Feb. 13, 1968 W. D. KIRKENDALL 3,369,208

VARIABLE RESISTORS

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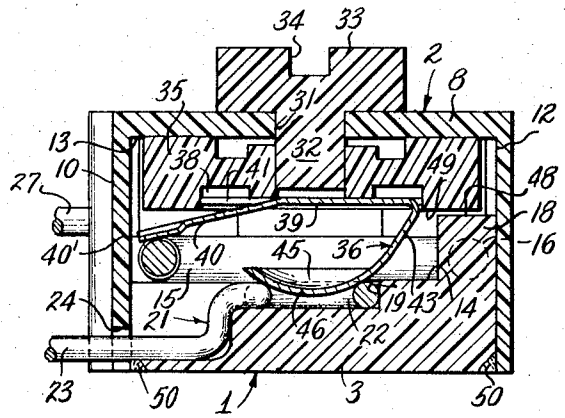

Fig. 1.

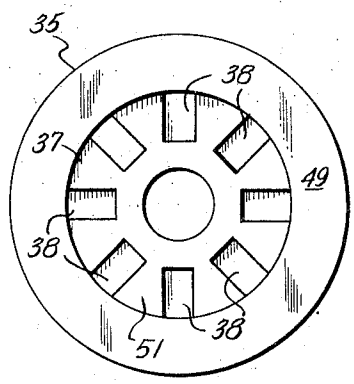

Fig. 4.

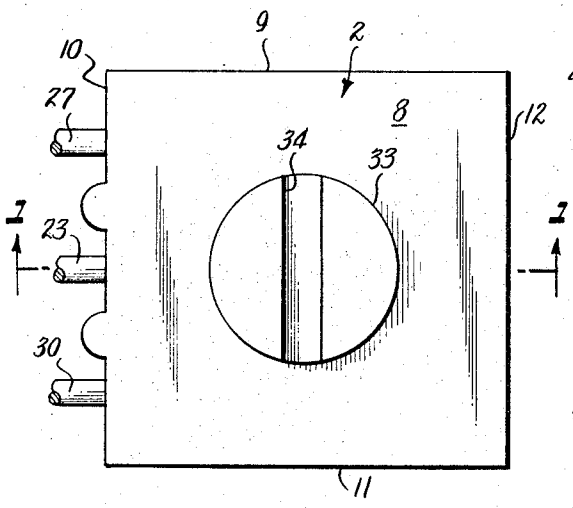

Fig. 2.

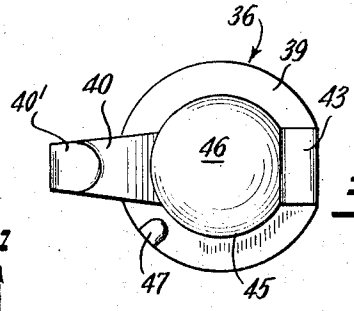

Fig. 5.

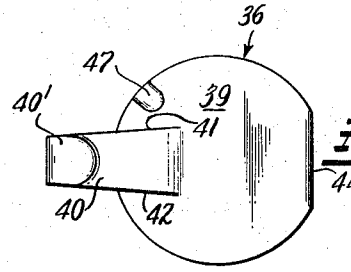

Fig. 6.

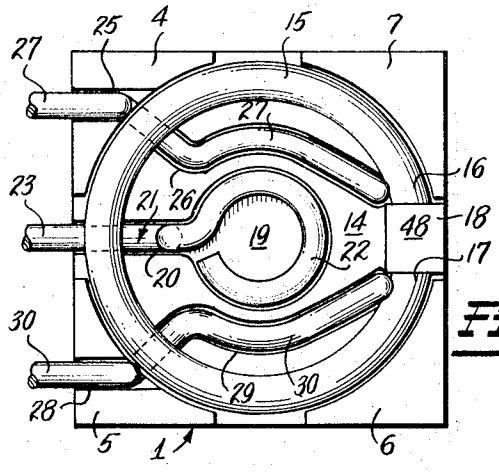

Fig. 3.

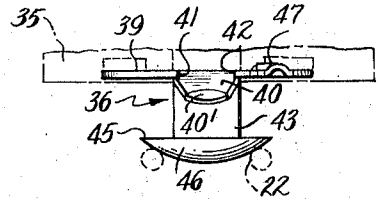

Fig. 7.

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Fig. 9.

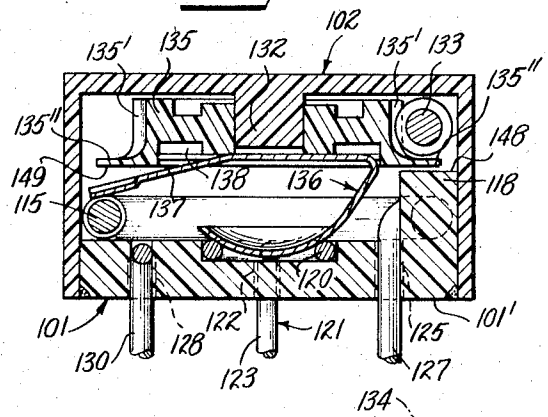
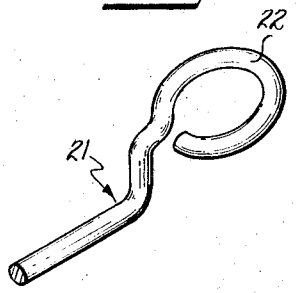


Fig. 8.



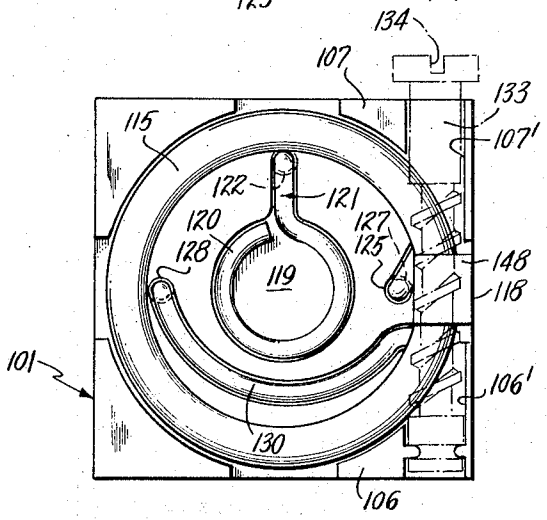


Fig. 10.

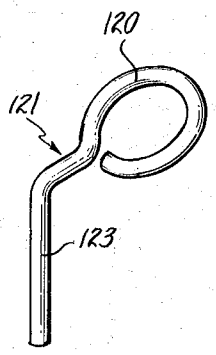


Fig. 11.

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VARIABLE RESISTORS

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5 Claims. (Cl. 338—174)

This invention relates to variable resistors and especially to miniaturized potentiometers, particularly those commonly known as "trimmer" potentiometers.

Though devices of this type have been known for some time and are now widely used in various forms, a number of problems are still encountered in attempting to provide truly satisfactory miniaturized trimmer potentiometers and like variable resistances. These problems can be characterized generally as arising from the small size of the device, typical miniature potentiometers having an overall maximum transverse dimension on the order of 5/16 in. When dealing with devices of this size, it is exceedingly difficult to provide even features which are considered very simple in larger structures. Thus, one particular problem has been encountered in attempting to provide a satisfactory mounting and lead-in arrangement for the movable contact of the resistor, and it has also been difficult to devise satisfactory means for retaining other elements of the device in proper positions within the housing.

A general object of the invention is to provide a variable resistor structure, particularly adapted to miniaturized potentiometers, employing a simplified, more effective and dependable rotary contact means.

Another object is to devise a miniature potentiometer which, though significantly improved in operation and dependability, can be manufactured and assembled more easily and less expensively than prior-art devices.

A further object is to provide a variable resistor wherein a single, very simple element serves both as an electrical lead for the rotary contact and as a bearing and centering element therefor.

Still another object is to provide, in a resistor of the type described, improved means acting both as a limit stop for the rotary contact and as means for restraining the rotary structure of the resistor against excessive axial movement in one direction.

Stated generally, the invention is characterized by a novel lead element and rotary contact structure, the lead element having an annular portion concentric with the axis of rotation of the rotary contact, the latter having a dished portion engaging the annular part of the lead in bearinged fashion, and the configuration of the rotary contact being such that the dished portion is urged resiliently into proper contact with the annular portion of the lead. The rotary contact is carried by a wheel-like element, or by a gear, spaced axially from the annular portion of the lead, and the wheel or gear is kept from shifting excessively, toward the resistance element, by an abutment formed on the housing and also serving both as a limit stop for the rotary contact and as a means for positioning the resistance element.

In order that the manner in which the foregoing and other objects are achieved in accordance with the invention can be understood, particularly advantageous embodiments thereof will be described in detail with reference to the accompanying drawings, which form a part of this specification, and wherein:

FIG. 1 is a transverse sectional view of a miniaturized potentiometer in accordance with one embodiment of the invention;

FIG. 2 is a top plan view of the device of FIG. 1;

FIG. 3 is a view similar to FIG. 1 but with the cover and rotary contact removed;

FIG. 4 is a bottom plan view of the rotary contact carrier of the device of FIG. 1;

FIGS. 5–7 are bottom plan, top plan, and side elevational views, respectively, of the rotary contact of the potentiometer of FIG. 1, each showing the contact in that resiliently distorted condition which it is forced to assume in the assembled device as seen in FIG. 1;

FIG. 8 is a perspective view of a combined lead and bearing member employed in the potentiometer of FIG. 1;

FIG. 9 is a transverse sectional view of a miniaturized potentiometer in accordance with another embodiment of the invention;

FIG. 10 is a top plan view of the device of FIG. 9 with the cover, rotary contact and driving gearing removed; and

FIG. 11 is a perspective view of a combined lead and bearing member employed in the potentiometer of FIG. 9.

Turning now to FIGS. 1–8 of the drawings, the embodiment of the invention here illustrated comprises a housing formed by a base portion **1** and a cover portion **2**, the base portion including a rectangular base wall **3** and upstanding corner portions **4–7**, the outer sides of the corner portions constituting extensions of the side edges of base wall **3**. Cover **2** includes a rectangular main wall **8** and four side walls **9–12**, the side walls **9–12** telescopically embracing base **1**, with corner portions **4–7** projecting into engagement with inner face **13** of wall **8** when the housing is fully assembled.

Base **1** has a face **14** directed toward face **13** and on which is supported the resistance element **15**. Element **15** extends for the major portion of a circle, as seen in FIG. 3, the ends **16** and **17** respectively engaging the sides of an abutment **18** which projects from the base. The inner faces of corner portions **4–7** are cylindrical surface portions with a common axis, and resistance element **15** extends close beside these faces. At the center of the base, the face **14** is interrupted by a circular recess **19** which opens toward face **13** and communicates with a lateral groove **20** which is of stepped configuration and opens outwardly through one side edge of base wall **3**, as will be clear from FIGS. 1 and 3.

Accommodated by recess **19** and groove **20** is an electrically conductive lead element indicated generally at **21**, FIG. 8. Element **21** is of wire of circular transverse cross-section. One end portion of element **21** is bent into a circular loop **22** of a size to fit snugly in recess **19**. The remainder of element **21** is bent to conform to the stepped bottom wall of groove **20** and projects outwardly from the base at **23**. Side wall **10** of cover **2** is notched at **24** to accommodate element **21**.

Corner portion **4** is provided with a groove **25**, and face **14** is provided with a groove **26**, to accommodate lead wire **27**, the end of this lead wire being soldered to end **16** of resistance element **15**. Appropriate grooves **28** and **29** are provided in corner portion **5** and wall **3**, respectively, to accommodate lead wire **30**, the end of lead wire **30** being soldered to end **17** of resistance element **15**.

Housing portions **1** and **2** are formed of a suitable synthetic resin material, such as a diallyl phthalate composition. The lead elements **21**, **27** and **30** are secured in place by means of an epoxy resin adhesive or the like.

The main wall **8** of cover **2** is provided with a centrally located circular opening **31** through which extends the shank **32** of a stub shaft member **33**, the head of which includes a tool slot **34**. A wheel member **35**, FIGS. 1 and 4, is fixedly secured to shank **32** in any suitable fashion, member **35** rotating with member **33** and serving as a carrier for the rotary contact indicated gen-

erally at 36. Wheel member 35 includes a shallow circular recess 37, FIG. 4, which opens toward base wall 3 and includes a plurality of radially extending depressions 38 extending more deeply into the body of the wheel member than does the main portion of recess 37.

Rotary contact member 36 is formed as an integral piece from thin resilient sheet metal and includes a circular main body portion 39 from which projects a contact arm 40, body portion 39 being provided with slits at 41, 42 and the contact arm being bent to project at an angle to the plane of body portion 39, as seen in FIGS. 1 and 7. Thus, contact arm 40 diverges outwardly from the plane of body portion 39. In a location diametrically opposed to contact arm 40, an intermediate arm portion 43 projects from main body portion 39, being bent, generally along line 44, FIG. 6, so as to extend away from the plane of body portion 39 on the same side as arm 40. Intermediate arm 43 terminates in a shallow, cup-shaped contact portion 45 which is concave when viewed from the side nearer body portion 39 and which presents a spherical or convex bearing surface 46.

The diameter of body portion 39 is such that the body portion can be snapped into recess 37, the rotary contact member 36 then being frictionally coupled to wheel member 35 to rotate therewith. The relaxed or undistorted configuration of member 36 is such that, when the parts are assembled, contact arm 40 must be resiliently distorted toward wall 8 in order to properly engage resistance element 15, and the combination of intermediate arm portion 43 and portion 45 must be displaced toward wall 8 in order to seat the spherical surface 46 on the circular bearing surface presented by loop 22 of lead element 21. Accordingly, with the potentiometer assembled as seen in FIG. 1, the tip 40' of arm 40 and the portion 45 are resiliently biased into sliding engagement with resistance element 15 and loop 22, respectively.

At a point angularly displaced from contact arm 40, body portion 39 of the rotary contacts is deformed to provide a radially extending protrusion 47 which is of generally arcuate transverse cross-section. Protrusion 47 projects from the plane of body portion 39 in a direction opposite to that in which the contact arm 40 is deflected. Accordingly, when body 39 is fully inserted in recess 37 so as to engage the main bottom surface 51 of the recess, and assuming that the contact member 36 has been rotationally oriented relative to wheel member 35 to align protrusion 47 with one of the depressions 38, the protrusion is then accommodated by the corresponding depression 38. The depressions 38 are identical, each commencing at the outer wall of recess 37 and extending radially inwardly through a distance longer than the length of protrusion 47. The maximum width of protrusion 47 is substantially equal to the width of depressions 38.

The friction engagement between the outer cylindrical wall of recess 37 and the periphery of body portion 39 is such that, under normal circumstances of operation of the potentiometer, the rotary contact 36 is constrained to rotate with wheel member 35 as that member turns with member 32, the latter member being adjusted manually by a tool engaged in slot 34. However, should an unusually large resistance to rotation of contact member 36 occur, the resulting increased torque is at first accepted by engagement of protrusion 47 with the corresponding side of the one of the depressions 38 into which the protrusion projects. Assuming that the torque persists and is adequately large, the curved surface presented by protrusion 47 rides over the edge of the depression, the body portion 39 being correspondingly deflected away from the bottom of recess 37, so that the protrusion escapes from depression 38 and wheel member 35 can turn while the rotary contact remains stationary. With continued rotation of the wheel member, the protrusion 47 is snapped into the next adjacent depression 38, the slip clutch action just described then being repeated.

The length of contact arm 40 is such that the arm projects substantially to the outer periphery of resistance element 15. Accordingly, when member 33 is turned to rotate contact 36 to such an extent that the tip 40' of arm 40 travels to one of the ends 16, 17 of the resistance element, the corresponding side edge of tip 40' comes into engagement with a side face of abutment 18. The abutment thus serves not only to position resistance element 15 but also as a limit stop, effective for both directions of movement of the rotary contact. Should the rotary contact be turned until arm 40 engages abutment 18, and should the adjusting torque then still be continued, the slip clutch action afforded by frictional engagement of body portion 39 in recess 37 and by engagement of the protrusion 47 in depressions 38 will occur.

The abutment 18 presents a flat end face 48 directed toward the annular face 49 of wheel member 35 which is exposed toward base 1. Abutment face 48 is disposed immediately adjacent to face 49 but out of contact therewith, when the parts are in their normal, assembled relation seen in FIG. 1, and the abutment 18 thus serves to prevent excessive movement of the wheel member toward the base since such movement would cause face 49 to engage abutment face 48.

Housing portions 1 and 2 are secured together, as by means of an epoxy resin adhesive at 50, FIG. 1. The lead wires 21, 27 and 30 are affixed to base portion 1 by an epoxy resin adhesive. Resistance element 15 is held in place by the effect of the solder connections to lead wires 27, 30, the spring action of the rotary contact, and the positioning effect of abutment 18.

FIGS. 9–11 illustrate a miniaturized trimmer potentiometer in accordance with a second embodiment of the invention wherein the rotary contact is adjusted by means of a worm gear. The potentiometer comprises a housing formed by base 101 and cover 102 which are telescopically interengaged as described with reference to the first embodiment. Cover 102 includes a fixed, centrally disposed, inwardly projecting, cylindrical boss 132 on which the worm gear 135 is journaled for free rotation. The side of gear 135 directed toward base 101 is identical with the corresponding side of wheel member 35, FIGS. 1 and 4, and thus includes recess 137, depressions 138 and annular face 149.

Rotary contact 136 and resistance element 115 are identical with the corresponding parts of the device of FIG. 1. Base 101 includes a central, circular recess 119 accommodating the circularly looped end 120 of lead element 121, and the abutment 118 is provided between the ends of the resistance element.

Gear 135 has peripheral worm teeth 135' which extend from the side of the gear adjacent cover wall 108 to the transverse annular flange 135'' which, projecting outwardly well beyond the gear teeth, provides the surface 149. Corner posts 106 and 107, FIG. 10, are provided with coaxial semicylindrical grooves 106' and 107', respectively, to accommodate the respective cylindrical end portions of worm 133. Shown in phantom lines in FIG. 10, worm 133 has a slotted head portion 134 disposed exterior to the housing so that the worm can be turned to drive the rotary contact.

As seen in FIG. 9, worm gear teeth 135' curve outwardly to join the adjacent face of flange 135'' and the relative positions and dimensions of the parts are such that the flange 135'' projects between the worm 133 and face 148 of abutment 118. Accordingly, the rotary contact 136, being distorted in compression between the bearing surface presented by loop 120 and gear 135, urges the gear into operative engagement with worm 133 and out of contact with face 148 of abutment 118. Possible movement of the gear toward base 101 is limited by contact of face 149 with abutment face 148.

In this embodiment, the worm 133 and gear 135 are advantageously fabricated from nylon, providing good mechanical characteristics as well as low friction bearing qualities.

Shown in FIG. 11, lead element **121** includes the looped end **120** and a straight portion **123**, which projects at right angles to the plane of loop **120** and outwardly through bore **122**. Lead wires **127** and **130**, each soldered to a different end of the resistance element, pass outwardly through bores **125** and **128**, respectively, so that the three lead wires project in parallel fashion from the outer face **101'** of the base of the housing.

Though particularly advantageous embodiments have been chosen for illustrative purposes, it will be understood by those skilled in the art that various changes and modifications can be made therein without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. In a variable miniature resistor, the combination of a housing comprising

a first wall,

a second wall spaced from and at least generally parallel to said second wall, and

side wall means cooperating with said first and second walls to define a cavity;

a resistance element mounted in said cavity and extending circularly in a plane parallel to said first and second walls;

bearing means carried by said first wall;

a rotary contacting driving member disposed in said cavity and mounted on said bearing means for rotation about an axis at right angles to said first and second walls,

one side of said contact driving member being directed toward said second wall,

said axis passing through the center of the circle in which said resistance element extends;

an electrically conductive lead element having one end portion disposed within said cavity and extending circularly in a plane parallel to said first and second walls,

said one end portion being supported by said second wall and centered on said axis with said one end portion of said lead element exposed toward said first wall,

said lead element being a wire of circular transverse cross section;

at least one additional electrically conductive lead connected to said resistance element; and

an integral rotary contact member of electrically conductive spring metal sheet, said rotary contact member comprising

a generally flat body portion of such configuration and dimensions as to be capable of slip clutch engagement with said one side of said contact driving member,

a first contact arm, and

a second contact arm,

said first contact arm extending generally radially relative to said body portion, being bent to diverge outwardly from the plane thereof, and terminating in a contact tip,

said second contact arm commencing in a bend at the edge of said body portion at a location opposite said first contact arm and extending away from the plane of said body portion, on the same side thereof as said first contact arm and toward said one end portion of said lead element, said second contact arm terminating in a cup-shaped contact portion having a concave side facing said body portion and a convex, generally spherical side facing away from said body portion;

said rotary contact member being located within said cavity with said body portion in slip clutch engagement with said one side of said contact driving member, said generally spherical side of said cup-shaped contact portion in sliding engagement with said one end portion of said lead element, and said contact tip of said first contact arm in sliding engagement with said resistance element,

said second contact arm being resiliently distorted, by reason of engagement of said rotary contact member between said rotary member and said one end portion of said lead element, to urge said body portion against said one side of said contact driving member and said cup-shaped contact portion against said one end portion of said lead element.

2. A resistor according to claim **1**, wherein said second wall includes an abutment located between the ends of said resistance element and disposed in the path of travel of said first contact arm so as to act as a limit stop therefor, said abutment projecting to a point adjacent said contact driving member to be engaged thereby in event of undue movement of said contact driving member toward said second wall.

3. A resistor according to claim **2**, wherein said contact driving member is a gear wheel having peripheral teeth and a flat annular flange extending transversely of said axis and beside said teeth on the side of said contact driving member which is nearer said second wall, said abutment having a surface disposed immediately adjacent to said flange.

4. A resistor according to claim **2**, wherein

said contact driving member is a gear wheel having

a circular body having peripheral teeth, and

a transverse annular flange extending outwardly from said body beside said teeth,

said flange being located between said teeth and said resistance element,

the resistor further comprising a driving worm extending at right angles to said axis and operatively engaged with said teeth,

said flange projecting beside said worm,

said abutment projecting to a point immediately adjacent said flange on the side thereof opposite said teeth and worm.

5. A resistor according to claim **1**, wherein said contact driving member is a gear wheel driving peripheral teeth and a flat annular flange extending transversely outwardly beside said teeth on the side of said wheel which is nearer said second wall, the resistor further comprising a driving worm extending at right angles to said axis and engaged with said teeth, said teeth curving outwardly and joining the adjacent face of said flange, whereby said second contact arm, being resiliently distorted in compression between said one end portion of said lead element and said contact support member, urges said teeth into engagement with said worm.

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