Sept. 3, 1963 L. A. SIELSCH 3,102,989

VARIABLE RESISTORS

Filed Oct. 25, 1960

Fig. 1.

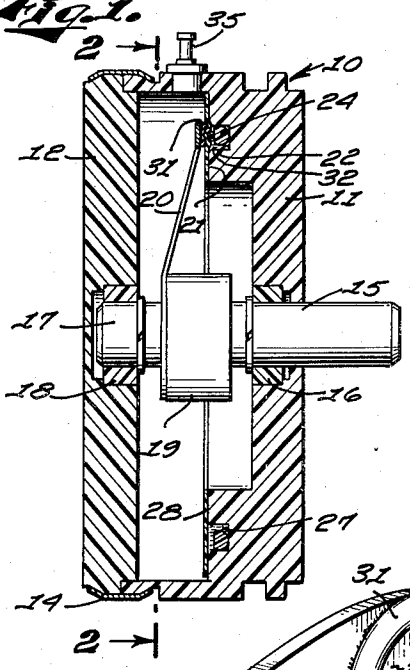
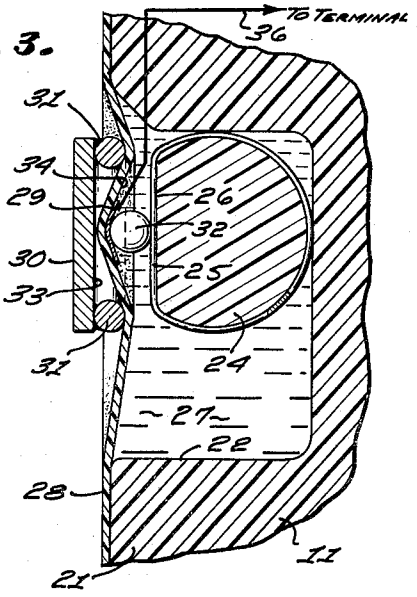


Fig. 3.



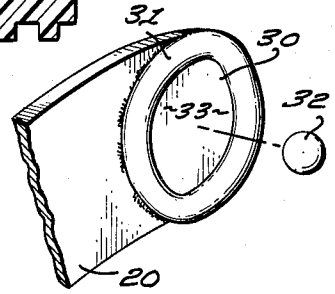


Fig. 4.

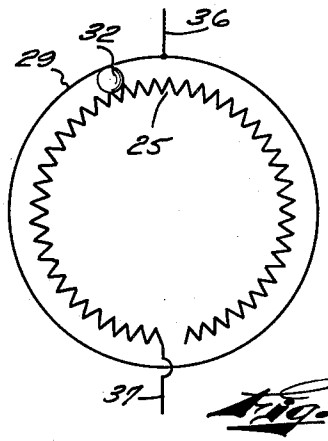
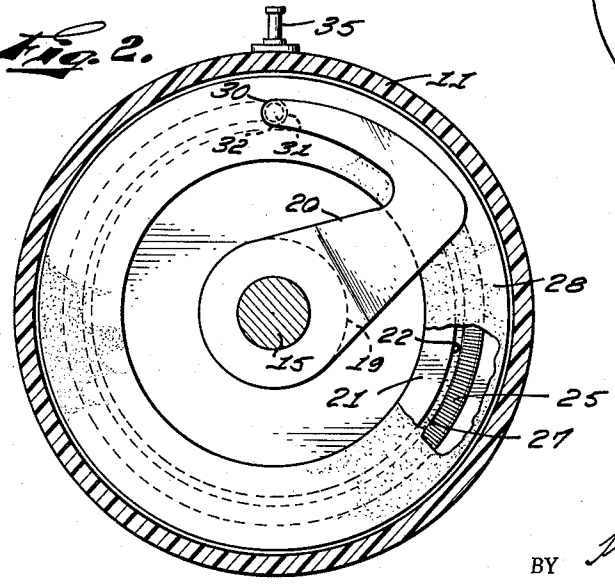


Fig. 5.

Fig. 2.



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VARIABLE RESISTORS

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My invention relates to electric measuring instruments, and more particularly relates to a variable electric resistor. As a principal use of such an instrument is as a potentiometer, such an embodiment of my invention will be herein described, although there are other uses to which it may be put. Also, although herein shown and described as a rotary potentiometer, it will be at once apparent to those skilled in the art that it may be constructed and used as a translatory instrument.

An object of my invention is to provide an electric resistor having its operating parts sealed in an oil bath of minimum size. While there have been numerous resistors heretofore which have operated in oil, they have been cumbersome, heavy, unnecessarily large, and difficult to seal, being usually entirely contained in an oil bath, the bulk of which served no useful purpose.

Another object of my invention is to provide an electric resistor in which temperatures generated in the resistance element are at once conducted away and dissipated by means of the bath and the intimate association of the bath with both the resistance element and the travelling element.

Other objects of my invention include provision of an electric resistor which has a low noise level, a high power rating, low torque, and a minimum of variation of electrical characteristics over its entire life.

In the accompanying drawing illustrative of a presently preferred type of potentiometer, but not intended to exclude instruments of the translatory type, FIG. 1 is a diametrical sectional view showing the assemblage of elements in a rotary annular instrument;

FIG. 2 is a sectional view on the line 2—2 of FIG. 1, a diaphragm part being shown broken away to disclose the underlying resistor element;

FIG. 3 is a greatly enlarged sectional fragment of FIG. 1, showing the upper course of the annular resistance element situated in an oil-filled groove, together with sealing diaphragm and slider elements;

FIG. 4 is a perspective view of the end of the slider arm and the ball contained thereby; and

FIG. 5 is a schematic diagram of the circuitry.

Having reference now to the details of the drawing, I have shown in FIG. 1 a housing **10** having a cup-shaped member **11** and a cap **12**, held together and sealed by a clamp ring **14**. A rotatable shaft **15** extends through a bearing **16** in the cup member **11** and is supported at its inner end **17** by a bearing **18** in the cap **12**. A drum **19** on the shaft **15** supports a slider arm **20** which is of leaf spring material.

In a recessed shoulder **21** in the cup member **11**, and facing toward the cap **12** is annular groove **22** (see FIG. 3). Within the groove **22** is an annular mandrel **24** upon which the resistance element **25** is supported. The mandrel **24** has one flat face **26**, and resistance element **25**, which may be a wire coil, is flattened correspondingly as it crosses the face **26**, to provide a suitable track for a slider or brush element. The groove **22** is filled with a fluid lubricant **27**. The lubricant **27** is held sealed in the groove **22** by an annular flexible diaphragm **28**, preferably of insulating material, which may be heat-pressed upon the shoulder **21** to secure it thereto. The diaphragm **28** is spaced from the resistance element **25** which lies entirely within the groove **22** and below the shoulder **21**. Secured to the under side of the diaphragm—that is, the side adjacent the resistance element **25** and the groove **22**—

is an annular flexible electroconductive tape **29**, in spaced overlying relationship to the mandrel **24** and the resistance element **25** wound thereon. Obviously the tape **29** may be combined with the diaphragm **28** by suitable changes in conductivity and insulating properties, rather than being secured to the diaphragm as a separate element.

The spring leaf slider arm **20** has at its end **30** a flange **31**, preferably toroidal, secured as by welding to the face of the arm **20** adjacent to the diaphragm **28**. A ball **32** is disposed in contact with the resistance element **25** and under the diaphragm **28** and tape **29** and within the cavity **33** defined by the flange **31**. When the arm **20** is moved, the flange **31** moves easily over the fluid-supported diaphragm **28**, depressing the diaphragm into the groove **22**. The ball **32** is pushed outward by the mandrel **24** and resistance element **25** into the cavity **33** within the flange **31**, the diaphragm **28** and tape **29** yielding to form a pocket **34** in which the ball **32** is confined. Thus, as the arm **20** sweeps the circle of the potentiometer, the ball **32** is moved by the flange **31** and the pocket **34**, from which the ball cannot escape, in contact with both the resistance element **25** and the conductive tape **29**.

Suitable terminals **35** are provided for completing the requisite circuits in the ordinary manner of such instruments. The tape **29** is connected to one such terminal as shown in FIG. 5, the circuit wire **36** being spot welded to the tape. The resistance element **25** is also connected to terminal **35** by a wire **37**.

It will be seen that the ball **32** has the function of the usual slider, but instead of being a rigid part of a slider arm or even being nested in a metallic socket on the slider arm, the ball **32** is nested in a movable pocket in the flexible diaphragm **28**. This construction results in a silent and very easy slider movement. It will also be seen that all the electrical conductive elements—except of course the terminal connections—are concentrated in the oil-filled groove **22**. The usual slip ring on the movable arm is replaced by the tape slip ring **29** which, like the ball **32** and resistance element **25**, is within the groove. All these elements are cooled by the lubricant **27** which is heat-conductive but not electro-conductive.

The disclosed embodiment is not to be construed as a limitation upon my invention, the scope of which is deemed to include any desirable constructive modification within the spirit and breadth of the appended claims.

I claim:

1. A variable resistor comprising housing means, a resistance element carried by said housing means, a flexible diaphragm attached to said housing means overlaying said resistance element and spaced therefrom so as to enclose said resistance element, an electro-conductive ball mounted for rolling between said resistance element and said diaphragm, an arm mounted on said housing means for movement of its free end over said diaphragm on the side of said diaphragm opposite to said ball and parallel to said resistance element, a flange on the free end of said arm defining a cavity within said flange, said flange pressing said diaphragm upon said ball to form a pocket confining said ball whereby upon movement of said arm said ball and arm are constrained to move as a unit having relative motion with respect to said resistance element and said diaphragm, an electric circuit connected to said resistance element, and a second electric circuit with which said ball is in circuit.

2. A variable resistor as set forth in claim 1, in which said housing means defines a groove containing said resistance element and said ball, said flexible diaphragm being sealed to said housing means over said groove, and said groove containing a fluid lubricant.

3. A variable resistor as set forth in claim 1, in which

said arm includes resilient means for maintaining said member pressed against said diaphragm.

4. A variable resistor comprising housing means having a groove, a resistance element within said groove, an electro-conductive ball arranged to roll upon said resistance element, a flexible insulating diaphragm overlaying said groove and sealing said groove, a flexible electro-conductive tape affixed to said diaphragm on the groove side of said diaphragm, overlaying but spaced from said resistance element, said tape bending coincidentally with bending of said diaphragm, electrical connections to said resistance element and to said tape, an arm mounted on said housing means for movement of its free end parallel to said resistance element, and a member mounted on the free end of said arm pressing on said diaphragm to flex said diaphragm and engaging said ball through said diaphragm so as to cause said ball to follow movements of said arm, said ball then rolling between said resistance element and said tape as a conductor therebetween.

5. A variable resistor comprising housing means, a resistance element carried by said housing means, an electro-conductive ball arranged to roll upon said resistance element, a flexible insulating diaphragm over-laying said housing means and said ball, a flexible electro-conductive tape affixed to the side of said diaphragm adjacent said ball, said tape and said diaphragm being bendable in unison, electrical connections to said resistance element and to said tape, an arm mounted on said housing means for movement of its free end over said diaphragm, and a substantially annular flange carried by the free end of said arm and defining a central cavity into which said ball fits, said flange pressing said diaphragm and said tape to form a pocket containing said ball, said ball moving relatively to said resistance element in response to movement of said flange.

6. A variable resistor comprising housing means, a resistance element carried by said housing means, a flexible diaphragm overlaying said resistance element and spaced therefrom, an electro-conductive ball mounted for rolling between said resistance element and said diaphragm, an arm mounted on said housing means for movement of its free end over said diaphragm on the side of said diaphragm opposite to said ball and parallel to said resistance element, a flange on the free end of said arm defining a cavity within said flange, said flange pressing said diaphragm upon said ball to form a pocket confining said ball, an electric circuit connected to said resistance element, and a second electrical circuit including a flexible electro-conductive tape carried by said diaphragm between said diaphragm and said ball, said ball engaging said tape.

7. A variable resistor which includes: a housing; a resistance element carried by said housing; a flexible diaphragm having edges, the edges of said flexible diaphragm being secured to said housing so as to define an enclosed area surrounding said resistance element; an electrical return mounted within said enclosed area adjacent to and spaced from said resistance element; contact means capable of simultaneously engaging said electrical return means and said resistance element and capable of being moved with respect to said electrical return means and said resistance element mounted within said enclosed area adjacent to said diaphragm; means for moving said contact means along said resistance element and said electrical return engaging said diaphragm and disposed on the side of said diaphragm remote from said enclosed area so as to deform said diaphragm into engagement with said contact means and moving along with said contact means.

8. A variable resistor which includes: a housing; a resistance element carried by said housing; a flexible diaphragm having edges, the edges of said flexible diaphragm being secured to said housing so as to define an enclosed area surrounding said resistance element; an electrical return mounted within said enclosed area adjacent to and spaced from said resistance element; contact means capable of simultaneously engaging said electrical return means and said resistance element and capable of being moved with respect to said electrical return means and said resistance element mounted within said enclosed area adjacent to said diaphragm; means for moving said contact means along said resistance element and said electrical return engaging said diaphragm and disposed on the side of said diaphragm remote from said enclosed area so as to deform said diaphragm into engagement with said contact means and moving along with said contact means; and an electrical non-conductive fluid filling said area between said housing and said diaphragm.

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