# United States Patent

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[54] **ADJUSTABLE THERMOSTAT**
**18 Claims, 5 Drawing Figs.**


[52] **U.S. Cl.** ..... **337/349,** 337/91, 337/354, 337/367
[51] **Int. Cl.** ..... **H01h 37/52**
[50] **Field of Search** ..... 337/91, 57, 93, 94, 347, 349, 357, 360, 361, 368, 374, 375, 367, 354



[56] **References Cited**

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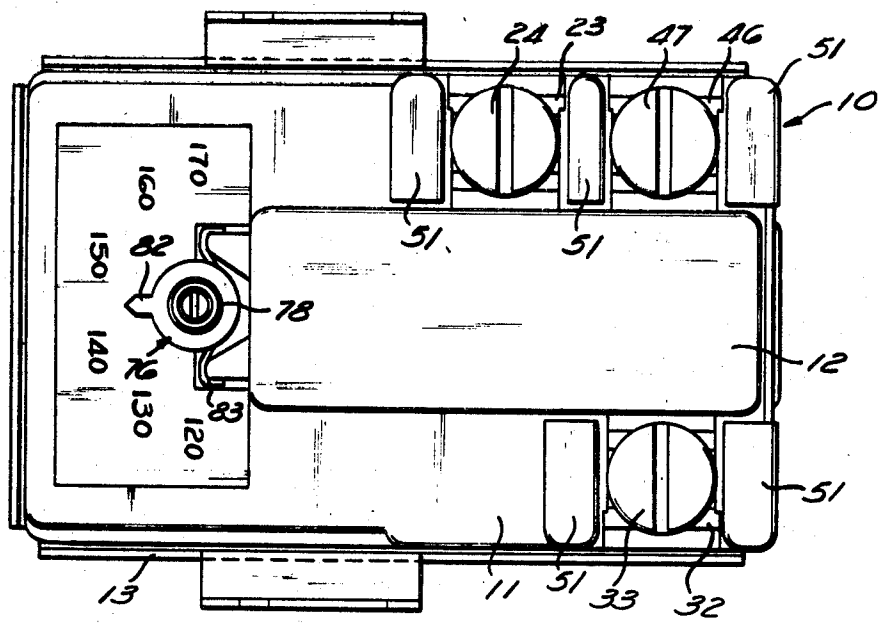
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**ABSTRACT:** An adjustable snap disc thermostat is disclosed which utilizes a bimetallic snap disc both for thermal response and snap action. The disc operates a single pole double throw switch only while the disc is in full snap movement. Therefore, full contact pressure is maintained until the instant the switch opens. Temperature adjustment is provided by a leaf spring pivotally supported at one end on the body and having an operating portion at the other end which urges the disc toward one position of stability. An adjusting screw engages the leaf spring at a location relatively close to the pivot end thereof so that excessive adjustment movement is not required for substantial force adjustment. Also, such spring provides a relatively low spring rate through the range of snap travel.

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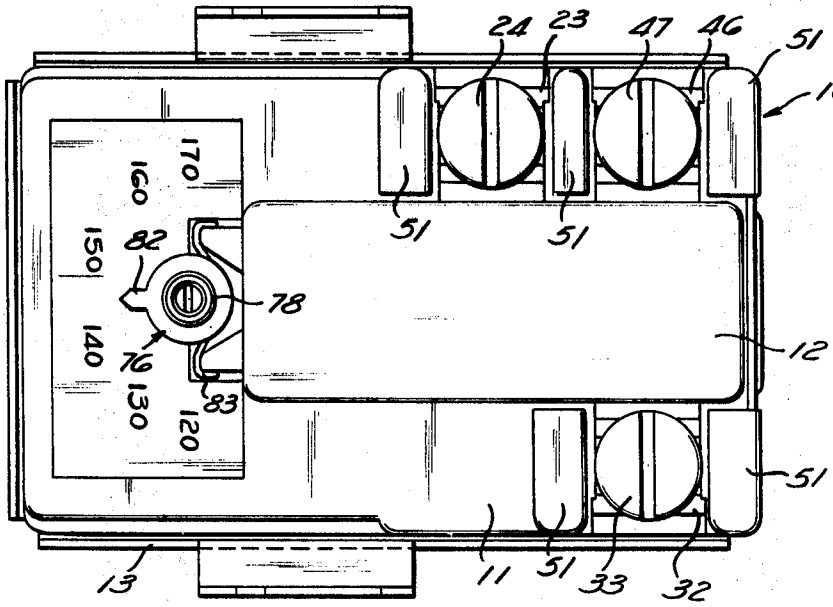



Fig. 1

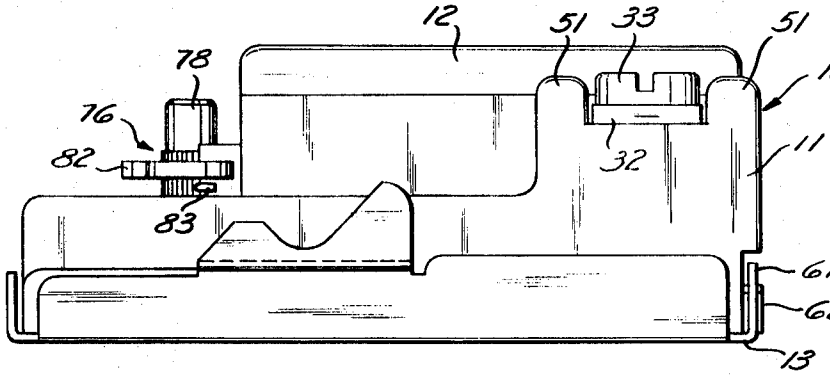



Fig. 2

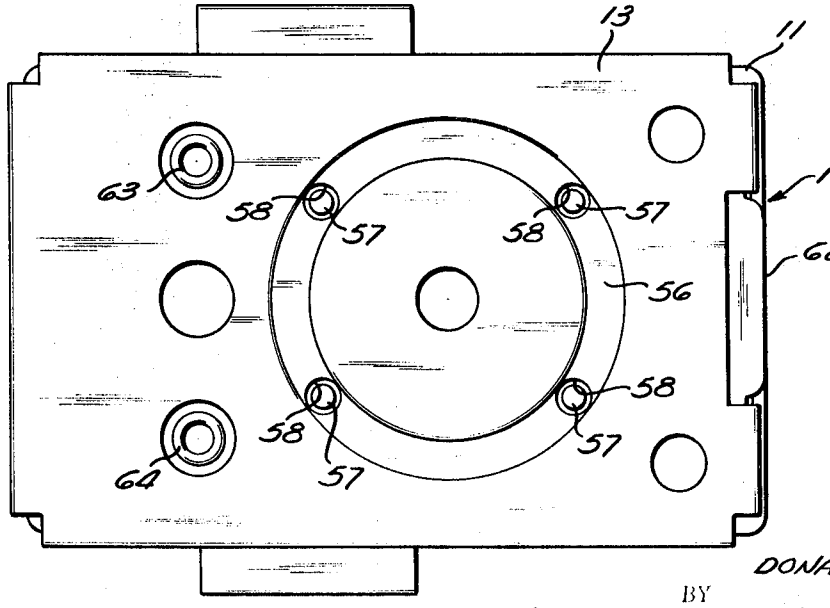



Fig. 3

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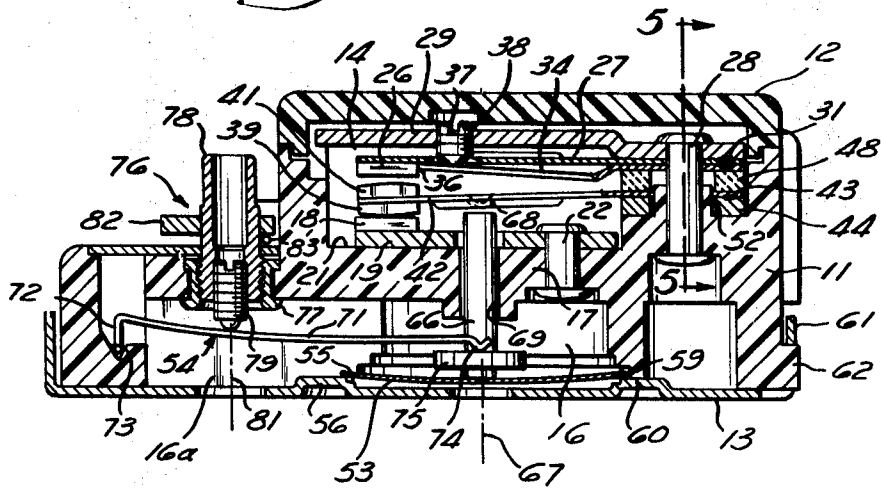
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Fig. 4



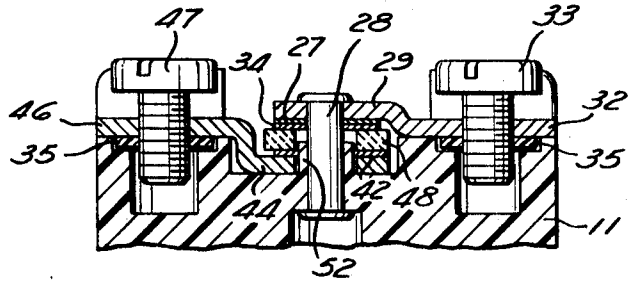




Fig. 5

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# ADJUSTABLE THERMOSTAT

## BACKGROUND OF THE INVENTION

This invention relates generally to thermostats and more particularly to a novel and improved adjustable thermostat which is operable by a bimetallic snap disc.

The pending application of Donald J. Schmitt, Ser. No. 779,680, filed Nov. 29, 1968, assigned to the assignee of the present invention, discloses embodiments of an adjustable thermostat incorporating a bimetallic snap disc to provide both the snap action and the thermal response. Reference to that application should be made for a discussion of the mode of operation of such disc and the manner in which the operating temperatures of such disc may be modified or adjusted by applying biasing forces to the disc.

## PRIOR ART

In the past is has been customary, in most instances, to utilize bimetallic blades which operate a snap switch when a bimetallic operated thermostat requires adjustment of operating temperature. Examples of such adjustable thermostats are disclosed in the U.S. Pat. Nos. 2,645,692; Re 26,554; and 3,462,772. Although some early patents disclose bimetallic snap disc thermostats which provide temperature adjustment (for example, U.S. Pat. Nos. 1,958,594; 1,972,832; and 2,153,297) in recent years the vast majority of bimetallic snap disc thermostats have not been adjustable, but rather have operated at predetermined temperatures that are determined by the manufacture of the disc itself. Examples of such nonadjustable thermostats are disclosed in the U.S. Pat. Nos. 2,717,936; 3,081,388; and 3,470,517.

## SUMMARY OF THE INVENTION

The present invention provides a simple and reliable adjustable thermostat incorporating a bimetallic snap disc. The illustrated embodiment is particularly suited for automatically controlling the operation of electric hot water heaters or the like. Such embodiment is suitable for repeatedly cycling the electric heaters in such hot water heating tanks and provides temperature accuracy and operating reliability for extended periods even when the thermostat is used to control high capacity heaters which require the initiation and interruption of large currents. In the illustrated embodiment the bimetallic snap disc is at all times seated around its entire periphery against a metallic cover element so direct conductive type heat exchange is provided between the cover and the disc. The metal cover is preferably positioned against the metal of the tank to insure rapid and accurate response.

A leaf spring is supported at one end by the thermostat body by a knife-edge-type pivot connection and is provided at its opposite end with a free end portion which engages the bumper so that the spring force is applied substantially along the center line of the disc. The force of the leaf spring on the disc is adjusted by an adjusting screw. The various elements are proportioned to minimize any friction in the spring system and thereby minimize any operating temperature inaccuracy which would result if significant friction were present.

The location of the adjustment screw is substantially adjacent to the pivotal mounting of the spring and a substantial distance from the free end of the spring. This provides substantial adjustment of the force of the spring on the disc with a relatively small movement of the adjusting screw. With this structure the leaf spring has a relatively low rate with respect to movement of the free end thereof.

The disc is free of positive restraint which would limit the disc travel. In the illustrated embodiment, the switch is a double throw switch and the fixed contact remote from the disc is supported by a spring arm so that it does not limit the disc travel. An adjustable stop is provided to limit the movement of this contact toward the disc to insure that the contacts open properly and to provide adjustment of the spacing between the two fixed contacts.



These and other features of this invention, which are discussed in considerable detail below, result in a novel and improved structurally simple, accurate, and reliable thermostat.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view of the front face of a thermostat incorporating this invention;

FIG. 2 is a side view;

FIG. 3 is a back view;

FIG. 4 is a longitudinal section taken generally along 4—4 of FIG. 1; and

FIG. 5 is a fragmentary section taken generally along 5—5 of FIG. 4 with the cover removed.

## DETAILED DESCRIPTION OF THE DRAWINGS

The illustrated embodiment of this invention is particularly suited for use in controlling the operation of an electric hot water heater or the like. In such systems it is customary to provide an upper heater located near the top of the tank and a separate or lower heater located adjacent to the bottom of the tank. In such systems an upper thermostat having a double throw switch is usually positioned adjacent to the upper heater and is connected to control the operation thereof. A similar, but usually single pole, single throw thermostat, is also normally mounted adjacent to the lower heater for control of the lower heater. It should be understood, however, that although the illustrated embodiment of this invention is particularly suited for use in the controlling of electric hot water heaters, such thermostats and other embodiments of thermostats incorporating this invention can be used for many other purposes with equal facility.

Referring to FIGS. 1 through 5, the thermostat includes a body assembly 10 consisting of three basic parts: a main body member 11, a cover member 12, both of which are preferably formed of a molded plastic material such as a phenolic resin, and a metallic cover and mounting plate 13 which is preferably a stamping. The main body member 11 and cover member 12 cooperate to define a switch cavity 14 which encloses the thermostat switch. A disc chamber 16 separated from the switch cavity 14 by a wall 17 in the main body member 11 is enclosed by the main body member 11 in cooperation with the cover and mounting plate 13.

The thermostat switch mechanism includes a first fixed contact 18 secured to a fixed contact support plate 19 which is, in turn, secured against one face 21 of the wall 17 by a rivet type fastener 22. The support plate 19 is provided with a lateral extension which projects out of the switch chamber 14 and functions as a terminal 23 which is threaded to receive a terminal screw 24.

A second fixed contact 26 is mounted on a spring arm 27 in a position overlying the first contact 18. The opposite end of the spring arm 27 is secured to the main body member 10 by a rivet 28. Extending along the upper side of the spring arm 27 is a plate 29 which is preferably permanently connected to the spring arm by spot welds at 31. The plate 29 is provided with a lateral projection which extends out of the switch chamber 14 and provides a terminal 32 which is threaded to receive a terminal screw 33. Positioned adjacent to the side of the spring arm 27 opposite the plate 29 is a stop strap 34 which is also secured to the spring arm by the spot welds at 31. The stop strap 34 extends along the spring arm 27 in spaced relationship with respect thereto to an end 36 which is engageable with the spring arm 27 adjacent to the fixed contact 26. An adjustment screw 37 threaded into the plate 29 extends through a clearance opening 38 in the spring arm 27 and engages the stop strap 34 adjacent to its free end. With this structure the screw 37 can be threaded in or out to change the position of the end 36 of the stop strap 34 and, in turn, adjust the position of the fixed contact 27 when the switch is in the position illustrated in FIG. 4. The spring arm 27 is arranged so that it is biased in a direction toward the stop strap and is normally maintained in engagement with the end 36 as illustrated. How-

ever, the fixed contact **26** is free to move against the spring bias of the spring arm **27** away from the stop strap when the switch operates.

A double throw mobile contact assembly is provided with opposed contacts **39** and **41**, secured to the free end of a mobile contact arm **42**. The opposite end of the arm **42** is welded at **43** to a plate member **44**. A lateral projection on the plate member **44** serves as the third terminal **46** of the switch. Here again, the terminal **46** is threaded to receive a terminal screw **47**. An insulating spacer **48** is positioned between the stop strap **34** and the mobile contact arm **42** to electrically isolate these two members. The structure, however, is arranged so that a single rivet **28** is the only element required to secure the second contact assembly and the mobile contact assembly in the body member **12**. The body member **11** is formed with upstanding projections **51** located on opposite sides of each of the terminals **23**, **32** and **46** which cooperate with the rivets associated with each of the terminals to insure that the contact assemblies are properly oriented in the body and that the contacts are properly positioned with respect to each other. The tubular extension **52** in the body member **11** extends along the rivet **28** through the mobile contact assembly to insure that the rivet is electrically isolated therefrom.

A rectangular washer **35** formed of fiber or plastic material is loosely located below each terminal in a body recess shaped to prevent washer rotation. Each screw is threaded through the associated washer with a friction fit. These washers function to prevent the screws form shaking out of the device and being lost during shipment of the thermostat. Therefore, the screws **24**, **33**, and **47** can be assembled during manufacture without being tightened and it is not necessary for the screws to be installed or backed off during wiring of the thermostat to its load.

Mounted in the disc chamber **16** is a smoothly dished bimetallic snap disc **53** and a temperature-adjusting spring assembly **54**. Although the illustrated embodiment utilizes a smooth disc, in some instances a disc shaped as disclosed in the pending application of Anton J. Gerich, Ser. No. 859,853, filed Sept. 22, 1969 may be used. The periphery of the disc is seated against a laterally extending annular seat **56** formed in the cover **13**. Radial location of the disc is provided by four projecting pins **57** (illustrated in FIG. **3**) which extend through mating openings **58** in the cover **13**. The seat **56** is provided with a small step **55** to provide a relatively sharp edge for engagement with the disc adjacent its periphery. With this sharp edge structure, the location of the support on the disc is more precisely determined than if a curved seat were employed. The body is provided with a wall **59** proportioned so that it is spaced form the disc to insure that the opposite faces of the disc are not tightly engaged along its periphery. The cover **13** is positioned against an annular end wall **60** which extends around the disc excepting along a radial extension **16***a*.

The cover **13** is secured to the body by mounting means arranged to insure a full seating contact between the annular step portion **56** and the end wall **60**. This mounting structure includes a lateral flange **61** provided with an opening proportioned to receive a tongue or projection **62** on the body and two rivets **63** and **64**. The various elements are proportioned so that the cover **13** can be positioned over the tongue **62** and then pivoted inward to its assembled position and riveted in place with rivets **63** and **64**. Such pivotal movement causes bending of the flange **61** as it passes over the tongue and provides a spring force urging the adjacent end of the cover **13** into tight engagement with the end face **60**. This mounting arrangement provides four forces applied at spaced locations around the periphery of the step **56** urging full seating against the end face **60**. The two rivets provide two locations and the other two locations are at the ends of the tongue **62**. Because the step **56** is deformed from the surface of the plate, a rigidity is provided which insures full contact between the step portion and the mating surface **60** and exact location of the cover with respect to the body. Since the disc **53** is positioned against the cover it is also located accurately with respect to the body and, in turn, the switch.

A bumper **66** provides an operative connection between the disc **53** and the mobile contact arm **42**. The bumper engages the disc along its center line **67** at one end and a dimple or projection **68** formed in the arm **42** at its other end. The wall **17** of the body is formed with an opening **69** through which the bumper **66** projects and which guides the bumper for longitudinal movement along the center line **67**.

The spring assembly **54** includes an elongated leaf spring **71** provided with a lateral flange **72** at one end. The edge of the flange **72** is located in a V-notch **73** in the body **11** to provide a substantially frictionless pivotal connection for the end of the leaf spring body. Sufficient length is provided at this pivot to insure that the spring is oriented properly toward the disc. The opposite or operative end of the spring is provided with a forked structure having a V'd contact section **74** in engagement with diametrically opposite sides of a flange **75** formed on the bumper. The various elements are proportioned so that the engagement between the V'd ends **74** and the flange **75** causes a force on the bumper in alignment with the center line **67** so eccentric spring forces are not applied to the bumper **66**.

An adjustment assembly **76** is mounted in the body and includes a mounting sleeve **77** which is threaded to receive a tubular mounting stem **78**. The mounting stem is internally threaded and a calibration screw **79** is threaded therein. The end of the calibration screw **79** engages the spring **71** along the line of action **81**. An indicator arm **82** is press fitted onto the stem **78**. During the manufacture of the thermostat the stem **78** is positioned at some calibration temperature and the calibration screw **79** is threaded in or out of the stem as required until the operating temperature of the thermostat equals the calibration temperature. After manufacture the calibration screw **79** is normally not again adjusted. A spring clip **83** serves as drag clutch to resist rotation of the stem **78** and to assist in retaining the stem in its adjusted position.

The spring **54** and its associated structure is proportioned so that the movement of the end thereof at the bumper **66** approaches a straight line in alignment with the axis **67**. This minimizes any lateral movement which would tend to cause friction when the disc operated and thereby minimizes any tendency for friction induced inaccuracies of operation to occur. Preferably, the pivot point at the V-notch **73** is in substantial alignment with the engaged surface of this flange **75** and the point of engagement with the screw **79** is located, when in the middle of its range of adjustment, so that the portion of the spring adjacent to the operating end at **74** is substantially perpendicular to the center line **67**. With the illustrated spring **71** this tends to cause the movement of the contact section to be aligned with the center line **67**.

In operation, the bumper **66** is biased toward the disc **53** in all positions of the disc. When the disc is in the position illustrated in FIG. **4**, it is curved toward the cover **13** and the mobile contact **39** engages the fixed contact **18**. At this time an electrical connection is provided between the terminal **46** and the terminal **23**. The various elements are sized so that a spacing exists between the projection **68** and the adjacent end of the bumper at this time.

When a temperature is reached at which the disc starts to snap from the position of FIG. **4** to its opposite position of curvature, the center portion of the disc moves toward the mobile arm and causes the end of the bumper **66** to engage the projection **68** on the mobile arm. This does not occur, however, until the disc is in snap motion. Therefore, full contact pressure is maintained until the instant the contacts open. As the disc continues to snap through to the opposite position of curvature, the mobile contact is moved upward causing the contacts **39** and **18** to separate and causing the contact **41** to engage the fixed contact **26**. This occurs before the disc snap movement is completed and when the disc reaches its opposite position of stability, the two contacts **26** and **41** are in engagement and the spring arm **27** is deflected slightly away from the end of the stop strap **34**. With this structure there is no positive restraint to limit this travel, therefore the snap range of the disc is a snap range determined by the manufacture of the disc itself. During the movement of the disc from the position

of FIG. 4 to its opposite position of stability, the adjusting spring 71 is deflected. However, the absolute spring rate of the adjusting spring is less than the absolute value of the negative spring rate of the disc so snap action is obtained.

When the disc reaches its second operating temperature, it starts to move with snap action toward the position of FIG. 4. During the first portion of this movement, until the arm 27 engages the end of the stop strap 34 at 36, the two contacts move together. Because the supports of the two contacts 26 and 41 tend to cause them to move along different paths a wiping action occurs as they move together. Further, since the spring arm 27 urges the contact 26 toward the contact 41, contact pressure is maintained until the instant the contacts open. As soon as the end 36 of the stop strap 34 is engaged, the contact 26 cannot continue to move with the contact 41 and the upper switch opens. Of course, the movement back to the position of FIG. 4 causes the contact 39 to engage the fixed contact 18 before the snap movement is completed, so very rapid closing of the two contacts 18 and 39 is achieved.

Preferably, the disc 53 moves to the position of FIG. 4 on decreasing temperature to its lower operating temperature and moves to its opposite position on increasing temperature to its upper operating temperature. The difference between the two temperatures, of course, is the differential temperature of the thermostat. With such an arrangement, it is preferable to connect the adjacent heater for operation when the disc is in the position of FIG. 4 because the disc is at this time closest to the cover and is therefore most responsive to the source of heat being sensed. When the upper operating temperature is reached the disc snaps through to its opposite position.

When it is desired to increase the operating temperature of the thermostat the stem 78 is turned in a clockwise direction as viewed in FIG. 1 causing the screw 79 to move down further against the spring. This causes an increase in force to be applied by the spring on the bumper and, in turn, the disc. Such increase in force increases the operating temperatures of the disc but does not materially change the differential temperature of operation. Preferably, the adjustment screw 79 is located so as to engage the spring 71 at a position substantially closer to the picot at 73 than the disc end of the spring. With this structure, the force of the spring on the disc can be changed substantially without excessive movement of the adjusting stem 78 and the spring 77 provides a relatively low spring rate and therefore does not excessively reduce the operating differential of the disc.

It should be understood that if a thermostat requires only a single throw switch the upper fixed contact assembly and the contact 41 may be eliminated. In such a thermostat, however, the functional operation of the thermostat is substantially identical with the thermostat illustrated.

Because the disc is not positively restrained, the location of its snap range is not altered when the operating temperature is changed. Therefore, the operation of the switch is not affected by temperature adjustment. Also, since the line of action 81 of the adjusting screw is perpendicular to a line between the two ends of the leaf spring, adjustment of the leaf spring does not materially alter the spring rate thereof. Consequently, adjustment of the thermostat's operating temperature does not alter the differential temperature of the disc.

Because full contact pressure is maintained at all times while the contacts are in engagement and because the contact separation occurs substantially simultaneously with the reduction in contact pressure, the tendency of the contacts to arc either on opening or closing is minimized and the switch can control circuits involving relatively large current without excessive contact deterioration. Further, since the disc and the bumper 66 is in snap motion before the contacts are separated, a substantial mass in motion is available to break any welds between the contacts which may occur. Also, the complete separation of the switch chamber from the disc chamber isolates the disc and the adjusting spring form contamination caused by arc splatter.

Although a preferred embodiment of this invention is illustrated, it is to be understood that various modifications and rearrangements of parts may be resorted to without departing from the scope of the invention claimed herein.

1. An adjustable thermostat comprising a body assembly, switch means mounted on said body assembly including a first fixed contact and a mobile contact movable toward and away from said fixed contact, a bimetallic snap disc on said body assembly operable to snap along a line of action in response to temperature changes, operating means connecting said disc and mobile contact for opening and closing said switch means only after said disc is in snap motion, said thermostat being substantially free of positive limits restricting the movement of said disc, an adjustable spring means operable to apply an adjustable biasing force to said disc and adjustably determine the operating temperature of said disc, said adjustable spring means including a leaf spring element supported on said body assembly at a first location spaced from said disc, said spring element providing an operating portion at a second location spaced from said first location applying a force to said disc along said line of action thereof in all positions of said disc, and adjusting means spaced from both said first and second locations operating to adjust the force of said spring applied to said disc, said adjusting means being located closer to said first location than to said second location.

2. An adjustable thermostat as set forth in claim 1 wherein said operating means is an elongated bumper guided in said body assembly for longitudinal movement along said line of action, said bumper being provided with a radial surface spaced from said disc and substantially symmetrical with respect to said line of action, said spring element engaging said surface to apply said force to said disc.

3. A thermostat as set forth in claim 2 wherein said body assembly includes a wall separating said switch means from said disc and said adjustable spring means, said wall being provided with an opening therethrough, said bumper extending through and being guided by said opening, said bumper and wall cooperating to isolate said switch means from said disc and said adjustable spring means.

4. An adjustable thermostat as set forth in claim 2 wherein said spring element provides a free end engaging said surface.

5. An adjustable thermostat as set forth in claim 4 wherein pivot means connects said spring element to said body assembly at said first location.

6. An adjustable thermostat as set forth in claim 5 wherein said pivot means includes a lateral projection on said spring element having an edge supported in a notch in said body assembly.

7. An adjustable thermostat as set forth in claim 6 wherein adjusting means provides an abutting surface engaging said spring element intermediate said first and second locations.

8. An adjustable thermostat as set forth in claim 7 wherein said abutting surface is adjustable relative to said body assembly in a direction substantially parallel to said line of action.

9. An adjustable thermostat as set forth in claim 8 wherein the section of said spring adjacent to said second location extends substantially perpendicular to said line of action and moves in response to movement of said disc in a direction substantially parallel to said line of action.

10. An adjustable thermostat as set forth in claim 9 wherein said body assembly includes a metal cover formed with a circular edge, and said disc is supported adjacent to its periphery by said circular edge when said disc is in at least one position of stability.

11. An adjustable thermostat as set forth in claim 10 wherein said cover is provided with an offset portion radially inward from said edge which provides clearance with respect to said disc.

12. An adjustable thermostat as set forth in claim 11 wherein said disc moves to a position in which it is curved toward said offset portion and is closely adjacent thereto when the temperature of said disc drops to its lower operating temperature.

13. An adjustable thermostat as set forth in claim 12 wherein said switch means includes a second fixed contact on the side of said mobile contact opposite said first fixed contact, and said disc maintains said mobile contact in engagement with one of said fixed contacts when said disc is in one position of stability and maintains said mobile contact in engagement with the other of said fixed contacts when said disc is in the other position of stability.

14. An adjustable thermostat as set forth in claim 13 wherein said switch means includes terminal means provided with terminal screws, and friction means engage said terminal screws resisting rotation thereof.

15. An adjustable thermostat as set forth in claim 1 wherein said body assembly includes a metal cover formed with a circular edge, and said disc is supported adjacent to its periphery by said circular edge when said disc is in at least one position of stability.

16. An adjustable snap-acting thermostat comprising a housing assembly, switch means in said housing assembly including a fixed contact and a mobile contact movable into and out of engagement with said fixed contact when said switch means is operated, a bimetallic snap element in said body movable with snap movement along a line of action between first and second positions of stability in response to temperature changes, operator means connected between said snap element and mobile contact operating said switch means in response to movement of said snap element only after said snap element is in snap movement, adjustable spring means operable to change the operating temperature of said snap element without positively restricting the movement thereof, said spring means including a leaf spring supported at one end on said housing assembly and providing at its other end an operating portion movable substantially parallel to said line of action and applying an adjustable spring force to said snap element substantially along said line of action urging said snap element toward one of said positions of stability, and adjusting means intermediate the ends of said spring operable to change the value of said spring force and the operating temperature of said snap element.

17. An adjustable thermostat as set forth in claim 16 wherein said adjustment means engages said spring substantially closer to said one end than said other end.

18. An adjustable thermostat as set forth in claim 16 wherein said body assembly includes a body member and a metallic cover, said disc being seated at its periphery against said cover, said body member being provided with an annular locating surface engaging and positioning said cover, said body member providing a tongue, said cover providing a strap section extending over said tongue and being deflected thereby to cause a force at two locations urging said cover against said surface, and fastener means cooperating with said tongue to secure said cover on said body.