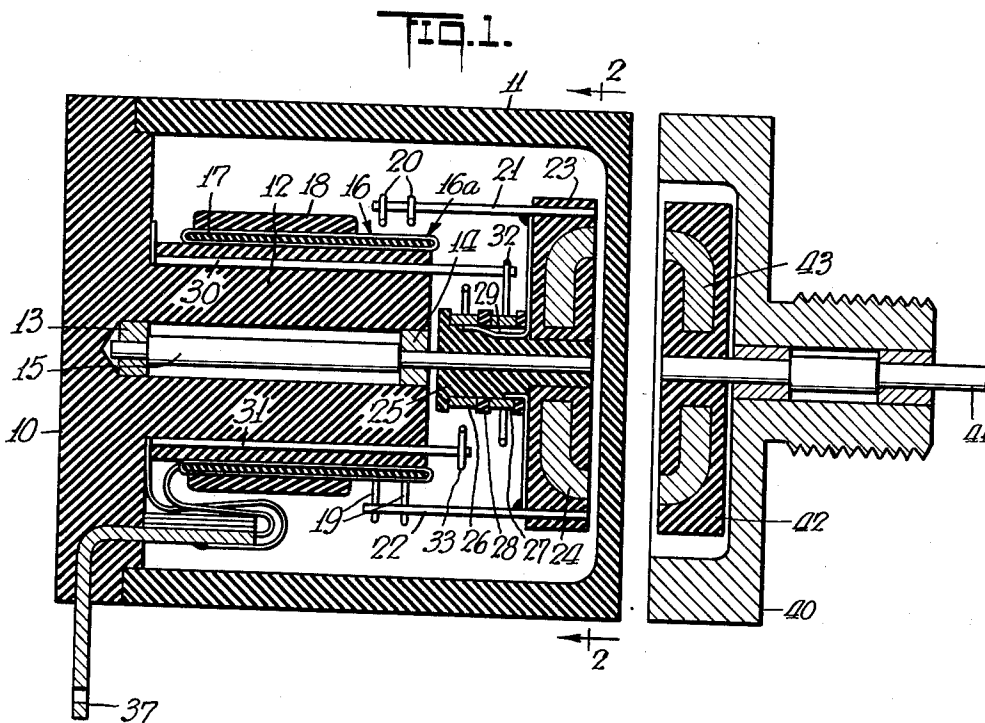
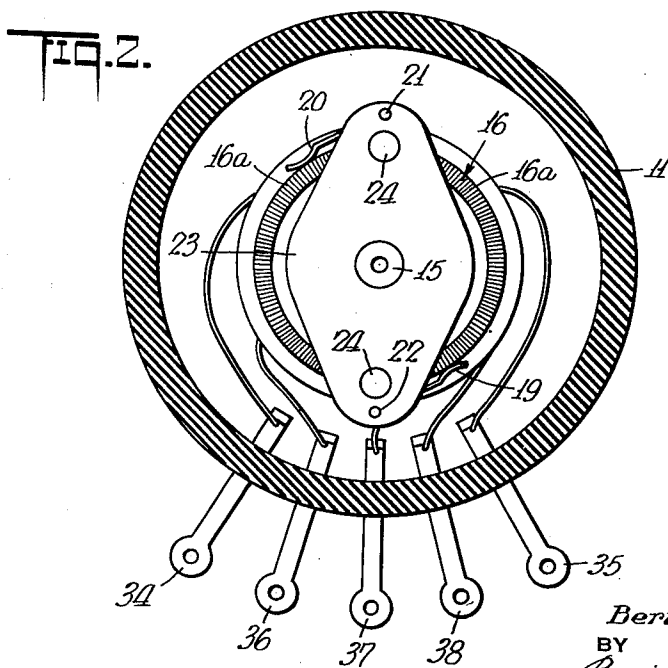


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VARIABLE RESISTOR
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VARIABLE RESISTOR

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This invention relates to variable resistors such as rheostats and potentiometers, and more particularly to ultra low torque potentiometers of the type used in telemetering devices, guided missiles, radiosondes, etc.

In the electrical telemetering art, for example, rheostats or potentiometers are employed in which very low power or torque is required to operate them. For many uses in this and related fields it is necessary to employ a variable resistor having a brush pressure of the order of 7 to 10 grams. The torque necessary to operate potentiometers of this type is about 1 inch ounce (1 ounce per inch of rotation). Such potentiometers are described in the trade as "low torque" potentiometers. There is also employed commercially today the so-called "ultra low torque" potentiometers in which torques as low as .003 inch ounce are required for their operation. This invention is particularly concerned with the construction and design of such low torque potentiometers; the term low torque is used herein to include potentiometers requiring a torque of the order of 1 inch ounce for operation as well as the "ultra low torque" potentiometers which can be operated with a torque as low as .003 inch ounce. It will be understood, however, that this invention is not limited to potentiometers involving a rotary member, such as a rotary brush, but is applicable to the construction of the resistance units of all delicate and precise variable resistors involving a resistance unit and a contact member which are relatively movable.

In the construction of such delicate and precise variable resistors it is important that the resistance unit and contacting brush or other contact have the following properties.

1. Low contact resistance, i. e., the pressure of the brush or contact member on the resistance unit is low. In the case of ultra low torque and even low torque potentiometers this is very important because if this resistance is high, torques in excess of the values above noted are required for their operation.

2. The resistance wire has a low temperature coefficient of resistivity, i. e., variation in resistance is very small when the wire is subjected to temperature changes.

3. The resistance wire has a relatively high resistance so that it can serve its intended function as a variable resistance unit.

4. The resistance wire has a high tensile strength so that it will not break readily in use and even when drawn to the very fine wire required for some variable resistors, it can be

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readily wound to form the variable resistance unit without danger of breaking.

A low torque potentiometer having a platinum or platinum-iridium wire resistance unit in combination with a platinum or platinum-iridium wire brush which is highly polished to give positive contact with relatively low contact resistance and low frictional drag is disclosed in United States Patent 2,456,261 granted December 14, 1948.

It is an object of this invention to provide a variable resistor which combines to an unusual extent the four properties hereinabove noted as requisite for variable resistors.

Other objects and advantages of this invention will be apparent from the following detailed description thereof.

In accordance with this invention the resistance unit of the variable resistor is formed of an alloy containing from 2% to 10%, preferably about 6% to 8%, by weight of tungsten or molybdenum, or both, the rest being chiefly platinum, the alloy containing, if desired, from .001% to .25% of an added metal such as manganese, titanium, aluminum, thorium, and/or zirconium. This resistance unit is contacted by a brush or sliding contact which may be of platinum, a platinum alloy, such as a platinum-iridium alloy or a platinum-rhodium-ruthenium alloy containing from 2% to 25% rhodium, 2% to 15% ruthenium, the rest being platinum disclosed in my Patent No. 2,080,110, but preferably is a platinum alloy known as Paliney 7 which is now manufactured by the J. M. Ney Company of Hartford, Connecticut, which alloy is believed to consist primarily of platinum, palladium, gold, silver and copper. For best results the alloy employed for the brush or movable contact should be of different composition from that of the resistance wire.

In the preferred embodiment illustrated on the drawing, the invention is shown incorporated in a low torque toroidal resistor and the description which follows will be confined to this illustrated embodiment of the invention. It will be understood, however, that this invention is susceptible to other applications, such, for example, as rheostats and potentiometers in which a movable contact member, such as a sliding member, engages a resistance wire, or in which the resistance unit and contact member are otherwise relatively movable. Hence, the scope of this invention is not confined to the embodiment herein described.

In the accompanying drawing forming a part

of this specification and showing, for purposes of exemplification, a preferred form of this invention without limiting the claimed invention to such illustrative instance:

Figure 1 is an enlarged sectional view of one form of low torque toroidal resistor in which this invention is embodied; and

Figure 2 is an enlarged sectional view taken in a plane passing through line 2—2 of Figure 1.

Referring to the drawing the low torque resistor shown comprises a base portion 10 covered by a hermetically sealed cover 11. Extending from the base portion 10 and forming an integral part thereof is a cylindrical extension 12 in which is disposed anti-friction bearings 13 and 14. A shaft 15 is rotatably journaled in the anti-friction bearings 13 and 14.

Around the periphery of cylindrical extension 12 is located a resistance unit 16 embodying my invention. This resistance unit consists of many turns of fine resistance wire 16^a which may be of a diameter of from .00035" to .010", preferably from .0004" to .002", wound on a cylindrical plastic or metal form 17. The wire may be wound in closely spaced convolutions, as shown in Figure 2, extending around the full 360° of the cylindrical form 17, or only around a portion of the cylindrical form, say about 270°, depending upon the use to which the resistor may be placed. Each convolution, it will be noted, extends the length of the cylindrical form 17, the wire being wound so that it passes about the outside of the form along the length of its cylindrical periphery then about the inside, etc. The resistance wire may be enamelled, except for the portion lying beneath the brushes and contacted thereby, which brushes are hereinafter described.

The wire 16^a of the resistance unit 16 in accordance with this invention is made of an alloy containing from 2% to 10% tungsten of molybdenum or both, preferably from about 6% to about 8%, the rest of the alloy being chiefly platinum. Small amounts, e. g., from .001% to .25% by weight of manganese, titanium, aluminum, thorium, or zirconium may be incorporated in the alloy. These metals when added to the melt from which the alloy is produced function as degasifiers, and, hence, result in better alloys.

Closely surrounding the resistance coil 16 is a cylindrical protector 18 which serves to keep the resistance wire 16^a snugly flat against form 17 and tends to prevent any separation of the turns of the wire under the minute drag of brushes 19 and 20. Cylindrical protector 18 may be made of plastic or any suitable dielectric.

The brushes 19 and 20, as above described, may be of platinum, a platinum alloy, such as platinum-iridium or platinum-rhodium-ruthenium. Preferably, they are made of the alloy Paliney 7 hereinabove described. The portion of the resistance wire 16^a adapted to be contacted by the brushes, and the brushes 19 and 20 are highly polished to present a minimal friction. I have found that the use of the platinum alloy hereinabove described for the resistance wire 16^a results in exceptionally low contact resistance between the brushes and the resistance wire. The brushes 19 and 20 are carried by two metal brush supports 21, 22 which extend from a supporting member 23 molded of a suitable plastic. A small permanent magnet 24 is disposed within the supporting member 23, which magnet may be formed from Alnico or other highly magnetizable material.

Mounted on rotatable shaft 15 is bushing 25. Collector rings 26, 27 separated by a washer 28 are disposed on this bushing. Small channels diametrically opposed are cut longitudinally in bushing 25 to accommodate the necessary electrical connections leading from the collector rings 26, 27 to the respective brush supports 21, 22. One of these channels is indicated at 29 in Figure 1. Leads 30 and 31 are imbedded in cylindrical extension 12 and serve to support wire brushes 32 and 33. These brushes contact the collector rings 26 and 27 which desirably are of platinum. Leads 30 and 31 are connected to terminals 34 and 35. Terminals 36, 37 and 38 communicate with taps on the resistance coil 16, which taps may be situated 120° apart. These terminals 34 to 38 may be of brass or of copper and are molded in place during the fabrication of base 10.

A detachable driving unit may be provided in the form of a cup-shaped member 40 adapted to be secured to cover 11 by any suitable means. This member has rotatably journaled therein a shaft 41 which has mounted thereon a supporting member 42 identical in shape, configuration and material to member 23. Member 42 has disposed therein a permanent magnet 43 identical with the permanent magnet 24. Shafts 15 and 41 have the same longitudinal axis and magnets 24 and 43 rotate in closely adjacent and substantially parallel planes. Accordingly, rotation of shaft 41 and magnet 43 will effect a corresponding rotation in magnet 24 and shaft 15, thus effecting the desired change in the resistance of the resistance unit.

The present invention is concerned primarily with the chemical composition of the alloy from which resistance wire 16^a is produced and with the brushes 19 and 20 which should be of a platinum composition different from that of resistance wire 16^a. Brushes 19 and 20 preferably are of Paliney 7. The remaining parts of the low torque toroidal resistor may be of any suitable construction. The construction herein illustrated and described is of the type disclosed in United States Patent 2,456,261. Reference may be had to this patent for a more detailed description of the remaining parts.

The following comparative data taken with the fact that the resistance unit of my invention when employed with a platinum or platinum alloy contact member, particularly a contact member of Paliney 7 has an exceptionally low contact resistance, demonstrates that my invention embodies to an exceptional extent the four properties hereinabove noted requisite for a low torque variable resistor.

Composition of Resistance Wire Tested	Resistance in Ohms per Circular Mill Foot at 23° C.	Electrical Coefficient of Resistivity in Ohms per Degree C. (0-100° C.)	Elongation, Per Cent	Tensile Strength, Pounds per Square Inch
60				
65 Resistor of this invention containing:				
8% tungsten.....	360	.00025	2	320,000
92% platinum.....				
2% molybdenum.....	420	.0002	2	340,000
6% tungsten.....				
92% platinum.....				
70 Prior known resistors:				
20% iridium.....	102	.0008	1	240,000
80% platinum.....				
25% iridium.....	205	.0006	1	260,000
75% platinum.....				

75 The iridium platinum alloys tested were wire

sold commercially for use in making the resistance units of low torque potentiometers. This wire had a diameter of .001". The platinum tungsten wire tested had the same diameter.

From the foregoing it will be evident that resistors embodying this invention combine to an exceptional extent the properties of (1) low contact resistance, (2) low temperature coefficient of resistivity, (3) relatively high resistance and (4) high tensile strength. They are therefore exceptionally useful in the field of low torque resistors and for delicate and precise resistors involving a resistance unit and contact member which are relatively movable to vary the resistance in the circuit in which the variable resistor may be disposed.

Since different embodiments of the invention could be made without departing from the scope of this invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A low torque toroidal resistor comprising a cylindrical support, a resistance wire wound on said support with successive convolutions disposed closely adjacent each other, each convolution being disposed the length of said cylindrical support, said resistance wire being composed of an alloy containing from 6% to 8% by weight of a metal from the group consisting of tungsten and molybdenum, from .001% to .25% by weight of a metal from the group consisting of manganese, titanium, aluminum, thorium and zirconium, the rest of said alloy consisting essentially of platinum, and a movable brush in contact with said resistance wire, said brush being rotatable about the periphery of said cylindrical support, said brush consisting of a platinum alloy the composition of which differs from the composition of said resistance wire.

2. A variable resistor comprising a longi-

tudinally extending support, a resistance wire wound on said support with successive convolutions disposed closely adjacent each other, said resistance wire being composed of an alloy containing from 2% to 10% by weight of metal from the group consisting of tungsten, molybdenum and mixtures of tungsten and molybdenum, the rest of said alloy consisting essentially of platinum, and a movable brush in contact with said resistance wire and movable across the windings, said brush being composed of a noble metal as a major constituent thereof.

3. A variable resistor as defined in claim 2, in which the resistance wire is composed of a platinum alloy which contains in addition to the metal from the group consisting of tungsten, molybdenum and the mixtures of tungsten and molybdenum from .0012% to .25% by weight of a metal from the group consisting of manganese, titanium, aluminum, thorium and zirconium.

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