June 13, 1939. R. R. CHAPPELL 2,162,296

SENSITIVE CONTROL DEVICE

Filed Dec. 23, 1936

FIG. 1.

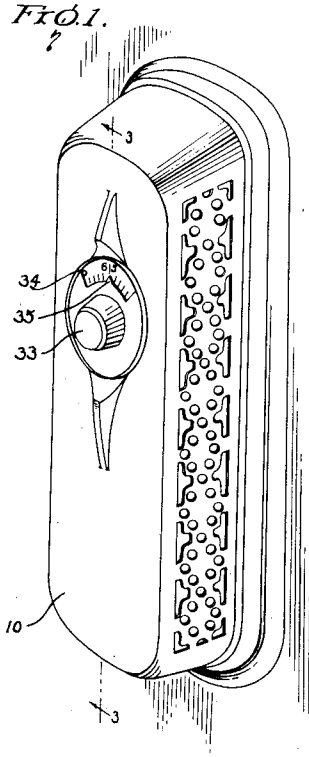


FIG. 2.

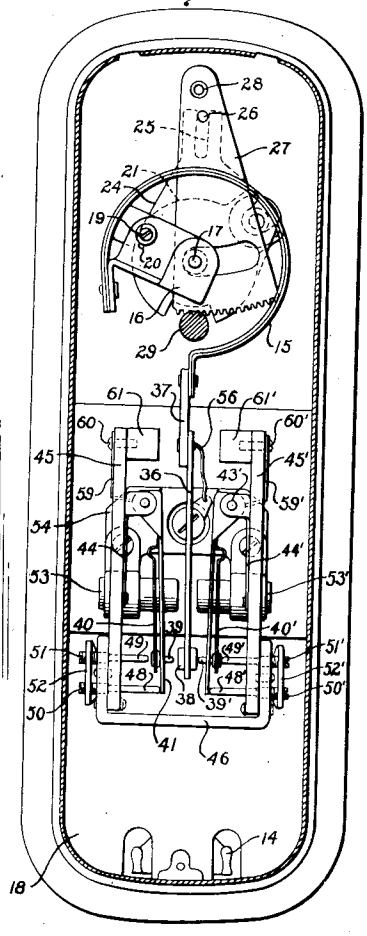


FIG. 3.

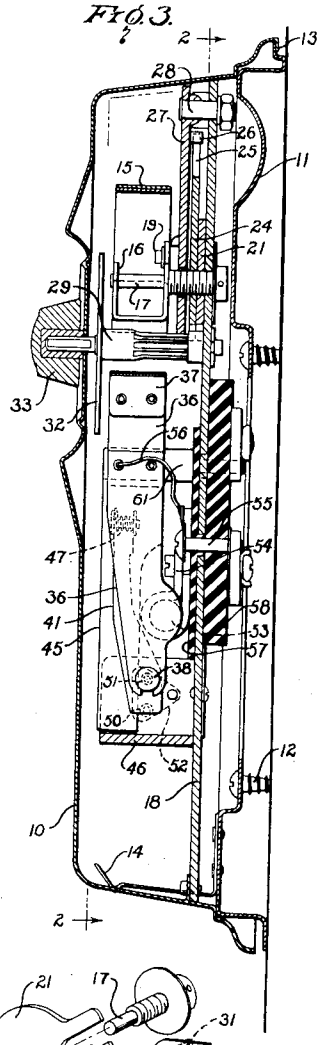


FIG. 5.

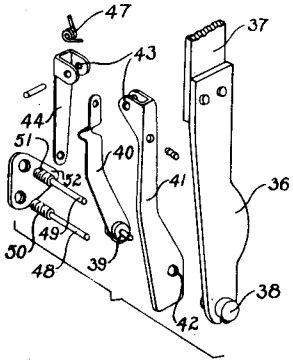
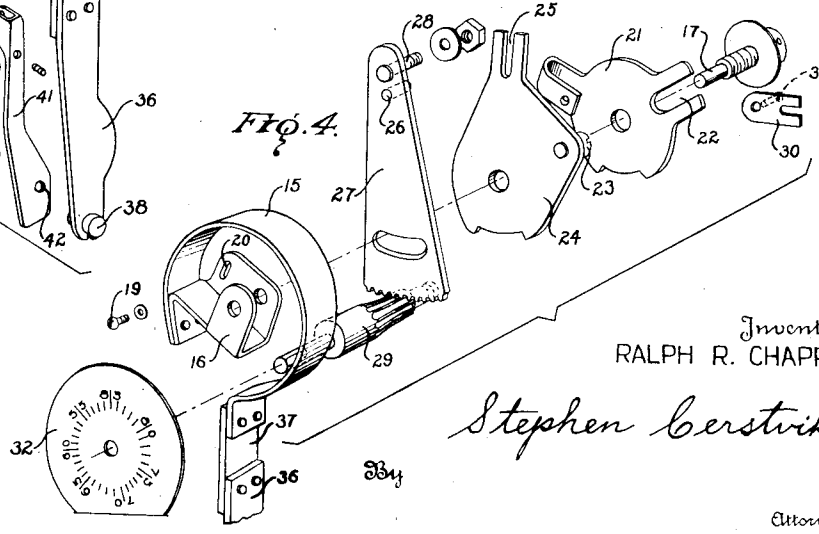


FIG. 4.



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SENSITIVE CONTROL DEVICE

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6 Claims. (Cl. 200—139)

This invention relates to electrical apparatus and more particularly to means adapted for controlling the making and breaking of electrical circuits by sensitive control elements in accordance with predetermined conditions of temperature, humidity, or the like.

In devices wherein a sensitive control element, such as an element responsive to changes in temperature, humidity, or the like, is employed for making and breaking an electric circuit, the control switch part which is actuated by said element for controlling said circuit must, in the interest of accuracy and sensitivity, be comparatively long and of light construction. Because of the construction of said switch part, the same is susceptible to vibration and, accordingly, when the instrument of which it forms a part is subjected in service to jarring or vibration, the movement or chattering of said part relative to a fixed contact causes the controlled circuit to be opened and closed or vice versa at a rapid rate. This results in improper operation of the particular apparatus which is being controlled by the flow of current in the circuit and, additionally, the frequent sparking at the contacts causes the same to burn, to become pitted and to otherwise deteriorate, thereby impairing the sensitivity of the device.

In an effort to overcome the above disadvantages, it has been heretofore proposed to provide a magnetic force for biasing the movable, contact carrying part of the control switch either in open or closed position, said force being of such character that, when the efforts of the sensitive element to move said contact oppose and become slightly greater than the magnetic biasing force, said contact moves from one of its positions to the other with a snap action. This method of overcoming the vibration of a movable contact has not proved entirely satisfactory, however, particularly when the effort or tension of the sensitive element is of about the same magnitude as and is acting in opposition to the magnetic biasing force. This latter condition is the one which normally exists in a great many installations.

It is accordingly an object of the present invention to provide a novel control device wherein the above difficulties and disadvantages are overcome.

Another object of the invention is to provide novel switch means and control means therefor whereby undesirable operation of said switch means as a result of vibration, jarring, tilting, or the like, is obviated.

Still another object is to provide novel means for controlling an electric circuit whereby switch means in said circuit may be quickly and positively actuated with utmost accuracy in response to small movements of a sensitive control element.

A further object is to provide a novel sensitive control device wherein accuracy is obtained without sacrificing sensitivity.

The above and further objects and novel features of the invention will more fully appear from the following detailed description when read in connection with the accompanying drawing. It is to be expressly understood, however, that the drawing is for the purpose of illustration only and is not intended as a definition of the limits of the invention, reference being primarily had for this latter purpose to the appended claims.

In the drawing, wherein like reference characters refer to like parts throughout the several views,

Fig. 1 is an isometric, outside view of a casing and wall mounting for a thermostat embodying the present invention;

Fig. 2 is a front view partly in section, of a thermostat embodying one form of the invention, the view being taken substantially on line 2—2 of Fig. 3;

Fig. 3 is a side view of said thermostat, partly in section and on an enlarged scale, taken substantially on line 3—3 of Fig. 1;

Fig. 4 is a detail exploded view, with parts broken away, of the sensitive control element of said thermostat and means for adjusting the same; and,

Fig. 5 is a detail exploded view, with parts broken away, showing a portion of the novel control switch mechanism.

Only a single embodiment of the invention has been illustrated in the drawing, by way of example, in the form of a thermostatically controlled switch mechanism which may be employed for opening and closing a circuit to control a heating plant, an air conditioning unit, a signal or the like, in response to changes in the temperature of the surrounding air. The operating parts of the illustrated device may be neatly and compactly housed in a casing 10 which may be removably secured to a support 11 (Fig. 3), fixedly mounted on a wall or the like by means of screws 12, the upper portion of said casing having overlapping engagement with the upper edge of said support at 13, and the lower portion being engaged by spring catch 14 mounted on and projecting from said support.

In the form shown, the sensitive element for actuating the novel control switch comprehended by the invention is constituted by a coiled, bimetallic strip 15 which is anchored at one end on a bracket 16 that is loosely mounted on the smooth, reduced outer end of a stud 17, the latter having threaded engagement with a metallic plate 18 which serves as a supporting means for all of the operating parts to be hereinafter described and which is removably mounted in casing 10. Adjustably secured to bracket 16 by means of a screw 19, extending through a slot 20 in said bracket and freely mounted on stud 17 for rotation relative thereto is a member 21 constituting in effect a bell-crank lever. Said member is provided with a bifurcated portion or fork forming a radial slot 22 into which the head of an eccentric screw 23 extends, the screw being mounted adjacent the periphery of another lever member 24, also rotatably mounted on stud 17. Member 24 is likewise provided with a radial slot 25 into which a pin 26 mounted on a sector gear 27 slidably projects. Said gear is pivotally mounted on a pivot pin 28 extending through plate 18 and the teeth on the lower, arcuate end thereof are in constant mesh with the toothed portion of a shaft 29. One end of said shaft also extends through plate 18 and is held in position by a forked member 30 that engages an annular groove adjacent said end, member 30 being secured to said plate by a screw 31. A graduated dial 32 is mounted adjacent the other end of shaft 29 and a knob 33 is also provided thereon for facilitating the turning thereof. Preferably, dial 32 is mounted inside of casing 10 and the latter has an opening 34 see Fig. 1 through which said dial may be viewed, said opening being provided with a pointer 35 constituting a reference mark.

Thus, when it is desired to adjust the tension of strip 15 and thereby regulate the temperature at which the switch mechanism, to be hereinafter described, is opened and closed, such adjustment may be made by rotating knob 33. This rotary motion is transmitted from said knob through shaft 29, sector gear 27, pin 26, member 24, eccentric screw 23, member 21, and bracket 16 to coiled, bimetallic strip 15. Calibration adjustments may be made by turning eccentric screw 23 or by changing the relative positions of bracket 16 and member 21 at the screw and slot connection 19, 20.

The novel switch mechanism comprehended by the invention and which is adapted to be actuated by thermostat 15 under the control of magnetic forces comprises a contact carrying armature 36, that is made of light-weight, magnetic material and is suspended from the free end of the thermostat by means of a short strip 37 of insulating material. A contact 38 may be provided adjacent the lower end of armature 36 and project on either side thereof for alternative engagement with a pair of oppositely disposed contacts 39 and 39'.

Insofar as we are aware, the contacts corresponding to contacts 39 and 39' in devices of the above character heretofore provided have been fixed, although adjustable for varying the gaps between the same and the center or movable contact 38. The present invention provides novel means for movably mounting contacts 39 and 39' and, at the same time, provides means for varying the extent of movement thereof and for adjusting the gap between the same and armature 36, 38. In the form shown, contacts 39 and 39' are oppositely disposed and mounted in the same manner. Accordingly, only the mounting for contact 39 will be described, corresponding parts of the mounting for contact 39' being designated by primed numerals. As illustrated, contact 39 is carried by a light, conducting spring 40 which is secured by riveting or other suitable means to a metallic arm 41 and tends to hold an enlarged portion of said contact in engagement with said arm while a reduced portion of the contact extends through an opening 42 in the arm for engagement with contact 38. Arm 41 is pivotally mounted at 43 on a metallic bracket 44 which is secured to a vertically disposed bar 45 of insulating material that is, in turn, supported by a U-shaped shelf 46 on plate 18. A coil spring 47 is provided at pivot 43 and tends to rotate arm 41 in a clockwise direction, as viewed in Fig. 2, to thereby hold the lower end of said arm in engagement with an insulating stop 48. A similar insulating stop 49 is provided for limiting the movement of contact 39 to the left (Fig. 2).

For the purpose of varying the range of movement of contact 39, i. e., the distance between stop 49 and arm 41, and for varying the gap between contacts 38 and 39, stop pins 48 and 49 are tightly fitted into bores in the inner ends of a pair of screws 50 and 51, respectively, which extend through and threadedly engage the vertical end portion of shelf 46. A plate 52, also adapted to be threadedly engaged by said screws and adapted to be secured to shelf 46 in tilted relation therewith, may be provided for locking screws 50 and 51 in adjusted position.

Means are provided whereby, whenever contact 38 moves or is about to move out of engagement with contact 39, for example, the former will be positively moved with a snap action into engagement with contact 39' and vice versa. Such means, in the form shown, are constituted by a magnet comprising a pair of permanently magnetized pole pieces 53, 53' supported in end-to-end relation by a bracket or yoke 54 which is made of soft magnetic iron to provide a highly permeable return path between said pole pieces and is secured to plate 18 by any suitable means such as a bolt 55. The adjacent faces of poles 53 and 53' are spaced apart a distance somewhat greater than the maximum traverse of armature 36 and are equally spaced on opposite sides of said armature when the latter is in its middle position. It will thus be seen that, when armature 36 moves from one side to the other between said faces, the attractive force of one pole piece thereon increases as the attractive force of the other decreases and that the greater effect or force will be exerted by the pole to which the armature is nearest. One of said poles is accordingly exerting a biasing force on armature 36 at all times, tending to hold contact 38 in engagement with one or the other of contacts 39 and 39', the armature contact being illustrated in engagement with contact 39'. It will be noted that, when bimetallic element 15 tends to move armature 36, 38 from one contact 39 or 39' to the other, said element acts first in opposition to the relative magnetic force of pole pieces 53 and 53' thereon respectively and then, as said armature passes its central position, in conjunction with 53' and 53 respectively to thereby assure a snap action of said armature from one of said contacts to the other.

In order to complete electric circuits through contacts 38, 39 and 38, 39', armature 36 is connected by a lead 56 to bolt 55 which is insulated

from plate 18 by means of insulations 57 and 58 disposed on opposite sides of said plate. Contact 39 may be connected to an exterior lead through spring 40, arm 41, bracket 44, a conductor strip 59, a screw 60, by means of which bar 45 is secured to a terminal block 61, and said terminal block which is supported by and extends through plate 18 and insulators 57 and 58.

In the operation of the above device, contact 38 is at all times held in engagement with one or the other of contacts 39 and 39' by the combined forces of magnet 53, 53' and the tension of strip 15, the latter of which varies in magnitude and direction with variations in the temperature of the surrounding air. Assume, for example, that the temperature of the surrounding air is higher than the temperature set on dial 32. Strip 15 will then be in expanded condition and tend to hold contact 38 in engagement with contact 39', as shown in Fig. 2. A circuit may thus be closed, to an air conditioning unit, fan, or the like, for lowering the room temperature to the desired degree. The pressure exerted on armature 36 by the tension in strip 15 and the attractive force of pole 53' is transmitted to contact 39' and is accordingly effective to move the latter into engagement with stop 49' and out of engagement with arm 41'.

As the desired room temperature is approached, strip 15 uncoils or contracts and, accordingly, tends to move armature 36, 38 toward contact 39. No movement of said armature can result, however, until the tension or effort of strip 15 is slightly greater than the resultant magnetic force of poles 53, 53' acting on the armature. When said tension and resultant magnetic force are of the same or about the same magnitude, but acting in opposite directions, it will be apparent that the position of armature contact 38 is extremely unstable and that said contact is very susceptible to movement in response to slight jars or vibrations. In devices heretofore provided, wherein contact 39' is fixed, the chatter or vibration of contact 38 under these circumstances causes rapid opening and closing of the controlled circuit. In the device of the present invention, the parts are preferably so adjusted that contact 39', for example, will just be held in engagement with stop 49' when the force of bimetallic strip 15 on armature 36 substantially balances the resultant magnetic force of pole pieces 53, 53' thereon. Thus, when the force of the bimetallic strip becomes slightly greater than said resultant magnetic force and starts to move armature 36 toward the left, spring 40' is also exerting a slight force toward the left, thereby causing contact 39' to follow armature contact 38 for a slight distance depending upon the position of arm 41'. During this movement of armature 36, the effect of pole piece 53' weakens because of the movement of said armature away from the same, and the effect of pole piece 53 thereon becomes greater. When, therefore, the movement of contact 39' is arrested by arm 41', said armature will have moved out of the influence of pole piece 53' to such an extent that the force exerted thereon by bimetallic strip 15 and the increased force of pole piece 53 greatly overbalances the attractive force of pole piece 53', thereby assuring a continuation of the excursion of the armature into engagement with contact 39.

Thus, when the above-described condition of equilibrium of forces acting on armature 36 exists, and vibration of the armature occurs, contact 39' will follow contact 38 during such vibratory motion and thus prevent opening and closing of the controlled circuit. If the magnitude of the vibrations exceeds the maximum movement of contact 39', armature 36, 38 will move into the influence of pole piece 53, as pointed out above, and be attracted thereby into engagement with contact 39.

With contact 38 in engagement with contact 39, the latter will be held against stop 49 in the same manner as described above in connection with contact 39'. When the room temperature is again raised above a predetermined degree, strip 15 expands and tends to move armature 36, 38 toward the right in opposition to the magnetic attraction of pole 53. When this magnetic force is overcome by the tension of strip 15 due to sufficient temperature rise, contact 38 will again snap into engagement with contact 39'.

There is thus provided a novel sensitive control device and novel means therein whereby positive switch actuation for opening and closing an electric circuit in response to a sensitive control element is obtained and wherein opening and closing of contacts and consequent burning and disintegration of the latter due to chatter and vibration, thereof is eliminated. Novel means which are simple both in construction and operation and whereby an electric circuit may be controlled in accordance with the reaction of a sensitive element without danger of being opened and closed except under predetermined desired conditions are also provided.

Although only a single embodiment of the invention has been illustrated and described in detail, it is to be expressly understood that the same is not limited thereto but that various changes may be made therein, such as in the design and arrangement of parts illustrated, without departing from the spirit and scope of the invention, as will now be apparent to those skilled in the art. For a definition of the limits of the invention, reference will be had primarily to the appended claims.

What is claimed is:

1. In apparatus of the class described, an arm of magnetic material having one of its ends free for movement, a pair of movably supported contacts mounted at opposite sides of said arm, means for limiting in two directions the movement of each of said contacts, a sensitive control element responsive to the condition of the surrounding air for moving the free end of said arm into engagement with one or the other of said contacts depending on said condition, and magnetic means affecting said arm and tending to hold the same in engagement with the contact engaged thereby and adapted to assist said sensitive element to insure movement of said arm from one contact to the other whenever said arm is moved out of engagement with said one contact.

2. In apparatus of the class described, a pair of pivotally mounted, oppositely disposed arms, resilient means tending to move the free ends of said arms outwardly from one another, means for limiting the movement of said arms by said resilient means, a spring mounted contact normally engaging the outer face of each of said arms, means for limiting the movement of said contacts outwardly from said arms, an armature having the free end thereof disposed between and engageable with said contacts to form switch means, magnetic means for normally holding said

armature in engagement with one or the other of said contacts, and a sensitive control element for moving said armature from one of said contacts toward the other in opposition to said magnetic means.

3. In apparatus of the class described, magnetic means including a pair of oppositely disposed pole pieces, an arm of magnetic material extending between the adjacent faces of said pole pieces, means independent of said magnetic means for moving said arm from side to side to vary the relative attractive force of said pole pieces thereon, stop means for limiting the range of movement of said arm, a movably mounted contact on each side of said arm and engageable thereby to form switch means, said contacts being interposed between said arm and stop means, and means for adjusting the minimum spacing between said contacts.

4. In apparatus of the class described, a support, an arm pivotally secured at one end of said support, stop means for limiting the pivotal movement of said arm, resilient means holding said arm against said stop means, a leaf spring secured at one end to said arm, a contact on said spring and normally held thereby against said arm, and stop means for limiting the movement of said contact away from said arm.

5. In apparatus of the class described, a pair of oppositely disposed units each comprising a support, an arm pivotally secured at one end to said support, stop means for limiting the pivotal movement of said arm in one direction, yielding means for holding said arm against said stop means, a spring-pressed contact limited in its movement in one direction by said arm and means for limiting the movement of said contact away from said arm, an armature extending between said contacts and alternatively engageable therewith to form switch means, and means for alternately moving said armature into engagement with said contacts.

6. In apparatus of the class described, a pair of oppositely disposed units each comprising supporting means, an arm pivotally secured at one end to said support, stop means for limiting the pivotal movement of said arm in one direction, yielding means for holding said arm against said stop means, a spring-pressed contact limited in its movement in one direction by said arm and means for limiting the movement of said contact away from said arm, an armature extending between said contacts and alternatively engageable therewith to form switch means, means for alternately moving said armature into engagement with said contacts, and magnetic means tending to attract said armature into engagement with one of said contacts and out of engagement with the other.

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