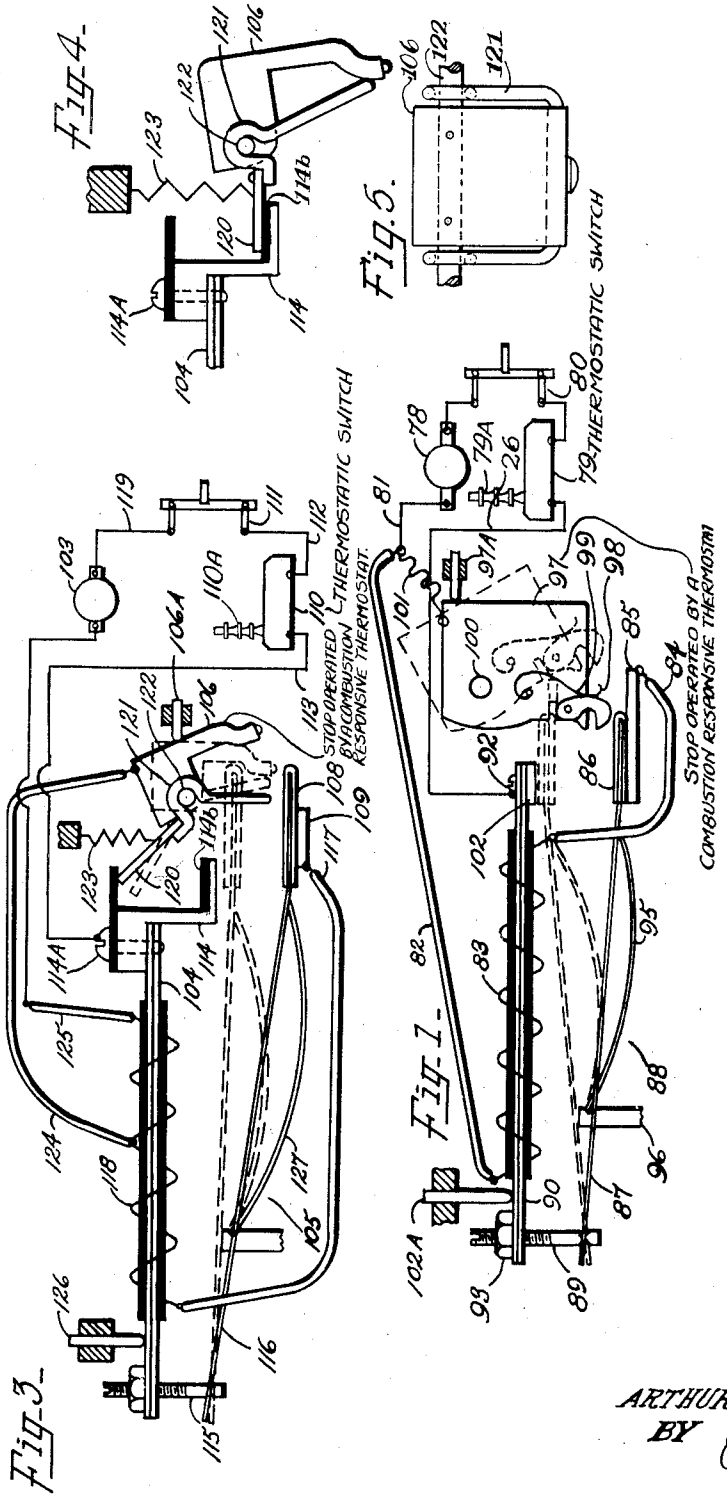
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ELECTRIC CIRCUIT CONTROL

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ELECTRIC CIRCUIT CONTROL

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This invention relates to improvements in the arrangement of electrical circuits and especially circuits for the control of the fuel supply to heating apparatus, particularly domestic oil burners.

It is an object of this invention to provide a control which permits the automatic operation of an electric motor which supplies fuel to the heating device under the control of a thermostat or hydrostat or by manual means and which automatically cuts off the source of power from the motor if within a predetermined time after the motor starts normal combustion conditions do not occur.

While this device is primarily intended for the use described its application is not limited to such use since it may be employed in a wide variety of circuits and it may be actuated by changes in pressure, temperature, drafts or humidity alone or in combination, or by manual control.

The accompanying sheets of drawings illustrate specific embodiments of the invention as applied to domestic oil burners of the electrically operated and thermostatically controlled type, but the invention is not limited to these embodiments.

In the drawing:

Figs. 1 and 3 are diagrammatic illustrations of the wiring of the controls in two different forms.

Fig. 2 is a top view of the snap spring assembly used in Figs. 1 and 3.

Figs. 4 and 5 are detailed views of one of the elements of Fig. 3.

The system of Fig. 1 includes a motor **78** for operating a liquid fuel burner of a building heating system (burner and heating system not shown). It includes, also, a thermostatic switch **79** responsive to the temperature of the room air and a knife switch **80** for making connection to a source of electric power (not shown). The room thermostatic switch **79** may consist of an electric switch of the type shown in United States patent to P. K. McGall 1,960,020, and an expansible liquid filled thermostatic bellows **92A** exposed to the air in the room or space to be heated. The circuit through the switch **79** and motor **78** is completed through conductor **81**, insulated conductor **82**, resistor **83**, insulated conductor **84**, fixed contact **85**, movable contact **86**, tension strip spring element **87** of spring assembly **88**, screw stud **89**, thermostatic metal blade **90** and conductor **91**. The thermostatic metal blade **90**, shown in the room temperature position, is deformed upwardly when heated by resistor **83** which surrounds it but which is separated therefrom by suitable insulating material such as mica. The blade **90** is mounted in cantilever fashion at **92** and has screw stud **89** mounted at its free end locked in position by nut **93**. The spring assembly **88** of the form shown in Fig. 2 comprises an elongated strip spring member **87** operatively mounted on a necked portion of the stud **89** which engages the notched hole **94**. The side spring elements **95** are compressively abutted against grooved or notched abutments **96** thereby putting member **87** in tension since the ends of elements **87** and **95** opposite their mounted ends are fastened together to form movable contact **86**. The operation of a snapswitch of this general type is described in Patent No. 1,960,020 except that in the present construction the snap movement of contact **86** is produced by the movement of the mounting point **94** of tension member **87** by stud **89**.

An abutment **97** with pivoted catch **98** and strip spring **99** mounted thereon, is mounted frictionally in a well-known manner on the end of the shaft **100** operated by the helical thermostatic member of a combustion responsive stack switch (not shown) of the heating system. This stack switch is located in the smoke flue of the liquid fuel burner to respond to the heat of combustion thereof. The abutment **97** is in the dotted position when the thermostatic spiral is cold. Upon heating of the cold spiral as a result of the combustion of the oil in the furnace, abutment **97** revolves clockwise to the position shown in full lines, that is, when normal ignition occurs. The passage of current through the circuit described including resistor **83** heats blade **90**. As the blade **90** is heated it moves upwardly and the tension center line of the spring **87** crosses the line of the pivoting grooves in abutments **96** causing the spring assembly **88** and especially movable contact **86** to suddenly snap upwardly and break the circuit through resistor **83**. In its upward motion the contact **86** moves catch **98** out of its path against the force of spring **99** but is stopped by abutment **97** which is in the full line position as a result of the rotation of the thermostatic spiral as described above. After the passage of the contact **86** the catch **98** again snaps into the position shown in full lines in Fig. 1, and thus prevents return of the contact **86** to its initial position as thermostatic blade **90** moves downwardly again. The catch **98** is electrically connected to abutment **97** whereby the electrical circuit from conductor **91** through blade **90**, stud **89** and spring assembly **88** is completed through flexible conductor **101** when contact **86** engages

either the catch 98 or the abutment 97. The resistor 83 is thereby disconnected from the circuit and the motor circuit completed by a path of negligible resistance. If, however, normal ignition does not occur the thermostatic spiral does not revolve shaft 100 so that abutment 97 and catch 98 remain in the position indicated by the dotted lines. When the spring assembly 88 snaps over under these conditions as a result of the heating of element 83 contact 86 clears catch 98 and abutment 97 and is carried up against stop 102 as shown in dotted lines thus opening the motor circuit. The heater element 83 and blade 90 cool and blade 90 returns to its cold position. The spring assembly 88 does not snap back to its initial position but remains in the position shown by the dotted lines since the tension center line of tension member 87 remains above the operative notches in abutments 96. The motor circuit is therefore held open until plunger 102A is manually depressed whereby the tension center line of member 87 is depressed below the operative notches in abutments 96 and thereby returns the spring 88 to its original position and again closes the motor circuit. Plunger 102A may also operate against tension strip spring 87. Also, if at any time during motor operation and after blade 90 has cooled to normal temperature, the stack temperature falls below a predetermined point, the counter-clockwise rotation of abutment 97 carries catch 98 from under the end of contact 86, allowing it to return to its initial position. This completes the circuit through resistor 83 and thermostatic blade 90 is again deformed causing the spring assembly 88 to snap into the upper position thus shutting off the motor. If such rotation of the abutment 97 occurs before blade 90 cools sufficiently to give the contact 86 a downward pressure, assembly 88 immediately snaps upward into the upper position as abutment 97 rotates sufficiently to release it, thereby opening the motor circuit. The rotation of abutment 97 in both directions is limited by stop 97A without limiting the movement of shaft 100 because of the frictional slip arrangement between shaft 100 and abutment 97. In Fig. 1 the support point of tension member 87 is raised and lowered by blade 90 with respect to the pivot points of compression members 95 on abutment 96 thereby operating spring assembly 88. This same relative movement of the tension member and the compression member pivot points for operating the switch also may be obtained by keeping the tension member support point fixed and attaching the abutment 96 to thermostatic blade 90 whereby the pivot points of the compression strip 95 move in a vertical direction causing the switch to operate when they cross the tension center line of tension strip 87.

Fig. 3, in which the cold condition of the control with the burner not operating is illustrated in solid lines, represents a modification of my invention shown in Fig. 1, which has the advantage that the motor 103 is stopped if a small drop in temperature occurs in the stack after ignition has been established and after thermostatic blade 104 has returned to its normal cool position. The spring assembly 105 immediately snaps over to the upper position upon anticlockwise rotation of abutment 106 instead of the movable contact 108 returning to engage the fixed contact 109 and thereby avoiding a continued operation of the motor 103 until the blade 104 is again heated. Upon closure of thermostat switch 110 current flows from switch 111 through conductor 112, switch 110, conductor 113, screw 114A, blade 104, stud 115, tension spring element 116, contacts 108 and 109, conductor 117, heating element 118, conductor 125, motor 103 and conductor 119 to switch 111. Heating element 118 is inductively wound about thermostatic blade 104, and insulated therefrom by material such as mica. Blade 104 is made of magnetic material and the circulation of current about it in the winding 118 causes a magnetic flux to be set up. This flux is communicated to iron bracket 114, which attracts iron armature 120 which armature is a portion of the element 121 loosely mounted on shaft 122 attached to the spiral thermostatic element. Since the element 121 is loosely mounted on the shaft 122 and is free to turn about the axis of that shaft, the attraction between armature 120 and the bracket 114 causes a movement of armature 120 against the force of a retractile spring 123 until the position shown in Fig. 4 is assumed, or until the element 121 stops against the abutment 126. In the position of Fig. 4, iron armature 120 has stopped against the insulator 114—*b* on the projection 114. The abutment 106 is attached to the shaft 122 frictionally in a well-known manner and when the stack temperature rises, due to the establishment of combustion, the abutment 106 is turned clockwise from the position shown in full line in Fig. 3 to that shown in dotted line, and carries the element 121 and the armature 120 into the position shown in dotted line in Fig. 3. Heating of blade 104 by element 118 causes it to be deformed upwardly and to carry with it the mounting of the tension spring element 116 causing the movable contact 108 to snap upwardly as previously described out of engagement with the fixed contact 109, and against the abutment 106. This action leaves the motor operating current passing through only the right half of the heating element 118 as it flows from contact 108 through abutment 106, conductor 124, a portion of heating element 118 to conductor 125. This causes thermostatic element 104 to remain heated sufficiently to hold contact 108 in engagement with abutment 106 during the period of motor operation. If, during the time thermostat switch 110 is closed, combustion fails while the motor 103 is in operation and the stack temperature falls, abutment 106 is moved in a counter-clockwise direction, carrying its lower point to the right out of the path of travel of the contact 108. The element 121 follows it into the position shown in Fig. 4 and contact 108 is free to snap into its upper position as shown in dotted line in Fig. 3. This opens the motor circuit and blade 104 cools until the entire spring assembly 105 takes the position shown in dotted line in Fig. 3. The motor circuit can be reclosed only by the manual operation of the plunger 126, which can be made to force the blade 104 or tension member 116 downward and carry the tension center line of spring element 116 across the operative mounting line of compression element 127 causing the entire spring assembly 105 to snap back into its full line or cold position.

When thermostat switch 110 opens and a normal shutdown of the burner occurs, abutment 106 rotates into the position shown in full line in Fig. 3 but the element 121 does not follow it since iron bracket 114 is demagnetized. Spring 123 causes armature 120 and the element 121 to assume the position shown in full line in Fig. 3. Contact 108 is thus prevented from snapping into its upper position as indicated in dotted line and

when blade 104 has cooled contact 108 snaps into engagement with contact 109 and the device is ready for another normal cycle of motor operations. The rotation of abutment 106 in both directions is limited by stop 106A without limiting the movement of shaft 122 because of the frictional slip arrangement between shaft 122 and abutment 106.

It will be apparent to those skilled in the art that the specific embodiments of the invention herein shown and described are offered merely by way of example and that the invention is capable of many modifications and variations. Accordingly, the invention is to be limited only in accordance with the appended claims.

I claim:

1. The combination with a heating device of a burner, a motor for operating said burner, a resistance heating element, an electric power supply for said motor and said heating element, a metallic thermostatic strip member mounted at one end and free to move at the other, said resistance heating element being adjacent said thermostatic strip member, and a multiple-position snap-switch comprising the combination of an elongated tension strip operatively mounted at the free end of said thermostatic strip member with the other end free to move, adjacent compression spring means of shorter effective length with an end thereof connected to the free end of said tension strip and stops comprising electric contacts between which said connected end portion moves, the opposite end of said spring means being pivoted at such a point laterally adjacent said tension strip that said spring means are in longitudinal compression, said mounting point of said tension strip being movable by said thermostatic strip across the plane of said compression spring means pivot point, one of said stops for said connected end portion being under the influence of combustion conditions of said burner, an electric circuit connecting said power supply, said motor, said resistance heating element, and the contacts of said switch, said switch and said circuit being so constructed and arranged that when said switch is in one position against one of said stops said electric power supply is connected with both said motor and said resistance element, and when said connected end portion of said switch is in contact with the stop which is under the influence of combustion conditions of said burner said motor remains connected to said power supply and said resistance element is disconnected therefrom, and when a predetermined temperature is developed in said resistance element and said combustion-influenced stop is not subjected to combustion conditions said connected end portion snaps into a position out of contact with both of said stops and disconnects both said motor and said resistance element from said power supply.

2. In combination in a device of the class described, a spring toggle snap mechanism including a bimetallic thermal actuator and an electric contact making follower, a first fixed stop for said follower, said first fixed stop constituting an electric contact, a second fixed stop for said follower, a removable stop for said follower, said removable stop constituting an electric contact and being movable into and out of operative position, an electric heater for said thermal actuator, said heater being connected between said first fixed stop and said removable stop, said removable stop and said follower being connected in an electric circuit to control it, said follower being so constructed as to snap from the position of the first fixed stop to that of the removable stop in response to movement of said actuator when warmed by said heater, and to snap from the position of the removable stop to that of the first fixed stop in response to a return movement of said actuator upon normal cooling thereof, said follower requiring, in order to snap away from the third fixed stop, a movement of said actuator through a distance in excess of that resulting from said normal cooling thereof, said actuator being movable manually through said excess distance, whereby, (1) when said follower engages said first fixed stop said heater is connected in the circuit to be controlled, (2) when said follower engages said removable contact said circuit is closed but excludes said heater, and (3) when said follower engages said second fixed stop said circuit is open.

3. The combination of the immediately preceding claim wherein said removable stop includes a catch so constructed and arranged that it retains said follower next said removable stop when said removable stop is in operative position, said catch being constructed and arranged to release said follower in response to said removable stop moving out of operative position.

4. In combination with an electric machine, a resistance element, an electric power supply for said electric machine and said resistance element, a combustion device, an automatic multiple-position switch having three operated positions thereof, an electric circuit connecting said power supply, electric machine, resistance element and switch, said switch and said circuit being so constructed and arranged that said switch in its initial position connects both said electric machine and said resistance element to said power supply, means operable in response to heating of said resistance element to operate said switch out of the initial position thereof to disconnect simultaneously said resistance element and said electric machine from said power supply, an electric contact movable into the path of the movable element of said switch to restrict the movement thereof, said electric contact being so connected in said electric circuit as to provide an electrical connection of said power supply with said electric machine without including said resistance element, means operable upon establishment of combustion to introduce said electric contact into the path of said movable element of said switch, said movable element and said electric contact being so constructed and arranged that said movable contact moves unrestricted from its initial position beyond said electrical contact to open circuit position should said combustion responsive means fail to move said contact into position to restrict the movement of said movable element.

5. In combination, an electric machine, a spring snap switch including a thermal actuator and a snap follower, a pair of fixed stops for said follower, a removable stop for said snap follower movable into and out of operative position, an electric heater for heating said thermal actuator, an electric power supply, circuit connections between said power supply, said heater, said electric machine and said switch, said follower being so constructed that it snaps back and forth between the position of the first fixed stop and the operative position of the movable stop in response to the heating and cooling of said thermal actuator, said follower being so constructed that it snaps away from the second fixed

stop only in response to an excursion of said actuator greater than that required to cause said follower to snap between said first fixed stop and the operative position of said removable stop, and control means for moving said removable stop into and out of operative position, said snap switch including contacts operated by said follower, said switch and said circuit being so constructed and arranged that said switch controls said heater, and, through its control of said heater, causes itself to operate out of the position of said first fixed stop.

6. The combination of the immediately preceding claim wherein said removable stop includes a catch so constructed and arranged that it retains said follower next said removable stop when said removable stop is in operative position, said catch being constructed and arranged to release said follower in response to said removable stop moving out of operative position.

7. The combination of an electric machine, a resistance element, an electric power supply for said resistance element, a three position switch having moving and stationary contacts, and having a normal position and two operated positions for a moving contact, said switch including a thermal actuator operating under the heating influence of said resistor element to move said moving contact between said normal position and the first of said operated positions and into the second of said operated positions, said thermal actuator being so constructed that it tends to move said moving contact into said normal position when said resistance element is deenergized, and circuit connections between said switch, power supply, and resistance element (1) for energizing said resistance element and electric machine when said moving contact is in said normal position, (2) for energizing only said electric machine when said moving contact is in said first operated position, and (3) for deenergizing both said resistance element and electric machine when said moving contact is in said second operated position, and control means operable to determine whether said switch, when operating said moving contact out of said normal position, moves said contact into said first operated position or into said second operated position.

8. In combination, an electrical device, a snap acting thermostat having a thermal element heated by said electrical device and having also a snap-acting electric contact operable to snap into a first extreme position in response to a temperature change of said thermal element, and to snap from said first extreme position toward a second extreme position in response to an opposite temperature change, a movable obstruction movable into obstructing position to stop said snap-acting contact in an intermediate position and thereby prevent it from moving into said second extreme position and movable therefrom into contact freeing position to release said snap-acting contact for snapping beyond said obstruction into said second extreme position, and another electric contact cooperating with said movable contact for controlling the energization of said electrical device.

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