April 23, 1957 R. W. ARMSTRONG 2,790,052

PRECISION RESISTANCE DEVICES

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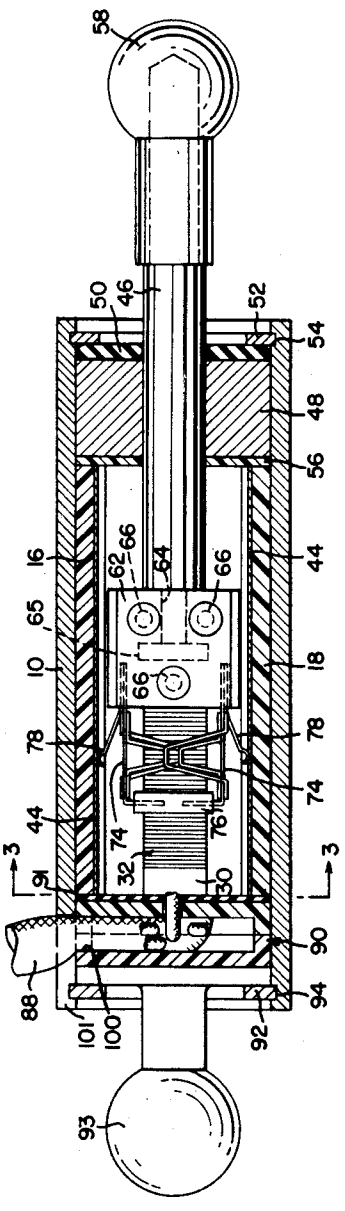


FIG. 1

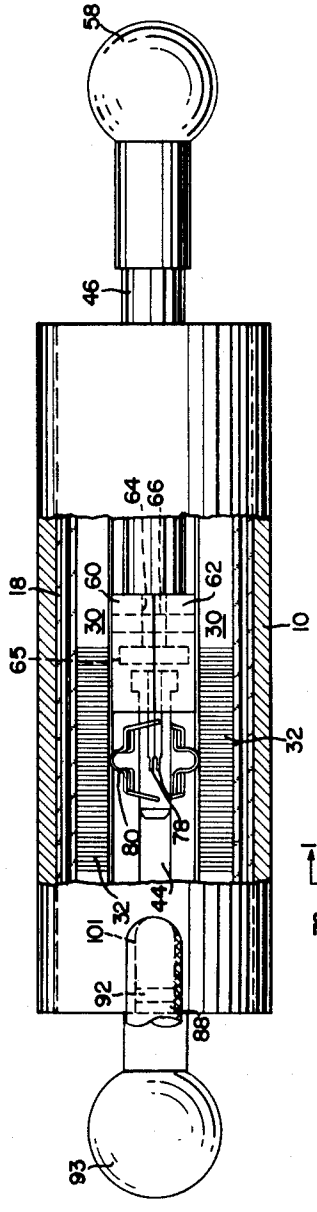


FIG. 2

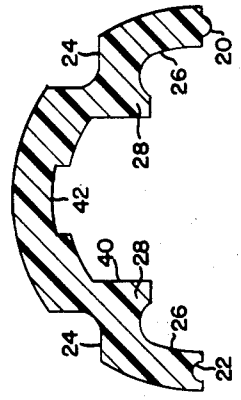


FIG. 4

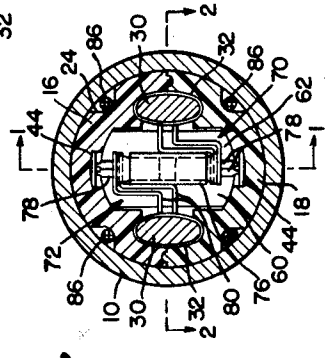


FIG. 3

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FIG. 5

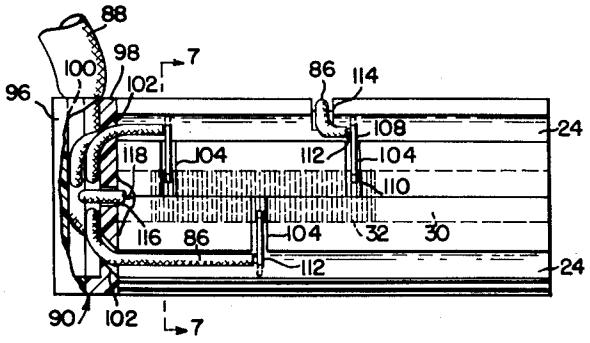


FIG. 6

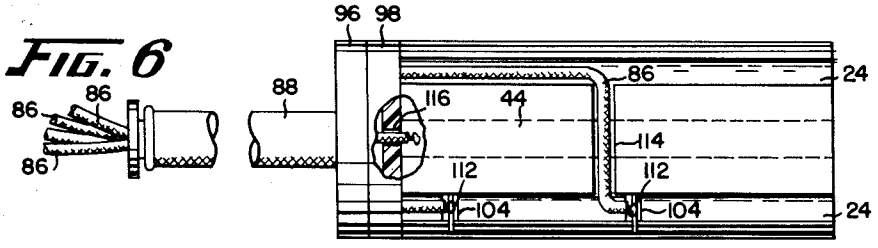
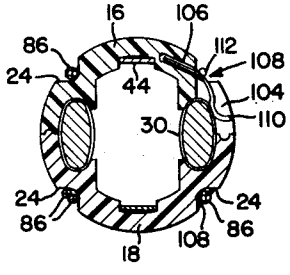


FIG. 7



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PRECISION RESISTANCE DEVICES

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6 Claims. (Cl. 201—62)

This invention in general pertains to precision resistance devices and more specifically to precision potentiometers.

Prior art potentiometers comprise generally a supporting member with resistance means and collector means attached thereto together with wiper means adapted to contact both the collector means and the resistance means. These prior art devices may be of the rotary type or of the linear type according to the application and in general, all of the prior art potentiometers have a common shortcoming which is that the contact pressure between the wiper member and the resistance means and the collector means does not stay constant as the resistance device is subjected to a wide range of temperature changes. One of the reasons for the change in contact pressure for temperature variations is the fact that there generally is a difference between the coefficient of thermal expansion of the support means and the resistance means. Since the ends of the resistance means generally are fixed with respect to the support means, the different rates of thermal expansion cause the resistance means to become distorted to the extent that the contact pressure of the wiper means thereon is changed. This change in contact pressure in turn causes a change in the resistance value reflected into the circuit in which the resistance device is a component with the accompanying error in the over-all system. In very sensitive applications this change of resistance due to a varying wiper pressure is very undesirable inasmuch as it destroys the accuracy of the system and it is the intent of this invention to overcome this problem by providing a means of maintaining constant wiper pressure.

An object of this invention is to provide a rugged, compact precision variable resistance device wherein means are provided to maintain a uniform contact pressure of the wiper means upon the resistance means and/or collector means for wide variations in temperature of the resistance device so that no change in resistance due to varying contact pressure is encountered. Certain novel aspects of this invention lie in the constructional details while other of the advantages of the invention lie in the selection of certain materials as will be pointed out with greater particularity in the detailed discussion of the device below.

Other objects of the invention will be set forth more fully in and become apparent from a reading of the following specification and appended claims, in conjunction with the accompanying drawing in which:

Figure 1 is a plan view in cross section of a precision potentiometer embodying the teachings of my invention;

Figure 2 is a side elevational view, partly in section, of the potentiometer shown in Figure 1;

Figure 3 is a transverse cross-sectional view of the device shown in Figure 1 taken along section line 3—3 of Figure 1;

Figure 4 is a transverse cross-sectional view, on an enlarged scale, of one of the main support members used in the potentiometer;

Figure 5 is a plan view of the device shown in Figure 1 with the housing member removed;

Figure 6 is a side elevational view of the device shown in Figure 5; and

Figure 7 is a transverse cross-sectional view of the subassembly as shown in Figures 5 and 6 as viewed along section lines 7—7 of Figure 5.

A housing member **10** having a hollow cylindrical tube-like configuration is made out of a suitable rigid material such as aluminum. A pair of generally semi-cylindrical hollow support members **16** and **18** are adapted to be positioned within housing member **10**. Support members **16** and **18** are preferably identically shaped and are made out of a plastic insulative material such as "nylon." The "nylon" material suggested for members **16** and **18** is desirable because of an inherent slipperiness quality. Obviously, other materials having the properties mentioned to the extent necessary for the particular application may be used.

Support members **16** and **18** are adapted to be assembled in abutting interlocking relationship. To this end support members **16** and **18** are fitted with cooperating tongue and groove projections and recesses **20** and **22** respectively along their common radial surfaces (see Figure 4). Support members **16** and **18** when thus assembled provide a rigid subassembly and have a common outer surface generally conformable to the inner surface of housing member **10**. A plurality of longitudinal recesses **24** are provided in the outer surfaces of support members **16** and **18** so that when the assembled support members are inserted into the housing **10**, longitudinal recesses or slots are formed between the inner surface of the housing member **10** and the support members **16** and **18**, the utility of these longitudinal slots to become clear in the description below.

A plurality of recesses are provided on the inner surfaces of support members **16** and **18**. Each of support members **16** and **18** has a pair of recesses **26** on the inner surface thereof, one recess **26** adjacent to each of the common abutting radial surfaces with the recesses **26** being so shaped such that overhanging or undercut portions **28** are defined. When support members **16** and **18** are assembled in interlocking relationship, the recesses **26** of the individual support members cooperate to form a pair of common recesses therebetween. Resistance means are adapted to be positioned in said pair of common recesses defined by recesses **26**, the resistance means comprising a pair of separate resistance elements, each comprising a bobbin or support member **30** having resistance wire **32** wound thereupon. As will be observed in Figure 3, the cross-sectional configuration of the bobbin members **30** with resistance wire **32** thereupon is generally conformable to the common recesses defined by the individual recesses **26** of the support members **16** and **18**. The resistance wire **32** is placed upon bobbin members **30** and insulated therefrom using conventional winding techniques as a preliminary step in the assembly of the devices. The resistance elements are then assembled with support members **16** and **18** by being placed in the recesses **26** of one of the support members and the other support member being then placed in abutting interlocking relationship with the first supporting member. The subassembly may then be inserted into the housing **10**. It will be noted that when support members **16** and **18** are assembled with the resistance means that the overhanging portions **28** thereof serve to hold or clamp the resistance elements with respect to the assembled support members **16** and **18** and preclude relative transverse motion therebetween. However, while transverse motion between support members **16** and **18** and the resistance means is precluded it will be appreciated that the inherent slipperiness quality of the "nylon"

support members will allow a slight amount of relative longitudinal movement between themselves and the resistance elements. Thus, upon wide variations in the ambient temperature to which the resistance device is subjected, slight longitudinal movement between the resistance means and the support means **16** and **18** will occur without any transverse movement. The elimination of the transverse movement allows the pressure of the wiper means to be described below on the resistance wire **32** to remain constant over wide temperature changes and thus eliminates the introduction of any errors into the system of which the resistance device is a component.

Each of the support members **16** and **18** has on the inner surface thereof a U-shaped recess **40** symmetrically positioned and having straight side portions and a curved bight portion with a further recess **42** centrally positioned in the bight portion. A collector strip **44** is adapted to be disposed in each recess **42**. A movable wiper carrying rod **46**, adapted to be longitudinally displaced by condition responsive means (not shown), is supported for reciprocation by a journal bearing **48** positioned within the right end of housing **10** as viewed in Figure 1.

A washer **50** of a suitable resilient material such as neoprene rubber is positioned about shaft **46** adjacent to the outer axial end of bearing member **48**. Washer **50** has, as shown, a rounded inner periphery as well as a rounded outer periphery and is proportional so as to fit snugly between shaft **46** and housing **10** as well as to snugly embrace shaft **46**. The rounded inner periphery of washer **50** prevents the washer from "pumping" any oil that might be present on the exposed part of shaft **46** inside to contaminate the resistance device. Washer **50**, in addition to providing an oil seal, serves as an expansion absorber between the housing **10** and the internal parts of the resistance device. A snap ring washer **52** disposed in a suitable recess **54** in the housing **10** serves as a retainer for bearing **48** and gasket **50**. A washer member **56** of an insulative material is disposed between the inner axial end of bearing member **48** and one end of the assembled interlocking support members **16** and **18** as is shown in Figure 1. Washer **56** prevents journal bearing **48** from shorting out the resistance means within housing **10**. A ball end connector **58** is secured to the outer end of rod member **46** so as to provide a means of connecting rod **46** to condition responsive means (not shown).

A wiper array is secured to the inner end of rod **46** which is relieved as at **64** so as to define a head **65**. The array comprises a pair of insulative members **60** and **62** fastened about head **65** of rod member **46** by suitable rivet means **66**. Members **60** and **62** are also preferably made out of a plastic material such as "nylon." The wiper array also comprises two wiper subassemblies **70** and **72** which are electrically insulated from one another. Each subassembly **70** and **72** includes an L-shaped electrically conductive support bracket **74**, the long ends of which are embedded in suitable recesses between insulative members **60** and **62** and the short ends of which extend toward one another but do not touch and are maintained in spaced relationship by an insulative spacer **76** as is shown in Figure 1. Each L-shaped bracket **74** has a first pair of wipers **78** electrically connected thereto by suitable means such as soldering which wipers **78** are adapted to engage collector strips **44** and a second pair of wiper members **80** also electrically connected thereto and extending normal to wipers **78** and being adapted to engage the resistance means **32** on the bobbin members **30**. Thus, in the embodiment of the precision resistance device shown, two independent potentiometers are provided, each potentiometer comprising a resistance winding **32** on a bobbin **30** and a collector strip **44** with electric continuity being established between the resistance winding **32** and the collector strip **44** by the cooperating wipers **80** and **78**. While two independent potentiometers or variable resistors are shown, it will be appreciated that the scope of the invention includes arrangements wherein only one of the common recesses between the individual recesses **26** in support members **16** and **18** is used to position resistive means as well as other arrangements wherein resistive means are disposed in both of the common recesses as shown herein, but are connected in series or parallel relationship instead of being electrically independent. The insulative members **60** and **62** when secured to the inner end of rod **46** have a cross-sectional configuration generally conforming to the space defined by the straight side portions and curved bight portion of recess **40** (see Figure 3). Thus rod **46** is supported not only by bearing member **48** but also to a lesser extent by members **60** and **62** coacting with support members **16** and **18**. Further, the insulative members **60** and **62** have recess means cooperating with the head portion **65** on rod member **46** so that relative rotation between rod **46** and the insulative members **60** and **62** is allowed although relative longitudinal motion therebetween is precluded. Thus, any longitudinal displacement of rod **46** by the condition responsive means will result in a positive displacement of the wiper means **78** and **80** with respect to the collector strips **44** and the resistive means **32**, but any relative rotation between the rod **46** and the housing **10** will not impart any change to the relationship of the wipers and the resistor means **32**. The importance of this arrangement is that any rotative torques imparted to shaft **46** through vibration or torsional stresses within the base upon which the housing **10** and/or condition responsive means are mounted are not imparted to the wiper arrays so as to vary the contact pressure thereof on the resistance wire **32** and thus impart an error into the system of which the resistance device is a component.

Referring to Figures 5, 6 and 7, it will be noted that recesses **24** in the outer surfaces of support members **16** and **18** are used to provide a means for connecting external connection means to the ends of the resistance wire **32** on bobbins **30** as well as center taps to the resistance wire **32** when and where desired. A plurality of connection leads **86**, individually insulated and having a common outer covering **88** are brought into the resistance device through a terminal box **90**. As viewed in Figure 1, terminal box **90** is positioned against the left end of the assembled and interlocked support members **16** and **18**. A resilient disc **91** is positioned between terminal box **90** and support members **16** and **18** and serves as additional expansion absorption means similar to washer **50**.

A ball end connector **93** for connecting the resistance device to a base, not shown, has its shank portion positioned against the outer face of terminal box **90** and is retained in position by a snap ring **92** disposed in a suitable recess **94**. Snap ring **92** thus cooperates with snap ring **52** in holding the internal components of the resistance device in assembled relationship.

Terminal box **90** comprises an outer recessed cup-like member **96** and an inner recessed cup-like member **98**, said cup-like members **96** and **98** being disposed with their recessed sides in abutting relationship so as to define a void space therebetween and both of said members having a peripheral aperture which combine to define a common aperture **100** through which extend the leads **86** covered with the common wrapping **88**. A notch **101** in housing **10** registers with aperture **100**. Further, the inner cup member **98** has apertures **102** therein registering with the ends of recesses **24** on the outer surfaces of support members **16** and **18** so that the individual lead wires **86** may be led out through apertures **102** and through suitable apertures, not shown, in resilient disc **91** and be disposed in said recesses. At the point at which it is desired to connect lead wires **86** to the resistance wire **32** on the bobbins **30**, a suitable aperture or notch **104** is provided in support members **16** and **18** (see Figure 7). Adjacent to said notches **104** in the

support members **16** and **18** are recesses **106** into which are placed and secured thereto by suitable means such as an adhesive the ends of spring contact members **108** which have free ends **110** extending through the apertures or notches **104** and bear against the resistance wire **32** on the bobbin members **30**. The individual leads **86** are connected to the spring contact members **108** at **112** by suitable means such as soldering and thus are effectively connected to the resistance wire **32** on the bobbins **30**. If desired, only one lead **86** may be placed in each of the recesses **24** or more than one lead may be so placed according to the particular application and size of wire and the recesses **24** (see Figure 7 where a single lead **86** is disposed in each of three of the recesses **24** while two connection leads **86** are disposed in the remaining recess **24**). Where there is only one wire in each recess **24** and where it is desired to have a connection to both ends of the resistance winding, one of the connection leads **86** initially disposed in a recess **24** spaced from the recess **24** adjacent to the resistance means is brought to the correct point by means of a circumferential recess **114** joining the two adjacent longitudinal recesses **24**. The leads **86** connected to the collector strips **44** pass through suitable apertures **116** in the inner cup member **98** of the terminal box **90** and are fastened to the collector strips **44** by suitable means such as soldering as at **118**.

While I have shown and described a specifice embodiment of this invention, further modifications and improvements will occur to those skilled in the art. I desire it to be understood, therefore, that this invention is not limited to the particular form shown and I intend in the appended claims to cover all modifications which do not depart from the spirit and scope of this invention.

What I claim is:

1. A resistance device of the class described comprising: a hollow housing member; a plurality of support members of a material characterized by having a slipperiness quality positioned in said housing member resilient means positioned in said housing member at the ends of said support members cooperating with said support members and said housing member, said support members having cooperating abutting surfaces, said resilient means acting to absorb expansion between said housing member and said support members; recess means on said abutting surfaces of said support members which define, when said support members are in abutting relationship, a common recess; resistance support means having a configuration substantially identical to said common recess defined by said support members; resistance means on said resistance support means, said resistance support means with said reistance means thereon being disposed in said common recess and said recess means being undercut such that transverse movement of said resistance support means with said resistance means thereon with respect to said hollow support members is precluded, said inherent slipperiness quality of said support members permitting relative longitudinal movement between said support members and said resistance support means with said resistance means thereon.

2. A variable resistance device of the class described comprising: a hollow housing member; a pair of hollow support members having inner and outer surfaces adapted when abutted against one another to have a common outer periphery generally identical to the inner periphery of said hollow housing member; recesses on said inner surfaces of said support members, selected ones of said inner recesses defining a common recess; resistance means disposed in said common recess; conductive means disposed on said inner surfaces; movable means journalled for longitudinal reciprocation by said pair of hollow support members and comprising conductive means in contact with said resistance means and said first named conductive means; apertures in said support members adjacent said resistance means; spring means secured to said support members and having free portions extending through said apertures and contacting said resistance means; and connection means connected to said spring means.

3. A variable resistance device of the class described comprising: a hollow housing member; a plurality of support members having inner and outer surfaces and adapted when assembled together to have a common outer surface generally conforming to the inner surface of said hollow housing member; recesses on said inner surfaces of said support members, selected ones of said recesses defining a common recess; resistance means disposed in said common recess; conductive means on said support members and condition responsive means slidably mounted between said support members and comprising conductive means in contact with said resistance means and said first named conductive means.

4. A variable resistance device of the class described comprising: a hollow housing member having an inner surface; a plurality of support members having inner and outer surfaces adapted when assembled to have a common inner surface and a common outer surface generally conforming to said inner surface of said hollow housing member; recesses on said outer surfaces of said support members; resistance means disposed between adjacent ones of said support members and adjacent to said common inner surface; conductive means disposed on said common inner surface; movable means adapted to be longitudinally reciprocated within said assembled support members and comprising conductive means in contact with said resistance means and said first named conductive means; apertures in said support members between said inner and said outer surfaces thereof and adjacent to said resistance means; contact means secured to said support members and having free portions extending through said apertures and contacting said resistance means; and connection means disposed in said recesses on said outer surfaces connected to said contact means.

5. A variable resistance device of the class described comprising: a hollow housing member having an inner surface; a plurality of support members of a material characterized by a slipperiness property, said support means having inner surfaces and outer surfaces and said support members being adapted when assembled to have a common outer surface generally conformable to the inner surface of said hollow housing member; recesses on said inner surfaces of said support members, selected ones of said inner recesses defining a common recess; resistance means disposed in said common recess; conductive mean disposed on said inner surfaces; and movable means positioned for longitudinal movement within said assembled support members and comprising conductive means in contact with said resistance means and said first named conductive means, said slipperiness property of said support members permitting relative longitudinal movement between said resistance means and said support members.

6. A resistance device of the class described comprising: a hollow cylindrical housing member, a plurality of support members of a material characterized by having a slipperiness quality snugly positioned in said housing member, resilient means positioned in said housing member at the ends of said support members to absorb expansion between said support members and said housing member, said support members having cooperating abutting surfaces and means which define, when said support members are in abutting assembled relationship, a common recess; and resistance means disposed in said common recess.

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