

[54] **METHOD OF MAKING A HOLLOW ELECTRICAL CONTACT**
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[22] Filed: **Nov. 16, 1971**
[21] Appl. No.: **199,383**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 52,546, July 6, 1970, abandoned.
[52] U.S. Cl. **29/630 A, 29/630 R, 339/252 P**
[51] Int. Cl. **H01r 11/00**
[58] Field of Search **339/252, 256; 219/69; 29/630 A, 630 C, 630 D**

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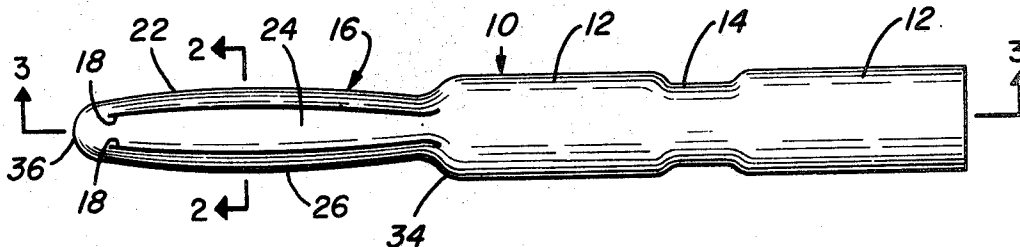
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Primary Examiner—Marvin A. Champion
Assistant Examiner—William F. Pate, III
Attorney, Agent, or Firm—Warren H. F. Schmieding

ABSTRACT

A releasable, hollow electrical connector formed from an elongated hollow body of resilient and flexible metal, an elongated section of which is provided with a plurality of elongated slots having width of less than .010 inch, which slots are formed by spark erosion of the metal.

3 Claims, 6 Drawing Figures



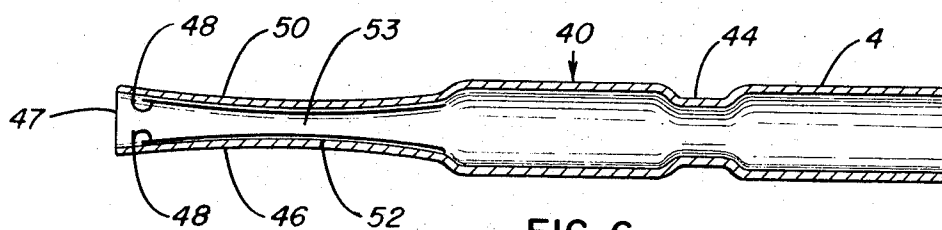


FIG. 6

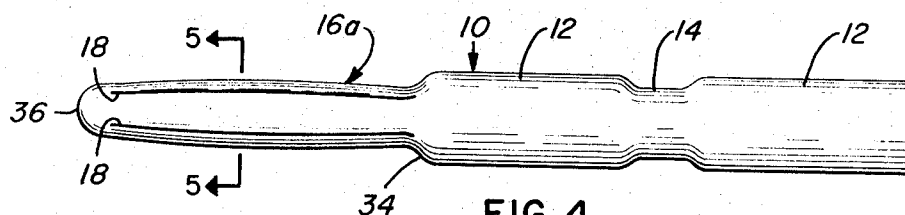


FIG. 4

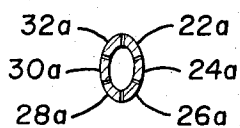


FIG. 5

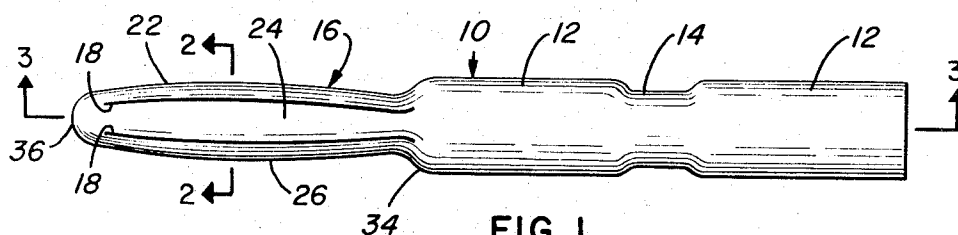


FIG. 1

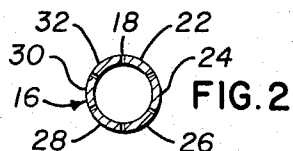


FIG. 2

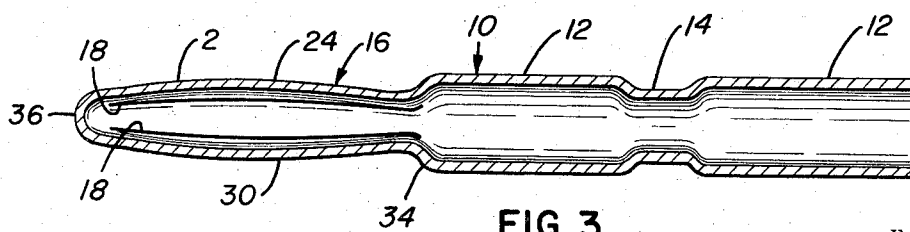


FIG. 3

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METHOD OF MAKING A HOLLOW ELECTRICAL CONTACT

CROSS-REFERENCE TO RELATED APPLICATION

The present application is a continuation-in-part of my earlier application, Ser. No. 52,546 filed July 6, 1970, now abandoned.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention is directed to electrical connectors of the type that are formed from elongated hollow metal bodies of such diameter as having capillary characteristic.

2. Description of the Prior Art

The prior art is represented by a connector such as that disclosed in the U.S. Pat. to Phillips No. 3,255,430 issued June 7, 1966. That connector requires a core wire and a plurality of encircling spirally wound wires. That connector requires specially constructed and complicated machinery for manufacturing the same. Other prior art known to applicant comprises the patents cited in the aforesaid application, Ser. No. 52,546. None of these patents show a conductor having slits having a width of approximately 0.004 inch. Although solutions to the problem of forming pin connectors and sockets therefor have repeatedly sought, those skilled in the art produced only the complicated and relatively thick structure shown in the Phillips patent because the minimum width of slots that could be cut by known machinery was 0.010 inch.

SUMMARY OF THE INVENTION

The connectors of the present invention are formed from elongated hollow bodies having small diameter which is generally referred to in the art as having capillary characteristic. The body includes an elongated section that is different in cross sectional width than another section of the body, and this elongated section is provided with elongated slots whereby the material between the slots forms a plurality of elongated, flexible and resilient contact portions. The slots are formed by the process of spark erosion of metal.

Other features and the advantages of the invention will be apparent from the following description, reference being had to the accompanying drawing wherein preferred embodiments of the invention are illustrated.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a side view of one form of the invention; FIGS. 2 and 3 are sectional views taken along lines 2—2, and 3—3, respectively of FIG. 1;

FIG. 4 is a view similar to FIG. 1 but showing another form of the invention;

FIG. 5 is a sectional view taken along line 5—5 of FIG. 4; and

FIG. 6 is a longitudinal sectional view of another embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The connector shown in FIGS. 1, 2 and 3 is formed of drawn resilient and flexible metal, such as beryllium copper, to provide an elongated hollow body 10. One end section 12 is in the form of a ferrule for receiving

a wire (not shown). An intermediate portion 14 of the ferrule section is further crimped after the wire is in position, the crimping being for fixing the wire to the body.

The opposite end section 16 of the hollow body 10 is provided with a plurality of elongated slots 18 to thereby provide a plurality of elongated, flexible and resilient contact portions 22, 24, 26, 28, 30 and 32. The contact portions are bent whereby the distances between them vary along the length thereof. When in the form of a pin type contact, as herein shown in FIGS. 1, 2 and 3 for illustrative purpose, the contact portions are bulged outwardly so as to resiliently engage a socket type connector having a cross sectional width which is narrower than the width of section 16 when the contact portion is in the bulged state.

The portion 34 between the ferrule section 12 and the contact section 16 forms a shoulder for limiting the movement of the body relative to the socket which receives section 16. As viewed in FIGS. 1 and 3, the left end of section 16 is in the form of a nose 36 which extends to the right and merges with the left ends of contact portions 22, 24, 26, 28, 30 and 32. The nose 36 is smaller diameter than the diameter of the major diameter of the bulge provided by those contact portions. Thus the nose provides a lead portion for entry of the connector into a socket type connector.

In the embodiments shown in FIGS. 1, 2, and 3, the section 16 is shown as a circle, while in FIGS. 4 and 5, a similar section 16a is shown as being elliptic, forming similar contact portions 22a, 24a, 26a, 28a, 30a and 32a.

The scale as shown herein is approximately 20 to 1, that is, the overall length of the body is approximately 0.298 inch. Since the circumferential length of section 16 is extremely small, many attempts to form elongated slots by various types of cutting machinery were unsuccessful. I have discovered that these slots 18, having a width of 0.004 inch, can be made by what is known in the trade as "spark erosion of metal" process. This process is described in an article entitled "Electrical Discharge Machine for Precision Spark Erosion of Metals" in the January 1965 pamphlet by Western Electric Company, Inc., Vol IX, No. 1, the title of which is The Western Electric ENGINEER, such article being incorporated, by reference, in this present application. This process is described also in Letters U.S. Pat. to Griffith No. 2,765,394, the disclosure therein being incorporated by reference in this present application.

Referring now to the embodiment shown in FIG. 6, the hollow body 40 is formed of drawn resilient and flexible metal, one end section 42 of which is in the form of a ferrule for receiving a wire (not shown). An intermediate portion 44 of the ferrule section is further crimped after the wire is in position, the crimping being for the purpose of fixing the wire to the body.

The opposite end section 46 is in the form of a socket, it being open as at 47 at the left end of the section for receiving a pin type connector, as for example like that shown in FIGS. 1, 2 and 3, or a connector which is not resilient and flexible. A plurality of elongated slots 48 are formed in the section intermediate the open end 47 and the left end of ferrule section 42. These slots provide a plurality of elongated, flexible and resilient contact portions. For illustrative purpose, four of these contacts are provided, three of which are shown at 50, 52 and 53. The contacts are bowed in-

wardly and are flexed outwardly when a pin type connector is inserted. Thus intimate contacts are present between the contacts of the socket and a pin type contact.

As in FIGS. 1 to 5 inclusive, the scale of FIG. 6 is approximately 20 to 1. The slots 48 are formed in the same process as explained with respect to slots in the embodiments shown in the other embodiment. Each slot 18 and 48 has a width of approximately .004 inch.

Specifically, in manufacturing a pin-type conductor, a disc of metal is selected for the desired electrical conductivity and having a thickness of 0.010 to 0.012 inch. This disc is introduced into dies and punches to progressively extrude the disc into a tubular body having a closed end. The closed nose 36 of the body has a spherical radius and the metal wall thickness is between 0.003 and 0.004 inch. The outer diameter is increased, preferably in steps, from the left end of the nose to an outside diameter of between 0.035 to 0.037 inch and the wall thickness is decreased to between 0.0025 and 0.003 inch. The outer diameter is then decreased, preferably in steps, to the right end of section 16, at which end the thickness of the metal is between 0.002 and 0.0025 inch. Thus the section 16 is bulged.

Some metals selected are work-hardened during the extrusion thereof and when slotted as herein shown, the portions between the slots are resilient and flexible. However, if the selected metal is not rendered resilient and flexible during the extrusion thereof, it must be heat treated to harden the same so that when the tube is slotted, the material will form a resilient and flexible contact. Any attempt to form slots in an annealed hollow body having a thickness as heretofore specified will destroy the shape and the symmetry of the body.

Persons skilled in metal fabrication are aware that slots having the limited width necessary to produce spring members in a pin-type conductor could not be cut with known slot-forming mechanism. Many prior attempts have been made to produce pin-type conductors, yet all failed because slots could not be cut having the necessary minimum width. Applicant's discovery that slots having a width of less than 0.010 inch could be cut by spark erosion of metal, led to the successful manufacture of long-sought pin-type conductors.

By employing the spark erosion of metal method, burr-free action is provided. Also, by the use of that method of cutting slots in the relatively thin metal tube, the slots can be cut without the use of a rigid support for the tube; whereas if cut otherwise, without a support, the tube would collapse.

The method employed for forming a socket-type conductor is substantially the same as that method employed for manufacturing the pin-type conductor. The exception being that the spring type contacts 50, 52 and 53 between the slots are bent inwardly to the extent that they resiliently embrace the contacts on the pin-type conductor. The contours of the contacts 50, 52 and 53 are designed so that the surfaces that resiliently engage the contacts on the pin-type conductor complement the outer surfaces of the latter conductor when the latter conductor is forced into contacting position with the socket.

It is to be understood also that the pin-type conductor can function successfully with sockets other than those having resilient contacts, and that the present socket can function successfully with conductors other than those having resilient contacts.

From the foregoing, it is apparent that by virtue of the present invention, I have perfected a long felt need for providing a pin-type connector and a socket type connector, both of which are manufactured at a relatively low cost when compared to pin-type connectors and sockets therefor now on the market.

The weight-saving characteristics become very apparent in high density applications, such as aerospace applications.

Both types of contacts, pin and socket, can be attached to current or signal carrying wire of solid, stranded or insulated form, or any combination thereof, by crimping, soldering or welding.

Advantages of this type contact are numerous. The contact surface area for current capacity is greater than that of most available designs. Pear shape, single point and double point contacts in the miniature sizes are most common.

The weight savings are quite substantial. In the pin type contact, such savings is approximately 50 percent; and in the socket contact, approximately 25 percent. The thin-wall design allows the use of a larger diameter wire attachment than present contacts permit. The slots allow ease of plating both inside and outside which, in miniature contacts, is critical in that plating solutions cannot readily be circulated in a miniature bore. The larger engagement area allows for more reliability from a mechanical standpoint, relative to vibration, and noise, created by vibration of point areas.

Both pin and socket contacts, in this design, can be used as free standing members in scoop proof connectors. The design permits the maximum density, in a given area, to be greater than any available to date. Because of the design, parts are readily adaptable to mass feeding in automated equipment making production savings of 25 percent to 40 percent possible.

It is also apparent from the foregoing that the pin-type connector as herein shown is effective to resiliently engage the walls of a complement socket in which the walls of the socket are not biased inwardly. And conversely the resilient contacts of the socket shown in FIG. 6 provides for resiliently embracing a non-radially expansible pin-type contact.

When employing the radially expandible pin-type connector such as that shown in FIGS. 1, 2 and 3 with a complementary socket like that connector shown in FIG. 6, there is then provided, as set forth in the aforementioned Phillips patent, a combination of two yielding means with two different natural frequencies of vibration so that only one of the two yielding means can be in resonance with an imposed vibratory frequency at one time, the other yielding means being out of resonance to maintain the effectiveness of the electrical joint.

While the socket shown in FIG. 6 is in the form of a true circle, it is to be understood that it can be shaped to complement the pin-type contact shown in FIGS. 4 and 5.

The pin-type connector like that shown in any of the embodiments offers resistance to withdrawal within a narrow range of desirable tolerances and such resistance to withdrawal is maintained substantially constant throughout repeated withdrawals. Yet the hollow pin connectors provide a sturdy spring action effect throughout long contact surfaces.

Having described my invention, I now claim.

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1. The method of forming an elongated pin type connector comprising the steps of,
extruding a disc of resilient and flexible metal into a tubular body having a closed end, which tubular body has a maximum outside diameter of about 0.037 inch,
bulging outwardly an elongated section of said tubular body to a wall thickness of about 0.003 inch,
heat treating the tubular body to uniform hardness to obtain consistent spring action,
cutting a plurality of elongated slots having a uniform width of less than 0.010 inch through the wall of said elongated section of said tubular body along the longitudinal length thereof and at circumferentially spaced locations by subjecting the metal to spark erosion.

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2. A method of forming an elongated pin type connector, comprising the steps of:
forming a disk of resilient metal into a tubular body having a closed end, the body having a maximum outside diameter of about 0.037 inch and a wall thickness of about 0.003 inch; and
cutting a plurality of elongated slots having a uniform width of less than 0.010 inch through the wall of said elongated section of said tubular body along the longitudinal length thereof and at circumferentially spaced locations by subjecting the metal to spark erosion.

3. The method defined in claim 2 and further comprising the step of heat treating the tubular body to obtain consistent spring action prior to cutting the slots.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,786,558 Dated January 22, 1974

Inventor(s) Lauris J. McCarthy

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

Column 1, line 12, "taht" should read --that--

line 25, "show" should read --shows--

line 28, after the word "have" insert --been--

Column 2, line 24, after the word "is" insert --of--

line 42, "Spart" should read --Spark--

Column 4, line 38, "taht" should read --that--

Signed and sealed this 13th day of August 1974.

(SEAL)
Attest:

McCOY M. GIBSON, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents