Jan. 25, 1949. J. L. SCHWARTZ 2,459,968

ADJUSTABLE THERMOSTAT

Filed Aug. 21, 1945

3 Sheets-Sheet 1

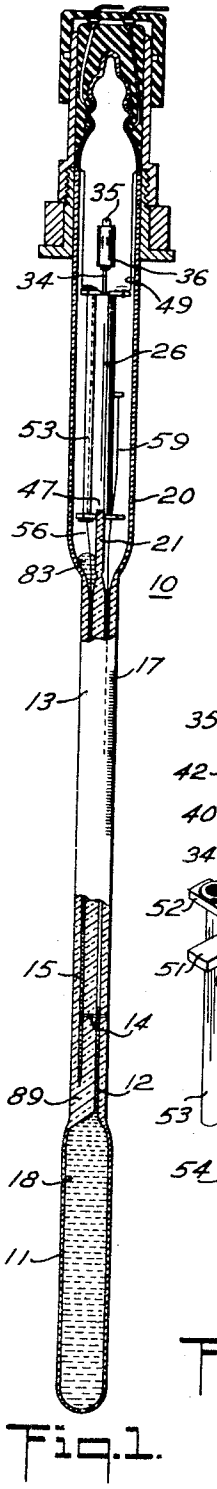

Fig. 1.

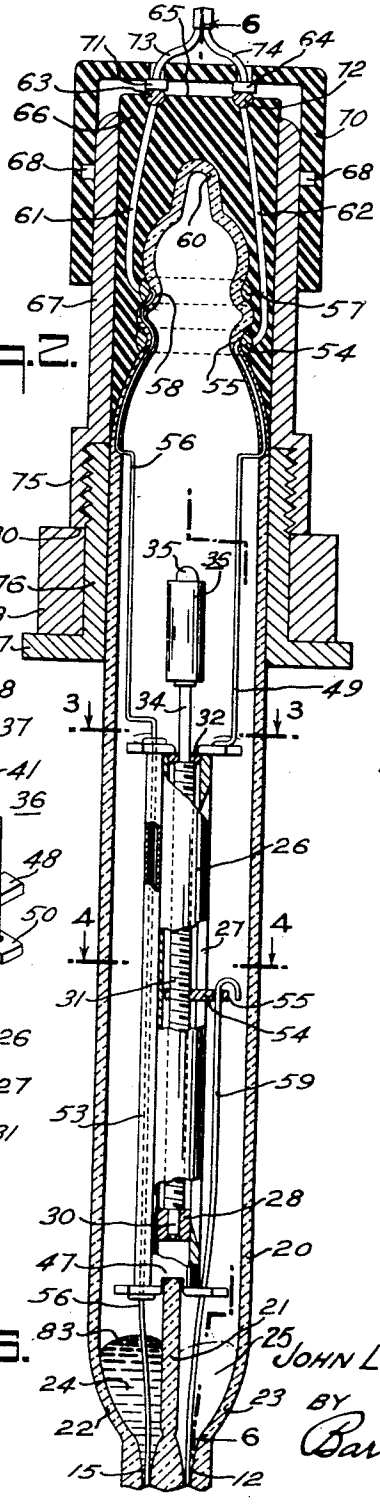

Fig. 2.

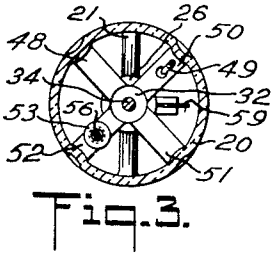

Fig. 3.

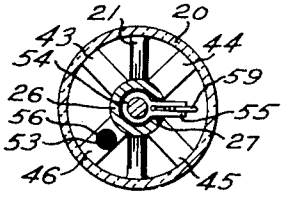

Fig. 4.

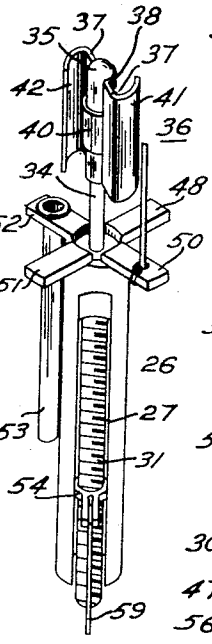

Fig. 5.

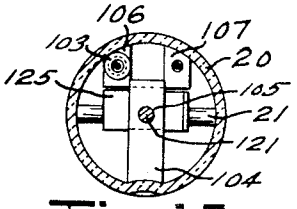

Fig. 10.

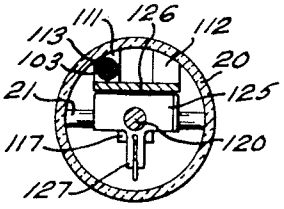

Fig. 11.

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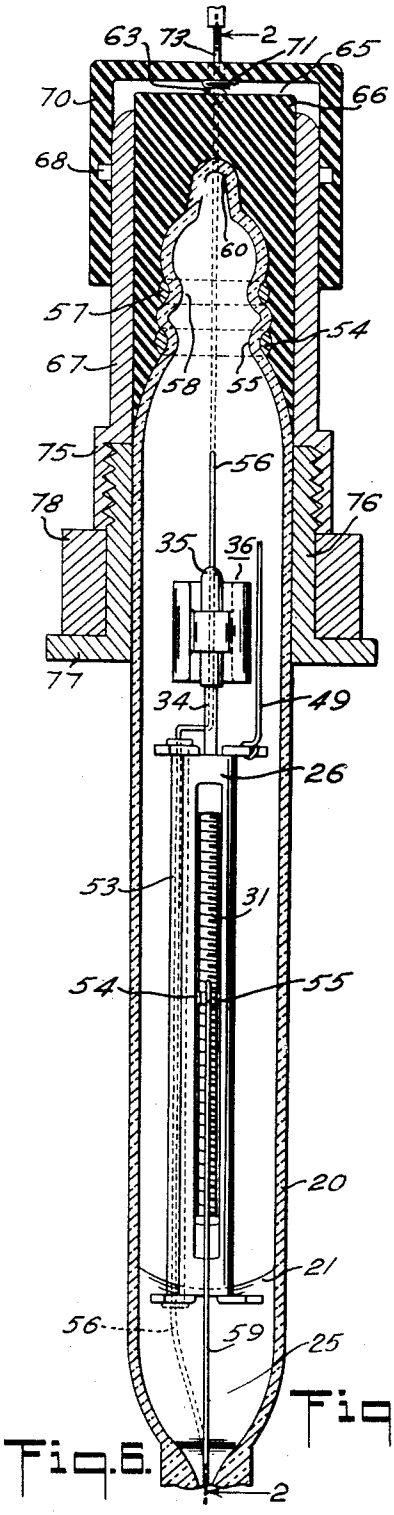


Fig. 6.

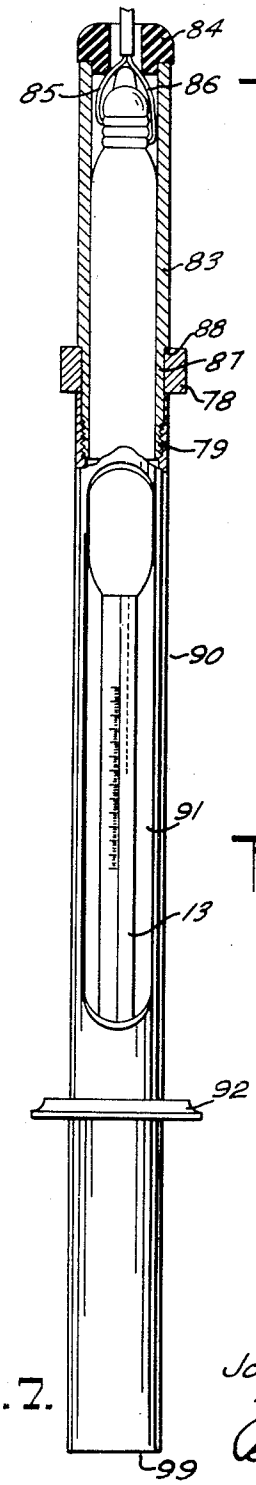


Fig. 7.

Fig. 8.

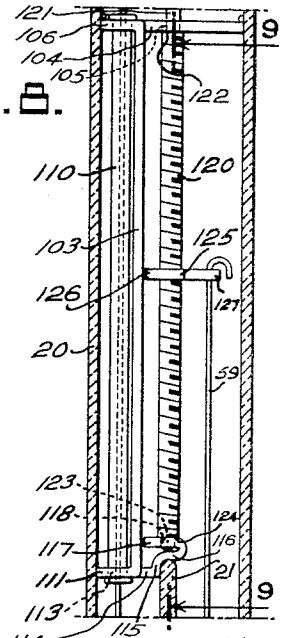
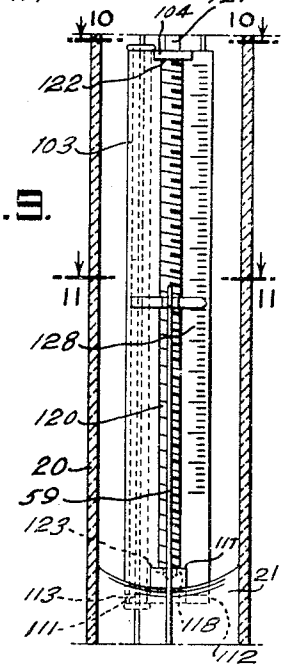


Fig. 9.



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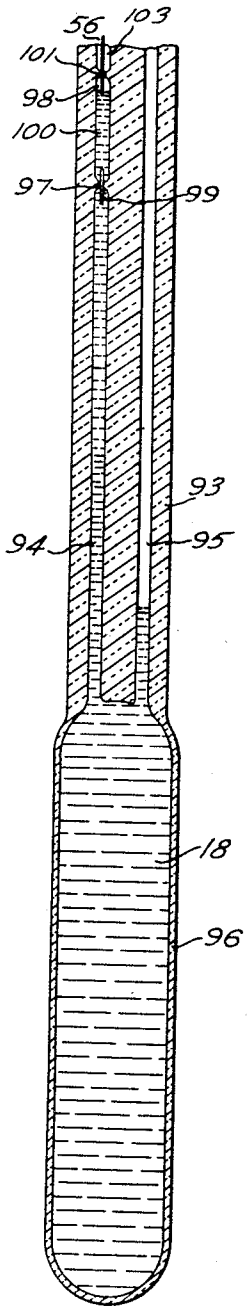

Fig. 12.

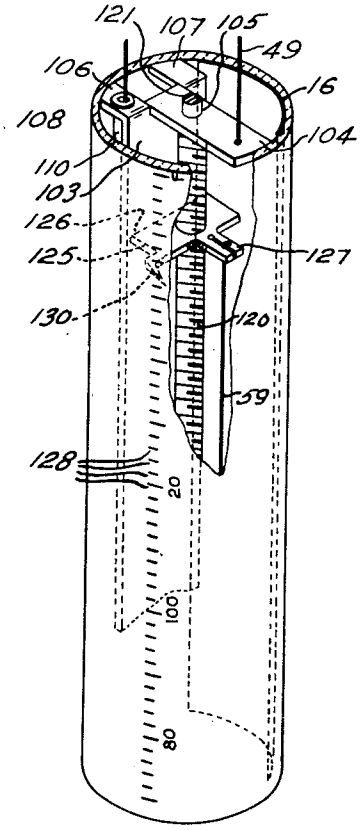

Fig. 13.

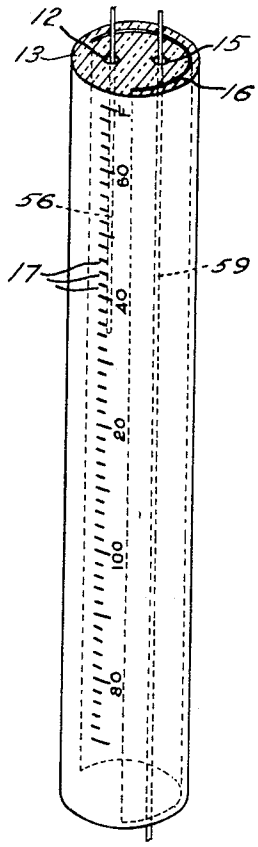

Fig. 14.

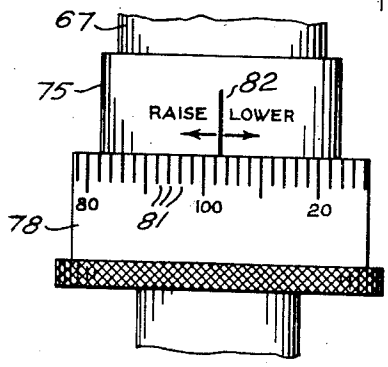

Fig. 15.

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UNITED STATES PATENT OFFICE

2,459,968

ADJUSTABLE THERMOSTAT

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Application August 21, 1945, Serial No. 611,819

26 Claims. (Cl. 200—141)

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This invention relates to adjustable thermostats, and particularly to devices controlling the closing of an electric circuit as a result of the expansion of mercury in a glass bulb, at a temperature which is predeterminedly variable.

In the prior art of such thermostats many efforts have been made to provide an adjustably positioned electrode moving in a packing gland or the like, but as these are never vacuum-tight, the devices are purely theoretical and for all practical considerations are inoperative. In the relatively few devices in which the operating parts are enclosed in a vacuum-tight disposition to the mercury column, the glass blowing problems connected with the manufacture have been so complex as to militate against commercial production, and moreover the operation of the adjustable electrode has been in many cases uncertain, subject to change under conditions of vibration, and of very limited range. Additionally, the marking of the devices for the point of desired temperature has been difficult and in many cases inaccurate. In many instances glass rupturing amalgamation of electrode and mercury has been accelerated by the necessary location of the electrodes in proximity to the bulb and exposure thereof to the heat of the bath incident upon the bulb. Finally, such prior devices have been cumbersome, possessed of strains which are incapable of relief, and are, therefore, delicate and incapable of use where frangibility is a hazard.

It is among the objects of this invention: to provide improvements in the art of adjustable thermostats of the thermometer type; to obviate the disadvantages of the prior art adjustable thermostats; to provide a thermometer type adjustable thermostat in which the working elements are preformed separately from the glass in which they are ultimately enclosed prior to evacuation of the glass portion; to provide an adjustable thermostat with a double bore column, in one bore of which the adjustable or working electrode is movable to varying contact with mercury movable in the bore from the bulb and the other bore of which receives a common electrode and contains mercury contacting same and which forms the common return; to provide an adjustable thermostat of the thermometer type in which the column leading from the mercury bulb has no encasing shell and which therefore avoids the thermal lag attaching to prior art devices; to provide an adjustable thermostat in which fractional degree adjustments can be obtained; to provide a micrometric adjustment for the electrode of an adjustable thermostat; to provide an adjustable thermostat of the thermometer type which minimizes and simplifies glass blowing techniques; to provide an adjustable thermostat with a column having a double

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bore leading to an enlargement in which there is a partition to form centering means for the adjustable and fixed electrode elements, and also, when required, which forms a pocket for a reserve supply of mercury to be used when changes of setting are to be made; to provide a thermometer type of adjustable thermostat by which calibration is simplified and rendered more accurate than has previously been thought possible; to provide an adjustable thermostat of extreme sensitivity; to provide an adjustable thermostat so arranged that the common electrode is remote from the mercury bulb to minimize the effects of the hot bath thereon; to provide an adjustable thermostat in which amalgamation of electrodes is minimized; and other objects and advantages will become more apparent as the description proceeds.

In the accompanying drawings forming part of this description:

Fig. 1 represents a transverse vertical section through one form of adjustable thermostat according to the invention, partially in elevation.

Fig. 2 represents a fragmentary enlarged section of the upper end of the thermostat of Fig. 1, taken on line 2—2 of Fig. 6.

Figs. 3 and 4 represent respectively horizontal sections through the thermostat taken on lines 3—3 and 4—4 respectively of Fig. 2.

Fig. 5 represents a fragmentary perspective of the preformed adjustment device of the invention according to the disclosure of Fig. 2.

Fig. 6 represents a fragmentary vertical section partially in elevation of the upper end of an adjustable thermostat taken on line 6—6 of Fig. 2.

Fig. 7 represents a side elevation, partially in section, of an assembled adjustable thermostat in a protective housing according to one form thereof.

Fig. 8 represents a fragmentary enlarged vertical section partially in elevation of a modified form of adjustment mechanism.

Fig. 9 represents a fragmentary enlarged transverse vertical section of the modified form of adjustment mechanism of Fig. 8, taken on line 9—9 thereof.

Figs. 10 and 11 respectively represent transverse horizontal sections of the modified form of adjustment taken on lines 10—10 and 11—11 respectively, of Fig. 9.

Fig. 12 represents a vertical transverse section through the double bore column and the mercury bulb, showing a modified form of common electrode disposition remote from the vicinity of the bulb to minimize amalgamation thereof with the mercury conductor.

Fig. 13 represents a fragmentary perspective partially in section of the adjustment according

to the modified form in the glass housing thereof and showing calibrations on the housing.

Fig. 14 represents a fragmentary enlarged perspective of the double bore column of Fig. 12, showing calibrations on the column.

Fig. 15 represents a fragmentary elevation of the annular magnet used to actuate the adjusting mechanism of either form of thermostat disclosed, showing the calibrations for same relative to a datum line on the fragmentary elevation of the stationary housing.

In carrying out the invention in a preferred embodiment, an arrangement of threaded shank and traveling nut is provided and a working electrode is carried and adjusted in setting by the nut, and this is disposed in a glass housing. An armature is provided internally of the housing for actuating the shaft in accordance with the rotations of an externally mounted annular magnet, and a double bore glass column is provided, one bore of which communicates with the bulb of mercury and the glass housing and the movable or working electrode travels in this bore to make and break contact with the mercury in the bore. The other bore forms a receiver for a common electrode as a common return and is in contact with the mercury bulb either directly or indirectly through the second bore, or through a cross connection to the first bore.

Referring to Figs. 1, 2, 3, 4, 5, 6 and 7, the thermostat 10, at the lower end, has a mercury bulb 11 in direct communication with a working bore 12 of a double bored column 13. In this embodiment of the invention a short transverse embedded wire connector 14 is fused into the glass of the column 13, and extends from the mercury in the bore 12 to the mercury in the common bore 15 of the double bore column. As shown in Fig. 14 in detail, the column 13 is preferably formed with an arcuate shield of white, as at 16 embedded and fused into or on the column itself and which is of such arcuate length and disposition as to shield the common bore 15 from view of the observer, while permitting the working bore 12 to be observed from a proper angle outside of the column. In one form of calibration of the instrument, the column 13 itself is graduated externally in lines 17 viewable against the background of the working bore, and of the electrode working therein, to be described. It will be observed that the mercury bulb 11 containing the mercury 18, and the double bored column 13 leading to it, are not housed by any additional glass housing or other shielding element so that when immersed in a hot bath the reactions of the expanding mercury in the bulb and column bore 12 are fast and free from inertial lag.

At the upper end of the column 13 a single slightly enlarged glass tube or housing 20 is fused, which is of such internal diameter and so arranged as to receive the metallic adjusting and supporting mechanism to be described. The upper end of the enlarged compartment defined by housing tube 20 is initially left open to receive the inserted assembly, to be described, and is arranged to be subsequently evacuated and the upper end fused shut in the completion of the instrument, as will be described. The merely slightly enlarged housing tube 20 and the upper end of the column 13 are provided with a median glass partition 21 extending diametrically completely across the lower end of the tube 20, and fused into the end of column 13 and into the wall of housing 20 to form with the convergent

walls 22 and 23 of the housing 20 generally funnel shaped pockets, respectively 24 and 25, leading respectively into the upper ends of the respective common bore 15 and the working bore 12 of the column 13. It will be seen that the funnel-like pockets 24 and 25 are preferably flattened on one side where they are formed by the sides of the relatively flat partition, and are rounded in the remainder of their peripheries. Pocket 24 forms a reservoir for receiving and storing mercury as a reservoir from which to restore mercury to the working bore, while pocket 25, in addition to forming a funnel for adding mercury to the working bore, also serves as a relief for mercury that may be extruded by excess heat and consequent expansion of the mercury from the working bore 12. Pocket 24 is used as a reservoir, as noted, from which the mercury can be moved by tilting the instrument to cause it to leave the pocket 24 to run into the chamber formed by the housing tube 20, after which the device can be rotated while tilted to place the pocket 25 downwardly, then the device can be restored to a vertical position and the mercury initially in the reservoir 24 will be disposed in the pocket funnel device 25. Excess mercury from bore 15, on the other hand, can be moved into the storage reservoir 24 by a reversal of this procedure. The provision of the double bore tube facilitates the formation of the partition 21 between the bores, and insures the exact symmetrical centering of the latter. As the partition also serves as a supporting and centering device for the electrode adjustment mechanism, this symmetrical disposition, while not essential, is preferred, and is of importance.

In the form of adjusting mechanism shown in the recited figures, a tube 26, formed, for instance, of stainless steel, or the like, is longitudinally slotted as at 27, and at the lower end is provided with an inset thrust bearing 28, into the opening of which the bearing stud element 30 of a threaded shank or shaft 31 is relatively dropped. The shaft is held against vertical retraction in the tube by an upper bearing member 32, and the shank is rotatable in the bearings in fixed concentric disposition in the tube. At its upper end the threaded shank 31 is continued beyond the upper bearing 32, in a shaft 34 upon the subsequently attached preferably enlarged head 35 of which the winged armature 36 is anchored. This latter may be of any desired construction but for cheapness and efficiency preferably comprises a single piece of sheet material of ferrous nature, so as to provide a central relatively planar portion 37 extending on each side of a central grooved portion 38 having a complemental gripping portion 40 embracing the enlarged head so that the planar portion is diametrical of the enlarged head, with oppositely directed generally arcuate wing elements 41 and 42 at the outer ends of planar portion 37. The armature is arranged to turn with a sufficient degree of clearance relative to the inner surface of the housing tube 20, while still being within the range of the magnetic flux of the magnet to be described, when the assembly is properly disposed in the glass housing 20. To secure such accurate disposition, the lower end of the tube 26 has four radially extending arms secured to the tube, and preferably comprising integral prolongations thereof, respectively designated as 43, 44, 45 and 46, and of such length as to center the lower end of the tube in the glass tube 20. Preferably, the lower end of the tube 26 has a transverse slot between pairs of arms, as at 47, arranged to receive

the upper end of the glass partition 21. The upper end of the metal tube 26 has a similar series of radial arms respectively designated as 48, 50, 51 and 52, and arranged in longitudinal axial alignment respectively with the lower arms.

Between a complemental pair of arms, such, for instance, as lower arm 46 and upper arm 52, there extends a permanently open glass tube 53 of small bore fused over laterally at the ends to anchor it in the arms, and which serves as an insulating guide for a common electrode, to be described. Upper arm 50 serves as a terminal for the grounding of the metal tube assembly by a lead 49 in electrical contact with the working electrode, to be described.

A traveling nut 54 is provided, having a lateral extension 55, guided and held against rotation in the slot 27 of the tube 26, threaded upon the shaft 31 and arranged to travel vertically as the shaft is rotated. The outer end of the extension 55 carries the elongated thin fairly stiff metallic electrode 59, which in final position extends downwardly between the lower arms 44 and 45, through the funnel-like pocket 25 and into the bore 12 in which it is vertically adjustable.

The assembly as described is dropped into the open upper end of the glass tube 20, guided by the respective arms of the metal tube, until slot 47 thereof seats upon the glass partition 21. At this juncture the glass of housing 20 just above the respective upper arms 43 to 52 respectively preferably is softened by heat, and a slight indentation is made therein, forming a small abutment of glass in the housing wall overlying and preventing axial movement of the upper arms and therefore of fixed portions of the entire unit. The common ground wire or connector 49 extending out of the top of the unit is preferably fused longitudinally into the wall of housing 20, for insulating same, and is then brought through and fused into sealing disposition in the glass wall adjacent the upper end of the glass housing 20, and is connected externally to a conducting annulus 54 disposed in a groove 55 toward the end of the glass housing. A common electrode 56 comprising a long relatively stiff thin metallic wire, is threaded through the glass insulating guide 53 and through the pocket 24 beside the partition 21 to enter into the common bore 15, where it remains permanently in electrical contact with mercury in said common bore, and in the form shown in the recited figures, through the lower transverse connection 14, with the mercury 18 in bore 12. The upper end of the common electrode 56 is then lead to and fused into the upper end of the glass tube 20, for insulating same and passes through the wall of the housing in sealed relation and is connected to the external annular conductor 57 received in another groove 58 formed adjacent to the glass tube end. Then the entire chamber is evacuated and the end of the tube sealed off under vacuum, as by the tip 60. Alternatively, the tube may be evacuated of air and then filled with an inert gas such as hydrogen or nitrogen under pressure, to minimize oxidation of the mercury.

In the preferred embodiments of the invention, the respective annular connectors 54 and 57 engaged in their respective grooves, are in electrical engagement with short connectors respectively 61 and 62 leading to terminals 63 and 64 on the end surface 65 of an insulating plastic mass 66 entirely surrounding the short connectors and the constricted end of the glass tube 20, and anchoring the whole in a guarding housing sleeve, preferably of metal, as 67. The housing, formed of brass or the like, terminates at the upper end just short of the upper end 65 of plastic mass 66, and is provided with diametrically oppositely disposed studs 68, for bayonet-joint coupling to a contact-making coupling member 70, by which the unit can be supported. The latter has contact elements 71 and 72 forming terminals for connectors 73 and 74 to the relay or other circuit operated by the thermostat. The metal sleeve 67 forming an effectively integral part of the thermostat unit in one form is rather short and at the lower end terminates in an internally threaded enlargement 75 spaced from the glass tube 20. A short externally threaded sleeve 76 of a diameter closely hugging the glass tube 20 is threaded into the enlargement and has an annular lower flange 77 forming a seat for an annular magnet 78. The flange is preferably knurled on its outer periphery to facilitate manual tightening, to engage the magnet between the flange and the planar lower surface 80 of the enlargement 75, to hold the magnet in a given position of angular adjustment. The length of the assembly of housing sleeves and magnet is such as to dispose the armature 36 of the adjusting unit axially so as to expose it to the magnetic flux of the magnet. A slight loosening of the lower threaded sleeve 76 enables manual angular adjusting of the magnet to rotate the armature to move the working electrode vertically in the working bore, to vary the setting at which the expanding mercury establishes contact. After a new setting has been made, the magnet is held stationary while the threaded sleeve is turned to tighten upon the magnet and hold it against undesired change of angular position.

As is known of such magnets, it is possible to have several different polarities in its peripheral extent, and the magnetic flux is of such strength that the armature 36 is in effect practically geared to the magnet and responds with an angular change of position to the minutest change of angular position of the magnet. By having a suitable fine pitch on the threaded shank 31 and the complemental traveling nut 54, an extremely minute change of vertical positioning of the working electrode is available, which can represent a small fraction of a degree, and this can be predetermined and controlled in a satisfactory manner. Illustratively, as shown in Fig. 15, the annular magnet is provided with a series of vertically extending calibrations, as at 81, at the upper edge of the magnet, passing successively under a vertical datum line 82, inscribed on the stationary enlargement 75. This convenience is facilitated by applying legends indicating the direction of relative movement of the magnet to secure a desired direction of vertical adjustment of the working electrode 59. Illustratively, small arrows indicate the direction of movement to secure relative raising or lowering of the working electrode, and the legends "raise" and "lower" are applied to the stationary part on the respective sides of the datum line 82. By such predetermined relationship micrometric adjustments of the working electrode are secured.

In the form of thermostat just described, the common bore 15, is provided with a block 89 to keep it out of contact with the mercury 18 in the bulb 11, and the bore is filled with mercury extending into the pocket 24 at the terminus of the common bore 15, and forming a globule of reserve mercury 83. The entire common bore is

filled with a continuation of the mercury globule down below the cross connection 14 and against the block 89. The common electrode extends well down into the mercury in the common bore. The calibrations 17 applied to the exterior of the column may be applied after the relation of the working electrode to the column of mercury in the working bore has been established, and in this case it may not be necessary to provide any reservoir globule of mercury in the pocket 24. Usually, however, the calibrations will be applied and subsequently interpreted in the light of actual functioning of the device.

The instrument will be suitably supported and connected through the couplings shown, to the relay or other instruments which are to be controlled, the magnet will be turned on its support to turn the armature and the threaded shaft in such direction as to dispose the free lower end of the working electrode opposite the proper calibration of the series 17 for the temperature at which the circuit is to be closed. The instrument in use is then placed in the bath or other heated medium and exposed to the varying heat thereof. When the predetermined heat is attained, through expansion of the mercury 18 in the bulb 11, the ascending column of mercury 18 in the working bore 12 will touch the free end of the working electrode and a circuit will be closed or completed from the wire 73, contact 71, terminal 63, short connector 61, through the common electrode 56, through the mercury 83 in the common bore, through the cross connection 14 into the mercury column in the working bore 12, through the adjustable electrode wire 59, into the metallic assembly of the nut, shaft, metal tube and grounding wire 49, and through short connection 57 to terminal 64, contact 72 and wire 74. The remainder of the electrical network is of no particular moment in the instant invention, but the closing of the circuit will perform such tasks as may be necessary, whether to actuate a relay, modify an existing electronic system, or the like.

If actual tests indicate that the level of the mercury 80 in the working bore is too high for the actual temperature for which the device has been calibrated and by which it is set, the device may be heated to a point of forcing some mercury outwardly into the pocket 25, after which the instrument is inverted, and turned to cause the globule to pass on the other side of the partition to storage in the pocket 24, upon restoring the vertical position of the instrument. Conversely, if the amount of mercury is low in the working bore, additional mercury can be caused to enter this bore from the storage globule, by reversing the inclination and rotation, and heating the bulb until the mercury then placed in the pocket 25 joins the column to form a solid column in the working bore 12 as it contracts.

It is to be observed that the instrument as formed, is slim, and has no supplemental enclosing tubes of glass surrounding other tubes or columns, as for protecting a common electrode entering the bulb 11, as in prior devices, and that extremely fine and delicate adjustments can be made for the circuit controlling temperatures.

Applicant has discovered that under certain conditions an amalgamation of the mercury with a connector wire or electrode occurs, which may ultimately be disruptive of the glass in which the wire is fused. Such a condition may occur when the embedded wire is in more or less constant contact with mercury at such elevated temperatures that volatilization of the mercury occurs.

Such a situation may occur, for instance, if the lower end of the instrument is inserted too deeply into the bath so that the latter surrounds the column 13 above the cross connection 14 of the device so far described. This may cause a gradual increase of thickness of the cross connection 14 from amalgamation with the mercury in the common bore, or from the working bore, which in due course, by a sort of creeping action along the cross connection sets up, internal strains by the enlarging cross connection, and rupture and destruction of the instrument may occur. Of course, in the normal proper use of the instrument, this hazard does not become effective, but it may be difficult to insure proper use.

As a modification that may well be the preferred form of the invention, to minimize the chances of the previously discussed undue amalgamation, the structure shown in Fig. 12 is provided. In this form of device a double-bored column 92 is provided in which both the common bore 94 and the working bore 95 are in constant communication with the interior of the bulb 96. The common bore 94 extends almost to the point of debouchment into the enlargement formed by the housing tube 20, beside the partition 21, where it is sealed transversely as at 97. The mercury 18 extends permanently from the bulb up into the common bore 94 to the transverse abutment 97 despite fluctuations in volume of the mercury in the bulb 96. The column 92 contains a short pocket 98 in axial alignment with the common bore 94 on the other side of the abutment 97, in which a globule of mercury 100 is disposed and permanently held and the upper end of the pocket 98, is provided with a transverse abutment 101 in which there is an aperture 102 to admit the downwardly pushed common electrode 56, extending through the opening 102 into the mercury in pocket 98 after passing through the relatively short upper bore 103 leading from the housing 20 in axial alignment with the pocket 98 and the common bore 94. A short wire 99 only long enough to establish a good electrical contact between the mercury in the common bore 94 and the mercury 100 in the pocket 98, is fused into the partition of abutment 97. The mercury 100 is preferably not of such volume as to completely fill the short bore 98, but is of such depth as to establish good electrical contact with the end of the common electrode 56 when the latter has been pushed a suitable distance into the bore 98.

It will be observed that with this modified form the circuit is from outside of the instrument, through the common electrode 56, the mercury 100 in pocket 98, the wire 99, and the mercury 19 in the common bore 94 and in the bulb 96, through the mercury in the working bore 95, and through the working electrode 59, and through the connections already described, out of the instrument. Note that the wire 99 is well toward the upper end of the instrument well away from the direct or radiant heat of the bath and is therefore so disposed as to be relatively immune to the amalgamation that might attach to its disposition close to the bulb.

As a further protection for the instrument either in the form just described or in the modified form to be described, a metallic shield and guard may be provided as shown in Fig. 7. In this form, illustratively, the upper metallic member comprises a short sleeve 93 closed at the

upper end by an insulating apertured plug 84 through which the lead wires for the instrument extend, as at 85 and 86 in the modified form of the upper end of the instrument shown, and the lower end is provided with a reduced portion 87 forming a downwardly presenting thrust shoulder 88, and upon which the annular magnet 78 is rotatably mounted. The sleeve 83 has an externally threaded portion 79 at its lower end below the reduced portion 87, and to this is threaded a longitudinally slotted cylindrical tube 90 in which the slot 91 forms a sight window for the double bore column 13. The protecting tube 90 is open at the lower end at 97 to enable the bath to enter the tube 90 to incidence upon the bulb 11, and preferably the tube 90 carries the anchored supporting flange 92 by which the instrument is held in predeterminedly positioned vertical disposition in the bath.

It will be seen that within the broad purview of the invention, of entirely preformed actuating means insertable in the glass assembly, other forms of actuating devices and assemblies can be used. One such modified form is illustrated in Figs. 8, 9, 10, 11 and 13. In this form of the invention, in place of the concentrically disposed slotted tube of the previous forms, an eccentrically disposed backing plate is provided as at 103 and which at the upper end has angularly divergent, preferably integral, arms, comprising a long arm 104 having an aperture 105, and a pair of spaced short arms respectively 106 and 107, the ends of which are preferably curved to conform to the interior of the slightly enlarged glass tube housing 20. In this connection, it is to be understood that the glass structure is the same in both types of thermostats, except possibly for graduations, and the same reference characters attach to like parts. Similarly the arms of the previously described form of actuating assembly will also preferably be curved to fit the housing tube 20. The short arm 106 of the instant form is apertured as at 108 and a short glass tube 110 as an insulating guide has one end fused over outwardly to anchor the tube in the arm 106. The outer ends of the arms 107 and 106 in one direction and of the long arm 104 in a diametrically opposite direction, have such spacing as just to conform to the interior circumference of the glass tube 20. At the lower end of the plate 103 there are a pair of spaced angularly divergent short arms, respectively 111 and 112, in alignment respectively, with the respective upper short arms 106 and 107, and arm 11 has an aperture 113 in which the lower end of the guiding insulating glass tube 110 is received and fused to anchored relation. The lower end of plate 103 has an angularly bent third arm, aligned with the upper long arm 104, and comprising a short member 114 in a plane above the lower short arms 111 and 112, bent upwardly as at 115, to abut against the side of the median partition 21, and member 114 terminates in a short transverse member 116 reentrantly bent upon itself as at 117. The reentrant portion 117 is apertured as at 118 and forms a vertical abutment to rest upon the top of the partition 21 to support the plate assembly just described. It will be understood that the short member 114 is of proper length between the vertical wall portion 115 and the free outer ends of the short arms 111 and 112 as to fit snugly between the partition and the inner surface of the glass tube 20 to anchor the plate. If desired, the proportions of the arms can be arranged so as to abut the plate itself laterally against the partition.

A threaded shaft 120 is provided having a reduced upper end 121 insertable though the aperture 105 in the upper arm 104 and forming a shoulder 122 for engagement beneath the said arm when inserted from below and at the lower end the shank is also reduced into a bearing extension 123 insertable through the aperture 118 in the upper bent member 117, and forming a shoulder 124 engaging the upper surface of member 117. The threaded shank is thus disposed concentrically and symmetrically in the glass housing. A traveling nut 125 is provided having a flattened edge surface at 126 arranged for substantially parallel juxtapositioning relative to the flat plate 103 to prevent the nut from turning with the shaft. The nut is provided with an angular projection 127 which carries the working electrode 59, in the same manner as before with the earlier figures. In assembling the threaded shank and the backing and supporting plate, the lower bent arm with the reentrant terminal is initially bent downwardly to enable the shank carrying the nut to be inserted from below into the upper arm, after which the lower arm is bent back substantially to the position indicated in Fig. 8, and the lower terminal is properly placed in the aperture to receive it, and the assembly is complete. If desired, and the flat backing plate conduces toward it, suitable graduations, as 128, are inscribed on the backing plate in a vertical column to which an edge of the traveling nut is juxtaposed, so that the setting of the instrument for the predetermined operating temperature can be read directly against the backing plate. The assembled plate and its members is inserted axially into the end of the relatively enlarged tube 20 and rests upon the partition 21. Then after suitably softening the glass adjacent to and over at least one of the upper arms 106 and 107, and 104, small indentations are made in the glass to anchor the metallic assembly in place, and the remainder of the closing steps are taken as recited of the earlier figures. The upper end of the reduced shank portion of the threaded shaft is supplied with the armature, as in the other figures and the arm 104 is in contact with the short connection 49, and the operation of the device will be clear.

A third point of application of the calibrations is upon the external surface of the glass tube 20, which is advantageous, as the calibrations can be applied, as can those identified as 17 in the earlier figures, after the instrument has been completed and the actual settings for the instrument can be determined by its performance. To utilize these external calibrations, a pointer 130 is formed on the traveling nut and juxtaposed to the interior of the glass tube 20. If the pointer is brightly colored, as by being painted red, or the like, it is perfectly easy to read the setting of the traveling nut, and therefore the operative position of the lower end of the working electrode 59, relative to the calibrations 128.

The simplicity, economy and accuracy of the instrument will be clear.

Having thus described my invention, I claim:

1. An adjustable thermostat assembly of glass which comprises a double bored column of glass, a bulb on one end of the column in communication with at least one of the bores therein, a hollow glass housing on and merging axially into the other end of the column and in direct communication with both bores of the column sub-

stantially at the mergence of the housing and the column, mercury in the bulb and in both bores, the mercury in the bores being electrically connected, said bores being arranged respectively to receive movable and stationary electrodes to complete a circuit through the thermostat.

2. An adjustable thermostat assembly of glass which comprises a double bored column of glass, a bulb on one end of the column in communication with at least one of the bores therein, a glass housing on the other end of the column in communication with both bores of the column, and a partition fused to the end of the column between the bores and to the interior of the housing to define spaced pockets communicating with the respective bores of the column mercury in both bores and in said bulb, the mercury in said bores being electrically inter-connected remote from the housing and said pockets and bores being arranged to receive respectively a fixed electrode in permanent contact with the mercury in one bore, and a movable electrode arranged for make and break contact with the mercury in the other bore to control a circuit through the thermostat.

3. An adjustable thermostat assembly of glass which comprises a double bored column of glass, a bulb on one end of the column in communication with at least one of the bores therein, a glass housing on the other end of the column in communication with both bores of the column, and a partition fused to the end of the column between the bores and to the interior of the housing to define spaced pockets communicating with the respective bores of the column, said housing tapering toward the end of the column to taper said pockets and impart a guiding funnel-like characteristic thereto mercury in both bores and in said bulb, the mercury in said bores being electrically interconnected remote from the housing and said pockets and bores being arranged to receive respectively a fixed electrode in permanent contact with the mercury in one bore, and a movable electrode arranged for make and break contact with the mercury in the other bore to control a circuit through the thermostat, one of said pockets being a reservoir in which to store excess mercury on one side of the partition.

4. An adjustable thermostat assembly of glass which comprises a double bored column of glass, a bulb on one end of the column in communication with at least one of the bores therein, a glass housing on the other end of the column in communication with both bores of the column, a metallic actuating assembly mounted in the housing, comprising a supporting member, a threaded shaft journalled on the member, a threaded nut axially movable on the threaded shaft, an electrode wire carried by the nut and having a free end extending into one of the bores of said column, means including mercury in the other of said bores establishing a common electrical ground, electrode connections for leading a power source to the common ground and to the actuating assembly, and means for establishing electrical connection between the working and common electrode.

5. An adjustable thermostat assembly of glass which comprises a double bored column of glass, a bulb on one end of the column in communication with at least one of the bores therein, a glass housing on the other end of the column in communication with both bores of the column a partition fused to the end of the column between the bores and to the interior of the housing to define spaced pockets communicating with the respective bores of the column, a metallic actuating assembly mounted on said partition and held against unitary movement axially of said housing, a metallic electrode connected operatively with the actuating assembly and extending into one of said bores for relative movement therein, a grounding electrode extending from the housing into the other of said bores in said column, mercury in both bores, and means forming an electrical connection between the mercury in the bores to close the electrical path between the electrodes.

6. An adjustable thermostat assembly of glass which comprises a double bored column of glass, a bulb on one end of the column in communication with at least one of the bores therein, a glass housing on the other end of the column in communication with both bores of the column a partition fused to the end of the column between the bores and to the interior of the housing to define spaced pockets communicating witht the respective bores of the column, a metallic actuating assembly mounted on said partition and held against unitary movement axially of said housing, said metallic assembly comprising a preformed unit of a support, a threaded shaft journalled on the support, a nut mounted on the shaft and held against rotation, an armature on the shaft in the housing, a working electrode carried at one end by said nut and extending into one of the bores in said column, and an external magnetic device juxtaposed to said armature to change the angular position of the latter and turn the shaft to control axial nut movement, an electrical connection between the bores, and an electrode extending from within the housing into the other of said bores to complete a circuit through the thermostat.

7. An adjustable thermostat comprising an electrode actuating unit including a threaded unit having an axis and the rotation of which unit controls the disposition of an electrode, an armature for the unit comprising a sheet metal element having wings spaced from the axis of the threaded unit.

8. An adjustable thermostat comprising an electrode actuating unit including a threaded unit having an axis and the rotation of which unit controls the disposition of an electrode, an armature for the unit comprising a sheet metal element having wings spaced from the axis of the threaded unit, said wings being joined to the threaded unit by a substantially planar section diametrically extending from the threaded unit and substantially intersecting said axis.

9. An adjustable thermostat comprising an electrode actuating unit including a threaded unit having an axis and the rotation of which unit controls the disposition of an electrode, an armature for the unit comprising a sheet metal element having wings spaced from the axis of the threaded unit, said wings being relatively oppositely extending from a substantially planar section, and the planar section being mounted on the threaded unit.

10. An armature for a threaded unit for an adjustable thermostat comprising an integral sheet metal assembly, the assembly having a symmetrically disposed axial rib and groove portion arranged to embrace a shaft, connecting portions extending laterally outwardly from the rib and groove and wings forming the terminals for the connecting portions each joined at one

end to the outer end of its respective connecting portion and extending arcuately in relatively opposite directions generally concentric with the rib and groove portions in spaced relation thereto.

11. An adjustable thermostat comprising a glass bulb, mercury in the bulb, a column of glass mounted on the bulb, said column having two parallel spaced bores comprising respectively a working and a common bore extending longitudinally thereof with one of the bores in communication with the bulb mercury in the common bore, a glass housing fused to the column remote from the bulb, a support mounted in the housing, a rotatable element mounted in the support and including an armature rotatable in the glass housing, an electrode axially adjustable in the working bore, means connecting the electrode and rotatable element for axially adjusting the electrode with rotations of the element, an electrical connecting system in electrical connection at one end with the electrode and at the other extending through the glass housing, a common electrode in the housing extending into the mercury in the common bore, electrical connecting means leading from said common electrode through the glass housing, means establishing electrical connection between the common electrode and the mercury in the working bore, and rotatable means establishing polarized magnetic flux externally of the housing incident upon said armature and so arranged as to rotate the armature and rotatable element as the means is rotated.

12. An adjustable thermostat comprising a glass bulb, mercury in the bulb, a column of glass mounted on the bulb, said column having two parallel spaced bores comprising respectively a working and a common bore extending longitudinally thereof with one of the bores in communication with the bulb, a glass housing fused to the column remote from the bulb, a support mounted in the housing, a rotatable element mounted in the support and including an armature rotatable in the glass housing an electrode axially adjustable in the working bore, means connecting the electrode and rotatable element for axially adjusting the electrode with rotations of the element, an electrical connecting system in electrical connection at one end with the electrode and at the other extending through the glass housing, a common electrode in the housing extending into the common bore, electrical connecting means leading from said common electrode through the glass housing, means establishing electrical connection between the common electrode and the mercury in the working bore, and rotatable means establishing polarized magnetic flux externally of the housing incident upon said armature and so arranged as to rotate the armature and rotatable element as the means is rotated, said means establishing electrical connection comprising mercury in the common bore in direct electrical commounication with the mercury in the bulb.

13. An adjustable thermostat comprising a glass bulb, mercury in the bulb, a column of glass mounted on the bulb, said column having two parallel spaced bores comprising respectively a working and a common bore extending longitudinally thereof with one of the bores in communication with the bulb, a glass housing fused to the column remote from the bulb, a support mounted in the housing, a rotatable element mounted in the support and including an armature rotatable in the glass housing, an electrode axially adjustable in the working bore, means connecting the electrode and rotatable element for axially adjusting the electrode with rotations of the element, an electrical connecting system in electrical connection at one end with the electrode and at the other extending through the glass housing, a common electrode in the housing extending into the common bore, electrical connecting means leading from said common electrode through the glass housing, means establishing electrical connection between the common electrode and the mercury in the working bore, and rotatable means establishing polarized magnetic flux externally of the housing incident upon said armature and so arranged as to rotate the armature and rotatable element as the means is rotated, said means establishing electrical connection comprising mercury in the common bore, an electrical connection embedded in the column and in contact with the mercury in both the common and working bores.

14. An adjustable thermostat comprising a glass bulb, mercury in the bulb, a column of glass mounted on the bulb, said column having two parallel spaced bores comprising respectively a working and a common bore extending longitudinally thereof with one of the bores in communication with the bulb, a glass housing fused to the column remote from the bulb, a support mounted in the housing, a rotatable element mounted in the support and including an armature rotatable in the glass housing, an electrode axially adjustable in the working bore, means connecting the electrode and rotatable element for axially adjusting the electrode with rotations of the element, an electrical connecting system in electrical connection at one end with the electrode and at the other extending through the glass housing, a common electrode in the housing extending into the common bore, electrical connecting means leading from said common electrode through the glass housing, means establishing electrical connection between the common electrode and the mercury in the working bore, and rotatable means establishing polarized magnetic flux externally of the housing incident upon said armature and so arranged as to rotate the armature and rotatable element as the means is rotated, said means establishing electrical connection comprising mercury in the common bore in communication with the bulb, a pocket being formed in the column in substantial alignment with the common bore, mercury disposed in said pocket, an electrical connector fused in the column and establishing electrical connection between the mercury in the common column and the pocket, and means defining an opening in the pocket into which said common electrode may be inserted to contact with the mercury therein.

15. An adjustable thermostat comprising a glass bulb, mercury in the bulb, a column of glass mounted on the bulb, said column having two parallel spaced bores comprising respectively a working and a common bore extending longitudinally thereof with one of the bores in communication with the bulb, a glass housing fused to the column remote from the bulb, a support mounted in the housing, a rotatable element mounted in the support and including an armature rotatable in the glass housing, an electrode axially adjustable in the working bore, means connecting the electrode and rotatable element for axially adjusting the electrode with rotations of the element, an electrical connecting system

in electrical connection at one end with the electrode and at the other extending through the glass housing, a common electrode in the housing extending into the common bore, electrical connecting means leading from said common electrode through the glass housing, means comprising mercury establishing electrical connection between the common electrode and the mercury in the working bore, and rotatable means establishing polarized magnetic flux externally of the housing incident upon said armature and so arranged as to rotate the armature and rotatable element as the means is rotated, and calibrations on the thermostat relative to which the axial disposition of the working electrode can be determined.

16. An adjustable thermostat comprising a glass bulb, mercury in the bulb, a column of glass mounted on the bulb, said column having two parallel spaced bores comprising respectively a working and a common bore extending longitudinally thereof with one of the bores in communication with the bulb, a glass housing fused to the column remote from the bulb, a support mounted in the housing, a rotatable element mounted in the support and including an armature rotatable in the glass housing, an electrode axially adjustable in the working bore, means connecting the electrode and rotatable element for axially adjusting the electrode with rotations of the element, an electrical connecting system in electrical connection at one end with the electrode and at the other extending through the glass housing, a common electrode in the housing extending into the common bore, electrical connecting means leading from said common electrode through the glass housing, means establishing electrical connection between the common electrode and the mercury in the working bore, rotatable means establishing polarized magnetic flux externally of the housing incident upon said armature and so arranged as to rotate the armature and rotatable element as the means is rotated, said means for establishing magnetic flux comprising an annular magnet, and means for locking the magnet in a given position relative to the glass housing.

17. An adjustable thermostat comprising a glass bulb, mercury in the bulb, a column of glass mounted on the bulb, said column having two parallel spaced bores comprising respectively a working and a common bore extending longitudinally thereof with one of the bores in communication with the bulb, a glass housing fused to the column remote from the bulb, a support mounted in the housing, a rotatable element mounted in the support and including an armature rotatable in the glass housing, an electrode axially adjustable in the working bore, means connecting the electrode and rotatable element for axially adjusting the electrode with rotations of the element, an electrical connecting system in electrical connection at one end with the electrode and at the other extending through the glass housing, a common electrode in the housing extending into the common bore, electrical connecting means leading from said common electrode through the glass housing, means establishing electrical connection between the common electrode and the mercury in the working bore, rotatable means establishing polarized magnetic flux externally of the housing incident upon said armature and so arranged as to rotate the armature and rotatable element as the means is rotated, said means for establishing magnetic flux comprising an annular magnet, means for locking the magnet in a given position relative to the glass housing, said means comprising a pair of relatively threaded sleeve elements, means for holding one of the elements against movement relative to the thermostat, and surfaces on the respective elements for engaging the magnet.

18. An adjustable thermostat comprising a glass bulb, mercury in the bulb, a column of glass mounted on the bulb, said column having two parallel spaced bores comprising respectively a working and a common bore extending longitudinally thereof with one of the bores in communication with the bulb, a glass housing fused to the column remote from the bulb, a support mounted in the housing, a rotatable element mounted in the support and including an armature rotatable in the glass housing, an electrode axially adjustable in the working bore, means connecting the electrode and rotatable element for axially adjusting the electrode with rotations of the element, an electrical connecting system in electrical connection at one end with the electrode and at the other extending through the glass housing, a common electrode in the housing extending into the common bore, electrical connecting means leading from said common electrode through the glass housing, means comprising mercury establishing electrical connection between the common electrode and the mercury in the working bore, rotatable means establishing polarized magnetic flux externally of the housing incident upon said armature and so arranged as to rotate the armature and rotatable element as the means is rotated, means for visually determining the exact relative position of the means for establishing the magnetic flux relative to the housing.

19. An adjustable thermostat comprising a glass bulb, mercury in the bulb, a column of glass mounted on the bulb, said column having two parallel spaced bores comprising respectively a working and a common bore extending longitudinally thereof with one of the bores in communication with the bulb, a glass housing fused to the column remote from the bulb, a support mounted in a housing, a rotatable element mounted in the support and including an armature rotatable in the glass housing, an electrode axially adjustable in the working bore, means connecting the electrode and rotatable element for axially adjusting the electrode with rotations of the element, an electrical connecting system in electrical connection at one end with the electrode and at the other extending through the glass housing, a common electrode in the housing extending into the common bore, electrical connecting means leading from said common electrode through the glass housing, means establishing electrical connection between the common electrode and the mercury in the working bore, rotatable means establishing polarized magnetic flux externally of the housing incident upon said armature and so arranged as to rotate the armature and rotatable element as the means is rotated, means establishing a fixed datum line relative to the glass housing, and said means establishing a magnet flux comprising an annular permanent magnet having calibrations viewable against said datum line to enable minute angular adjustments of the magnet to secure minute axial adjustments of the working electrode.

20. An adjustable thermostat comprising a

mercury bulb, a housing, an electrode adjusting mechanism in the housing, a column extending between the bulb and housing as the only structure therebetween, said column containing two relatively parallel bores, of which one is a working bore, and visual masking means operatively associated with the column and so arranged as to substantially conceal the other one of the said two bores from a given angle of observation thereof while enabling proper visual observation of the said working bore.

21. An adjustable thermostat assembly of glass which comprises a column of glass having a bore eccentric to the axis thereof, a bulb in communication therewith, a glass housing on the other end of the column in communication with said bore substantially concentric with the axis of said column, an actuating assembly mounted in said housing and carrying a movable electrode eccentric of said housing and in substantially axial alignment with said bore, said actuating assembly incorporating a rotatable element disposed substantially concentric with the housing and with said column, an axially movable threaded device mounted on the shaft and having a portion in substantial alignment with said bore to which said electrode is attached, and means for guiding the threaded device for axial movement while substantially precluding rotative motion so as to maintain the alignment of the electrode and bore.

22. An adjustable thermostat assembly of glass which comprises a column of glass having a bore eccentric to the axis thereof, a bulb in communication therewith, a glass housing on the other end of the column in communication with said bore substantially concentric with the axis of said column, an actuating assembly mounted in said housing and carrying a movable electrode eccentric to said housing and in substantially axial alignment with said bore, said actuating assembly incorporating a rotatable element disposed substantially concentric with the housing and with said column, an axially movable threaded device mounted on the shaft and to which said electrode is attached, means for guiding the threaded device for axial movement while substantially precluding rotative motion so as to maintain the alignment of the electrode and bore, sail last means comprising a stationary guide device and a complemental guide means on said device both eccentric to said housing, diametrically spaced from said eccentric electrode.

23. An adjustable thermostat comprising a bulb for mercury, a hollow housing having upper and lower ends, a column extending between the bulb and the lower end of the housing as the only structure therebetween, said column having a bore communicating with the housing and with the bulb, an electrode movable into the bore, electrode adjusting mechanism disposed in the housing and comprising a fixed unit and a movable unit, said fixed unit comprising an elongated member disposed longitudinally in the housing having at one end at least transverse inner surface-abutting means joined substantially rigidly to the elongated member to maintain the fixed unit in predeterminedly transversely located position in the housing, and said movable unit connected to said electrode.

24. An adjustable thermostat comprising a bulb for mercury, a hollow housing having upper and lower ends, a column extending between the bulb and the lower end of the housing as the only structure therebetween, said column having a bore communicating with the housing and with the bulb, an electrode movable into the bore, electrode adjusting mechanism disposed in the housing and comprising a fixed unit and a movable unit, said fixed unit comprising an elongated member disposed longitudinally in the housing having at one end at least transverse inner surface-abutting means joined substantially rigidly to the elongated member to maintain the fixed unit in predeterminedly transversely located position in the housing, means formed in the housing to limit the axial movement of the fixed unit to hold it substantially rigid and immovable during motions of the movable unit, and means connecting the movable unit to the electrode.

25. An adjustable thermostat comprising a bulb for mercury, a hollow housing having upper and lower ends, a column extending between the bulb and the lower end of the housing as the only structure therebetween, said column having a bore communicating with the housing and with the bulb, an electrode movable into the bore, electrode adjusting mechanism disposed in the housing and comprising a fixed unit and a movable unit, said fixed unit comprising an elongated member disposed longitudinally in the housing having at one end at least transverse inner surface-abutting means joined substantially rigidly to the elongated member to maintain the fixed unit in predeterminedly transversely located position in the housing, said column having a second bore substantially parallel to the first and forming a channel for a common ground for a circuit controlled by the thermostat.

26. An adjustable thermostat comprising a bulb for mercury, a hollow housing having upper and lower ends, a column extending between the bulb and the lower end of the housing as the only structure therebetween, said column having a bore communicating with the housing and with the bulb, an electrode movable into the bore, electrode adjusting mechanism disposed in the housing and comprising a fixed unit and a movable unit, said fixed unit comprising an elongated member having integral spacing means at both ends arranged to cooperate with surfaces in the housing to maintain the elongated member in the housing against any lateral shifts therein, said housing including a relative indentation juxtaposed to the spacing means at one end of the elongated member to preclude axial motion of the fixed unit in at least one direction, said elongated member comprising a guide for the movable unit, and said movable unit being connected to said electrode.

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