June 8, 1937. N. C. SCHELLENGER 2,083,507

RESISTANCE ELEMENT

Filed Jan. 16, 1936 2 Sheets-Sheet 1

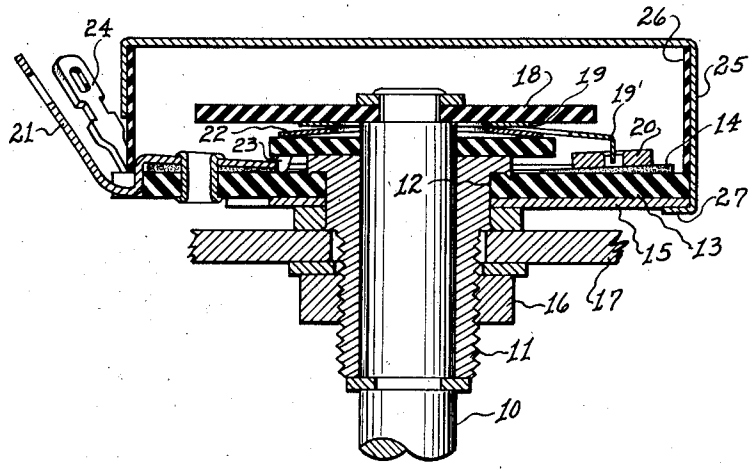


FIG. 1.

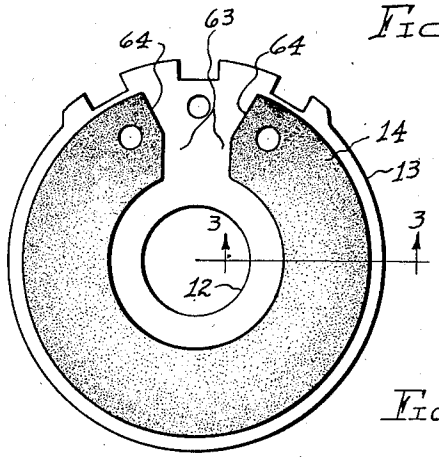


FIG. 2.

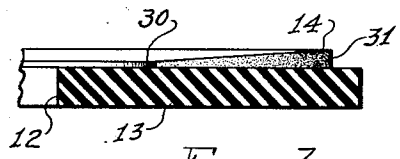


FIG. 3.

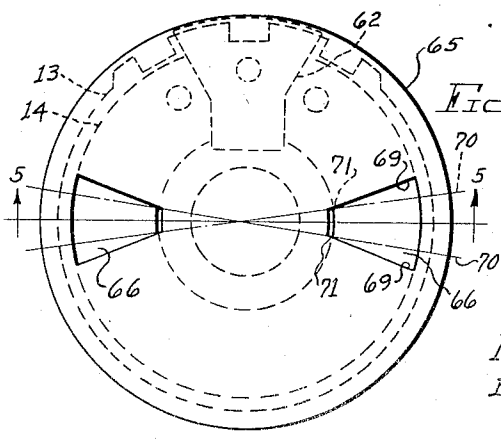


FIG. 4.

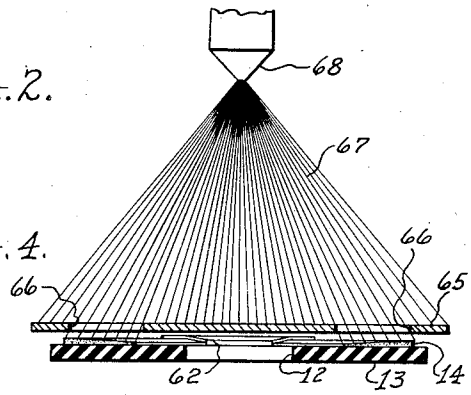


FIG. 5.

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June 8, 1937. N. C. SCHELLENGER 2,083,507

RESISTANCE ELEMENT

Filed Jan. 16, 1936 2 Sheets-Sheet 2

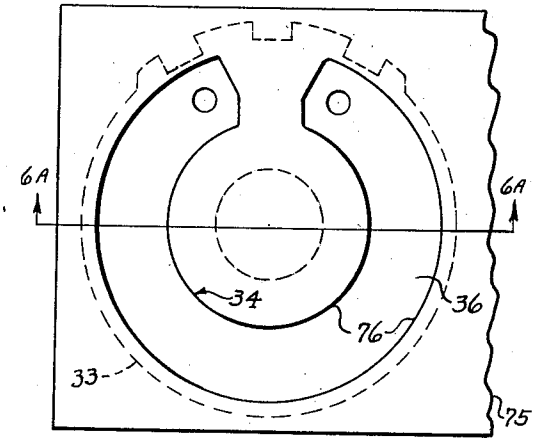


FIG. 6.

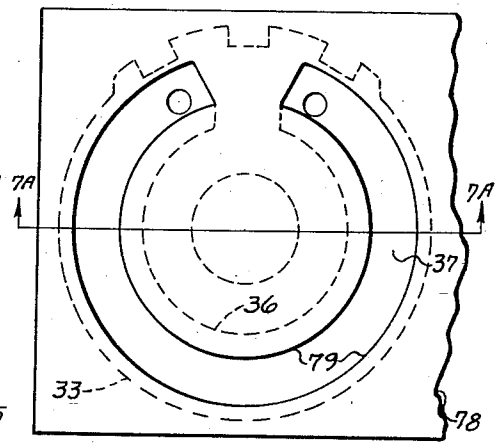


FIG. 7.

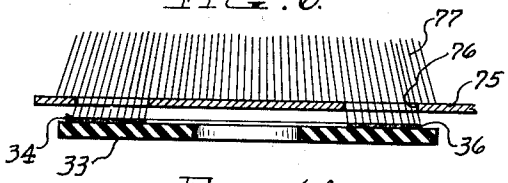


FIG. 6A.

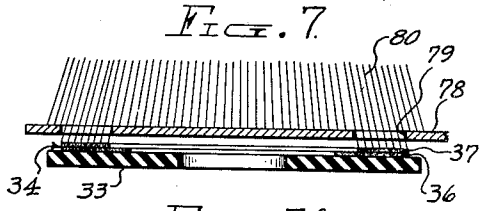


FIG. 7A.

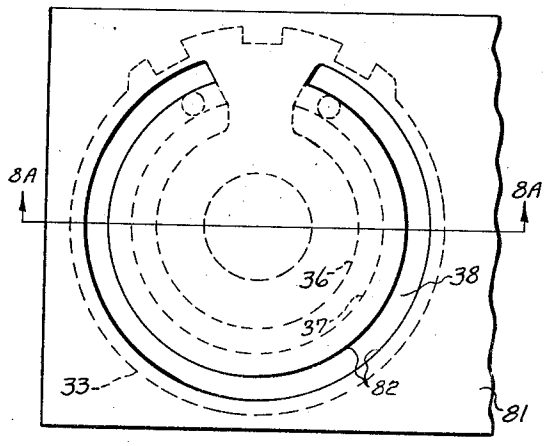


FIG. 8.

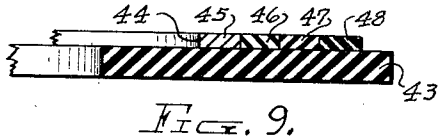


FIG. 9.

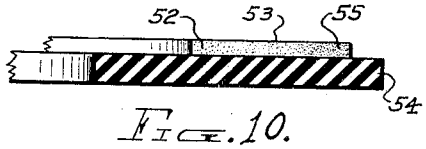


FIG. 10.



FIG. 11.

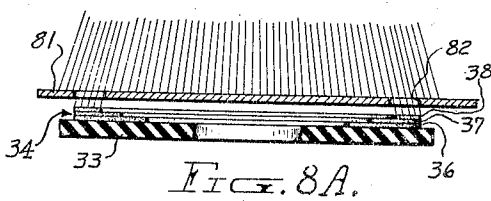


FIG. 8A.

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Patented June 8, 1937 2,083,507

UNITED STATES PATENT OFFICE

2,083,507

RESISTANCE ELEMENT

Newton C. Schellenger, Elkhart, Ind., assignor to Chicago Telephone Supply Co., Elkhart, Ind., a corporation of Indiana

Application January 16, 1936, Serial No. 59,349

17 Claims. (Cl. 201—73)

My invention relates to a new and improved resistance element and more particularly relates to a resistance element adapted for use in a resistor employed in a radio set.

In resistance elements which are adapted for use in variable resistors and control devices of radio sets, and the like, it has been customary to provide the resistance element by mounting a resistance strip, which is usually in a flat annular form, upon a base. Such resistance strips are invariably constructed so as to be of substantially uniform thickness and uniform resistive effect in a direction transversely of the strip and radially of the base, although some resistance strips have been made which vary in thickness and in resistive effect in a direction circumferentially of the strip, or in the direction of rotation of the contactor over the strip.

It has been found in practice that where the ordinary type of flat annular resistance element is used, the concentration of current around the inner portion of the element is much higher than around the outer portion, in view of the fact that the resistance of the inner portion is lower than that of the outer portion, because of its shorter length. For that reason, the inner portion of the resistance element will become overheated and destroyed before the outer portion is in any way damaged.

I have discovered that such unequal distribution of heat and overheating defects can be overcome by varying the resistive effect of the resistance element in a direction transversely of the element and radially outwardly of the base on which it is supported. This may be done in various ways, as shown in the attached drawings and described in the specification, and I can overcome this overheating defect very effectively by increasing the thickness of the film of conductive material of the resistance element, transversely from its inner edge toward its outer or peripheral edge. I can also accomplish the desired effect by varying the composition or nature of the material of the film, so that it will vary or will decrease gradually in its resistive effect in a direction outwardly from the inner edge of the element toward the outer edge thereof, although it remains uniform in thickness. In this manner, and with either of these forms of construction, I make the resistance of the outermost ring or section of the annular element equal to or less than that of the innermost ring or section. In cases where this improved resistance element is quite wide the resistance per unit of area of the outer section also is much lower than that per unit of area of the inner section by an amount sufficient to give a substantially uniform distribution of heat per unit of area thereover.

This resistance element can be constructed in various ways to incorporate the desired properties therein and accomplish the desired effect. It is conveniently made with an increased thickness in a direction across the element, extending radially outwardly of the base; and I do this by building up the element either so as to taper uniformly transversely thereof in its outward direction, as shown in Figs. 1 to 5; or by making the element so that its thickness increases outwardly in progressive steps, as shown in Figs. 6 to 8A.

I also construct the resistance element so as to increase gradually in conductivity and to decrease gradually in its resistive effect in a direction transversely outwardly from the inner edge toward the outer edge thereof, although making it of substantially uniform thickness in such transverse direction. This I can do by building together or combining a plurality of annular films or rings which are arranged concentrically, and each of which varies from the adjacent one in conductivity and resistive effect, so as to provide the desired flat annular film of the resistance element, as shown in Fig. 9. I can also provide this film of varying resistive effect but of uniform thickness transversely thereof by using materials of different conductivity and resistivity and arranging and intermingling said materials during the application thereof to the supporting means or base, so as to place the more conductive and less resistive material to a greater extent along the outer part of the annular film, and with a gradually increasing density in conductivity in such outward direction, as indicated in Fig. 10.

In making this resistance element, in either of its forms, I choose to do the same by the use of spraying means, and in several of these forms also with shielding means, whereby the carbonaceous material in fluid form is directed and sprayed onto the base, so as to increase in its conductivity and decrease in its resistivity from the inner edge of the element transversely outwardly toward the outer edge thereof, substantially in the manner indicated in the drawings.

It is, therefore, one of the main objects of this invention to overcome the unequal heating defects indicated above, and to provide a resistance element for the resistor or control device of a radio set and the like which will distribute the

electrically generated heat uniformly over the various parts of the resistor and associated elements, so that it will be readily and evenly dissipated therefrom.

Another object of this invention is to provide resistance means of this type which is inexpensive in construction as well as efficient in use, and which may be done by applying the carbonaceous material of the resistance element in its desired outline and shape directly upon the supporting base or other suitable supporting means of non-conductive material.

A further object is to provide a method of making this resistance element so that it can be quickly produced and in an inexpensive manner, preferably by directing and applying a spray of carbonaceous material in the liquid form onto a base or onto a supporting member of the desired shape and material, so as to bond the resistance element thereon in the form of a film of the desired shape and with its resistive effect decreasing transversely outwardly of the element.

These and other objects and advantages are attained with this invention, as will become apparent from the following description taken in connection with the accompanying drawings wherein the invention is shown in its preferred forms of construction, it being understood that various other forms and modifications may be resorted to for carrying out the objects and purposes of this invention.

In the drawings:

Fig. 1 is a sectional view of a resistor or control device showing my invention applied thereto, in its preferred form of construction.

Fig. 2 is a plan view showing a base having the resistance element provided thereon in the form of construction wherein the thickness of the element increases uniformly transversely outwardly of said element.

Fig. 3 is an enlarged partial sectional view, taken on line 3—3 of Fig. 2.

Fig. 4 is a plan view showing the shield positioned over the base and resistance element, as employed for making this form of the invention.

Fig. 5 is a sectional view thereof, taken on line 5—5 of Fig. 4, also showing the manner of applying the spray of material in the liquid form through the openings in the shield onto the base.

Figs. 6, 7 and 8 are plan views showing the invention in another form, increasing in thickness outwardly by successive layers, and the successive shield means employed progressively for building up the film in its successive steps.

Figs. 6A, 7A, and 8A are sectional views, taken respectively on lines 6A—6A, 7A—7A, and 8A—8A on Figs. 6, 7 and 8, also showing the manner of applying the spray of material through the shield means onto the base.

Fig. 9 is a partial sectional view of a modified form of the invention, showing the resistance element comprising a plurality of concentrically arranged annular sections or rings of material, each of which possesses different specific resistance, but which film is substantially uniform in thickness.

Fig. 10 is a partial sectional view of another modified form, showing the resistance film of substantially uniform thickness transversely thereof, and composed of material wherein the conductive particles are present with increasing density in the outward direction, whereby the resistive effect of the film decreases in such outward direction.

Fig. 11 is a sectional view showing the application of this type of resistance film upon a thin annular strip as the supporting member which is in turn mounted upon the usual disc-like base.

For the purpose of illustration I have shown my invention in the drawings in connection with a resistor or resistance device of the type employed for volume and tone control in radio receiving sets, which comprises a rotary shaft 10 journalled in a metal bushing or thimble 11 which is secured in an aperture 12 provided in the base or main supporting member 13, formed of bakelite or similar suitable non-conductive material, whereon the resistance element 14 is mounted. A ground plate 15 is mounted under the base 13, and suitable washers and a nut 16 are provided on the bushing for mounting the device on a supporting structure, such as a radio panel 17 or the like. A drive plate 18 of insulating material is secured onto the reduced top part of shaft 10 and a metallic spring arm 19 is secured thereunder which carries at its outer end 19' a contactor shoe 20 having a sliding or wiping contact with the resistance element 14 on the base. An end terminal 21 is mounted on base 13, in contact with the resistance element 14, and a collector ring 22 surrounds the shaft beneath the actuating member 18, having its arm 23 electrically connected to the central terminal 24. A metal cover 25 provided with an insulating lining 26 is placed over the resistor for housing the same, and has integral ears 27 crimped underneath the ground plate for securing the metal cover 25 in position.

The above described form of rheostat construction is one that is known and already in use, and my invention has been shown in connection therewith merely for the purpose of illustration, but it is not confined in its use to this particular type of variable resistor or rheostat alone.

The present invention resides chiefly in providing a resistance element for a variable resistance device, arranged in such shape and form that the heat generated by the current flowing through the resistance element will be distributed uniformly thereover and will be readily dissipated from the resistor. This can preferably be accomplished by constructing the resistance element so that it increases in conductivity in a direction extending outward from the inner edge of the resistance element to the outer edge thereof so that the longer paths which the current may traverse along the outer portions of the resistance element will have the same resistance as or less than the shortest path along the innermost edge thereof, thereby causing the current to distribute over the entire width of the resistance element in such proportions as will give a uniform distribution of the heat which is generated.

In the drawings I have shown a few of the various forms of construction adapted for carrying my invention into effect, and have also indicated several methods for manufacturing these forms of resistance elements. The first form and method are illustrated in Figs. 1 to 5, inclusive; and the second form and method are illustrated in Figs. 6 to 8A, inclusive; while further forms of construction are shown in Figs. 9 and 10; and Fig. 11 shows a different form of application of the film to a thin supporting member.

In the form of construction illustrated in Figs. 1 to 4, inclusive, the resistance element 14 is

substantially planar and substantially in the shape of an annular or arcuate film which is mounted and secured onto the upper face of the supporting base 13. The resistance film 14 increases in thickness gradually from its inner edge 30 to its outer edge 31, as best shown in Fig. 3, being shown in a grossly exaggerated form and thickness, for the purpose of illustration. The inner edge 30 is spaced from the central opening 12 of the base, and the outer edge 31 is spaced from the outer or peripheral edge of the base, substantially as shown. For the sake of economy, as well as for efficiency, the base is preferably made of bakelite, and the annular resistance film is bonded directly onto the upper face thereof, so as to form one unit therewith; and the base is preferably made of material having substantially the same coefficient of expansion as that of the film bonded thereon, so as to retain complete cohesion therebetween and prevent fractures which might otherwise occur.

In Figs. 6 to 8A, inclusive, I have illustrated my invention in another form of construction, wherein the film 34 is provided on the base 33 so as to increase in thickness progressively in successive steps or layers in the direction transversely of the element from the inner to the outer part thereof. Although only three layers or steps, 36, 37 and 38, are illustraded herein, a larger number of layers may be employed to increase the thickness of the strip more gradually. The first layer 36 extends the entire width of the resistance element from the inner edge to the outer edge thereof, as indicated in Fig. 6A; and the second layer 37 extends from a position slightly outwardly of the inner edge of the first layer, up to the outer edge of said first layer, as indicated in Fig. 7A; while the succeeding layer 38 extends from a position outwardly of the inner edge of said second layer to the outer edge thereof, in the manner indicated in Fig. 8A. This resistance element, like the preceding one, increases in thickness transversely thereof from its inner edge towards its outer edge, but in progressive steps, instead of increasing uniformly as the form shown in Fig. 3.

In Figs. 9 and 10, I have shown how I carry my invention into effect by constructing the film so that it will vary in resistance transversely of the element, as desired, although making the element of uniform thickness in such transverse direction.

As shown in Fig. 9, I can accomplish this by building up the resistance element with conductive paints or materials which possess different specific resistances; the paint of highest specific resistance and least conductivity being deposited upon the supporting member or base 43 adjacent the innermost edge of the resistance element 44, to provide the inner annular portion or ring 45 thereof, and the succeeding annular portions or rings 46, 47 and 48, of paint or material of a progressively less specific resistance and greater conductivity being applied concentrically outwardly thereof, toward the outer edge of the element. This is preferably done by the use of spraying means and shields which have arcuate openings therein, each of the proper size to provide the particular ring and all of different diameters, to be used in conjunction with the successive spraying operations.

As shown in Fig. 10, I can also build this desired resistance element so as to vary in resistance effect transversely thereof, though being uniform in thickness in such transverse direction, by depositing the film of paint on the base by intermingling the several sprays of the several paints or materials, and in such a manner that an excess of the material with the higher resistance and lower conductivity is applied chiefly along the inner part 52 of the annular element 53, upon base 54; while an excess of the material with the lower resistance and higher conductivity is applied chiefly along the outer part 55 of the element. In this form the particles of the carbonaceous conductive material will increase gradually in density in the carrier of resin or the like, from the inner part 52 toward the outer part 55 of the element 53, in the manner indicated in Fig. 10, to produce the resistance element possessing the desired properties, whereby to distribute the heat uniformly over the resistance element and the base.

By either of these two forms I construct a planar resistance element of substantially arcuate or annular form which is of uniform thickness and wherein the conductivity increases and the resistivity decreases from the inner edge toward the outer edge of the element, to produce a uniform distribution of heat thereover.

In Fig. 11, I have furthermore illustrated how the principle of my invention may be carried into effect by applying the film 57 of resistive material in either of its several forms of construction onto a thin annular strip or sheet 58 of fibrous material, preferably by spraying and bonding it onto the surface thereof, so that the strip provides the supporting means for the film, and by mounting such resistance element including the film 57 and strip 58 upon the usual supporting base 59 of the desired shape and material.

I can also carry out my invention by constructing the resistance element by itself, without in any way mounting or bonding it upon any supporting member or base; and I can make the element of substantial thickness or body, so that it will possess sufficient inherent strength to retain its shape and will not need any supporting member or base for retaining it in position.

In developing this invention I have also provided novel and improved methods for making these improved resistance elements. In Figs. 4 and 5, I have indicated how the tapering resistance element 13 can be made, by placing above or upon the base a short stationary shield 62, to cover the space 63 on the base, between the ends 64 of the arcuate resistance element; furthermore, positioning a rotary shield 65 a short distance above the base, said shield being provided with suitably shaped and placed openings 66, as best shown in Fig. 4, whereby the spray 67, preferably supplied by a spray gun 68, is directed into the proper position on the base for forming the resistance element. It should be noted that these openings 66, at their outward ends 69, have their two sides placed farther apart or beyond the radii 70 which extend through their inner ends 71, in order to expose the base to a relatively larger extent along the outer side of the resistance element than along the inner side thereof, so as to increase the spray and the deposit of carbonaceous material in the outward direction of the element. By properly slanting these sides of the opening, the increase in thickness transversely of the element or from the inner side to the outer side thereof, can be formed in the particular shape necessary to provide for uniform distrbution of heat over the surface of the resistance element. It is also apparent that by rotating the shield at a speed which varies dur-

ing each rotation thereof, while traveling from one end to the other end of the arcuate resistance element, the thickness of film and the resistive effect thereof can likewise be varied in the direction circumferentially of the element or in the direction of rotation of the contactor traveling thereover, so as to provide a resistance element having any predetermined rate or rates of resistance increase between terminals, as well as one wherein the heat will be uniformly distributed throughout the width of the element.

The form shown in Figs. 6 to 8A, inclusive, is preferably built up in successive steps or layers **36**, **37** and **38**, by the use of a series of successive shields having openings therein which decrease in width. The first shield **75**, which is provided with the larger opening **76** therein of the proper size to provide the layer **36**, is placed in a stationary position above the base **33**, whereupon the spray **77** of liquid carbonaceous material is directed through the opening **76**, as indicated in Fig. 6A, and the layer **36** is deposited upon the base. The shield **78** with an opening **79**, slightly narrower than the opening **76**, is next placed above the base **33** upon which the layer **36** has been deposited, and the spray of material **80** is directed through said opening to deposit the next layer **37**, as indicated in Fig. 7A. Thereupon the succeeding shield **81** is positioned above the base and above the layers of films so far provided thereon; and the succeeding layer **38** is next applied by the spray passing through the narrower opening **82** provided in said shield, so as to form the following layer of the film, as indicated in Fig. 8A. The successive layers are thus provided, so as to increase the film conductivity and decrease the resistivity in a direction transversely of the resistance element outwardly from the inner edge to the outer edge thereof.

In this form of the invention the resistance film is also shown excessively thick and with an exaggerated increase in thickness in an outward direction, for the purpose of illustration; and it is shown with three layers, although more layers may be used to provide the increase of conductivity more gradually.

The forms shown in Figs. 9, 10 and 11 are also conveniently built up by spraying the resistive material onto the supporting base or onto the thin supporting means mountable on or mounted upon the base, this being done substantially in the manner indicated above in the particular descriptions concerning each of these forms.

With this arrangement of resistance element, in either of its forms, the heat is uniformly distributed over the element and is readily dissipated from the device. Said heat which is generated by the resistance element is radiated from the device, through the cover thereon, and through the base and the ground plate thereunder to the panel, being therefrom dissipated. The heat is also dissipated by conduction, by passing from the resistance element and the base and from the cover onto the ground plate, and therefrom onto the bushing and the panel therebelow to be dissipated thereby. The unequal heating and overheating of the resistance element is thus effectively overcome with this invention.

Although I have herein disclosed certain preferred ones of the various contemplated forms of my invention, I do not intend to be limited to the particular embodiments shown and described, but only insofar as defined by the scope and spirit of the appended claims.

I claim:

1. In a resistance device, a substantially arcuate resistance element of conductive material, wherein the conductive material is so positioned that the conductivity increases and the resistance of the resistance element per unit of area decreases in a direction extending transversely outwardly across the element, to provide for a uniform distribution of heat thereover.

2. In a variable resistance device, a substantially annular resistance element of conductive material, said element including carbonaceous means provided to an increased extent transversely of the element from its inner edge toward its outer edge, whereby it decreases in resistance in such transverse outward direction, to provide for a uniform distribution of heat over the element.

3. In a variable resistance device, a substantially annular resistance element of conductive material, which is increased in thickness transversely outwardly across the element, and thereby increases the conductivity and decreases the resistance of the element transversely outwardly thereof, to provide for a uniform distribution of heat over said element.

4. In a variable resistance device, a supporting member having a substantially annular resistance element of conductive material bonded on its face, said element increasing in conductive means and thereby decreasing in resistance in a direction transversely outwardly from the inner edge toward the outer edge thereof, to facilitate the current in flowing outwardly of the element and to provide for a uniform distribution of heat over the element.

5. A resistance unit comprising a supporting base of non-conductive material, and a curved resistance element of carbonaceous material which is secured on the face of the base and wherein the conductive means is provided to an increasing extent per unit of area in a direction outwardly across the element, so that the element gradually increases in conductivity and decreases in resistance in such transverse outward direction, to distribute the heat uniformly thereover.

6. A resistance unit adapted for a variable resistance device, said unit comprising in combination, a base of non-conductive material, and a curved resistance element of carbonaceous material secured on the base, said element having carbon particles therein which increase in number gradually in a direction transversely outwardly of said element, whereby to increase the conductivity and to decrease the resistance of the element transversely outwardly thereof, for providing a relatively even dissipation of heat from said unit and device.

7. A resistance unit comprising a member of non-conductive material, and a resistance element of conductive material bonded onto the face of said member, said resistance element being substantially annular in form and increasing in thickness and conductivity in a direction transversely outwardly across the element, to provide for a uniform distribution of heat over the element.

8. A resistance unit comprising a base of non-conductive material, and a resistance element substantially in the form of an annular film of carbonaceous material which is bonded onto the face of said base and increases in thickness and in conductivity uniformly in a direction trans-

versely outwardly of the element, to distribute the heat uniformly thereover.

9. A resistance unit comprising a supporting base, and a substantially annular resistance element of conductive material secured on said base, the element containing the conductive means to a progressively increasing amount in a direction transversely outwardly thereof, so that it increases in conductivity and decreases in resistance in progressive steps in a direction transversely outwardly of the element, to provide for a substantially even distribution of heat thereover.

10. A substantially arcuate resistance element of conductive material comprising a plurality of successively narrower superposed layers, combined into a unitary element which increases in thickness and conductivity transversely outwardly thereof, to provide for a substantially even distribution of heat over the element.

11. In a resistance device, a supporting member, and a substantially annular resistance element of conductive material supported on said member, said element comprising a plurality of successively narrower superposed annular layers, combined into a unitary structure which increases in thickness and in conductivity transversely outwardly of the element, to provide for a substantially even distribution of heat thereover.

12. A resistance unit comprising a base of non-conductive material, and a resistance element substantially in the form of an annular film of carbonaceous material bonded onto the face of said base, said film consisting of a plurality of successively narrower superposed annular layers, providing a unitary film which increases gradually in thickness and in conductivity transversely from the inner edge toward the outer edge of the element, to provide for a substantially uniform distribution of heat over the element.

13. A resistance unit comprising a supporting base, and a resistance element of conductive material bonded onto the face of said base, being substantially in the form of an annular film which increases in thickness in progressive steps in a direction transversely from the inner edge, toward the outer edge of the film, to provide for a substantially uniform distribution of heat over the element.

14. In a resistance device, a supporting member, a substantially annular resistance element of conductive material supported on said member, said element containing conductive particles to an increasing extent per unit of area in a direction transversely outwardly across the element, whereby it increases in conductivity and decreases in resistance in such outward direction, and the element being of substantially uniform thickness in such transverse direction, to provide for a uniform distribution of heat over the element.

15. A substantially annular resistance element consisting of a plurality of concentrically positioned rings of conductive material which are each of decreasing specific resistivity in a direction transversely outwardly of the element, being combined into a unitary element which increases in conductivity and decreases in resistance in such transverse outward direction, to distribute the heat substantiallly uniformly thereover.

16. In a resistance device, a supporting member, and a substantially annular resistance element of conductive material supported on said member, said element comprising a series of substantially concentrically positioned joined rings of conductive material, each succeeding one of which is of less resistivity than the preceding ring, in a direction transversely outwardly across the element, whereby the element decreases in resistance in such outward direction, to distribute the generated heat substantially uniformly thereover.

17. A resistance unit comprising a supporting member of non-conductive material and a resistance element in the form of a substantially annular resistance film bonded on said member, said element comprising a plurality of concentrically positioned rings of conductive material, each of which is of material possessing less specific resistivity than the ring inwardly thereof, said rings being combined into a unitary element which decreases in resistance transversely outwardly thereof, but is of a substantially uniform thickness in such transverse direction, to distribute the generated heat substantially uniformly over the element.

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