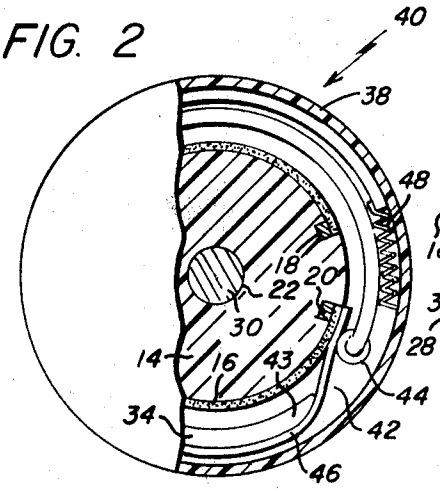
June 2, 1970 R. J. ESTLICK 3,516,041

VARIABLE RESISTANCE DEVICE

Filed Dec. 24, 1968

FIG. 2



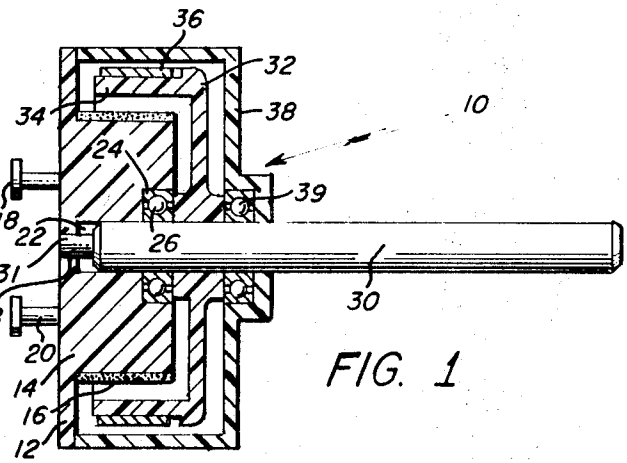


FIG. 1

FIG. 3

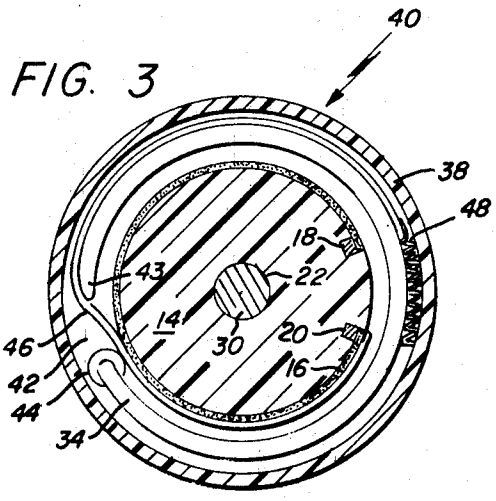


FIG. 4

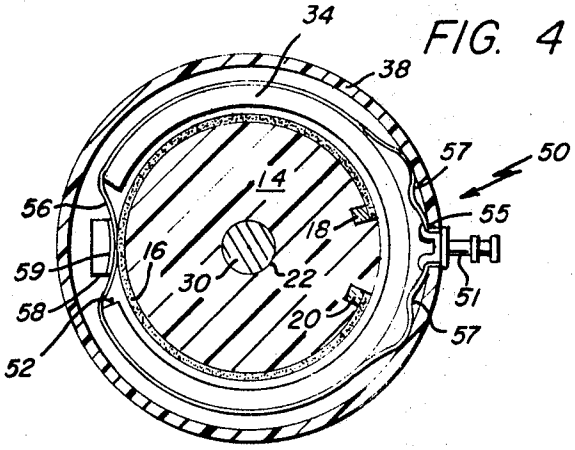


FIG. 5

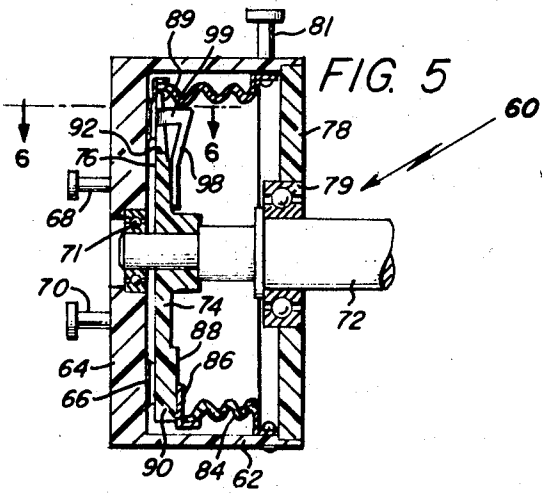
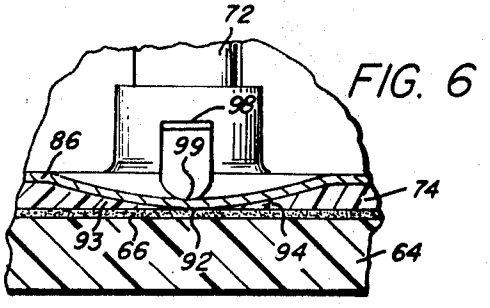


FIG. 6



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United States Patent Office 3,516,041 Patented June 2, 1970

3,516,041

VARIABLE RESISTANCE DEVICE

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Filed Dec. 24, 1968, Ser. No. 786,692
Int. Cl. H01c 9/00
U.S. Cl. 338—154 13 Claims

ABSTRACT OF THE DISCLOSURE

A variable resistance device comprising a resistive element having at least one end attached to an electrical terminal, a resilient band of conductive material disposed in spaced relationship with the resistive element and having a portion thereof connected to another electrical terminal, and an intervening dielectric member having a movable opening through which a selected portion of the resilient band is pressed against an adjacent portion of the resistive element.

BACKGROUND OF THE INVENTION

This invention is related generally to electrical control devices and is concerned more particularly with variable resistance devices.

A variable resistance device usually comprises a resistive element having at least one end connected to an electrical terminal and a tap slidable upon the resistive element and connected to another electrical terminal. Moving the slidable tap changes the length of the resistive element between the two terminals and, therefore, provides a means for selecting various values of electrical resistance. Generally, the resistive element is a wire coil or a thin film of resistive material disposed on a rigid surface, and the slidable tap is a wiper arm contact which presses resiliently against a selected surface portion of the resistive element. In many types of variable resistance devices, such as rheostats and potentiometers for example, the resistive element is arcuate in shape and one end of the wiper arm is attached to a rotatable shaft having an indicator knob attached to one end thereof. Thus, turning the indicator knob rotates the shaft and attached wiper arm, thereby sliding the wiper arm contact over the resistive surface until the desired length of resistive element is obtained. Since the wiper arm contact is movable and the associated electrical terminal is fixed, commutator brushes or the like are required to frictionally engage the rotatable shaft in order to achieve an electrical connection between the wiper arm contact and the connecting terminal. Due to frictional engagement of commutator brushes or the like with the rotatable shaft and the wiper arm contact sliding over the resistive surface, an undesirable level of electrical noise is introduced into connecting circuitry. Furthermore, the wiper arm contact pressing resiliently against the resistive surface as it slides to each newly selected position causes an excessive amount of wear, particularly in the case of thin film resistive elements.

The problems of electrical noise and abrasion of the resistive surface can be solved by eliminating the slidable tap and substituting in place thereof another means for selecting various lengths of the resistive element. One method of achieving this objective is to dispose a resilient band of conductive material in spaced, parallel relationship with a surface of the resistive element and to provide a roller or similar means for pressing only a discrete portion of the resilient band against a selected surface area of the resistive element. The resilient band is a fixed element and, therefore, is attached directly to the associated electrical terminal. Consequently, commutator

brushes or the like and the frictional engagement thereof are not required, and this source of electrical noise is eliminated. The selected value of electrical resistance is proportional to the length of the resistive element between one end thereof and the contacting portion of the resilient band. Thus, various lengths of the resistive element can be connected between the associated electrical terminals by moving the roller or similar means and thereby changing the discrete portion of the resilient band in contact with the adjacent surface of the resistive element. Since the resilient band does not move transversely in relation to the resistive surface, friction and abrasive wearing away of the resistive element are eliminated. Therefore, the resilient band also functions as a protective wear strip btween the pressure of the roller or similar means and the adjacent surface of the resistive element.

Some variable resistance devices of the prior art have a resilient band of conductive material in pressure contact with a selected portion of a resistive surface. However, most of these prior art devices depend upon the resiliency of the conductive band to prevent undesired contact between the conductive band and the adjacent resistive surface. In severe environments, such as military and space vehicles for example, it has been found that the resilient band is extremely sensitive to vibration, and undesired contact occurs intermittently between the resilient band and the adjacent resistive surface. If the conductive band loses resiliency due to age or fatigue, the problem of undesirable contact between the conductive band and the adjacent resistive surface becomes even more acute. Furthermore, the aforementioned prior art devices do not provide means for controlling the selected area of contact between the resilient band and the adjacent resistive surface. In order to obtain discrete data, conductive engagement should be confined to a definite area of contact between the resilient band and the adjacent resistive surface.

SUMMARY OF THE INVENTION

Accordingly, this invention provides a variable resistance device including a conductive element in spaced relationship with a resistive element and an intervening, rotatable, dielectric member having an opening through which a definite portion of the resilient band is pressed into conductive engagement with a selected portion of the adjacent resistive surface by means of a deflection device carried on the dielectric member adjacent the movable opening. The intervening dielectric member prevents undesired contact between areas of the resilient band and adjacent areas of the resistive surface. One embodiment of this invention is a rheostat comprising a resistive element having one end attached to an electrical terminal, a resilient band of conductive material in spaced, parallel relationship with the resistive element and having one end attached directly to another electrical terminal, a rotatable dielectric member having a portion thereof which interleaves between unengaged portions of the resistive surface and the resilient band where conductive engagement is not desired, and further having a movable opening through which a definite area of the resilient band is pressed into conductive engagement with a selected area of the adjacent resistive surface by a roller deflection device carried on the dielectric member adjacent the opening. Another embodiment of this invention is a potentiometer comprising a resistive element having ends attached to respective electrical terminals, a resilient band of conductive material in spaced, parallel relationship with the resistive element and having a portion thereof attached to another electrical terminal and an intervening, rotatable, dielectric member having an opening through which a discrete portion of the resilient band is pressed into contact with an adjacent portion of the re-

sistive surface by means of a cantilever deflection device carried on the dielectric member adjacent the movable opening. A third embodiment of this invention is a continuous rotation potentiometer comprising a conductive bellows having an end portion attached to an electrical terminal and an opposite end portion holding a resilient band of conductive material against the cam-like surface of a rotatable dielectric disc which overlays a resistive element having ends attached to respective electrical terminals. The dielectric disc carries a cantilever deflection device which presses a discrete portion of the resilient band through an opening in the disc and into conductive engagement with a selected portion of the adjacent resistive surface.

BRIEF DESCRIPTION OF THE DRAWING

For a better understanding of this invention, reference is made to the accompanying drawing wherein:

FIG. 1 is an axial sectional view of a preferred embodiment of this invention;

FIG. 2 is a plan view, partly in transverse cross-section, of a rheostat embodying the invention;

FIG. 3 is a transverse sectional view of the rheostat of FIG. 2 showing the intervening dielectric member rotated approximately ninety degrees;

FIG. 4 is a transverse sectional view of a potentiometer embodying the invention;

FIG. 5 is an axial sectional view of a potentiometer embodying another form of the invention; and

FIG. 6 is an enlarged, fragmentary view taken along line 6—6 of FIG. 5 looking in the direction of the arrows.

DESCRIPTIONS OF THE PREFERRED EMBODIMENTS

Referring to the drawing wherein like characters of reference designate like parts throughout the several views, there is shown in FIG. 1 a variable resistance device **10** having a circular base **12** of dielectric material, such as phenolic for example, which supports a centrally located drum **14** of dielectric material, such as phenolic for example. The base **12** and drum **14** may be integral parts of the same member or may be separate parts that are bonded together by conventional means, such as epoxy adhesive for example. An arcuate-shaped resistive element **16** comprising a thin film of resistive material, such as carbon granules for example, is disposed on the external circumferential surface of drum **14** by any convenient means, as by deposition for example. The ends of resistive element **16** are connected electrically to inner ends of respective terminals **18** and **20** which are embedded in the dielectric material of drum **14**. The opposite ends of terminals **18** and **20** protrude from the external surface of base **12** for convenience in attaching electrical conductors thereto. A centrally located bore **22** in drum **14** terminates at one end in a larger diameter cavity **24** into which is pressed a ball bearing **26**. The opposite ends of bore **22** surrounds a smaller diameter bore **28** in the base **12**.

A shaft **30** is mounted in bearing **26** and is provided with a reduced shank **31**, at one end, which rotates within bore **22**. Fixedly attached to shaft **30** is a cup-shaped housing **32** of dielectric material, such as laminated fiberglass for example, which encloses the drum **14** and resistive element **16**. The longitudinal wall **34** of housing **32** separates a surrounding band **36** of highly conductive material, such as beryllium-copper for example, from the adjacent surface of resistive element **16**. A ball bearing **39** is centrally located in the closed end of a cup-shaped cover **38** and rotatably supports shaft **30** when cover **38** is installed. Cover **38** is made of dielectric material, such as phenolic for example, and is attached, at the other end, to the outer periphery of the base **12** by any convenient means, such as bonding with epoxy adhesive for example. Since housing **32** is fixedly attached to shaft **30**, turning of shaft **30** rotates the longitudinal wall **34** of

housing **32** around the fixed resistive element **16**. This described structure may be adapted to provide a rheostat or a potentiometer as will be brought out in the following discussion.

In the rheostat **40** shown in FIG. 2, a resilient band **46** of conductive material is attached, at one end, to terminal **20** by suitable means, as by welding for example, and is passed through a slotted opening **42** in the longitudinal wall **34** of housing **32**. A roller **44**, mounted on wall **34** at one side of opening **42**, presses a discrete portion of band **46** against the adjacent surface of resistive element **16**. Band **46** curves around a tapered edge **43** on the opposite side of opening **42** and follows the external contour of wall **34**. At the opposite end, band **46** is attached, as by welding for example, to one end of a helical spring **48**. The opposite end of spring **48** is secured to the wall of cover **38** by conventional means, as by hooking the adjacent end of spring **48** into a suitably located hole (not shown) in the wall of cover **38**. Spring **48** maintains a tension on band **46** and holds it against the external surface of wall **34**.

The portion of resistive element **16** between roller **44** and terminal **20** is short-circuited by the conductive band **46**. Therefore, the electrical effect of the rheostat is the same even when terminal **20** is insulatingly spaced from the adjacent end of the resistive element **16**. Only the portion of resistive element **16** between terminal **18** and the roller **44** is effective as an electrical resistance. Since roller **44** moves along the band **46** when the housing **32** is rotated, the value of electrical resistance connected between terminals **18** and **20** may be selected by turning shaft **30**. As shown in FIG. 3, when the housing **32** is rotated clockwise, the edge **43** of opening **42** moves toward terminal **18**. The roller **44** advances smoothly along the band **46**, continuously pressing successive discrete contiguous portions thereof into conductive engagement with the adjacent surface of resistive element **16**. The entire length of band **46** which has been passed over by the roller **44** need not remain in contact with the resistive element **16** since that portion of the resistive element is short-circuited by the engaged portion of band **46**. Therefore, only the discrete portion of band **46** between the roller **44** and the adjacent resistive surface is conductively engaged with the resistive element **16**.

If the edge **43** of opening **42** is spaced too close to roller **44**, the band **46** will not curve smoothly under the roller **44** and the shaft **30** will be difficult to turn. If the edge **43** of opening **42** is spaced too far from the roller **44**, a random-sized area will contact the exposed surface of resistive element **16** in front of the advancing roller **44**. Therefore, edge **43** of opening **42** is so spaced from the roller **44** that the band **46** will curve smoothly around the tapered edge **43** and under the roller **44**, without contacting the exposed surface of resistive element **16** prior to the roller **44** pressing a discrete portion thereof against the adjacent surface of resistive element **16**. Since the roller **44** engages the conductive band **46** tangentially, a definite line of contact is established between the band **46** and the exposed surface of resistive element **16**. Thus, only a controlled portion of the conductive band **46** is permitted to conductively engage the exposed surface of resistive element **16**, namely the discrete portion of conductive band **46** which is pressed against the adjacent surface of resistive element **16** by the roller **44**.

When housing **32** is rotated counter-clockwise, the roller **44** moves arcuately toward terminal **20** and the tapered edge **43** of opening **42** interleaves between the conductive band **46** and the adjacent surface of resistive element **16**. The spring **48** maintains tension on conductive band **46** and holds the disengaged portion thereof against the external surface of wall **34**. The disengaged portion of conductive band **46** is insulated from the exposed surface of resistive element **16** by the intervening wall **34** of dielectric housing **32**. Thus, undesired contact cannot occur between the disengaged portion of conductive band

46 and the exposed surface of resistive element 16 even under severe conditions of shock and vibration. It should be noted that the definite line of contact between band 46 and the exposed surface of resistive element 16 is maintained when housing 32 is rotated in the counter-clockwise direction also. Therefore, the controlled portion of band 46 in contact with the adjacent surface of resistive element 16 is still limited to the discrete portion of band 46 being pressed against the exposed surface of resistive element 16 by the roller 44.

In the potentiometer 50 shown in FIG. 4, the respective ends of resistive element 16 are connected directly to the respective terminals 18 and 20. A terminal 51 is inserted through an opening 55 in the longitudinal wall of cover 38 and attached, as by swaging for example, to both ends of a conductive band 56. The band 56 is made of a resilient material, such as beryllium-copper for example, and encircles the longitudinal wall 34 of dielectric housing 32. Convolutions 57, formed in the band 56 adjacent the respective ends thereof, function as integral springs which maintain tension on the band 56 and hold it against the external surface of wall 34. A slotted opening 52, having opposing longitudinal edges, is provided in the wall 34, and a cantilever deflector arm 58 presses a portion of the band 56 through the opening 52 toward the exposed surface of resistive element 16.

The deflector arm 58 comprises an L-shaped bracket of resilient material, such as spring steel for example. A transversely extending portion of the deflector arm 58 is attached, as by riveting for example, to the closed end of the housing 32 adjacent the opening 52. Thus, the deflector arm 58 is fixedly attached to the housing 32 and rotates with it when the shaft 30 is turned. A longitudinally extending portion of the deflector arm 58 is centrally disposed in the opening 52 of wall 34. The deflector arm 58 slopes inwardly toward the resistive element 16 and has an end portion in closely spaced, parallel relationship with the adjacent surface of resistive element 16. The longitudinal edges of deflector arm 58 are bowed away from the resistive element 16 thereby providing a longitudinally extending crest 59 which presses a discrete portion of the conductive band 56 against the adjacent surface of resistive element 16. Thus, the crest 59 establishes a definite line of contact between the band 56 and the exposed surface of resistive element 16.

In the operation of the potentiometer 50 shown in FIG. 4, the terminals 18 and 20 are connected to respective terminals of a voltage source (not shown) and a potential gradient is established along the length of resistive element 16 from terminal 18 to terminal 20. Since the deflector arm 58 rotates with housing 32, any discrete portion of the conductive band 56 can be selected for conductive engagement with an adjacent portion of the resistive element 16. Thus, various intermediate values of voltage potential can be connected between terminal 18 and terminal 51 by turning shaft 30 and rotating housing 32. When housing 32 is rotated, the deflector arm 58 moves smoothly along the conductive band 56 which is held stationary by the terminal 51 and the convolutions 57. The crest 59 of deflector arm 58 presses successive discrete portions of the band 56 into conductive engagement with the adjacent surface of resistive element 16. Since the arcuate-shaped end of deflector arm 58 engages the conductive band tangentially, a definite line of contact is established between the conductive band 56 and the exposed surface of resistive element 16. The motion of each discrete portion of band 56 when pressed by the deflector arm 58 is nutational with respect to the exposed surface of resistive element 16. Thus, sliding engagement does not occur between the conductive band 56 and the resistive element 16. However, sliding engagement does occur between the conductive band 56 and the adjacent surface of deflector arm 58. Therefore, the conductive band 56 functions as a protective wear strip between the deflector arm 58 and the exposed surface of resistive element 16.

If the edges of opening 52 are too close to the deflector arm 58, the band 56 will not curve smoothly between the crest 59 of arm 58 and the adjacent surface of resistive element 16. Consequently, the shaft 30 will be difficult to turn and will move irregularly. If the edges of opening 52 are too far apart, more than a discrete portion of the band 56 will be conductively engaged with the exposed surface of resistive element 16 and the crest 59 of deflector 58 will not establish a definite line of contact between the band 56 and the adjacent surface of resistive element 16. Therefore, the arcuate-shaped surface of deflector arm 58, adjacent the band 56, and the width of the opening 52 control the portion of band 56 that will be conductively engaged with the exposed surface of resistive element 16 and ensure that the band 56 will curve smoothly between the crest 59 of deflector arm 58 and the adjacent surface of resistive element 16. In this manner, a definite line of contact will be established between the crest 59 and the adjacent surface of resistive element 16. The disengaged portion of band 56 is insulated from the exposed surface of resistive element 16 by the intervening wall 34 of dielectric housing 32. Therefore, undesired contact cannot occur between the disengaged portion of band 56 and the adjacent surface of resistive element 16.

In FIG. 5, there is shown a continuous rotation potentiometer 60 comprising a cup-shaped housing 62 made of dielectric material, such as phenolic for example, having an integral base 64. An arcuate-shaped resistive element 66, similar to resistive element 16 shown in FIG. 4, is deposited on the internal surface of the circclar base 64. The ends of resistive element 66 are connected directly to respective terminals 68 and 70 which extend through the base 64 to protrude from the external surface thereof, similar to terminals 18 and 20 shown in FIG. 4. A ball bearing 71 is centrally mounted, as by press-fitting, in the base 64 and supports one end of a rotatable shaft 72 which carries a disc 74. The disc 74 is made of a dielectric material, such as phenolic for example, and is provided with a flat surface 76 which is disposed in close-spaced, parallel relationship with the base 64 and the adjacent surface of resistive element 66.

An electrical terminal 81 is inserted through the longitudinal wall of housing 62 and is attached to one end of a conductive bellows 84 by suitable means, as by swaging for example. The adjacent periphery of the conductive bellows 84 is attached to the wall of housing 62 by convenient means, as by rivets for example. The opposite end of the bellows 84 is fixedly attached, as by welding for example, to the longitudinally extended rim of an annular band 86. Band 86 comprises a conductive ring of resilient material, such as beryllium-copper for example, which is pressed against an adjacent sloped surface 88 of the dielectric disc 74 by the bellows 84. The sloped surface 88 of disc 74 meets the flat surface 76 thereof in an oblique angle which forms a thin region 89 in the disc diametrically opposite a thick region 90. As shown in FIG. 6, a radial slot 92 is provided in the thin region 89 of dielectric disc 74 and has opposing sides which taper to thin edge portions 93 and 94 respectively. A cantilever deflector arm 98 of resilient material, such as phenolic for example, is fixedly attached, at one end, to the dielectric disc 74, as by bonding for example, and is centrally disposed, at the other end, in the opening of radial slot 92. An arcuate-shaped end 99 of the deflector arm 98 presses a discrete portion of the conductive band 86 into contact with the adjacent surface of resistive element 74, shown greatly exaggerated in FIG. 6 for purposes of clarity. Since the arcuate-shaped end 99 of the deflector arm 98 engages the conductive band 86 tangentially, a definite line of contact is established between the band 86 and the resistive element 66.

A ball bearing 79 (FIG. 5) is centrally disposed in a circular cover 78 of dielectric material, such as phenolic

for example. The ball bearing 79 slidingly engages the shaft 72 when cover 78 is assembled and secured to the open end of housing 62 by any convenient means, as by bonding with epoxy adhesive for example. Thus, shaft 72 is rotatably supported by ball bearing 71 in the base 64 and ball bearing 79 in the cover 78. Turning of shaft 72 rotates the dielectric disc 74 and the deflector arm 98, thereby causing the arcuate-shaped end 99 of deflector arm 98 to move around the conductive band 86, pressing contiguous successive discrete portions thereof into conductive engagement with the exposed surface of resistive element 66. The conductive band 86 is held stationary by the conductive bellows 84, and the motion of each discrete portion of the conductive band is nutational with respect to the exposed surface of the resistive element 66. Consequently, sliding engagement does not occur between the conductive band 86 and the exposed surface of resistive element 66.

Because of the arcuate-shaped end 99 of deflector arm 98 and the tapered edge portions 93 and 94 on respective sides of slot 92, the conductive band 86 curves smoothly between the deflector arm 98 and the exposed surface of resistive element 66. If the edges of slot 92 are too close to the end 99 of deflector arm 98, the conductive band 86 may not contact the adjacent surface of resistive element 66, and the shaft 72 will be difficult to turn. If the edges of slot 92 are too far apart, more than a discrete portion of the conductive band 86 will contact the exposed surface of resistive element 66, and the arcuate end 99 of deflector arm 98 will not establish a definite line of contact between the band 86 and the resistive element 66. Therefore, the arcuate-shaped end 99 of the deflector arm 98 and the width of the slot 92 control the portion of the band 86 that conductively engages the exposed surface of resistive element 66 and ensure that the band 86 will curve smoothly between the deflector arm 98 and the adjacent surface of resistive element 66. In this manner, a definite line of contact will be produced between a discrete portion of the band 86 and the exposed surface of the resistive element 66. Since this potentiometer permits continuous rotation of the dielectric disc 74, the contacting area of the conductive band 86 must not be large enough to span the distance between the respective ends of the arcuate resistive element; otherwise, the connecting voltage source will be short-circuited. However, this invention provides means for controlling the contacting area of the conductive band 86 and limiting it to the discrete portion of the band 86 tangentially engaged by the arcuate end 99 of the deflector arm 98. Thus, with the use of this invention, the respective ends of the arcuate resistive element 66 can be spaced quite close to one another and a short-circuit will not occur between them. The disengaged portion of the conductive ring 86 is insulated from the adjacent surface of the resistive element 66 by the intervening dielectric disc 74. Therefore, undesired contact cannot occur between the disengaged portion of the conductive ring 86 and the adjacent surface of the resistive element 66.

Thus, there has been disclosed herein a novel resistance device of the variable type having a resilient band of conductive material disposed in spaced relationship with an exposed surface of a resistive element and an intervening dielectric member having a movable opening through which a discrete portion of the conductive band is pressed into conductive engagement with a selected portion of the resistive element by means of a deflection device carried by the dielectric member and adapted to move with the opening in the dielectric member. Although this invention has been illustrated herein with arcuate-shaped resistive elements, it may be readily adapted for use with resistance elements having other configurations such as linear resistive elements, for example. Furthermore, this invention is applicable to variable resistance devices having a wire coil or other type of resistive element such as conductive epoxy, for example. These and other modifications which may occur to those skilled in the art are considered to be within the spirit and scope of this invention and, as such, are intended to be inclined within the claims appended hereto.

What is claimed is:

1. An electrical control device comprising:
a resistive element connected to a first electrical terminal;
a conductive element connected to a second electrical terminal and having a portion thereof disposed in spaced relationship with a portion of the resistive element;
a dielectric member disposed between said spaced portions of the resistive element and conductive element and having an opening therein; and
pressure means for moving the conductive element and resistive element into contact with one another through the opening in the dielectric member.

2. An electrical control device comprising:
a resistive element having an end portion connected to a first electrical terminal;
a dielectric member having one surface disposed in spaced, parallel relationship with the resistive element, an opposite surface, and an opening therethrough;
a conductive element connected to a second electrical terminal disposed upon said opposite surface with a portion thereof disposed within said opening; and
means for pressing a discrete area of said portion of the conductive element into electrical contact with the resistive element.

3. A variable resistance device comprising:
a movable dielectric member having a first surface, an opposite surface and an opening therethrough;
a resistive element having an end portion connected to a first electrical terminal and disposed in spaced, parallel relationship with the dielectric member;
a conductive element connected to a second electrical terminal disposed upon the surface of dielectric member opposite the resistive element and said opening; and
means carried by the dielectric member, adjacent the opening therein, for pressing successive discrete portions of the conductive element into conductive engagement with the resistive element.

4. A variable resistance device as set forth in claim 3 wherein the dielectric member is rotatable and the resistive element is arcuate.

5. A variable resistance device as set forth in claim 3 wherein said means comprises a deflection device having an arcuate surface pressed tangentially against the conductive element thereby establishing a definite line of contact between the conductive element and the resistive element.

6. A variable resistance device as set forth in claim 5 wherein the opening in the dielectric member has sides spaced a predetermined distance apart and, in conjunction with the arcuate surface of the deflection device, cooperatively determine the area of the resistive element conductively engaged by the conductive element.

7. A variable resistance device as set forth in claim 6 wherein the conductive element is a resilient band of conductive material.

8. A variable resistance device as set forth in claim 7 where in the band is linear.

9. A variable resistance device as set forth in claim 7 wherein the band is annular.

10. A variable resistance device comprising:
a first dielectric cylinder,
an arcuate resistive element concentrically disposed on the convex surface of the first dielectric cylinder and having an end portion attached to a first electric terminal,
a rotatable second dielectric cylinder disposed in encircling relationship with the resistive element and

having a slotted opening therethrough of predetermined width,

an elongated band of conductive material having a major portion thereof disposed in parallel relationship with the resistive element and having one end portion attached to an electrical terminal, an opposite end portion held resiliently against the convex surface of the second dielectric cylinder and an intermediate discrete portion disposed within the opening of the dielectric cylinder and conductively engaged with the resistive element, and

a deflection device carried by the second dielectric cylinder adjacent the opening therein and having an arcuate surface disposed in tangential engagement with the discrete portion of the conductive band.

11. A variable resistance device as set forth in claim **10** wherein said device is a rheostat, and said one end portion of the band is disposed between the resistive element and the second dielectric cylinder, and said deflection device is disposed on the side of the opening adjacent the second electrical terminal.

12. A variable resistance device as set forth in claim **10** wherein said device is a potentiometer, said one end portion of the band is held resiliently against the convex surface of the second dielectric cylinder, said opposite end of the resistive element is attached to a third electrical terminal, and said deflection device is centrally disposed in the opening of the dielectric cylinder.

13. A variable resistance device comprising:

an arcuate resistive element disposed on a flat surface of dielectric material and having end portions attached to respective electrical terminals,

a rotatable disk of dielectric material in parallel spaced relation ship with the resistive element and having an opening therethrough of predetermined width,

an annular band of conductive material disposed in resilient engagement with the side of the disk opposite the resistive element, the band being connected to a third electrical terminal and having a discrete portion disposed within the opening of the dielectric disk and conductively engaged with the resistive element, and

a deflection device carried by the dielectric disk adjacent the opening therein and having an arcuate surface disposed in tangential engagement with the discrete portion of the conductive band.

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U.S. Cl. X.R.

338—96