

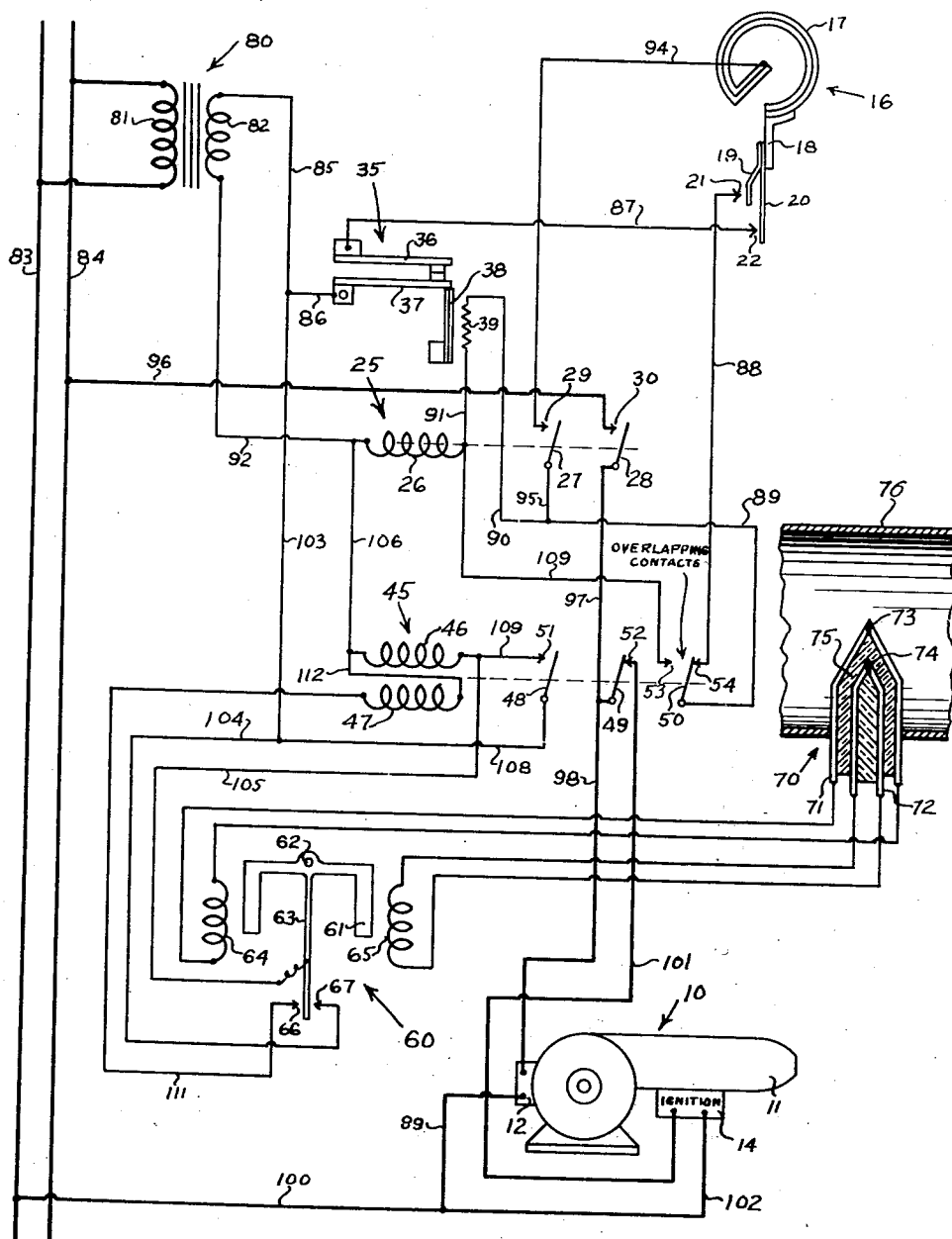
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FLUID FUEL BURNER CONTROL SYSTEM

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FLUID FUEL BURNER CONTROL SYSTEM

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The present invention relates to a fluid fuel burner control system and more particularly to one in which certain switching operations take place upon the initiation of combustion.

It is the usual practice with fluid fuel burner control systems, particularly oil burning systems, to perform certain switching operations upon combustion taking place. One need for such switching operations arises from the fact that it is the usual practice to employ some cut-out mechanism, usually a safety switch, which is effective unless rendered inoperative to terminate operation of the fuel feeding means after a predetermined period of time. The switching operations incidental to combustion have as one of their objects to render inoperative this cut-out mechanism after combustion takes place within the predetermined period of time. It is usually also the practice to render ineffective the ignition means after the burner is ignited, particularly where electric ignition is employed. The logical time for doing this is when combustion is first definitely established.

In order to have these operations performed relatively quickly upon a temperature rise and also in order to have certain safety operations performed quickly after combustion is interrupted, it is necessary to have a switch which does not operate at a predetermined temperature but rather operates as a result of predetermined temperature changes. In the past, it has been the usual practice to employ what is known as a "slip friction" switch. This switch consists essentially of a temperature responsive element connected to one or more switches by a connection which is capable of slipping after the switching function has been accomplished. It may be readily seen that such devices are subject to the possibility of unstable operation in that they depend upon two members slipping relative to one another but still having sufficient friction between them that they initially move together.

An object of the present invention is to provide a burner control system in which the switching function incidental to the initiation of combustion is accomplished by means of an electromagnetic switch energized by thermo-couple means.

A further object of the invention is to provide a burner control system in which the switching function incidental to the initiation of combustion is accomplished by means of an electromagnetic switch energized by thermo-couple means having at least two junctions of different capability for absorbing and giving up heat.

A further object of the invention is to provide

a burner control system according to the previous objects in which the electromagnetic switch is in the form of a balanced relay having opposed coils and a pair of thermo-couples each connected to one of said coils, the hot junctions of said thermo-couples having different capacities for absorbing and giving up heat.

Another object of the invention is to provide an improved switch movable in response to the direction of a temperature change.

Further objects of the present invention will be apparent from a consideration of the accompanying specification, claims and drawing.

In the single figure of the drawing, the present invention is shown in schematic form. In this figure, the invention is shown in the form of an oil burner control circuit although it is to be understood that the invention is not limited to the oil burning art.

Referring to the figure, an oil burner is indicated by the reference numeral 10. This oil burner comprises a burner nozzle 11 through which a mixture of fuel and air is forced by the action of a motor 12. Associated with the oil burner 10 is an ignition means 14. This ignition means may take any suitable form, one form being that of a high voltage transformer which energizes a pair of spaced electrodes to provide a spark therebetween.

A room thermostat 16 constitutes the primary control of the system. This thermostat consists of a bimetallic element 17 to which is secured a contact arm 18. This contact arm 18 carries a pair of blades 19 and 20, which blades are adapted to engage fixed contacts 21 and 22. The blade 20 is adapted to engage contact 22 first upon movement of the arm 18 to the left and thereafter blade 19 is adapted to engage contact 21.

The thermostat 16 controls the energization of a relay 25. This relay comprises a relay coil 26 and a pair of switch blades 27 and 28 adapted to be moved in engagement with contacts 29 and 30. The switch blades 27 and 28 are normally out of engagement with contacts 29 and 30 but are moved into engagement therewith by energization of relay coil 26.

A thermal safety switch 35 also controls the energization of relay 25. This thermal safety switch may be of any suitable form, one preferable form being that shown in the patent to Frederick S. Denison No. 1,958,081, issued May 8, 1934. The switch is shown in schematic form as comprising switch blades 36 and 37, the lower one of which is pivotally mounted so as to drop away from the upper blade unless otherwise re-

strained. Located so as to extend under the right-hand end of switch blade 37 is a bimetallic element 38. A heating element 39 is located adjacent the bimetallic element 38 and is designed to heat the element to warp the same to the right. As long as the bimetallic element 38 is not heated beyond a predetermined point, switch blade 37 will remain held in engagement with switch blade 36 by the bimetallic element 38. Upon sufficient warping of the bimetallic element 38, however, switch blade 37 will drop away from switch blade 36 and the switch cannot be re-closed automatically.

A second relay is generally indicated by the reference numeral 45. This relay comprises a "pull in" coil 46 and a "bucking coil" 47. The relay also comprises a plurality of switch blades 48, 49, and 50 which are adapted to cooperate with fixed contacts 51, 52, 53, and 54. Switch blades 49 and 50 are biased into engagement with contacts 52 and 54, and switch blade 48 is biased out of engagement with contact 51. Upon the relay being energized, switch blades 48 and 50 are moved into engagement with contacts 51 and 53, switch blade 50 being moved out of engagement with contact 54 and switch blade 49 out of engagement with contact 52. Switch blade 50 is so designed with respect to contacts 53 and 54 that it engages contact 53 before it disengages contact 54. This is indicated in the drawing by the legend "Overlapping contacts."

A relay 60 controls the energization of relay 45. This relay comprises a U-shaped armature 61 pivoted adjacent its midpoint at 62 and carrying a switch blade 63. The armature is adapted to cooperate with two coils 64 and 65, the energization of which exert opposing forces upon the armature 61. The switch blade 63 is adapted to cooperate with two fixed contacts 66 and 67. Upon relay coil 64 being more highly energized than relay coil 65, the left-hand portion of armature 61 is drawn downwardly and switch blade 63 is moved into engagement with contact 67. On the other hand, when relay coil 65 is the more highly energized of the two, the switch blade 63 is moved into engagement with contact 66.

The reference numeral 70 is used to generally refer to a thermo-couple means comprising two thermo-couples 71 and 72. The thermo-couple means 70 extends into a pipe 76 which constitutes a stack pipe of the furnace in which the oil burner 10 is located. It is to be understood that upon operation of the oil burner, the stack temperature rises very quickly and upon the oil burner stopping, the stack temperature cools down very rapidly. The stack temperature is thus a very good indication of the combustion conditions and it is quite common to place combustion responsive switches in the stack. The hot junction of thermo-couple 71 is indicated by the reference numeral 73 and the hot junction of the thermo-couple 72 by the reference numeral 74. The thermo-couple 72, particularly adjacent the hot junction thereof, is entirely surrounded with insulating material which is shown in section in the drawing and indicated by the numeral 75. The purpose of this insulating material is to insure that the hot junction 74 of thermo-couple 72 will not be heated immediately and when the temperature within the stack is falling will not cool as rapidly as the hot junction 73 of thermo-couple 71.

Power is supplied for operation of the control

portion of the system by a step-down transformer generally indicated by the reference numeral 80. This transformer comprises a line voltage primary 81 and a low voltage secondary 82. The line voltage primary 81 is connected to line wires 83 and 84 leading to a suitable source of power (not shown).

Operation

The various elements of this system are shown in the position which they occupy when the temperature to which thermostat 16 is subjected is above the desired value. Let it be assumed now that this temperature starts dropping. The effect of this would be to cause contact arm 18 to move to the left bringing first blade 20 into engagement with contact 22 and then blade 19 into engagement with contact 21. Upon engagement of both blades 19 and 20 with contacts 21 and 22, the following circuit to relay coil 26 is established: from the upper terminal of secondary 82 through conductors 85 and 86, switch blades 37 and 36, conductor 87, contact 22, thermostat switch blades 20 and 19, contact 21, conductor 88, contact 54, switch blade 50, conductors 89 and 90, heating element 39, conductor 91, relay coil 26, and conductor 92 to the other terminal of secondary 82. The establishment of this circuit results in the energization of relay coil 26 and the moving of switch blades 27 and 28 into engagement with contacts 29 and 30, respectively. The movement of switch blade 27 into engagement with contact 29 establishes a holding circuit to the relay coil 26 as follows: from the upper terminal of secondary 82 through conductors 85 and 86, switch blades 37 and 36, conductor 87, contact 22, blade 20, arm 18, bimetallic element 17, conductor 94, contact 29, switch blade 27, conductors 95 and 90, heating element 39, conductor 91, relay coil 26, and conductor 92 to the other terminal of secondary 82. It will be noted that this holding circuit is independent of the engagement of contacts 19 and 21. Thus the temperature must rise sufficiently to cause disengagement of not only contacts 19 and 21 but also of 20 and 22 before the relay is again deenergized. The result of this is that there is a differential between the energization and deenergization of the thermostat, this differential preventing any chattering of the relay as the thermostat first makes or first breaks the contacts.

It will be noted that both the holding and energizing circuits through relay coil 26 include the heating element 39 and also include the switch blades 36 and 37. Thus if these circuits remain unchanged for a length of time, the relay will be deenergized by reason of the safety switch 35 opening.

The engagement of switch blade 28 with contact 30 results in the following energizing circuit to oil burner motor 12: from line wire 84 through conductor 96, contact 30, switch blade 28, conductors 97 and 98, burner motor 12, and conductors 99 and 100 to the other line wire 83. At the same time, a circuit is also established to the ignition means 14 as follows: from line wire 84 through conductor 96, contact 30, switch blade 28, conductor 97, switch blade 49, contact 52, conductor 101, ignition means 14, and conductors 102 and 100 to the other line wire 83.

The establishment of the last two traced circuits to the oil burner motor and to the ignition means results in the establishment of the

conditions necessary for combustion. If the apparatus is operating properly, combustion will take place and within a very short period of time the stack temperature will rise. As the stack temperature rises, the two thermo-couples 71 and 72 are subjected to the heating effect of the stack gases. Due, however, to the fact that the hot junction 73 of the thermo-couple 71 is exposed directly to the stack gases whereas the hot junction 74 of thermo-couple 72 is thermally insulated, the hot junction 73 will be the only one which heats to any appreciable extent initially. The result is that the current flowing through coil 64 will far exceed that flowing through coil 65. The effect of this will be that the armature 61 is rotated in a counter-clockwise direction moving switch blade 63 into engagement with contact 67.

The movement of switch blade 63 into engagement with contact 67 results in the establishment of the following energizing circuit to relay coil 46 of relay 45: from the upper terminal of secondary 82, through conductors 85, 103, and 104, contact 67, switch blade 63, conductor 105, relay coil 46, and conductors 106 and 92 to the other secondary 82. The establishment of this energizing circuit to relay coil 46 results in switch blades 49 and 50 moving out of engagement with contacts 52 and 54 and switch blades 48 and 53 moving into engagement with contacts 51 and 53. The moving of switch blade 49 out of engagement with contact 52 results in the deenergization of the ignition. This will be obvious inasmuch as the only circuit traced to the ignition means was through contact 52. The deenergization of the ignition is desirable at the present stage since it is assured that the oil burner has been properly lighted for at least several seconds and there is no need of further operation of the ignition with the resultant current consumption and deterioration of the parts.

The moving of switch blade 48 into engagement with contact 51 establishes a holding circuit to relay coil 46 which is independent of relay 60. This holding circuit is as follows: from the upper terminal of secondary 82 through conductors 85, 103, and 108, switch blade 48, contact 51, conductor 109, relay coil 46, and conductors 106 and 92 to the other terminal of secondary 82.

The moving of switch blade 50 out of engagement with contact 54 and into engagement with contact 53 establishes a circuit to relay coil 26 which is independent of the heating element 39 and also breaks the previously established circuits through the heating element. As previously indicated, the switch blade 50 is so designed with respect to contacts 53 and 54 that it engages contact 53 before it disengages contact 54. Thus the old circuit is not broken until the new circuit is established, which is as follows: from the upper terminal of secondary 82 through conductors 85 and 86, switch blades 37 and 36, conductor 87, contact 22, blade 20, arm 18, bimetallic element 17, conductor 94, contact 29, switch blade 27, conductors 95 and 89, switch blade 50, contact 53, conductor 109, relay coil 26, and conductor 92 to the other terminal of secondary 82.

The operation which has just been described is that which takes place under normal circumstances. If for some reason or other combustion does not take place, the stack temperature will not rise and consequently the heating element will not be deenergized by the action of relay 45. The result will be that the safety switch

35 will open causing deenergization of the entire system. The system cannot then be restarted without the safety switch 35 being manually reset.

After the burner has been in operation for a while, the temperatures of the hot junctions 73 and 74 will become substantially equalized due to the heat penetrating through the insulation 75. Under these circumstances, the switch blade 63 will assume a position intermediate contacts 66 and 67. If for any reason combustion should be interrupted while the thermostat is still calling for heat, provision is made for attempting to restart the burner. Under these circumstances the stack temperature will cool down very quickly. Since the hot junction 73 is exposed, this junction will cool down. On the other hand, the hot junction 74 will remain quiet hot since the insulation 75 prevents the heat from being dissipated therefrom. Under these circumstances, the relay coil 65 will be the more highly energized of the two causing switch blade 63 to move into engagement with contact 66. The effect of this will be to establish an energizing circuit to bucking coil 47 as follows: from the upper terminal of secondary 82, through conductors 85, 103, and 108, switch blade 48, contact 51, conductors 109 and 105, switch blade 63, contact 66, conductor 111, bucking coil 47, and conductors 112, 106, and 92 to the other terminal of secondary 82. The establishment of this circuit to the bucking coil 47, in view of the fact that the coils 46 and 47 have an opposite effect, results in the deenergization of the relay causing the various switch blades to assume the position shown in the drawing. The separation of switch blade 48 from contact 51 insures the deenergization of the relay even though switch blade 63 a moment later disengages from contact 66, since the only circuit established to coil 46 is through switch blade 48 and contact 51. The moving of the switch blade 50 out of engagement with contact 53 and into engagement with contact 54 reestablishes the circuit to the heating element 39 and breaks the previously established circuit to relay coil 26 which is independent of the heating element 39. The moving of switch blade 49 back into engagement with contact 52 results in the reestablishment of the ignition. If the condition which caused the extinguishment of the burner was merely a temporary one, the oil burner will now be reignited and the apparatus will go through the same cycle previously traced. If, however, combustion does not take place, the continued heating of heating element 39 will cause an opening of the thermal safety switch 35 causing deenergization of the system.

After the oil burner has started, under normal circumstances, the burner will continue to run until the thermostat 16 is satisfied, that is, until switch blade 20 has disengaged from contact 22. Since the circuits to both relays 45 and 26 are controlled by the thermostat 16, the opening of the thermostat will cause deenergization of both relays and consequently of the oil burner.

It will be seen that with my improved fuel burner control system, the switching operation necessary upon the establishment of combustion are accomplished by a thermo-couple arrangement employing no moving parts. It will further be seen I have provided a novel combination of a thermo-couple arrangement and an electromagnetic relay wherein the relay is actuated in

accordance with the direction of temperature change.

While I have shown a specific embodiment of my invention, this is for purposes of illustration only and it is to be understood that the invention is limited only by the scope of the appended claims.

I claim as my invention:

1. A switching device responsive to the direction and extent of temperature changes comprising a relay having actuating coil means and a switch movable into and out of a circuit making position dependent upon the direction and extent of energization of said coil means and a pair of thermo-couples independently connected to said coil means, the hot junction of one of said thermo-couples being capable of quickly absorbing and giving up heat and the hot junction of the other of said thermo-couples being capable of only slowly absorbing and giving up heat whereby upon a temperature rise the first mentioned junction is the hotter of the two and upon a temperature fall the other junction is the hottest.
2. A switching device responsive to the direction and extent of temperature changes comprising a relay having actuating coil means and a switch movable into and out of a circuit making position dependent upon the direction and extent of energization of said coil means and a pair of thermo-couples independently connected to said coil means, the hot junction of one of said thermo-couples being exposed and the hot junction of the other being insulated whereby upon a temperature rise said first junction will be the first to heat up and upon a temperature fall said first junction will be the first to cool off.
3. A switching device responsive to the direction and extent of temperature changes comprising a balanced relay having a pair of opposing coils and a switch positioned in accordance with the relative energization of said coils, a pair of thermo-couples each connected to one of said coils, the hot junction of one of said thermo-couples being capable of quickly absorbing and giving up heat and the hot junction of the other of said thermo-couples being capable of only slowly absorbing and giving up heat, whereby upon a temperature rise one of said coils will be more highly energized and upon a temperature fall the other will be more highly energized.
4. A switching device responsive to the direction and extent of temperature changes comprising a balanced relay having a pair of opposing coils and a switch positioned in accordance with the relative energization of said coils, a pair of thermo-couples each connected to one of said coils, the hot junction of one of said thermo-couples being exposed and the hot junction of the other of said thermo-couples being insulated whereby upon a temperature rise said first junction

tion will be the first to heat up and upon a temperature fall said first junction will be the first to cool off so that upon a temperature rise one of said coils will be more highly energized and upon a temperature fall the other will be more highly energized.

5. A device responsive to the direction and extent of temperature changes comprising a pair of opposed electromagnetic coils, a balanced armature positioned in accordance with the relative energization of said coils, a pair of thermo-couples each connected to one of said coils, the hot junction of one of said thermo-couples being capable of quickly absorbing and giving up heat and the hot junction of the other of said thermo-couples being capable of only slowly absorbing and giving up heat, whereby upon a temperature rise one of said coils will be more highly energized and upon a temperature fall the other will be more highly energized.

6. A device responsive to the direction and extent of temperature changes comprising a pair of opposed electromagnetic coils, a balanced armature positioned in accordance with the relative energization of said coils, a control member positioned by said armature, a pair of thermo-couples each connected to one of said coils, said thermo-couples being disposed with one surrounding the other, heat insulating material between the inner and outer thermo-couples so that the hot junction of the inner thermo-couple absorbs and gives up heat more slowly than the hot junction of the outer thermo-couple with the result that upon a temperature rise the coil to which said outer thermo-couple is connected will be more highly energized and upon a temperature fall the other coil will be more highly energized.

7. A thermocouple device responsive to rate of temperature change, comprising a pair of thermocouples disposed with one surrounding the other, heat insulating material between the inner and outer thermocouples so that the hot junction of the inner thermocouple absorbs and gives up heat more slowly than the hot junction of the outer thermocouple, and electrical means connected to said thermocouples so as to respond to the difference between the electromotive forces of said thermocouples.

8. A thermocouple device responsive to rate of temperature change, comprising a pair of thermocouples mounted adjacent each other, the hot junction of one of said thermocouples being capable of quickly absorbing and giving up heat and the hot junction of the other of said thermocouples being capable of only slowly absorbing and giving up heat, and electrical means associated with said thermocouples so as to respond to the difference between the electromotive forces thereof.

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