Sept. 20, 1960 W. L. DENISTON 2,953,762

PRECISION POTENTIOMETER

Filed Dec. 17, 1957 2 Sheets-Sheet 1

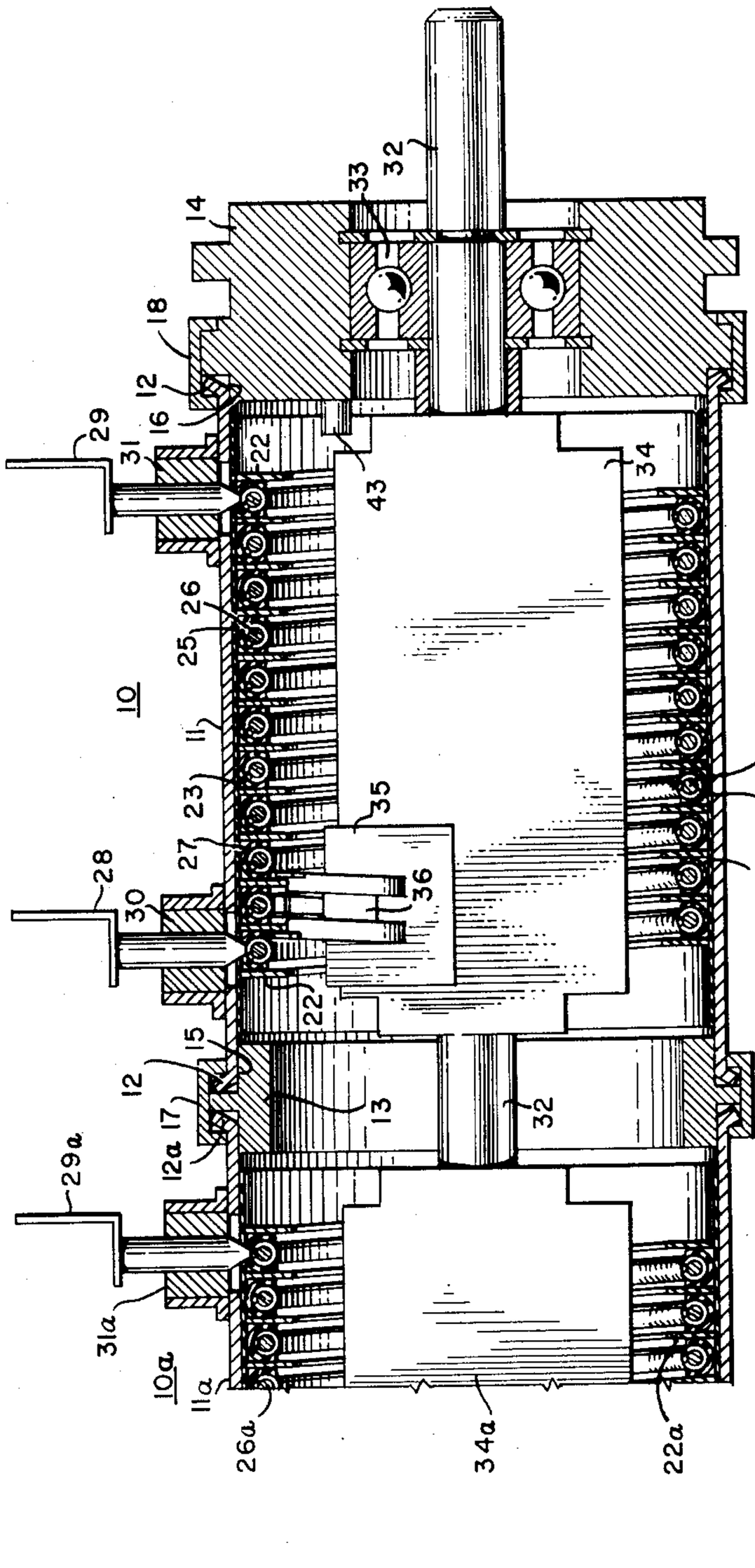

FIG. 1

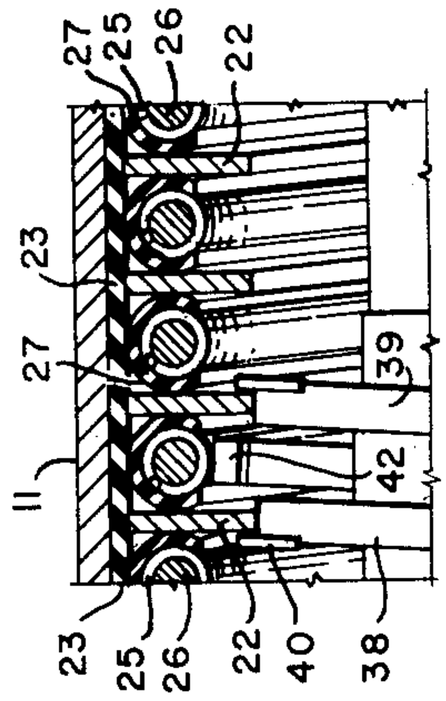

FIG. 1a

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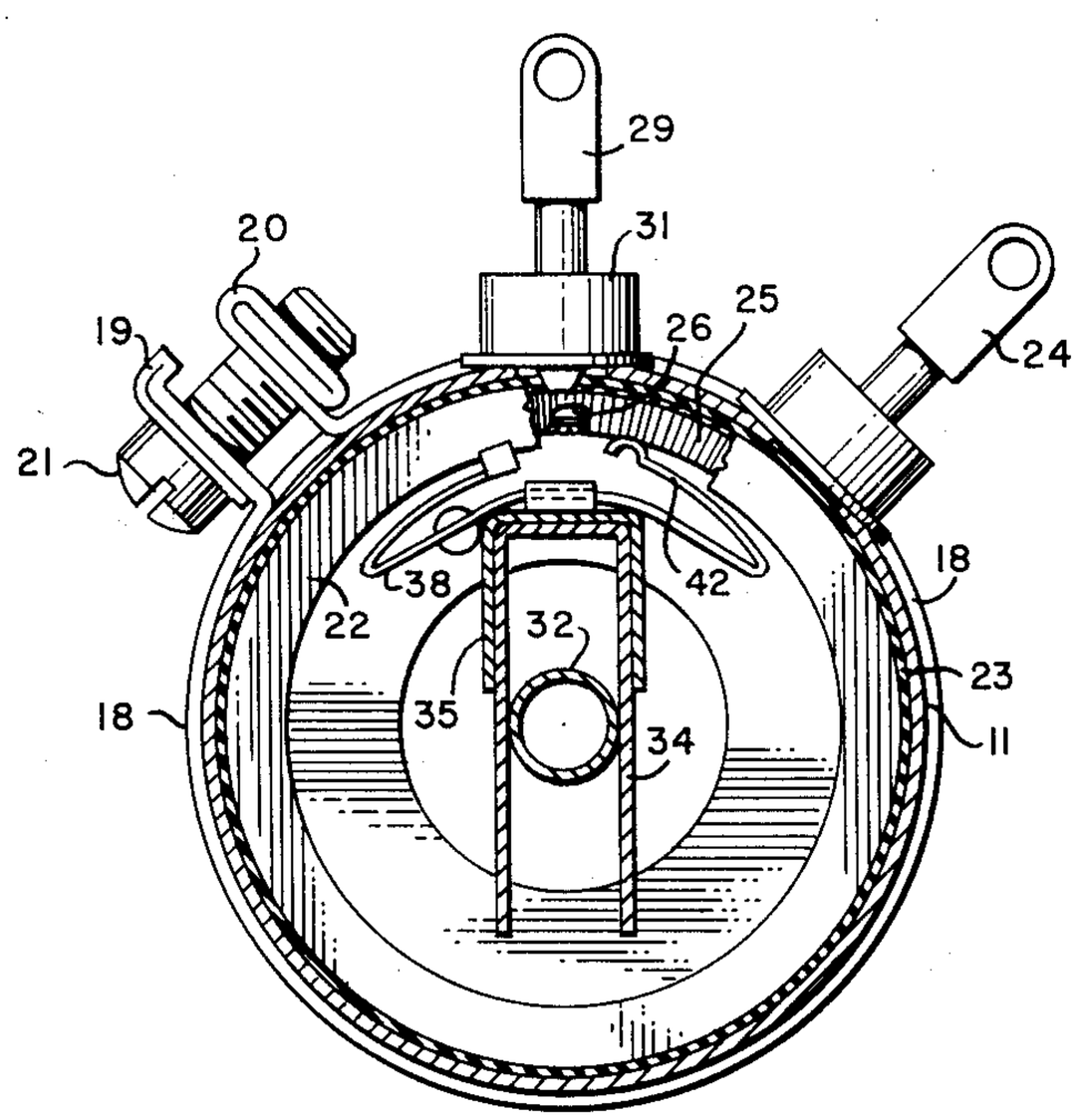

FIG. 2

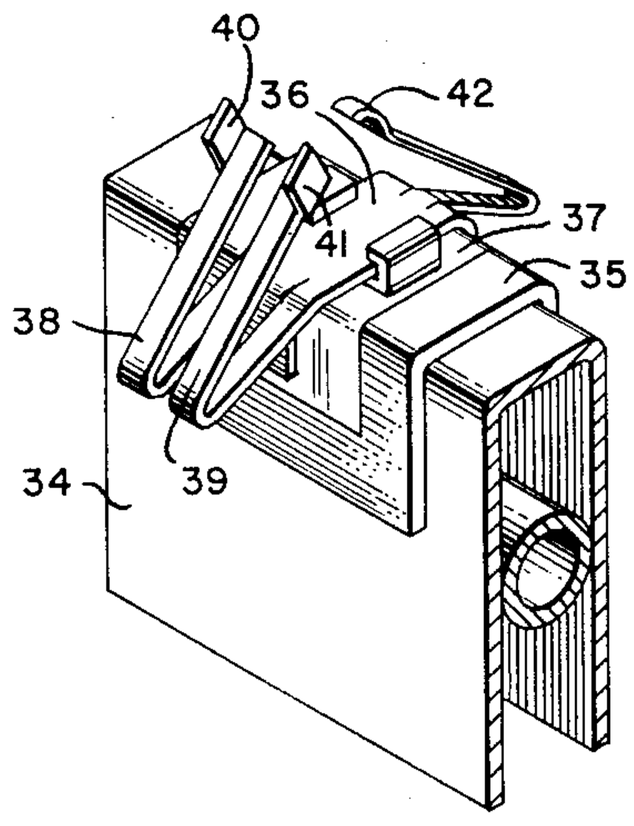

FIG. 3

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PRECISION POTENTIOMETER

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7 Claims. (Cl. 338—146)

This invention relates to precision potentiometers and, more particularly, to such potentiometers of the multi-turn type which may be readily assembled as a single unit or a multiple unit assembly for use in electric and electronic control circuits.

Various forms of multi-turn potentiometers have heretofore been put on the market. In general, such potentiometers have comprised a cylindrical housing in which the resistance element is mounted in the form of a helical coil. A contact element is disposed within the housing to engage the resistance element and is caused to move in a helical path in order to traverse the resistance element from end to end. The rotational component of this helical movement is generally obtained by disposing it on an internal rotor with an extending actuating shaft, while the axial component of motion is provided either by a direct engagement between the contact assembly and the resistance element, so that the latter acts as a guide for the contact, or by positively driving the contact assembly axially, as by a lead screw. The first arrangement has the disadvantage that the forces required to move the contact assembly axially result in objectionable wear of the resistance element and the contact assembly. The second arrangement has the disadvantages that it is difficult to maintain accurate registry between the contact and the resistance element over the entire range of movement with usual manufacturing tolerances and that, with a given rotor and lead screw assembly, it is not possible to assemble potentiometers with resistance elements of different pitches. Both arrangements have the disadvantage that they have required a pigtail connection of considerable length between the movable contact assembly and the terminal therefor at one end of the housing or an insulated rotor shaft co-operating with a slip ring at one end of the housing.

It is an object of the present invention, therefore, to provide a new and improved precision potentiometer which eliminates one or more of the undesirable characteristics of prior potentiometers noted above.

It is a further object of the invention to provide a new and improved precision potentiometer including one or more of the following advantageous constructional features:

(*a*) Elimination of the pigtail connection between the moving contact and the external terminal therefor with consequent increased reliability, reduction in electrical noise, and freedom in the positioning of the external terminal;

(*b*) Positive positioning of the resistance element throughout its length;

(*c*) Elimination of the use of the resistance element as a guide for moving the contact assembly, thus eliminating wear of the resistance element resulting therefrom;

(*d*) Simplified construction of the rotor and stator units to facilitate "ganging" two or more units and assembly as a self-contained sub-assembly;

(*e*) Improved heat dissipation with reduced temperature gradients and thermo-electric voltages appearing in the unit.

In accordance with the invention, a precision potentiometer comprises a cylindrical housing, an elongated axially flexible guide and slip ring mounted around the inner periphery of the housing and having a terminal projecting therefrom, and an elongated resistance element mounted adjacent the slip ring and insulated therefrom and having at least one end terminal projecting from the housing. A rotor is rotatably mounted within and coaxial with the housing and a contact assembly is disposed on the rotor and includes a conductive guiding element engaging the slip ring to determine the axial position of the contact assembly and to make electrical contact therewith, and a contact element electrically connected to the guiding element and engaging the resistance element.

For a better understanding of the present invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawings, while its scope will be pointed out in the appended claims.

Referring now to the drawings:

Fig. 1 is a longitudinal sectional view of one complete multi-turn potentiometer unit embodying the invention and a portion of a second unit to show the method of ganging;

Fig. 1*a* is an enlarged longitudinal sectional detail view of a portion of the assembly of Fig. 1;

Fig. 2 is a cross-sectional view of the potentiometer shown in Fig. 1; while

Fig. 3 is an enlarged perspective view of the contact assembly of the potentiometer of Figs. 1 and 2.

Referring to Figs. 1 and 1*a* of the drawings, there is illustrated a multi-turn precision potentiometer comprising units **10** and **10***a*. To the extent that the elements of the unit **10***a* are identical with those of the unit **10** they will be identified by corresponding reference numerals with a suffix "*a*" and only the elements of the unit **10** will be specifically described. The unit **10** comprises a cylindrical housing including a cylindrical metallic shell **11** having an outwardly flared flange **12** at either end. The housing also includes a pair of circular supporting elements such as the ring **13** and a disc **14** individually engaging opposite ends of the shell **11**, as by means of the cylindrical shoulders **15** and **16** engaging the internal surfaces of the ends of the shell **11**. The unit also comprises a pair of clamping rings **17**, **18** of channel-shaped cross section engaging radially extending flanges of the supporting elements **13**, **14** and the respective adjacent flanges **12** of the shell **11**. Each of the clamping rings is provided with up-turned flanges such as the flanges **19** and **20** of the ring **18** as shown in Fig. 2, the flange **19** being apertured and the flange **20** threaded to receive a bolt **21** for tightening the ring **18** to secure the disc **14** to the shell **11**.

Mounted on the interior surface of the housing shell **11** is a slip ring **22** consisting of a strip of conductive material, such as coin silver, wound edgewise into an open helix. The slip ring **22** is insulated from the housing shell **11** as by a sheet of insulation material **23** lining the interior surface of the shell. The slip ring **22** is electrically connected to a terminal **24** (Fig. 2) projecting from one end of the shell **11**.

The potentiometer unit also comprises a wire-wound double-helical resistance element mounted between and closely filling the space between, and positively positioned by, the turns of the slip ring **22**. This resistance element is best shown in the detail view of Fig. 1*a* and comprises an insulated resistance wire **25** wound on a helical copper coil **26**. This double helix is then covered by a layer of insulation material **27** and the dimensions are so proportioned that the resistance element assembly fits

closely between adjacent turns of slip ring 22 and is positively positioned thereby. The insulation is removed from the inner surface of the composite resistance element to expose it to the movable contact to be described. Electrically connected to opposite ends of the resistance wire 25 are terminals 28 and 29 projecting from the housing shell 11 and secured in place by suitable insulating bushings 30, 31, respectively. It will be understood that the resistance element 25, 26 may have a linear resistance characteristics or may be tapered to match any desired function.

The potentiometer of the invention further comprises an elongated rotor assembly rotatably mounted within and coaxial with the housing shell 11. This rotor assembly includes a shaft 32 journalled in the end supporting disc 14 by means of anti-friction bearings 33. Mounted on the shaft 32 is a guide 34 of rectangular cross section, such as in the form of a deep channel straddling the shaft 32 as shown in Fig. 2 and secured thereto in any suitable manner as by spot welding.

The potientometer further comprises a contact assembly disposed on the rotor and slidable longitudinally thereof. This contact assembly is shown most clearly in Fig. 3 and includes a metallic stirrup 35 snugly fitting on, but slidable along, the guide 34. Secured to the stirrup 35 is a metallic contact and guiding element 36 insulated from the stirrup 35 as by a sheet of insulation material 37. One end of the element 36 is formed into a pair of guiding elements 38, 39 having upstanding ears 40 and 41, respectively, positioned resiliently to engage the outer opposing surfaces of adjacent turns of the slip ring 22 as shown in Fig. 1*a*. The other end of the element 36 is formed into a contact element 42 which is electrically connected to the guide elements 40, 41 by virtue of the integral construction. The contact element 42 is of a configuration resiliently to engage the helical resistance element, as shown most clearly in Fig. 2. The potentiometer further includes a stop element 43 secured to the end supporting disc 14 and disposed to engage the stirrup 35 of the contact assembly to determine the limit of its movement in its right-hand position as seen in Fig. 1.

The unit 10 of the multi-torn potentiometer has so far been described as one unit of a multiple unit potentiometer including also the unit 10*a*, in which case the left-hand supporting element of the unit 10*a* may be identical to the supporting element 14. In this case, no physical separation between the interior of the units 10 and 10*a* is required and the supporting element 13 is in the form of an annular ring. In this arrangement, no bearing is required at this point between the two units. Similarly, the stop element for limiting the movement of the contact assemblies in the opposite direction is mounted on the opposite supporting element (not shown) as the stop 43 on the disc 14.

In the event that only a single unit potentiometer is desired, it will be apparent that a closing disc like the disc 14 may be substituted for the annular ring 13, in which event the shaft 32 will be supported in anti-friction bearings mounted in such disc. In this event also, the stop pin for limiting the motion of the contact assembly in its extreme left-hand position will be disposed on such disc. Each of the units 10, 10*a* may include a resistance element 25, 26 of any selected number of turns or, if desired, a single turn in which case the helical slip ring 22 may be replaced by a pair of circular rings on either side of the resistance element and extending around the inner periphery of the housing.

It is believed that the operation of the multi-turn precision potentiometer of the invention will be apparent from the foregoing description. Rotation of the shaft 32 and its connected guide 34 imparts a rotational component of motion to the contact assembly 35–42, inclusive. The guiding elements 40, 41, resiliently engaging adjacent turns of the helical slip ring 22, give the necessary

axial component of motion to the contact assembly, which slides along the guide 34 so as to maintain the contact element 42 continuously in engagement with the resistance element. When the contact assembly reaches the limit of its movement, as determined by engagement of the stirrup 35 with the stop pin 43, or with a corresponding stop pin at the opposite end of the unit or connected unit, the contact element 42 will register with one end of the resistance element. The two end terminals 28, 29 of the resistance element and the terminal 24 connected to the slip ring 22, which, in turn, is electrically connected to the contact element 42, provide the conventional electrical connections to the potentiometer. If it is desired to use the unit as a simple variable resistor, only one of the end terminals 28, 29 and the slip-ring terminal 24 is required.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A precision potentiometer comprising: a cylindrical housing; an elongated axially flexible guide and slip ring mounted around the inner periphery of said housing and having a terminal projecting therefrom; an elongated resistance element mounted adjacent said slip ring and insulated therefrom and having at least one end terminal projecting from said housing; a rotor rotatably mounted within and coaxial with said housing; and a contact assembly disposed on said rotor and including a conductive guiding element engaging said ring to determine the axial position of said contact assembly and to make electrical contact therewith and a contact element electrically connected to said guiding element and engaging said resistance element.

2. A multi-turn precision potentiometer comprising: a cylindrical housing; an open helical axially flexible guide and slip ring mounted on the interior surface of said housing and having a terminal projecting therefrom; a helical resistance element mounted between the turns of said slip ring and insulated therefrom and having at least one end terminal projecting from said housing; a rotor rotatably mounted within and coaxial with said housing; and a contact assembly slidably disposed on said rotor longitudinally thereof and including a conductive guiding element engaging said ring to actuate said contact assembly axially upon rotation of said rotor and to make electrical contact therewith and a contact element electrically connected to said guiding element and engaging said resistance element.

3. A multi-turn precision potentiometer comprising: a cylindrical housing; a guide and slip ring consisting of a strip of conductive material wound edgewise into an open axially flexible helix and mounted on the interior surface of said housing and having a terminal projecting therefrom; a helical resistance element mounted between the turns of said slip ring and insulated therefrom and having at least one end terminal projecting from said housing; a rotor rotatably mounted within and coaxial with said housing; and a contact assembly slidably disposed on said rotor longitudinally thereof and including a conductive guiding element engaging said ring to actuate said contact assembly axially upon rotation of said rotor and to make electrical contact therewith and a contact element electrically connected to said guiding element and engaging said resistance element.

4. A multi-turn precision potentiometer comprising: a cylindrical housing; an open helical axially flexible guide and slip ring mounted on the interior surface of said housing and having a terminal projecting therefrom; a wire-round double-helical resistance element mounted be-

tween the turns of said slip ring and insulated therefrom and having at least one end terminal projecting from said housing; a rotor rotatably mounted within and coaxial with said housing; and a contact assembly slidably disposed on said rotor longitudinally thereof and including a conductive guiding element engaging said ring to actuate said contact assembly axially upon rotation of said rotor and to make electrical contact therewith and a contact element electrically connected to said guiding element and engaging said resistance element.

5. A multi-turn precision potentiometer comprising: a cylindrical housing; an open helical axially flexible guide and slip ring mounted on the interior surface of said housing and having a terminal projecting therefrom; a helical resistance element mounted between and closely filling the space between and positively positioned by the turns of said slip ring and insulated therefrom and having at least one end terminal projecting from said housing; a rotor rotatably mounted within and coaxial with said housing; and a contact assembly slidably disposed on said rotor longitudinally thereof and including a conductive guiding element engaging said ring to actuate said contact assembly axially upon rotation of said rotor and to make electrical contact therewith and a contact element electrically connected to said guiding element and engaging said resistance element.

6. A multi-turn precision potentiometer comprising: a cylindrical housing; an open helical axially flexible guide and slip ring mounted on the interior surface of said housing and having a terminal projecting therefrom; a helical resistance element mounted between the turns of said slip ring and insulated therefrom and having at least one end terminal projecting from said housing; a rotor rotatably mounted within and coaxial with said housing and including a guide of rectangular cross section; and a contact assembly including a stirrup slidably disposed on said guide and a conductive guiding element engaging said ring to actuate said contact assembly axially upon rotation of said rotor and to make electrical contact therewith and a contact element electrically connected to said guiding element and engaging said resistance element.

7. A multi-turn precision potentiometer comprising: a cylindrical housing; an open helical axially flexible guide and slip ring mounted on the interior surface of said housing and having a terminal projecting therefrom; a helical resistance element mounted between the turns of said slip ring and insulated therefrom and having at least one end terminal projecting from said housing; a rotor rotatably mounted within and coaxial with said housing; and a contact assembly slidably disposed on said rotor longitudinally thereof and including a pair of conductive guiding elements engaging adjacent turns of said ring to actuate said contact assembly axially upon rotation of said rotor and to make electrical contact therewith and a contact element electrically connected to said guiding elements and engaging said resistance element.

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