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FLUID FUEL BURNER CONTROL SYSTEM

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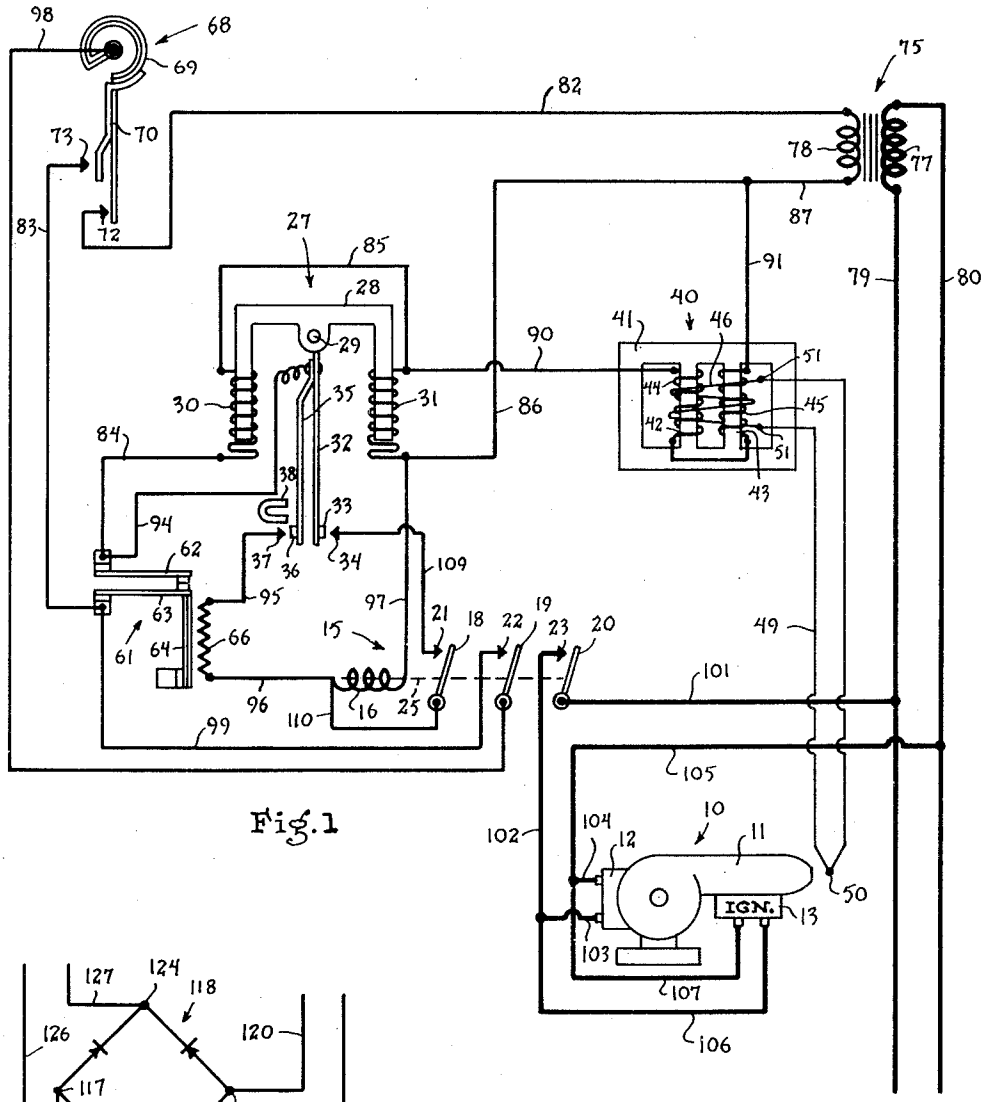

Fig.1

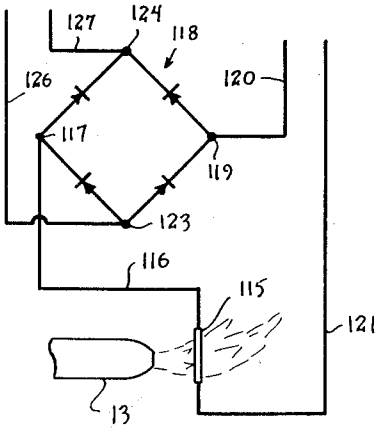

Fig.2

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FLUID FUEL BURNER CONTROL SYSTEM

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14 Claims. (Cl. 158—28)

The present invention relates to a fluid fuel burner control system and more particularly to improvements in the switching means thereof operable as an incident to the establishment of combustion.

An object of the present invention is to provide a fluid fuel burner control system of the type employing an electrically operated cut-out means for terminating operation of the burner at the end of a predetermined period of time in which a slow acting relay with contacts overlapping in one direction only is employed for rendering the cut-out means inoperative upon the establishment of combustion and for introducing a delay between successive operations of the fluid fuel burner.

A further object of the present invention is to provide such a system in which the energization of the relay coil is controlled by a thermo-couple located so as to be exposed to the temperature of the zone of combustion.

A still further object of the present invention is to provide such a system in which the energization of a relay coil of the slow acting relay is controlled by an element located so as to be responsive to the temperature of the zone of combustion and having a substantial temperature coefficient of resistance.

A still further object of the present invention is to provide such a system in which the energization of a relay coil of the relay is controlled by a saturable reactor, the energization of the saturating winding of which is varied by either a thermo-couple or an element having a negative coefficient of resistance.

A further object of the present invention is to provide a fluid fuel burner control system employing a relay for controlling the starting of the burner and rendering the cut-out mechanism inoperative in which the relay has opposing coils and in which a variable combustion responsive impedance is connected in series with one of the coils and in parallel with the other.

A further object of the present invention is to provide a system such as set forth in the last object in which the combustion responsive variable impedance is a saturable reactor whose saturating winding is variably energized under the control of either a thermo-couple or an element having a negative temperature coefficient of resistance.

A further object of the invention is to provide a novel combustion responsive apparatus of the type set forth above irrespective of its application to a fluid fuel burner control system.

A still further object of the present invention is to provide a new and novel method of obtaining an overlapping in one direction only in a switch movable in accordance with combustion conditions.

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

Figure 1 is a schematic view of one form of the invention, and

Figure 2 is a schematic view of a portion of a modification thereof.

Referring to the drawing, an oil burner is generally designated by the reference numeral 10. This oil burner is of conventional construction comprising a nozzle 11 and a blower driven by a motor 12. Associated with the burner 10 is an electrically operated ignition means 13 of any desired type.

The energization of the oil burner and the ignition means is controlled by a relay generally designated by the reference numeral 15. This relay comprises a relay coil 16 and relay switch blades 18, 19, and 20 which are adapted to cooperate with contacts 21, 22, and 23, respectively. The switch blades 18, 19, and 20 are biased to the right and are adapted upon energization of the relay to be moved through the action of an armature 25 into engagement with their associated contacts.

The energization of the relay 15 is controlled in part by a relay 27. This relay comprises a U-shaped armature 28 pivoted at its mid point at 29. Associated with the two legs of the armature 28 are coils 30 and 31. Carried by the armature 28 is a flexible contact blade 32 of bronze or other similar non-magnetic material. Contact blade 32 carries at its lower end a contact 33 which is adapted to engage with a fixed contact 34. Also secured to the contact blade 32 is a second contact blade 35 of flexible magnetic material, such as steel. Contact blade 35 carries a contact 36 adapted to engage with a fixed contact 37. A magnet 38 is located adjacent the magnetic contact blade 35.

The position of contact blades 32 and 35 is determined by the relative energization of the coils 30 and 31 which act in opposite directions upon armature 28. When contacts 36 and 37 are moved into engagement, the magnet 38 retains the contact blade 35 in such position upon movement of the armature 28 in a counterclockwise direction until contact blade 32 effects engagement of contacts 33 and 34. Thereafter,

upon further movement of armature 28, enough tension is put on blade 35 to break the same loose from magnet 38.

Upon movement of blades 32 and 35 in a clockwise direction, however, blade 35 is out of the field of magnet 38 and contacts 33 and 34 separate immediately and contacts 36 and 37 do not engage until the contact blades 32 and 35 have moved an appreciable distance thereafter. It will thus be seen that the contacts are overlapping in one direction and not in the other. As will be apparent from a subsequent description, the contacts 33 and 34 are the contacts which are engaged upon the establishment of combustion and contacts 36 and 37 are the contacts which are engaged upon termination of combustion. Contacts 33 and 34 are thus termed the hot contacts and contact 36 and 37 the cold contacts. When the coils 30 and 31 are deenergized, the contacts assume the intermediate position in which they are shown in the drawing.

The relative energization of relay coils 30 and 31 is controlled by a saturable core reactor 40. This reactor comprises a rectangular magnetic core 41 having two intermediate legs 42 and 43. Located on the legs 42 and 43 are windings 44 and 45 which may be termed alternating current windings. Surrounding both legs 42 and 43 is a direct current saturating winding 46, which winding is variably energized to vary the reactance of the unit including windings 44 and 45 and the core 41. The windings 44 and 45 are oppositely disposed so that no alternating current component is induced in the winding 46. The saturating winding 46 is connected to a thermo-couple 49, the hot junction 50 of which is located so as to be responsive to the temperature of the zone of combustion. While the thermo-couple has been shown with the hot junction located adjacent the burner, it will be understood that the hot junction may actually be located a considerable distance therefrom in the combustion chamber and may even be located in the stack. The cold junction 51 is located at a point a substantial distance away from the combustion chamber so as not to be affected to a great extent by the combustion temperature.

The cut-out mechanism previously referred to takes the form of a thermal safety switch indicated by the reference numeral 61. This thermal safety switch is preferably of the type shown in the patent to F. S. Denison No. 1,958,081 issued May 8, 1934. As shown in the drawing for purposes of illustration, the switch comprises a pair of switch blades 62 and 63. The upper switch blade 62 is relatively rigid and the lower switch blade 63 is biased downwardly. The bimetallic element 64 when in its cold condition extends underneath the lower end of switch blade 63 and serves to hold the same in engagement with switch blade 62. Located adjacent the bimetallic element 64 is a heater element 66 which upon energization thereof serves to heat the bimetallic element 64. The bimetal element is so disposed that upon being heated, it tends to warp to the right and thus move from underneath the switch blade 63. It will thus be seen that switch 61 is able to deenergize the system after a predetermined period of time.

A room thermostat 68 is employed as a main controlling switch. This thermostat comprises a bimetallic element 69 to which is secured a composite contact arm 70. Contact arm 70 cooperates with contacts 72 and 73, being spaced further from contact 73 than from contact 72. The bimetallic element 69, upon a temperature fall, is adapted to move the contact arm 70 to the left causing engagement thereof first with contact 72 and then with contact 73.

A step-down transformer 75 supplies power for the operation of the control portion of the system. This transformer comprises a line voltage primary 77 and a low voltage secondary 78. The line voltage primary 77 is connected to line wires 79 and 80.

Operation of Figure 1 species

The various elements of the system are shown in the position which they occupy when the temperature to which thermostat 68 is responsive is at or above the desired value. Let it be assumed now that the temperature falls until contact blade 70 first engages contact 72 and then contact 73. Nothing happens until the contact blade 70 engages contact 73 whereupon the following circuit is established to relay coils 30 and 31: from the upper terminal of secondary 78 through conductor 82, contact 72, contact blade 70, contact 73, conductor 83, switch blades 63 and 62, conductor 84, winding 30, conductor 85, winding 31, and conductors 86 and 87 to the other terminal of secondary 78. Connected in parallel with winding 31 by conductors 90 and 91 are the alternating current windings 44 and 45 of the saturable core reactor. Since the windings of the reactor are connected in parallel with coil 31 they are also connected in series with coil 30. It will be obvious that any increase in the reactance of reactor 40 will tend to increase the energization of relay coil 31 relative to that of relay coil 30 whereas any decrease in the reactance of reactor 40 has the opposite effect. In view of the fact that at the time for the call for heat, the hot junction of the thermo-couple will be cold, the saturating winding 46 will not be energized so that the reactance of reactor 40 is relatively high. Under these circumstances, the winding 31 will be much more highly energized than the winding 30 so that switch blade 35 will be in its extreme left position wherein contacts 36 and 37 are in engagement and wherein the magnet 38 is holding the switch blade 35.

Under these circumstances, a circuit will be established to relay coil 16 as follows: from the upper terminal of secondary 78 through conductor 82, contact 72, contact arm 70, contact 73, conductor 83, switch blades 63 and 62, conductor 94, contact blade 35, contacts 36 and 37, conductor 95, heater 66, conductor 96, relay coil 16, and conductors 97, 86 and 87 to the other terminal of secondary 78. It will be noted that the circuit just traced is through the heating element 66 so that the establishment of this circuit not only results in the energization of relay 15 but also in the energization of heating element 66 so as to initiate the timing period of the safety switch 61.

The energization of relay 15 causes the switch blades 18, 19, and 20 to move into engagement with contacts 21, 22, and 23, respectively. The moving of switch blade 19 into engagement with contact 22 establishes a holding circuit to relay coil 16 as follows: from the upper terminal of secondary 78 through conductor 82, contact 72, contact arm 70, bimetallic element 69, conductor 98, switch blade 19, contact 22, conductor 99, switch blades 63 and 62, conductor 94, switch blade 35, contacts 36 and 37, conductor 95, heating element 66, conductor 96, relay coil 16, and conductors 97, 86 and 87 to the other terminal

of secondary 78. It will be noted that the new energizing circuit is independent of contact 73 so that even though the temperature rises sufficiently to cause disengagement of contact arm 70 from contact 73, the energization of the relay will not be terminated. A differential is thus interposed between the energization and deenergization of relay coil 16, thus avoiding any chattering in the operation of the relay.

The movement of relay switch blade 20 into engagement with contact 23 results in the following energizing circuit being established to the oil burner: from line wire 79 through conductor 101, switch blade 20, contact 23, conductors 102 and 103, oil burner motor 12 and conductors 104 and 105 to the other line wire 80. At the same time, a circuit is established to the ignition means 13 as follows: from line wire 79 through conductor 101, switch blade 20, contact 23, conductors 102 and 106, ignition means 13, and conductors 107 and 105 to the other line wire 80.

The establishment of the energizing circuit to the oil burner motor and to the ignition means results in the establishment of the conditions necessary for combustion and under normal circumstances, combustion will almost immediately take place. The resulting combustion will cause the heating of the hot junction of the thermo-couple 49 so as to result in the energization of saturating winding 46. As the temperature of the thermo-couple is gradually raised, the saturating winding is gradually energized to a greater and greater extent. This gradual change in the energization of the saturating winding produces a similar gradual change in the reactance of reactor 40 and consequently in the relative energization of relay coils 30 and 31. As the saturating winding becomes more highly energized, the reactance of reactor 40 is decreased and the energization of relay coil 30 with respect to that of relay coil 31 is increased. This tends to cause the armature 28 to rotate in a counter-clockwise direction to move switch blades 32 and 35 towards the right. The movement to the right of switch blade 35 is prevented by reason of the action of the magnet 38 thereon. Contact blade 32 is, however, free to move so that the engagement of contacts 33 and 34 is effected. Shortly after contacts 33 and 34 are moved into engagement, switch blade 35 is moved away from the magnet 38 so as to cause separation of contacts 36 and 37.

As soon as contacts 33 and 34 are engaged, a circuit is established to the relay winding 16 as follows: from the upper terminal of secondary 78, through conductor 82, contact 72, contact arm 70, bimetallic element 69, conductor 98, switch blade 19, contact 22, conductor 99, switch blades 63 and 62, conductor 94, switch blade 32, contacts 33 and 34, conductor 109, contact 21, switch blade 18, conductor 110, relay coil 16, and conductors 97, 86, and 87 to the other terminal of secondary 78. It will be noted that the new circuit is independent of the heating element 66 so that immediately upon the establishment thereof, heating element 66 is short circuited. As soon as contacts 36 and 37 are separated, the energizing circuit to heating element 66 is interrupted. Thus if combustion takes place within the period of time for operation of safety switch 61, the same is rendered inoperative to open the circuit controlled by switch blades 63 and 62.

Under normal circumstances, the operation of the burner continues until the temperature adjacent thermostat 68 has risen to the point where contact arm 70 is separated from contact 72. Under these circumstances, all energizing circuits to relay 16 are interrupted so that the operation of the oil burner and the ignition means is terminated.

If during operation of the system, combustion should be interrupted for some reason or other, the system will reestablish combustion if possible. The interruption of combustion will result in the hot junction 50 cooling off so as to cause the gradual deenergization of saturating winding 46. As the current flowing through saturating winding 46 decreases, the energization of relay winding 31 with respect to that of relay winding 30 increases so that the armature 28 is gradually moved in a clockwise direction and moves switch blades 32 and 35 towards the left. Since a certain amount of heat will be transmitted to the cold junction and the voltage produced by the thermo-couple is dependent upon the difference between the temperature of the hot and cold junctions, the energization of the saturating winding 46 will be decreased to a point sufficient to cause clockwise movement of armature 28 before the thermo-couple has cooled down to the temperature it assumed when combustion was first initiated. Thus, a much quicker response is obtained than if the current through winding 46 were dependent solely upon the temperature of the hot junction.

The clockwise movement of armature 28 causes first the disengagement of contacts 33 and 34. the contacts 36 and 37 are engaged only after the armature 28 has gradually moved to a point such that these contacts are almost in engagement. When the contacts are nearly in engagement, the magnet 38 will impart sufficient force to blade 35 to snap the blade the rest of the way. Due to the fact that the change in the reactance of reactor 40 is relatively slow due to the lag in the thermo-couple, the relay will be moved relatively slowly so that an appreciable period of time exists between the disengagement of contacts 33 and 34 and the engagements of contacts 36 and 37. Upon the disengagement of contacts 33 and 34, relay winding 16 is deenergized and operation of the oil burner and ignition means is immediately terminated. The separation of switch blade 18 from contact 21 as a result of the deenergization of relay winding 16 insures that the winding will not be reenergized by a fluttering reengagement of contacts 33 and 34 so as to cause a chattering of the relay. The oil burner and ignition means cannot be reenergized until contacts 36 and 37 are reengaged. During the intervening period, an opportunity is given for any accumulated gases in the furnace to pass out through the stack. In this manner, any danger of explosion due to the ignition of accumulated unburned gases is avoided. Upon contacts 36 and 37 being reestablished, the relay coil 16 is again reenergized by means of the originally traced energizing circuit through heating element 66. If the conditions which interrupted combustion were temporary, the cycle previously described will be repeated. If these conditions are permanent, however, the heating element 66 will be sufficiently energized to cause bimetallic element 64 to warp to the right causing switch blade 63 to separate from switch blade 62.

In the event of a momentary power failure, it is impossible for the burner and ignition means to come on immediately after restoration of

power causing the ignition of accumulated vapors. This is the case because of the fact that such a momentary power failure causes deenergization of relay 15 and, accordingly, separation of contacts 18 and 21. The separation of these contacts prevents reenergization of the relay except through contacts 36 and 37 so that it is necessary in order to start the operation of the system for contacts 36 and 37 to be in engagement and these contacts are in engagement only when the combustion chamber is relatively cooled.

Species of Figure 2

In the species of Figure 1, a thermo-couple was employed for energizing the saturating winding. In Figure 2, a different method of energizing this saturating winding is shown. In this species, a ceramic element 115 is positioned in the zone of combustion. The element 115 is of a type which has a substantial negative temperature coefficient of resistance. In other words, as the element 115 is heated up by reason of combustion taking place, the resistance thereof will drop appreciably. This element 115 is connected by conductor 116 to the input terminal 117 of a conventional copper oxide rectifier. The other input terminal 119 of the rectifier is connected by means of conductor 120 to a suitable alternating source of power which may be by means of the line wire 79. The other terminal of element 115 is connected by conductor 21 to the source of power through line wire 80. The output terminals 123 and 124 of the rectifier are connected to conductors 126 and 127 which are connected to the saturating winding 46 of the saturable core reactor.

From the foregoing, it will be apparent that the saturating winding is connected in series with the alternating source of power through the element 15 and the rectifier 118. Upon flame being established, the flow of current through this circuit is increased so that the flow of current to the saturating winding is increased as in the previous species. Similarly, upon combustion being terminated, the flow of current to the saturating winding is decreased. It will thus be seen that this portion of the system operates in substantially the same manner as the equivalent portion of Figure 1.

It will be seen that I have provided a new and novel fluid fuel burner control system wherein the need for the well known slip friction combustion responsive switches is entirely eliminated. This, moreover, is accomplished by the use of extremely simple apparatus.

While I have shown certain specific embodiments of my invention, it is to be understood that these are for purposes of illustration only and that the invention is limited only by the scope of the appended claims.

I claim as my invention:

1. In a fluid fuel burner control system comprising a fluid fuel burner, electrically operated means for controlling the flow of fuel thereto, and electrically operated cut-out means for terminating the fuel feeding operation of the flow controlling means at the end of a predetermined period of time after the system has been placed in operation; a relay having contacts for controlling the operation of said cut-out means, said relay comprising a pair of opposed coils and means for positioning said contacts in accordance with the relative energization of said coils, a variable impedance connected in parallel with one of said coils and in series with the other of said coils, and combustion responsive means for varying said impedance to thereby vary the relative energization of said coils.

2. In a fluid fuel burner control system comprising a fluid fuel burner, electrically operated means for controlling the flow of fuel thereto, and electrically operated cut-out means for terminating the fuel feeding operation of the flow controlling means at the end of a predetermined period of time after the system has been placed in operation; a relay having contacts for controlling the operation of said cut-out means, said relay comprising a pair of opposed coils and means for positioning said contacts in accordance with the relative energization of said coils, a variable impedance connected in parallel with one of said coils and in series with the other of said coils, and a thermo-couple exposed to the temperature of the combustion zone and operative to vary said impedance to thereby vary the relative energization of said coils.

3. In a fluid fuel burner control system comprising a fluid fuel burner, and electrically operated means for controlling the flow of fuel thereto, electrically operated cut-out means for terminating the fuel feeding operation of the flow controlling means at the end of a predetermined period of time after the system has been placed in operation; a relay having contacts for controlling the operation of said cut-out means, said relay comprising a pair of opposed coils and means for positioning said contacts in accordance with the relative energization of said coils, a variable impedance connected in parallel with one of said coils and in series with the other of said coils, and an element having a large temperature coefficient of resistance exposed to the temperature of the combustion zone and operative to vary said impedance to thereby vary the relative energization of said coils.

4. In a fluid fuel burner control system comprising a fluid fuel burner, electrically operated means for controlling the flow of fuel thereto, and electrically operated cut-out means for terminating the fuel feeding operation of the flow controlling means at the end of a predetermined period of time after the system has been placed in operation; a relay having contacts for controlling the operation of said cut-out means, said relay comprising a pair of opposed coils and means for positioning said contacts in accordance with the relative energization of said coils, a variable impedance connected in parallel with one of said coils and in series with the other of said coils, and an element having a large negative temperature coefficient of resistance exposed to the temperature of the combustion zone and operative to vary said impedance to thereby vary the relative energization of said coils.

5. In a fluid fuel burner control system comprising a fluid fuel burner, electrically operated means for controlling the flow of fuel thereto, and electrically operated cut-out means for terminating the fuel feeding operation of the flow controlling means at the end of a predetermined period of time after the system has been placed in operation; a relay having contacts for controlling the operation of said cut-out means, said relay comprising a pair of opposed coils and means for positioning said contacts in accordance with the relative energization of said coils, a saturable core reactor connected in parallel with one of said coils and in series with the other of said coils, said reactor being provided with a saturating winding, and combustion responsive means for controlling the energization of said

saturating winding to vary the reactance of said reactor and hence to vary the relative energization of said coils.

6. In a fluid fuel burner control system comprising a fluid fuel burner, electrically operated means for controlling the flow of fuel thereto, and electrically operated cut-out means for terminating the fuel feeding operation of the flow controlling means at the end of a predetermined period of time after the system has been placed in operation; a relay having contacts for controlling the operation of said cut-out means, said relay comprising a pair of opposed coils and means for positioning said contacts in accordance with the relative energization of said coils, a saturable core reactor connected in parallel with one of said coils and in series with the other of said coils, said reactor being provided with a saturating winding, and a thermo-couple exposed to the temperature of the combustion zone and connected to said saturating winding to vary the energization thereof thus varying the reactance of said reactor and the relative energization of said coils.

7. In a fluid fuel burner control system comprising a fluid fuel burner, electrically operated means for controlling the flow of fuel thereto, and electrically operated cut-out means for terminating the fuel feeding operation of the flow controlling means at the end of a predetermined period of time after the system has been placed in operation; a relay having contacts for controlling the operation of said cut-out means, said relay comprising a pair of opposed coils and means for positioning said contacts in accordance with the relative energization of said coils, a saturable core reactor connected in parallel with one of said coils and in series with the other of said coils, said reactor being provided with a saturating winding, and an element having a negative temperature coefficient of resistance exposed to the temperature of the zone of combustion and connected in series with a source of power to said saturating winding variably to energize the same and thus to vary the reactance of said reactor and the relative energization of said coils.

8. In a combustion responsive switch, a pair of oppositely disposed contacts, a pair of contact carrying blades movable between said contacts and each adapted to engage one of said contacts, a member for actuating both of said switch blades, means for moving said member in accordance with the presence or absence of combustion, and a magnet for restraining a first of said blades in engagement with its contact until the other blade has engaged its contact and then upon further movement of said member to release said first blade, said magnet being ineffective upon return movement of said blades to cause engagement of said first blade with its contact until after said other blade has separated from its contact.

9. In a combustion responsive switch, a pair of oppositely disposed contacts, a pair of contact carrying blades movable between said contacts and each adapted to engage one of said contacts, a member for actuating both of said switch blades, means for moving said member in accordance with the presence or absence of combustion and operative upon the cessation of combustion to move a first of said blades into engagement with its fixed contact and upon the establishment of combustion to move the other of said blades into engagement with its contact, and a magnet operative to restrain said first blade in engagement with its fixed contact upon the establishment of combustion until said other blade has engaged its contact and thereafter to release said first blade, said magnet being ineffective upon the cessation of combustion and the accompanying return movement of the blades to cause engagement of said first blade with its contact until after said other blade has separated from its contact.

10. In a fluid fuel burner control system comprising a fluid fuel burner, means for controlling the flow of fuel thereto, electrically operated cut-out means for terminating the fuel feeding operation of the flow controlling means at the end of a predetermined period of time after the system has been placed in operation, combustion responsive contact means comprising cold contacts and hot contacts, means operative during the closure of either said cold contacts or said hot contacts to cause said fuel controlling means to supply fuel to said burner, and means operative upon closure of said hot contacts to render said cut-out means inoperative; combustion responsive apparatus for controlling said contacts comprising an electromagnetic coil positioning said contacts, combustion responsive means for slowly varying the energization of said coil, and means associated with said contacts and cooperating with said coil upon a change in one direction in the energization thereof to cause first engagement of said hot contacts and then disengagement of said cold contacts and upon a change in the other direction to cause first disengagement of said hot contacts and then engagement of said cold contacts.

11. In a fluid fuel burner system comprising a fluid fuel burner, means for controlling the flow of fuel thereto, electrically operated cut-out means for terminating the fuel feeding operation of the flow controlling means at the end of a predetermined period of time after the system has been placed in operation, combustion responsive contact means comprising cold contacts and hot contacts, means operative during the closure of either said cold contacts or said hot contacts to cause said fuel controlling means to supply fuel to said burner, and means operative upon closure of said hot contacts to render said cut-out means inoperative; combustion responsive apparatus for controlling said contacts comprising an electromagnetic coil positioning said contacts in accordance with the degree of energization of said coil, combustion responsive means for slowly varying the energization of said coil and consequently the controlling position of said contact means, and means associated with said contacts and cooperating with said coil upon a change in one direction in the energization thereof to cause first engagement of said hot contacts and then disengagement of said cold contacts and upon a change in the other direction to cause first disengagement of said hot contacts and then engagement of said cold contacts.

12. In a fluid fuel burner control system comprising a fluid fuel burner, means for controlling the flow of fuel thereto, electrically operated cut-out means for terminating the fuel feeding operation of the flow controlling means at the end of a predetermined period of time after the system has been placed in operation, combustion responsive contact means comprising cold contacts and hot contacts, means operative during the closure of either said cold contacts or said hot contacts to cause said fuel controlling means to supply fuel to said burner, and means operative upon closure of said hot contacts to render said cut-out

means inoperative; combustion responsive apparatus for controlling said contacts comprising an electromagnetic coil positioning said contacts, means controlled by a thermo-couple exposed to the temperature of the combustion zone for slowly varying the energization of said coil, and means associated with said contacts and cooperating with said coil upon a change in one direction in the energization thereof to cause first engagement of said hot contacts and then disengagement of said cold contacts and upon a change in the other direction to cause first disengagement of said hot contacts and then engagement of said cold contacts.

13. In a fluid fuel burner control system comprising a fluid fuel burner, means for controlling the flow of fuel thereto, electrically operated cut-out means for terminating the fuel feeding operation of the flow controlling means at the end of a predetermined period of time after the system has been placed in operation, combustion responsive contact means comprising cold contacts and hot contacts, means operative during the closure of either said cold contacts or said hot contacts to cause said fuel controlling means to supply fuel to said burner, and means operative upon closure of said hot contacts to render said cut-out means inoperative; combustion responsive apparatus for controlling said contacts comprising an electromagnetic coil positioning said contacts; means including a saturable core reactor having a saturating winding whose energization is controlled by a thermo-couple exposed to the temperature of the combustion zone, said last named means being operative upon a change in the temperature of the combustion zone to slowly vary the energization of said coil, and means associated with said contacts and cooperating with said coil upon a change in one direction in the energization thereof to cause first engagement of said hot contacts and then disengagement of said cold contacts and upon a change in the other direction to cause first disengagement of said hot contacts and then engagement of said cold contacts.

14. In a fluid fuel burner control system comprising a fluid fuel burner, means for controlling the flow of fuel thereto, electrically operated cut-out means for terminating the fuel feeding operation of the flow controlling means at the end of a predetermined period of time after the system has been placed in operation, combustion responsive contact means comprising cold contacts and hot contacts, means operative during the closure of either said cold contacts or said hot contacts to cause said fuel controlling means to supply fuel to said burner, and means operative upon closure of said hot contacts to render said cut-out means inoperative; combustion responsive apparatus for controlling said contacts comprising an electromagnetic coil positioning said contacts, means controlled by an element exposed to the temperature of the combustion zone and having a large temperature coefficient of resistance for slowly varying the energization of said coil, and means associated with said contacts and cooperating with said coil upon a change in one direction in the energization thereof to cause first engagement of said hot contacts and then disengagement of said cold contacts and upon a change in the other direction to cause first disengagement of said hot contacts and then engagement of said cold contacts.

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