(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 201 989 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
25.09.2024 Bulletin 2024/39

(21) Application number: **15847577.2**

(22) Date of filing: **02.10.2015**

(51) International Patent Classification (IPC):
H01R 4/02 *(2006.01)* ***H01R 4/62*** *(2006.01)*
H01R 43/02 *(2006.01)* ***H01R 43/28*** *(2006.01)*
H01B 1/02 *(2006.01)* *H01R 4/18* *(2006.01)*

(52) Cooperative Patent Classification (CPC):
H01R 4/184; H01B 1/023; H01B 1/026; H01B 7/2806; H01R 4/187; H01R 4/625; H01R 43/0207; H01R 43/28

(86) International application number:
PCT/US2015/053738

(87) International publication number:
WO 2016/054516 (07.04.2016 Gazette 2016/14)

(54) **WIRE AND METHODS FOR PREPARING A WIRE TO RECEIVE A CONTACT ELEMENT**

DRAHT UND VERFAHREN ZUR HERSTELLUNG EINES DRAHTES ZUR AUFNAHME EINES KONTAKTELEMENTS

FIL ET PROCÉDÉS DE PRÉPARATION D'UN FIL DESTINÉ À RECEVOIR UN ÉLÉMENT DE CONTACT

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **03.10.2014 US 201462059317 P**

(43) Date of publication of application:
09.08.2017 Bulletin 2017/32

(73) Proprietor: **General Cable Technologies Corporation**
Highland Heights, KY 41076 (US)

(72) Inventors:
- **TRAFTON, Michael, L.**
  Lake Orion, MI 48360 (US)
- **STEINER, Robert, D.**
  Macomb, MI 48044 (US)

(74) Representative: **Colombo, Stefano Paolo et al**
Marchi & Partners S.r.l.
Via Vittor Pisani, 13
20124 Milano (IT)

(56) References cited:
WO-A1-2011/118416
WO-A1-2012/048103
WO-A1-2013/145670
WO-A1-2014/114672
DE-A1- 10 223 397
GB-A- 2 349 018
JP-A- 2007 305 314
US-A- 3 247 316
US-A- 3 541 227
US-A- 3 716 909
US-A- 3 988 563
US-A- 5 425 832
US-A1- 2004 158 981
US-A1- 2010 096 185
US-A1- 2010 096 185

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 3 201 989 B1

Description

TECHNICAL FIELD

[0001] The articles and methods described below generally relate to the field of preparing a wire to receive a contact element.

BACKGROUND

[0002] Automotive cables, such as a battery cable, can include an aluminum conductor which can be lighter and less expensive than conventional copper conductors. A contact element, such as a ring terminal, is crimped or otherwise secured to a bare end of the aluminum conductor to form a terminated end. The contact element is typically made from copper based alloys such as brass, for example, or another material that is different than aluminum.

[0003] The bare end of aluminum conductor, however, can be susceptible to oxidation (e.g., sapphire oxidation) which can inhibit conductivity between the bare end and the contact element and thus can prevent proper termination with a contact element. The aluminum conductor can also be susceptible to galvanic corrosion when it is terminated to a material that is more basic than aluminum, such as brass, and when moisture is present at the interface between the conductor and the contact element. The galvanic corrosion can cause aluminum dissolution which can adversely affect the conductivity between the aluminum conductor and the contact element. Once terminated, the aluminum conductor can be more susceptible to mechanical creep at its terminated end at low temperatures (e.g., 80 degrees C) than conventional copper conductors which can result in undesirable impedances. The aluminum conductor is also weaker than a copper conductor which can result in the aluminum conductor being easier to pull out of the contact element after termination.

[0004] WO 2011/118416 A1 discloses a method relating to the preamble of claim 1 and more specifically it discloses an aluminum electric wire (10) with a female terminal fitting (20) comprising an electric wire (10) with a metal core (11) covered by an insulation sheath (13); a terminal fitting (20) provided with an electric wire connecting section (25) that is connected to the core (11) and made from a different type of metal than the core (11); and a thin adherend (30) made of metal that has similar ionization tendencies to the terminal fitting (20) and that is attachable from an end where the core (11) has been exposed by the peeling away of the insulation sheath (13) on the electric wire (10) to an end where the insulation sheath (13) remains intact. The adherend (30) is formed by winding copper foil in a plurality of layers. The adherend (30) is bonded to the core (11) of the electric wire (10) by ultrasonic welding and the electric wire connecting section (25) of the terminal fitting (20) is crimped to the adherend (30).

[0005] DE 102 23 397 A1 discloses a method involving sliding a metal sleeve (14), that is tinned at least on its inside, over a stripped end (13) of the cable, and metallically tinned by ultrasonic tinning with the conductors (11) at the end of the cable. A metal tinned contact terminal (22) is placed over the tinned end of the cable and pressed. An independent claim is included for a connection for contacting and fixing a cable.

SUMMARY

[0006] The invention is defined by the independent claims 1 and 10.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] It is believed that certain embodiments will be better understood from the following description taken in conjunction with the accompanying drawings in which:

FIG. 1 is a perspective view depicting a wire, a conductive foil layer, and a terminal prior to the conductive foil layer being installed on a conductor of the wire, in accordance with one embodiment;
FIG. 2 is a perspective view depicting the conductive foil layer installed on the wire of FIG. 1;
FIG. 3 is a perspective view of the terminal installed on the wire of FIG. 1;
FIG. 4 is a cross-sectional view taken along the line 4-4 in FIG. 3;
FIG. 5 is a perspective view depicting a wire, a conductive foil layer, and a terminal prior to the conductive foil layer being installed on a conductor of the wire, in accordance with another embodiment presented for illustrative purposes only;
FIG. 6 is a perspective view of the terminal installed on the wire of FIG. 5;
FIG. 7 is a cross-sectional view taken along the line 7-7 in FIG. 6;
FIG. 8 a perspective view depicting a wire, a conductive foil layer, and a terminal prior to the conductive foil layer being installed on a conductor of the wire, in accordance with this invention;

FIG. 9 is a perspective view depicting a wire and ferrule prior to the ferrule being installed on a conductor of the wire, in accordance with another embodiment not encompassed by the claims; and
FIG. 10 is a perspective view of the wire of FIG. 9, but with the ferrule installed on the conductor.

DETAILED DESCRIPTION

[0008] In connection with the views and examples of FIGS. 1-10, wherein like numbers indicate the same or corresponding elements throughout the views, FIG. 1 illustrates a wire 10 having a conductor 12 and an insulating layer 14 surrounding the conductor 12. A portion of the insulating layer 14 is shown to be removed from the conductor 12 to expose a bare portion 16 of the conductor 12. The insulating layer 14 can be removed with any of a variety of suitable methods, such as through interaction with a set of wire strippers. Although a multi-strand insulated conductor is shown, it will be appreciated that any of a variety of suitable alternative conductors can be used having different quantities/sizes of strands, including a conductor having an individual strand (e.g., a solid conductor) and/or being devoid of insulation (e.g., a grounding conductor.

[0009] As illustrated in FIGS. 1 and 2, a conductive foil layer 18 is attached to a portion of the bare portion 16 of the conductor 12. In one embodiment, the conductive foil layer 18 can be wrapped around the bare portion 16 of the conductor 12, as illustrated in FIG. 2, and pressure can be applied to the conductive foil layer 18 (in the direction of the arrows P). In one embodiment, the application of pressure to the conductive foil layer 18 can be the result of simply overlying the conductive foil layer 18 onto the bare portion 16 of the conductor 12 (e.g., by grasping the ends of the conductive foil layer 18 and wrapping it around the bare portion 16). In certain embodiments, the desired pressure can be applied by hand, with a tool (e.g., pliers), or any of a variety of other suitable methods.

[0010] Once the conductive foil layer 18 has been provided onto the bare portion 16 of the conductor 12, the bare portion 16 of the conductor 12 and the conductive foil layer 18 are joined together. In one embodiment according to the present invention, the bare portion 16 and the conductive foil layer 18 are joined together through welding, such as through ultrasonic welding, for example. Welding the bare portion 16 and the conductive foil layer 18 together can bond the conductive foil layer 18 to the conductor 12 as well as bond the strands of the conductor 12 together to form an amalgamated mass (e.g., a nugget). Welding can also help break apart any oxidation formed on the conductor 12 that might adversely affect the conductivity between the conductor 12 and the conductive foil layer 18. Welding can accordingly enhance the conductivity characteristics between the conductor 12 and the conductive foil layer 18.

[0011] Once the conductor 12 and the conductive foil layer 18 have been joined together, a terminal 20 is slid over the conductive foil layer 18 and secured to the amalgamated mass of the bare portion 16 and the conductor 12, such as with a crimping tool, for example, to create a terminated wire 21, as illustrated in FIGS. 3 and 4. In one embodiment, as illustrated in FIG. 3, an exterior surface 22 of a crimping portion 24 of the terminal 20 can be reinforced, such as by applying solder 26 at a separation point 28 of the crimping portion 24, to enhance the durability of the connection between the terminal 20 and the conductor 12. In certain embodiments, the terminal 20 can be nickel plated, or plated with another conductive material, prior to attachment of the terminal 20 to the conductor 12. In such an embodiment, the nickel plating can protect the terminal from galvanic corrosion to enhance the conductivity between the conductor 12 and the material that forms the terminal 20 (e.g., brass). The terminated end can additionally or alternatively be dipped in molten solder to enhance durability of the terminated wire 21. It is to be appreciated that although the terminal 20 is shown to be a ring terminal, it is to be appreciated that any of a variety of suitable alternative contact elements, such as a slotted terminal, a bus bar, or a termination block, for example, can be attached to the wire 10. It is also to be appreciated that the terminated wire 21 is contemplated for use in a variety of suitable applications, such as, for example, as a vehicular battery cable.

[0012] The conductor 12 and the conductive foil layer 18 are formed of different conductive materials with the conductive foil layer 18 having about the same or higher conductivity than the conductor 12. As a result, when the conductive foil layer 18 is interposed between the conductor 12 and the terminal 20, the conductive foil layer 18 can enhance the overall conductivity between the conductor 12 and the terminal 20 as compared to the conductive foil layer 18 not being present (i.e., the conductor 12 and the terminal 20 being entirely in contact with each other). In one embodiment according to the present invention, the conductor 12 is formed of aluminum or an aluminum alloy, the conductive foil layer 18 is formed of copper, and the terminal 20 can be formed of brass. In such an embodiment, the copper of the conductive foil layer 18 can allow the interaction between the aluminum conductor 12 and the brass terminal 20 to be more conductive than crimping the brass terminal 20 directly to the aluminum conductor 12 (which in some instances can be non-conductive). It is to be appreciated that the conductive foil layer 18 can be formed of a material that is, in examples not according to the present invention, as conductive as or, in embodiments according to the present invention, more conductive than the conductor 12. In certain embodiments according to the present invention, the conductor 12 can be formed of a conductive material having a conductivity of about $3.5*10^7$ S/m (at 20 degrees C) or less, and the conductive foil layer 18 can be formed of conductive material having a conductivity of about $4.1*10^7$ S/m (at 20 degrees C) or more. In other embodiments which are reported here for illustrative purposes, the conductor 12 can be formed of a conductive material

that is substantially susceptible to oxidation, such as an aluminum alloy, a chromium alloy, and/or a magnesium alloy, and the conductive foil layer 18 can be formed of conductive material that is not substantially susceptible to oxidization such as a copper alloy, silver, nickel, and/or gold.

[0013] As illustrated in FIG. 1, the conductive foil layer 18 is shown to have a length L1, a width W, and a thickness T and the bare portion 16 of the conductor 12 is shown to have a length L2, a diameter D, and a circumference C. In one embodiment which is not according to the present invention, the length L1 and width W of the conductive foil layer 18 can be less than the circumference C and the length L2 of the bare portion 16 of the conductor 12, respectively, such that when the conductive foil layer 18 is attached to the conductor 12, the conductive foil layer 18 neither reaches the end of the conductor 12 nor completely surrounds it. According to the present invention, the length L1 of the conductive foil layer 18 is more than the circumference C of the bare portion 16 of the conductor 12, respectively, such that when the conductive foil layer 18 is attached to the conductor 12, the conductive foil layer 18 overlaps at its ends such that it entirely surrounds the bare portion 16. In certain embodiments, the diameter D of the conductor can be significantly more than the thickness T of the conductive foil layer 18, and can in certain embodiments have a ratio of between about 100:1 and about 500:1 and in certain embodiments can have a ratio of about 200:1. In one embodiment, for a 0 AWG wire, the length L1 can be about 40 mm, the width W can be about 18 mm, the thickness T can be about 0.035 mm, the length L2 can be about 20 mm, the diameter D can be about 8 mm, and the circumference C can be about 25 mm. It will be appreciated that a layer described herein as being a foil, such as conductive foil layer 18, should be understood to mean that the layer is a sheet-like substrate having a length and width that are substantially greater than the thickness of the substrate. In certain embodiments, ratio of the combined length and width of the layer to the thickness of the layer can be between about 500:1 to about 100,000:1. In certain embodiments, the ratio can be about 10,000: 1 to about 25,000: 1 and preferably about 14,000:1

[0014] In some embodiments, the bare portion 16 of the conductor 12, alone or in combination with the conductive foil layer 18, can be cleaned before or after application of the conductive foil layer 18 to remove any oxides on the conductor 12 and/or between the conductor 12 and the conductive foil layer thus enhancing the effectiveness of the conductivity between the conductor 12, the conductive foil layer 18, and the terminal 20. In one embodiment, the conductor 12 and/or conductive foil layer 18 can be cleaned via a plasma treatment performed by a blown-ion air system (not shown). The blown-ion air system can force pressurized air towards an electrode, through a narrow nozzle, and onto the bare portion 16. The electrode creates positively charged ions in the pressurized air which is then accelerated by the nozzle and provided onto the bare portion 16 of the conductor 12. The positively charged ions in the airstream positively charge the outer surface of the bare portion 16 thereby increasing its surface energy to remove any oxides. In another embodiment, the conductor 12 and/or conductive foil layer 18 can be cleaned via a high temperature induction heating process that applies a flame to the conductor 12 and/or conductive foil layer 18 using any of a variety of fuels, such as, for example, hydrogen gas, alcohol, and/or acetylene.

[0015] In certain embodiments which are not according to the present invention and are reported here for illustration purposes only, the bare portion 16 of the conductor 12 and the conductive foil layer 18 can be joined by soldering such as by dipping the bare portion 16 and the conductive foil layer 18 together in a molten material (e.g., such as molten tin) or resistance soldering the bare portion 16 and the conductive foil layer 18 together, for example, both of which can enhance the conductivity between the bare portion 16, the conductive foil layer 18, and the terminal 20. It is to be appreciated that cleaning the bare portion 16 and/or the conductive foil layer 18 can encourage the application of solder. However, the soldering can be performed in addition to the welding or in addition to or in lieu of the cleaning described above. It is also to be appreciated that the bare portion 16 and/or the conductive foil layer 18 can undergo any of a variety of other suitable treatment processes to prepare for affixation of the terminal 20.

[0016] FIGS. 5-7 illustrate an embodiment which is not according to the present invention and is presented here for illustration purposes only. This embodiment relates to a wire 110, a conductive foil layer 118 and a terminal 120 that are similar to, or the same in many respects as, the wire 10, the conductive foil layer 18 and the terminal 120, respectively, illustrated in FIGS. 1-4. For example, the wire 110 can include a conductor 112, an insulating layer 114, a bare portion 116, and a conductive foil layer 118. However, the conductive foil layer 118 can be joined to the bare portion 116 of the conductor 112 by applying pressure to the conductive foil layer 118 (in the direction of the arrows P) and without any welding (ultrasonic or otherwise). In such an arrangement, the terminal 20 can be slid over the bundle of strands (e.g., 123) at the bare portion 16 and secured to the bundle of strands (e.g., 123), such as with a crimping tool, for example. An exterior surface 122 of a crimping portion 124 of the terminal 120 can be reinforced, such as by applying solder 126 at a separation point 128 of the crimping portion 124.

[0017] FIG. 8 illustrates a wire 210, a conductive foil layer 218 and a terminal 220 that are similar to, or the same, in many respects as the wire 10, the conductive foil layer 18 and the terminal 20, respectively, illustrated in FIGS. 1-4. For example, the wire 210 can include a conductor 212, an insulating layer 214, and a bare portion 216. The conductive foil layer 218, according to this invention, is a corrugated screen having a plurality of elevated portions (e.g., points) distributed along upper and lower surfaces (upper surface 230 shown). When the conductive foil layer 218 is attached to the bare portion 216 of the conductor 212, the points can abrade the bare portion 216 of the conductor 212 (e.g., remove any

oxidation) to facilitate effective electrical contact between the bare portion and the conductive foil layer 218. If the bare portion 216 and the conductive foil layer 218 are joined by soldering, as described above, the solder can collect in pockets defined between the points to facilitate effective bonding between the bare portion 216 and the conductive foil layer 218. In one embodiment, the conductive foil layer 218 can be formed of nickel and the conductor 212 can be formed of aluminum 212.

[0018] FIGS. 9-10 illustrate a wire 310 that is similar to, or the same, in many respects as the wire 10 illustrated in FIGS. 1-4. For example, the wire 310 can include a conductor 312, an insulating layer 314, and a bare portion 316. According to embodiments not encompassed by the claims, a ferrule 331, however, can be provided in lieu of, or in addition to, a conductive foil layer (e.g., 18). The ferrule 331 can be joined to the bare portion similarly as described above and a terminal (not shown) can then be secured thereto.

[0019] Another alternative embodiment of a terminated wire (e.g., an alternative terminated wire) is also contemplated, which however is not according to the present invention. The alternative terminated wire can be similar in many respects to the terminated wire 21 described above except that the alternative terminated wire does not include a conductive foil layer (e.g., 18). To prepare the alternative terminated wire, a portion of an insulating layer (e.g., 14) can be removed from a conductor (e.g., 12) to expose a bare portion (e.g., 16) of the conductor (e.g., 12). The bare portion can then be cleaned (e.g., with a plasma treatment) and welded (e.g., through ultrasonic welding) to bind individual strands of the conductor together.

[0020] The steps of cleaning and welding can be performed in any order. Once welded, the bare portion can be soldered (e.g., through tin dipping or resistive soldering). A terminal (e.g., 20) can then be attached to the bare portion insulating layer to create the alternative terminated wire. In one embodiment, the conductor 112 can be formed of aluminum and the conductive foil layer can be formed of nickel.

EXAMPLES

[0021] Testing was conducted on a terminated wire similar to the terminated wire 21 described above. The terminated wire that was tested was a 0 AWG (1/0) aluminum wire having a bare portion (e.g., 14) measuring about 20 mm, a copper conductive foil layer (e.g., 18) having a length (e.g., L1) of about 40 mm, a width (e.g., W) of about 18 mm, and a thickness (e.g., T) of about 0.035 mm, and a brass terminal. The copper conductive foil layer was manually wrapped onto the bare portion and then was ultrasonically welded to form a nugget. A terminal was then crimped onto the nugget. Ten separate resistance tests were then performed to measure the resistance between the conductor and the terminal (e.g., between points A and B illustrated on FIG. 3). Each test resulted in a resistance between 0.041 Ohms and 0.045 Ohms, having an example resistance of 0.043 Ohms. The maximum allowable resistance for use as a vehicular battery cable is 0.057 Ohms.

[0022] Comparative testing was also conducted to compare the results for different terminations of a 0 AWG (1/0) aluminum wire having a bare portion (e.g., 14) measuring about 20 mm, a copper conductive foil layer (e.g., 18) having a length (e.g., L1) of about 40 mm, a width (e.g., W) of about 20 mm, and a thickness (e.g., T) of about 0.035 mm, and a brass terminal. A variety of different terminated wires were assembled using certain of the methodologies described above and resistance tests were performed on the terminated wires. The results of the resistance tests are as follows:

Example	Termination Method	Resistance (Ohms)
Example #1	Bare Conductor with Terminal Crimped Directly to Bare Conductor	Open Circuit (high resistance)
Example #2	Terminated Conductor Prepared and Terminated Without Conductive Foil Layer as Follows: 1. Ultrasonically Weld Bare Conductor 2. Plasma Clean Welded Bare Conductor 3. Dip Bare Conductor in Molten Solder 4. Crimp Terminal to Soldered End of Bare Conductor. 5. Resistance Solder Outer Surface of Terminal	0.345 milliohms

(continued)

Example	Termination Method	Resistance (Ohms)
Example #3	Terminated Conductor Prepared and Terminated Without Conductive Foil Layer as Follows: 1. Plasma Clean Bare Conductor 2. Ultrasonically Weld Bare Conductor 3. Plasma Clean Bare Conductor 4. Dip Bare Conductor in Molten Solder 5. Crimp Terminal to Soldered End of Bare Conductor. 6. Resistance Solder Outer Surface of Terminal	0.179 milliohms
Example #4	Terminated Conductor Prepared and Terminated With Solid Copper Conductive Foil Layer as Follows: 1. Ultrasonically Weld Bare Conductor and Conductive Foil Layer Together 2. Dip Welded End in Molten Solder 3. Crimp Terminal to Soldered End of Bare Conductor. 4. Resistance Solder Outer Surface of Terminal	0.046 milliohms

[0023] The foregoing description of embodiments and examples of the disclosure has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the disclosure to the forms described. Numerous modifications are possible in light of the above teachings. Some of those modifications have been discussed and others will be understood by those skilled in the art. The embodiments were chosen and described in order to best illustrate the principles of the disclosure and various embodiments as are suited to the particular use contemplated. The scope of the disclosure is, of course, not limited to the examples or embodiments set forth herein.

[0024] Rather it is hereby intended the scope of the invention be defined by the claims appended hereto. Also, for any methods claimed and/or described, regardless of whether the method is described in conjunction with a flow diagram, it should be understood that unless otherwise specified or required by context, any explicit or implicit ordering of steps performed in the execution of a method does not imply that those steps must be performed in the order presented and may be performed in a different order or in parallel.

Claims

1. A method for terminating a wire (10; 210) with a contact element (20; 220), the wire comprising a conductor (12; 212) and an insulating layer (14; 214) surrounding the conductor, the conductor being formed of aluminum or an aluminum alloy, the method comprising:

removing the insulating layer from the conductor to expose a portion (16; 216) of the conductor, the exposed portion having a circumference;
installing a conductive foil layer (18; 218) on the exposed portion of the conductor such that the conductive foil layer (18; 218) entirely surrounds the circumference of the exposed portion of the conductor;
welding the conductive foil layer (18; 218) and the exposed portion of the conductor together to form an amalgamated mass; and
installing the contact element (20; 220) on the amalgamated mass, the contact element being formed of a different material than the conductor (12; 212) and the conductive foil layer (18; 218), wherein:

the conductive foil layer (18; 218) is formed of copper,
the method being **characterized in that** the conductive foil layer (218) comprises a corrugated screen having a plurality of elevated portions distributed along upper and lower surfaces; and
when the conductive foil layer(218) is installed on the exposed portion (216), the elevated portions are configured to abrade the exposed portion (216) of the conductor (212) prior to the welding of the conductive foil layer (218) and the exposed portion.

2. The method of claim 1, wherein the installing the contact element (20: 220) on the amalgamated mass comprises crimping the contact element.

3. The method of claim 1 or claim 2 wherein welding the conductive foil layer (18; 218) and the exposed portion (16; 216) of the conductor (12; 212) together comprises ultrasonically welding the conductive foil layer to the exposed portion of the conductor.

4. The method of any of claims 1-3 further comprising cleaning the exposed portion (16; 216) of the conductor (12; 212) prior to welding the conductive foil layer (18; 218) and the exposed portion of the conductor together, and optionally wherein cleaning the exposed portion of the conductor comprises plasma treating the exposed portion of the conductor.

5. The method of any of claims 1-4 further comprising applying solder (26) to the amalgamated mass, and optionally wherein applying solder to the amalgamated mass comprises dipping the amalgamated mass into a molten material.

6. The method of any of claims 1-5 wherein the contact element (20; 220) is formed of brass.

7. The method of any of claims 1-6 wherein the conductive foil layer (18; 218) has a thickness, and the ratio of the diameter of the conductor (12; 212) to the thickness of the conductive foil layer is about 200: 1 .

8. The method of claim 2 further comprising soldering an exterior surface of the contact element (20; 220).

9. The method of any of claims 1-8 wherein installing the conductive foil layer (18; 218) comprises wrapping the conductive foil layer entirely around the exposed portion (16; 216) of the conductor (12; 212) such that opposing ends of the conductive foil layer overlap each other.

10. A terminated wire (21) comprising:

a conductor (12; 212), the conductor comprising an exposed portion (16; 216) and being formed of aluminum or aluminum alloy, the exposed portion having a circumference;
a conductive foil layer (18; 218) formed of copper and installed on the exposed portion of the conductor such that the conductive foil layer entirely surrounds the circumference of the exposed portion of the conductor;
a contact element (20; 220) formed of a different material than the conductor and the conductive foil layer;
wherein:

the conductive foil layer (18; 218) and the exposed portion of the conductor are welded together to form an amalgamated mass;
the contact element (20; 220) is secured to the amalgamated mass,
the terminated wire being **characterized in that** the conductive foil layer (218) comprises a corrugated screen having a plurality of elevated portions distributed along upper and lower surfaces; and
when the conductive foil layer (218) is installed on the exposed portion (216), the elevated portions are configured to abrade the exposed portion (216) of the conductor (212) prior to the welding of the conductive foil layer (218) and the exposed portion.

11. The terminated wire of claim 10 wherein the conductor (12; 212) is a bare conductor.

12. The terminated wire of claim 10 or claim 11 wherein the conductor (12; 212) is formed of an aluminum alloy and contact element (20; 220) is formed of brass.

13. The terminated wire of any of claims 10-12 wherein the conductive foil layer (18; 218) and the exposed portion (16; 216) of the conductor (12; 212) are joined together by ultrasonic welding.

14. The terminated wire of any of claims 10-13 wherein the conductor (12; 212) has a diameter, the conductive foil layer (18; 218) has a thickness, and the ratio of the diameter of the conductor to the thickness of the conductive foil layer is about 200:1.

15. The terminated wire of any of claims 10-14 wherein the conductive foil layer (18; 218) comprises opposing ends that overlap each other when installed on the exposed portion (16; 216) of the conductor (12; 212).

Patentansprüche

1. Verfahren zum Anschließen eines Drahtes (10; 210) mit einem Kontaktelement (20; 220), wobei der Draht einen Leiter (12; 212) und eine den Leiter umgebende Isolierschicht (14; 214) umfasst, wobei der Leiter aus Aluminium oder einer Aluminiumlegierung gebildet ist, wobei das Verfahren umfasst:

   Entfernen der Isolierschicht von dem Leiter, um einen Teil (16; 216) des Leiters freizulegen, wobei der freigelegte Teil einen Umfang aufweist;
   Anbringen einer leitenden Folienschicht (18; 218) auf dem freigelegten Teil des Leiters, so dass die leitende Folienschicht (18; 218) den Umfang des freigelegten Teils des Leiters vollständig umgibt;
   Verschweißen der leitenden Folienschicht (18; 218) und des freiliegenden Abschnitts des Leiters miteinander, um eine verschmolzene Masse zu bilden; und
   Anbringen des Kontaktelements (20; 220) auf der verschmolzenen Masse, wobei das Kontaktelement aus einem anderen Material als der Leiter (12; 212) und die leitende Folienschicht (18; 218) gebildet ist, wobei:
   die leitende Folienschicht (18; 218) aus Kupfer gebildet ist, wobei das Verfahren **dadurch gekennzeichnet ist, dass** die leitende Folienschicht (218) eine gewellte Abschirmung mit einer Vielzahl von erhöhten Abschnitten umfasst, die entlang der oberen und unteren Oberflächen verteilt sind; und wenn die leitende Folienschicht (218) auf dem freiliegenden Abschnitt (216) installiert wird, die erhöhten Abschnitte so konfiguriert sind, dass sie den freiliegenden Abschnitt (216) des Leiters (212) vor dem Verschweißen der leitenden Folienschicht (218) und des freiliegenden Abschnitts abschleifen.

2. Verfahren nach Anspruch 1, wobei das Anbringen des Kontaktelements (20; 220) auf der verschmolzenen Masse das Crimpen des Kontaktelements umfasst.

3. Verfahren nach Anspruch 1 oder 2, wobei das Zusammenschweißen der leitenden Folienschicht (18; 218) und des freiliegenden Abschnitts (16; 216) des Leiters (12; 212) das Ultraschallschweißen der leitenden Folienschicht mit dem freiliegenden Abschnitt des Leiters umfasst.

4. Verfahren nach einem der Ansprüche 1 bis 3 umfassend das Reinigen des freiliegenden Abschnitts (16; 216) des Leiters (12; 212) vor dem Zusammenschweißen der leitenden Folienschicht (18; 218) und des freiliegenden Abschnitts des Leiters, und optional umfasst das Reinigen des freiliegenden Abschnitts des Leiters die Plasmabehandlung des freiliegenden Abschnitts des Leiters.

5. Verfahren nach einem der Ansprüche 1 bis 4, das ferner das Aufbringen von Lot (26) auf die amalgamierte Masse umfasst, und wobei das Aufbringen von Lot auf die amalgamierte Masse optional das Eintauchen der amalgamierten Masse in ein geschmolzenes Material umfasst.

6. Verfahren nach einem der Ansprüche 1 bis 5, wobei das Kontaktelement (20; 220) aus Messing besteht.

7. Verfahren nach einem der Ansprüche 1 bis 6, wobei die leitende Folienschicht (18; 218) eine Dicke aufweist und das Verhältnis des Durchmessers des Leiters (12; 212) zur Dicke der leitenden Folienschicht etwa 200:1 beträgt.

8. Verfahren nach Anspruch 2 umfasst ferner das Löten einer Außenfläche des Kontaktelements (20; 220).

9. Verfahren nach einem der Ansprüche 1 bis 8, wobei das Anbringen der leitenden Folienschicht (18; 218) das vollständige Umwickeln des freiliegenden Abschnitts (16; 216) des Leiters (12; 212) mit der leitenden Folienschicht umfasst, so dass sich gegenüberliegende Enden der leitenden Folienschicht überlappen.

10. Anschlussdraht (21), umfassend: einen Leiter (12; 212), wobei der Leiter einen freiliegenden Abschnitt (16; 216) umfasst und aus Aluminium oder einer Aluminiumlegierung gebildet ist, wobei der freiliegende Abschnitt einen Umfang aufweist; eine leitende Folienschicht (18; 218), die aus Kupfer gebildet und auf dem freiliegenden Abschnitt des Leiters so installiert ist, dass die leitende Folienschicht den Umfang des freiliegenden Abschnitts des Leiters vollständig umgibt; ein Kontaktelement (20; 220), das aus einem anderen Material als der Leiter und die leitende Folienschicht gebildet ist; wobei:
    die leitende Folienschicht (18; 218) und der freiliegende Abschnitt des Leiters miteinander verschweißt sind, um eine verschmolzene Masse zu bilden; das Kontaktelement (20; 220) an der verschmolzenen Masse befestigt ist, wobei der abgeschlossene Draht **dadurch gekennzeichnet ist, dass** die leitende Folienschicht (218) eine gewellte Abschirmung mit einer Vielzahl von erhöhten Abschnitten umfasst, die entlang der oberen und unteren Oberflächen

verteilt sind; und wenn die leitende Folienschicht (218) auf dem freiliegenden Abschnitt (216) installiert ist, die erhöhten Abschnitte so konfiguriert sind, dass sie den freiliegenden Abschnitt (216) des Leiters (212) vor dem Verschweißen der leitenden Folienschicht (218) und des freiliegenden Abschnitts abschleifen.

11. Anschlussdraht nach Anspruch 10, wobei der Leiter (12; 212) ein blanker Leiter ist.

12. Anschlussdraht nach Anspruch 10 oder 11, wobei der Leiter (12; 212) aus einer Aluminiumlegierung und das Kontaktelement (20; 220) aus Messing besteht.

13. Anschlussdraht nach einem der Ansprüche 10-12, wobei die leitende Folienschicht (18; 218) und der freiliegende Teil (16; 216) des Leiters (12; 212) durch Ultraschallschweißen miteinander verbunden sind.

14. Anschlussdraht nach einem der Ansprüche 10-13, wobei der Leiter (12; 212) einen Durchmesser hat, die leitende Folienschicht (18; 218) eine Dicke hat und das Verhältnis des Durchmessers des Leiters zur Dicke der leitenden Folienschicht etwa 200:1 beträgt.

15. Anschlussdraht nach einem der Ansprüche 10-14, wobei die leitende Folienschicht (18; 218) gegenüberliegende Enden aufweist, die einander überlappen, wenn sie an dem freiliegenden Abschnitt (16; 216) des Leiters (12; 212) angebracht ist.

Revendications

1. Procédé de raccordement d'un fil (10 ; 210) à un élément de contact (20 ; 220), le fil comprenant un conducteur (12 ; 212) et une couche isolante (14; 214) entourant le conducteur, le conducteur étant formé d'aluminium ou d'un alliage d'aluminium, le procédé comprenant :

le retrait de la couche isolante du conducteur pour exposer une partie (16 ; 216) du conducteur, la partie exposée ayant une circonférence ;
l'installation d'une couche de feuille conductrice (18 ; 218) sur la partie exposée du conducteur de sorte que la couche de feuille conductrice (18 ; 218) entoure entièrement la circonférence de la partie exposée du conducteur ;
le soudage de la couche de feuille conductrice (18 ; 218) et de la partie exposée du conducteur l'une à l'autre pour former une masse amalgamée ; et
l'installation de l'élément de contact (20; 220) sur la masse amalgamée, l'élément de contact étant formé d'un matériau différent du conducteur (12 ; 212) et de la couche de feuille conductrice (18 ; 218), dans lequel :

la couche de feuille conductrice (18 ; 218) est formée de cuivre,
le procédé étant **caractérisé en ce que** la couche de feuille conductrice (218) comprend un écran ondulé ayant une pluralité de parties élevées réparties le long de surfaces supérieure et inférieure ; et
lorsque la couche de feuille conductrice (218) est installée sur la partie exposée (216), les parties élevées sont configurées pour abraser la partie exposée (216) du conducteur (212) avant le soudage de la couche de feuille conductrice (218) et de la partie exposée.

2. Procédé selon la revendication 1, dans lequel l'installation de l'élément de contact (20 ; 220) sur la masse amalgamée comprend le sertissage de l'élément de contact.

3. Procédé selon la revendication 1 ou la revendication 2 dans lequel le soudage de la couche de feuille conductrice (18 ; 218) et de la partie exposée (16 ; 216) du conducteur (12 ; 212) l'une à l'autre comprend le soudage par ultrasons de la couche de feuille conductrice sur la partie exposée du conducteur.

4. Procédé selon l'une quelconque des revendications 1 à 3 comprenant en outre le nettoyage de la partie exposée (16 ; 216) du conducteur (12 ; 212) avant le soudage de la couche de feuille conductrice (18 ; 218) et de la partie exposée du conducteur l'une à l'autre, et facultativement dans lequel le nettoyage de la partie exposée du conducteur comprend le traitement au plasma de la partie exposée du conducteur.

5. Procédé selon l'une quelconque des revendications 1 à 4 comprenant en outre l'application d'un métal d'apport (26) sur la masse amalgamée, et facultativement dans lequel l'application du métal d'apport sur la masse amalgamée

comprend l'immersion de la masse amalgamée dans une matière en fusion.

6. Procédé selon l'une quelconque des revendications 1 à 5 dans lequel l'élément de contact (20 ; 220) est formé de laiton.

7. Procédé selon l'une quelconque des revendications 1 à 6 dans lequel la couche de feuille conductrice (18 ; 218) présente une épaisseur, et le rapport du diamètre du conducteur (12 ; 212) à l'épaisseur de la couche de feuille conductrice est d'environ 200:1.

8. Procédé selon la revendication 2 comprenant en outre le soudage d'une surface extérieure de l'élément de contact (20 ; 220).

9. Procédé selon l'une quelconque des revendications 1 à 8 dans lequel l'installation de la couche de feuille conductrice (18 ; 218) comprend l'enveloppement de la couche de feuille conductrice entièrement autour de la partie exposée (16 ; 216) du conducteur (12 ; 212) de sorte que des extrémités opposées de la couche de feuille conductrice se chevauchent.

10. Fil raccordé (21) comprenant :

un conducteur (12 ; 212), le conducteur comprenant une partie exposée (16 ; 216) et étant formé d'aluminium ou d'un alliage d'aluminium, la partie exposée ayant une circonférence ;
une couche de feuille conductrice (18 ; 218) formée de cuivre et installée sur la partie exposée du conducteur de sorte que la couche de feuille conductrice entoure entièrement la circonférence de la partie exposée du conducteur ;
un élément de contact (20 ; 220) formé d'un matériau différent du conducteur et de la couche de feuille conductrice ; dans lequel :

la couche de feuille conductrice (18 ; 218) et la partie exposée du conducteur sont soudées l'une à l'autre pour former une masse amalgamée,
l'élément de contact (20 ; 220) est fixé à la masse amalgamée,
le fil raccordé étant **caractérisé en ce que** la couche de feuille conductrice (218) comprend un écran ondulé ayant une pluralité de parties élevées réparties le long de surfaces supérieure et inférieure ; et
lorsque la couche de feuille conductrice (218) est installée sur la partie exposée (216), les parties élevées sont configurées pour abraser la partie exposée (216) du conducteur (212) avant le soudage de la couche de feuille conductrice (218) et de la partie exposée.

11. Fil raccordé selon la revendication 10 dans lequel le conducteur (12 ; 212) est un conducteur nu.

12. Fil raccordé selon la revendication 10 et la revendication 11 dans lequel le conducteur (12 ; 212) est formé d'un alliage d'aluminium et l'élément de contact (20 ; 220) est formé de laiton.

13. Fil raccordé selon l'une quelconque des revendications 10 à 12 dans lequel la couche de feuille conductrice (18 ; 218) et la partie exposée (16 ; 216) du conducteur (12 ; 212) sont assemblées entre elles par soudage par ultrasons.

14. Fil raccordé selon l'une quelconque des revendications 10 à 13 dans lequel le conducteur (12 ; 212) présente un diamètre, la couche de feuille conductrice (18 ; 218) p une épaisseur, et le rapport du diamètre du conducteur à l'épaisseur de la couche de feuille conductrice est d'environ 200:1.

15. Fil raccordé selon l'une quelconque des revendications 10 à 14 dans lequel la couche de feuille conductrice (18 ; 218) comprend des extrémités opposées qui se chevauchent lorsqu'elle est installée sur la partie exposée (16 ; 216) du conducteur (12 ; 212).

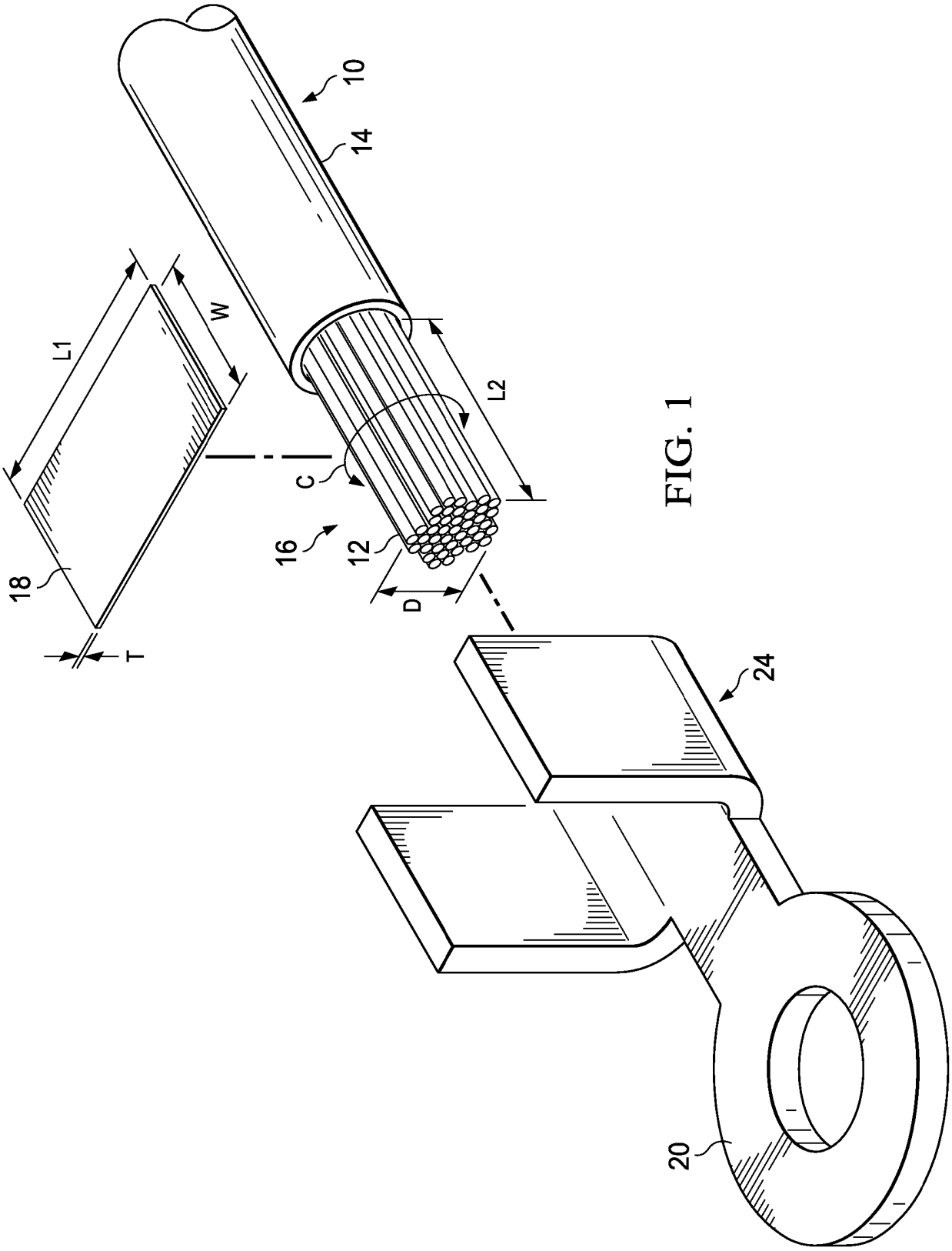


FIG. 1

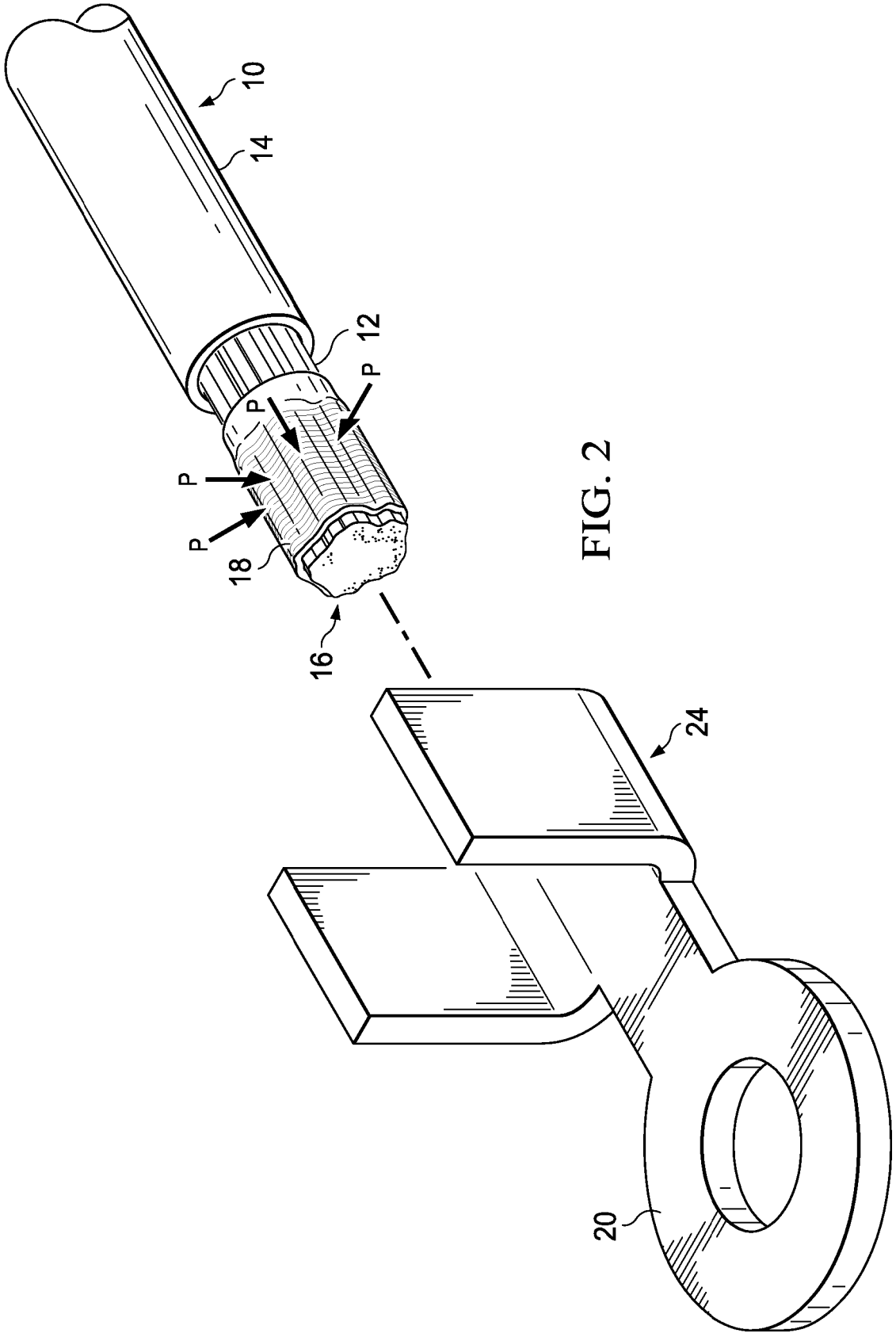


FIG. 2

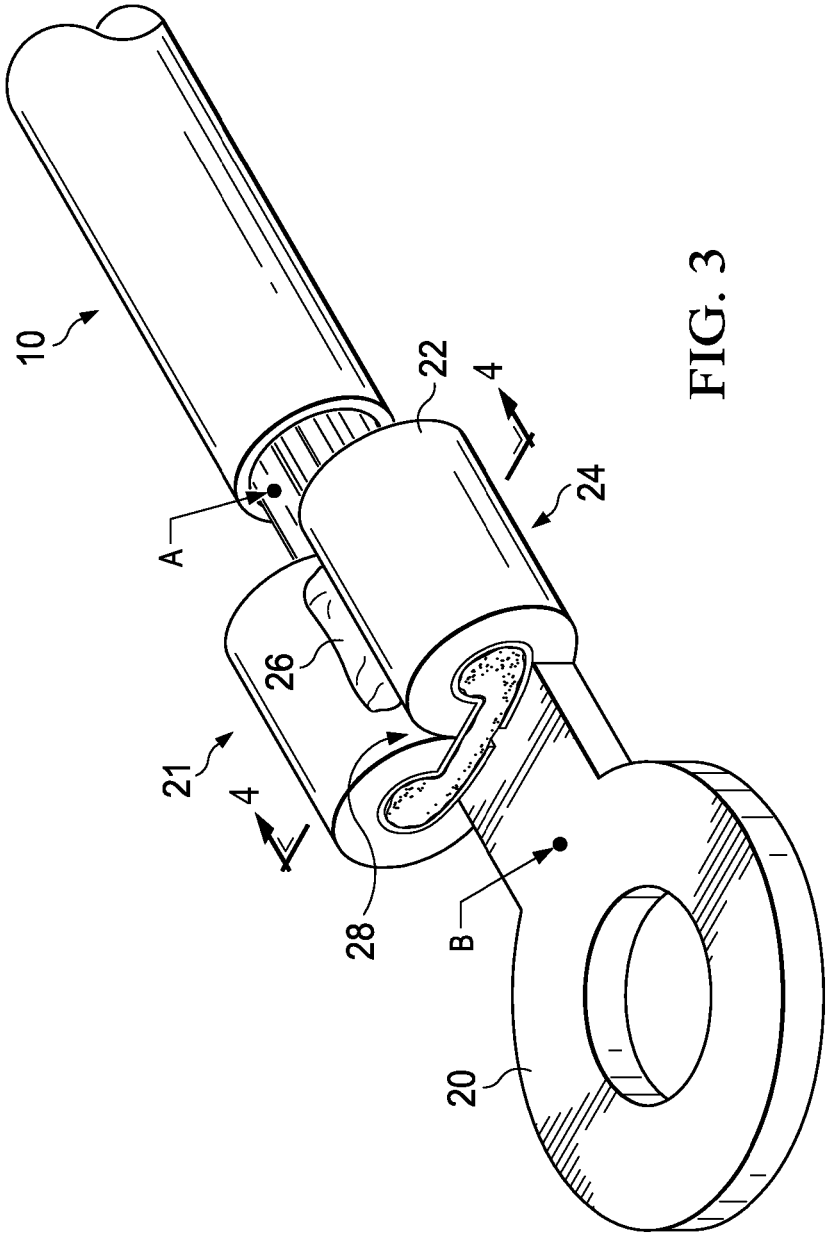


FIG. 3

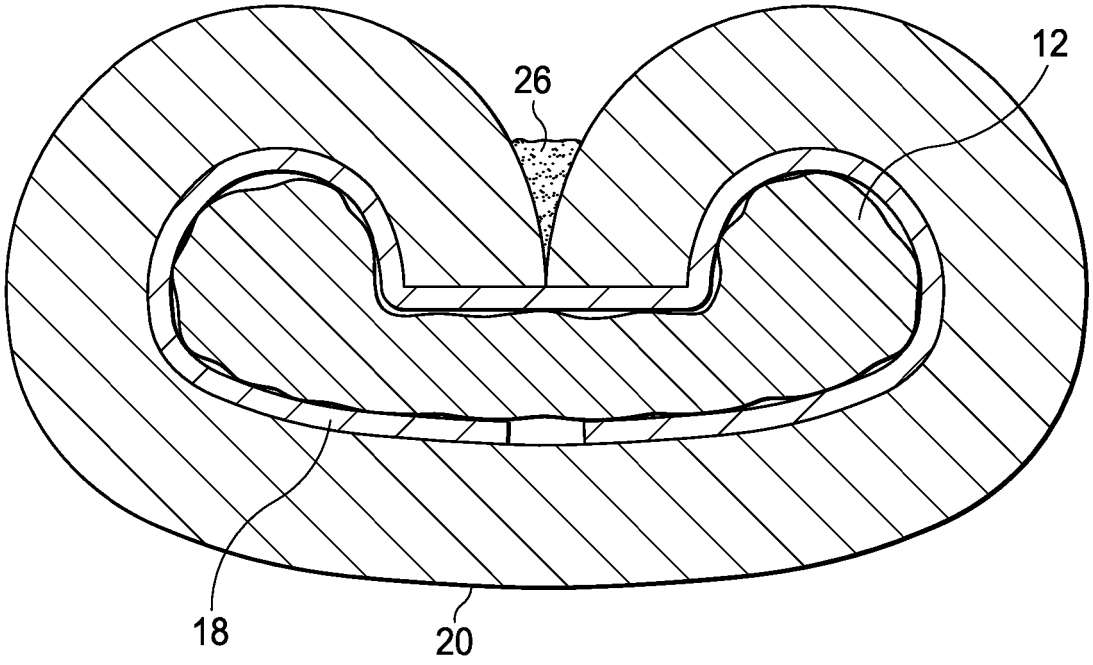


FIG. 4

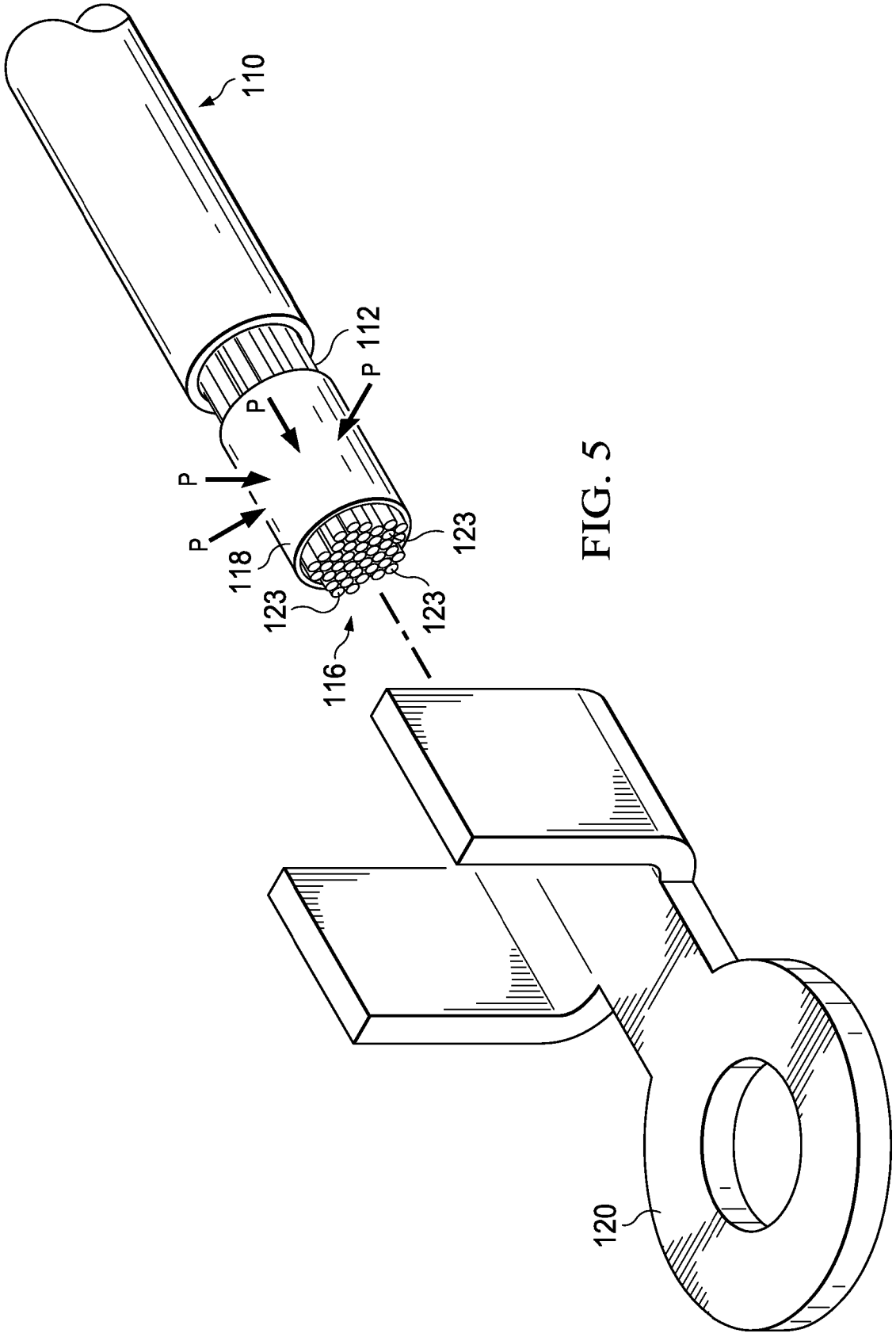


FIG. 5

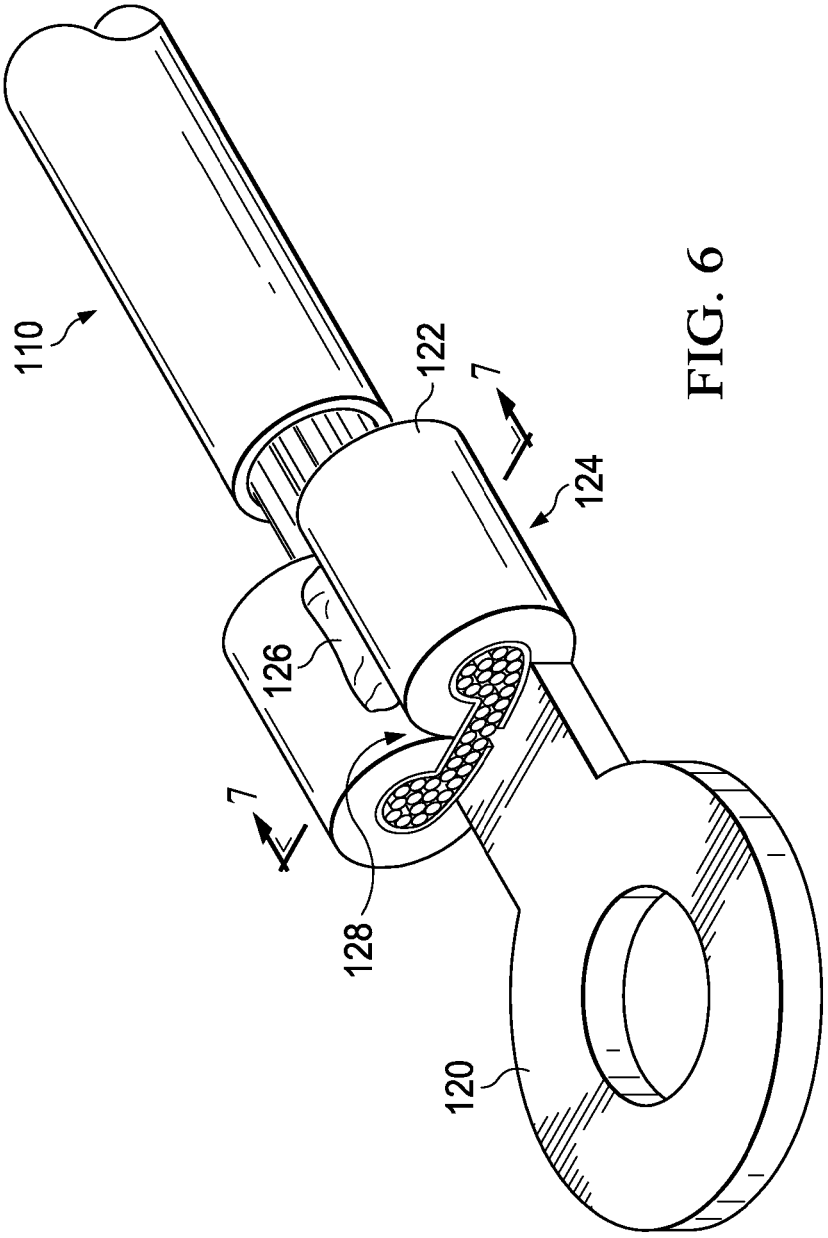


FIG. 6

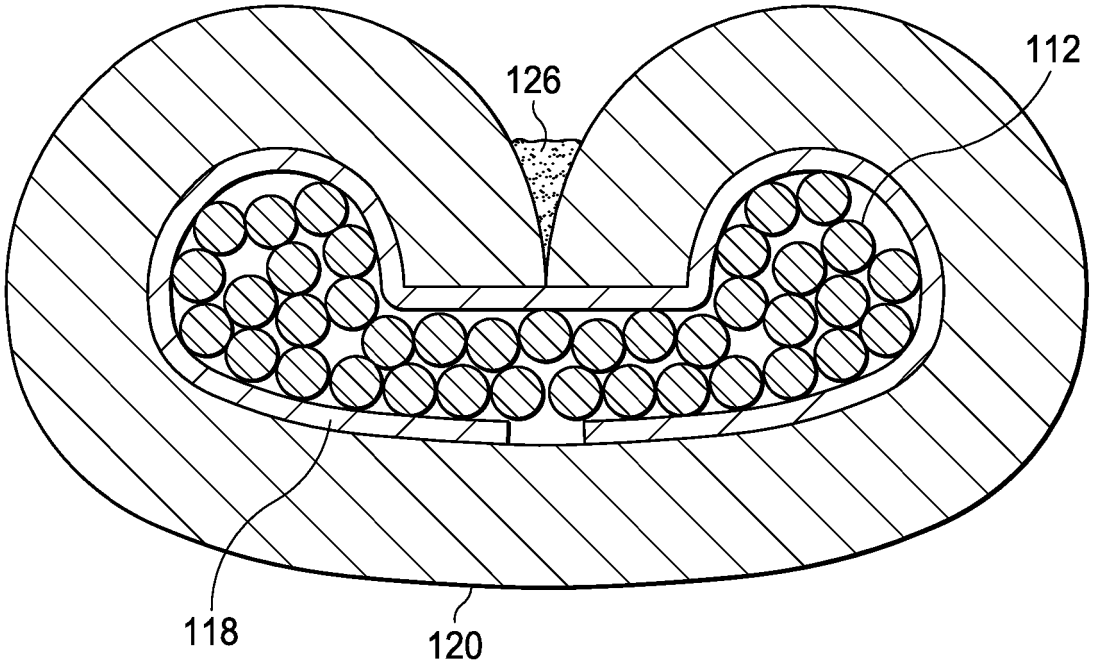


FIG. 7

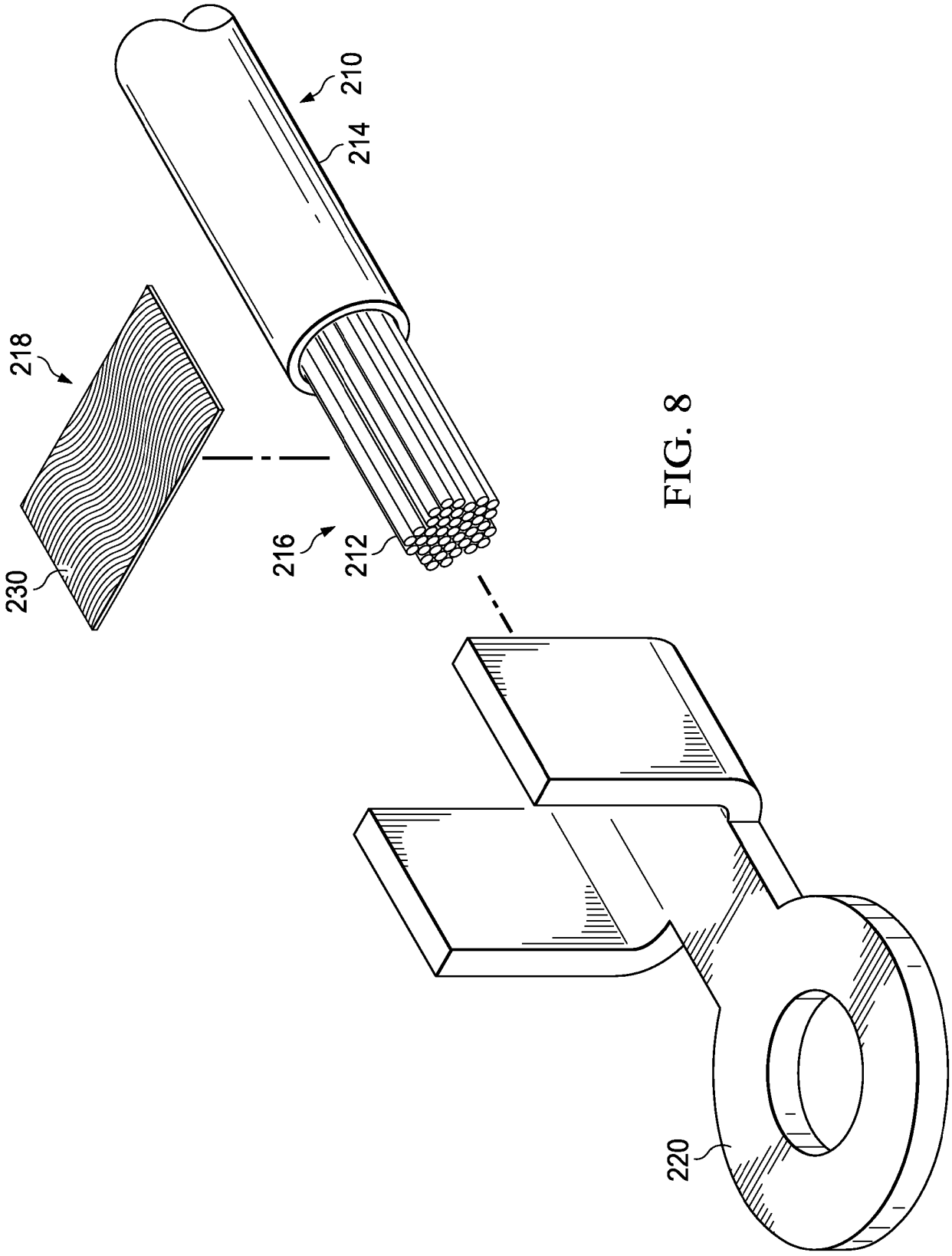


FIG. 8

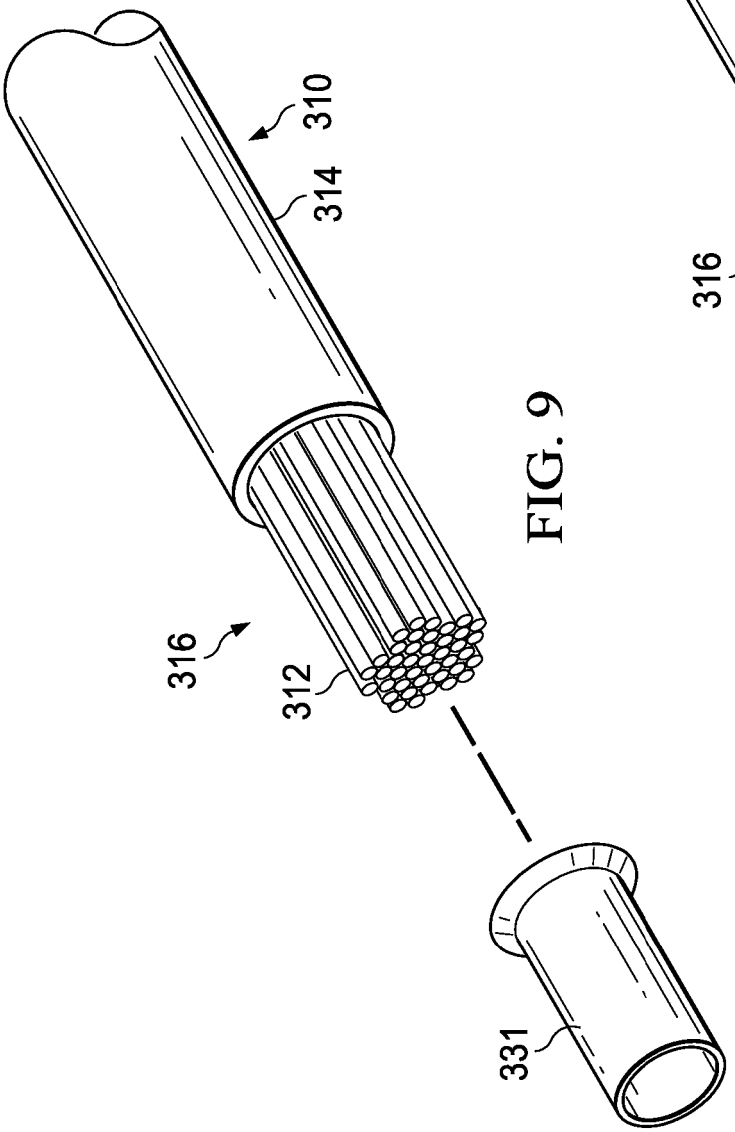


FIG. 9

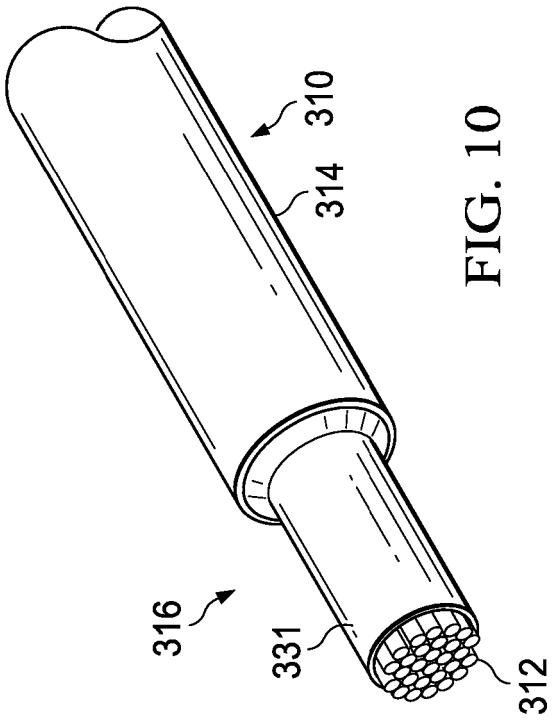


FIG. 10

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO 2011118416 A1 **[0004]**
- DE 10223397 A1 **[0005]**