Aug. 28, 1928. 1,682,395

H. C. MILLER ET AL

CONTROL DEVICE

Filed April 28, 1927 2 Sheets-Sheet 1

Fig. 1.

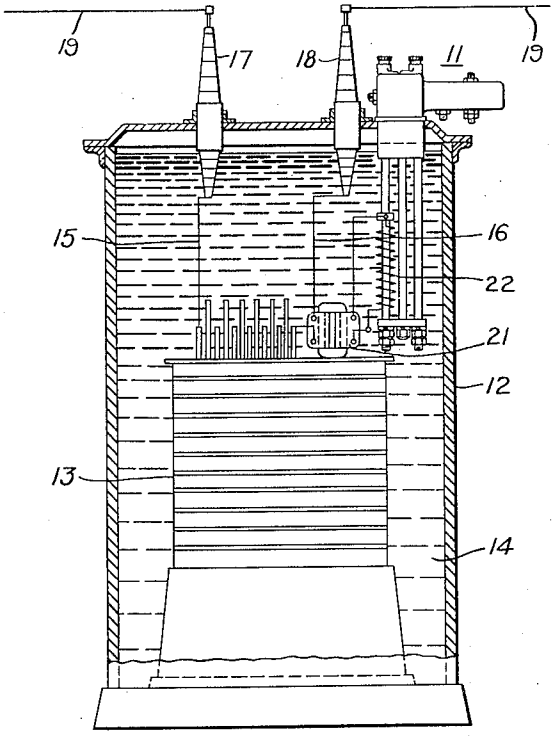
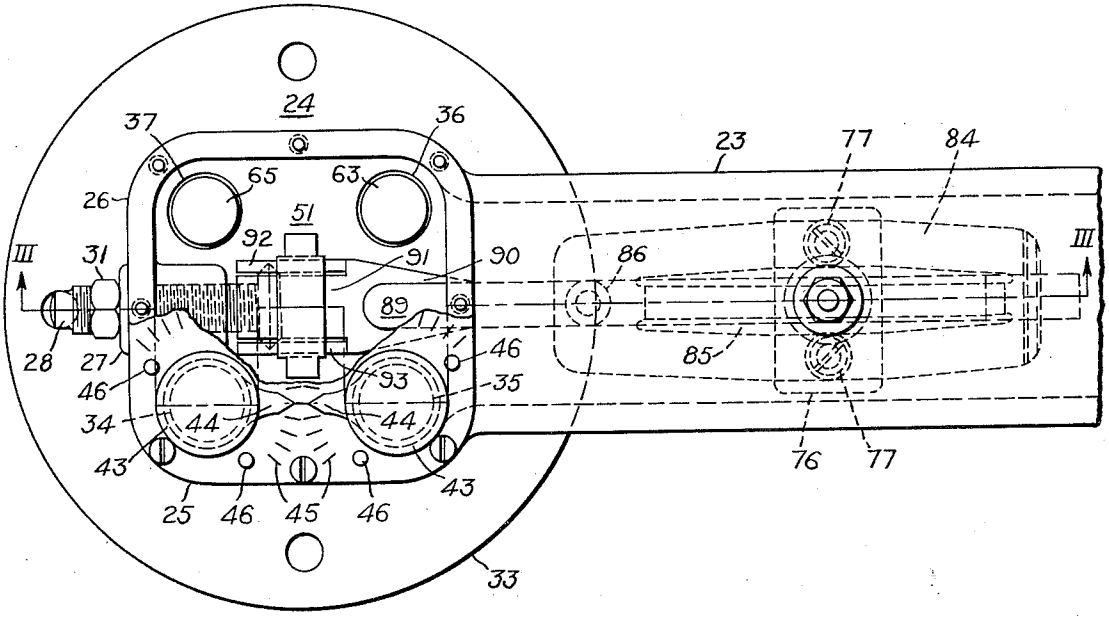


Fig. 2.



WITNESSES:

Wm. C. Groome,

G. B. Fjoslot

INVENTORS.

August J. Mottlau &

Harry C. Miller.

BY

Wesley G. Carr

ATTORNEY

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Fig. 3.

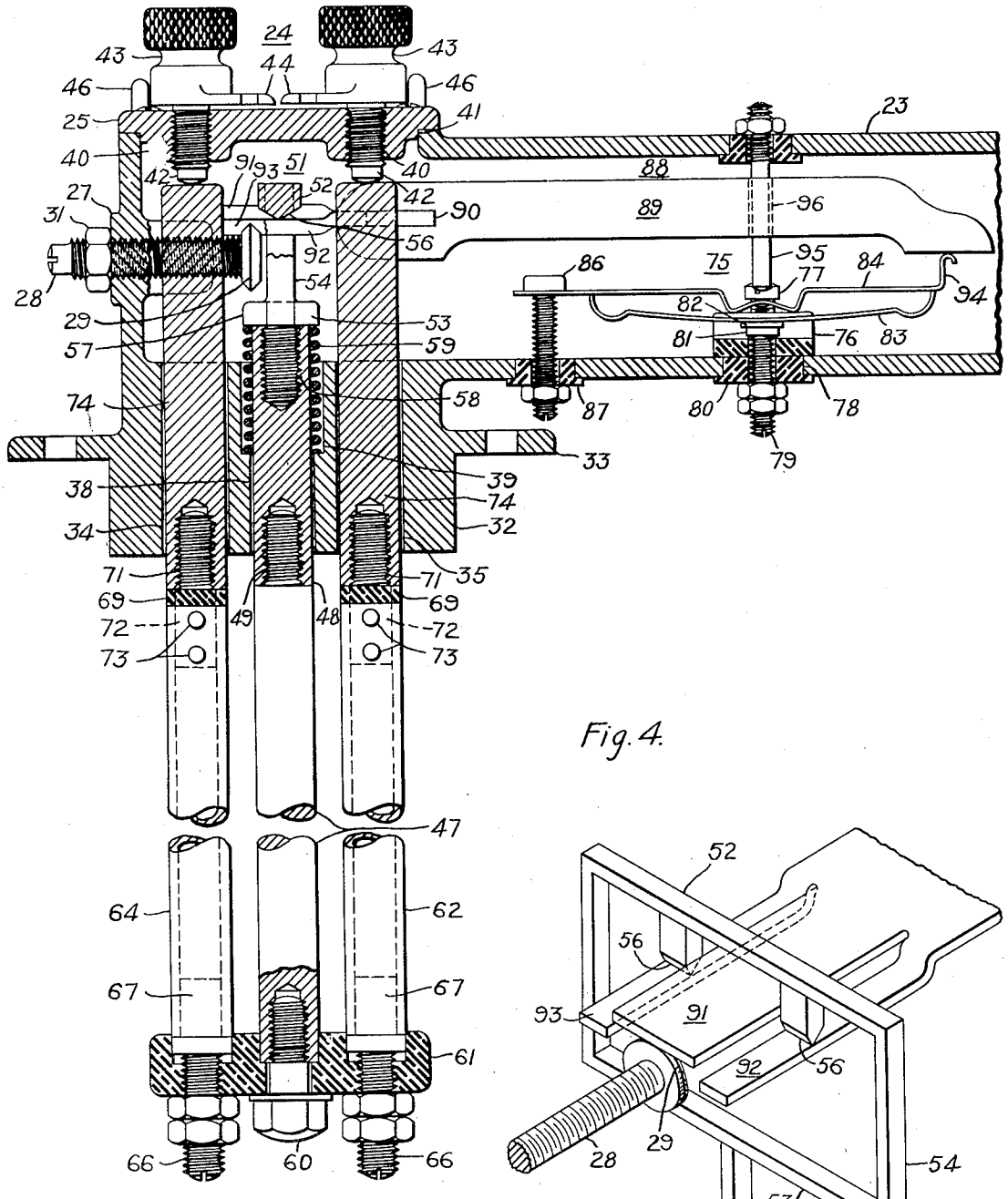


Fig. 4.

WITNESSES:

Wm. C. Groome.

G. B. Tjoflat

INVENTORS.

August J. Mottlau &

Harry C. Miller.

BY

Wesley G. Carr

ATTORNEY

Patented Aug. 28, 1928. 1,682,395

UNITED STATES PATENT OFFICE.

HARRY C. MILLER, OF WILKINSBURG, AND AUGUST J. MOTTLAU, OF PITTSBURGH, PENNSYLVANIA, ASSIGNORS TO WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

CONTROL DEVICE.

Application filed April 28, 1927. Serial No. 187,341.

Our invention relates to control devices and particularly to devices that are responsive to a plurality of such conditions as temperature, excessive current flow in electric circuits, pressure, etc., whether such conditions occur simultaneously or independently.

An object of our invention is to provide for the control of a plurality of associated causes and effects by means of one device.

Another object of our invention is to provide for the actuation of one control device in accordance with the condition of a plurality of elements, the elements being responsive to individual causes producing a resultant effect.

A further object of our invention is to provide a universal actuating means for a control device that shall be adapted to be operated by a plurality of devices, whether said devices be responsive to conditions of temperature, pressure, current or conditions of similar characteristics.

A still further object of our invention is to provide a relay that shall be of rugged and simple construction and easily manufactured and installed.

In practicing our invention, we provide a control device and a plurality of elements for actuating, either individually or collectively, the device in accordance with a plurality of conditions to be regulated.

For a fuller understanding of the device embodying our invention, reference should be had to the following description and the accompanying drawings, in which,

Figure 1 is a view, partially in section, of a transformer equipped with a control device embodying our invention,

Fig. 2 is a top plan view of a portion of the relay illustrated in Fig. 1,

Fig. 3 is a view, in vertical section, taken on the line III—III of Fig. 2, and

Fig. 4 is a diagrammatic illustration of a detail embodied in the control device illustrated in the preceding figures.

In Fig. 1 of the drawings, a control device 11 is supported by the cover of a transformer casing 12. A transformer coil assembly 13 is located within the casing 12 in the usual manner, which casing is filled with a fluid 14, such as oil, suitable for use in transformers.

Terminals 15 and 16 of the transformer coil assembly are connected to insulating bushings 17 and 18, whereby connection may be made through the transformer casing cover to a supply conductor 19. A current transformer 21 is connected in circuit with the terminal 16, one winding of which is connected to a heating coil 22 of the control device 11.

The control device 11 is illustrated more in detail in Figs. 2 and 3 and, as there shown, a casing is provided which consists of an elongated portion 23 of substantially rectangular shape in lateral and longitudinal section and a left hand end portion 24 having an opening in the top thereof that is provided with a cover 25.

An end wall 26 of the casing is provided with a boss 27, a minor portion of which projects outwardly and a major portion thereof projecting into the casing.

A screw 28 has screw-thread engagement with the boss 27 and is provided at one end with a circular head having a knife edge 29. The circular head of the screw 28 projects into the casing and may be locked in a desired position by means of a nut 31 that has screw-thread engagement with the screw 28.

The bottom wall of the portion 24 is provided with a boss 32 having an annular flange 33 integral therewith.

The boss 32 is provided with a plurality of holes 34 to 27, inclusive disposed in such manner as to form the outline of a rectangle and a central hole 38.

The upper portion of the hole 38 is counterbored in order to provide an annular shoulder 39 for a purpose to be hereinafter set forth. The cover 25 is provided with an off-set portion 41 extending along the periphery thereof in order that the cover may fit snugly into the opening of the portion 24 of the casing. The cover is provided with tapped holes 40 (only two of which are shown) and located directly above the holes 34 to 37, inclusive. The holes are provided with bolts 42 that have screw-thread engagement with the cover 25. The bolts 42 are provided with knobs 43 having pointers 44 thereon, the pointers being adapted to register with the dials 45 disposed annularly about the holes 40.

The angular travel of the pointers 44 may

be limited by stop members 46, between which the pointer may move. The bolts 42, as illustrated, project inwardly into the casing and are located above, and in alinement with, the holes 34 to 37, inclusive, for a purpose to be hereinafter set forth.

A compound rod, comprising members 47 and 48 having temperature coefficients of expansion, projects through the central opening 38 of the boss 32 and extends upwardly into the casing. The rod 47 may be provided with a screw-threaded portion 49 so as to have screw-thread engagement with the member 48. The upper end of the member 48 is provided with a yoke 51. The yoke 51 consists of a rectangular member having top, bottom and side portions 52 to 54, inclusive. The top portion 52 is provided with a pair of wedges 56 having knife edges thereon for a purpose to be hereinafter set forth. The bottom portion 53 is provided with an annular shoulder 57 having a depending screw or stud 58 integral therewith. The stud 58 has screw-thread engagement with the upper end of the rod 48, in order that the yoke and the rod 48 may be held securely together.

In order that the rods 47 and 48 may be yieldingly supported by the boss 32 of the casing, a coil spring 59 is disposed between the shoulder 57 and the shoulder 39 and about the rod 48.

The bottom portion of the rod 47 is provided with a support or base 61 that may be secured thereto, by means of a stud 60 having screw-thread engagement with the lower end of the rod 47. The base 61 may be made preferably of insulating material which may be molded, although other materials may be employed.

The base 61 is of substantially the same shape in contour as the cover 25 and is provided with a plurality of holes that are substantially in alignment with the holes 34 to 37, inclusive, of the boss 32.

A plurality of rods 62 to 65, inclusive, is supported by the base 61, each of which may be made from hollow metal tubing having a high temperature coefficient of expansion relatively to that of the compound rod. The rods 62 to 65, inclusive, may be secured to the base 61 by means of bolts 66, the lower portions of which have screw-thread engagement with the base 61 and the upper portions 67 of which have screw-thread engagement with the members 62 to 65, inclusive.

The upper ends of the rods 62 to 65 are provided with insulating bushings each having a shoulder or annular flange 69 disposed between a screw-threaded portion 71 and a portion 72 that projects into the upper end tubular members. The bushings 69 may be secured to the tubular members by means of pins 73, or other equivalents.

The tubular members 62 to 65, inclusive, are provided with extension rods 74, that have screw-threaded engagement with the portions 71 of the bushings 69, that extend upwardly through the holes 34 to 37, inclusive. The extension rods 74 are adapted to abut against the bolts 42 (see Fig. 3) when the tubular members 62 to 65, have expanded a predetermined amount. If expansion continues, the spring 59 is caused to be compressed by the downward movement of the base 61.

Upon contraction of the tubular members, the spring 59 is released and the rods 47 and 48 caused to be moved upwardly to assume a position substantially as illustrated in Fig. 3 of the drawings. It is to be understood that the clearance between the bolts 42 and the upper ends of the extension rods 74 may be of different values so that each of the rods 62 to 64 may be caused to expand a greater or less amount, as desired, before the extension rods 74 are caused to abut against the bolts 42.

It is readily seen from the drawings that the member consisting of the rods 47 and 48 is yieldingly supported by the boss 32 of the casing which, in turn, supports the tubular members 62 to 65 by means of the base 61.

It is to be understood that one or more of the tubular members 62 to 65 may be replaced by other actuating elements for abutting against the bolts 42 in order to actuate the yoke carried by the rod 48 downwardly. Such actuating elements may comprise pressure-actuating pistons or sylphon tubes of any desired type. These elements may be disposed between the extension rods 74 and the base 61. It is also to be understood that either one or all of the tubular members 62 to 65 may be provided with individual heating coils in order that each one of them may be heated individually in accordance with a predetermined temperature time characteristic.

A controlling device 75 in the form of an electric switch is positioned in the portion 23 of the casing and is secured to a base 76 of insulating material by bolts 77. The base 76 that projects through an opening 78 in the bottom wall of the portion 23 is secured to the bottom wall by means of a screw 79 and a bushing 80, the bushing 80 having a shoulder portion thereon for registering with the outer surface of the bottom wall. The upper end of the screw 79 is provided with a head 81 which forms the stationary contact of the switch. A movable contact 82 normally engages the stationary contact 81 and is carried by a resilient bridging member 83 that is integral with a resilient metallic plate 84. The bridging member 83 is adapted to deflect upwardly with a snap motion through an aperture 85 in the plate 84 when the right

hand end of the plate is bent downwardly.

Upon the upward movement of the bridging member 83, the contact 82 is caused to be disengaged from the contact 81. If the right hand end portion is released to the position illustrated in Fig. 3 of the drawings, the bridging member 83 returns to its normal position, namely, that which is shown in Fig. 3 of the drawings and contact is again made between the contacts 81 and 82.

The left hand end of the plate 84 is provided with a bolt 86 that has screw-thread engagement with a bushing 87 located in the bottom wall of the portion 23. By means of the bolt 86 the left hand end of the frame 84 may be bent downwardly to any desired position and if so desired, it may be deflected to such a position that the bridging member 83 is just at the point of moving upwardly with a snap motion.

The switch 75 illustrated in the drawings is described in detail in a copending application, filed October 15, 1926, Serial No. 141,712, which is assigned to the Westinghouse Electric & Manufacturing Company, therefore, it is believed not necessary to describe in detail its construction and operation.

In order that the relative movement between the tubular members 62 to 65 and the resiliently mounted member comprising the rods 47 and 48 and the yoke 63 may be utilized for actuating the switch 75, a switch actuating mechanism 88 is provided.

The switch actuating mechanism 88 comprises a lever 89 having a tail piece 90 secured to the left hand end thereof. The tail piece 90 consists of a bifurcated metal strip, the central portion 91 and the two edge portions 92 and 93 being bent upwardly and downwardly, respectively. The tail piece 90 is disposed between the knife edges 56 of the yoke and the knife edge 29 of the screw 28 that the central portion 91 of the tail piece rests upon the knife edge 29 and the knife edges 56 of the yoke rest on the side portions 93 of the tail piece. The right hand end of the lever 89 rests on an upwardly extending portion 94 of the switch plate 84.

It should be noted that since the distance between the knife edges 29 and 56 is very short relatively to the length from the knife edges 56 to the right hand end of the lever 89 a very small downward movement of the rods 47 and 48 produces a large deflection of the right hand end of the lever. The lever 89, the screw 28 and the knife edges carried by the yoke, therefore, cooperate as a movement-multiplying mechanism for the thermostatic device comprising the rods 62 and 65 and the compound rod.

In order that the lever 89 may be restrained from lateral and longitudinal movement, a guide pin 95 is provided and so secured to the upper wall of the portion 23 that it projects downwardly through an aperture 96 located in the lever 89.

Assuming that the switch 75 is in its circuit-closing position (see Fig. 3), and that the tubular member 62 has been heated and caused to expand upwardly to abut against the bolt 42 so as to limit further upward movement thereof, a further increase in temperature of the tubular member will cause it to expand still further. As it cannot continue to move upwardly, the lower end thereof moves downwardly against the force of the spring 59. The downward movement of the tube 62 causes the base 61, the rods 47 and 48 and the yoke carried at the upper end thereof to move downwardly and to rock the lever on the knife edge 29. Thus, the right hand end of the lever 89 is actuated downwardly to bend the right hand end of the switch plate 84 in a corresponding direction until contact is broken between the contacts 81 and 82.

It is to be understood that the upward movement of the rod 62 may be so limited that the switch contacts 81 and 82 are actuated out of engagement when the temperature thereof attains a predetermined value of say 75° C. or any other desired temperature, and that the other rods, namely, 63 to 65, may be caused to operate the switch 75 at successively higher temperatures. The operation of the switch at the various temperatures referred to may be attained by increasing the clearance between the bolts 42 and the extension rods 74, the clearance being greater for the higher temperatures and smaller when the lower temperatures are required to actuate the switch to its circuit-opening position.

In Fig. 4 of the drawings, the yoke carried by the rod 48 and of the tail piece 90 carried by the lever 89 are illustrated schematically in perspective. As there shown, the wedges carried by the yoke 51 are provided with knife edges, as previously set forth herein, and are so spaced that they straddle the portion 91 or the central portion of the tail piece. The head of the screw 28 is located on the underside of the central portion of the tail piece and supports the left hand end portion of the lever 89.

A particular application of the control device 11 is illustrated in Fig. 1 of the drawings, previously mentioned herein. In this application the flange 33 is supported by the cover of the transformer tank 12 in such manner that the tubular members 62 and 64 are submerged in the oil 14 contained therein.

As there illustrated, the tubular member 64 is provided with the heating coils 22

which are connected in circuit with one of the windings of the current transformer 21. In this particular application the clearance between the bolt 42 and the extension rod 74 carried by the tubular member 64 may be so adjusted that the switch is actuated to its circuit-opening position when a temperature of 75° C. obtains in the tubular member 64. The clearance between the extension rod 74 carried by the tubular member 62 may be so adjusted that a temperature of 80° in the oil is required before the tubular member 62 will be effective to cause the switch 75 to be actuated to a circuit-interrupting position in the manner hereinbefore set forth.

Thus, the switch may be caused to be opened to effect control of a circuit interrupter (not shown), whereby the transformer is disconnected from the supply line 19 when a predetermined value of current, say 200% normal rating, has traversed the transformer windings for a predetermined length of time.

The tubular member 62, being responsive to the oil temperature, may be effective to cause actuation of the switch 75 to effect deenergization of the transformer coils in the manner hereinbefore set forth, when a value of current, say 125% of normal, has traversed the transformer windings for a predetermined length of time, said time being evidently geater than the permitted time when an overload of 200% is imposed on the transformers.

It is obvious that the tubular members 62 to 64, inclusive, may be equipped with separate heating coils, if so desired, in order to provide for phase protection in three-phase motors, generators and the like, or any other dynamo-electric machines having different numbers of phases. In this case two of the tubular members may be caused to operate when an abnormal overload, say 600%, has been imposed on the motor or generator for a few seconds of time and the other tubular members may be equipped with heating coils and the clearance between the bolts 42 and the extension rods 74 so adjusted that the relay 11 is operable to cause deenergization of the motors or generators when a predetermined continuous overload has been imposed thereon for a greater length of time.

Various modifications may be made in the device embodying our invention without departing from the spirit and the scope thereof. It is desired, therefore, that only such limitations shall be placed thereon as are imposed by the prior art and set forth in the appended claims.

We claim as our invention:

1. A thermostatic device comprising a support, a movable member yieldingly mounted thereon, a thermally-responsive element carried by the movable member and means for restraining the movement of the thermally responsive element in one direction.

2. A thermostatic device comprising a support, a movable member yieldingly mounted thereon, a thermally responsive element carried by the movable member and adjustable means for restraining the movement of the thermally responsive element in one direction.

3. A thermostatic device comprising a support, a movable member yieldingly mounted thereon, a thermally responsive element carried by the movable member, means for restraining the movement of the thermally responsive element in one direction and a movably mounted actuating member operated by said yieldingly mounted movable member.

4. A thermostatic device comprising a support, a movable member yieldingly mounted thereon, a thermally responsive element carried by the movable member, means for restraining the movement of the thermally responsive element in one direction and movement-multiplying means actuated by said yieldingly mounted movable member for multiplying the movement of said yieldingly mounted member.

5. A thermostatic device comprising a support, a movable member yieldingly mounted thereon, a plurality of thermally responsive elements carried by the movable member and means for restraining the movement of the thermally responsive elements in one direction.

6. A thermostatic device comprising a support, a movable member yieldingly mounted thereon, a plurality of independently heated thermally responsive elements carried by the movable member and means for restraining the movement of the thermally responsive elements in one direction.

7. A thermostatic device comprising a support, a movable member yieldingly mounted thereon, a plurality of thermally responsive elements carried by the movable member, means for restraining the movement of the thermally responsive elements in one direction and separate adjustable means for each of said thermally responsive elements for restraining the movement thereof in one direction.

8. A thermostatic device comprising a support, a movable member yieldingly mounted thereon and a thermal element carried by the movable member and cooperating with the support for actuating the yieldingly mounted movable member.

9. A thermostatic device comprising a support, a movable member yieldingly mounted thereon and a plurality of thermal elements carried by the movable member and cooperating with the support for individually actuating the yieldingly mounted movable

member in response to a predetermined thermal condition of said elements.

10. A thermostatic device comprising a support, an actuating member movably mounted thereon, a movable member yieldingly mounted on the support for operating the actuating member and thermally responsive means cooperating with the support and the yieldingly mounted member for actuating the movable member in response to temperature variations thereof.

11. In a regulator, the combination with a control device and a movement-multiplying means for actuating said device, of a thermostat comprising a support, a movable member for actuating said movement-multiplying means yieldingly mounted on the support and means responsive to a condition to be controlled carried by said yieldingly mounted member and cooperating with said support for actuating said yieldingly mounted member.

12. In a regulator, the combination with a controlling device and a movement-multiplying lever, for actuating said device, of a thermostat comprising a support, a movable member for actuating said movement-multiplying lever yieldingly mounted on the support and means responsive to a condition to be controlled carried by said yieldingly mounted member and cooperating with said support for actuating said yieldingly mounted member.

13. The combination with a switch and a movement-multiplying means for actuating said switch, of a thermostat comprising a support, a movable member for actuating said movement-multiplying means yieldingly mounted on the support and means responsive to a condition to be controlled carried by said yieldingly mounted member and cooperating with said support for actuating said yieldingly mounted member.

14. A thermostatic device comprising a support, a rod having a relatively low temperature coefficient of expansion yieldingly mounted thereon and a plurality of rods having relatively high-temperature coefficients of expansion carried by said yieldingly mounted rod and cooperating with said support for actuating said yieldingly mounted rod individually or collectively when temperature of predetermined values obtain in one or all of said rods.

15. A thermostatic device comprising a support, a rod having a relatively low-temperature coefficient of expansion yieldingly mounted thereon and a rod having a relatively high-temperature coefficient of expansion carried by said rod and cooperating with said support for actuating said yieldingly mounted rod when a temperature of a predetermined value obtains therein.

16. A thermostatic device comprising a support, a rod having a relatively low-temperature coefficient of expansion yieldingly mounted thereon and a plurality of independently heated rods having relatively high-temperature coefficients of expansion carried by said yieldingly mounted rod and cooperating with said support for actuating said yieldingly mounted rod individually or collectively when temperatures of predetermined values obtain in one or all said rods.

17. A thermostatic device comprising a support, a rod having a relatively low-temperature coefficient of expansion yieldingly mounted thereon, a rod having a relatively high-temperature coefficient of expansion carried by said yieldingly mounted rod for actuating said rod and adjustable means for restraining the movement of the rod having the higher coefficient in one direction in accordance with the temperature at which it shall be effective to actuate said yieldingly mounted rod.

18. A thermostatic device comprising a support, a rod having a relatively low-temperature coefficient of expansion yieldingly mounted thereon, a plurality of rods having relatively high-temperature coefficients of expansion carried by said yieldingly mounted rod and separate adjusting means for restraining the movement of each of the rods having the higher coefficient in one direction, whereby each of said rods may be caused to actuate said yieldingly mounted rod at different temperatures.

In testimony whereof, we have hereunto subscribed our names this 21st day of April, 1927.

HARRY C. MILLER.
AUGUST J. MOTTLAU.