

March 1, 1966

J. E. LANGENBACH ET AL

3,238,488

VARIABLE RESISTOR

Filed Jan. 15, 1962

2 Sheets-Sheet 1

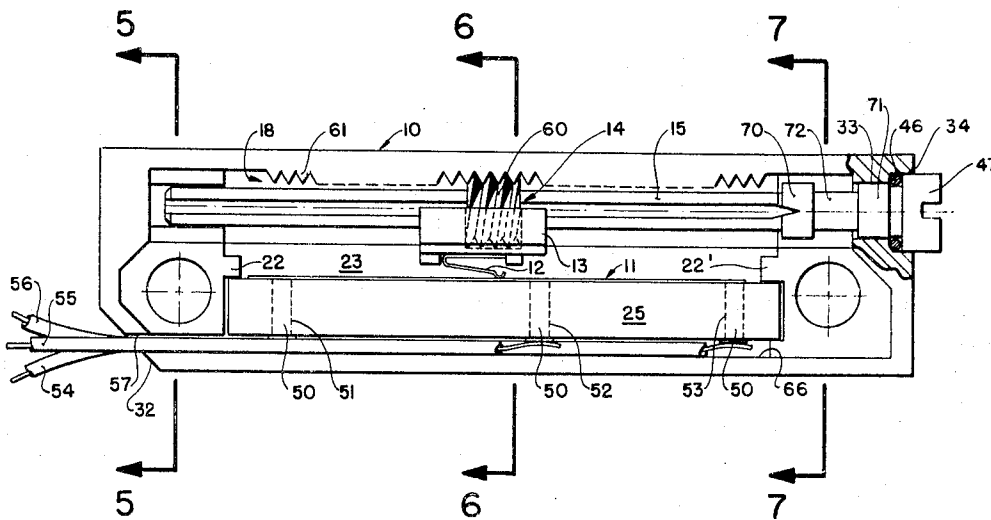


FIG. 1

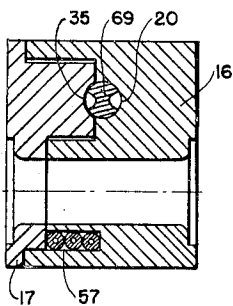


FIG. 5

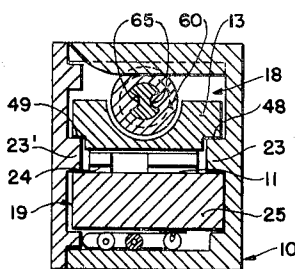


FIG. 6

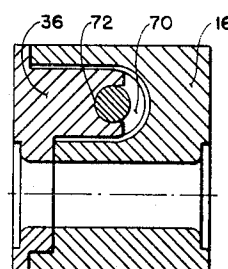


FIG. 7

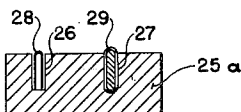


FIG. 8

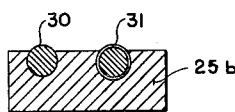


FIG. 9

INVENTORS
JACK E. LANGENBACH
BY DELBERT L. SINGLETON
Louis J. Knoble
ATTORNEY

March 1, 1966

J. E. LANGENBACH ET AL

3,238,488

VARIABLE RESISTOR

Filed Jan. 15, 1962

2 Sheets-Sheet 2

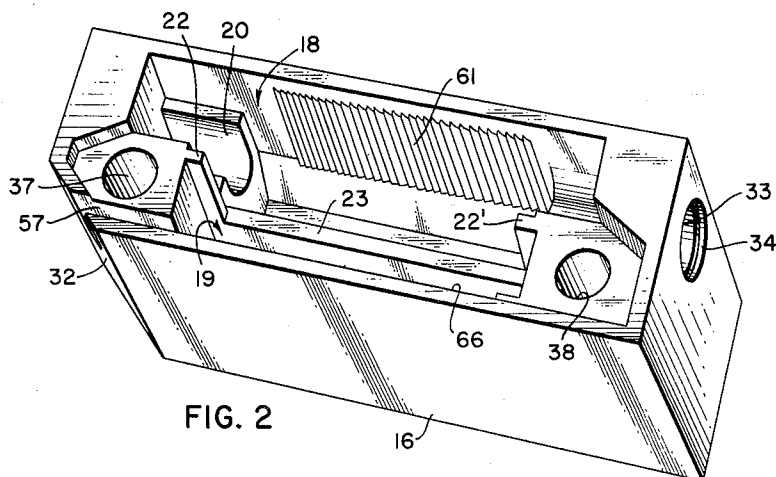


FIG. 2

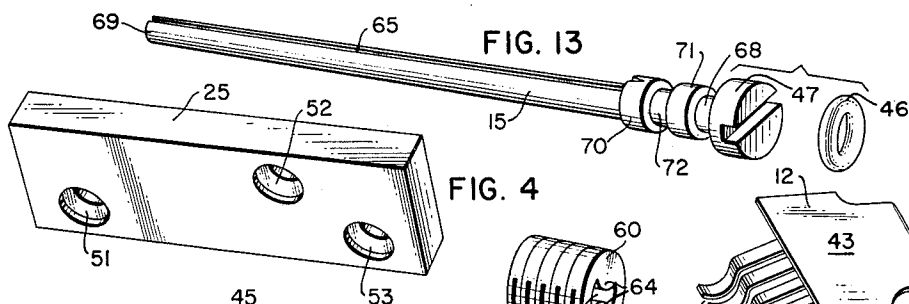


FIG. 13

FIG. 4

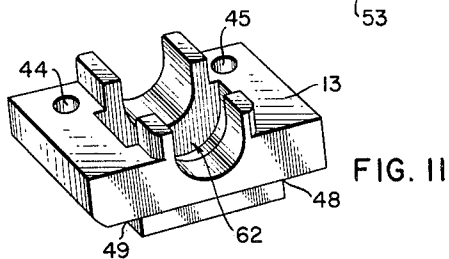


FIG. 11

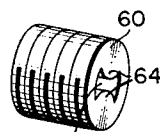


FIG. 14

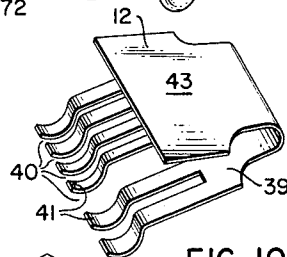


FIG. 10

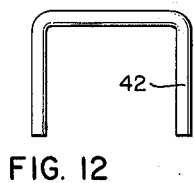


FIG. 12

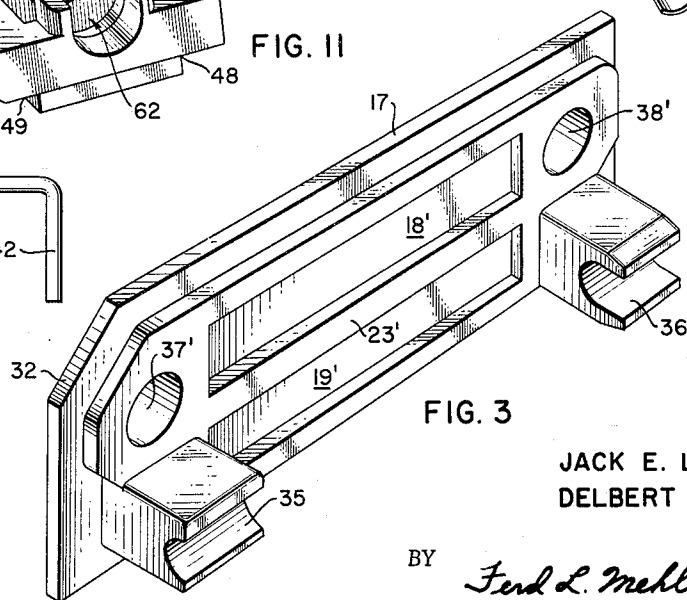


FIG. 3

INVENTORS
JACK E. LANGENBACH
DELBERT L. SINGLETON

BY

Ferd L. Mehlhoff
ATTORNEY

3,238,488

VARIABLE RESISTOR

Jack E. Langenbach, Corona del Mar, and Delbert L. Singleton, Diamond Bar, Calif., assignors to Beckman Instruments, Inc., a corporation of California
Filed Jan. 15, 1962, Ser. No. 166,054
4 Claims. (Cl. 338—180)

This invention relates to variable resistance devices and, more particularly, to variable resistance devices having particular utility in the class of potentiometers known in the art as rectilinear trimming potentiometers.

In the present state of the art, there are numerous designs for the construction of rectilinear trimmer potentiometers. Notwithstanding this extensive development in the art, the commercially successful trimmer potentiometers have tended to be quite complex in design with resultant high manufacturing costs. This complexity of design has been justified in the past as being necessary in order to produce trimmer potentiometers which will pass the military specifications prepared by the Armed Services Electro-Standards Agency. These specifications specify, for example, power rating, insulation resistance, maximum operating torque, resistance-temperature characteristic, humidity cycling, moisture resistance, salt spray, temperature cycling, acceleration, shock and vibration.

Accordingly, it is an object of this invention to provide an improved variable resistance device which meets military specifications while having a minimum number of components which are easily constructed and assembled.

The military specifications further provide for both wirewound and non-wirewound types of resistance elements, the former type normally comprising a plurality of turns of resistance wire wound upon a card or cylindrical mandrel whereas the latter type includes deposited metallic films, cermet films, carbon films, and conductive plastics. Each of these different resistance elements have certain advantages and disadvantages so that no one resistance type is suitable for all trimmers. By way of example, the cermet film offers infinite resolution and high temperature cycling but is usually more costly to manufacture than the finite resolution wirewound resistance elements. Accordingly, in order to manufacture a fully competitive line of trimmer potentiometers, it is necessary to construct trimmer potentiometers embodying at least several of these resistance element types. However, the prior art trimmer potentiometer designs have usually been adapted to incorporate only a particular one of the several types of resistance elements.

It is, therefore, another object of this invention to provide an improved variable resistance device in which any one of several different resistance elements may be easily incorporated during the manufacture of the device.

Other and further objects, features, and advantages of the invention will become apparent as the description proceeds.

Briefly, in accordance with a preferred form of the present invention, there is provided a rectilinear trimming potentiometer having a two piece molded housing comprising a main body member and a cover plate member. These members are molded so as to form an interior cavity in which is positioned the movable electrical contact and apparatus for translating same relative to the potentiometer resistance element and an adjoining receptacle for receiving the resistance element. This construction enables trimmer potentiometers to be constructed with the same housing components while utilizing any one of several different types of resistance elements.

The two piece molded housing further rotatably mounts the potentiometer control shaft, the end of the shaft con-

veniently being mounted in mating half-bearings integral with said main body and cover plate members. Also, the cover plate member preferably incorporates an integral keeper member adapted to engage an annular groove of the control shaft thereby preventing axial movement of the shaft relative to the housing. The control shaft further includes a gland in which is mounted a resilient O ring. The control shaft annular groove is so located with respect to the cooperating keeper of the cover plate that an axial force must be exerted inwardly upon the shaft in order to insert the keeper into the groove. This axial force thus causes the resilient O ring to distort within its gland. Upon removal of the inward axial force, a residual outward force is maintained on the shaft due to the distortion of the O ring. Accordingly, the shaft is restrained against unwanted movement in conditions of shock or vibration without exceeding the maximum operating torque allowed by military specifications. Moreover, the O ring seals the shaft opening thus preventing the ingress of undesirable environmental elements so as to easily pass the humidity cycling, moisture resistance and salt spray specifications.

A more thorough understanding of the invention may be obtained by study of the following detailed description taken in connection with the accompanying drawings in which:

FIG. 1 is a longitudinal cross-section of a typical trimmer potentiometer constructed according to the present invention;

FIG. 2 is a perspective view of the main body member of the potentiometer housing;

FIG. 3 is a perspective view of the potentiometer housing cover plate;

FIG. 4 is a perspective view of the potentiometer resistance element supporting base;

FIG. 5 is a cross-sectional view of the structure of FIG. 1 taken along the line 5—5;

FIG. 6 is a cross-sectional view of the structure of FIG. 1 taken along the line 6—6;

FIG. 7 is a cross-sectional view of the structure of FIG. 1 taken along the line 7—7;

FIGS. 8 and 9 illustrate cross-sectional views of other embodiments of the resistance element support base, commutator and resistance element;

FIG. 10 is a perspective view of the potentiometer movable electrical contact;

FIG. 11 is a perspective view of the potentiometer travel block;

FIG. 12 illustrates a typical staple for joining the movable electrical contact to the travel block;

FIG. 13 is a perspective view of the potentiometer control shaft and O ring seal; and

FIG. 14 is a perspective view of the worm gear employed in the movable contact assembly.

Referring now to FIG. 1, there is shown a trimmer potentiometer constructed according to the present invention having a housing 10, a rectilinear resistance element 11 mounted within the housing, a movable electrical contact 12, a travel block 13 to which the electrical contact 12 is fixedly mounted, and an actuation mechanism 14. The actuation mechanism shown is the invention of William J. H. Thoele and is disclosed and claimed in the co-pending application Ser. No. 166,199, now Patent No. 3,178,664 entitled "Variable Resistance Device," filed on even date herewith and assigned to Beckman Instruments, Inc., assignee of the present invention. As described in further detail below, the actuation assembly 14 includes control shaft 15 which, when rotated, causes a corresponding translatory motion of the travel block 13.

It will be understood that the trimmer potentiometer shown in the figures is considerably enlarged for illustra-

tive purposes. Representative outside dimensions of potentiometers constructed in accordance with this invention are $1\frac{1}{4}'' \times 1\frac{1}{32}'' \times \frac{1}{4}''$.

As shown in detail in FIGS. 2 and 3, housing 10 preferably includes only two pieces, the main body or housing member 16 and the cover plate member 17. Each of these members are preferably molded from a plastic material or a refractory material, or die-cast from a metal or metallic alloy, the particular metal and mode of construction depending upon the environmental strength and temperature conditions in which the potentiometer will be used. By way of specific example, these members have been easily molded from diallyl phthalate resin to tolerances of ± 0.003 inches.

The main body member 16 comprises a generally rectangular member defining a recess having one side thereof open to the exterior and having a first or upper cavity 18 and a second or lower adjoining cavity or receptacle 19 which are divided by projections 22 and 22' and rib 23 parallel to the top and bottom walls of the main housing member 16. The upper cavity 18 encloses the actuation mechanism 14. Receptacle 19 is generally rectangular in shape for retaining the rectangular resistance element base 25 (FIG. 4). As described more in detail hereinafter, projections 22, 22' facilitate precisely locating the resistance element base 25 with respect to the movable electrical contact 12 and rib 23 cooperates with a rib 23' on the housing cover plate member 17 for preventing rotation of the travel block 13 with respect to the housing 10.

The main body member 16 and also the cover plate member 17 are provided with a corner 32 cut at a 45° angle with respect to the base and end wall of these members. This construction greatly facilitates the close stacking of a plurality of variable resistance elements constructed in accordance with this invention without interference from the flexible leads 54, 55 and 56 extending outwardly through the slot 57 in corner 32 of the main body member (FIGS. 1 and 2). Main body member 16 further includes a cylindrical hole 33 whose axis is parallel to the longitudinal walls of the member. This hole includes a counter sunk opening 34 in which may be located an O ring 46 and a portion of the adjustment head 47 of the control shaft 15. The dual functions of this O ring are described below.

The resistance element base 25 is shown in detail in FIG. 4. This base may be constructed of any suitable material although ordinarily it will be of a material having a high dielectric resistance and adapted to undergo the environmental conditions to which the resistance element 11 will be exposed. For example, the base element 25 may be of a ceramic material such as steatite upon which is formed a cermet resistance element according to the teachings of U.S. Patents No. 2,950,995 of Tom Place, Sr., et al. and No. 2,950,996 of Tom Place, Sr., et al., both of which are assigned to Beckman Instruments, Inc. The base element will then have the cross-sectional configuration shown in FIG. 6 wherein a cermet resistant element is applied to the base 25 by a silk-screen procedure. As shown in FIG. 6, there is also applied to the base 25 a conductive commutator 24 also engaged by the movable electrical contact 12, this commutator serving to provide the electrical connection between the movable contact and a stationary electrical terminal. This commutator may, for example, comprise a plated or coated conductive layer. In order to incorporate a terminal for the commutator and also the respective ends of the resistance element, the base 25 is provided with respective openings 51, 52 and 53.

Other and different types of resistance elements may also be applied to the base 25. For example, deposited metallic films, carbon films and conductive plastics will ordinarily present the cross-sectional configuration shown in FIG. 6. Other embodiments of the resistance element

base 25 which are particularly adapted for still other types of resistance elements are shown in FIGS. 8 and 9. Thus, in FIG. 8, the resistance element base 25a includes two parallel, longitudinally extending grooves 26 and 27 formed in the flat top surface thereof. Seated within groove 26 is a generally U-shaped conductor strip 28 which serves as the electrical commutator; while groove 27 has a card type resistance element 29 comprising a flat, thin card of insulating material upon which is wound a plurality of turns of resistance wire. The resistance base 25b shown in FIG. 9 incorporates a cylindrical conductive commutator 30 and a resistance element 31 comprising a cylindrical mandrel upon which is wound a plurality of turns of resistance wire. It will, of course, be apparent that the plated, coated, film type, etc., commutator 24 may be utilized with the card type resistance element 29 or the mandrel type 31. Also, some types of resistance elements such as conductive plastics, may be formed in a longitudinally extending groove in the top surface of the resistance element base 25 instead of immediately on the surface as shown in FIG. 6. These and like variations will be apparent to those having skill in the variable resistance art.

It will thus be seen that the resistance base 25 and the commutator and resistance element form a sub-assembly which is inserted in the housing 10 by merely sliding the base 25 into the receptacle 19 of the main body member 16. The position of the resistance element relative to the movable contact is maintained constant by abutting the base 25 against the projections 23 and 23' of the housing member 16 and 17 respectively. Accordingly, variations in the thickness of the resistance element base do not affect the spatial relationship between the contact and the resistance element. This construction has the significant advantage that a number of different types of variable resistance devices may be constructed with the same housing, actuation assembly, movable electrical contact, etc., the desired resistance element and base assembly being inserted within the receptacle 19 during the assembly of the variable resistor. This is a significant advantage in view of the many different applications for which the small trimming potentiometers are used today with resultant varying specifications of linearity, resistance value, resistance temperature characteristics, etc.

The housing cover plate 17 shown in detail in FIG. 3 is preferably molded from the same material as the main housing member 16 and includes integral therewith a rear half-bearing 35 and a shaft-keeper 36. Cover plate 17 further includes an upper cavity 18' and a lower cavity or recess 19' separated by rib 23'. As shown in FIG. 6, when the cover plate is joined to the main body member 16, these cavities mate with respective cavities 18 and 19 of the main body member so as to enclose the movable contact member and actuation assembly in the upper cavity 18 and the resistance element base 25 in the lower receptacle. In a manner well known in the art, the main body member 16 and cover plate member 17 are normally joined by eyeletting through the two holes 37, 37' and 38, 38'. Of course, other methods of attaching the cover plate to the housing may be employed, such as rivets, screws, or adhesives. As shown in FIG. 5, the cover plate 17 also encloses groove 57 so as to form an aperture in the corner 32 of the housing 10 for the leads 54, 55, 56. If desired, the space between these leads may be filled with a suitable potting compound so as to effectively seal this opening.

The rear half-bearing 35 of the cover plate member 17 cooperates with the half-bearing 20 of the main body member 16, as shown in FIG. 5, to rotatably support the end portion 69 of the control shaft 15. The front portion of the shaft, specifically collar 71, is rotatably mounted in hole 33 of the main body member which serves as a bearing therefor.

The electrical contact element 12 and the movable contact block 13 are respectively shown in detail in FIGS.

5

10 and 11. The electrical contact 12 may be of a customary design in which a sheet of conductive material is formed in a general V-shape with the lower leg 39 having a plurality of slots 40 thereby providing a plurality of split contact elements or fingers 41. As shown the ends of each of these contact elements are arcuately shaped so as to form radius type contacts. Contact element 12 is retained to the travel block 13 by staple 42 (FIG. 12) which engages the underside of upper leg 43 of contact 12 and passes through holes 44, 45 of the block 13 after which the ends of the staple are bent over thereby fixedly mounting the contact element 12 with respect to the contact block 13. The movable contact block 13, as shown in FIGS. 6 and 11, also includes shoulders 48 and 49 which cooperate with the ribs 23 and 23' of the housing 10 for preventing rotation of the travel block relative to the housing when rotation control shaft 15 is rotated. Contact block 13 further forms a portion of the actuation assembly 14 described below.

It will be understood that the particular movable electrical contact 12 shown is by way of specific example only; other types of contacts known in the art may be preferred in certain applications depending upon the type of resistance element utilized. For example, with cermet type resistance elements, in many applications it may be desirable to use the conductive plastic contact described in the application of Kenneth F. Miller et al. entitled "Variable Resistor Contact," filed December 11, 1961, Serial No. 158,318, and assigned to Beckman Instruments, Inc. Likewise, other means may be used to attach the contact 12 to the block 13, e.g. suitable cements may be used to adhere the contact to the block or a portion of the contact 12 may be embedded in the block 13.

As shown in FIGS. 1 and 6, the travel block 13 with the electrical contact 12 attached thereto is mounted within the upper cavity 18 formed by the mating cavity sections of the main body member 16 and the cover plate member 17. As shown in FIG. 6, a plurality of the split contact elements 41 engage the resistance element 11 and a lesser number engage the conductive commutator 24. As shown in FIG. 1, conductive terminals 50, preferably metallic pins, extend through the respective openings 51, 52 and 53 provided in the resistance base 25 and engage the ends of resistance element 11 and the commutator strip 24. These pins are also respectively connected to electrical leads 54, 55 and 56 which extend through the slot 57 in the rearward corner portion 32 of the main housing member 16. In an alternative arrangement, contact pins (not shown) adapted for use with printed circuitry may extend through the bottom of the housing 10. As described below, the leads 54, 55 and 56 may also be used during the assembly of the variable resistance device to temporarily retain the resistance base 25 against the projections 22 and 22'.

Practically all of the rectilinear trimming potentiometers constructed to date have employed either a linearly slidable member extending outside of the housing or a threaded shaft cooperating with a threaded travel block for translating same upon rotation of the shaft. Either of these actuation means may be employed in the present invention. Thus, for the linear actuation type, control shaft 15 would be affixed to travel block 13. The cover plate 17 would then, of course, not include keeper 36 so that shaft 15 could freely slide in bearing hole 33. In the threaded shaft, rotary actuation type, shaft 15 would be threaded, these threads would either engage like threads of the travel block 13 or the shaft itself may form these threads if travel block 13 is made from a resilient material with a low coefficient of friction and a good cold memory, such as polytetrafluoroethylene. For additional constructional details regarding these actuation assemblies, see for example, chapter 27 of the book entitled, "Resistance and Resistors" by Charles L. Wellard, published by the McGraw-Hill Book Company, Inc., in 1960. The actuation assembly shown herein is disclosed and

6

claimed in the co-pending application entitled, "Variable Resistance Device," supra, and comprises travel block 13 shown in detail in FIG. 11, the control shaft 15 shown in detail in FIG. 13, the worm gear 60 shown in detail in FIG. 14, and the rack gear 61 integrally formed in the top inside surface of the main body member 16, as shown in FIGS. 1 and 2. The teeth of this rack are formed with the same pitch as the threads of the worm gear 60. As shown in FIGS. 1 and 6, worm gear 60 is retained in the semi-circular trough 62 formed in the top surface of the travel block 13 (FIG. 9). This trough is partially closed at each end and the length of the worm is dimensioned to be a line to line fit with the respective ends thereby preventing longitudinal movement of the worm gear with respect to the travel block 13. The worm 60 is however so dimensioned that its diameter is slightly smaller than the diameter of the semi-circular trough 62 thereby allowing free rotation of the worm about its spiral axis with respect to the travel block 13.

Worm gear 60 is mounted on and rotates in unison with the control shaft 15. For this purpose, the worm gear 60 has a longitudinal hole 63 therethrough including a pair of projecting keys 64 which mate with corresponding longitudinal slots or key ways 65 in the control shaft 15. This construction, while permitting translatable movement of the worm relative to the shaft, prevents rotational movement between these members.

The exposed threads of the worm gear 60 mate with like pitched teeth of the rack gear 61 in the assembled resistance element, as shown in FIGS. 1 and 6. Accordingly, as the control shaft 15 is rotated about the bearings defined by the main body member 16 and the cover plate member 17, the worm gear 60 travels down the rack gear 61 due to the engagement of the worm threads with the rack teeth. The rectilinear movement of the worm causes it to exert a force on the closed end of the semi-circular trough 62 of the travel block 13, thereby imparting a corresponding rectilinear motion to the travel block and a movable electrical contact 12.

The fabrication and assembly of variable resistance elements constructed according to the present invention may be done quickly and with a minimum of manufacturing expense. Thus, the body members 16 and 17, the travel block 13, the resistance base 25 and the worm gear 60 are preferably molded or die-cast as the elements shown with no additional manufacturing operations being required. The O ring 46 and staple 42 are readily available components and the electrical contact 12 and control shaft 15 are of simple design adapted for machine manufacture.

A preferred method of assembling trimmer potentiometers embodying the features of the present invention is as follows: The resistance element base with the resistance element 11, commutator 24, and electrical leads 54, 55 and 56 attached thereto is slid into the rectangular receptacle 19 of the main body member 16. Preferably, the insulation of the electrical leads is made from a resilient material and is slightly greater in diameter than the distance between the bottom of the resistance base 25 and the inside bottom wall 66 of the main body member 16. The leads must then be slightly deformed so as to wedge within the space provided thereby temporarily retaining the resistance base 25 against the projections 22 and 22' which separate the upper cavity 18 from the lower cavity 19. As previously noted, these projections define the spatial relationship between the movable contact 12 and the resistance element 11 and commutator 24. In order to permanently mount the resistance base 25 in position, it is preferably cemented to both the main housing member 16 and cover plate 17 by a suitable epoxy adhesive. Prior to positioning the cover plate member, however, the travel block 13 with the electrical contact 12 affixed thereto and the worm gear 60 resting within the semi-circular trough 62 is placed in the upper cavity 18 so

7

that the shoulder 48 of the travel block rests upon rib 23 of the main housing member 16, as shown in FIGS. 1 and 6. The control shaft 15 with O ring 46 positioned in the O ring gland 68 is then inserted into the hole 33 of the main body member 18 into the upper cavity 13 and continued through the hole 63 of the worm gear 60 with the end portion 69 of the shaft 15 finally resting in the half-bearing 20 and the bearing collar 71 positioned in the bearing hole 33. The cover plate 17 is then located on the main body member 16 so that its half-bearing 35 cooperates with the half-bearing 20 of the main body member 16 so as to rotatably mount the end portion 69 of the control shaft. When positioning the cover plate 17, the rib 23' must be in abutment with the shoulder 49 of the travel block 13 thereby positively preventing any misalignment of the movable contact 12 with respect to the resistance element 11 and commutator 12 which might otherwise be caused by the travel block rotating with respect to the housing 10.

The keeper member 36 molded integral with the cover plate 17 is designed to enter the annular groove 72 defined by the collars 70, 71 so as to retain the shaft 15 against linear movement with respect to the housing 10, in those applications requiring this retention. In order to insure that the shaft 15 is so retained while also sealing the opening 33 through which the shaft enters, the collar 71 of shaft 15 is so positioned that it remains within the hole 33 of the main body member 16 so long as an inward axial force is not applied to the shaft 15 against the O ring 46. Accordingly, the keeper 36 cannot enter the groove 72 unless this force is applied. During the assembly of the unit, such inward axial force is applied upon the shaft 15 so as to compress the O ring against the base of countersunk opening 34 and expose the entire groove 72 thus permitting the insertion of the keeper half-bearing 36 between collars 70 and 71 of the control shaft. When the inward axial force is removed from the shaft 15, a residual outward force will be maintained on the shaft due to the distortion of the O ring. This shaft is thereby restrained against unwanted movement in conditions of shock or vibration. Also, the O ring effectively seals the housing opening, and thus prevents the ingress of undesirable environmental elements so that variable resistance devices constructed in accordance with this invention easily meet the military specifications of humidity cycling, moisture resistance and salt spray. Moreover, this construction, while providing an effective seal, does not necessitate that a substantial torque be applied to rotate the control shaft; accordingly, units constructed therewith easily meet the maximum operating torque specified by military specifications.

Although an exemplary embodiment of the invention has been disclosed herein for purposes of illustration, it will be understood that various changes, modifications and substitutions may be incorporated in such embodiment without departing from the spirit of the invention as defined by the claims which follow.

We claim:

1. A variable resistor comprising:

a main housing member defining a generally rectangular recess open to the exterior at one side thereof, projections on the side walls of said housing extending partially into the recess thereby to divide said recess substantially into first and second adjoining interior cavities each communicating with said opening to said recess on one side of said housing;

a resistance element sub-assembly including a generally rectangular resistance element base adapted to slide into said second cavity and a longitudinal resistance element affixed to said resistance element base; electrical terminals retained in said resistance element base and connected to the respective ends of said resistance element affixed thereto;

electrical leads having one end respectively connected to said terminals and positioned between said re-

8

sistance element base and a sidewall of said housing, said leads having a resilient insulation and being of such dimensions that the insulation is deformed upon so positioning the leads so that the top surface of said resistance element base is biased against the projections of said main housing member thereby to fixedly locate said resistance element on said base within said housing;

a cover plate housing member adapted to close said open side of said housing, said cover plate housing member having a generally rectangular recess cooperating with said second cavity of said main housing member to enclose resistance element base;

a movable electrical contact engaging said resistance element; and

means in said first cavity for linearly actuating said contact with respect to said resistance element including a control shaft rotatably mounted with its axis parallel to said resistance element.

2. A variable resistor comprising:

a main housing member defining a recess open to the exterior at one side thereof and including at least one shaft opening through a sidewall thereof;

a rectilinear resistance element affixed within said housing;

a movable electrical contact engaging said resistance element;

means for linearly actuating said contact with respect to said resistance element including a control shaft rotatably mounted with its axis parallel to said resistance element and having an end thereof extending through said shaft opening in said sidewall of said main housing member, said shaft having an annular groove therein;

a cover plate housing member adapted to cover said opening on said one side of said main housing member and having integral therewith a keeper member engaging said annular groove in said control shaft thereby preventing linear movement of said shaft with respect to said main housing member; and

a resilient O ring supported in a gland around said control shaft, said O ring cooperating with said main housing member to seal the shaft opening in said one sidewall through which said shaft extends, said annular groove of said shaft being positioned with respect to said integral keeper of said cover plate member so that an inward axial force must be exerted upon said shaft in order to seat said keeper in said annular groove so that upon removal of said force, a residual outward force will be maintained on the shaft due to the distortion of the O ring.

3. A variable resistor comprising:

a main housing member defining a recess open to the exterior at one side thereof, said housing including oppositely disposed projections extending into said recess and dividing said recess into first and second adjoining interior cavities each communicating with the opening to the exterior, said second cavity defining a substantially rectangular receptacle;

a resistance element sub-assembly comprising:

a generally rectangular resistance element base adapted to slide into said receptacle so that its top surface abuts said oppositely disposed projections; and

a longitudinal resistance element affixed to said resistance element base;

a movable electrical contact engaging said longitudinal resistance element, said oppositely disposed projections defining the spatial relationship between said movable electrical contact and said longitudinal resistance element;

a cover plate housing member adapted to cover said opening to said recess on one side of said main housing member and having integral therewith a projecting keeper member;

and actuation means mounted within said first cavity for linearly actuating said contact with respect to said resistance element including a control shaft rotatably mounted with its axis parallel to said resistance element and having an annular groove therein which is engaged by said keeper member for preventing linear movement of said shaft with respect to said main housing member. 5

4. A variable resistor comprising:

a main housing member defining a recess open to the exterior at one side thereof, said housing including oppositely disposed projections and a longitudinal rib extending into said recess and dividing said recess into first and second adjoining interior cavities each communicating with the exterior through said opening on said one side of said housing member; 10

a resistance element sub-assembly comprising:

a resistance element base, and a longitudinal resistance element affixed to said resistance element base; 20

said second cavity defining a receptacle which locates the resistance element base so as to maintain said longitudinal resistance parallel to said rib, said resistance element base abutting said oppositely disposed projections; 25

a movable electrical contact engaging said resistance element;

a travel block having a pair of shoulders formed thereon, said travel block fixedly mounting said movable electrical contact; 30

means mounted within said first housing cavity for linearly actuating said travel block with respect to said resistance element;

and a cover plate member adapted to close said opening to said recess on one side of said main housing member and including first and second recesses separated by a rib which cooperates with said first and second cavities so as to enclose said actuation means in said first cavity and said resistance element base in said second cavity, said shoulders of said travel block respectively abutting said rib of said main housing member and said rib of said cover plate member so as to prevent said travel block from rotating with respect to said housing.

References Cited by the Examiner

UNITED STATES PATENTS

2,668,218	2/1954	Searles	338—133
2,711,463	7/1955	Geoppinger et al.	338—323
2,831,094	8/1958	Bourns et al.	338—125
2,850,608	9/1958	Bourns et al.	338—183
2,857,497	10/1958	Bourns et al.	338—183
2,860,216	11/1958	Hubbard et al.	338—180
2,870,303	1/1959	O'Brian	338—180
2,898,236	8/1959	Long et al.	
2,922,977	1/1960	Gottschall	338—183
2,926,324	2/1960	Barden et al.	338—183 X
2,935,716	5/1960	Bourns	338—180
2,946,975	7/1960	Caddock	338—183
2,953,763	9/1960	Bourns et al.	338—183
2,958,062	10/1960	Barden et al.	338—180
2,976,507	3/1961	Di Girolamo et al.	338—180
2,999,995	9/1961	Bourns et al.	338—180
3,002,168	9/1961	Green et al.	338—180

RICHARD M. WOOD, *Primary Examiner.*