the gas from the burner. In such case it would be unnecessary to supply the igniter electrodes 13.

In order to detect the presence or absence of the flame 12 a light sensitive device or photo cell 17 is provided in such position that the light rays from the flame 12 can impinge thereon. As will be hereinafter set forth, the photo cell 17 is employed for controlling the functioning of the electro-responsive device 11.

The control of the burner system is initiated by a room thermostat indicated at 20. It will be understood that the room thermostat 20 will be located in a position which fairly represents the temperature of the space that is to be heated by the burner 10. It may be of various types. For convenience a room thermostat of the bimetallic type is illustrated but it will be understood that other types of similar control devices can also be employed.

The room thermostat 20 is arranged to complete the energization of a control circuit from

a secondary winding 21 of a transformer, shown generally at 22. The transformer 22 comprises a primary winding 23 which is connected through a manually operable switch 24 for energization to a suitable source 25 of alternating current, such as a 60 cycle, 110 volt source.

The operation of the room thermostat 20 at a predetermined temperature is intended to effect the energization of an operating winding 27w of a tube control relay designated generally at 27. The relay 27 includes normally open contact members 27a and 27b which are arranged to be closed on energization of the winding 27w.

The closure of contact members 27a completes a circuit from a secondary winding 28 of the transformer 22 for energizing a filament 29 of an electric valve, shown generally at 30, of the gas filled type having an indirectly heated cathode 31. The valve 30 also includes a control grid 32, a screen grid 33 and an anode 34.

The closure of contact members 27b completes a circuit through a winding 37w of a start relay, shown generally at 37, to the screen grid 33. The start relay 37 is provided with normally open contact members 37a.

Connected in series circuit relation with the anode 34 is a winding 38w of an auxiliary control relay, shown generally at 38. The auxiliary control relay has normally open contact members 38a. A resistor 39 is connected in series circuit relation with the winding 38w for a purpose which will be described hereinafter.

The closure of contact members 38a of the auxiliary control relay 38 completes a circuit for energizing a winding 40w of a main control relay, illustrated generally at 40. The main control relay 40 includes normally open contact members 40a and normally closed contact members 40b. It also includes normally open contact members 40c and normally closed contact members 40d.

A time delay relay, shown generally at 41, is provided for taking care of certain intermittent operation of the flame 12. This relay is of the thermal type and it includes a heater element 41r, a bimetallic element 41m and normally closed contact members 41a. The heater element 41r is energized on closure of the contact members 37a of the start relay 37 and it is arranged so that a predetermined time interval, such as one minute, elapses before the contact members 41a are opened.

With a view to locking out the system under certain fault conditions a lock out time delay relay, shown generally at 42, is provided. This relay comprises a heater element 42r and a bimetallic element 42m together with normally closed contact members 42a. The contact members 42a are connected in series circuit relation with the source 25 so that, when they are opened, the entire system is deenergized. An extension 43 is provided for the contact members 42a which has a hook portion 44 that is arranged to interfit with a hook portion 45 that is stationarily mounted. A manually operable button 46 is provided for releasing the hook portion 44. It will be understood that once contact members 42a are opened, they are locked in the open position and that the manually operable push button 46 must be operated in order to permit reclosure of the contact members 42a. If desired the push button can be so mounted as to be inaccessible except to an authorized person who, before resetting the lock out time delay relay 42 would inspect the entire system to see that it is in proper con-

dition for resuming operation. The particular lock out mechanism shown is merely for illustrative purposes since it will be obvious that any suitable lock out mechanism can be employed for effecting the lock out function as previously set forth.

In describing the operation of the system shown in the drawing it will first be assumed that the contact members 42a of the lock out time delay relay are closed and that the room thermostat 20 is in the open circuit position. It will also be assumed that the manual control switch 24 is closed. Under these conditions the primary winding 23 of the transformer 22 is energized through the closed contact members 42a and the switch 24 from the source 25.

When the room thermostat is subjected to a predetermined temperature it will close and complete an obvious circuit for energizing the winding 27w of the tube control relay 27. The energizing current will also flow through the heater element 42r of the lock out time delay relay 42. This relay may be adjusted so that its contact members 42a will be opened only after the heater element 42r has been energized for a predetermined interval, such as one half minute. During this period certain control functions are completed which, if the system operates as intended, render the heater element 42r ineffective to open contact members 42a.

The energization of winding 27w of the tube control relay 27 closes contact members 27a to complete an obvious energizing circuit for the filament 29 of the electric valve 30. Contact members 27b are closed to complete a circuit through the winding 37w of the start relay 37 to the screen grid 33.

A predetermined time, for example five seconds, after the contact members 27a and 27b are closed, sufficient current flows between the cathode 31 and the screen grid 33 to energize winding 37w of the start relay 37 and close its contact members 37a.

The circuit for energizing the winding 37 can be traced from the source 25 through conductor 50, switch 24, conductor 51, normally closed contact members 42a, conductor 52, contact members 27b, conductor 53, winding 37w, screen grid 33, cathode 31, resistor 54, and conductors 55 and 56 back to the source 25.

The closure of contact members 37a of the start relay 37 completes circuit for energizing the electro-responsive device 11 and also the primary winding 16 of the transformer 15 for energizing the igniter electrodes 13. The burner unit 10 then is initiated in operation and, as soon as the fuel is discharged, it is ignited to form the flame 12.

The circuit for energizing the electro-responsive device 11 can be traced from the conductor 53, previously described as being energized, through contact members 37a, conductor 57, normally closed contact members 41a, normally closed contact members 40b, conductor 58, electro-responsive device 11, and conductors 59 and 56 back to the source 25. The circuit for energizing the primary winding 16 extends from the conductor 57 through normally closed contact members 40d, conductor 60, primary winding 16 and conductors 59 and 56 back to the source 25.

The closure of contact members 37a also effects the energization of heater element 41r of the time delay relay 41. This circuit extends from the conductor 53, previously described as energized, through heater element 41r and con-

ductors 61 and 66 to the source 25. The contact members 41a are delayed in opening for a time interval depending upon the adjustment of the relay. As previously described, this time interval may be one minute.

As soon as the flame 12 appears light rays from it impinge on the photo cell 17. It will be observed that the photo cell 17 is connected by conductors 62 and 63 for controlling the energization of the electric valve 30. It is connected by conductor 62 to control grid 32. By conductor 63 it is connected to the common connection 64 between the winding 38w and the resistor 39. The purpose of this arrangement will be presently set forth. As soon as the electric valve 30 is rendered conducting, winding 38w of the auxiliary relay 38 is energized and its contact members 38a are closed.

The circuit for energizing the winding 38w can be traced from the conductor 63, previously described as energized, through resistor 39, winding 38w, anode 34, cathode 31, resistor 54 and conductors 55 and 56 to the source 25.

Closure of contact members 38a completes an obvious energizing circuit for the operating winding 40w of the main control relay 40. Contact members 40d are opened and the transformer 18 is deenergized since it is no longer necessary to maintain the igniter electrodes 13 energized. Contact members 40b are opened and the previously traced energizing circuit for the electro-responsive device 11 is opened. However, the energizing circuit for the electro-responsive device 11 is completed through contact members 40c which are now closed and the electro-responsive device 11 is transferred from the standby to running condition.

The continued energization of the heater element 41r of the time delay relay 41 will effect the opening of contact members 41a. However, it is no longer necessary to maintain the circuit through these contact members for energizing the electro-responsive device 11 under normal operating conditions and hence no functioning takes place at this time as a result of opening of these contact members.

It will be observed that contact members 40a, which are closed on energization of the winding 40w, are connected by conductors 65 and 66 to shunt the heater element 42r of the time delay lock out relay 42. Since this element is shunted in this manner it is ineffective to cause movement of the bimetallic element 42m and opening of the contact members 42a.

When sufficient heat has been applied to cause the room thermostat 20 to be moved to the open position, operating winding 27w of the tube relay 27 will be deenergized, resulting in a deenergization of the start relay 37 and the electric valve 30. This further results in the deenergization of the windings 38w and 40w of the auxiliary and main control relays 38 and 40 and subsequently the deenergization of the electro-responsive device 11. The system is then ready to perform the cycle of operations just described when the room thermostat 20 again calls for heat.

It may happen that the oil supply for the burner 10 may become exhausted. When this occurs air is introduced into the fuel lines as well as sediment and other foreign substances. When the fuel supply is replenished, due to the fact that air is present in the fuel line and also due to the possibility that there may be some sediment therein or because of cold weather the fuel may not flow readily, there may be some

intermittent or stuttering operation of the flame 12 on initiation of the foregoing described cycle of operations. It is desirable that the system be permitted to operate for a short period of time under these conditions so that, if they automatically right themselves, the system can continue to function in the intended manner. However, if the condition tends to persist, of course the system should be rendered inoperative.

It will be recalled that, as soon as light from the flame 12 impinges on the photo cell 17, the electric valve 30 is rendered conducting and subsequently main control relay 40 is operated. As soon as the flame 12 disappears, the electric valve 30 is no longer conducting and the main control relay 40 is deenergized. The circuit for energizing the electro-responsive device 11 then extends through the contact members 41a of the time delay relay 41, as previously described. If the stuttering of the flame 12 continues for a time longer than the time for which the relay 41 is set, for example one minute, then at the expiration of this interval contact members 41a are opened and when the main control relay 40 is deenergized, no energizing circuit for the electro-responsive device 11 is completed. Consequently, the electro-responsive device 11 is deenergized and fuel is no longer supplied to the burner.

While the main control relay 40 has been intermittently operated in accordance with the presence or absence of the flame 12, its contact members 40a have been intermittently short circuiting the heater element 42r of the time delay lock out relay 42. During the period required for effecting the opening of contact members 41a of time delay relay 41 the heater element 42r will be intermittently energized but not sufficiently to effect operation of the bimetallic element 42m and opening of contact members 42a. When the main control relay 40 is finally deenergized because of the absence of the flame 12, the heater element 42r is energized for a time sufficiently long to cause the bimetallic element 42m to open contact members 42a and operate the hook member 44 to the lock out position where a manual operation is required in order to restore the system to operative condition.

It is important to note that, if the conductors 62 and 63 which form the circuit interconnecting the electric valve 30 and the photo cell 17 are short circuited, relay 38 will be deenergized since the energizing current which previously flowed through the resistor 39 and operating winding 38w will then flow directly to the control grid 32 and not through the operating winding 38w. Main control relay 40 will then be deenergized and consequently the electro-responsive device 11 will be deenergized. The system will then be locked out as soon as heater element 42r has been heated sufficiently to effect operation of the bimetallic element 42m to open contact members 42a. If the conductors 62 and 63 are short circuited while the room thermostat 20 is in the open circuit position nothing will happen. However, as soon as room thermostat 20 calls for heat the heater element 42r will be energized and, since main control relay 40 under these assumed conditions cannot be energized, the bimetallic element 42m will be operated to open contact members 42a and lock out the system.

Of course if the electric valve 30 is removed or if it fails to function it is not possible to effect

energization of the auxiliary control relay 38. Likewise it is not possible to effect the energization of the main control relay 40 and, if the room thermostat 20 should call for heat under these conditions, the system would be properly locked out.

Since certain further changes can be made in the foregoing system and different embodiments of the invention can be made without departing from the scope thereof, it is intended that all matter shown in the accompanying drawing and described hereinbefore shall be interpreted as illustrative and not in a limiting sense.

I claim as my invention:

1. A burner control system comprising, in combination, temperature responsive means; an electric valve including a cathode, a control grid, a screen grid and an anode; means controlled by said temperature responsive means for energizing said cathode on the occurrence of a predetermined temperature, electro-responsive means for controlling the supply of fuel to the burner, a start relay having an operating winding connected for energization to said screen grid and contact members disposed to be closed on energization of its winding, circuit means connecting said electro-responsive means for energization to a current source on closure of said contact members, means connected to said control grid for rendering said electric valve conducting as long as there is a flame on said burner, a main control relay having an operating winding connected to be energized as long as said electric valve is conducting and one set of contact members disposed to be opened and another set of contact members disposed to be closed on energization of its operating winding, said sets of contact members being connected in parallel circuit relation with each other and in series circuit relation with said circuit means, and time delay means including normally closed contact members connected in series circuit relation with said one set of contact members and adapted to be opened a predetermined interval after the operating winding of said start relay is energized for thereafter preventing energization of said electro-responsive means when the flame on said burner intermittently appears beyond a limited extent during said predetermined interval.

2. A burner control system comprising, in combination, temperature responsive means; an electric valve including a cathode, a control grid, a screen grid and an anode; means controlled by said temperature responsive means for energizing said cathode on the occurrence of a predetermined temperature, electro-responsive means for controlling the supply of fuel to the burner, a start relay having an operating winding connected for energization to said screen grid and contact members disposed to be closed on energization of its winding, circuit means connecting said electro-responsive means for energization to a current source on closure of said contact members, means connected to said control grid for rendering said electric valve conducting as long as there is a flame on said burner, a main control relay having an operating winding connected to be energized as long as said electric valve is conducting and one set of contact members disposed to be opened and another set of contact members disposed to be closed on energization of its operating winding, said sets of contact members being connected in parallel circuit relation with each other and in series circuit relation with said circuit means, time delay means

including normally closed contact members connected in series circuit relation with said one set of contact members and adapted to be opened a predetermined interval after the operating winding of said start relay is energized for thereafter preventing energization of said electro-responsive means when the flame on said burner intermittently appears beyond a limited extent during said predetermined interval, and time delay lock out means initiated in operation by said temperature responsive means and adapted to be rendered ineffective by said main control relay on operation thereof for preventing subsequent control of the system by said temperature responsive means in the event that said time delay lock out means is not rendered ineffective during a predetermined interval after operation of said temperature responsive means.

3. In a burner control system, in combination, temperature responsive means; an electric valve including a cathode, a control grid, a screen grid and an anode; means controlled by said temperature responsive means for energizing said cathode on the occurrence of a predetermined temperature, electro-responsive means for controlling the supply of fuel to the burner, a start relay having an operating winding connected for energization to said screen grid when said cathode reaches a predetermined operating condition and contact members disposed to be closed on energization of said winding for initially connecting said electro-responsive means for energization to a current source, control relay means for maintaining said electro-responsive means in energized operating condition, a resistor, circuit means connecting said control relay means for energization to said anode and through said resistor to a current source, a light sensitive device located so that light from the flame of said burner impinges thereon and connected between said control grid and the common connection between said control relay means and said resistor for maintaining said valve conducting as long as the flame persists, short circuiting of said light sensitive device effecting deenergization of said control relay means and of said electro-responsive means, and time delay means initiated in operation by said start relay for preventing subsequent initiation of the operation of said electro-responsive means by said start relay when the flame on said burner intermittently appears beyond a limited extent during a predetermined interval after operation of said start relay.

4. In a burner control system, in combination, temperature responsive means; an electric valve including a cathode, a control grid, a screen grid and an anode; means controlled by said temperature responsive means for energizing said cathode on the occurrence of a predetermined temperature, electro-responsive means for controlling the supply of fuel to the burner, a start relay having an operating winding connected for energization to said screen grid when said cathode reaches a predetermined operating condition and contact members disposed to be closed on energization of said winding for initially connecting said electro-responsive means for energization to a current source, control relay means for maintaining said electro-responsive means in energized operating condition, a resistor, circuit means connecting said control relay means for energization to said anode and through said resistor to a current source, a light sensitive device located so that light from the flame of said burner impinges thereon and connected between said control grid

and the common connection between said control relay means and said resistor for maintaining said valve conducting as long as the flame persists, short circuiting of said light sensitive device effecting deenergization of said control relay means and of said electro-responsive means, time delay means initiated in operation by said start relay for preventing subsequent initiation of the operation of said electro-responsive means by said start relay when the flame on said burner intermittently appears beyond a limited extent during a predetermined interval after operation of said start relay, and time delay lock out means initiated in operation by said temperature responsive means and adapted to be rendered ineffective by said control relay means on operation thereof for preventing subsequent control of the system by said temperature responsive means in the event that said time delay lock out means is not rendered ineffective during a predetermined interval after operation of said temperature responsive means.

WARREN F. SCANLAN.