July 7, 1953 K. E. VROOM ET AL 2,644,873

THERMOSTATIC AND CIRCUIT BREAKER DEVICE

Filed March 7, 1950

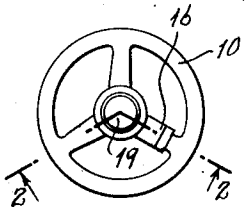


Fig. 1.

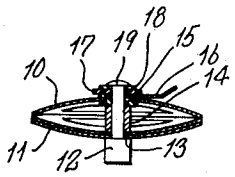


Fig. 2.

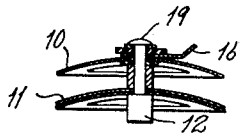


Fig. 2a.

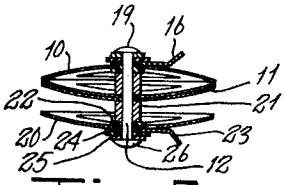


Fig. 5.

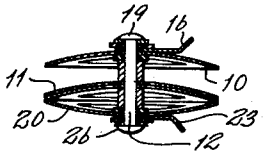


Fig. 5a.

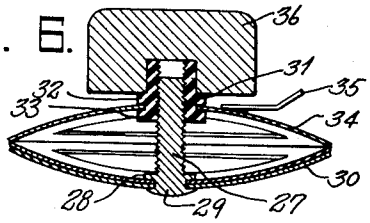


Fig. 6.

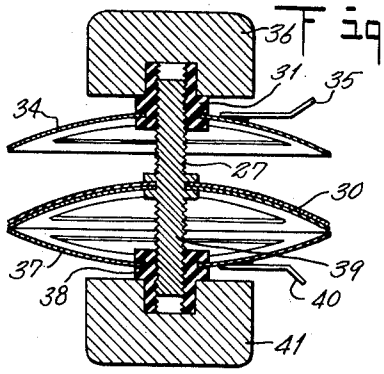


Fig. 7.

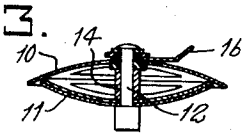


Fig. 3.

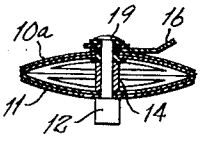


Fig. 4.

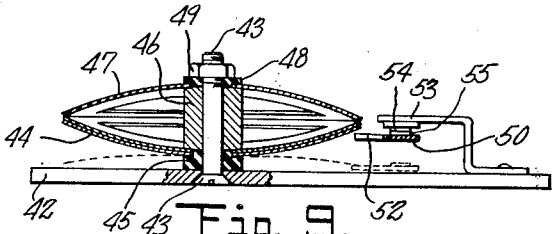


Fig. 9.

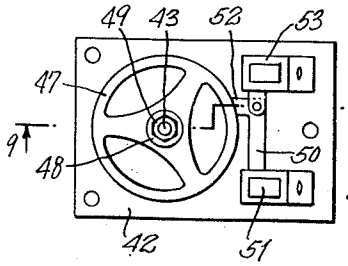


Fig. 8.

INVENTORS
KENNETH E. VROOM
BY ELBERT DEF. TIDD

Campbell, Brumbaugh, Free & Graves
ATTORNEYS

Patented July 7, 1953

2,644,873

UNITED STATES PATENT OFFICE

2,644,873

THERMOSTATIC AND CIRCUIT BREAKER DEVICE

Kenneth E. Vroom, West Englewood, and Elbert De F. Tidd, Clinton, N. J., assignors to John B. Pierce Foundation, New York, N. Y., a corporation of New York

Application March 7, 1950, Serial No. 148,196

16 Claims. (Cl. 200—138)

1

This invention relates to snap spring controlled devices of various types, and more particularly to thermal-responsive devices utilizing bimetallic and monometallic snap springs as their fundamental components.

Bimetallic snap springs, by virtue of their thermal-responsive snap action in which the configuration of the spring changes forcefully and instantaneously through a relatively wide excursion, may be used as a motivating component in such devices as thermostats, overload-current circuit breakers and the like. An inherent characteristic of these snap springs, however, is their tendency to creep under the influence of heat toward the critical configuration at which the snap action takes place. In thermostats and circuit breakers, for example, this uncompensated creeping movement has been found to cause variations of electrical-contact pressure prior to snapping, which may cause premature contact deterioration, as well as inconsistencies in the calibration characteristics.

Currently used methods for stabilizing calibration values and contact pressures have been found to be costly as well as mechanically unsatisfactory.

It is, accordingly, an object of this invention to provide economical and highly efficient snap spring assemblies having either fixed or variable calibration characteristics comprised of a minimum number of parts and conducive to assembly on a mass production basis without sacrificing preciseness of calibration.

It is a further object of this invention to provide thermal-responsive snap spring assemblies for controlling electrical circuits wherein the engaging pressure of the separable, current-carrying contacts is maintained at a uniform value up to the instant of separation.

Another object of this invention is to provide a simplified assembly for thermal-responsive snap springs whereby any given calibration value may be accurately and simply achieved at the time of factory assembly, as in the case of a device of fixed rating, or in the case of a device of adjustable rating, to provide a simplified organization of components whereby calibration adjustments may be readily effected in the field.

According to the invention spring discs are utilized to bias snap discs by peripheral engagement in the direction of movement of the latter under the influence of heat or thrust so that more uniform peripheral engaging pressures may be maintained therebetween up to the point of snaps, this by virtue of less change in biasing

2

force per unit of preliminary or creeping movement by the snap disc than has heretofore been possible. Furthermore, a highly simplified screw-assembly is provided by means of which biasing pressures may be accurately adjusted in the field in order to attain any desired calibration characteristics of the snap-spring device within pre-established limits.

These and other features of the invention will be apparent from the following detailed disclosure of preferred embodiments thereof taken in conjunction with the accompanying drawings, in which

Fig. 1 is a plan view of a thermal-responsive snap disc assembly having a fixed calibration rating;

Fig. 2 is a view in cross-section of the assembly taken along the line 2—2 of Fig. 1 and showing the device in its circuit-closed position;

Fig. 2*a* is a view in cross-section corresponding to Fig. 2 showing the device in its circuit-open position;

Fig. 3 is a view in cross-section of a modified form of the invention;

Fig. 4 is a view in cross-section showing a further modification of the invention;

Fig. 5 is a view in cross-section of a double-acting thermal-responsive device having fixed calibration ratings for both directions of movement;

Fig. 5*a* is a view in cross-section of a thermal-responsive device corresponding to that of Fig. 3 and showing the snap spring in a second configuration;

Fig. 6 is a view in cross-section of a thermal-responsive device having means for adjusting its calibration rating;

Fig. 7 is a view in cross-section of a thermal-responsive device having means for adjusting its calibration ratings in two directions of movement;

Fig. 8 is a plan view of another modified form of the invention; and

Fig. 9 is a view in cross-section taken along the line 9—9 of Fig. 8.

Referring to Figs. 1, 2 and 2*a* of the drawing there is shown a thermal-responsive device comprising a resilient monometallic spring disc 10 and a resilient bimetallic snap spring disc 11, each formed with a central aperture and mounted thereby on a common post 12 in normally opposed, rim-engaging relation as shown in Fig. 2.

The lower surface of the bimetallic disc 11 rests on a shoulder 13 of the post 12, and a metallic space or bushing 14 is fitted over the

necked-down portion of the post 12 to rest on the upper surface of the disc 11. An insulating, shouldered washer 15 is seated on the spacer 14, with the narrow, upper portion of the washer being received in an enlarged central aperture of the monometallic disc 10 to electrically insulate the latter from the post.

A flexible metal terminal lead 16 is held in engagement with the upper surface of the monometallic disc 10, but spaced from the post 12, by an insulating washer 17 and a metallic washer 18, the entire assembly being secured by a riveted head 19 on the post 12.

The electrical path through the device includes the terminal lead 16, monometallic disc 10, bimetallic disc 11 (by virtue of rim contact), and mounting post 12, to which a second terminal lead (not shown) may be affixed. Accordingly, the device may be used either as an over-load-current circuit breaker or as a thermostat by virture of the action of the bimetallic snap disc 11 which is adapted upon heating to snap into the inverted, dished configuration shown in Fig. 2*a*, thereby opening the said electrical circuit by breaking rim contact with the disc 10. For a more detailed disclosure of the structure, methods of manufacture, and characteristics of snap springs of the types contemplated herein, reference may be had to the pending U. S. applications entitled Toggle Springs, Serial No. 628,447, filed November 14, 1945; Snap Spring Discs, Serial No. 635,956, filed December 19, 1945; and Snap Disc Springs and Methods of Manufacture, Serial No. 139,182, filed January 18, 1950.

As a circuit breaker device, heat is preferably developed in the bimetallic disc by internal heating caused by current flowing directly therethrough, while as a thermostat heat is derived from an external source such as the surrounding fluent medium.

Because bimetallic discs may partake of limited creeping movement under the influence of heat prior to snapping, there is a tendency in thermostatic devices or circuit breakers controlled by uncompensated snap springs for the engaging pressure of the electrical contacts to be lessened prematurely. In order to insure good contact pressure up to the moment of snap according to this invention, the rim portion of the resilient spring disc 10 is made to bear against the rim portion of the snap disc 11 in the direction of snap movement so that as the disc 11 tends to change its configuration prior to snapping, the spring disc 10 is able to follow it to maintain good contact pressure up to the point of snap. Thus a uniformly high contact pressure and hence low electrical resistance is maintained up to the point of contact separation, preventing heating of the contacts which may cause rapid deterioration. Moreover the rapid separation or engagement of the contacts, as controlled by the snap action, protects the contacts against arcing, which is highly detrimental to good service life. The use of a spring disc 10 as a means for rim-biasing the bimetallic snap disc 11 in the direction of preliminary movement has been found to be superior to other known spring-biasing means for the reason that spring discs are prestressed to provide less change in biasing force per unit of spring displacement than is ordinarily characteristic of biasing springs. Moreover, the use of a spring disc as a biasing member has been found to facilitate the use of a mechanically and electrically improved assembly by virtue of the increased contacting surface as well as the decreased number of elements required to complete an operable assembly.

The calibration of the device shown in Figs. 1 and 2 is preferably fixed at the time of assembly and is dependent upon three constants including, (1) the characteristics of the bimetallic snap disc 11, (2) the characteristics of the spring disc 10, and (3) the length of the spring spacing bushing 14. Considering first the characteristics of the bimetallic disc 11, it has been found that such disc requires a definite force in order to effect snapping from one configuration to another. This force may be applied externally or may be developed internally through the application of heat to the disc, or may be combinations of both. For a bimetallic disc with a given snapping characteristic there will be a definite maximum temperature to which the disc must be heated to cause snapping if all of the force is developed through heat. On the other hand the disc can be made to snap at room temperature solely by force or thrust applied externally. It is possible therefore, to provide a disc which will snap at any temperature between the room temperature and the preestablished maximum temperature by varying the manual force applied, which in the instant case is by the monometallic disc spring 10 in peripheral engagement therewith.

Assuming a fixed characteristic of both discs 10 and 11 variations in the temperature of snap may be effected by changing the length of the bushing 14, with increased length resulting in decreased mechanical biasing pressure between the discs. Similarly, for fixed characteristics of the disc 11 and the fixed length of bushing 14 a change in calibration can be effected by a change in the spring characteristics of the monometallic disc 10. In addition the bimetallic snap disc 11 may be so formed as to require an externally applied force to effect resetting from the position as shown in Fig. 2*a* to the position shown in Fig. 2, or it can be made to be self-returning when a given lower temperature value is attained, as set forth in the said pending applications.

It has been found that a loose coupling for securing the monometallic disc 10 to the post 12 is desirable in certain cases for the reason that it makes possible certain random rotation of the disc 10 relatively to the disc 11, thereby greatly increasing the combination of possible electrical contact points between the contiguous rims of the respective discs. This is particularly desirable for the reason that perfect rim-engagement does not occur in common practice, and that as the circuit is opened the final break occurs at one or two points only. With continued operation of the switch this may eventually result in contact deterioration at those points. By allowing freedom of rotation for one disc, as described, it is possible to increase contact life by multiplying, by continued use, the number of contact-break points in the switch.

The material of the contacting portions of the discs may be varied in accordance with the electrical demands of the unit. Thus where low current values are to be controlled, the bare materials of which the discs are formed may be used; if current values are increased, the rims of the discs may be silver plated; and if heavy currents are involved the use of two or more sets of contoured contact elements, affixed to the discs as by welding or soldering, has been found desirable.

In the event that the disc material itself is used as the contacting material, one of the discs,

preferably the bimetallic disc 11 may be made smaller in diameter than the spring biasing disc 10, as shown in Fig. 3. In this case a certain desirable wiping action has been found to occur between the discs, keeping the contacting surfaces clean as well as tending to provide improved contact.

As another modification of the invention, a bimetallic, thermal-responsive disc 10*a* (Fig. 4) may be substituted for the monometallic disc 10 in the assembly of Figs. 1 and 2 to effect ambient temperature compensation. Circuit breakers are in general rated to function at predetermined electrical current values as stated ambient temperatures. An increase in ambient temperature, however, is necessarily accompanied by a decrease in current required to trip the circuit breaker. This is true because the bimetallic snap disc will always operate at a fixed temperature level and a known current will be required to raise the temperature through a fixed differential between the fixed temperature and the ambient temperature. An increase in ambient temperature, therefore, decreases this differential and less current is required for initiating the snap action. Conversely the device may be made to operate as a temperature-compensated low-load breaker by arranging the snap disc to snap at a given lower temperature and the biasing disc to back-off with decreased ambient temperature.

In the above assembly the bimetallic snap disc 11 will tend to move downwardly and hence closer to this trip point with an increase in surrounding air temperature. By substituting a bimetallic disc 10*a* for the monometallic biasing disc 10, and arranging the disc 10*a* so that an increase in ambient temperature causes its periphery to move upwardly or away from the snap disc 11, the mechanical force against the disc 11 will be decreased. Hence a greater current value will be required to trip the breaker.

In the units described above no provision is made for calibrating the return point of the snap disc 11. This may be effected according to the invention by applying a return biasing force to the snap disc 11 in its tripped position, as by the duplex assembly shown in Figs. 5 and 5*a*. In this embodiment the upper portion of the assembly is the same as that described, with the addition of a second monometallic spring disc 20 for biasing the disc 11 in the direction of return movement, mounted on the depending end of the post 12 together with a second bushing 21, an insulating shouldered washer 22 received by an enlarged aperture in the spring disc 20, a flexible terminal lead 23, an insulating washer 24, a metallic washer 25 and a riveted head portion 26 of the post 12. Calibration of the reverse action of disc 11 is likewise a function of the characteristics of the bimetallic disc 11, the characteristics of the spring biasing disc 20, and the length of the bushing 21.

The two-point calibrated device shown in Figs. 5 and 5*a* may operate as a single-pole, single-throw switch or as a single-pole double-throw switch. The electrical path as a single-pole, single-throw switch is similar to that described with reference to Figs. 1 and 2 with the exception that either of the terminal lead 16 or 23 may be used as the current carrying terminal. As a single-pole, double-throw switch, on the other hand, both terminal strips 16 and 23 are used in conjunction with the common terminal comprising the post 12.

Thermostat or circuit breaker devices of the types described may be provided according to the invention with calibration adjusting mechanism, as shown in Figs. 6 and 7, by means of which adjustments may be made in the calibration values in the field. A preferred embodiment of the device comprises a threaded post 27 (Fig. 6) the lower end of which is formed with an annular shoulder 28 and a riveted head portion 29 embracing the center of a bimetallic snap disc spring 30 mounted on the post by means of a central aperture. Threaded upon the upper end of the post 27 is a screw fitting 31 formed with a pair of annular shoulders 32 and 33 embracing a monometallic spring disc 34 centrally mounted on the post in opposed relation to the bimetallic disc 30 and normally engaging the latter in rim contact. The disc-confining shoulders 32 and 33 are preferably spaced to provide a loose mounting for the disc 34 to permit limited turning movement thereof for the purpose of improving contact wear, as described above, and to permit turning movement of the screw-fitting 31 independently of the disc 34. A metallic terminal strip 35 is welded or soldered to the upper surface of the spring disc 34. A knob 36 is affixed to the upper end of screw fitting 31 by means of which the fitting may be conveniently turned either to increase or decrease the rim biasing pressure between the two discs 30 and 34, hence varying the calibration value of the device. The electrical path corresponds to that described above with reference to Figs. 1 and 2.

In order to provide for variable calibration in the other direction of movement of the bimetallic disc the assembly is expanded to include a second monometallic spring disc 37 (Fig. 7) loosely carried on a screw fitting 38 threaded on a depending shank portion 39, formed integrally with the post 27, a terminal lead 40 and knob 41.

Thus by turning the screw fitting 38 the spring disc 37 may be moved toward or away from the bimetallic snap disc 30, thereby to vary the temperature rating at which the bimetallic disc 30 reverts from its position as shown in Fig. 7 to that shown in Fig. 6.

A further modification of the device according to the invention is shown in Figs. 8 and 9 and includes an electrical contact assembly which is mounted externally of the spring discs so that the discs themselves are not required to carry an electrical current.

The device comprises a mounting plate 42 supporting an upstanding threaded post 43. A bimetallic snap disc 44 is fitted over the post 43 by means of a central aperture and is spaced from the mounting plate by a bushing 45. A spacer or bushing 46 is fitted over the post followed by a biasing spring disc 47, normally opposed to and in rim engagement with the bimetallic snap spring 44, a suitable washer and nut, 48 and 49 respectively, completing the assembly. A resilient contact-carrying arm 50 is endwise mounted at 51 on the plate 42 adjacent the snap disc assembly and is formed with a finger 52 underlying the rim portion of the snap disc 44 and adapted to be depressed by the snap action thereof as shown in broken lines in Fig. 9. A stationary contact-carrying arm 53 overlies the free end of the arm 50 and carries a stationary contact 54 which is engaged by a contact 55 secured to the free end of the arm 50. The arm 50 is self-biased upwardly so that the contacts 54 and 55 are normally in engagement with a fixed con-

tacting pressure. Upon snapping of the bimetallic disc 44 downwardly the contact arm 50 is depressed, separating contacts 54 and 55 and opening the electrical circuit. By virtue of this construction contact pressure may be made independent of the biasing pressures effecting calibration of the unit.

It will be understood that modifications may be made in the several preferred embodiments of the invention described herein for purposes of illustration, and that the invention should accordingly be determined in scope by the following claims.

We claim:

1. In combination, a snap switch assembly comprising a snap spring disc having at least one dished configuration of stable equilibrium and adapted to snap into a reversed configuration, a dished spring disc, means supporting said discs at their respective centers in coaxial relationship with their respective rim portions free to partake of spring movement, said supporting means being adapted to hold said discs with their rim portions in substantially circumferential engagement and with the rim portion of the spring disc biasing the rim portion of the snap disc in the direction of the snap movement out of said configuration of stable equilibrium whereby the rim portions of the snap spring disc and the spring disc maintain contact during preliminary creeping movement of the snap spring disc prior to snapping, separable electrical contact means adapted to be separated in response to snap movement of the rim portion of the snap spring disc and to maintain contact during preliminary creeping movement of the snap spring disc prior to snapping, and means for initiating snapping action of said snap disc.

2. In combination, a snap switch assembly comprising a snap spring disc having at least one dished configuration of stable equilibrium and adapted to snap into reversed configuration, a dished spring disc, means supporting said discs at their respective centers in coaxial relationship with their respective rim portions free to partake of spring movement, said supporting means being adapted to hold said discs in mutual rim-engagement with the spring disc biasing the snap disc in the direction of the snap movement out of said configuration of stable equilibrium, means for initiating snap action of said snap disc whereby the rim portions of said discs are disengaged, first terminal means electrically connected to said snap disc, second terminal means electrically connected to said spring disc, said switch having an electrical path between said terminals including said snap disc, the disengageable rim portions of said discs, and the spring disc.

3. A snap disc switch assembly as set forth in claim 1 including a second spring disc centrally supported and coaxially disposed with respect to said snap disc and having a rim portion adapted to be engaged by the rim portion of said snap disc when the latter is snapped out of said configuration of equilibrium and to spring bias the same in the direction of return movement into said configuration of equilibrium.

4. A snap disc switch assembly as set forth in claim 1 including screw means for varying the position of said spring disc with respect to said snap disc to change the rim-biasing pressures therebetween.

5. A thermal-responsive switch assembly of adjustable calibration comprising a threaded post, a thermal-responsive snap disc centrally supported by said post and having two reversibly dished configurations of equilibrium governed by temperature, a first collar threaded on said post for movement toward and away from said snap disc by turning, and a first spring disc of dished configuration centrally supported by said collar and adapted to spring bias said snap disc through peripheral engagement in the direction of snapping from one configuration of equilibrium to another, said biasing pressure being variable by turning said collar, thereby to change the temperature at which snapping occurs.

6. A thermal-responsive switch assembly as set forth in claim 5 wherein said spring disc is freely rotatably mounted on said collar.

7. A thermal-responsive switch assembly as set forth in claim 5 including a second collar threaded on said post on the opposite side of said snap disc from said first collar for movement toward and away from said snap disc by turning, a second spring disc of dished configuration centrally supported by said collar and adapted to spring bias said snap disc through peripheral engagement in the reverse direction of snapping, said biasing pressure being variable by turning said second collar to change the temperature of snap in that direction.

8. In combination, a bimetallic snap disc adapted to snap between two dished configurations of equilibrium under the influence of heat, means for supporting said disc at its center, a spring disc of dished configuration coaxially disposed with respect to said snap disc and having its center spaced therefrom and its rim-portion bearing against the rim-portion of said snap disc to bias the latter in the direction of movement under the influence of heat, and electrical circuit means adapted to be opened upon snapping of said bimetallic disc from one configuration of equilibrium and closed upon snapping to said one configuration of equilibrium, said electrical contact means comprising contacts disposed respectively at the rim portions of said snap disc and spring disc, whereby the electrical contact means remain closed during preliminary creeping movement of said snap disc prior to snapping and separate only when snapping occurs.

9. In combination, a dished bimetallic thermal-responsive snap disc adapted to snap between two configurations of equilibrium, means for supporting said disc at its center, a first spring disc centrally supported coaxially with respect to said snap disc with its rim-portion being engaged by the rim-portion of said snap disc when the latter is in one configuration of equilibrium, a second spring disc disposed on the opposite side of said bimetallic disc and centrally supported coaxially therewith, said second spring disc being mounted so that its rim-portion is engaged by the rim-portion of said snap disc when the latter is disposed in its second position of equilibrium, and separable electrical contact means including contact means carried by the rim portion of said snap disc and corresponding contact means carried by the rim portion of said first spring disc, whereby said electrical contact means maintain engagement during preliminary creeping movement of the snap disc prior to snapping and separate when snapping occurs.

10. A bimetallic snap disc assembly as set forth in claim 8 including screw means for adjusting the axial spacing of said snap disc and spring disc thereby to vary the peripheral biasing pressure

exerted by the latter on the former to vary the temperature at which snapping occurs.

11. In a bimetallic snap disc assembly as set forth in claim 9 including manually controlled screw means for displacing said first spring disc axially relatively to said snap disc, and manually operated screw means for displacing said second snap spring axially relatively to said snap disc, thereby to vary the spring biasing pressures of the rim portion of said spring discs against the rim-portion of said snap disc.

12. A current-responsive circuit breaker having ambient temperature compensation and adapted to break a given electrical circuit at a preestablished current value therein, including, a thermal-responsive snap spring disc having two configurations of equilibrium and adapted to snap between said configurations at a preestablished disc temperature, means for varying the temperature of the snap spring disc as a function of the current flow in the said electrical circuit, means supporting said snap spring disc enabling its rim-portion to partake of snap movement between the configurations of equilibrium, a thermal-responsive biasing-spring disc coaxially disposed with respect to said snap spring disc and mounted to spring-bias the latter through mutual rim engagement in the direction of snap movement thereof, said biasing-spring disc being adapted upon change in ambient temperature to change its configuration by rim displacement in a direction opposite to the direction of snap movement of the snap spring disc, thereby to change the spring-biasing pressure on the snap spring disc as a function of ambient temperature, and normally-closed electrical contact means in said electrical circuit operatively connected to said snap spring disc and adapted to be opened by snap action movement thereof to break said electrical circuit, said electrical contact means maintaining their closed condition during preliminary creeping movement of the snap spring disc prior to snapping.

13. In a current-responsive circuit breaker having ambient temperature compensation as set forth in claim 12, wherein said snap spring disc and biasing spring disc are formed at least partially of electrically conducting material and said electrical contact means comprise the mutually engaged rim-portions of the two discs, including means connecting said discs in said electrical circuit whereby the temperature of the snap spring disc is varied as a function of the flow of current therethrough and whereby the snap movement of the snap spring disc breaks the

electrical circuit by breaking the mutual rim engagement between the two discs.

14. In combination, a thermal-responsive switch assembly including a bimetallic snap disc of dished configuration adapted to reverse configuration under the influence of heat, means for centrally supporting said disc with the rim-portions thereof being displaced by the snapping action, a spring disc coaxially disposed with respect to said snap disc and having a rim-portion disposed to spring bias the rim-portions of said snap disc in the direction of movement thereof under the influence of heat, said bimetallic disc having a diameter differing from that of said spring disc whereby the periphery of the one disc engages the other disc within the periphery thereof, and electrical circuit means controlled by said bimetallic snap disc, said circuit means including the engaging portions of said snap and spring discs, whereby said electrical circuit means is maintained in a closed circuit condition during preliminary creeping movement of said snap disc prior to snapping.

15. In combination, a thermal-actuated snap disc of dished configuration, means for centrally supporting said snap disc with the peripheral portion adapted to be displaced under the influence of heat, spring means adapted to bias the periphery of said snap disc in the direction of movement as caused by heating, electrical switch means, a driving link interposed in the path of movement of the peripheral portion of said snap disc, and connecting linkage between said driving link and said switch means whereby the latter is actuated upon snapping of said bimetallic disc under the influence of heat.

16. In a bimetallic thermal-responsive switch assembly as set forth in claim 15 wherein the spring biasing means for said bimetallic snap disc comprises a coaxially disposed spring disc having its center portion axially spaced from said bimetallic disc with its peripheral portion adapted to bear against the peripheral portion of said bimetallic disc in the direction of movement of the latter under the influence of heat.

KENNETH E. VROOM.
ELBERT De F. TIDD.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
2,407,537	Chapman	Sept. 10, 1946
2,498,039	Gunn	Feb. 21, 1950
2,543,040	Mertler	Feb. 27, 1951