Nov. 25, 1958 W. J. MAIRS 2,862,089

VARIABLE RESISTOR OR POTENTIOMETER

Filed Feb. 24, 1956 2 Sheets-Sheet 1

Fig. 1.

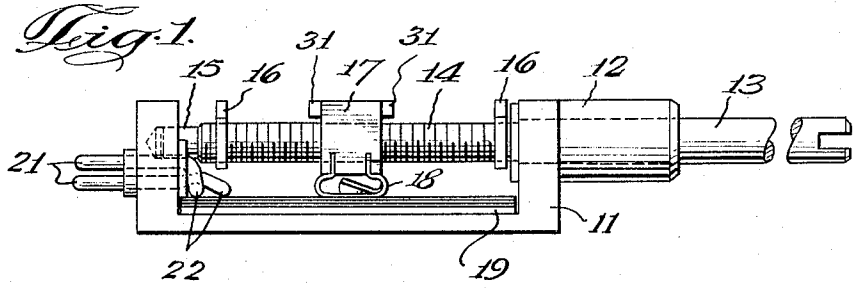


Fig. 2.

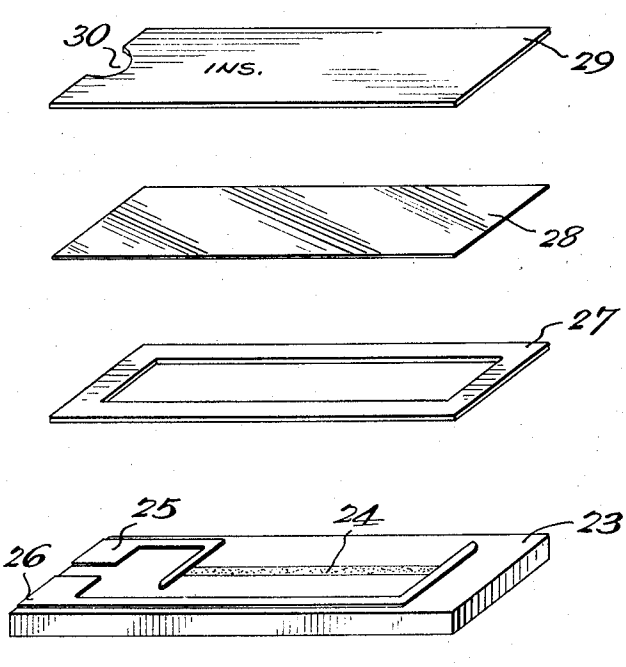


Fig. 3.

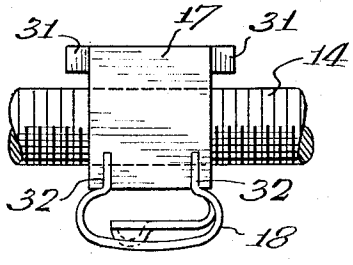
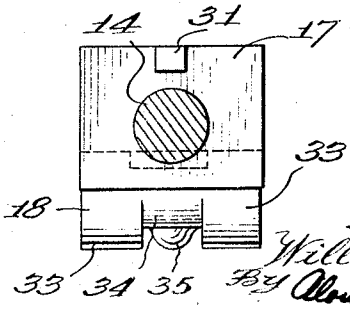


Fig. 4.



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Fig. 5.

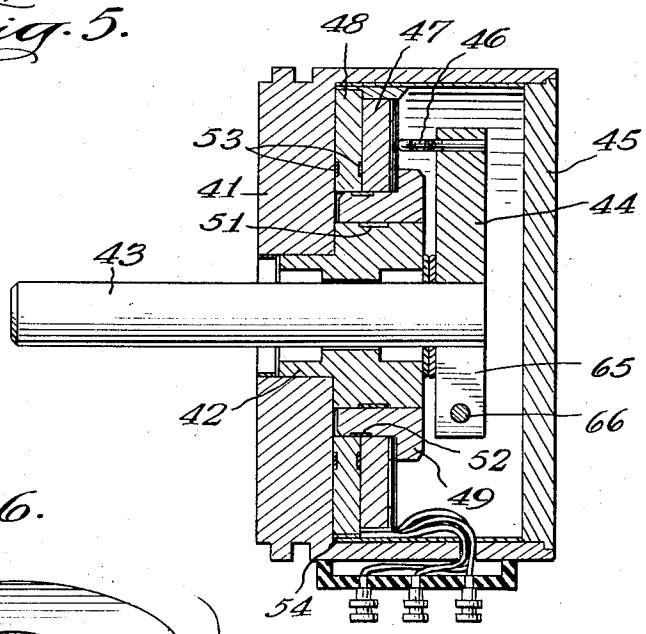


Fig. 6.

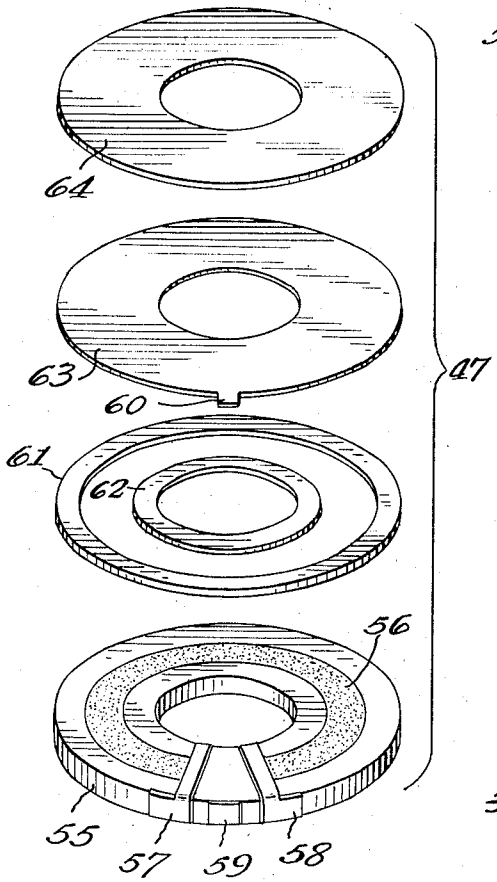


Fig. 7.

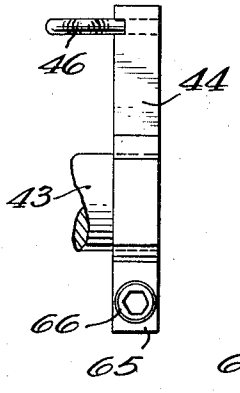
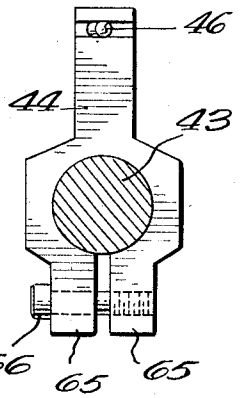


Fig. 8.



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VARIABLE RESISTOR OR POTENTIOMETER

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Application February 24, 1956, Serial No. 567,613

25 Claims. (Cl. 201—62)

The present invention relates to an improved variable resistor or potentiometer, and more particularly to a device of this type which resists the effects of humidity, fumes and other foreign matter.

In variable resistors or potentiometers, it is customary to have a movable contact which is carried by an arm or a movable contact carrying member so that the contact engages different portions of a resistance element. In such arrangement variations in contact resistance are encountered. As the device continues to be used, wear of the contact and the resistance element may introduce further significant changes in the output. Another difficulty encountered in such constructions is that of enclosing such mechanism so as to minimize the effects of humidity, fumes, dust and other foreign matter.

While heretofore the resistance elements in most variable resistors or potentiometers have been wire wound elements, steps now have been taken to employ deposited film resistance elements in order to obtain infinite resolution. One difficulty, however, has been encountered with deposited film resistance elements, and that is that they are much more susceptible to the effects of wear. Therefore, it would be desirable to provide some improved structure which would increase the life of deposited film resistor elements.

In accordance with the present invention an improved structure has been devised which will minimize the deleterious effects of wear heretofore encountered in deposited film resistor elements. Instead of passing, by a sliding action, a contact member over the deposited film resistor, a pressure contact of a piece of metal foil is employed. Further, in accordance with the present invention the improved structure provides an arrangement for a sealed element so that the variable resistor or potentiometer is not affected by humidity, fumes, dust or other foreign matter.

It, therefore, is an object of the present invention to provide an improved variable resistor or potentiometer.

Another object of the invention is to provide an improved variable resistor or potentiometer which resists the effects of humidity, dust or other foreign matter.

Another object of the invention is to provide an improved variable resistor or potentiometer employing a deposited film resistor element which will have a long life.

A still further object of the invention is to provide an improved variable resistor or potentiometer wherein wear on the resistor element is kept at a minimum.

A still further object of the invention is to provide an improved variable resistor or potentiometer wherein the contact resistance with the resistance element remains substantially constant.

A further object of the invention is to provide an improved variable resistor or potentiometer wherein an electrical connection is made to the adjustable contact without the use of slip rings, sliding takeoff brushes, or pigtails.

Other and further objects of the present invention subsequently will become apparent by reference to the following specification taken in conjunction with the accompanying drawings, wherein:

Figure 1 is a side view of a translatory variable resistor or potentiometer;

Figure 2 is an exploded view of the resistor unit;

Figures 3 and 4 are detailed views of the pressure contact of the device shown in Figure 1;

Figure 5 is a longitudinal cross-sectional view through a rotary potentiometer;

Figure 6 is an exploded view of the resistor element or unit employed in the device of Figure 5; and

Figures 7 and 8 are detailed views of the pressure contact arm used in the device of Figure 5.

Referring to Figure 1, there is shown a translatory variable resistor or potentiometer having a base or frame **11**, which at one end carries a bearing member **12** supporting a rotatable shaft **13** which has a threaded portion **14** and a reduced diameter and bearing portion **15**. At suitable places on the threaded portion **14** there are provided stop members **16** to engage a contact carrying member **17** to limit the longitudinal or linear movement thereof. The contact carrying member **17** has a contact pressure member **18** which is shown in greater detail in Figures 3 and 4. The contact member **18** bears on the uppermost surface of a resistor unit **19** which is shown in exploded view in Figure 2. A plurality of contact lugs **21** are connected by suitable conductors **22** to the resistance unit **19**.

In the exploded view of Figure 2, there is shown an insulating base member **23**, which conveniently may be made of glass or ceramic material. Deposited on the insulating support member **23** is a deposited film **24** which extends between two highly conductive terminal members **25** and **26**. The resistance element, in the form of a deposited film strip **24**, may be of various compositions dependent upon the value of resistance desired and other possible characteristics. The contact strips **25** and **26** most conveniently are of a silver composition. Fired silver paint has been found adequate to serve as a contact strip, although sometimes a silver foil is placed in position and by suitable means secured to the ends of the deposited film strip **24**. A gasket **27** is next placed upon the support **23**. This gasket may be kraft paper or other material from .0015 to .035 inch thick. The purpose of gasket **27** is primarily to provide a spacing between the film strip **24** and the next element **28** which may comprise a thin sheet of highly conductive material, such as coin silver. Other materials also have been found suitable comprising various precious metal alloys. Beryllium copper plated with rhodium also has been employed. The element **26** preferably should be selected of such material as to have high electrical conductivity and appreciable resiliency so that the metal member **28** will resume substantially its original position after pressure thereon has been removed. On top of the metal foil element **28** there is placed an insulating member **29** having a cut out portion **30** so that convenient contact may be made with one of the conductors **22** of Figure 1 to the metal member **28**. Several materials have been employed for the insulating member **29**, and among the ones giving the greatest satisfaction are polyester film and a tetrafluoroethylene resin or fluorocarbon plastic coated glass fabric. The coated fiber glass is advantageous because of its superior strength, non-fatiguing resilient spring-like qualities, and the inherent lubrication occurring between the individual glass fibers embedded in fluorocarbon plastic, tetrafluoroethylene resin or similar material. Preferably fiber glass woven so that it has the same fiber count in each direction is selected, and the longitudinal member **29** is cut on the bias to give the greatest wear life. The silver member **28** is preferably of coin silver foil and is attached to the

fiber glass member 29 by means of an adhesive. Suitable adhesive is applied on both sides of the gasket 27 so as to provide a hermetic seal. Thus with the hermetic seal including the entire resistance unit, it cannot be affected by humidity, fumes or other foreign matter.

What normally would correspond to the contact carrying member in a translatory potentiometer, in the present construction comprises the contact carrying member 17 and a pressure foot 18. This foot 18 is shown in detail in Figures 4 and 5. The carrying member 17 is provided with projections 31 at each end which are to be engaged by the stop members 16 at the ends of the travel of the member 17 along the threaded portion 14 of the actuating shaft 13. The pressure foot or contact making member 18 is a single unitary sheet of resilient metal, the ends of which are carried in two slots 32 on the bottom side of the member 17. The member 18 has two guiding portions 33 and a central resilient portion 34 which carries a dimpled member 35. The dimpled member 35 presses upon the fiber glass member 29 to move the adjacent metal foil 28 into contact with the resistance element metal film strip 24.

Since there is no metal contact sliding the entire length of the resistance film strip 24, wear is clearly minimized. In the structure shown there actually is a very small vertical sliding action of the coin silver foil 28 on the resistance strip 24 which assures a substantially constant electrical contact with the resistance strip 24 at all times.

The principles of the present invention are also adaptable to variable resistors and potentiometers of the rotary type, such as that illustrated in Figure 5. In this figure there is shown a cylindrical housing 41 provided with a suitable bearing structure 42 for carrying an actuating shaft 43. The actuating shaft at its rear end is provided with a pressure arm 44 shown in detail in Figures 7 and 8. The case 41 at its rear is provided with a suitable cover 45. The rounded tip of spring 46 mounted on arm 44 bears against the upper surface of a resistance unit 47 which is positioned on a support ring or washer 48 held in concentric location by a retaining ring 49. It will be noted that the bearing member 42 has an annular recess 51 in which a suitable adhesive or cement is placed to hold the retaining ring 49 in position. The retaining ring 49 in turn has an annular recess 52 for receiving adhesive. The annular washer or support 48 has two annular recesses 53 for receiving suitable adhesive. Around the periphery of the member 48 and the resistance unit 47 other adhesive 54 is applied.

The resistance unit 47 is shown in exploded form in Figure 6, and comprises a base member 55 of suitable insulating material such as glass, upon which there has been deposited an annular strip of metal film 56 to serve as the resistance element. Suitable end terminations or contact portions 57 and 58 are provided for making electrical contact to the metal film resistance strip 56. Another contact element 59 is provided on the peripheral portion of th base 55 for cooperation with a projecting tab 60 on the metal foil contact member.

Two annular washers 61 and 62 are placed upon the base 55 to support in spaced relation a metal foil contact element 63 having the projecting tab 60 which engages the contact portion 59 on the base 55. Immediately above the metal foil member 63 is the insulating annular member 64 which again preferably is of Teflon impregnated fiber glass cloth. Suitable adhesive such as epoxide adhesive is applied to both sides of the annular gaskets or washers 61 and 62 so that the entire assembly when completed is hermetically sealed. It, of course, will be appreciated that while separate metal contact elements have been shown in the exploded views of Figure 6 and Figure 2 that these could consist of plated surfaces on one side of the fiber glass fabric element, such as the one 64 in Figure 6 and the member 29 in Figure 2.

Figures 7 and 8 are side and end views, respectively, of the brush arm or pressure element which deflects the metal foil member 63 so as to make contact at a selected point on the resistance strip 56. The arm 44 at its lower end has a bifurcated portion 65 which is adapted to be drawn together by a cap screw 66 so as to clamp the arm 44 upon the end of the shaft 43. It, of course, will be appreciated that the adhesive employed in the assembly of the resistance unit in either construction is preferably baked so as to be thoroughly cured. Likewise the adhesive employed in holding the various elements together in their proper relation as shown in Figure 5 may be thermosetting adhesives which are baked so as to harden them.

While for the purpose of illustrating and describing the present invention several preferred embodiments have been shown, it is to be understood that the invention is not to be limited to the specific constructions employed since such variations are contemplated as may be commensurate with the spirit and scope of the invention set forth in the accompanying claims.

I claim as my invention:

1. A variable resistor comprising a first flat sheet of insulating material having on one surface thereof a resistance element, a second sheet of flexible resilient insulating material positioned parallel to and spaced from said resistance element, said second sheet fully overlying said resistance element, a resilient metal contact surface adjacent to the inner surface of said second sheet of insulating material and arranged parallel to and spaced from said resistance element, and means hermetically sealing together the edges of said first and second insulating material sheets.

2. A variable resistor comprising a first flat sheet of insulating material having on one surface thereof a resistance element, a second sheet of flexible resilient insulating material fully overlying and spaced from said resistance element, a resilient metal contact surface adjacent to the inner surface of said second sheet of insulating material and spaced from the resistance element, means hermetically sealing the edges of said first and second insulating material sheets together, and means for pressing a small area of said second sheet of insulating material toward said first sheet of material to cause said metal contact surface to engage said resistance element.

3. A variable resistor comprising a sheet of rigid insulating material having on one surface thereof a film resistance element, a plastic imprgenated woven fiber glass sheet positioned parallel to and spaced from said resistance element by gasket means, a resilient metal contact surface adjacent to the inner surface of said fiber glass sheet arranged parallel to said resistance element, means sealing the edges of said gasket means, said rigid insulating material and said fiber glass sheet, and means movable along said resistance element to press a small area of said fiber glass sheet toward said resistance element to cause said metal contact surface to engage a portion of said resistance element.

4. A variable resistor comprising a sheet of rigid insulating material having on one surface thereof a deposited film resistance element, a plastic impregnated woven fiber glass sheet positioned parallel to and spaced from said resistance element by gasket means, a resilient metal foil contact surface attached to the inner surface of said fiber glass sheet, means sealing the edges of said gasket means, said rigid insulating material and said fiber glass sheet, and means movable along said resistance element on the exterior of said fiber glass sheet to press a small area of said sheet toward said resistance element to cause said metal contact surface to engage a selected point on said resistance element.

5. A hermetically sealed electric element comprising a flat rigid base of insulating material supporting on the top a resistor, a flexible resilient impervious member of insulating material positioned parallel to the top of said base, a resilient low resistance thin flat conductive member adjacent to the inner surface of said resilient insulat-

ing member, means sealing the edges of said resilient member to said base, and electrical connections to said resistor and said resilient conductive member.

6. The element of claim 5 with movable means for pressing said flexible insulating member and the adjacent low resistance conductive member toward said resistor to complete a desired electrical circuit between said resistor and said conductive member.

7. A hermetically sealed electric element comprising a flat rigid base of insulating material, a film resistance element on one surface of said base, a flexible impervious insulating member overlying said one surface of said base, a resilient thin conductive member on the under side of said insulating member, means supporting said insulating member and said conductive member in parallel spaced relation with said resistance element, means hermetically sealing the edges of said insulating member to said base, and electrical connections to said resistance element and said resilient conductive member.

8. The electric element of claim 7, further including movable means for pressing said insulating member toward said base to place a small area of said conductive member in engagement with a selected portion of said resistance element.

9. A hermetically sealed electric element as defined by claim 8, wherein said movable means is movable back and forth along a straight line path parallel to the plane of said base.

10. A hermetically sealed electric element as defined by claim 8, wherein said resistance element comprises a circular strip of metal film deposited on said base and further wherein said movable means is movable back and forth in a circular arc.

11. A hermetically sealed element as defined by claim 7, wherein said conductive member is made of coin silver.

12. A hermetically sealed element as defined by claim 7, wherein said conductive member is made of a precious metal alloy.

13. A hermetically sealed element as defined by claim 7, wherein said conductive member is made of beryllium cooper plated with rhodium.

14. A hermetically sealed element as defined by claim 7, wherein said insulating member is a polyester film.

15. A hermetically sealed element as defined by claim 7, wherein said insulating member is made of a plastic coated glass fabric.

16. A hermetically sealed element as defined by claim 15, wherein said glass fabric is coated with a fluorocarbon plastic.

17. A hermetically sealed element as defined by claim 16, wherein said fibre glass fabric is coated with tetrafluoroethylene plastic.

18. A hermetically sealed element as defined by claim 7, wherein said insulating member is made of woven glass fabric.

19. A hermetically sealed element as defined by claim 18, wherein said glass fabric is cut on a bias.

20. A hermetically sealed element as defined by claim 19, wherein said glass fabric has the same fibre count in each direction.

21. A hermetically sealed element as defined by claim 7, wherein said means sealing said insulating member to said base is an epoxide adhesive.

22. A variable resistor comprising a flat rigid insulating base, an annular resistance element on the top surface of said base, said resistance element extending in a circular arc through an angle less than 360 degrees, contact elements connected to the ends of said resistance element, first and second gaskets engaging the top surface of said base, said first gasket surrounding said resistance element and said second gasket surrounded by said resistance element, a resilient conductive member overlying said gaskets out of contact with said resistance element, a flexible impervious insulating member attached to said conductive member in overlying and fully covering relation therewith, a contact member connected to said conductive element, means hermetically sealing together the edges of said insulating member said conductive member and said base, pressure means acting on the top surface of said insulating member to press a limited area of said conductive member into contact with said resistance element, and means for moving said pressure means back and forth along a circular arc to place said conductive element in contact with different portions of said resistance element.

23. A rotary potentiometer comprising a hermetically sealed resistance unit, said unit comprising a rigid insulating base provided with a central opening, an annular resistance element on the top surface of said base in concentric spaced relation with said central opening, first and second gaskets on the top surface of said base with said first gasket surrounding said resistance element and said resistance element surrounding said second gasket, said second gasket being disposed in concentric spaced relation with said central opening, a flexible impervious insulating member fully overlying said gaskets and said resistance element, a resilient thin conductive member on the under side of said insulating member, said insulating and conductive members each having a central opening in axial alinement with the central opening of said base, first and second contact elements connected to said resistance element, a third contact element connected to said conductive member, and means hermetically sealing said gaskets to said base and to the marginal edges of said flexible insulating member, whereby said resistance element and said conductive member are sealed off from the atmosphere, a closed housing having an end wall provided with a central opening, means fixedly supporting said resistance unit within said housing with the opening in said base disposed in concentric relation with said end wall opening, three terminals on the outside of said housing, means connecting said terminals to said contact elements, a shaft having one end extending into said housing through said end wall opening, means rotatably supporting said shaft, an arm carried by said one end of said shaft, and a pressure member carried by said arm acting against a small area of said insulating member to press a limited portion of said conductive member into conductive engagement with said resistance element.

24. A variable resistor comprising a first rigid sheet of insulating material, a film resistance element on one surface of said first sheet, a non-conductive gasket having one face abutting said one surface, a second sheet of flexible resilient insulating material disposed in parallel fully overlying relation with said resistance element and spaced from said resistance element by said gasket, a resilient metal contact surface secured on the side of said second sheet facing said resistance element, said contact surface disposed in parallel spaced relation to said resistance element, means hermetically sealing together said gasket and the edges of said first and second sheets, whereby said resistance element and said contact surface are sealed off from the atmosphere, movable pressure means operative upon said second sheet for forcing successive portions of said metal contact surface into contact with said resistance element, first and second terminal contacts conductively secured to said resistance element at different points, and a third terminal contact conductively secured to said metal contact surface.

25. A variable resistor as defined by claim 24, wherein said gasket has a thickness within the range of .0015 to .035 inch.

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