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2,873,339

VARIABLE RESISTOR

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This invention relates to new and improved hermetically sealed electrical instruments such as, for example, potentiometers, variable resistors and the like.

For both military and commercial purposes it is frequently advisable to utilize electrical instruments which are completely immune to the effects of various ambient atmospheric conditions. Thus, for example, for many tropical applications it is an absolute necessity to utilize electrical instruments which are unaffected in their electrical operation by the moisture normally present and which also are completely immune to the effect of various fungi. It has been found in accordance with this invention that such immunity of electrical instruments to attack by fungi and by various atmospheric conditions can best be achieved by utilizing a hermetically sealed instrument in which the various electrical parts are completely isolated from the atmosphere surrounding an electrical instrument.

It is accordingly a broad object of the present invention to provide hermetically sealed potentiometers, variable resistors, etc., in which the various operative electrical parts are completely sealed within the instrument itself. This broad objective of the invention is accomplished by providing a bellows like structure which, when other parts of the instrument are actuated, changes configuration in order to accommodate the adjustment of an electrical value as will be more fully explained hereinafter. Another object of the invention is to provide electrical instruments of the class described which are comparatively inexpensive to manufacture, which are extremely reliable to use and which are sufficiently rugged so as to withstand a great deal of physical abuse. It will be realized that these latter three objectives of the invention are essentially of a basic category. The qualities indicated by these objectives must, in effect, be possessed by virtually any new and improved potentiometers, variable resistor or the like in order for such unit to be completely acceptable on the commercial market today.

Further objects and advantages of the invention will be more fully apparent to those skilled in the art to which this invention pertains from a consideration of the remainder of this disclosure, including the appended claims and the accompanying drawing in which:

Fig. 1 is a perspective view of a new and improved electrical potentiometer 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 view similar to Fig. 2 of a modified potentiometer of this invention; and

Fig. 5 is a cross-sectional view taken at line 5—5 of Fig. 2.

In all figures of the drawing like numerals are used to designate like parts wherever convenient for purposes of illustration and explanation. It is to be understood

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that the accompanying drawing is not to be taken as limiting the invention in any respect. In it two preferred forms of the present invention are shown. While these forms of the invention are presently of a "preferred" status, it is contemplated that future development work will result in a large number of other differently appearing units utilizing the essential features of this invention. Those skilled in the art to which this invention pertains can obviously design a large number of other units utilizing the basic features of this invention.

In order that the present invention may be easily understood, it may be stated in essentially summary form that hermetically sealed electrical instruments of this invention each are formed or manufactured so as to include a housing, a threaded shaft mounted on said housing so as to project into the same; a movable member engaged by the threaded shaft employed, said movable member being positioned within the housing; a bellows member attached to the housing and to the movable member so as to, in effect, divide the housing into two chambers, one of which is completely sealed from the outside atmosphere; and electrical means, such as will be more specifically indicated, mounted within the sealed one of these chambers. Various secondary means, such as, for example, electrical terminals are mounted within the housing in order to complete an operative unit. An important feature of this type of construction lies in the fact that the movable member and a bellows forms what is actually a completely sealed chamber within a complete housing utilized. The electrical value of an instrument of this invention is adjusted with this type of construction by turning the threaded shaft so as to cause movement of the movable member mounted within the housing itself.

The actual nature of this invention is best more fully explained in detail by directly referring to the accompanying drawing. In Figs. 1, 2, and 3 there is shown a new hermetically sealed potentiometer 10 of the present invention which is built about a can-like metal housing 12 having an open end within which there is located a closure 14. This closure may be formed of either a conductive or a non-conductive material and may be secured to the housing 12 by any convenient means, such as for example, an adhesive as shown, various screws or the like. The closure 14 is formed so as to have a centrally located opening 16 formed therein so that a threaded shaft 18 may be supported within this opening so that a head 20 attached to this shaft 18 extends to the outside of the housing 12.

A movable member 24 is located within the housing as it is best seen in Fig. 2 of the drawings. This movable member serves as an actuating means, and is provided with a threaded bore 23 which is designed so as to receive the shaft 18 in such a manner that as the shaft 18 is turned as through the head 20 being engaged by a common screwdriver or the like, this movable member is shifted with respect to the shaft 18 along the axis of the housing 12. In order to prevent rotation as the shaft 18 is rotated the movable member 24 is also provided with a non-round shaft 28 which passes into a correspondingly shaped non-round bore 30 in a bearing 31 extending from one end 32 of the housing 12. This bearing 31 is attached to the housing by welding or like processes.

Within the housing 12 a small bellows-like corrugated metal member 34 of essentially a conical shape is located so as to be welded or otherwise similarly secured to the interior wall of the housing 12 adjacent to the end containing the closure 14 and to the exterior of the movable member 24 so as to in effect divide the housing 12 into two chambers 36 and 38. As will be seen from examina-

tion of Fig. 2 the chamber 36 is not hermetically sealed since various gases from the outside of the potentiometer 10 can enter through the opening 16 into this chamber. The other chamber is, however, completely hermetically sealed. The bellows-like member 34 may conveniently be formed of metals such as brass, or may be manufactured from various flexible resinous materials such as polytetrafluoroethylene; this member in the preferred construction is essentially spring-like in operation, holding the member 24 against the shaft 18 so as to prevent what may be termed "back lash" when the shaft 18 is operated.

Within the chamber 38 there is mounted by any conventional means such as, for example, an adhesive, an appropriate non-conductive support 40 which is utilized in a conventional manner so as to hold a conventional resistance element 42 and a conventional electrical return 44. The resistance element 42 and the return 44 are both connected by means of wires 46 to various conventional sealed terminals 48 in the end 32 of the housing 12. A spring-like contact member 50 is used to engage the resistance element 42 and the electrical return 44 in the established manner. This contact member 50 is attached to the movable member 24 in a known manner as illustrated.

Obviously a number of different modifications may be made in the potentiometer 10 without changing the essential way or manner of operation of this potentiometer. As an example of this the movable member 24 can be formed of a metallic material instead of a non-conductive resinous material as shown. In this case, the contact member 50 must, of course, be insulated from the movable member. Similarly the shaft 18 may be formed of either a metallic or a non-metallic composition.

In Figs. 4 and 5 of the drawing there is shown a modified electrical instrument 52 of the invention which is built about a housing 54 similar to the housing 12 previously described. Within the bottom 56 of this housing there are provided two rows of appropriate electrical terminals 58 of a conventionally sealed design. These terminals are in turn connected by means of wires 60 to resistance elements 62 and to an electrical return 64 located as by appropriate printed circuit techniques upon rigid non-conductive supports 66. It will be noted that the supports 66 are held in position within the housing 12 by bearing against the end of this housing and by being located against appropriate grooves 68 located in the exterior of the housing 54. Slots 70 are formed in the bottoms of the support 66 for the purpose of carrying the wires 60 as illustrated.

The housing 54 is divided into a sealed chamber 72 containing the various electrical elements described in the previous paragraph and into another chamber 74 by means of a bellows-like member 76 of a similar type to the member 34 mounted within the interior of this housing 54 so as to be welded to or otherwise similarly attached to a small ring-like or flange-like ferrule 78 which in turn is similarly attached to the wall of the housing 54. Closure plates 80 are located in the open end 82 of the housing 54 by an adhesive or similar means in such a manner as to support within this housing a threaded shaft 84 so that an enlarged head 86 upon this shaft is located within a recessed cavity 88 against a shoulder 90 in such a manner that this shaft 84 cannot fall from or otherwise be removed from the housing 54.

The shaft 84 projects into a movable member 92 so as to be securely held within a threaded bore 94 formed in this movable member. Preferably the movable member 92 is formed as shown of a non-conductive resinous material such as, for example, any known phenolic composition so that the various conventional metal contacts 96 may be directly secured to it in a known manner. Resilient fingers 98 forming a part of these contacts extend from them in order to engage the resistance elements 62 and the electrical returns 64.

The movable member 92 is, with this construction,

also sealed as by various known techniques familiar to those skilled in the art to which this invention pertains to the bellows 76 in such a manner as to complete the formation of a sealed chamber 72 substantially as indicated. If desired, a small bracket 100 may be attached to the bottom 56 of the housing 54 so as to prevent the shaft 84 from being turned in such a manner as to move the movable member 92 so that this movable member slides off of the shaft 84. Rotation of the movable member 92 is prevented by means of small grooves 102 in the housing 54 engaging corresponding grooves 104 in the periphery of this movable member 92. Other similar means such as, for example, the shaft and bearing structure previously described may also be utilized so as to prevent rotation of the movable member 92.

The instrument 52 is essentially of a dual category. The precise resistance element and electrical return structure shown in the instrument may, of course, be changed so as to utilize other types of resistance elements and electrical returns. The particular structure shown is considered to be advantageous since the resistance elements 62 and the electrical returns 64 are applied to the supports 66 by various known, conventional printed circuit techniques.

The operation of the potentiometer 10 is essentially identical with the instrument 52 and hence will not be explained in more detail. Those skilled in the art to which this invention pertains will realize that the various electrical means within the sealed chambers in both of these embodiments of the invention operate in essentially a known manner through actuation of the shafts illustrated. Because of the use of bellows-like members in both of these constructions and the use of movable members secured to these bellows-like members there is no danger in either of these units of various atmospheric conditions effecting the operation of such electrical means. Hence, the units shown are considered to be extremely well adapted or qualified to be used in extreme conditions such as are found in the tropics or the like. The instruments shown may be operated as variable resistors by not connecting one of the terminals attached to one end of any of the resistance elements shown. Other terminal structures and other electrical means than the potentiometers shown can obviously be employed with the sealed closure construction shown and described.

Obviously a large number of other modifications may be made in the structures shown without departing from the essential nature of this invention. Because of this, this invention is to be considered as being limited by the appended claims only. Wherever the term "means" is employed in these claims, this term is to be taken as defining the corresponding structure set forth in the specification or the equivalent of the same.

We claim:

1. A variable resistor comprising a housing having a cavity formed therein, a resistance element mounted within said cavity, a flexible bellows secured to one end of said housing and sealing said cavity, operating means attached to said bellows and extending into said cavity, said operating means having a contact wiping on said resistance element, a leadscrew rotatably mounted on said housing and having threaded engagement with said operating means, said leadscrew being constrained against endwise movement with respect to said housing, and guide means on said housing slidably supporting said operating means.

2. A variable resistor comprising a tubular shell of rectangular cross section, ends attached to said shell and defining an enclosed cavity, a support block mounted within said cavity against one side wall of said shell, a resistance element mounted on the top surface of said support block, said block having a longitudinally extending channel formed in the bottom side thereof, terminal means passing through one of said ends, electrical leads attached to opposite ends of said resistance element

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and to said terminal means, one of said leads passing through said channel from the remote extremity of said resistance element to said one end, a rotatable leadscrew journaled in the other of said ends and extending into said cavity parallel to said resistance element, said leadscrew being constrained against endwise movement with respect to said shell, operating means engaged by said leadscrew and movable thereby lengthwise of said resistance element when the leadscrew is rotated, contact means on said operating means wiping on said resistance element, and means sealing said resistor between said leadscrew and said shell.

3. A variable resistor comprising a rigid body having an enclosed cavity provided therein, a resistance element mounted on said body within said cavity, a member movable along a path parallel to said resistance element, a contact on said member wiping on said element, a leadscrew extending through one end of said body and into said cavity parallel to said resistance element, said leadscrew being threaded into a blind hole in said member, whereby rotation of said leadscrew causes said member

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to move along the length of said element, and a flexible bellows attached to said movable member and to said body adjacent said one end, said bellows sealing said cavity against the entry of moisture and dirt.

4. A variable resistor as defined in claim 3, wherein said body is provided with guide ridges extending parallel to said leadscrew, and said movable member is provided with corresponding grooves engaging said guide ridges.

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