July 15, 1969 B. A. PAINE ET AL 3,456,227

VARIABLE RESISTOR

Original Filed Nov. 2, 1965

FIG-1

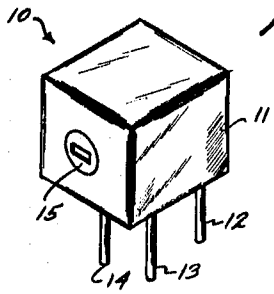


FIG-2

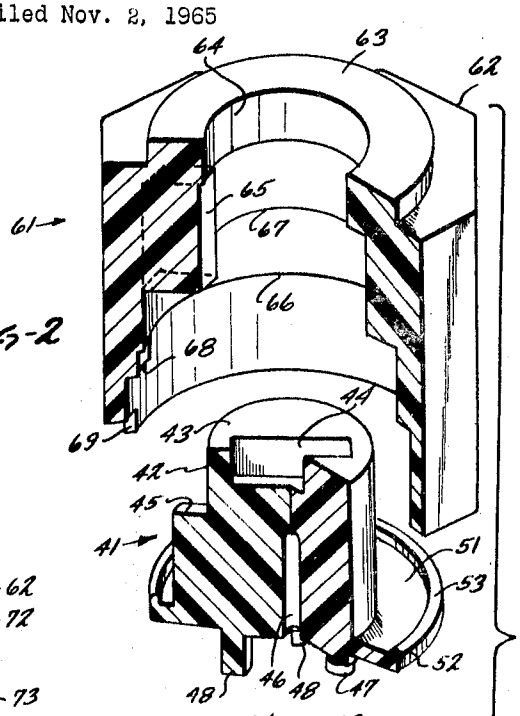
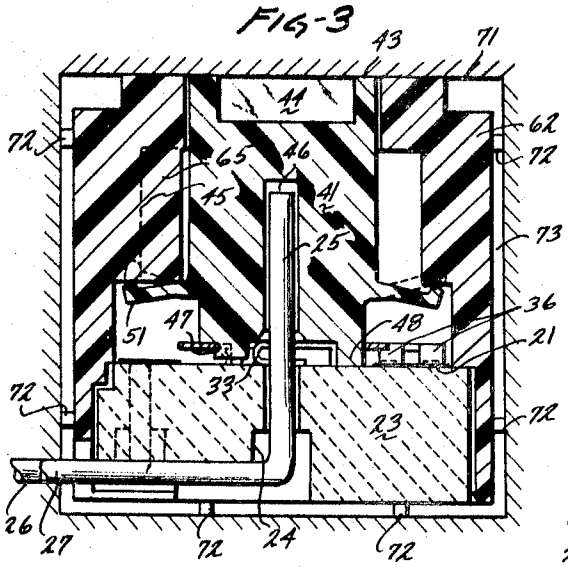
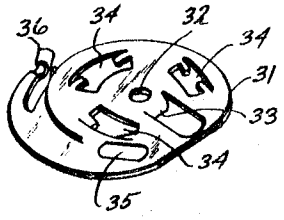


FIG-3





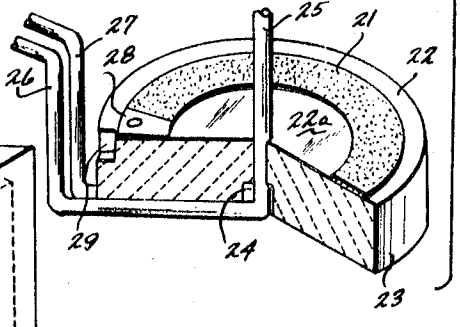
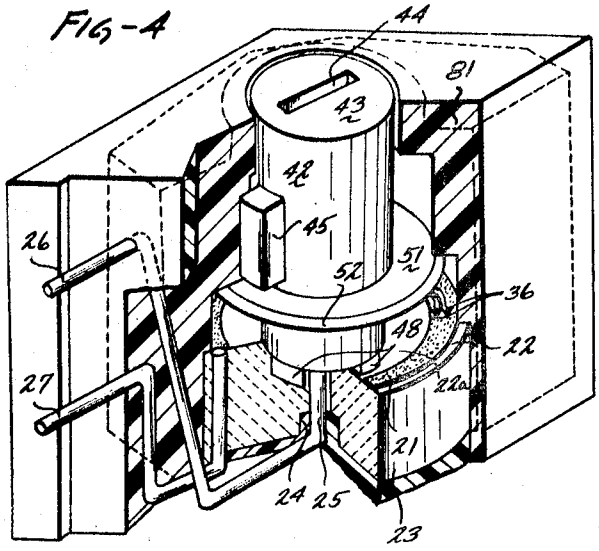


FIG-4



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United States Patent Office 3,456,227 Patented July 15, 1969

3,456,227

VARIABLE RESISTOR

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Continuation of application Ser. No. 506,072, Nov. 2, 1965. This application Feb. 16, 1968, Ser. No. 709,164

Int. Cl. H01c 5/02

U.S. Cl. 338—164 10 Claims

ABSTRACT OF THE DISCLOSURE

Disclosed is a variable resistor which is constructed and held in place without the utilization of adhesives and which provides a seal from foreign contaminants without the utilization of the traditional O-rings. The resistor consists of an aligned base and rotor member surrounded by a shroud member which engages both the rotor and the base and urges a contact element carried by the rotor into electrical contact with a resistance element carried by the base. A housing is molded around the shroud member in such a manner that the rotor is adjustable from externally of the completed variable resistor.

Cross-reference to related application

This application is a continuation application of Ser. No. 506,072, filed Nov. 2, 1965 by Bud A. Paine and Paul R. Trautmann for "Variable Resistor and Method of Making Same."

Background of the invention

This invention relates generally to variable resistors and, more particularly, to a sealed variable resistor having an in-situ molded housing and the method of making the same.

Variable resistors of all types and particularly miniature potentiometers are well known in the prior art and have been used for long periods of time. These devices and particularly the miniature potentiometers must be sealed from the ambient atmosphere to preclude the entry of foreign contaminants which might interfere with the mechanical or electrical functioning of such devices. The housings of such prior are devices have traditionally been made of several parts, preferably of plastic, which are brought together and bonded by the use of various well-known adhesives. The use of such adhesives necessitated much hand assembly operation which not only increased the cost of manufacture of such devices but also in many instances lowered the quality thereof. As is also well known in the prior art, the use of adhesives for such bonding purposes presented low-voltage breakdown areas which for many operations are not desirable.

In order to further accomplish the desired seal, particularly between the rotating portions extending externally of the housing of the device for adjustment purposes and the housing, an O-ring is normally utilized. As is well known, such O-rings are inserted into a groove formed within a portion of the housing and are then compressed by being brought into contact with a section of the housing. Such operations require hand assembly thus again increasing the cost of the device. Furthermore, as is kell known, such O-rings are subject to inherent material flaws, to aging which causes the seal of the O-ring to become defective, and to misalignment of the O-ring with the grooves provided for it.

Such prior art devices also by necessity were manufactured utilizing a multitude of parts in order to accomplish desired electrical and mechanical functioning

thereof. Such multitude of parts not only increased the cost of manufacture but at the same time inherently decreases the reliability of the device.

Summary of the invention

Accordingly, it is an object of the present invention to provide a variable resistor having a minimum number of parts, which is highly reliable even under adverse operating conditions, and is inexpensive to manufacture as compared to prior art variable resistors.

It is another object of the present invention to provide a variable resistor which accomplishes a seal between the internal parts of the variable resistor and the outside ambient atmosphere while obviating the prior art sealing problems.

It is another object of the present invention to provide a variable resistor which includes a housing that is sealed from the ambient atmosphere without the use of adhesives.

It is another object of the present invention to provide a method of manufacturing a variable resistor which is simple, efficient and inexpensive and results in a superior, more reliable variable resistor than those presently in existence in the prior art.

A variable resistor in accordance with the present invention includes a base member and a rotor member which are brought together in an aligned fashion along with an aligning means which urges an electrical contact carried by the rotor into electrical engagement with a resistance element carried by the base. After being thus properly aligned and positioned, a housing member is molded in-situ about the base, rotor and aligning means.

Brief description of the drawings

Other and more specific objects and advantages of the present invention both as to its organization and method of operation will become apparent from a consideration of the following description taken in conjunction with the accompanying drawing which is presented by way of example only and is not intended as a limitation upon the scope of the present invention and in which:

FIGURE 1 is a perspective view of a completed variable resistor constructed in accordance with the present invention;

FIGURE 2 is an exploded view, partly in cross-section, of some portions of a variable resistor constructed in accordance with the present invention;

FIGURE 3 is a cross-sectional view of the elements of a variable resistor as illustrated in FIGURE 2 brought together in aligned relationship within the cavity of a mold prior to the formation of the in-situ molded housing; and

FIGURE 4 is a perspective view, partly in cross-section, of a completed variable resistor in accordance with the structure and method of the present invention.

Description of the preferred embodiment

Referring now to the drawing and more particularly to FIGURE 1 thereof, a completed variable resistor in accordance with the present invention is shown generally at **10**. The variable resistor **10** is shown as a trimmer potentiometer and includes a body or housing portion **11** having electrically conductive pin members or leads **12, 13** and **14** etxending therefrom. A rotatable adjusting means **15** is accessible from the exterior of the body portion **11** of the housing as is illustrated for purposes of adjusting the electrical resistance of the potentiometer **10** in accordance with that which is desired for any given application.

Referring now more particularly to FIGURE 2, the internal construction of the potentiometer **10** is illustrated more in detail. As is shown in FIGURE 2, a resistance

element 21 is disposed on the upper surface 22 of a base member such as substrate 23. In the presently preferred embodiment of the present invention the substrate 23 is constructed of a ceramic material such, for example, as steatite. As is illustrated in FIGURE 2, the resistance element 21 may be constructed of a partially conductive material applied as a very thin layer by means well known to the art, to the surface of the ceramic substrate 23. It should, however, be expressly understood that the resistance element 21 may be of any type desired for a particular application. For example, a wire wound resistance element may be utilized in which case the substrate or base 23 would be changed sufficiently to receive that particular resistance element.

The base 23 defines a centrally disposed bore 24 which receives an electrically conductive center post 25. As is illustrated in FIGURE 2 the center post 25 is a continuation of electrical lead 26 which extends externally in the finished product as one of the pin members 12, 13 or 14 as shown in FIGURE 1. An additional lead 27 extends through an opening (not shown in FIGURE 2) defined by the base member 23 and makes electrical connection to one terminal portion 28 of the electrical connection to one terminal portion 28 of the electrical resistance element 21. Similar electrical connection is made by a third electrical lead (not shown) to the opposite terminal portion of the resistance element 21 as is well known in the prior art.

The base member 23 defines a notch or recess 29 which is utilized for alignment purposes as will become more fully apparent hereinbelow.

An electrical contact element 31 is provided for making movable electrical contact to the resistance element 21 and to the electrically conductive center post 25. The contact element 31 defines a centrally disposed aperture 32 which receives the center post 25. A tongue 33 is struck from the contact 31 and turned under and back and also defines an opening (not shown in FIGURE 2), which is aligned with the opening 32 and also receives the center post 25. (This structure is more clearly seen in FIGURE 3.)

A plurality of openings 34 are equally distributed about the contact 31 and are disposed to receive a like number of protrusions extending downwardly from the rotor as will be more fully described hereinbelow. A stiffening rib 35 is provided in the contact element to strengthen the arm forming the fingers 36. The opening formed by striking the tongue 33 receives a protrusion extending downwardly from the rotor, which protrusion is heat-deformed to rigidly secure the contact element to the rotor. Extending also downwardly, from the general plane described by the contact member 31, are two contact fingers 36 which make the movable electrical contact with the resistance element 21. The two contact fingers 36 are provided to assure electrical interconnection between the center post 25 and the resistance element 21 at all times.

The rotor shown generally at 41 includes a body member 42 having an upper surface 43 defining a slot or kerf 44 adapted to receive an adjusting tool as is well known in the prior art. The upper surface 43 and kerf 44 is illustrated at 15 in FIGURE 1 as it relates to the overall structure of the potentiometer 10. The body 42 of the rotor defines a stop means such as tongue 45 extending outwardly therefrom. As is well known in the prior art, the stop means may be eliminated if a continuously rotatable potentiometer is desired. The body 42 of the rotor 41 defines a central bore 46 which is adapted to receive the center post 25. Extending downwardly from the lower surface of the body member 42 is a protrusion 47 which extends through the opening 35 and which is heat-deformed to secure the contact member 31 to the rotor 41. A plurality of protrusions 48 also extend downwardly from the lower surface of the body portion 42 of the rotor 41 and extend through the openings 34 in the contact member. The bottom surface of these protrusions 48 engage that portion of the top surface 22 inwardly of the resistance element 21 as shown at 22*a* when the potentiometer is in its fully assembled form. The purpose of such engagement is to stabilize the rotor and thus the contact fingers 36 upon the resistance element 21 to preclude accidental relative movement between the contact fingers and the resistance element when an adjusting tool is inserted into the kerf 44 or the potentiometer is otherwise contacted. Thus the protrusions 48 function as a thrust bearing for the rotor 41.

Extending radially outwardly from the body 42 of the rotor 41 is a flange 51 which terminates in an upwardly turned lip 52 having a curved upper surface 53. The flange 51 is resiliently deformable and in its nonstressed state (as shown in FIGURE 2) is angularly disposed in an upward direction, as viewed in FIGURE 2 (clearly shown in dashed lines in FIGURE 3) for purposes which will be more fully explained hereinbelow. Preferably the rotor 41 is formed in such a manner that the body 42 and flange 51 are integrally molded as a single unitary structure and preferably are made of a fiberglass filled plastic material which thus provides spring or resiliency to the rotor assembly and particularly to the flange 51.

An aligning means or shroud member shown generally at 61 includes a body 62 which is octagonal in configuration. It should, however, be understood that the body can have any geometric configuration desired without departing from the spirit or scope of the present invention. The body 62 defines at its upper end a collar 63 which in turn defines an opening 64 adapted to receive the upper portion of the body 42 of the rotor 41. The collar 63 is displaced inwardly from the outer surface of the shroud body 62 for a purpose to be more fully described hereinbelow. Internally of the body 62 there is provided a stop lug 65 which cooperates with the stop tongue 45 on the rotor 41 to preclude the contact fingers 36 leaving the resistance element 21. As was above pointed out, however, the stop lug 65 may be dispensed with. A plurality of shoulders 66 and 67 are provided on the internal surface of the body 62. Projecting downwardly from the shoulder 66 is a key 68 which mates with the recess or notch 29 in the base 23 to thereby properly aligned the resistance element 21 and the stop lug 65. A recess 69 is provided in the lower edge of the body 62 through which one of the leads 26–27 passes. Additional recesses similar to that illustrated at 69 are also provided for the remaining leads.

The particular relationship of each of the parts described above in detail with respect to FIGURE 2 can be better understood by viewing FIGURE 3 to which reference is hereby made. As is illustrated in FIGURE 3, the three major subassemblies of the potentiometer have been brought together; i.e., the rotor is positioned upon the base by inserting the center post 25 into the bore 46 in such a manner that the thrust bearings 48 rest upon the surface 22*a* of the base 23. The shroud 61 is then positioned over the rotor 41 in such a manner that the upper portion of the body 42 extends through the opening 64 therein. In so doing the shoulder 67 formed internally on the body 62 contacts the upper curved surface 53 of the flange 51. When the shoulder 67 first contacts the surface 53 of the flange 51, the flange is in the nonstressed position shown in dotted lines in FIGURE 3. Thereafter the shroud 61 is forced downwardly, as viewed in FIGURE 3, to the position illustrated in solid lines, in such a manner that the shoulder 66 rests upon the outer edge of the surface 22 of the base 23 as illustrated. In this manner the shroud 61 properly aligns each of the operating parts of the potentiometer in their proper dimensional and spatial relationship.

Referring again to the flange 51, it should be expressly noted that a continuous dynamic seal is provided between the upper surface of the lip 52 and the shoulder 67 on the internal portion of the body 62. By providing the flange 51 in a resiliently deformable form through the utilization of the fiberglass filled nylon, a continuous upward stress is provided to assure an effective seal.

After alignment of the three major subassemblies in the manner above described, the combinatiton is placed within a mold. The mold is schematically illustrated at **71** in FIGURE 3. It will be noted that the shroud **61** is spaced inwardly from all surfaces of the mold except the upper surface as viewed in FIGURE 3. This spacing is accomplished by spacer members **72** provided on the face of the mold. The desired spacing is provided for reception of the final outer housing for the potentiometer. It should be noted that the mold is provided with an aligning and receiving means (not shown) for receiving the leads **26–27** of the potentiometer.

After the subassemblies have thus been properly aligned and placed within the mold, in such a manner that the upper surface as viewed in FIGURE 3 thereof makes intimate contact with the top surface of the shoulder **63** and the upper surface **43** of the body **42** of the rotor, as is illustrated in FIGURE 3, the mold is closed into the position illustrated in FIGURE 3. Thereafter a flowable plastic material is injected into the space **73** provided entirely about the thus assembled subcombination of the potentiometer. The plastic material thus injected is caused to set, after which the mold **71** is parted and the finalized potentiometer is removed therefrom.

By reference to FIGURE 4 the completed potentiometer is illustrated in its final form. As can therein be seen, the outer housing **81** appears as a shell which has adhered to or fused with the surface of the shroud and in any event has completely surrounded the entire subassembly as placed within the mold and above described, with the exception of the upper surface of the collar and the upper surface of the rotor which were in contact with the surface of the mold and were thus "coined off." Thus a complete seal or bond of the housing by in-situ molding thereof has been accomplished. This in-situ molding retains the subassemblies in proper aligned position as above described and retains thusly the flange **51** in its stressed position, as illustrated in FIGURE 3. It can thus be now more fully appreciated that the flange **51** with the upturned lip **52** thereof by being stressed against the shoulder **67** operates as a sealing gland to seal the internal electrical portions of the potentiometer from the ambient atmosphere and contaminants which may be present therein.

It should also be noted that the leads **26–27** shown leaving the housing of the potentiometer at 90° displaced from the longitudinal axis of the rotor may leave parallel thereto if such is desired. It should also be noted that any pin configuration desired for any particular application may readily be obtained with the construction of the potentiometer of the present invention.

There has thus been disclosed a simple, rugged, variable resistor having a minimum number of parts and which is externally sealed by an in-situ molded outer housing that accomplishes a bond or seal of the housing without the use of adhesives. Although a specific form of a potentiometer in accordance with the present invention has been illustrated and described in detail, such is not to be taken as a limitation upon the scope of the present invention but merely as illustrative thereof.

What is claimed is:

1. A variable resistor comprising:

(a) a base member of electrically nonconductive material carrying a resistance element and electrically conductive leads connected to said resistance element;

(b) a rotor of electrically nonconductive material carrying an electrically conductive contact element and having adjusting means;

(c) shroud means engaging said base member and said rotor and urging said contact element into contact with said resistance element,

(1) said engagement between said shroud means and said rotor means being a seal against foreign contaminants; and

(d) a housing member of electrically nonconductive material molded in-situ about said base, said rotor and said shroud means,

(1) said adjusting means of said rotor being engageable through said housing member.

2. A variable resistor as defined in claim **1** in which said rotor further includes resiliently deformable means extending outwardly therefrom into engagement with said aligning means.

3. A variable resistor as defined in claim **2** in which said resiliently deformable means is formed integrally with said rotor and said shroud means defines a continuous shoulder which engages said resiliently deformable means to urge said contact element into contact with said resistance element.

4. A variable resistor as defined in claim **3** in which said rotor further includes thrust bearing means extending axially therefrom into engagement with the surface of said base member.

5. A variable resistor as defined in claim **3** in which said rotor is molded of plastic material and said resiliently deformable means is a radially extending flange of fiberglass filled plastic and with said shoulder forms said seal as a continuous seal.

6. A variable resistor as defined in claim **5** in which said flange in its nonassembled state is angularly disposed with respect to the longitudinal axis of said rotor in a direction such that said flange in its assembled state applies a continuous force against said shoulder.

7. A variable resistor as defined in claim **6** in which said shroud means is a molded plastic member defining a second shoulder engaging said base member.

8. A variable resistor as defined in claim **7** which further includes at least one protrusion extending from said rotor, and formed integrally therewith, into contact with the same surface of said base member upon which said resistance element is disposed.

9. A variable resistor comprising:

(a) a base member of electrically nonconductive material carrying a resistance element and electrically conductive leads connected to said resistance element;

(b) a rotor of electrically nonconductive material carrying an electrically conductive contact element and having adjusting means;

(c) housing means surrounding said base member and rotor and defining a cavity area; and

(d) a resiliently deformable radially extending member formed integrally with one of said rotor and said housing means disposed between said housing means and said rotor, in said cavity area forming a seal against foreign contaminants.

10. A variable resistor as defined in claim **9** wherein said resiliently deformable radially extending member is formed integrally with said rotor and extends outwardly therefrom in a stressed condition.

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U.S. Cl. X.R.

200—168; 338—184, 199