United States Patent [19]

Dieterich

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[45] **May 15, 1973**

[54] **POTENTIOMETER CONTACT SPRINGS**

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[21] Appl. No.: **146,360**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 728,683, May 13, 1968, Pat. No. 3,579,822.

[52] **U.S. Cl.** .... **338/202,** 29/193.5, 29/630 E

[51] **Int. Cl.** **H01c 1/12**

[58] **Field of Search** .... 338/202, 171, 174, 338/162, 183, 176; 29/193.5, 193, 630 E; 310/248, 251; 200/168 BH

[56] **References Cited**

UNITED STATES PATENTS

2,760,036	8/1956	Raymer	338/202 X
3,328,707	6/1967	Louis et al.	338/202

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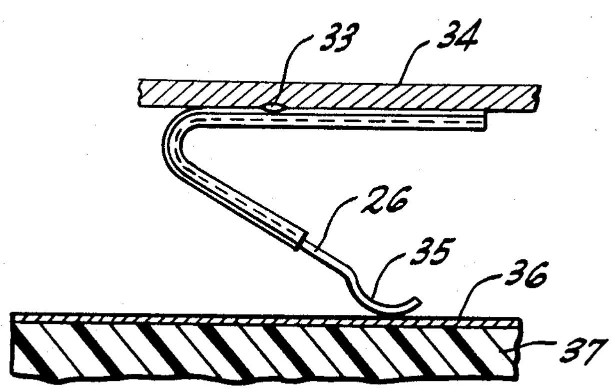
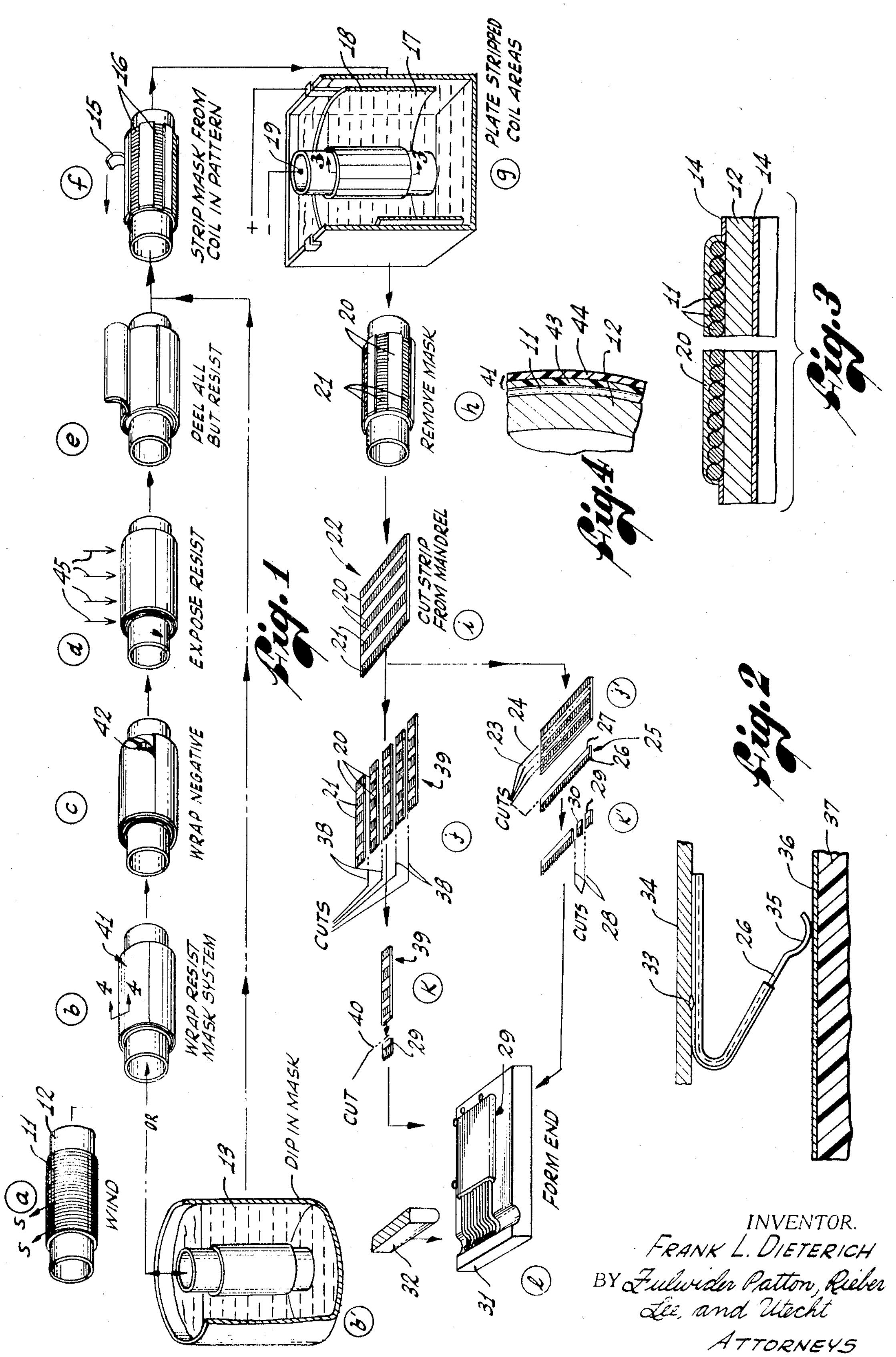
[57] **ABSTRACT**

A method of manufacturing miniature potentiometer contact springs by winding a substantial length coil of a single layer of fine, heat-treatable precious metal alloy wire on a generally cylindrical form, masking spaced strips longitudinally of the wire coil, plating the wire coil between the masked strips, removing the strips and cutting the strip-plated wire band from the mandrel as a sheet, cutting the wire sheet to produce contact strip blanks of various forms severable into individual contacts. A multi-layer masking system is used to photographically define the spaced strips. An adherent support about the wire coil permits the coil to be removed before masking and processed in sheet form.

Contact springs using wire of a reduced lateral diameter are produced by flattening the wire prior to winding on the form.

17 Claims, 14 Drawing Figures





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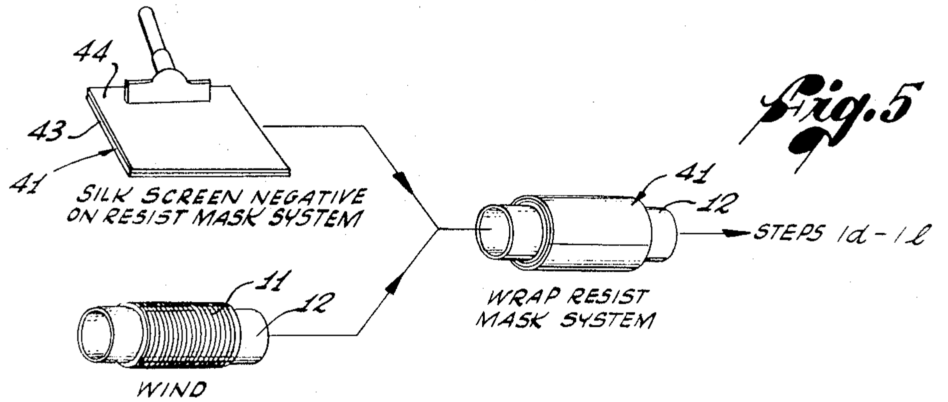

Fig. 5

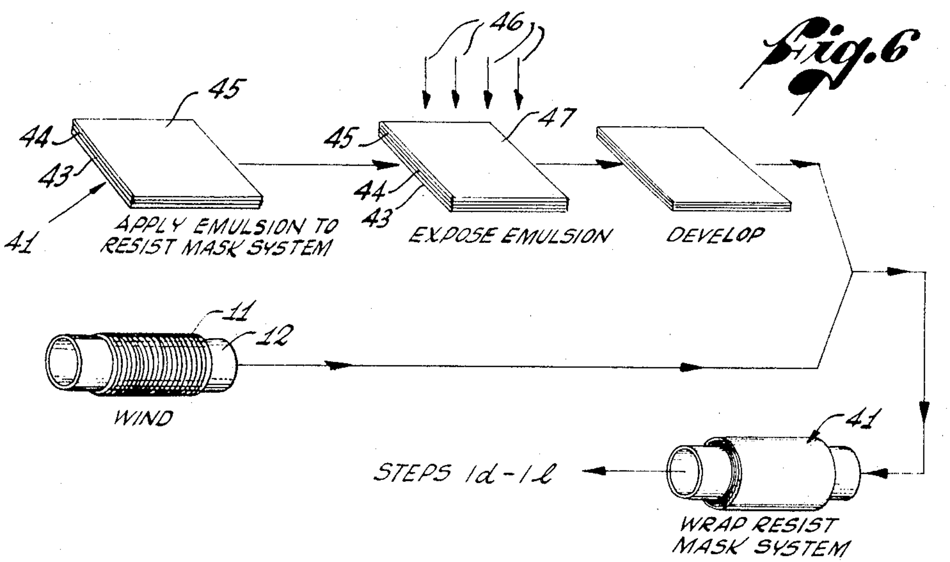

Fig. 6

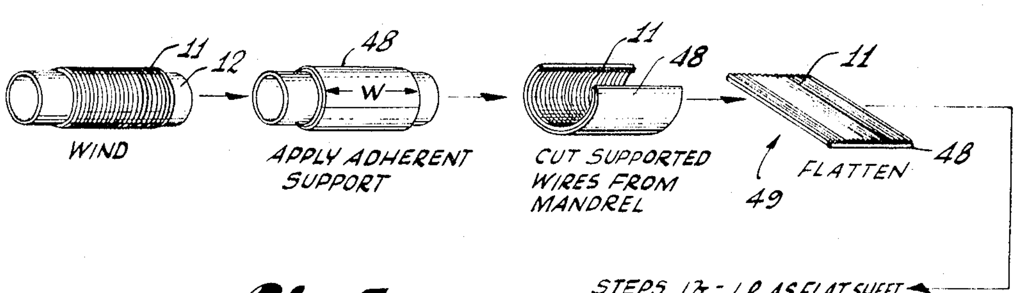

Fig. 7

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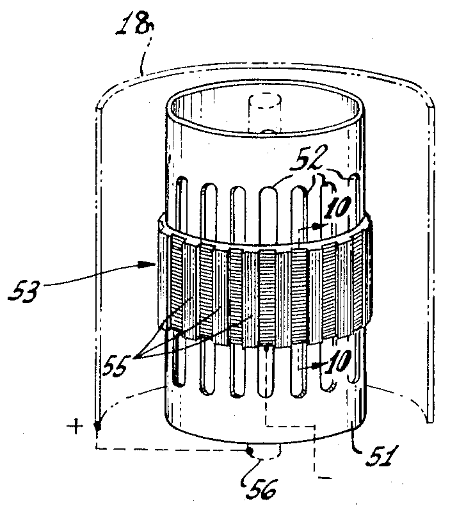

Fig. 8

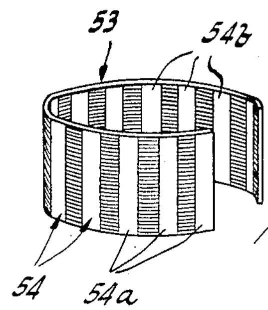

Fig. 9

Fig. 10

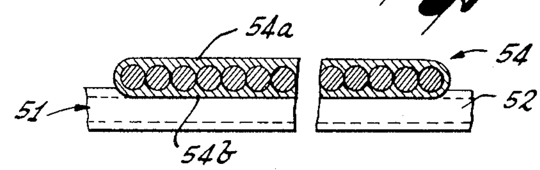

Fig. 11

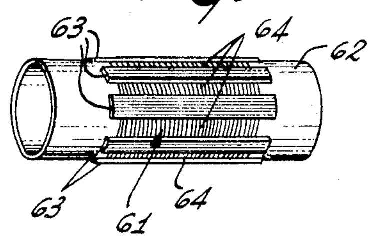

Fig. 12

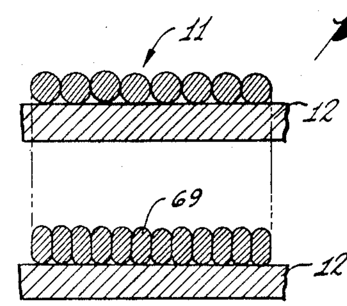

Fig. 13

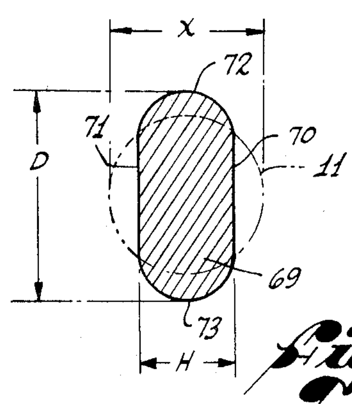

Fig. 14

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POTENTIOMETER CONTACT SPRINGS

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a Continuation-In-Part of U.S. Ser. No. 728,683, filed May 13, 1968 now U.S. Pat. No. 3,579,822, and entitled "METHOD AND BLANK FOR MAKING POTENTIOMETER CONTACT SPRINGS."

BACKGROUND OF THE INVENTION

1. This invention is directed to multiple contact point contact springs for miniature potentiometers in which contact fingers engage a resistance surface under pressure and are slidably movable therealong to effect electrical contact therewith at the points of contact finger engagement and to methods for making such contact springs.

2. Potentiometer contact springs have long been made from thin sheets or strips of heat-treatable metal alloy, with the contact slotted or slit to provide a plurality of fingers to ensure full contact and engagement with the resistance surface. In miniature potentiometers, the contact becomes very small and it is difficult to slit it into the small finger width and also to provide the slot widths without increasing the overall width of the contact. Punching of the slits in a die has become impractical because of the narrowness of the slits and fingers and the very short life of dies which will produce such narrow slits and contact fingers. Narrow slits can be produced with electron beam cutting but this requires an extremely costly machine which must be operated in a vacuum and involves other production difficulties.

It has, therefore, been proposed to produce multi-finger contact springs of small size by using small round or rectangular wires which are placed parallel to each other and joined together at one end, with their free ends forming the multiple contact fingers. Such multiple wire contacts are shown in the U.S. Pat. to Raymer No. 2,760,036 and Louis et al. No. 3,328,707.

The method employed by Raymer is described in his specification in columns **8** and **9** under the central heading "C. Manufacture of wiper brush." Raymer winds his wire upon a carbon rod and plates the entire wire coil with copper. He then removes the plated band from the rod and coats the portion of the plating which is to remain intact with an acid-resisting material and then removes the copper from the remainder of the wire by nitric acid. Thereafter the contacting end is formed and the contact mounted. The Raymer process is subject to several disadvantages including the limiting of his contact wires to platinum because of the acid treatment, the fact that he can plate on only one side of the wire coil, and must plate the entire circumference of the coil. His method is considerably more complex, expensive and time-consuming than that of the present invention.

In the Louis et al. patent, the contact wire springs are handled individually and are individually mounted in clips or clamps in which they are welded and soldered. In view of the small size of the individual wiper wires, such manipulation is extremely difficult and time-consuming and is not suited to high production output.

In addition to the above, potentiometer contact springs in general suffer from noise problems. In this regard, it is known that increasing the number of wire contact fingers decreases the amount of noise and improves the contact spring efficiency. Typically, this is accomplished by using a smaller diameter finger, so that the number of contact points is increased without increasing the lateral width of the contact spring. However, lesser diameter fingers present their own inherent problems.

First, it has been shown that the pressure per finger should be approximately in the range of 3 to 7 grams, preferably about 5 grams. Greater pressure could tend to excessively abrade the contact point, while lesser pressure could tend to introduce noise. As the finger diameter is decreased, the finger stiffness correspondingly decreases until the finger can no longer provide the desired contact pressure. While the length of the wire finger could be reduced to provide greater stiffness, this length is typically itself only about 0.05 inches and reducing it would decrease the finger flexibility and present very critical manufacturing tolerances and increased costs. Moreover, it becomes more difficult and costly to draw wire smaller than a given diameter of about 0.002 inches, so that use of such extremely fine wire, even if feasible, becomes unduly expensive.

SUMMARY OF THE INVENTION

In its broad aspect the present invention provides methods of economically forming high-quality spring contacts in large quantities without the drawbacks of the prior art. To this end the contacts are formed by winding a coil layer of wire on a form, masking the coil to provide circumferentially spaced, longitudinal coil strips which receive conductive metal deposits. The coil is cut longitudinally and removed from the form as a sheet which is processed as contact strip blanks of end-to-end or side-by-side connected spring contacts from which individual contacts are severable.

In another aspect of the invention, the masking may be by photographic techniques to provide highly accurate delineation of the spaced strips. A photosensitive resist masking system is applied to the coil, exposed through a negative of the desired strip pattern, and developed to from the strips.

In one modification, the process of the invention includes applying an adherent support to the coil and then removing the coil from the form as a sheet of wire fingers held together by the support. Subsequent processing, including the masking and metal strip deposition, can be accomplished on this flat sheet with the support being removed at a point subsequent to the metal deposition.

More specifically, in preferred embodiments according to the present invention, the contact spring is made from a heat-treatable metal alloy wire which is plated adjacent its attachment end, leaving free multiple wire fingers which are to make contact with the potentiometer resistance surface. The wire is wound on a mandrel and is masked so that the plating metal, such as silver, copper, or nickel, will be deposited in spaced strips running longitudinally of the wire coil on the outside of the coil.

The mask may be a photosensitive resist wrapped around the coil as a multi-layer system having a resist layer and a protective layer therefor. The strip pattern negative is wrapped and fastened, as by adhesive, around the resist system or, alternatively, is produced directly adherent to the protective layer as a silk-screened image or a developed photosensitive emulsion layer, the emulsion having been exposed by light to which the resist is insensitive.

The coil is removed from the mandrel in the form of a sheet which is then cut transversely of the wires at the center portions of both the plated and unplated strips, resulting in long contact strip blanks of short wires bonded at one end and free at the other, or is cut parallel to the wires to form blanks of severable end-to-end connected contacts. The free ends of the wires may then (or after individual contacts are cut off) be formed to radiused points of contact and heat-treated in conventional manner at a temperature and for a time to develop hardness, wear resistance and spring characteristics. The sheet or contact blanks may form articles of commerce with the customer slicing the strip into the individual contacts or performing any other required processing. In any case, the individual contacts are formed at their plated portions, if desired, and assembled to a support. The mask may remain on and provide protection for the delicate wires, at least until the wires are formed or heat-treated.

To process the coil in sheet form, including the steps of masking and metal deposition, the adherent support is applied around the coil exterior in the form of, for example, an adherent lacquer or piece of adhesive tape, the lacquer or tape tightly securing the wire fingers. The wire surfaces formerly interior of the coil are exposed in sheet form for subsequent processing.

The metal strip deposition can be performed on both sides of the coil by wrapping the coil about a slotted tube, the deposition to the inside coil surface being through the tube slots, the tube thereby functioning as a mask.

In another aspect of the invention, the wire fingers of a contact spring have a reduced diameter in the direction of the lateral contact width. In this embodiment, the wire may be flattened, for example, between rollers, prior to being wound on the form. This operation produces a barrel-shaped wire with relatively flat opposing sides along the wire length, the barrel height connecting the flat sides being reduced from the original wire diameter, while the barrel diameter is increased. With this structure the number of fingers for a given width contact spring is greater, providing more contact points, while the wide barrel diameter, in the direction of the wire finger flexure, stiffens the fingers to maintain proper contact pressure on the resistance surface.

The above invention lends itself to high production automation procedures and is superior in economy and in the performance of the contact spring product. It does not require handling of parts smaller than the finished contact and enables the accurate definition and production of contacts of any desired size in a standard contact strip.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a progressive, perspective view showing the steps in the process of forming potentiometer contact springs according to the present invention;

FIG. **2** is a view partly in section and partly in side elevation showing the contact mounted in a potentiometer in engagement with a resistance surface;

FIG. **3** is a partial longitudinal sectional view on the line **3—3** of FIG. **1** showing plating deposited on the outside of the wire coil while wrapped on a mandrel;

FIG. **4** is a partial cross-sectional view on the line **4—4** in FIG. **1** showing wire wound on a mandrel and covered by a multi-layer masking system;

FIG. **5** is a progressive, perspective view showing application of an adherent negative image to the multi-layer masking system;

FIG. **6** is a progressive, perspective view showing another technique for applying an adherent image to the masking system;

FIG. **7** is a progressive, perspective view showing a modification of the process of FIG. **1** for processing the wire coil in sheet form;

FIG. **8** is a perspective view showing a slotted tube used in plating on both sides of the wire coil;

FIG. **9** is a perspective view of the wire band obtained by the plating method of FIG. **8**;

FIG. **10** is a partial longitudinal sectional view on the line **10—10** of FIG. **8**;

FIG. **11** is a perspective view of a modified tube mandrel, wire coil and masking prior to plating;

FIG. **12** is a partial longitudinal sectional view on the line S—S of FIG. **1** showing several turns of the wire coil wrapped on a mandrel;

FIG. **13** is a partial longitudinal sectional view similar to FIG. **12** showing several turns of barrel-shaped wire wrapped on the mandrel; and

FIG. **14** is a cross-sectional view through a barrel-shaped wire formed by flattening round wire and shows in dotted outline the original size of the round wire.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in the drawings, for purposes of illustration, and in particular FIGS. **1**, **2**, and **3** thereof, the present invention is embodied in a process of forming contact springs for miniature potentiometers using a wire coil **11** wound on a tube mandrel **12** as shown in FIG. **1***a*, the coil being processed in the steps depicted in the figures to form contact springs having a plurality of wire fingers.

The coil **11** of bare wire is wound spirally in immediate turn by turn contact upon the tube **12**, the tube being of conductive material such as stainless steel. The wire may be of any desired size and composition, an example being a heat-treatable alloy of about 32 percent palladium, 27 percent silver, 17 percent copper, 14 percent platinum, 9 percent gold, remainder zinc, this alloy commercially available under the name PALINEY from the J. M. Ney Company of Bloomfield, Conn. While the size of the wire will depend upon the performance and physical requirements of the finished contact, a typical example in a miniaturized potentiometer would be wire of a diameter in the range of 0.002 – 0.005 inches; however, wire of a diameter greater or less than this range may be processed according to the present invention, if desired.

A first process according to the invention is depicted in step sequence of FIGS. **1***a*, **1***b'*, and **1***f* through **1***l*. There the wire wound tube **12** is dipped in a non-conducting rubber or plastic base platers' masking solution **13**, shown in FIG. **1***b'*, to completely cover the tube and wire and the resulting mask **14** is thoroughly dried and, thereafter, strips **15** removed longitudinally of the coil to leave circumferentially spaced bare strips **16** on the wire coil, as shown at FIG. **1***f*, on which conductive metal plating will be deposited.

The resulting strip, coil and mandrel are placed in an electroplating bath **17** surrounded by a cylindrical anode **18** of silver which is connected to the positive terminal of a direct current voltage source. The negative terminal of the direct current source is connected at **19** through the mask directly to the tube **12** so that contact is made through the tube to the wire coil **11.** Silver is then deposited on the wire coil in strips **20** to any desired thickness, for example, 0.002 – 0.005 inch, as shown in FIG. **3.** Alternatively, the deposition may be by electroless plating or other suitable metal deposition techniques. In addition, while silver has been utilized for the strips **20,** copper or nickel are also satisfactory materials.

The plated wire coil and the tube mandrel are then removed from the bath **17** and the mask removed (FIG. **1***h*) by mechanical or chemical peeling, leaving non-plated coil strips **21.** However, the mask need not be removed at this point, and in many cases it is desirable to leave the mask on to protect the delicate wire coil fingers during subsequent processing, handling, and shipping. In any event, the wire coil is then cut longitudinally, for example in the middle of a strip **21,** and is removed from the mandrel and straightened to form a sheet **22** having spaced strips of silver plating **20** with strips **21** of unbonded wire therebetween. The band or sheet **22** is then sheared into strips by cuts **23,** preferably through the middle of the unbonded strips **21,** and cuts **24** through the middle of the plated strips **20** as shown in FIG. **1***j'*. This results in a plurality of individual contact strip blanks **25** having free unbonded wires **26** at one edge and bonding plating **27** at the other edge. The cuts **23** and **24** need not necessarily be made through the middle of respective strips **21** and **20**; however, this is less difficult than, for example, cutting a line at the intersection of a strip **21** and the adjacent strip **20.**

At this point alternate procedures may be followed in which either the strip blank **25** is formed and heat-treated while intact to produce an article of commerce where the customer will slice the blank at lines **28** into individual contact widths or the strip blanks are immediately cut along lines **28** to form individual contacts **29** and **30** of any desired width and the forming of the free ends of the wires **27** and their heat-treatment performed on the individual contacts. For either case, the forming of the wire fingers into radius points of contact is indicated in the dies **31** and **32,** which operation should be done before heat-treating the contact fingers in conventional manner at a temperature and for a time to develop hardness, wear resistance and spring characteristics. Any forming of the plated portion of the contact may be done after heat-treating, if desired, because the silver prevents any spring back from changing the set of the form. The finished contact may be spot welded at **33** to a support **34** as shown in FIG. **2** where the contact wires **26** have radius ends **35** contacting a potentiometer resistance surface **36** on a ceramic substrate **37.** The spring fingers **26** engage the surface **36** under pressure and are slidable thereacross by the support **34** in conventional manner.

Instead of forming a forminga strip blank **25** by cuts **23** and **24** perpendicular to the wire fingers as in FIG. **1***j'*, the sheet **22** may be cut along lines **38** parallel to the wire fingers, as in FIG. **1***j*, to form strip blanks **39** comprising end-to-end connected spring contacts **29** which may be severed therefrom by a cut **40** in step **1K** and thereafter formed and heat-treated as previously described. The cuts **38** may be spaced any desired amount with the strip blank **39** having a lateral width greater than a single contact **29,** if desired, in which case the cut **40** would produce a strip blank similar to blank **25** requiring a cut **28** to sever an individual contact **29** therefrom.

Because of the minute sizes of the contact springs, it is important that the bare strips **16** along the coil **11** and the metal strips **20** deposited thereon be equally, circumferentially-spaced and in absolute longitudinal parallelism. To this end, a modified process according to the invention is shown in steps *b–e* in FIG. **1** in which photographic masking is utilized to define the longitudinal strips.

After winding the coil **11** on the tube **12** in step **1-***a*, a photosensitive resist is applied around the exposed circumference of the coil at **1-***b*. While the resist may be applied wet by spraying or dipping, in a preferred form it is applied by wrapping a dry, multi-layer masking resist system **41** around the coil. Thereafter, a negative **42** is wrapped around the resist system at **1-***c*. After exposing the resist through the negative at **1-***d*, all layers, including negative **42,** radially outward of the resist are removed at **1-***e*, and the resist is chemically developed at **1-***f* to remove the strips **15.**

One satisfactory resist system, sold under the Trademark RISTON, comprises a photosensitive resist layer **43** sandwiched between a 1 mil, transparent polyethylene cover sheet and a 1 mil, transparent polyester protective layer **44,** the layer **44** being specifically of the polyester sold under the Trademark MYLAR. The cover sheet is removed and discarded and the dual-layer of resist **43** and protective MYLAR **44** is wrapped around the coil **11** as shown in FIG. **4,** the tube **12** having been previously heated to about 220°–250°F. At this temperature, the resist becomes tacky and is pressed into the grooves between the wires and is adherent to the wires.

The photographic negative **42,** with the longitudinal strip pattern image formed thereon, is then rolled onto the protective layer **44** after the application of a thin, transparent adhesive coating to the layer **44** which serves to secure the negative in close, adherent contact to the protective layer. The tube **12** is then rotated before a collimated light source **45** of 3,500A. to expose the resist **43** through the negative. Thereafter, the protective layer is peeled away as shown in step **1-***e* carrying the negative with it, and the resist is developed in a bath of trichloroethane which dissolves the unexposed resist strips **15** leaving the coil bare in strips **16** for previously described plating step **1-***g*. Prior to plating, a suitable non-conductive mask **14** (FIG. **3**) is applied to the tube areas not covered by the coil **11** to prevent metal deposition thereon.

In an alternative process of the invention, the necessity of wrapping the negative **42** around the protective layer **44** is eliminated by depositing the negative image directly on the protective layer prior to wrapping the resist system **41** around the coil **11.** As shown diagramatically in FIG. **5,** the resist system **41** is laid flat and the negative image is silk-screened directly on the protective layer **44** using conventional screening inks and techniques. The negative is adherent to and, thus, is in the closest possible contact with the protective layer, and as a result, the image definition is controlled entirely by the sharpness of the silk-screening. After applying the resist system with the adherent negative image to the coil, the process of steps **1**-*d* through **1**-*l* is carried out.

The resist system can be made entirely photographic by applying a photosenstive emulsion **45** to the protective layer **44** as shown in FIG. **6.** The emulsion is exposed with collimated light **46** through a negative **47** of the desired longitudinal strip pattern and then developed, so that the protective layer has the pattern image adherent thereto. After wrapping the resist system and adherent negative image around the coil **11**, the coil is processed according to steps **1**-*d* through **1**-*e*. The resist **43** should be insensitive to light of the wavelength used to expose the emulsion **45.**

According to another aspect of the invention, shown in FIG. **7**, the coil **11** may be removed from the tube **11** as a sheet prior to masking steps **1**-*b* or **1**-*b'* and processed thereafter in sheet form. After winding the coil on the tube, an adherent support **48** is applied to the coil circumference. The support may be an adherent lacquer sprayed on the coil and allowed to dry. In another form, the support may be a piece of adhesive, plastic tape wrapped around the coil. The tape should have a width "*w*" spanning all turns of the coil **11.** The support **48** and coil are then slit longitudinally, and the coil is flattened in sheet form. The support holds the wire fingers together, and the finger surfaces originally interior of the coil flush against the tube are thus exposed in planar fashion. This sheet **49** of wire fingers is then processed as in FIGS. **1** through **6**, beginning with masking step **1**-*b* or **1**-*b'*, the only difference being that the sheet is flat, not cylindrical, and thus easier to handle. To ensure electrical connection to all wire fingers in the plating operation **1**-*g* in the absence of tube **12**, a suitable shorting contact or clip should be applied spanning and contacting all fingers. The adherent support **48** can be stripped from the sheet at any point after the plating operation, since the metal strips **20** then provide adequate support to the fingers. The support **48** should withstand the chemicals or other materials used in the masking and plating operations, so that the support afforded the wire fingers is not impaired.

A modified process which plates the wire coil and contacts on both sides is illustrated in FIGS. **8–10.** Here a cylindrical mandrel **51** is provided with a plurality of longitudinally extending, circumferentially spaced slots **52** therethrough and the mandrel **51**, which may again be of stainless steel, is dipped in the masking solution **13** and dried prior to the winding of a wire coil **53** thereon. The width of the slots **52** after masking is the desired width of the plated bands **54** on the wire coil (FIG. **9**). The wire coil **53** is then wound around the cylindrical mandrel **51** and the masking solution is painted on the wire coil to cover only the area of the bridges of the slotted cylinder as at **55.**

The masked coil and mandrel are then placed in a plating bath, as at **17**, with an outer cylindrical anode, the same as **18** in the description of the FIG. **1** illustrated process, and also with an axial silver rod anode **56**, the anodes **18** and **56** being connected together to the positive side of a direct current voltage source and the wire coil **53** itself being connected directly to the negative side of the direct current source. Plating then occurs on the outside of the wire coil between the masking strips **55** and on the inside of the masked coil through the slots **52** to provide plating, as shown in FIGS. **9** and **10**, at **54***a* on the outside and at **54***b* on the inside of the wire coil. The platings **54***a* and **54***b* are each of the order of 0.001 – 0.002 inches of silver.

After plating, the mask on the wire coil is peeled off and the coil cut through the middle of an unplated wire strip and removed from the cylindrical mandrel, as shown in FIG. **9,** whereupon the band is developed into a sheet as indicated at **22** in FIG. **1** and the remaining operations carried out as described in the process illustrated in FIG. **1.** The mask is desired beneath the wire coil **53** with the slotted mandrel **51** to provide a resilient surface on which the wire is wound to prevent creeping of the plating up the wire from the slot area.

A further modification of the process is illustrated in FIG. **11** wherein a wire coil **61** is wound on a nonconducting tube mandrel **62,** of glass or the like, and is masked by means of strips **63** of platers' masking tape which are adhered to the outside surface of the coil in longitudinally extending strips circumferentially spaced to provide bare wire strips **64** therebetween to which the plating is applied in a plating bath as illustrated in FIG. **1.** In this arrangement, the overall masking step is avoided as is the stripping of the mask from the coil where plating is desired. The coil itself will be connected to the negative terminal of the d.c. voltage source and anode **18** to the positive side as in the plating bath **17.** After plating, the masking tape strips **63** are readily peeled off and the band cut from the mandrel and developed into the sheet **22** and processed as previously described.

The previous embodiments utilized conventional wire of round cross-section. This is depicted in FIG. **12** where several turns of wire coil **11** are shown in a cross-sectional view through the coil **11** and the tube **12** on which the coil is wound.

Referring to FIGS. **13–14**, another embodiment of the invention is shown in which contact springs are produced with wire having a reduced diameter portion. Prior to winding the wire of coil **11** on tube **12**, the wire is flattened, resulting in a wire cross-section **69** of barrel-shape having opposing flat surfaces between which the barrel height "H" is measured and opposing arcuate surfaces, at 180° to the flats, spaced apart by the barrel diameter "D." This may be accomplished by passing the wire between two rollers (not shown) which flatten the wire on opposing sides. As shown in FIG. **14,** the flattening of originally round wire **11** of original diameter "X" produces relatively flat, opposing wire surfaces **70** and **71** spaced apart by the height "H." In addition, the wire has top and bottom arcuate circumferential surfaces **72** and **73**, respectively, spaced apart by the diameter "D" and connecting the surfaces **70** and **71.**

The barrel-shaped wire is wound on the form **12** as shown in FIGS. **13** with the flat surfaces **70** and **71** of each wire turn in lateral, side-by-side relation and with the bottom arcuate surface **73** in wrapped contact with the tube. Since the height "H" of each wire turn is less than the original diameter of the wire **11**, it is evident that for a given longitudinal distance along the tube **12,** more wire turns are produced using the barrel-shaped wire than the original round wire. For example, FIG. **12** shows eight turns of round wire **11**, while FIG. **13** shows 12 turns of barrel-shaped wire **69** in the same space along the tube **12.** As a result, a contact spring made from the coil of FIG. **13** has more contact points then would a coil of FIG. **12** of the same lateral width. In addition, it is significant that the flattening process does not destroy the arcuate circumference at the contact spring contact point. Thus, either surface **72** or **73** presents a desirable small area of contact when formed into an electrical contact point for an individual contact spring.

The winding may be accomplished by positioning the two rollers vertically, close to the tube **12,** so that the wire is oriented properly when received by the tube. In addition, a finger (not shown) may bear against each wire turn when received by the tube to press it securely against the preceding turn.

Contact springs are made with barrel-shaped wire using the previously described processes of FIGS. **1–11,** the only difference in the processing being the shape of the wire.

In addition to providing more wire fingers for a given width contact spring, the barrel-shaped wire of height "H" is inherently stiffer than a round wire with a diameter equal to the height "H." This is evident since the barrel wire diameter "D" is greater than the round wire diameter, and the barrel wire thus is wider in the direction of flexure of the wire finger to maintain proper contact pressure on a resistance surface.

In one example, 0.003 inch diameter round wire of the "PALINEY" alloy previously mentioned was rolled to produce a barrel-shaped wire having a height "H" of 0.002 inches and a diameter "D" of 0.0041 inches. The flattening also elongated the wire about 3 percent. The relative values of "D" and "H" will depend, of course, on the type of wire used. A spring contact with this 0.002 inch height barrel-shaped wire would have the same number of fingers as an identical width contact of 0.002 inch diameter round wire; however, the barrel wire is stiffer because of its increased diameter "D" of 0.0041 inches.

The barrel-shaped wire can be produced having a height less than 0.002 inches, if desired. In this form, it can be used as extremely minute contact spring fingers of height "H" 0.001 inch or less at a cost considerably less than round wire of the same size while simultaneously providing a stiffer, better contacting finger than the round wire.

In the above-described embodiments of the invention, the tube **12** may have a diameter of about 8 inches and the wire coil **11** may be wound for 12 inches longitudinally along the tube. This would produce a sheet **22** of about 12 inches by 24 inches or about 288 square inches. A typical individual contact spring measures 0.1 by 0.1 inches or 0.01 square inches. Thus, the above sheet would contain about 28,800 individual contact springs. The diameter of tube **12** and the length that coil **11** is wound can be less than or even greater than the above values to produce sheets **22** of various desired sizes.

It will be apparent from the foregoing that while particular forms of the invention have been illusand described, various modifications can be made without departing from the spirit and scope of the invention. Accordingly, it is not intended that the invention be limited except as by the appended claims.

I claim:

1. An intermediate product comprising:

a contact strip blank for spring contacts comprising a plurality of side-by-side, relatively fine wire fingers, said wire fingers being joined by plural, spaced, continuous bonded strips of conductive metal, said strip blank including a plurality of end-to-end connected spring contacts severable therefrom by cuts perpendicular to said wire fingers.

2. An intermediate product as defined in claim **1,** wherein said wire fingers are of a precious metal alloy substantially 0.002–0.005 inches in diameter.

3. An intermediate product as defined in claim **1,** wherein said strips of conductive metal are formed from the group including silver, copper, or nickel plating.

4. An intermediate product as defined in claim **1,** wherein said blank further includes a plurality of side-by-side connected ones of said contacts severable therefrom by cuts parallel to said wire fingers.

5. An intermediate product as defined in claim **1,** wherein the portions of said wire fingers between said strips of conductive metal are covered by a non-conductive, protective mask.

6. An intermediate product as defined in claim **1,** wherein the cross-section of said wire fingers is barrel-shaped, the barrel height being less than the barrel diameter, with the barrel height aligned to position the relatively flat wire finger surfaces in side-by-side relation.

7. A potentiometer contact spring, comprising:

a plurality of relatively fine wire fingers positioned side-by-side in a lateral direction, said fingers having a small-area, electrical contacting surface near one end thereof, said fingers having a reduced diameter in said lateral direction between opposing lateral sides of each finger.

8. A potentiometer contact spring as defined in claim **7,** wherein said opposing sides are relatively flat.

9. A potentiometer contact spring as defined in claim **7,** wherein the cross-section of said fingers is barrel-shaped, said opposing sides are connected by top and bottom arcuate, circumferential finger surfaces, one such circumferential surface forming said small-area electrical contacting surface.

10. A potentiometer contact spring as defined in claim **9,** wherein the height of said barrel is said reduced diameter and the diameter of said barrel is the distance between said top and bottom surfaces, the barrel height being less than the barrel diameter.

11. A potentiometer contact spring as defined in claim **10,** wherein said wire fingers are formed by flattening originally round cross-section wire, said barrel height being less than and said barrel diameter being greater than the original diameter of said round wire.

12. A potentiometer contact spring as defined in claim **10,** wherein said wire fingers are shaped in the axial direction of said fingers to form said small-area electrical contacting surface.

13. A potentiometer contact spring as defined in claim **12,** wherein the shaping in the axial direction provides a radiused contact area.

14. A potentiometer contact spring as defined in claim **10,** and further including:

lateral support means for joining said fingers at the end thereof opposite said one end to provide electrical interconnection therebetween, said fingers extending freely in independent flexure relation from said lateral support means.

15. A potentiometer contact spring is defined in claim **14,** wherein said support means is a metal layer selected from the group of silver, copper, or nickel.

16. A potentiometer contact spring as defined in claim **10,** wherein said barrel height is less than about 0.002 inches.

17. A potentiometer contact spring as defined in claim **16,** wherein said barrel height is less than about 0.001 inches.

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