United States Patent

Beck

[15] **3,656,082**

[45] **Apr. 11, 1972**

[54] POSITIONING DEVICE

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[22] Filed: **Sept. 28, 1970**

[21] Appl. No.: **75,924**

[52] **U.S. Cl.**.....**337/366,** 335/205

[51] **Int. Cl.**.....**H01h 1/66,** H01h 37/66, H01h 37/68

[58] **Field of Search**.....337/54, 90, 134, 340, 344, 337/366; 335/145, 153, 205, 206, 207

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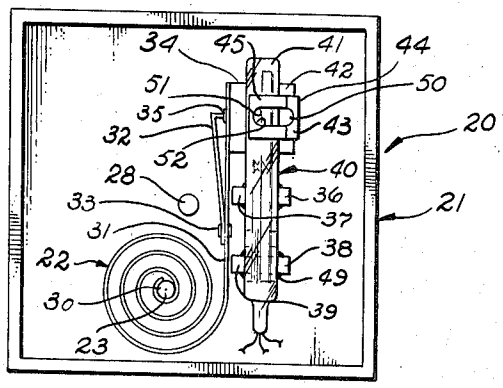
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[57] **ABSTRACT**

A thermostat for supplying natural gas to a gas fired furnace or the like at two different rates, depending upon the difference between the temperature setting of the thermostat and the ambient temperature. The thermostatic switch has a ferromagnetic armature which is normally attracted by a fixed magnet and is selectively attracted by a movable magnet fixed to a bimetal. A cantilever spring wire makes it possible for the magnet to close two pairs of contacts in the switch at different times. Both pairs of contacts are closed with a snap action even though only one pair of movable ferromagnetic bodies are employed.

10 Claims, 12 Drawing Figures



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SHEET 1 OF 2

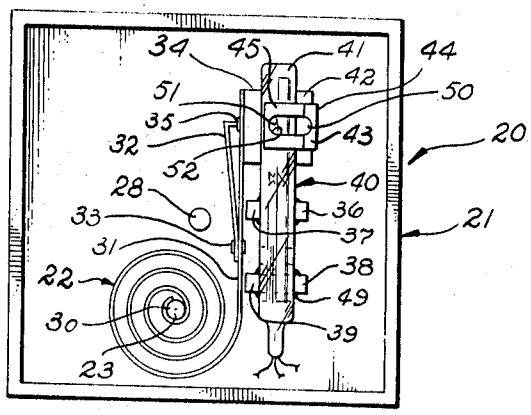


Fig. 1.

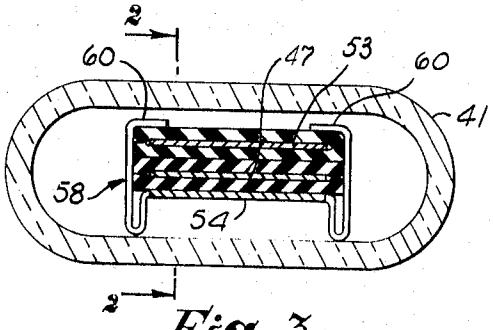


Fig. 3.

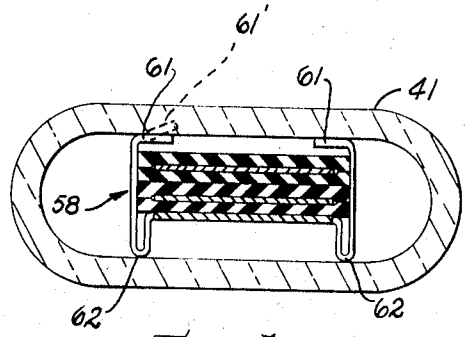


Fig. 4.

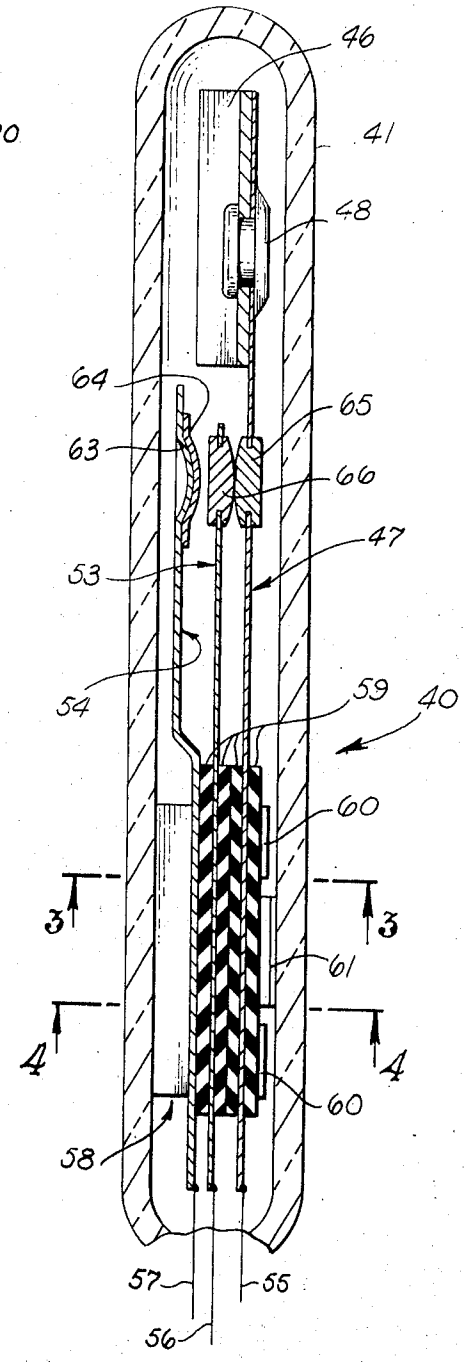


Fig. 2.

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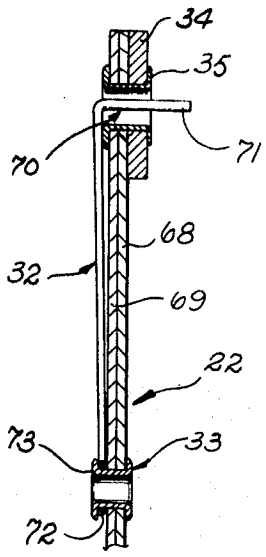


Fig. 5.

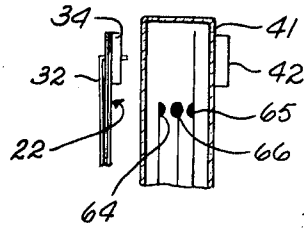


Fig. 10.

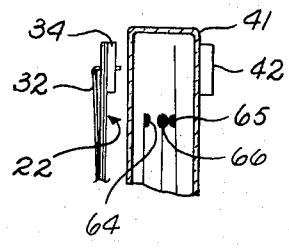


Fig. 11.

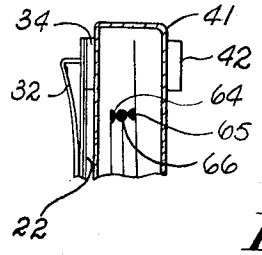


Fig. 12.

Fig. 6.

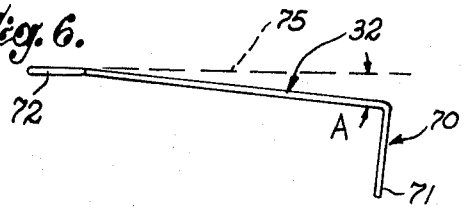
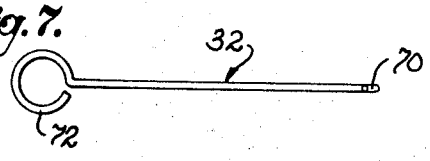


Fig. 7.



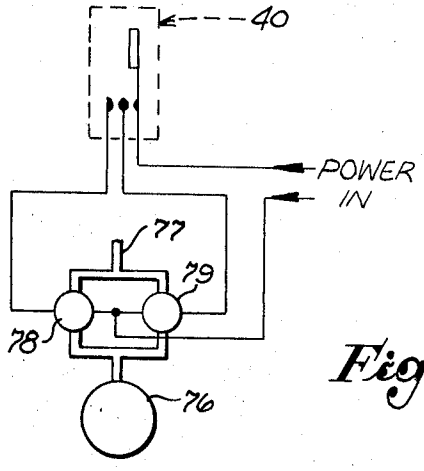


Fig. 9.

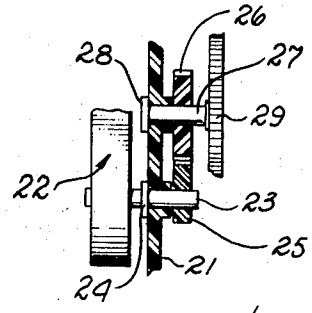


Fig. 8.

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POSITIONING DEVICE

BACKGROUND OF THE INVENTION

This invention relates to sequencing devices, and more particularly, to an arrangement for dividing the movement between two magnetic bodies into two successive, discrete movements, each of which two movements may take place over an extremely short time in comparison to the time interval between the movements.

Although the device of the present invention will have broad application and should not be limited to those applications disclosed herein, the invention has been found to have exceptional utility in a permanent magnet operated switch for providing low fire and high fire in a gas furnace. That is, the invention may be employed in a thermostat.

Permanent magnet operated thermostat switches are not broadly new in the art. For example, see my abandoned application, Ser. No. 617,191 filed Feb. 20, 1967, for Magnetically Operable Reed Switch, and the prior art patents and other prior art made of record in said application including, but not limited to, that made of record by me through my attorney.

In the past, a magnetically operated switch could not provide more than one switching function in one switching direction. This was true because once a permanent magnet became attracted to a ferromagnetic armature and vice versa, the magnet and the armature would accelerate toward each other until they were as close as possible. This motion was uninterrupted. Prior art magnetically operated switches have thus not been employed for both low fire and high fire control.

Notwithstanding the foregoing, a magnetically operable switch is highly reliable and may cycle several hundred thousand times without failure. Although to the present time there has been no low fire/high fire type magnetically operable switch, the need, however, does in fact exist for such a device because of its high reliability.

SUMMARY OF THE INVENTION

In accordance with the device of the present invention, the above-described and other disadvantages of the prior art are overcome by providing a two position switch utilizing a biased member, the biasing force of which can be overcome.

According to one feature of the invention, a fixed magnet is used with a movable magnet on the thermostat bimetal, and a cantilever wire spring prevents the movable magnet from touching the glass member of the switch when a first pair of contacts are engaged therein. The bimetal then either releases some of its restraining force on the fixed magnet or, in fact, applies some thereto to move it toward the member. Thus, when the cantilever wire spring force is overcome, the permanent magnet, in a snap action, moves against the glass member.

It is an outstanding feature of the invention that the permanent magnet moves with a snap action in two stages, each stage of which may be separated by an interval of time much greater than the time during which the snap action takes place. Thus, the switch contacts are made positively without bounce, and arcing and welding are avoided.

Another feature of the invention resides in the use of three leaf springs in the switch, one leaf spring on one side carrying a ferromagnetic armature. Movement of the armature toward the other two leaf springs provides successive valve actuation to admit combustible gas first at a first rate and second at a higher rate.

The above-described and other disadvantages of the present invention will be better understood from the following detailed description when considered in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings which are to be regarded as merely illustrative:

FIG. 1 is a rear elevational view of a thermostat constructed in accordance with the present invention;

FIG. 2 is a vertical sectional view through the thermostat switch taken on the line 2—2 shown in FIG. 3;

FIG. 3 is a transverse sectional view of the thermostat switch taken on the line 3—3 shown in FIG. 2;

FIG. 4 is a transverse sectional view of the thermostat switch taken on the line 4—4 shown in FIG. 2;

FIG. 5 is an enlarged longitudinal sectional view through a portion of a bimetal strip with several structures fixed thereto;

FIG. 6 is a side elevational view of a spring wire shown in FIG. 5;

FIG. 7 is a bottom plan view of the wire;

FIG. 8 is a sectional view through the thermostat showing an adjustment for the bimetal position;

FIG. 9 is a diagrammatic view of a heating system in which the thermostat of the invention may be employed; and,

FIGS. 10, 11 and 12 are side elevational views of the thermostat, partly in section, illustrating the operation thereof.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1, the thermostat of the present invention is indicated at 20 including a housing portion 21 having a bimetal strip 22 mounted thereon. A shaft 23 is rotatable with respect to housing portion 21 but is fixed axially with respect thereto with a flange 24 integral with shaft 23, and a sector-shaped gear 25 fixed to shaft 23, as shown in FIG. 8. A gear 26 meshes with gear 25 and is fixed to a shaft 27 that has an integral flange 28. Shaft 27 is thus also rotatable with respect to housing portion 21 but is axially fixed with respect thereto. A neural control knob 29 is fixed to shaft 27. When it is desired to adjust the temperature in a room in a building where a conventional natural gas fired furnace is used, the rotatable position of knob 29 is adjusted.

All of the structures shown in FIG. 8 may be entirely conventional.

From FIG. 1, it appears from the drawing that bimetal 22 is made of a single piece of metal. However, this view is quite small, and the separation between the two metal pieces, to be described in FIG. 5, is not shown in FIG. 1 for clarity.

One end 30 of bimetal 22 is fixed to shaft 23, as shown in FIG. 1. The other end of bimetal 22 is indicated at 31, and is relatively long, flat and straight. As is conventional, bimetal 22 may have a uniform width throughout its length equal to that shown in FIG. 8. The side edges of the bimetal which can be seen in FIG. 1 lie in substantially a single plane, as do the opposite edges thereof, not shown in FIG. 1.

As shown in FIG. 1, bimetal 22 has an L-shaped cantilever spring wire 32 fixed thereto by an eyelet 33. A movable permanent magnet 34 is fixed to bimetal 22 by means including an eyelet 35. As will be described, wire 32 has an end portion which projects through the hole in eyelet 35. Although magnet 34 is fixed relative to bimetal 22, when bimetal 22 moves, magnet 34 moves with it.

Housing portion 21 has four rectangular integral projections 36, 37, 38, and 39 which help support a switch 40. Switch 40 includes an envelope 41 which may be sealed, as desired. Although the seal does not have to be hermetic, it may be advantageous to employ a hermetic seal, and fill the envelope with an inert gas such as nitrogen.

A permanent magnet 42 is held in a fixed position relative to envelope 41 by a spring clip 43. Spring clip 43 may be U-shaped having a back portion 44 and two identical side portions 45. The side portions 45 may be spaced a distance slightly smaller than the vertical dimension of envelope 41 in FIG. 3 so as to grip the envelope 41.

In calibration, envelope 41 may be moved upwardly and/or downwardly, as viewed in FIG. 1, between projections 36–39. At the same time, magnet 42 may be adjusted upwardly and/or downwardly by moving spring clip 43 along envelope 41.

Switch 40 includes a ferromagnetic armature 46, shown in FIG. 2. After the thermostat 20 is calibrated, magnet 42 does not move. It is, thus, necessary for magnet 34 to attract armature 46 out of the influence of magnet 42. The influence of

magnet 42 on armature 46 must, thus, be less than that of magnet 34. One way in which to reduce the influence of magnet 42 is to move it downwardly, as viewed in FIG. 1. This reduces the torque on a leaf spring 47 to which armature 46 is fixed by a rivet 48, as shown in FIG. 2.

After calibration, envelope 41 may be fixed to projections 36–39 by sealing wax or other cementing compounds indicated at 49. Magnet 42 may similarly be fixed to clip 43 at 50, and clip 43 may be fixed to envelope 41 and 51 and 52.

In FIG. 2 the structures outside envelope 41 have been omitted for clarity. If such structures were shown in elevation in FIG. 2, they would be in a position identical to that shown in FIG. 1. However, in FIG. 2, the switch 40 has been greatly enlarged and the said structures would, of course, be larger in proportion.

In FIG. 2, leaf springs 53 and 54 are provided in addition to leaf spring 47. Electrical leads 55, 56 and 57 are electrically connected to leaf springs 47, 53 and 54, respectively. If desired, envelope 41 may be made of glass and hermetically sealed to and around all three of the leads 55, 56 and 57.

Leaf spring 54 is substantially thicker than leaf springs 47 and 53. Leaf spring 54 may take some deflection, if desired, but may take little or no deflection in many cases.

Leaf springs 47, 53 and 54 are fixed relative to each other at their lower ends by a metal spring clip 58 which is integral with leaf spring 54. Insulator strips 59 keep the leaf springs insulated from each other. Projections 60, integral with clip 58, hold all the leaf springs and insulators in compression to firmly mount the lower ends of the leaf springs relative to each other.

A pair of projections 60 are provided at each of the upper and lower ends of clip 58. A center pair of projections 61 may be bent outwardly, when unstressed, so that they hold the lower ends of the leaf springs in a fixed vertical position, as viewed in FIG. 2, by causing a tight fit between U-shaped channels 62 and projections 61 with envelope 41 when mounted in the envelope, as shown in FIG. 2. That is, a projection 61 may have a position 61', shown in FIG. 4, before insertion into envelope 41. The same is true of both projections 61.

Envelope 41 is non-magnetic. Further, none of the structures inside envelope 41 are magnetic except armature 46. However, rivet 48 may or may not be made of a magnetic or ferromagnetic material, as desired.

If desired, each of the leaf prings may have equal widths, as shown. The relative proportions are indicated in FIGS. 2, 3 and 4. The leaf springs may have a uniform width throughout their entire lengths. Armature 46 may have a width equal to that of leaf spring 47. Rivet 48 may be located mid-way between the side edges of leaf spring 47.

Leaf spring 54 has a concave portion 63 over which a layer 64 is fixed. Layer 64 may be an entirely conventional contact material.

Contact buttons 65 and 66 are disposed through holes in springs 47 and 53, respectively. The holes through which buttons 65 and 66 are located may be centrally located across the widths of the corresponding springs and be of a size relative to the widths, as shown in FIGS. 2, 3 and 4. Buttons 65 and 66 may also be made of an entirely conventional electrical contact material as is layer 64 on leaf spring 54.

Note will be taken that leaf spring 47 is substantially longer than leaf springs 53 and 54. Note that button 66 does not appear to contact layer 64, but does appear to contact button 65. This may be the case when both of magnets 34 and 42 are removed from a position in proximity to envelope 41.

As shown in FIG. 5, bimetal 22 may include two strips of metal 68 and 69 bonded or fixed together in the conventional way.

As stated previously, wire 32 is L-shaped and has a portion 70 which projects through the hole in eyelet 35, as shown in FIG. 5. Portion 70 has an outer extremity 71 which projects beyond the right side of end of magnet 34 and eyelet 35, respectively, to keep magnet 34 from engaging envelope 41 under conditions to be described. Extremity 71 is also shown in FIG. 5.

In FIG. 5, the manner in which wire 32 is fixed to bimetal 22 is shown including eyelet 33. Spring 32 has a circular portion 72 which fits contiguous around the periphery of eyelet 33 and is clamped to bimetal 22 by an eyelet flange 73. Eyelet 33 is fixed relative to bimetal 22 by another flange 74 at its opposite end.

Wire 32 is shown again in FIGS. 6 and 7. The shape of the wire will be understood from FIGS. 6 and 7. A top plan view of the wire 32 will be identical to FIG. 7; however, portion 70 thereof would then be hidden. Although the precise construction of the wire 32 need not be used, if desired, it may have a circular cross-section uniform throughout its entire length including the entire length of loop 72 and the entire length of portion 70, as well as the straight portion connecting loop 72 and portion 70.

When unstressed, wire 32 appears as shown in FIG. 6. Note in FIG. 6 that a plane tangent to the upper surface of loop 72 in FIG. 6 and perpendicular to the paper would pass through a line 75. Note, too, that line 75 is disposed at an angle A relative to the lower most surface of the portion of wire 32 connecting loop 72 and portion 70.

The bend in the wire which creates angle A puts a prestress in wires 32 when mounted in FIG. 5. This, and other features, are provided in accordance with the device of the present invention. However, it is to be noted that each feature of the invention may be employed by itself or in combination with any one or more or all of the other features without departing from the invention.

The invention has three modes of operation. These three modes are illustrated in FIGS. 10, 11 and 12, respectively. In FIG. 10, note will be taken that buttons 65 and 66 are spaced from each other, and that button 66 is spaced from layer 64. Thus, no circuit is made. Note that even though buttons 65 and 66 are in contact in FIG. 2 when fixed magnet 42 is appropriately positioned, the armature 46 and leaf spring 47 is pulled over to separate button 65 from button 66. At this time, bimetal 22 has not brought magnet 34 close enough to armature 46 to pull it, by the magnetic force of attraction therebetween, out of the influence of fixed magnet 42.

When bimetal 22 brings magnet 34 close enough to envelope 41, at a certain position, with spring extremity 71 still out of contact with envelope 41, the magnetic force of attraction between movable magnet 34 and armature 46 will exceed the opposite force created on magnet 34 by bimetal 22 combined with the additive force of leaf spring 47, and magnet 34 will move abruptly with a snap action toward envelope 41 and armature 46 therein. At the same time, armature 46, and leaf spring 47, will move toward magnet 34 until leaf spring 47 reaches a final resting position, shown in FIG. 11. Movable magnet 34 will also move to the position shown in FIG. 11 relative to envelope 41 with the extremity 71 of wire 31 in abutment with envelope 41. In this position, wire 32 takes no substantial deflection because of the prestress. Note, too, that in FIG. 11, movement of leaf spring 47 toward leaf spring 53 causes button 65 to make electrical contact with button 66, but that the restraining forces on leaf spring 47, due to the spring force on leaf spring 53 and the spring force of leaf spring 47, itselves, prevent button 66 from making electrical contact with layer 64, as shown in FIG. 11.

The change in operation from FIG. 11 to FIG. 12 may take place a number of ways. As the bimetal 22 cools down further, it will unwind to lessen the restraining force on movable magnet 34. Another way is that if the spring force constant of wire 32 is sufficiently high, it may in fact be necessary to place the outside layer 68 in the spiral in FIG. 1 in tension to overcome the restraining force of wire 32. In the former case, the magnetic force of attraction between movable magnet 34 and armature 46 may be adequate to pull these bodies together, as shown in FIG. 12. In the latter case, such is not necessary. In either case, when the force on magnet 34 to the left, as viewed in FIG. 11, is less than that to the right, magnet 34 will snap from the position shown in FIG. 11 to that shown in FIG. 12. That is, the movement of magnet 34 will be abrupt.

The snap action in each case i.e., from FIG. 10 to FIG. 11 and from FIG. 11 to FIG. 12, is due to the inherent unstable character of magnetically attracted bodies which either do not move at all or which will rapidly accelerate toward each other until they contact each other.

Note will be taken in FIG. 12 that leaf spring 47 is moved so far to the left that not only does button 65 lie in electrical contact with button 66, but also that button 66 lies in electrical contact with layer 64.

In accordance with an outstanding feature of the present invention, the operation is, as described previously, in connection with FIGS. 10, 11 and 12. Another outstanding feature of the invention is that the steps are reversible and, in general, identical. That is, as the bimetal 22 winds to a first extend, it will pull movable magnet 34 away from envelope 41 from the position shown in FIG. 12 to the position shown in FIG. 11 with a snap action.

Conversely, as before, a further winding of, i.e., heating of, bimetal 22 will cause movement of magnet 34 abruptly from the position shown in FIG. 11 to the position shown in FIG. 10.

The device of the present invention will have a great many applications and should not be limited to that disclosed herein. However, the thermostat may be used with an otherwise entirely conventional gas furnace used in dwellings or the like. The manner of such use is indicated in FIG. 9 wherein a main burner 76 is supplied with natural gas from an inlet 77 through two gas valves 78 and 79. Switch 40 may thus energize valves 79 and 78 in succession, respectively, as room temperature drops. Main burner 76 may then, when ignited, provide heat at two rates. That is, heat may be provided by burner 76 at a lower rate when only valve 79 is energized, and at a higher rate when both valves 79 and 78 are energized. What is known in the art as "low fire" and "high fire" is, thus, provided.

Note will be taken that housing portion 21 acts as a base. Envelope 41, or the left side thereof as viewed in FIGS. 10, 11 and 12, provides a stop against which the right side of eyelet 35 may abut. Further, the said left side of envelope 41 also can act as a stop for magnet 34 and the right end of extremity 71, as viewed in FIG. 5.

The upper end 31 of bimetal 22, shown in FIGS. 1 and 5, may be described as a "main member." Wire 32 may be described as an "auxiliary member." Extremity 71 thus is a portion which projects from the "main member" as described above, in a direction toward the said left side of envelope 41.

The phrase "first means to apply a first force to said main member to move it" may be employed to describe magnet 34 and armature 46.

The phrase "second means between said members to apply a second force to said main member" may include wire 32.

The phrase "third means for increasing said first force" may be employed to describe the entire length of bimetal 22 with the exception of end 31.

What is claimed is:

1. A multiple positioning device comprising: a base, a stop fixed relative to said base; a main member movable relative to said base toward said stop; second means including an auxiliary member carried by said main member, said auxiliary member projecting from said main member in a direction toward said stop; first means to apply a first force to said main member to move it and said auxiliary member to a first position in which said auxiliary member contacts said stop and said main member is spaced from said stop; said second means applying a second force to said main member to resist movement of said main member relative to said auxiliary member in a direction toward said stop when said auxiliary member first lies in contact with said stop as aforesaid; and third means for increasing said first force to overcome said second force to cause movement of said main member into engagement with said stop.

2. The invention as defined in claim 1, wherein said main member including a first movable magnetic body, a second movable magnetic body, at least one of said first and second bodies being adapted to produce a magnetic field, bias means to resist movement of said second body toward said first body, said third means being adapted to move said first body to a position such that the force of attraction between said bodies first moves said first body toward said stop with a snap action and holds said auxiliary member against said stop, said snap action being created by the increasing of the said force of attraction approximately inversely with the distance squared between said bodies, said third means also causing a second further movement of said first body to a position in contact with said stop, said second movement being with a snap action when the sum of the forces separating said bodies falls below said force of attraction due to the same said square law.

3. The invention as defined in claim 2, wherein said second means is a first spring.

4. The invention as defined in claim 3, wherein said auxiliary member is an integral end portion of said first spring, said bias means being a second spring, said first spring being prestressed so as to take no substantial deflection when it first comes to rest on said stop, both of said first and second springs being cantilever springs, said second spring being a leaf spring, said first spring being a wire, a bimetal fixed to one side of said first body opposite the side thereof on which said stop is located, a first hole in said bimetal, a second hole in said first body, said first and second holes lying in registration, said wire having a portion fixed to the back of said bimetal, said wire being generally L-shaped having a first length tying flush to and in pressure contact with the bimetal back and a second length perpendicular thereto extending through said registering holes, said wire extending closer to said stop than said first body at least when neither wire nor first body contact said stop.

5. The invention as defined in claim 2, wherein said bias means is a first cantilever leaf spring, second and third cantilever leaf springs disposed successively closer to said first body from said first leaf spring, said first movement causing said first leaf spring to contact said second leaf spring without causing said second leaf spring to contact said third leaf spring, said second movement causing said first leaf spring to remain in contact with said second leaf spring and, at the same time, causing said first leaf spring to move said second leaf spring into contact with said third leaf spring.

6. The invention as defined in claim 5, wherein said first body is a first permanent magnet, and a second permanent magnet fixed relative to said stop on the side of said second body opposite that on which said first body is located.

7. The invention as defined in claim 6, wherein said second and third leaf springs do not contact each other when said magnets are removed, said first and second leaf springs being mounted to contact each other when said magnets are removed.

8. The invention as defined in claim 3, wherein said spring is prestressed.

9. The invention as defined in claim 8, wherein a temperature sensitive element is provided, said first body being fixed to said element, said spring being a cantilever leaf spring having one end fixed to said element, the other end of said spring being adapted to be held stationary by said stop while said element moves toward said stop so as to deflect said spring in a predetermined direction, limit means to limit movement of said spring in a direction opposite said predetermined direction, said spring having a bend therein when unstressed, said bend being located between said one spring end and said limit means, said spring lying in pressure contact with said limit means when said spring is spaced from said stop.

10. The invention as defined in claim 1, wherein said device is a thermostat, a switch, said switch including first, second and third leaf spring conductors, an envelope surrounding said conductors, said envelope providing dust protection for said conductors and, at the same time, acting as said stop, means mounting one end of each conductor in a predetermined position adjacent the others inside said envelope, said second conductor being positioned in between said first and third con-

ductors, said conductors being made of thin metal strips, said strips being approximately parallel, said second conductor having first and second electrical contacts fixed on each side thereof, respectively, at the same position along the length thereof, said first conductor having a third contact fixed thereto to engage said first contact, said third conductor having a fourth contact to engage said second contact, said third conductor having an extension at its free end above said fourth contact, said extension being fixed to said third conductor, an armature fixed to the upper end of said extension, said armature being made of a magnetic material, said switch being made of all non-magnetic materials except said armature, a permanent magnet fixed relative to said envelope on one side thereof opposite the side on which said main member is positioned, said main member including a spiral wrapped bimetal having one straight outer extremity tangent to the spiral, said base having a hole therethrough, a shaft rotatable in, but axially fixed in, said base hole, the inner end of said bimetal being fixed to said shaft, said bimetal spiralling about the axis of said shaft, said bimetal having a uniform width along its length, the side edges of said bimetal lying in parallel planes perpendicular to said axis, a movable permanent magnet positioned adjacent to said bimetal extremity between said extremity and said envelope, first and second holes in said extremity, a hole in said movable magnet in registration with said first bimetal hole, a first eyelet extending through said movable magnet hole and said first bimetal hole holding said movable magnet in a fixed position relative to said extremity, said auxiliary member being a spring wire having a loop in a predetermined plane at one end thereof, a second eyelet extending through said second bimetal hole and the hole in said loop holding said one wire end in a fixed position in flush contact with the rear side of said extremity opposite the side on which said movable magnet is fixed, said wire being substantially L-shaped in a plane perpendicular to said predetermined plane, the leg of the L being bent at its juncture with the loop so as to be held in pressure contact with the rear side of said extremity, the base portion of the L extending through said first eyelet, said base portion having a length sufficiently great that when said base portion does not touch said envelope, the end of said base portion lies closer to said envelope than does said movable magnet, and means to turn said shaft.

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