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ELECTRICAL RESISTANCE DEVICES

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This invention relates generally to electrical resistance devices and, more particularly, to potentiometers capable of being easily assembled and disassembled, said potentiometers having long-wearing and low-noise characteristics.

In the design of potentiometers, especially those of substantially small size which may be used in airborne systems, it is desirable to provide units which have long life and which have substantially stable resistances over wide ranges of temperature and moisture conditions. Moreover, it is desirable to obtain resistive elements in the potentiometers which have low noise characteristics and which maintain substantially linear resistance characteristics over the usable range of the unit. In addition, such potentiometers should be capable of being easily assembled so as to reduce construction difficulties and, hence, reduce manufacturing costs.

Prior art devices of this type have utilized resistance elements fabricated from the newer conductive plastic materials in order to obtain potentiometers having infinite resolution, a high reliability of operation and long life. However, even these potentiometers, as well as those using more conventional resistance materials, have some undesirable disadvantages. For example, many prior art potentiometers, especially those where small size is a necessity, are relatively difficult to assemble correctly without a great deal of skill and time being required. Moreover, the disassembly of such potentiometers usually involves such difficulties that the resistance track or other elements in the potentiometer are easily damaged. In the assembly of such prior art potentiometers, it is not always possible to assure that the commutator wiper arm is actually making a good contact with the commutator. In addition, the susceptibility to change in electrical or mechanical characteristics due to moisture conditions has been an undesirable feature of such prior art devices. In many instances, expansion of the materials used in prior art potentiometers has caused cracking of the potentiometer cases.

This invention, however, provides a potentiometer which is easily assembled and disassembled without damage to the potentiometer elements. In the invention, this is accomplished by providing a rotor-commutator subassembly unit which is itself easily assembled prior to the final assembly of the entire unit. This subassembly unit may be easily attached to the potentiometer housing by means of a retaining washer readily accessible for that purpose. The commutator wiper arm of the invention is constructed in a V-shaped form and secured to the wiper terminal mounted on the potentiometer end plate prior to securing the end plate to the housing. The rotor-commutator subassembly is constructed so as to have rounded or beveled edges to provide an inclined surface. Thus, during final assembly, the V-shaped wiper arm is allowed to slide easily over this inclined surface so that the V-shaped legs of the wiper arm straddle the commutator in an appropriate manner to maintain continuous contact with the commutator during rotation of the potentiometer shaft. Thus, there is a high degree of assurance that, when the end plate containing the resistance element and the commutator wiper arm is secured to the housing containing the rotor-commutator subassembly, the commutator will be brought into contact with and

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continue to remain in contact with the V-shaped wiper arm.

Other advantages in the potentiometer of the invention over the prior art devices will become apparent to those in the art in the more detailed description which follows. The potentiometer of the invention can be most easily described with the help of the drawing in which:

FIG. 1 shows a particular embodiment of the potentiometer of the invention; and

FIG. 2 shows a portion of another particular embodiment of the invention utilizing an alternative method for contacting the resistance track during rotation of the potentiometer shaft.

In FIG. 1, there is shown a partially cut-away, exploded view of a particular embodiment of the potentiometer of the invention. The potentiometer is shown in three sections: a housing unit 11, a rotor-commutator subassembly unit 24, and an end-plate unit 40. The potentiometer comprises a housing shell 19 having an opening 12 at one side through which extends a shaft 13 shown as part of rotor-commutator subassembly unit 24. Shaft 13 is supported by bearing 14 which is held within a recess 15 of housing 11 by means of screws (not shown) inserted within holes 17 placed in washer 16.

End plate 40 is made of a suitable nonconductive plastic material which has a low coefficient of expansion in the presence of moisture or heat. End plate 40 is sometimes familiarly known to those skilled in the art as the resistance card. It has a raised circular track 18 mounted concentric with shaft 13. Track 18 has a first section 41 made of a suitable resistance material. For many applications, it is desirable to utilize a conductive plastic material as the resistance material of section 41 of track 18. Besides the advantage of long life and reliability obtained from using such conductive plastics, it has been found that wider flexibility with regard to the ranges of resistance values desired is possible with these materials. A pair of terminals 20 are electrically connected to conductive plastic section 41 of track 18 and extend through end plate 40 so that external connections can be easily made. Conductive plastic section 41 comprises substantially the entire length of track 18. A second section 42 of track 18 is located in the region comprising the shorter path between terminals 20. Section 42 is made of a nonconductive plastic material having a low coefficient of friction.

A bearing 22 supports the inner end of shaft 13 in an opening 23 of end plate 40. Inner end 21 of shaft 13 extends through opening 23 and has a slot 43 into which a screw driver may be inserted to adjust the mechanical zero of the potentiometer when the potentiometer is mounted for use in conjunction with other equipment.

Rotor-commutator subassembly 24 is mounted on shaft 13 in the general vicinity of resistance track 18. Subassembly 24 is composed of an insulating element 25 mounted directly on shaft 13 near its inner end. A rotor 26 has a cylindrical portion 27 mounted so as to enclose insulating element 25. A commutator ring 28 is press fit over cylindrical portion 27 of rotor 26. The exposed ends of rotor portion 27 and fluorocarbon insulating element 25 and the outer edges 45 of commutator 28 are rounded for easier assembly, as described in subsequent paragraphs. A contact wiper arm 29 is secured to rotor 26 by means of a pair of rivets only one of which (rivet 30) is shown on the drawing, the other being hidden behind the rotor, commutator and insulating element subassembly. Contact wiper 29 includes a spring element 31 having a contact tip 32 which is tensioned against resistance track 18 so that tip 32 moves along track 18 as shaft 13 is rotated. The low coefficient of friction of conductive plastic section 41 and of nonconductive plastic

section 42 assures a smooth easy tracking of the contact tip during rotation of the shaft.

A third terminal 33 is inserted in end plate 40 and extends through end plate 40 so that an external connection can be easily made. V-shaped wiper 35 is secured to inner end 34 of terminal 33. The legs of V-shaped wiper 35 are positioned so as to straddle commutator ring 28 when the potentiometer is completely assembled. Thus, as shaft 13 is rotated, terminal 33 maintains continuous electrical contact with commutator ring 28 and, hence, with contact member 29.

Insulating element 25 is made of a fluorocarbon material which provides good mechanical strength and good electrical characteristics. Its insulation resistance is very high even in the presence of moisture because the material is substantially not permeable to the presence of moisture. Commutator 28 is constructed of a solid coin silver material and contact tip 32 is fabricated from a precious metal alloy. One such alloy which has been found to be satisfactory for this use is a palladium alloy sold commercially under the name "Paliney." The combination of coin silver and precious metal protects against excessive wear during rotation and, thus, assures a long, usable life as well as low electrical noise characteristics.

The potentiometer is designed so that bearing 14, shaft 13, and rotor assembly 24 can be preassembled prior to final assembly of the complete potentiometer. The assembling of rotor-commutator subassembly unit 24 to housing 11 is then easily made prior to attaching end plate 40 by securing retaining washer 16 to housing 11 by means of screws (not shown) inserted through holes 17. The screws may be tightened by inserting a screw driver through an opening 41 in rotor 26 which can be appropriately positioned opposite each of holes 17.

The cylindrical shape and rounded edges of the rotor-commutator-insulator assembly permits a relatively easy blind assembly of end plate 40 to housing 11 with a high degree of assurance that V-shaped wiper 35 will straddle commutator ring 28 and maintain its position during use.

The embodiment shown in FIG. 1 is not necessarily the only embodiment that is capable of utilizing the structure of the invention. FIG. 2 shows a partial sectional view of a portion of a potentiometer assembly which uses a different structure for providing a contact between the rotor and the resistance track. In that figure there is shown a portion of shaft 13, commutator 28, and insulating element 25. A rotor 50 is shown mounted on shaft 13. Rotor 50 has a contact arm 51 riveted to rotor 50 by a pair of rivets 52. Contact arm 51 is made of a spring-like material and has a contact tip 53 which is thereby caused to ride upon the inner slanting surface 54 of a resistance track 55 mounted on end plate 40. The embodiment shown in FIG. 2 represents one of many alternative ways of providing contact between the rotor and resistance track. Other ways will be obvious to those skilled in the art within the scope of this invention. As in the embodiment shown in FIG. 1, contact tip 53 is made of a precious metal.

The potentiometers shown in the figures and described above represent two particular embodiments of the invention. Other embodiments within the scope of the invention utilizing obvious variations in construction may occur to those skilled in the art. The resistance track need not necessarily be of a conductive plastic but any material of an electrical resistive nature may be used. The contact wiper arm may be constructed to contact resistance track 18 in other ways so long as a good contact is provided to the resistive material. The rotor and commutator need not necessarily be constructed as two separate pieces. For example, the rotor and commutator may be constructed as one piece wherein the rotor is constructed from a suitable material, such as brass, and its cylindrical portion is plated with silver to provide good electrical contact with V-shaped wiper 35. Hence,

the invention is not to be construed to be limited to the specific embodiment described herein and shown in the drawing except as defined by the appended claims. The edges of the commutator, the rotor and the insulating element need not be necessarily rounded as shown, but other methods may be devised by those in the art to eliminate the sharp edges and, thus, provide an inclined surface for the V-shaped wiper arm. For example, the edges of these elements may be beveled so that, during the assembling process, the wiper arm may easily slide over the beveled portion and come to rest in a straddled position about the commutator.

What is claimed is:

1. A variable resistance device comprising a conductive plastic resistance element; a rotor having a cylindrically shaped portion; contact means attached to said rotor; a shaft for rotating said rotor to move said contact means along the surface of and in electrical contact with said resistance element; a commutator ring mounted over said cylindrical portion of said rotor, said commutator ring having substantially rounded edges for providing an inclined surface; a third terminal; a V-shaped wiper slidable over said inclined surface being connected to said third terminal and straddling said commutator ring for providing a continuous connection between said rotor and said third terminal; and a fluorocarbon insulating element mounted on said shaft for electrically insulating said rotor from said shaft.

2. A variable resistance device comprising a conductive plastic resistance element; a pair of terminals connected to said resistance element; a rotor having a cylindrically shaped portion, a precious metal contact means attached to said rotor; a shaft for rotating said rotor to move said contact means along the surface of and in electrical contact with said resistance element, a third terminal, a coin silver commutator ring mounted over said cylindrical portion of said rotor, said commutator ring having substantially rounded edges for providing an inclined surface, a V-shaped wiper slidable over said inclined surface being connected to said third terminal and straddling said commutator ring for providing a continuous connection between said rotor and said third terminal, and a fluorocarbon insulating element mounted on said shaft for electrically insulating said rotor from said shaft.

3. A potentiometer device comprising a case having an end plate; a conductive plastic resistance element secured to said end plate; a pair of terminal attached to and in electrical contact with said resistance element; a rotor-commutator subassembly including a shaft extending through an opening in said case, a fluorocarbon insulating element mounted on said shaft, a rotor having a cylindrically shaped portion mounted on said insulating element, a precious metal contact means attached to said rotor and movable along the surface of and in electrical contact with said resistance element upon rotation of said shaft, and a commutator ring mounted on said cylindrical portion of said rotor, said commutator ring having substantially rounded edges for providing an inclined surface; a third terminal; a V-shaped wiper slidable over said inclined surface being attached to said third terminal and straddling said commutator ring for continuously connecting said commutator ring to said third terminal when said shaft is rotated; and a retaining washer mounted on said shaft for securing said rotor-commutator subassembly to said case whereby said shaft, said rotor, said insulator, said commutator ring and said contact means may be preassembled and mounted as an integral unit within said case.

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