March 12, 1968 C. W. YUNGBLUT ET AL 3,373,396

VARIABLE RESISTANCE DEVICE

Filed July 29, 1965 2 Sheets-Sheet 1

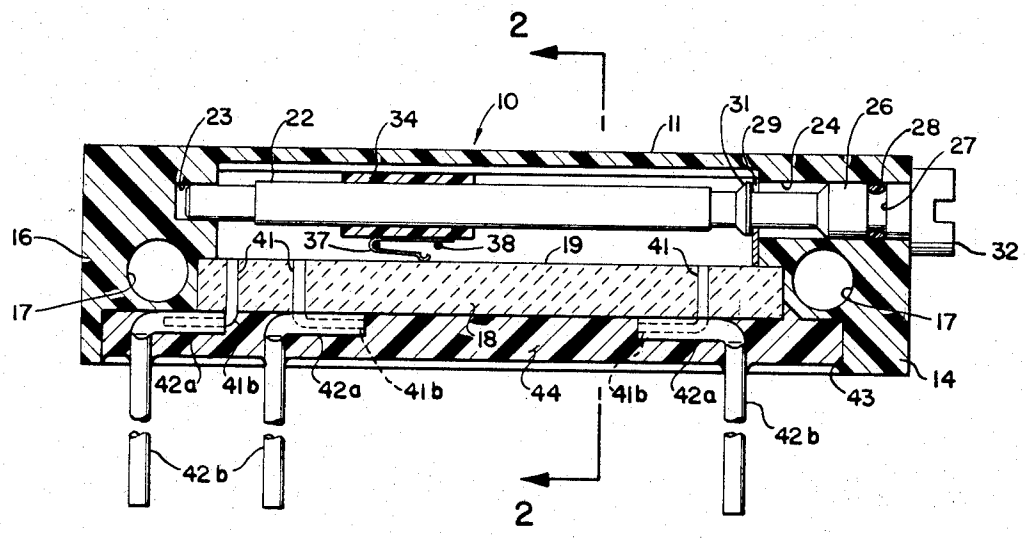

FIG. 1

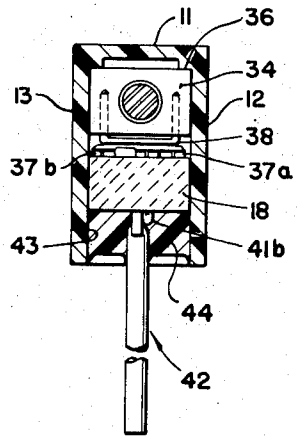

FIG. 2

INVENTORS
CHARLES W. YUNGBLUT
ALAN J. WRIGHT
LESLIE T. PEART
BY
ATTORNEY

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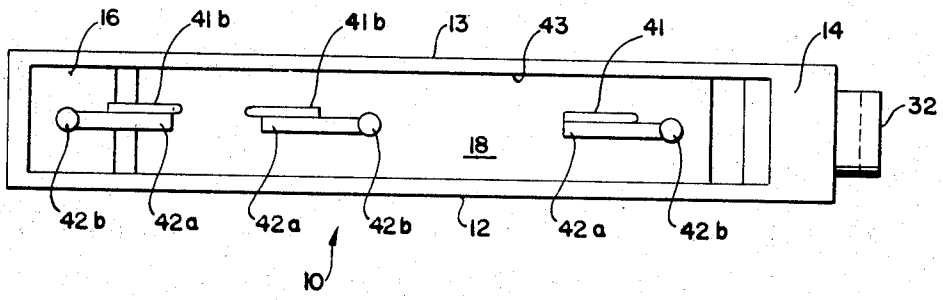

FIG. 3

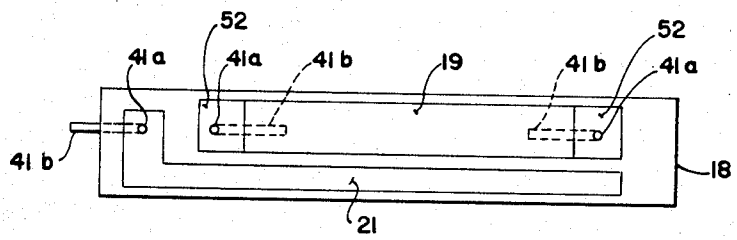

FIG. 5

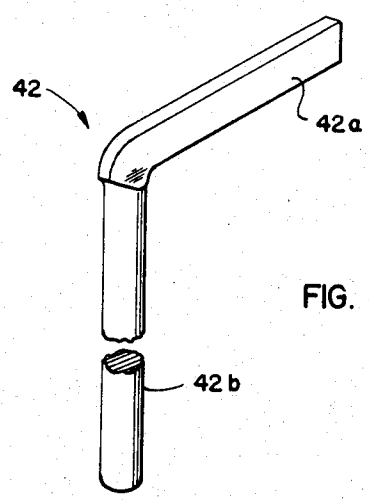

FIG. 4

INVENTORS
CHARLES W. YUNGBLUT
ALAN J. WRIGHT
LESLIE T. PEART
BY
ATTORNEY

United States Patent Office 3,373,396
Patented Mar. 12, 1968

3,373,396

VARIABLE RESISTANCE DEVICE

Charles Walter Yungblut, Santa Ana, Alan John Wright, Orange, and Leslie Thomas, Peart, Santa Ana, Calif., assignors to Beckman Instruments, Inc., a corporation of California

Filed July 29, 1965, Ser. No. 475,648
3 Claims. (Cl. 338—183)

ABSTRACT OF THE DISCLOSURE

A variable resistance device including a housing open on one side thereof and having disposed therein a nonconductive ceramic base member supporting a resistance element. Terminal pins are fired into the base member each having an end thereof in contact with the resistance element and an opposite end portion extending through the base member and bent parallel to the surface of the base member opposite from the resistance element. To these bent end portions of the terminal pins are connected L-shaped terminal extensions having one leg disposed adjacent to bent portion of the terminal pin and welded or otherwise secured thereto. A nonconductive potting material surrounds the weld and supports the terminal extension adjacent to base member of the device so that bending of the terminal pin takes place at points remote from the weld.

The present invention relates to variable resistance devices such as potentiometers, rheostats and the like having a movable electrical contact adapted to traverse a resistance element, and more particularly to variable resistance devices commonly known as trimming potentiometers.

Potentiometers of the trimmer class function mainly as auxiliary resistance adjusting devices and are intended for infrequent adjustment. Trimmers generally include a resistance element, which may be a wound wire element or a deposited metallic, ceramic or conductive plastic element, having at least two terminal connections for applying a voltage across the resistance element. A movable wiper is mounted for adjustment along the length of the resistance element and a third terminal means is provided for electrically connecting the wiper into an external circuit. Trimmer potentiometers are usually small in size as compared with precision potentiometers.

The terminals of the resistance element and the wiper, as well as any tap connections to the resistance element, are adapted for connection into external circuitry by means of terminal pins or wires that protrude from the trimmer housing. Because of the wide variety of connections required by the various circuits into which trimmer potentiometers are employed, it is sometimes necessary to bend or adjust the position of the terminal pins and wires for connection into their specific circuitry. Users of trimmer potentiometers generally specify the desired location of the terminal pins and wires so that they may be easily incorporated into the customer's circuitry. While the remaining components of trimmer potentiometers of a particular manufacture may be somewhat standardized, it is difficult to comply with the customer's requirements for pin locations without modifying to some extent the internal components of the potentiometer and the terminal connections to these electrical components.

It is, therefore, an object of the present invention to provide a trimmer potentiometer having an improved structural design for its terminal pins protruding from the terminal housing which permits a wide variety of different terminal pin or wire locations without requiring any particular design changes in the resistance element substrate or the terminal connections to the resistance element.

It is another object of the present invention to provide a trimmer potentiometer having a new improved arrangement for the terminal pins extending from the housing which may be subjected to extreme amounts of bending or adjustment without impairing the electrical connections to the resistance element and the seal into the trimmer housing.

It is sometimes desirable to fire a terminal pin into the substrate base member before the resistance element is formed thereon. The firing operation usually causes the substrate to shrink around the terminal pin. In cermet type trimmer potentiometers, the unit is then fired again to fuse the resistance material. The terminal pins, therefore, must be capable of withstanding the necessary firing temperatures with essentially no oxidation. Such pins are usually constructed of expensive materials, such as gold-palladium alloys or must have extremely heavy gold plating, and, when the pin is necessarily required to be long or heavy, in order to comply with the customer's circuit connection requirements, the use of costly materials capable of withstanding oxidation at the firing temperatures contributes substantially to the cost of the trimmer.

It is, therefore, another object of the present invention to provide an improved variable resistance device employing a "fired-in-pin" in the substrate but utilizing a design arrangement which is less costly and more commercially feasible for circuit connections requiring lengthy or bulky pins.

Further objects and advantages of the invention will become apparent as the following description proceeds and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In accordance with the present invention, there is provided a variable resistance device including a housing having sidewalls and a pair of end walls enclosing a cavity open on one side thereof in which there is mounted a nonconductive base member carrying a resistance element. A lead screw driven contact is disposed for reciprocation back and forth over the resistance element during rotation of the lead screw. A plurality of terminal pins are positioned through the nonconductive base member, each terminal pin having an end thereof in contact with the resistance element or its end terminations and its opposite end portion bent parallel to the surface of the base member opposite from the resistance element. In order to connect the terminal pins into external circuitry there are provided a plurality of L-shaped terminal extensions having one leg disposed adjacent the bent end portion of the terminal pin and welded or otherwise secured thereto. The L-shaped terminal pin extensions have their other leg extending substantially normal to the base member through the open side of the housing. A nonconductive potting material surrounds the weld portion of the terminal pin and its respective terminal pin extension and supports the terminal pin extensions so that bending of the terminal pin extension takes place outside the potting material at a point remote from the weld and the terminal pin extending through the base member.

For a better understanding of the invention, reference may be had to the accompanying drawing in which:

FIGURE 1 is a side elevation view taken in cross-section of a preferred embodiment of the invention;

FIGURE 2 is a cross-sectional view taken substantially along line 2–2 of FIGURE 1;

FIGURE 3 is a bottom view of a trimming potentiometer, illustrating an arrangement in which the terminal

pin extensions protrude along a center line and are an equal distance apart;

FIGURE 4 is an enlarged isometric view of a terminal pin extension; and

FIGURE 5 is a plan view of a substrate carrying a preferred embodiment of the resistance element and its collecting track.

Referring now to the drawing, there is shown a preferred embodiment of a trimmer potentiometer, which is generally designated by the reference numeral **10**. In this embodiment, the housing is rectangular in shape having longitudinal sidewalls **11**, **12**, and **13** and a pair of end walls **14** and **16**. The housing may be formed of a plastic, such as diallyl phthalate or the like or may be formed of a metal such as aluminum. While the housing, in the illustrated embodiment, is rectangular in shape it may be formed in any desired shape such as cylindrical or square. The housing **11** is provided with a pair of holes **17**, which are employed for mounting purposes and for stacking trimmer potentiometers one adjacent the other.

Securely mounted within the housing **11** and supported by the end walls **14** and **16**, is a nonconductive base member **18** formed of alumina, steatite, or plastic upon which, as may best be seen in FIGURE 5, are mounted a resistance element **19** and a conductive collector strip **21**. The resistance element **19** is preferably formed of a deposited film of resistance material, such as a cermet resistance material, conductive plastic resistance material or a metallic film material and includes a pair of end terminations **52** attached thereto. The resistance element can also be formed of a wirewound resistance element attached to the substrate base member or disposed in a suitable groove formed therein. The conductive strip may be formed of a suitable conductive material, such as a silver or gold platinum film, or may comprise a continuous strip of conductive wire.

As will be seen in FIGURE 1, the substrate **18** is supported within shoulders formed in the end walls **14** and **16** of the housing. The substrate **18** is placed in position in the housing with the resistance element **19** facing the cavity. After the substrate **18** is positioned in the housing **11**, it is secured with potting material at each end and a bead of resilient sealing material is applied along the edges of the substrate **18** where it joins the housing. The sealing material may be a silicone rubber or other suitable material to provide a good seal. This sealant together with the O ring **28** completely seals the interior or cavity of the device and protects it from undesirable environmental ingress.

Referring again to FIG. 1, a threaded adjustment shaft **22** is supported by the housing end walls **14** and **16**. A blind opening **23** in the housing end wall **16** supports one end of the shaft **22** and a "through" opening **24** and the end wall **14** supports the other end of the shaft. The end passing through the opening **24** comprises a shank **26** having a slotted groove **27** in which is located a shaft sealing O ring **28**. The shaft **22** is axially secured in the housing **11** by a bowed retainer **29** preferably formed of spring material such as beryllium-copper-nickel alloy. Retainer **29** abuts against a shoulder **31** on the shaft and constantly pulls the shaft inwardly so that the head **32** abuts against the outer surface of end wall **14** of the housing. The head **32** is preferably slotted or otherwise formed so that it may be rotated by a screwdriver or other tool.

A slider block **34**, formed preferably of an insulating material such as polytetrafluoroethylene, is threadedly engaged on the adjustment shaft **22** for reciprocation along a path parallel to the resistance element located on the base member **18**. The adjustment shaft **22** may utilize a double thread for economy and ease of fabrication; and, due to the large number of threads engaging the slider block **34**, excellent clutch action may be realized

and the slider block positively moved during relatively small rotational movement of the shaft.

Rocking of the slider block with respect to the shaft in its path of reciprocation is prevented by having the upper portion of the slider block **34** abut against the shoulders **36** formed in the housing. Preferably there is an interference fit between the upper surface of the slider block **34** and the shoulders **36** of the housing. This interference fit is made possible by use of a resilient polytetrafluoroethylene for the slider block, which is deformed by the narrow shoulders **36**. This slight deformation of the block sets the block, producing a tight fit, but still allows smooth and easy sliding thereof during rotation of the threaded adjustment shaft.

An electrically conductive contact or wiper member **37** is mounted on the slider block **34** by press fitting a pair of U-shaped wires or staples **38** into holes in the slider block. As may best be seen in FIG. 2, the wiper includes a plurality of resilient contact arms **37***a* and **37***b* which engage the resistance element **19** and the conductive track **21** and provide an electrically conductive path therebetween.

As may best be seen in FIGURES 1 and 5, the resistance element **19** and the conductive track **21** are connected into external circuitry by means of terminal pins **41** and terminal pin extensions **42**. The terminal pins **41** are preferably made of a precious metal alloy, which may be fired into the substrate **18** in the manner described in the Szobonya patent application Ser. No. 416,074, entitled "Terminal Structure," which is also assigned to the assignee of the present invention. Terminal pins **41** have their one or embedded end **41***a* in contact with the resistance element terminal pads **52** or directly in contact with the resistance element and with the conductive strip **21**. The opposite ends of each terminal pin **41** is bent substantially parallel to the surface of the substrate **18** on the surface opposite from that surface upon which is located the resistance element. The end portions **41***b* of the terminal pins, as may best be seen in FIGURE 1, may be bent in any direction, as may be desired in accordance with the location of the external connection to be made for the particular trimmer potentiometer.

As may best be seen in FIGURE 4, the terminal pin extension **42** is preferably formed in an L-shape with one leg **42***a* arranged at substantially right angles to the opposite leg **42***b*. The leg **42***a* is preferably flattened on at least one side to provide an appropriate surface for attaching to a terminal pin **41**. The flattened portion **42***a* not only simplifies the spot welding process, but also aids in producing a very reliable connection. The pin extension **42***a* may be formed of a much more inexpensive material than the terminal pin **41** and may be of a much stronger of bulkier design. For example, in a preferred embodiment, extensions **42** are formed of an annealed material, such as gold-plated nickel alloy, while the terminal pins are formed of an alloy of gold-palladium. The flat surface **42***a* is disposed adjacent the bent end portion **41***b* of the pin terminal **41** and welded thereto. It will be seen that the relative position of the two surfaces may be adjusted over a wide range to locate the particular position of the protruding leg **42***b* of the pin extension. For example, as may be seen in FIGURE 3, the relative location of the leg **42***a* and the bent end portion **41***b* may be adjusted to provide a multitude of different positions for the leg **42***b* of the pin extensions. As may be seen in FIGURE 3, the pin extensions **42***b* protrude from the trimmer along a center line and are arranged approximately equal distance from each other. Other arrangements are possible and the particular length of the leg **42***a* of the pin extensions **42** may be varied in order to permit an infinite number of pin positions.

As will be seen in FIGURES 1 and 3, the end walls **14** and **16** and the under-surface of the substrate member **18** forms a trough **43** in the open side of the cavity. The trough **43** is filled with a potting insulation material **44**,

such as an epoxy, which provides additional strength to hold the substrate **18** in place as well as to securely bind the welded portions of the terminal pins **41** and pin extensions **42** in place. After the potting material is inserted, surrounding the welded portions of the welded pin and pin extensions, any bending of the external leg **42***b* of the pin extensions must necessarily take place outside the potting material and forces applied to the pin extension legs **42***b* are not transmitted directly to the pins **41** and the substrate **18**. By using an epoxy potting material **44**, no cover is required for the bottom of the housing.

While in accordance with the patent statutes there has been shown and described what at present is considered the preferred embodiment of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention and it is the intent of the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A variable resistance device comprising:

an elongated housing including sidewalls and a pair of end walls enclosing a cavity open on one side of said housing;

a longitudinal nonconductive ceramic base member supported within said cavity and including a longitudinal resistance element disposed on one surface thereof;

a lead screw supported by said end walls within said cavity parallel to said base member, said lead screw having a shank extending through one end wall, said shank having a head thereon adapted to permit rotation of said lead screw;

a contact carrier block mounted within said cavity, said carrier block being constructed and arranged for translational motion back and forth by said lead screw in a path parallel to said resistance element upon rotation of said lead screw;

a contact member carried by said carrier block and extending into electrical contact with said resistance element on said base member;

terminal means connecting with said contact member and said resistance element for conducting electrical current thereto, said means including at least one terminal pin formed of a nonoxidizing conductive material fired into said ceramic base member and extending through said base member into contact with said resistance element, said terminal pin having its end portion bent parallel to the surface of said base member opposite from said resistance element;

at least one L-shaped terminal pin extension having one leg with a flat surface portion disposed adjacent said bent end of said terminal pin and welded thereto, said L-shaped terminal pin extension having another leg extending substantially normal to said base member through said open side of said housing; and

a potting material surrounding said welded portions of said terminal pin and said terminal pin extension and filling said open side of said housing, said potting material supporting said terminal pin extensions so that forces exerted against said terminal pin extension are not transmitted to the weld or to the portion of said terminal pin extending through the base member.

2. A variable resistance device comprising:

an elongated housing including sidewalls and a pair of end walls enclosing a cavity open on one side of said housing;

a longitudinal nonconductive ceramic base member supported within said cavity and including a longitudinal resistance element and an electrically conductive collector track disposed parallel to each other on one surface of said base member;

a lead screw supported by said end walls within said cavity parallel to said base member, said lead screw having a shank extending through one end wall, said shank having a head thereon adapted to permit rotation of said lead screw;

a contact carrier block mounted within said cavity, said carrier block being constructed and arranged for translational motion back and forth by said lead screw in a path parallel to said resistance element upon rotation of said lead screw;

a contact member carried by said carrier block having electrically conductive legs extending respectively into contact with said resistance element and said conductive track on said base member;

a plurality of terminal pins formed of a nonoxidizing conductive material fired into said ceramic base member and extending through said base member, at least one terminal pin having one end thereof in contact with said resistance element and another terminal pin having one end thereof in contact with said conductive electrical track, said terminal pins having their opposite ends bent over parallel to said base member adjacent the surface opposite from that surface carrying said resistance element and said conductive track;

a plurality of L-shaped terminal pin extensions each having one leg thereof with a flat surface portion disposed adjacent the bent end of a terminal pin and conductively bonded thereto, said L-shaped terminal pin extensions each having another leg thereof extending substantially normal to said base member through said open side of said housing; and

an insulating potting material surrounding said bonded portions of said terminal pins and said terminal pin extensions and filling said open side of said housing, said insulating potting materials supporting said terminal pin extensions so that forces exerted against said terminal pin extensions are not transmitted to the bond or to the portion of said terminal pin extending through said base member.

3. A variable resistance device comprising:

an elongated housing including sidewalls and a pair of end walls enclosing a cavity open on one side of said housing;

a longitudinal nonconductive ceramic base member supported within said cavity and including a longitudinal resistance element and electrically conductive collector track disposed parallel to each other on one surface of said base member;

a longitudinal guide surface in said housing disposed in a path parallel to said resistance element;

a lead screw supported by said end walls and extending through said cavity parallel to said base member, said lead screw having a shank extending through one end wall, said shank having a head thereon adapted to permit rotation of said lead screw;

a contact carrier block mounted on said lead screw within said cavity, said contact carrier block having a surface thereof engaging said guide surface of said housing thereby preventing rotation of said carrier block with said lead screw so that rotation of said lead screw moves said carrier block back and forth in a path parallel to said resistance element, said contact carrier block being constructed of resilient polytetrafluoroethylene and being so constructed and arranged that the fit of said carrier block between said lead screw and said guide surface of said housing partially deforms said carrier block producing an interference fit thereby eliminating loose play of said carrier block on said lead screw;

a contact member carried by said carrier block having electrically conductive legs extending respectively into contact with said resistance element and said conductive track on said base member;

a plurality of terminal pins formed of a nonoxidizing conductive material fired into said ceramic base member and extending through said base member, at least one terminal pin having one end thereof in

contact with said resistance element and another terminal pin having one end thereof in contact with said conductive electrical track, said terminal pins having their opposite ends bent over parallel to said base member adjacent the surface opposite from that surface carrying said resistance element and said conductive track;

a plurality of L-shaped terminal pin extensions each having one leg thereof with a flat surface portion disposed adjacent the bent end of a terminal pin and conductively bonded thereto, said L-shaped terminal pin extensions each having a leg thereof extending substantially normal to said base member through said open side of said housing; and

an insulating potting material surrounding said bonded portions of said terminal pins and said terminal pin extensions and filling said open side of said housing, said

insulating potting materials supporting said terminal pin extensions so that forces exerted against said terminal pin extensions are not transmitted to the bond or to the portion of said terminal pin extending through said base member.

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RICHARD M. WOOD, *Primary Examiner.*

J. G. SMITH, *Assistant Examiner.*