FAIL-SAFE CONTROL

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References Cited
UNIVERSAL PATENTS
2,686,250 8/1954 Schroeder 219/510 X

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Abstract

A control of the type having a bistable mechanism operable in accordance with condition responsive means to affect opening and closing of snap-acting switch means series connected to directly control an electrical operation including means for providing fail-safe operation of the control which assure that the snap-acting switch means is in an open or non-energizing position upon failure of the condition responsive means.

12 Claims, 3 Drawing Figures
FAIL-SAFE CONTROL

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention pertains to the art of controls and particularly to oven control systems for cooking ovens.

2. Description of the Prior Art

Hydraulic type oven controls which use a bistable mechanism subject to adjustment by the oven user to obtain a given oven temperature range, and operated in cooperation with oven temperature responsive means which control snap-acting switch means, with the switch means in series to directly control energization of the oven heaters are conventional in this art. However, failure of the hydraulic temperature responsive means for any reason, will cause a loss of temperature control. The applicant is aware of no art wherein means are included which assure that the oven control will assume an open circuit position upon failure of the hydraulic temperature responsive means as the present invention provides.

SUMMARY OF THE INVENTION

In accordance with the invention, a fail-safe oven control is provided in which a snap-acting overcenter mechanism operates a switch contact means connected in series with the heating means in an oven, in cooperation with an oven temperature responsive means to control the temperature setting at which the oven temperature responsive means affects the cycling of the switch means. Means are included to assure that the snap-acting overcenter mechanism operates the switch contact means to an open circuit position upon failure of the oven temperature responsive means.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a rear face view of a thermostatic oven control according to the invention with the rear cover or removed;

FIG. 2 is a vertical section taken along line II—II of FIG. 1, but with the rear cover of the control in place;

FIG. 3 is a schematic view of a circuit for a control system for a self-cleaning pyrolytic oven including the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The main parts of the oven control are shown in FIGS. 1 and 2. The casing 10 for the control is a molded plastic, generally box-shaped member with an intermediate wall 11 separating the interior into opposite, outwardly open front and rear chambers 12 and 13, respectively. The front chamber 12 and rear chamber 13 are enclosed by removable covers 14 and 15.

The front chamber 12 basically contains the circuit switching arms and contacts and the operable mechanism for setting the thermostat. The rear chamber 13 essentially contains the bistable mechanism which operates the main switch means for the oven heater, the hydraulic wafer which exerts the force upon the bistable mechanism in accordance with oven temperature variations; and the failsafe control means.

The locations of the contact terminals on the exterior of the casing through which the control is connected into the circuits in which it functions are best seen in FIG. 1. These terminals are identified as 1, 2, 4, 5, 6 and 7 to correspond with the terminal indicia to be provided on proposed commercial controls. These numeric designations also correspond to the numerals shown in FIG. 3.

Electrically conductive strips which terminate in the exterior terminals are riveted to the casing 10 and are provided with the same numeral as the terminal plus a suffix letter A to indicate an electrically common connection. As an example, in FIG. 2 the strip 5A is seen, and in FIG. 1 strips 1A, 2A, 8A and 9A are seen.

A pair of contact spring arms 8 and 9 with only 8 seen in FIG. 2 are located in the front chamber 12. Spring arm 8 is anchored at its right end as seen in FIGS. 1 and 2 by extending through a slot in the intermediate wall 11 into the rear chamber 13. The spring arm 8 is riveted to the intermediate wall and carries contact 8C thereon. The spring arms 8 and 9 serve to affect circuit selections in accordance with the particular oven operation that is to be carried out by rotating cam 16, FIG. 2.

The main or cycling switch arrangement generally designated 17 in FIG. 2 includes a pair of electrically conductive bridging strips 18 carried in spaced apart electrically insulated relation by the plastic carrier 19 upon which they are secured in loosely held relation to accommodate proper seating upon the contacts which they bridge. When the cycling switch 17 is closed, the one strip 18 bridges from contact 2h. FIG. 2, to 8c while the other bridges from 1b to 9c. The carrier 19 is attached to a spring arm or leaf 20 which has, at its right end as seen in FIGS. 1 and 2, a T-shaped end 21 which seats in a niche 22 formed in the casing material. The left end of the arm 20 is received in an indent at one end of a curved overcenter spring 33 which has a dimple 24 at its opposite end. The dimple 24 seats on the point of an adjusting screw 25 turned into the left end wall of the casings 10. The arm 20 is fulcrumed at an intermediate location against the end of a movable pin 26. A pressure wafer 27 is connected by a capillary tube 28 to an oven temperature sensitive bulb, not shown. The wafer 27 bears against the spring arm 20 at a location between the pin 26 fulcrum location and the left T-shaped end 21.

The general way in which the main or cycling switch 17 works is as follows as viewed in FIG. 2. With an increase in oven temperature the pressure wafer 27 exerts a correspondingly increasing force downwardly on the arm 20 at the bearing location between the fulcrum 26 and the end 21. When the force provided by the pressure wafer exceeds the balancing force of the overcenter spring 23, the overcenter spring 23 snaps the cycling switch carrier 19 upwardly. The carrier 19 is stopped by the inwardly projecting springs 29 extending from the cover 15. Thus, the main switch 17 to the oven heaters is opened. As the temperature in the oven decreases below a given temperature, the pressure wafer 27 retreats with the slightly bowed spring arm 20 following so that at a given point it will cause the carrier to snap back to close the cycling switch 17. Thus, the mechanism is a bistable mechanism in that it remains in either of two positions until external forces derived from a temperature change in the oven causes it to change positions. It will be appreciated that by moving the pin 26 in an axial direction, the temperature setting of the control may be changed.

The general arrangement of the cycling switch 17 with an overcenter snap-action, having its operation controlled by the relationship between user operated
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positional means such as shaft 26, and pressure wafer 27 is commonly known in the art. Nor is it new to provide the circuit selecting arrangements with the spring arms 8 and 9 and the contact terminal arrangement as previously described. The arrangement, whereby most of the rotation of a user shaft 30 controls the selection of temperatures in the cooking range, while a relatively minor part of the rotation moves the pin 26 axially a sufficient distance to set up a selected operating temperature is known. The structure indicated as 31 accomplishes this and may best be understood by referring to U.S. Pat. No. 3,648,012.

In the mechanism as described so far, if during operations of the range, for any reason, the pressure in the pressure wafer 27 would be lost, the cycling switch 17 would remain in the closed position with the bridge contacts 18 against the various circuit terminal connections. However, this possibility is precluded by the present invention, wherein a wafer bias spring 70 formed in a generally C-shaped configuration is clamped around the wafer 27 with one section fitting between the wafer 27 and the bearing point on the arm 20. In the absence of hydraulic pressure within the wafer 27, the spring 70 acting in compression will cause the wafer 27 to return to its unexpanded or most upward position in FIG. 2. A leftward arm 72 of the bias spring is extended toward the plastic carrier 19. A lifting bracket 74 formed generally in the shape of a Z, as shown in FIG. 2, is connected to the plastic carrier 19 and the arm 20. An upper leg 76 of the lifting bracket 74 extends outwardly toward the leftward arm 72. The upper leg 76 overlaps in spaced apart relation, the leftward arm 72. An adjustment screw 78 is screwed into the upper leg 76 of the lifting bracket 74 and is held in place by a lock nut 79. The adjustment screw 78 is turned into the upper leg 76 of the lifting bracket 74 sufficiently so that when loss of pressure occurs in the wafer 27, and the bias spring 70 compresses the wafer 27, the leftward arm 72 of the bias spring 70 moves in an upward direction in FIG. 3, and contacts the adjustment screw 78 forcing it and the lifting bracket 74 in an upward direction. This causes the carrier 19 to be lifted from the contacts. The circuit is now open and the heating elements of the oven cannot be electrically energized.

The adjustment screw 78 provides the necessary adjustment, to compensate for tolerance variation and, also to place the screw 78 in a position which assures the travel of the leftward arm 72 will cause the main cycling switch 17 to open upon pressure failure in the wafer 27. The compression of the wafer 27 resulting from the spring force of the bias spring 70 is sufficient to return the wafer to its unexpanded position but not strong enough to inhibit movement of the wafer 27 in response to oven temperatures.

In the preferred embodiment the wafer 27 is designed designed to start to expand, that is leave its internal mechanical stop at 50°F, this temperature, the off-stop temperature, was arrived at after considerations of oven function and the strength and life of available material. Under normal conditions, the bias spring 70 is always extended by an amount equal to the wafer expansion, that is, the difference between the off-stop temperature, 50°F, and the normal room ambient. If for any reason the ambient temperature drops to the off-stop temperature, the switch 17 will be open as described above. Because of this the fail-safe operation can be field checked by merely submerging the bulb in a tray of ice water and checking to assure the heating element cannot be energized.

It is currently contemplated that the fail-safe feature provided by the invention will be incorporated in an oven control used in a domestic oven as shown in FIG. 2. However, the invention could be used in various known controls which utilize a condition responsive means such as, some range burner controls and some washer controls.

In FIG. 3, the major components of the control system, in addition to the control 10 are shown. These include the oven operation selector switch 48, a lock assembly 49 for the purpose of insuring that a cleaning operation cannot occur without the oven door 44 being locked during the high temperature operation at latch 45, a bake heating element 50, a broil element 51 and an optional auxiliary broil heating element 52. All of the heating elements, of course, are located within the oven 46 which is schematically illustrated.

For purposes of understanding the invention, it is considered unnecessary to detail the particular circuits which are energized and all the various cooking operations and cleaning operation. For those who wish to examine which switches are closed for various operations, reference should be had to U.S. Pat. No. 3,648,012 which provides this information. Further details of the door lock assembly and switching means, therefore, are disclosed in U.S. Pat. No. 3,752,954.

Although the invention has been described above as being associated with a hydraulic temperature sensing means the invention is not limited to this system. The fail-safe feature of the invention could be equally adapted to systems using condition responsive means comprising bimetallic mechanisms, bourdon tubes and differential expansion systems.

From the foregoing description taken along with the drawings, it can be seen that the invention has provided a means of assuring fail-safe operation of a control utilized as the main cycling switch of an electrically heated cooking oven.

I claim:

1. An oven control comprising: a snap-action switch means adapted to be series connected to an oven heating means for directly controlling the energization of said oven heating means; a bistable mechanism for controlling said snap-action switch means; oven temperature responsive means acting upon said bistable mechanism to effect opening and closing of said snap-action switch means in accordance with oven temperature variations; means for fail-safe operation of said control which are non-operative during normal operation of said temperature responsive means and upon failure of said oven temperature responsive means moves said snap-action switch means to an open position deenergizing said oven heating means.

2. The oven control of claim 1, wherein: said means for fail-safe operations comprises bias spring means which return said temperature responsive means to a predetermined position upon failure of temperature responsive means and, linkage means connected with said spring means which operate said snap-action switch means to an open position.

3. An oven control according to claim 1, wherein:
said oven control is connected to control said oven heating means for a oven adapted for both cooking and a cleaning operation.

4. The oven control of claim 2, wherein:
said linkage means includes means for position adjustment of said linkage means to assure proper operation of said control.

5. In a control comprising a condition responsive sensing means for cooperating with a bistable mechanism in controlling snap-action switch means, which switch means control an electrical operation in accordance with a predetermined external condition, a fail-safe assembly, said fail-safe assembly comprising:
means which are non-operative during normal operation of said condition responsive means for assuring said snap-action switch is in an open deenergizing position upon failure of said condition responsive sensing means.

6. In the control of claim 5, wherein said means for assuring said snap-action switch is in an open deenergizing position comprises:
- a bias spring which returns said condition responsive means from a condition sensing position to an off position; and,
- linkage means mechanically attached to said snap-action switch means which linkage means is engaged by said bias spring to move said snap-action switch means from a closed energizing position to an open deenergizing position upon failure of said condition responsive sensing means.

7. A thermostat control comprising a switch, temperature responsive means having an output member moveable as a function of temperature sensed thereby and connected to operate said switch, said output member being located in a normal range of positions during normal operation and being moveable to a failure position outside said range upon failure of said temperature responsive means, said output member operating to open and close said switch by movement within said normal range and moving said switch to a fail-safe position when said output member moves to said failure position.

8. A thermostat control as set forth in claim 7 wherein said thermostat includes fail-safe means operable to move said switch to said fail-safe position and which are rendered inoperative by said output element when the latter is in its normal range of positions.

9. A thermostat control as set forth in claim 8 wherein said fail-safe means includes a spring biasing said output member toward said fail position.

10. A thermostat as set forth in claim 9 wherein said switch is adapted to be connected to and to control an oven heater, and said fail-safe means open said switch upon failure of said temperature responsive means.

11. A thermostat control as set forth in claim 10 wherein said temperature responsive means includes a fluid the pressure of which responds to oven temperature, and said output member moves to said fail-safe position when said fluid escapes.

12. A thermostat comprising switching means adapted to be connected to a heating system to control the operation thereof, a fluid pressure operated temperature responsive means having a control fluid and a moveable output member operable when response to changes in pressure of said control fluid resulting from changes in temperature sensed by said temperature responsive means, switch operating means connecting said output member to said switching means, said output member being moveable within a normal range of positions in response to pressure resulting from temperatures at least equal to normal environmental temperatures and being moveable to a fail position outside said range of positions upon loss of said control fluid, said switch operating means opening and closing said switching means in response to movement of said output member within said normal range and moving said switching means to a fail-safe position in response to movement of said output member to said fail position.