Jan. 31, 1939. C. I. HALL 2,145,722

CONDITION RESPONSIVE CONTROL

Filed Jan. 15, 1937

Fig. 1.

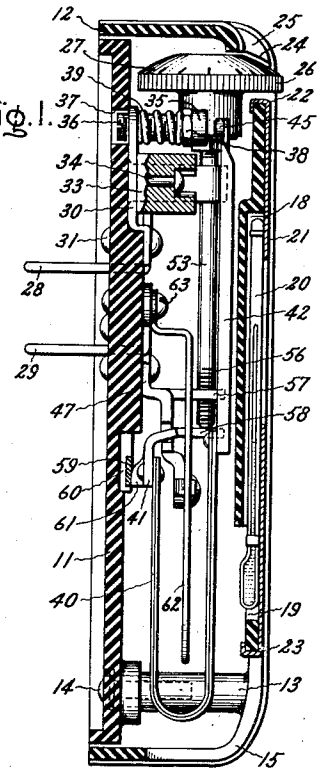


Fig. 2.

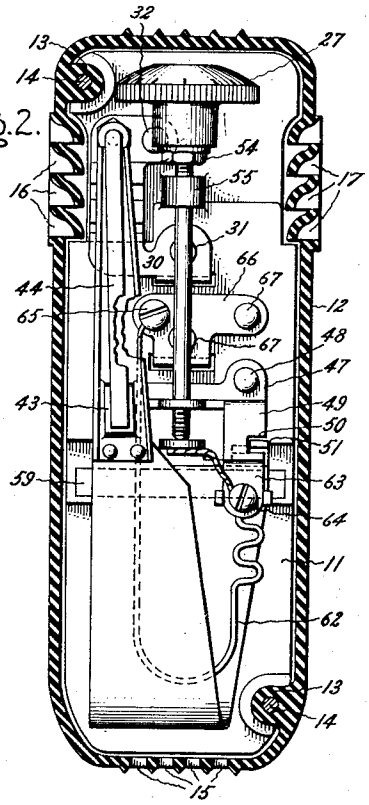


Fig. 3.

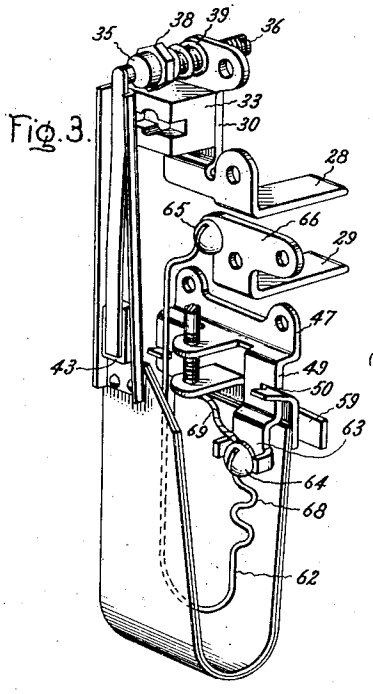


Fig. 6.

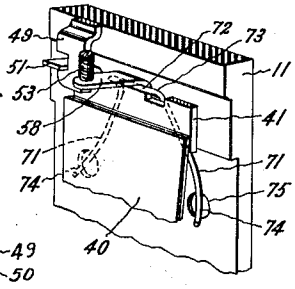


Fig. 5

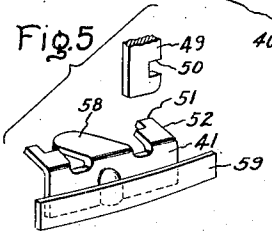


Fig. 4.

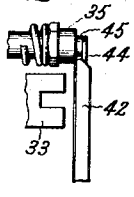
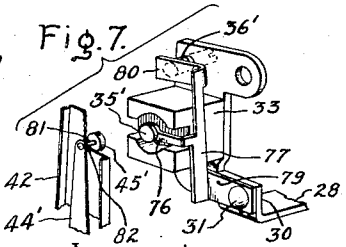


Fig. 7.



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UNITED STATES PATENT OFFICE

2,145,722

CONDITION RESPONSIVE CONTROL

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Application January 15, 1937, Serial No. 120,747

16 Claims. (Cl. 200—122)

The present invention relates to condition responsive control and particularly thermostatic control switches actuated automatically in response to variations in temperature in room heating or cooling control service.

It is the primary object of the present invention to provide a new and improved room thermostatic control switch structure that is free from contact vibration troubles, is readily adjustable to meet varying operating conditions, and is of minimum overall size yet having all the operating and current carrying parts relatively large and rugged to insure reliability and accuracy of the control operations.

A further object of the invention is to provide improved detachable and adjustable mounting means for the thermostatic actuating element. More particularly, it is an object of this invention to provide a detachable and adjustable hinge mounting for the thermostatic actuating element permitting accurate adjustment as well as ready removal of the thermostatic element from the switch assembly for inspection, repair or replacement.

Another object of the invention is to provide a room thermostatic switch structure with improved adjusting means so constructed and arranged that the adjustment may be accurately observed and operated when the switch is placed at either eye level or the three-foot level within the enclosure being conditioned. This construction is highly desirable because it has been found through experience that comfort conditions within different enclosures may be indicated and better controlled when the thermostatic control device is at different levels.

Still another object of the invention is to provide an improved form of removable or portable condition responsive switch of the plug-in type provided with prong or stab mounting contacts for both supporting the device and establishing electrical connection therewith. It is a special object to provide a thermostatic switch of the plug-in type in which a magnet for obtaining snap action of the contacts and one of the main switch contacts are mounted as a unit on an extension of one of the mounting prongs or contacts in cooperating relationship with the thermostatic contact element of the switch.

A still further object of the invention is to provide a thermostat of the type utilizing an auxiliary source of heat, such as a preheat resistor, to vary the time of operation thereof with an improved form of resistor having a plurality of spaced apart substantially U-shaped loops providing means for ready attachment thereof at any selected loop to a terminal and thereby readily obtain different predetermined amounts of auxiliary heat.

A further object of the invention is to provide an improved mounting arrangement of the preheat resistor with respect to the bimetallic actuating element.

Further objects and advantages of my invention will become apparent as the following description proceeds, and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of my invention reference may be had to the accompanying drawing in which Fig. 1 shows a side view, partially in section, of a thermostat constructed in accordance with my invention; Fig. 2 shows a front view, also partially in section, of the same thermostat; Fig. 3 shows a perspective view of the thermostat structure with the base and casing removed; Fig. 4 is a partial view of the switch structure showing in detail the fixed and movable contacts in engagement; Fig. 5 is an exploded view of the hinge structure and biasing spring; Fig. 6 shows a modified form of biasing spring that may be used in place of the one illustrated in Fig. 5; and Fig. 7 shows a modified form of fixed contact that may be used in place of the one illustrated in Figs. 1, 2 and 3.

The thermostat consists of a substantially flat base member 11 preferably molded of insulating material, and a casing 12 fitting substantially therearound. The latter is provided with integral projections 13 extending inwardly from the front wall into abutting relationship with the base member whereby the two may be secured together in spaced apart relationship by means of screws or the like 14.

In order to obtain a good circulation of air through the casing the latter is provided with slots 15 extending substantially across the bottom and a short distance up the front wall and horizontal louvres 16 and 17 on both sides and near the top. The front of the casing is provided with longitudinal channels 18 and an opening 19 in which is placed the thermometer 20 held in place by a dial plate 21 having end portions 22 and 23 bent around the casing through slots 15 and an opening 24 on the upper side of the front wall, respectively, for securely folding the dial in place.

The casing is provided with an arcuate indentation 25 above the opening 24 so that an indi-

cating and adjusting knob 26 projecting through the opening may be readily adjusted and the indications 27 thereon noted. The indications or indicia 27 are placed on a portion of the knob having an angle of approximately 45° to the horizontal whereby they may be readily read by a person in case the thermostat is located at or below the eye level. The thermostat is to be used primarily at a level of three feet from the floor and the described arrangement is particularly suitable for this type of thermostat.

The thermostat is of a type designed to be attached to or removed readily from a wall socket or the like (not shown) by providing the base 11 with a pair of prong or stab contacts 28 and 29 extending through the base. Contact 28 is provided with a substantially L-shaped portion 30 extending at right angles to the prong contact 28 and suitably fastened to the base member by suitable means, such as a pair of rivets 31 and 32.

The thermostat is designed to operate with snap action, this action being achieved through the use of a permanent magnet 33 suitably secured to the portion 30 as by a rivet or the like 34 and cooperatively associated with an armature to be described hereinafter. The portion 30 also mounts a fixed contact consisting of a cylindrical-headed screw 35 in threaded engagement with the portion. The position of the screw may be adjusted to vary the temperature differential of adjustment in a manner also to be described hereinafter either by means of a slot 36 formed on the end thereof and extending into an opening 37 formed in the base or by a hexagonal portion 38 of the screw adjacent the cylindrical head. The contact is held in adjusted position by means of a spring 39 preventing undesired rotation thereof under normal operating conditions.

The condition responsive actuating means of the thermostat is a substantially U-shaped bimetallic element 40 rigidly fastened at one end as by riveting or welding to a male hinge member 41 and has attached to its free end a channel-shaped lengthwise extending armature member 42. The latter is provided with a pillow block 43 formed near the end fastened to the bimetallic member and mounting a flexible resilient spring 44 extending along and beyond the armature. A movable contact 45 adapted to cooperate with the fixed contact 35 is mounted on the end of the spring 44. The armature member 42 extends into the field of the magnet and, when actuated into the field by the bimetallic member as upon a decrease in temperature, it is attracted toward the magnet with a snap action but is prevented from actually engaging the latter by the fixed contact 35 which acts as a stop for the armature. Likewise, when the bimetallic member exerts a predetermined force the armature member in response to an increase in temperature is moved from the field with a snap action.

The differential adjustment of the thermostat is obtained through adjustment of the fixed contact 35 which acts as a stop for the armature 42 when the latter is attracted by the magnet. Rotation of the contact varies the distance between the armature and magnet and thereby the force exerted by the magnet. The rotation of the contact does not affect the contact pressure because the spring 44 is always flexed a predetermined amount upon closure of the switch. The spring is biased to engage the armature when the switch is open, as illustrated in Fig. 1, and is moved an amount depending upon the thickness of the contact when closed, as illustrated in Fig. 3.

The bimetallic actuating element 40 and the male hinged member 41 are swingably mounted on and are readily removable from a female hinge member 47 suitably secured as by rivets 48 to the base 11. The female hinge member has a first outwardly and downwardly extending portion 49 provided with slots or perforations 50 through which the relatively smaller tongue-like projections 51 formed on the outwardly bent portion 52 of the male hinge member 41 extend.

Adjustment of the range of operation of the thermostat is obtained through rotation of the adjusting knob 26 which extends without the casing 12 through opening 24. The knob is mounted upon a vertical rotatable adjusting shaft 53 and is held in suitable angular relationship thereto by a nut 54. The shaft extends through an opening formed in an outwardly extending portion 55 of the base and has a threaded end portion 56 extending in threaded engagement through an outwardly projecting tongue-like extension 57 formed on the fixed female hinge member 47. The end of the shaft extends into the path of movement of a second tongue-like outwardly extending projection 58 formed on the movable male hinge member 41. The male hinge member is held in operative relationship with the female hinge member and the tongue 58 is held in abutting relationship with the end of the adjusting shaft 53 by means of a leaf spring 59 loosely mounted in a depression 60 formed in the base 12 and engaging a projection 61 formed on the hinge member. The leaf spring 59 may be replaced by a hairpin spring of the type shown in Fig. 6 and which will be described hereinafter.

The local source of heat affecting the bimetallic element consist of a substantially U-shaped preheat coil or resistor 62 mounted at one end to a terminal 63 formed as a second outwardly and downwardly extending projection on the female hinge member and is fastened thereto by a screw 64. The other end of the preheat coil is fastened by means of a screw 65 to a portion 66 that is formed integrally with the stab contact 29 and is bent at right angles thereto. The prong contact 29 is attached to the base by means of a pair of rivets 67.

The preheat resistor extends down between the bent portions of the U-shaped bimetallic member and is provided with a series of convolutions or substantially loop-shaped portions 68 providing means whereby the preheat resistor may be readily attached to the terminal 63 at predetermined points. The radius of curvature of the loops is slightly larger than the diameter of screw 64 whereby the resistor may be attached to the terminal with little effort. The arrangement of the preheat coil between the legs of the U-shaped bimetallic arrangement also provides an arrangement whereby the value of preheat is controlled not only by the length of the preheat coil but also by the position thereof between the legs of the U. Movement of the preheat coil upwardly reduces the effective area of the bimetal acted upon by the preheat coil.

To obtain a better flow of current across the hinged member there is provided a flexible connector 69 connected at one end to tongue 58 and at the other end to terminal 63. The connector is thus in parallel with the hinge members.

The switch structure described above is readily assembled in a series of simple steps. The prong contact 28, permanent magnet 33 and the relatively fixed contact 35 are assembled as a first unit. The male hinge member 41, the bi-

metallic element 40, armature 42 and movable contact 45 are assembled as a second unit. After the base has been molded the parts are assembled by attaching to the base the first unit, the prong contact 29 and the female hinge member 47. Thereafter the spring 59 is placed into the hollowed-out portion 60 of the base and the male hinge member is placed into cooperative relationship with the female member by a "hooking" movement. The adjusting shaft 53 and knob 26 may be placed into the position indicated either before or after the second unit is placed in position. It is obvious from the above that the second unit including the bimetallic element may be readily assembled and disassembled whenever desired. This presents an advantage whenever it is necessary to remove the bimetallic actuating element for repairs.

The thermostat is adapted to be utilized in any system in which thermostats are used at the present time. It is particularly designed to be used in arrangements in which a heating or cooling apparatus control circuit leads to a room and is fastened to a wall plug or socket into which the prong contacts 28 and 29 are adapted to extend. The thermostat is placed in position merely by inserting the prong contacts into the socket.

The electric circuit through the thermostat extends from contact 28 through the extending portion 30, contact 35 and when the thermostat has been actuated to its closed position through the contact 45, spring 44 and armature 42 in parallel, bimetallic element 40, and through the hinge and flexible connector 69 in parallel to the preheat coil 62 and then to portion 66 of the prong contact 29.

Upon closure of the circuit by the bimetallic actuating element the heating apparatus controlled by the thermostat is placed into operation and the preheat coil 62 energized in order to locally influence the bimetallic element and thereby change the time of operation thereof after the manner described in Letters Patent No. 1,583,496—Shafer.

The use of the preheat coil is of course optional and in case its use is not desired, it may be omitted and the terminal 63 connected directly by the flexible connector 69 to the prong contact 29. In case the preheat coil is eliminated it may be desirable also to combine the prong contact 29 with the female hinge member 47 in an obvious manner.

The range of operation is readily adjusted by means of the adjusting knob 26. When it is desired to raise the range the adjusting shaft is rotated to move it downwardly to thereby force the tongue portion 58 in a clockwise direction, referring to Fig. 1, to force the male hinge member 41 in a clockwise direction against the bias exerted thereupon by the leaf spring 59. The effect of this adjustment is to move the contact 45 and armature 42 to the right, further from the permanent magnet and relatively fixed contact, thereby requiring a higher temperature to move the latter to the left.

When it is desired to lower the range the shaft 53 is rotated in an opposite direction to allow movement of the male hinge member 41 in a counterclockwise direction, in which direction it is forced by the leaf spring 58.

To vary the differential of operation, that is, the temperature difference required to operate the thermostat from a closed position to an open position and vice versa, all that is necessary is the movement of the relatively fixed contact 35 either by means of a screw driver inserted into slot 36 or by means of a wrench which may be used on the hexagonal portion 38.

When it is desired to increase the differential of operation the magnet must be made to exert a greater force on the armature when the latter is in its closed position and this is accomplished by rotating the adjustable contact so that its top is more nearly in alignment with the top of the magnet thereby reducing the distance between the magnet and armature when the contacts are in engagement.

In order to decrease the differential of operation the contact 35 is moved in an opposite direction thereby to increase the space between the magnets and armature when the contacts are in a closed position. It is obvious that in this case the thermal responsive actuating element would have to exert a lesser force in order to open the contact against the force exerted by the magnet.

By having the relatively fixed contact 35 act as a stop for the armature 42 and having the resilient contact carrying element 44 biased against the outer extremity of the armature member, I have provided an arrangement whereby the distance that the contact 45 moves relative to armature 42 upon closure of the switch is constant for all adjustments of differential. Furthermore, the movable contact 45 is prevented from vibrating when the thermostat is in its open position and the contact is also opened with a "hammer blow" as clearly illustrated in Fig. 4. When the armature 42 starts to move it strikes the flexible member 44 with a "hammer blow".

As stated previously, the leaf spring 59 of the previously described figures may be replaced by a hairpin or substantially U-shaped spring as illustrated in Fig. 6. The bimetallic element 40 is securely fastened to the swingably mounted male hinge member 41 (only part of which is shown), and in this modification the outwardly extending tongue-like projection 58 is held in abutting relation with the vertical adjusting shaft by a substantially U-shaped spring having a pair of downwardly extending legs 71 and a horizontal connecting portion 72. The connecting portion 72 is in front of the projecting portion 58, as viewed in Fig. 6, and the legs 71 are in back of the projection and the male hinge member 41 and bimetallic member 40, the spring being slightly bent at 73 to provide a construction whereby it may be readily slipped into place. The spring is held in place and exerts a force on the swingably mounted unit tending to move the latter in such direction that the tongue 58 is held in abutting engagement with shaft 53 by reason of its resiliency and the fact that movement of the ends of the legs 71 is restrained. The legs are slightly bent as at 74 and the curved portion may extend into spaced apart depressions 75 formed in the base 11 if desired although this is not essential.

The assembly of the switch when utilizing the last described modification is slightly changed as the spring 71—72 may be assembled and mounted with the removably mounted unit comprising the male hinge member, bimetallic element, and the movable contact structure. This construction thus permits of a somewhat simpler assembly. The operation or adjustment of the switch will not be changed from that previously described.

Fig. 7 is a perspective view of a modified form of contact arrangement which may be used with

the thermostatic switch structure shown in Figs. 1, 2 and 3 if desired. In this modification the stationary or fixed contact 35' is adjustably mounted centrally between the poles of the permanent magnet 33 to avoid variation in the thermostat differential when the temperature setting is varied. The contact 35' is shown mounted upon the projection 76 extending from the middle portion of the adjustable arm 77 which may be formed of phosphor bronze or other suitable resilient material. The projection 79 extends from the lower part of the arm 77 and is fixedly secured at its end to the extension 30 of the contact prong 28 by means of the rivet 31. The projection 80 extends from the upper end of the arm 77 into engagement with the adjusting screw 36'. Thus the contact 35' may be moved forward or back of the position in which it is shown by adjusting the screw 36'. The resilience of the projection 79 insures that the projection 80 is biased into engagement with the end of the adjusting screw 36'.

As shown in Fig. 7 the movable contact 45' is carried upon a pin 81 which is riveted or otherwise secured to the spring 44' carried by the arm 42 which is attached to and operated by the thermostatic element 40. In this case the spring 44' may be made somewhat shorter than the spring 44 shown in Figs. 1, 2 and 3 so that it does not extent beyond the end of the arm 42. The contact mounting pin 81 passes through a hole 82 formed in the arm 42 of sufficient size to permit free movement of the pin 81.

The spring 44' is initially tensioned so that the contact 45' is normally biased away from the arm 42 in the direction to engage with the contact 35'. This insures a slight wiping engagement between the contacts 35' and 45' when the arm 42 is moved by the thermostatic element into the magnetic field of attraction of the permanent magnet 33 and spring 44' is flexed due to the slight upward movement of the contact 45' resulting from the flexing of spring 44'. After the movable contact 45' initially engages with the fixed contact 35' the movement of the arm 42 toward the poles of the magnet 33 can continue only until the portion of the arm 42 around the hole 82 engages with the back side of the contact 45'. Thereupon further movement of the arm 42 toward the magnet 33 is stopped. Thus the position to which the contact 35' is adjusted by operation of the screw 36' determines the limit of movement of arm 42 by magnet 33. In this way the thermostat differential or temperature variation required to open the contact 35' and 45' after closure thereof is determined. To increase the differential, the fixed contact 35' is adjusted to permit arm 42 to approach closer to the poles of the permanent magnet 33. To decrease the differential the contact 35' is adjusted in the opposite direction. The contact arrangement shown in Fig. 7 insures that the desired differential remains substantially constant irrespective of variation in the temperature setting of the actuating thermostatic element 40 effected by operation of the adjusting knob 26.

While I have shown particular embodiments of my invention, it will be understood, of course, that I do not wish to be limited thereto since many modifications may be made, and I, therefore, contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. A thermostat having a fixed contact, a movable contact, a thermostatic bar carrying said movable contact at one end thereof and provided with detachable pivot mounting means at the other end thereof, an adjustable stop limiting the rotation of said bar about said mounting means for determining the operating temperature of the thermostat and a spring for both controlling detachment of said pivot mounting means and maintaining said bar and adjustable stop in operative relationship.

2. In a thermostat the combination of a base member, a contact on said base, a movable contact, a thermostatic bar carrying said movable contact and provided with detachable pivot members for mounting the bar on said base, control means for varying the relative position of said pivot members to adjust the operating temperature of the thermostat, and a spring for maintaining said detachable pivot members in engagement and in operative relation with said control means.

3. In a thermostat, the combination including a base, a thermostatic bar, means including a pair of detachably interlocking members for pivotally mounting said bar on said base, one of said members being connected with the base and the other of said members being connected with said bar and provided with a projection, a control device adapted to engage said projection for imparting rotary movement to said bar, and means including a spring for maintaining said members in interlocking engagement and said control device and projection in operative relation.

4. In a thermostat, the combination of a base, a shaft rotatably mounted on the base and having an adjusting knob at one end thereof, a fixed contact mounted on said base at one side of said adjusting knob, a member movably mounted on said base in engagement with the other end of said shaft, a U-shaped bimetallic element mounted at one end on said member, and a contact carrying arm mounted on the other end of said bimetallic element and extending into opposing relationship with said fixed contact.

5. In a thermostat, the combination including a base, a U-shaped resilient bimetallic actuating element means including a substantially rigid member secured to one end of said resilient element and formed with a projection extending in a a direction across the legs of the U for rotatably mounting said element on said base with the legs thereof in substantially parallel relation with said base, an adjusting device mounted on said base to engage said projection, an arm secured to the other end of said element and extending in substantially parallel relation with said base, a movable contact carried at the end of said arm, and a fixed contact mounted on said base in operative relationship with said movable contact.

6. In a thermostat of the type having a rotatable mounting means carrying a thermostatic element whereby the position of the latter may be adjusted, the combination including a casing for said thermostat having an opening near the upper end of its front wall, a vertical shaft rotatably mounted within said casing for adjusting the position of the element, and an adjusting knob mounted on the upper end thereof and extending outside said casing through said opening, said knob being provided with indicia placed at an angle of approximately 45° from the horizontal

whereby they may be read readily when the thermostat is at any level below eye level.

7. In a thermostat the combination including a base member, a casing therefor having an opening near the upper end of its front wall, a thermostatic element, a rotatable mounting means for said element having a portion extending outwardly from said base, an adjusting shaft adapted to engage said portion rotatably mounted on said base, and an adjusting knob mounted at the upper extremity of said shaft and extending outside the casing through said opening, said knob being provided with indicia at an angle easily readable at a level substantially below eye level.

8. A portable thermostat of the magnetic snap action type readily detachable from a support having a pair of sockets including in combination a base member, a pair of metallic strips mounted on the front side thereof having terminal portions projecting through said base for insertion into said socket, one of said strips fixedly mounting a permanent magnet and adjustably mounting a contact.

9. In a thermostat of the magnetic snap action type readily detachable from a support having a pair of sockets, the combination including a base member, a pair of prongs mounted thereon and adapted to be inserted into said socket, one of said prongs comprising a strip of metal extending through the base and having a portion on the side opposite the prong mounting a magnet and a fixed contact.

10. A thermostat including in combinations a base member, a pair of prong terminals mounted thereon and extending therethrough, one of said terminals fixedly mounting a magnet and a contact, a hinge member mounted on said base, a second hinge member swingably and detachably mounted on said first hinge member, a thermostatic actuating element attached to said second hinge member, and a movable contact actuatable by said element into engagement with said first mentioned contact.

11. A thermostat including in combination a base member, a pair of prong terminals mounted thereon and extending therethrough, one of said terminals fixedly mounting a contact and a magnet, a hinge member mounted on said base, a cooperating hinge member swingably and detachably mounted on said first hinged member, a thermostatic actuating element attached to said cooperating member, an armature and movable contact actuatable by said element into the field of said magnet and into engagement with said fixed contact, spring means engaging said cooperating hinge member and said base for maintaining said hinge members in operative relationship, and an electrical connection from said second terminal to the thermostatic element.

12. A thermostat including in combination a base member, a pair of prong terminals mounted thereon and extending therethrough, one of said terminals fixedly mounting a contact and a magnet, a hinge member mounted on said base, a cooperating hinge member swingably and detachably mounted on said first hinged member, a thermostatic actuating element attached to said cooperating member, an armature and movable contact actuable by said element into the field of said magnet and into engagement with said fixed contact, adjusting means carried by said base member and adapted to engage a portion of said cooperating hinge member for rotating the latter, spring means engaging said base for maintaining said hinge members in operative relation and the cooperating member in engagement with the adjusting means, and an electrical connection from the second terminal to the thermostatic element.

13. For use with a thermal responsive means, an adjustable preheat coil adapted to be fastened to a screw terminal and provided with a plurality of convolutions having a radius of curvature slightly larger than the radius of the screw whereby the coil may be attached readily to the terminal at any selected one of said convolutions.

14. A thermostat of the preheat type having a thermal responsive element and a preheat coil preformed with a plurality of convolutions providing a plurality of points at which the coil may be attached readily in circuit with the thermal responsive element.

15. In a thermostat of the type provided with an auxiliary source of heat the combination including a substantially U-shaped bimetallic contact actuating element having pivotal mounting means at one end thereof including a fixed pivot member extending between the legs of said U-shaped bimetallic element and an auxiliary source of heat consisting of a substantially U-shaped resistor extending downwardly between the legs of the U-shaped bimetallic element and having one end thereof mounted upon said fixed pivot member.

16. In a thermostat of the type provided with an auxiliary source of heat, the combination including a substantially U-shaped bimetallic contact actuating element and an auxiliary source of heat consisting of a substantially U-shaped resistor extending downwardly between the legs of the U-shaped bimetallic element, one end of said resistor being provided with a plurality of equally spaced convolutions for indicating heating capacity.

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