June 4, 1968 R. E. MISHLER 3,387,247

HOUSING AND BASE CONSTRUCTION FOR VARIABLE RESISTANCE DEVICE

Filed Feb. 28, 1966 2 Sheets-Sheet 1

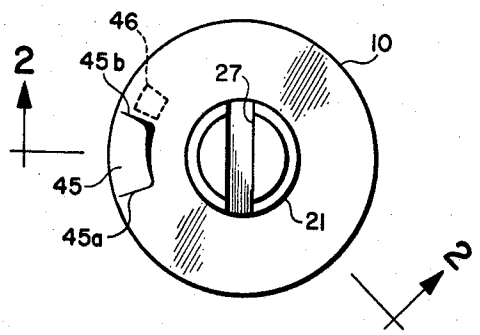

FIG. 1

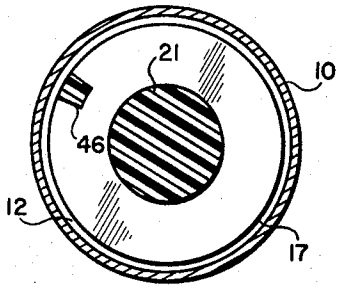

FIG. 3

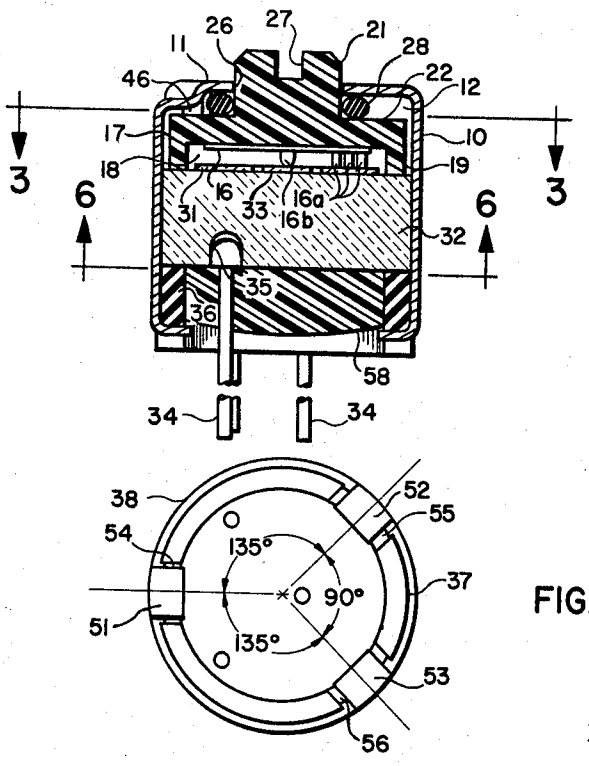

FIG. 2

FIG. 9

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HOUSING AND BASE CONSTRUCTION FOR VARIABLE RESISTANCE DEVICE

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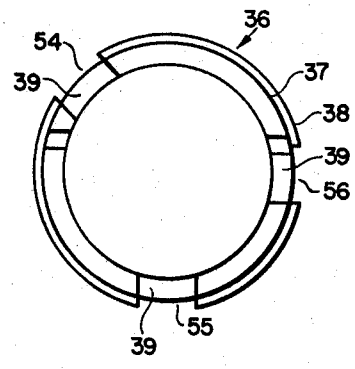

FIG. 5

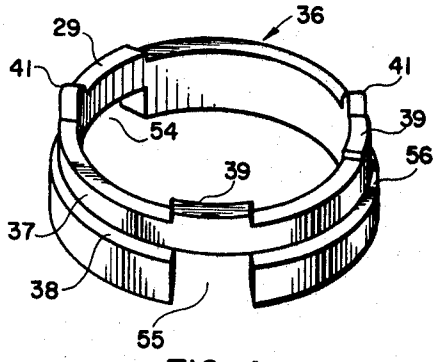

FIG. 4

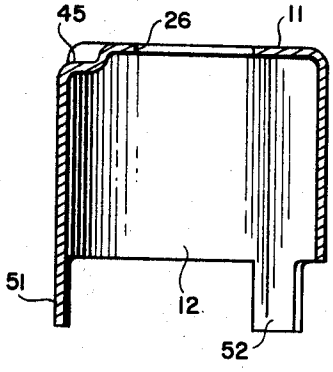

FIG. 8

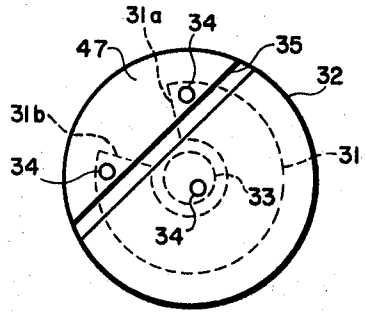

FIG. 6

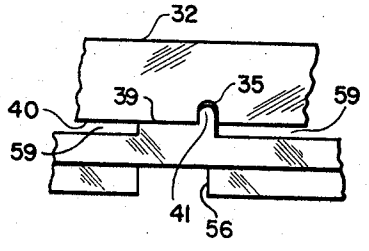

FIG. 7

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HOUSING AND BASE CONSTRUCTION FOR VARIABLE RESISTANCE DEVICE

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ABSTRACT OF THE DISCLOSURE

A "fool-proof" construction for a variable resistance device having a stop means built into the housing thereof for limiting excursion of a wiper contact adapted to traverse a resistance element mounted within the cavity of the housing. The housing includes a plurality of tabs so arranged and spaced as to mate with grooves formed in the base assembly supporting the resistance element thereby assuring that the housing and base assembly are assembled in a predetermined position with the resistance element properly oriented with respect to the limits of excursion of the wiper.

This invention relates to variable electrical resistance devices and more particularly to such devices commonly known as potentiometers and rheostats.

Potentiometers and rheostats are employed in electrical circuitry to permit adjustment of the voltage and resistance values for a particular circuit. These members generally include a housing which supports a resistance element, having appropriate terminals for connection with the external electrical circuit, and an electrically conductive contact or wiper element which may be moved or adjusted to make the appropriate voltage or resistance changes.

The trend toward miniaturization and weight reduction has created a demand for small variable resistance devices which may be employed in computors, telemetry systems, missiles and in various type of commercial appliances. As the size and weight of variable resistance devices decrease, it has been found necessary to simplify the design and construction of their components and to minimize the number of parts required to perform the functions of the device.

While the present invention is not limited to a particular housing shape, it is particularly applicable to those variable resistance devices employing a resistance element of arcuate or semicircular shape with which the housing is usually made cylindrical. With such a configuration, the movable electrical contact member or wiper traverses the electrical resistance element over an arcuate path which may be less than 360° of electrical continuity travel. It is sometimes a requirement of such devices that the wiper not break electrical contact with the resistance element or that the wiper or contact member be stopped during its rotational excursion when it encounters an electrical termination pad connecting the end of the electrical contact element with the terminal member through which the device is connected into the external electrical circuitry. Therefore, a stop mechanism is sometimes built into the apparatus as a part of the housing which stops the movement of the contact member at a predetermined point during its excursion along the resistance path. When the stop member is rigidly attached or formed as an integral part of the housing, it is necessary to assemble the resistance element so that it and its associated end terminations are precisely located with respect to the path of wiper travel and the particular points at which wiper travel is stopped. Unless means are built into the respective components of such a device, considerable

time and expense may be entailed in manually or electrically positioning such parts during assembly of the device.

Accordingly, it is an object of the invention to provide a variable resistance device having an improved structure which during assembly thereof automatically orients the resistance element and its end terminations with respect to the path of electrical contact travel and the limits of its excursion.

Further objects and advantages of the invention will become apparent as the following description proceeds, and the features of novelty which characterize the invention will be pointed out with particularity in the claim annexed to and forming a part of this specification.

For a better understanding of the invention, reference may be had to the accompanying drawings, in which:

FIGURE 1 is a top view of the variable resistance device of the present invention;

FIGURE 2 is a cross-sectional view of the variable resistance device of FIGURE 1 taken along line 2—2;

FIGURE 3 is a cross-sectional view of the variable resistance device taken along line 3—3 of FIGURE 2;

FIGURE 4 is a perspective view of a stand-off member which forms one section of the base assembly of the present invention;

FIGURE 5 is a plan view of the stand-off member;

FIGURE 6 is a bottom view of the base member taken along line 6—6 of FIGURE 2 and showing in dotted lines the disposition of the resistance element on the opposite surface thereof;

FIGURE 7 is a partial elevation view illustrating the assembled positions of the base member and the associated stand-off member;

FIGURE 8 is a cross-sectional elevation view of the housing structure illustrating the tabs extending from the open end thereof before being bent over; and

FIGURE 9 is a view taken from the bottom of the device as shown in FIGURE 2 illustrating the engagement of the housing tabs with the grooves formed in the base assembly.

Referring now to the drawings, there is shown in FIGURES 1–3 a variable resistance device, which, in the illustrated embodiment, is a rotary potentiometer. This embodiment of the invention employs a generally cylindrical or cup-shaped housing **10** which is substantially closed across one end **11** and substantially open at the other end and enclosing a chamber **12** therein. The housing **10** may be formed of any suitable metallic material such as stainless steel, nickel, silver, or aluminum which may be drawn or pressed into the shape shown, or may be formed of a suitable plastic material molded into the desired shape.

An electrically conductive movable contact member **16** is mounted in the chamber **12** for movement in a predetermined path. In the embodiment illustrated in FIGURE 2, the electrically conductive contact member or wiper **16** comprises a one-piece sheet metal stamping or disc fabricated of a precious metal alloy and attached securely on a rotor member or body **17** mounted for rotational movement within the cavity **12**. The rotor body **17** may be fabricated of a non-conducting material, such as molded epoxy resin, and includes an upper cylindrical portion or extension **21** projecting from the larger, lower cylindrical body **17**. The upper surface **22** of the rotor **17** is horizontal and disposed substantially parallel to end wall **11**. The lower section of the rotor **17** is provided with a cylindrical shaped cavity **18** defined by a ring-like flange or spacer **19**. The cavity **18** is adapted to receive the electrical contact element or disc **16** which may be suitably attached to the rotor in a conventional manner, such as by staking.

In the embodiment shown, a pair of resilient conductive arms or fingers **16***a* and **16***b* extend from the disc **16** and

make contact with a resistance element and collector member. The resilient fingers 16*a* and 16*b* are bent outwardly from the disc 16 and provide a spring bias resisting any force applied against them in the direction of the disc.

As may be seen in FIGURE 2, the cylindrical extension 21 of the rotor body extends through a bearing 26 formed in the substantially closed end 11 of the housing. The bearing 26 supports the extension 21 axially with respect to the housing and the extension 21 provides means for adjusting or moving the rotor 17 and its electrical contact member 16 within the housing. For this purpose a slot 27 is provided in the upper cylindrical section 21 for rotation of the rotor by means of a screwdriver or similar tool. It should be understood, that the rotor 17 may be rotated by any other means, such as by means of a threaded drive screw journaled through a side wall of the housing and engaging gear teeth formed on the rotor 17. Such an arrangement is disclosed in the Habereder Patent No. 3,099,810 also assigned to the same assignee as the present invention. In a drive screw actuated arrangement, it would not be essential to have the extension 21 protruding through the end wall of the housing and other means could be employed for rotatably supporting the rotor.

As may be seen in FIG. 2, a resilient O ring is mounted between the inner surface of the end wall 11 and the upper surface 22 formed on the rotor 17. The O ring has the dual function of sealing the potentiometer interior from contamination and providing a downward or biasing force on the rotor in the direction of the open end of the housing 10 to force the ring or spacer 19 of the rotor against the upper surface of the base assembly as will be explained hereinafter.

A base assembly is provided which is mounted through the open end of the housing and supports an electrical resistance element 31 in juxtaposed relation with the conductive fingers or contact of the movable contact member so that the resistance element is traversed by the movable contact member or wiper during movement or rotation thereof along its path. In the described embodiment of the invention, the base assembly comprises a base member or wafer 32 of non-conductive material, such as a plastic material or ceramic material, which is formed in a size and shape permitting it to be inserted through the open end of the housing. The base member 32 supports the resistance element 31 which, in the disclosed embodiment of the invention is in the form of a thin arcuate strip and may comprise any suitable resistance material, such as the type commonly referred to as "cermet" material or conductive plastic material, or any other suitable resitsance material. Means are provided for connecting the contact member or disc 16 to a source of electrical potential. In the disclosed embodiment this comprises the collector disc 33 mounted on the base member and in contact with fingers 16*b* extending from the contact member 16. The collector 33 may typically comprise a thin disc of sheet metal fabricated of platinum or silver alloy or the like. Three terminals designated by the reference numeral 34 are provided to connect the resistance element 31 and the collector disc 33 to a source of electrical power or into an external electrical circuit in which the variable resistance device is to be employed.

As will be seen in FIGURE 2, the ring 19 rests on the surface of the base member 32 and serves to space the conductive contact disc 16 a predetermined distance above the surface of the resistance element 31 and the collector 33. The spring force of the associated fingers 16*a* and 16*b* impart a biasing force against the resistance element 31 and the collector 33 making exceedingly good contact therewith. The force of the O ring 28 continually biases the rotor against the surface of the base assembly.

As may best be seen in FIGURES 2 and 6, the base member 32 has a slot 35 molded or otherwise formed therein which performs several functions. In the manufacturing process the slot 35 supports or locates the wafer 32 during the deposition process or molding process when the resistance element 31 and collector disc 33 are formed on the opposite surface of the base member. Thus, the slot 35 serves to locate precisely the position of the arcuate resistance element 31 and, by properly orienting this slot during assembly of the base member 32 within the housing 11, a precise orientation of the arcuate resistance element 31 may be obtained. While the resistance element 31 is shown in one position on the surface of the wafer 32, it should be understood that the position or orientation of the element 31 and the configuration thereof may be at any location on the surface of the wafer 32 and still be disposed at a precisely known location with respect to the slot 35.

In addition to the base element 32 the base assembly includes a stand-off member 36 which is shown in FIG. 4. The stand-off 36 may be fabricated of any suitable non-conductive material, such as a molded phenolic plastic, and is generally cylindrical in shape with an upper cylindrical section 37 adapted to fit within the cavity 12 of the housing and a lower cylindrical section 38 of slightly larger diameter, which does not fit within the cavity of the housing. Obviously, if the housing is not cylindrical or is not provided with a cylindrical cavity, the stand-off member may be of a suitable shape, such as rectangular, or other shape corresponding to the shape of the housing. In the embodiment shown, the stand-off member 36 is provided with a plurality of upwardly extending bars 39 the upper surface of which contacts the lower surface or bottom 40 (see FIGURE 7) of the non-conductive base member 32. Two of the supporting bars 39 are provided with rounded upwardly protruding shoulders 41 adapted to fit within the slot 35 formed in the lower surface of the base member 32. The shoulders 41 engage the base member and prevent rotatioin of the stand-off member 36 with respect to the base member. The shoulders 41 engaging with slot 35, also precisely locates the position of the stand-off member with respect to the slot 35 formed in the base member. Because the slot 35 is precisely located with respect to the resistance element, the shoulders also locate the stand-off member with respect to the orientation of the resistance element on the surface of the base member.

Stop means are provided in the housing to interrupt or stop movement of the contact member at a predetermined position along its path. As may be seen in FIGURES 1, 2 and 3, the stop means comprises an indented portion 45 formed in upper surface of the housing or in the closed end 11 of the housing. The indentation 45 protrudes well into the cavity in the housing and the opposite edges 45*a* and 45*b* of the indentation form a stop against which a lug 46, protruding from the surface 22 of the rotor, engages during movement or rotation of the rotor 17 in either direction. As previously explained, the purpose of the stop means is to prevent disengagement of the wiper fingers 24 from the resistance element 31, as the fingers 24 approach the end sections or termination sections 31*a* and 31*b* (as indicated in dotted lines in FIGURE 6), of the resistance element.

Means associated with the housing 10 and base assembly are provided to precisely position the electrical resistance element 31 with respect to the contact member 16 so that the extending fingers 16*a* of the rotatable contact member are stopped at the limits of rotational excursion of the contact member in a position so that they contact with the end portions 31*a* and 31*b* of the resistance element.

In order to precisely locate the base assembly, and the associated electrical resistance element, with respect to the stop means 45, there are provided a plurality of tabs 51, 52 and 53 (see FIGURES 8 and 9) extending downwardly from the open end of the housing 10. A plurality of mating grooves 54, 55 and 56 (best seen in FIGURES 5 and 9) are also formed in the stand-off member 36. As will be noted in FIGURES 5 and 9 at

least one pair of grooves **55** and **56** in the base assembly, or in the stand-off member **36**, and at least one pair of tabs **52** and **53**, extending from the housing, are positioned a predetermined distance apart differing from the distance apart between the other of said grooves and tabs so that the respective pairs of grooves and tabs may only be engaged when the base assembly is arranged in a predetermined position with respect to the housing member **11** and its associated stop means or indentation **45**. Thus, as may be seen in FIGURE 5, grooves **55** and **56** are spaced apart a distance less than the distance between grooves **54** and **55** or between grooves **54** and **56**. Similarly tabs **52** and **53** are spaced apart a similar distance less than the space between the tabs **51** and **52** or between tabs **51** and **53**. Thus, as may be seen in FIGURE 9, the relative positions of the tabs and the grooves makes it essential that the base assembly be positioned in only one precise position within the housing before the tabs will mate or correspond with the respective grooves formed in the stand-off **36** of the base assembly. After the stand-off member and the base assembly associated therewith have been rotationally oriented with respect to the tabs, the tabs are bent over within the grooves to support the base assembly within the cavity of the housing.

As may be seen in the drawings, the base assembly, including the base member **32** and the stand-off **36**, is of sufficient width that the tabs **51** engage the stand-off **36** to force the base assembly into snug engagement with the rotor **17** and the O ring **27**. In order to further accurately locate the resistance element **31** within the housing, it may be desirable to make one of the grooves, such as groove **54**, as may be seen in FIGURE 9, only slightly larger than its associated tab **51**. This, then makes it absolutely essential that the one tab fit precisely within its respective groove and thereby locate the remaining tabs, such as tabs **52** and **53**, centrally within their associated grooves.

After the tabs have been bent over against the base assembly and, thereby, securely retain the base assembly within the housing, the open space, surrounding the terminals **34** within the confines of the stand-off and the bottom **40** of the base member **32** is preferably filled with an epoxy material **58** which also flows into the spaces **59** (best seen in FIGURE 7) formed between the bars **39** of the stand-off and the bottom **40** of the base member **32**. The epoxy or other suitable sealing material seals this end of the device against contamination from external sources and also helps support the terminals **34** within the housing.

While, in accordance with the patent statutes, there has been described what at present is considered to be the preferred embodiment of the present invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention and it is, therefore, the aim of the appended claim to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A variable resistance device comprising:

a cup-shaped housing open at one end and having an end wall across the other end, said housing substantially enclosing a chamber communicating with the open end of said housing;

a depression formed in said end wall of said chamber and protruding into said chamber;

a rotor body mounted in said chamber for rotation therein, said rotor body supporting an electrically conductive rotatable contact member for rotation about an arcuate path, a lug extending from said rotor and so constructed and arranged as to engage said depression in said end wall of said housing and stop rotation of said rotor in either direction;

adjustment means for rotating said rotor, said means being adjustable externally of said housing;

a non-conductive base member adapted to be mounted in said chamber through said open end thereof, said base member having a grooved section on one side thereof and an arcuate shaped electrical resistance element supported on the opposite side thereof, said electrical resistance element being adapted to be supported on said base member in juxtaposed relation with respect to said movable contact member so that said rotatable contact member traverses said resistance element during rotation of said contact member around its arcuate path, said resistance element including end terminations electrically connected to opposite ends thereof;

a stand-off member of electrical insulating material including a pair of lugs extending from the periphery thereof and adapted to fit within said slot in said base member and orient said stand-off member with respect to said base member, said stand-off member being provided with a cylindrical shaped flange which encounters and supports the open end of said housing;

terminal means for connecting said end terminations of said resistance element and said electrically conductive rotatable contact to a source of electrical potential;

means associated with said housing and said base and stand-off members for supporting and positioning said base member within said housing, said means comprising:

a plurality of tabs extending from said housing adjacent the open end thereof, said tabs being adapted to fold over and support said base and stand-off members within said housing, a plurality of grooves formed in said stand-off member, each of said grooves being so constructed and arranged as to receive one of said tabs of said housing;

at least one pair of said grooves in said stand-off member and at least one pair of said tabs extending from said housing being positioned a pre-determined distance apart differing from the distance apart between the other of said grooves and tabs so that said pair of grooves and said pair of tabs may only be engaged when said base assembly and said stand-off member are arranged in a pre-determined position within said housing with said resistance element on said base member so oriented with respect to the path of said contact member that said lug of said rotor engages said depression in said housing to stop said contact member during the course of its excursion in either direction as said contact member encounters said end terminations of said resistance element.

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