May 14, 1957 G. F. DALES 2,792,474

THERMOSTATS

Filed Oct. 19, 1954 2 Sheets-Sheet 1

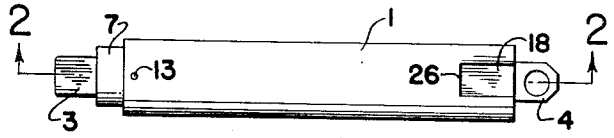


FIG. 1

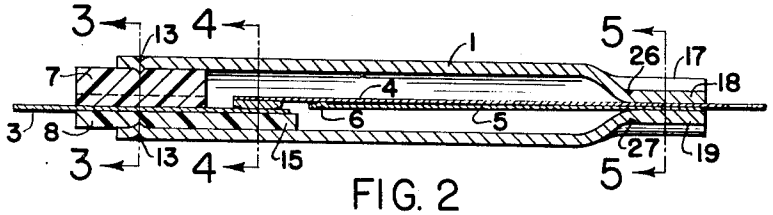


FIG. 2

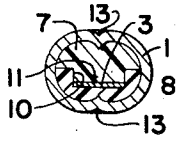


FIG. 3

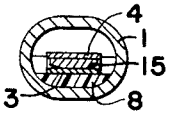


FIG. 4

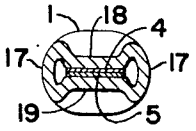


FIG. 5

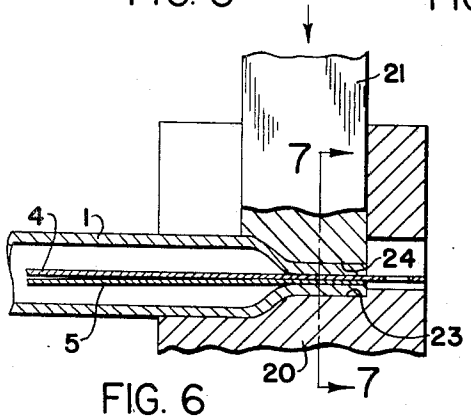


FIG. 6

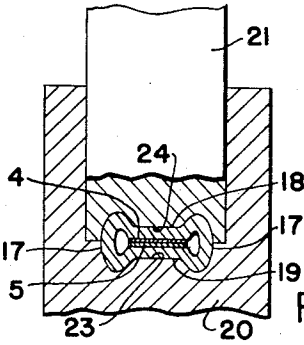


FIG. 7

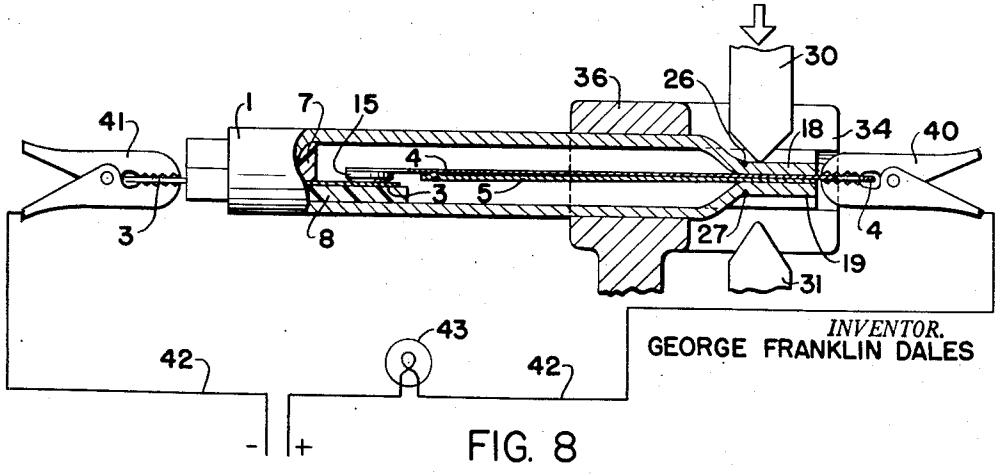


FIG. 8

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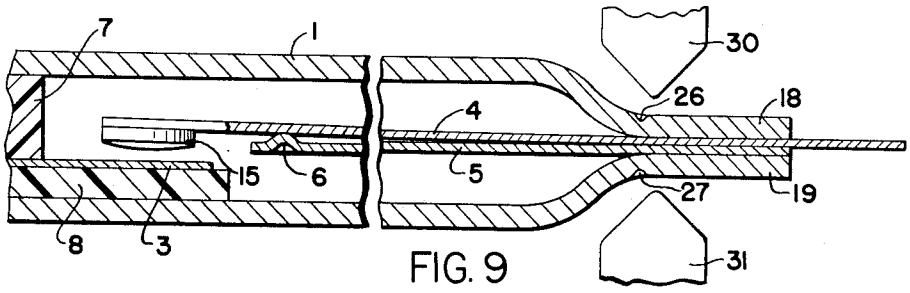


FIG. 9

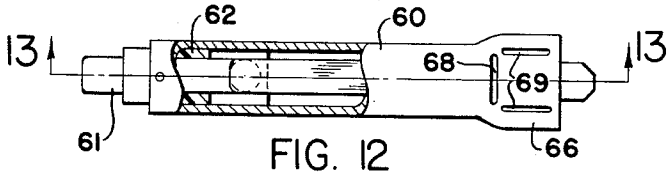


FIG. 12

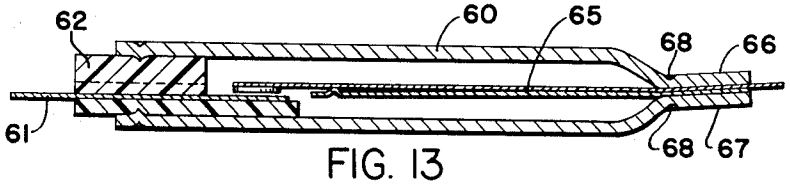


FIG. 13

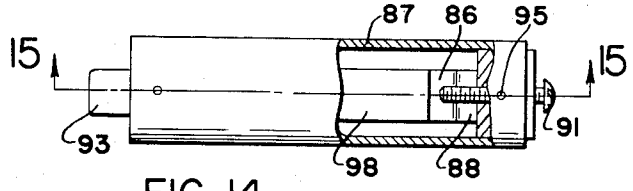


FIG. 14

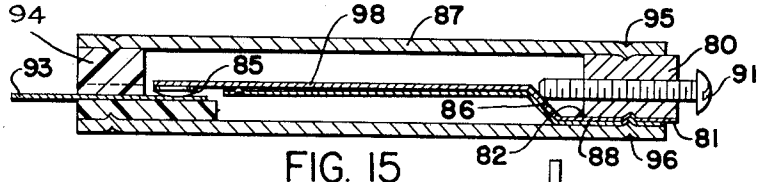


FIG. 15

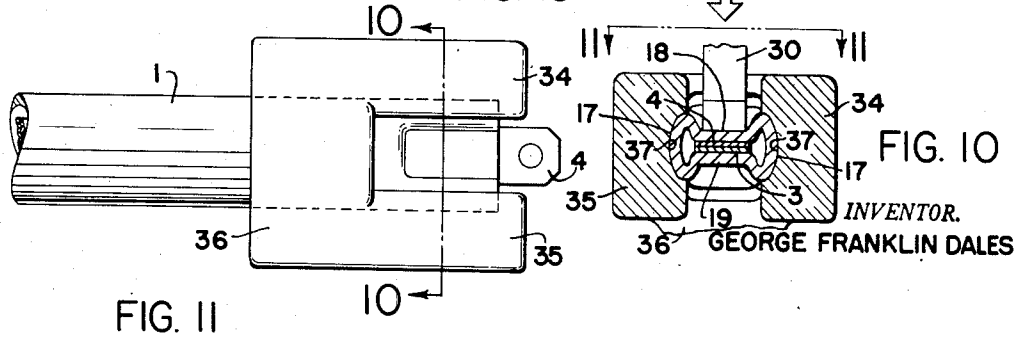


FIG. 11

FIG. 10

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THERMOSTATS

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Application October 19, 1954, Serial No. 463,120

10 Claims. (Cl. 200—138)

This invention relates to thermostats.

The invention relates more particularly to small thermostats which may not be more than an inch or two long and need not be over a quarter to a half inch in width and height. Casings for these thermostats are preferably made from a tube of a metal which is both a heat conductor and an electrical conductor, such as copper, steel, brass, etc. These tubes are preferably seamless. An electrode is fastened into one end of the casing where it is separated from the casing by suitable insulation. An area of the electrode is exposed within the casing. One end of bimetallic means is fastened in the other end of the casing in conducting contact with the wall of the casing. The free end of the bimetallic means moves into and out of contact with the exposed area of the electrode, making and breaking contact therewith.

Such thermostats are made in a variety of different designs. There is a large demand for thermostats of this type to be inserted in the windings of electric motors to protect the motors from burning out. Thermostats of this type are also used in electric toasters, coffee pots, heating pads, etc.

The bimetallic means is not insulated from the metallic casing, but is in contact with it. It heats faster and operates more accurately than if insulated from the casing. Furthermore, no harm is done if, moving in response to thermal changes, it contacts the inner surface of the casing. This is an important improvement over those types of small thermostats in which the bimetallic means is insulated from the casing with which it may form a short when its free end, in response to a thermal change, is moved away from the electrode. Small sizes of these thermostats may be operated at voltages of up to 220 volts because there is no possibility of the free end of the bimetallic means forming a short with the casing. For such voltages larger casings are required for those designs in which the bimetallic means is insulated from the casing.

The calibration of the thermostats is advantageously effected by deforming the casing of the thermostat by the application of pressure, preferably by a series of sharp blows, to an end of the casing in which the bimetallic means is fastened, thereby causing a change in the relative position of the free end of the bimetallic member and the exposed area of the electrode. In a preferred type of electrode, the pressure for calibration is applied only to a small flattened area of the casing located centrally of one end of the electrode. The free end of the bimetallic means may be moved nearer the exposed area of the electrode during the calibration or it may be moved further from it. It may be moved first in one direction, and then in the other.

Herein whe shall refer to bimetallic means as including any bimetallic structure which carries the current and makes or breaks contact with an electrode. This may be simply a bimetallic strip which serves as the conductor. Spring means may be provided adjacent the bimetallic strip to give more positive action. Alternatively, the spring means may carry the current and a bimetallic member may be located adjacent to it to move it into and out of contact with the electrode. There are a number of bimetallic structures known in the art which may be used in the thermostats of this invention.

For convenience, we shall herein refer to the direction in which the free end of the bimetallic means moves away from the electrode as up, although it is to be understood that the thermostat may be positioned so that the free end of the bimetallic means moves in any other direction.

The bimetallic element of the bimetallic means may be so located in the thermostat, that its bottom surface has a greater coefficient of expansion than its top surface. In that case, as the temperature increases, its free end will move upward, away from the exposed area of the electrode, and return as the temperature is lowered. Conversely, the top surface of the bimetallic element may have a greater coefficient of expansion than the bottom surface so that the free end moves downwardly toward contact with the exposed area of the electrode as the temperature increases, and moves away from it when the temperature decreases.

The casing being an electrical conductor and the bimetallic means being supported in contact with it, the casing itself may serve as one terminal of the heating circuit operated by the thermostat. In that case the end of the casing in which the bimetallic means is fastened may be closed. Alternatively, the bimetallic means may extend outwardly through the end of the casing in which it is supported and serve as a terminal for the attachment of a wire or the like. The electrode will extend outwardly through insulation in the other end of the casing and provide a terminal for the attachment of a wire or the like.

The invention will be further described in connection with the accompanying drawings in which Fig. 1 is a plan view of a thermostat; Fig. 2 is a section on line **2—2** of Fig. 1; Figs. 3, 4, and 5 are sections on the lines **3—3**, **4—4**, and **5—5**, respectively, at different locations along the length of the thermostat as shown in Fig. 2; Fig. 6 illustrates apparatus for fastening the bimetallic means in one end of the thermostat; Fig. 7 is a section on the line **7—7** of Fig. 6; Fig. 8 illustrates the thermostat supported at one end connected in a circuit in which it is being calibrated, most of the front of the thermostat being broken away to expose its interior; Fig. 9 is an enlarged longitudinal section through the thermostat, the central portion being broken away, to illustrate more particularly the method of changing the position of the free end of the bimetallic means with respect to the exposed area of the electrode during calibration of the thermostat; Figs. 10 and 11 illustrate the use of the supporting means shown in Fig. 8, Fig. 10 being a section on the line **10—10** of Fig. 11, and Fig. 11 being a plan on the line **11—11** of Fig. 10; Fig. 12 is a plan view of a modified thermostat, a portion of the top of the casing thereof being broken away to show the interior; Fig. 13 is a side view in section taken on the line **13—13** of Fig. 12, the end of the thermostat which supports the bimetallic member being bent to an exaggerated extent to illustrate how the calibration may be effected; Fig. 14 is a plan view of a further modified form of the thermostat, a portion of the tubular casing being broken away; and Fig. 15 is a section on the line **15—15** of Fig. 14, illustrating the internal construction of this thermostat.

The casing of the thermostat is preferably formed of a length of seamless metal tubing, such as copper tubing or the like. The tubing may be cylindrical or have an oblong or other cross-section. The thermostats illustrated in Figs. 1–11 and 12–13 have a generally circular

or oval cross-section, and the cross-section of the casing of the thermostat illustrated in Figs. 14 and 15 is substantially rectangular in cross-section.

Figures 1 to 11

The casing of the thermostat of Figs. 1 to 11 is made of copper tubing **1**. The tubing for this thermostat may, for example, be about 1 to 2 inches in length and be about a quarter of an inch in each of the other directions. Fig. 1 is a top view of the thermostat and, as here illustrated, its width is somewhat greater than its height.

The electrode **3** is made of steel or other conducting material and is fastened in one end of the thermostat; and one end of the bimetallic means is fastened in the other end of the thermostat. The bimetallic means includes the steel spring element **4** which carries the current, and the bimetallic element **5**. The dimple **6** at the inner end of the bimetallic element makes contact with the spring **4**. As the temperature of the thermostat increases, the bimetallic element **5** curls upwardly and breaks the circuit. In doing so, the dimple **6** slides on the spring **4**, and this frictional contact steadies the movement of the bimetallic means in its responses to temperature changes. As the temperature lowers, the spring **4** lowers into contact with the electrode **3**, and the circuit is closed and heat is generated.

The electrode **3** is held between two pieces of insulating material, the top piece being identified by the reference numeral **7** and the lower piece by the reference numeral **8**. These pieces of insulating material may be formed of nylon, teflon, Bakelite, or other insulating material. Other means may be employed for supporting the electrode in the end of the casing out of electrical contact with the casing. In the preferred construction illustrated in the drawings, the bottom insulating element is channeled out at **10** (Fig. 3) and the electrode **3** rests on this channeled out portion. The upper insulating member **7** is formed with the boss **11** which fits into the channel **10** and presses against the top of the electrode **3** holding it snugly in place. The insulating elements are held in position in the end of the tubing by peening the tubing at points **13** on the top and bottom of the tubing, or otherwise pressing the top and bottom of the tubing together against the insulation. Other fastening means may be employed.

The inner end of the insulating member **8** is flat as illustrated in Fig. 4, and supports the electrode **3**. The upper insulating member **7** does not extend inwardly as far as the lower insulating member. This exposes the upper surface of the inner end of the electrode **3** so that it may be contacted by the bimetallic means.

The bimetallic means may include a button **15** of silver or other conducting material on the under side of its free end to insure better contact with the element **3** when the thermostat circuit is closed.

The bimetallic means is held in direct contact with the top and bottom inner surfaces of the end of the thermostat. This is done by squeezing only the central portion of the end of the casing against the bimetallic means, without affecting the edge surfaces **17** of the casing. If the entire width of the casing were thus squeezed, these edges **17** would be flattened out and the width of the end of the casing would be increased. By limiting the area of squeezing to an area which is roughly the width of the bimetallic member, no substantial change is made in the width of this end of the thermostat. The thermostat made in this way has a distinct advantage over that in which the entire end is flattened, where only a small space is available for the thermostat, as in the windings of a motor, because a thermostat of irregular width requires more space than one of uniformly small dimensions.

By squeezing the central portion of the end of the casing, the two platforms **18** and **19** are formed on the outer surfaces of this end of the thermostat, and the inner surfaces of the casing within these platforms are squeezed into flat contact with the bimetallic means and support it. The outer edges **17** of the casing adjacent these platforms **18** and **19** are not affected by this squeezing (Figs. 2, 5, and 7).

Figs. 6 and 7 illustrate apparatus which may be used in forming these platforms. The bimetallic means is inserted to the required extent in the end of the casing **1**. The end of the casing is placed on the block **20**. Its top surface is hollowed out to receive the plunger **21**. The central portions **23** and **24** of the block and plunger, respectively, are shaped to form the platforms **18** and **19** at the end of the thermostat, without changing the contour of the edges **17**. Plunger **21** is brought down, and the surfaces **23** and **24** squeeze and shape the end of the casing. The casing is held substantially horizontal during this operation, and if the thermostat is to be calibrated for use at an intermediate temperature, the platforms **18** and **19** are substantially horizontal so that the free end of the bimetallic means is positioned about midway between the top and bottom of the casing. If the thermostat is to be used at an extremely hot or extremely cold temperature, the end of the thermostat may be tilted somewhat, one way or the other, to minimize the amount of beinding required during calibration.

The inner edges of the platforms are staked at **26** and **27** to form a pivotal line about which the platforms are flexed during the calibration.

In calibrating the thermostat pressure is applied to one of the platforms **18** or **19**, or it may be applied first to one and then the other. This may be a steady, firm pressure, or preferably it is a series of sharp, quick blows such as would be delivered by a peening hammer. Figs. 8 and 9 show two such hammers **30** and **31**. The hammer **30** is operating on the upper platform. The hammer **31** is ready for use when needed. They operate on the respective platforms close to the stake marks **26** and **27**. When the upper hammer **30** is operating the bimetallic means is brought into closer contact with the electrode **3**. When the lower hammer **31** is being used, the bimetallic means is bent upward away from the electrode.

During the calibration, the end of the thermostat in which the bimetallic means is fastened, is rigidly supported between the fingers **34** and **35** of the support **36**. The support is hollowed out and the inner surfaces of the fingers are depressed at **37** to receive a thermostat and hold it firmly. Any suitable support may be employed.

The position of the bimetallic means is altered by the action of the peening hammers so that it is in light contact with the electrode at the temperature to which the thermostat is heated at the time of calibration. Clamps **40** and **41** are fastened to the terminals at the respective ends of the thermostat. These are connected by the wires **42** to the light **43**.

When the button **15** of the bimetallic member is in contact with the electrode **3**, the light **43** goes on. When the contact is broken, the light goes off. In calibrating the thermostat, the casing **1** is first heated to the temperature at which the thermostat is to operate. This heats the bimetallic member. It is then placed in the support which is preferably located in an insulated chamber. The chamber may hold a series of thermostats for simultaneous calibration, or thermostats may be moved into and out of the chamber in series, each being held there a sufficient time to bring it to the calibrating temperature.

The peening hammers **30** and **31** are located where they will strike rapid sharp blows against the inner end of the platforms **18** and **19**. Blows on the upper platform **18** bend the free end of the bimetallic means toward the electrode **3**, and blows on the lower platform **19** bend the free end of the bimetallic means away from the electrode **3**.

In bringing the free end of the bimetallic means into proper relationship with the electrode **3**, it may be necessary to operate only the upper or lower peening hammer, but ordinarily one will be operated, and then the other, until the free end of the bimetallic means is brought into just the proper relationship to the electrode. This desired relationship is when the bimetallic means exerts the minimum contact on the electrode to close the circuit, so that it is broken by the silghtest upward movement of the free end of the bimetallic element when caused by a change in the temperature of the element. The adjustment may be accomplished by automatic means utilizing an electric eye, or an operator may manually turn on and off the switches which operate the peening elements until the light gives the desired response.

The thermostat when put to use, may either close a heating circuit or open it. It is located with its metal casing in contact with the windings of a motor or the heated element of a toaster or iron or other material the temperature of which is to be controlled. The thermostat may be so sensitive that it responds to temperature changes no greater than a degree or two Fahrenheit. It may hold constant low freezing temperatures or temperatures as high as 500 or 600° F. or higher.

Figures 12 and 13

The thermostat of Figs. 12 and 13 is of somewhat different design. It is somewhat cheaper than the former design because the entire end in which the bimetallic means is held, is flattened, and this takes less equipment and is chaper than when only a limited area of the end is flattened, as in the thermostat of Figs. 1–11.

This thermostat is made from copper tubing **60**. The electrode **61** is supported in insulation **62** in one end of the tubing in the manner described for a thermostat of the type illustrated in the previous drawings.

Instead of flattening only a limited area of the opposite end of the thermostat in order to bring it into contact with the bimetallic means **65**, the entire end of the thermostat is flattened, producing the flattened top area **66** and bottom area **67**. To provide a pivotal line around which the end of the thermostat may be bent, it is staked across the line **68**. In order to fasten the bimetallic means **65** firmly in this end of the thermostat, the end may also be staked at **69** on opposite sides of the bimetallic means. These stake lines may be continuous or discontinuous, as desired.

In calibrating this thermostat it is heated to the temperature at which it is to operate. The opposite ends are connected in an electric circuit, with a lamp or other signal. The flattened end of the thermostat is then put in a slot, and the protruding portion is bent in one direction or the other until the bimetallic means **65** is brought into the desired light contact with the electrode **61**. In Fig. 13 the end of the thermostat is bent up at an exaggerated angle in the direction it would be bent when the thermostat is calibrated to operate at a high temperature.

Figures 14 and 15

The end of the thermostat illustrated in Figs. 14 and 15 is not flattened to bring the inner surfaces of the tubing into electrical contact with the bimetallic means. Instead, a block **80** of conducting material such as copper or other metal is first fastened to the outer end of the bimetallic means **81** as by welding at **82**. The free end of the bimetallic means advantageously includes a button **85** for the purpose previously described. Between the two ends, the bimetallic means is bent sharply upwardly at **86** so that its free end is located about midway between the top and bottom of the casing **87** while the outer end **88** of the bimetallic means is held flat against the inner surface of the end of the casing.

The block **80** is tapped and the bolt **91** is threaded into it. The inner end of this bolt presses against the upwardly slanting portion **86** of the bimetallic means.

In the opposite end of the thermostat the electrode **93** is held between pieces of insulation **94**, which may be any suitable insulation as previously described in connection with the preceding figures. In assembling the thermostat, the block **80** is first welded to the end of the bimetallic means and this assembly is then inserted in the casing **87**. The block **80** and the insulation **94** are held in place by peening or otherwise indenting the casing at points **95** and **96**.

The position of the free end **98** of the bimetallic means is determined by the pressure applied by the bolt **91**. Screwing the bolt into the block **80** bends the free end of the bimetallic means **98** downwardly, and screwing the bolt **91** out of the block permits the bimetallic means to raise its free end **98** away from the electrode **93**.

The thermostat shown in Figs. 14 and 15 is calibrated by adjusting the position of the bolt **91** in the block **80**. The operating temperature of the thermostat may readily be changed from time to time by adjusting the setting of the bolt **91**.

The method of calibration described herein is covered in a divisional application Serial No. 612,229 filed September 26, 1956.

The invention is defined in the claims which follow:

What I claim is:

1. An open-end thermostat formed of a tube of metal the respective ends of which are collapsed against an electrode covered with insulation at one end thereof and bimetallic means at the other end thereof, which tube conducts both heat and electricity, said electrode in the opening in one end of the tube which electrode is separated from the tube by said electrical insulation, having an exposed area of the electrode within the tube, and said bimetallic means one end of which is supported in the opening in the other end of the tube and in electrical conducting contact with it, having the other end of the bimetallic means free and adapted to move into and out of contact with the exposed area of the electrode as it responds to changes in temperature.

2. The thermostat of claim 1 in which the tube is of seamless metal.

3. The thermostat of claim 1 in which the tube is seamless and made of copper.

4. The thermostat of claim 1 in which the insulation below the electrode extends inwardly to a greater extent than the insulation above it and is in contact with the inner wall of the tube and supports the exposed area of the electrode.

5. The thermostat of claim 1 in which the bimetallic means extends out of the tube through said opening in said other end of the tube.

6. A thermostat formed of a tube of metal which conducts both heat and electricity, an electrode in one end of the tube which is separated from the tube by electrical insulation, an exposed area of the electrode within the tube and bimetallic means one end of which is supported in the other end of the tube in electrical conducting contact with it, there also being insulating means in said other end of the tube, the other end of the bimetallic means being free and adapted to move into and out of contact with the exposed area of the electrode as it responds to changes in temperature, with mechanical adjusting means in said insulating means in said other end of the tube which is adapted to bring pressure on the bimetallic means so as to alter the position of its free end with respect to the exposed area of the electrode.

7. The thermostat of claim 6 in which the supported end of the bimetallic means is located near the bottom of the tube and the bimetallic means is bent upwardly intermediate its two ends and said mechanical adjusting means includes a bolt which is threaded in closure means which closes the end of the tube in which the bimetallic means is supported, the inner end of the bolt being adapt-

ed to contact the upwardly bent portion of the bimetallic means so that as the bolt is turned in said closure means the free end of the bimetallic means is bent more and less toward the exposed area of the electrode.

8. The thermostat of claim 1 in which the bimetallic means is held between opposite inner surfaces of the tube which are pressed against it, and the inner edge of the outer surfaces of said pressed portions of the tube which contact the bimetallic means are staked to form a pivotal line about which the pressed portions of the end of the tube may be flexed.

9. The thermostat of claim 1 in which the bimetallic means is held between the opposite inner surfaces of the tube which are pressed against it, said pressed-together surfaces of the tube being less than the width of the tube, and the tube being substantially the same width from one end thereof to the other.

10. The thermostat of claim 1 in which the bimetallic means is held between the opposite inner surfaces of

the tube which are pressed against it, said pressed-together surfaces of the tube being less than the width of the tube, and the tube being substantially the same width from one end thereof to the other, said pressed-together portion of the end of the tube being staked on opposite sides of the bimetallic means to hold the bimetallic means in place.

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