United States Patent

[11] **3,574,929**

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[45] Patented **Apr. 13, 1971**
[73] Assignee **Bourns, Inc.**

[54] **ADUSTABLE RESISTORS AND METHOD**
7 Claims, 21 Drawing Figs.

[52] **U.S. Cl.** **29/610,** 264/272, 338/203, 338/334
[51] **Int. Cl.** **H01c 17/00**
[50] **Field of Search** ..... 29/610, 613, 203 (R), 203 (S); 264/272 (X), 275, 277; 338/160, 184, 199, 203 (X), 334 (X)

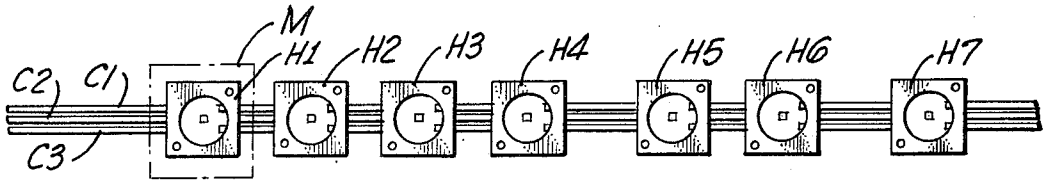
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Primary Examiner—John F. Campbell
Assistant Examiner—Victor A. DiPalma
Attorney—Fritz B. Peterson

ABSTRACT: A method of making adjustable resistors including three-terminal resistors (potentiometers) in which a set of long flat conductors is fed from a source in parallel array through a molding machine which in a step-by-step operation forms on and around the conductors a series of spaced-apart insulative resistor bodies in which portions of the conductors are exposed for contact or for welding on of resistance elements, the conductors being severed between the resistor bodies and formed into or left in place as electrical terminals. In some forms, resistor body covers are similarly formed on a metal strip, and individually mated with resistor bodies.



3 Sheets-Sheet 1

FIG. 1.

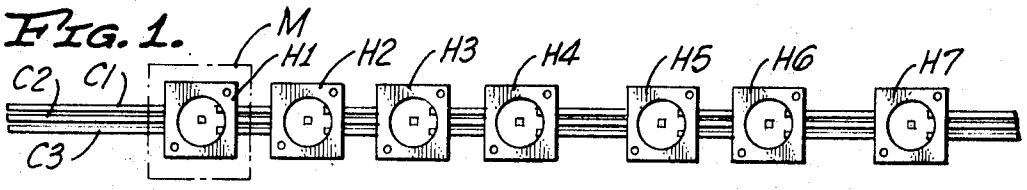


FIG. 2.

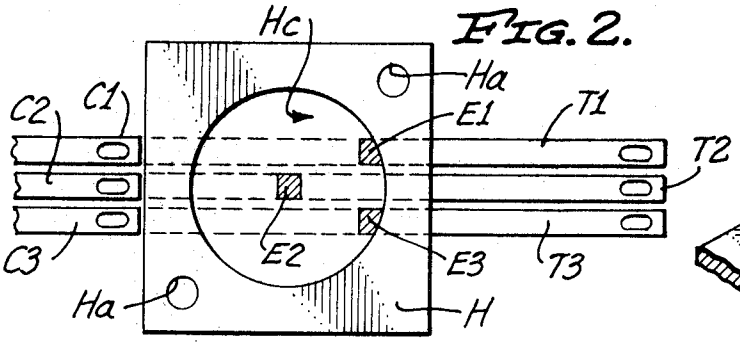


FIG. 2A.

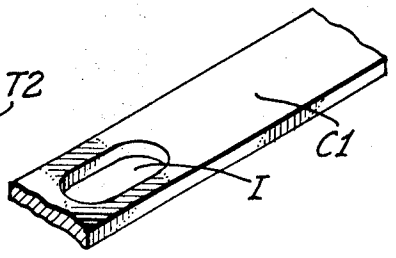


FIG. 3.

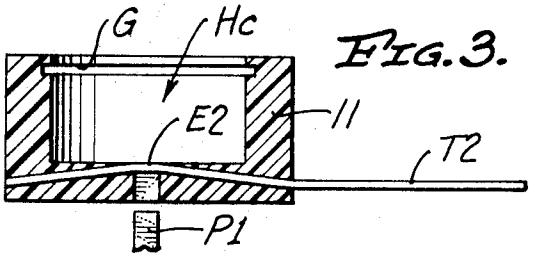


FIG. 4.

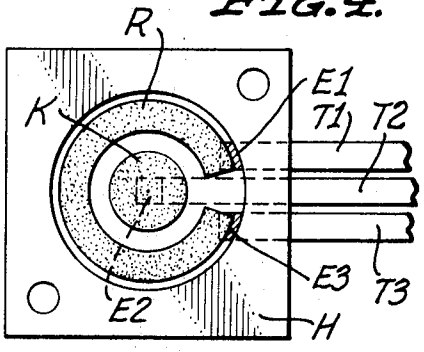


FIG. 5.

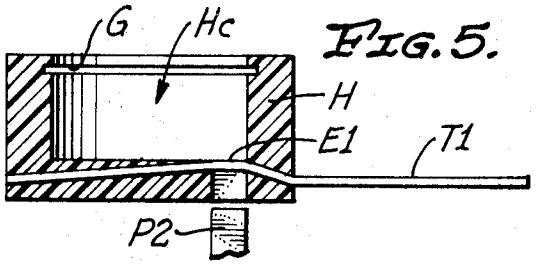


FIG. 7.

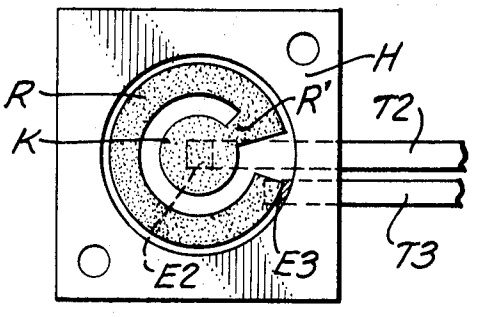


FIG. 6.

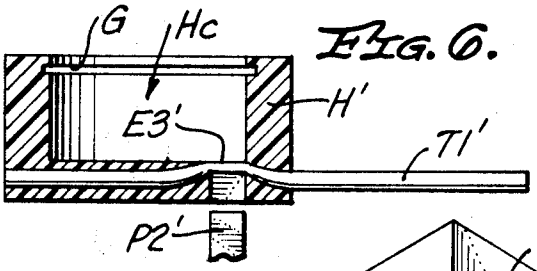
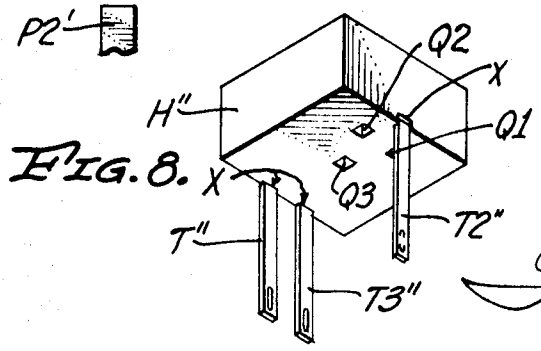


FIG. 8.



INVENTOR
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FIG. 9.

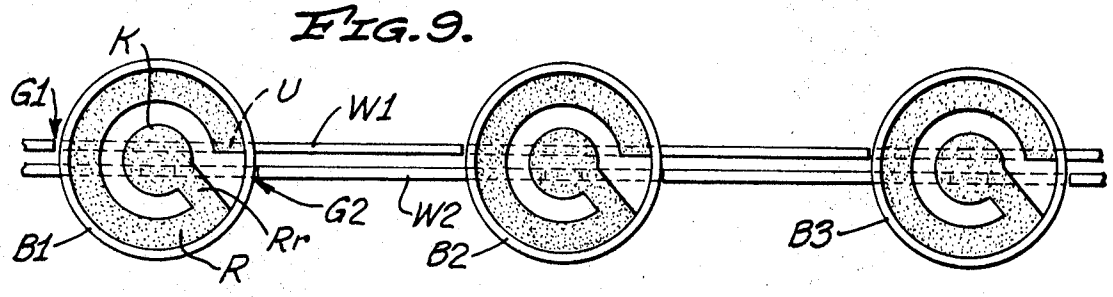


FIG. 10.

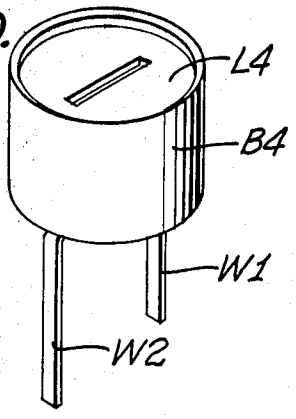


FIG. 11.

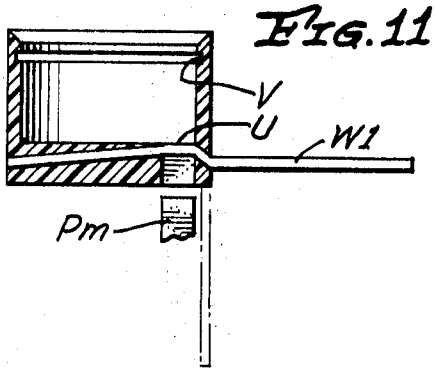


FIG. 12.

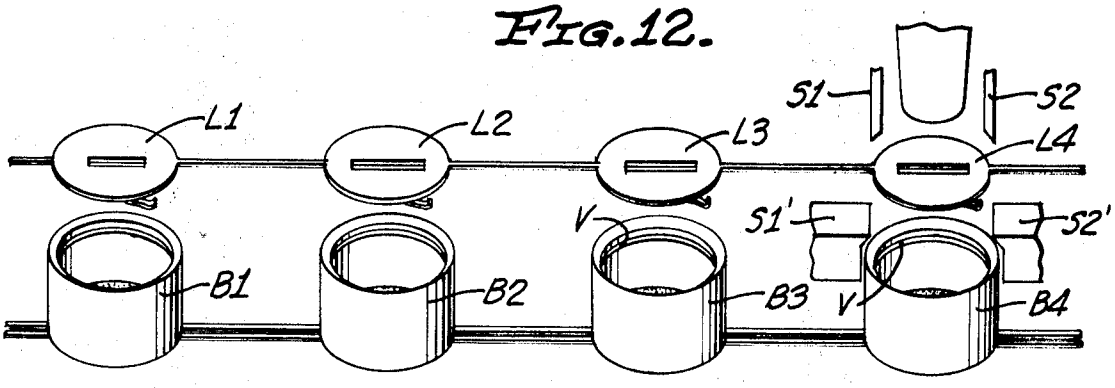
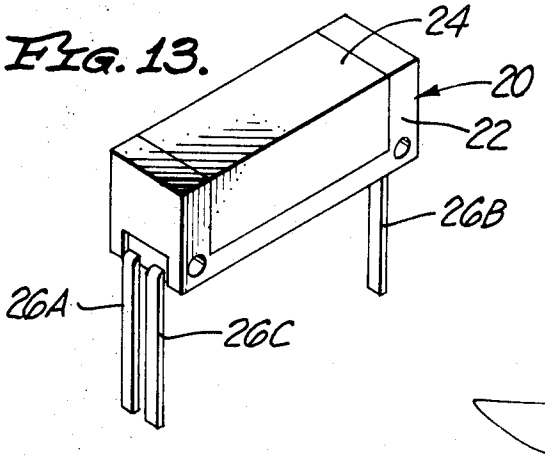


FIG. 13.



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FIG. 14.

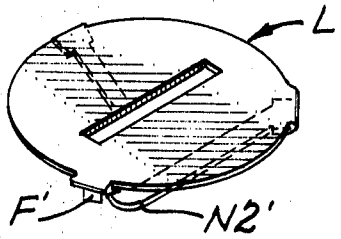


FIG. 15.

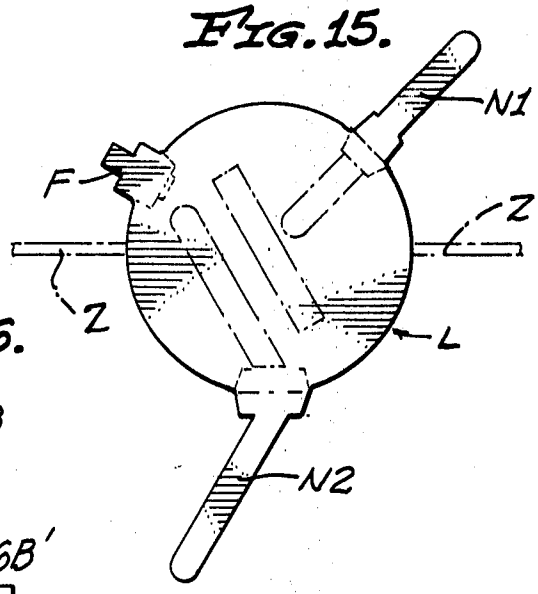


FIG. 16.

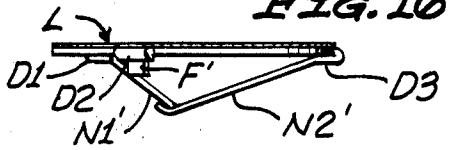


FIG. 17.

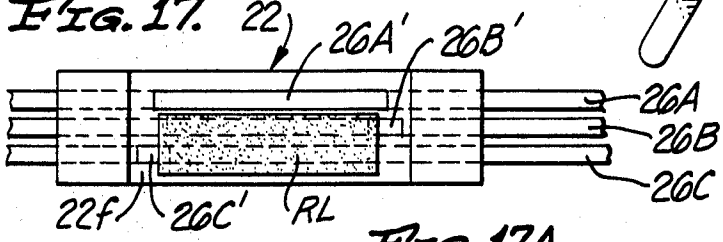


FIG. 17A.

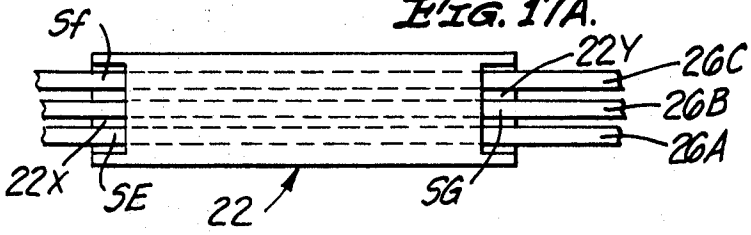


FIG. 18.

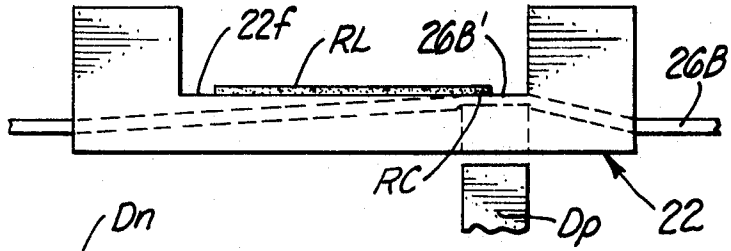
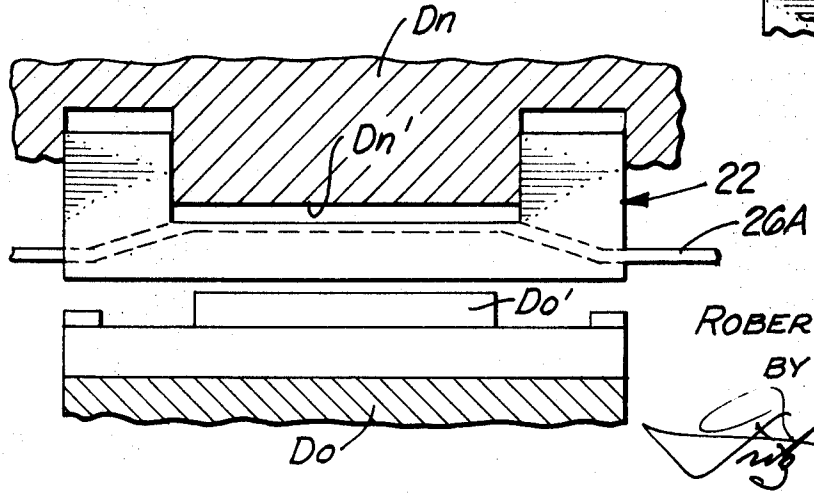


FIG. 19.



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ADUSTABLE RESISTORS AND METHOD

BRIEF SUMMARY OF THE INVENTION

Production of adjustable trimming resistors and potentiometers is presently encumbered by much manual assembly, which is not alone objectionable because of the cost of labor but also because manual operations are not rapidly performed (especially when components assembled are very small) and because the results of manual manipulations are generally not uniform. It is an object of this invention to reduce the number of manual operations in the production of variable trimming resistors such as potentiometers and to increase the extent to which manufacture of those devices can be accomplished by automatically acting machinery. Additionally, it is an object to provide variable resistor constructions or arrangements which facilitate accomplishment of the first-mentioned object, and to provide novel manufacturing processes and procedures which simplify and permit acceleration of manufacturing of such variable resistors and concurrently reduce cost of manufacture of those devices.

Principally and in large measure the objects are attained by arranging in parallel disposition a plurality of elongate conductors and while intermittently advancing the conductors through a molding station, embedding portions of the conductors in a mix or composition such as a thermoplastic or thermosetting polymer or the like while the composition is being molded into shape to form a part of the resistor housing, whereby a series of conductor-interconnected housing parts is produced which can readily be advanced, one unit per step, past other stations at each of which other resistor parts are added or installed, as by automatic means, until interconnected resistors are completed except for severance, and thereafter severing the conductors to form pin terminals. During the embedment of the conductors as the housing member is formed, selected operations are performed on appropriate portions of the conductors whereby the latter are positioned so as to be exposed at desired locations within the housing, to facilitate electrical connection to other conductive or resistive parts as the latter are added during the step-by-step assembling procedure.

DESCRIPTION OF THE DRAWINGS

The novel features of construction embodied in the invention, and the novel procedural steps, are illustrated in a preferred form and mode in the accompanying drawings. In the drawings:

FIG. **1** is a plan view, to no particular scale, of a group of three elongate conductors of indefinite length disposed in parallel array, with portions of each embedded in each of a series of spaced-apart potentiometer-housing bodies, each of the conductors being exposed at a selected location in each of the bodies, and certain details omitted to improve clarity of the illustration;

FIG. **2** is a somewhat enlarged view of a portion of the structure shown in FIG. **1**, illustrating one resistor-housing unit and the severing of interconnecting conductors;

FIG. **2A** is an enlarged view of a short length of one of the conductors shown in FIG. **2**, illustrating a preferred form of conductor or wire;

FIG. **3** is a sectional view through the resistor housing unit with embedded conductors shown at the right in FIG. **2**;

FIG. **4** is a plan view similar to FIG. **2**, showing a single housing unit with resistive and collector elements added during a later stage of construction;

FIG. **5** is a sectional view similar to FIG. **3**, illustrating placement of a conductor during molding of a housing member, whereby the conductor is exposed near the outer periphery of the cavity or recess formed in the housing member;

FIG. **6** is a view similar to FIG. **5**, but illustrating a conductor-forming action when conductors of round cross section are employed when round terminal pins are desired;

FIG. **7** is a view, in plan, illustrating a "circuit nominal" variable resistor employing principles of the invention;

FIG. **8** is a pictorial view of an exemplary potentiometer embodying concepts according to the invention, and showing structural features at the lower face of the potentiometer;

FIG. **9** is a view illustrating the mode of constructing a "circuit nominal" variable resistor similar in some respects to that shown in FIG. **7**;

FIG. **10** is a pictorial view of a complete "circuit nominal" variable resistor using a housing body produced by procedures illustrated in FIG. **9**;

FIG. **11** is a sectional view illustrating structural characteristics of, and procedures employed in forming, the variable resistor of FIG. **10**;

FIG. **12** is a pictorial view illustrating the step of bringing together two series of component assemblies each produced according to the invention, and indicating the mode of producing complete variable resistors;

FIG. **13** is a pictorial view showing an alternative mechanical form of variable resistor produced by utilizing novel procedures of the invention;

FIG. **14** is a pictorial view of a novel cover and contact device adapted for use in resistors of the type illustrated in FIGS. **9**, **10** and **11**;

FIG. **15** is a plan view of the device depicted in FIG. **14**, following severance from an integral series of like members and prior to formation or bending of contact limbs and a stop member;

FIG. **16** is a view in elevation illustrating the folding and bending effected in production of the device of FIG. **14**;

FIG. **17** is a plan view similar to FIG. **2** but illustrating the application of procedures of the invention to production of potentiometers having elongate housings as shown in FIG. **13**;

FIG. **17A** is a bottom view of the device depicted in plan in FIG. **17**;

FIG. **18** is a side view of the device sown in FIG. **17**; and

FIG. **19** is a drawing useful in explaining a procedure used in producing the device of FIG. **17**.

DESCRIPTION OF THE ILLUSTRATED METHODS AND DEVICES

Essentially, in practicing the present invention, a plurality of wirelike or ribbonlike conductors are moved at intervals through a region or zone at which there is molded about the conductors a body of insulation which is to become a part of the housing of a variable resistor such as a potentiometer. Thus, there is produced a series or "string" of such bodies held together by the conductors. The latter are by mold pins or the like brought to the surface inside the body, and extend outwardly through the body where they may be severed to free the body and bent or shaped to form terminals or contacts. Preferably the latter operations are performed subsequent to installation of other components of the resistor in the body. Thus, referring to FIG. **1**, conductors C1, C2 and C3 are passed from a source of supply through a diagrammatically illustrated molding machine M at which location potentiometer housing members H1, H2, etc., are formed on an about the conductors. The conductors, which in this case are flat wires, are preferably plated with a precious metal such as gold, and preferably perforated as indicated at I in FIG. **2A** to provide perforated tip terminals. The intermittent advance of the conductors, between successive molding operations, is controlled to provide lengths of exposed wire to form terminals of desired extent.

Thus, as indicated in FIG. **1**, the housing components H2, H3 and H4 have been molded with relatively short extents of conductors therebetween, for severance to provide short terminals; whereas components H5 and H7 have been formed at locations such that relatively long terminals will result when the interconnecting wires are severed. The wires are severed as indicated in FIG. **2**, closely adjacent a housing component, and other operations are performed as will hereinafter be

described. It is to be noted that the housing members or components H1, H2, etc., are only diagrammatically depicted in FIG. 1, principal details illustrated in others of the drawings.

FIGS. 2, 3 and 4, details of structure shown diagrammatically in FIG. 1, and the procedural steps followed in producing a subassembly of a potentiometer are illustrated. Therein a generally square potentiometer body H of boxlike configuration having a central cavity Hc is shown, with wires C1, C2 and C3 embedded therein. As shown in FIG. 2, wires C1 and C3 extend upwardly in the molding to the surface of the floor of the cavity at areas designated E1 and E3, and wire C2 similarly extends to the surface at area E2. Otherwise the wires are disposed within and encircled by the insulation of which the body H is formed. The method of bringing wire C2 to the surface of the floor in cavity Hc is illustrated in FIG. 3, wherein is shown the upper end P1 of a square molding pin which works in an aperture in the lower outer mold member which defines the lower exterior of body H. The wires extend through slots in the mold member, and when all members of the mold are brought into place the molding pins press respective wires against the face of the interior (male) mold member at the locations E1, E2 and E3. Pins such as P2 (FIG. 5) are similarly pressed into the space into which the thermoplastic molding material is injected, and press wires C1 and C3 against the face of the male mold member at locations E1 and E3, adjacent to the interior wall of housing member H.

As the wires are drawn step by step past stations, housings such as housing H are successively inspected, cleaned of flash, and subjected to cleaning abrasion at the areas E1, E2 and E3 that are exposed, have a conductor K of conductive paint or ink (FIG. 4) applied over and around location E2, and have a resistive element R applied in an arcuate form around the outer area of the cavity floor encircling the central conductor K and terminating at areas E1 and E3. At a subsequent station, the wires or conductors C1, C2 and C3 are clipped or severed at the outer face at one side of the body H, in a fashion illustrated in FIG. 2, leaving conductor ends at the opposite or second side to form terminals T1, T2 and T3. The exposed ends of the wires that are flush with the first side are insulated by applying adhesive insulative paint, and the small cavities left by the molding pins under locations E1, E2 and E3 are filled with plastic insulation, to complete formation of the lower part of the housing of a potentiometer.

Following completion of the housing body H including conductor and resistance element, rotary-contact means, contact-actuating means, and housing cover means are added. These latter means, per se old in the prior art and per se not the present invention and hence not herein illustrated, are added to complete construction of a potentiometer.

Utilizing a modified form of mold employing only two wire depressing pins, and using a modification of the process hereinbefore described, a circuit nominal resistor (FIG. 7) is constructed. Therein only two wires or conductors are employed, similar in all respects to wires C2 and C3 and similarly manipulated, whereby two terminals T2 and T3 are formed. That end of the resistance element R which would otherwise be left open (at area E1) is connected to the central conductor K by a second resistive coat or film, which forms an auxiliary element R', of selected value usually dependent upon the total resistance *TR* of the principal element R. Thus auxiliary element R' is serially connected between terminal T2 and principal element R.

In each of the forms of variable resistor devices described in the preceding description, a cover subassembly is mounted over the cavity or chamber Hc. The cover, which may be secured to the housing body H by adhesive, or may fit in the circular cavity and held therein by snap-acting or retainer-ring means operating in a groove G and similar to those later herein described, comprises a rotatable member carrying a contact device arranged to contact and brush on the central conductor K and the arcuate resistance element R. Thus the contact device forms an electrical connector to bridge conductor K with a selected area or point along resistance element R, in a known manner. One cover and rotating contact means of the type here usable is illustrated in U.S. Pat. No. 3,242,450; another is illustrated in U.S. Pat. Re. 25,510.

In FIG. 6 there is illustrated a modified form of arrangement wherein the housing H' has embedded therein conductors of round cross section, and wherein movable molding pins such as P2' of round cross section are employed to bring the round wires against the made mold member and in conjunction with the latter as an anvil, to flatten the round wire over an area, such as E3', to provide a more extensive area for easy termination of active components of the resistor.

In FIG. 8 is illustrated in a bottom pictorial view a preferred form and mode of arranging and shaping the terminal members when a "pin-mounted" resistor is desired. While therein flat wires have been used as illustrative, it will be evident that round wires, treated as described in the preceding paragraph, may be used. In the drawing, Q1, Q2 and Q3 represent the recesses formed in the bottom of the housing member H'' by the movable molding pins. Those recesses or holes are preferably filled with insulative self-curing resin or potting compound. Whereby the wires can be bent downwardly to form pin terminals that do not extend outwardly of the housing, the latter is molded with inwardly extending marginal notches as indicated at X. The notches thus provided accommodate the bends of the wires which when bent down as indicated form pin terminals T1'', T241 and T3''. As is evident, with the terminals thus arranged, severance of the body H'' from next-adjacent similar bodies is modified to the extent of severing the two outer conductors or wires adjacent the next-following housing unit and only the middle wire adjacent the preceding unit, rather than severing all three conductors adjacent the preceding unit as in FIG. 2.

In FIGS. 9 through 12 are illustrated a variable resistor and a mode of making the same, the housing being of circular plan form, and illustrating formation of the resistor cover utilizing principles of the invention. Therein a series of open-top cuplike resistor-housing bases including B1, B2 and B3 is produced with the bases spaced apart along a set of wires W1 and W2, the bases being molded about the wires in a manner explained in connection with FIGS. 1—5. The wires are brought to the interior surface of the floor during molding, as by movable molding pins such as P*m* (FIG. 11) during operations at a molding station. At further stations along a course of travel of the wires, a central conductor K and a terminal conductor at area U are applied, followed by a resistance element R. The latter includes a radial section R*r* which extends between conductor K and the principal arcuate resistance element R. Following the preceding operations, the series or "string" of interconnected bodies is moved into juxtaposition with an interconnected series of cover devices such as L1, L2, L3 and L4, as indicated in FIG. 12. At a selected station, the wire reaches extending from the cover device at that station are severed by cutters S1, S2 and S1', S2' at locations denoted G1 and G2 in FIG. 9, and concurrently the released cover device such as L4 (FIG. 12) is forced into position in an internal groove V (FIG. 11) formed in the upper inside wall of the housing body. The cover comprises contact means carried on its lower face. The contact means engages and brushes on the conductor K and element R in a known manner. The covers may be produced in any desired manner, such as by molding the cover body about a length of wire, and attaching a metal contact to the lower face of the cover in a fashion known per se in the art, or in a manner and by means illustrated in FIGS. 14—16 and latter herein described. Each cover is provided with a screwdriver slot as indicated, to facilitate rotation in the circular groove V.

In FIGS. 14, 15 and 16, there is illustrated a mode of producing a cover for use in a variable resistor of the type previously described and illustrated in FIG. 10. The latter resistor comprises a body B4, a cover L4, and terminals W1 and W2 formed by bending down the wires shown in FIG. 9. The cover is formed by a punching operation using a strip of sheet stock, the sheet being punched as indicated in FIG. 15,

leaving a thin wirelike strip Z extending between next-adjacent cover members, and further leaving protrusions N1, N2 and F. Prior to severance of the individual covers, the protrusions are bent and formed to provide three bearing surfaces D1, D2 and D3 (FIG. 16), a stop F', and first and second contact limbs N1' and N2' each terminating in a contact. The completed cover L, shown in FIG. 14, is produced by shearing off the interconnecting wirelike strips Z just before insertion of the cover into a resistor body.

In FIG. 13 is illustrated a rectangular potentiometer 20 which comprises a body 22, a cover 24, and terminals 26A, 26B and 26C. The cover is or may be conventional, of open-faced channel configuration and secured to the body 22 by, for example, adhesive. The working inner parts of the potentiometer, such as leadscrew, slider and contacts have been omitted in the interest of clarity and brevity, since they are or may be conventional and well known per se. The novel body part of the housing, and the mode of producing it, are illustrated in FIGS. 17, 17A, 18 and 19. Therein, a typical body 22 is formed by molding, as one of an indefinite number or series of like bodies formed on and about a plurality of wires 26A, 26B and 26C which are drawn from a supply and progressed past a plurality of stations including a molding station, in a fashion previously described in connection with FIG. 1. The wires are drawn along intermittently, and are initially arranged in substantially parallel disposition. At the molding station wire 26A, which is to serve as the collector bar in a leadscrew-adjusted potentiometer, is embedded in the end portions of the body, and brought to the interior surface at the floor 22*f* (FIG. 19) by male member D*o*' of lower molding die D*o*, which presses wire 26A against the lower face D*n*' of the upper die D*n* when the dies are closed. Thus a long section of wire 26A is exposed as indicated at 26A' in FIG. 17. The dies are shown slightly separated or opened, following injection and cooling of the thermoplastic molding compound, in FIG. 19.

Continuing with the description of the rectangular potentiometer of FIGS. 17—19, wires 26B and 26C are brought to the surface at respective ends of the floor 22*f* of body 22, as indicated at 26B' and 26C' in FIG. 17, by action of movable die pins such as that shown at D*p* in FIG. 18. The dies are so formed that each of the wires 26A, 26B and 26C extends out of the body 22 within the confines of a recess in the lower face of the body at each end thereof, as indicated at 22X and 22Y in the bottom view of FIG. 17A. Thus, the wires 26A and 26C may be severed closely adjacent their points of exit from the body at respective points SE and SF (FIG. 17A), and wire 26B severed at point SG, and bent down to form the terminals 26A, 26B and 26C (FIG. 13). Prior to severance and bending of the wires to form pin terminals, a resistance element RL (FIGS. 17 and 18) is applied on the floor 22*f* and over the exposed areas 26B' and 26C' of wires 26B and 26C, as indicated at RC in FIG. 18. Following production of the potentiometer body subassembly as described, the operating instrumentalities are added, and cover 24 applied; however, these latter steps and means are conventional and hence are not here further illustrated or described.

I claim:

1. An article of manufacture comprising:

a plurality of wires disposed in generally parallel spaced-apart relationship;

a plurality of variable resistor housing parts of molded insulation disposed in spaced-apart relationship along and molded about said wires;

each of said housing parts having an interior floor;

each of said wires extending through portions of said housing parts and having a surface area thereof exposed at the floor of each of said housing parts, and each of said wires arranged and adapted to be severed to provide a respective terminal for each of said variable resistor housing parts;

whereby said wires and molded housing parts may be intermittently drawn through operation stations in a step-by-step movement for performance of manufacturing operations thereon, to reduce the expense of manufacturing variable resistors.

2. An article of manufacture as defined in claim 1, in which said housing parts are of circular cuplike conformation and in which each of the said housing parts bears a resistance element connected between the said exposed surface areas of two of said wires.

3. An article of manufacture as defined in claim 2, including a variable resistor cover member for each of said housing parts.

4. An article of manufacture as defined in claim 1, each of said housing parts being of elongate rectangular configuration and said wires arranged generally lengthwise of said housing parts.

5. An article of manufacture as defined in claim 4, in which each of said housing parts has an elongate floor, and in which a first of said wires is exposed at one end of said floor and a second one of said wires is exposed at the other end of said floor, and in which each of a number of said housing parts bears an elongate resistance element on said floor connected at respective ends with said first and second wires where the latter are exposed at said floor.

6. A method of manufacturing a series of variable resistors, comprising the steps of:

arranging a plurality of wires in spaced-apart generally parallel disposition;

intermittently advancing the wires past a plurality of stations;

at one of the stations, molding a variable resistor housing part about a reach of said wires to embed the wires in said part, and during the molding operation forcing a portion of at least one of the wires to lie and become exposed at a surface of the housing part, whereby to form an interconnected series of spaced-apart resistor housing parts spaced along said wires;

at another of the stations, applying a resistive element to a portion of the said housing part between exposed portions of two of the wires as each part is at the latter station, whereby to provide each of the housing parts with a resistance element while the housing parts are interconnected each to others to avoid individual manual handling of the housing parts; and

at another of the stations, severing the wires extending between the housing parts, to provide electric terminals which are firmly secured to the housing parts.

7. A method according to claim 6, including the intermediate step of applying, at an intermediate station, adherent conductive material to areas of the housing parts adjacent exposed portions of said wires, whereby to improve electrical connections to the exposed wires.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,574,929 Dated April 13, 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 2, line 37, "sown" should read --shown--. Column 2, line 61, "an" should read -- and --. Column 3, line 3, insert --being-- after "details". Column 3, line 4, insert --In-- before "FIGS." Column 3, line 23, "5" should read --3--. Column 4, line 8 "made" should read --male--. Column 4, line 14, "pin mounted" should read --"pin" mounted--. Column 4, line 27, "T241" should read --T2--. Column 4, line 55, "FIG. 9" should read --FIG. 10--. Column 4, line 66, "latter" should read --later--.

Signed and sealed this 22nd day of August 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents