Jan. 13, 1959 W. F. DEHN ET AL 2,868,931

VARIABLE RESISTANCE CONTROL

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Fig. 1.

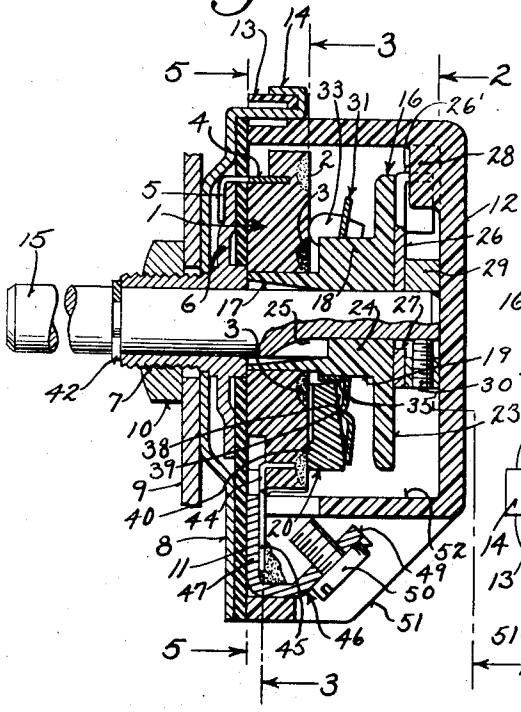


Fig. 2.

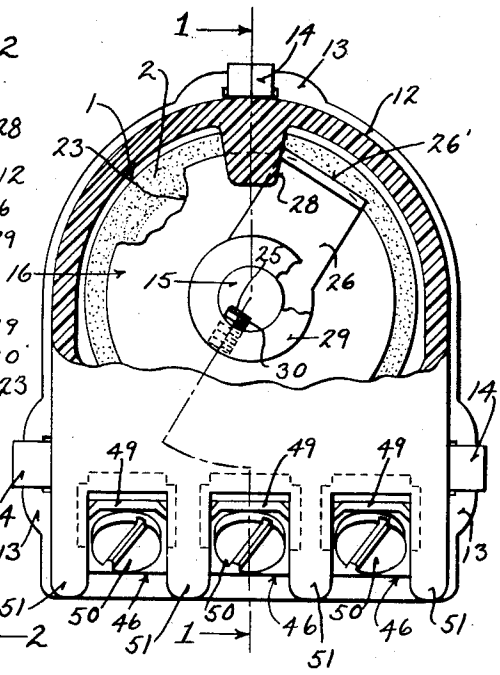


Fig. 3.

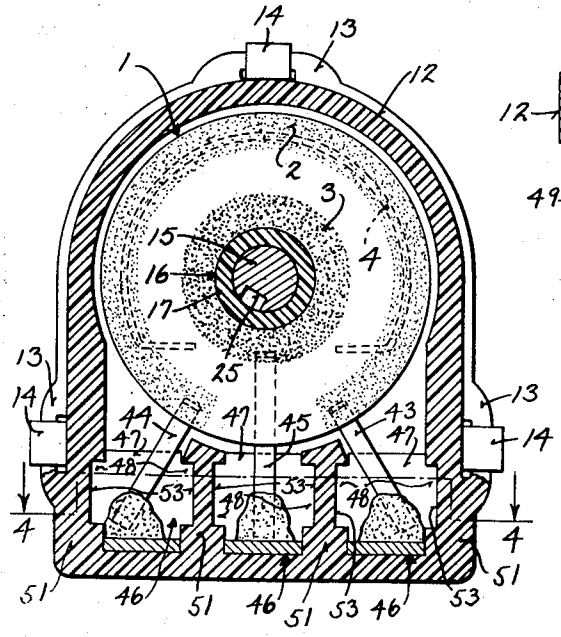
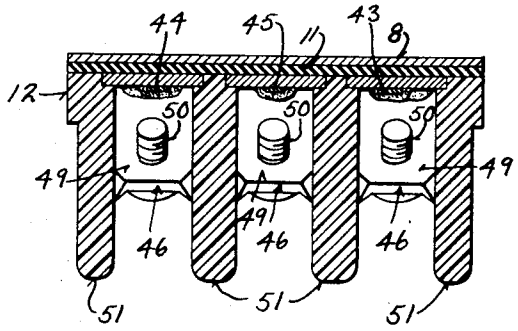


Fig. 4.



INVENTORS
William F. Dehn
Clarence R. Dickinson
BY
Arthur H. Seidel
ATTORNEY

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Fig. 5.

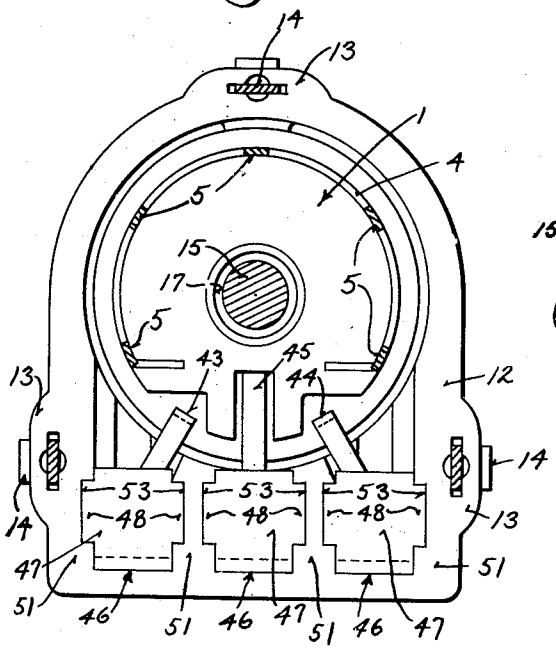


Fig. 6.

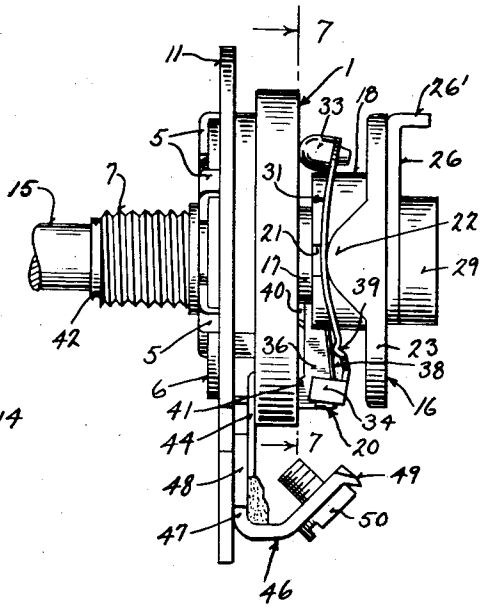


Fig. 7.

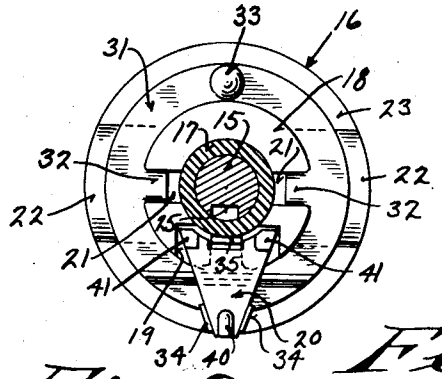


Fig. 8.

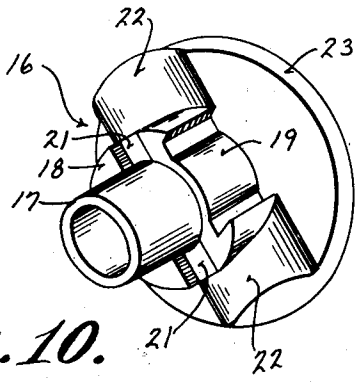


Fig. 9.

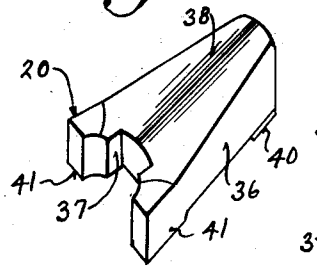
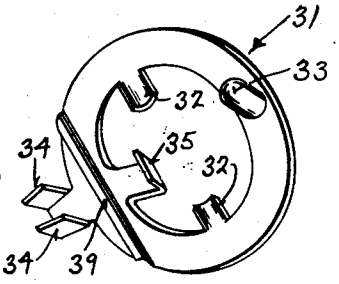


Fig. 10.



INVENTORS
William F. Dehn
Clarence P. Dickinson
BY
Arthur H. Seidel
ATTORNEY

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2,868,931

VARIABLE RESISTANCE CONTROL

William F. Dehn, Wauwatosa, and Clarence R. Dickinson, Greendale, Wis., assignors to Allen-Bradley Company, Milwaukee, Wis., a corporation of Wisconsin

Application June 11, 1956, Serial No. 590,427

7 Claims. (Cl. 201—55)

This invention relates to variable resistance apparatus that may be employed as a potentiometer or rheostat, and it more specifically resides in apparatus having a rotatable operating shaft for moving a brush along an arcuate resistance track, wherein it is one aspect of the invention to provide a bias spring for the brush that has reaction forces, acting upon the shaft, which are distributed in such manner that the resultant torque, acting to cause a tilt of the shaft, is a minimum. Another aspect of the invention resides in a bias spring that carries the brush and resiliently bears upon it, to urge the brush not only against the resistance track, but also radially outward against a pair of radially converging engagement faces that form integral parts of the spring. In addition, the invention provides for terminal members securely mounted by the casing of the apparatus, whereby such terminal members are isolated mechanically from the resistance track and brush.

When adjustment of a variable resistance is made by grasping and turning the operating shaft, subsequent release of the shaft may be accompanied by a slight shift of the shaft that alters the setting that had been selected. Such a shift is due, primarily, to spring forces within the resistance apparatus that cause a tilt of the shaft within its mounting. Although the shaft may be mounted in a bushing with a close fit, the degree of tilt permissible may be sufficient to create a shift in brush position when the shaft is disengaged, that causes a perceptible change in the resistance value selected. This is particularly evident in apparatus employed in circuits having exacting requirements for the circuit parameters, for the adjustment of the variable resistance must in such instances be precise.

In the present invention the reaction force of the bias spring, for creating contact pressure, is transmitted to the operating shaft in a manner that the resultant net torque acting to apply a tilt to the shaft is at or near the vanishing point. To accomplish this minimization of net torque the bias spring is placed in stress to react on both the brush and the shaft, as has been conventional practice in prior devices. The spring, however, extends about the shaft and bears upon the stationary base of the apparatus at more than one point. Between these points of bearing the spring reacts against the shaft and the reaction points are positioned so that the resultant net torque of the forces acting to produce a tilt of the shaft is at, or near, the vanishing point. In this manner if the control shaft be grasped and adjusted by turning to a selected position there will be no tendency for the shaft to shift, in response to internal torques, as one disengaging from the shaft.

A further feature of the apparatus shown and described herein lends the apparatus to industrial control applications, where handling is often excessively abusive, as contrasted with laboratory usage and the usual treatment of communication equipment. The terminals, to which connections are made with other circuit components, take a form that will withstand abuse and severe treatment,

and they are mechanically separated from finely constructed interior parts to isolate such interior parts from abusive treatment that may be delivered to the terminals and the casing for the apparatus. Relatively large terminals are selected and these are engaged by the outer casing to prohibit a movement of the terminals independent of the casing. A flexible conductor connects each terminal with the interior elements. In this manner the terminals become a part of the casing isolated mechanically from the interior, in that forces delivered to the terminals are transmitted to the casing rather than the electrically conductive elements within the casing.

It is an object of this invention to provide a variable resistance of rugged construction adapted for industrial control applications.

It is another object of this invention to provide a variable resistance in which adjustments of the control shaft, and hence of the resistance, are retained after disengagement from the control shaft.

It is another object of this invention to provide a variable resistance in which wear between the control shaft and its supporting bushing is minimized.

It is another object of this invention to provide a variable resistance in which the exposed terminals for connection with other circuit components are isolated mechanically from interior electrical parts to eliminate transmission of abusive forces directed upon the terminals to the interior.

It is another object of this invention to provide a variable resistance with a set of terminals arranged adjacent one another at one side of the apparatus that are each insulated from the others for insuring a high breakdown voltage rating.

It is another object of this invention to provide a variable resistance in which heat generated in the resistance track is quickly dissipated to enhance the rating of the apparatus.

It is another object of this invention to provide a variable resistance in which forces tending to cause a tilt of the shaft within its bearing support are minimized.

It is another object of this invention to provide a variable resistance in which a positive bearing pressure between the brush and the resistance track is insured at all times.

The foregoing and other objects and advantages of this invention will appear from 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 particular form in which the invention may be embodied.

In the drawings:

Fig. 1 is a side view in elevation and in section of variable resistance apparatus embodying the invention,

Fig. 2 is a rear view in elevation of the apparatus shown in Fig. 1 taken through the plane 2—2,

Fig. 3 is a rear view in section of the apparatus taken through the plane 3—3 indicated in Fig. 1,

Fig. 4 is a view in section of the apparatus taken through the plane 4—4 indicated in Fig. 3,

Fig. 5 is a front view of the apparatus taken through the plane 5—5 indicated in Fig. 1,

Fig. 6 is a side view in elevation of a portion of the apparatus,

Fig. 7 is a view in section of that portion of the apparatus shown in Fig. 6 taken through the plane 7—7,

Fig. 8 is a view in perspective of the spring and brush carrier forming a part of the apparatus,

Fig. 9 is a view in perspective of the conductive brush forming a part of the apparatus, and

Fig. 10 is a view in perspective of the bias spring forming a part of the apparatus.

Referring now to the drawings, the variable resistance

apparatus embodying the invention, as shown, has a molded insulating base 1 formed of a synthetic resin comprising ingredients as already known and understood by those skilled in the art. An arcuate resistance track 2 is exposed about the periphery of the rear face of the base 1 and concentric with the resistance track 2 is a circular collector track 3. The track 3 is also exposed as a part of the rear face of the base 1. The electrically conductive tracks 2 and 3 each comprise a shallow layer of finely divided conductor particles dispersed and embedded within the molding material comprising the base 1. An example of a substance that may be employed for the particles, and which is also known to those skilled in the art, is calcined carbon black. In the resistance track 2 the particles are dispersed in such quantity that the desired resistance for the apparatus is attained, and in the collector track 3 the particles are more dense to provide a conducting track having negligible resistance as compared to that of the resistance track 2.

Embedded in the molded insulating base 1 is a heat extractor 4 composed of a thin sheet of heat conductive metal formed into an arcuate configuration, as is clearly shown in Fig. 3. The heat extractor 4 is positioned with an edge disposed closely to and immediately to the front of the arcuate resistance track 2, and emerges at the front of the base 1 with a set of five ears 5 that are tightly clinched over a flange 6 of a bushing 7. The ears 5 form a heat conductive path extending from the embedded portions of the heat extractor 4 to the bushing flange 6 to conduct heat rapidly away from the interior of the base 1, where the heat generated within the resistance track 2 might otherwise develop hot spots limiting the rating of the apparatus. The bushing 7 and flange 6 are also formed of heat conductive metal, and thereby provide a heat sink capable of absorbing substantial quantities of heat. This heat sink, in turn, is in heat conductive relation to a metallic front plate 8 that is adapted to be brought up tightly against a metallic mounting panel, such as designated by the numeral 9 in Fig. 1. The panel 9 is not a part of the apparatus of the invention, but is illustrative of a typical mounting for the invention. To position the apparatus a nut 10 threadedly received by the bushing 7 is brought up tight. In this fashion heat is rapidly drawn away from the apparatus so that the interior of the base 1 may be retained at a relatively low temperature.

A front housing wall 11 of sheet insulating material is interposed between the front of the base 1 and the after-side of the bushing flange 6. The housing wall 11 is retained tightly in position by the clinching of the heat extractor ears 5 over the front face of the bushing flange 6. There is provided a molded cover 12, which is open at the front and brought up tightly against the front housing wall 11 to form with the wall 11 a casing in which the base 1 resides. The cover 12 has a set of three slotted ears 13 disposed about its forward edge, and a finger 14 extending from the edge of the front plate 8 is inserted through each ear 13. Each of the fingers 14 is bent backwardly over its associated ear 13 to retain the front plate 8 in place, and also to maintain the cover 12 tightly against the front housing wall 11. The cover 12 will be described in additional detail hereinafter.

A rotatable control shaft 15 extends from the exterior through the bushing 7 with a close fit to the interior of the apparatus. A spring and brush carrier 16 is mounted within the cover 12 upon the shaft 15 to the immediate rear of the base 1. The carrier 16 is formed of a molded insulating material with an intricate configuration as shown in Fig. 8. The forward end of the carrier 16 comprises a sleeve 17 extending through a circular opening in the base 1 and fitting closely about the shaft 15 to provide insulation between the shaft 15 and the conductive collector track 3. At the after termination of the sleeve 17 the brush carrier 16 extends radially outward

to form a central boss portion 18 cut away at 19 to receive a conductive brush 20. The boss portion 18 is also recessed to form a pair of abutments 21 that are on opposite sides of the shaft 15 and which lie along a common diameter. A shoulder 22 continues radially outward from each abutment 21 and a circular flange 23 extends circumferentially between the shoulders 22 to form a back for the spring and brush carrier 16. As is shown in Fig. 1, the carrier 16 is formed with a key 24 extending within a complementary keyway 25 in the shaft 15, thereby providing a coupled rotation of the shaft 15 and the carrier 16.

A stop member 26, of sheet material, shown in Figs. 1, 2 and 6, fits against the after face of the flange 23 of the brush carrier 16 and is provided with a key 27 fitting within the keyway 25, so as also to be rotatable with the control shaft 15. The stop member 26 has a turned end 26' that will strike against a stop abutment 28 formed integrally within the cover 12. In this fashion rotation of the shaft 15 and its associated spring and brush carrier 16 is limited, for a purpose as will be hereinafter set forth. A small collar 29 is seated on the after end of the control shaft 15 and has a set screw 30 brought up within the keyway 25 to retain the carrier 16 and stop member 26 in position.

A bias spring 31, clearly shown in Fig. 10, encircles the boss portion 18 of the spring and brush carrier 16. The bias spring 31 has the general form of an open ring and is composed of flat spring material such as beryllium copper. Extending radially inward is a pair of fulcrums 32 that fit in the recessed abutments 21 of the carrier 16. Each fulcrum 32 is slightly dished with the convex side resting against an abutment 21, so that a line of contact is established between the abutments 21 and the fulcrums 32 that coincides with a shaft diameter. In this fashion pressure exerted by the spring upon the carrier 16 is applied along a definite well defined line. In quadrature with the fulcrums 32 is a button 33 that is attached to the spring 31 in a position to ride upon the rear face of the base 1, as shown in Figs. 1 and 6. The button 33 is selected of a material having good bearing qualities to insure a smooth ride along the surface of the base 1, which likewise is smooth to present a desirable bearing surface.

The portion of the spring 31 diametrically opposite the button 33 is formed with a pair of radially outer brush engaging fingers 34 and a radially inner brush retaining finger 35. Each of the fingers 34, 35 is turned in a direction substantially normal to the plane of the spring 31. In addition, the outer fingers 34 are closely spaced with the major surfaces thereof set in planes that converge in a radially outward direction.

The brush 20, as seen in Fig. 7, is generally triangular in configuration, and has a pair of side faces 36, one of which is clearly shown in Fig. 9, which converge toward one another in similar fashion as the surfaces of the fingers 34. The side faces 36 may then be received between the fingers 34, with a firm fit that causes the brush 20 to closely follow rotational movements of the spring 31. Thus, upon a rotation of the shaft 15, and hence of the bias spring 31, the brush 20 will be rotated without lost motion between the spring 31 and brush 20. The brush retaining finger 35 of the spring 31 extends about the inner end of the brush 20, which inner end is recessed at 37, to preclude escape of the brush 20 in case of an accidental jar or similar impact delivered to the apparatus.

The back of the brush 20, as shown in Fig. 9, is crowned with a convex surface 38 and has a marked slope, clearly observed in Figs. 1 and 6. The slope at the back of the brush 20 imparts a radially outward divergence from the rear face of the base 1. A ridge 39 is formed in the spring 31 to bear against the crowned surface 38 with a point to point contact. Thus, with the spring 31 bearing upon the sloping surface 38 the

brush 20 will be urged radially outward, upon a rotation of the shaft 15, as well as against the conductive tracks 2, 3. The brush 20 is then firmly held between the brush engaging fingers 34 of the spring 31.

The front face of the brush 20 is provided with a resistor contacting foot 40 that slides upon the arcuate resistance track 2. At the radial inner extent of the front face of the brush 20 is a pair of collector engaging feet 41 disposed on opposite sides of the finger 35. The feet 41 bear upon the circular collector track 3, so that the brush 20 electrically bridges between the tracks 2 and 3. To serve the purpose of an electrical bridge the brush 20 is composed of a hardened conductive material, such as carbon that presents negligible resistance to current flow. The resistance track engaging foot 40 may be swung along the entire arcuate length of the resistance track 2, and as an end of the track 2 is approached the stop member 26 engages the stop abutment 28. The travel of the brush 20 is thus limited to prohibit overrunning the ends of the arcuate track 2.

As viewed in Fig. 6, the bias spring 31 appears as a beam fixed at its ends by engagement with the rear face of the base 1. The upper end portion of the spring 31 bears through the button 33 against the base 1, and the lower end portion of the spring 31 bears through the brush 20 against the base 1. The spring 31 is loaded, that is retained in a stressed condition, by disposing the abutments 21 of the carrier 16 in a position that warps the spring 31. The reaction of the spring 31 against the abutments 21 urges the shaft 15 rearwardly, and the shaft 15 is restrained from a rearward motion by a stop ring 42 fitted in a complementary groove of the shaft 15 at a point immediately to the front of the forward end of the bushing 7. The reaction forces of the spring 31 are along a diameter of the shaft 15 and are applied in equal amounts at opposite sides of the shaft 15. The application of spring pressure through a spring fulcrum 32 presents a torque urging a tilt of the shaft 15 within its bushing 7. However, since each abutment 21 is a like radial distance from the shaft 15 and the force at each fulcrum 32 is of like amount the resultant net torque presented is near or at the vanishing point, the torques cancelling one another.

Since the shaft 15 is not subject to any substantial net force urging a tilt of the shaft within the bushing 7 a person may grasp the external end of the control shaft 15 and adjust the position of the brush 20, and then release his grip upon the shaft 15 without an attendant tilting shift of the shaft due to internal forces created by the bias spring 31. The brush 20, consequently, will remain in the position to which it was adjusted. This aspect of the invention is of particular advantage in applications calling for precise adjustments of the brush 20, and wherein slight brush movements cause relatively substantial changes in circuit parameters. Further, bearing life between the control shaft 15 and the bushing 7 will be materially enhanced by the elimination of torques urging a tilt of the shaft. Accuracy and precision of adjustment will then be had over a greater period of life, and the apparatus, consequently, will give a greater duration of service.

In the practice of the invention the elimination of torque, that would otherwise urge a tilt of the shaft, is accomplished by having the reactive forces of the bias spring 31 upon the brush carrier 16 be of such magnitude and applied in such positions that the torques set up thereby cancel one another. In the form of the invention shown in the drawings, the reaction forces of the spring 31 are applied at the two positions of the diametrically opposed fulcrums 32. These positions, in addition to being diametrically opposite one another, are equally distant from the center of the shaft 15 and the forces are equal. As a consequence, the net torque is either zero or close thereto, since the individual torques are equal and opposite in direction. With the elimination of such internally developed torque the shaft 15 will not tend to seek out any particular position, so that upon selecting a position for the control shaft 15, it will not stray from that position.

Having the brush 20 carried by the spring 31 further enhances the reliability of the apparatus. The relative shift, in a direction normal to the rear face of the base 1, that may occur between the brush 20 and the spring fingers 34 will be minimized, as contrasted with a structure in which the spring is an element wholly separate from the converging faces between which the brush is urged. In the present invention the brush 20 will, at all times, be pressed against the base 1 with full spring pressure. Further, each of the brush feet 40, 41 will ride smoothly along the conductive tracks 2, 3. A point to point contact between the crowned portion 38 of the brush 20 and the ridge 39 of the spring 31 is retained, regardless of any tilt of the spring 31 that may occur, thereby insuring that the brush 20 rides along the face of the base 1 with each of the three feet 40, 41 bearing with a substantial pressure against the base 1. This minimizes the introduction of noise in high gain amplification circuits.

To provide for electrical connection with the conductive tracks 2 and 3 metallic leads 43, 44 and 45 are provided. One end of each of the leads 43, 44, 45 is embedded within the base 1 at the time of molding, and each embedded lead end extends to within a conductive track. Thus, the embedded end of the lead 43 is disposed within one terminus of the arcuate resistance track 2, the lead 44 has an end embedded in the opposite terminus of the resistance track 2, and the lead 45 has one end embedded in the collector track 3. Each lead 43, 44, 45 extends downwardly from the base 1 to present an array as shown in Figs. 2, 3 and 5. Each lead 43, 44, 45 is quite thin in the fore and aft direction to permit ready bending for forming the embedded ends of the leads, and for allowing the free ends to be readily moved forwardly toward the casing wall 11. Each of the leads 43, 44, 45 is quite thick in the direction paralleling the plane of the casing wall 11, so that the leads may not be readily bent toward one another to cause unwanted displacement from the desired spaced positions shown. Each lead 43, 44, 45 is connected at its lower end to a terminal 46 of substantial size and dimension to present a strong, rugged means for attachment with external circuit leads. As shown in Figs. 2 to 5, the terminals 46 are positioned in a horizontal row at the bottom of the apparatus and by reason of the rigidity of the leads 43, 44, 45, in a direction paralleling the wall 11, the terminals 46 are held in spaced positions. Each terminal 46 has a base plate 47 disposed against the back face of the housing wall 11, to which the associated leads 43, 44, 45 is fixed. Each of the base plates 47 is provided with a set of ears 48 protruding at the opposite sides. Each terminal 46 continues downwardly from its base plate 47 and then turns rearwardly and upwardly at an oblique angle to present a connection flange 49 that receives a terminal screw 50.

The lower portion of the cover 12 is formed with openings and recesses complementary to the configurations of the terminals 46, as will now be described. The case 12 has a horizontal enclosing wall 52 from which a set of four spaced vertical ribs 51 extend downwardly so that a partitioned space is provided for each of the terminals 46. Rcesses 53 are formed in the forward edges of the ribs 51, each recess 53 having a configuration mating that of a terminal ear 48. The depth of the recesses 53 corresponds to the thickness of the terminals 46, so that upon disposing the cover 12 against the front wall 11, with the terminals 46 in place, the terminals 46 are rigidly held and are immovable with respect to the casing formed by the cover 12 and front housing wall 11. Further, the spacing between the ribs 51 matches the width of the connection flanges 49 of the terminals 46 to restrict turning of the terminals upon application of

twisting torque to the terminal screws 50. Since movement of the terminals 46 is restricted to preclude shifting with respect to the cover 12 and housing wall 11 the terminals 46 are mechanically isolated from the internal electrically conductive elements of the base plate 1 and the carrier 16. In this fashion, high peak stresses and shock blows may be delivered to the terminals 46 upon making connections with other circuit components, which will not be transmitted to the precise electrical elements housed within the cover 12.

The mechanical isolation of the terminals 46 is accomplished by presenting terminal surfaces facing rearwardly and forwardly, and also upwardly, downwardly and to both sides, all of which surfaces have mating counterparts in closely conforming surfaces of the cover 12 and housing wall 11. By transmitting stress from the terminals 46 directly to the members 11 and 12 the apparatus becomes ideally suited for industrial applications. The use of precise variable resistance apparatus can, therefore, be extended to fields not heretofore open for such apparatus.

We claim:

1. In a variable resistance apparatus having an arcuate resistance track and a rotatable operating shaft concentric with the track, the combination of a contact brush in engagement with the resistance track that is rotatable with the shaft and has a pair of radially extending outwardly converging side surfaces together with a back surface sloping radially outwardly away from the base; a brush biasing spring rotatable with said shaft having a pair of radially extending outwardly converging retaining surfaces complementary to the side surfaces of said brush between which said brush is disposed to be housed by and rotated with said spring; and a brush urging portion for said spring bearing upon the sloping back of said brush to thereby urge the brush against the resistance track and radially outward as said shaft, spring and brush are rotated to firmly retain the brush between said retaining surfaces.

2. In a variable resistance apparatus the combination comprising a base including a resistance track; a plurality of leads each electrically connected at one end to the resistance track and extending from the base; a terminal for each of said leads electrically secured thereto, each terminal having a mounting portion with retaining surfaces facing forwardly and rearwardly, upwardly and downwardly, and to each side, each terminal extending from its mounting portion with a screw receiving connecting end that turns forwardly and across the front of the mounting portion to provide for a shank of a screw to be disposed between the mounting portion and connecting end with the screw head exposed to the front of the terminal; a housing member supporting said base; and a cover movable into abutting relation with the housing member to form a casing for the base, and removable from such abutting relation with the housing member; said cover and housing member when in abutting relation having a set of faces for each terminal which match each of the retaining surfaces of the associated terminal and closely conform therewith to retain the terminals in fixed relation with the housing member and cover.

3. In a variable resistance apparatus the combination comprising a base having conductive track areas; a plurality of leads each electrically connected to the conductive areas and extending from the base in side by side relation, each lead being relatively stiff in a sidewardly direction and flexible in the direction normal to the sidewardly direction; a housing member having a flat wall portion extending alongside the leads; a terminal joined to each lead having a flat face adapted to be placed against the flat wall portion of said housing member, and each terminal further having retaining surfaces facing to each side, upwardly and downwardly and in the direction opposite the housing member; and a cover adapted to be brought up against the housing member which has face areas matching and closely conforming with the retaining faces of the terminals thereby holding the terminals fixed with respect to the cover and housing member.

4. In a variable resistance apparatus the combination comprising a base; a circular resistance track carried by said base; a rotatable operating shaft concentric with said resistance track; a conductive brush disposed radially from and rotatable with said shaft that is in bearing engagement with said resistance track, which brush has a pair of radially extending outwardly converging side surfaces together with a back surface sloping radially outwardly away from the base; a brush biasing spring having a portion urging said brush against the resistance track and extending circumferentially about the shaft to a position diametrically opposite said portion, said biasing spring having a sliding engagement with said base at the position opposite said portion, and said portion of the spring urging the brush against the resistance track having a pair of radially extending outwardly converging retaining surfaces that face one another and are complementary to the side surfaces of said brush between which said brush is disposed to be carried by and rotated with said spring, said spring portion also having a brush engaging portion bearing upon the sloping back to said brush to thereby urge the brush against the resistance track with a force component in radially outward direction to retain the brush between said retaining surfaces; and a pair of diametrically opposite spring engaging abutments extending radially of the shaft in quadrature with respect to said brush urging portion, each of which bears against said spring on the side opposite said base to thereby stress the spring and urge both the brush and the sliding engagement against the base, whereby the reaction forces of the spring against the abutments create torques that individually urge a tilting of the shaft and which cancel one another.

5. In a variable resistance apparatus the combination comprising a base; a shaft rotatable with respect to said base; a resilient spring member in the form of a closed ring with an open center that encircles said shaft and is spaced from the base; a contact brush inserted between the spring and the base which moves with the spring and bears against the base in response to spring pressure, which brush has a pair of radially extending outwardly converging said surfaces together with a back surface sloping radially outwardly away from the base; brush retaining means forming an integral part of said spring that has a pair of radially extending outwardly converging retaining surfaces complementary to the side surfaces of said brush between which said brush is disposed to be housed by and rotated with said spring, which means further includes a brush urging portion bearing upon the sloping back of said brush to urge the brush against the resistance track and radially outward to firmly retain the brush between said retaining surfaces; a bearing portion on said spring that bears against and slides across said base in response to spring pressure that is at a position diametrically opposite said brush; and a pair of diametrically opposite abutments on said shaft in quadrature with said brush and bearing portion that bear against the spring at positions that are at equal radial distances from the shaft axis.

6. In a variable resistance apparatus the combination comprising a base; a shaft rotatable with respect to said base; a resilient spring member in the form of a closed ring with an open center that encircles said shaft and is spaced from the base; a contact brush inserted between the spring and the base which moves with the spring and bears against the base in response to spring pressure; a bearing portion on said spring that bears against and slides across said base in response to spring pressure that is at a position diametrically opposite said brush and at a radial distance from said shaft substantially the

same as the mean point of application of the forces between the brush and base; and a pair of diametrically opposite abutments on said shaft in quadrature with said brush and bearing portion that bear against the spring at positions that are at equal radial distances from the shaft axis.

7. In a variable resistance apparatus the combination comprising a base; a shaft rotatable with respect to said base; a resistance track on said base concentric with the shaft; a collector track on said base concentric with the shaft and spaced from the resistance track; a resilient spring member in the form of a closed ring with an open center that encircles said shaft and is spaced from the base; a contact brush inserted between the spring and the base that spans between the resistance and collector tracks and which moves with the spring and bears against the base in response to spring pressure; a bearing portion on said spring that bears against and slides across said base along a path between the resistance and collector tracks in response to spring pressure and that is at a position diametrically opposite said brush; and a pair of diametrically opposite abutments on said shaft in quadrature with said brush and bearing portion that bear against the spring on the side thereof opposite said base and act upon the spring at positions that are at equal radial distances from the shaft axis.

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UNITED STATES PATENT OFFICE

Certificate of Correction

Patent No. 2,868,931 January 13, 1959

William F. Dehn et al.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below

Column 1, line 65, for "disengaging" read —disengages—; column 8, line 26, for "to said" read —of said—; line 47, for "said" read —side—.

Signed and sealed this 28th day of April 1959.

[SEAL]

Attest:
T. B. MORROW,
Attesting Officer.

ROBERT C. WATSON,
Commissioner of Patents.

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