United States Patent

Froebe et al.

[15] **3,704,436**

[45] **Nov. 28, 1972**

[54] **MULTI-WIRE POTENTIOMETER CONTACT DEVICE**

[72] Inventors: **Ronald L. Froebe; Howard H. Hatch,** both of Riverside, Calif.

[73] Assignee: **Bourns, Inc.,** Riverside, Calif.

[22] Filed: **Feb. 24, 1971**

[21] Appl. No.: **118,246**

[52] **U.S. Cl.** **338/202,** 338/180, 338/183

[51] **Int. Cl.** **H01c 9/02**

[58] **Field of Search** .29/630 R, 630 A, 630 B, 630 E; 200/166 F, 166 CM, 160; 338/118, 160, 176, 180, 183, 202

[56] **References Cited**

UNITED STATES PATENTS

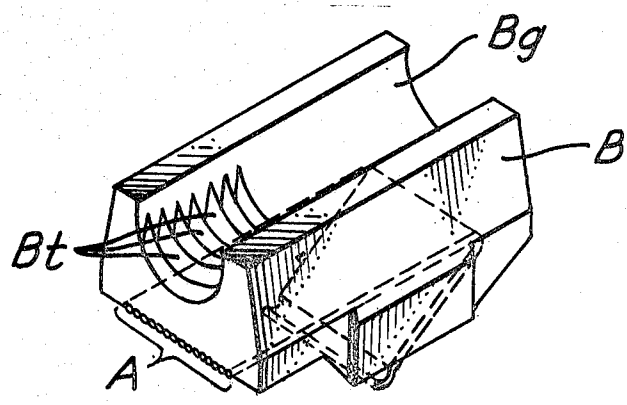
3,274,368	8/1966	De Boo	200/166 F
1,399,492	12/1921	Krantz	200/166 F
2,760,036	8/1956	Raymer	338/202 X
3,328,707	6/1967	Louis	338/202 X

Primary Examiner—Robert K. Schaefer
Assistant Examiner—Gerald P. Tolin
Attorney—William G. Becker

[57] **ABSTRACT**

A contact device for potentiometers and method of producing the device, the device being devised and arranged to facilitate automatic manufacture thereof by a machine into which a strip-like sheet or array of fine-gauge wires is drawn in side-by-side relation under tension past stations at a first of which flat plates are bonded to the wires at locations at measured intervals apart to integrate the wires and plates into a unitary assembly and at a second of which stations an insulative body is molded around each of the plates in succession, and at a third of which stations the wires are severed adjacent one end of the body and are formed into a set or array of side-by-side cantilever contact fingers each offering lateral support to another thereof and each having a contact point disposed in a common straight line extending transversely of the fingers.

4 Claims, 18 Drawing Figures



PATENTED NOV 28 1972

3,704,436

SHEET 1 OF 2

FIG. 1.

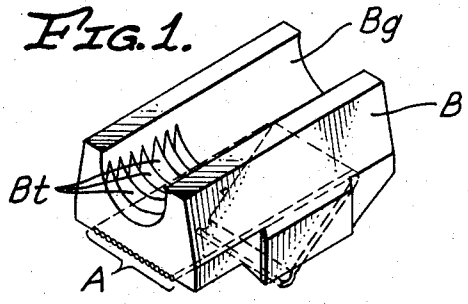


FIG. 2.

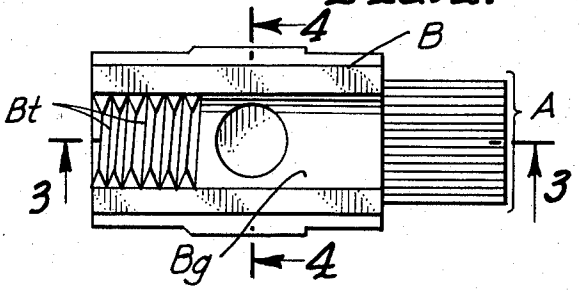


FIG. 3.

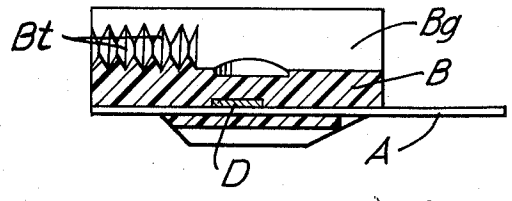


FIG. 4.

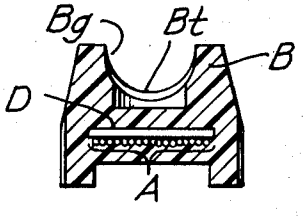


FIG. 5.

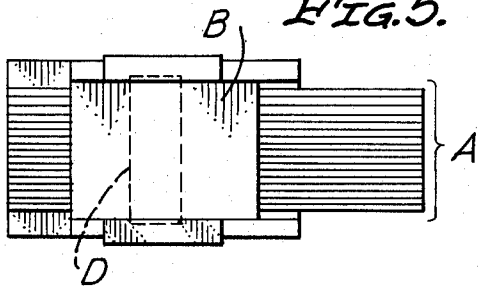


FIG. 6.

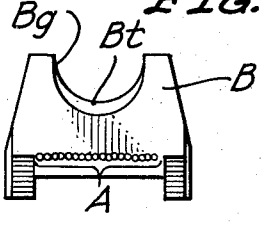


FIG. 7.

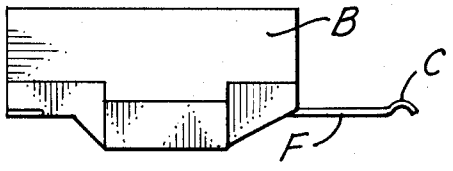


FIG. 8.

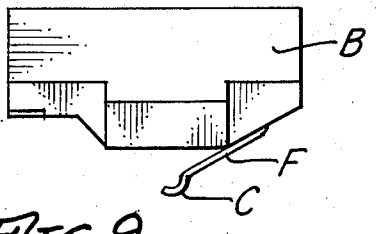


FIG. 9.

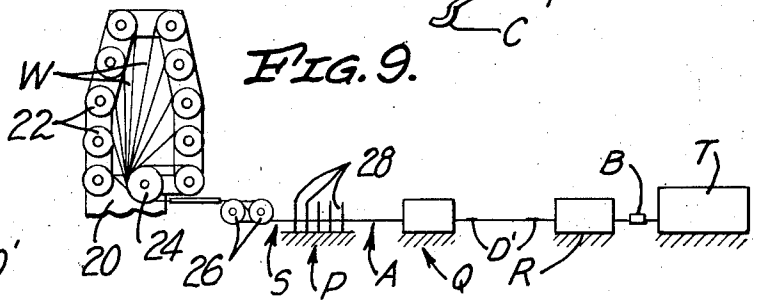
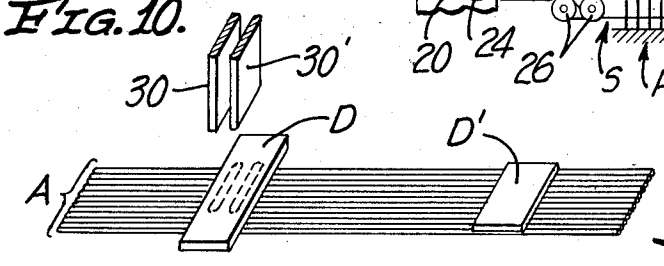


FIG. 10.



INVENTORS
RONALD L. FROEBE,
HOWARD H. HATCH
BY

FIG. 11.

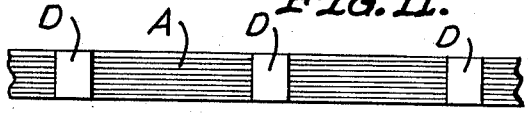


FIG. 11a.

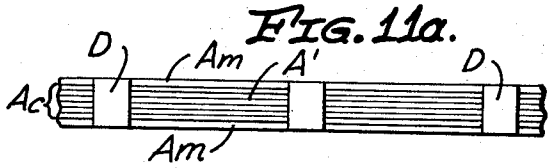


FIG. 12.

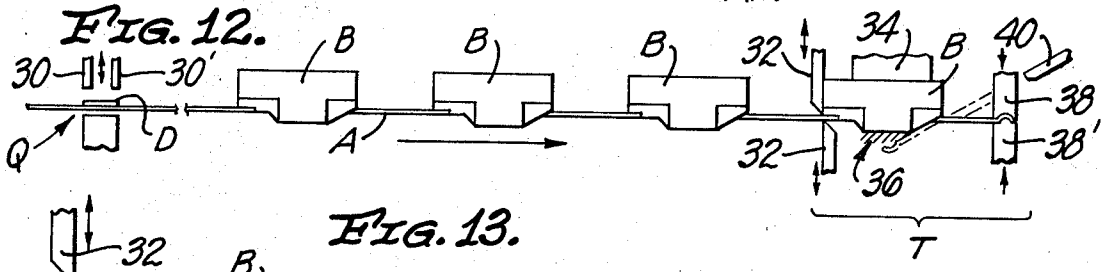


FIG. 13.

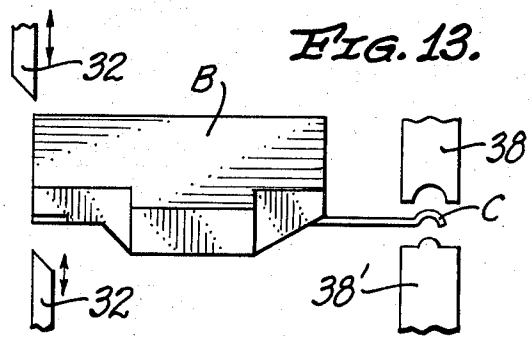


FIG. 14.

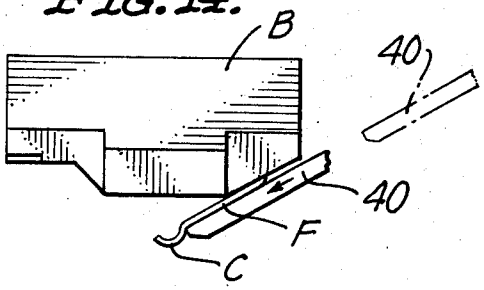


FIG. 15.

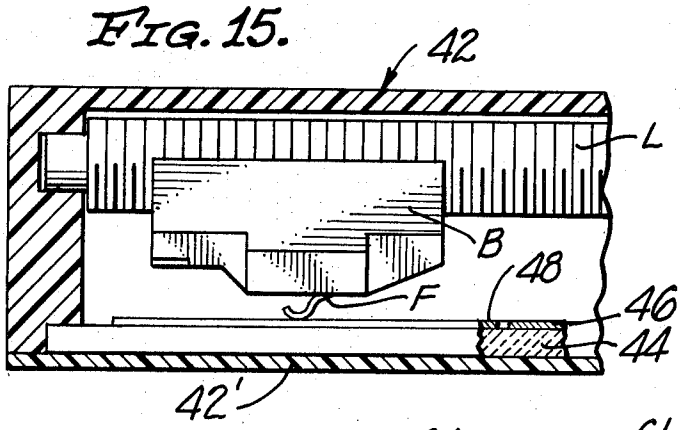


FIG. 16.

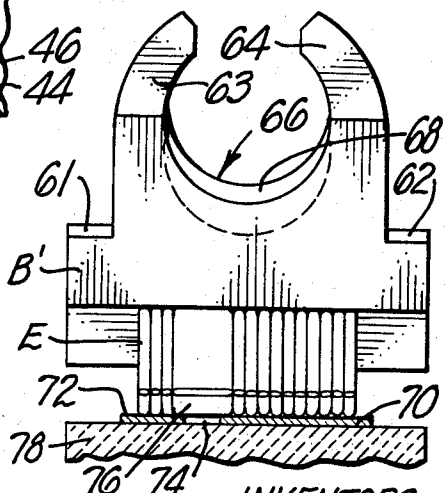
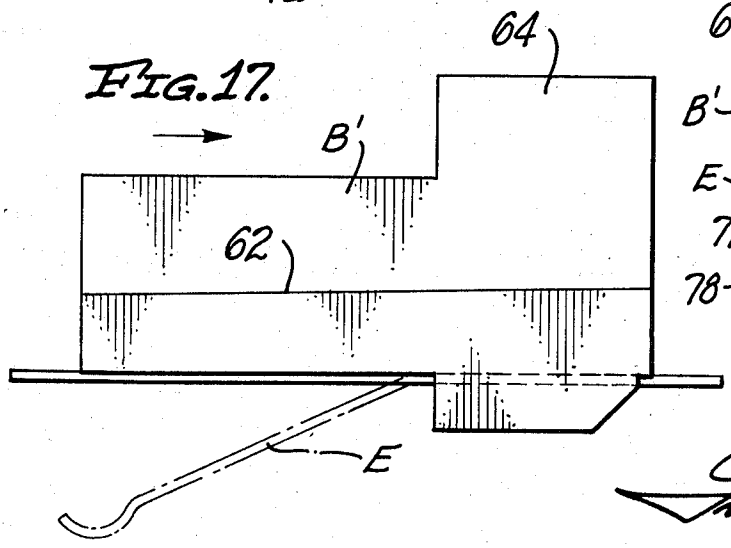


FIG. 17.



INVENTORS
RONALD L. FROEBE,
HOWARD H. HATCH
BY

MULTI-WIRE POTENTIOMETER CONTACT DEVICE

BRIEF SUMMARY OF THE INVENTION

1. The prior art

It has heretofore been the practice, in manufacturing multiple-wire contact devices for potentiometers, to clamp together a set of wires in clamping means such as are shown in FIG. 13 of U.S. Pat. No. 2,760,036, or in folded limbs of a contact arm such as shown at 68–68 in FIGS. 3A and 4 of U.S. Pat. No. 3,328,707, and to form the wires into cantilever contact fingers while thus held. In the practice exemplified by the latter patent, a portion of the length of the wires, initially in a flat-sheet parallel disposition, is flattened in the general plane of the wires so as to prevent axial rotation of wires and to slightly space the wires apart throughout the cantilever contact finger portion; and the flattened portion is gripped by opposing contact-arm limbs such as the elements 68 in the patent. In the practice exemplified by U.S. Pat. No. 2,760,036, the wires are formed into a sheet or strip as by winding several convolutions of wire on a carbon rod, preferably spaced apart, the wire is plated to bond the convolutions together, the coil thus formed is removed and cut to form a strip comprising several wires, the assembly is flattened, brush blanks are severed, the blank is clamped leaving a free end (FIG. 13 of the patent), the free end is formed with a V-groove, the formed blank is removed and the opposite end is coated with conductive cement and a coating resistant to acid, the free end treated with acid to remove the bond from the wires except at the cemented region, and the coating removed, and the completed brush is dipped in an acid-neutralizer. Thereafter the brush is cemented to a metallic contact-carrier. The procedure is explained in columns 8 and 9 of the patent. As is evident, a large number of procedural steps, some of which must be very carefully performed and by hand, are involved in the process detailed in U.S. Pat. No. 2,760,036. The method followed in producing the "wiper assembly" of U.S. Pat. No. 3,328,707, while not as complex as that characterizing the wiper brush of U.S. Pat. No. 2,760,036, is such that reasonably accurate wiper assemblies can be produced only when a small number of rather coarse-gauge wires are used, due to the difficulty of handling, flattening, and positioning the individual wires. Thus, unless exhorbitant assembly expense is involved, the wiper brush 64 is limited to something less than a half-dozen coarse-gauge wires, and, due to the gauge of the wire, flexing of individual wiper fingers (78, 96, or 111) can be effected only by spacing the fingers apart. That is accomplished, principally, and concurrently with preventing finger rotation, by flattening a portion of each finger.

2. The present invention

A much superior contact device or wiper brush is produced with considerable reduction of assembly time and expense and with greatly improved uniformity in successively made devices, in accord with the present invention. Thus, for example, a much larger number of wires of much finer gauge are easily accommodated, providing a group of independently-flexing contact fingers comprising for example, from six to 30 or more wires in side-by-side arrangement. In one present commercially produced form, nineteen fingers are utilized in a device whose brush width is only three thirty-seconds inch wide at the contact line. The wires are drawn under tension from respective spools or reels, through aligning guide pin means at which the wires are brought into a flat side-by-side array in which as a strip-like array they are drawn intermittently past a station that is for convenience termed a uniting station at which at each halt a flat plate is applied across the sheet or strip of wires and is secured to each of the wires to thereat bond or integrate a short portion of the wires and the plate into a unitary relative stiff or rigid assembly. The array of wires with the uniting spaced-apart plates advances from the plate-applying or uniting station under draft or tension applied at a final station, to a thermo-molding station at which a contact-carrier body of insulation is molded about the wire array and each of the plates in succession. The carrier bodies are preferably formed by injection-molding using mold means through which the wires extend and into which one of the plates is drawn and positioned at each step or advance of the array. Following opening of the mold means the array is advanced one unit, leaving a determined length of the wire array extending between successive molded contact-carrier bodies, by means at a forming and drawing station. As that means comes to rest with the leading body of the series in position for performance of further operations, the body is held by gripping means, the wires are severed closely adjacent one end of the body leaving an appropriate length of parallel wires extending away from the body, and forming-die means are successively operated to form at or adjacent the free ends of the protruding wires respective contact points, and to bend the wires to form therefrom a group of resilient cantilever-type contact fingers appropriately extending from the body and adapted to individually flex to and fro out of the side-by-side relationship with a next-adjacent finger. Following severance of the wires, which may be made to occur adjacent an end of the body at the finger-forming station or adjacent an end of the next-succeeding body, depending upon the finger configuration desired, and following finger formation, the gripped contact device is released for possible inspection, testing, or packaging, none of which latter steps is a necessary part of the method of this invention. The resulting product, as well as the intermediate products used in the finally-assembled contact device, are, however, parts of this invention as defined in the accompanying claims.

The preceding brief summary makes evident that it is a primary object of the invention to provide improvements in methods and steps for producing potentiometer contact devices and parts thereof. Another object of the invention is to provide an improved potentiometer contact device. An additional object of the invention is to effect reductions in the cost of producing potentiometer contact devices. Another object of the invention is to reduce the number and complexity of operations necessary for producing potentiometer contact devices. An additional object of the invention is to provide a potentiometer contact device characterized by markedly reduced contact-resistance-variation (CRV) when in operation. Another object of the invention is to provide a potentiometer contact device characterized by a maximum feasible number of independently-flex-

ing contact fingers having respective contact points disposed in a common contact line. Other objects and advantages of the present invention are set out or made evident in the appended claims and following detailed description of the invention as illustrated in the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a pictorial representation of a preferred form of contact device according to the invention, to grossly exaggerated scale;

FIG. 2 is a top view of the structure illustrated in FIG. 1, prior to contact-point formation and prior to bending of wires to form shaped resilient contact fingers;

FIG. 3 is a sectional view of the structure depicted in FIG. 2, the section being as indicated by indicators 3—3 in the latter drawing;

FIG. 4 is a transverse sectional view of structure shown in FIG. 2, the sectioning being indicated by indicators 4—4 in the latter drawing;

FIG. 5 is a bottom view of the structure depicted in FIG. 2;

FIG. 6 is an end view of the structure depicted in FIGS. 2 and 5, viewed from the left in FIG. 5;

FIG. 7 is a side elevation view of the structure depicted in FIG. 1, following formation of contact points and preceding bending of the contact fingers;

FIG. 8 is a view similar to FIG. 7 but showing the completed contact device following bending of the contact fingers;

FIG. 9 is a schematic diagram illustrating a preferred sequence of steps in producing a device according to the invention;

FIG. 10 is a partly schematic portrayal of actions occurring at one station indicated in FIG. 9;

FIGS. 11 and 11*a* are plan views of arrays of wires and applied plates according to the invention as they appear at one stage of the manufacturing procedure;

FIG. 12 is a partly schematic portrayal of stations at which certain manufacturing steps are performed, with portions of wires removed and apparatus schematically indicated;

FIGS. 13 and 14 are side views, to scale similar to that of FIG. 1, illustrating certain operations performed in the procedure of the invention;

FIG. 15 is a view to a grossly enlarged scale, of a contact device according to the invention, disposed in operative position in a potentiometer, with portions of the latter in section and other portions broken away in the interest of clarity of illustration;

FIG. 16 is an end view to a grossly enlarged scale, of a modified form of contact device according to the invention, in operative relation in a potentiometer, partly in section and with parts removed; and

FIG. 17 is a partly schematic view of a device according to the invention, to grossly enlarged scale, useful in explaining certain features of the invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring first to FIG. 9, there is shown a stand or frame 20 on each of the face and rear of which are mounted several reels or spools, such as 22, each bearing a wound supply of fine-gauge contact wire such as W. Ten such spools are depicted on the face of the stand, and an equal number are hidden from view and supported on support pins on the back of the stand. As is evident, a greater number of spools may be so supported if a larger number of wires must be accommodated, and one or more pins may be left unoccupied if fewer wires are required. The spools are biased against completely free rotation, as by conventional drag or brake means well known in the textile and wire-working arts for example, and here not shown for the reason indicated. From the several spools respective wires are drawn and passed about a guide roll 24 and along respective courses about additional guide rolls 26 and through a set of guide pins 28 firmly supported at a station P and arranged to bring the now planar sheet S of wires into respective positions in which the wires are disposed in side-by-side contacting relationship in a strip-like array A.

The strip-like array of wires is advanced, tensioned, in a stepwise succession of advances into, through, and past stations herein denoted P, Q, R and T as indicated in FIG. 9. At station Q a transversely extending metal plate member D (FIG. 10), which preferably bears a coat of solder over its lower face, is secured or bonded to each of the wires of the array. A set of current electrodes 30, 30′ is brought into pressing engagement with the plate D and current passed from one electrode to the other through the plate whereby to heat the plate and melt the solder to thereby fusion-unite or bond the wires and the plate into an integral or unitary assembly. Following removal of the electrodes and cooling of the plate, the ends of the latter are trimmed to be flush with the outer edge of the array of wires, as indicated by D′ (FIG. 10). The plate may be formed at station Q by transverse advancement of a metal strip from which plates are sheared or otherwise severed as needed; or they may be supplied from a stack or other store of finished plates. Following trimming of the applied plate, the array is drawn forwardly one step by reciprocatory draft means at end station T; and thereby one of the bonded plates D′ is removed into molding apparatus at station R. At station R, mold-forming means including plates are closed about the array A and a plate D′, and a charge of thermoplastic or thermosetting insulative resinous material injected and molded about the plate and wires thereat to form a contact-device body such as that indicated by B. While the shape of the molded body thus formed is dependent upon the mold and thus can be of any of a large variety of configurations, in the illustrated exemplary form of the invention the body is adapted for use with a lead-screw in a leadscrew-adjusted potentiometer, as will presently be made evident. Following the molding and mold-opening steps, any protruding flash may be removed at station R, and then the train comprising a length of the wires, attached plates such as D, and one or more molded bodies, is advanced one step to bring a body B into wire-operations station T. At the latter station the present body B is gripped and firmly held in position for performance of wire-severing and wire-forming operations such as are diagrammatically indicated in FIGS. 12, 13 and 14. Thus, as indicated at the right in FIG. 12, while the body B is clamped by presser 34 against a tapered base indicated at 36, shear means 32 close and sever the strip of wires closely adjacent one end of the body while a set of contact-point

forming die means 38, 38' close upon the ends of the forwardly extending wires protruding from and extending beyond the other end of the body B at station T. Thus the die means 38, 38' produce small bights or bends of the desired shape at the free ends of the side-by-side wires, such as those indicated in FIG. 13 for example, to provide respective contact points C all of which lie along a line extending transversely of the array of wires. Following formation of the contact points C and retraction of the die means 38, 38', a bending plate 40 (FIG. 14) is translated downwardly along an inclined path to strike and bend the strip-like sheet of wires into the position indicated, to form a set of resilient cantilever contact fingers F each of which may flex toward or away from body B without interference from any next-adjacent finger. The contact device structure prior to bending of the wires to form fingers is depicted in FIG. 7, and the completed device is shown in FIG. 8, (to greatly enlarged scale) it being understood that the selected body shape and contact finger disposition shown are exemplary and may be varied within the scope of the invention as defined by the claims.

The exemplary insulative contact device body B is arranged with a longitudinal groove or trough Bg (FIGS. 1, 4 and 6) arranged and dimensioned to receive a lower portion of a length of a leadscrew L (FIG. 15) mounted for rotation in known manner in a potentiometer housing 42. The body is provided along the bottom of a portion of trough Bg with half-threads Bt (FIGS. 1, 2, 3, 4) arranged for cooperative engagement with the complementary thread of the leadscrew. The other end-portion of the groove or trough is smooth and uninterrupted and is dimensioned for an easy sliding fit on the leadscrew.

The exemplary potentiometer in which the described contact device is adapted for use is illustrated in fragmentary section in FIG. 15, and comprises a cermet or film-type resistance element structure comprising a base or substrate 44 on which a resistance element 46 and return conductor 48 are disposed in parallel relation in position for brushing contact by the contact points of respective portions of the several contact fingers of the array. As is shown or indicated in the latter drawing, the relationship and dimensioning of the components is such that when the potentiometer housing cover 42' with the substrate 44 thereon is assembled to the housing body 42, the resilient contact fingers F are stressed and press the body B into position engaging the leadscrew with the half threads of the body meshed with convolutions of the thread of the leadscrew. Due to the arrangement of the body and contact fingers, when the body is driven against either end wall in the interior of the potentiometer housing, the half threads are cammed and made to ride over the leadscrew thread convolutions without translational movement of the contact points on the resistance element and without damage to other components.

In a modified form of contact device according to the invention wherein extremely fine gauge wires are employed, it has been found that utilization of a flat wire at each margin of the array of wires is of considerable value, such a wire acting to prevent lateral spreading of the relatively weak contact fingers formed from wire of round cross-section, and also acting to bear a disproportionate share of the contact load. Thus, as indicated in FIG. 11*a*, the array A' of wires includes a central group Ac of very fine gauge wires and flat marginal wires Am of thickness equal to the diameter of the fine wires. As in the previously described arrangement, the wires are disposed in side-by-side relation in a flat strip-like configuration, and have conductive plates D bonded to each of the wires at spaced intervals to form a unitary sub-assembly. In other respects, formation and use of the unitary array A' is the same as that of array A.

In a different modified form of contact device according to the invention, the body B' (FIGS. 16 and 17) is molded with a pair of longitudinally extending steps 61, 62, and a pair of short upstanding curved inwardly converging horns 63, 64 arranged to clasp a leadscrew in a known manner. The leadscrew is received in an elongate trough or slot 66, and the body is adapted to be urged upwardly as shown by force exerted by contact fingers E whose contact points are arranged to brush on resistance element means and conductor means supported on a substrate or base 78 as indicated in FIG. 16. The components 70, 72 and 78 are conventional in the art. The trough or groove at the horn end is smooth-bottomed, whereas at the opposite end half-threads 68 are formed. Thus the driving effort is transmitted through the half threads; hence when the contact device is driven against an end wall in a potentiometer, the fingers E flex and permit the half threads to slip over convolutions of the leadscrew thread, the contact fingers flexing slightly to accommodate the rocking movement of the body.

In FIG. 16 is illustrated another modified form of contact device wire arrangement particularly adapted for use with thick-film type resistance element structures. In the latter structures a thick film of resistive material, such as shown in greatly exaggerated dimension in FIG. 16 at 70, and a generally parallel conductor film such as 72, are separated by an insulative gap 74 of sufficient depth to sometimes permit one or more of the fine gauge wire contact points of the contact device to migrate laterally into the groove formed by the gap, and become permanently mispositioned out of desired contact with the resistive or conductive element. According to the invention such migration is prevented by incorporation of a wide flat wire 76 into the contact-finger array, that wire being dimensioned and disposed to bridge the gap, i.e., to be slightly wider than the gap, as illustrated. If found to be desirable, as may be the case with certain film-type resistive elements or tracks and when very fine gauge wires are used, wide wires may also be incorporated into the array at the marginal positions, as illustrated in the modified form of array depicted in FIG. 11*a*.

It is made evident in the preceding description that utilization of the invention procedure eliminates a large number of hand operations in the manufacture of potentiometer contact devices while concurrently providing improvements in uniformity of the devices by virtue of the fact that successive operations performed by automatic cyclical machines are more nearly identical than are such operations performed manually. Further, it is evident that the cost of producing devices of the class described is greatly reduced. Also it is evident that securing the several wires of the group or

array into an integral or unitary structure by bonding or securing them to a transverse plate permits molding thereon a contact-carrier body without disruption of displacement of the wires, and that by bonding the wires into such unitary structure by means of a metal plate all of the wires are efficiently connected together electrically whereby a stable electrical path of low resistance is provided between those wires or fingers engaging the resistive element and those engaging the return conductor of a potentiometer. Thus the preferred embodiment described presents two extremely desirable attributes. By drawing the wires into a flat strip-like array under tension, and advancing the array step-wise or intermittently through a plurality of stations at each of which an important step of the procedure is performed, marked improvements in uniformity of completed contact devices are attained while concurrently waste of extremely expensive fine gauge wire is substantially entirely eliminated. Thus it is evident that the aforementioned objects of the invention have been fully attained.

We claim:

1. A potentiometer contact device comprising:

electrically conductive means;

a strip-like, one layer array of fine-gauge wires arranged in side-by-side relationship contacting said electrically conductive means, wherein the outermost wires along each side of the array are of greater width than at least some of the inner wires, whereby lateral deflection of the contact fingers from side-by-side relationship is inhibited;

a thin flat plate of material disposed with one face thereof extending transversely across said array of wires at a location intermediate the ends of the array and firmly secured to each of said wires at said location whereby said wires and plate form a unitary assembly, said plate being out of contact with an elongate free section of the array of wires to provide a group of individual contact fingers having contact points in side-by-side juxtaposition along a straight line and each finger free to flex perpendicularly of the line independently of the other wires of the array; and

a contact-carrier body of electrically insulative material intimately bonded to the wires of said array at said location, whereby said wires are accurately secured in a predetermined side-by-side arrangement thereof irrespective of said body and are each in part secured to and carried by said body whereby said contact fingers may contact and be moved as a unit along a resistance element device to provide minimal contact resistance variation during such movement.

2. A potentiometer contact device as defined in claim 1, in which said thin flat plate is a solder-coated metal and is secured to each of the wires by solder adherent to both the plate and the wires, whereby construction of the device is facilitated and electrical resistance between wires is minimized.

3. A potentiometer contact device as defined in claim 1, in which said contact-carrier body encircles said wires and said plate at said location, whereby to provide a stronger device.

4. A potentiometer contact device comprising:

electrically conductive means of a resistance element device;

a strip-like, one layer array of fine-gauge wires arranged in side-by-side relationship contacting said electrically conductive means, wherein one of the wires intermediate the outermost wires of the array is relatively wider than at least some of the other wires whereby said one wider wire directly bridges a longitudinally extending gap or depression between said electrically conductive means of a resistance element device and contacts the members, thereby supporting next-adjacent wires of the array against movement into the gap;

a thin flat plate of material disposed with one face thereof extending transversely across said array of wires at a location intermediate the ends of the array and firmly secured to each of said wires at said location whereby said wires and plate form a unitary assembly, said plate being out of contact with an elongate free section of the array of wires to provide a group of individual contact fingers having contact points in side-by-side juxtaposition along a straight line and each finger free to flex perpendicularly of the line independently of the other wires of the array; and

a contact-carrier body of electrically insulative material intimately bonded to the wires of said array at said location, whereby said wires are accurately secured in a predetermined side-by-side arrangement thereof irrespective of said body and are each in part secured to and carried by said body whereby said contact fingers may contact and be moved as a unit along a resistance element device to provide minimal contact resistance variation during such movement.

* * * * *