

[72] Inventor **Robert D. Michik**
Riverside, Calif.
 [21] Appl. No. **789,108**
 [22] Filed **Jan. 2, 1969**
 [45] Patented **Apr. 27, 1971**
 [73] Assignee **Bourns, Inc.**

3,300,594 1/1967 Paine..... 200/166
 3,365,691 1/1968 Hillman..... 338/183
 3,371,167 2/1968 Soulakis..... 200/166
 3,378,802 4/1968 Mishler..... 338/174

Primary Examiner—Lewis H. Myers
 Assistant Examiner—Gerald P. Tolin
 Attorney—Fritz B. Peterson

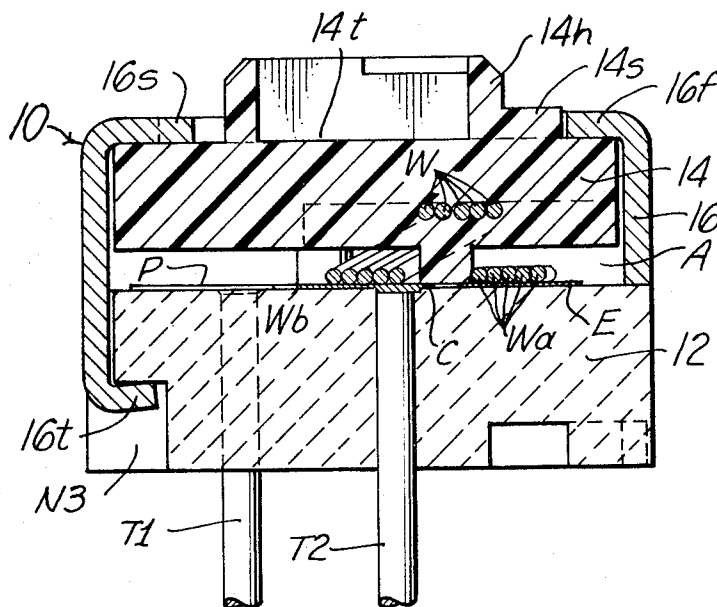
[54] **POTENTIOMETER WITH EMBEDDED
 REVERSELY BENT CONTACT WIRES**
8 Claims, 9 Drawing Figs.

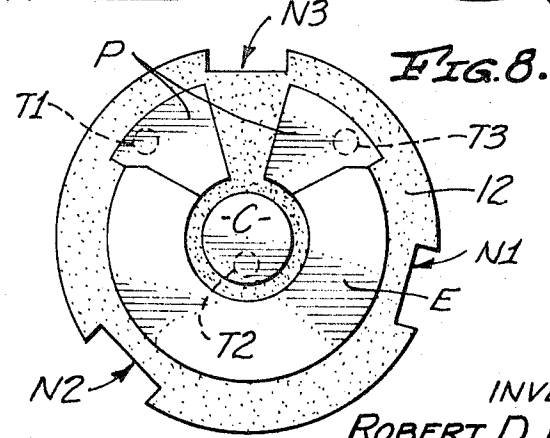
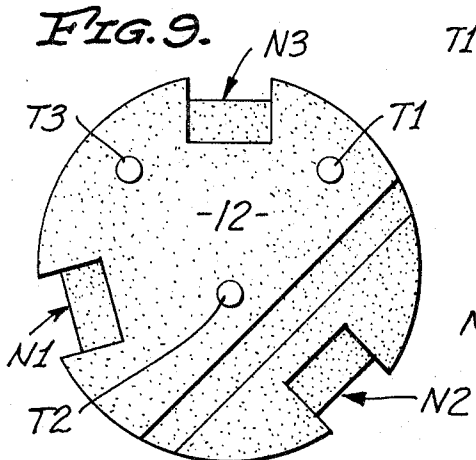
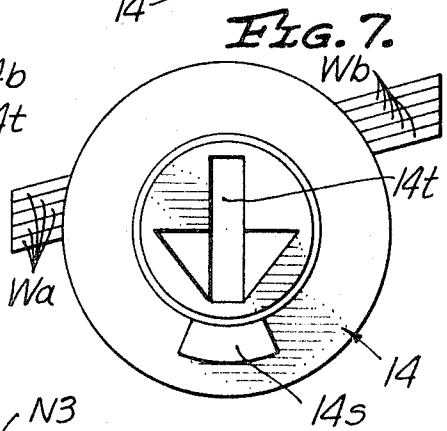
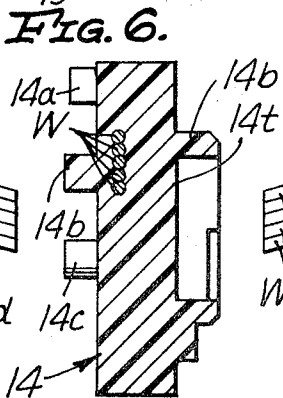
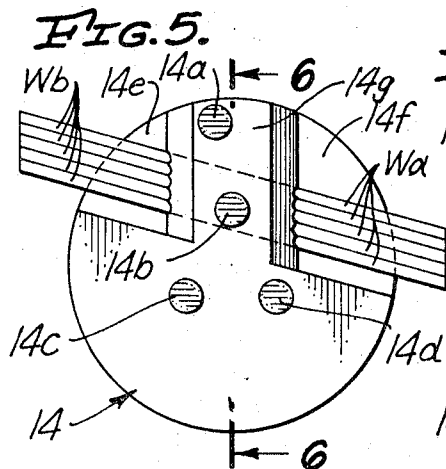
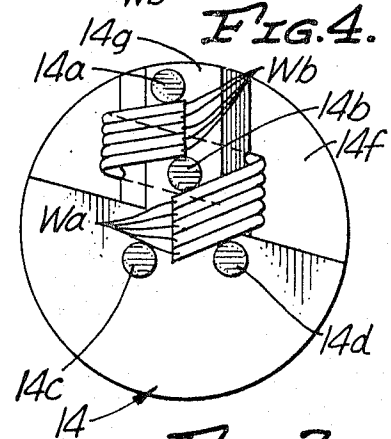
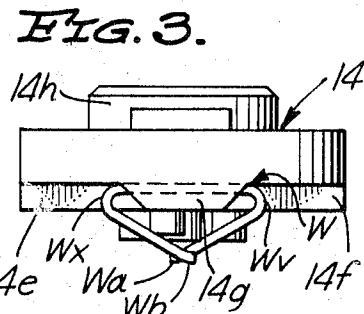
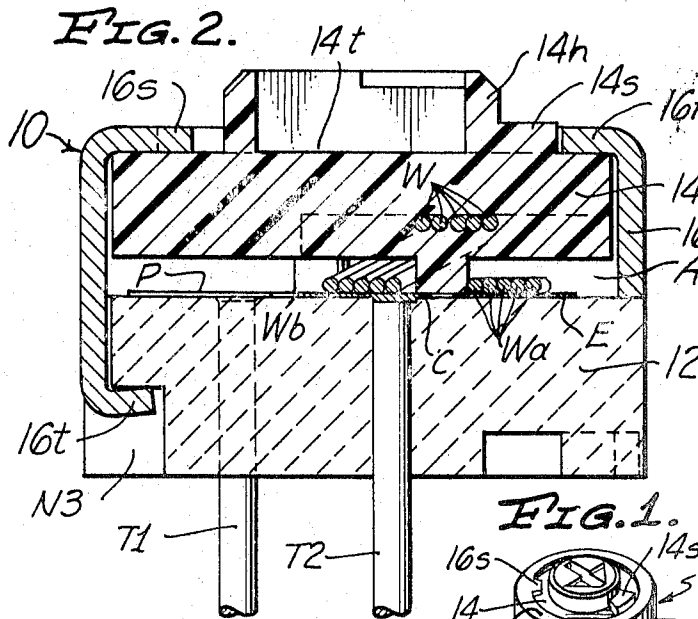
[52] U.S. Cl..... 338/202,
 338/171
 [51] Int. Cl..... H01c 1/12,
 H01c 5/02
 [50] Field of Search..... 338/(screw
 digest), 162, 163, 166, 171, 174, 183, 202;
 200/166 (B8)

[56] **References Cited**

UNITED STATES PATENTS
 3,274,368 9/1966 DeBoo 29/630

ABSTRACT: Miniature potentiometer of such small dimensions that resistance element and contact dimensions are so reduced as to create severe problems in respect to high contact-resistance-variation, wherein contact-resistance-variation is grossly minimized by employing as a contact device for brushing and bridging the resistance element and a return conductor or bus a set of very small-gauge resilient wires arranged in side-by-side ribbonlike configuration with central portions embedded in a rotor member and end portions reversely bent to form a number of resilient independently movable spring contacts disposed to brush a series of closely spaced points along a line transverse of the resistive element. Thus the contact pressure is not concentrated at a single point but at a maximum number of points, reducing contact wear and electrical contact-resistance-variation.





INVENTOR
ROBERT D. MICHIK
BY
Robert D. Peterson

POTENTIOMETER WITH EMBEDDED REVERSELY BENT CONTACT WIRES

BACKGROUND OF THE INVENTION

Increasing complexity of electronic circuitry, together with increasing usage of electronic-circuit components in environments such as satellite and like vehicles, wherein reduction of occupied space and of weight are of prime importance, has intensified the need for smaller, lighter and simpler components. Mere scalar reduction of size whereby to attain the noted ends can be carried on only to a limited extent. Therebeyond, further reduction results in parts failure, excessive wear, unacceptable electrical capacity and/or performance, and other undesirable results. Among the latter, in the case of potentiometers, is unacceptably high variation of contact resistance; that is, change of resistance exhibited between a resistance element and the movable contact at the region of contact therebetween. That variation of resistance is termed contact-resistance-variation, abbreviated CRV. As the physical sizes of the resistance element and the movable contact or wiper of a potentiometer are reduced, the pressure force required to attain a reasonably low value of contact resistance (CR) increases and thus unacceptable excessive wear of the contact occurs. This effect is aggravated in the case of cermet resistance elements, which tend to be more abrasive than carbon or composition elements. One expedient to which resort has been taken to alleviate the problem of high CRV and excessive wear due to high contact pressure force has been to divide the contact into several fingers or limbs, each of which serves as an independently sprung contact and which fingers thus multiply the number of areas or regions of contact and concurrently reduce the individual contact force required and, hence, the CRV. However, slitting or punching of a thin sheet of metal to produce multiple fingers becomes an exorbitantly expensive operation when the strip dimensions become small. For example, to provide four fingers at the end of a strip one-sixteenth inch wide, requires clean and accurate parting of fingers one-sixty-fourth inch wide. Die means to perform such an operation, even in seriatim, are very expensive and of short life duration. Further, such sheared or slit-strip contacts often are nonuniform in action, that is, successive ones of a group thereof vary widely in contact resistance and in CRV during operation; such variability probably being the result of interfering burrs along adjacent sheared edges of the fingers. It is of great importance, in the manufacture and sale of potentiometers, that the important characteristics of all potentiometers of a manufactured class be as nearly uniform or alike as possible. When CRV and like characteristics vary from potentiometer to potentiometer among a group of supposedly identical potentiometers, the sales quality is downgraded; hence it is highly desirable that CRV be uniform from one potentiometer to another in the same group or class, and that it be as low in value as possible.

SUMMARY OF THE INVENTION

The present invention achieves marked improvement over prior-art potentiometer contacts in the noted respects, by utilizing a set of very closely spaced fine-gauge wires arranged in a sheetlike or ribbon formation and doubly bent as a group whereby one end of each wire is disposed to wipe a respective one of points dispersed transversely across a resistance element. Preferably, also, the other end of each wire contacts and wipes a return conductor. The wires as a group are held in place in side-by-side disposition by having an intermediate portion of the wire embedded in an insulative wiper block or carrier. Further, the wires are so bent, adjacent each exit from the embedment, that the middle portion of each wire is torsionally stressed, whereby the force with which each wire presses its contacting end against the resistance element is not, as is usual in potentiometer contacts, the result of unbalanced compression-tension strains such as are experienced by a stressed leaf spring. Because of the utilization of torsional stressing of the wires of the contact, the lengths of the wires

can be greatly reduced with no detrimental increase in the spring rate of the contact device. Further, because of the oval or round cross section and curved surfaces thereof, each wire is stressed and may come and go or yield, in operation, substantially entirely independently mechanically as well as electrically of its next-adjacent neighbor. This duo of advantages attained by the torsional stressing of the contact wires and the shapes thereof permits an extremely compact contact device to be attained, and one in which CRV from device to device coming off the assembly line does not widely vary as in the prior-art strip- or sheet-type multifinger contact devices.

DESCRIPTION OF THE DRAWINGS

The presently preferred exemplary embodiment of the invention is illustrated in the drawings comprised in this description, in which drawings:

FIG. 1 is an enlarged pictorial view of a single-turn rotary potentiometer, comprising a rotor carrying a contact device, embodying the principles of the invention;

FIG. 2 is a grossly enlarged sectional view in elevation of the potentiometer shown in FIG. 1;

FIG. 3 is a view in elevation of the contact device and actuator or rotor, of the exemplary potentiometer depicted in section in FIG. 2;

FIG. 4 is a bottom view of the structure shown in elevation in FIG. 3;

FIG. 5 is a bottom view of the device shown in FIGS. 3 and 4, prior to bending of the contact wires;

FIG. 6 is a sectional view of the rotor and contact wires depicted in FIGS. 4 and 7, the section being as indicated by indicators 6-6 in FIG. 5;

FIG. 7 is a top view of the device shown in FIGS. 3 and 4, prior to bending of the contact wires;

FIG. 8 is a top plan view of a potentiometer base comprised in the potentiometer depicted in FIG. 1, the base comprising an insulative plate, terminal pins or wires, conductive means, and a resistive track or element; and

FIG. 9 is a bottom plan view of the base shown in FIG. 8.

DESCRIPTION OF THE ILLUSTRATED EMBODIMENT OF THE INVENTION

The invention is for convenience illustrated herein as being comprised in a very small miniature potentiometer of the single-turn rotary class, but it will be evident to those skilled in the resistor art that the principles of the invention are equally applicable to other types of potentiometers, including lead screw adjusted potentiometers. The illustrative potentiometer is of the order of 6 millimeters diameter as commercially produced. The potentiometer, labeled 10 as a unit (FIGS. 1 and 2) comprises a support means in the form of an insulative baseplate 12, preferably of alumina or steatite, a contact carrier in the form of a rotary means comprising an insulative rotor 14, a contact means carried by the carrier, and a metal cap 16 which serves to provide an operating chamber A above the plate and to confine the rotor to rotary movements in the chamber. The baseplate 12 has embedded therein portions of terminals T1, T2 and T3 (FIG. 1) of wire, the upper ends of the terminals being accessible at the upper to top face of plate 12 as indicated in FIG. 9.

Bridging the upper exposed ends of terminals T1 and T3 and adherent on the upper face of the plate is a flat resistive element E (FIG. 8) of resistive material such as cermet, the ends of which element are conductively connected to the noted terminals by conductive paint P as is or may be customary in modern resistor manufacture. A centrally disposed conductor or collector, C, is similarly adherent upon the upper surface of baseplate 12 and is directly connected to the terminal T2 as is indicated in FIG. 2. The baseplate is provided with three spaced-apart notches N1, N2 and N3 (FIG. 9), for reception of complementary tabs such as 16t (FIG. 2) provided along the lower edge of cap 16, whereby the cap is retained to the base plate 12.

The rotor 14 is confined in the chamber A by the baseplate 12 and the inwardly extending flange 16f (FIG. 1) of the cap which overlies the periphery of the upper or top surface of the body of the rotor. The rotor comprises an operator in the form of an upwardly extending formation 14h (FIG. 2) which is provided with a driver-receiving slot 14i (FIG. 7). The formation 14h extends through the upper aperture of the cap 16; and the rotor, being of round configuration, is journaled in the encircling cylindrical body of the cap. The inwardly directed flange of cap 16 is extended inwardly to form a 7) 16s (FIGS. 1 and 2) for coaction with a complementary stop 14s (FIGS. 2 and 7) in the form of an abutment or protuberance formed on the upper face of rotor 14, whereby rotation of the rotor is restricted to somewhat less than 360° of rotation in either direction.

On its bottom face the rotor 14 is formed to provide a plurality of downwardly extending pluglike protuberances 14a, 14b, 14c and 14d (FIGS. 4 and 5), and first and second depressions 14e and 14f separated by a beveled portion 14g the principal surface of which is generally coplanar with that of the lower face of the main body of the rotor. Embedded in the rotor as a side-by-side ribbonlike sheet is the intermediate length of a plurality of set of very fine-gauge wires W (FIGS. 2 and 3). The sheet or set of wires W is initially straight, as indicated in FIGS. 5 and 7, lying flat against the surface of the body of the rotor at the base of the depressions 14e and 14f, and extending through the body of the rotor between the depressions, as indicated by dotted lines in FIG. 5. During manufacture of the contact carriers, the contact wires W are drawn from spools through guide and tensioning means into parallel side-by-side flat ribbonlike formation, through molding machinery which molds onto the ribbon of wires a continuing series of spaced-apart contact carriers (here, rotors), and on through machinery which severs the ribbon of wires between successive rotors, clamps the severed unit, and reversely bends and offsets the wires as a sheet or unit into the configuration illustrated in FIG. 4. Thus the short ribbon of parallel wires W, with first and second ends Wa and Wb, respectively, as shown in FIG. 5, is reversely bent at locations Wv and Wx as indicated in FIG. 3, and laterally offset as indicated in FIG. 4 to position the ends Wa between two of the protuberances 14b and 14d and the ends Wb between protuberances 14a and 14b. The protuberances serve the dual functions of preventing undesired lateral splaying or spreading of the wires when the ends are stressed in brushing the resistive element or collector, and of contacting the surface of the base-supported components and thereby establishing a predetermined minimum spacing of the rotor from the baseplate and a determined maximum stressing of the contact wires.

As has been made clear, the contact wires at ends Wb are laterally offset when reversely bent, and the wires are at ends Wa laterally offset in the opposite direction. Valuable results are attained by so bending and offsetting the wire ends, in addition to the large savings in manufacturing (fabricating) and material costs. First, an exceptionally compact contact-carrier and contact-spring arrangement is attained. Secondly, a maximum number of fully independent contact areas brushing the resistance element is provided. Thirdly, by offsetting either of the ends and thus torsionally stressing the wires, much greater contact pressure is attained in a resilient contact than is attainable in a cantilever-type spring contact. This advantage is of critical importance in potentiometers of very small dimensions, since it allows the individual contact members a considerable measure of resilience while they press against the resistive element with the requisite force. If a relatively non-resilient contact member having the same contact-area brushes the element with the same force, it would with a high degree of probability dig into the element and rapidly destroy the usefulness of the potentiometer.

The use of contact wires of round or oval cross section permits the contact members to be crowded together in side-by-side contacting relationship without either thereof interfering with any other in their slight relative movements during brush-

ing of the element and collector surfaces. Such permitted and desirable relative movement is as a practical matter substantially impossible of attainment with sheared-sheet contact members without splaying or spreading the contacts with resultant loss of effective contact area, because of the interaction of minute burrs along the adjacent sheared edges of the contact fingers.

Sealing of the potentiometer is accomplished by conventional O-ring means (not shown) and sealant (not shown) applied around the lower juncture of the cap and baseplate, both of which means are conventional in the art and neither of which is, per se, of the present invention.

I claim:

1. In a potentiometer,

support means for supporting a substantially flat elongate resistive element an exposed surface of which provides a resistive track to be brushed, and such a resistive element thereon, with terminals at each end thereof;

conductive means including collector means and a terminal therefor;

a contact carrier and contact means carried by said carrier, said contact means comprising a ribbonlike array of individual elongate wires in side-by-side relationship throughout their lengths, each of said wires having an intermediate straight portion in substantially planar disposition with the others of said wires and all of the intermediate straight portions of said wires being embedded in said carrier and all of said wires having first end portions reversely bent closely adjacent to said embedded portion and laterally offset from said straight portions thereof to provide at the first ends of said wires respective contact areas brushing on said resistive element, the second end portions of said wires being similarly but oppositely reversely bent and oppositely offset relative to said straight portions and having at the ends thereof respective contacts brushing on said conductive means, at least said first end portions being torsionally stressed; and

means coacting with said support means to retain said carrier in position with the contact areas of said contact means in brushing relation to said element;

whereby said contact means provides a plurality of individually sprung resilient torsionally stressed wires presenting contacts in side-by-side closely spaced relationship to greatly minimize contact-resistance-variation as said element is brushed by said contact means.

2. Potentiometer means as defined by claim 1, in which said collector means is a conductive member having a flat surface, and in which the second end of each of said wires comprises a contact area brushing on said conductive member.

3. Potentiometer means as defined in claim 2, in which said second end portions of said wires are closely adjacent to said embedded portion, whereby said contact areas on said second ends of said wires are closely adjacent to the contact areas of said first ends of said wires, whereby an extremely compact contact construction occupying a minimum of space is provided.

4. Potentiometer means as defined by claim 3, in which said contact carrier comprises protuberances extending therefrom and between respective pairs of opposed surfaces of which protuberances the said first ends and the said second ends of said wires as groups extend, whereby the ribbonlike ends of said wires receive lateral support so that the ends do not splay or spread when brushing on said element.

5. A single-turn miniature potentiometer comprising:

first means, including housing means forming an enclosure, a resistive element and a conductive element disposed in the enclosure, and terminal connections to said elements extending therefrom to the exterior of the housing means, said resistive element being an arcuate member having a substantially flat exposed surface disposed around an axis defined by said housing means;

second means, including rotary means comprising a rotor rotatable about said axis and having means for effecting

rotation thereof, said rotor having a portion confined in said enclosure by said housing means for rotation about said axis; and

third means, including a plurality of elongate fine-gauge contact wires arranged in side-by-side ribbonlike array with first and last wires of the array confined at the edges of the array by means included in said second means, said wires as a group having a central portion thereof embedded in and firmly integrated with said rotor and having a first end portion thereof reversely bent and extending away from said rotor into side-by-side brushing engagement with said arcuate element and said wires as a group having the second end portion thereof reversely bent and extending away from said rotor into brushing contact with said conductive element;

whereby aid reversely bent end portions of said group of wires provide a plurality of resilient brushing contacts in side-by-side contacting relationship to minimize contact-resistance-variation.

6. A miniature potentiometer according to claim 5, in which said rotor comprises spaced-apart protuberances between which said ribbonlike array of wires extends and by which they are restrained from laterally separating.

7. A miniature potentiometer according to claim 5, in which each end portion of said group of wires in ribbonlike array is laterally offset from said central portion as well as reversely bent, whereby individual wires are subjected to torsional stress as well as compressive stress.

8. In a potentiometer,

support means for supporting a substantially flat elongate resistive element an exposed surface of which provides a resistive track to be brushed, and such a resistive element thereon, with terminals at each end thereof;

conductive means including collector means and a terminal therefor;

a contact carrier and contact means carried by said carrier, said contact means comprising a ribbonlike array of individual elongate wires in side-by-side relationship throughout their lengths, each of said wires having an embedded portion embedded in said carrier and having at least a first end thereof reversely bent closely adjacent to said embedded portion to provide at the said one end a contact area brushing on said resistive element, the contact areas of at least some of said wires brushing said element along a line transversely of said track, and at least some of the ends of said wires contacting said conductive means; and

means coacting with said support means to retain said carrier in position with said contact means in brushing relation to said element;

whereby said contact means provides a plurality of individually sprung resilient contacts in side-by-side closely spaced relationship to greatly minimize contact-resistance-variation as said element is brushed by said contact means.

30

35

40

45

50

55

60

65

70

75

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,576,514 Dated April 27, 1971
Inventor(s) Robert D. Michik

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, line 10, "7)" should read -- stop --.
Column 5, line 16, "aid" should read -- said --.

Signed and sealed this 30th day of November 1971.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Acting Commissioner of Patent