April 16, 1929. E. K. CLARK 1,709,656

THERMOSTATIC REGULATOR

Filed April 2, 1927 2 Sheets-Sheet 1

Fig.1.

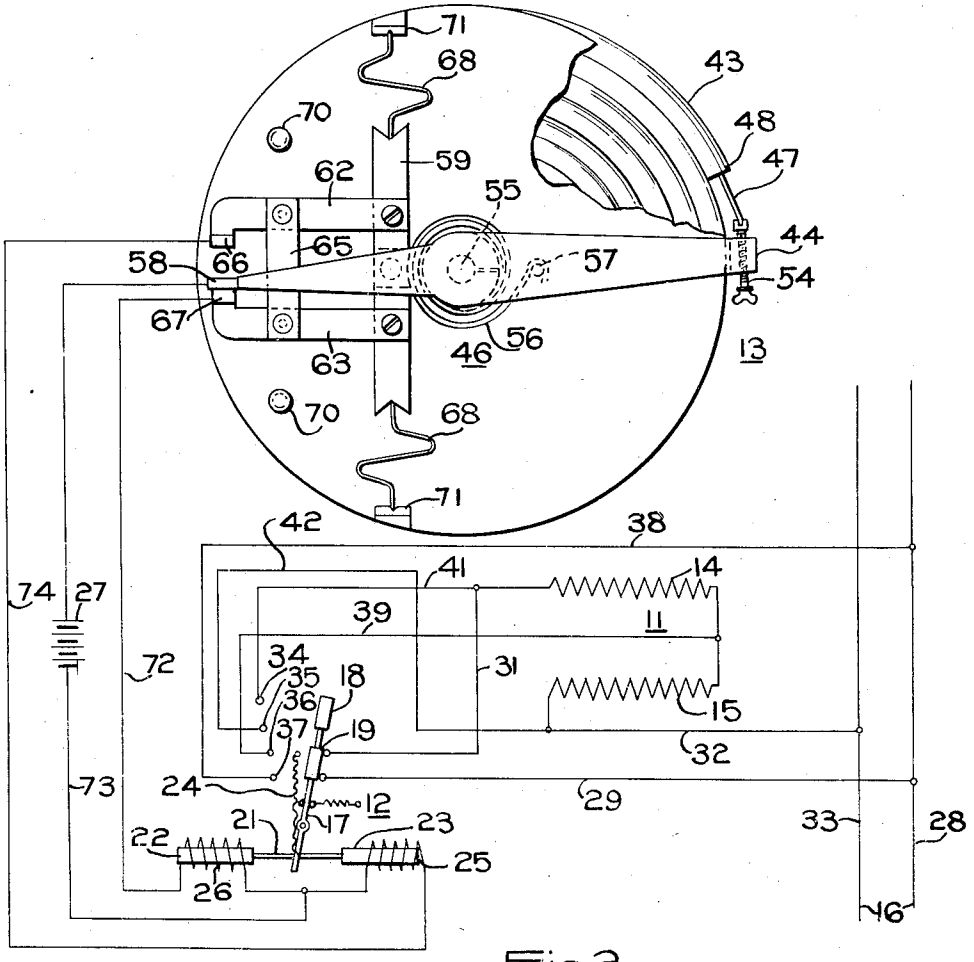
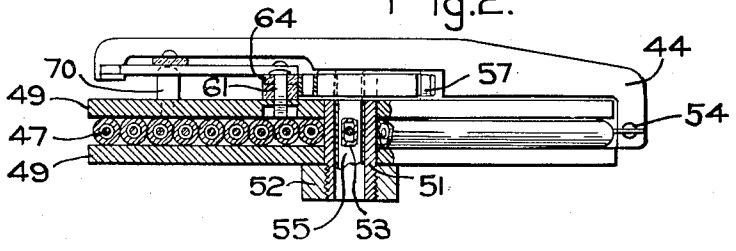


Fig.2.



WITNESSES:
Alf Schiefelbein.
G. B. Fjoslah

INVENTOR
Earl Kirkwood Clark.
BY
Wesley G. Carr
ATTORNEY

April 16, 1929. E. K. CLARK 1,709,656

THERMOSTATIC REGULATOR

Filed April 2, 1927 2 Sheets-Sheet 2

Fig. 3.

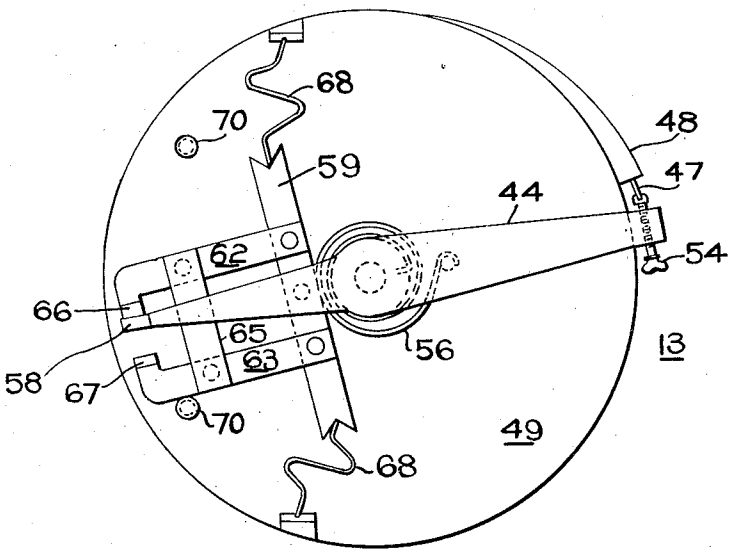
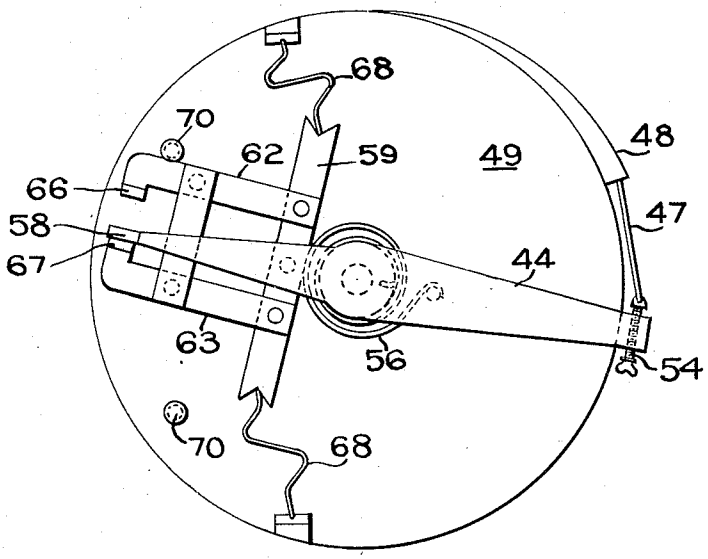


Fig. 4.



WITNESSES:
A. J. Schiefelbein.
G. B. Tjoflat

INVENTOR
Earl Kirkwood Clark.
BY
Wesley G. Carr
ATTORNEY

Patented Apr. 16, 1929. 1,709,656

UNITED STATES PATENT OFFICE.

EARL KIRKWOOD CLARK, OF MANSFIELD, OHIO, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

THERMOSTATIC REGULATOR.

Application filed April 2, 1927. Serial No. 180,466.

My invention relates to control devices and particularly to thermostatic regulators.

An object of my invention is to provide a control device that shall be sensitive to changes in conditions of temperature and that shall be of rugged, compact structure.

Another object of my invention is to provide a temperature-responsive element for a control device that utilizes the principle of straight-bar expansibility, the element being in the form of a spiral.

And a further object of my invention is to provide a thermally actuable control device for controlling electric circuits that shall embody means for actuating contact members to circuit-making and breaking positions with a snap motion.

In practicing my invention, means responsive to a condition to be controlled are provided for selectively actuating a movable contact-carrying member into, or out of, engagement with a plurality of independent contact members.

One embodiment of the means referred to above comprises a thermal-responsive element arranged in the form of a spiral and spacing means for maintaining the distance between the respective turns of the spiral substantially constant. The inner end of the spiral is fixed and its outer end engages the movable contact-carrying member. A change in temperature of the spiral or thermal element is accompanied by a change in length proportional to its original length, its temperature co-efficient of expansion, and the change in temperature with respect to the temperature at which the original length thereof is measured.

By making the thermal-responsive element of spiral form, an element of great length is provided that occupies a relatively small space, as compared with the same element in the form of a straight bar.

In the case of a straight metallic element, the greater its length, the greater will be its change in length per degree of change in temperature, which change in length may be utilized for actuating a circuit-controlling mechanism. In accordance with my invention, a thermal element of relatively great length may be coiled in spiral form, thus reducing the space required by an equivalent straight element, whereby the expansion thereof may be utilized substantially in the same manner as when a straight element is employed.

The switch mechanism embodied in the device comprising my invention, consists of two pivoted members, one of which carries a pair of spaced contact members, and the other of which carries a contact member that moves between the spaced contact members.

The pivoted member to which the spaced contact members are attached, is normally biased either towards one side or the other of an unstable position by means of opposed springs maintained under compression. If the pivoted member is turned on its pivot towards either the one or the other side of its unstable position, the springs are further compressed and the pivoted member passes through a state of unstable equilibrium from which, on further turning thereof in the same direction, it is actuated abruptly to a position of stable equilibrium by reason of the compressive forces stored in the springs.

The pivoted member referred to above is actuated to the one or the other position by means of a second pivoted member having a single or common contact attached thereto, the second pivoted member being actuated by the thermal element or spiral member previously mentioned herein. When the spring-biased pivoted member passes through its state of unstable equilibrium, the contact carried thereby that engages the common or single contact member is actuated out of engagement therewith, thus interrupting an electric circuit controlled thereby.

In the drawings;

Figure 1 is a top plan view of the device embodying my invention, a portion being broken away, and a diagrammatic showing of an electric circuit controlled thereby,

Fig. 2 is a view, in side elevation, partly in section, of the device illustrated in top plan view in Fig. 1,

Fig. 3 is a top plan view of the device, illustrated in Figs. 1 and 2, showing the device in one circuit-controlling position; and

Fig. 4 is like view of the same device in another circuit-controlling position.

With reference to Fig. 1 of the drawings,

the energization of a heating unit 11 is controlled by means of an electro-magnetically operable switch mechanism 12 and a temperature-control device 13. The device 13 being responsive to a thermal condition effected by the heating unit 11, is operable to so control the degree of energization of the heating unit that the thermal condition is maintained substantially constant.

The heating unit 11 comprises a pair of resistor elements 14 and 15 that are energized from a suitable source of electric energy 16. By means of the switch mechanism 12, the elements 14 and 15 may be either connected in series or in parallel-circuit relation, depending upon the thermal condition of the medium surrounding the heating unit 11 to which the device 13 is responsive.

The switch mechanism 12 is schematically illustrated and comprises, in general, a pivoted bar 17 that carries a pair of contact-bridging members 18 and 19 at one end thereof. The other end of the bar 17 is pivotally connected to a rod 21, to the ends of which are attached movable core members 22 and 23. The bar 17 is normally biased towards the one or the other side of a vertical position by means of an over-center spring 24.

The core members 22 and 23 are movable horizontally by means of solenoids 25 and 26 that are adapted to be selectively energized from a suitable source of electromotive force 27 by means of the control device 13. When the magnet coil 26 is energized, the bar 17 is actuated to the position illustrated in the drawings, whereby the resistor elements 14 and 15 are connected in series-circuit relation to the source of supply 16. Thus, an energizing circuit therefor is established from conductor 28, conductor 29, contact bridging member 19, conductor 31, resistor elements 14 and 15, and conductor 32 to conductor 33 of the source of supply 16.

When the coil 25 is energized, the coil 26 being deenergized, contact-bridging members 18 and 19 are actuated to the left and into engagement with a plurality of stationary contact members 34, 35, 36, and 37. If the contact-bridging members 18 and 19 are in this position, the resistor elements 14 and 15 are connected in parallel-circuit relation. The energizing circuit of resistor element 14 is thereby established comprising conductor 28, conductor 38, contact-bridging member 19, conductor 39, resistor element 14, conductor 41, contact-bridging member 18, conductors 42 and 32 to conductors 33, and that of the resistor element 15 comprising conductor 28, conductor 38, contact-bridging member 19, conductor 39, resistor element 15, and conductor 32 to conductor 33.

The energization of the electromagnet coils 25 and 26 is effected by means of the temperature-control device 13, as previously stated herein, that comprises, in general, a temperature-responsive element 43, a pivoted member 44 actuated thereby and a contact-carrying means 46.

The thermal element 43 consists of a wire 47 coiled in the form of a spiral. The wire 47 is threaded through a spirally coiled tubular member 48 that serves to maintain the distance between the adjacent turns of the wire substantially constant. The tubular member 48 is positioned between a pair of clamping plates 49 that are held in a substantially fixed position by means of a hollow bushing 51 that is provided with a head at one end and screw threads at the other for engaging a nut 52.

The inner ends of the wire 47 and the tubular member 48 are squeezed together and inserted in a slot 53 (see Fig. 2) and are maintained fixed with respect to the plates 49. The outer end of the wire 47 is adjustably attached to the pivoted member 44 by means of a screw 54 having screw-threaded engagement therewith, the outer end of the tubular member 48 being free to move along the wire 47. The member 44 is of substantially L-shape and is provided with a pivot 55 that projects from substantially the middle thereof into the hollow bushing 51. The member 44 is biased in one direction by means of a spiral spring 56, the outer end of which engages a pin 57 carried thereby and the inner end of which engages the bushing 51. A contact member 58 is carried at the end of the member 44 opposite that to which the wire 47 is attached.

The contact-carrying means 46 comprises a bar 59 that is pivotally secured to one of the plates 49 by means of a bolt 61 that extends through the plate 49 and the bar. The ends of the bar may be provided with notches of substantially V-shape, for a purpose to be hereinafter set forth. A pair of contact-supporting brackets 62 and 63 of substantially L-shape, extend laterally from the bar 59 and are suitably secured thereto by such means as screws or rivets, and insulated therefrom by suitable insulation 64. A short strip of insulating material 65 is secured to the brackets 62 and 63, near their outer ends, to maintain these ends fixed relatively to each other. Switch contacts 66 and 67 are carried at the respective outer ends of the members 62 and 63 and are adapted to be engaged by the contact member 58.

The position occupied by the bar 59, as illustrated in Fig. 1 of the drawings, is unstable, the bar being biased towards a stable position located at either the one side or the other thereof, by means of a pair of springs 68 of substantially sinuous shape. The inner ends of the springs en-

gage the notched ends of the bar 59, and the outer ends thereof abut against a pair of lugs 71 that are secured to the top clamping plate 49. The springs 68 are of such length that they are normally maintained in compression, but tend to elongate when the bar 59 has been actuated to a stable position.

If the member 44 is turned in a counter clock-wise direction, the contact members 58 and 67 will be maintained in engagement, and the bar 59 will be turned, on its pivot 61, to a position slightly beyond that illustrated in Fig. 1 and in a counter clock-wise direction. When the latter position is reached, the springs 68 are so deflected that both of them tend to elongate, thereby causing the bar 59 to move abruptly from this position to a stable position whereby the contact member 67 becomes disengaged from contact 58 with a snap motion. However, when this stable position is reached, the contact 66 immediately engages the contact 58 (see Fig. 3).

If the bar 44 is turned in a clock-wise direction, the bar 59 is caused to be turned on its pivot in a clock-wise direction also to a position slightly beyond that of unstable equilibrium (see Fig. 1), from which position it is caused to be moved with a snap motion because of the elongation of the springs 68 to the stable position illustrated in Fig. 4. Thus, the contact member 66 is positively disengaged from contact member 58 with a sudden, snap motion. But, immediately upon the disengagement of the contacts 58 and 66, the contact 58 makes engagement with the contact 67 (see Fig. 4.)

In order to limit the degree of movement of the bar 59, a pair of lugs 70 are attached to the plate 49 in the path of movement of the brackets 62 and 63.

If it is desired that the contacts 66 and 67 shall not immediately make engagement with the contact 58, upon the actuation of the bar 59 to the one or the other of its stable positions (see Figs. 3 and 4), the brackets 62 and 63 may be spaced farther apart than is indicated in the drawings. In this event, a certain interval of time will elapse between the disengagement of contacts 58 and 66 and the re-engagement of contacts 58 and 67, or vice versa. Since the contacts 66, 67 and 58 move in the same, general direction, and engagement and disengagement thereof is effected by the bar 59 and the springs 68, the contact 58 may be considered to be stationary relatively to the contacts 66 and 67.

The energizing circuit of the solenoid 26, being established by the engagement of contacts 58 and 67, comprises one terminal of the source of electric energy 27, contacts 58 and 67, conductor 72, coil 26, conductor 73 and the other terminal of the source 27. The energizing circuit of the coil 25, being established by the engagement of contacts 58 and 66, comprises one terminal, the source of electric energy 27, contacts 58 and 66, conductor 74, coil 25, conductor 73 and the other terminal of the source 27.

As illustrated in the drawings, the member 44 may be turned about its pivot 55 by means of the wire 47 which expands and contracts in accordance with increasing and decreasing changes in temperature. If it be assumed that wire 47 is subjected to the temperature of a body heated by means of the heating unit 11 and that the temperature thereof is receding from a relatively high temperature of a predetermined value, the wire 47 decreases in length and causes the bars 44 and 59 to turn on their pivots in a counter-clockwise direction, the contacts 58 and 67 being in engagement. If the temperature continues to decrease, the movement of the bars in a counter-clockwise direction will continue until the bar 59 moves abruptly to the position illustrated in Fig. 3 to effect engagement of the contacts 58 and 66, and energization of the solenoid 25. Upon the energization of the solenoid 25, the bar 17 is so actuated that the bridging members 18 and 19 engage the stationary contacts 34 to 37 inclusive, whereby the resistor elements 14 and 15 are connected in parallel, thereby increasing the heat-generating capacity of the heating unit 11.

When the temperature of the wire 47 has increased to a predetermined value in response to the increased energization of the heating unit 11, its length increases also until the bar 44 has actuated the bar 59 in a clock-wise direction through its unstable position (see Fig. 1) to the stable position illustrated in Fig. 4. Thus, disengagement of the contacts 58 and 66, deenergization of the solenoid 25, and re-engagement of the contacts 58 and 67 and consequent reenergization of the solenoid 26 are effected. When the solenoid 26 is energized, the bar 17 is actuated to the position illustrated in Fig. 1, whereby the resistor elements are again connected in series-circuit relation to the supply conductors 28 and 33.

The initial position of the movable member 44 may be adjusted by means of the screw 54.

Since the wire 47 slides along the tubular member 48, a slight amount of friction is encountered which may be compensated for by means of the coil spring 56.

By providing a thermal element of the type illustrated in Figs. 1 and 2 of the drawings, a thermal-responsive element, which consists of a single metallic wire or bar, may be utilized for actuating a circuit-controlling mechanism. The thermal element comprises the wire 47 wound in the form of a spiral that is threaded within the spiral tubular member 48 so that any increase or decrease in length of the wire 47 results in its sliding within the tube 48. The effect of a wire 47,

having the form of a spiral, when subjected to temperature, is substantially the same as if the wire 47 were disposed in a straight line, so that it may expand in a linear direction. A wire extending in a linear direction would occupy a much greater space than that occupied when coiled in the form illustrated in Figs. 1 and 2 of the drawings. Further, a wire of the size illustrated in the drawings would be impracticable when used as a linear expansion member since the rigidity thereof would be insufficient to render the device practicable.

While the clamping plates 49 are illustrated as being of a solid nature, it is to be understood that they may be so slotted that a large portion of the metal is removed therefrom, thus reducing the thermal capacity thereof. Likewise, the tubular member 48 may be provided with a plurality of apertures in order that the temperature, to which the wire 47 is to be responsive, may affect it directly, thereby reducing its thermal lag relatively to that which would be present in the absence of such apertures.

Various modifications may be made in the device embodying my invention without departing from the spirit and scope thereof. I desire, therefore, that only such limitations shall be placed thereon as are imposed by the prior art and the appended claims.

I claim as my invention:

1. A temperature-control device comprising a pivotally mounted member, a contact mechanism actuated thereby, and thermo-responsive means for actuating said pivotally mounted member, said means comprising a hollow spiral tube, a metallic member having a relatively high temperature co-efficient of expansion disposed within said spiral tube, said metallic member being fixed at one end and operatively connected to said pivotally mounted member at the other end.

2. A control switch comprising a pivotally mounted member, a plurality of contacts carried thereby, a plurality of springs for holding said pivotally mounted member in one or another of a plurality of stable positions, said springs being effective to actuate said member from an unstable position to one or another of said stable positions with a snap motion, a common contact normally engaging one of said plurality of contacts, and means responsive to a condition to be controlled for actuating said member past its unstable position whereby disengagement of one of said plurality of contacts from said common contact is effected.

3. The combination with a pivoted member, spring means for holding said pivoted member in either one or another of a plurality of stable positions, said spring means being effective to actuate said pivoted member from an unstable position located between said stable positions to one of said stable positions with a snap motion, and spaced apart contacts carried by said pivoted member, of a second pivoted member normally engaging one of said contact members, and means for actuating the second pivoted member whereby said first named pivoted member is actuated past its unstable position to effect disengagement of one of said contacts from said second pivoted member.

4. A control device comprising a pivotally mounted member, resilient means for holding said member in either one or another of a plurality of stable positions, said springs coacting to cause said member to be in an unstable position when said member is in a position intermediate said stable positions, a plurality of movable contacts controlled by said member, a common contact for engaging one or another of said movable contacts, said common contact being stationary relatively to and normally engaging one of said movable contacts, and means responsive to a condition to be controlled for actuating said member through its unstable position whereby disengagement of one of said movable contacts from said common contact and engagement of another of said movable contacts therewith is effected.

In testimony whereof, I have hereunto subscribed my name this 29 day of March, 1927.

E. K. CLARK.