Sept. 2, 1958 M. E. BOURNS ET AL 2,850,607

VARIABLE RESISTOR CONSTRUCTIONS

Filed Dec. 13, 1954

FIG. 2.

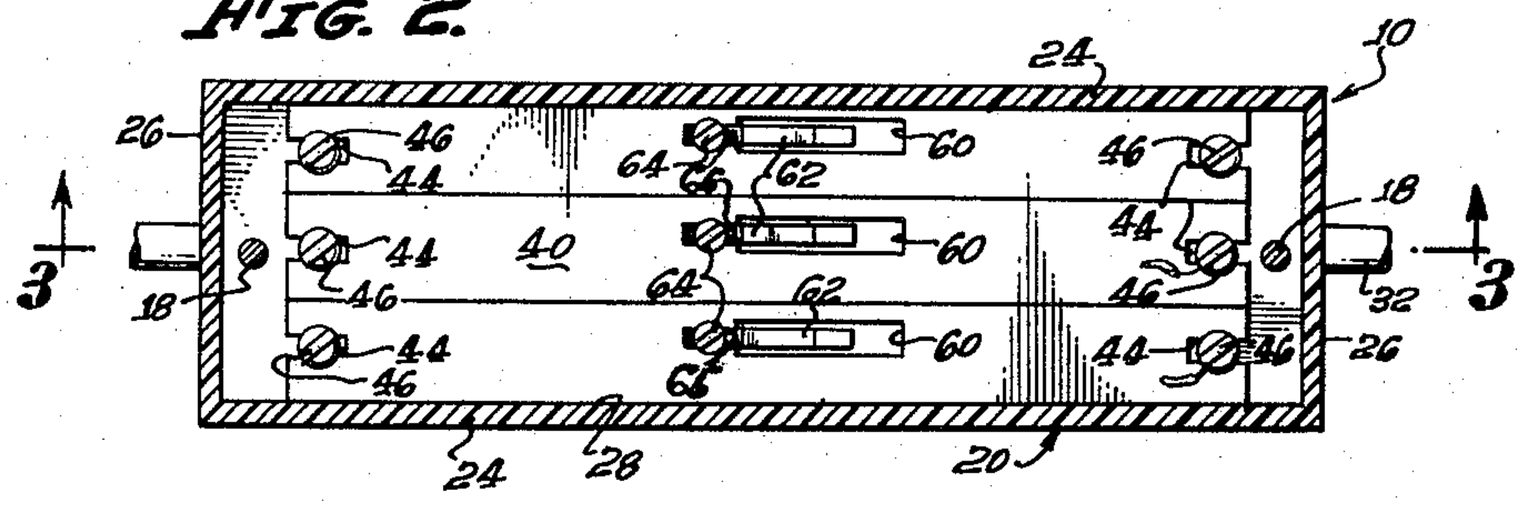


FIG. 3

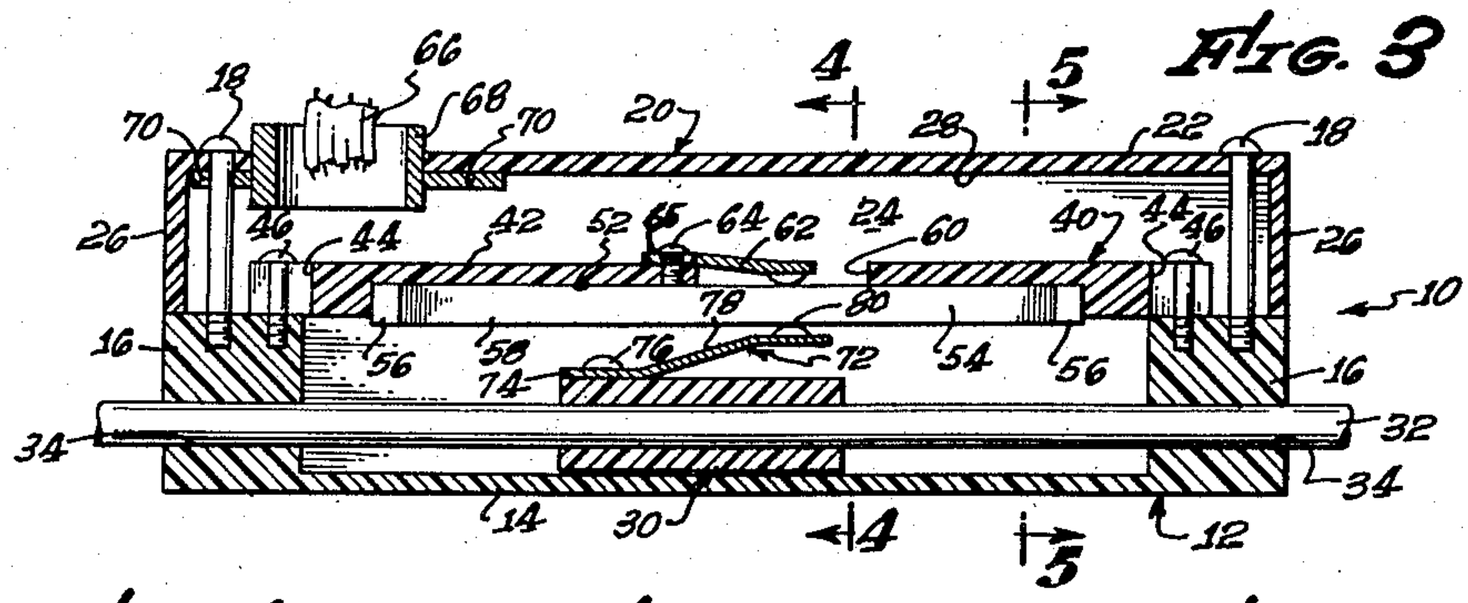


FIG. 4.

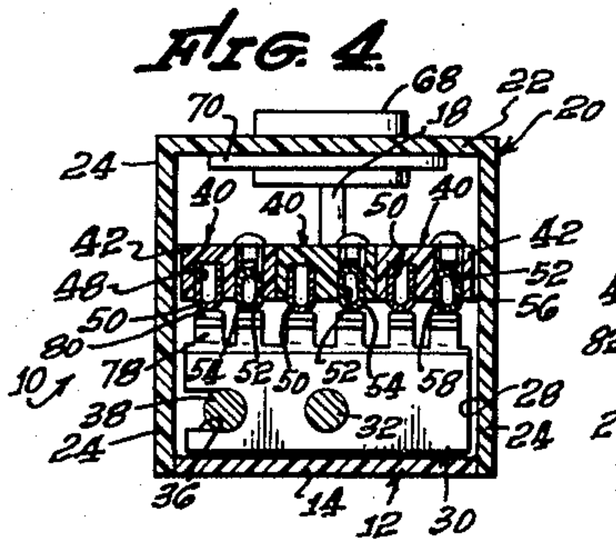


FIG. 5.

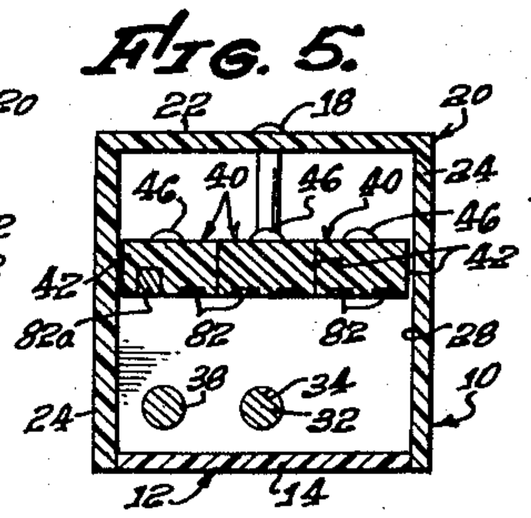


FIG. 6.

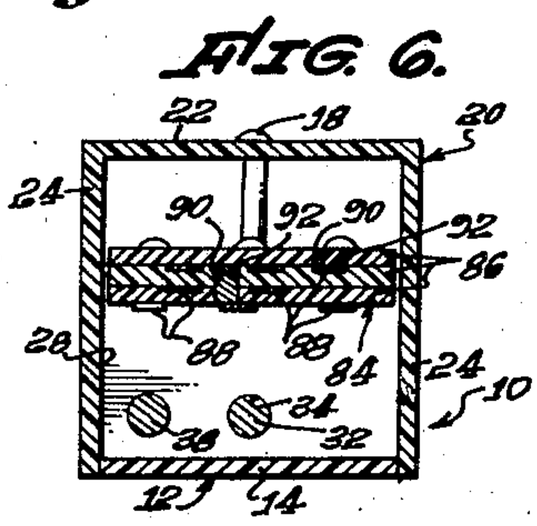


FIG. 8.

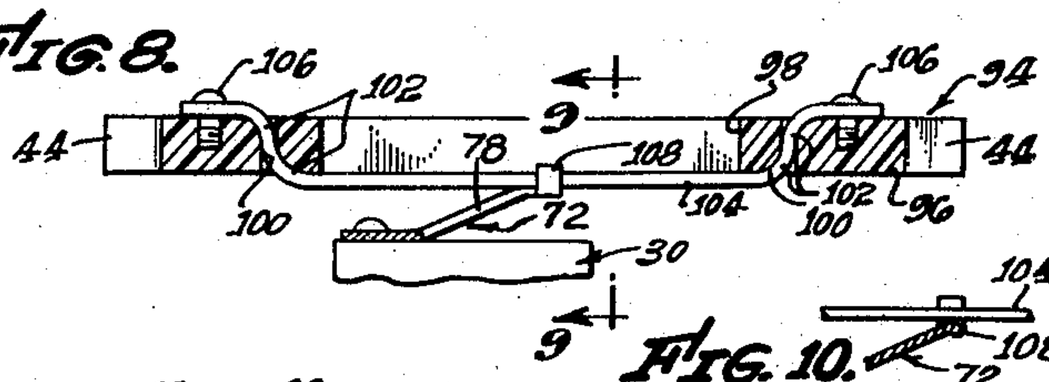


FIG. 9.

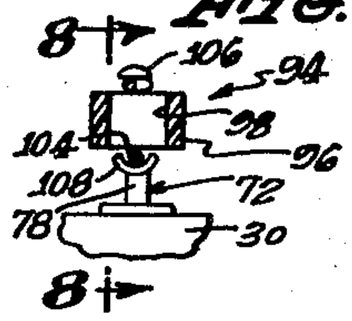


FIG. 10.

FIG. 1.

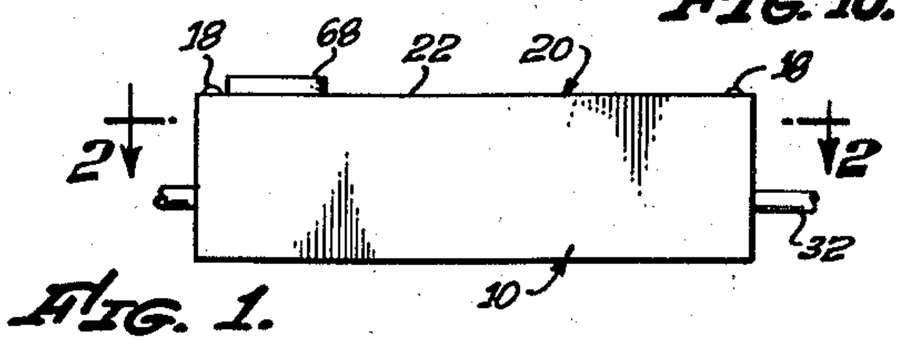
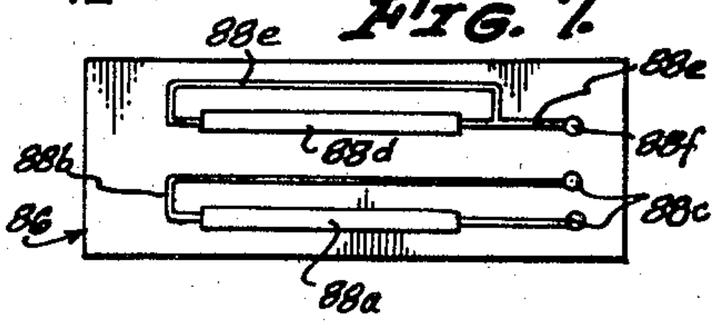


FIG. 7.



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VARIABLE RESISTOR CONSTRUCTIONS

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2 Claims. (Cl. 201—62)

The present invention relates primarily to new and improved variable resistor constructions, although, as will be subsequently indicated it is capable of other applications.

This invention is best summarized as being concerned with variable resistor constructions which include a base, a cover attached to said base so as to define a cavity between this base and the cover, a movable member positioned within this cavity, means attached to this movable member for moving the movable member, at least one electrically conductive member positioned within this cavity, and means for mounting this electrically conductive member in such a manner that the position of the electrically conductive member may be adjusted with respect to the movable member and the base as desired so as to achieve proper operation of the complete variable resistor.

Unfortunately a brief summary of this category does not describe the actual details of the invention to a sufficient extent to appraise those familiar with the usual variable resistors commercially produced at the present time with the actual purpose of the present invention. An object of the present invention is to provide variable resistors as indicated in the above brief summary in which the position of the electrically conductive members employed can be adjusted relative to the location of the movable member used, once this movable member has been assembled in an operative position. This feature is particularly advantageous when a plurality of separate electrically conductive members are employed in a single variable resistor, and when it is desired to have all of these conductive members be touched in synchronism by contact members attached to the movable member.

Another object of the invention is to provide variable resistors of the class described in which electrical connections can be made to the electrically conductive members at a number of different locations after the movable and electrically conductive members indicated above have been secured in an operative relation to one another, and after the positions of these members have been adjusted with respect to one another. Such electrical connections are usually what may be termed "center taps," and serve to adapt electrical resistors of the class described for use in specialized circuit applications. Such taps need not be in any definite location. They may also be used as end connections or terminals. With this invention such center taps can be adjusted after assembly.

The term "electrically conductive member" employed in the aforegoing discussion and the remainder of this specification is not to be considered as being restricted to a single element which is electrically conductive. This term, as employed herein, is intended to include single electrically conductive elements which are not employed with any mounting or supporting structure, and to include electrically conductive elements formed upon, held by, or otherwise secured to mounting or supporting structures. Thus, the term "electrically conductive member" as used in this specification includes conductive wires, metal strips, conductive composition

layers, wound resistance elements, printed circuit type conductive areas, and the like, regardless of whether such conductive means are self-supporting or not.

It is considered obvious from the above definition that a further object of the invention is to provide variable resistors in which a variety of different types of electrically conductive members may be employed. A related object is to provide variable resistors of the type indicated in which the individual electrically conductive members employed can be easily and conveniently adjusted to correct operating positions with a minimum of difficulty. Another related object is to provide constructions of this category in which the individual electrically conductive members can also be replaced with a minimum of difficulty.

It will be obvious from the remainder of this description that a number of individual features of the variable resistor constructions described are not limited in their application to variable resistors as described in the brief summary of the invention given above, but can obviously be used in other resistor constructions.

Further objectives of the invention and the actual details of the invention are best explained with reference to the accompanying drawings in which:

Fig. 1 is a side view of a variable resistor of this invention;

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

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

Fig. 4 is a cross-sectional view taken at line **4—4** of Fig. 3;

Fig. 5 is a cross-sectional view of a modified variable resistor of the invention taken in the direction of line **5—5** in Fig. 3;

Fig. 6 is a cross-sectional view which is similar to Fig. 5 of a second modified variable resistor of the invention;

Fig. 7 is a view showing a type of electrically conductive member which may be employed with the invention;

Fig. 8 is a side cross-sectional view of an electrically conductive member which can be employed with the invention taken at line **8—8** of Fig. 9;

Fig. 9 is a cross-sectional view taken at line **9—9** of Fig. 8; and

Fig. 10 is a detail view of part of the structure shown in Figs. 8 and 9.

For convenience, like numerals in the various figures of the drawings have been used to designate like parts. Also the actual dimensions of the various parts shown have in many cases been distorted from the actual commercial dimensions of these parts in order that the invention may be more easily explained and illustrated.

In Figs. 1, 2, 3, and 4 of the drawings a variable resistor **10** is shown which includes a base **12** having an elongated flat bottom or center section **14** and upstanding ends **16**. Attached to these ends **16** by means of screws **18** is a cover **20** having a top **22**, side walls **24**, and end walls **26**. When the cover **20** is secured to the base **12** as shown this cover defines, in conjunction with the base **12**, a cavity **28**.

Within the cavity **28** there is located a slider **30** which is secured around an elongated shaft **32** in such a manner that the ends of this shaft **32** project out through the ends **16** of the base **12** through openings **34** formed within the ends **16**. Thus, as the shaft **32** is reciprocated axially, the slider **30** is moved along the bottom **14** of the base **12** between the ends **16**. Rotation of the slider **30** within the cavity **28** is prevented by means of a notch **36** on the slider **30** engaging a shaft **38** secured in a fixed position parallel to the bottom **14** between the ends **16** of the base **12**. This shaft **38** is held within appropriate openings (not shown) in the ends **16**.

Positioned immediately above the shaft **32** so as to be located parallel to this shaft are a plurality of electrically conductive members **40**. Each of these members **40** includes a supporting carrier **42** of a non-conductive material, which carriers **42** are formed with end slots **44** in such a manner that these end slots are adapted to overlie the ends **16** of the base **12**. Conventional screws **46** are employed to secure the carriers **42** to the ends **16** by projecting through the slots **44** in the manner indicated in Figs. 2 and 3 of the drawings. With this type of construction the locations of the electrically conductive members **40** can be readily adjusted by merely loosening the screws **46**, moving the members **40**, and then tightening the screws **46**.

Each of the electrically conductive members **40** includes an elongated slot **48** within a carrier **42** which is designed to hold a conductive U-shaped collecting element **50**. Each of the electrically conductive members **40** also includes another slot **52** within a carrier **42** which is designed to carry a resistance element **54**. All of the slots **48** and **52** are positioned parallel to the shaft **32**. The elements **50** and **54** are adapted to be secured in their respective slots by conventional means such as, for example, an adhesive. Each of the resistance elements **54** employed with the invention preferably include an inert base **56** of a non-conductive material around which there is an actual resistance means **58**. Such resistance means can comprise a wire coil, a spiral composition layer, or, as indicated in the drawings a single composition layer which is uniformly spaced around the base **56**.

Within each of the carriers **42** immediately above the slots **52** there are provided elongated openings **60** in the essential form of slots which are in communication with the slots **52**. These openings **60** are designed to be used in enabling a center connection to be made to the resistance elements **54** through the use of metallic contact members **62**. The contact members **62** are of essentially conventional design, and are secured to the carriers **42** by means of screws **64** projecting through slots **65** within these members. With this construction the position of these contact members **62** may be easily adjusted after assembly. If desired, soldered or spot welded or other connections to the resistance elements **54** may be made directly through the openings **60**, thus avoiding the use of these contact members **62**. It is to be understood that any number of openings **60** may be provided within the carrier **42**, and that the location of these openings may be varied in each of the carriers **42** illustrated. Further such openings may be provided in back of the slots **48** in order to make contact with the collecting elements **50**.

During the assembly of the variable resistor **10** wires **66** are secured to the extremities of the collecting elements **50** and the resistance elements **54**, and to the contact members **62** for the obvious purpose by conventional means. These wires are collected together and passed out of the resistor **10** through a bushing **68** secured by means of flanges **70** to the top **22** of the cover **20**. If desired other conventional terminal means can be provided.

In order that the variable resistor **10** may be made operative it is necessary to provide upon the slider **30** a contact element **72** having a base **74** attached to the slider **30** by means of screws **76**. The contact **72** is electrically conductive, and includes a plurality of resilient arms **78** which are designed to hold curved extremities **80** against the collecting elements **50** and the resistance elements **54**. If desired the contact **72** may be broken up into a plurality of separate parts each of which is designed to engage one or more of the electrically conductive members **40**.

One major advantage of the present invention lies in the fact that the cover **20** can be removed from the base **12** exposing the electrically conductive members **40** so that the position of these electrically conductive members and the contact members **62** can be adjusted in any

manner deemed desirable with the slider **30** and the contact **72** in any desired operative position. Normally the slider **30** employed with the variable resistor **10** is formed of an insulating material. If desired, however, this member may be formed of a conductive material so as to in effect establish electrical communication from the contact **72** through the slider **30** to either the shaft **32** or the shaft **38**. If this is done one of the wires **66** is preferably connected to the shaft 38, or an appropriate electrical connection is made to the shaft **32** on the exterior of the variable resistor **10**. Usually when the slider **30** is made conductive it is preferred to form the shaft **32** of a non-conductive material.

In Fig. 5 of the drawings a modified construction is shown in which the electrically conductive members **40** are also formed so as to include carriers **42**. Each of these carriers **42** is provided with at least one conductive element **82** which may be placed upon the carrier **42** by any of the established printed circuit techniques. If desired resistance elements **82***a* consisting of a mixture of resistance particles and a resinous binder may be formed as indicated within one or more of the carriers **42**. This is conveniently done when the carrier holding the resistance element **82***a* is formed of a synthetic resin or plastic by co-molding the carrier and the resistance element together. In Fig. 6 of the drawings a second modified construction is shown in which a single electrically conductive member **84** is employed. This member is composed of a plurality of generally flat non-conductive sheets **86** upon the surfaces of which there are disposed a plurality of conductive elements **88**, some of which may be connected together by means of solder terminals **90** projecting through openings **92** within these sheets **86** or other equivalent means. These conductive elements **88** may also be created by printed circuit techniques. With the construction shown in Fig. 6 some of the conductive elements **88** are disposed upon the portion of the conductive member **84** immediately adjacent to the bottom **14** of the base **12** so as to be contacted by the contact **72** during movement of the slider **30**.

Both of the constructions shown in Figs. 5 and 6 of the drawings may be employed with the variable resistor **10** in order to add a high degree of versatility to this resistor, and the constructions shown in either of these figures can be employed together with the electrically conductive members **40** as indicated in the initial figures of the drawings. The type of construction shown in Fig. 6 is particularly advantageous since certain of the conductive elements **88** may be located and formed so as to constitute capacitors and resistors coupled together as complete circuit components. These sheets **86** shown in Fig. 6 of the drawings may be readily adjusted with respect to one another as indicated in the preceding discussion when located on the base **12**.

One manner in which one of the sheets **86** intended to be positioned immediately adjacent to the slider **30** may be provided with conductive elements **88** is shown in Fig. 7. Here a sheet **86** is illustrated as being coated by printed circuit techniques with coatings **88***a* and **88***d* designed to be engaged by the contact member **72**. The coating **88***a* is preferably of a resistance type, and is connected by conductive strips **88***b* connecting the ends of the coating **88***a* to contact points **88***c* designed to be connected to wires **66**. The coating **88***d* is preferably of a highly conductive tape and is similarly connected by conductive strips **88***e* to a contact point **88***f* which is also designed to be connected to a wire **66**. The broad type of configuration illustrated in Fig. 7 is not restricted to use as the construction illustrated in Fig. 8, but can be employed on each of the carriers **42** illustrated in Fig. 5. Also, considerable variation may be made in the configurations and number of the conductive coatings upon the sheet **86**.

In Figs. 8, 9, and 10 of the drawings a modified electrically conductive member **94** is indicated as including a carrier **96** having an elongated centrally located slot **98**

adjacent to the ends of which there are formed openings 100 having curved shoulders 102. With this construction a single conductive wire 104 which may have appreciable resistance is held as indicated in Fig. 8 by means of screws 106. This wire 104 is adapted to be engaged by a curved extremity 108 upon an arm 73 of the contact 72 substantially as indicated in Figs. 9 and 10 of the drawings. The term "curved extremity" employed here is intended to designate the curvature shown in Fig. 9 of the drawings for the extremity 108 which may be described as being in a plane perpendicular to the axis of the wire 104. The extremity may also be curved in a direction longitudinally of the wire 104 in order to provide for essentially point contact between the contact member 72 and the wire 104. By virtue of this construction the extremity 108 is not apt to be knocked off of the wire 104 due to the normal jolts received in handling and use.

When the wire 104 is of extremely small diameter it is frequently desirable to mount the wire 104 directly upon a rigid member extending the length of this wire 104 using a suitable adhesive. When this is done the wire 104 is preferably mounted directly in a small groove so as to project from the supporting member a short distance. With the type of construction employed in this embodiment of the invention the terminal means may be on the same side of the supporting member as the principle portion of the wire 104.

Those skilled in the art will realize that a comparatively large number of modifications may be made within the scope of the present disclosure without departing from the essential teachings of this specification. As an example of such modifications any number of electrically conductive members may be employed within a single variable resistor, and further the electrically conductive members employed together may be of completely different constructions, such as any of the constructions specifically indicated herein. The shaft 34 need not project from both ends of the complete unit shown. If it only projects from one end of a variable resistor the non-projecting end is preferably carried within an opening in a suitable bushing-like construction formed as part of the base 12, this opening being aligned with an opening in the other end of the base. All such modifications of this category are to be considered as part of the inventive concept insofar as they are defined by the appended claims.

It is thought that those skilled in the art will realize from this description the extreme flexibility of variable resistor constructions of the invention. With these constructions both the positions of the electrically conductive members employed and of the contacts made to various portions of electrical elements carried by these electrically conductive members may be easily and conveniently adjusted with all of the parts of the units in an operative position. It is possible to use the openings 60 and contact members such as the contact members 62 normally employed with these openings not only as

centrally located connections as indicated in Figs. 2 and 3 of the drawings, but also as end terminals.

We claim:

1. A variable resistor comprising a body, a slider movable linearly with respect to said body, a plurality of laterally spaced contacts mounted on said slider, a plurality of element support members arranged side by side on said body, each of said support members having a resistance element mounted on one side thereof and wiped by one of said contacts, each of said support members having an aperture in the other side thereof exposing a portion of its respective resistance element, tap means on said other side of said support member making electrical contact with said resistance element through said aperture, and means securing each of said support members to said body for individual adjustment with respect thereto along the line of travel of said slider.

2. A variable resistor comprising a body member having a cavity provided therein, a linearly movable shaft disposed within said cavity, a slider mounted on said shaft and having a contact attached thereto, an element support member mounted on said body member to bridge said cavity, a resistance element mounted on the under side of said element support member in a position to be wiped by said contact, said support member having an aperture in the top side thereof exposing a portion of said resistance element, a tap adjustably mounted on the top side of said support and making electrical contact with said resistance element through said aperture, said tap being shiftable along the length of said resistance element, and means securing said element support member to said body and permitting adjustment thereof along the line of travel of said slider, said means including at least one screw threaded into one of said members and having a head engaging the other member so as to clamp said element support member tightly to said body member.

References Cited in the file of this patent

UNITED STATES PATENTS

753,716	Leonard	Mar. 1, 1904
966,555	Jesse	Aug. 9, 1910
1,660,979	Thayer	Feb. 28, 1928
1,724,538	Weichelt et al.	Aug. 13, 1929
1,901,233	Glowacki	Mar. 14, 1933
2,197,312	Nelson	Apr. 16, 1940
2,339,721	Wilson	Jan. 18, 1944
2,551,989	Wilson	May 8, 1951
2,592,392	Canziani et al.	Apr. 8, 1952
2,617,912	Colvin	Nov. 11, 1952
2,657,295	Barclay	Oct. 27, 1953
2,668,218	Searle	Feb. 2, 1954
2,706,230	Bourns et al.	Apr. 12, 1955

OTHER REFERENCES

Brunetti et al.: "National Bureau of Standard Circular" #468, Nov. 15, 1947.