Oct. 16, 1962 J. W. BAMFORD 3,059,200

MINIATURE POTENTIOMETER

Filed Nov. 9, 1959 3 Sheets-Sheet 1

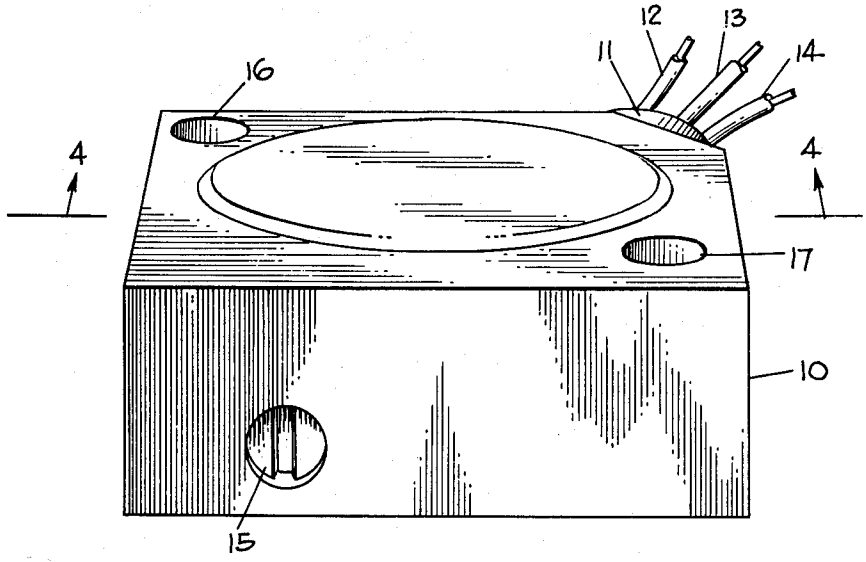


FIG. 1.

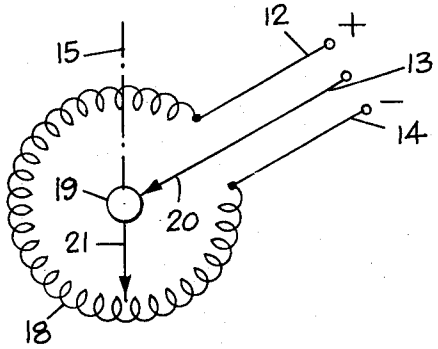


FIG. 2.

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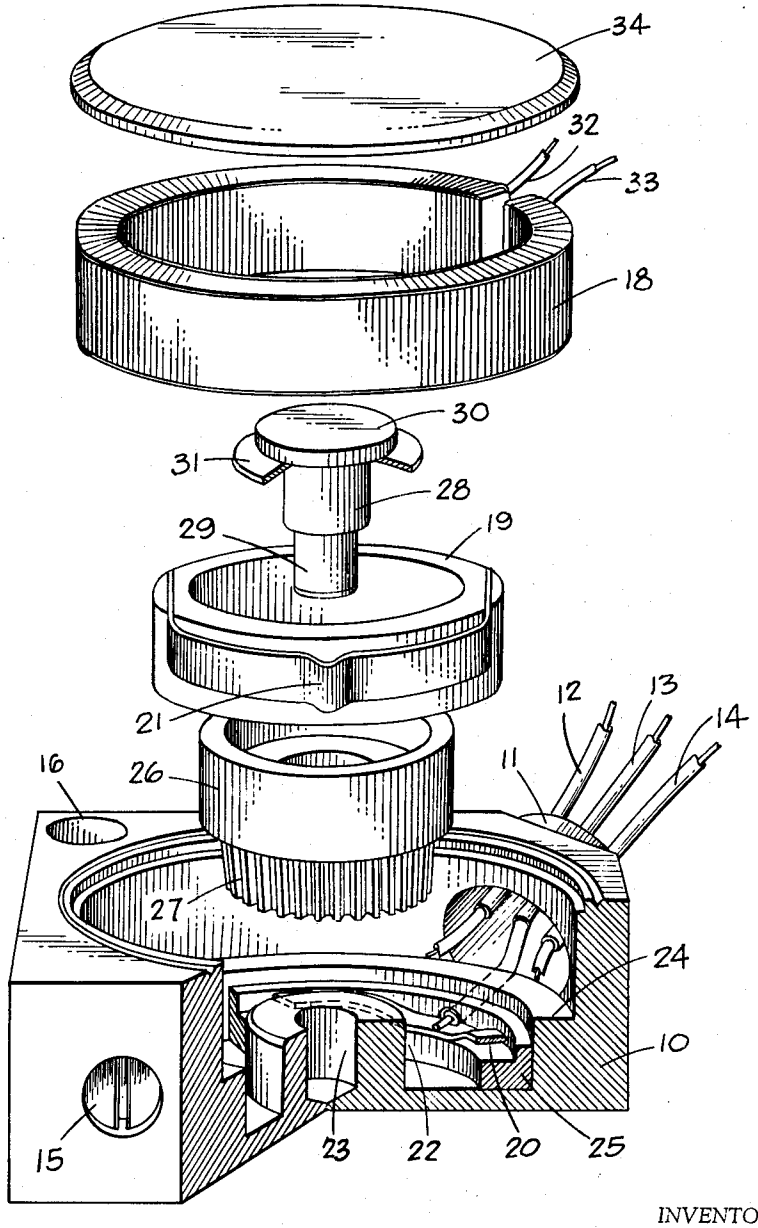


FIG. 3.

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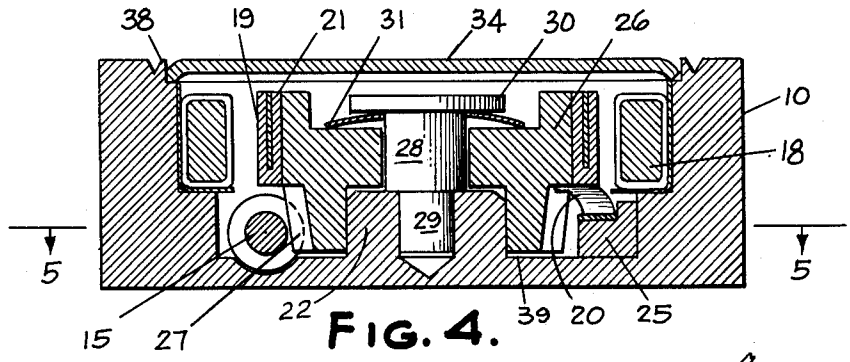


FIG. 4.

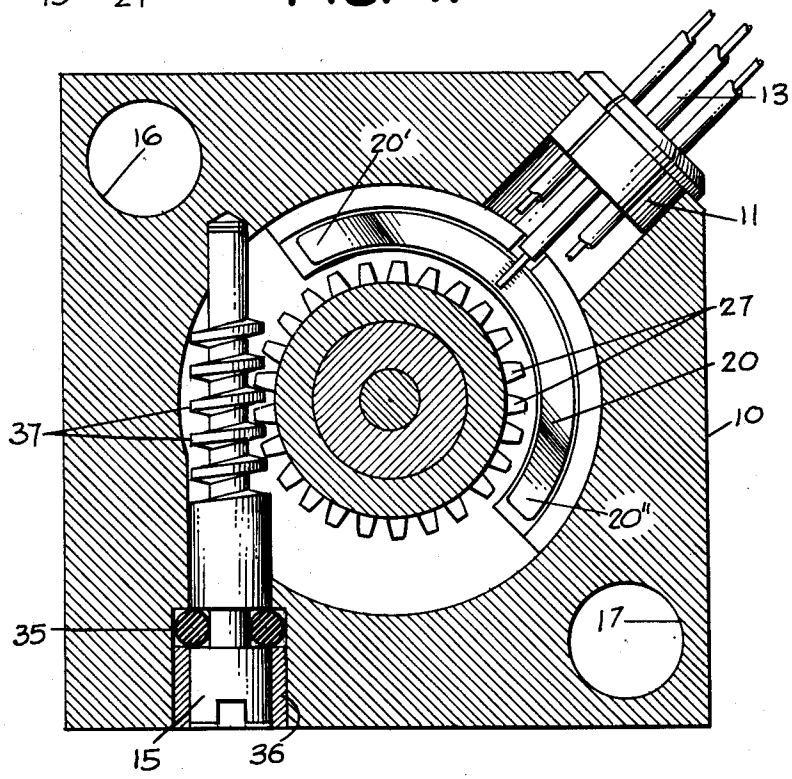


FIG. 5.

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MINIATURE POTENTIOMETER

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8 Claims. (Cl. 338—174)

This invention relates generally to electrical potentiometers and more particularly to an improved miniature potentiometer which is adjustable.

In the miniaturization of voltage dividing potentiometers, the preferred designs presently available generally incorporate a C-shaped resistance element positioned within a casing. A wiper arm assembly is arranged to rotate about a central axis to engage various annular portions of the resistance element. Generally a simple gear and worm drive are employed to effect this rotation. By such an arrangement, a relatively large range in resistance variation can be accommodated within a small volume.

In assemblies of the foregoing type, it is important that a reliable electrical connection from the movable wiper contact to one of the external terminals on the casing be assured. Towards this end, various types of contacting means in combination with suitable bearing supports have been proposed to insure a proper contact at all times. It has heretofore been difficult however to insure reliable electrical continuity without unduly increasing the thickness dimensions of the potentiometer casing itself.

Another problem which requires careful attention in the miniaturization of electrical potentiometers is that of enabling sufficient heat dissipation to take place. The size of the potentiometer has therefore been compromised to provide sufficient heat dissipating surface to meet the required power handling capabilities.

In addition to the foregoing, gear driven potentiometers are subject to backlash unless suitable steps are taken to avoid this problem. Any such backlash will seriously affect the accuracy with which the potentiometer may be pre-set. It is thus desirable to provide some means for avoiding backlash in the gear drives without increasing the overall dimensions of the device itself. Also, the potentiometer casings in present day devices are carefully sealed and in the event the cover portions include structural elements necessary for effective operation of the potentiometer, it is not possible to check out the device until after the cover has been sealed in position.

Bearing all of the foregoing in mind, it is a primary object of the present invention to provide a greatly improved miniaturized electrical potentiometer in which improved electrical continuity is realized and yet in which the overall thickness dimensions of the casing itself can be made smaller than present day devices of equal capacity.

Another important object of this invention is to provide a modified type of resistance element in which a greater length of resistance wire can be accommodated within a given circumferential opening thereby increasing the overall resistance range of the device and in addition providing an increased area for heat dissipation, to the end that improved operation and greater versatility can be realized without increasing the overall casing dimensions beyond prescribed limits.

Other objects of the invention include means for avoiding backlash and for enabling check out of the instrument prior to closing and sealing.

Briefly these and many other objects and advantages of this invention are attained by providing a miniature casing having a central recessed opening. A modified type of C-shaped resistance element having a rectangular cross section is positioned about the inside annular wall of the opening. This rectangular cross section not only enables

a greater length of resistance wire to be used, but also provides an increased surface area for heat dissipation. Also concentrically positioned in the central opening is a gear body having lateral gear teeth positioned below the resistance element. A worm extends horizontally into the casing to drive the gear. The upper part of the gear body in turn is rigidly secured to a wiper contact supporting ring. This ring is of conducting material and is generally cylindrical shaped and positioned concentrically and coplanarly with the resistance element. The conducting ring includes a wiper contact arranged to wipe about the inside surface of the resistance element. By this concentric and co-planar arrangement, the casing structure may be maintained relatively thin since no wiping takes place about the top of the resistance element.

A preferred type of resilient contacting means for making electrical connection from a fixed terminal on the casing to the wiper contact is achieved by a flexible strip secured to the floor of the recessed opening and having at least one end biased into engagement with the conducting ring. This electrical connection is effected in a region substantially wholly within the area enclosed by the resistance element and gear body so that again minimum thickness of the overall structure can be realized.

In accord with an important feature of the invention, the gear body is biased in a manner to cause the gear teeth to be urged into the corresponding teeth of the worm drive thereby preventing any backlash.

A better understanding of the foregoing as well as further features of the invention will be had by referring to the detailed description of one embodiment thereof in conjunction with the accompanying drawings, in which:

FIGURE 1 is a perspective view of the miniature potentiometer in completely assembled condition;

FIGURE 2 is a schematic electrical circuit diagram of the potentiometer;

FIGURE 3 is an enlarged perspective exploded view showing various components of the miniature potentiometer;

FIGURE 4 is a cross section of the potentiometer in assembled condition taken in the direction of the arrows 4—4 of FIGURE 1; and

FIGURE 5 is a top cross section taken in the direction of the arrows 5—5 of FIGURE 4.

Referring first to FIGURE 1, the potentiometer comprises a casing 10 having a beveled corner and inlet plug 11 for first, second, and third terminal leads 12, 13, and 14. An adjustment screw 15 is exposed on one side of the casing 10 to enable adjustment of the potentiometer. Suitable corner bore holes 16 and 17 are provided for physically securing the potentiometer in a given location.

In the actual embodiment of the potentiometer, the width and length dimensions are of the order of three-eighths of an inch and the thickness dimension of the order of three-sixteenths of an inch.

FIGURE 2 illustrates the electrical portions of the circuit schematically. As shown, a generally C-shaped wire wound resistance element 18 has its ends connected directly to the first and third terminal leads 12 and 14. The second input terminal lead on the other hand connects to a wiper support ring 19 by means of a resilient contact 20. The ring 19 in turn carries a wiper contact 21 arranged to engage the inside surface of the C-shaped resistance element 18. With this arrangement, it will be evident that the voltage of a battery applied between the first and third terminals 12 and 14 may be divided at the second terminal 13.

Referring now to the exploded view of FIGURE 3, the manner in which the potentiometer is constructed to realize the heretofore described objects and advantages of the invention will be evident.

In FIGURE 3, the casing 10 which is shown partly broken away includes an upper annular recessed opening and a lower reduced diameter recessed opening. A core 22 with a central bore 23 projects upwardly from the floor of the opening. The lower recessed opening surrounds the core and defines with the upper recessed opening, an annular ledge 24. This ledge serves as a seating surface for the annular resistance element 18 shown in the upper portion of the exploded view. Within the lowermost portion of the reduced diameter recessed opening there is provided an annular L-shaped base member 25 for securing the resilient contact strip 20 within the lower recessed area. As shown, this resilient contact strip is connected to the second terminal lead 13 as described in connection with FIGURE 2.

Arranged to be received over the central upwardly extending core 22 is a gear body 26 of generally cylindrical shape having a lower cylindrical portion tapering radially inwardly and including lateral gear teeth 27. The wiper contact support ring 19 described in FIGURE 2 is shown above the gear body 26 in FIGURE 3 and when in assembled position, will surround the upper cylindrical portion of the gear body and be rigidly secured to the gear body for rotation therewith. The actual wiper contact itself as shown at 21 takes the form of a metallic strip having its ends received in suitable vertical slots in diametrically opposite sides of the conducting ring 19.

The gear body 26 together with the wiper support conducting ring 19 are held within the recessed opening by a retaining pin 28 having a lower reduced diameter portion 29 receivable in the central bore 23 of the upwardly extending core 22. The portion 29 is force fitted within the bore 23. The upper end of the pin 28 terminates in an enlarged head 30. The underside of the head 30 serves to secure a biasing means in the form of a disc spring 31 to an annular portion in the upper end of the gear body 26 as will be more evident when the assembled view is described with reference to FIGURE 4. A cover 34 is provided to close off the upper opening in the casing.

In the assembly of the device, the gear body 26 with the conducting ring 19 rigidly secured about the upper portion thereof may be telescoped over the central core 22 in proper position. The resilient contacting strip 20 will then make electrical contact with the underside of the conducting ring 19. The retaining pin 28 will secure the gear body and conducting ring within the casing 10. The C-shaped resistance element 18 of rectangular cross section can then be positioned about the conducting ring 19 to seat on the ledge 24 in the casing. Two end terminals 32 and 33 of the resistance element 18 are shown and these are connected to the first and third terminals 12 and 14 extending from the corner of the casing. The resistance element 18 itself may be force fitted within the upper annular recessed opening so that it will be held stationary against the inside of this opening. Suitable insulation means is provided to prevent short circuiting of the resistance wire by the casing.

The system may be checked out electrically with the elements so assembled prior to positioning of the cover 34. The cover itself is independent of any of the structural components and its sole purpose is to maintain the mechanism within the casing free of dirt and dust.

With particular reference now to FIGURES 4 and 5, the assembled position just described will become clear. In this connection, it will be noted that in the particular embodiment chosen for illustrative purposes, the resilient contacting strip 20 is curved in its own plane and has its central portion connected to the second input terminal lead 13 as best seen in FIGURE 5. Both of the free end portions of the curved resilient contact are biased upwardly as indicated at 20′ and 20″ to engage the smooth under peripheral surface portion of the wiper support ring 19. By having both ends of the resilient strip contact the under side of the ring, electrical continuity is assured notwithstanding possible tilting of the axis of rotation of the gear body and ring with respect to the axis of the casing.

The adjusting screw 15 referred to in FIGURE 1 is shown in FIGURES 4 and 5 as extending horizontally into the side of the casing. This screw takes the form of a worm gear suitably sealed to prevent entry of dirt and dust into the interior recessed opening of the casing by an O-ring seal 35. Longitudinal movement of the worm gear is checked by a sleeve 36 as best shown in FIGURE 5 bearing against the O-ring seal. By this arrangement, rotation of the worm can take place but longitudinal movement is blocked. The worm gear teeth 37 are shown in FIGURE 5 in meshing engagement with the teeth 27 of the gear body.

With particular reference to FIGURE 4, the operation of the anti-backlash feature will be best understood. As noted, the gear teeth 27 are formed on a radially inwardly tapered lower portion of the gear body 26 and thus form a slight angle with the vertical as viewed in FIGURE 4. The disc spring 31 under the enlarged head 30 of the retaining pin 28 biases the entire gear body 26 generally in a downward direction tending to telescope it more completely over the central core 22. This action in turn will tend to wedge the tapered lateral gear teeth 27 into tighter engagement with the worm gear teeth 37 of the worm gear and thereby remove any possibility of backlash.

The operation of the potentiometer will be evident from the foregoing description. By rotating the worm gear screwhead 15, the gear body 26 will be caused to rotate which in turn will rotate the wiper arm contact supporting ring 19 to cause the wiper element 21 to engage different inside peripheral portions of the resistance element 18. It will be noted that the contacting portion of the wiper element 21 extends to form a line contact in a direction parallel to the axis of the gear body and conducting ring for a distance substantially equal to the inside long dimension of the rectangular cross section of the resistance element. This line contact will insure a reliable electrical connection. Moreover, by wiping on the inside of the C-shaped resistance element, not only is space with respect to the thickness dimension of the overall device conserved but in addition, unstressed portions of the wound wire itself forming the resistance element are engaged to the end that wear or possible breakage of the wire is minimized as compared to the results of wiping on an upper or outer peripheral portion of the element where the wound wires are generally stressed to a greater degree.

The core of the rectangular cross-sectioned C-shaped resistance element 18 is metal and thus provides excellent heat dissipation. Further, as mentioned heretofore, the operation of the device may be thoroughly checked out before securing the cover 34 in position. After the device has checked out properly, the cover 34 is positioned as shown in FIGURE 4 and the sealing thereof in place is effected by peening over a small annular lip 38 formed at the upper peripheral entrance portion of the upper recessed opening so that the cover is held securely in position.

While only one embodiment of the invention has been described, it will be evident to those skilled in the art that many of the principles set forth are applicable to modified versions all falling clearly within the scope and spirit of the invention. The miniature potentiometer is therefore not to be thought of as limited to the exact details in the embodiment set forth.

What is claimed is:

1. A miniature potentiometer comprising, in combination: a casing having a recessed opening; a C-shaped resistance element in said opening; a central cylindrically shaped gear body positioned in said opening and surrounded by said resistance element, said gear body having a radially inwardly tapered lower portion having lateral

gear teeth cut therein; a worm gear extending horizontally into said casing in engagement with said gear teeth; biasing means urging said gear body downwardly to cause said gear teeth to engage tightly said worm gear; a wiper contact means carried by said gear body to engage a point on said resistance element, and electrical connections to said wiper contact means and the ends of said resistance element respectively.

2. The subject matter of claim 1, in which said biasing means includes a pin member passing downwardly centrally through said gear body and having its lower end secured to the floor of said casing, said pin having an enlarged head; and a disc spring disposed between the underside of said head and said gear body.

3. The subject matter of claim 2, in which said wiper contact means includes a conducting ring member surrounding the upper portion of and secured to said gear body substantially concentric and co-planar with said resistance element and a resilient wiper contact extending from said ring to make contact with the inside surface of said resistance element, said electrical connections including a resilient strip secured to said casing within said recessed area, and having at least a portion thereof biased to engage said connecting ring.

4. A miniature potentiometer comprising in combination: a casing having an annular recessed opening; a central core extending upwardly from the floor of said recessed opening; a C-shaped resistance element of rectangular cross-section positioned about the inside annular wall of said recessed opening; an annular gear body having lateral gear teeth concentrically received over said core so that said gear teeth surround said core below said resistance element; a wiper support ring of conducting material concentric with and carried by said gear body in a position above said gear teeth in substantially co-planar juxtaposed relation to the inside surface of said resistance element; a wiper contact secured to said wiper supporting ring in position to engage a portion of said inside surface of said resistance element; resilient contact strip means secured to said floor of said recessed opening and having at least one end biased to engage a portion of said wiper support ring; a retaining pin extending through said gear body and into said core, the upper end of said pin terminating in an elarged head for retaining said gear body and wiper support ring within said recessed opening about said core; a worm gear extending horizontally into one side of said casing with its worm teeth in engagement with said lateral gear teeth of said gear body; and first, second, and third terminals extending from said casing, said first and third terminals being respectively connected to the ends of said C-shaped resistance element and said second terminal being connected to said resilient contact strip means.

5. A miniature potentiometer comprising, in combination: a casing having an upper annular recessed opening terminating in a reduced diameter lower recessed opening to define an annular ledge with said upper recessed opening, said casing including a central core extending upwardly from the floor of said lower recessed opening; a C-shaped resistance element of rectangular cross-section seated on said ledge and having its end terminals adjacent each other at one corner of said casing; a gear body having a generally cylindrical exterior tapering radially inwardly at its lower portion, said lower portion having lateral gear teeth cut therein, said body concentrically being received over said core so that said gear teeth surround said core, the lower end of said lower portion of said body being spaced from the floor of said casing; a wiper support ring rigidly secured about the upper portion of said cylindrical gear body to be carried thereby; a wiper contact secured to said wiper support ring in position to engage an inside surface portion of said resistance element; resilient contact strip means secured to said floor of said lower reduced diameter recessed portion and having at least one end biased upwardly to engage the lower surface portion of said wiper support ring; a worm gear extending horizontally into one side of said casing with its worm teeth in engagement with said lateral gear teeth of said gear body; a retaining pin extending through said gear body and into said core, the upper end of said pin terminating in an enlarged lead; a disc spring positioned between the underside of said head and the upper portion of said gear body to bias said gear body downwardly and urge said gear teeth into tight engagement with said worm teeth; first, second, and third electrical terminals extending from said corner of said casing, said first and third terminals being respectively connected to said terminals of said C-shaped resistance element and said second terminal being connected to said resilient contact strip means; and a cover member closing said upper recessed opening.

6. The subject matter of claim 5 including a sealing O-ring about said worm gear.

7. A miniature potentiometer comprising, in combination: a casing having an upper annular recessed opening terminating in a reduced diameter lower recessed opening to define an annular ledge with said upper recessed opening, said casing including a central core extending upwardly from the floor of said lower recessed opening; a C-shaped resistance element of rectangular cross section seated on said ledge with its outer peripheral surface positioned juxtaposed the inside annular wall of said upper annular recessed opening; an annular gear body having lateral gear teeth concentrically received over said core so that said gear teeth surround said core below said resistance element; a wiper support ring of conducting material concentric with and secured to said gear body; a wiper contact secured to said wiper supporting ring in position to engage a portion of the inside surface of said resistance element; a retaining pin extending through said gear body and into said core, the upper port of said pin terminating in an enlarged head; biasing means under said head for retaining said gear body and wiper support ring within said reccessed opening about said core; a worm gear extending horizontally into one side of said casing with its worm teeth in engagement with said lateral gear teeth of said gear body; and first, second, and third terminals extending from said casing, said first and third terminals being respectively connected to the ends of said C-shaped resistance element and said second terminal being connected to said wiper support ring.

8. A miniature potentiometer comprising: a casing having a recessed opening; a C-shaped resistance element in said opening; a central cylindrically shaped gear body positioned in said opening and surrounded by said resistance element; a worm gear extending horizontally into said casing in engagement with said gear teeth; biasing means urging said gear body downwardly to maintain said worm and said gear in tight engagement with one another; a wiper contact means carried by said gear body to engage a point on said resistance element; an electrically conductive resilient strip member secured to said casing within said recess; said strip member including a plurality of discrete areas biased into electrical engagement with said wiper contact means; and electrical connections to said strip member and the ends of said resistance element respectively.

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