Dec. 18, 1962 E. D. O'BRIAN 3,069,647

ADJUSTABLE ELECTRICAL INSTRUMENTS

Original Filed March 1, 1957 2 Sheets-Sheet 1

FIG. 1.

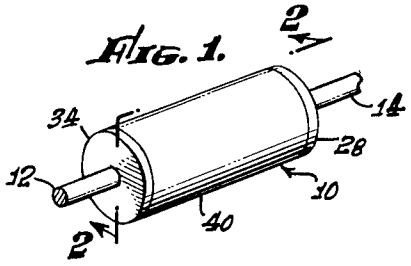


FIG. 3.

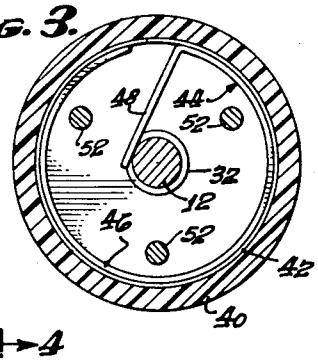


FIG. 2.

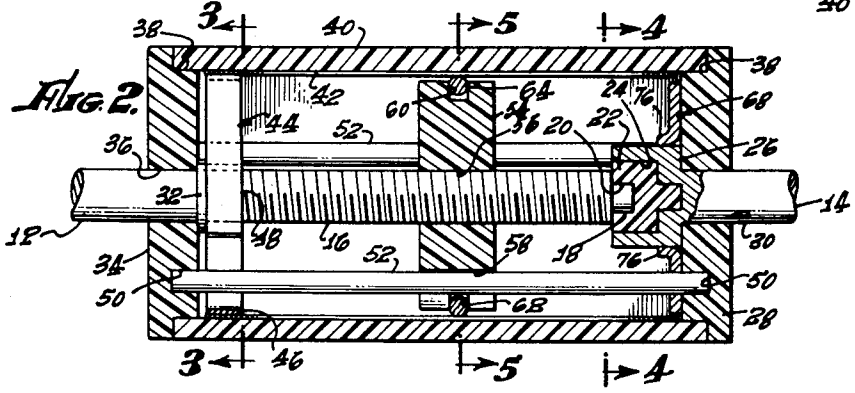


FIG. 4.

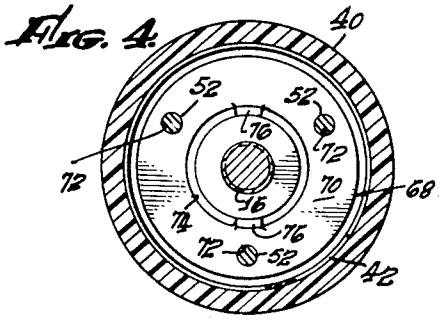


FIG. 5.

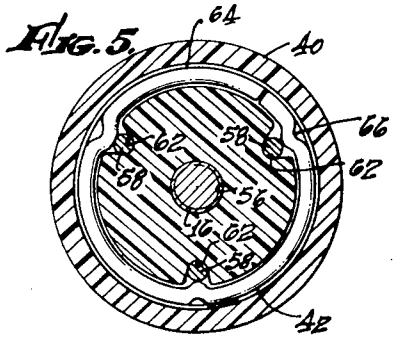
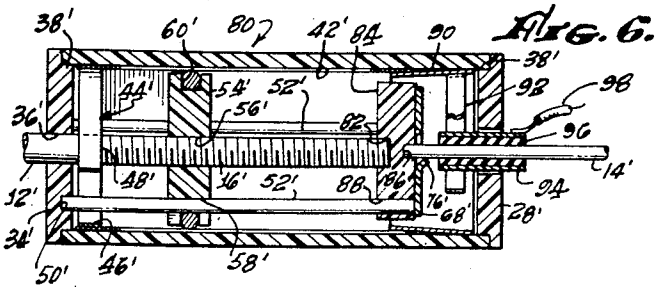


FIG. 6.



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FIG. 7.

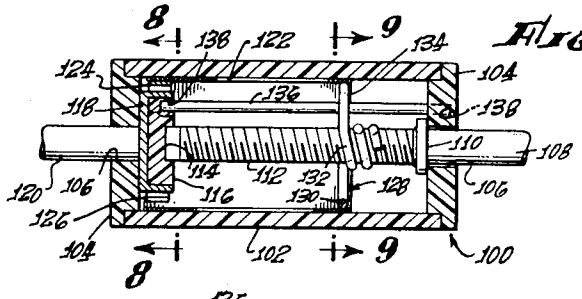


FIG. 9.

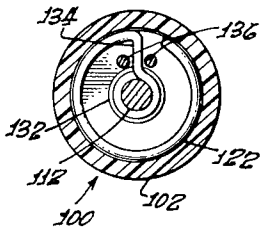


FIG. 8.

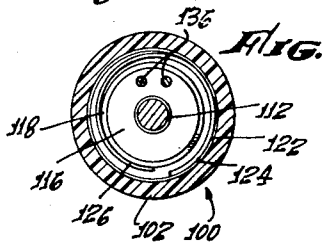


FIG. 10.

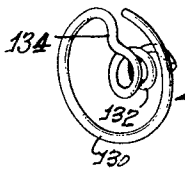


FIG. 11.

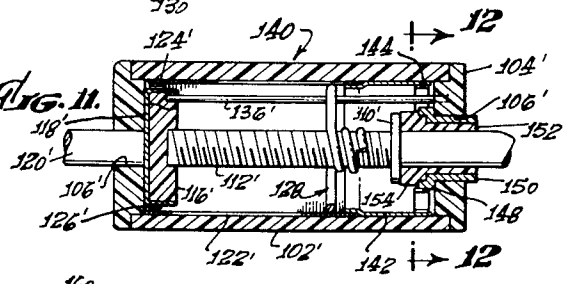


FIG. 13.

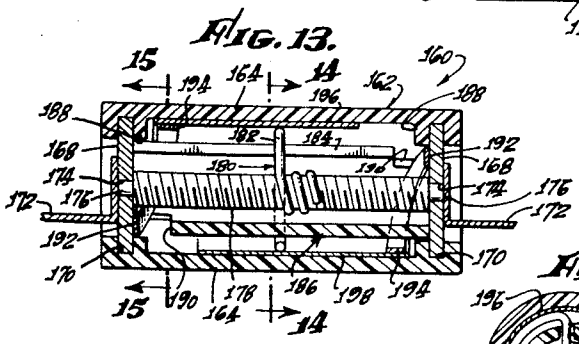


FIG. 12.

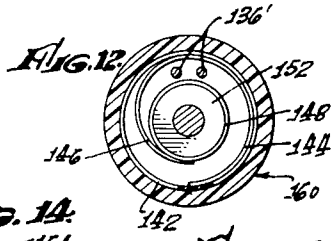


FIG. 14.

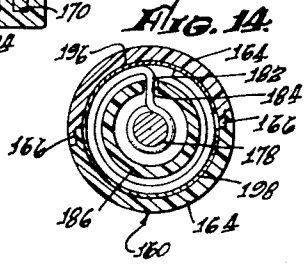


FIG. 15.

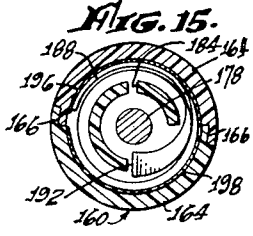


FIG. 16.

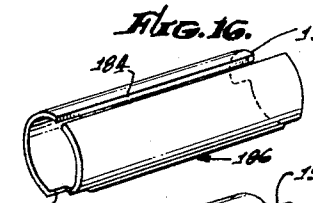
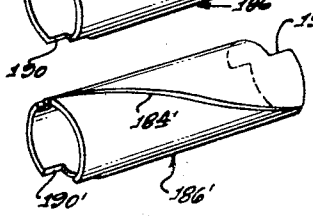


FIG. 17.



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Patented Dec. 18, 1962

3,069,647

ADJUSTABLE ELECTRICAL INSTRUMENTS

Edward D. O'Brian, Anaheim, Calif., assignor to Bourns, Inc., a corporation of California

Original application Mar. 1, 1957, Ser. No. 643,358, now Patent No. 2,870,304, dated Jan. 20, 1959. Divided and this application Jan. 19, 1959, Ser. No. 792,243
4 Claims. (Cl. 338—180)

This invention relates to new and improved adjustable electrical instruments and more particularly to adjustable electrical instruments such as variable resistors, potentiometers and the like. This application is a division of my co-pending application, Serial No. 643,358, filed March 1, 1957, now Patent 2,870,304, granted January 20, 1959, for Adjustable Electrical Instruments.

Extremely small potentiometers and variable resistors are commonly manufactured at the present time so as to include housings which are designed to be mounted in a fixed position by bolts or other similar means. Within the housings in common instruments of this category there are mounted resistance elements and electrical returns; appropriate terminals are, of course, connected to the ends of the resistance elements used and to the electrical returns. Such common instruments are designed to be actuated by rotation or linear movement of a shaft. In either of these cases within the present-day common, small potentiometers and variable resistors the shafts are connected by one means or another to a movable member or post and these posts in turn carry resilient contact members which are designed so as to engage both an electrical return and a resistance element. Movement of such contact members with respect to two such parts is employed to adjust an electrical value.

Instruments of the broad category briefly indicated in the preceding paragraph are extremely valuable for a number of purposes, and they have been widely used. In certain cases, however, it is desired to mount extremely small electrical instruments by means of their terminals as with a channel or upon a printed circuit board or the like. Instruments of the category indicated in the preceding sentences are frequently disadvantageous for such use because of space limitations, and because of the difficulty in locating such instruments so that the shafts used to actuate them may be conveniently located so as to be capable of adjustment. In the foregoing patent application a number of electrical instruments were described in which the terminals could be rigidly mounted in the manner herein indicated. Such electrical instruments, however, are adjusted by movement of a housing along a linear path. Thus, a comparatively large amount of space is required in order to permit complete adjustment of these instruments. In many cases this amount of space is not available.

It is a broad object of the present invention to provide new and improved adjustable electrical instruments which overcome various disadvantages and limitations of the aforegoing other related types of electrical instrument constructions. A more specific object of the present invention is to provide adjustable electrical instruments, such as, for example, variable resistors and potentiometers which are adapted to be mounted by means of terminals, and which are adapted to be adjusted through the rotation of a housing which interconnects the terminal means employed. A related object of the present invention is to provide extremely effective electrical instruments of this category which may be manufactured to a comparatively small size, and which are relatively inexpensive to manufacture, and which are extremely reliable in use.

Still further objects of this invention, as well as many advantages of it, will be more fully apparent to those skilled in the art to which the invention itself pertains

from a detailed consideration of the remainder of this specification including the appended claims and the accompanying drawing in which:

FIG. 1 is a perspective view of an adjustable electrical instrument of this invention;

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 a cross-sectional view taken at line **4—4** of FIG. 2;

FIG. 5 is a cross-sectional view taken at line **5—5** of FIG. 2;

FIG. 6 is a cross-sectional view similar to FIG. 2 of a modified electrical instrument of this invention;

FIG. 7 is a cross-sectional view similar to FIG. 2 of another modified electrical instrument of the invention;

FIG. 8 is a cross-sectional view taken at line **8—8** of FIG. 7;

FIG. 9 is a cross-sectional view taken at line **9—9** of FIG. 7;

FIG. 10 is a perspective view indicating a part of the modified instrument shown in FIG. 7;

FIG. 11 is a cross-sectional view similar to FIG. 2 of a further modified electrical instrument of the invention;

FIG. 12 is a cross-sectional view taken at line **12—12** of FIG. 11;

FIG. 13 is a cross-sectional view similar to FIG. 2 of a still further modified electrical instrument of this invention;

FIG. 14 is a cross-sectional view taken at line **14—14** of FIG. 13;

FIG. 15 is a cross-sectional view taken at line **15—15** of FIG. 13;

FIG. 16 is a perspective view of a part of the electrical instrument shown in FIG. 13; and

FIG. 17 is a perspective view showing a modified form of the part shown in FIG. 16.

It is to be understood that the accompanying drawing is not to be taken as limiting the invention in any respect. It will be obvious from a detailed study of this specification that a wide variety of differently appearing adjustable electrical instruments may be designed utilizing the essential principles or features of this invention. Such design of other instruments of this category is considered to be within the skill of those familiar with the art to which this invention pertains.

As an aid to understanding the invention itself, it may be stated in essentially summary form that it concerns adjustable electrical instruments, each of which is formed so as to include first and second terminal means which are insulated from one another and which are adapted to be mounted in a fixed position. Within constructions of this invention shaft means are attached to one of the terminal means; and contact means are mounted upon the shaft means. Further, housing means are rotatably positioned around the shaft means employed and means are incorporated within the housing means which are adapted to cause movement of the contact means during rotation of the housing means employed. Within the housing means employed, resistance means are located so as to be disposed completely around the shaft means employed, and further these resistance means are engaged by the contact means. In order to complete an adjustable electrical instrument of the invention, means are provided which connect one end of the resistance means to one of the terminal means, and means are provided to electrically connect the contact means to the other of the terminal means. Obviously other elements can, of course, be added to an electrical instrument of this invention in providing adjustable potentiometers and various equiva-

lent elements may be substituted for certain of the elements specified.

The foregoing summary does not in and of itself completely indicate the actual nature of the invention. It is considered important that the terminal means described in the preceding discussion are adapted to be held in a fixed position, and that the housing means provided are adapted to be rotated with respect to these terminal means so as to cause movement of the contact means with respect to a resistance element located within the housing means itself. Thus, by rotation of the housing means utilized, an adjustment of an electrical value takes place. Such rotation does not result in any change in the amount of space required for an instrument of this invention, and indeed adjustable electrical instruments falling within the scope of this invention can be used in very restricted areas. Because of the fact that adjustment of these instruments occurs by rotation of the housings employed, it is comparatively easy to adjust these instruments, and small screwdrivers or the like are not required for this purpose.

In FIG. 1 of the drawing there is shown an adjustable electrical instrument 10 of the present invention. It will be obvious to those skilled in the art to which the invention pertains from a consideration of the remainder of this description that this instrument is a variable resistor. The instrument 10 includes first and second wire-like cylindrical terminals 12 and 14. The terminal 12 carries as an integral part of it a small threaded shaft 16 having formed at its end a small cylindrical projection 18 which is adapted to fit within a correspondingly shaped cavity 20 formed within an insulating housing or member 22. This insulating member is carried within a corresponding cup-shaped cavity 24 formed in an enlarged end 26 of the terminal 14. It is to be noted that the end 26 of this terminal 14 is preferably of a cylindrical configuration, and that it bears directly against a non-conductive end cap 28 which is disposed in such a manner that the terminal 14 projects through a centrally located cylindrical opening 30 in this end cap.

At the end of the instrument 10 adjacent to the terminal 12 a small retaining flange 32 is provided on this terminal 12 adjacent to the shaft 16. This flange also bears against an end cap 34 which is similar to the cap 28 in that it includes a centrally located cylindrical opening 36 through which the terminal 14 projects. The caps 28 and 34 are each provided with exterior shoulders 38 which are adapted to carry the ends of a cylindrical non-conductive housing 40. The housing 40 may be secured to these end caps by any convenient means, such as for example, an adhesive or the like. Preferably the caps 28 and 34 and the housing 40 are formed of a non-conductive material, such as an appropriate epoxy resin, an appropriate phenolic composition or the like. Within the interior of the housing 40 there is located a cylindrical resistance element 42. This resistance element may consist of a winding of the resistance wire secured directly to the housing 40. It may also consist of a small resistance layer such as, for example, a metal alloy layer or a printed circuit type of layer deposited or otherwise located within the housing 40 in accordance with known techniques.

One end of the resistance element 42 is adapted to be electrically connected to the terminal 12 by means of a spring-like brush member 44. The configuration of this member is best seen in FIG. 3 of the drawings. Here it is shown that it consists of a large band-like section 46 and a bent-over end 48 which resiliently bears against the terminal 12 so as to establish electrical contact therewith at all times. Preferably the brush member 44 is formed in such a manner that the band-like section 46 tends to spring outwardly so as to establish electrical communication with resistance element 42. If desired, this band-like section 46 may be attached thereto by solder or other equivalent means known to the industry. Obviously it is possible for form electrical instruments falling within the scope of this invention in which other equivalent brush-type constructions are used instead of the brush member 44. This particular member is, however, considered to be preferable because of its extreme simplicity and ease of assembly.

Within the instrument 10 the end caps 28 and 34 are provided with pairs of aligned openings or cavities 50, each pair of which is designed to carry and support a shaft 52 formed of wire or the equivalent so that the individual shafts 52 extend through the housing 40 parallel to the shaft 16. These shafts 52 are adapted to be used as means for controlling rotation of a non-conductive post or movable member 54. The post 54 may be conveniently formed of nylon or a wide variety of other insulating materials, such as, for example, phenolic compositions. It is provided with an internally threaded opening 56 which is adapted to fit on the threads of the shaft 16 so that the threads upon the shaft 16 mate with the threads in the opening 56. It is also provided with a plurality of openings 58 through which the individual shafts 52 project.

Around the periphery of the post 54 there is provided an angular groove 60 which is interconnected to the openings 58 by means of short notches 62. A contact member 64 formed out of wire or the equivalent so as to be of a resilient character is disposed within the groove 60 in such a manner that small U-shaped bent sections 66 fit within the notches 62 so as to resiliently bear against the shafts 52 so as to establish electrical contact therewith. It is to be noted that the contact member 64 and the groove 60 are located in a plane which is transverse to the axis of the shaft 16 and the axis of the resistance element 42 within the housing 40; further, the contact member 64 resiliently engages the resistance element 42. All points of the periphery of the contact member 64 are thus equally spaced from the band-like section 46 of the brush member 44.

Upon the end cap 28 there is mounted as by means of a conventional adhesive or the functional equivalent a washer-like brush member 68 which includes a central body portion 70 in which there are formed holes 72 through which the shafts 52 project. Preferably these shafts 52 fit closely within the holes 72 so as to establish electrical contact directly with the brush member 68. If desired, however, the shaft 52 may be secured by welding, soldering or the like, to the body portions 70. From the central periphery 64 of the body portion 70 there project several resilient, brush-like arms 76 which resiliently engage the end 26 of the terminal 14 so as to be in electrical communication therewith at all times as the housing 40 is rotated.

It is considered that the use of the instrument 10 is essentially obvious from the above brief description of the construction of this instrument. In use the terminals 12 and 14 may be mounted in any desired manner, and may be connected to various types of established circuits. When the instrument 10 is used, current may flow from the terminal 12 through the brush-member 44 to the resistance element 42 and along the length of this resistance element to the contact member 64 and thence through the shafts 52 to the brush member 68 and then to the terminal 14, or in a reverse direction. The position of the contact member 64 within the instrument 10 will govern the resistance of the complete instrument. The position of this contact member 64 may be readily adjusted by merely rotating the housing 40 upon the terminals 12 and 14. As this occurs the shafts 52 will cause the post 54 to rotate and by virtue of the engagement of this post with the shaft 16 it will move toward either of the ends of the instrument 10. During such movement the contact member 64 is at all times in engagement with the resistance element 42.

Obviously a number of changes may be made within the precise construction of the instrument 10 shown. As

an example of this, the shaft 16 need not be formed as an integral part of the terminal 12. If this shaft 16 is formed of a non-conductive material it is not necessary that the post 54 be formed of a non-conductive material. Further, other equivalent contact members can be used instead of the type of contact member shown, although this type of contact member is considered preferable in establishing electrical contact with substantially all points of a resistance element 42 in a plane transverse to the axis of the entire instrument 10. Also, other insulating means than those shown can be used in order to separate the terminals 12 and 14; if desired, appropriate bearings or the like may be used to support the housing 40 instead of using the terminals 12 and 14 for the purposes. Further various friction means can be used to prevent accidental rotation of the housing 40, although such means are not considered necessary because of the internal friction within the instrument 10.

A modified electrical instrument 80 of this invention is illustrated in FIG. 6 of the drawing. This instrument 80 is formed as a potentiometer; since the vast majority of parts comprising this instrument are identical with various parts of the instrument 10, those parts of an identical nature are designated by the primes of the numerals previously used, and are not specifically described in connection with this embodiment of the invention.

Within the instrument 80 the end of the shaft 16' remote from the terminal 12' is carried within a small cavity 82 located centrally within a disc-like, non-conductive member 84. This is preferably free to rotate with respect to the shaft 16'; it also includes another cavity 86 which is adapted to carry a terminal 14 in such a manner as to permit rotation between those parts. Within the member 84 there are provided a plurality of openings 88 corresponding to the cavities 50' located within the end cap 34'. Shafts 52' are adapted to project through these openings and to be attached to a brush member 68' secured as by adhesive or the like to one surface of the non-conductive member 84. This brush member 68' may of course be attached to the shafts 52 as by welding or the like; it includes arms or brushes 76' which bear against the terminal 14' at all times so as to establish electrical communication therewith.

It is noted that the non-conductive member 84 is spaced from the housing 40' and that the end of the resistance element 42' adjacent to the end cap 28' is located generally beneath this non-conductive member 84 adjacent to a plane transverse to the end of the shaft 16'. This end of the resistance element 42' is overlaid by a conductive metal or other equivalent band 90 from which there projects a brush 92 similar to the end 48 of the brush member 44 previously described. This brush member at all times resiliently bears against a cylindrical metal terminal sleeve 94 located around an insulating bushing 96 formed of a phenolic composition or other equivalent non-conductive materials. The bushing 96 is in turn located around the terminal 14; preferably it is secured to this terminal 14' so as to be incapable of rotation with respect thereto. The bushing 96 and the sleeve 94 project through.

In FIG. 7 there is shown a further modified electrical instrument of this invention. As those skilled in the art will realize this instrument 100 is a variable resistor; it includes an outer cylindrical housing 102 formed of appropriate rigid non-conductive material. The ends of this housing 102 are closed by means of end caps 104 which are preferably also formed of a non-conductive material. The ends caps 104 may be conveniently attached to the housing by means of adhesive or other various equivalents. The end caps 104 are each provided with centrally located openings 106. Through one of these openings 106 there projects a wire-like terminal 108 having a flange 110 formed thereon which is adapted to rest against the interior of one of the ends caps 104. The terminal 108 includes a threaded shaft 112 which extends from the flange 110 taken through the interior of the housing 102 so as to be co-axial with this housing. The end of the shaft remote from the terminal 108 is designed so as to rotatably fit within a bearing-like opening 114 formed in a non-conductive spacer 116. This spacer is held generally within a cup-like retainer 118 which is attached to another terminal 120 which in turn projects through the opening 106 in the other end cap 104. It will be realized that the retainer 118 acts so as to prevent movement of the terminal 120 away from the housing 102, and that the flange 110 serves this same purpose. With the construction shown it is necessary that the spacer 116 be rotatably held within the retainer 118. If desired, various spring means (not shown) may be incorporated in the unit so as to take up slack between the two terminals 108 and 120.

On the interior surface of the housing 102 there is provided a cylindrical resistance element 122. It is noted that this element 122 extends from around the outside of the retainer 118 to adjacent to the other end of the housing 102. The portion of the resistance element 122 immediately adjacent to the retainer 118 is engaged as indicated in FIG. 8 of the drawing by means of a resilient band 124 which normally tends to spring outwardly so as to establish electrical contact with resistance element 122. The end 126 of the band 124 points inwardly so as to engage the retainer 118 in the manner in which a common brush and slip-ring operate. Thus, the terminal 120 is directly connected to the resistance element 122 at all times.

During the operation of the instrument 100 the resistance element 122 is connected to the terminal 108 by means of a resilient metal contact member 128. The contact member 128 is preferably formed of wire so as to include an exterior band-like section 130 which normally is held under pressure so as to firmly establish contact with the resistance element 122. This section 130 is attached to a small coiled section 132 by means of a radial section 134. The coiled section 132 is designed in such a manner that it will mate with the threads upon the shaft 112 as shown so that rotation of the housing 102 when transmitted to this contact member will cause the contact member 128 to move along the length of this shaft 112 in order to place the section 130 in contact with various portions of the resistance element 122. Such rotation of the housing 102 is transmitted to the contact member 128 by means of two solid rods 136 formed of a non-conductive material. It is noted that these rods are closely spaced to one another so as to, in effect, define a slot within which the radial section 134 fits closely. The rods 136 are mounted within the openings 138 in the spacer 116 and one of the end caps 104 as shown; if desired, they may be secured in place by an adhesive or the like.

The shaft 112 of the instrument 100 serves as an electrical return, and in effect the coiled section 132 of the contact member 128 serves essentially as a post in the instrument 100. If desired, the exterior of the housing 102 can be knurled, and a number of other obvious modifications may be in the construction shown. It is noted that the contact member 128 can, in the instrument 100, be moved so that the section 130 does not engage the resistance element 122; thus, in effect a switch action is achieved in this instrument 100. If desired, various cam surfaces or the like (not shown) may be mounted or formed upon the interior of the housing 102 so as to engage the section 130 in order to provide essentially a snap or click type of action in order to indicate when the contact member 128 has been removed from the resistance element 122.

It is also noted that the contact member 128 in the instrument 100 is of such a nature that substantially no damage can be done to this contact member when the housing 102 is turned to such an extent that this contact member is jammed against either end of the instrument itself. When the contact member 128 is moved against either end of the instrument, this contact member will "give" so as to avoid stripping threads upon the shaft 112, and will automatically re-engage these threads when the housing 102 is turned in the proper direction so as to reverse the motion of the contact member 128.

In FIG. 11 of the drawing there is shown a modified instrument 140 which is extremely similar to the instrument 100. For convenience only those parts of this instrument 140 which are different from those of the instrument 100 will be specifically discussed in this specification. All other parts of the instrument 140 which are identical to the equivalent parts of the instrument 100 previously described are designated by the primes of the numerals previously employed to designate the same parts.

The instrument 140 is, as shown, a potentiometer. In order to complete a potentiometer using the type of construction involved in the instrument 100, it is necessary to include terminal means so that the unconnected end of the resistance element 122' may be connected into a circuit. Within the housing 102' a cylindrical conductive area 142 such as may be formed by known techniques which overlies an end of the resistance element 122' so as to be in electrical communication therewith serves this purpose. This area 142 need not be of a cylindrical category, and if desired, merely a wire or the like may be used in place of it in the housing 102. Within any construction of this category, however, it is necessary to employ a slip-ring and brush type of arrangement. In the particular construction of the instrument 140 illustrated this takes the form of a cylindrical band 144 similar to the band 124 previously described. This band 144 normally tends to spring outwardly so as to firmly engage the area 142, and has an end 146 which projects toward the interior of the housing 102 so as to resiliently engage at all times a small cylindrical flange 148 formed upon a metal sleeve 150.

This sleeve 150 projects through an opening 106' of one of the end caps 104'; it is insulated from the terminal 108' by means of a small non-conductive bushing 152, which bushing includes an interior flange 154 which in turn bears against the flange 110' upon the terminal 108'. It will be realized that essentially a rigid type of construction when the instrument 140 is assembled and the parts are manufactured as shown. The interior of the sleeve 150 with this construction serves essentially as bearing in the same manner as the exterior of the terminal 108 serves as a bearing in the instrument 100. A conventional wire or other equivalents may be attached by known means to the sleeve 150 for the purpose of connecting the instrument 140 to the appropriate circuit.

In FIG. 13 of the drawing there is shown a still further modified electrical instrument 160 of the present invention. This instrument 160 includes a housing 162 of a cylindrical configuration. It is noted that the housing 162 is formed of two similar parts 164 which are adapted to be snapped together by means of resilient latch-type joints 166. If desired, an adhesive may be used within the joints 166, or other equivalent means can be employed to reinforce them. Obviously the complete instrument 160 need not be assembled using these joints 166, but they are considered preferable inasmuch as they facilitate the assembly of the entire instrument.

When the parts 164 are attached together they serve to hold in position metal closures 168 within the ends of the housing 162. It is noted that each of the closures 168 fits within a complete annular groove 170 defined by the parts 164 in the housing 162 and that the closures 168 act as bearing means to support the housing 162 during the rotation of it when the instrument 160 is adjusted. To each of these closures there are attached conventional bent-over type terminals 172 such as may be readily attached to a fixed mounting surface.

Within the center of each of the closures 168 there are formed non-round openings 174 which are adapted to hold correspondingly shaped extensions 176 formed on a threaded non-conductive shaft 178 which extends through the housing 162 in such a manner as to be coaxially aligned therewith. The shaft 178 carries a contact member 180 similar to the contact member 128 illustrated in FIG. 10 of the drawings. A radial section 182 of the contact member 180 extends through a slot 184 in a cylindrical non-conductive guide 186 of resilient character such as is indicated in FIG. 16 of the drawing. This guide is normally of such a dimension as to spring outwardly so as to rest against raised portions 188 of the housing 162 adjacent to the closures 168. If desired, the guide 186 may be secured in place by means of adhesive or the like, although this is not normally necessary.

Within the ends of the guide 186 there are provided large slots 190 which are designed so as to permit brushes 192 of a resilient category to extend through them so as to engage the closures 168 in a manner in which brushes are commonly used to engage a slip ring. These brushes 192 are in effect bent-over ends of resilient metal rings 194 which are adapted to be located in the housing 162 in such a manner as to snap outwardly and be resiliently held within this housing so as to be in electrical communication with either a resistance element 196 or a conductive electrical return 198. If desired, these rings 194 can of, course, be welded or adhesive secured to these elements.

It will be noted that the resistance element 196 is completely formed within one of the parts 164 of the housing 162, and that the electrical return 198 is located within the other of the parts 164. It is also noted that the contact member 180 extends completely around the guide 186 so as to resiliently engage simultaneously both the resistance element 196 and the return 198 in the same plane perpendicular to the axis of the housing 162. The resistance element 196 and the return 198 may be formed as shown by means of various printed circuit techniques or other equivalents known to the art. If desired these elements may be co-molded with the parts 164 so as to be securely bonded to the housing 162.

The operation of the instrument 160 is substantially the same as the other instruments previously described, in that the housing 162 is adapted to be rotated after the terminals 172 have been rigidly mounted in position. If desired, the exterior of the housing 162 may of course be knurled or otherwise formed so as to be readily engaged by hand. During rotation of the housing the cylindrical guide 186 rotates and the contact member 180 hits against the sides of the slot 184. This in turn causes the contact member to rotate upon the shaft 178, and causes the contact member to move along the length of the housing 162. It is noted again that the contact member 180 is formed in such a manner that if it turns against either end of the housing 162 little or no damage to the complete instrument 160 will occur by virtue of the resilient character of the housing. It is also noted that when the housing 162 is rotated so as to move the contact member 180 to either end of the instrument shown that the contact member rides off the resistance element 196 or the electrical return 198. Thus, in effect, with the instrument 160 a switch type of action is achieved when the contact member 180 is moved too far in either direction. If desired, various cams or the like can be formed in the interior of the housing 162 in order to provide a snap type action when the instrument 160 is "switched off" in this manner.

Obviously the instrument 160 may be modified a number of different ways. In order to obtain a differential type of action which will tend to slow up or speed up the movement of the contact member 180 within this instrument during rotation of the housing 162, it is possible to provide a modified guide 86' as shown in FIG. 17. This modified guide differs from the guide 186 in that the slot 184' in it is curved so as to extend in essentially a helical path instead of extending in a straight line parallel to the axis of the guide. For certain purposes, as when fine adjustment is required, this type of construction shown in FIG. 17 can prove advantageous.

Obviously a wide variety of different modifications than

have been specifically indicated in the preceding discussion can be made in any of the instruments herein shown and discussed. Thus, for example various different types of guide means can be employed in these instruments and further, different types of sealing means can be employed. Because of the fact that the instruments herein shown and described can be modified in a great number of ways, this invention is to be considered as being limited only by the appended claims. Those skilled in the art to which this invention pertains will realize that extremely compact, inexpensive, reliable units may be manufactured in accordance with the broad teachings of this invention, and that the type of action described herein can be applied to a wide variety of differently appearing electrical instruments without departing from the essential features of this invention.

I claim:

1. A variable resistor comprising, in combination, an electrically conductive shaft having a threaded portion, a terminal wire disposed in axial alignment with said shaft at one end thereof and insulated from said shaft, a tubular housing rotatably mounted on said shaft and said terminal wire coaxial therewith, said shaft projecting from one end of said housing and said terminal wire projecting from the other end thereof, means restraining said tubular housing against relative movement with respect to said shaft along the longitudinal axis thereof, a resistance element affixed to the inner surface of said tubular housing around the entire circumference thereof, a contact member disposed within said housing and wiping on said resistance element, said contact member making electrical connection with said conductive shaft, means on said contact member engaging the thread of said shaft in driving connection therewith, whereby relative rotation between said shaft and said contact member causes the latter to move along the length of the shaft, guide means fixed with respect to said housing and slidably engaging said contact member so as to cause the latter to rotate with the housing, and an electrical connection between one end of said resistance element and said terminal wire.

2. A variable resistor as defined in claim 1, wherein said guide means consists of a pair of guide rods attached at their ends to said housing and extending parallel to said shaft, and said contact member includes a radially extending portion passing between and slidably engaging said guide rods.

3. An adjustable electrical instrument as defined in claim 1 wherein said contact member is formed of resilient wire so as to include a helically coiled section engaging the threads on said shaft means in driving connection therewith, and an exterior section engaging said resistance means.

4. An adjustable electrical instrument as defined in claim 1 wherein said resistance element extends completely around the interior of said housing means and wherein said contact member is formed of resilient wire so as to include a helically coiled section engaging the threads on said shaft means in driving connection therewith, a radial section extending from said coiled section and a circular band-like exterior section engaging said resistance element around substantially the entire periphery thereof.

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