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C. B. SAWYER

THERMOSTATIC CONTROLLING DEVICE

Filed March 17, 1924

FIG. 1.

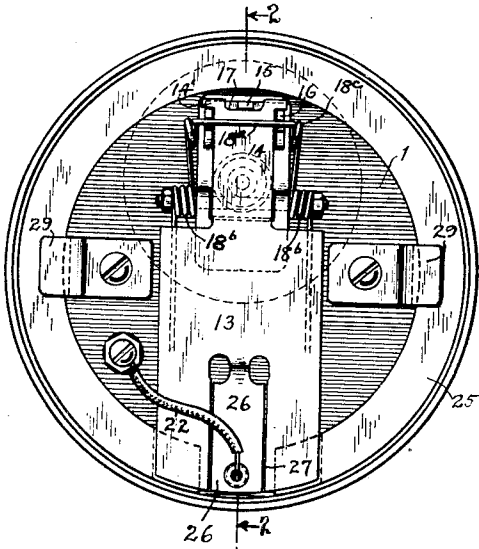


FIG. 2.

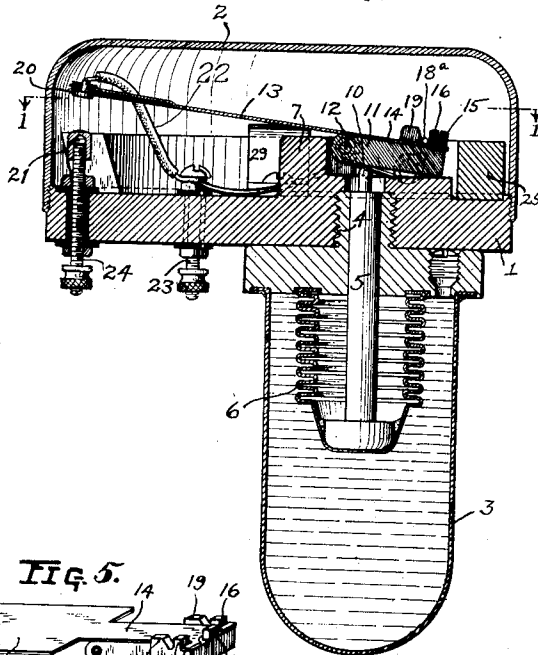


FIG. 5.

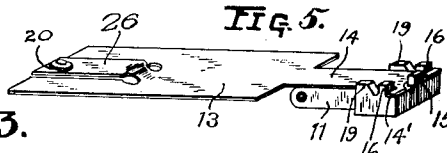


FIG. 3.

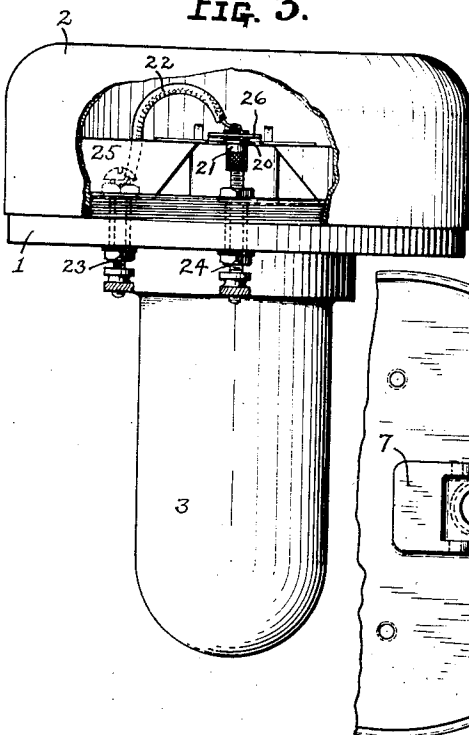


FIG. 4.

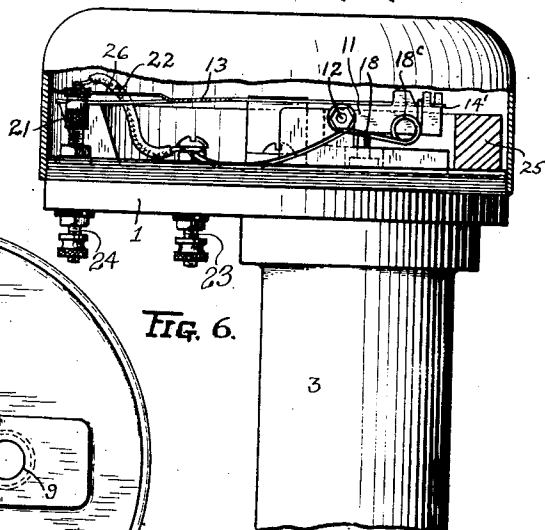
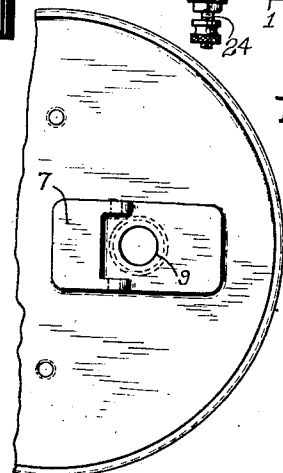


FIG. 6.



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THERMOSTATIC CONTROLLING DEVICE.

Application filed March 17, 1924. Serial No. 699,707.

This invention relates to improvements in electric circuit making and breaking devices, and more particularly to a device of this character for use in thermostatically controlled machines.

This application is a continuation in part of my prior applications relating to thermostatic controlling mechanisms Serial No. 601,653 and Serial No. 601,652, both being filed on November 17, 1922.

In thermostatic controlling devices in which electric circuit make and break devices are actuated by a body of liquid without vapor space acting through a plunger or other suitable actuating member, the extent of movement of the plunger or other actuating member is dependent on changes in volume due to temperature variations, and the force which may be exerted upon the make and break devices is relatively great. It is desirable, therefore, and it is an object of the present invention, to so design the make and break devices that they will be sensitive and positive in operation upon a predetermined movement of the actuator and will permit, without damage or loss of sensitivity, a movement in excess of the predetermined amount.

A further object is to provide a make and break device in which, when the contacts are brought into engagement, they are yieldingly held by a pressure sufficient to maintain proper engagement, and further to provide means for engaging and separating the contacts by a sudden movement to prevent arcing between the contacts.

Another object of my invention is to provide an improved thermostat cartridge for use in thermostat control mechanisms.

A further object of my invention is to provide an improved method of treating liquids for use in liquid operated thermostat cartridges and an improved method of filling such thermostat cartridges.

With the above and other objects in view, the invention may be said to comprise the devices illustrated in the accompanying drawings, hereafter described and particularly set forth in the appended claims, together with such variations and modifications thereof as will be apparent to those skilled in the art to which the invention appertains.

Reference should be had to the accom-

panying drawings forming part of this specification, in which

Figure 1 is a plan view of the make and break device with the casing cover removed.

Figure 2 is a section taken on line 2—2, Fig. 1.

Figure 3 is a front elevation of the device, a portion of the switch casing being broken away to show the poles of the magnet and contact members.

Figure 4 is a side elevation of the device with a portion of the casing broken away to show the switch mechanism.

Figure 5 is a perspective view of the armature plate and the lever upon which it is mounted.

Figure 6 is a top plan view of the supporting base showing the lever supporting bracket.

Referring to the accompanying drawings, a base plate 1 of suitable material forms the support for both the electric circuit make and break mechanism enclosed with a casing formed by a cover 2 fitted upon the base 1, and the thermostatic actuator which is entirely separate from the make and break mechanism and consists of a fluid-tight cartridge 3 which has a threaded boss 4 at its upper end screwed into an aperture through the base 1 and an actuating plunger 5 which is connected to a fluid-tight bellows 6 within the cartridge 3 and is moved in response to variations in the volume of liquid in the cartridge. The liquid is preferably boiled before it is put in the cartridge to remove all gases in solution, so that the liquid will not be saturated with any gases in solution within the operating range. This can easily be done by immersing the cartridge in a boiling solution or in various other ways.

The plunger 5 will have a definite vertical movement for any given change in the temperature of the liquid and the cartridge as a whole is bodily adjustable with respect to the base 1 by screwing the boss 4 inwardly or outwardly in the aperture of the base, so that the cartridge may be set in such position, and the plunger 5 will be moved to a desired actuating position when the liquid therein attains a predetermined temperature.

The base 1 may be and is shown circular in form and the cap 2 may be screwed upon

the base 1 as is shown in the drawing, the cartridge 3 being screwed to the base eccentrically. The form of the base and the manner of attaching the cap may, however, vary greatly, depending more or less on the nature of the apparatus to which the controlling device is applied.

One of the features of the present invention is the make and break mechanism that is mounted within the casing formed by the base 1 and cap 2, the manner in which this mechanism is housed being of minor importance. The base 1, adjacent the aperture through which the actuating plunger 5 extends, is provided with upwardly projecting ears 7 which may, if desired, be formed integrally with the base 1. The base is provided with an aperture 9 through which the reduced end portion 10 of the plunger 5 extends. A lever 11 is connected at its inner end to the ears 7 by a horizontal pivot pin 12 and the under face of the lever 11 adjacent the pivot bears upon the upper end of the reduced end portion 10 of the plunger 5. In case the lever 11 be made of soft metal, a hardened wear plate should be inserted for the portion 10 of the plunger to engage.

The lever 11 supports a combined armature and contact carrying member 13 which is in the form of a flat plate of resilient sheet metal. The end of the armature plate 13 which overlies the upper face of the lever 11 is cut away to form a central tongue 14 which overlies the lever. The lever 11 is provided with a central, upwardly projecting lug 15 at its free end and with upwardly projecting lugs 16 adjacent the corners at the free end. The tongue 14 of the armature plate has at its outer end a central notch 17 to receive the lug 15 of the lever and laterally projecting lugs 14' at its outer corners to engage behind the lugs 16 of the lever. The interengaging lugs on the tongue 14 of the armature plate and the lever serve to hold the armature plate against longitudinal movement relative to the lever but permit relative movement toward and from the face of the lever under certain conditions, as will be hereinafter described.

The lever 11 is held at all times in engagement with the plunger 5 and the armature plate 14 is held in place on the lever 11 by means of a spring 18. The spring 18 may be of any suitable form but is shown as substantially U shaped, the central or connecting portion 18^a of which is outermost and extends across the upper face of the lever 11 adjacent the free end thereof. The opposite ends of the spring are coiled at 18^b about the pivot pin 12 and extend downwardly into engagement with the base 1. Between the outer portion 18^a and the coils 18^b the wire of the spring is bent down at substantially right angles from the portion 18^a and formed into a coil 18^c from which the wire extends

inwardly along the sides of the lever 11 to the coils 18^b.

The plunger 5 may engage the lever 11 close to its pivot so that the spring 18 has a good leverage to maintain the lever in engagement with the plunger and so that the movement of the plunger may be multiplied to the desired extent in the make and break device. The outer portion 18^a of the spring bears upon the outer end of the armature plate extension 14 and yieldingly holds the plate in engagement with the upper face of the lever 11, the spring being held from displacement on the lever by means of the corner lugs 16 of the lever and additional lugs 19 arising from opposite sides of the lever slightly inside the lugs 16, the outer portion 18^a of the spring lying between the spaced lugs 16 and 19 and held in place thereby.

Since the body portion of the armature plate 13 lies entirely beyond the inner pivoted end of the lever 11, the free end of the plate will be swung downwardly when the lever 11 is raised by the plunger 5. The spring 18 engages the extension 14 of the armature plate quite close to its outer end so that after the contact carrying portion of the armature 13 has reached the limit of its downward movement the plate will swing relative to the lever 11 although the spring 18 tends to keep the plate in engagement with the lever. The spring, however, engages the plate very near the pivotal point and will exert only a comparatively small resistance to the limited swinging movement of the lever. Thus excessive movements of the plunger, such as may occur when the device is designed to operate at a low temperature as in refrigerating apparatus and is subjected to relative warm temperature, such as room or atmospheric during shipment, storage, or the like, are permitted without exceeding the elastic limit of the spring.

The free end of the armature plate 13 carries a contact member 20, which cooperates with a contact member 21 carried by the base to complete an electric circuit, which may control the operation of a motor or other actuating mechanism of the thermostatically controlled machine, or may control the operation of valves, signalling or other instrumentalities depending upon the character of the apparatus to which the thermostatic controller is applied. Obviously, various arrangements of a contact member on the movable and stationary elements may be employed.

As illustrated in the drawing, the contact member 20 on the armature is connected by a flexible conductor 22, with a terminal post 23 mounted in the base, and the contact member 21 is connected to a second terminal post 24 mounted in the base.

The movements of the plunger 5 in response to variations in the temperature of the body of liquid in the cartridge 3 are ordinarily very slow and if the movable contact of the switch were movable into and out of engaging position by movement corresponding to the movements of the plunger, the contact members would often be in imperfect contact and would soon be worn and rendered ineffective by arcing.

It is one of the main objects of the present invention to avoid the objectionable feature of arcing due to imperfect contact engagements by providing means which will cause one contact member to be engaged and disengaged with the other contact member by a quick snap action so that the contact members are held firmly in engagement until the actuating plunger has been retracted sufficiently to permit the armature to move quickly away from the magnet and thus cause the contact to be quickly and positively broken. To cause the movable contact member 20 to be snapped into engagement with the fixed member 21, a magnet 25 is mounted upon the base 1 and has its poles disposed upon opposite sides of the fixed contact 21 in position to be engaged by the opposite edge portions of the free end of the armature plate 13. The magnet 25 may be of any suitable form but is shown as a permanent magnet screwed to the base 1 by means of suitable clips 29, the magnet being annular in form and fitting closely within the cap 2.

As the armature plate is moved into proximity to the poles of the magnet 25, it gradually enters the magnetic field until the magnetic force is sufficient to draw the flexible plate into engagement with the magnet, thus causing the contact member 20 to be shifted rapidly in its final movement into engagement with the contact member 21. In order to permit the armature plate to properly engage the poles of the magnet and to provide effective means for utilizing the pull of the magnet to maintain the contact members in firm engagement, the contact member is mounted upon a central tongue 26 formed in the plate 13 by longitudinal slots 27. When the plate 13 is drawn into engagement with the magnet, the resilient tongue 26 is flexed upwardly and serves to hold the contacts firmly in engagement.

In its final position the armature is held in contact with the magnet and contact 21 is so adjusted that the armature plate 13 is slightly flexed at the moment engagement between the armature and the magnet is broken.

When the plunger 5 moves downwardly to break the circuit by releasing the make and break device, the spring 18 causes the lever 11 to follow the movement of the

plunger to thereby gradually swing lever 11 about the pivot pin 12 and upwardly flex the resilient armature plate 13. The armature plate 13 will be held in engagement with the magnet by the magnetic attraction until the armature has been sufficiently flexed by the downward movement of the plunger 5 to overcome the attraction of the magnet. It will then abruptly lift from the poles of the magnet, carrying with it contact 20. It is to be noted, however, that the first effect of the upward motion of the armature is not to separate the contact points 20 and 21 but to merely release some of the tension on armature tongue 26, so that the contact points do not separate until the armature has moved a perceptible distance from the magnet pole faces and acquired a considerable velocity, thereby actually jerking the contact members apart.

This delayed separation of the contacts 26 and 21 is necessary for the following reason:

At the moment when the plunger 5 has moved downwardly to such an extent that the force with which the armature tends to leave the magnet poles is almost equal to the force with which it is attracted by them, the resultant force drawing the armature toward the magnet is practically zero and fluttering of the armature on the magnet occurs. Were the contact 26 rigidly mounted on the armature, it would also flutter and destructive sparking would occur. This fluttering is prevented by the tension of tongue 26 which acts to press contact 20 against contact 21 with a constant force independent of the resultant force drawing the armature toward the magnet.

It will be noted that the resiliency of the flexible armature 13, the resiliency of armature tongue 26, the magnetic force, and the position of contact 21 with reference to the position of the magnet must all be adjusted to cooperate properly to produce a successfully operated device.

If the contact 21 is so far extended above the face of the magnet that the tension of armature tongue 26 can prevent the actual contact of the armature with the magnet, fluttering, with its destructive results of sparking, will occur at the moment of break. It is apparent, then, that motion of the armature toward the magnet must be limited by a comparatively rigid stop rather than by the resiliency of a spring. The rigid stop is a very important factor and it may be effectively accomplished in other ways than by allowing the armature to come in direct contact with the magnet. Any means which definitely limits the approach of the armature toward the magnet, in contradistinction to the indefinite limit afforded by a spring, is an effective stop.

The resiliency of flexible tongue 26 will

govern the distance by which the contact points are separated at the moment when the breaking of the circuit is just completed. The tension of spring 18 has no effect, within reasonable limits, on the operation of the device, provided it always exceeds that which is necessary to effect the separation of the armature from the magnet.

Should the contact points stick together for any cause, such as passing of an unduly large electric current, the armature plate 13 and the pivotal lever 11 constitute a toggle system, so that a large force will be developed, tending to slide the contact points one over the other in addition to the normal separating force and in this way break them apart and effect their separation. In normal operation this condition is likewise present and causes a sliding motion of the contact points with respect to each other on opening and closing which tends to keep the contact surfaces bright and in good electrical condition.

Should the upward movement of the plunger 5 continue beyond the point necessary for closing the switch, no harm will be done, since the armature plate 13 will then pivot about the outer end of the extension 14 and the only forces acting on the plate will be the spring 18 at one end and the magnet 25 at the other. Excessive movement of the actuating plunger are thus rendered in capable of damaging any part of the make and break device. Also, in this case the contact points will slide one on the other so that no damage is done.

It will be seen that by screwing the cartridge 3 into or out of the base member 1 the plunger 5 will have to be moved to a further extent or to a less extent respectively to operate the circuit opening and closing mechanism. It will thus be seen that the cartridge 3 can be so set that it will close the circuit at any desired temperature and this temperature may be changed from time to time if desired merely by altering the position of the cartridge with respect to the make and break mechanism.

It is obvious that my device can be used without a magnet type of switch, that is, such, for instance, as any switch device utilizing the principle of a member having a position of unstable equilibrium and operated by a weight or spring or the equivalent instead of magnetic force.

It will also be noted that the electrical contacts are located between the poles of the magnet so that they are positioned in a field of magnetic force, which overcomes the tendency to arc due to the blowout action.

While I have shown and described my invention as applied to a thermostat for cooling or refrigerating means, it is obvious that the principles disclosed herein are perfectly applicable to controlling electrical heat-

ing means for a chamber, in which case it is necessary to change the relationship of the parts so that upon expansion of the liquid the plunger will cause the armature to move to break contact and upon contraction of the liquid the armature will be moved to make contact. Many of the principles disclosed in this application are, therefore, broadly claimed.

Furthermore, it is to be understood that the particular forms of apparatus shown and described, and the particular procedure set forth, are presented for purposes of explanation and illustration and that various modifications of said apparatus and procedure can be made without departing from my invention as defined in the appended claims.

What I claim is:

1. A device for controlling the operation of heat transfer apparatus to maintain the temperature within predetermined limits which comprises in combination, a controlling means for the heat transfer apparatus, an actuator for the controlling means which comprises a sealed chamber with an expandible portion, means operatively connecting said portion with said controlling means, said connecting means being adapted to considerably magnify the motion of said controlling means, said chamber being completely filled with liquid not saturated with gases in solution within the operating range, whereby movement of the expandible portion is solely dependent on the volume of the enclosed liquid and substantially independent of the forces opposing such movement.

2. In apparatus of the class described, a circuit opening and closing mechanism including a resilient, movable armature, a contact member yieldingly carried by said armature to open and close said circuit, said contact member being yieldable only in a direction transverse of the armature, a fixed, opposing contact, an enclosed chamber completely filled with liquid and having an expandible portion movable in response to changes in volume of said liquid, a magnet, said movable portion of the enclosed chamber being adapted to actuate said armature to cause it to move into the magnetic field and to cause said contact to move to circuit closing position, and means for causing said armature to move with said movable portion.

3. In apparatus of the class described, a circuit opening and closing mechanism including a support, a lever pivoted to said support, a movable, actuating member engageable with one face of said lever, a resilient armature overlying said lever and projecting beyond the pivoted end thereof, a contact member carried by said armature, an opposing contact, a magnet adapted to engage the projecting end of said armature, means engaging the armature to yieldingly

hold it in engagement with said lever and said lever in engagement with the actuating member, said actuating member comprising a closed chamber completely filled with liquid and having an expansible portion movable in response to changes in volume of said liquid, said actuating member engaging said lever in such a position that the movement of the actuating member is considerably multiplied.

4. The invention claimed in claim 3, in which said contacts are positioned to close the circuit before the armature reaches the limit of its motion toward the magnet, and the contacts are arranged to keep the circuit closed until after the armature moves away from the magnet.

5. The invention claimed in claim 3, in which one of said contacts is yieldingly supported.

6. The invention claimed in claim 3, in which the armature is bifurcated to engage the poles of the magnet and the contact member carried by the armature is carried by a resilient tongue positioned between the bifurcated ends of the armature.

7. In apparatus of the class described, a circuit opening and closing mechanism including a support, a lever pivoted to said support, a movable, actuating member engageable with one face of said lever, a resilient armature overlying said lever and projecting beyond the pivoted end thereof, a contact member yieldingly carried by said armature, an opposing contact fixed to said support, a magnet adapted to engage the projecting end of said armature, means engaging the armature to hold it in engagement with said lever and said lever in engagement with the actuating member, said actuating member comprising a closed chamber completely filled with liquid and having an expansible portion movable in response to changes in volume of said liquid, said actuating member engaging said lever in such a position that the movement of the actuating member is considerably multiplied.

8. A circuit make and break device for thermostatic controlling devices comprising a support, a lever pivoted adjacent one end to said support, a movable actuating member engaging the inner face of the lever, a resilient armature overlying the outer face of said lever and projecting beyond the pivoted end thereof, cooperating contacts carried by the projecting end of the armature and the support, and means engaging the portion of the armature overlying the lever for holding said armature in engagement with the lever and said lever in engagement with the actuating member.

9. A circuit make and break device for thermostatic controlling devices comprising a support, a lever pivoted adjacent one end to the support, a movable actuating member

engaging the inner face of the lever, a resilient armature overlying the outer face of said lever throughout substantially the entire length thereof and projecting beyond the pivoted end of the lever, cooperating contacts carried by the projecting end of the arm and the support, and a spring acting on said lever to hold the lever in engagement with the actuating member, said spring having a portion overlying the arm adjacent the free end of the lever to yieldingly hold the arm in engagement with the lever.

10. A circuit make and break device comprising a support, a magnet on said support, a fixed contact member on the support, a bifurcated armature having end portions engageable with the poles of the magnet and an intermediate tongue extending from the armature, a contact member carried by the intermediate tongue and adapted to engage the fixed contact member, and means to actuate said armature to make and break the circuit.

11. A circuit make and break device for thermostatic controlling devices comprising a support, a lever pivoted adjacent one end to the support, an actuating member engaging the inner face of the lever, a magnet mounted on the support, an armature in the form of a sheet metal plate having one end overlying the outer face of the lever and its opposite end projecting beyond the pivoted end of the lever and adapted to be moved into engagement with the poles of the magnet, a spring for holding the lever in engagement with the actuating member, said spring having a portion overlying the armature plate to yieldingly hold the plate upon the lever, and cooperating contact members carried by the armature plate and support.

12. A circuit make and break device for thermostatic controlling devices comprising a support, a lever pivoted adjacent one end to said support, a wire spring having its opposite ends coiled about the pivot and extending into engagement with the support and its intermediate portion extending outwardly along the lever and extending across the outer face thereof adjacent the free end of the lever, a plunger engaging the inner face of the lever, a magnet mounted on the support, an armature plate having one end overlying the outer face of the lever and extending under the intermediate portion of said spring and its other end extending beyond the pivoted end of the lever and overlying the poles of the magnet, a fixed contact member mounted on the support adjacent the poles of the magnet, and a contact member yieldingly supported on the armature plate and adapted to engage with the fixed contact member.

13. A sensitively actuated precision electrical contact mechanism comprising a lever

arm having a relatively rigid portion and a relatively flexible portion, a pivot for said relatively rigid portion of said arm constituting a fixed fulcrum for said lever, means responsive to temperature variations capable of exerting great force and acting over a relatively small range of movement adapted to actuate said arm from a point adjacent the pivotal support for said arm and constituting the force applied to the lever, a pair of yieldingly related electrical contact members actuated from open to closed position by the movement of said arm, the flexible portion of said arm having a magnetizable portion, one of said contact members being flexibly supported relative to said magnetizable portion, magnetic means of sufficient strength to retain the magnetizable portion of said arm until the flexible portion of said arm is flexed by the actuating means to a degree sufficient to positively actuate said contact members when the arm is released by the magnet, whereby critical operation of said contact members between extreme positions is obtained by slight range of movement of said actuating means.

14. A sensitively actuated mechanism comprising a supporting base, a lever arm having a relatively rigid portion and a flexible portion, a pivotal support for said relatively rigid portion constituting a fixed fulcrum for said arm within the normal range of operation of the device, means having a relatively small range of very positive movement actuating the relatively rigid portion of said arm from a point adjacent the pivotal support thereby constituting the actuating force for said lever, means associated with the relatively flexible portion of said arm adapted to critically operate said arm to one or the other of two extreme positions within the range of flexure of said arm to effect critical movement of said arm against or away from a suitable stop, and the electrical contact mechanism yieldingly associated with the flexible portion of said arm adapted to maintain positive contact for one critical position of said critically operated means and to positively disengage contact for the other critical position of said critically operative means, said critically operative mechanism constituting the load on said lever.

15. A sensitively actuated contact mechanism comprising a base, a lever arm having a relatively rigid portion and a relatively flexible portion, a pivotal support for the rigid portion of said arm constituting a fulcrum of the lever, actuating means for said lever having relatively small range of positive movement adapted to positively actuate the rigid portion of said arm, the movement of said actuating device being substantially independent of the forces required to actuate said arm, the flexible portion of said arm

having a magnetizable portion, a magnet adapted to critically retain or critically release said magnetizable portion upon relatively slight movement of said actuating mechanism, said magnet being of sufficient strength to slightly flex the flexible portion of said arm, and a pair of electrical contact members yieldingly associated with the magnetizable portion of said arm adapted to positively establish contact when said magnetizable portion is engaged by said magnet, and to positively interrupt contact within the range of flexure necessary to effect the release of said magnetizable portion of said arm from said magnet.

16. A sensitively actuated contact mechanism comprising a base, an armature, a pivot mounting on the base for one end of said armature constituting a fixed fulcrum for one end of said armature, actuating means capable of exerting relatively great force without material change in its degree of movement and having relatively small range of very positive movement, said actuating means being supported by the base and adapted to positively actuate said armature, said armature having magnetizable portions flexibly carried thereby, a contact member also carried by said armature, yielding means interposed between said contact member and said magnetizable portions of materially greater flexibility than the relative flexibility of said support for said magnetizable portions, a permanent magnet arranged substantially parallel with the base and adapted to magnetically engage said magnetizable portions with sufficient strength to slightly flex the flexible portion of said armature and to actuate said contact member against the pressure of the yielding contact support, the range of flexure of said contact support being such that the contact is maintained closed for an instant after the release of said magnetizable portions by the magnet whereby the armature is always in a state of motion between critical positions at the instant of interruption of the contact established by said mechanism.

17. A sensitively actuated contact mechanism comprising a base, an armature, a pivot mounting on the base for one end of said armature constituting a fixed fulcrum for one end of said armature, actuating means having relatively small range of movement supported by the base and adapted to positively actuate said armature, said armature having a magnetizable portion flexibly carried thereby, a contact member also carried by said armature, yielding means interposed between said contact member and said magnetizable portion of materially greater flexibility than the relative flexibility of said support for said magnetizable portion, a permanent magnet carried by the base and adapted to magnetically engage said mag-

netizable portion with sufficient strength to slightly flex the flexible portion of said armature and to actuate said contact member against the pressure of the yielding
 5 contact support, the range of flexure of said contact support being such that the contact is maintained closed for an instant after the release of said magnetizable portion by the magnet whereby the armature is always
 10 moving between critical positions at the instant of interruption of the contact established by said mechanism and whereby the inertia of the moving armature assists in making a quick separation of said contact
 15 members.

18. A thermally responsive switch comprising a sealed thermostat cartridge having an expansible portion, a thermally responsive liquid completely filling said cartridge,
 20 said liquid being freed from vaporizable substances capable of being released within the cartridge as vapors within the normal temperature range of operation of said switch, an electrical switching means embodying en-
 25 gageable contact members, means mechanically operating the switching means from movement of the expansible portion of said cartridge, and quick acting critically operated mechanism adapted to firmly establish
 30 and positively disengage said contact member upon relatively slight movement of said expansible portion of said cartridge, the movement of said expansible portion being dependent upon changes of volume of the en-
 35 closed liquid and substantially independent of the forces opposing said movement.

19. A thermally responsive switch comprising a sealed thermostat cartridge having an expansible portion, a thermally responsive
 40 liquid completely filling said cartridge, said liquid being freed from vaporizable substance capable of being released within the cartridge as vapors within the normal temperature range of operation of said switch, an electrical switching means embodying en-
 45 gageable contact members, means mechanically connecting the expansible portion of said cartridge with said switching means so as to greatly magnify the movement of said
 50 expansible portion, one of said contact members being yieldingly supported from said mechanical connecting means, said mechanical connecting means having a resilient portion permitting only slight flexure of the end
 55 of said mechanical means of greatest range of movement relative to its normal unflexed condition, and means adapted to critically operate within the range of flexure of said connecting means to positively engage and
 60 to positively disengage the end of greatest movement of said mechanical means.

20. A thermally responsive switch comprising a sealed thermostat cartridge having an expansible portion, a thermally responsive
 65 liquid completely filling said cartridge,

said liquid being freed from vaporizable substance capable of being released within the cartridge as vapors within the normal temperature range of operation of said switch, an electrical switching means em-
 70 bodying engageable contact members, means mechanically connecting the expansible portion of said cartridge with said switching means adapted to greatly magnify the movement of said expansible portion, one of said
 75 contact members being yieldingly supported from said mechanical connecting means, said mechanical connecting means having a resilient portion permitting only slight flexure of the end of said mechanical means of great-
 80 est range of movement independent of said expansible portion of said cartridge, said mechanical connecting means having a magnetizable portion at its contact-carrying end, and a magnet adapted to engage said mag-
 85 netizable portion within the range of flexure of the end of said connecting means and to magnetically actuate said contact member against the flexing force of said member.

21. A sensitively actuated contact mechanism adapted to control an electric circuit comprising a base, a lever carrying an armature, a pivot mounting on the base for one end of said lever constituting a fixed fulcrum
 90 for one end thereof, actuating means having relatively small range of very positive movement supported by the base and adapted to positively actuate said lever, a contact member carried by said lever, the connection from the pivot mounting to said contact being
 95 substantially inextensible, resilient means interposed between said contact member and said armature, a second contact member carried by the base, a magnet adapted to magnetically engage said armature with sufficient
 100 force to slightly flex the flexible portion of said lever and to actuate said first contact member against the pressure of the yielding support for said second contact member, the range of flexure of said contact support being
 105 such that the electric circuit controlled thereby is maintained closed for an instant after the release of said armature by the magnet whereby the armature is always in a state of movement between critical positions
 110 at the instant of interruption of the contact established by said mechanism.

22. A sensitively actuated contact mechanism adapted to control an electric circuit comprising a base, a lever carrying an armature, a pivot mounting on the base for one end of said lever constituting a fixed fulcrum for one end of said lever over the normal range of operation of said mechanism, actuating means carried by the base and adapted to
 120 positively actuate said lever, said armature being longitudinally inextensible relative to said pivot mounting over the normal range of operation of said mechanism, a contact member also carried by said lever, yielding
 125
 130

means interposed between said contact member and said armature of materially greater flexibility than the relatively flexible support for said armature, a permanent magnet carried by the base and adapted to magnetically engage said magnetizable portions with sufficient force to slightly flex the flexible portion of said armature and to actuate said contact member against the pressure of the yielding contact support, the range of flexure of said contact support being such that the contact is maintained closed for an instant after the release of said magnetizable portions by the magnet whereby the armature is always in a state of movement between critical positions at the instant of interruption of the contact established by said mechanism.

23. In mechanism of the character described, the combination of a supporting base, electric circuit control mechanism carried by said base, a thermostat cartridge for operating the electric control mechanism adjustably carried by said base and adapted to be bodily moved relative thereto for adjusting the operation of said control mechanism, said cartridge comprising a relatively inextensible cup-shaped member, a relatively extensible cup-shaped bellows member disposed entirely within said inextensible cup-shaped member, a sealing member connecting the open ends of said members to define therebetween a sealed liquid-tight chamber for receiving a thermostatic liquid, said sealing member being provided with a threaded extension having an aperture therein of materially less diameter than the diameter of said inextensible cup shaped member, and an actuating plunger extending through the apertured portion of said disk to the closed end of said extensible cup shaped member, said cartridge being adapted to be adjustably secured to said base by means of said screw threaded portion whereby said cartridge may be bodily moved relative to said base and said control mechanism for adjustably regulating the temperature of operation of said control mechanism, said actuating plunger being adapted to substantially fill the aperture in said disk and to extend only slightly beyond the open end of said screw threaded portion.

24. In mechanism of the character described, the combination of a supporting base, electric circuit control mechanism carried by said base, a thermostat cartridge for operating the electric control mechanism adjustably carried by said base and adapted to be bodily moved relative thereto for adjust-

ing the operation of said control mechanism, said cartridge comprising, a relatively inextensible cup-shaped member, a relatively extensible cup-shaped member disposed entirely within said inextensible cup-shaped member and adapted to be extended and contracted in a longitudinal direction only with respect to said inextensible member, a sealing member connecting the open ends of said members to define a sealed liquid-tight chamber between said members for receiving a thermostatic liquid, said sealing member being provided with an externally screw threaded portion of fine pitch having an aperture therein of materially less diameter than the internal diameter of said inextensible cup-shaped member, and an actuating plunger extending through the apertured portion of said disk to the closed end of said extensible cup-shaped member, said cartridge being adapted to be adjustably secured to said base by means of said threaded portion whereby said cartridge may be bodily moved relative to said base and said control mechanism for adjustably regulating the temperature of operation of said control mechanism, said actuating plunger being adapted to substantially fill the aperture in said disk and to extend only slightly beyond the open end of said externally threaded portion.

25. In mechanism of the character described, the combination of a supporting base, electric circuit control mechanism carried by the base, and a thermostatic cartridge for operating said control mechanism adjustably carried by said base and adapted to be bodily adjusted relative thereto for adjustably regulating the temperature of operation of said control mechanism, said cartridge comprising, a relatively inextensible cup-shaped member, a relatively extensible cup-shaped bellows member disposed entirely within said inextensible member, the open ends of said cup-shaped members being connected to define a liquid tight chamber between said members adapted to be completely filled with a thermostatic liquid and sealed, adjustment means on the cartridge adjustably connecting the cartridge to the base and having an aperture therethrough, and an actuating plunger extending through the aperture in said adjustment means and seated in the closed end of said extensible cup, said adjustment means being adapted to act as a guide for said plunger.

In testimony whereof, I hereunto affix my signature.

CHARLES B. SAWYER.