Nov. 18, 1958 K. W. JARVIS 2,861,158

VARIABLE RESISTOR

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FIG. 1

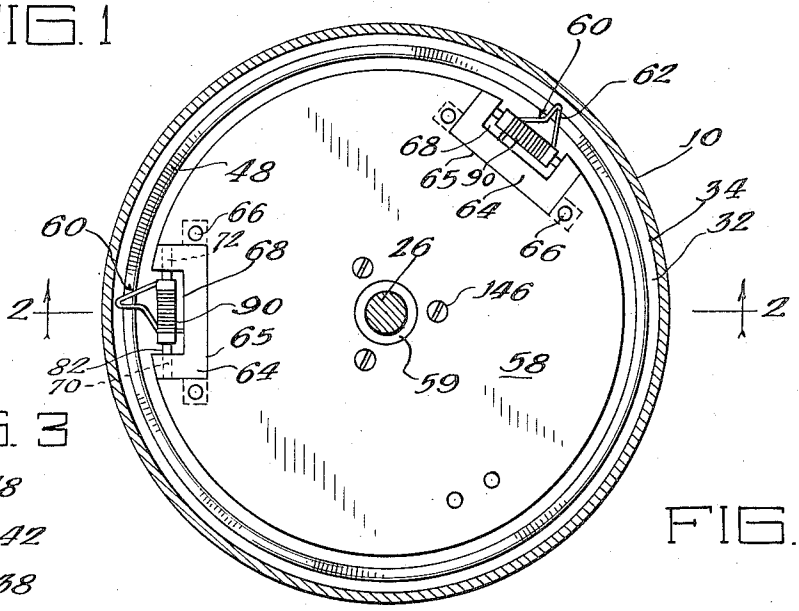


FIG. 3

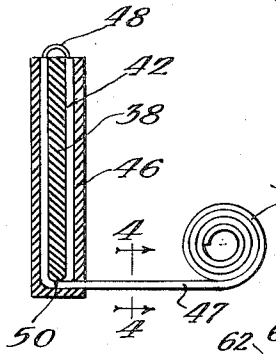
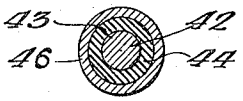


FIG. 4



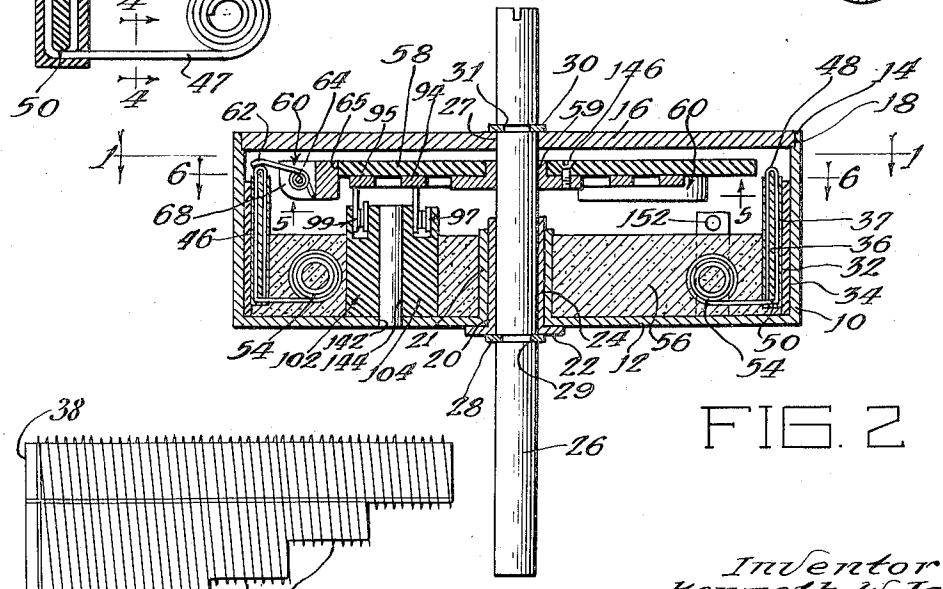


FIG. 2

FIG. 9

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FIG. 5

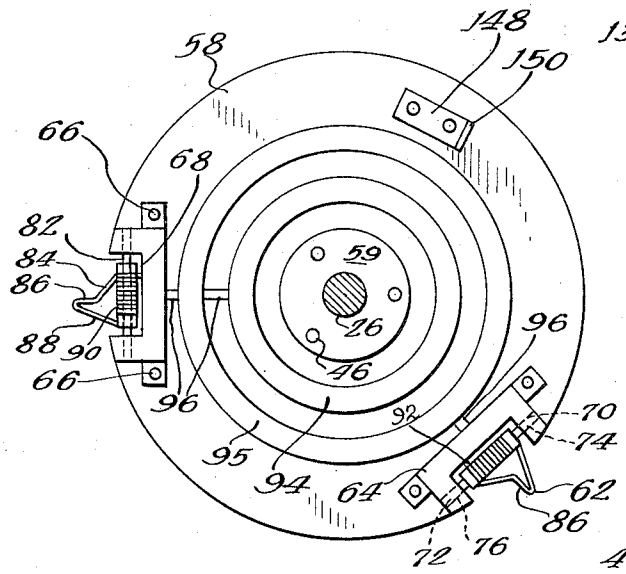


FIG. 7

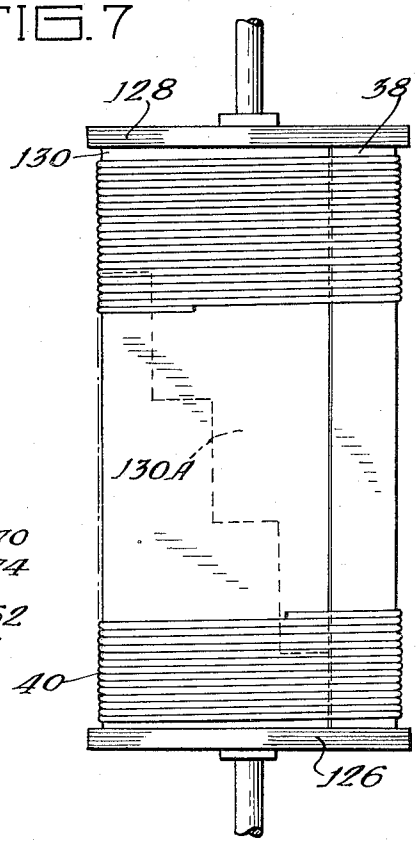


FIG. 6

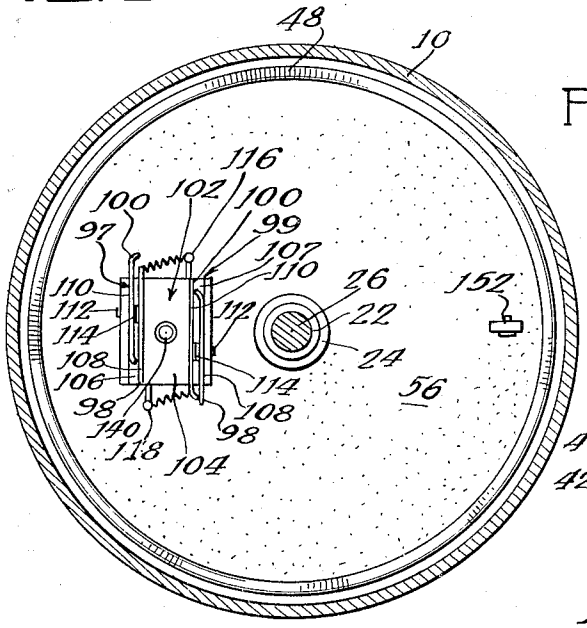
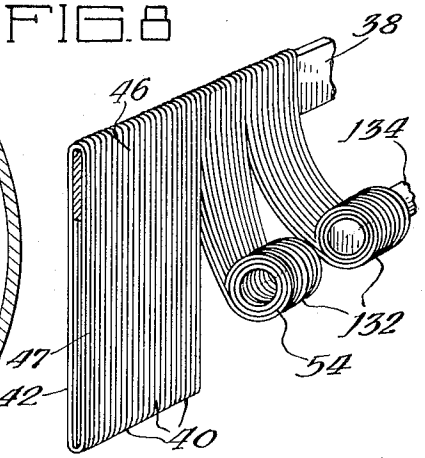


FIG. 8



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2,861,158

VARIABLE RESISTOR

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Application August 27, 1956, Serial No. 606,407

15 Claims. (Cl. 201—48)

The present invention relates to variable resistors, particularly variable resistors for use in devices requiring relatively small currents, such as electronic equipment.

Most variable resistors of this type are constructed with cards which include a plurality of turns of resistance wire wound transversely around a strip of electrical insulating material. The card is usually provided with an insulating coating except for a narrow strip which extends along the card generally normal to the turns. An electrical contact is then mechanically mounted in slidable contact with the narrow strip of exposed turns of resistance wire on the card.

There is an ever increasing demand for smaller electronic components. Unfortunately, resistance wire smaller than about size A. W. G. No. 45 does not have sufficient mechanical strength to withstand the wear of the slidable contact nor sufficient current carrying capacity for many applications. It has thus been necessary to reduce the total resistance of variable resistors in order to reduce their physical size. It is one of the objects of the present invention to provide a smaller variable resistor than has presently been available in the art without reducing the total resistance of the unit.

In the conventional annular construction of variable resistors, the resistance card is placed within a hollow cylindrical container and positioned adjacent to the periphery of the container. A rotatable shaft is then disposed on the axis of the cylindrical container and an arm is secured to the shaft and mounts the slidable contact abutting the exposed portion of the card. There is generally a volume of unused space between the shaft and the resistance card. The inventor has found that this space can be utilized in order to increase the resistance of the variable resistor, or conversely, to reduce the length of the resistance card, and thus the size of the unit.

Further, it is an object of the present invention to provide a method of producing variable resistors which utilize the space between the shaft and the resistance card. The present invention will be more fully understood, together with further advantages and uses for the invention, from a further reading of this disclosure, particularly when viewed in the light of the drawings, in which:

Figure 1 is a sectional view of a variable resistor constructed according to the teachings of the present invention, the section being taken along the line 1—1 of Figure 2;

Figure 2 is a sectional view of the variable resistor taken along the line 2—2 of Figure 1;

Figure 3 is a transverse sectional view of the resistance card shown in Figures 1 and 2 before being assembled into the variable resistor;

Figure 4 is a sectional view taken along the line 4—4 of Figure 3;

Figure 5 is a sectional view taken along the line 5—5 of Figure 2 showing the contact disc;

Figure 6 is a sectional view taken along the line 6—6 of Figure 2;

Figure 7 is an elevational view of a portion of a coil winding machine with the resistance card of the variable resistor illustrated during the process of manufacture;

Figure 8 is an isometric view illustrating another step in the manufacturing process of the resistance card; and

Figure 9 is an alternative embodiment of a resistance card of the type having a step resistance to contact displacement characteristic.

The variable resistor illustrated in the figures has a hollow cylindrical casing 10 with a closed end 12 and an open end 14. A cover 16 is secured to the open end 14 of the casing 10 by pressed fitting the cover 16 within an indentation 18 in the open end 14 of the casing 10. The closed end 12 of the casing 10 is provided with a central aperture 20, and has a sleeve 21 which extends toward the open end 14 of the casing 10. A bushing 22 is secured to the casing 10 and disposed within the aperture 20 and sleeve 21. The bushing 22 has a hollow cylinder 24 which extends into the sleeve 21 of the casing 10 coaxially therewith. A shaft 26 is journaled within the cylinder 24 of the bushing 22 and extends through an aperture 27 in the cover 16. The shaft 26 is provided with a C-washer 28 secured within a groove 29 and abutting the bushing 22, and a second C-washer 30 disposed within a groove 31 and abutting the cover 16, thereby preventing translation of the shaft 26 within the bushing and limiting its motion to rotation.

The interior of the casing 10 is lined with an annular strip 32 of electrical insulating material which is secured to the interior surface of the casing 10; for example by a layer of cement 34. A resistance card 36, which will be described in detail, is annular in form and disposed in contact with the strip 32 of electrical insulating material. The resistance card 36 extends about the periphery of the interior of the casing 10 and is secured to the strip 32 by a layer of cement 37.

The resistance card 36 is provided with a strip 38 of electrical insulating material which is disposed in an annular form within the casing 10. The strip 38 supports a plurality of turns 40 of resistance wire 42. The resistance wire 42 is provided with a core 43 of electrically conducting wire of uniform resistivity and a coating 44 of electrically insulating material, such as enamel for example. A layer 46 of electrically insulating adhesive material is also disposed about the strip 38 and turns 40 except for the edge 48 of the resistance card 36 which confronts the open end 14 of the container. This edge 48 is free of insulating coating 46, and the turns 40 of resistance wire 42 are also free of the electrical insulating coating 44.

In the embodiment of Figures 1 through 9, each of the turns 40 about the strip 38 is longer than the distance about the periphery of the strip, and the excess portion of the turns, designated 47, extends outwardly from the edge 50 of the resistance card 36 opposite to the edge 48. This outwardly extending portion 47 is also covered by the adhesive layer 46, and is wound into coils 54 which are disposed between the resistance card 36 and the sleeve 21 of the casing 10. The interior of the casing 10 contains a layer 56 of potting compound from the closed end 12 of the casing 10 to a level adjacent to the end of the sleeve 21, thereby anchoring the coils 54 into place within the casing 10 and providing additional electrical insulation for the outwardly extending portions 47 of the turns 40.

A disc 58 of electrically insulating material has a hub 59 at its center which is secured to the shaft 26 between the cover 16 and the sleeve 21, and a pair of spaced electrical contact members 60 are mounted to the disc 58 adjacent to its periphery. Each contact member 60

has a wire shaped contact 62 which is disposed abutting the exposed portion of the turns 40 on the edge 48 of the resistance card 36.

Each contact member 60 has a support bar 64 constructed of electrically conducting material which is secured to the electrical insulating disc 58 in a peripheral indentation 65 and is disposed generally parallel to the periphery of the disc 58, for example, by a pair of screws 66 disposed at the ends of the support bar 64. The support bars 64 are each provided with an indentation 68 on the side confronting the resistance card 36, and a pair of aligned screws 70 and 72 parallel to the axis of the support bar 64 are threadedly engaged within apertures 74 and 76 extending through the support bars 64 into the indentation 68. A pin 82 is pivotally disposed between screws 70 and 72.

The illustrative embodiment of contact 62 shown in the drawing is in the form of a ridged electrically conducting wire which is secured to the ends of the pin 82 and makes electrical contact with the pin 82, for example, by soldering the contact 62 to opposite ends of the pin 82. Each contact 62 has three adjacent portions 84, 86 and 88. The central portion 86 is disposed normal to the pin 82, and the end portions 84 and 88 are disposed between the central portion 86 and the pin 82. A helical spring 90 is also disposed about the pin 82 between the ends thereof, and one end of the spring 92 extends outwardly from the helix and abuts the support bar 64 to place a spring bias upon the contact 62 in the direction of the resistance card 36. In this manner, the central portion 86 of each contact member 62 is maintained in abutment with the exposed turns 40 on the edge 48 of the resistance card 36. The above-described construction of contact member 60 and contact 62 is intended to be merely illustrative and it is contemplated that various other equally advantageous constructions may be devised by those skilled in the art.

The electrical insulating disc 58 also supports a pair of concentric electrically conducting rings 94 and 95 which are coaxially disposed about the shaft 26 on the side of the disc 58 confronting the closed end 12 of the casing 10. The ring 94 is electrically connected to one of the contact members 60 and the ring 95 is connected to the other contact member 60 by wires 96.

The conducting rings 94 and 95 are each in slidable contact with a pair of contact asemblies 97 and 99 which have a pair of electrically conducting contacts 98 and 100 of a take-off assembly 102. The take-off assembly 102 has an electrically insulating block 104 which is mounted to the end 12 of the casing 10 confronting the conducting rings 94 and 95, as illustrated in Figure 2. A pair of parallel slots 106 and 107 generally parallel to the confronting of the conducting rings 94 and 95 are disposed in the surface of the block 104 confronting the conducting rings 94 and 95. Each of the contacts 98 and 100 are mounted at the ends of arms 108 and 110, respectively, which are constructed of electrically conducting material. Each pair of arms 108 and 110 is pivoted at a point between their ends on a pin 112 which extends into the block 104 of insulating material normal to the arms 108 and 110 and through one of the slots 106 in the block 104. A helical spring 114 is disposed about the pin 112 between each pair of arms 108 and 110. One end of each spring 114 is attached to the end of arm 108 opposite to the contact 98, and the other end of each spring 114 is attached to the adjacent arm 110 opposite the contact 100, thereby spring-biasing these ends of the arms 108 and 110 toward the slot 106, or in other words, spring biasing the contacts 98 and 100 outwardly from the slot 106.

The arms 108 and 110 of each contact assembly 97 and 99 are electrically interconnected by the pins 112. Also, one of the arms 108 of contact assembly 97 is connected to a terminal 116, and the arm 110 of contact assembly 99 is connected to a terminal 118. Electrical contact to the other arm of each pair of arms is made through the pins 114. Electrical connections may be made to these terminals 116 and 118 and to one or more points on the resistance card, in the conventional manner.

It is to be understood that the invention can be practiced with any type of contact to the resistance card 36, but that the contacts 60 here disclosed are particularly satisfactory. Also, the invention may be practiced with other means to make electrical contact with the slidable contact in place of the take-off assembly 102, even though the take-off assembly 102 is of particular advantage.

The inventor has found that a preferred method of manufacturing the variable resistor described in Figures 1 through 6 is to mount the electrically insulating strip 38 which is to become a part of the resistance card 36 between the chucks 126 and 128 of a coil winding machine, and mount a second strip 130 in the same plane with the strip 38 adjacent thereto, as illustrated in Figure 7. Operation of the coil winding machine will then place the turns 40 of resistance wire around the combined strips 38 and 130, the portions of each of the turns 40 which are disposed adjacent to the strip 130 becoming the outwardly extending portions 47, illustrated in Figure 3. After the turns 40 of resistance wire are placed upon the strips 38 and 130, the wire 42 being coated with the electrically insulating coating 44 before winding, the turns 40 are coated with the layer 46 and cemented to the strip 38.

The portion of the turns 40 which are adjacent to the strip 130 are coated with the layer 49 to bind them together, but this portion of these turns 40 are not cemented to the strip 130. The strips 38 and 130 are then removed from the chucks 126 and 128 of the winding machine, and the strip 130 is withdrawn from the turns 40. The strip 130 has completed its purpose and forms no further portion of the manufacturing procedure, or the finished product. The strip 38 is then taken and the outwardly extending portion 47 of the turns are separated into small groups, designated 132 in Figure 8, and wound up on dowels 134. The dowels 134 are then removed, leaving a plurality of small windings of turns which are kept together by the adhesive layer 46 thereon. The edge 48 of the strip 36 is then cleaned, the electrically insulating layer 46, and the coating 44 of varnish or other electrically insulating material being removed so that the contact 62 will be able to make good electrical contact with each of the turns 40 when it is disposed in contact therewith. All of the small coils 54 are then positioned on the same side of the strip 36, and the strip is placed within the container 10 and bent into the annular form it must assume to fit against the electrically insulating strip 32.

After the resistance card 36 is cemented into the casing 10, the take-off assembly 102 is mounted to the closed end 12 of the casing 10. This can be most readily accomplished by inserting a pin or screw 140, shown in Figure 6, through an aperture 142 in the closed end of the casing 10 and a bore 144 in the block 104 provided for the purpose of aligning the take-off assembly with the contact rings 94 and 95. The potting compound 56 is then poured into the closed end 12 of the casing 10 until the level of the compound 56 approaches the end of the casing sleeve 21 confronting the open end 14 of the casing 10, thus covering and anchoring the coils 54. After the potting compound 56 hardens, the pin or screw 140 may be removed, the potting compound holding the take-off assembly 102 in place.

The disc 58 and shaft 26 are assembled, the hub 59 being first conveniently secured to the disc 58 by screws 146 extending through the disc 58 and threaded into the hub 59. The contact members 60 are also fastened to the

disc 58 by the screws 66. The assembled shaft 26 and disc 58 are then inserted into the casing 10, and the C-washer 28 put in place. Next the cover 16 is pressed into the groove 18, and the C-washer 30 inserted into the groove 31 in the shaft 26.

If a stop on rotation of the shaft is desired, an angle bracket 148 is secured to the disc 58 confronting the closed end 12 of the casing 10, and the bracket is provided with an outwardly extending portion 150 which is generally normal to the disc 58. A post 152 is secured to the closed end 12 of the casing 10 and projects above the level of the potting compound 56 to abut the portion 150 of the bracket 148, thus providing the desired stop.

The variable resistor described above has a linear resistance to contact displacement characteristic. A variable resistor may be provided with other characteristics by shaping the strip 130 to provide coils of different length. The dotted line in Figure 7 indicates a strip 130A which has one straight edge abutting strip 38, and one edge graduated in steps, thereby providing a step resistance to contact displacement characteristic. The manner in which strip 130A cooperates with strip 38 is better seen in Figure 9. It is also to be noted that a portion of the turns 40 do not extend around the strip 130A, but merely extend about the strip 38.

From the foregoing disclosure, the man skilled in the art will readily devise many modifications and additional applications for the present invention beyond those disclosed herein. For example, the present invention may be practiced with the particular contact mechanism for making contact with the resistance card disclosed herein, or practiced with more conventional contact mechanisms. Further, the invention may be practiced either with or without the particular contact ring take-off assembly here described. For these reasons, it is intended that the scope of the present invention be not limited by the foregoing disclosure, but rather only by the appended claims.

I claim as my invention:

1. A variable resistor comprising an elongated strip of electrically insulating material, a coil of resistance wire wound about the strip and secured to the strip, said coil having a plurality of turns with adjacent portions of each turn electrically insulated from each other and each turn substantially longer than the distance around the perimeter of the strip, and means to make electrical contact with the resistance wire including a slidable contact confronting the strip and abutting the turns of said coil.

2. A resistor comprising a hollow cylindrical casing, an elongated strip of electrically insulating material disposed concentrically within the casing, a coil of resistance wire wound about the strip and secured to the strip, said coil having a plurality of turns with adjacent portions of each turn electrically insulated fro each other and each turn substantially longer than the distance around the confronting perimeter of the strip, whereby each turn has an outwardly extending portion, said outwardly extending portions being electrically insulated from each other and from the other elements of the resistor and being disposed between the strip and the axis of the casing.

3. A variable resistor comprising the elements of claim 2 in combination with a shaft rotatably mounted on the axis of the casing, and an electrical contact mounted to the shaft and slidably disposed abutting the portion of the coil adjacent to the strip.

4. Available resistor comprising a hollow cylindrical casing closed at one end, a shaft rotatably mounted to the casing and disposed on the axis thereof, an elongated strip of electrically insulating material disposed concentrically about the shaft, a coil of resistance wire wound about the strip and secured thereto, said coil having a plurality of turns with adjacent portions of the turns electrically insulated from each other, each of said turns being substantially longer than the confronting perimeter around the strip and having an outwardly extending portion disposed between the shaft and the strip, a mass of potting compound disposed over the outwardly extending portion of the coil of resistance wire in the closed end of the casing, an electrical contact mounted to the shaft and slidably disposed in abutment with the coil of resistance wire along a path confronting the strip, a terminal mounted to the casing, and electrically conducting means to connect the slidable contact with the terminal.

5. A variable resistor comprising a cylindrical hollow container having one end provided with a central aperture, a shaft disposed on the axis of the container and rotatably journaled in the aperture in the end thereof, a strip having parallel faces and parallel edges annularly disposed within and adjacent to the periphery of the container, a plurality of turns of resistance wire disposed about the strip and secured to the faces and one edge thereof, said turns being secured to the strip in parallel spaced apart insulated relationship and extending outwardly from the other edge of the strip, a coating of electrically insulating material covering the strip and windings except for a band generally normal to the turns and spaced from the apertured end of the container, and an electrical contact mounted to the shaft and slidably abutting the uncoated band of windings.

6. A variable resistor comprising a cylindrical hollow container constructed of electrically conducting material having one end provided with a central aperture, a shaft disposed on the axis of the container and rotatably journaled in the aperture in the end thereof, a strip of electrical insulating material having parallel faces and generally parallel edges, said strip being annularly disposed within and adjacent to the periphery of the container, an electrically insulating member disposed between the strip and the container, a plurality of turns or resistance wire disposed about the strip and secured to the faces and one edge thereof, said turns extending outwardly from the other edge of the strip in the region between the strip and shaft and being secured to the strip in parallel spaced apart insulated relationship, a coating of electrical insulating material covering the strip and windings except for a band generally normal to the turns and spaced from the apertured end of the container, a mass of electrical insulating material disposed in the container covering the outwardly extending portions of the windings, and an electrical contact mounted to the shaft slidably abutting the uncoated band of windings.

7. A variable resistor comprising a cylindrical hollow container having one end provided with a central aperture, a shaft disposed on the axis of the container and rotatably journaled in the aperture in the end thereof, a strip having parallel faces and generally parallel edges annularly disposed within and adjacent to the periphery of the container, a plurality of turns of resistance wire disposed about the strip and secured to the faces and one edge thereof, said turns extending outwardly from the other edge of the strip and being secured to the strip in parallel spaced apart insulated relationship, the outwardly extending portions being wound into a plurality of coils and disposed in the region between the strip and shaft, a coating of electrical insulating material covering the strip and windings secured thereto except for a band generally normal to the turns and spaced from the apertured end of the container, and an electrical contact mounted to the shaft slidably abutting the uncoated band of windings.

8. The method of manufacture comprising the steps of securing the ends of a first and second flat elongated strip adjacent to each other in a common plane, placing the ends of said strip in a winding machine and winding a plurality of turns of resistance wire tightly about both of said strips generally normal to the axis of elongation thereof, removing the strips from the winding machine, securing the turns abutting one strip thereto, and

removing the second strip from the first strip and turns, whereby the turns have portions secured to the strip and portions extending outwardly therefrom.

9. The method of manufacture comprising the steps of securing a first and a second flat elongated strip adjacent to each other in a common plane, winding a plurality of turns of resistance wire tightly about both of said strips generally normal to the axis of elongation thereof, securing the turns abutting the first strip thereto, and removing the second strip from the turns and first strip, whereby the turns have portions secured to the first strip and portions extending outwardly therefrom.

10. A variable resistor comprising a cylindrical hollow container having one end provided with a central aperture, a shaft disposed on the axis of the container and rotatably journaled in the aperture in the end thereof, a strip having parallel faces and generally parallel edges disposed within and adjacent to the periphery of the container, a plurality of turns of resistance wire disposed about the strip and secured to the faces and one edge thereof, said turns extending outwardly from the other edge of the strip and being secured to the strip in parallel spaced apart insulated relationship, the outwardly extending portions being wound into a plurality of coils and disposed in the region between the strip and shaft, a layer of electrical insulating material covering the strip and windings secured thereto except for a band generally normal to the turns and spaced from the apertured end of the container, a mass of electrical insulating potting compound disposed in the container covering the outwardly extending portions of the windings, and an electrical contact mounted to the shaft slidably abutting the uncoated band of the windings.

11. The method of manufacture comprising the steps of securing a first and second flat elongated strip adjacent to each other in a common plane, winding a plurality of turns of resistance wire tightly about both of said strips generally normal to the axis of elongation thereof, securing the turns abutting the first strip thereto, removing the second strip from the turns and first strip, whereby the turns have portions secured to the first strip and portions extending outwardly therefrom, winding the outwardly extending portions of the turns into coils to reduce the space required therefor, bending the strip and turns into a cylindrical shape, and inserting the strip and turns into a cylindrical container.

12. The method of manufacture comprising the steps of securing a first and second flat elongated strip adjacent to each other in a common plane, winding a plurality of turns of resistance wire tightly about both of said strips generally normal to the axis of elongation thereof, securing the turns abutting the first strip thereto, removing the second strip from the turns and first strip, whereby the turns have portions secured to the first strip and portions extending outwardly therefrom, winding the outwardly extending portions of the turns into coils to reduce the space required therefor, bending the strip and turns into a cylindrical shape, inserting the strip and turns into a cylindrical container, and filling the container with a potting compound to a level above the outwardly extending portion of the turns and below the top of the strip.

13. The method of manufacture comprising the steps of securing a first and second flat elongated strip adjacent to each other in a common plane, winding a plurality of turns of resistance wire having an electrically insulating covering tightly about both of said strips generally normal to the axis of elongation thereof, securing the turns abutting the first strip thereto, coating the turns with an electrically insulating adhesive material, coating the portion of the turns secured to the first strip with an electrically insulating material, removing the second strip from the turns and first strip, whereby the turns have portions secured to the first strip and portions extending outwardly therefrom, removing the electrically insulating coating from the turns in a band generally parallel to the edges of the strip, winding up the outwardly assembled portions to reduce the space required therefor, bending the strip and turns into a cylindrical shape, inserting the strip and turns into a cylindrical container, and filling the container with a potting compound to a level above the outwardly extending portion of the windings and below the top of the strip.

14. A variable resistor comprising an elongated strip of electrically insulating material, a coil of resistance wire wound about the strip and secured to the strip, said coil having a plurality of turns with adjacent portions of each turn electrically insulated from each other and at least a portion of the turns being substantially longer than the distance around the perimeter of the strip, and means to make electrical contact with the resistance wire including a slidable contact confronting the strip and abutting the turns of said coil.

15. A variable resistor comprising an elongated strip of electrically insulating material, a coil of resistance wire wound about the strip and secured to the strip, said coil having a plurality of turns with adjacent portions of each turn electrically insulated from each other, at least a portion of said turns being substantially longer than the distance around the perimeter of the strip, and said longer portion having a plurality of different length turns, and means to make electrical contact with the resistance wire including a slidable contact confronting the strip and abutting the turns of the coil.

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