April 7, 1959

M. E. BOURNS ET AL

2,881,296

POTENTIOMETER CONSTRUCTIONS

Filed May 3, 1956

FIG. 1.

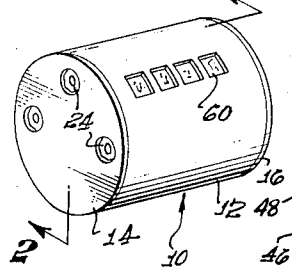


FIG. 2.

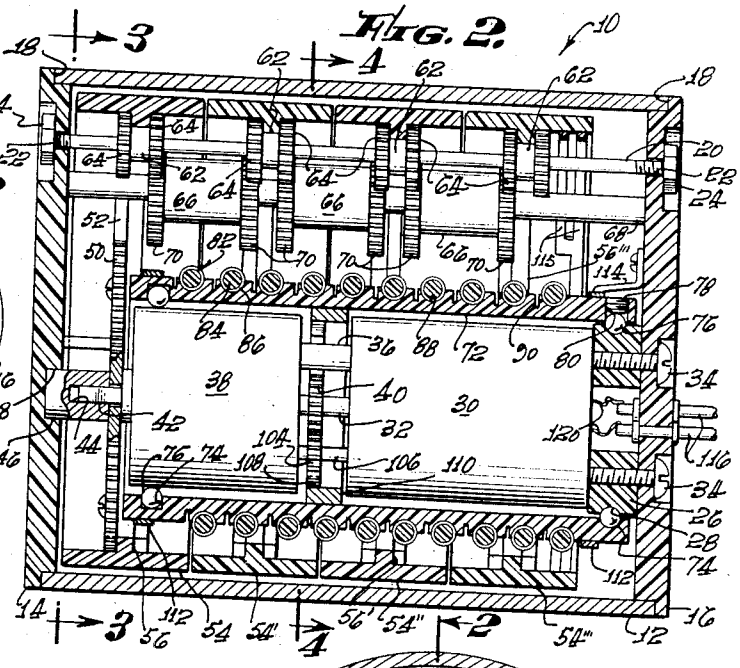


FIG. 5.

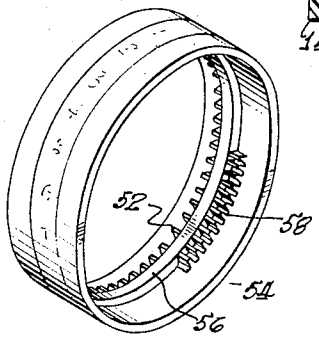
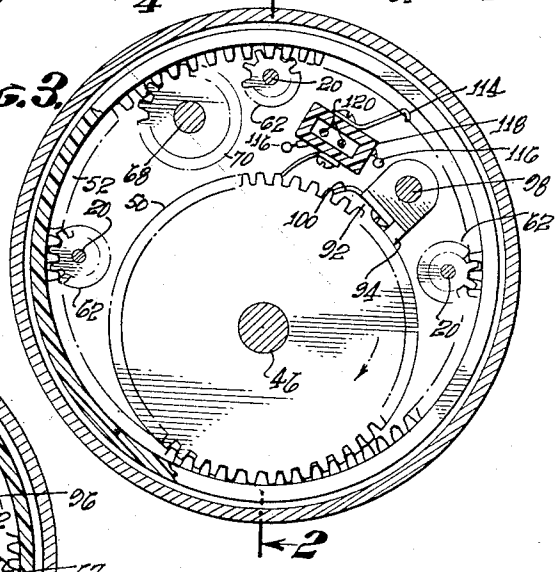


FIG. 3.



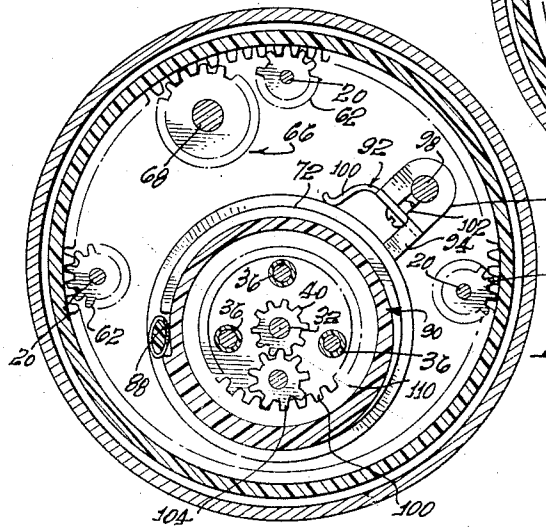


FIG. 4.

INVENTOR.

BY Marlon E. Bourns
Edward D. O'Brien
Inventor and Attorney.

United States Patent Office

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POTENTIOMETER CONSTRUCTIONS

Marlan E. Bourns, Riverside, and Edward D. O'Brian, Anaheim, Calif.; said O'Brian assignor to Bourns Laboratories, Inc.

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8 Claims. (Cl. 201—56)

This invention relates to new and improved potentiometer constructions. More specifically it relates to potentiometers including readout means so that the position of a wiper within a potentiometer may be determined through the use of such readout means with a minimum of difficulty.

The terms "miniature" and "sub-miniature" are frequently mentioned in the electrical industry today because there is an ever increasing demand for electrical components and assemblies which are extremely small and light in weight. A great deal of work has gone into developing different types of so-called miniature and sub-miniature devices for a variety of purposes. In spite of this work there are, at present, no known small, compact units manufactured which combine a potentiometer with a readout member so that the relative adjustment or position of the wiper of the potentiometer can be readily determined by simple visual inspection.

A broad object of this specification is to provide a small, compact light-weight combined potentiometer and readout construction as briefly indicated in the preceding sentence. A further general object of the invention is to provide electrical instruments of this category which can be easily manufactured using established techniques, which are exceedingly reliable in use, and which are capable of withstanding a great deal of physical abuse.

Another object of the invention is to provide various means for actuating the readout means utilized as well as for simultaneously adjusting the potentiometer in accordance with an electrical signal. Thus, the instruments of this invention are extremely well adapted for use in various control applications where an analog quantity represented by an electrical current is used to adjust a potentiometer for any desired control purpose. The amount of such adjustment can, with the devices of this invention, be determined in a digital form by simple visual inspection of the readout means employed.

Other objects and advantages of the invention will appear to those skilled in the art to which this specification is addressed from a detailed examination of the remainder of this description, including the appended claims and the accompanying drawing, in which:

Fig. 1 is an isometric view of a potentiometer construction of this invention;

Fig. 2 is a cross sectional view in which certain parts are shown in elevation, 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 cross sectional view taken at line 4—4 of Fig. 2; and

Fig. 5 is an isometric view showing the construction of a readout ring or wheel.

It is to be understood that the accompanying drawing is not to be considered as limiting the scope of this invention inasmuch as a number of differently appearing constructions can be readily created by skilled mechanics in the field to which this invention pertains by utilizing the features herein explained. Obviously various

sizes, shapes, and arrangements of parts may be altered while retaining the mode of operation and construction involved with this invention.

As an aid to understanding the new potentiometer constructions of this invention it may be stated by way of an explanatory summary that each of these constructions involves a resistance element; a wiper positioned adjacent to the resistance element so as to be movable along it; means for causing said wiper to assume different positions along the length of the resistance element; and readout means operatively attached to said means for causing said wiper to assume different positions. The inventive concept back of the present application is more fully defined or summarized in detail by the appended claims.

The exact nature of potentiometer constructions of the present invention can be more fully explained by direct reference to Figs. 1 through 4 of the accompanying drawings. Here there is shown a device **10** of the present invention which includes a cylindrical metal housing **12**, the ends of which are closed by non-conductive generally circular plates **14** and **16** formed out of a phenolic or other equivalent composition. Around the periphery of each of these plates there is provided a flange **18** adapted to bear against the housing **12** so as to form a substantially sealed unit when these plates are secured to one another through the use of three shafts **20**. The ends of these shafts **20** project through openings **22** in the plates **14** and **16** and are threaded so that nuts **24** can be utilized to secure these plates and the housing **12** together.

Mounted upon the plate **16** which, if desired, may be considered a rear plate is a non-conductive ring **26**, around the periphery of which there is located a curved, continuous groove **28** which forms the inner race for a ball bearing, as will be described in more detail presently. Positioned upon the ring **26** is a small reversible electric motor **30** which has a shaft **32** extending from the opposite end thereof. Screws **34** are employed to attach the ring **26** and the motor **30** to the plate **16**. Other screws **34** are employed together with small cylindrical spacers **36** to position a small cylindrical speed multiplying device **38** of any desired internal construction upon the motor **30** so that this device **38** is axially aligned with the motor **30**. The shaft **32** serves to connect the motor **30** and this device **38**; it also serves to carry a small gear **40** which is employed as will be more fully explained later. A non-round driven shaft **42** extends from the device **38** along the axis of this device on the side opposite the motor **30** so as to fit within a correspondingly shaped socket **44** in a larger round shaft **46**. The shaft **46** is rotatably supported within a cylindrical opening **48** in the plate **14**, and carries a large drive gear **50**.

This drive gear **50** is designed so as to coact with an internal ring gear **52** formed within the interior of a first readout ring or wheel **54**. Within the device **10** are four of these readout rings or wheels of substantially identical construction except for certain minor details as will be explained later. For convenience of explanation these readout rings or wheels are designated as **54**, **54'**, **54''**, and **54'''** respectively; as will be more fully apparent these wheels are used to indicate successive numbers, such as, for example, the numbers in a decimal fraction. At least one of the wheels are required with the invention as a "readout means," and any desired number of these rings or wheels can be employed. All four of these readout rings or wheels are formed as indicated in Fig. 5 of the drawing so as to each include a centrally located internal flange **56**. On one side of each of these flanges there is formed a continuous internal ring gear **52** as indicated in the preceding discussion. On the other side of each of these flanges **56** there is formed a segmental internal ring gear **58** which, in the form of the invention illus-

trated, extends for 36° of a circle around the interior of each of these readout rings or wheels **54**. All of the readout rings or wheels **54** are preferably formed of a non-conductive material such as, for example, a phenolic composition by various molding procedures well known to the art. Numerals 0 to 9 are painted or otherwise applied on the exterior of each of these rings or wheels **54** so as to be equally spaced in order that the position of these wheels **54** may be visually determined through a series of transparent windows **60** formed in a line along the wall of the housing **12**.

The readout rings or wheels are all supported with respect to one another against undesired movement through the use of spacer spools **62** rotatably positioned around the shafts **20** and suitably secured against endwise movement with respect thereto. The ends **64** of the spacer spools **62** are preferably formed in the shape of gears so as to coact with the ring gears **52** and the segmental ring gears **58** as the readout wheels **54** are rotated; the length of these spacer spools **62** is such that the ends **64** fit closely against the flanges **56** so as to effectively hold the readout rings or wheels against undesired movement, and the centers of these spools **62** normally bear against the flanges **56**. It is considered obvious that the various shafts **20** are spaced from one another a sufficient amount so as to prevent shifting of the readout rings or wheels **54** in planes transverse to the axis of the housing **12**.

Within the device **10** the readout rings or wheels **54**, **54'**, **54''**, and **54'''** are periodically moved with respect to one another in accordance with the rotation of the preceding readout ring or wheel by the use of gear spools **66** rotatably mounted on a shaft **68** supported within openings (not shown) in the plates **14** and **16**. Each of the gear spools **66** is formed with ends **70** having the general shape of gears so that when one of these ends is engaged by a segmental ring gear on one of the readout wheels the continuous ring gear **52** on the next adjacent readout wheel is operated so as to turn this next adjacent ring or wheel. This mechanism of correlating the motion of a series of wheels in accordance with a predetermined mathematical relationship enables these wheels to be used in designating the digits in a number. Geneva cross or other indexing movements can be substituted for the specific gear type connection between the various readout wheels **54** so long as such means are located generally within these wheels so as to obtain a compact unit. If such other means are substituted care must be taken that these means do not interfere with the other operative parts of the device **10**.

One of these other parts is a cylindrical non-conductive support **72** formed of a phenolic resin or similar composition so as to have grooves **74** similar to the groove **28** formed on the inside thereof in such a manner as to hold small ball bearings **76** in order to rotatably mount this support **72** on the ring **26** and the device **38**. Preferably the groove **28** and the groove **74** immediately adjacent thereto are formed as illustrated so that the ball bearings around the ring **26** serve to prevent shifting of the support **72** in a direction along its axis. Small plugs **78** can be threaded within holes **80** in the support **72** for introducing the ball bearings **76** into either of the channels carrying these bearings.

Around the periphery of the support **72** there is located within the preferred embodiment of the device **10** a 10-turn helical resistance element **82**. This element **82** in the form of the invention illustrated includes a continuous non-conductive base **84** around which is wound resistance wire **86**; other types of resistance elements can be employed. For mechanical stability it is preferred to locate the resistance element **82** so that at least half of its depth is secured within a helical groove **88** in the support **72** by means of a conventional adhesive or the like. A helical, slot-like groove **90** having the same pitch as the resistance element **82** is formed adjacent to this resistance element within the exterior of the non-conductive support **72**.

With this construction a small metallic contact member **92** having an extension **94** formed thereon is mounted upon a non-conductive block **96** so that this extension fits within the slot-like groove **90** causing the block to slide along a shaft **98** secured between the plates **14** and **16** from within openings (not shown) in each. The contact member **92** also has a curved resilient extension **100** designed to engage the resistance element **82** and another extension designed to engage the shaft **98** so that this shaft may serve as an electrical return.

The support **72** is rotated during the operation of the device **10** through the gear **40** coacting with another gear **104** held upon an idler shaft **106** positioned so as to extend between the motor **30** and the device **38**. The gear **104** coacts with an internal ring gear **108** formed on a flange of a ring **110** secured to the interior of the support **72** as by means of screws (not shown) or like equivalents. Electrical connection is made to the ends of the resistance element **82** by means of slip rings **112** mounted on the ends of the support **72** so as to be electrically connected as by means of short wires (not shown) to the ends of this resistance element. One of these slip rings **112** is engaged by a brush **114** mounted upon the plate **16** so as to be connected directly to one of a series of terminals **116**. The other of the slip rings **112** is designed to be engaged by means of another brush **114** (Fig. 3) mounted upon a non-conductive hollow brace **118** carried by the plates **14** and **16**. A wire **120** leading from the brush **114** engaging this other slip ring to another of the terminals **116** may be conveniently passed through the brace **118**.

Further, as desired, other slip rings **115** or contact members may be located within the interiors of the readout rings or wheels. Such other slip rings or contact members can be interconnected in any desired pattern so that when engaged by brushes such as the brushes **114** various electrical devices may be actuated in various sequential or other manners. Thus, conductors **115** having the general shape of slip rings having gaps formed therein on the interior of the readout wheel **54'''** can be used so as to cause either the motor **30** to stop rotation or to cause this motor to reverse its direction of rotation. The terminals **116** employed may be of any known category and may be arranged in various configurations with respect to one another for convenient mounting in sockets or the like.

It is considered that the operation of the device **10** is essentially obvious from the aforegoing description of the construction of this device. When the motor **30** is caused to be operated the support **72** is rotated and simultaneously the contact member **92** moves along the resistance element **82** disposed upon this support. Also, as the motor **30** is operated the speed multiplying device **38**, which, if desired, may be termed gear means, is actuated so as to turn the gear **50**, turning the first readout ring or wheel **54**. Once during every revolution of this member a gear spool **66** causes the second readout ring or wheel **54'** to move a fraction of a turn. When the second readout ring or wheels **54'** has been moved so as to finish a complete turn the third readout ring or wheel **54''** is then turned a fraction of a turn and so on until the fourth ring or wheel **54'''** is turned one complete revolution corresponding in a time interval to the period required for the contact member **92** to move completely along the resistance element **82**.

It will be realized from the aforegoing description that the device **10** is essentially a very compact effective specialized potentiometer construction. The basic principles of construction illustrated may be utilized in devices having other gear means and other speed multiplying means such as, for example, exposed epicyclic gearing than are specifically illustrated. If desired the motor **30** can be mounted within a support **72** so that separate

gear trains are attached to shafts projecting from each end of it to operate the readout wheels and the support **72**. It is possible to replace the motor **30** with various other structures for causing rotation of a known category. Further, it is possible in some devices utilizing a series of concentrically mounted members as herein defined to incorporate an amplifier within certain of the members utilized. If desired the entire device **10** may be mounted directly upon a small amplification unit used to operate the motor **30**. Since this device **10** is, as formed, entirely reversible it is very advantageous for many applications. Obviously a five or other number of turn resistance element can be used instead of the specific resistance element shown. With any construction of this invention care must be taken that the readout means and the potentiometer wiper are operatively interconnected so that they are both actuated simultaneously in accordance with a desired mathematical pattern or interrelationship.

Because of the fact that a large number of modifications such as are indicated above may be made in the structure shown without departing from the essential features of this invention, the appended claims are to be afforded wide scope, and are not to be considered as being limited by the specific construction disclosed.

We claim:

1. An electrical instrument of the class described which includes: a resistance element; a wiper mounted adjacent to said resistance element so as to be capable of being moved along said resistance element; means for moving said wiper along said resistance element; a series of readout wheels rotatably mounted around said resistance element and said wiper; means for rotating a readout wheel of said series as said wiper is moved along said resistance element; and means for rotating the other of said readout wheels in said series in accordance with the rotation of said readout wheel.

2. An electrical instrument of the class described which includes: a support; a resistance element mounted on said support; means for moving said support; a wiper mounted adjacent to said resistance element so as to move along said resistance element as said support is moved, said wiper continuously engaging said resistance element as said support is moved; a series of readout wheels rotatably mounted around said resistance element and said wiper; means for rotating a readout wheel of said series as said wiper is moved along said resistance element; and means for rotating the other of said readout wheels in said series in accordance with the rotation of said readout wheel.

3. An electrical instrument of the class described which includes: a housing; a resistance element rotatably mounted within said housing; a contact member mounted within said housing so as to engage said resistance element as said resistance element is rotated; at least one readout wheel rotatably mounted in said housing around said resistance element and said contact member; and means interconnecting said resistance element and said readout wheel so as to simultaneously rotate said resistance element and said readout wheel so that the position of said contact member with respect to said resistance element can be determined by the position of said readout wheel.

4. An electrical instrument of the class described which includes: a housing; a cylindrical support rotatably mounted within said housing; a helical resistance element mounted upon said support; a contact member movably mounted within said housing adjacent said resistance element, said contact member engaging said resistance element; means for moving said contact member along said resistance element as said support is rotated; movable readout means mounted within said housing around said resistance element and said contact member; and means connecting said readout means and said support so as to move said readout means in accordance with the rotation of said support whereby the position of said contact member with respect to said resistance element can be determined by the position of said readout wheel.

5. A potentiometer construction which includes: a housing; a resistance element rotatably mounted within said housing; a contact member mounted within said housing so as to engage said resistance element as said resistance element is rotated; a series of readout wheels rotatably mounted within said housing; a reversible electric motor mounted within said housing; gear means connecting said resistance element to said electric motor so that as said motor is operated said resistance element is rotated; gear means connecting the first of said series of readout wheels to said electric motor so that as said motor is operated said first readout wheel is rotated and means for rotating said readout wheels of said series in accordance with the rotation of said first readout wheel.

6. A potentiometer construction which includes: a housing; a cylindrical support rotatably mounted within said housing; a helical resistance element mounted upon said support; a contact member movably mounted within said housing adjacent said resistance element, said contact member engaging said resistance element; means for moving said contact member along said resistance element as said support is rotated; a series of readout wheels rotatably mounted within said housing around said support and said contact member; means for rotating the first readout wheel in accordance with the rotation of said support; means for rotating the remainder of said readout wheels of said series periodically in accordance with the rotation of said first readout wheel; and terminal means electrically connected to the ends of said resistance element and said contact member.

7. A potentiometer construction which includes: a housing; a hollow cylindrical support rotatably mounted within said housing; a resistance element mounted on said support so as to extend around said support; a contact member mounted within said housing so as to engage said resistance element as said support is rotated; a series of readout wheels rotatably mounted within said housing so as to be positioned around said support and said contact member; an electric motor positioned within said support; and gear means connecting said motor to said readout wheels and said support so that said readout wheels are rotated to positions indicating the position of said contact member with respect to said resistance element when said support is rotated through the operation of said motor.

8. A device of the class described which includes: a housing; a hollow, cylindrical support rotatably mounted within said housing; a helical resistance element mounted upon said support; a contact member movably mounted within said housing adjacent to said resistance element, said contact member engaging said resistance element; means for moving said contact member along said resistance element as said support is rotated; a series of readout wheels rotatably mounted within said housing around said support and said contact member; an electric motor positioned within said support; gear means operated by said electric motor for rotating said support; means operated by said electric motor for rotating the first of said series of readout wheels in accordance with the rotation of said support; means for rotating the remainder of said readout wheels of said series periodically in accordance with the rotation of said first readout wheel; and terminal means electrically connected to the ends of said resistance element and to said contact member.

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