Nov. 9, 1954 R. L. FEARN 2,694,127

CYLINDRICAL RHEOSTAT

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Fig. 1.

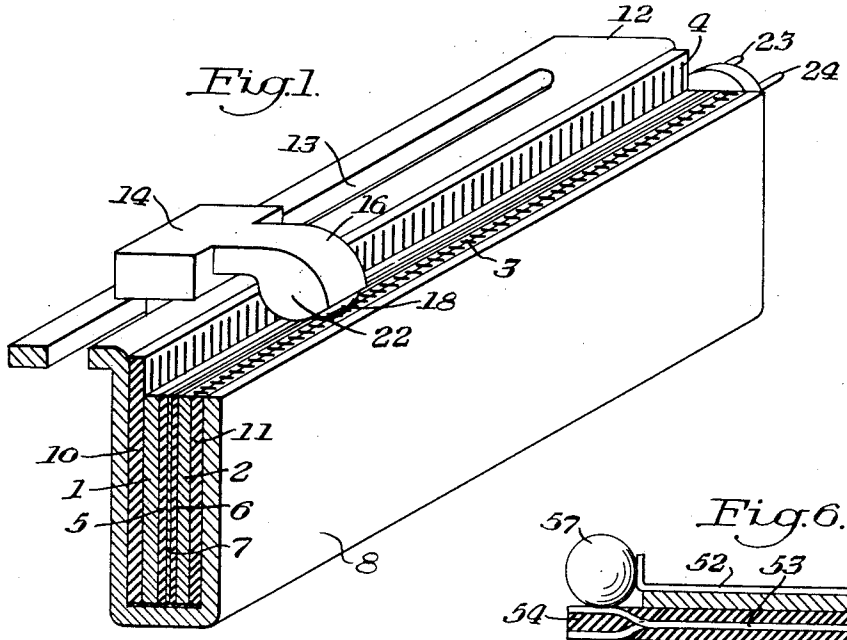


Fig. 6.

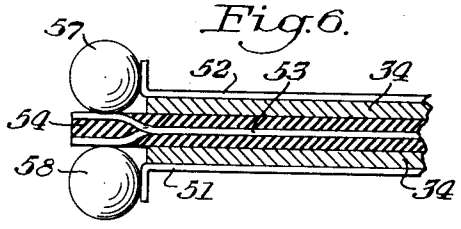
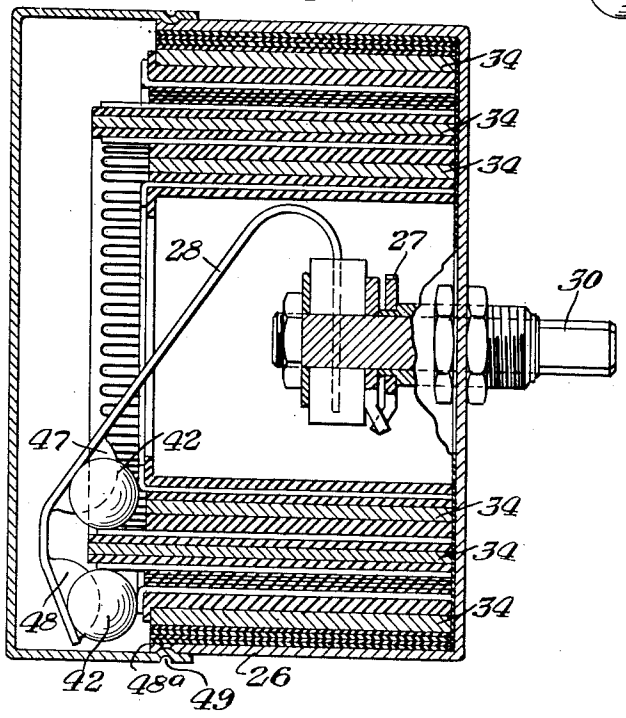


Fig. 5.



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Fig. 3.

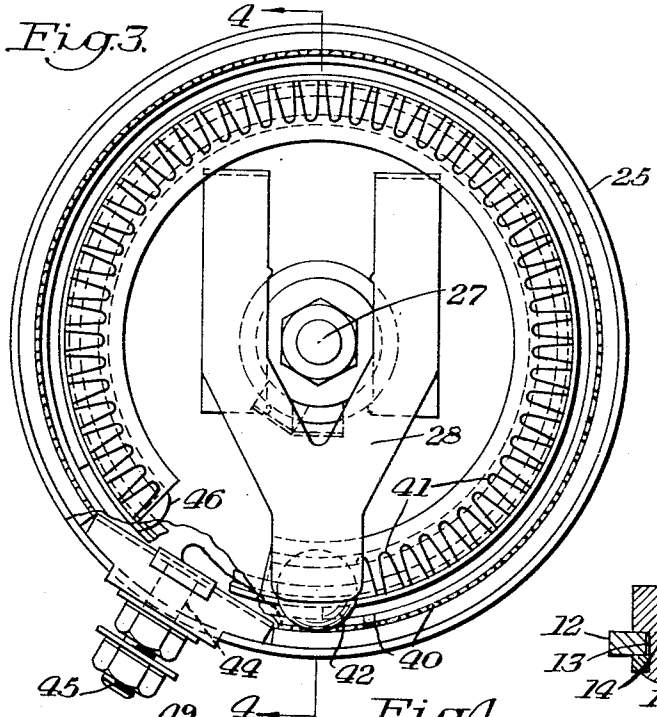


Fig. 2.

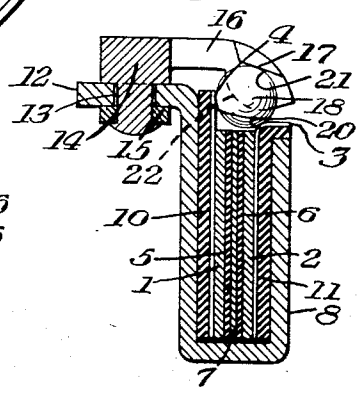
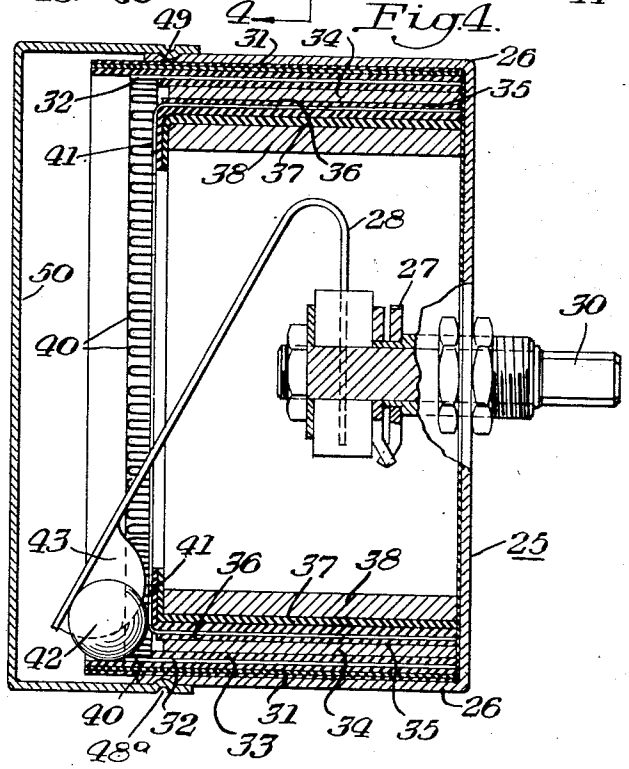


Fig. 4.



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Fig. 7.

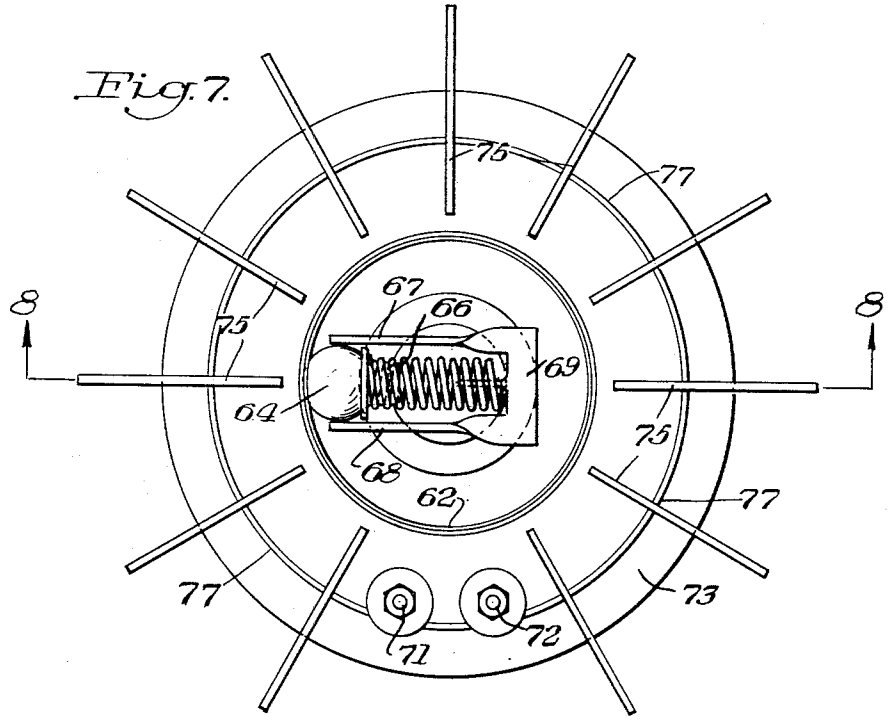
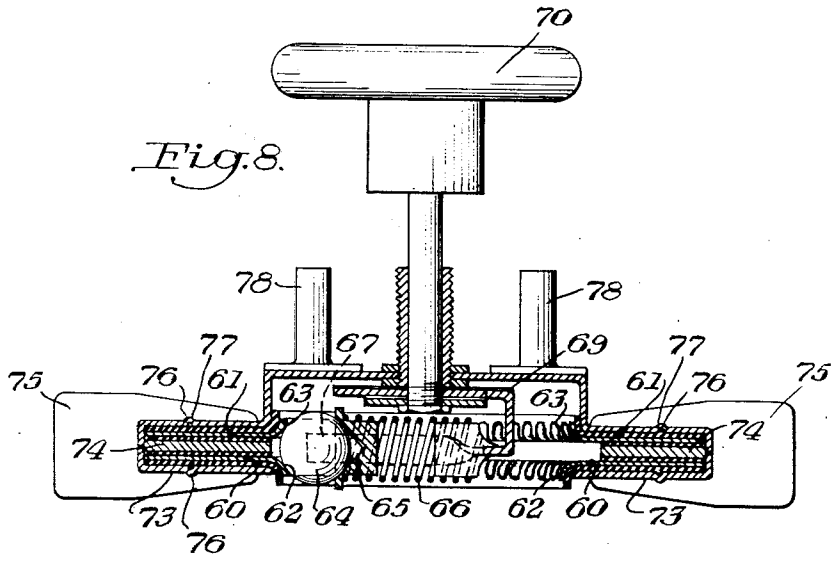


Fig. 8.



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CYLINDRICAL RHEOSTAT

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Application July 1, 1952, Serial No. 296,657

11 Claims. (Cl. 201—48)

This invention relates generally to resistors, and more particularly to rheostats for use in electrical circuits to vary the resistance thereof.

Rheostats are generally constructed with the resistance wire being wound around a body of insulating material such as a ceramic core. The contact arm that sweeps around in engagement with the resistance wire to vary the resistance thereof, ordinarily carries the current of the circuit and is provided with a conductor leading to the outer end or contact part of the arm that engages the resistance wire for this purpose.

The principal object of this invention is the provision of a rheostat employing a non-inductive ribbon made of a single strip or sinuous wire, as the resistance element which does not encircle an insulating body, but lies substantially in a common plane and is tightly clamped and encased in a metal cover which prevents exposure of the principal mass of the resistance element, and readily conducts heat generated in the resistance element to the exterior of the resistor where it may be dissipated. This structure is obtained by placing the resistance ribbon element between layers of thermally conductive and electrically insulating material, and tightly clamping the same in an outer metallic case, so that any heat is conveyed by conduction through the insulating element to the metal case and dissipated. By constructing the resistor in this manner, the resistance element may have a much higher rating, owing to the rate in which the heat is conducted from the element and dissipated. The ribbon resistance elements may have many forms. Sinuated wire ends may extend from one edge of a series of the ribbon conductors which may be straight or a single conductor or loops which are engaged by a contact member preferably a ball containing a carbonaceous material or graphite. The ball engaging the outwardly extending conductor tips merely provides a path across the resistor, from one side of the resistor element to the other, and changes the resistance by making this path shorter or longer. The resistor elements may be constructed from one resistant element by bending it back on itself, or by two separate resistor elements. The ball should never come out of contact from the conductor elements, and thus, always maintain a close circuit. If it is desired to have an open circuit rheostat, then the ball is arranged to run off resistance at the remote end from the terminals and the two resistance elements must be independent from one another. Since the arm which carries the ball to vary the resistance need not carry current, it can be made of insulating material.

It has been discovered that when employing projecting conductors that extend from the edge of the resistance element, they should be offset slightly from one another and the ball will never rotate on an axis parallel to a line directed through the conducting points of the two resistor elements, but will rotate on an axis substantially vertical to a line passing through these points. Thus, the ball will never roll dirt or other foreign matter into contacting surface, or into the surface of the wire or other conductor which the ball engages. The ball provides a wiping action, since the rotary movement of the ball is on an axis substantially normal to the line passing between the contacting points of both resistor elements which represents a smaller diameter of the sphere than the great diameter of the contact ball.

The contact portion of this rheostat element may be straight or may be, relative to the body, angular, and may be connected with two or more groups of resistance

elements. When made in circular form, pressure may be applied thereto by an internal spring producing an outward radial pressure to clamp the resistance elements and at the same time increase thermal conduction and to compensate for shrinkage of the parts making up the resistor. Again, the resistance element may be made flat in pancake form with the pressure elements squeezing the resistance tightly between insulated covers forming a case and in contact with the elements insulating them from the case. In constructing a rheostat that has increased thermal conductivity with high heat dissipation it can be tightly sealed against dust and still have an increased electrical rating.

This rheostat radiates heat from the electrical resistance element at a fast rate irrespective of whether it is enclosed in a case or exposed.

This rheostat structure lends itself to the adaptation of cooling elements such as fins that may be air or water cooled.

Owing to the fact that this rheostat does not contain friable elements, it is relatively non-shatterable and will withstand thermal, as well as mechanical shock. These advantages permit this structure to operate at higher temperatures and with greater overloads.

Other objects and advantages appear hereinafter in the following description and claims.

The accompanying drawings show, for the purpose of exemplification, without limiting the invention or claims thereto, certain practical embodiments of the invention wherein:

Fig. 1 is a perspective view partly in section, illustrating a straight resistor.

Fig. 2 is an enlarged detailed section on line 2—2 of Fig. 1.

Fig. 3 is a top plan view of an annular resistor.

Fig. 4 is a sectional view of Fig. 3.

Fig. 5 is a sectional view showing the rheostat such as illustrated in Fig. 3 and having a plurality of variable resistance elements.

Fig. 6 is a partial sectional view of a rheostat having three resistance elements with independent contact members.

Fig. 7 is a plan view of a flat pancake rheostat.

Fig. 8 is a sectional view of Fig. 7.

Referring to Fig. 1 of the drawings, the rheostat is made up of the resistance elements **1** and **2**, and may be constructed of a sinuous ribbon or flat strips of resistance material or conductors imbedded in a resistance composition and are provided with the exposed conductors **3** and **4** extending upwardly and outwardly therefrom. The conductors **4** extend straight up from the resistance element **1** and the conductors **3** extend laterally from the resistance element **2**. An insulating layer **5** and **6** is provided on the adjacent sides of the resistance elements **1** and **2** and intermediate of the two insulating layers **5** and **6** is a metal plate **7** which extends to the bottom resistor and may be integrally connected with the outer cover member **8** which is U-shaped and is sufficiently thick so as to enable it to hold the rheostat assembly in compression. On the outer side of the resistance elements **1** and **2**, another layer of insulating material, such as illustrated at **10** and **11**, is provided, which separates and electrically insulates the resistance elements from the U-shaped casing **8**. The casing **8** is provided with a laterally extending flange **12** which has a slot **13** cut therein for receiving the rider **14** slidably mounted thereon by cap **15**.

The rider has an outwardly projecting arm **16** containing a pocket **17** for the purpose of receiving the ball **18**. The ball **18** engages with the exposed conductor members **3** and **4**. The conductor members **4**, standing vertically, and the conductor members **3**, laying over on their side, so as to provide a contact point along the line as indicated at **20** in Fig. 2. At the upper end of the pocket, as indicated at **17**, is the pressure point **21**, which with the contact points, simulates the species of an isosceles triangle and exerts pressure on the ball **18**, so that it will engage both contact points of the conductors **3** and **4**, with substantially equal pressures. The sides of the pocket **17** extend downwardly, as indicated at **22**, for the purpose of moving the ball backward and

forward, as the rider 14 is shoved along the slot 13. The arm and the rider need not be of electrical conductor material, as they do not, in any way, carry current. The current is merely transferred through or around the surface of the ball from conductor 3 to conductor 4.

Terminals 23 and 24 are provided at the end of the resistance elements for connecting the resistance elements 1 and 2 respectively in an electrical circuit. If desired, the opposite ends of the resistance elements may be connected together or the resistance elements 1 and 2 may represent a folded section of a single resistance element.

The U-shaped metal cover 8 provides means for exerting the clamping pressure on the parts making up the resistance, and this pressure is sufficient to permit heat to be readily conducted through the insulating layers to the cover 8 where it may be dissipated to the air and the only portion of the resistance elements exposed is the one edge thereof from which the contacting conductors 4 and 3 extend.

Referring to Figs. 3 and 4, the rheostat 25 is mounted in a circular can 26, which is provided with a rotary shaft 27 for supporting the arm 28. The arm 28 may be of insulating material, or it may be insulated from the shaft in order to prevent any part of the circuit from being transmitted to the shaft 27 so that it will not, in any way, bring any part of the electrical circuit out near the knob 30 which is employed for rotating the shaft and the arm.

The can 26 is lined with an insulating material 31, such as mica, which is faced with a softer pad of high temperature electrical insulation 33 which supports the resistor element 32 on both sides thereof. A partial cylindrical metallic sleeve 34 is placed inside the insulating layer 33, and is covered by a third insulating padding layer 35 on which supports the resistor element 36 on both sides thereof, and another insulating layer 37 of harder material such as mica has the U-shaped spring member 38, which, when released within the can, exerts outward pressure, forcing the assembly tightly against the inner walls of the can.

The resistance elements 32 and 36 are ribbons of sinuous resistance wire, their upper or top edge extending beyond the sandwiched pack, and are in the form of U-shaped loops or hair-pins, as indicated at 40 and 41 in Fig. 3. The U-shaped loops are merely portions of the sinuous ribbon and represent that portion of the resistance element that is exposed for contact by the cylindrical graphite ball member 42 which is placed in the pocket 43 of the arm 28 and pressure is applied at the top thereof which is substantially at right angles to a line passing through a contact position of the resistance elements 32 and 36. By rotating the knob 30, the ball member is made to travel around the circumference of the resistance elements engaging the hair-pin extensions 40 and 41. As shown in Fig. 3, the resistance element 32 is connected to the terminal 44, and the resistance element 36 is connected to the terminal 45 which represent the ends of the resistance elements 32 and 36, whereas the opposite ends are connected together as indicated at 46. Thus, the sinuous wire ribbon, in making up the resistance elements 32 and 36, is in reality a single ribbon that is folded back on itself and the terminals 44 and 45 would be employed in a circuit that is never desired to be opened by the rheostat. When the arm is turned in a counter-clockwise direction toward the opposite end of the run, the total resistance of the sinuous ribbon is connected into the circuit through the terminals 44 and 45.

Referring now to Figs. 5 and 6, the can 26 is provided with two stacks of resistance elements, each insulated from each other, and each having a means separated by a metallic spacer 34. In this structure, two variable resistance elements are employed which may be connected in series, or may be independent of one another. However, they are operated in unison by reason of the fact that the arm 28 is provided with two pockets, 47 and 48, to receive the ball members 42. In the structures as shown in Fig. 4 and Fig. 5, an annular groove 48*a* encircles the can 26 for the purpose of receiving the ridge 49 of the cap member 50, which tightly encloses and seals the rheostat, and keeps any foreign material from entering the same.

In the modification shown in Fig. 6, only three resistance elements are employed as illustrated at 51 and 52 and the center element 53. The center element 53 has alternate parts of its hair-pin contact conductors extending on both sides of the insulating element 54, and thus, the same resistance element 53 is engaged independently by the ball 57, as well as the ball 58. In this manner, one is enabled to decrease the thickness of two elements or wherein one resistance element can be connected to the other two. This also eliminates the center metallic member 34, as shown in Fig. 5, which is for the purpose of conducting heat from the resistor. Such a rheostat of this character is obviously a special type.

Referring now to Fig. 7 and Fig. 8, the sinuous ribbon forming the resistance elements 60 and 61 lie in a horizontal plane and may be independent or a single ribbon turned back on itself. The hair-pin contact conductors 62 and 63, extending from one edge of the resistance elements, are both turned over for the purpose of providing a riding surface for the ball member 64 which is held by the spherical pocket members 65 and compressed in contact relation by the spring member 66. The pocket member 65 may be of insulating material so that the ball will not, in any way, conduct current to the control. The side arms 67 and 68 are connected to the arm 69 that is mounted on the control shaft 70 for the purpose of rolling the ball around the rheostat to change the resistance thereof. The terminals 71 and 72 are mounted on the outer pancake cover member 73 which is preferably made in two sections to permit the metal member 74 to extend therebetween, to be clamped therewith by the C clamps 75 which are forced onto the outer shell 73 to tightly clamp the insulated resistance elements 60 and 61 and the flat annular plate 74 in tight with each other. The C clamps may be provided with a notch, such as illustrated at 76 to lock over an annular bead 77 in the outer face of the casing for the purpose of interlocking the C clamps in position after they have been once forced in place, and tightly compressed the rheostat parts. The mounting members 78 are provided on the casing for the purpose of supporting the resistor on the back of a panel to permit the control member to extend therethrough.

I claim:

1. A rheostat comprising a plurality of electrical resistance elements mounted together and insulated from each other and extending in parallelism, a series of outwardly projecting conductors extending from each of the electrical resistance elements in parallelism and disposed at an angle to each other, a terminal attached to each electrical resistance element for connecting the same to a circuit, a rider having a pocket means extending over and movable along said series of outwardly projecting conductors, and a ball means containing electrical conducting material seated in said pocket means and receiving pressure therefrom to simultaneously engage the outwardly projecting angularly disposed conductors to effect an electrical connection therebetween as the ball means is rolled along said resistance elements by said rider.

2. A rheostat comprising a plurality of electrical resistance elements mounted together and insulated from each other and extending in parallelism, a series of outwardly projecting conductors extending from each of the electrical resistance elements in parallelism, a terminal attached to each electrical resistance element for connecting the same to a circuit, a rider having a pocket means extending over and movable along said series of outwardly projecting conductors, and a ball means containing electrical conducting material seated in said pocket means and receiving pressure therefrom to simultaneously engage the outwardly projecting conductors to effect an electrical connection therebetween as the ball means is rolled along said resistance element by said rider, and characterized in that said ball is made of carbonaceous material and engages the conductors of both rows at points equally distant from the pressure point produced by the rider to cause the ball to rotate about an axis that is not parallel to a line connecting the conductor engaging points on the ball.

3. The structure of claim 1 which also includes a metal sheath enclosing and engaging said electrical resistance elements through insulation to radiate heat therefrom, a metal cover enclosing over said rider and engaging with said metal sheath to completely enclose said rheostat.

4. The structure of claim 3 characterized in that the insulation between the electrical resistance elements

contains a metal member which extends to the exterior of said rheostat.

5. The structure of claim 1 characterized in that there are two electrical resistance elements electrically joined together at the ends opposite from said terminal.

6. The structure of claim 1 characterized in that said electrical resistance elements are made of flat ribbon formed of sinuous resistance wire and the projections are loops making up one edge of the ribbon.

7. The structure of claim 1 characterized in that said electrical resistance elements are made up in cake form and the projections extending therefrom are conductors.

8. A rheostat comprising a metallic can, a plurality of insulated electrical resistance elements mounted in said can, a terminal attached to each electrical resistance element for connecting the same to a circuit, a series of outwardly projecting conductors extending from one edge of said electrical resistance elements in parallelism and disposed at an angle to each other and backed by insulation, a rotary shaft journaled coaxially on said can, an arm carried by said post and extending over said conductors, pocket means carried by said arm, and ball means containing electrical conducting material seated in said pocket means and receiving pressure to simultaneously engage the outwardly projecting angularly disposed conductors to effect an electrical connection therebetween as the ball means is rolled along by said arm.

9. A rheostat comprising a metallic can, a plurality of insulated electrical resistance elements mounted in said can, a terminal attached to each electrical resistance element for connecting the same to a circuit, a series of outwardly projecting conductors extending from one edge of said electrical resistance elements in parallelism and backed by insulation, a rotary shaft journaled coaxially on said can, an arm carried by said post and extending over said conductors, pocket means carried by said arm, and ball means containing electrical conducting material seated in said pocket means and receiving pressure to simultaneously engage the outwardly projecting conductors to effect an electrical connection therebetween as

said ball means is rolled along by said arm, said outwardly extending metal plate means sandwiched in and insulated from the resistance elements and extending to said can to conduct heat from the sandwich pile to the can.

10. A rheostat comprising insulated electrical resistance means sandwiched in spaced relation and providing spaced rows of exposed conductors, a metal casing tightly embracing both sides of said insulated resistance in clamped relation to enclose the same, terminals for connecting said insulated resistance means to an electrical circuit, ball means engaging said exposed conductors, pocket means to receive and move the ball means along the spaced rows of exposed conductors to vary the resistance.

11. A tri-legged rheostat comprising three electrical resistance elements each having circuit connections and mounted in parallelism with each other, a series of outwardly projecting conductors extending from each of the electrical resistance elements in parallel rows with the conductors of the outer rows disposed at an angle relative to the conductors of the middle row, rider socket means extending over each of the adjacent rows of conductors, and a ball means containing electrical conducting material for engaging each of the adjacent angularly disposed rows of co-conductors to effect a tri-legged electrical circuit therebetween as the ball means is rolled along conductors by said rider pocket means.

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