June 5, 1934. D. G. TAYLOR 1,961,802

BURNER CONTROLLING APPARATUS

Filed May 8, 1930

Fig. 1

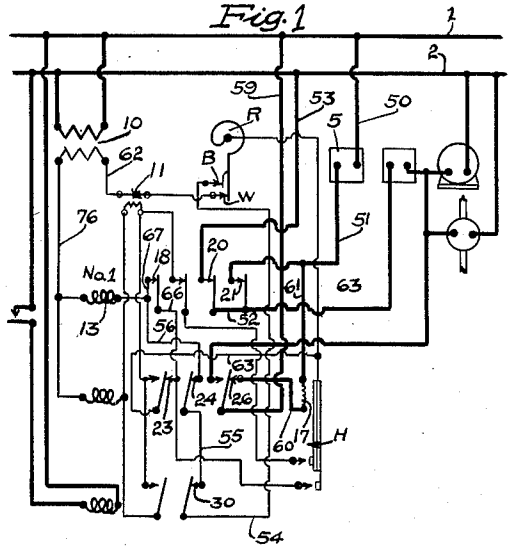


Fig. 2

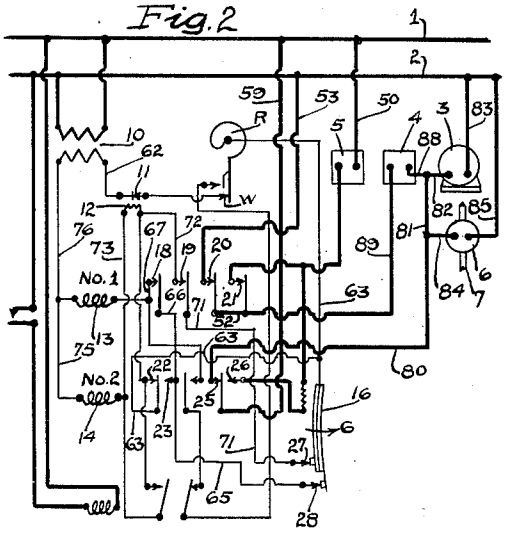


Fig. 3

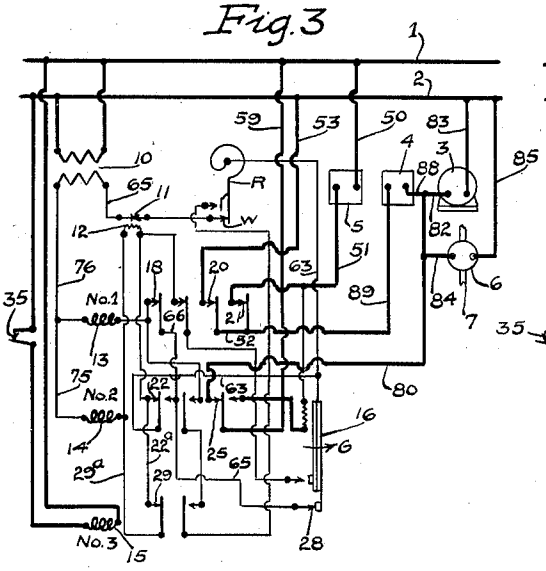
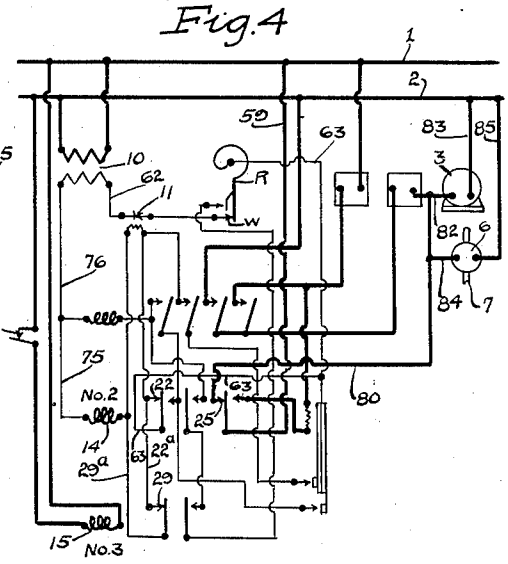


Fig. 4



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BURNER CONTROLLING APPARATUS

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7 Claims. (Cl. 158—28)

This invention relates to improvements in oil burners, and is adapted and provides means for the complete safety control of oil burners, and provides means for initiating and timing two ignition periods, one before and one after burner motor activation. The timing periods depend upon the particular type of burner to which the control is attached. In the present device, when the thermostat closes its contact, the burner motor is not started immediately but a definite interval elapses between the closure of the room thermostat and the starting of the motor. At the beginning of this period ignition is furnished, and at the end of this period the burner motor starts, and ignition is continued for a predetermined period, at the end of which period, the ignition circuit is rendered inoperative, and the burner motor operation, as well as fuel feed, continues and combustion is sustained without continued ignition. When the thermostat opens its contact, the burner and fuel supply is rendered inoperative and cannot be again operated until a certain burner flame responsive switch has cooled sufficiently to open its contact.

Features of the invention include all details of arrangement, along with the methods disclosed. Features, as well as advantages, will be pointed out in the description of the drawing.

The invention has been illustrated by a series of diagrams respectively showing successive positions of the parts, as during a normal expected operation, in which ignition is successful.

Figure 1 shows the condition of the apparatus after the room thermostat has closed on a call for heat, with the pre-ignition means and coil of the time switch energized as the result of such closure;

Figure 2 shows the condition of the apparatus, at the end of some predetermined time after energization of the time switch coil, with both ignition means operative as well as the motor and fuel supply means;

Figure 3 shows the condition of the apparatus at the end of a predetermined time, after heat supply to the time switch coil has been discontinued and after flame has been produced at the burner; and

Figure 4 shows the condition of the apparatus at the end of a predetermined time after the time switch coil has been de-energized, with the ignition means rendered inoperative, but with motor and fuel supply maintained.

For the purpose of clearness, such terms as relay, thermal safety switch, time switch, pre-ignition apparatus, post-ignition apparatus, motor, oil valve, flame responsive device, etc., have been used, but it will be understood that other mechanical and/or electrical devices which are equivalent of those named may be used and substituted without changing the principle of operation.

The form of device as shown herein for illustrating the principle of the invention includes main lines 1 and 2, a transformer 10 including the primary, and a secondary winding, along with suitable circuit connections between the primary and lines 1 and 2. To avoid confusion the reference numerals are applied in the various figures only to those parts which are active at the particular stage in the cycle as represented by the particular figure. Additional elements are: a burner motor 3, post ignition means 4, such as a spark, pre-ignition means 5 such as a glow bar, and a fuel supply control means 6. for fuel supply pipe 7. The ignition means may be a single device which is adapted to remain energized for a predetermined time after motor energization. The foregoing parts may be considered the main parts of the fuel burning apparatus herein.

The circuit arrangement of each figure is identical with that of every other, only the positions of the relays and contacts differ. The numerals have, to avoid confusing multiplication, been applied in any figure only to the active parts of the circuit, but any missing numeral can be easily found by reference to another figure (see description of operation).

The foregoing parts may be considered the main parts of a fuel burning apparatus. In addition, there is employed a room thermostat including the elements R—B—W; a thermal safety switch including a switch 11 and a coil 12 adapted to be electrically heated and adapted to cause opening of the switch at the end of a predetermined heating period; a thermally operable time switch including the thermally sensitive switch element 16, and coil 17 adapted to be electrically heated. This time switch is adapted to close at the end of a predetermined heating period. In addition, there is employed a burner flame responsive switch 35 adapted to close on production of flame at the burner, which switch includes a heat sensitive element. In addition, three relays or equivalent devices, are employed respectively referred to as relay No. 1, No. 2 and No. 3. Relay No. 1 when closed as the result of the closure of a room thermostat is (see Figure 1) adapted to activate the pre-ignition means and to cause a supply of heat to be delivered to coil

17 of the time switch. Relay No. 2 when energized as result of closure of the time switch is adapted to (see Figure 2) cause heat supply to the coil 17 of the time switch to be discontinued, and is further adapted to initiate operation of the motor and fuel control means in a manner to cause delivery of fuel, to also cause energization of the coil 12 of the thermal safety switch, and to energize a separate ignition means or to maintain operation of the same ignition means for a predetermined timed period while the motor is operating and fuel is being delivered. Relay No. 3 is adapted to close as the result of production of flame at the burner, and when closed is adapted (see Figure 3) to shunt out the coil 12 of the thermal safety switch and, therefore, render this coil inactive, and to establish a holding circuit for relay No. 2 which is operative after the time switch has cooled sufficiently to open its contact. This relay No. 3, when closing also breaks a starting circuit to relay No. 1 whereby as long as relay No. 3 is closed, relay No. 1 cannot be re-energized if, in the meantime, it has for any reason been de-energized. At the end of a cooling period of the time switch, (see Figure 4) the circuit controlling relay No. 1 is de-energized and ignition is discontinued, while burner and fuel supply operation is continued, until a call for less heat by the room thermostat. More detailed numerical reference to the parts will be found in the description of the operation.

Operation

The normal expected operation of the device is as follows (referring to Figure 1): Suppose a call for heat at the room thermostat R and closure of contacts B—W. If the apparatus is in proper operating condition this will result in energization of coil 13 of relay No. 1 through the following circuit: One side of the secondary of the transformer, contact 11 of the thermal safety switch, W—B of the room thermostat conductor 54, contact 30 of open relay No. 3, conductor 55, contact 24 of open relay No. 2, conductor 56, coil 13 of relay No. 1, conductor 76, to the opposite side of the secondary of the transformer. The energization of coil 13 closes the contacts 18, 19, 20 and 21. Closed contact 18 of relay No. 1 and contact 23 of relay No. 2 establish a holding circuit for relay No. 1 prior to the closing of contact 28 of the time switch 16. This circuit is as follows: One side of the secondary of the transformer, contact 11, W—R of the room thermostat, conductor 63, contact 23 of relay No. 2, conductor 66, contact 18 of relay No. 1, conductor 67 coil 13, conductor 76 to the other side of the secondary of the transformer. The closure of contacts 20 and 21 results in energization of the pre-ignition means or glow bar 5 through the following circuit: from hot line 1, conductor 50, pre-ignition means 5, conductor 51, contact 21, conductor 52, contact 20, conductor 53 to ground line 2. At this time, the coil 17 of the time switch 16 is also energized through the following circuit: hot line 1, conductor 59, contact 26 of relay No. 2, conductor 60, heating element 17 of the time switch, conductor 61, contact 21, conductor 52, contact 20, conductor 53 to ground line 2.

The pre-ignition timing period now begins and element 16 of the time switch is deflected (see Figure 1) and moves in direction of the arrow H. Holding contact 28 (see Fig. 2) first closes and then contact 27. The length of time required for element 16 to move from its initial position to its closed position is the measure of the pre-ignition period. On making at 27 energization of coil 14 of relay No. 2 through the following circuit results: One side of the secondary 10 of the transformer, contact 11 of the thermal safety switch, W, R, conductor 63, element 16 contact 27, conductor 71, contact 19 of relay No. 1, conductor 72, heating coil 12 of the thermal safety switch, conductor 73, coil 14 of relay No. 2, conductors 75, 76 to the other side of the transformer. The holding circuit for No. 1 relay which was established for relay No. 1 before closure of contact 27, is as follows: one side of the secondary 10 of the transformer, 62, contact 11, W, R, 63, 16, 28, 65, 66, 18, 67, coil 13 of relay No. 1, 76 to transformer. This shunt circuit around contact 23 is established before the energization of relay No. 2 and opening of contact 23. On closure relay No. 2 establishes its own holding circuit in the following manner: one side of the secondary 10, 62, contact 11, W, R, 63, contact 22 of relay No. 2, coil 12 of the thermal safety switch, 73, coil 14 of relay No. 2, 75, 76 to transformer. Thus at this stage and at the end of the pre-ignition period, the heating element 12 of the safety switch 11 is energized.

When relay No. 2 closes, current to the heating coil 17 of the time switch is interrupted by opening of contact 26, and element 16 of the time switch begins to cool, and move in direction of arrow G, to open its contacts at the end of a predetermined cooling period. The thermal safety switch has now begun its post-ignition timing cycle at the end of which, if flame is not produced, the apparatus will be rendered inoperative by the opening of contact 11. By closure of relay No. 2, ignition means 4 is started as is also the motor 3. The post-ignition and motor circuits are now completed as follows: line 1, 59, contact 25, 80, 81, 82, one side of the motor 3, opposite side of the motor, 83, to line 2. The fuel control valve 9 is also energized and the circuit can be traced from contact 25, 80, 84, 6, 85, to line 2. The ignition circuit is traced from line 1, 59, contact 25, 80, 81, 88, 4, 89, 52, contact 20, 53 to line 2. The glow bar 5 is at this time also operative.

Under normal conditions, ignition will take place before the thermal safety switch opens its contact 11. Assuming this normal operation the flame of the burner will cause contact 35 of the flame responsive device to close (see Figure 3), which will result in energization of coil 15 of relay No. 3, and closure of contact 29 to provide a shunt circuit around the heating element 12 of the thermal safety switch 11, thus permitting its thermal element to cool and assume its initial position. At the same time, the starting circuit for relay No. 1 is broken by the opening of contact 30 and if, for any reason, contact 35 of the flame responsive device should stick, relay 3 would remain closed or energized and contact 30 would remain open so that no restart of the apparatus could be had, (see Figure 1) because this contact must be closed before relay No. 1 can be energized. All three relays are now closed, and contact 28 maintains a holding circuit for relay No. 1.

The burner has now been properly ignited, and is otherwise properly operating to deliver heat. When contact 28 of the time switch opens (see Figure 4) due to cooling motion of the thermal element of the time switch, relay No. 1 is de-energized, and the ignition circuit is, or the ignition circuits are, opened, but the motor and

fuel control circuits remain energized through contact 25 of relay No. 2, this relay No. 2 being held closed through the following circuit: from one side of the secondary of the transformer, 62, contact 11, W, R, 63, 22, 22a, contact 29 of relay No. 3, 29a, coil 14, 75, 76 to opposite side of the transformer. The burner is now in normal operation and on call for less heat, would result in opening of contact R—W, at which time relay No. 2 drops out, opening contact 25, thus breaking the circuit to the motor and fuel control means.

Let it be assumed that ignition is not successful, after relays No. 1 and 2 have been energized, and that contact 11 opens before ignition takes place. Under these conditions, relays 1 and 2 will open and the system will become inoperative, and cannot be again started because contact 11 remains open; manual closure of this contact being necessary to establish a circuit through any element receiving power from the secondary of the transformer 10.

It will be noted that both heating and cooling motions of the thermal element 16 of the time switch are utilized; that is, motions in two different directions, in one direction to time the pre-ignition period, and in another direction to time the post-ignition period. This is one of the important features of this invention, that is, the utilization of the cooling and heating movements in a system wherein timed ignition periods are required both before and after fuel feed is begun. Although in the illustrated embodiment of the invention the heating motion is utilized for timing the pre-ignition period and the cooling motion for timing the post-ignition period, it will be understood that there is no intention to be limited in this regard because the gist of this feature is the utilization of different motions of the thermal element or its equivalent to respectively time different ignition periods.

This device finds valuable application in a type of burner known as the vertical shaft rotary cup type, which is a difficult type in which to ignite the oil by an electric spark alone, because the flame is thin and is spread out, and is difficult to get vaporization of the fuel in absence of preheating. The activation of the igniter for a timed period before feeding fuel is particularly desirable when ignition means of the hot wire or glow bar type is used. This type of ignition means is incapable of igniting oil until the igniter becomes red hot. However, when the glow bar is repeatedly heated to such high temperature it deteriorates very quickly, whereas if it is only heated sufficiently to cause it to act as a vaporizer and not as an igniter, its life is prolonged. In the present disclosure, therefore, glow bar and spark ignition are used, the spark ignition acting after the glow bar has been operated to obtain vaporization.

The following features and advantages are stressed: If flame is extinguished due to water in the oil, lack of oil, or other causes, the whole apparatus will be rendered inactive and will not again start automatically until repair or adjustment has been made, and until a device for automatically locking the switch 11 in closed position after opening due to the sufficiently prolonging action of the heating coil 12 has been manually operated to close the switch. If current fails, even momentarily, the control which is the subject of this invention, will cause what is termed a "recycling operation" (including pre- and post-ignition timing periods) resulting under normal conditions in again starting the burner. Relay No. 1 controls the energization of the pre-ignition means 5 in this case a glow bar and the closing of relay No. 1 energizes this glow bar and causes the thermal element 16 of the time switch to move toward the contacts 27—28. It is assumed that the time switch is, initially, sufficiently cold to be at its maximum set distance from the contacts. Its heating movement from this cold position to the contacts is a measure of the pre-ignition period. It may vary within the range of from 20 to 120 seconds. It should be noted that the heating motion of the time switch to close the contact 27 determines the pre-ignition timing period, and that the opening of the contact 28 due to the cooling motion determines the post-ignition timing period.

In a typical case a thermal safety switch will, under the proper conditions, trip and open its contact at the end of sixty seconds. In this same typical case, the time switch 16 will move and break the holding circuit for No. 1 relay at the end of ninety seconds. Under this same condition, the burner should light in about twenty-five seconds. Should, however, the burner fail to light within sixty seconds, the thermal safety switch 11 will open its contact and the system will be locked against further operation until after repair and manual re-closing of the thermal safety switch. The opening of the contact 28 by cooling of the thermal element 16 of the time switch determines the end of the post-ignition timing period, about ninety seconds.

I claim as my invention:

1. In a combustion control system, a first electrically operable igniter, a second electrically operable igniter, electrically operable fuel control means, an electrically operable thermal timer switch controlling first and second contacts, and including a heater, a first relay controlling first and second contacts, and controlling both ignition means to dominate control of the first and assist in control of the second, a second relay controlling first, second and third contacts to close the first and second when the relay opens and to open the first and second and close the third when the relay closes, electrical means by which the second relay is adapted when open to obtain energization of the heater on closure of the first relay, and when closed to de-energize the heater and energize the second igniter and the fuel control means, a device responsive to the presence of fuel combustion and controlling a third relay having first and second contacts to close the first in absence of combustion, and to open the first and close the second when combustion is obtained, a starting circuit for the first relay including therein the first contact of the third relay, and the first contact of the second relay, a holding circuit for the first relay including the second contact of the second relay and the first contact of the first relay, a starting circuit for the second relay including the second contact of the timer switch, and the second contact of the first relay, a holding circuit for the second relay including the third contact of the second relay, a second holding circuit for the first relay which includes the first contact of the timer switch and the first contact of the first relay, and a second holding circuit for the second relay which includes the third contact of the second relay and the second contact of the third relay.

2. A device of the class described including an electrically operable thermal timer switch controlling first and second contacts, and including

a heater, a first relay controlling first and second contacts, a second relay controlling first, second and third contacts to close the first and second when the relay opens and to open the first and second and close the third when the relay closes, means by which the second relay is adapted when open to obtain energization of the heater on closure of the first relay, and when closed to de-energize the heater, a third relay controlling a contact to close it when the relay opens and to open it when the relay closes, a starting circuit for the first relay including therein the contact of the third relay and the first contact of the second relay, a holding circuit for the first relay including the second contact of the second relay and the first contact of the first relay, a starting circuit for the second relay including the second contact of the timer switch and the second contact of the first relay, a holding circuit for the second relay including the third contact of the second relay, and a second holding circuit for the first relay which includes the first contact of the timer switch and the first contact of the first relay.

3. A control system for a fluid fuel burner having an electrical burner motor and an electrically operated igniter, said control system comprising a timing switch having a single thermal element forming its sole actuator, an electrical heater therefor, and electrical means so interconnecting the burner motor, igniter, timing switch, and heater as to result in the following operation sequence; (1) energization of said igniter and control of the heater of said thermal element to cause closure of said switch after a time period; (2) closure of said switch causing energization of said burner motor and control of the heater of said thermal element to cause opening of said switch after a time period; (3) opening of said switch causing de-energization of said igniter only.

4. A control system for a fluid fuel burner having an electrical burner motor and first and second electrically operated igniters, said control system comprising a timing switch having a single thermal element forming its sole actuator, an electrical heater therefor, and electrical means so interconnecting said motor, first and second igniters, timing switch, and heater as to result in the following operation sequence; (1) energization of said first igniter and control of the heater of said thermal element to cause closure of said switch after a time period; (2) closure of said switch causing energization of both said burner motor and said second igniter and control of the heater of said thermal element to cause opening of said switch after a time period; (3) opening of said switch causing de-energization of both igniters only.

5. A device of the class described comprising a room thermostat, an electrically operable thermal safety switch including a heater, an electrically operable thermal timer switch including a heater, first and second relays, a third relay and a combustion responsive device controlling it to energize it as a result of combustion and vice versa, ignition means, a motor, and a fuel controller, means by which energization of the first relay energizes the ignition means and the timer switch heater, said timer switch operating after a time period to close first and second contacts means by which energization of the second relay energizes the motor and the fuel controller, and de-energizes the timer switch heater, said room thermostat controlling: a starting circuit for the first relay having therein said safety switch, a first contact of the third relay, and a first contact of the second relay; a first holding circuit for the first relay having therein said safety switch, a second contact of the second relay, and a first contact of the first relay; a second holding circuit for the first relay having therein, said safety switch, the first contact of said timer switch, and the first contact of said first relay; a starting circuit for the second relay having therein said safety switch, the second contact of said timer switch, a second contact of the first relay, and said safety switch heater; a first holding circuit for the second relay having therein said safety switch, and a third contact of the second relay and said safety switch heater; and a second holding circuit for said second relay having therein the safety switch, the third contact of the second relay and a second contact of the third relay.

6. A device of the class described comprising, first and second relays, a third relay and means for contolling it, an electrically operable thermal timer switch operable to close first and second contacts after a time period and means by which it is energized when the first relay is energized, a main switch controlling: a starting circuit for the first relay having therein, a first contact of the third relay and a first contact of the second relay; a first holding circuit for the first relay having therein, a second contact of the second relay and a first contact of the first relay; a second holding circuit for the first relay having therein the first contact of said timer switch and the first contact of said first relay; a starting circuit for the second relay having therein the second contact of said timer switch and a second contact of the first relay; a first holding circuit for the second relay having therein a third contact of the second relay; and a second holding circuit for said second relay having therein the third contact of the second relay and a second contact of the third relay.

7. A control system for a fluid fuel burner having an electrical burner motor and an electrically operated igniter, said control system comprising, a main switch, a first electro-magnet, switching means under the control thereof and moved to closed position when the electro-magnet is energized, a second electro-magnet, second and third switches under the control of the second electro-magnet and moved to open position when said second electro-magnet is energized, a fourth switch which is moved to closed position when said second electro-magnet is energized, a thermo-electric timer including an electrical heating coil, fifth and sixth switches sequentially closed by the timer when its heating coil is energized, an initial energizing circuit for the first electro-magnet including the main switch and third switch, a circuit for the timer heater controlled by the switching means and second switch, an ignition circuit controlled by the switching means, a holding circuit for the first electro-magnet controlled by the main switch and the fifth switch, an energizing circuit for the second electro-magnet including the main switch and sixth switch, a seventh switch controlled by the second relay and moved to closed position thereby when energized, a holding circuit for the second relay controlled by the main switch and seventh switch and a burner motor circuit controlled by the fourth switch.

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