July 28, 1964 J. CLAYTON, JR 3,142,812

POTENTIOMETER

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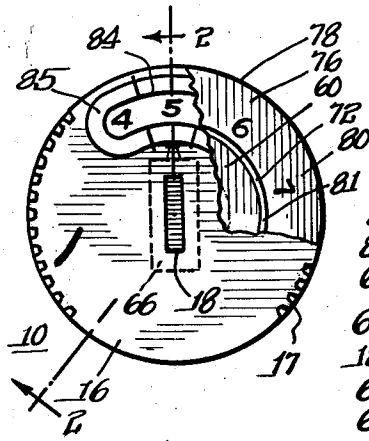


Fig. 1.

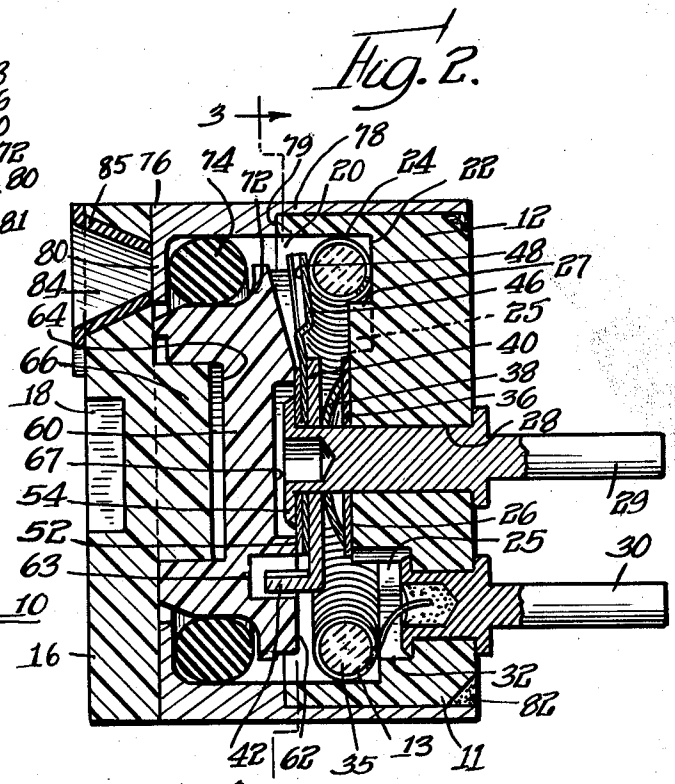


Fig. 2.

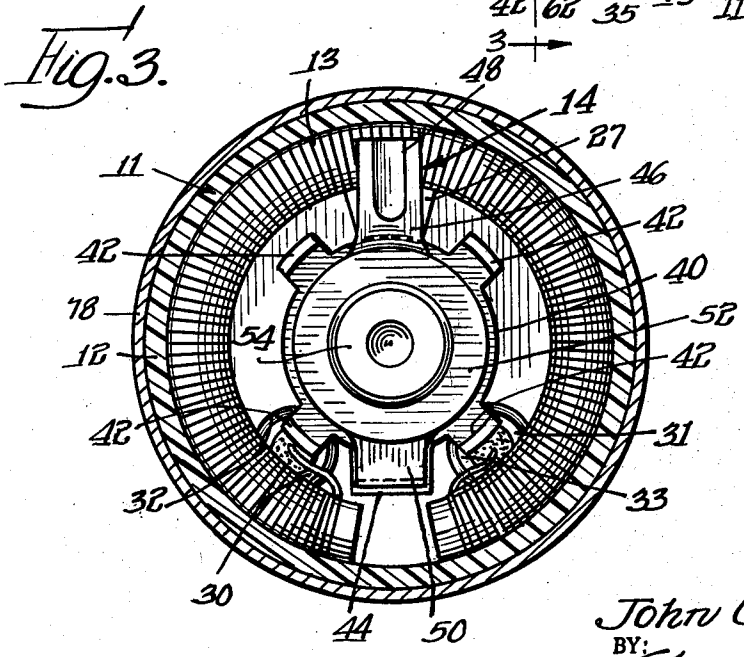


Fig. 3.

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Fig. 4.

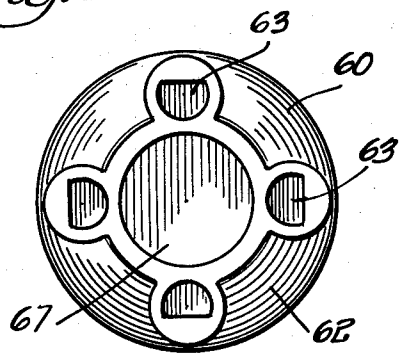


Fig. 5.

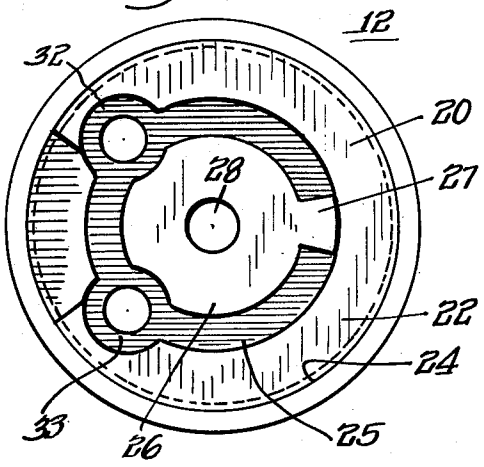


Fig. 6.

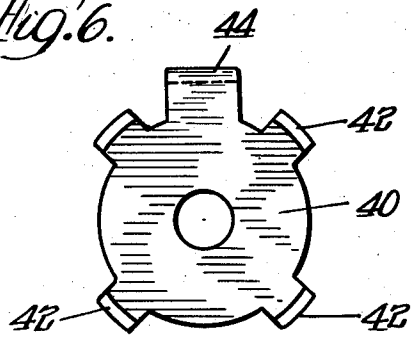


Fig. 7.

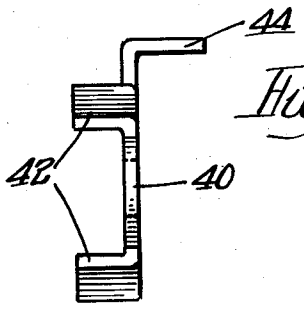
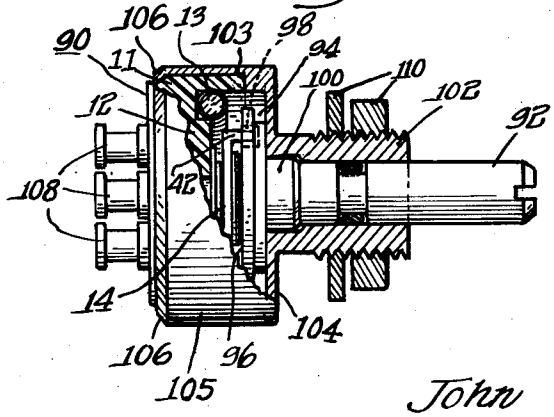


Fig. 8.



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3,142,812

POTENTIOMETER

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7 Claims. (Cl. 338—163)

The present invention relates to potentiometers and more particularly to precision rotary potentiometers.

It is the principal object of the invention to provide an improved potentiometer construction which allows the manufacture and maintenance of a minimum inventory of sub-assemblies and allows a maximum amount of interchangeability of components, without adding substantially to the complexity, and thus without impairing the full economic advantage of the "universal" type of construction. Rotary potentiometers are employed in a wide variety of types of uses and have a correspondingly wide variety of external construction details, a "full line" of even a single size, ohmic value, temperature characteristic, etc., including a variety of combinations of external drives (ordinary shafts of various lengths, terminating in various forms of coupling shapes for operation by tools, motors, knobs, etc., and also worm drives, dial-type drives and others) and other mechanical variations (threaded bushings of various dimensions, locking or non-locking, "servo" and other types having no bushing, calibrated exteriors, etc.). All of these variations prevent the manufacture and distribution of precision rotary potentiometers at costs comparable to those which would prevail if the volume of distribution were not divided, because of these variations, into a large number of fragments, each constituting a separate item as regards manufacture and distribution. Various structures have been devised to permit the construction of rotary potentiometers of a variety of mechanical types and configurations by assembly from more or less interchangeable parts, but the provisions for interchangeability or "universality" have in general defeated their own purpose by being of excessive cost, particularly when miniaturized.

It is a further object of the invention to provide a low-cost standardized base, resistance element, and wiper assembly for use in a variety of external potentiometer constructions, which allows a maximum amount of flexibility in the final assembly of the potentiometers, and which may be stored as a unit. In accordance with the invention, this assembly is installed in a simple and novel manner in a variety of types of "fronts" of varying configuration, and with various types of drive members.

In any pre-assembled construction designed for the attachment of shafts or similar drive members to the rotating wiper, arrangement must be made for keying of the wiper assembly to the drive members. In the present construction, the added fabrication cost of providing such keying is recouped in a novel manner by utilizing the necessity for a coupling at this point to permit the elimination of the complex constructions normally required in insulating the wiper from its axial support; in the present construction, an insulating member is inserted in the coupling between the external operating or drive member and the wiper assembly, the entire rotatable drive assembly being constructed of easily fabricated metal conductors, and being rotatably mounted on an axial conducting terminal member extending through the insulating base, which thus serves as an internal rotational bearing and an external wiper connection, eliminating the necessity for any separate bearing structure and for any wiper take-off *in* the nature of a slip-ring, beyond the electrical contact at the bearing interface.

The insertion of the insulator in the coupling between the wiper and the external drive may be further utilized to

eliminate other parts and assembly operations, as will be better understood from the description of the embodiments of the invention shown in the drawing. The elimination of parts and assembly operations is of particular advantage in the case of subminiature potentiometers (diameter less than ¾ inch) because of the extreme precision of manufacture and assembly which is required to produce such potentiometers by mere scaling-down of dimensions of constructions heretofore known.

In one form of "front" applied to the base assembly to be described, in accordance with further novel teachings of the invention, there is provided to manipulate the wiper assembly a manually or otherwise rotatable surface disc covering the front face of the stationary portion of this front assembly. This disc has a window or viewing section through which can be seen position-indicating numbers marked on the underlying portion of the front assembly, which is fixedly secured to the base, the number visible being indicative of the position of the wiper on the resistance element. To provide further universality, this covering disc is keyed to a rotatable drive member extending through the center of the numbered stationary portion of the front, which has a suitable marker giving a similar, but less convenient, visual indication of wiper position when the disc is omitted, for uses where space and cost are to be minimized.

These, and additional constructional features and advantages of the invention, will best be understood by reference to the following detailed description taken in connection with the accompanying drawings in which:

FIGURE 1 is a top or front view, with a portion partially broken away, of a potentiometer embodying one form of the invention (it will of course be understood that "top" and "front" are substantially interchangeable in description of structures of this type, because of the variety of orientations encountered in use);

FIGURE 2 is a sectional view taken along line **2—2** of FIGURE 1;

FIGURE 3 is a sectional view taken along line **3—3** of FIGURE 2, showing the base assembly in elevation;

FIGURE 4 is a bottom or rear view of an insulating coupling member constituting a portion of the potentiometer;

FIGURE 5 is a top plan view of the base structure prior to assembly with the front;

FIGURE 6 is a top plan view of a conducting coupling member used on the wiper assembly;

FIGURE 7 is a side elevational view of the member of FIGURE 6; and

FIGURE 8 is a side elevational view, partially broken away in section, of another assembly utilizing the invention.

In FIGURES 1 through 7 there is shown one form of potentiometer **10** which includes a unitary base assembly **11**. Base assembly **11** includes a hollow cylindrical base **12** of suitable insulating material. Housed within base **12** are a resistance element **13** and a wiper assembly **14**, both mounted in the base in a permanent manner, as will be described hereinafter. From the resistance element and wiper assembly there extend three terminal members **15** (only two of which are visible in FIGURE 2) which protrude through the bottom or rear wall of base **12**. The terminal member set as shown is of the type which may plug directly into suitable mounting sockets such as used in printed circuits. Covering the front end of potentiometer **10** is a rotatable outer disc **16** with serrations **17** about its periphery and with a suitable screwdriver-receiving slot **18** substantially centrally located in its surface.

The base **12**, shown in its unassembled state in FIGURE 5, has on its inner face a generally cup-shaped recess **20** having around the bottom an annular ledge **22** which

extends to the sidewall **24** and serves as the mounting support for resistance element **13**. Inwardly of the ledge **22** is an annular channel **25**. In the center is a circular raised floor or boss **26**. In a small angular sector, floor **26** continues radially outwardly in a rib **27** blocking the channel. At the center of floor **26**, there is provided a circular opening **28** within which is tightly fitted a central terminal **29**, as can be seen best in FIGURES 1 and 2. Terminal **29** is one of the terminals of set **15**, the other terminals **30** and **31** extending into terminal wells or enlargements **32** and **33** in channel **25**.

Within the base **12** there is positioned an annular resistance element **13**. The resistance element shown may be wire wound about a mandrel **35** to encompass a functional angle of 300 degrees or more and with its ends soldered to terminals **30** and **31**. The resistance element is positioned and suitably secured within the base so that the open region between its ends is diametrically opposite the rib **27** in the channel **25**, the purpose of which will be described later.

The center terminal **29** serves as a pintle or bearing about which wiper assembly **14** is pivoted and also serves the function for which a slip ring is normally provided in conventional constructions. This terminal **29** protrudes from the central floor area **26** to a height sufficient to accommodate the components of wiper assembly **14**. The bottom component of this wiper assembly is a metallic flat washer **36** which rests on floor **26** surrounding the terminal **29**. Abutting against washer **36**, also surrounding terminal **29**, there is positioned a bowed or arched bias spring **38**. Wiper assembly **14** further includes, abutting bias spring **38**, a coupling plate **40** which is generally circular, with an opening passing the center terminal **29**. Extending integrally from the outer periphery of the coupling plate in the forward or upward direction away from floor **26** are four equally spaced coupling lugs **42**. These lugs form substantially right angles with the coupling plate proper, are mutually parallel and are symmetrically disposed about the center terminal **29**. Between one pair of adjacent lugs **42**, the coupling plate **40** includes a stop arm **44** which is formed to extend radially outwardly and then substantially perpendicularly into channel **25**. This arm strikes rib **27** to form end-stops for the wiper assembly in both directions at or near the contacting by the wiper of the respective ends of the resistance element.

A centrally flat wiper member **46** is locked to coupling plate **40** for rotation therewith. Wiper member **46** includes a generally circular central portion about the center terminal and a radially extending resilient contacting or brush arm **48** of sufficient length to contact the resistance element and is formed with a longitudinal bend-line at its outer end to provide a narrow region of contact with resistance element **13**. Extending radially from the wiper member central portion diametrically opposed to the contacting arm **48** in the plane of the wiper member is an aligning arm **50** secured to stop arm **44**, as by spot-welding.

Wiper assembly **14** is completed by the addition of a flat washer **52** forwardly adjacent to the wiper member, against which the forward end of terminal member **24** is swaged or flared as indicated at **54** to hold all the members of the wiper assembly between flared end **54** of the terminal member **29** and the floor **26**. Within wiper assembly **14**, the arched spring **38** exerts axial biasing force to produce firm electrical contact between the abutting surfaces. All elements of the wiper assembly and its associated terminal are of easily fabricated conductive materials, and the tiny molded or machined insulators normally employed in miniature precision potentiometers of this type are eliminated, as is the separate wiper normally used with a slip ring for external connection.

By superimposing aligning arm **50** on stop arm **44**, the position of the contacting arm **48** is set with respect to stop arm **44** to establish extreme rotary positions at the ends of the element.

The base assembly as described may be used with any one of a large number of driving member assemblies or "fronts." In the form of the invention shown in FIGURES 1 to 7, the coupling plate **40** is engaged in driven relation with an insulating coupling **60**, preferably molded of a suitable plastic, having a circular surface **62** adjacent to coupling plate **40**. In surface **62**, as shown in FIGURE 4, there are provided a set of four sockets or wells **63**, spaced to receive the lugs **42**, the regions between the wells being somewhat bevelled or conical. These wells and their mating lugs are spaced a radial distance from the axis of rotation of the wiper assembly much greater than the radius of the terminal **29** to provide cooperating or keyed parts large enough to allow easy manual handling in assembly. This feature is of special importance in miniature precision potentiometers which have an outer diameter of ¾ of an inch or less.

Suitable adhesive sealing materials (not shown) may be set into wells **63** to insure permanent and continuous engagement of the lugs **42** with the coupling **60**. To provide clearance for end **54** of terminal **29**, surface **62** is recessed at its center as indicated at **67** (FIGURE 2). The form of the invention shown in FIGURES 1 and 2 utilizes on the outer surface **65** of coupling **60** a slot **64**. Slot **64** is sized to accept a screwdriver-like blade **66** extending inwardly from the outer covering disc **16** and secured in the slot **64** by an adhesive as the final step of assembly, and being itself provided with a screwdriver slot **18**.

The perimeter **72** of the forward portion of coupling **60** is formed with a shoulder seating an O-ring **74** which in turn fits snugly within a metallic outer cup-shaped housing **76**. This O-ring serves to effectively seal the interior against moisture. The metal outer or front housing **76** includes a tubular sidewall **78** having a shoulder **79** seating the lip of the base. The front housing or shell **76** has at its front end an annular inwardly directed flange **80** surrounding a circular opening **81** through which the comparatively small outer end **65** of the coupling **60** rotatably fits. To complete the assembly of cup-shaped housing shell **76** to base **12**, the rear end of the shell may be spun over against the base rear wall, or suitably sealed to the base by adhesives as illustrated in FIGURE 2, the rear edge of the base having a bevel at **82** for such fastening.

Shown also in FIGURE 1 is a viewing window **84** through the thickness of disc **16**. As the disc is rotated with respect to the outer housing **76**, window **84** passes over the surface flange **80** of the outer housing and exposes numbers inscribed on the flange face to indicate the position of the rotor or wiper assembly, the angular width of the window being greater than the spacing between numbers to permit visual interpolation. It will be observed that the "framing" of the calibration markings thus provided makes reading of the setting extremely easy, and that adjustment is readily made either by the convenient thumb wheel type of "knob" thus provided or by means of a screwdriver. With this construction, the general utility of the device is greatly aided; where the potentiometer is installed in a relatively inaccessible location where a screwdriver must be employed, the difficulty of reading normally associated with such locations is greatly eased by the window type of indicator, the reading of which is further facilitated by a liner **85** inscribed with easily visible marker lines. Where economy and space are predominant factors, the outer disc **16** may be omitted, and the adjustment made by screwdriver or wrench insertion in the slot **64**, reading of position being indicated by a suitable indicator arrow (not shown) extending from slot **64** on the top surface **65** of coupling **60**. Preferably, a slightly modified form of coupling **60** should be used in such a case, to provide a dust-tight path into the interior. This function is served by the outer disc

16 in the illustrated embodiment, the periphery of the disc being in close sliding relation to the flange 80 of the housing; this relation is easily obtained without precision tolerances in manufacture by simply pressing these surfaces into firm sliding contact in the final assembly operation of insertion of the blade 66 into the adhesive (not shown) in the slot 64.

It will be noted that the diameter of surface 62 of coupling 60 is greater than that of opening 81 in flange 80 so that the coupling is firmly held against axial movement when the O-ring 74 is utilized and housing 76 is locked to the base.

Now turning to FIGURE 8, there is shown another potentiometer 90 of the miniature precision type having a conventional type of shaft 92. In the details of its inner construction potentiometer 90 closely resembles potentiometer 10. Potentiometer 90 includes a base assembly 11 identical to that described for the embodiment described above, including a base 12, a resistance element 13 and a wiper assembly 14. Protruding from wiper assembly 14 toward the drive shaft is a coupling plate 40 identical to the coupling plate previously described with its extending lugs 42. For engagement with this coupling plate and its lugs, the form of the invention shown in FIGURE 8 utilizes an insulating coupling plate 94 which has a face 96 with suitable openings or wells 98 engaging the lugs 42. The face 96 of the engaging plate 94 is identical in configuration with that of engaging structure 60.

On its surface opposite face 96, plate 94 includes an annular projection 100 which is fitted in suitable fashion to shaft 92 to form an integral unit. The shaft 92 is fitted rotatably within a threaded mounting bushing 102 of cup-shaped housing 103. Housing 103 includes a front cover plate 104 which covers the base interior and further includes a tubular sidewall 105 which fits about the base structure 12 and has its rearward edge affixed to the rear wall of the base as shown at 106 (the spinning-over of the rearward edge previously mentioned being illustrated in this case) to complete the assembly.

A set of terminals 108 extend from the base. This terminal set as shown in FIGURE 8 is of the type designed for the soldering of connecting leads in this instance.

Potentiometer 90 is of the bushing-mounted type in which the shaft-bearing bushing 102 is mounted in a suitable opening by the use of nuts 110 and having a conventional forwardly extending keying pin (not shown) to prevent rotation in the mounting panel. It will be noted that the coupling plate 94 in this instance slides against the inside of cover plate 104 and acts to prevent axial movement of shaft 92. As in the previous case, great precision in manufacture of the parts to provide exact fit may be avoided by assembly of the portions constituting the "front" to the "universal" base before complete setting of the adhesive in the wells 98; to accommodate tolerances achieved without great expense, the wells, as illustrated, are slightly greater than a half-circle of a diameter slightly larger than the width of the lugs 42, the latter and their supporting plate being desirably formed of a soft beryllium copper alloy to permit slight deformation; although adhesive is desirably used in this joint, the fit and accommodation may easily be made adequate to assure proper alignment without the use of adhesive, with no backlash problem created except in uses involving an extraordinary number of readjustments of position during the lifetime of the equipment in which the potentiometer is to be installed. Substantial tolerances in longitudinal dimensions are permissible even in very tiny structures without requiring excessive care in assembly, and with a minimum of mechanical parts, all of relatively low cost. No locking rings or other stops for axial motion of the drive member are required. Because of the illustrated construction of the unitary base assembly, excessive inward thrust on the shaft in use of the device, as in lack of care in making a screwdriver adjustment, merely results in temporary deformation of the spring 38, the recessing of the drive member at 67 preventing the application of any force to the center terminal (serving as slip ring and rotational bearing) which might deform it in a manner to interfere with the electrical contact with the wiper assembly. The bevelled or conical shape of the insulating coupling member in the region of the wiper contact accommodates corresponding temporary bending back of the contact arm without injury.

It can be seen that either base assembly as described herein (differing only in the terminals) is capable of being mounted or assembled to many forms of driving members of which only two have been shown, and with many front housing configurations. Precision potentiometers of a diameter of a half-inch or less are thus easily and inexpensively fabricated in a variety of forms.

While there have been described what are at present thought to be the most preferred forms of the invention, it may be understood that modifications may be made therein and the patent protection afforded the invention shall accordingly be determined in accordance with the structures as described in the appended claims, and equivalents thereof.

What is claimed is:

1. A potentiometer comprising a circular housing, a resistance element and a wiper contact within the housing, and an operating member coupled to the wiper contact and extending centrally from the face of the housing, said potentiometer having:

(*a*) spaced position calibration markings inscribed on the face of the housing surrounding the operating member, and

(*b*) a circular manipulating knob on the outer end of the operating member, substantially coextensive with the face of the housing and closely overlying the calibration markings in sliding relation with the face of the housing,

(*c*) the knob having a window opening exposing in its successive rotational positions only the portion of the calibration markings corresponding to the respective positions, the window opening being of angular width greater than the spacing between markings.

2. A potentiometer as described in claim 1 characterized by:

(*d*) the knob being in keyed engagement with the portion of the operating member extending through the housing substantially at the outer surface of the housing,

(*e*) said portion itself having an indicator adapted for reading of position in cooperation with the calibration markings.

3. A potentiometer comprising:

(*a*) a circular insulating base having interior and exterior sides,

(*b*) a resistance element mounted on the interior side of the base,

(*c*) a rigid conducting terminal extending centrally through the base and fixedly mounted therein and having its inner end extending from the interior side,

(*d*) a wiper entirely of conductive materials having a first portion contacting the resistance element and a second portion mounted for rotation on, and in electrical contact with, the portion of the terminal within the interior,

(*e*) a front housing enclosing the interior side of the base and means mounted entirely on the base for retaining said wiper in position on the base,

(*f*) an external operating member extending through the front housing,

(*g*) an insulating coupling between the wiper and the operating member,

(*h*) the insulating coupling including a pair of mem-

bers of larger diameter than the terminal and having mutually interengaging rotational coupling elements thereon,

(*i*) one of the members of said pair having a plurality of axially extending prongs and the other having recesses registering therewith,

(*j*) the front housing having a central aperture of smaller diameter than the members of said coupling pair, and the forward member of said coupling pair being confined in axial position by the portion surrounding the aperture and having a forwardly extending portion in the aperture,

(*k*) the rearward member of said pair being affixed to the wiper and having a rearwardly extending portion, and

(*l*) the base having a fixed stop portion in the rotational path of said rearwardly extending portion fixing the rotational limits of the wiper path.

4. The potentiometer of claim 3 further characterized by:

(*m*) the front surface of the front housing having calibration markings thereon surrounding the portion of the operating member extending therethrough and the operating member having a portion overlying the markings and having a viewing window therethrough, for indication of the rotational position of the wiper.

5. A potentiometer comprising:

(*a*) a circular insulating base having interior and exterior surfaces and having a central conducting terminal and two other conducting terminals extending therethrough in the axial direction,

(*b*) a resistance element mounted on the interior surface of the base outwardly spaced from the central terminal to form an annular region therebetween and having the ends thereof electrically connected to said other terminals,

(*c*) a rotary wiper assembly having a radial wiper portion engaging the resistance element and having a portion extending in the axial direction into the annular region,

(*d*) a fixed stop member on the base in said annular region spaced in the axial direction from the path of the radial wiper portion but engaging said axially extending portion of the rotary wiper assembly to limit the rotation thereof,

(*e*) means on the inner end of the central terminal for mounting the wiper assembly thereon in conductive rotary contact therewith,

(*f*) a cup-shaped front housing enclosing the interior surface of the base,

(*g*) an external operating member extending centrally through the front housing, and

(*h*) mating members on the wiper assembly and the operating member coupling them for rotational motion.

6. The potentiometer of claim 5 characterized by:

(*i*) the wiper assembly comprising a substantially rigid conducting member having a body portion surrounding the central terminal and having an integrally formed tab extension extending in one axial direction into said annular region to engage the fixed stop member and having integrally formed prongs extending in the opposite axial direction to mate with the drive member.

7. A potentiometer comprising:

(*a*) an insulating base having interior and exterior surfaces,

(*b*) a resistance element and a rotary wiper mounted on the interior surface of the base,

(*c*) a metallic tubular front housing member enclosing the interior surface of the insulating base and having an inwardly extending flange on the front end thereof defining an aperture,

(*d*) an insulating drive member within the housing coupled to the wiper and having an outer portion rotatable in the aperture and an inner portion underlying the flange,

(*e*) a knob member secured in mating engagement with the outer portion of the drive member and having a periphery substantially coextensive with the end of the front housing member and in sliding engagement with the flange,

(*f*) spaced visual position indicia on the flange, and

(*g*) a window in the knob member for viewing of the indicia on the flange, the window being of angular width greater than the spacing between calibration markings.

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