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ADJUSTABLE ELECTRICAL INSTRUMENTS

Original Filed May 20, 1957

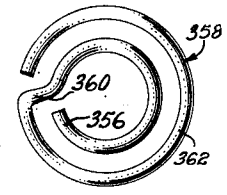


FIG. 2

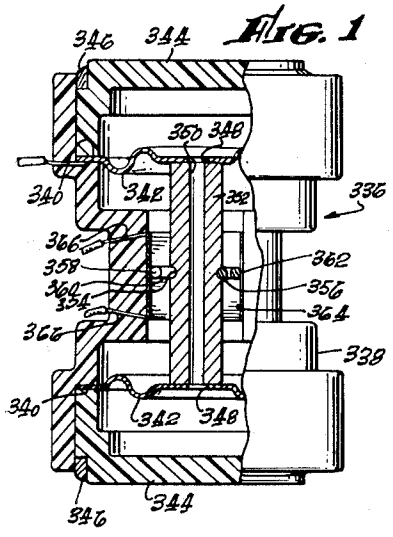


FIG. 1

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3,020,505
ADJUSTABLE ELECTRICAL INSTRUMENTS

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Original application May 20, 1957, Ser. No. 660,247, now Patent No. 2,932,808, dated Apr. 12, 1960. Divided and this application Apr. 8, 1960, Ser. No. 23,123

9 Claims. (Cl. 338—43)

This invention relates to new and improved adjustable electrical instruments and more particularly to electrical instruments each of which utilizes a wound resistance element and contact means engaging this element. This application is a division of our pending application, Serial No. 660,247, filed May 20, 1957, now U.S. Patent No. 2,932,808, granted April 12, 1960.

A number of different types of electrical instruments are known which are capable of being actuated manually or in response to variables such as acceleration, pressure, etc., in order to vary an electrical value. At the present time a large number of such instruments utilize a resistance element and contact means resiliently engaging the resistance element so as to permit adjustment of the relative positions of these two parts. In most cases instruments using both a resistance element and contact means are formed in order to obtain a potential dividing action; hence, they may be termed "potentiometers" even if they are manufactured so as to be capable of other than manual adjustment. Frequently, however, such instruments are used in order to vary a resistance value; instruments of this category may be termed "variable resistors."

Although a large number of attempts have been made to develop and manufacture satisfactory composition and other resistance elements for use in potentiometers and variable resistors, experience has proved the value of instruments of this category in which a wound resistance element is created by winding an appropriate Nichrome wire or the equivalent upon a non-conductive carrier or mandrel. With this type of construction the wire in effect extends along a helical path and resembles a common coil spring in configuration. With conventional wire wound variable resistors and potentiometers the contact means employed are mounted so that during adjustment the resistance element and/or the contact means employed are moved so that the contact means in effect "jumps" from one turn of the resistance wire to the next turn.

With this type of construction when the change in resistance between the contact member and one end of the resistance element is plotted on a graph against the adjustment of the instrument itself a curve is obtained which tends to have a stair-step appearance. For many applications it is desired that this curve be of a smooth, continuous category in order to provide uniform readings. The term "resolution" is used in the industry so as to indicate the degree to which a curve of this type tends toward smoothness. Thus, the operation of a potentiometer or a variable resistor having a high degree of resolution may be graphically illustrated in this manner, and the curve obtained while of a "jumping" or zig-zag category nevertheless tends to be of a smoother nature than an equivalent curve for a potentiometer or variable resistor having comparatively low resolution.

In order to provide electrical instruments such as potentiometers and variable resistors having a high degree of resolution a number of different expedients have been proposed. Usually the resolution of potentiometers is increased by forming elongated resistance elements out of comparatively fine wire. This type of solution to the problem is disadvantageous inasmuch as fine wire tends to be relatively expensive and somewhat difficult to handle satisfactorily in many manufacturing operations. Also

the lengths of such elements often are disadvantageous. Also, relatively fine resistance wire may be of a non-uniform character. Attempts have also been made to improve the resolution of potentiometers and variable resistors by providing various types of resilient contact constructions. Although these and related expedients have proved relatively effective for the purpose intended, they have not resulted in instruments having extremely great or, in effect, infinite resolution.

A broad object of the present invention is to provide potentiometers and variable resistors having extremely great or substantially infinite resolution. A related object of the present invention is to provide instruments of this category which may be manually actuated, or which may be actuated in accordance with the variables such as acceleration, pressure or the like. Another object of the present invention is to provide new and improved potentiometers and variable resistors which may be easily and inexpensively manufactured and which are extremely reliable in use.

Because of the nature of this invention and because of the fact that a great many different constructions fall within the general scope of the invention itself, and because of the fact that many of these constructions are in and of themselves considered to be of an inventive nature, it is not considered necessary to set forth in the initial part of this specification a detailed list of various objects and advantages of each of the various constructions falling within the scope of this invention. Further, various other objects and advantages of the invention will be fully apparent to those skilled in the art to which this invention pertains from an examination of the appended claims and the accompanying drawings in which:

FIG. 1 is a partial cross-sectional view of an acceleration responsive potentiometer or accelerometer of the present invention; and

FIG. 2 is a detailed view of a contact member employed in the instrument shown in FIG. 1.

The accompanying drawings are not to be considered as limiting the present invention in any respect. Obviously a wide variety of differently appearing instruments may be manufactured which utilize the essential features and principles of operation set forth in this specification and illustrated in the drawings. Whenever convenient for purposes of illustration and explanation like numerals have been used to designate like parts in various figures of the drawing.

As an aid to understanding the basic features of this present invention it may be stated in essentially summary form that it involves adjustable electrical instruments such as potentiometers or variable resistors, each of which includes: an elongated, wound resistance element having an axis extending along its length; contact means resiliently engaging substantially all points of this resistance element in a plane perpendicular to the axis of the element; means for varying the relative positions of the resistance element and the contact means so that the contact means at all times engages substantially all points of this resistance in a plane perpendicular to the axis of the resistance element itself. Within the broad scope of this invention instruments are involved in which the resistance element itself may be located on either the outside of an appropriate mandrel or be located within an internal cavity and in which the resistance element itself or the contact means employed or both are capable of being moved so as to vary their relative positions.

The nature of the contact means employed with the present invention is considered to be important. Such contact means may comprise or include a resilient wire ring or a plurality of resilient fingers. Such fingers may advantageously be manufactured so as to have different

resonant frequencies by either varying their lengths or their weights. When the various resilient fingers employed in a contact member or a contact means of the present invention differ from one another in this manner, the contact means employed do not vibrate at the same frequency and, hence, various errors caused by vibration are substantially eliminated.

The use of contact means of the type broadly indicated in the preceding in conjunction with wound resistance elements has a number of practical ramifications. Frequently prior potentiometers and variable resistors have been manufactured with comparatively long resistance elements so as to obtain satisfactory resolution. Because of the high degree of resolution possible with electrical instruments constructed in accordance with the teachings of this invention, instruments having very satisfactory resolution for virtually any purpose can be manufactured having relatively short resistance elements. These elements can be satisfactorily formed of comparatively high resistance wire so as to lessen the size required for an instrument of this invention below that of comparable conventional instruments. The fact that such resistance elements can be manufactured so as to be relatively short has the effect that instruments falling within the scope of this invention may be directly connected to bellows, Bourdon tubes, etc., used in adjusting or varying the relative positions of the contact means and the resistance elements in units of this invention. Such elimination of conventional mechanical linkages such as conventional multiplying linkages has the result that the instruments of the present invention tend to be relatively simple to construct. Such elimination of parts is also very advantageous in overcoming friction and vibration errors such as are often encountered with accelerometers or various types of pressure responsive instruments.

The basic principle of this invention can also be applied to advantage with accelerometers, as is evident from the disclosure container in the aforementioned Patent No. 2,932,808, the disclosure of which is incorporated herein by reference. In FIG. 1 of the drawing there is shown an accelerometer **336** having a housing **338** formed of a non-conductive material so as to have internal shoulders **340** located therein. Within this instrument corrugated, spring-like metal diaphragms **342** are held against these shoulders by means of non-conductive end caps **344** which may be held in place by means of an adhesive ring **346**. Each of these diaphragms **342** is provided with a centrally located aperture **348** and these apertures **348** are connected together by means of a passage **350** located so as to extend through the center of an elongated cylindrical weight or mass **352**. Such a mass **352** may be conveniently formed of metal and may be attached to the diaphragms **342** by means of welding, soldering, or other equivalent techniques. Around the center of weight **352** there is provided an external groove **354** which is adapted to carry an interior snap ring **356** formed as a part of a contact member **358** as indicated in FIG. 1 of the drawing. This contact member can be conveniently formed out of resilient metal so as to include a connecting radial section **360** and a resilient band **362** which resiliently bears against a cylindrical resistance element **364** formed so as to be supported by and attached to the housing **338**. Appropriate wire leads **366** are connected to the ends of this resistance element **364** so as to extend to the exterior of the housing **338**. Another similar lead **366** is attached to one of the diaphragms **342** so as to also extend through the housing **338**.

It will be realized that as the accelerometer **336** is subjected to acceleration with the weight or mass **352** will be moved within the housing **338** and that the passage **350** within this mass connecting what in effect are chambers defined by each of the end caps **344** and each of the diaphragms **342** will act as an air damping passage to prevent unnecessary or overly rapid movement of this weight. Obviously various types of adjustable orifices or the like may be incorporated within the instrument **336** so as to control the damping. During such movement of the mass **352** the contact member **358** will be moved within this instrument so as to engage successive portions of the resistance element **364**. At all times the contact member will make electrical connection with portions of this resistance element within a plane perpendicular to the axis of the resistance element itself so as to obtain extremely great or infinite resolution as indicated in the preceding discussion.

The various constructions of resistance elements and wipers herein disclosed by reference are considered to be particularly applicable to units such as accelerometers where it is desired to have a high degree of resolution and where it is normally desired to use as small a resistance element as possible in order to avoid the necessity of mechanical linkages and the like. Instruments of the present invention having a high degree of resolution or infinite resolution are considered to be extremely well adapted for such use. In addition the use of contact means having fingers capable of vibrating at different resonant frequencies is considered to be extremely important in eliminating certain errors which frequently occur in the operation of electrical instruments of the type to which this invention pertains.

Because of the fact that this invention is capable of exceedingly wide modification, it is to be considered as being limited only by the appended claims forming a part of this disclosure.

We claim:

1. An accelerometer which includes: a housing; means movable in response to acceleration mounted within said housing; a wound resistance element having a uniform cross-sectional configuration along its length mounted within said housing; and contact means mounted on said means movable in response to acceleration, said contact means engaging substantially all points of said resistance element in a plane perpendicular to the axis of said resistance element and being movable along the length of said resistance element as said means movable in response to acceleration are moved within said housing.

2. An accelerometer which includes: a housing; spring means positioned within said housing so as to be secured thereto; mass means attached to said spring means within said housing so as to be movable in response to acceleration; a wound resistance element having a uniform cross-sectional configuration along its length mounted within said housing; and contact means carried by said mass means, said contact means engaging substantially all points of said resistance element within a plane perpendicular to the axis of said resistance element, said contact means being movable along the length of said resistance element during movement of said mass means.

3. An accelerometer which includes: a housing; first and second bellows means mounted within said housing so as to define chambers within said housing; mass means secured to both of said bellows means so as to extend between said bellows means; contact means attached to said mass means so as to extend therefrom; and a wound resistance element located within said housing so as to extend around said mass means and said contact means, said resistance element having a uniform cross sectional configuration along its length and being engaged by said contact means in substantially all points of said resistance element within a plane perpendicular to the axis of said resistance element, said contact means being movable along the length of said resistance element during movement of said mass means so as to always engage substantially all points of said resistance element within a plane perpendicular to the axis of said resistance element.

4. An accelerometer as defined in claim 3 including means defining a damping passage leading through said mass means and connecting said chambers.

5. An accelerometer comprising a housing having a cavity provided therein, a mass member disposed within said cavity, spring means yieldingly supporting said mass member for linear movement in one direction or the other responsive to acceleration forces, an elongated resistance element of uniform cross section, and a contact element engaging said resistance element at substantially all points thereon within a plane perpendicular to the longitudinal axis of said resistance element, one of said elements being mounted on said mass member and movable therewith, and the other of said elements being mounted on said housing.

6. An accelerometer as defined in claim 5, wherein said elongated resistance element is mounted on said housing parallel to the line of travel of said mass member, and said contact element is mounted on said mass member and movable therewith.

7. An accelerometer as defined in claim 5, wherein said housing is provided with an aperture, said resistance element being attached to the surface of said aperture around the circumference thereof, said mass member projecting through said aperture parallel to the longitudinal axis thereof, and contact means on said mass member engaging said resistance element around substantially the full circumference thereof within a plane perpendicular to the longitudinal axis of said aperture.

8. An accelerometer as defined in claim 5, wherein said resistance element is mounted on the surface of said housing within a cylindrical aperture therein, said cylindrical aperture being disposed with its longitudinal axis parallel to the line of travel of said mass member, and said contact element being in the form of a ring mounted on said mass member in a plane perpendicular to the longitudinal axis of said cylindrical aperture.

9. An accelerometer comprising a housing having an enclosed cavity provided therein, said cavity including two spaced apart end portions joined together by a cylindrical portion, a cylindrical mass member extending through said cylindrical cavity portion concentric therewith, said mass member being supported at its ends by resilient spring diaphragms mounted within said end portions of said cavity, a restricted passage extending through said mass member from one end thereof to the other and connected to said end portions of said cavity beyond said diaphragms, said restricted passage providing an orifice damping effect as said mass member moves responsive to acceleration, a resistance element attached to said housing within said cylindrical cavity portion, and a contact member on said mass member engaging said contact member at substantially all points thereon within a plane perpendicular to the longitudinal axis of said cylindrical cavity portion.

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