

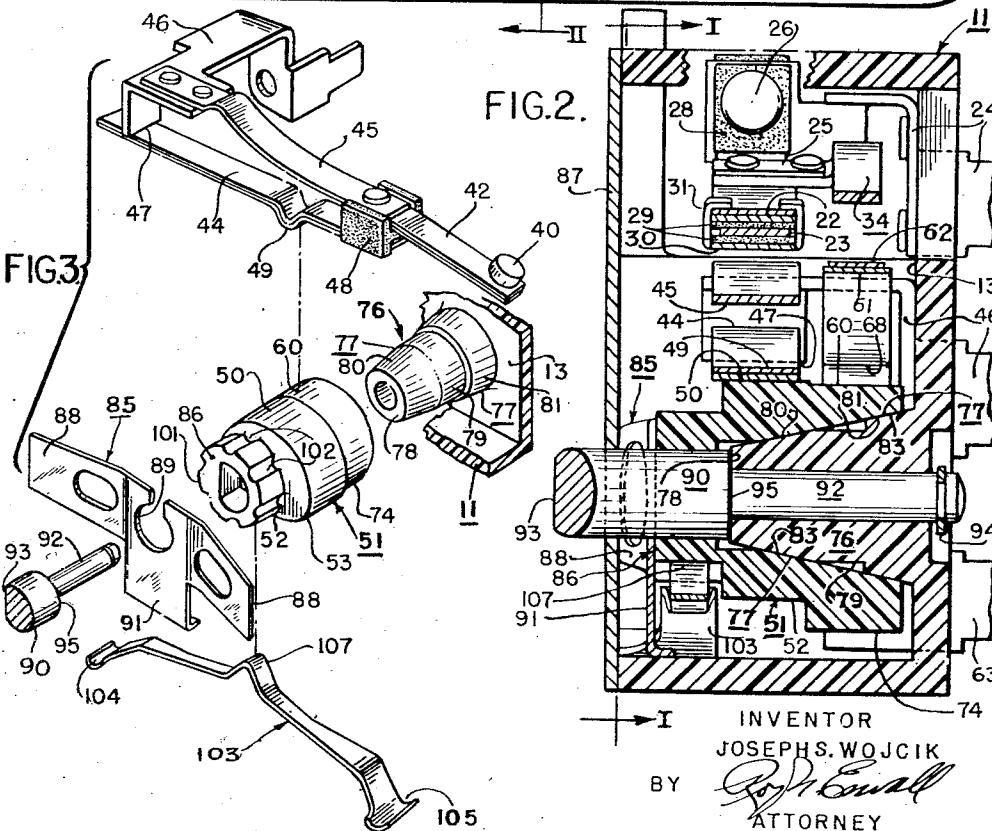
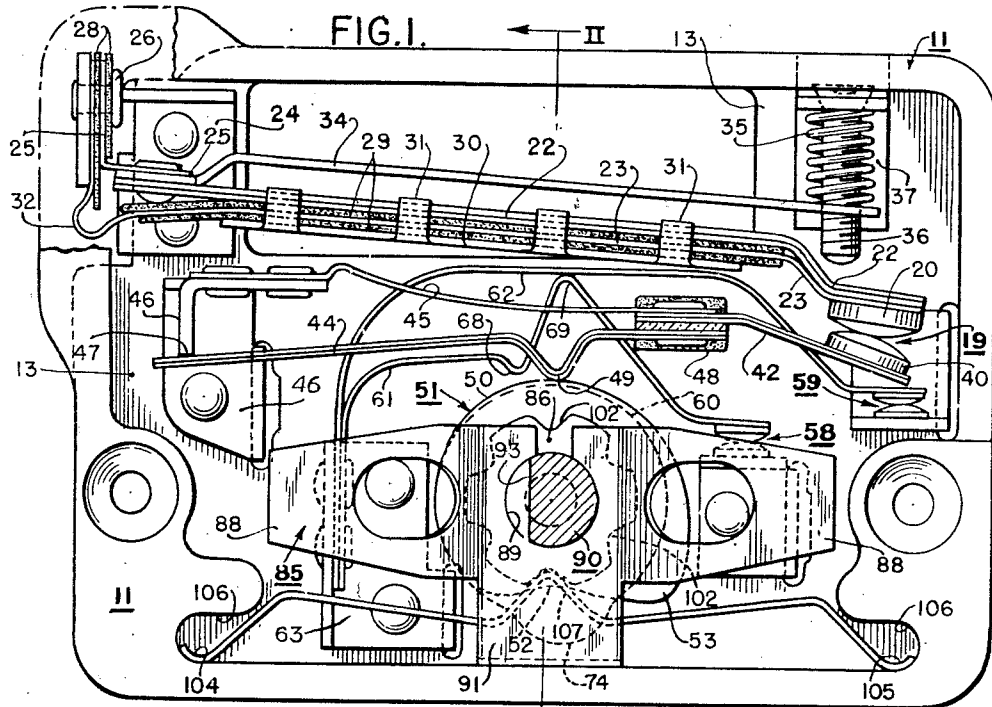
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HEATING UNIT CONTROL

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1

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HEATING UNIT CONTROL

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This invention relates to a thermally actuated cycling switch for controlling the rate of energization of a surface heating unit for an electric range or the like and is more specifically related to the cam construction for adjusting a switch of this type.

It is an object of this invention to provide, in a thermally actuated cycling switch of the above-mentioned type, improved means for manually adjusting the cycling of the switch, which means may be readily manufactured and easily assembled and is substantially unaffected by normal wear.

Another object of this invention is to reduce the wobble or eccentric movement of a rotatable switch adjusting cam relative its axis of rotation.

In accordance with this invention, a thermal cycling switch is provided with a novel adjustable cam construction and mounting for actuating an adjustable contact carrying arm to any of a plurality of positions for selectively varying the cycling operation of the switch.

The cam is rotatable and is positioned to adjust the arm by engaging and moving a portion of the latter in a direction that is substantially radial relative the cam's axis of rotation. A conical bearing surface is provided on the switch casing coaxial with the axis of rotation of the cam to support the latter. A complementary conical recess is formed in the cam to engage this conical bearing surface and accurately position the cam to prevent any wobble or lateral movement thereof. A spring means is provided to hold the tapered or conical bearing surfaces in engagement.

These and other objects are effected by the invention as will be apparent from the following description taken in connection with the accompanying drawings, forming a part of this application, in which:

Fig. 1 is a front elevation of a switch incorporating this invention, with the front cover thereof removed;

Fig. 2 is a vertical section taken along the line II—II of Fig. 1, with the front cover in place and showing a cross section of the cam assembly; and

Fig. 3 is an exploded view showing in perspective the cam, the cam supporting member, the adjustable switch arm, the cam shaft and the springs which cooperate with the cam in the manner shown in Figs. 1 and 2.

The thermally actuated cycling switch assembly comprises an open-front, box-shaped casing 11 of insulating material having a base or rear wall 13. A main switch 19 supported within the casing comprises a cycling contact 20 and an adjustable contact 40. The cycling contact 20 is supported on the free end of a main thermally actuated bimetallic strip member 22 that has an auxiliary heater strip 23 adjacent thereto. The bimetal 22 deflects upwardly when heated to move contact 20 in the direction away from contact 40. The other end of the bimetallic strip 22 is pivotally supported on a terminal 24 by a flexible hinge strip 25. The heater strip 23 has one end connected to the cycling contact 20 and extends along the bimetal 22 on the high expansion side thereof, and

2

its other end is riveted to the terminal 24 at 26. Thin mica sheets 28 insulate the hinge strip 25 to prevent the bimetallic strip 22 from electrically shunting the heater 23. Mica sheets 29 are provided on both sides of the heater strip along the main bimetal 22, and a brass plate 30 having a plurality of ears 31 bent around the edge of the main bimetal 22 holds the heater strip 23 in good heat transfer relationship with the latter. A small loop 32 is formed in the heater strip 23 adjacent the terminal 24 to minimize the effect of expansion and contraction of the strip on the deflection of the main bimetal 22. The base of the casing is partially cut away to the rear of the main bimetal to permit the circulation of air there-through.

The main bimetal 22 may be pivotally adjusted by means of a rigid L-shaped lever 34 having its short arm fastened thereto adjacent the terminal 24. An adjusting screw 36 is threaded in the longer arm of the lever 34 and extends through a hole in a metal bracket 37 attached to the base 13. The lever 34 is biased away from the bracket 37 by a coil spring 35 and its position together with that of the supported end of the bimetal 22 is adjustable by rotating the screw 36.

The adjustable contact 40 is positioned to cooperate with the cycling contact 20 by a subassembly shown in Fig. 3, comprising a contact accelerating bimetallic strip 42, a compensating bimetallic strip 44 and a resilient strip 45. The ends of these bimetal strips 42 and 44 tend to deflect upwardly when heated to move contact 40 in the direction of contact 20.

The resilient strip 45 has one end attached to a stationary terminal 46. The bimetal strip 42 is attached at one end to the free end of the strip 45 and supports the adjustable contact 40 on its other end in a position to cooperate with the cycling contact 20. The compensating bimetal 44 is secured at one end to the adjacent ends of the strip 45 and the bimetal 42 and is thermally insulated from the latter by a ceramic member 48. The other end of the bimetal 44 engages a bearing surface 47 formed by the terminal 46.

A portion 49 of the compensating bimetal 44 intermediate its ends is biased by the resilient strip 45 into engagement with an active surface 50 of a cam member 51, the latter being rotatable about an axis normal to the common plane of deflection of the three bimetallic strips 22, 42 and 44, i. e., parallel to the rear wall 13.

The active cam surface 50 is generated by a line generally parallel to the axis of rotation of the cam 51 moved thereabouts to form a low or off portion 52, a high or full heat portion 53 and an infinite number of intermediate portions for positioning the compensating bimetal 44 and its associated contact 40 to provide various rates of energization of a main heating element to be controlled. The cam surface 50 operates in each of its adjusted positions as a fulcrum, causing the force exerted by the strip 45 on the end of the compensating bimetal strip 44 to pivot the latter to maintain its other end in abutment with the fixed bearing surface 47. Since the bimetal 44 acts as a lever to position contact 47, any bowing of this lever in response to a change in ambient temperature will adjust the position of the contact 40 to effect ambient temperature compensation as described hereinafter.

The cam has a second active surface 60 generally parallel to the cam axis and positioned to the rear of the surface 50 for the actuation of a pair of L-shaped spring arms 61 and 62. These arms operate a pilot light switch 58 and a line switch 59, respectively, and have fixed ends fastened together on a terminal 63. The free end of the arm 61 supports the movable contact of the switch 58. Both spring arms 61 and 62 are self-biased toward the cam surface 60 and one intermediate portion 68 of the spring arm 61 projects toward the cam surface

60 to form a cam follower, whereas an adjacent portion 69 extends in the opposite direction to engage the other spring arm 62 intermediate its ends to move the latter in response to movement of the cam 51. The free end of the spring arm 62 supports the movable contact of the switch 59. All of the above-mentioned terminals and those supporting the stationary contacts of switches 58 and 59 are provided with portions extending beyond the outer surface of the base 13 for making external electrical connections thereto.

When the cam 51 is adjusted to the "off" position, the compensating bimetal 44 rests on the low point 52 of the cam surface 50 and the contacts of switch 19 are kept open. At the same time the spring arm 61 is engaged by the highest point 74 of the cam surface 60 to open the contacts of both switches 58 and 59.

When the cam 51 is adjusted to any "on" or active position, both switches 58 and 59 are closed and the contacts of switch 58 support the strip 61 out of engagement with the cam surface 60, as shown in Figs. 1 and 2, and the cam surface 50 adjusts the compensating bimetal to position the contact 40 in active engagement with the contact 20.

The relationship of the main bimetal 22, the bimetal 42 and the compensating bimetal 44 and the manner in which they are adjusted to operate the switch 19 is described and claimed in the copending application of Gerard H. Risacher and Harold P. Allen, Serial No. 516,964, filed June 21, 1955, and assigned to the assignee of the present invention.

In accordance with the present invention, the cam 51 is supported by means comprising a conically tapered bearing member 76 fixed to the rear wall 13 with its axis normal thereto and coaxial with the cam 51, its conical surface 77 being tapered in the direction away from the rear wall 13. This bearing member 76 has a flat end 78 normal to its axis and an intermediate portion of the surface 77 is cut away, as shown at 79, to form two radially and axially spaced surface portions or rings 80 and 81. The cam 51 has a complementary recess providing an interior conically tapered surface 83 that slips over the bearing member 76, and two axially spaced portions or rings of the tapered surface 83 at all times engage the two bearing surface portions 80 and 81 to firmly support the cam and prevent wobble or eccentric movement thereof. By removing the central band of the conical surface 77, there is greater assurance that the conical surfaces 77 and 83 will nest to provide wobble-free support of the cam. The cam will be stable by being supported at axially spaced points, and irregularities in the central portion of these conical surfaces and foreign particles therebetween are less likely to interfere with the operation of the cam to select a desired cycling operation of the switch.

Each of the active cam surfaces 50 and 60 encompasses a portion of both the stationary conical surface 77 and the interior conical surface 83. The conical bearing surfaces shown in the drawing extend continuously around the axis of the cam. Each surface may be considered as made up of a large number of conical segments, a few of which would be sufficient, when spaced about the axis and inclined thereto at the same angle, to practice this invention.

The cam 51 is biased into engagement with the bearing member 76 by means of a leaf spring 85 positioned between the front face 86 of the cam and a cover 87 closing the open-front side of the casing 11. Outer end portions 88 of the spring 85 press against the cover 87 and the central portion engages the face 86 of the cam and has an opening 89 therein to accommodate an adjusting shaft 90 for rotating the cam. A side extension 91 of the leaf spring 85 abuts the wall of the casing 11 to hold the spring 85 in a fixed position as the cam 51 and the adjusting shaft 90 are rotated.

The cam surface 50 is designed to have a predetermined

rate of rise about an axis that must be made to substantially coincide, within close limits, with the axis of the conical surface 83 so that the switch will operate in a desired manner in each position of the cam. However, the location of the surface 83 along the axis of the cam is not as critical, since considerable axial movement of the cam 51 can be tolerated in any of its adjusted positions without affecting the operation of the switch. For the same reason, wear of the conical surfaces 77 or 83, taken up by axial movement of the cam, will not affect the cycling operation of the switch.

The adjusting shaft 90 extends coaxially through the cam 51 and has a reduced portion 92 extending through the bearing member 76. The shaft 90 is provided with a flat surface 93 to key it to the cam, while the reduced portion 92 of the shaft is permitted to rotate in the bearing member 76 and is held therein by means of a lock ring 94 on the end of the shaft. The shaft 90 may have a sliding fit with the cam 51 to permit slight axial movement of the shaft without affecting the position of the cam and to permit axial forces on the shaft to be transmitted from the shoulder 95 to the face 78 and through the bearing member 76 to the base 13, preventing damage to the cam.

The cam 51 is provided adjacent the cover 87 with a cylindrical surface 101 having a plurality of notches 102 therein spaced about the shaft 90. A leaf spring 103, having opposite ends 104 and 105 supported and held against endwise movement in recesses 106 in the casing wall 12, has a detent 107 at its center biased upwardly, as shown in Fig. 1, into engagement with the surface 101. The detent 107 and the notches 102 permit the cam 51 to be readily adjusted to any one of a plurality of distinct active positions and to an off position. However, the cam 51 may be adjusted to an infinite number of positions in which the detent 107 does not slip into one of the notches 102, but rather rides on a portion of the surface 101 of the cam between the notches.

The switch described above is designed so that the circuit through the bimetal heater 23, the contacts of the main switch 19 and the bimetal 42 will be connected in series between one conductor of a power source and a heater to be controlled, so that the current through the latter also flows through these elements. The controlled heater will be connected to the other conductor of the power source by switch 59. In the "off" position of the adjustable cam 51, switches 19 and 59 are open.

To initiate energization of the controlled heater, the cam is adjusted to close switches 19 and 59, whereupon current flows through the bimetal heater 23 to cause the main bimetal 22 to deflect upwardly and open the contacts of switch 19. Upon separation of these contacts, the bimetal will cool and deflect to reengage the contacts, and this cycle will be repeated as long as the switch is turned on.

When the contacts of switch 19 are first engaged, the current therethrough passes through the auxiliary heater 23 to gradually heat the main bimetal 22, and through the self-heated bimetal 42 to rapidly heat the latter. Both bimetals deflect upwardly in response to an increase in temperature, but the bimetal 34 initially tends to deflect at a more rapid rate than the bimetal 24 to increase the pressure between the contacts of switch 19. As these two bimetals deflect together in response to heating, the bimetal 42 will reach its point of maximum deflection and will stop, but the main bimetal 22 will continue deflecting upwardly until it opens the switch 19. Upon opening of this switch, the thermal inertia of the main bimetal 22 causes the latter to deflect slightly further in contact opening direction, whereas the bimetal 42 quickly cools to deflect in the opposite direction and accelerate the opening of switch 19. The main bimetal will subsequently cool and cause the contacts of switch 19 to be reengaged, whereupon the switch will again cycle in a manner similar to that described above.

The percentage of closed contact or "on" time with respect to total cycling time may be varied by adjusting the cam surface 50. As the cam moves or biases the adjusted contact 40 further in the direction toward the cycling contact 20, the percentage of "on" time relative to the total cycling time will be increased, since it will take longer for the main bimetal 22 to be heated and deflected far enough away from the bimetal 42 to separate the contacts of switch 19.

When the ambient temperature within the casing 11 rises, the main bimetal 22 will respond to this temperature rise and will deflect further in contact opening direction, thereby tending to decrease the total cycling time that the contacts 20 and 30 are engaged. To compensate for the additional deflection of the main bimetal and the contact 20, bimetal 44 deflects to move or bias the contact 40 in the direction of the cycling contact 20 to maintain the percentage of "on" time relative to the total cycling time substantially independent of changes in ambient temperature.

When the cam 51 is adjusted to the maximum or full heat position in which the high point 53 engages the bimetal 44, the adjusted contact 40 will be moved and biased upwardly to such extent that the main bimetal 22 cannot deflect sufficiently even when continuously heated, to separate the contacts of switch 19.

While the invention has been shown in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications without departing from the spirit thereof.

What I claim is:

1. A switch comprising a base, a contact on an adjustable support attached to said base, a second contact on a movable support attached to said base, means for cyclically moving said second contact into and out of engagement with said first contact, a rotatable cam member having an active surface generally parallel to and encircling its axis of rotation, said adjustable support being biased into engagement with said active surface, said adjustable support being movable radially relative to said axis by rotation of said cam to adjust the point of engagement of said contacts, a bearing member attached to said base and having surface portions spaced both radially and axially around said axis and inclined thereto at the same angle for engaging and supporting said cam member, and means biasing said members into engagement with each other.

2. A switch comprising a base, a contact on an adjustable support attached to said base, a second contact on a movable support attached to said base, means for cyclically moving said second contact into and out of engagement with said first contact, a rotatable cam member having an active surface generally parallel to and encircling its axis of rotation, said adjustable support being biased into engagement with said active surface, said adjustable support being movable radially relative to said axis by rotation of said cam to adjust the point of engagement of said contacts, a bearing member attached to said base for engaging and supporting said cam member at

points spaced both radially and axially in a conical surface coaxial with said cam, the bearing forces at each point having both radial and axial components, and means biasing said members into engagement with each other.

3. A thermally actuated cycling switch comprising a casing, an adjustable contact, an adjustable means mounted in said casing and supporting said contact, a cycling contact, means including a thermally actuated member with heating means therefor supporting said cycling contact in said casing and for periodically moving the same into and out of engagement with said adjustable contact, a rotatable cam having an active surface generally parallel to its axis of rotation, means for biasing a portion of said adjustable means into engagement with said active surface, said active surface being adapted to move said adjustable means to vary, during operation of said member, the period of time said contacts are engaged relative to the period of disengagement of the contacts, dependent upon the angular position of said cam, a bearing member attached to said casing and having a conical surface, said cam having a complementary coaxial conical surface engaging the conical surface of said bearing member, resilient means biasing said cam into engagement with said bearing member, and means for rotating the cam.

4. A thermal cycling switch according to claim 3 wherein said last-mentioned means includes a shaft keyed to said cam for rotating the latter but slidable axially relative thereto, and means on said shaft for transmitting substantially all axial forces thereon directly to said casing.

5. A thermal cycling switch comprising a casing, an adjustable contact, an adjustable means mounted in said casing and supporting said contact, a cycling contact, means including a thermally actuated member with heating means therefor supporting said cycling contact in said casing and for periodically moving the same into and out of engagement with said adjustable contact, a rotatable cam having an active surface generally parallel to its axis of rotation, means for biasing a portion of said adjustable means into engagement with said active surface, said active surface being adapted to move said adjustable means to vary, during operation of said member, the period of time said contacts are engaged relative to the period of disengagement of the contacts, dependent upon the angular position of said cam, a bearing member attached to said casing and having an exterior conical bearing surface, said cam having a coaxial interior conical surface engaging said bearing surface, resilient means biasing said cam into engagement with said bearing member, one of said conical surfaces being cut away in a band around a central portion thereof to form two axially spaced surface portions engaged by the other of said conical surfaces, and means for rotating the cam.

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