

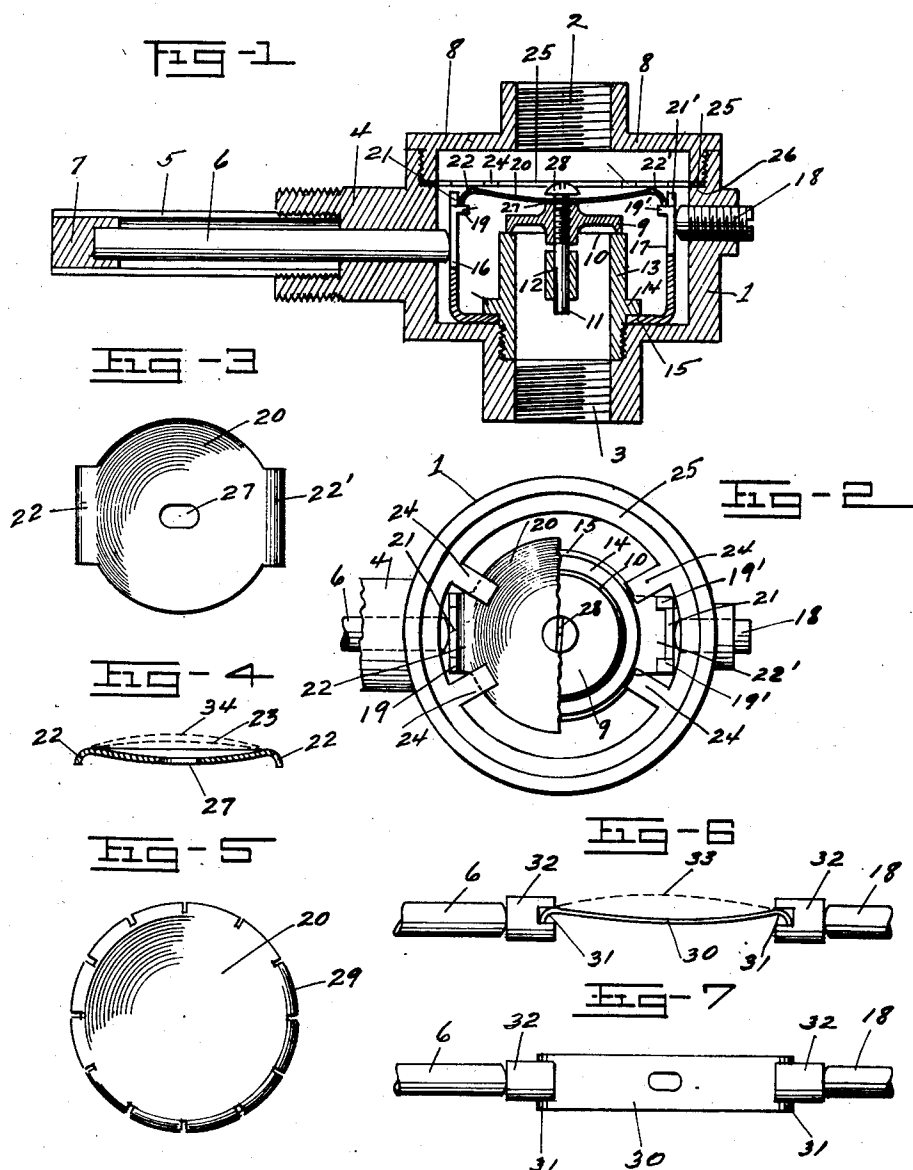
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THERMOSTAT

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THERMOSTAT

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The invention may be manufactured and used by or for the Government for governmental purposes without the payment to me of any royalty thereon.

Heretofore in thermostats of the valve snap-acting diaphragm type with which I am familiar, the diaphragm is generally in the form of a concavo-convex spring disc, which is made to snap over dead center into a reverse form by pressure applied to the convex side of the disc in order to actuate the valve. The pressure is generally applied by thermal responsive members and the distance of travel of the members is limited generally to the travel of the center of the disc when snapped into a reverse form. Any further travel of the thermally responsive members will cause abnormal strains in the disc which may prevent the disc regaining its normal form when the pressure is removed and make the thermostat inoperative.

One important feature of the device of my invention lies in the method used in causing the disc to snap into a reverse form. Instead of applying the pressure to the convex side of the disc I apply the pressure to the edge of the disc which is especially formed for the purpose. I employ a normally concavo-convex spring disc having its periphery or a part thereof, cupped or bent in the direction of the normal convex side of the disc and apply the pressure at two diametrically opposite points on the periphery. When sufficient pressure is applied the center of the disc will snap over dead center into a reverse form and if the pressure movement continues the disc will bow in the middle without setting up strains that would prevent the disc regaining its normal form when the pressure is removed. The degree of bend in the cupped periphery determines its sensitiveness to pressure. If the bend is very short it will require only a very slight movement of the thermally responsive members to snap the disc into a reverse form. I have found that a movement of only 1/500 inches will snap a one inch disc into a reverse form. Another important feature is the simplicity of the application of the principles in operating valves, electrical switches and such devices.

The foregoing, together with such other objects as may hereinafter appear, or, are incident of my invention, I obtain by means of a construction described herein and illustrated in the accompanying drawing wherein:

Fig. 1 is a central longitudinal section through a thermally controlled gas valve made in accord-

ance with my invention and showing the position of the parts when the valve is closed. Fig. 2 is a sectional plan view of the valve with the cap removed. Fig. 3 is a plan view of one form of snap acting disc used. Fig. 4 is a longitudinal sectional view of Fig. 3. Fig. 5 is a plan view of a modified form of disc. Fig. 6 is a sectional elevation illustrating a modified form of the snap acting overcenter spring. Fig. 7 is a plan view of Fig. 6.

Similar reference numbers refer to corresponding parts throughout the several views.

The thermostat in connection with which my invention is illustrated comprises the usual elements, the one being non-expanding or having a low coefficient of expansion such as a rod of invar 6, and the other being expansible or having a high coefficient of expansion such as a copper tube 5. The inner end of the tube 5 is screwed into an internally threaded neck 4 of a cast hollow valve body 1. The invar rod 6 is secured within the tube at its outer end to a plug 7 fixed gas tight in the outer end of the tube 5. By virtue of this construction it will be evident that expansion and contraction of the copper tube 5 results in slight endwise movement of the inner or free end of the rod 6 which is slidably mounted in the neck 4 of the valve body 1. The neck 4 of the valve body is threaded on the outside to screw into the wall of a water tank or oven containing the fluid to be heated and of which it is desired to control the temperature. The valve body 1 has an inlet port 2 formed in a cap member 8 closing the bore of the valve body, which may be connected to the gaseous fuel supply, and an outlet port 3 which may be connected to the burner used to heat the fluid.

The flow of the gaseous fuel is controlled by a poppet type of valve 9, shiftable onto and off its seat 10 provided within the valve body between the inlet and outlet ports 2 and 3. The valve 9 is supported on a valve stem 11 slidably mounted in a guide 12 formed in a web member extending across the opening of a nipple member 13 screwed into the outlet port 3 within the valve body. The valve seat 10 is formed in the upper end of the nipple member 13. The nipple has an annular shoulder 14 which clamps a ring member 15 between the shoulder 14 and the bottom of the bore of the valve body. The ring member 15 has two resilient levers 16 and 17 extending therefrom and upwardly along the inside walls of the valve body and diametrically opposite to each other. One of the levers 16 is arranged in contact with the inner or free end of the invar rod 6 in such a

manner as to amplify the endwise movement of the rod. The opposite lever 17 is arranged in contact with the inner end of an adjustment screw 18 provided to time the action of the valve with reference to temperature desired. The upper ends of both levers 16 and 17 are provided with inwardly extending lugs or shelves 19 and 19' arranged at a suitable height from the base of the levers which support the snap acting disc 20 provided to actuate the valve 9. An upward extension 21 and 21' of the levers 16 and 17 act as movable abutments to press against the cupped periphery of the disc. The snap acting spring disc 20 may take the form illustrated in Figs. 3 and 4 in which a normally concavo-convex spring disc is provided with two diametrically opposed tongues 22 extending radially from the disc and cupped or bent toward the normal convex side of the disc. The tongues 22 of the disc 20 rest on the shelves 19 and 19' of the levers 16 and 17 between the movable abutments 21 and 21' in such a manner that any inward movement of the levers exert a pressure on the edges of the tongues and set up bending moments or stresses in the metal disc, which, due to its form and elasticity, will cause the disc to snap into a reverse or convexo-concave form as indicated by the dotted lines 23 in Fig. 4. Any further pressure after the disc has been snapped into a reverse form merely causes it to bow in the middle as indicated by the dotted lines 34 without setting up strains that would prevent the disc snapping into its normal form after the pressure is removed. The disc 20 is held in position on the lugs 17 by flat resilient arms 24 extending inwardly over the edge of the disc from a ring 25 clamped tight between the cap member 8 and an annular shoulder 26 (Fig. 1) formed in the wall of the bore of the valve body. The valve 9 is moved to and from its seat 10 by the action of the disc which has a central opening 27, slightly elongated on the longitudinal axis of the disc, through which passes the valve stem 11. The valve stem has a screw head 28 slightly spaced from the concave side of the disc against which the disc acts to open the valve. The valve stem 11 is screwed through the valve member 9 so that proper adjustment may be made between the valve stem head 28 and the top of the valve member 9 to allow a slight movement in the disc center before snapping over dead center. Normally, the convex side of the disc presses downwardly on the top of the valve 9 and holds it on its seat, but when the edge of the tongues 22 and 22' of the disc are pressed inwardly the center of the disc will at first move slowly upward toward its dead center line. As the movement continues the center of the disc will reach a point where the stresses in the metal will cause it to snap quickly into a reverse form. The valve stem head is so adjusted that the disc does not touch it until the stresses in the metal are sufficient to snap it into a reverse form. This arrangement insures a positive snap movement in opening the valve.

In operation, the thermostatic rod 6 moves inwardly when the copper tube contracts. The movement is amplified by the lever 16 which transmits the movement to the edge of the tongue 22. When the pressure on the tongue is sufficient the disc will snap into a reverse form as illustrated by the dotted lines 23 in Fig. 4 and cause the valve to open. When the thermostatic rod 6 moves outwardly or away from the lever 16 the pressure on the disc is removed and it will snap back to its original form and close the valve.

To adjust the thermostat for operation at a predetermined temperature, the distance of travel of the inner end of the rod 6 with reference to the disc may be increased or decreased by screwing in or out the adjustment screw 18 which moves the disc toward the rod or allows it to move away from the rod, thus advancing or delaying the opening of the valve. The opening 27 in the disc through which the valve stem passes is slightly elongated to allow for the necessary endwise movement of the disc.

In Fig. 5 a form of disc is illustrated in which the entire periphery 29 of the disc 20 is cupped or bent toward the convex side of the disc, and that part which is cupped is serrated to allow the disc to bow after it is snapped. Sufficient pressure on diametrically opposite points on any part of the periphery will cause the disc to snap into a reverse form. The sensitivity of the thermostat to changes in temperature is governed entirely by the degree of bend in the cupped periphery and the amount the movement of the thermal responsive elements is amplified.

In Figs. 6 and 7 is illustrated another modified form of overcenter spring for producing either a snap action or a slow action for actuating valves etc. A flat spring member 30 normally concave and having its ends 31 bent toward the convex side of the spring member is supported between two abutment members 32, either or both of which may be moved toward or away from each other by the action of the thermostatic rod 6 and the adjustment screw 18 which increases or decreases the pressure on the bent ends of the spring. If the pressure on the ends of the spring is sufficient the spring will snap or bow upward into a reverse form as indicated by the dotted lines 33 which movement may be utilized to actuate a valve or other device. In this modification it will be noted that the movement of the thermostatic rod is not amplified by a lever as illustrated in Fig. 1. The levers need not be used except where it is desired to obtain a sensitive action.

It is believed that the foregoing description conveys a clear understanding of the objects and advantages of my invention. While I have illustrated and described the advantages and application thereof to thermostatic valves I anticipate numerous other possible applications. All legitimate modifications of my invention are therefore to be construed as coming within the scope and spirit of the appended claims.

I claim:

1. A snap acting device comprising a dished spring plate having two or more of its opposite edges bent or beveled toward the normally convex side of the plate, and means for exerting a pressure on opposite edges acting toward the center of the plate to set up stresses in the plate which causes the dished portion of the plate to attain a reverse form with a snap action, said plate having the property of regaining its normal form when said pressure is removed.

2. A valve actuating mechanism comprising a normally concavo-convex spring plate having opposite ends bent or beveled toward the normally convex side of the plate, and a thermally responsive element arranged to apply a pressure according to temperature variations to the bent or beveled ends acting toward the center of the plate to set up stresses which causes the plate to attain a reverse or convexo-concavo form, said plate having the property of regaining its normal concavo-convex form when said pressure

is removed, and said valve being arranged in operative relation to the normal concave side of the plate.

3. In a thermostat, the combination of a thermal responsive element arranged to transmit motion in event of temperature variation, a valve or other element arranged to be operated by said motion, and means intermediate said thermal responsive element and said valve or other element to amplify and transmit said motion with a snap action, said means comprising a dished plate of spring material having two or more opposite edges bent or beveled in the direction of the convex side of the plate and so arranged with reference to said thermal responsive element that the motion thereof is applied to exert a pressure on the bent or beveled edges acting toward the center of the plate, which, by virtue of the stresses set up therein, causes the dished portion of the plate to snap into a reverse form and operate the valve or other element, said plate having the property of regaining its normally dished form when said pressure is removed.

4. In a thermostat, the combination of a thermal responsive element arranged to transmit motion in event of temperature variation, a valve or other element arranged to be operated by said motion, and means intermediate said thermal responsive element and said valve or other element to amplify and transmit said motion with a snap action, said means comprising a normally concavo-convex spring disc, having its periphery serrated and cupped or bent toward the normally convex side, so arranged with reference to said thermal responsive element that the motion thereof exerts an inward pressure on the periphery of the disc and causes the disc to attain a reverse or convexo-concave form with a snap action by virtue of the stresses set up in the disc, said disc having the property of regaining its normal form when the pressure is removed.

5. A valve actuating mechanism comprising a normally concavo-convex spring plate, opposite ends on said plate, said ends being bent toward the normally convex side of said plate, a thermally responsive element, means intermediate said plate and said thermally responsive element arranged to transmit pressure from said thermally responsive element according to temperature variations to the bent ends and acting toward the center of the plate to set up stress which cause the plate to attain a reverse or convexo-concave form, and a screw adjustment included in said intermediate means whereby to advance or delay the transmission of said pressure, said plate having the property of regaining its normal concavo-convex form when said pressure is removed, said valve being arranged in operative relation to the normal concave side of the plate.

6. In a thermostat, the combination of a thermally responsive element arranged to transmit motion in event of temperature variation, a valve or other element arranged to be operated by said motion, means intermediate said thermally responsive element and said valve or other element to amplify and transmit said motion with a snap action, said means comprising a dished plate of spring material having a plurality of opposite edges bent in the direction of the convex side of the plate, and means for mounting said plate with reference to said thermally responsive element that the motion thereof is applied to exert a pressure on the bent edges acting toward the center of the plate which by virtue of the stress

set up therein causes the dished portion of the plate to snap into reverse form and operate the valve or other element, said plate having the property of regaining its normally dished form when said pressure is removed, said mounting means including a screw adjustment for advancing or delaying the pressure applied to the edges of the spring plate by causing the mounting means to move the plate toward or away from the thermally responsive element.

7. In a thermostat, the combination of a thermally responsive element arranged to transmit motion in event of temperature variation, a valve or other element arranged to be operated by said motion, means intermediate said thermally responsive element and said valve or other element to amplify and transmit said motion with a snap action, said means comprising a dished plate of spring material having a plurality of opposite edges bent in the direction of the convex side of the plate, and means for mounting said plate with reference to said thermally responsive element that the motion thereof is applied to exert a pressure on the bent edges acting toward the center of the plate which by virtue of the stress set up therein causes the dished portion of the plate to snap into reverse form and operate the valve or other element, said plate having the property of regaining its normally dished form when said pressure is removed, said mounting means serving to amplify the movement of the thermally responsive element with reference to the spring plate.

8. The combination of a thermally responsive element arranged to transmit motion in event of temperature variation, a valve or other element arranged to be operated by said motion, means intermediate said thermally responsive element and said valve or other element to amplify and transmit said motion with a snap action, said means comprising a normally concavo-convex spring disc, the periphery of said disc being serrated and cupped toward the normally convex side, and means for mounting said disc with reference to said thermally responsive element so that the motion thereof exerts an inward pressure on the periphery of the disc and causes the disc to attain a reverse or convexo-concave form with a snap action by virtue of the stress set up in the disc, said disc having the property of regaining its normal form when the pressure is removed, said mounting means serving to amplify the movement of the thermally responsive element with reference to said spring disc.

9. The combination of a thermally responsive element arranged to transmit motion in event of temperature variation, a valve or other element arranged to be operated by said motion, means intermediate said thermally responsive element and said valve or other element to amplify and transmit said motion with a snap action, said means comprising a normally concavo-convex spring disc, the periphery of said disc being serrated and cupped toward the normally convex side, means for mounting said disc with reference to said thermally responsive element so that the motion thereof exerts an inward pressure on the periphery of the disc and causes the disc to attain a reverse or convexo-concave form with a snap action by virtue of the stress set up in the disc, said disc having the property of regaining its normal form when the pressure is removed, said mounting means serving to amplify the movement of the thermally responsive element with reference to said spring disc, and means for ad-

justing said mounting means for advancing or delaying the pressure applied to the serrated periphery of said disc by moving said disc toward or away from the thermally responsive element.

5 10. A snap device comprising a normally concavo-convex spring plate, a plurality of oppositely disposed separate edges on said plate, said edges being bent toward the normally convex side of said plate whereby, when a pair of said oppositely
10 disposed edges are pressed toward each other, said spring plate will snap into a reverse or convexo-concave form, said plate regaining its normal form when the pressure is released.

11. A snap device comprising a normally concavo-convex spring plate, a plurality of individual
15 opposite ends or edges on said plate bent or beveled toward the normally convex side so that when said ends or edges are pressed toward each other, the spring plate will snap into a reverse or convexo-
20 concave form, said plate having the property of regaining its normal form when the pressure is removed.

12. A snap acting device comprising a normally concavo-convex spring plate and two diametrically
25 opposite separated sections on the peripheral edge of said plate bent or cupped toward the normally convex side of said plate, said plate having the property of snapping into a reverse or convexo-concave form when sufficient pressure is applied
30 on the two bent sections toward the center of the plate and the property of regaining its normal form when the pressure is removed.

13. A snap acting device comprising a normally concavo-convex spring plate, the periphery of said
35 plate being serrated into a plurality of individual segments bent or cupped toward the normally

convex side of said plate, said plate having the property of snapping into a reverse or convexo-concavo form when sufficient inward pressure is applied to oppositely disposed bent segments and the property of regaining its normal or concavo-convex form when the pressure is removed. 80

14. A leaf spring adapted to actuate a valve or other element when bowed or flexed by an end thrust applied thereto, said leaf spring having
85 one or both its ends bent away from the normal plane of the leaf spring so that the end thrust will cause the leaf spring to bow or flex in a direction opposite to the bent ends. 85

15. A leaf spring adapted to actuate a valve or other element when bowed or flexed by an end thrust applied thereto, said leaf spring being
90 slightly bowed in the middle and having both its ends bent in a direction opposite to the bowed portion so that the end thrust will cause the leaf spring to bow or flex in a direction opposite to
95 its normal bow and opposite to the bent ends. 95

16. A leaf spring, said spring being bowed or flexed in one direction, one end of said leaf spring bent away from the normal plane of the bowed
100 portion of the leaf spring so that an end thrust on said spring will cause the leaf spring to bow or flex in a direction opposite to the bent end. 100

17. A leaf spring, said leaf spring being slightly bowed in the middle, the opposite ends of said
105 leaf spring being bent in a direction opposite to the bowed portions, whereby an end thrust will cause the leaf spring to bow or flex in a direction opposite to its normal bow and opposite to the bent ends. 105

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