Sept. 12, 1961 M. E. BOURNS ET AL 2,999,994

ADJUSTABLE ELECTRICAL RESISTORS

Original Filed Sept. 1, 1955 3 Sheets-Sheet 1

FIG. 1.

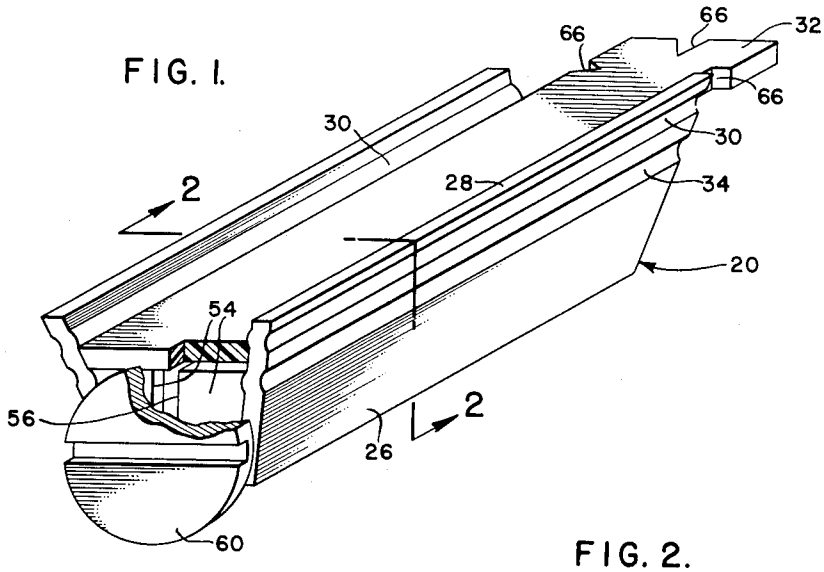


FIG. 2.

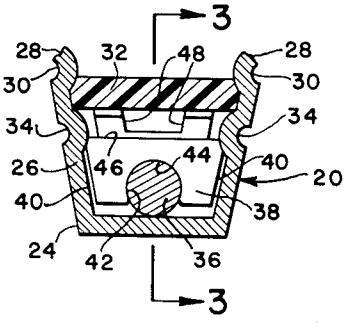
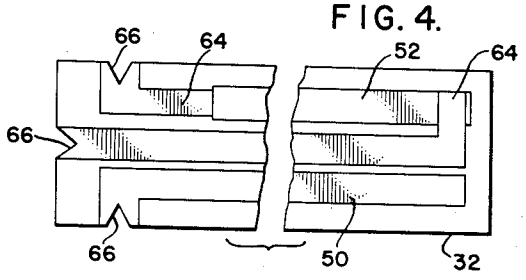


FIG. 4.



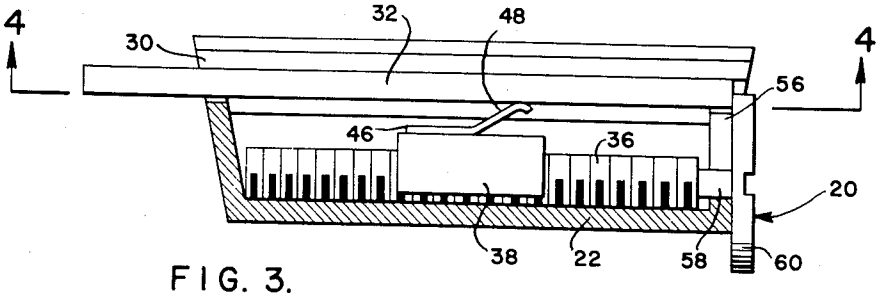


FIG. 3.

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ADJUSTABLE ELECTRICAL RESISTORS

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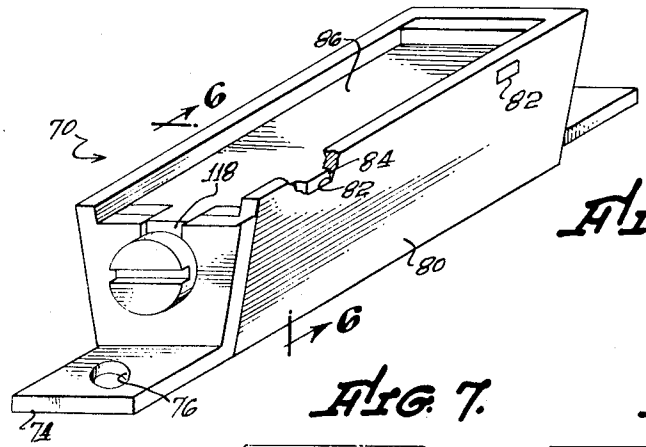
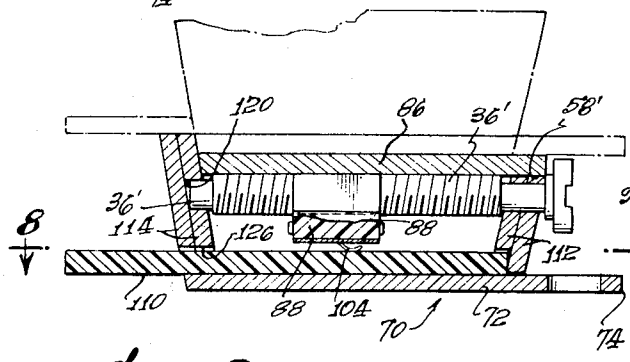


FIG. 5.

FIG. 7.

FIG. 6.



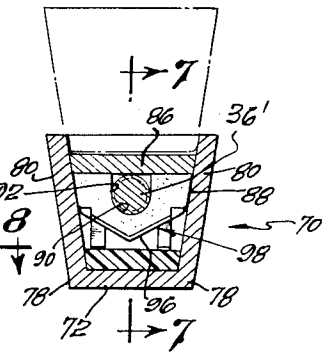


FIG. 8.

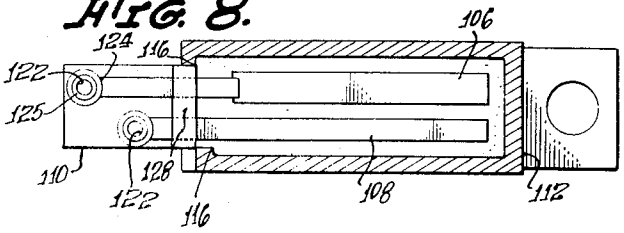
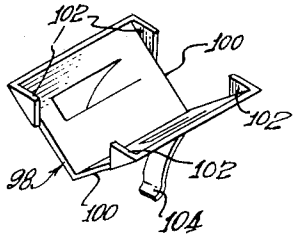


FIG. 9.



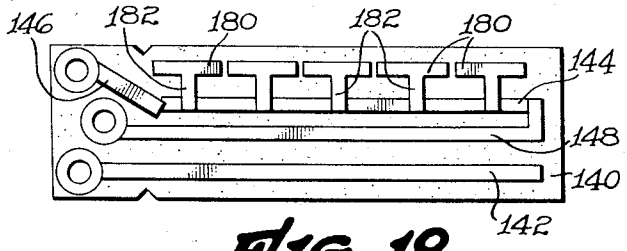


FIG. 18

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ADJUSTABLE ELECTRICAL RESISTORS

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FIG. 10.

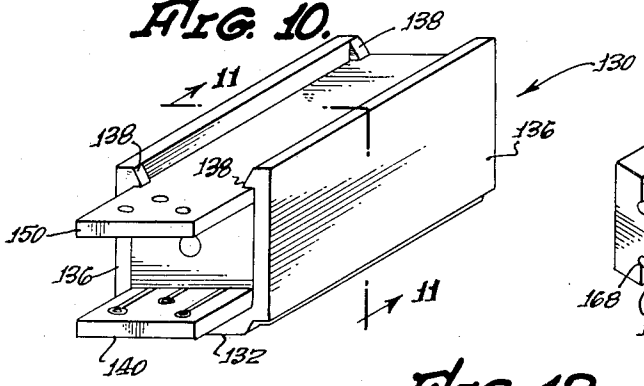


FIG. 14.

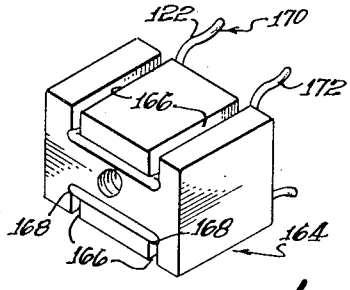


FIG. 12.

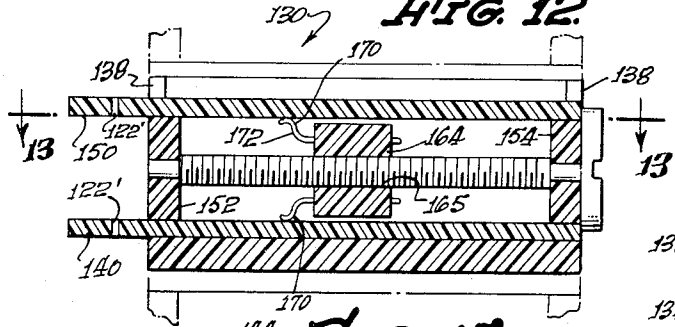


FIG. 11.

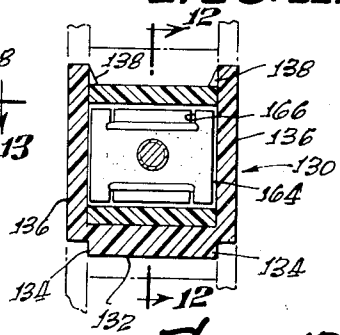


FIG. 15.

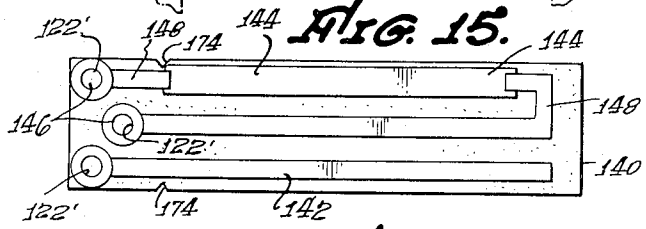


FIG. 13.

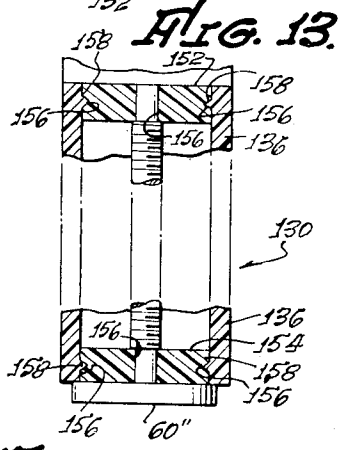


FIG. 16.

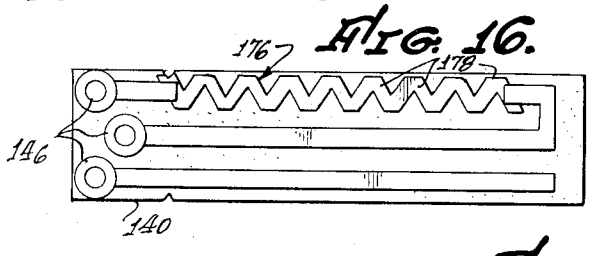
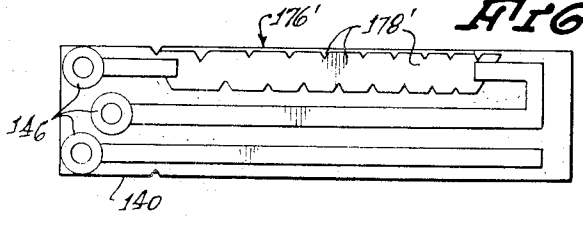


FIG. 17.



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2,999,994

ADJUSTABLE ELECTRICAL RESISTORS

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Original application Sept. 1, 1955, Ser. No. 531,956, now Patent No. 2,935,715, dated May 3, 1960. Divided and this application Mar. 4, 1960, Ser. No. 12,773
9 Claims. (Cl. 338—180)

The present invention relates to new and improved adjustable electrical resistors.

This application is a division of application by these inventors, Serial No. 531,956, filed September 1, 1955, for Adjustable Electrical Resistors, now Patent No. 2,935,715.

In the current technical journals pertaining to the electronic field there have been recently a number of articles which indicate the need for electrical instruments such as adjustable resistors which can be readily and easily manufactured and assembled completely by machine. Such units, to be acceptable, must be of very rugged construction so as to be capable of withstanding physical abuse and further must be light weight and of very small dimension to be acceptable to many applications. Also, it is preferred that such units be capable of being fitted or nested together as in a row or column for convenience in mounting and for convenience in adjustment.

It is an object of the present invention to provide various new and improved adjustable electrical resistors which can be easily assembled by machine, and which meet other qualifications set forth in the preceding paragraph. A further object of the invention is to provide adjustable electrical resistors which are especially adapted to utilize printed circuit components of a category that may be separately manufactured by machine apart from the other parts utilized.

The present invention is not restricted to the use of conventional printed circuit components, but includes the use of very specialized types of printed circuit constructions as will be hereinafter described. Certain printed circuits of the invention may, if desired, be used in other units besides the specific electrical resistors herein described, although they are specifically adapted and designed to be used with such resistors. Similarly, the various adjustable electrical resistors herein described can be modified so as to use conventional shorting strips, resistance elements and the like, although such use is not preferred because it detracts from an object of the invention, this object being to provide units capable of mass manufacture and assembly by machine.

Further objects of this invention as well as many advantages of it will be more fully apparent from the remainder of this description including the appended claims and the accompanying drawings in which:

FIG. 1 is an isometric view partially broken away of an adjustable resistor of the instant 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. 3;

FIG. 5 is an isometric view of a modified adjustable resistor of this invention;

FIG. 6 is a cross sectional view taken at line 6—6 of FIG. 5;

FIG. 7 is a cross sectional view taken at line 7—7 of FIG. 6;

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

FIG. 9 is an isometric view of an electrical contact used in the resistor shown in FIG. 5;

FIG. 10 is an isometric view taken from the rear of a second modified resistor of the invention;

FIG. 11 is a cross sectional view taken at line 11—11 of FIG. 10;

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

FIG. 13 is a partial cross sectional view taken at line 13—13 of FIG. 12;

FIG. 14 is an isometric view of a slider and contact assembly used in the adjustable resistor shown in FIG. 10; and

FIGS. 15, 16, 17 and 18 are top views of printed circuits such as are capable of being used with any of the resistors shown.

In all figures of the drawings, like numerals are used to designate like parts whenever convenient for purposes of explanation or illustration. It is to be understood that the drawings themselves do not purport to represent any precise commercial units drawn to scale, but instead are so scaled as to indicate clearly the essential features of the present invention.

Because of the nature of the subject matter of this patent application, it is difficult to briefly define the invention or summarize it as required by the Rules of Practice of the United States Patent Office. The appended claims forming a part of this specification provide in detail a summary of the various concepts present herein which are considered inventive. However, the invention may be briefly summarized as being concerned with electrical instruments such as adjustable resistors such as potentiometers or the like each of which comprises or includes: an elongated base having side edges and ends; upstanding sides attached to said side edges so as to project upwards from said base, said sides having top edges; a lid positioned parallel to said base between said sides, said lid being spaced from said top edges so as to define a space for holding the base of an adjacent electrical instrument at the top of said electrical instrument; closure means located adjacent to the ends of said base between said sides for closing the ends of a cavity defined by said sides, said lid and said base; a threaded shaft held by said closure means within said cavity, said shaft projecting externally of said cavity; a slider positioned within said cavity, said slider including a threaded portion engaging said threaded shaft, said slider further fitting closely adjacent said sides so as to be incapable of rotating within said cavity; an electrical return member positioned within said cavity; an electrical resistance member positioned within said cavity, said electrical return member and said electrical resistance member being insulated from one another, being parallel to one another and to said shaft, and being spaced from said slider; and contact means operatively attached to said slider, said contact means electrically connecting said resistance member and said electrical return member. Various specific concepts involved in this invention are defined in much less detail in certain of the appended claims.

In order to understand this invention, it is necessary to refer in detail to the accompanying drawings. In FIGS. 1 through 4 of the drawings there is shown an adjustable potentiometer **20** of the invention. As will be realized by those familiar with the field in which this invention pertains, such a potentiometer is a species of an electrical resistor. This potentiometer includes a base **22** having side edges **24** to which there are attached upstanding sides **26**. These sides of this construction are formed integrally with the base **22** so as to diverge from

one another at points remote from this base. Along each of the top edges 28 of the sides 26 there are formed elongate parallel inwardly projecting ridges 30 which serve to hold a lid 32 between these sides 26 against another set of elongate parallel inwardly projecting ridges 34 located immediately below the ridges 30. The ridges 34 also serve to hold in position against a threaded shaft 36 a slider 38 having sloping walls 40 which fit closely against the sides 26. Within the center portion of the slider 38 there is located a generally U-shaped passage 42, a curved end 44 of which is provided with threads engaging the shaft 36. On top of the slider 38 there is located a small contact member 46 having resilient arms 48 serving to engage an electrical return 50 positioned on the under side of the lid 32 and a resistance member 52 also positioned on that side of the lid.

Attached to the sides 26 at one end of potentiometer 20 are two end closures 54 which meet together midway between the sides 26 so as to define a slot 56 serving to engage a narrow portion 58 of a shaft 36 so as to hold the shaft in position with respect to the body of potentiometer 20. In order that the shaft 36 may be turned, the shaft is provided with a slotted head 60 disposed immediately in front of the end closures 54. This head 60 effectively seals the slot 56 against the ingress of dirt or the like. This end of the potentiometer 20 remote from the screw head 60 is also sealed by a pair of end closures 62 which join together so as to prevent the ingress of contaminants such as dirt into the potentiometer 20. If desired, the juncture between these two end closures 62 may be welded or soldered.

In the preferred mode of construction of the potentiometer 20, the base 22, the sides 26 and the closures 54 and 62 are all formed out of a metal sheet capable of withstanding a great deal of abuse. The shaft 36 and the screw head 60 are preferably constructed of metal. However, in order for potentiometer 20 to be operative, it is necessary that the slider 38 be formed out of a material such as nylon which is non-conductive in nature so that current passing through the contact member 46 from the resistance member to the electrical return is not shorted to the outside of the potentiometer. The contact member 46 is preferably formed out of any suitable resilient metal and may be secured to the slider 38 by means of rivets, solder, adhesive or the like.

With the construction shown in FIGS. 1 through 4 of the drawings, the lid 32 is preferably formed out of a non-conductive resinous material such as filled phenolic resin so that the electrical return 50 and the resistance member 52 may be placed directly upon it by appropriate printed circuit techniques, these two members being insulated from one another. Suitable known compositions, conventionally used in the printed circuit field may be used for forming the electrical return 50 and the resistance member 52. The same material as is used in forming the electrical return 50 is preferably used for forming terminal segments 64 overlying ends of the resistance member 52 so that this resistance member may be conveniently connected in an electrical circuit. As is best seen in FIGS. 1 and 4 of the drawings, the lid 32 extends over the end closures 54 so as to project out beyond the base 22 of the potentiometer. Appropriate notches 66 are provided in respective ends of the terminal segments 64 and in the end of the electrical return 50 on its projecting portion of the lid 32, so that wires or the like may be soldered directly to those elements. Preferably in the construction shown, the lid 32 is spaced a short distance from the end closures 54 so as to prevent shorting. If desired, however, the portion of the lid 32 directly overlying the end closures 54 may be separated from these end closures 54 by either a short sheet of a dielectric material or other insulating means.

The manufacture and assembly of the potentiometer 20 is comparatively easy to carry out. The base 22, the sides 26 and the end closures 54 can conveniently be stamped of a single sheet of metal. The shaft 36 may then be snapped into position with an enlarged portion in the slot 56 engaging the narrow portion 58 of this shaft so as to effectively lock the shaft into location. Next, the slider 38 with contact member 46 attached to it may merely be dropped and snapped into position against the inheerently resilient sides 26. The lid 32 may then be similarly snapped into position. All of these operations may be easily carried out by machine, although they are also capable of being carried out by hand.

In FIGS. 5, 6 and 7 of the drawings, a modified potentiometer 70 according to the invention is shown which is very similar to the potentiometer 20 previously described. This potentiometer 70 includes a base 72 having extending from the front thereof a short projection 74 within which there is located an opening 76 for use in attaching the potentiometer 70 to any desired supporting member. Attached to the side edges 78 of base 72 are upstanding sides 80 similar to the sides 26. Within each of these sides 80 there are formed small elongated openings 82 which are designed to receive projections 84 formed on the sides of a lid 86 so as to hold this lid in position against a shaft 36' similar to the shaft previously described.

Thus, with this construction the lid 86 serves to hold the shaft 36' against a small slider 88 so that the threads of the shaft 36' engage threads formed on a curved bottom end 90 of a passage 92 located centrally within the slider 88. As indicated in FIG. 6, the slider 88 is preferably formed with sloping side walls of the same slope as the sides 80 of the potentiometer. The bottom of the slider 88 is formed with converging walls 96 which are designed to hold a contact member 98 such as that shown in FIG. 9 of the drawings.

The contact member 98 is preferably formed out of a sheet of resilient metal so as to include sides 100 upon which there are formed terminal projections 102 adapted to engage the ends of the slider 88 preventing lateral movement of the contact member with respect to the slider. Resilient arms 104 are formed on the sides 100 as shown, so that when the contact member and the slider are in an operative position these arms 104 bear against the resistance member 106 and an electrically conductive member 108 located upon a non-conductive support 110 held upon the base 72. This non-conductive support is held in position by front end closures 112 and by rear end closures 114, substantially as shown in FIGS. 7 and 8 of the drawings. Recessed notches 116 are formed on the support 110 adjacent to the rear end closures 114 so as to bear against portions of these rear end closures preventing movement of the support 110 away from the base 72 when the potentiometer 70 is assembled. The front end closures 112 are provided with a top notch 118 designed to engage the narrow portion 58' of the shaft 36' employed, preventing lateral movement of this shaft. The other end of the shaft 36' is designed to ride within an opening 120 formed within one of the rear end closures 114. If desired, this opening 120 may, however, be omitted.

The portion of the support 110 projecting out from the base 72 is provided with holes 122 which are designed to receive wires or screws or metal eyelets or other means designed to connect the conductive member 108 and the resistance member 106 into an electrical circuit. The hole 122 used to connect the resistance member 106 are surrounded by terminal segments 124 overlying the end of this resistance member. A corresponding terminal segment is formed integrally as part of the conductive member 108. If desired, metal eyelets such as the eyelets 125 can be inserted through the holes 122 so that wires or the like can be soldered to these eyelets instead of to the terminal segments as when materials are used for the terminal segments which are difficult to solder to directly. Such eyelets overlie

the ends of the terminals and are headed over so as to be secured to the support.

The assembly of the potentiometer **70** is comparatively simple. The base **72**, the sides **80** and the front and rear end closures **112** and **114** are preferably formed as shown by simple metal stamping and forming operations out of a single sheet of comparatively resilient strong sheet metal. The support **110** may then be snapped into position by inserting it above the base **72** between the sides **80**. By virtue of the fact that a small space **126** is left beneath the rear end closure **114** no insulating means are normally required to prevent shorting of the conductive member **108** or resistance member **106**. However, if desired, a small coating **128** of a dielectric ceramic or the like may be placed immediately above the conductive member **108** and terminal segment **124** so as to prevent such shorting.

The support **110** is preferably formed of substantially the same material as the lid **32** previously described; the conductive member **108** and resistance member **106** are preferably formed of the same materials as the electrical return **50** and resistance member **52**, respectively. The slider **88** may be conveniently formed of the same materials as the slider **38** and the shaft **36** and lid **86** may be formed out of conductive metal.

The contact member **98** and the slider **88** after being positioned together, and the shaft **36'** may, in the potentiometer **70**, be merely dropped into position after the support **110** has been inserted into the location shown. The sides of the potentiometer support the slider in an operative position above the support **110**. The lid **86** may then be snapped into place holding all of the elements in an assembled relation. This series of steps is easily carried out by machine although it may also be carried out by hand.

In FIG. 10 of the drawings, a second modified potentiometer **130** of the invention is shown which includes a base **132** having side edges **134**. To the top portion of these side edges there are attached sides **136** having formed on the top corners thereof small inwardly extending projections **138**. Thus, with this construction, the side edges **134** of the potentiometer **130** are designed so that the base **132** of this potentiometer may fit within the top of an adjacent potentiometer of similar construction with the bottoms of the side edges of the potentiometers resting against the tops of the sides of the next adjacent potentiometer. In a similar manner other units may be stacked beneath the potentiometer **130**.

Carried upon the base **132** is a support **140** which is designed to hold an electrical return **142** and an electrical resistance element **144** substantially as shown in FIG. 15 of the drawings. As is apparent in FIG. 10 an end of the support **140** is designed to project from the body of the potentiometer **150** so that terminals **146** formed on the electrical return **142** and on terminal segments **148** overlying the ends of the resistance element **144** may be conveniently connected into an electrical circuit. Holes **122'** are provided to aid in doing this. The support **140** is preferably formed of the same materials as can be used for the lid **32**; the elements in it are preferably located in place in the obvious manner utilizing printed circuit techniques and compositions.

The top of the potentiometer **130** is sealed by another support **150** of identical construction with the support **140** just described. This support **150** is held in place against end closures **152** and **154** by engagement with the small projections **138**. These end closures are preferably formed so as to be capable of being slid into position with grooves **156** formed therein engaging small projections **158** located parallel to one another upon the sides **136**. These end closures **152** and **154** each include an opening to receive a respective reduced portion **156** of the actuating shaft, thereby holding the shaft in position within the potentiometer **130**. When the head of the shaft is turned, a generally rectangular slider **164** in the

form of a block having a central threaded opening **165** formed therein may be moved back and forth within the potentiometer **130**. This slider (FIG. 14) is formed of a slightly resilient non-conductive resin such as nylon with top and bottom notches **166** formed therein, each of the notches including an enlarged end **168** so that small wire contact members **170** formed out of a resilient metal in a generally U-shape so as to include bent ends **172** serving as resilient contact arms may be snapped into position within the slider **164**. Thus, with this construction the contact members **170** are insulated from one another and their terminal ends **172** bear against the resistance elements and electrical returns formed on the supports **140** and **150**. It will be realized from this description that the potentiometer **130** is what may be termed a dual unit.

All of the structural parts in the potentiometer **130** may be conveniently formed out of an appropriate non-conductive resin with the exception of the contact member **170**. The assembly of these various parts is considered to be essentially obvious from the foregoing description of them. Within the potentiometer **130** small grooves **174** in the supports **140** and **150** engage the projections **158**, preventing undesired lateral movement of these supports.

If desired, the support **140** may be modified in the manner shown in FIG. 16 of the drawings so as to replace the resistance element **144** with another type of resistance element **176** composed of a plurality of segments **178** of equal width disposed in a zig-zag fashion. With this construction the effective resistance of the resistance element **176** is greater than the resistance element **144** because of the length of the path of this resistance element. The individual segments **178** are preferably located substantially as shown in such a manner that as the slider **164** is moved a terminal end **172** of a contact member **170** moves directly from one segment **178** to the next in much the manner in which a resilient contact arm in a conventional potentiometer moves from one wire of a wound resistance element to another.

The essential benefits of the type of construction shown in FIG. 16 can be achieved by modifying this construction in the manner shown in FIG. 17 so as to utilize a resistance element **176'** similar to that just described except for the fact that the segments **178'** are all unequal in width so that the effective cross sectional area of a resistance element varies from one end of the element to the other, giving a non-linear change in resistance along the element itself. With this element a continuous path for the contact is provided.

In FIG. 18 of the drawings, another modified construction capable of being used with the potentiometer **130** is illustrated. This modified construction is substantially identical with that of the support **140** except for the fact that a plurality of electrically conductive elements **180** each including a terminal segment **182** are located so as to overlie periodically spaced portions of the resistance element **144**. These electrically conductive segments are preferably formed of the same material as the electrical return **142** and are located with their terminal segments aligned with one another so that a resilient metal contact member used with this construction moves upon the terminal segments giving a digital type of current readout.

Those skilled in the art will realize that by simple modification any of the complete units shown herein can be altered so as to be used as either potentiometers or common adjustable resistors. Further, they will realize that the constructions illustrated in FIGS. 16, 17 and 18 can be utilized with any of the units illustrated with a minimum of modification so as to achieve different electrical characteristics for such units. This versatility of the various constructions of the invention is considered to be of extreme importance inasmuch as it permits a manufacturer to interchange within a given unit any

number of different types of different resistance constructions so as to achieve specialized effects as desired. All of the constructions herein described can be easily stacked or nested together for convenience in mounting and assembly into a final electrical circuit.

While various preferred modes of the invention are described in the foregoing it is to be understood that those skilled in the art may substitute plastic casings instead of metal casings and vice versa without changing the effective principles of construction herein described. All modifications of this nature are considered to be part of the invention insofar as they are defined by the appended claims.

We claim:

1. A variable resistor comprising a housing having a base, relatively flat sidewalls diverging outwardly and upwardly at an angle from said base, and end closures, said base, sidewalls and end closures being formed from a single piece of metal sheet, a nonconductive support member positioned upon said base in the housing and extending externally of said housing past one of said end closures, a slider having relatively flat sloping sidewalls diverging at the same angle as and engaging said housing sidewalls, contact means operatively connected to said slider, elongate resistor means mounted on said support within said housing, elongate conductor means mounted on said support within said housing, means for moving said slider for variably connecting said elongate resistor means and elongate conductor means by said contact means, terminals mounted on the part of said support which is outside of said housing, and means for connecting said terminals to said resistor means and conductor means.

2. A variable resistor comprising a housing having a base, relatively flat sidewalls diverging outwardly and upwardly from said base, a cover, and end closures, a nonconductive support member positioned upon said base within the housing and extending outside of said housing beyond one of said end closures, a slider, contact means operatively connected to said slider, elongate resistor means mounted on said support within said housing, elongate conductor means mounted on said support within said housing, means for disposing said slider for contacting said elongate resistor and elongate conductor means with said contact means, the part of said support member which is outside of said housing having a plurality of apertures therein, conductors on said support member extending from each of said apertures to respective ones of said resistor means and conductor means in said housing, and a conductive eyelet in each of said apertures fastened to said support and each making contact with a respective one of said conductors.

3. A variable resistor comprising a housing having a base, relatively flat sidewalls diverging upwardly and outwardly at an angle from said base, end closures extending from said sidewalls, an extension of said base protruding from the housing beyond one of said end closures and having an aperture therein for supporting said variable resistor, a sheet-like lid for closing said housing, said lid having projections extending from opposite edges thereof, said sidewalls having slots near the upper edges thereof disposed for co-operative reception of respective ones of said projections, a nonconductive support positioned upon said base within the housing and extending outside of said housing in the direction away from said one end of said base, a slider having relatively flat sloping sidewalls diverging at the same angle as and disposed between and engaging said housing sidewalls, contact means operatively engaged by said slider for movement of the contact means by the slider, elongate resistor means mounted on said support within said housing, elongate conductor means mounted on said support within said housing, means including rotatable threaded means for moving said slider for contacting said elongate resistor means and said conductor means with said contact means, terminals mounted on the part of said support which is external to said housing, and means for connecting said terminals to said resistor means and conductor means.

4. A variable resistor as recited in claim 3 wherein said slider has a top portion with a threaded portion disposed for cooperation with said threaded means and a bottom portion facing said non-conductive support and said bottom portion extending from the sidewalls of said housing downwardly and inwardly toward said support, and wherein said contact means comprises a conductive sheet bent to closely engage the bottom portion of said slider and said conductive sheet having inwardly directed projections at the upper end corners closely engaging respective ends of said slider to insure concurrent movement of the contact means with the slider, and said contact means comprising a pair of resilient arms extending therefrom and disposed to make contact with said resistor and conductor means.

5. In a variable resistor of the type having a closed housing having walls, a base and end closures defining a cavity, a leadscrew supported for rotation within said cavity, a slider device having conductive contacts and threadably engaged with said leadscrew to be laterally moved by rotation thereof, the improvement comprising a nonconductive support member disposed principally within said housing and having a portion extending externally of said housing past one of said end closures, elongate resistor means mounted on said support within said housing, elongate conductor means mounted on said support within said housing adjacent to said resistor means and extending on said support member outside of said housing, the conductive contacts of said slider contacting said elongate resistor means and elongate conductor means, terminals mounted on the portion of said support member which is external to said housing, one of said terminals being mounted in contact with said elongate conductor, and other conductor means mounted on said support and interconnecting another of said terminals and said elongate resistor within said housing.

6. In a variable resistor of the type defined by claim 5 wherein said terminals comprises metal eyelets, said nonconductive elongate support member having apertures through which said eyelets extend and make contact with respective ones of said elongate conductor means and said other conductor means.

7. In a variable resistor as recited in claim 5, the defined structure in which said resistor means includes a printed-circuit resistor, in which said elongate conductor means and said other conductor means are printed-circuit conductors.

8. A variable resistor comprising, in combination:

first means, including means forming an elongate housing, said housing having sides, ends, a base and a cover, and said housing being of less width at the base thereof than at the cover thereof and being thereby constructed and arranged for nesting of similar housings into a stack thereof;

second means, including a support meber and electrical means including resistive means and terminal means on the support member, said support member being constructed and arranged with said electrical and resistive means largely enclosed within said housing and said support member having a portion protruding from said housing and having said terminal means on the protruding portion to provide support for and access to said terminal means outside of said housing;

and third means, comprising movable contact means connecting at least part of said electrical means to said resistive means and movable to vary the resistance exhibited between said terminal means, and said third means further comprising means accessible from outside said housing and constructed and arranged for moving said movable contact means.

9. For a variable resistor of the type having a closed

housing having a base and sidewalls upwardly and outwardly diverging from said base and having a leadscrew supported for rotation within the housing and the variable resistor including an elongate resistor and an adjacent elongate conductor in the housing supported by said base and there being a slider having a pair of flat contiguous bottom surfaces facing the resistor and the conductor and sloping sides engaging the housing sidewalls and being threadably engaged with said leadscrew to be moved longitudinally along the leadscrew as the leadscrew is rotated:

an improved contact means for attachment to the slider for movement along the elongate resistor and conductor as said slider is moved, said contact means comprising a resilient sheet-like body portion of generally shallow V-shaped lateral cross-section shaped to closely engage the pair of bottom surfaces of the slider facing the elongate resistor and conductor, said body portion having

inwardly directed projections at the upper corners thereof for closely engaging and gripping complementary end portions of the slider, and said resilient sheet-like body portion having a pair of electrically conductive arms extending away therefrom and constructed and arranged to make contact with the resistor and conductor.

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