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3,083,758

BURNER CONTROL MEANS

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2 Sheets-Sheet 1

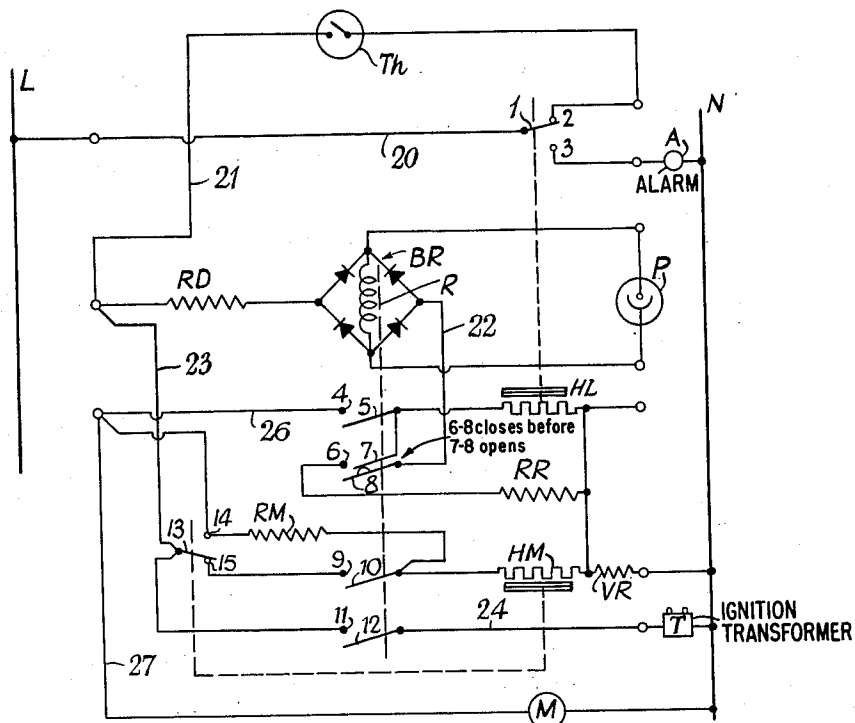


FIG. 1

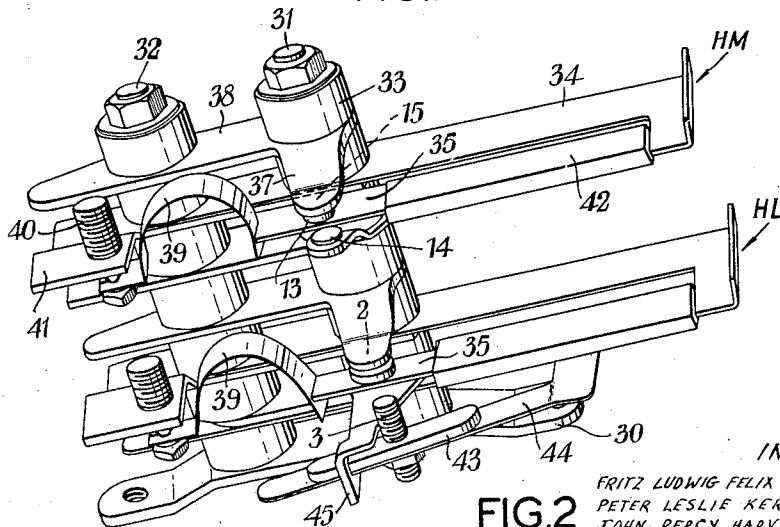


FIG. 2

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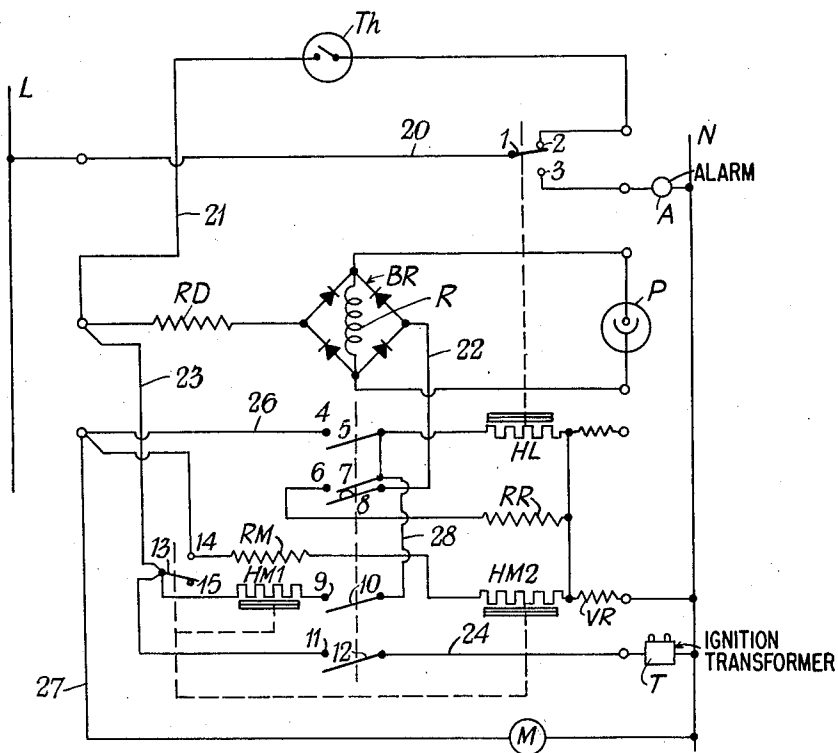
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BURNER CONTROL MEANS

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4 Claims. (Cl. 158-28)

This invention concerns improvements in fuel control means and has more particular reference to means for controlling the supply of fuel to a burner and at the same time controlling the ignition of the fuel. The embodiments to be particularly described relate to oil burners, but it should be understood that the invention is equally applicable to other forms of burners susceptible to the same type of control.

The safety regulations in many countries are very stringent as concerns oil burner control systems for central heating or the like, for it will be understood that the situation might become dangerous if, for example, oil were pumped to the burner when it has not ignited. Thus in general it is desirable for safety that, should there be a failure in any part of the system so that the various operations do not take place in the prescribed order, the apparatus must go to an inoperative state if it is not possible to rectify the error by starting the cycle anew.

It is an object of the present invention, therefore, to provide a fuel control system taking into account the above safety precaution.

According to the present invention there is provided fuel control means comprising a relay controlling two delay devices, the second of which delay devices is only energised after the first has been activated and said relay being de-energised in the run condition to de-energise the second delay means.

Very briefly, the preferred arrangement in accordance with the present invention comprises a sensitive relay having a plurality of contacts which control the various functions and the arrangement is that thermal delays are heated (when the relay is energised) so as to provide for delays before switching on the fuel supply and before going to the lock-out position, it being arranged that if flame appears at the appropriate time the relay is de-energised so as to break the circuit to a thermal delay which controls lock-out, thereby preventing the lock-out. In contradistinction to the majority of relay-operated burner controls, the relay of the present invention is energised only during the initial start-up period and as soon as the burner is operating satisfactorily the relay goes to the released position.

In one arrangement in accordance with the present invention three delay devices may be provided, but again these are under the control of the relay with the exception that one of the delay devices remains energised when the relay is de-energised. The chief function of the third delay means is to provide a purge time preventing immediate restart, thereby to increase the safety of the system. Moreover, in this embodiment the contact arrangement of the flame relay may be simplified so that it now carries merely one make-before-break contact.

It is extremely desirable in devices of this general character that all the contacts of the main relay should be "tested" during ordinary operation of the control means so as to ensure that the situation cannot arise that a pair of contacts may be defective but still allow the controller to operate without going to lock-out.

In order that the invention may more readily be understood, certain embodiments of the same will now be described with reference to the accompanying drawings, in which

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FIGURE 1 is a circuit diagram;

FIGURE 2 is a perspective view of a delay unit shown diagrammatically in FIGURE 1; and

FIGURE 3 is a circuit diagram of a second embodiment.

Referring to the drawings, it should be mentioned that the circles appearing in certain of the leads (see FIGURE 1) indicate the external connections to the unit and that in the FIGURE 2 part of the unit itself is shown but without the parts connected to such external connections.

Referring particularly to FIGURE 1, the circuit comprises two leads L and N supplied with alternating current at mains voltage and frequency. Connected to the live mains lead L is a lead 20 which passes via contacts 1 and 2 of a thermal switch HL (controlling "lock-out") to a thermostat Th. The other side of this thermostat is connected via a lead 21 to a resistance RD and thence to a bridge rectifier BR. The other side of the bridge rectifier BR is connected by a lead 22 to contacts 8 and 7 of a relay R which has its operating coil connected across the other two corners of the bridge rectifier BR. The contact 7 is connected to the heater of the thermal switch HL and the other side of this heater is connected via a resistance VR to the lead N of the mains supply. The resistance VR is the voltage adjusting resistance for the circuit.

In the circuit so far described, if the thermostat Th closes to call for more heat, the bridge rectifier BR is energised and the relay R pulls in to close the contact 8 upon a contact 6 and to break the contact 7 from the contact 8. The effect of closing the contacts 6 and 8 is to bring a resistance RR into series between the lead 22 and the resistance VR, this resistance RR having a resistance equivalent to that of the lock-out heater HL. Consequently the relay R remains energised and it is obvious that the contacts 6 and 8 close before the contacts 7 and 8 open so that although the circuit to the heater of the thermal switch HL is broken, the relay R is not simultaneously de-energised.

The coil of the relay R is in parallel with a photo-resistive type of photo-cell F and it will be clear that if there is light on the photo-cell, for example, if for any reason the furnace is incandescent, the relay R will not pull in as its coil will be shunted by the photo-cell F. Similarly the relay R will not pull in if there is an open circuit in the resistance RD or in the heater of the thermal switch HL.

The lead 21 between the thermostat Th and the resistance RD is connected to a lead 23 which terminates at a contact 11 which makes with a contact 12 of the relay R when the relay pulls in and this contact 12 is connected by a lead 24 to an ignition transformer T which has its other side connected to the neutral lead N. Thus as soon as the relay R pulls in the ignition is started.

The lead 23 is also connected to a contact 13 of a thermal switch HM (for motor control) which, in the cold condition, makes with a contact 15 connected to a contact 9 of the relay R. When the relay R pulls in, this contact 9 is connected to a contact 10 and thence to the heater of the thermal switch HM which has its other side connected to the resistance VR. Thus the heater of the thermal switch HM is energised.

The relay contact 7 is connected to a relay contact 5 of the relay R and, on energisation of the relay, this contact 5 makes with a contact 4 connected via a lead 26 to a contact 14 of the thermal switch HM and thence via a resistance RM to the contact 10. Thus when the relay R is energised, the heater of the thermal switch HL is energised at a low rate via the following circuit: lead 23, contacts 13 and 15, contacts 9 and 10, resistance RM, lead 26, contacts 4 and 5, the heater coil of the thermal switch HL, resistance VR and the neutral lead.

After a pre-ignition period of some 10 to 12 seconds, the thermal switch HM will operate and will switch the contact 13 from the contact 15 to the contact 14 thus connecting the lead 23 to the lead 26 and applying full power through resistance VR to the heater of the thermal switch HL. The lead 26 is connected to a lead 27 and thence to a motor M for the oil pump, this motor having its other side connected to the neutral supply line so that on operation of the thermal switch HM full mains voltage is applied to the motor M which is thus switched on to supply the fuel. At the same time the circuit to the thermal switch HM through the contact 15 is broken and is re-established through the contact 14 and the resistance RM so as to supply a reduced amount of current to the heater of this switch but just sufficient to maintain the same energised.

When flame is established, the resistance of the photo-cell P is reduced to shunt the coil of the relay R, thus causing the relay to open to break the ignition circuit at the contacts 11 and 12 and to break the circuit to the thermal switch HL at the contacts 4 and 5. The circuit is now in the normal run condition.

If, however, the flame is not established the relay will remain energised and after approximately 10 seconds the thermal switch HL will be energised to break the contacts 1 and 2 and make the contacts 1 and 3, thus switching in an alarm A and simultaneously de-energising the relay R and, therefore, stopping the motor M and the ignition transformer T. The thermal switch HL has to be reset manually and this cannot be accomplished until the heater of the switch HL has cooled down, such cooling taking over 60 seconds.

If at any time during the normal run the flame should fail or an open circuit should occur in the photo-cell leads, the shunt resistance is removed from the coil of the relay R which will pull in to restore the ignition circuit and energise the heater for the lock out switch HL, whereby the equipment recycles or goes to lock-out if the flame is not re-established within the correct time. Similarly also if the thermostat Th opens, the power supply to the motor M is broken and the circuit is switched off.

FIGURE 2 illustrates the thermal switches HL and HM, these switches being designed for attachment by means of a footplate 30 to a relay unit incorporating the relay R and the rectifier BR. It is not necessary to illustrate the relay R which is conventional, except in so far as the contacts 6, 7 and 8 are concerned where the arrangement is that in the de-energised condition of the relay the contacts 7 and 8 are made, whilst in the energised condition the contacts 6 and 8 are made, the operation being a make-before-break operation insofar as these contacts are concerned.

The footplate 30 carries a pair of upstanding pillars 31 and 32, which, by means of insulating spacers 33, serve to mount the two thermal switches. Each switch comprises a long relatively broad limb 34 which is secured on the posts 31 and 32 and which is unitary with a shorter narrower limb 35, the two limbs being joined together to form a U and being composed of identical bi-metallic material so that the arrangement is self-compensating for ambient temperature. In FIGURE 2, the upper switch is the switch HM whilst the lower switch is the switch HL.

As can be seen from FIGURE 2, the limb 35 of the switch HM has its end positioned between a pair of fixed contacts forming the contacts 14 and 15, such contacts being carried by bent arms 37 mounted upon the pillar 31 and each unitary with a plate 38 extending to the pillar 32 so that electrical connections can be made to the remote ends of such plates. The arm 35 itself carries the contact 13. The end of the arm 35 is engaged by a C-type spring 39 which has its end secured immediately below the head of a set screw 40 which is adjustable in a plate 41. It will be understood that movement of the set screw 40 in the plate 41 changes the effective angle of the spring 39 and thus controls its operation.

A heater 42 is located about the limb 35.

The operation of the switch HM is that, as the heater 42 is energised, the limb 35 bows relatively to the limb 34 against the action of the spring 39 so that, as soon as the action of the spring is overcome, the arm 35 snaps into the position in which the contact 13 makes with the contact 14. However, the spring 39 does not go over dead centre and so when the heater 42 cools down the arm 35 may snap back into the position shown in the drawings in which the contacts 13 and 15 are made.

The switch HL is substantially identical in construction to the switch HM except that the second contact (corresponding to the contact 14) is arranged differently. This second contact, which forms the contact 3, is constituted by a set screw mounted in a plate 43 carried by a resilient arm 44 which is located in a slot in a guide member 45, such guide member 45 being mounted upon the stud 31 and the resilient arm 44 being mounted upon the two studs 31 and 32. The arrangement is that as the arm 35 of the switch HL is heated it acts against its spring 39 until it overcomes the action of this spring and it then moves over the dead-centre position so as to make with the contact 3. Since the spring 39 has moved over the dead-centre position, the switch HL does not reset on cooling and must be manually reset by operation of the end of the resilient arm 44 which can be moved in the guide 45 so as to urge the arm 35 upwardly (as seen in FIGURE 2) and over the dead-centre position to engage with the contact 2. When urged in this way, the arm 35 snaps into the position shown in the drawing and remains there whilst the contact 3 restores itself under the influence of its resiliency to the position shown. Thus, although the switches HM and HL are constructionally almost identical, they differ in that the switch HM works entirely on one side of the dead-centre position and is thus self restoring, whilst the switch HL works on both sides of the dead-centre position and must be manually reset.

In the circuit described above with reference to FIGURE 1, it is possible that contacts 4 and 5 may fail to make when relay R pulls in. The arrangement of FIGURE 1 would then operate normally except that, should flame not be established or should the flame fail during a run the switch of the delay device controlling lock-out would fail to operate and this circumstance would be potentially dangerous.

To avoid this risk the circuit of FIGURE 1 may be modified as shown in FIGURE 3. In the circuit shown in FIGURE 3 the delay device controlling the motor M is provided with two heaters HM1 and HM2, the heater HM1 being connected between contacts 9 and 13 and heater HM2 being connected between resistors RM and VR. The contacts 4, 5, 6, 8, 11 and 12 of the relay R are connected as they are in FIGURE 1 but contact 7 of the relay R is connected to contact 10 of the relay via lead 28. Furthermore, contact 15 of the motor control delay device is not used in the circuit.

When the thermostat Th makes to call for heat the relay R is energised, as in the circuit of FIGURE 1, via resistor RD, bridge rectifier BR, contacts 7 and 8, the heater HL of the delay device controlling lock out and resistor VR. On picking up the relay R completes a circuit from lead 23 via the heater HM1, contacts 9, 10, lead 28 and the series paralld circuit having as one branch the heater HL and resistor VR in series, as a second branch the contacts 4, 5, leads 26 and 27 and motor M in series and as a third branch resistor RM and heater HM2 in series. The resistance of heater HM1 is, however, sufficiently high to prevent operation of the motor M and also to prevent the temperatures of heaters HL and HM2 rising above respective predetermined values.

The resulting current flowing through heater HM1 causes contacts 13 and 14 to make after heater HM1 has been energised for a pre-ignition period and the making

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of these contacts fully energises the motor M. The making of contacts 13, 14 also fully energises heater HM2 via resistor RH to cause contacts 13 and 14 to be held closed after relay R releases when flame is established and heater HM1 becomes de-energised as a consequence.

Should contacts 4 and 5 in the circuit of FIGURE 3 fail to make when relay R picks up initially an energising circuit for the lock-out heater HL is completed from lead 23 via heater HM1, contacts 9, 10, lead 28, heater HL and resistor VR. The values of the resistive elements in this energising circuit are so chosen that the current flowing therein will cause the contact 1 of the lock-out delay device to operate before contact 13 of the motor control delay device operates. Consequently, instead of the burner being lit as it would be with the circuit of FIGURE 1, the circuit of FIGURE 3 assumes the lock-out condition if contacts 4 and 5 fail to make when relay R picks up originally.

We claim:

1. A fuel control means for a burner comprising fuel supply means; fuel ignition means; a thermostat responsive to a temperature which is increased by operation of said burner; a relay having a coil and first, second and third switch means; a first circuit for energising said coil, the first circuit including the thermostat and being energised to operate the relay in response to the thermostat calling for heat; a first delay device comprising a first switch, a first actuator and first heater means for heating the first actuator to operate the first switch; a second circuit for energising the fuel supply means, the second circuit including the first switch and being fully energised when the first switch is operated; a third circuit for energising the fuel ignition means, the third circuit including the third switch means and being energised when the relay is operated; circuit means for energising the first heater means, the circuit means including the second switch means and the first switch, the circuit means being fully energised when the relay is operated and the first switch is unoperated and being energised to maintain the first switch operated when the relay and the first switch are operated; a manually resettable second delay device comprising a second switch, a second actuator and second

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heater means for heating the second actuator to operate the second switch; a fourth circuit for energising the second heater means, the fourth circuit including the first switch means and the first switch and being energised when the relay and the first switch are operated, the second switch being connected in controlling relation to and operative to de-energise all the circuits and the circuit means, and means responsive to said fuel being ignited to reduce the energisation of the coil to release the relay.

2. A fuel control means according to claim 1 comprising a resistive element connected to the first switch means and wherein the first circuit includes the first switch means and the first switch means connects the second heater means in the first circuit initially and substitutes the resistive element for the second heater means in the first circuit when the relay is operated.

3. A fuel control means according to claim 1 wherein the first heating means comprises two heater elements; the circuit means comprise a fifth circuit for energising one of said heater elements and a sixth circuit for energising the other of said heater elements, the fifth circuit including the second switch means and the second heater means and being energised to operate the first switch when the relay is operated, the sixth circuit including the first switch and being energised upon operation of the first switch to maintain the first switch operated, the relative resistances of the first heater element and the second heater means being such that when they carry the same current the second switch operates before the first switch.

4. A fuel control means according to claim 1 wherein the means responsive to ignition of the burner is a photo-resistive cell connected to provide when illuminated a current path in parallel relation to the coil.

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