May 3, 1960 M. E. BOURNS ET AL 2,935,715

ADJUSTABLE ELECTRICAL RESISTORS

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FIG. 1.

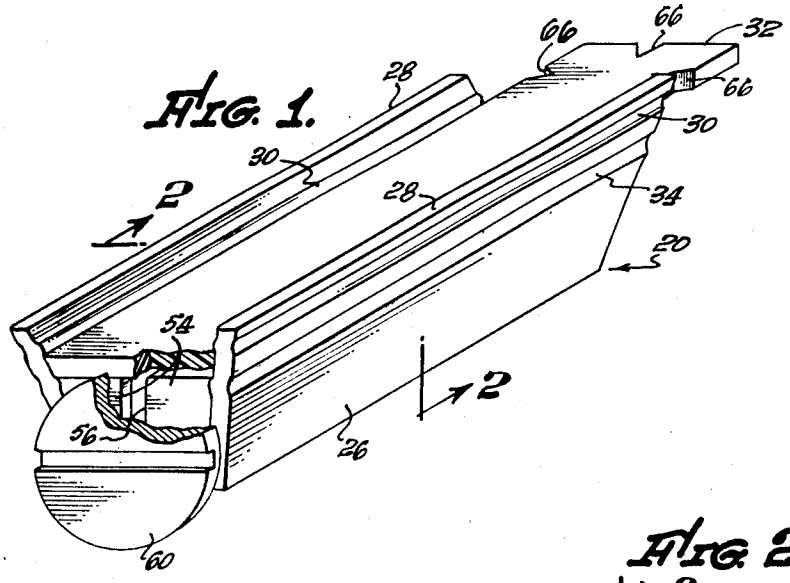
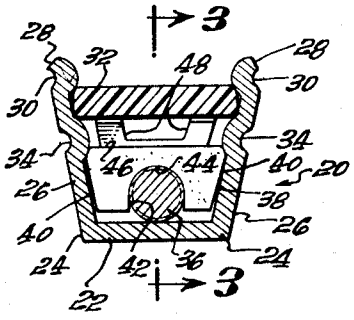


FIG. 2.



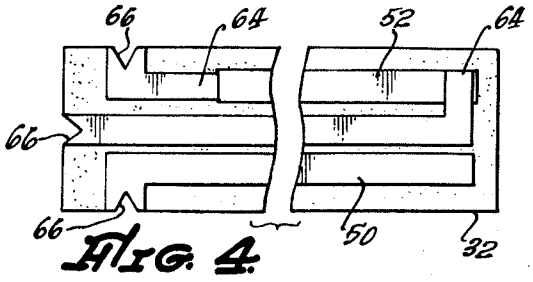


FIG. 4.

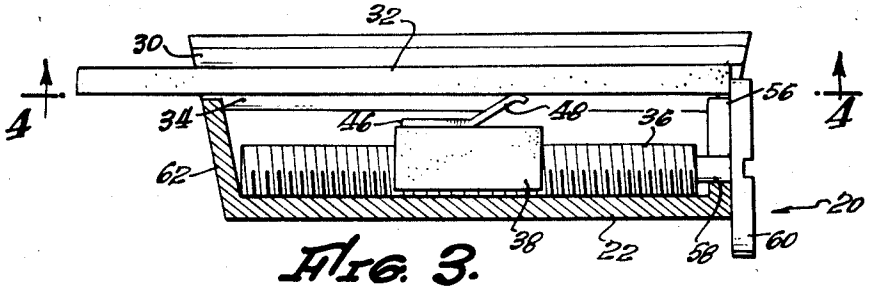


FIG. 3.

INVENTOR.

Marlan E. Bourns

William J. Hardison

Theodore O. Beckman

May 3, 1960 M. E. BOURNS ET AL 2,935,715

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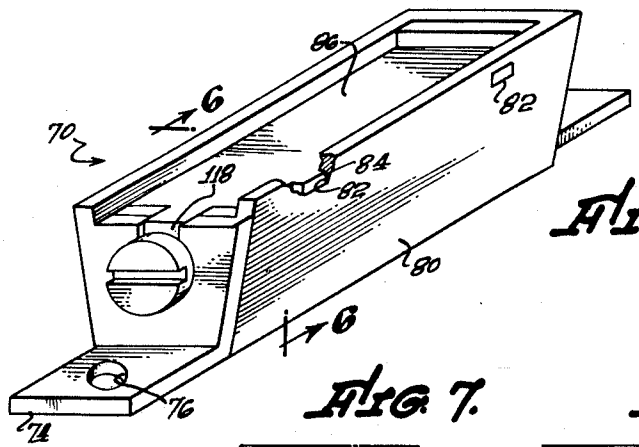
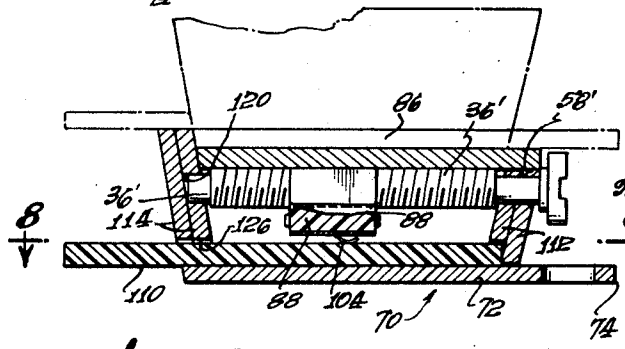


FIG. 5.

FIG. 7.

FIG. 6.



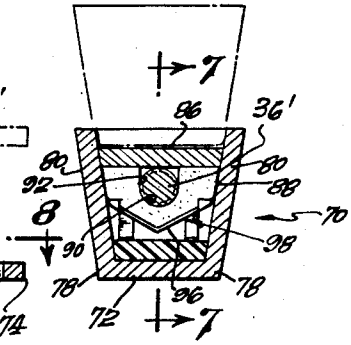


FIG. 8.

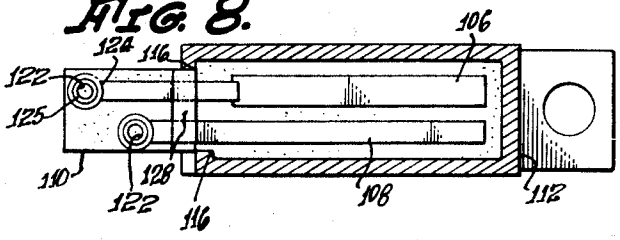
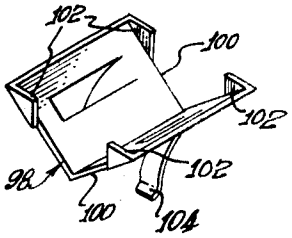


FIG. 9.



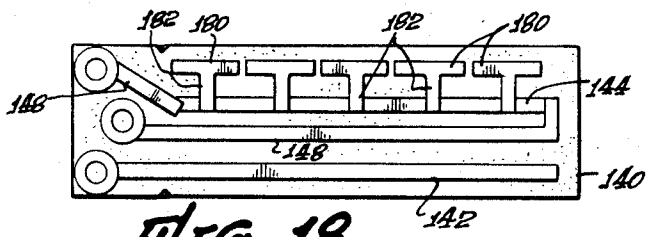


FIG. 10.

INVENTOR.

Marlan C. Bourns

William T. Henderson

Edward P. O'Brien

May 3, 1960 M. E. BOURNS ET AL 2,935,715

ADJUSTABLE ELECTRICAL RESISTORS

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FIG. 10.

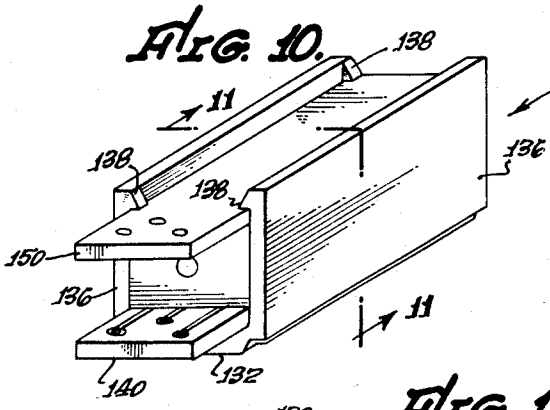


FIG. 14.

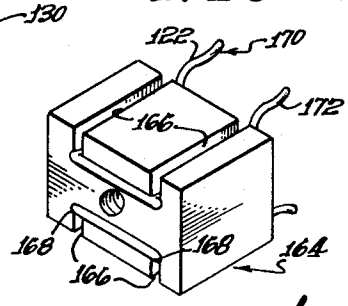


FIG. 12.

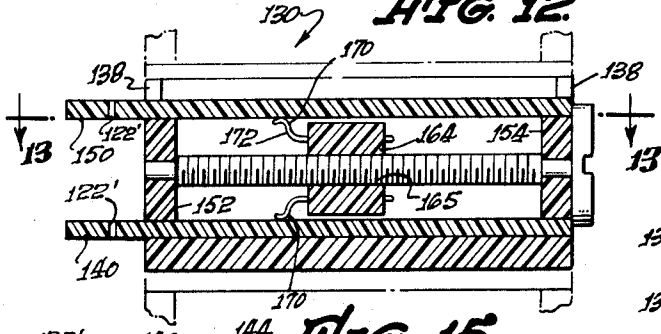


FIG. 11.

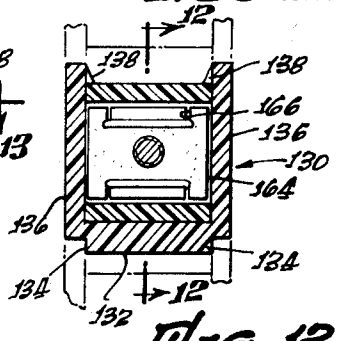


FIG. 15.

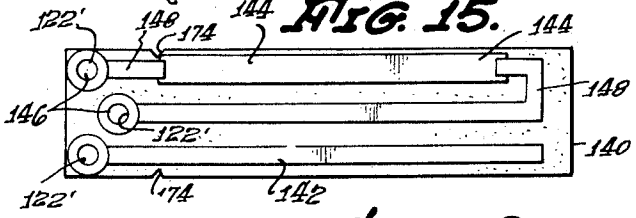


FIG. 13.

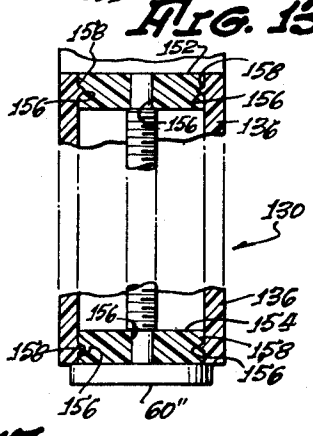


FIG. 16.

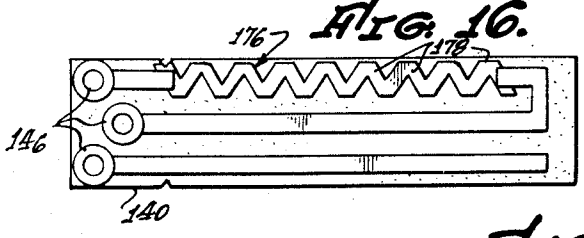
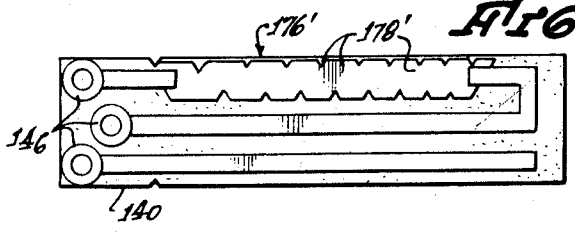


FIG. 17.



INVENTOR.

Marion E. Bourns

William J. Harding

Elliott D. O'Brien

United States Patent Office

2,935,715

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2,935,715

ADJUSTABLE ELECTRICAL RESISTORS

Marlan E. Bourns and Wilbur T. Hardison, Riverside, and Edward D. O'Brian, Anaheim, Calif.; said Hardison and said O'Brian assignors to Bourns, Inc.

Application September 1, 1955, Serial No. 531,956

3 Claims. (Cl. 338—180)

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

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 utlized.

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 report 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. If desired, 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 side of this construction are formed integrally with the base **12** 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

elongated parallel projecting ridges 30 which serve to hold a lid 32 between these sides 26 against another set of elongated parallel 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 positoned on the under side of the lid 32 and a resistance member 52 also positioned on this side of the lid.

Attached to the sides 26 at one end of potentiometer 20 are two bilaterally symmetrical 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 on the shaft 36 so as to hold this shaft in position with respect to the potentiometer 20. In order that the shaft 36 may be turned, a common screw head 60 is formed on the shaft 36 immediately in front of the end closures 54. This screw head 60 effectively seals the slot 56 against the ingress of dirt or the like. The end of the potentiometer 20 remote from the screw head 60 is also sealed by a pair of bilaterally symmetrical 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 this 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 62 so as to project out beyond the base 22 of the potentiometer. Appropriate notches 66 are provided in the end of the terminal segments 64 and in the end of the electrical return 50 on its projecting potrion of the lid 32 so that the various wires or the like may be soldered directly to these elements. Preferably in the construtcion shown, the lid 32 is spaced a short distance from the end closures 62 so as to prevent shorting. If desired, however, the portion of the lid 32 directly overlying the end closure 62 may be separated from these end closures 62 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 68 of 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 inherent resiliency of the 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 of 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' such as 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. The slider 88 is preferably formed with sloping side walls 94 of the same slope as the sides 80 of the potentiometer 70. The bottom of the slider 88 is formed with converging walls 96 which are designed to hold a contact member 98 such as is shown in Fig. 9 of the drawings.

This contact member 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 98 with respect to this 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 holes 122 used to connect the resistance member 116 are surrounded by terminal segments 124 overlying the end of this resistance member 106. 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**. 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 supports 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 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 these 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 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** are further designed so as to include openings **156** formed therein in order that these closures may engage portions **156** of a shaft **36''** holding the shaft into position within the potentiometer **130** so that as the screw head **60''** is turned a generally rectangular slider **164** in the form of a block having a central threaded opening **165** formed

there 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 terminal ends **172** serving as resilient contact arms may be snapped into position within the slider **146**. Thus, with this construction the contact members **170** are insulated from one another and their terminal ends **172** bearing 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 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 instead of moving upon the resistance element **144'** moved upon the terminal segments giving a digital type of current readout from a unit utilizing this construction.

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 construction 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 an elongated body having a generally trapezoidal cross sectional shape, the two non-parallel sides of said body being extended slightly beyond the wider parallel side to form a shallow recess adapted to receive the narrower parallel side of a like resistor body for nesting purposes, a resistance element mounted within said body, a contact member movable along said resistance element and wiping thereon, actuating means for moving said contact member, and electrical return means electrically connected to said contact member.

2. A variable resistor comprising an elongated, generally channel-shaped body having upwardly diverging, opposed side walls, each of which is provided with a pair of spaced parallel ridges extending longitudinally of said body, a plate disposed between said side walls and having its opposite side edges resiliently gripped between said pairs of spaced parallel ridges, said plate having a resistance element mounted on the under side thereof, a lead screw rotatably supported within said body, a slider operatively engaged by said lead screw and movable along said resistance element responsive to rotation of the lead screw, the lower ridge on each of said side walls slidably engaging said slider to guide the same with respect to said resistance element, a contact on said slider wiping on said resistance element, and electrical return means electrically connected to said contact.

3. A variable resistor comprising an elongated channel-shaped body of resilient material having sidewalls diverging upwardly from the bottom, a cover plate resiliently gripped between said sidewalls a short distance below the top edges thereof, the inside width dimension between said sidewalls above said cover plate being substantially the same as the outside width dimension of said body across the bottom thereof, whereby the bottom of one instrument can be nested within the top of another instrument, a resistance element attached to the inside surface of said cover plate, a contact member movable lengthwise of said resistance element and wiping thereon, and actuating means for moving said contact member.

References Cited in the file of this patent

UNITED STATES PATENTS

2,229,072	Green	Jan. 21, 1941
2,561,535	Paulet et al.	July 24, 1951
2,625,633	Warsher	Jan. 13, 1953
2,668,218	Searle	Feb. 2, 1954
2,687,463	Riley	Aug. 24, 1954
2,706,230	Bourns et al.	Apr. 12, 1955

FOREIGN PATENTS

584,798	France	Nov. 28, 1924
668.186	Great Britain	Mar. 12, 1952
821,376	Germany	Nov. 19, 1951