June 17, 1958 C. R. DICKINSON ET AL 2,839,642

VARIABLE RESISTANCE DEVICE

Filed Oct. 13, 1953

2 Sheets-Sheet 1

Fig. 1.

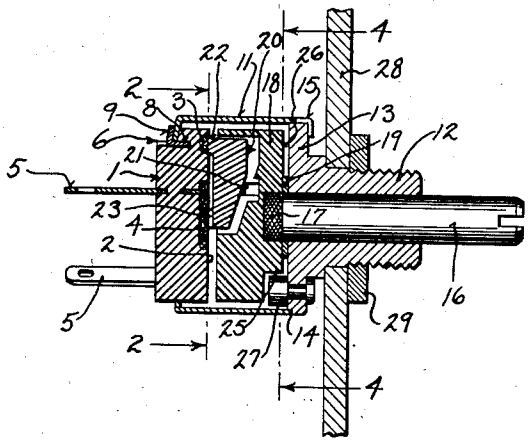


Fig. 2.

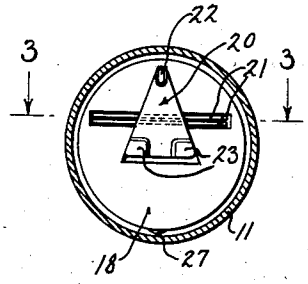


Fig. 3.

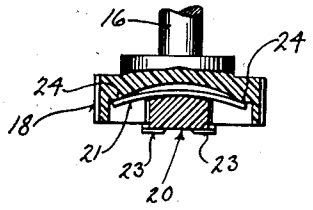
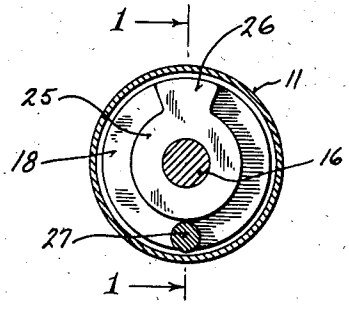


Fig. 4.



INVENTORS

Clarence R. Dickinson

Bernhard F. Tellkamp

BY

Arthur H. Seidel

ATTORNEY

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Fig. 5.

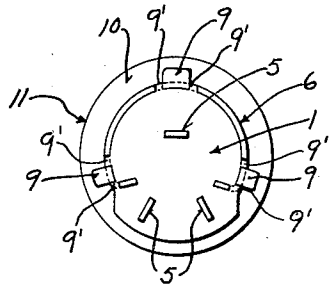


Fig. 6.

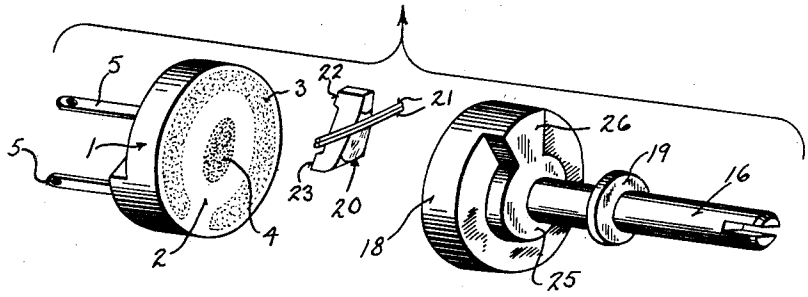


Fig. 7.

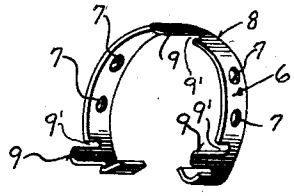
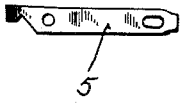


Fig. 8.



INVENTORS

Clarence R. Dickinson

Bernhard F. Tellkamp

BY

Arthur N. Seidel

ATTORNEY

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VARIABLE RESISTANCE DEVICE

Clarence R. Dickinson, Greendale, and Bernhard F. Tellkamp, Muskego, Wis., assignors to Allen-Bradley Company, Milwaukee, Wis., a corporation of Wisconsin

Application October 13, 1953, Serial No. 385,848

5 Claims. (Cl. 201—55)

This invention relates to variable resistance apparatus such as may be employed as a rheostat or potentiometer and it more specifically resides in an apparatus having a base upon which is exposed a layer of resistance material that forms a partial circle to provide a resistance track and a layer of conducting material to provide a collector track with brush engaging surface areas substantially concentric with said resistance track, which resistance and collector tracks are electrically bridged by a conducting brush rotatable about an axis substantially concentric with said resistance track having collector engaging portions in sliding contact with said collector track and a resistance engaging portion in sliding contact with said resistance which engaging portions define a base area for said brush that is intersected by the axis of rotation.

It is an object of this invention to provide a variable resistance apparatus with a resistance track and a collector track with exposed brush engaging surfaces confined within a circular area of extremely small diameter lending the apparatus to miniaturization desirable for use in complex circuit networks having a great multiplicity of components compacted within confined space limitations.

It is another object of this invention to provide a variable resistance apparatus with a rotatable conducting brush bridging resistance and collector tracks having contacting portions in sliding engagement with the tracks that define a base area intersected by the center of rotation of the brush to permit a reduction of overall dimension.

It is another object of this invention to provide a variable resistance apparatus with an operating shaft mounting a brush carrier that extends from the carrier in a direction opposite that of the resistance and collector tracks, whereby the base supporting the resistance and collector tracks may have a solid transverse cross section.

It is another object of this invention to provide a variable resistance apparatus in which a seal may be placed about the operating shaft and housed within the interior of the apparatus to protect the same and promote long life for the seal.

It is another object of this invention to provide a variable resistance apparatus with a minimum of metallic material in close association with conducting elements of the apparatus to reduce the possible leakage paths to a minimum.

These and other objects and advantages of this invention will appear in the description to follow. In the description, reference is made to the accompanying drawings, which form a part hereof, and in which there is shown by way of illustration and not of limitation a specific form in which this invention may be embodied.

In the drawings:

Fig. 1 is a side view in elevation and in section of a variable resistance apparatus mounted upon a panel in which this invention is embodied,

Fig. 2 is a view in elevation and in section of the apparatus viewed through the plane 2—2 indicated in Fig. 1.

Fig. 3 is a fragmentary view in section of the brush carrier and operating shaft forming a part of the apparatus viewed through the plane 3—3 indicated in Fig. 2,

Fig. 4 is a view in elevation and in section of the apparatus shown through the plane 4—4 indicated in Fig. 1,

Fig. 5 is a rear view in elevation of the apparatus shown in Fig. 1,

Fig. 6 is an exploded view in perspective of portions of the apparatus,

Fig. 7 is a view in perspective of a heat extracting insert forming a part of the apparatus, and

Fig. 8 is a side view in elevation of a terminal lead as is employed in the apparatus.

Referring now to the drawings, there is shown a molded base 1 of insulating material having a circular front face 2 that is clearly shown in Fig. 6. Embedded within the base 1 and exposed flush with the face 2 is a circular resistance track 3 in the form of a nearly completed ring. The track 3 comprises a shallow layer of conducting material in the form of distributed carbon black particles dispersed within the molding material of the base 1 to have become an integral portion thereof upon molding. Substantially concentric with the resistance track 3 is a collector track 4, also exposed flush with the face 2. The track 4 covers a circular area at the center of the face 2 and, like the track 3, is formed of a plurality of conducting particles molded integrally within the base 1 in a shallow layer near the surface. The particles comprising the collector track 4 are more densely distributed than in the resistance track 3 to provide a conducting spot area of very small resistance. Variable resistance apparatus comprising resistance and collector tracks of conducting particles molded within a base of insulating material, such as herein described, are known as integrally molded resistors of which certain forms have been set forth and described in the patents to Tellkamp No. 2,269,136, dated January 6, 1942, and No. 2,514,682, dated July 11, 1950.

A set of three terminal leads 5 are embedded within the base 1 at the time of molding and are disposed with the embedded end of one in electrical contact with the collector track 4 and the embedded ends of the others in contact with the end portions of the resistance track 3. The configuration of a lead 5 is clearly shown in Fig. 8. The hook shaped end is embedded in the base 1 to be rigidly held in place with the tip entering into a layer of conducting material that forms one of the tracks 3, 4.

The molded base 1 also has embedded therein a metallic heat extracting and housing anchoring insert 6, preferably composed of a metal having high heat conductivity. The insert 6 is in the form of an interrupted cylinder, as is more clearly shown in Fig. 7, with a plurality of perforations 7 through which the material of the base 1 may flow, upon molding, to rigidly secure the insert 6 in position. The insert 6 is embedded with its forward edge 8 behind, spaced from but very near the resistance track 3, as shown in Fig. 1, to readily receive heat released within the resistance track 3 and to conduct the same to the exterior of the base 1 for disposal as hereafter described.

As shown in Figs. 1 and 5 the rear of the element 6 is exposed and forms a cylindrical metallic wall adjacent a rearwardly facing ledge extending partly around the body 1. A set of attachment ears 9, integral with the element 6, partly isolated from the main body thereof by deeply indented filleted notches 9' flanking the same, projects rearwardly as shown in Fig. 7 at the time of

molding. A sleeve shaped metallic housing 11, inwardly flanged at its rear and punched to closely surround the rearward extension of the base 1 is placed as shown in Fig. 1, in close contact with the exposed portion of the insert 6. After being thus assembled, the ears 9 are clinched outwardly and forwardly as shown in Figs. 1 and 5, securely holding the housing 11 in place and in contact with the insert 6 to conduct heat therefrom for dissipation over the entire surface of the housing 11. The ears 9, being set apart from the remainder of the insert 6 by the notches 9', are free to be clinched against the housing 11 in spite of inevitable dimensional variations in the base 1, the insert 6 and the housing 11, without splitting of the base 1.

At the front, the circular cylindrical housing 11 has a lip 14 from which extends a set of ears 15. A bushing 12 with a circular base 13 seats upon the lip 14 and the free ends of the ears 15 are bent over the bushing base 13 to secure the bushing 12 in position. Extending through the bushing 12 is an operating shaft 16 having a knurled end 17 within the housing 11 that is embedded within a molded brush carrier 18 composed of an insulating material. Compressed between the bushing 12 and the carrier 18 is a seal 19 that closely encircles the shaft 16.

As shown in Figs. 1, 2 and 3 the carrier 18 is recessed to receive an electrically conducting brush 20 of carbon and a pair of bias springs 21. The brush 20 converges radially to terminate in an apex at the outer end that has a contact toe 22 with a small face area in sliding engagement with the exposed surface of the resistance track 3. The brush 20 widens from the apex into a broad inner end from which project a pair of collector engaging toes 23 each having a surface in sliding engagement with the collector track 4. The three contact toes 22, 23 of the brush 20 define a triangular base area that extends across and includes the axis of rotation of the operating shaft 16 whch is in substantial coincidence with the centers of the circular concentric tracks 3, 4. The two contact toes 23 rotate within a restricted radius confined to the limits of the spot like area of the collector track 4. The spacing of the toes 23 is, however, considerable to provide stability for the brush 20 by providing a substantial dimension of the brush base area along all radii.

As shown in Fig. 3, the springs 21 rest at their ends against abutments 24 in the recess in the carrier 18. The intermediate portion of each spring 21 bears against the back of the brush 20 and is bowed to provide necessary contact pressure between the brush toes 22, 23 and the exposed surface areas of the tracks 3 and 4. The use of a plurality of springs 21 permits contacting engagement with the curved back of the brush 20 at more than one point and the spring characteristic obtained is similar to that of a flat spring.

The forward portion of the carrier 18, in which the shaft end 17 is embedded, comprises a boss 25 of reduced diameter from which extends radially an integral lug 26 clearly shown in Figs. 4 and 6. Secured to the base 13 of the bushing 12 is a stop 27 that protrudes into the path of the lug 26 to limit rotation of the carrier 18 and brush 20. The movement of the brush contact toe 22 will thus be confined to within the limits of the resistance track 3. To mount the apparatus on a panel, such as designated by the numeral 28 in Fig. 1, the bushing 12 is inserted within an opening provided in the panel 28 and a nut 29 threadedly received by the bushing 12 is brought up tight against the panel 28 to clamp the panel 28 between the base 13 of the bushing 12 and the nut 29.

Leakage resistance paths and breakdown voltage values are maintained at desired high levels in the apparatus of this invention. The molded base of insulating material provides sufficient insulation between the resistance

track 3 and collector track 4. The terminal leads 5 extending directly to the rear are well spaced from one another and from the housing 11, and the side walls of the housing 11 is spaced from the base 1 with a substantial gap therebetween to insulate the periphery of the resistance track 3. The shaft 16 is extended away from the tracks 3, 4 and the conducting brush 20 that is seated within the carrier 18, thus eliminating a possibility of insulation breakdown between the shaft 16 and the conducting elements of the apparatus.

With the shaft 16 disposed entirely to one side of the base 1 the diameter of the base may be reduced from that otherwise necessary if the shaft 16 were extended through a central opening in the base. With elimination of a central opening in the base the collector track 4 is reduced to a spot area and the brush 20 is disposed with the contacting toes defining an area encompassing the axis of rotation. The resistance between the lead embedded in the collector track 4 and the brush toes 23 will be very small and will be a nearly constant value over the entire range of brush rotation. As the brush is rotated about an axis intersected by the brush base area one of the collector contacting toes 23 will move toward the lead end embedded in the track 4 and the other toe 23 will recede. This movement tends to retain the resistance of the collector track 4 nearly constant. In the event the embedded lead end is concentric with the brush axis, then the geometry will remain the same regardless of rotation.

We claim:

1. In a variable resistance apparatus the combination of a base having a front face with an arcuate resistance track, side faces extending rearwardly from the front face, and an extension rearward of said side faces that has sidewardly facing orientating walls set back from said side faces to form a rearwardly facing ledge; a cover formed of a thin metallic sleeve that is flanged inwardly at the rear with inner edges of the flanging closely conforming with said orientating walls, said cover encircling said base with the flanging seated upon said ledge and positioned by the conformance of said flanging inner edges with said orientating walls whereby the inner surface of said sleeve extends forwardly from the ledge at a predetermined spaced distance from said side faces of said base to present a gap therebetween; clamping means on said base holding said flanging against said ledge; a shaft supporting member to the front of said base mounted on said cover; and an operating shaft assembly borne by said shaft supporting member including a sliding contact bearing upon said resistance track.

2. In a variable resistance apparatus the combination of a molded insulating base having a front face with an arcuate resistance track and side faces extending rearwardly from the front face; a metallic heat conductive arcuate insert embedded in said base to the rear of said resistance track with exposed side walls set back from the side faces of said base to form a ledge at the rear of the base and having a plurality of attachment ears extending therefrom; a cover formed of a thin metallic sleeve that is flanged inwardly at the rear with inner edges of the flanging presenting an opening closely conforming with the exposed side walls of said insert, said cover encircling said base with the flanging seated upon said ledge and positioned by the conformance of said flanging with the side walls of said insert, and said cover being held tightly in position by clinching said attachment ears over the flanging of the cover; a shaft supporting member to the front of said base mounted on said cover; and an operating shaft assembly borne by said shaft supporting member including a sliding contact bearing upon said resistance track.

3. In a variable resistance apparatus the combination of a base assembly having a molded body with a front face presenting an arcuate resistance track and side faces extending rearwardly from the front face, and a metal-

lic insert of arcuate configuration partially embedded in the molded body with an edge in close proximity to said resistance track to receive heat evolved in the track and protruding at the rear of the base with a set of attachment ears; said base assembly presenting sidewardly facing orientating surfaces to the rear of and set back from the side faces of the molded body to form a rearwardly facing ledge over which said attachment ears may be turned; a metallic cover formed of a thin sleeve encircling the base that is flanged inwardly at the rear with flanging conforming to the orientating surfaces of the base assembly, which flanging is seated upon said ledge with the attachment ears clinched thereon whereby the cover is retained in predetermined position both circumferentially and radially by the conformance of the flanging with said orientating surfaces such that the inner surfaces of said sleeve extend forwardly from the ledge at a spaced radial distance from the side faces of said molded body; and a sliding contact member engaging said resistance track mounted at the front of said sleeve.

4. In a variable resistance apparatus the combination of a base having a front face with an arcuate resistance track, rearwardly extending side faces, and a rear portion with a ledge comprising rearwardly and sidewardly facing orientating walls; a cover formed of a sleeve encircling said base that has flanging at the rear turning over and seated upon said ledge with close conformance to said orientating walls thereby retaining the cover and base in fixed relative position with the walls of the cover spaced from the side faces of the base, and said cover also having a mounting surface at its front; clamping means on said base holding said cover flanging against said ledge; a member including a bushing spaced from the front of said base which is supported on said mounting surface of said cover; second clamping means retaining said member in position on said mounting surface of said cover; a rotatable operating shaft extending through said bushing to the interior of said cover; and a brush member within said cover carried by said shaft and in engagement with said resistance track.

5. In a variable resistance apparatus the combination comprising a metallic housing having front and after ends; an insulating base attached to the after end of said housing in fixed relation thereto; an arcuate resistance track carried on the forward side of the base; a conductive collector track radially within the resistance track carried on the forward side of the base; a metallic arcuate insert embedded in said base to the rear of said resistance track having exposed clamping portions that engage said housing in heat transferring relation thereto and retain the housing and base in attached, fixed relation; a bushing attached to the forward end of the housing in fixed relation thereto; a rotatable operating shaft extending through the bushing with an end within the housing spaced from the forward side of the insulating base; a non-deformable conductive brush spanning between the resistance and collector tracks having a contact toe engaging the resistance track and a pair of contacting toes engaging the collector track, said toes defining a triangular base area encompassing the axis of rotation of said shaft; a brush carrier mounted on said end of said shaft for rotation therewith, which carrier has a cavity that receives said brush for engaging the sides thereof to impart rotational movement thereto and which also has spring receiving recesses disposed to the sides of and in communication with the cavity; and a transversely deflectable wire spring interposed between the brush and brush carrier with the ends thereof received in and engaging said recesses and the center portion thereof engaging said brush to urge the brush against said tracks and the carrier toward the bushing.

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