Aug. 4, 1959 M. E. BOURNS ET AL 2,898,568

ADJUSTABLE RESISTORS

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FIG. 1

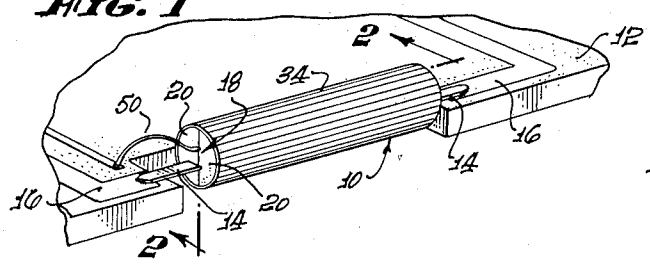


FIG. 3.

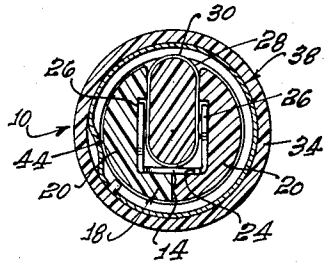
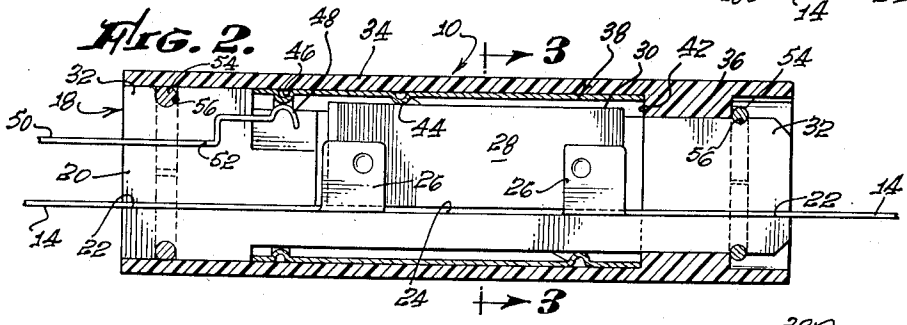


FIG. 2.



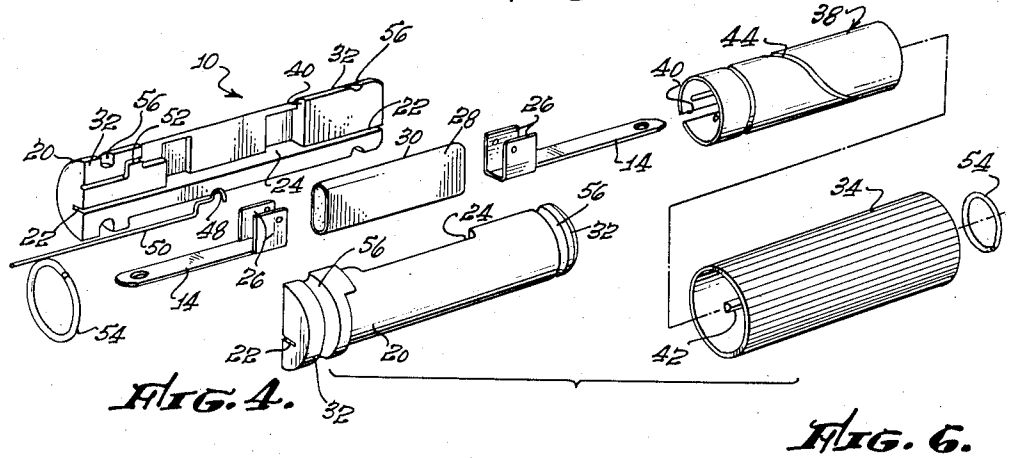


FIG. 4.

FIG. 6.

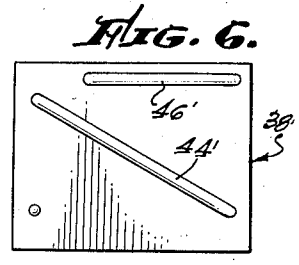
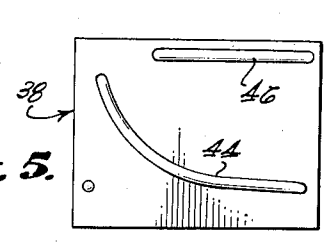


FIG. 5.



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ADJUSTABLE RESISTORS

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FIG. 10.

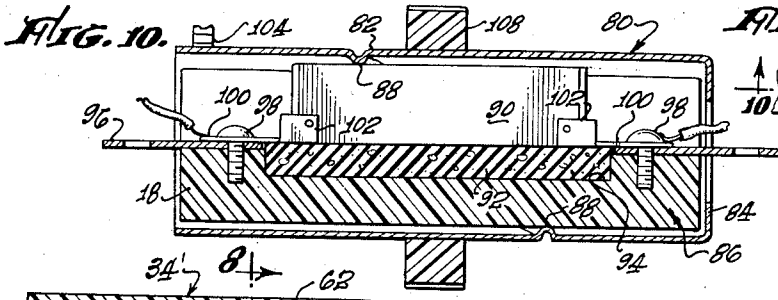


FIG. 9.

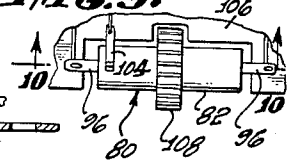


FIG. 7.

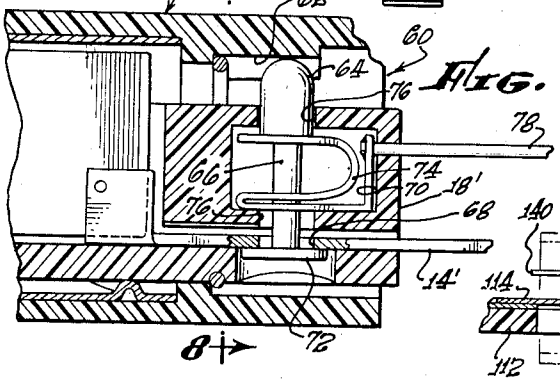


FIG. 11.

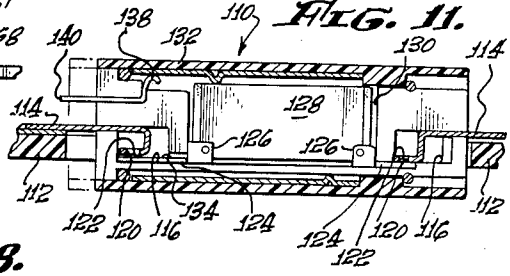


FIG. 8.

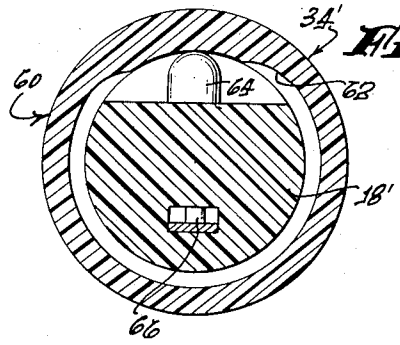
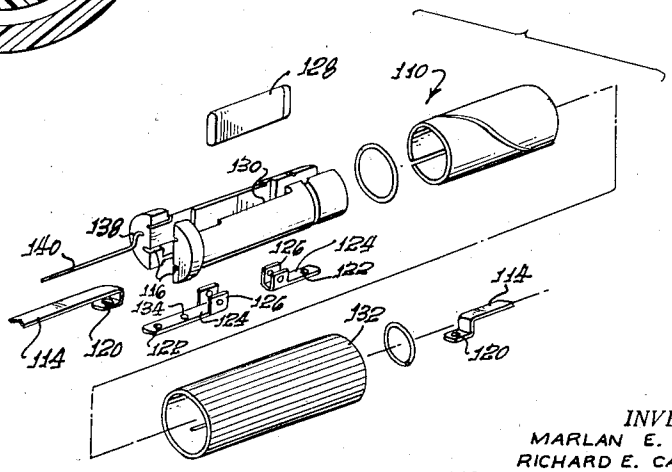


FIG. 12.



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ADJUSTABLE RESISTORS

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FIG. 13.

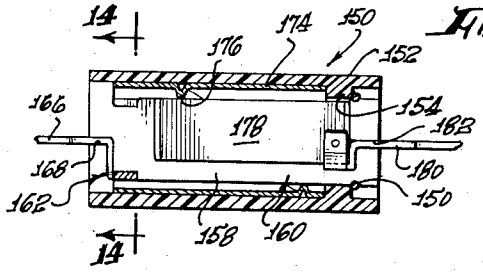


FIG. 14.

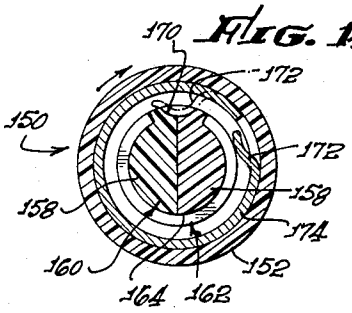


FIG. 15.

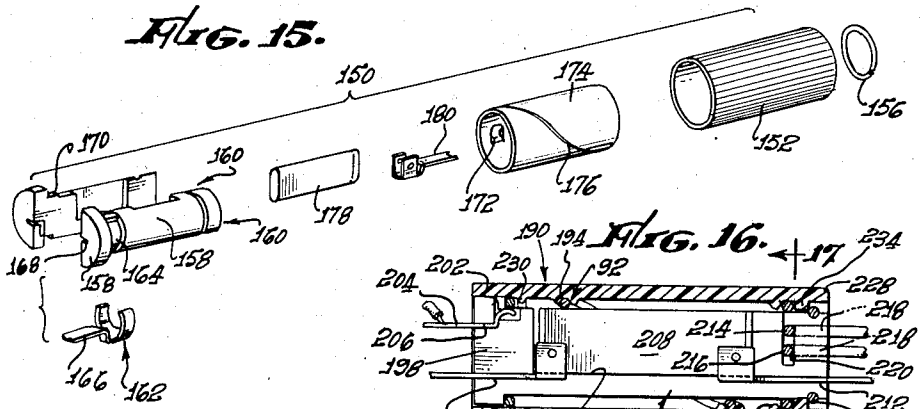


FIG. 16.

FIG. 18.

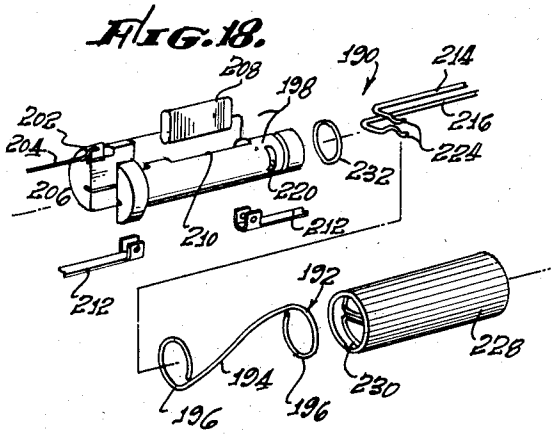
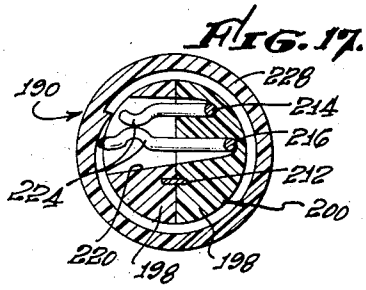


FIG. 17.



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United States Patent Office 2,898,568 Patented Aug. 4, 1959

2,898,568

ADJUSTABLE RESISTORS

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Application July 17, 1956, Serial No. 598,284

4 Claims. (Cl. 338—117)

This invention relates to new and improved adjustable resistors. More specifically it relates to new and improved potentiometers.

Any adjustable or variable resistor or potentiometer to find commercial acceptance at the present time must have a number of advantageous qualities. As an example of this, any electrical instrument of this type must be reliable, must be resistant to rough handling, must be easy to mount, and must be inexpensive. In spite of the fact that a large number of different variable resistors and potentiometers meet these qualifications and are being widely sold for a number of diverse applications there remains a definite need for extremely small, inexpensive, reliable adjustable electrical instruments of a resistance category which are specifically designed for many specialized applications.

A broad general object of the present invention is to provide "tailor made" variable resistors or photentiometers having the qualities briefly indicated in the preceding, which instruments are specifically adapted for use in small, compact devices. The instruments of the present invention are primarily intended for use in modern hearing aids and the like employing transistors, and are specifically adapted for such use. They are not however, limited to this class of applications, since the principal feature of this invention can be employed in units for use with a wide variety of different types of electrical apparatus.

One of the prime objectives of the present invention is to depart from the more or less standard type of variable resistor or potentiometer constructions and to utilize novel contact means as will be hereinafter described in conjunction with a new type of means for actuating these contact means. Since mere newness in design is never sufficient to justify a change in construction, it is also a related object of the present invention to provide contact and actuating means offering a number of distinct advantages such as, for example, ease in manufacture, inexpensiveness, and improved utility over the prior units of a similar category.

Another objective of the invention is to teach the construction of adjustable resistors or potentiometers employing switching means as hereinafter described as an integral part of these units. Combined constructions of this category thus can be manufactured so as to serve a dual purpose. Further, the devices of this invention incorporate the switching means utilized so that a common actuating means is used to govern the switching means and to adjust an electrical value.

More specific objects of this invention, as well as many advantages of it, will be apparent to those familiar with the field to which the invention pertains from a detailed consideration of the remainder of this description, the appended claims and the accompanying drawings in which:

Fig. 1 is an isometric view of a potentiometer of this invention mounted for use;

Fig. 2 is a cross sectional view taken at line 2—2 of Fig. 1;

Fig. 3 is a cross sectional view taken at line 3—3 of Fig. 2;

Fig. 4 is an expanded isometric view showing the construction of various parts of the potentiometer shown in Fig. 1 and indicating in a general manner the assembly of these parts;

Figs. 5 and 6 are top elevational views of parts capable of being utilized in the potentiometer shown in Fig. 1;

Fig. 7 is a partial cross sectional view similar to part of Fig. 2 showing a modified construction of this invention;

Fig. 8 is a cross sectional view taken at line 8—8 of Fig. 7;

Fig. 9 is a top elevational view of another modified potentiometer of this invention mounted in an operative position;

Fig. 10 is a cross sectional view taken at line 10—10 of Fig. 9;

Fig. 11 is a cross sectional view similar to Fig. 2 of a third modified potentiometer of this invention;

Fig. 12 is an expanded isometric view similar to Fig. 4 showing the construction of various parts of the potentiometer shown in Fig. 11;

Fig. 13 is a cross sectional view similar to Fig. 2 of an adjustable resistor of this invention;

Fig. 14 is a cross sectional view taken at line 14—14 of Fig. 13;

Fig. 15 is an expanded isometric view showing the construction of various parts of the potentiometer shown in Fig. 13, this view being similar to Fig. 4;

Fig. 16 is a cross sectional view similar to Fig. 2 of a fourth modified potentiometer of this invention;

Fig. 17 is a cross sectional view taken at line 17—17 of Fig. 16; and

Fig. 18 is an expanded isometric view showing the construction of various parts of the potentiometer shown in Fig. 16.

In all figures of the drawings like numerals are used to designate like parts wherever convenient for purposes of illustration and explanation. It is to be understood that electrical instruments falling within the scope of this specification are not to be limited by these drawings with respect to size, shape or configuration inasmuch as a wide variety of diverse units can be readily designed and manufactured utilizing the essential principles herein set forth. Actual potentiometers constructed in accordance with the teachings of this invention have been made which have an extremely small physical size.

As an aid to understanding this invention it may be stated in summary form that it concerns electrical instruments such as adjustable resistors or potentiometers, each of which utilizes an element support; a resistance element mounted on said element support so as to have an edge projecting from it; a contact member rotatably mounted around said element support and said resistance element, said contact member including spiral means engaging the projecting edge of the resistance element so that as said contact member is rotated said spiral means engages different portions of the resistance element. It may also be stated in essentially summary form that the invention concerns electrical instruments as indicated employing switch means operatively mounted upon an element support of the type indicated in the preceding sentence.

Obviously this invention is much more complicated than this cursory summary would indicate. The actual portions of this invention considered to be "inventive" in nature are specifically set forth in the appended claims. For a complete understanding of the invention it is necessary to refer in detail to the accompanying drawings.

In Figs. 1 through 4 of the drawings there is illustrated a potentiometer 10 of the present invention

mounted upon a supporting surface 12 such as is found in any common printed circuit type construction. This potentiometer 10 is mounted by means of extending flat terminals 14 being soldered or otherwise secured directly to conductive areas 16 upon the surface 12. The potentiometer 10 includes a non-conductive element support 18 formed of two bilaterally symmetrical sections 20, each of these sections having been manufactured by suitable injection molding or other techniques from a phenolic or equivalent non-conductive composition. For convenience of explanation the element support 18 will be described in this specification as being one member, although actually it consists of two sections as indicated.

The terminals 14 project through slots 22 in the support 18 to within an enlarged, elongated cavity 24 having an open top. Bent over ends 26 having a U shape formed on the terminals 14 serve as clips so as to resiliently engage and provide electrical termination for a conventional resistance element 28 mounted within the cavity 24 so as to have an edge 30 extending therefrom a short distance. As is best seen in Fig. 2 of the drawings this edge 30 is flat when viewed from the side so as to have substantially the configuration of a line. Rotatably mounted upon cylindrical ends 32 having different diameters of the element support 18 is a non-conductive, tubular or cylindrical housing 34 formed of a phenolic or other similar non-conductive composition so as to include an internal, generally ring-shaped flange 36 bearing against the smaller of the ends 32.

Within the housing 34 a contact member 38 formed of any resilient metal is disposed in essentially a tube-shape so that adjacent portions of it define a slot 40 designed to bear against the sides of a ridge 42 formed within the housing 34. As can be seen in Fig. 2 one of the ends of the contact member 38 normally fits against the flange 36 so as to be held between this flange and one of the cylindrical ends 32. It is considered obvious from Fig. 2 of the drawings that the element support 18 is spaced from the contact member adjacent to this contact member so as to accommodate a spiral shaped, bead or ridge 44 formed on the contact member 38 so as to extend in such a manner as to engage the edge 30 of the resistance element 28. Another bead or ridge 46 is formed upon the contact member 38 in a plane transverse to the axis of the housing 34 so as to extend around this housing. This other bead or ridge 46 is designed to be engaged in a resilient manner by a hook-shaped end 48 of a wire 50 extending in a circuitous groove 52 through the element support 18. This wire 50 is adapted to be connected directly to another conductive area 16 on the surface 12 by any convenient means such as solder.

The operation of the potentiometer 10 is essentially very simple. Preferably the exterior of the housing 34 is grooved or serrated so that it may be rotated easily when engaged by the hand. When this occurs the contact member 38 is simultaneously rotated so that the spiral bead or ridge 44 resiliently engages different points along the edge 30 of the resistance element 28. During such rotation the contact member 38 is in electrical communication with the exterior of the potentiometer 10 through the engagement of the end 48 with the bead or ridge 46.

The contact member 38 may be conveniently formed as by conventional metal stamping techniques so as to have an initial flat shape as indicated in Fig. 5 of the drawings. It is also possible to form a similar contact member 38' having an initial flat shape or configuration as indicated in Fig. 6 of the drawings. These two figures differ from one another in that the beads or ridges 44 and 44' illustrated extend in different paths so that when the contact members shown are curved to the final desired cylindrical configuration either linear or non-linear adjustment of the potentiometer 10 occurs during uniform

rotation of the housing 34. Thus, it is possible with the present invention to avoid the use of non-linearly manufactured resistance elements in order to achieve various functional outputs of the potentiometer 10. This is frequently desired, as where this potentiometer can be used so as to compensate for non-linearity of a circuit. Any contact element can easily be bent to a curved configuration and "snapped" into a final, operative position.

It should be specifically noted that the element support 18 is prevented from rotating through the use of the flat terminals 14. If desired, these terminals may be replaced by any equivalent non-rotating members. It is also to be noted that the element support 18 is held as one unitary piece by snap-rings 54 fitting within grooves 56. One of these snap-rings bears agianst the flange 36 so as to effectively lock the entire unit together.

In Figs. 7 and 8 of the drawings there is shown a modified potentiometer 60 which is identical with the potentiometer 10 except for certain constructional details as described. Because of the identical nature of this unit the primes of the reference numerals used in describing the potentiometer 10 are employed in designating the equivalent parts of it. One end of the housing 34' is provided with an internal cam or eccentric surface 62 serving to actuate a projecting button 64 attached to and forming a part of an electrically conductive, metal switch arm 66. This switch arm 66 projects through an opening 68 in a terminal 14' and through another cavity 70 formed in the element support 18'; it is provided with an enlarged head 72 normally engaging one side of the terminal 14'. A curved, resilient metal strip 74 is positioned within the cavity 70 so that the switch arm 66 passes through holes 76 formed in it and so that this strip resiliently engages the button 64 holding the head 72 against the terminal 14'. A wire 78 is attached to the metal strip 74 so as to extend therefrom out of the potentiometer 60 through a passage 79.

It will be realized from the above description that the means illustrated in Figs. 7 and 8 of the drawings in effect constitute a switch. When the housing 34' is rotated the eccentric surface 62 engages the button 64 pushing the switch arm 66 so as to disengage the head 72 from the terminal 14' breaking electrical contact. When the housing 34' is rotated further the metal strip 74 returns this head 72 to its initial position so that, if desired, current from a battery or the like can be conveyed from the wire 78 through the strip 74, the head 72, the switch arm 68 and the button 64 to the terminal 14'. If desired this terminal can be connected directly to the ground in certain types of circuits.

In the potentiometer 10 the bead or ridge 44 must be comparatively resilient and capable of some deflection in order to establish satisfactory electrical contact with the resistance element 18. If desired the bead or ridge 46 may be dispensed with, and the end 48 of the wire 50 may bear directly against the contact member 38. In Figs. 9 and 10 of the drawings there is shown a modified potentiometer 80 in which the contact member 82 employed need not be of this resiliency required with the potentiometer 10. As can be seen from an examination of Fig. 10 a metal contact member 82 in this unit is formed of a cylindrical shape so as to have end flanges 84 bearing against the ends of an element support 86 similar to the element support 18. This contact member 82 is provided with an internal bead or ridge 88 similar to the bead or ridge 44 engaging a conventional resistance element 90 resiliently mounted upon a block 92 of a resilient material such as sponge rubber or the like. Both the resistance element and the block 92 are located within a slot-like cavity 94 in the element support 86.

Terminals 96 extend from this cavity to the exterior of the potentiometer 80; these terminals 96 are preferably held to the support 86 by means of small screws 98 and include flexible, resilient necks or arms 100 carrying ends 102 similar to the ends 26 serving as clip means holding

the resistance element **90** and providing electrical termination thereto. These necks also are preferably formed so as to bias the resistance element **90** against the bead or ridge **88**. If desired the block **92** may be omitted and these necks alone, or other equivalent spring means may be used for this purpose; also, if desired the necks **100** may be replaced by wires or the like. Electrical contact is made to the contact member **82** by means of a resilient metal brush **104** mounted upon a supporting surface **106** along with the terminals **96**. Both the brush **104** and the terminals **96** can be secured to this surface **106** in any desired manner.

A non-conductive ring **108** may be located around the contact member **80** so as to facilitate the turning of this member. If desired the surface of this ring may be serrated or knurled, or even may be formed with gear teeth so as to be actuated by gear means (not shown). The ring **108** may be attached to the contact member in any desired manner, such as for example through the use of an adhesive or the like. The operation of this modified potentiometer **80** is substantially identical with the operation of the potentiometer **10**, and hence will not be described in detail.

With the potentiometer **60** previously described an essentially rotary type of switch action is employed. With this construction there is no positive "feel" given so as to indicate to an operator of this unit when the switch goes on or off. With small potentiometers of this invention which are primarily designed for use with hearing aids or the like some sort of positive indication in the operation of the instrument is frequently desired to inform a user by "feel" such as results from a snap-action as to whether or not the switching means employed have been moved to an on or off position. A construction of this category is illustrated in Figs. 11 and 12 of the drawings.

Here there is shown a potentiometer **110** of the invention which is adapted to be mounted upon a surface **112** such as the surface **12** previously described by means of flat, resilient sheet metal terminals **114**. These terminals project into end cavities **116** within an element support similar to the element support **18**. As can be best seen in Fig. 11 of the drawings the portions of these terminals **114** within these end cavities are bent over, and are provided with small apertures **120** which are adapted to receive projecting bumps **122** upon flat sections **124** of end terminals **126** connected to a resistance element **128**. The end terminals **126** are mounted in such a manner that they are located within elongated slots **130** so that by engagement of the housing **132**, similar to the housing previously described, the entire potentiometer **110** except for the terminals **114** may be moved from the position shown a short distance to the left as indicated by the phantom lines in Fig. 11 of the drawings.

When the housing **132** is so moved the terminal **114** at the right end of the potentiometer **110** is disengaged by the bump **122** on the corresponding end terminal **126**, and the element support **118** is moved so that the aperture **120** in this end terminal **114** engages a small bump **134** within the corresponding end cavity **116**. It is obvious that when this occurs the potentiometer **110** is no longer connected in a circuit as a potentiometer. Corresponding movement also occurs at the left end of the potentiometer **110** as illustrated in Fig. 11, but the terminal **114** always remains in resilient contact with the corresponding end terminals **126** here. The bumps **122** and the aperture **120** at the left end of this instrument merely serve as additional means to provide essentially "snap" type of feel so as to indicate that the potentiometer **110** is in on or off position.

This feature of resilient engagement of the terminals **114** and the end terminals **126** is considered quite important in achieving satisfactory results with the invention. The particular structure shown in effect locks this unit in either of two positions in such a manner that a user of this potentiometer, such as for example, an individual adjusting a hearing aid can readily determine whether the potentiometer **110** is turned on or off. The potentiometer **110** also includes a contact member **138** similar to the contact member **38** previously described, a wire **140** serving essentially as the wire **50** previously described and other parts of an identical nature to parts employed with the potentiometer **10**. For convenience of explanation such other parts are not described in detail herein.

Occasionally it is desired to utilize this invention as an adjustable or variable resistor. Any of the preceding units may be manufactured or connected so as to serve this function by either omitting one of the terminals connected to a resistance element and providing an equivalent mounting member, or by failing to connect these terminals into an electrical circuit. In Figs. 13, 14 and 15 of the drawings there is illustrated a variable resistor **150** of the present invention which is designed specifically so as to incorporate a rotary switch action. This unit employs a non-conductive tubular housing **152** similar to the housing **34** previously described. Within this housing there is located an internal ring-like flange **154** against which there bears a snap ring **156** holding two parts **158** or sections of an element support **160** similar to the element support **18** together so as to lock these parts within the housing **152**.

The other ends of the parts **154** are held together by means of a partially cylindrical snap band **162** fitting within a correspondingly shaped groove **164** in the element support **160**. A terminal **166** projects in a circuitous groove **168** from this snap band **162** to the exterior of the potentiometer. As will be noted from Fig. 14 of the drawing the ends of the snap band **162** are spaced from one another by a small section of the element support **160** within which there is located a depression **170**.

This is designed so that a small resilient contact arm **172** formed on a resilient metal contact member **174** corresponding to the contact member **38** previously described can, when the housing **152** is turned to an appropriate position, snap within this depression **170** so as to, in effect, lock the variable resistor **150** in an off position so that no current flows through it. When the housing **152** is turned the contact arm **172** is moved out of this depression from the position shown in phantom in Fig. 14 so as to slide around the snap band **162** in essentially the manner in which a brush slides around a slip ring. As the housing **152** is moved in a corresponding fashion a spiral bead or ridge **176** is turned about the resistance element **178** so as to resiliently engage different portions of this resistance element. Another electrical terminal **180** extends through a slot **182** in the element support **160** so as to provide electrical termination for the end of the resistance element **178** remote from the snap band **162**.

With this construction the contact member **174** can be conveniently formed of a single sheet of metal as previously indicated, and can merely be held within the resistor **150** by the inherent spring pressure or tension of this metal, although if desired an adhesive can be employed to hold it in position. It is also possible to utilize the ridge and groove type of structure employed with the potentiometer **10**, or with any of the other preceding units of similar nature, although this is not considered necessary. It is also possible to modify the potentiometers **10**, **60** and **110** so that the contact members employed in them are mounted as indicated in this paragraph.

It is possible to utilize with the invention a different form of contact member than has been previously described. In Figs. 16, 17 and 18 of the drawings there is shown a still further modified potentiometer **190** of the invention utilizing a contact member **192** formed of a resilient wire. This wire is as indicated in Fig. 18 shaped

so as to include a center spiral section 194 and circular ends 196. These ends serve essentially as snap rings resiliently engaging the exterior of bilaterally symmetrical sections 198 composing a non-conductive support element 200 similar to the support element 18 previously described. One of the ends 196 is also engaged by a small hook 202 on a wire 204 passing through a circuitous groove 206 in the support element 200. This wire 204 corresponds to the wire 50 previously described, and in essence it constitutes a brush riding upon one of the circular ends 196.

A resistance element 208 is located within a cavity 210 within the support 200 in substantially the manner previously described so that one edge of this resistance element is resiliently engaged by the spiral section 194 of the contact member 192. Terminals 212 corresponding to the terminals 14 previously described are used to connect the ends of the resistance element 208 and to mount the potentiometer 190.

This potentiometer also differs from the units previously described in that two wires 214 and 216 pass through openings 218 in one end of this unit into a cavity 220 located at right angles to the openings 218 within the element support 200. Both of the wires 214 and 216 are provided with curved sections 224 normally engaging one another, and the wire 216 extends generally beyond the support element 200 so as to be capable of being engaged by a sloping cam surface 226. Such engagement occurs as a non-conductive housing 228 similar to the housing 34 is turned, and results in the cam surface 226 pushing the wire 216 so that the curved sections 224 are brought out of contact with one another until the housing 228 is turned sufficiently so that the wire 216 passes past the end of the cam surface 226. At this time the wire 216 will snap so that the wires 214 and 216 are in contact with one another. The construction of the potentiometer 190 shown is particularly advantageous when a separate circuit is to be utilized turning a circuit external to the potentiometer on and off in accordance with its operation.

In the potentiometer 190 the contact member 192 is held in place by means of ridges 230 within the housing 228 so as to be capable of resiliently engaging both the resistance element 208 and the element support 200, although it is to be understood that other equivalent means may be employed. A small snap-ring 232 in this construction bears against a flange 234 within the housing 228 so as to secure this potentiometer together with one of the circular ends 196 against the flange 234. The type of contact member construction shown in Fig. 16 can be employed with virtually any of the units previously illustrated and described, or these other contact member constructions can be substituted in the potentiometer 190.

No attempt has been made in this specification to specifically describe all of the various modified switch constructions which may be utilized with the invention; instead the principal types of switching means capable of being employed, and which are considered preferable for use with the invention because of ease of manufacture and assembly and reliability of operation, have been specifically described and illustrated. It is to be understood that the different types of switching means described can be utilized with other units of the invention than the specific potentiometers and variable resistors with which they are specifically shown and described.

Those skilled in the art to which this invention pertains will realize that it is capable of extremely wide modification within the scope of this disclosure. Therefore it is not to be considered as being limited except by the appended claims.

We claim:

1. A potentiometer which includes: a non-conductive element support having an internal cavity therein; a resistance element positioned within said cavity so as to have an edge extending therefrom; a pair of terminals engaging opposite ends of said resistance element in said cavity; an electrically conductive tubular contact member rotatably mounted around said element support and said resistance element, said contact member including inwardly projecting spiral means located so as to resiliently engage said edge of said resistance element as said contact member is rotated; a third terminal engaging said contact member so as to establish electrical communication therewith; and means extending from each end of said element support for mounting said element support against rotation.

2. A potentiometer which includes: a non-conductive element support having an internal cavity formed therein, said cavity having an open top; a resistance element positioned within said cavity so as to extend through said open top; a metal contact member positioned around said element support and said resistance element, said contact member having the general shape of a cylinder; a cylindrical non-conductive housing positioned around said contact member, said contact member being operatively secured to the interior of said housing; means defining an internal bead on said contact member, said bead extending in a spiral path around the interior of said contact member and resiliently engaging said resistance element so as to establish electrical contact therewith; means defining slots in said element support leading from the ends of said cavity to the ends of said element support; a pair of terminals extending through said slots into said cavity, said terminals being attached to said resistance element within said cavity and having extremities projecting from said element support, said extremities being adapted to be connected to a supporting surface; a third terminal member held by said element support so as to resiliently engage the interior of said contact member, said third terminal member extending from said element support through an end of said housing; and means preventing movement of said housing, said contact member and said element support with respect to one another in the direction of the axis of said housing.

3. An electrical instrument of the class described which includes: a non-conductive element support; a resistance element mounted on said element support so as to have an edge extending therefrom; a tubular contact member rotatably mounted around said resistance element and said element support, said contact member being electrically conductive and including inwardly projecting spiral means engaging portions of said edge of said resistance element as said contact member is rotated; a non-conductive housing rotatably mounted around said element support, said resistance element and said contact member, said housing being operatively secured to said contact member so that said contact member rotates with said housing; means defining a cam surface on the inside of said housing; terminal means connected to the ends of said element, and switch means connected into one of said terminal means, said switch means being actuated by said cam surface as said housing is rotated beyond the point where said spiral means begins to wipe on one end of said resistance element.

4. A variable resistor comprising an element support, a resistance element mounted on said support so as to have one edge extending therefrom, and a rotatably supported tubular contact member encircling said resistance element and support, said contact member being formed with an inwardly projecting spiral rib that wipes across said projecting edge of said element at an angle, whereby said rib makes a substantially point contact with said projecting edge of said element, said point of contact being moved lengthwise along said element as said tubular contact member is rotated about said element and support.

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