

Oct. 22, 1963

J. W. BAMFORD ETAL
POTENTIOMETER

3,108,245

Filed Oct. 31, 1960

3 Sheets-Sheet 1

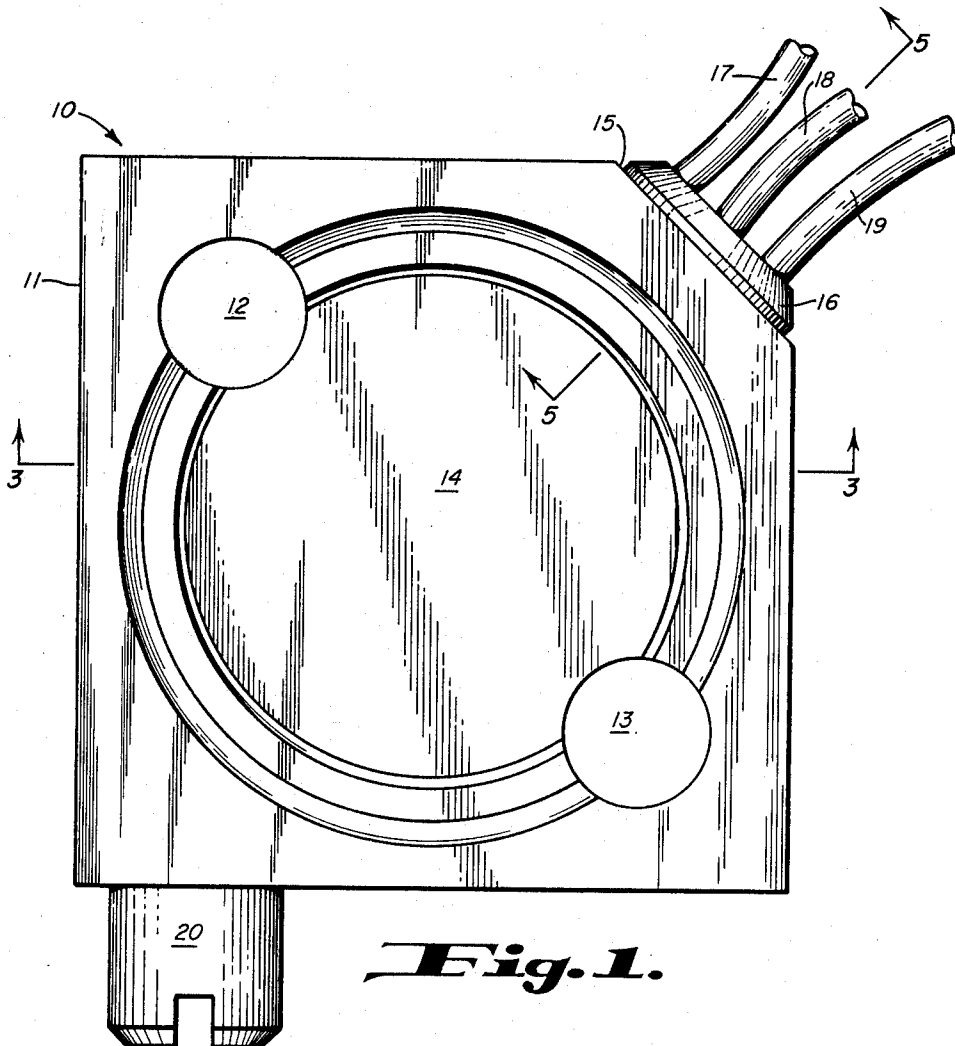


Fig. 1.

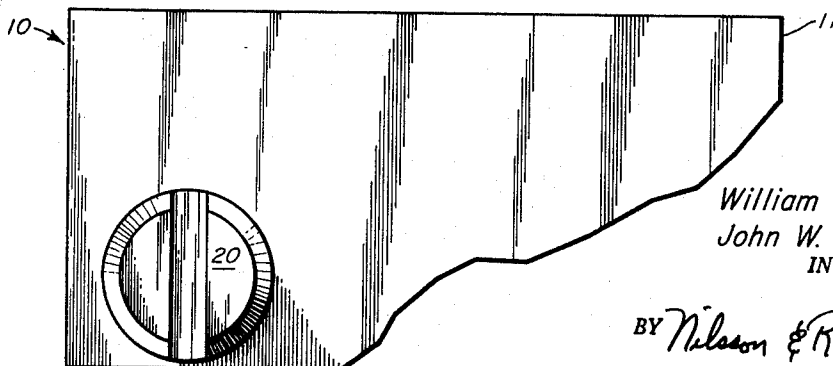


Fig. 2.

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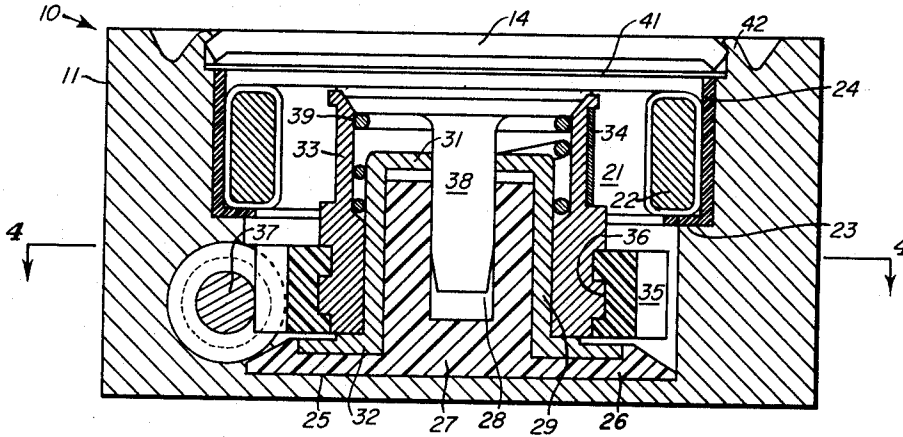


Fig. 3.

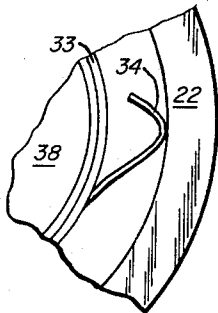


Fig. 6.

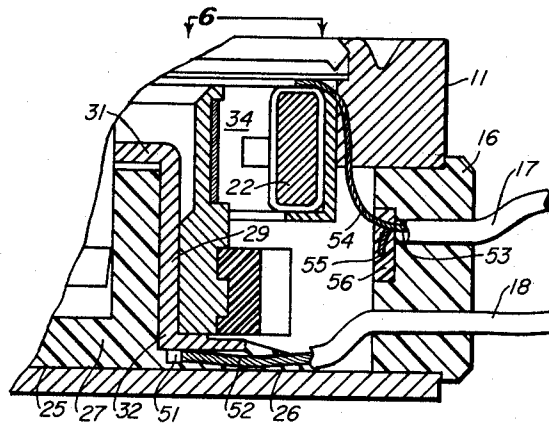


Fig. 5.

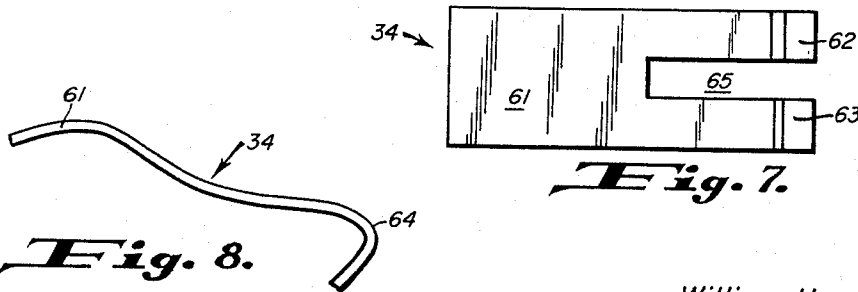


Fig. 8.

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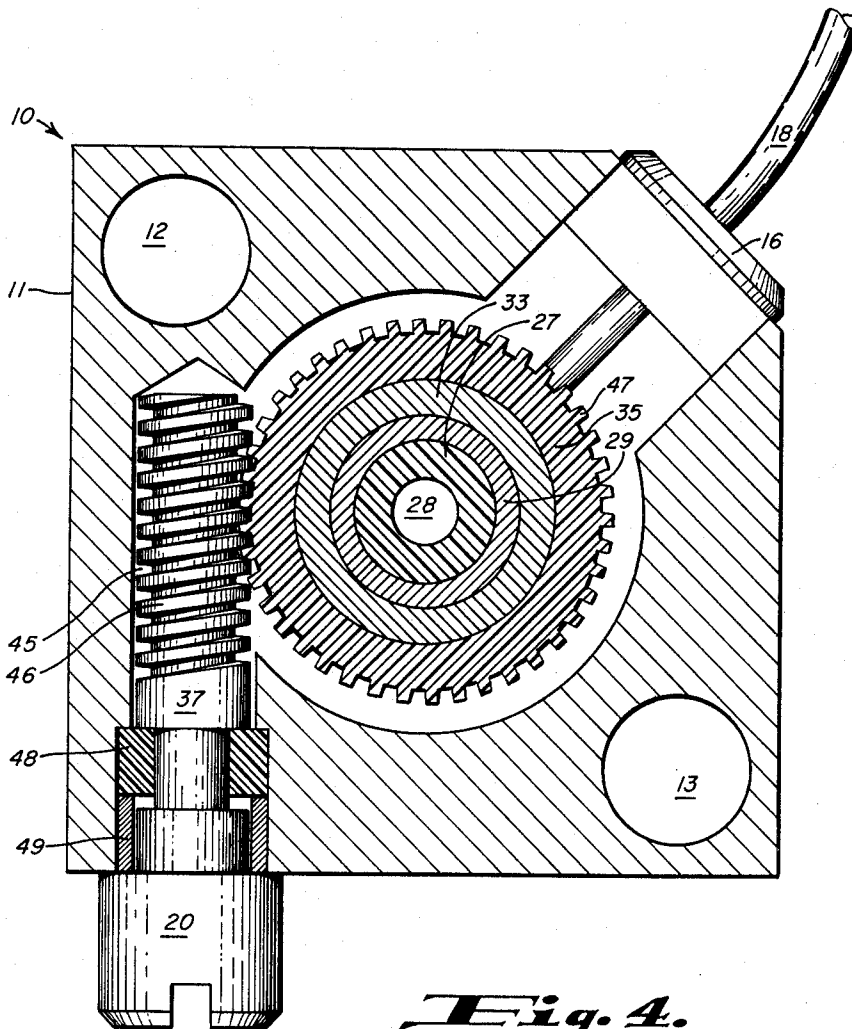
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3 Sheets-Sheet 3



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POTENTIOMETER

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8 Claims. (Cl. 338-174)

This invention relates generally to variable resistors, and more particularly to potentiometers of the miniature type.

Miniature potentiometers and particularly those referred to in the art as "trimmer" potentiometers have been known and widely used for high voltage division in order to accomplish fine adjustment in systems employing electronic and electric circuits. Such trimmer potentiometers have assumed various shapes and the present invention relates particularly to those trimmer potentiometers having an internal, substantially circular recess and preferably a square external shape. Such trimmer potentiometers presently in existence, for the most part, provide excellent operation, however, it has been discovered that various problems exist under certain conditions of operation.

When such potentiometers are utilized as part of a component which, during operation, is subject to severe vibrations, it has been found that the prior art potentiometers tend to generate severe noise which, in most cases, has a deleterious effect upon the desired signal characteristics. Also in some instances, minute particles of dust or other foreign matter may during the manufacture of the potentiometer, be inadvertently deposited upon the surface of the resistance element within the potentiometer. When this occurs, the wiper contact arm within the potentiometer passes over the particle of foreign matter thus causing it to become separated from the resistance element and interrupting the signal or creating noise.

It has also been found that when prior art trimmer potentiometers are subjected to severe temperature cycling, the characteristics of the resistance element and the remaining portions of the potentiometer, in their relationship to the resistance element, have a tendency to change. This, therefore, introduces somewhat erratic operation of the potentiometer. As a result thereof, reliability of such prior art potentiometers under these operating conditions has left much to be desired.

As is well known in the potentiometer art, the electrical contact which is made by way of the wiper contact arm to the resistance element must be carried externally of the potentiometer in a reliable manner. For the most part, prior art trimmer potentiometers have employed relatively complex mechanical apparatus to accomplish this desired result. As a result thereof, the prior art potentiometers have been relatively complex and therefore expensive to manufacture, and in some cases, quite sensitive to their environmental operating conditions. Furthermore, the fixed electrical connections made to each end of the resistance element and carried externally of the prior art potentiometer housing have in many cases been pulled off under normal conditions of installation and operation. Such occurrences cause the potentiometer to become inoperable.

Accordingly, it is an object of the present invention to provide a miniature trimmer potentiometer which is simple, rugged and inexpensive to manufacture.

It is another object of the present invention to provide a miniature trimmer potentiometer which has a reliable wiper contact to the resistance element and therefore exceedingly low noise generation characteristics under adverse operating conditions and environment.

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It is another object of the present invention to provide a miniature trimmer potentiometer which employs a simple mechanical structure to accomplish the external electrical connections to the resistance element, therefore providing reliable external electrical connections under all reasonable conditions of use.

It is another object of the present invention to provide a miniature trimmer potentiometer which is resistant to high temperature operation, and remains stable irrespective of rapidly changing temperature conditions.

Other objects and advantages of the present invention, both as to its operation and organization, will become apparent from a consideration of the following description taken in conjunction with the accompanying drawings, which are presented by way of example only, and are not intended as a limitation upon the scope of the claims of the present invention, and in which:

FIGS. 1 and 2 are plan views of the external configuration of a preferred embodiment of the present invention;

FIG. 3 is a cross-sectional view of a potentiometer in accordance with the present invention which is taken about the lines 3-3 of FIG. 1;

FIG. 4 is a cross-sectional view of the structure of FIG. 3 taken about the lines 4-4 thereof.

FIG. 5 is a cross-sectional view taken about the lines 5-5 of FIG. 1;

FIG. 6 is a view taken about the lines 6-6 of FIG. 5; and

FIGS. 7 and 8 are elevational views of the wiper contact in accordance with the present invention.

In accordance with one aspect of the present invention, there is provided a metallic casing having an internal recess with an electrical resistance element mounted therein. A pair of electrically conductive members are supported within the recess, the first being non-movably supported while the second is rotatably supported and has a substantially annular shaped cross-section. The second electrically conductive member is also in contact with the first electrically conductive member. Wiper means is affixed to the second member in such a manner that it is in contact with a surface of the resistance element. Gear means is also affixed to the second electrically conductive member for causing the wiper means to move across the surface of the resistance element in response to rotation of the gear means. An electrical connector is affixed to the first non-movably supported electrically conductive member and extends externally of the casing in order to provide electrical connection to the movable contact upon the resistance element.

In accordance with a more specific aspect of the present invention, an electrically non-conductive cylinder having a flange at one end thereof and an electrically conductive sleeve fitted upon the cylinder is affixed to the floor of the recess within the metallic casing. An electrically conductive, substantially cylindrical hub having a wiper means and gear means affixed thereto is then mounted rotatably upon the cylinder in such a manner that upon rotation of the gear means the wiper means is caused to move across the surface of the resistance element. A lead is affixed to the electrically conductive sleeve and extends externally of the potentiometer casing in order to provide external electrical connection to the movable contact of the resistance element.

More specifically, a wiper means in accordance with the present invention includes a pair of electrical contact arms which ride upon or move across a surface of the resistance element. The pair of contact arms are adapted to operate independently of each other and in

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addition thereto, have different thicknesses which are chosen specifically to assure that the mechanical resonant frequency of each of the two contact arms of the wiper is different.

Referring now to the drawings, and more particularly to FIGS. 1 and 2 thereof, a potentiometer in accordance with the present invention is illustrated generally at 10 and includes a casing 11, having a pair of openings 12 and 13 therethrough to enable ready mounting of such potentiometers in any manner desired as is well known in the prior art. A cover 14 is sealed in place over a recess, which contains the internal operating parts of the potentiometer to be explained more fully below, to prevent dust and other foreign matter from entering the potentiometer. One corner of the casing is removed as at 15, and is provided with an opening to receive a plug 16 from which electrical leads 17, 18, and 19 protrude to provide external electrical connection to the resistance element housed within the internal recess of the casing 11. A slotted head 20 protrudes from one side of the casing 11 to permit adjustment of the variable contact to the resistance element housed internally of the casing 11. As is illustrated in FIGS. 1 and 2, the casing 11 has a substantially square top and bottom elevation and a substantially rectangular side elevation.

Referring now more particularly to FIG. 3, the internal structure of the trimmer potentiometer in accordance with the present invention is illustrated in detail. As is shown therein, the casing 11 has an internal substantially circular recess 21 within which a resistance element 22 is mounted upon a ledge 23. An insulator 24 is inserted between the resistance element 22 and the wall of the recess 21. The resistance element is preferably a mandrel having a resistance wire wound thereon as is well known in the prior art. It should be expressly understood, however, that the resistance element 22 may take any form which is presently known to the art such as a resistance film or the like. The insulator 24 should be maintained as thin as possible to permit the ready dissipation of heat from the resistance element through the casing to the atmosphere. In order to facilitate the dissipation of heat generated within the resistance element 22, it has also been found that the casing 11 should preferably be constructed of metal. In the presently preferred embodiment of this invention, the casing is constructed of aluminum, and to prevent erratic operation as a result of severe temperature cycling, it has been discovered that the mandrel which forms an integral part of the resistance element 22 should also preferably be constructed of aluminum. By so doing, the thermal coefficient of expansion and contraction of the resistance element and the casing remain the same and therefore little or no strain is placed upon the resistance element as a result of temperature cycling. This, therefore, provides excellent and reliable operation of the potentiometer in accordance with the present invention irrespective of extreme temperature changes in its environmental operating conditions.

Affixed, such as by cementing, to the floor 25 of the recess 21 within the casing 11 is a substantially disc-shaped nonconducting member 26 and extending therefrom is a post 27 which protrudes into the recess 21. The disc 26 and the post 27 may be viewed as an integrally formed closed cylinder having a flange extending radially from one end thereof. The post, or cylinder, 27 has a bore 28 formed therein for purposes to be explained more fully below. A first electrically conductive member, such as a sleeve 29, is nonmovably supported within the recess 21 and preferably is press-fitted over the post or cylinder 27. The sleeve 29 may, if such is desired, be in the form of a cylinder which is substantially closed by an inwardly extending flange member 31 having a bore therein and at the other end thereof having an outwardly extending flange member 32 which is fitted within a recess in the top of the disc-shaped member 26. As seen

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in FIG. 3, the sleeve 29 may be viewed as a hat or cap-shaped member. Such a structure, provides the post 27 with additional support and therefore internal tolerances of the potentiometer in accordance with the present invention are more readily maintained.

A second electrically conductive member in the form of a substantially cylindrical hub 33 is rotatably supported within the recess by being placed over the sleeve 29 so that it rests upon the flange member 32. The hub 33 carries wiper contact means 34 (more readily seen in FIG. 5) and gear means 35. The wiper contact means is preferably spot welded to the hub 33 and the gear means 35 is an electrically non-conductive material which is molded upon the lower portion of the hub 33. As can be seen, the lower portion of the hub 33 contains a protrusion 36 which tends to maintain the molded gear means 35 in place at all times. Gear means 35 engages a worm screw 37 which, upon turning the slotted head 20, as shown in FIG. 1, causes the gear means 35 to rotate, thus in turn causing the wiper means 34 to move across the internal surface of the resistance element 22.

A T-shaped member 38 has its lower portion press fitted into the bore 28 of the post 27 so that the upper end thereof which is substantially circular in shape contacts the hub 33, thus holding the hub 33 in place at all times during operation. It can be seen from FIG. 3 that the bore within the internally extending flange member 31 of sleeve 29 is such as to receive the lower portion of the T-shaped member 38 in a press-fit.

From a consideration of the foregoing description, it should become apparent that the variable electrical contact to the resistance element 22 is provided by way of the wiper means 34, the electrically conductive rotatably mounted hub 33, the sleeve 29, and through an electrical lead which is affixed to the outwardly extending flange 32, as more clearly seen in FIG. 5. Electrical contact may also be traced through the upper portion of the T-shaped member 38 and the press-fit between the lower portion of the T-shaped member 38 and the inwardly extending flange 31 of the sleeve 29. In order to insure under all operating conditions a positive electrical contact to the inner portion of the resistance element 22, a spring 39 may be inserted within the cavity formed between the hub 33 and the T-shaped member 38 as illustrated.

After the potentiometer as above described is assembled, it may be electrically tested and if found to be satisfactory, the cap 14 is brought into place upon an electrically insulating washer 41 and secured in place by bending over a portion 42 of the upper section of the casing. This provides a seal for the potentiometer casing to prevent the entry of dust or other foreign matter after final assembly of the potentiometer.

As is more clearly shown in FIG. 4, the worm screw 37 is inserted within one side of the casing 11 through a recess 45 provided therein in such a manner that the teeth 46 of the worm 37 engage the teeth 47 of the gear 35. As the worm 37 is rotated by engaging the slotted head 20 thereof, the gear 35 is caused to move in accordance therewith, thus causing the internal structure of the hub 33 carrying the wiper and the gear means to rotate. The cavity in the casing 11 through which the worm 37 is inserted is sealed by a ring seal 48 which is held in place by a sleeve 49. The combination of the ring seal 48 and the sleeve 49 also operates to prevent longitudinal movement of the worm 37 thereby preventing backlash.

Referring now more particularly to FIG. 5, there is illustrated the specific manner in which the external electrical connections are made to the internal portions of the potentiometer in accordance with the present invention. As above referred to, the external electrical connection to the variable contact upon the resistance element which is made by way of the wiper contact arm 34 is effected by affixing lead 18, such as by soldering or the like, to the lower portion of the flange 32 on the

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sleeve 29 which is non-movably supported within the recess 21 of the casing 11. This connection is made by providing an opening between the disc 26 and the outwardly extending flange 32. The wire 52 extending from the lead 18 is soldered to the flange 32 before the sleeve 29 is pressed into place over the post 27. By so soldering, the lead 18 is permanently and non-removably affixed to the electrically conductive sleeve 29.

The remaining leads which are connected to the end portions of the resistance element 22 are permanently held in place in the following manner which will be described with particular reference to the lead 17 illustrated in FIG. 5.

The wire 53 extending from the lead 17 is divided into two portions 54 and 55. The portion 55 is clipped and bent downwardly as illustrated in FIG. 5. The remaining portion 54 is brought upwardly and affixed to the resistance element 22 as by soldering, or the like. As is illustrated, the plug 16, which is of insulative material, is bored to receive the various leads. These bores which receive leads 17 and 19 are counterbored as illustrated in FIG. 5. After the lead, for example as shown at 17, has been clipped as illustrated at 55, and placed in the desired position, the counterbore is filled with an insulative material such as epoxy resin 56 which adheres to the plug 16 and which fixedly secures the lead 17 in place so that it cannot be removed even under adverse operating conditions which might otherwise tend to do so. In this manner, positive reliable electrical connections are made to the various desired portions of the resistance element. Such a structure overcomes the prior art critical problem of having the externally extending leads slip within the bores of the plug 16 and thereby breaking the electrical connections made to the resistance element.

FIG. 6 illustrates the position of the wiper contact arm 34 as it appears in the finally assembled potentiometer in accordance with the present invention, while FIGS. 7 and 8 illustrate more in detail the construction of the wiper arm.

As is illustrated in FIGS. 7 and 8, the wiper arm 34 may be constructed of a single member 61 of sheet material which is manufactured by stamping in such a manner as to have two separate resilient contact arms 62 and 63.

As is illustrated more clearly in FIG. 8 at the time of formation of the wiper arm 34, it is provided with a curvature 64 permitting smooth and noise-free contact with the resistance wire which is wound upon the resistance element 22. The opposite end of the wiper arm may, if such is desired, although it is not necessary, be given a slight curvature in order to facilitate spot welding of the arm to the surface of the hub 33. As is clearly illustrated in FIG. 7, the separate contact arms 62 and 63 are of sufficient length to permit them to operate independently of each other. That is, if the contact arm 62 were, during movement across the surface of the potentiometer resistance element 22, to pass over a piece of foreign matter causing it to be moved outwardly and out of contact with the inner surface of the resistance element, the contact arm 63 remains in contact with the resistance element thereby preventing an interruption in the signal delivered by the potentiometer. Such independent operation is achieved by providing the opening or cut 65 between the two contact arms 62 and 63 of the wiper arm 34. It should be expressly understood, however, that the contacts 62 and 63 may be provided by affixing two separate and distinct members to the hub 33. As is also clearly illustrated in FIG. 7, the contact arms 62 and 63 are constructed of material having different thicknesses. The particular thicknesses of each of the two contact arms 62 and 63 is not critical as such. The only critical criterion to be observed is that the contact arms 62 and 63 must remain resilient and the thicknesses must be chosen so that they are sufficiently different to provide a different mechanical resonant frequency for each contact arm. This difference in

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resonant frequencies is required to prevent interruption of the electrical signal delivered by the potentiometer and to prevent the generation of noise by the potentiometer. It is well known that when a particular mechanical apparatus or structure is subjected to mechanical vibrations, it may begin to vibrate at its resonant frequency. If such phenomenon occurs within a potentiometer structure, the vibration would cause a chattering or bouncing of the contact against the resistance element and would thus create undesired noise. By providing a wiper contact arm having a split contact portion, thus providing two individual contacts, each of which has a different mechanical resonant frequency, it can be seen that electrical contact is never interrupted even though one of the contacts is vibrating at its natural resonant frequency.

There has thus been disclosed a miniature potentiometer of the trimmer type which is reliable under adverse conditions of operation, which is simple and inexpensive to manufacture, and which provides noise-free operation irrespective of environmental operational conditions of vibration, temperature and the like.

Although various features and concepts of the present invention have been set forth in the foregoing illustrative embodiment, the present invention is not to be limited in accordance therewith but is to be constructed in accordance with the claims set forth below.

What is claimed is:

1. A miniature potentiometer comprising: a casing defining a recess having a resistance element mounted therein; an electrically non-conductive post extending from the bottom of said casing into said recess; a first hollow substantially cylindrical electrically conductive member having an outwardly extending flange member at one end thereof non-movably supported centrally within said recess upon said post and insulated from said casing; a second hollow substantially cylindrical electrically conductive member rotatably positioned upon and surrounding said first cylindrical member and slidably contacting said flange member; retaining means contacting each of said first and second electrically conductive members to hold said second member in continuous electrical contact with said first member; wiper means affixed to said second member and extending outwardly from the periphery thereof into contact with said resistance element; gear means affixed to said second member for causing said wiper means to move across a surface of said resistance element in response to rotation thereof; and an electrical connector affixed to said first member and extending externally of said casing.

2. A miniature potentiometer comprising: a metallic casing defining a recess having a floor; a resistance element mounted within said recess; an electrically non-conductive disc-shaped member affixed to the floor of said recess and having an integral post rising centrally therefrom and extending into said recess; an electrically conductive sleeve fitted upon said post; an electrically conductive substantially cylindrical hub member rotatably mounted upon said post and contacting said sleeve; retaining means contacting said sleeve and said hub to hold said hub in continuous electrical contact with said sleeve; wiper means affixed to said hub member and having electrical contact with said resistance element; and gear means affixed to said hub member for causing said wiper means to move across a surface of said resistance element in response to rotation of said hub member.

3. A miniature potentiometer comprising: a metallic casing defining a recess having a floor; a resistance element mounted within said recess; an electrically non-conductive disc-shaped member affixed to the floor of said recess and having an integral post rising centrally therefrom and extending into said recess; an electrically conductive sleeve having an outwardly extending flange fixedly secured upon said post, said flange contacting said

disc-shaped member; an electrically conductive substantially cylindrical hub member rotatably mounted upon said sleeve and slidably engaging said flange; retaining means contacting said sleeve and said hub to hold said hub in continuous electrical contact with said sleeve; wiper means affixed to said hub member and having electrical contact with said resistance element; and gear means affixed to said hub member for causing said wiper means to move across a surface of said resistance element in response to rotation of said hub member.

4. A miniature potentiometer comprising: a metallic casing defining a recess having a floor; a resistance element mounted within said recess; an electrically non-conductive disc-shaped member affixed to the floor of said recess and having an integral post rising centrally therefrom and extending into said recess; an electrically conductive sleeve having an outwardly extending flange fixedly secured upon said post, said flange contacting said disc-shaped member; an electrically conductive substantially cylindrical hub member rotatably mounted upon said sleeve and slidably engaging said sleeve and said flange; retaining means contacting said sleeve and said hub to hold said hub in continuous electrical contact with said sleeve; wiper means affixed to said hub member and having electrical contact with said resistance element; gear means affixed to said hub member for causing said wiper means to move across a surface of said resistance element in response to rotation of said hub member; and an electrical connector affixed to said flange and disposed between said flange and said disc, said connector extending externally of said casing.

5. A miniature potentiometer comprising: a metallic casing defining a recess having a floor; a resistance element mounted within said recess; an electrically non-conductive disc-shaped member affixed to the floor of said recess and having a post rising centrally therefrom and extending into said recess; an electrically conductive sleeve having an outwardly extending flange fixedly secured upon said post, said flange contacting said disc-shaped member; an electrically conductive substantially cylindrical hub member rotatably mounted upon said sleeve and slidably engaging said flange; wiper means affixed to said hub member and having electrical contact with said resistance element; said wiper means having two resilient contact arms each being of sufficient length to operate independently of the other, each of said contact arms having a different thickness, said thicknesses being chosen so that each of said contact arms has a different resonant frequency; and gear means affixed to said hub member for causing said wiper means to move across a surface of said resistance element in response to rotation of said hub member.

6. A miniature potentiometer comprising: a metallic casing defining a recess having a floor; a resistance element mounted within said recess; an electrically non-conductive disc-shaped member affixed to the floor of said recess and having an integral post rising centrally therefrom and extending into said recess; an electrically conductive hat shaped member fixedly secured upon said post; said hat and said post defining axially aligned openings providing a centrally disposed bore extending inwardly into said post; an electrically conductive substantially cylindrical hub member rotatably mounted upon and

slidably engaging the outer surface of said hat member; a T-shaped pin member secured within said bore and contacting the upper portion of said hub member thereby to retain said hub member in slidable engagement with said hat member; wiper means affixed to said hub member and having electrical contact with said resistance element; gear means affixed to said hub member for causing said wiper means to move across a surface of said resistance element in response to rotation of said hub member; and an electrical connector affixed to said hat member and disposed between said hat member and said disc, said connector extending externally of said casing.

7. A miniature potentiometer comprising: a casing defining a recess having a resistance element mounted therein; an electrically non-conductive post extending from the bottom of said casing into said recess; a first substantially cylindrical electrically conductive member non-movably supported within said recess upon said post; a second substantially cylindrical electrically conductive member rotatably supported within said recess and in direct but slipping contact with said first electrically conductive member, thereby to provide electrical continuity between said members; retaining means contacting each of said first and second electrically conductive members to hold said second member in continuous electrical contact with said first member; wiper means affixed to the outer surface of said second electrically conductive member and extending outwardly from the periphery thereof into contact with said resistance element; gear means affixed to said second electrically conductive member for causing said wiper means to move across a surface of said resistance element in response to rotation thereof; and an electrical connector affixed to said non-movably supported first member for providing external variable electrical connection to said resistance element.

8. A miniature potentiometer comprising: a casing defining a recess having a resistance element mounted within the upper portion thereof; an electrically non-conductive post extending from the bottom of said casing into said recess; a first substantially cylindrical electrically conductive member non-movable supported within said recess upon said post and having the upper portions thereof below the upper surface of said resistance element; a second substantially cylindrical hollow electrically conductive member rotatably supported within said recess surrounding said first member and having at least a portion thereof in the same plane as said resistance element, said second member being in slidable electrical contact with said first member; retaining means contacting each of said first and second electrically conductive members to hold said second member in continuous electrical contact with said first member; wiper means affixed to the outer surface of said second member and extending outwardly from the periphery thereof in said plane and into contact with said resistance element; gear means affixed to said second member below said wiper means for causing said wiper means to move across a surface of said resistance element in response to rotation thereof; and an electrical connector affixed to said first member and extending externally of said casing.

No references cited.