Jan. 31, 1933. J. A. SPENCER 1,895,590

SNAP ACTING DEVICE

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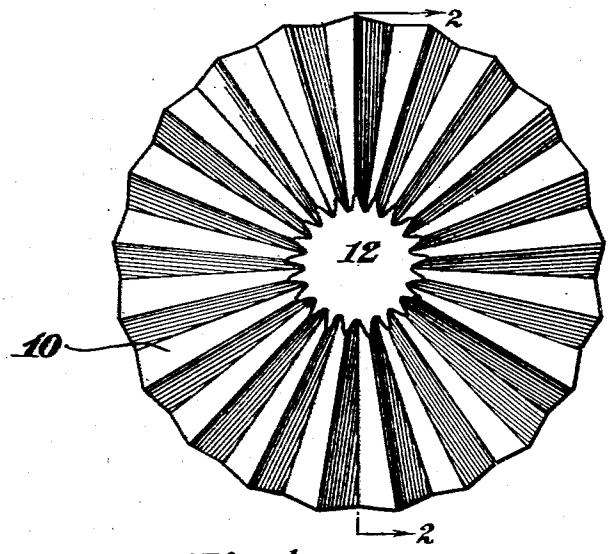



Fig. 1.

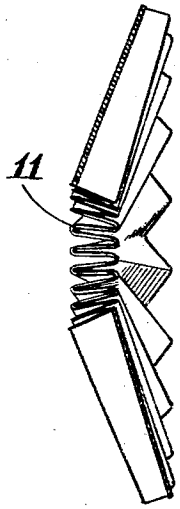



Fig. 2

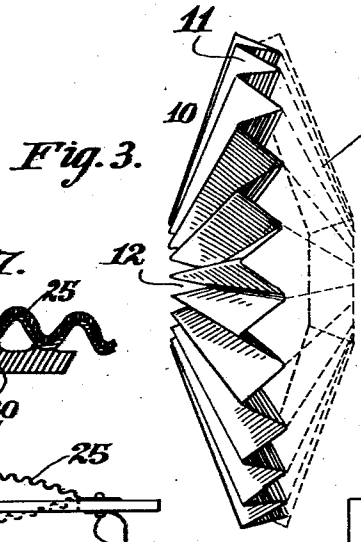



Fig. 3.

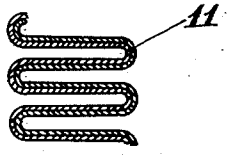



Fig. 4.

Fig. 7.



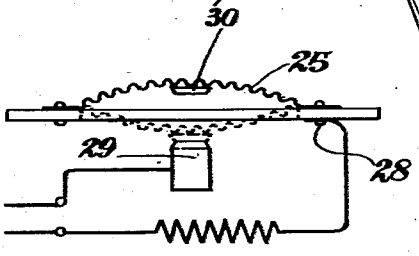
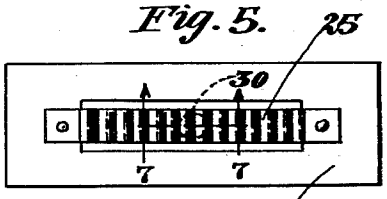




Fig. 6.

Fig. 5.




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SNAP ACTING DEVICE

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*Fig. 8.*

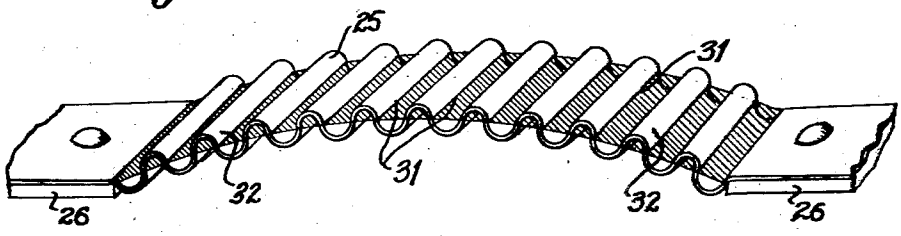



*Fig. 9.*

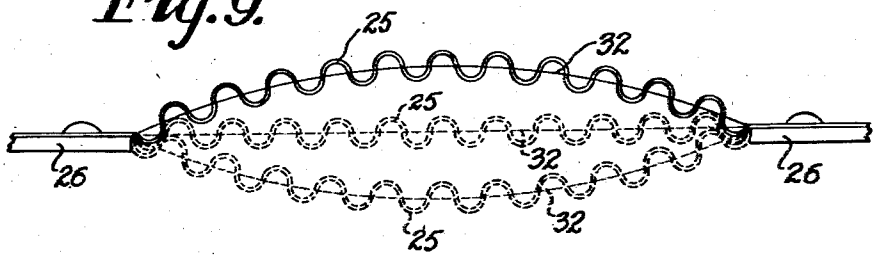
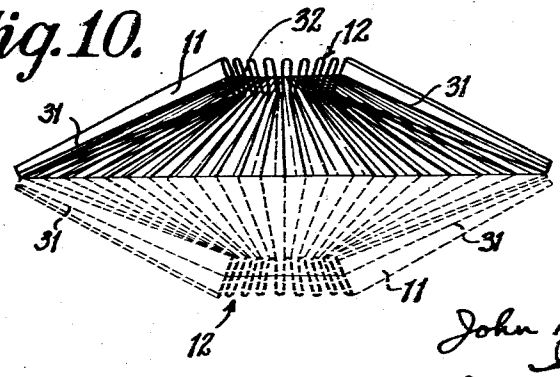



*Fig. 10.*




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Patented Jan. 31, 1933 1,895,590

# UNITED STATES PATENT OFFICE

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## SNAP ACTING DEVICE

Application filed June 26, 1930. Serial No. 463,961.

This invention relates to snap-acting devices, and, with regard to certain more specific features to snap-acting devices, including snap-acting temperature responsive devices particularly adapted to operate valves, switches, and the like, in response to ambient temperature variations of predetermined range.

Among the several objects of the invention may be noted the provision of snap-acting, or overcentering devices, particularly thermostats, of the class described, which respond to suitable actuation with an improved "snap" or sudden action; which have a greatly increased range of action or extent of throw; and which are sufficiently resilient or flexible in themselves to provide for the absorption of relatively slight movements, such as creeping, without causing undesirable movement of the device as a whole. Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly comprises the elements and combinations of elements, features of construction, and arrangements of parts which will be exemplified in the structure hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings, in which is illustrated one of various possible embodiments of the invention,

Fig. 1 is a plan view of a snap-acting disc embodying the present invention;

Fig. 2 is a section taken along line 2—2 of Fig. 1;

Fig. 3 is an elevation of the disc of Fig. 1, an alternative position being indicated in dotted lines;

Fig. 4 is a fragmentary cross-section showing a characteristic conformation of the invention;

Fig. 5 is a plan view of a thermostatic strip embodying the present invention;

Fig. 6 is an elevation of the strip of Fig. 5.

Fig. 7 is a section taken on line 7—7 of Fig. 5;

Fig. 8 is an enlarged diagrammatic showing of the strip of Fig. 5;

Fig. 9 is a diagrammatic elevation of the strip of Fig. 8; and,

Fig. 10 is a diagrammatic section, similar to Fig. 2, showing certain characteristics of the disc embodiment of the invention.

Similar reference characters indicate corresponding parts throughout the several views of the drawings.

In my prior Patent No. 1,448,240, granted March 13, 1923, I have shown a snap-acting unit which is thermostatic or responsive to temperature changes, comprising a disc of bimetal, or composite thermostatic material, provided with a non-developable portion. In response to the forces set up in the bimetal by temperature change, this non-developable portion undergoes a reversal of curvature, or change of flexure, with a "snap". This device may also be snapped, by suitable application of external forces, without regard to temperature changes. This prior patented device has proved quite satisfactory in practical usage. However, in my prior device, the extent of movement or "throw" of the device is somewhat small, and it can be increased only by so greatly increasing the overall size of the device as to lead to an impracticable article.

The throw of a snap-acting device, such as a thermostat of this character is determined by the distance between its positions of stability, or of opposite flexure. This factor is in turn determined by the extent of dishing, or depth of the undevelopable portion. However, this depth cannot be increased indefinitely, as a point is soon reached where the normal resistance to reversal of curvature is in excess of the reversal force obtained thermally in the bimetal, whereupon the device will not change form in response to temperature variations.

The invention will be described principally by reference to its thermostatic embodiment, that is, where it performs in response to temperature changes. However, it will be understood that, even as a thermostat, the invention is fundamentally a snap-acting device.

The reversal force, or thermal force, is set up by the differing linear expansions of the constituent metals of the bimetal. It is proportional to the area of bimetal in the given device. Thus, if the area of bimetal in

a given device may be increased, the thermal forces obtainable will be proportionally increased, and with increased thermal forces available, the depth of curvature may be increased, all with the ultimate, desired result of increasing the throw of the thermostat.

The present invention concerns the provision of a greater area of composite thermostatic material, such as bimetal, within a given overall size of device, and thus attains the desired result above set forth. Briefly, the present invention provides the increased area through corrugation of the bimetal. Incident to this corrugation procedure, other advantageous results accrue, as will be pointed out hereinafter.

The invention is illustrated in this application in two of its embodiments, namely, a disc (Figs. 1, 2, 3, and 10) and a strip (Figs. 5, 6, 7, 8, and 9).

The disc embodiment of the invention comprises a sheet 10 of composite thermostatic material which is initially formed as a truncated cone, that is, the central portion of the disc is displaced or in a different plane than the periphery of the disc. The corrugations are provided in radial arrangement as indicated by numeral 11, corresponding roughly to the elements of the basic truncated cone. Numeral 12 indicates the central hole of the disc, from and about which the corrugations 11 radiate. Desirably the disc 10 is formed by corrugating a cylinder or the like and compressing one end of the cylinder inwardly, as this procedure provides more composite thermostatic material in the inner region of mobility of the device, where it is most advantageously employed. If a circular cylinder be used, it will be apparent that the developed inner periphery of the device is even equal in length to the developed outer periphery.

When the predetermined temperature change of the device occurs, it snaps instantaneously to a position of opposite curvature or stability, indicated by dotted lines in Fig. 3.

The disc embodiment thus shown is entirely self snapping, and requires no extraneous confining or compression members to operate.

In Figs. 5, 6, 7, 8 and 9 is illustrated the strip embodiment of the present invention. A strip 25 of composite thermostatic material is provided with cross-wise corrugations, as shown. The strip 25 is secured at its ends, in such manner as to be somewhat arched or bowed, to a support 26. The strip 25 carries, for example, a contact member 30, which cooperates with a relatively stationary contact 29 to control an electrical circuit (Fig. 6). It will be understood that this is but one of the manners in which the strip form of the present invention may be utilized.

Upon predetermined change of temperature, as in the case of the disc embodiment, the strip reverses the direction of its arch or curvature and snaps to the dotted line position (Fig. 5).

There are certain criteria which must apparently be fulfilled before either the disc or strip embodiments of the invention will snap back and forth in response to temperature changes in opposite directions. For example, in Fig. 8 is shown an enlarged view of the strip embodiment. A series of imaginary lines or norms 31, located on each of the corrugations, determines an imaginary or norm surface 32, which may be considered to represent the strip with all of its corrugations flattened out. When the strip is in a position of stability, as in Fig. 8, this imaginary surface is arched upwardly. Ordinarily, the surface 32 may be considered as lying in the central axis of the corrugations, but its location varies as the shape of the corrugations and other factors vary.

In order for the strip to snap back and forth, as desired, the surface 32 must be capable of undergoing a decrease in area to a minimum, when it is flat, and when it represents a central condition of instability of the strip (Fig. 9). After passing through this position of minimum area, the surface 32 must again increase in area, but in an opposite direction, corresponding to the opposite or second position of stability of the strip. Throughout all of this change of area and position of the surface 32, the disposition of the corrugations on either side thereof should not change substantially.

If the conditions above indicated are met, the strip will, upon rise of temperature to a predetermined value, snap from one position of stability through its position of instability to its second position of stability, and then, upon fall of the temperature to a predetermined value, the strip will again snap back through its position of instability to its first position of stability, all automatically and without the application of any extraneous forces other than the thermal ones.

The criteria for snapping of the disc embodiment of the invention are similar. The imaginary or norm surface 32 (Fig. 10) in the disc form, instead of being in the form of a simple arch, resembles an uncorrugated, truncated cone. Its devolution, to a flat, central position of instability, represents a decrease in area to a minimum value, and its subsequent increase in area carries it to the second position of stability of the disc. As in the strip form, the disposition of the corrugations on both sides of the surface 32 should remain substantially unchanged from position of stability through position of instability to alternate position of stability.

Thus constituted, the disc form of the invention is likewise capable, upon increase of temperature, of snapping from one position

of stability through its position of instability to its second position of stability, and then, upon fall of temperature, of again snapping, back through its position of instability to its first position of stability, all automatically and without the application of any extraneous forces.

It will be seen that, when the thermostat is so constructed as to comply with the above conditions, it is so formed (either strip or disc) that it can be flattened without temperature change only by compressing the corrugations to such a position that the device is in an unstable position.

The term "composite thermostatic material" as used herein is accordingly defined as a sheet of two or more layers of metals having different coefficients of thermal expansion. When two layers are used, the material is commonly called "bimetallic". It is to be understood that the several layers need not be in discrete steps, a material having a varying composition throughout its cross section (such as disclosed in the patent issued to Vannevar Bush, No. 1,870,235, dated August 9, 1932), being likewise contemplated by the term "composite thermostatic material". As the disc or strip is formed, for use where the normal position is cold, the component of the thermostatic material having the higher coefficient of thermal expansion is, in the "cold" position of the thermostat, located upon the concave side of the strip or disc.

If the invention is to be employed as a simple mechanical snap-acting or overcentering device, or spring, it will readily be seen that the use of composite thermostatic metal is unnecessary, although possible. In such instances, a sheet of single resilient metal may be used with success. The action of the device as an overcentering element needs no further description, as it varies from the thermostatic element only in that applied external forces replace the self-engendered thermostatic forces in effecting the change of shape desired.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As many changes could be made in carrying out the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. A thermostat comprising a sheet of composite thermostatic material having a large number of corrugations therein, each of said individual corrugations being small as compared to the size of the sheet, said sheet and said corrugations being so shaped that an imaginary surface determined by a series of lines on said corrugations, within the envelopes of said corrugations, has two separate positions of relatively large area, establishing two positions of stability of the device, and an intermediate position of minimum area, establishing a position of instability of the device, the said corrugations being so formed that they are disposed on both sides of said surface in substantially the same manner in both positions of stability and in the intermediate position of instability, said device thereby automatically snapping, upon change of temperature in one direction, from one position of stability through the position of instability to the second position of stability, and automatically snapping, upon change of temperature in the reverse direction, from said second position of stability through the position of instability back to the said first position of stability.

2. A thermostat as set forth in claim 1 in which the thermostatic sheet is in the form of a strip, held at its ends between relatively rigid abutments, and in which the corrugations are at an angle to the length of the strip.

3. A thermostat as set forth in claim 1 in which the thermostatic sheet is in the form of a disc, and the corrugations are positioned radially on the disc.

4. A thermostatic unit comprising a sheet of composite thermostatic material formed of two layers of different coefficients of thermal expansion, and shaped in the form of a truncated cone with an opening at its apex, the unit having its surfaces corrugated and being adapted to assume a position of opposite configuration under influence of temperature changes of predetermined ranges.

5. A snap-acting bimetallic thermostatic disc in the form of a truncated cone having a hole at its apex, the disc having its surfaces corrugated and being capable of automatically assuming a position of opposite configuration under influence of temperature changes of predetermined range.

6. A thermostat comprising a disc of composite thermostatic material having radial corrugations therein, the plane of the central portion of said disc being displaced from the plane of the peripheral portion thereof, whereby said disc is adapted at predetermined respective critical temperatures to assume positions of opposite configuration.

7. A thermostat comprising a disc of composite thermostatic material having the general shape of a cone and having at least part of its surface corrugated, said disk having two positions of stable equilibrium and an intermediate position of unstable equilibrium, said disk being adapted to assume said positions of stable equilibrium under influence of temperature changes of a predetermined range.

8. A snap-acting thermostat comprising

an annulus of composite thermostatic material, the annulus being so bent that its inner and outer developed peripheries are of substantially equal lengths, said annulus having the plane of its inner periphery displaced from the plane of its outer periphery.

9. A snap-acting thermostat comprising an annulus of composite thermostatic material, said annulus being corrugated and having the plane of its central portion displaced from the plane of its peripheral portion.

10. A thermostat comprising a frustum of a cone formed of composite thermostatic material, said frustum being so corrugated that its developed internal periphery is greater in length than the developed internal periphery of a smooth-surface frustum of equivalent size.

11. A snap-acting device comprising a disc of resilient material having radial corrugations therein, the plane of the central portion of said disc being displaced from the plane of the peripheral portion thereof, the said disc being suitably resilient, whereby upon suitable actuation thereof, it overcenters to assume a position of opposite configuration.

12. A snap-acting device comprising an annulus of resilient material, the annulus being so bent that its inner and outer developed peripheries are of substantially equal lengths, said annulus having the plane of its inner periphery displaced from the plane of its outer periphery.

In testimony whereof, I have signed my name to this specification this 25th day of June, 1930.

JOHN A. SPENCER.