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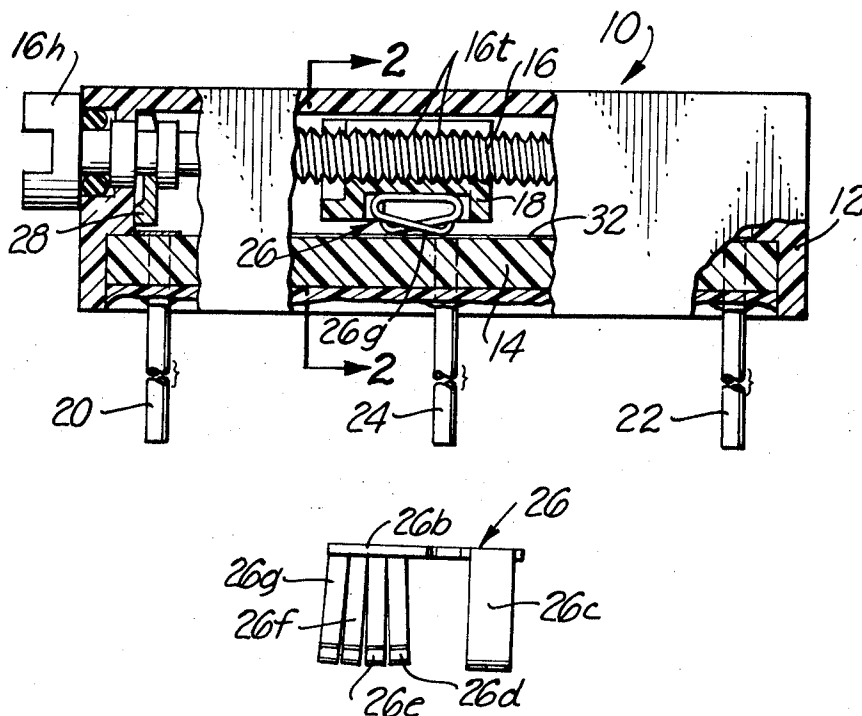
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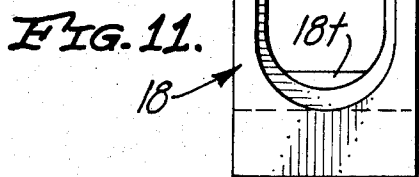
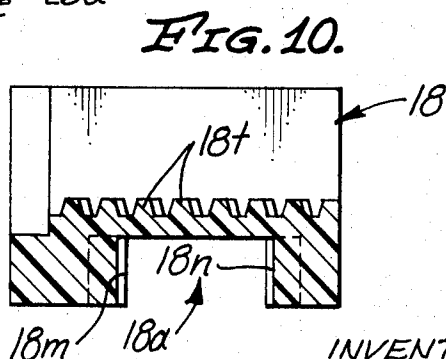
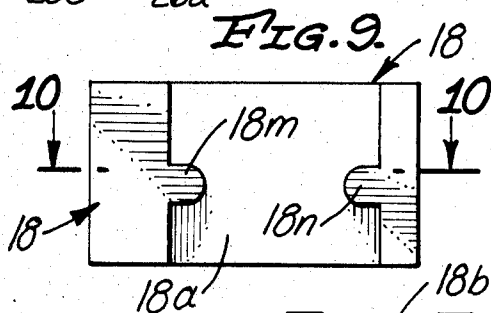
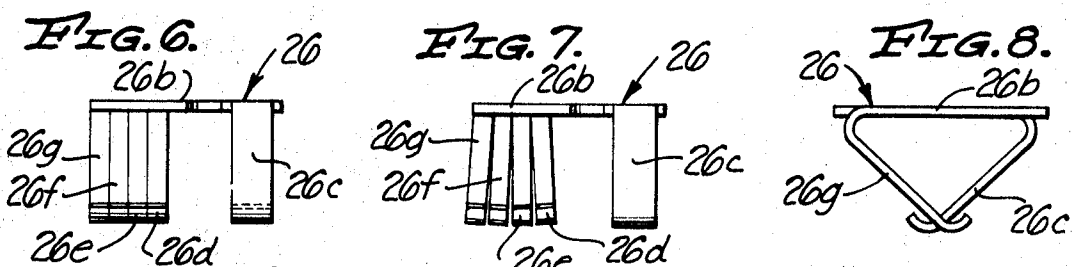
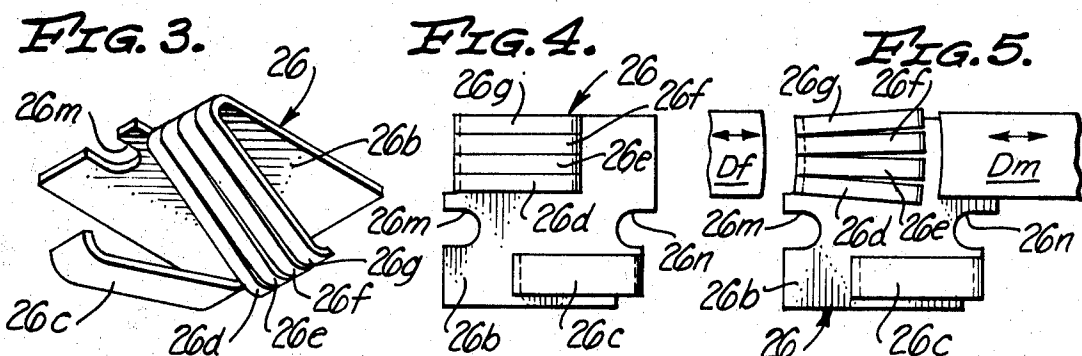
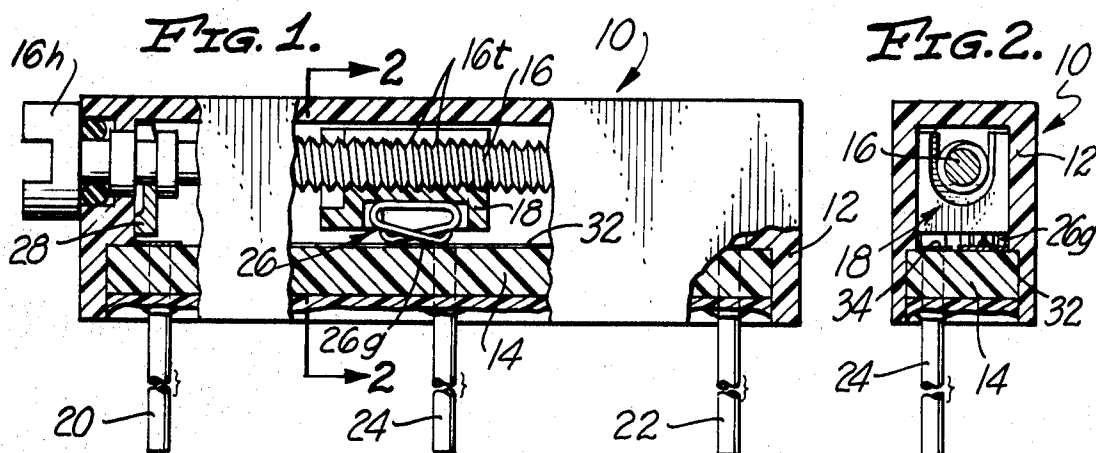
[54] **POTENTIOMETER MULTI-FINGER CONTACT ASSEMBLY**

4 Claims, 11 Drawing Figs.

[52] U.S. Cl. 338/183,
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 [51] Int. Cl. H01c 9/02,
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 (E), 630 (C&E); 338/(Screw Digest), 160, 180,
 183, 202; 113/119; 200/166 (B)3

ABSTRACT: Multifinger contact and contact carrier especially adapted for use in extremely small leadscrew adjusted potentiometers having flat-surface resistance elements such as cermet and wherein available space for a contact is extremely limited, the contact comprising a collector-brushing limb and a plurality in excess of two of element-brushing limbs formed by longitudinal slit shearing of a contact strip and fanning-out or separating the element-brushing limbs or fingers by a dimpling operation, whereby each of the fingers is capable of flexing independently of the others.





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POTENTIOMETER MULTI-FINGER CONTACT ASSEMBLY

BACKGROUND OF THE INVENTION

Potentiometers comprising flat resistance elements such as cermet or metal films have suffered the objection that contact resistance variation (CRV) is high and not uniform among otherwise similar elements. Various expedients or palliatives have been devised in efforts to overcome the objection, including surface treatment of the resistance element by lapping and chemical etching. The difficulty encountered in producing resistance elements exhibiting low CRV is aggravated by the fact that in producing elements of high values of total resistance TR and elements of low values of TR all using the same composition, the abrasiveness of the element on the contact varies widely between two extremes. The elements of high TR are much more abrasive than are those of low TR. Further, the difficulties are also aggravated as the size (length and width) of the resistance element is decreased. At this time extensive demands are made for greatly reducing the size of adjustment potentiometers of all types, and concurrently for reducing costs of such potentiometers. The two demands tend to further aggravate the noted difficulties, since as parts such as contacts are made smaller and smaller, the precision with which they must be made and the production costs increase out of proportion, as does the difficulty of handling and assembling the parts. Thus, whereas in the case of a cermet element three-sixteenth inch wide and three-fourth inch long the resistive track permits the use of a multifinger contact such as that illustrated in the U.S. Pat. to Thoele, No. 3,178,664, when the element is reduced to a size of the order of one-sixteenth inch wide and seven-sixteenth inch long, with a resistive track only one thirty-second inch wide and nine thirty-seconds inch long, a multifinger contact made according to the previously known procedures and exemplified by that shown in the Thoele patent cannot be made except at prohibitive cost. The dies requires for cutting out the strip material between the fingers, which material must be removed to permit individual flexure of the fingers, become too delicate to withstand repeated die operations sufficiently long to be economically feasible. Additionally, removal of material to form independent fingers leaves the fingers too delicate to withstand the rigors of usage and too sharp to avoid damage to the resistive track. Hence for practical reasons related to cost of manufacture and allied matters, return to single-finger contacts for such tiny contacts is dictated.

SUMMARY OF THE INVENTION

The present invention, by resorting to successive shearing operations to form contact fingers integral with a contact body, and subsequently slightly separating or splaying the otherwise contiguously contacting fingers somewhat in the manner of an opening fan, by an operation herein termed dimpling, or by otherwise distorting a portion of the contact so as to cause the fingers to slightly spread apart and become independently flexible, avoids detrimental removal of material from between the fingers and the necessity for delicate punching dies, and provides a method for inexpensively producing a novel and extremely effective multifinger contact the fingers or limbs of which are independently flexible and capable of enduring extended usage without damage to the resistive element. The novel contact is adapted for simple and easy assembly on a miniature insulated slider for drop-in installation in a potentiometer housing.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view of a typical exemplary adjustment potentiometer of the type to which the invention is applicable, with parts broken out and partly in section to illustrate components including a contact device according to the invention, to grossly enlarged scale;

FIG. 2 is a transverse sectional view of the potentiometer depicted in FIG. 1, taken as indicated at 2-2 in the latter FIG.;

FIG. 3 is an isometric or pictorial view of a contact device according to the invention and as depicted in installed condition in FIG. 1, on a still further enlarged scale;

FIG. 4 is a bottom view of the contact device shown in FIGS. 1 and 3, prior to dimpling or spreading of the contact fingers, the scale being about the same as that of FIG. 3;

FIG. 5 is a view similar to FIG. 4, but depicting the contact device after the fingers have been spread;

FIG. 6 is an end view of the contact device shown in FIGS. 1 through 5, prior to spreading of the contact fingers;

FIG. 7 is a view similar to FIG. 6 but showing the device after spreading of the fingers;

FIG. 8 is a side view of the contact device depicted in FIGS. 5 and 7, with contact fingers separated for individual flexing and in relaxed condition ready for inverted assembly into a potentiometer subassembly;

FIG. 9 is a bottom view of an insulation slider block depicted in use in FIG. 1, on a still further enlarged scale;

FIG. 10 is a longitudinal sectional view of the slider block shown in FIG. 9, taken as indicated at indicator lines 10-10 in FIG. 9; and

FIG. 11 is an end view of the block depicted in FIGS. 9 and 10.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, there is shown an exemplary adjustment potentiometer 10 of the type commonly referred to as a leadscrew adjusted potentiometer (LSAP), which comprises as major components an elongate boxlike housing member 12 and a complementary lid or cover 14, a leadscrew 16, a slider block 18, a set of terminals 20, 22 and 24, and a contact device 26. The leadscrew is mounted in bearings formed in member 12, in the manner indicated, and is restrained against axial translation by a retainer clip 28 and the head 16h of the screw, both of which abut against surfaces on the member 12. The retainer clip 28 is bifurcate and the tines or limbs thereof are received in an annular groove in the leadscrew to operate in a well-known manner.

The lid or cover 14 of the exemplary potentiometer is formed of insulation such as a ceramic material and fits in a complementary recess formed in member 12, as indicated in FIGS. 1 and 2. It is retained therein by adhesive sealant such as is indicated at 30. The terminals 20, 22 and 24 have one end portion of each embedded or otherwise affixed in the cover 14, and the other end portion extending to the exterior of the potentiometer for electrical connection in an electrical device or circuit not pertinent to this invention. The inner ends of terminals 20 and 22 are electrically connected to respective ends of a thin narrow film or layer of resistive material which for convenience is here termed a resistance element 32 and which is disposed along one side of the inner flat surface of cover 14 as indicated in FIGS. 1 and 2. The electrical connection of either end of the resistive film or element is by means of a conductive film such as silver, gold, platinum or the like, which in this exemplary structure is applied over an L-shaped area at either end of element 32, whereby all three terminals may lie in a common plane or line. The conductive film in each instance extends over or under (or both) the end of the element 32 and into contact with the inner end of the respective terminal.

Terminal 24 has its inner end exposed at the inner face of cover 12 and is electrically connected to a thin narrow conductive film 34 which is somewhat shorter than element 32 and which is disposed alongside the resistive film 32. Film 34 is insulated from the element 32 by being spaced therefrom, and serves as a conventional return bus or collector. The electrical connection in this instance is by direct contact of the film 34 with the inner end of terminal 24.

The aforementioned slider block 18 is yieldingly held engaged with the thread of the leadscrew 16 inside the housing by the spring-action of the limbs of the contact device 26, which device is, during assembly of the cover 14 to housing

member 12, compressed between the cover and a complementary seat formed by a recess in the block 18. As is indicated generally in FIGS. 1, 3 and 8, limbs of the contact device extend in two opposite directions away from a base portion 26b to which they are integrally connected. The elastic or resilient limbs, shown in relaxed condition in FIGS. 3 and 8, become tensed or stressed as the cover 14 is seated in member 12, and by reason of being so stressed, serve to resiliently hold the slider block against leadscrew 16.

As is portrayed in FIGS. 9, 10 and 11, the slider block 18 is formed, as by injection molding of thermoplastic synthetic resin or polymer, to have a contact device receiving recess 18a across one face, and a deep longitudinal groove 18b in the opposite face, the inner surface of the groove being interrupted by a partial thread 18t which is complementary to the thread of the leadscrew. The recess 18a is interrupted by a plurality of nubs or projections, 18m, 18n for a purpose presently explained. The slider block has smooth exterior side surfaces which, as is indicated in FIG. 2, are adapted to engage respective smooth interior walls of housing member 12 to thus stabilize the slider block and restrict it to longitudinal motion. As is similarly indicated in the latter figure, the partial thread of the slider block is pressed into engagement with the thread 16t of the leadscrew by the resilience or spring action of the contact device. Thus rotation of the leadscrew causes longitudinal translation of the slider block along the interior of the housing, the direction of translation depending upon the direction of rotation of the screw.

As is illustrated in FIG. 4, the platelike base portion 26b of the contact device 26 is provided with two notches 26m, 26n, which are complementary to and each of which is adapted to receive and closely fit a respective one of the nubs 18m and 18n of the slider block. Also, the base portion 26b is shaped and dimensioned to fit closely in the recess 18a FIGS. 9 and 10) of the slider block. Thus the contact device is constrained to traverse with the slider block as a unit and as is evident, the slider block functions as a contact-carrier which moves the contact device to and fro along a resistive element. As is depicted in FIGS. 3 to 8 inclusive, a single relatively wide resilient limb 26c which is integral with the base portion 26b is arranged to brush on the conductive film 34, and at the opposite side of the device a plurality (four, as illustrated) of resilient contact fingers 26d, 26e, 26f and 26g constituting another limb of the device is arranged to brush on the resistance element 32. To attain a maximum of active contact surface along a line transversely of the resistance element, while concurrently attaining a gross reduction in CRV, the contact fingers are not formed by cutting slots in the sheet stock from which the contact device is formed; but, rather, the fingers are formed in side-by-side contact by shearing operations. Thus none of the valuable support of the contact fingers by the base portion is sacrificed. When consideration is given to the fact that the maximum width of the contact device (that of the base portion 26b) may be of the order of only one-sixteenth of an inch, and that the four contact fingers are derived from only a minor fraction of that total width (about one-third, as illustrated, for example), it is seen that the resulting cross-sectional dimensions of either of the fingers are very small. Hence it is essential that there be no sacrifice of metal at the roots of the fingers, or between the fingers such as is inherently done when the base strip is slotted as by sawing or punching. Otherwise, the noted dimensions of the fingers would be so small that the fingers would be too weak and fragile to perform their intended functions.

However, when the contact fingers 26d, 26e, 26f and 26g are thus formed by shearing to conserve valuable material and space, the contact fingers are left in lateral contact with each other and are thus constrained to flex as a single unit. Thus the prime purpose of shear forming the contact fingers is apparently defeated, for when in lateral contact with each next adjacent finger the fingers cannot flex or yield freely independently. As a consequence they act quite like a single wide contact finger and result in equivalently high CRV. In accord with

the present invention, the contact fingers, while formed by a shearing operation and hence in contiguous contact each with one or two next adjacent fingers, are caused to become independent of each other and out of mutual contact except at and closely adjacent their junctures where they merge with the base portion 26b. This independence of each finger whereby each may flex and yield to minute irregularities in the surface of the resistance element 32 and hence permit the entire set or group of fingers to act as a multielement brush to reduce CRV, is effected by an operation which is for convenience herein termed a dimpling operation and which results in a slight lateral separation of the principal portions of the fingers.

The aforementioned dimpling operation may be effected in various ways by any of several means; but as presently preferred in an exemplary procedure is effected by flat curved die means, Dm and Df, of shape as indicated in FIG. 5. The die members are brought into pressing engagement with the roots or base ends of the fingers adjacent their mergence with the base portion 26b, care being taken to restrict the deformation of the fingers to only the extent required to result in freeing a principal portion of each finger from contact with another thereof. The resultant slight spreading or separation of the fingers permits each finger to flex largely independently of the others so that the tip of any finger may follow very slight irregularities in the surface of the element 32 and thus avoid the much coarser action of a single wide contact which can brush only the highest point along any transverse line of contact with the element. While the fingers in the exemplary contact device are curved at their free ends, to provide a curved contact surface, they may be oppositely curved, so as to present an end surface to the resistance element. The choice depends upon the hardness of the resistive film in comparison with that of the alloy of which the contact device is made. Thus the contact device attains the objectives of the invention and greatly reduces contact resistance variation.

As will be evident from consideration of FIG. 1, the potentiometer construction depicted permits easy and rapid assembly. The leadscrew is inserted into the housing member 12, the latter inverted with the open side facing upwardly, and the clip 28 pressed into place. The slider block is dropped into place straddling the leadscrew, and the contact device is dropped into recess 18a. The cover 14 is then pressed downwardly into seating engagement with the complementary peripheral step formed in member 12, stressing the limbs of the contact device, and adhesive sealant 30 is applied and permitted to harden while the cover is held seated, as by a clamp, clip, or the like. Despite the small sizes of components in an exemplary potentiometer of body dimensions 0.500 inch long, 0.100 inch wide, and 0.150 inch high, in which the contact device when in expanded relaxed condition would readily fit in a cube of the order of one-sixteenth of an inch dimensions, the disclosed potentiometer operates satisfactorily in all respects and is characterized by much lower CRV than any known potentiometer having similar resistive element means and a metal contact device.

While for purposes of illustration in exemplary form the contact device has been depicted as used in a leadscrew adjusted potentiometer, it will be evident to those skilled in the art that the meritorious and novel features of the device are equally applicable to other forms of potentiometers such as, for example, miniature single-turn rotary potentiometers. As is evident, the invention, by providing the maximum number of resilient independently flexible contact fingers possible along a line of contact with the resistance element, provides by virtue of the multiple points of contact therealong, a maximum reduction of CRV as the contact device is traversed along the resistance element. That is, by forming the elongate contact fingers by a shearing operation whereby a maximum number of self-supporting resilient fingers are provided, and separating them along a major portion of their lengths so each is independently flexible or capable of independent flexure, a maximum of effective electrical contact of the device with the resistance element along a line of contact is attained with a

concurrent maximum reduction of CRV as the contact device is traversed along the resistance element. As is evident, the number of such fingers that can be formed is dependent upon the width of the resistive film to be brushed, and other design dimensions, and upon the material of which the contact device is made. The invention is applicable to all metal and alloy contact devices.

As is further evident, by mergence of the contact fingers (26d, 26e, 26f and 26g) with the base portion of the contact device along one margin of the latter, and mergence of the collector-brushing limb (26c) with the base portion along a diagonally opposite margin of the base portion, the forces exerted by the several limbs on the base portion are balanced and such as to effectively hold the contact device seated in the complementary recess in the contact-carrier or slider block, irrespective of the direction of traverse of the contact device. This balancing of the forces exerted by the resilient limbs of the contact device is enhanced by making the respective sets of limbs (26c in a collector-brushing set, and 26d, 26e, 26f and 26g in a resistance element-brushing set) so they extend in generally opposite directions away from the base portion (26b) of the contact device. The value of this balancing of forces in permitting the contact device to operate efficiently and effectively without being positively secured to the contact-carrier is evident to those skilled in the art, and, as is now clearly evident, permits of simple "drop-in" assembly operations.

We claim:

1. In a potentiometer having a resistance element, an electrical return member, a contact-carrier, and means to move the contact-carrier to traverse along an extent of the resistance element;

a contact device complementary to the contact-carrier whereby to be traversed by movement of the contact-carrier, said contact device being formed from thin metallic sheet and comprising;

a base portion of thin metallic sheet material, having side edges and end portions, and adapted for attachment to the contact-carrier, and

a plurality of elongate resilient contact fingers integral with said base portion and each merging with each next adjacent finger and with the base portion in a region of the order of one-sixteenth inch wide and in which each contact finger is in physical contact with each next adjacent other of said contact fingers, and each contact finger diverging away from each next adjacent contact finger so as to be out of physical contact therewith along a major

portion of the length thereof so as to be capable of flexing independently of all other of said contact fingers;

whereby with an integral one-piece metal contact device in the stated environment, a maximum of effective electrical contact with the resistance element along a line of contact therewith is attained with a concurrent maximum reduction of contact resistance variation as the contact device is traversed along the resistance element.

2. A structure as defined in claim 1, in which said contact device base portion is of flat platelike configuration and in which said conductive limb and said contact fingers are mergent with said base portion along opposite edge portions of said base portion and extend away from said base portion in generally opposite directions whereby to exert forces along opposite margins of said base portions to balance the forces applied to said base portion.

3. The method of reducing to a minimum the contact resistance variation in a potentiometer having an electrical return collector means, an elongate resistance element and a metal contact device having a thin sheetlike base portion and contact limbs, said method comprising the steps of:

forming by parallel shearing inwardly from one end portion of a sheet of metal, a plurality of elongate resilient contact fingers in contiguous side-by-side disposition while leaving each contact finger in physical contact with each next adjacent finger and each mergent with at least such next adjacent finger and with the base portion in a region of mergence of the order of less than one-sixteenth inch wide;

applying forces to at least some of said fingers in the regions of mergence thereof with said base portion, sufficient to permanently deform at least enough of said fingers to cause separation of each of said fingers from any next adjacent finger along a major extent thereof, while leaving each of the contact fingers in contact with each next adjacent finger along a portion thereof close to said base portion,

whereby each of the fingers may resiliently flex independently of the others thereof and is positioned to individually make physical and electrical contact with the resistance element, and whereby a maximum number of effective contact fingers is provided between the two most widely separated ones of said fingers.

4. The method according to claim 3, further including the step of bending the free end portions of the contact fingers to provide respective curved surfaces for contact with the resistance element.