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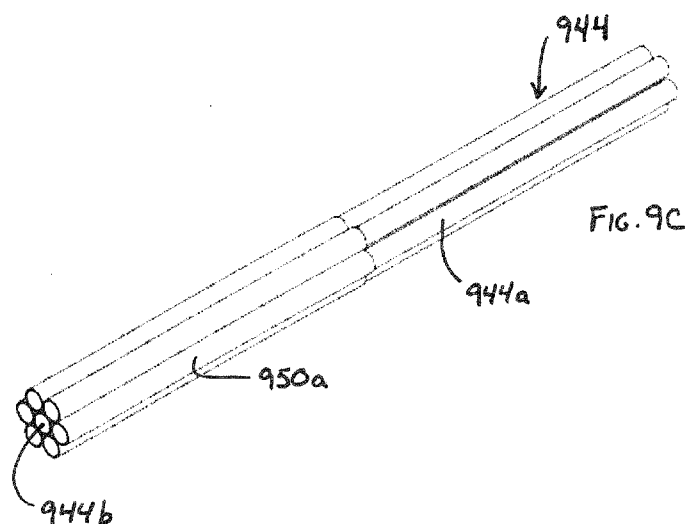
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(57) Abstract: A termination arrangement for securing an overhead electrical cable having a multi-element strength member to a dead-end structure such as a dead-end tower. The termination arrangement includes a compression sheath structure that is configured to be disposed over the individual composite rods of the strength member. The compression sheath structure mitigates damage to the strength member that may occur when an outer metallic sleeve is compressed around the conductive strands and the conductive strands are compressed against the strength member. The arrangement is particularly useful for securing overhead electrical cables having a composite strength member to a dead-end structure.

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TERMINATION ARRANGEMENT FOR AN OVERHEAD ELECTRICAL CABLE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the priority benefit of US Patent Application No. 16/521,580 by Pilling and filed on July 24, 2019, the disclosure of which is incorporated herein by reference in its entirety.

FIELD

[0002] This disclosure relates to the field of overhead electrical cables, and in particular relates to structures and methods for the termination of overhead electrical cables having a multi-element composite strength member, such as termination at a dead-end structure.

BACKGROUND

[0003] In the construction of an overhead electrical transmission and/or distribution line, the overhead electrical cable that transmits the electricity is strung upon support towers along the length of the line. The overhead electrical cable typically includes one or more conductive layers that each include of a plurality of individual conductive strands that are wrapped around and are supported by a strength member. The strength member is necessary because the conductive strands do not have sufficient mechanical properties (e.g., tensile strength) to be self-supporting when strung between the support towers. Traditionally, the conductive strands are fabricated from aluminum or an aluminum alloy and the strength member is fabricated from steel, specifically several independent steel elements that are combined (e.g., twisted together) to form the strength member, a configuration referred to as ACSR (aluminum conductor steel reinforced).

[0004] In recent years, the steel strength member has been replaced by advanced composite materials for some installations. The advanced composite materials include two or more distinct material phases, such as structural fibers in a binding matrix, that combine to enhance one or more properties of the strength member. Some of these

composite materials offer significant benefits as compared to steel, including higher tensile strength, lower coefficient of thermal expansion, resistance to corrosion and the like.

[0005] One example of an overhead electrical cable having such a composite strength member is the ACCC[®] overhead electrical cable available from CTC Global Corporation of Irvine, CA, USA. See, for example, U.S. Patent No. Pat. No. 7,368,162 by Hiel et al, which is incorporated herein by reference in its entirety. The ACCC[®] electrical cable includes a plurality of conductive aluminum strands surrounding a single-element (e.g., single rod) fiber-reinforced composite strength member. The composite strength member includes an inner core of continuous carbon fibers in a polymer (e.g., resin) binding matrix, surrounded by an outer layer of continuous glass fibers in the binding matrix.

[0006] When constructing electrical transmission and distribution lines, the electrical cable must be frequently terminated, such as for connection to another segment of electrical cable, for drop down to a power station, or for drop down to an underground cable. In these cases, the electrical cable is terminated and attached to a dead-end structure (e.g., a dead-end tower) using termination hardware. Often, the termination hardware requires crimping of an outer conductive metal sleeve onto the electrical cable using very high compressive forces to deform the metal outer sleeve.

[0007] Some fiber-reinforced composite strength member configurations include multiple individual composite elements (e.g., individual composite rods) that are operatively combined to form the strength member. When an overhead electrical cable having such a strength member configuration is compressed during termination of the electrical cable, the compressive forces are transferred to the underlying composite strength member, i.e., are transferred onto the individual strength elements. Due to the relatively low ductility of the composite material and due to the point-to-point contact among the individual composite rods, cracking of the composite rods under the compressed area may occur.

SUMMARY

[0008] Disclosed herein is a termination arrangement that, when used to terminate and overhead electrical cable having a strength member of multiple composite rods reduces localized pressure on the composite strength member during crimping operations to reduce or eliminate cracking of the composite rods. The termination arrangement includes a compression sheath structure that is placed over the individual composite rods in the area where the outer housing is compressed over the conductive strands. The compression sheath structure may remain within the termination arrangement for the life of the connection. The compression sheath structure may be composed of individual cylindrical tubes, or may be composed of a unitary body having a plurality of apertures extending therethrough to receive the individual composite rods.

[0009] In one embodiment, a termination arrangement securing an overhead electrical cable to a dead-end structure is disclosed. The overhead electrical cable includes a composite strength member comprising a plurality of individual composite rods that are operatively combined to form the composite strength member and having conductive strands surrounding the composite strength member. The termination arrangement includes a connector anchoring the termination arrangement to a dead-end structure and an outer metallic sleeve surrounding the proximal end of the overhead electrical cable, the outer metallic sleeve having a compressed portion disposed over the proximal end of the overhead electrical cable. A compression sheath structure is disposed between at least the individual composite rods along at least the length of the conductive strands under the compressed portion.

[0010] The foregoing termination arrangement may be characterized as having further refinements and/or additional features, which may be implemented alone or in any combination. For example, in one refinement, the individual composite rods of the strength member comprise reinforcing fibers disposed within a binding matrix. The binding matrix may be a metallic matrix or may be a polymeric matrix. The polymeric matrix may include a polymer selected from a thermoset resin polymer and a thermoplastic polymer. The reinforcing fibers may include fibers selected from the group consisting of carbon fibers, boron fibers, metal oxide ceramic fibers, glass fibers, carbide

fibers, aramid fibers and basalt fibers. In one particular refinement, the reinforcing fibers comprise carbon fibers.

[0011] In another refinement, at least a portion of the conductive strands have a cross-sectional shape that is polygonal. In yet another refinement, at least a portion of the conductive strands have a cross-sectional shape that is non-polygonal. In another refinement, the conductive strands comprise aluminum strands, and in one particular refinement the conductive strands comprise hardened aluminum strands. In yet another refinement, the conductive strands comprise copper strands.

[0012] In one construction, the compression sheath structure does not extend substantially beyond the compressed portion of a distal end of the termination arrangement.

[0013] In another construction, the compression sheath structure comprises a plurality of individual cylindrical tubes, wherein each of the individual cylindrical tubes is disposed over an end of an individual composite rod. In one refinement of this construction, the strength member comprises a central composite rod and a plurality of outer composite rods surrounding the central rod, wherein one of the individual cylindrical tubes is disposed over an end of each of the outer composite rods. In another construction, one of the individual cylindrical tubes is disposed over an end of the central composite rod. In one refinement, the individual cylindrical tubes comprise closed cylindrical tubes. In yet another refinement, the individual cylindrical tubes comprise tubes having a slot along a length thereof, e.g., to facilitate placement of the cylindrical tubes over the composite rods. In another refinement, the individual cylindrical tubes have a wall thickness of at least about 2 mm. In yet another refinement, the individual cylindrical tubes have a wall thickness of not greater than about 12 mm.

[0014] In another construction, the compression sheath structure comprises a unitary body having a plurality of apertures longitudinally-extending through the body and defining walls between adjacent apertures, wherein the apertures are configured to operatively receive the individual composite rods within the apertures. In one characterization, the unitary body has a length of at least about 400 mm. In another characterization, the unitary body has a length of not greater than about 1 meter. In yet

another characterization, the walls between adjacent apertures have a minimum wall thickness of at least about 2 mm, and in a further characterization the walls between adjacent apertures have a minimum wall thickness of not greater than about 12 mm. In another refinement, the unitary body has a substantially circular cross-section.

[0015] In another construction, the compression sheath structure is structurally independent from the composite strength member. In one refinement, compression sheath structure is fabricated from a material selected from the group consisting of a metallic material, a polymeric material, and a composite material. In one particular refinement, the compression sheath structure is fabricated from a metallic material. The metallic material may be aluminum, particularly annealed aluminum, for example.

[0016] In one construction, the connector comprises an eye bolt. In another construction, the termination arrangement further comprises a jumper plate.

[0017] The present disclosure also relates to a method for terminating an overhead electrical cable, e.g., for securing an overhead electrical cable to a dead-end structure. The overhead electrical cable comprises a composite strength member that includes a plurality of individual composite rods that are operatively combined to form the composite strength member, and includes conductive strands surrounding the composite strength member. The method includes the steps of placing a compression sheath structure over the individual composite rods at a proximal end of the overhead electrical cable, placing an outer metallic sleeve over at least the proximal end of the overhead electrical cable and the compression sheath structure, and compressing at least a portion of the outer metallic sleeve onto the conductive strands.

[0018] The foregoing method may be characterized as having further refinements and/or additional steps, which may be implemented alone or in any combination. In one characterization, the compressing step comprises applying a pressure of at least about 15 tons to the outer metallic sleeve. In another characterization, the method includes the step of securing a proximal end of the composite strength member to a connector. In yet another characterization, the method includes the step of anchoring the connector to a dead-end structure.

[0019] In another embodiment, a kit comprising components that are configured to

be assembled into a termination arrangement for securing an overhead electrical cable to a dead-end structure is disclosed. The components are configured to be assembled into a termination arrangement for securing an overhead electrical cable to a dead-end structure, the overhead electrical cable having a composite strength member comprising a plurality of individual composite rods that are operatively combined to form the composite strength member and having conductive strands surrounding the composite strength member. The kit includes a connector configured to anchor the termination arrangement to a dead-end structure, an outer metallic sleeve configured to surround the proximal end of the overhead electrical cable, and a compression sheath structure that is configured to be disposed over the individual composite rods along at least the length of the outer metallic housing.

DESCRIPTION OF THE DRAWINGS

[0020] FIG. 1 illustrates a schematic view of a termination arrangement for an overhead electrical cable having a composite strength member.

[0021] FIG. 2 illustrates a perspective view of a termination arrangement that has been crimped onto an overhead electrical cable.

[0022] FIG. 3 illustrates a perspective view of an overhead electrical cable having a composite strength member.

[0023] FIGS. 4A - 4B illustrate a compression sheath according to an embodiment of the present disclosure.

[0024] FIG. 5 illustrates a termination arrangement according to an embodiment of the present disclosure.

[0025] FIGS. 6A - 6B illustrate cross-sectional views of overhead electrical cables.

[0026] FIG. 7 illustrates a cross-sectional view of a termination arrangement and a compression sleeve according to an embodiment of the present disclosure.

[0027] FIG. 8 illustrates a perspective view of an overhead electrical cable having a multi-element composite strength member.

[0028] **FIGS. 9A – 9C** illustrate a compression sheath structure according to an embodiment of the present disclosure.

[0029] **FIGS. 10A – 10B** illustrate a compression sheath structure according to an embodiment of the present disclosure.

[0030] **FIGS. 11A – 11B** illustrate a compression sheath structure according to an embodiment of the present disclosure.

[0031] **FIGS. 12A – 12B** illustrate a compression sheath structure according to an embodiment of the present disclosure.

[0032] **FIGS. 13A – 13B** illustrate a termination arrangement according to an embodiment of the present disclosure.

DESCRIPTION OF THE EMBODIMENTS

[0033] **FIG. 1** illustrates a termination arrangement (e.g., a dead-end) for use with an overhead electrical cable. The termination arrangement **110** illustrated in **FIG. 1** is also illustrated and described in PCT Publication No. WO 2005/041358 by Bryant and in U.S. Patent No. 8,022,301 by Bryant et al., each of which is incorporated herein by reference in its entirety.

[0034] Broadly characterized, the termination arrangement **110** illustrated in **FIG. 1** includes a gripping element **112**, an outer sleeve **120** and a connector **130** for anchoring the termination arrangement **110** to a dead-end structure (e.g., to a termination tower), not illustrated, e.g., using eyebolt **132**. Opposite the eyebolt **132**, the termination arrangement **110** is operatively connected to an overhead electrical cable **140** that includes an electrical conductor **142** that surrounds a composite strength member **144**.

[0035] The gripping element **112** tightly grips the composite strength member **144** to secure the overhead electrical cable **140** to the termination arrangement **110**. As illustrated in **FIG. 1**, the gripping element **112** includes a collet **116** having a lumen that surrounds and grips onto the strength member **144**. The collet **116** is disposed in a collet housing **114**. As the electrical cable **140** is tensioned and pulls the strength member **144**,

friction develops between the strength member **144** and the collet **116** (e.g., along the lumen), and the strength member **144** pulls the collet **116** further into the collet housing **114**. The conical shape of the collet **116** and the funnel shape of the collet housing **114** create increased compression on the strength member **144**, ensuring that the strength member **144** does not slip out of the collet **116**.

[0036] An outer sleeve **120** surrounds the gripping element **112**, and surrounds the threaded portion **134** and on intermediate portion **136** of the connector **130**. The outer sleeve **120** includes a conductive body **128** to facilitate electrical conduction between the electrical conductor **142** and a jumper plate **126**. For example, the conductive body **128** may be fabricated from aluminum. As illustrated in **FIG. 1**, the jumper plate **126** is welded onto the conductive body **128**. In use, the jumper plate **126** is configured to attach to a connection plate **150** to facilitate electrical conduction between the electrical cable **140** and another conductor, e.g., another electrical cable (not illustrated) that is operatively connected to the connection plate **150**.

[0037] The connector **130** includes an eyebolt **132** at a proximal end of the connector **130** and a threaded portion **134** disposed at a distal end of the connector **130**. The threaded portion **134** is configured to operatively mate with a threaded portion **118** of the collet housing **114** to facilitate movement of the connector **130** toward the collet **116**, pushing the collet **116** into the collet housing **114**, when the connector is rotated, e.g., rotated clockwise. This strengthens the grip of the collet **116** onto the strength member **144**, further securing the overhead electrical cable **140** to the termination arrangement **110**. The eyebolt **132** is configured to be attached to a dead-end structure to secure the termination arrangement **110** and hence the electrical cable **140**, to the dead-end structure, e.g., to a termination tower.

[0038] In some situations, it is desirable or necessary to further secure the overhead electrical cable **140** to the termination structure **110**. For example, it may be desirable to crimp the outer sleeve **120** onto the connector **130**, particularly onto the intermediate portion **136** of the connector. Crimping involves the application of extreme pressure to the sleeve **120** using a press and die to mechanically deform and compress the sleeve **120** onto the connector **130**. Further, the sleeve **120** may also be crimped onto

the overhead electrical cable **140** at the distal end of the termination structure **110**. Such crimping of the outer sleeve **120** ensures that the housing **120** will not move relative to the overhead electrical cable **140** after installation. The termination structure **110** may also include a metallic (e.g., aluminum) inner filler sleeve **122** to enhance the electrical and mechanical contact between the outer sleeve **120** and the electrical cable **140** when the sleeve **120** is crimped onto the electrical cable **140**. The use of a soft (e.g., annealed) aluminum for the electrical conductor **142** (e.g., conductive strands), and the use of trapezoidal conductive strands, prevents damage to the composite strength member **144** when the outer sleeve **120** is crimped onto the electrical cable **140**.

[0039] FIG. 2 illustrates a perspective view of a termination arrangement that has been crimped onto an overhead electrical cable. As is described above with respect to FIG. 1, the termination arrangement **210** includes a connector having an eye bolt **232** that extends outwardly from a proximal end of an outer metallic sleeve **220**. A jumper plate **226** is welded to the proximal end of the conductive body **228** for electrical connection to, e.g., a connection plate (see FIG. 1). As illustrated in FIG. 2, the outer sleeve **220** is crimped over two regions, namely proximal crimped region **220b** and distal crimped region **220a**. The proximal crimped region **220b** is situated over an intermediate portion of the connector (see FIG. 1), and the distal crimped region **220a** is situated over a portion of the overhead electrical cable **240**. The extreme compressive forces placed around the outer sleeve **220** during the crimping operation are transferred to the underlying components, i.e., to the connector under the crimped region **220b** and to the overhead electrical cable **240** under the crimped region **220a**.

[0040] Thus, the conductive strands and other components of the termination arrangement, e.g., the outer sleeve, are fabricated from aluminum. As used herein, and unless otherwise specified, when the term “aluminum” is used on its own, it refers generally to pure aluminum or aluminum alloys (e.g., comprising at least about 50 wt.% aluminum), as well as all types of aluminum that have been heat treated (e.g., annealed), work hardened, extruded or otherwise processed in a manner that results in a desirable property in the final component. As used herein, the term “soft aluminum” refers to a substantially pure (e.g., unalloyed) form of aluminum, which may be annealed. Examples of soft aluminum include the Aluminum Association “1xxx” series (e.g., greater than 99%

aluminum) that have been annealed, such as the AA1350-O aluminum, which is a fully annealed aluminum. Further, the terms "hardened aluminum" or "hard aluminum" refer to aluminum that has a tensile strength of at least about 100 MPa, such as at least about 120 MPa, such as at least about 150 MPa, or even at least about 200 MPa. Hardened aluminum may have a tensile strength up to about 380 MPa, for example. As noted above, when the conductive strands surrounding the composite strength member are fabricated from a soft aluminum, the strand will deform and absorb some of the compressive force, thereby reducing the stresses on the underlying composite strength member. The use of trapezoidal-shaped (i.e., trapezoidal cross-section) conductive strands, which have a high surface area in direct contact with the strength member, can also reduce the stress that is placed on the composite strength member. As a result, there is very low probability that the crimping operation will damage the underlying composite strength member.

[0041] FIG. 3 illustrates a cross-section of an overhead electrical cable **340**. The cable **340** includes an electrical conductor **342** for the conduction of electricity. The electrical conductor includes two layers of conductive strands **342a** and **342b** that are wrapped (e.g., stranded) around a central strength member **344**. The strength member **344** is formed from a single rod of a fiber-reinforced composite material having an inner carbon fiber core **344a** and an outer layer **344b** of an insulative material such as glass fibers.

[0042] The conductive strands **342a/342b** have a substantially trapezoidal cross-section with top and bottom surfaces that may be slightly curved (e.g., arcuate) to form the substantially cylindrical conductor structure with few gaps between adjacent strands **342a/342b** and between the strands **342a** and the strength member **344**. The conductive strands **342a/342b** are selected to have a high conductivity and are fabricated from AA-1350-O aluminum having a high conductivity (e.g., about 61% IACS).

[0043] In some installations, however, the overhead electrical cable includes a conductor formed from conductive strands that have a shape (e.g., the cross-section) that creates stress points along a length of the composite strength member when the outer sleeve is compressed onto the conductive strands. For example, conductive strands

having a circular cross-section may produce stress points due to the relatively small contact area of the strands with the underlying composite strength member. Under such circumstances, the strength member may be susceptible to damage (e.g., fracture) when the conductive strands are compressed onto the strength member at high pressure.

[0044] The conductive strands may also be formed from hard aluminum, such as when the line is installed in a region the experiences heavy ice-loading of the electrical cable. For example, the conductive strands may include, but are not limited to, conductive strands of Al-Zr alloys or AA1350-H10 aluminum, which is a strain-hardened aluminum.

[0045] According to the present disclosure, a compression sheath is included between the conductive strands and the composite strength member, at least along the portion of the overhead electrical cable that is subject to compression. The compression sheath is configured to absorb (e.g., to dissipate) at least a portion of the compressive stresses that would otherwise be placed on the composite strength member. **FIG. 4A** illustrates a perspective view of a compression sheath according to an embodiment of the present disclosure, and **FIG. 4B** illustrates a cross-section of the compression sheath of **FIG. 4A**. The compression sheath **460** is configured (e.g., shaped and sized) to slide over a composite strength member, for example a single-element composite strength member having a circular cross-section, and under the conductive strands.

[0046] In this regard, the inner diameter (ID) of the compression sheath **460** is sized to substantially match the outer diameter of the strength member, e.g., so that there is substantially no gap between the inner circumference of the compression sheath **460** and the outer circumference of the composite strength member. For example, the inner diameter of the compression sheath for use with a single-element composite strength member may be at least about 1 mm, such as at least about 2 mm, such as at least about 2.5 mm. Typically, the inner diameter of the compression sheath for use with a single-element composite strength member will typically not be greater than about 25 mm, such as not greater than about 20 mm, or even not greater than about 15 mm.

[0047] The thickness (t) of the compression sheath should be sufficient to protect the underlying composite strength member from fracturing under the compressive forces of the crimping operation. However, if the thickness is too large, it may be difficult to place

(e.g., to slide) the sheath between the composite strength member and the conductive strands during the termination process. In one characterization, the sheath has a thickness of at least about 0.20 mm, such as at least about 0.5 mm, such as at least about 1.0 mm. In another characterization, the sheath has a thickness of not greater than about mm, such as not greater than about 2.0 mm.

[0048] The compression sheath **460** may be fabricated from a variety of materials. In one characterization, the compression sheath **460** is fabricated from a metallic material. In one particular characterization, the compression sheath may be fabricated from aluminum. The use of hardened aluminum is particularly advantageous for the compression sheath because it allows the aluminum sheath to maintain its shape while being installed in between the composite core strand and the conductive strands wrapped around the composite core. Hardened aluminum is also readily extrudable.

[0049] In one particular characterization, the compression sheath is fabricated from an Aluminum Association Series 6xxx alloy ("AA6xxx alloy"), which typically has a tensile strength of at least about 150 MPa and not greater than about 380 MPa. AA6xxx alloys include silicon and magnesium as alloying elements to form magnesium silicide with the alloy. Other useful aluminum alloys include Al-Zr alloys such as AA7xxx alloys. Other useful metals for the compression sleeve may include copper and steel. Non-metallic materials may also be useful, such as high performance plastics (e.g., polymers) including, but not limited to, PEEK (polyetheretherketone), PEK (polyetherketone) and PES (poly(ethersulfone)). Such plastics may be reinforced with fibers such as carbon fibers, glass fibers, aramid fibers, fluorocarbon fibers (e.g., PTFE fibers) and the like to enhance the mechanical properties of the plastic.

[0050] As illustrated in **FIGS. 4A-4B**, the compression sleeve **460** may include a longitudinally-extending slot **462**. The longitudinally extending slot **462** may facilitate the placement of the compression sleeve **460** over the composite strength member during assembly of the termination arrangement. Although illustrated as a longitudinally-extending slot **462**, the compression sleeve **460** may also include a non-linear slot, such as a slot that is in the shape of a spiral around the outer circumference of the sleeve **460**. Other sheath configurations may include knurls around the outside of the surface of the

sheath, and/or a taper on one or both ends. These configurations may facilitate the separation of the conductive strands from the composite strength member and allow the sheath to more easily be inserted between the composite strength member and the conductive strands wrapped around the composite strength member. Further, the sheath may be configured in two or more parts that can come together to form a substantially continuous cylinder around the composite strength member when installed between the strength member and the conductive strands wrapped around the strength member.

[0051] In another configuration, the compression sheath may include a closed cylindrical tube, e.g., a cylindrical tube that is open at both ends and does not include a slot or other separation along the wall of the sheath.

[0052] The length of the compression sheath **460** is selected such that the compression sheath **460** surrounds the composite strength member at least along the length of composite strength member that is subjected to the compressive forces during the crimping process. In one characterization, the compression sheath **460** has a length of at least about 150 mm, such as at least about 450 mm. However, the compression sheath **460** should not extend substantially beyond the length of composite strength member that is under compression, e.g., should not extend toward the connector beyond the conductive strands. In one characterization, the compression sheath **460** has a length of not greater than about 915 mm, such as not greater than about 650 mm.

[0053] **FIG. 5** illustrates a partial cross-section of a termination arrangement according to the present disclosure, e.g., for securing an overhead electrical cable to a dead-end structure. The overhead electrical cable **540** includes a composite strength member **546** and conductive strands **542** surrounding the composite strength member **546**. The termination arrangement **510** includes a gripping element secured by the connector and gripping the composite strength member **546** at a proximal end of the overhead electrical cable **540**. As illustrated in **FIG. 5**, the gripping element **512** includes a collet **516** and a collet housing **514**, where the collet **516** extends slightly beyond the housing **514** and grips the composite strength member **546**. The outer metallic sleeve **520** surrounds the gripping element **512** and the proximal end of the overhead electrical cable **540**. A compressed portion **520a** of the outer metallic sleeve **520** is disposed over

(e.g., around) the proximal end of the overhead electrical cable **540**. The compression sheath **560** is disposed between the composite strength member **546** and the conductive strands **542** along at least the length of the compressed portion **520a**.

[0054] The termination arrangement **510** is particularly suited for use with an overhead electrical cable **540** that includes a composite strength member **546**. Examples of overhead electrical cables for which the termination arrangement **510** is particularly useful include, but are not limited to, those having a strength member comprising reinforcing fibers bound in a matrix, such as a polymeric matrix or a metallic matrix. The reinforcing fibers may be substantially continuous reinforcing fibers that extend along the length of the composite strength member, and/or may include short reinforcing fibers (e.g., fiber whiskers or chopped fibers) that are dispersed through the matrix. The fibers may be selected from a wide range of materials, including but not limited to, carbon, glass, boron, metal oxides, metal carbides, high-strength polymers such as aramid fibers or fluoropolymer fibers, basalt fibers and the like. The matrix material may include, for example, a plastic (e.g., polymer) such as a thermoplastic polymer or a thermoset polymer. The matrix may also be a metallic matrix, such as an aluminum matrix. One example of an aluminum matrix composite strength member is illustrated in U.S. Patent No. 6,245,425 by McCullough et al., which is incorporated herein by reference in its entirety. One example of a polymer matrix fiber-reinforced strength member is the strength member used in the ACCC[®] overhead electrical cable that is manufactured by CTC Global Corporation of Irvine, CA, USA. Such an overhead electrical cable is illustrated, for example, in U.S. Pat. No. 7,368,162 by Hiel et al, which is incorporated herein by reference in its entirety. Although illustrated in **FIG. 5** as a single-element strength member **546** (e.g., a single rod), the strength member may include a plurality of individual composite elements that are combined (e.g., helically twisted together) to form the strength member, as is discussed in more detail below.

[0055] The conductive strands **542** may have a polygonal or a non-polygonal cross-section. In one characterization, the conductive strands **542** have a non-polygonal cross-section, e.g., that creates stress points along the length of the composite strength member **546** that is being compressed. In one characterization, the conductive strands

include strands having a circular cross-section section that are in direct contact with the composite strength member **546**. Strands having a circular cross-section concentrate the applied force along the line of contact between the circular strand and the composite strength member, which may lead to fracture of the composite strength member **546** even under relatively moderate compressive loads. The conductive strands may be fabricated from conductive metallic materials, including but not limited to, aluminum and copper. One particular characterization, the conductive strands include hardened aluminum, e.g., non-annealed, aluminum conductive strands such as Al-Zr conductive strands or AA1350-H19 conductive strands.

[0056] **FIGS. 6A** and **6B** illustrate schematic cross-sections of an end of an overhead electrical cable without a compression sheath (**FIG. 6A**) and with a compression sheath (**FIG. 6B**). As illustrated in **FIG. 6A**, the overhead cable **640A** comprises a composite strength member **646A** that includes carbon fibers in a polymeric matrix. A plurality of conductive strands **642A** having a circular cross-section are helically wrapped around the strength member **646A**. It can be seen in **FIG. 6A** that the circular conductive strands **642A** have a relatively small portion that is in direct contact with the underlying strength member **646A**. Thus, when the conductive strands **642A** are compressed onto the strength member **646A** during a crimping operation, stresses are concentrated under the portion of conductive strand **642A** contacting the strength member **646A**.

[0057] **FIG. 6B** illustrates the use of a compression sheath during the termination process according to an embodiment of the present disclosure. Similar to **FIG. 6A**, the overhead cable **640B** comprises a composite strength member **646B** that includes carbon fibers in a polymeric matrix. A plurality of conductive strands **642B** having a circular cross-section are helically wrapped around the strength member **646B**. In the embodiment of **FIG. 6B**, a compression sheath **624B** is placed between the conductive strands **642B** and the composite strength member **646B**. The compression sheath **624B** is a closed cylindrical tube that is placed over (e.g., slid onto) the composite strength member **646B** before the crimping operation. As a result, when the conductive strands **642B** are compressed onto the strength member **646B** during the crimping operation, the compression sheath **624B** absorbs and distributes the compressive forces around the entire circumference of the strength member **646B**, thereby reducing the chance of a

fracture in the strength member **646B**.

[0058] **FIG. 7** illustrates another embodiment of a termination arrangement according to the present disclosure. The embodiment of a termination arrangement illustrated in **FIG. 7** is a modification of the termination arrangement disclosed in U.S. Patent No. 7,348,489 by Chadbourne, which is incorporated herein by reference in its entirety.

[0059] As illustrated in **FIG. 7**, the termination arrangement **710** includes a connector **730** having an eye bolt **732**, e.g., for anchoring the termination arrangement **710** to a dead-end structure. A distal portion **724a** of the compression sheath **724** is disposed between the composite strength member **746** and the conductive strands **742** along a distal portion **720a** of the outer metallic housing. The compression sheath **724** includes a proximal portion **724b** that has an outer diameter that is larger than the outer diameter of the distal portion **724a**. The proximal portion **724b** is disposed between the interior of the connector **730** and a portion of the composite strength member **746** that extends beyond the conductive strands **742**. In this manner, the outer metallic housing **720** may be crimped along substantially its entire length, e.g., along portions **720a** and **720b**, while the composite strength member **746** remains protected along the entire length that is subject to the compressive stresses.

[0060] It will be appreciated from the foregoing that the present disclosure is also directed to a method for securing an overhead electrical cable to a dead-end structure. Broadly characterized, the overhead electrical cable includes a composite strength member and conductive strands surrounding the composite strength member. The method includes placing a compression sheath between the composite strength member and the conductive strands at a proximal end of the overhead electrical cable, placing an outer metallic sleeve over at least the proximal end of the overhead electrical cable and the compression sheath, and compressing at least a portion of the outer metallic sleeve onto the conductive strands.

[0061] The method may be implemented using the termination arrangement disclosed above. The step of compressing the outer sleeve onto the conductive strands may utilize a pressure of at least about 15 tons to deform and compress the outer sleeve.

[0062] It will also be appreciated from the foregoing that the present disclosure is also directed to a kit, e.g., an assembly of components that are configured to be assembled into a termination arrangement for securing an overhead electrical cable to a dead-end structure is disclosed. The kit may include a connector configured to anchor the termination arrangement to a dead-end structure, a gripping element configured to be secured by the connector and to operatively grip the composite strength member at a proximal end of the overhead electrical cable, an outer metallic sleeve configured to surround at least the gripping element and the proximal end of the overhead electrical cable, and a compression sheath configured to be disposed between the composite strength member and the conductive strands along at least the length of the outer metallic housing.

[0063] **FIG. 8** schematically illustrates a configuration for an overhead electrical cable **840**. As illustrated in **FIG. 8**, the strength member **844** includes seven individual composite rods, e.g., rods **844a** and **844b**, that are operatively combined (e.g., helically wrapped) to form the strength member **840**. The composite rods may be fabricated from, for example, a fiber-reinforced composite material. An electrical conductor **842** comprises conductor strands, e.g., strands **842a** and **842b** that may be fabricated from an electrically conductive material, such as copper, aluminum, copper alloys or aluminum alloys. Although illustrated as including seven composite rods, it will be appreciated that the strength member **844** may include any number of composite rods, e.g., few than seven or more than seven composite rods. In certain embodiments, the strength member includes a single central rod, e.g., rod **844c**, with an even number (e.g., 4, 6, 8 or 10) of outer rods surrounding (e.g., helically wrapped around) the central rod.

[0064] Such a multi-element configuration will typically have an effective outer diameter that is larger than the diameter of a single-element composite strength member. Examples of such multi-element composite strength members include, but are not limited to: the multi-element aluminum matrix composite strength member illustrated in U.S. Patent No. 6,245,425 by McCullough et al.; the multi-element carbon fiber strength member illustrated in U.S. Patent No. 6,015,953 by Tosaka et al.; and the multi-element carbon fiber strength member illustrated in U.S. Patent No. 9,685,257 by Daniel et al. Each of these U.S. patents is incorporated herein by reference in its entirety.

[0065] In one embodiment, a compression sleeve structure is utilized, where the compression sleeve structure surrounds a plurality of the individual composite rods to create a ductile barrier between the composite strength member (e.g., the individual composite rods) and the conductive strands, and to create a ductile barrier between adjacent composite rods. In this manner, direct contact between adjacent composite rods can be reduced or eliminated, as well as contact between the composite rods and the electrical conductor.

[0066] One arrangement of such a compression sleeve structure is illustrated in **FIGS. 9A – 9C**. The arrangement illustrated in **FIGS. 9A – 9C** includes the use of **FIG. 9A** illustrates a perspective view of an individual cylindrical tube **950** that may be utilized. The cylindrical sleeve **950** may be fabricated from a variety of materials including, but not limited to, metallic materials and polymeric materials. Useful metallic materials include aluminum, particularly annealed (soft) aluminum which has the ability to deform and flow around the composite rods when the strength member is compressed. Useful polymeric materials include thermoplastic polymers and thermoset polymers.

[0067] Thus, the compression sleeve structure is comprised of several individual elements, e.g., is comprised of a plurality of individual tubes, e.g., cylindrical tubes **950**. The cylindrical tubes are sized such that the tubes can be placed over the ends of the individual composite rods. For example, the individual tubes may have an inner diameter ("ID") that closely approximates the outer diameter of the composite rods so that the tubes may be friction fit over the ends of the strength member **944** as illustrated by cylindrical sleeve **950a** fit over composite rod **944a** in **FIG. 9C**. To ensure an adequate amount of material between adjacent composite rods, the cylindrical sleeves **950** may have a wall thickness ("t") of at least about 2 mm, such as at least about 4 mm. It is generally preferred that the wall thickness be not greater than about 15 mm, such as not greater than about 12 mm, such as not greater than about 10 mm. The cylindrical sleeves **950** should have a length that is sufficient to ensure protection of the composite rods along the entire length that is subjected to compressive forces during crimping. For example, the cylindrical sleeves may have a length of at least about 300 mm, such as at least about 400 mm, or even at least about 500 mm. Typically, the length of the sleeve will not exceed about 1 meter. Although illustrated in **FIG. 9A** as comprising a closed cylinder, the composite rod

may include a longitudinal slot (e.g., a cut) in the cylinder wall, e.g., to facilitate placement of the cylindrical tube over the composite rod. See **FIG. 4A**, for example.

[0068] As illustrated in **FIG. 9C**, a cylindrical tube is placed over an end of each of the composite rods, e.g., each of the outer cylindrical rods (e.g., rod **944a**), as well as over central rod **944b**. However, it may not be necessary to place a cylindrical tube over an end of each rod. For example, a cylindrical tube may be placed over an end of each of the outer composite rods while the central composite rod **944b** remains bare.

[0069] Another arrangement of such a compression sheath structure is illustrated in **FIGS. 10A** and **10B**. The compression sheath structure **1050** includes a unitary body **1051** having a circular cross-section and a plurality of apertures longitudinally-extending through the body **1051**, such as a central aperture **1052b** and a plurality of outer apertures, e.g., aperture **1052a**. The apertures define walls between adjacent apertures, e.g., wall **1058a** between apertures **1052a** and **1052b**. Each of the apertures is configured (e.g., shaped and sized) to operatively receive a composite rod when the compression sheath structure **1050** is placed onto the strength member. The sheath structure **950** should have a length that is sufficient to ensure protection of the composite rods along the entire length that is subjected to compressive forces during crimping. For example, the sheath structure **950** may have a length of at least about 300 mm, such as at least about 400 mm, or even at least about 500 mm. Typically, the length of the sheath structure will not exceed about 1 meter.

[0070] Preferably, the minimum thickness of the walls (e.g., at the point that two adjacent apertures are closest) will be at least about 4 mm, such as at least about 6 mm. It is generally preferred that the wall thickness be not greater than about 25 mm, such as not greater than about 20 mm, such as not greater than about 15 mm.

[0071] **FIGS. 11A** and **11B** illustrate another arrangement of such a compression sheath structure. The compression sheath structure **1150** includes a unitary body having fluted interior circumference that forms a plurality of longitudinally-extending grooves (e.g. groove **1152a**). The grooves are configured (e.g., sized and shaped) to operatively separate and restrict movement of the composite rods when the sheath structure is placed over the strength member. In this manner, the outer composite rods may be

protected from the adjacent outer composite rods. Optionally, the sheath structure **1150** may be used in combination with a cylindrical tube (e.g., as illustrated in **FIG. 9C**) to prevent direct contact between the outer composite rods and the central composite rod.

[0072] **FIGS. 12A and 12B** illustrate yet another arrangement of a compression sheath structure according to the present disclosure. The compression sheath structure **1250** includes a longitudinally-extending central aperture **1256** and a plurality of longitudinally- extending channels (e.g., channel **1254a**) radially spaced away from the central aperture **1256** and separated from the central aperture, e.g., by wall **1258a**. The channels are configured (e.g., sized and shaped) to operatively receive composite rods along a length of the sheath structure **1250** to operatively separate adjacent composite rods that are disposed in adjacent channels. As illustrated in **FIGS. 12A and 12B**, the compression sheath structure **1250** is formed by combining a plurality of individual channel elements, e.g., each element including a channel and a curved portion of the wall forming the central aperture **1256**. In another embodiment, the compression sheath structure **1250** may be formed from a single unitary body.

[0073] **FIGS. 13A – 13B** illustrate a termination arrangement according to the present disclosure, e.g., for securing an overhead electrical cable to a dead-end structure. The overhead electrical cable **1340** includes a composite strength member **1346** and conductive strands **1342** surrounding the composite strength member **1346**. The composite strength member **1346** includes a plurality of composite rods (e.g., composite rod **1346a**) that are combined to form the strength member **1346**. An outer metallic sleeve **1320** the proximal end of the overhead electrical cable **1340**. A compressed portion **1320a** of the outer metallic sleeve **1320** is disposed over (e.g., around) the proximal end of the overhead electrical cable **1340**. The compression sheath structure **1350** is disposed between the composite strength member **1346** and the conductive strands **1342** along at least the length of the compressed portion **1320a**. A partial cross-section of the compressed portion **1320a** is illustrated in **FIG. 13B**. The compression sheath structure **1350** is now plastically deformed to the point where the material has flowed around and between the composite rods (e.g., rod **1346a**) and has protected the rods from cracking during the crimping operation.

[0074] The present disclosure also relates to a method for securing an overhead electrical cable to a dead-end structure where the overhead electrical cable includes a composite strength member and conductive strands surrounding the composite strength member, the strength member comprising a plurality of individual composite rods that are operatively combined to form the composite strength member. In one embodiment, the method includes placing a compression sheath structure over the individual composite rods at a proximal end of the overhead electrical cable, placing an outer metallic sleeve over at least the proximal end of the overhead electrical cable and the compression sheath, and compressing at least a portion of the outer metallic sleeve onto the conductive strands. The compression sheath structure may comprise an arrangement as described above and as illustrated in **FIGS. 9 - 12**.

[0075] The present disclosure also relates to a kit comprising components that are configured to be assembled into a termination arrangement for securing an overhead electrical cable to a dead-end structure, the overhead electrical cable having a composite strength member comprising a plurality of individual composite rods that are operatively combined to form the composite strength member and having conductive strands surrounding the composite strength member. The kit may include, for example, a connector configured to anchor the termination arrangement to a dead-end structure, an outer metallic sleeve configured to surround the proximal end of the overhead electrical cable, and a compression sheath structure that is configured to be disposed over the individual composite rods along at least the length of the outer metallic housing. The compression sheath structure may comprise an arrangement as described above and as illustrated in **FIGS. 9 - 12**.

[0076] While various embodiments of a termination arrangement and a method for securing an overhead electrical cable to a dead-end structure have been described in detail, it is apparent that modifications and adaptations of those embodiments will occur to those skilled in the art. However, it is to be expressly understood that such modifications and adaptations are within the spirit and scope of the present disclosure.

What is Claimed is:

1. A termination arrangement securing an overhead electrical cable to a dead-end structure, the overhead electrical cable having a composite strength member comprising a plurality of individual composite rods that are operatively combined to form the composite strength member and having conductive strands surrounding the composite strength member, the termination arrangement comprising:

a connector anchoring the termination arrangement to a dead-end structure;

an outer metallic sleeve surrounding the proximal end of the overhead electrical cable, the outer metallic sleeve having a compressed portion disposed over the proximal end of the overhead electrical cable; and

a compression sheath structure disposed between the individual composite rods to at least partially separate the composite rods along at least the length of the conductive strands under the compressed portion.

2. The termination arrangement recited in Claim 1, wherein the individual composite rods comprise reinforcing fibers disposed within a binding matrix.

3. The termination arrangement recited in Claim 2, wherein the binding matrix is a metallic matrix.

4. The termination arrangement recited in Claim 2, wherein the binding matrix is a polymeric matrix.

5. The termination arrangement recited in Claim 4, wherein the polymeric matrix comprises a polymer selected from a thermoset resin polymer and a thermoplastic polymer.

6. The termination arrangement recited in any one of Claims 2 to 5, wherein the reinforcing fibers comprise fibers selected from the group consisting of carbon fibers, boron fibers, metal oxide ceramic fibers, glass fibers, carbide fibers, aramid fibers and basalt fibers.

7. The termination arrangement recited in Claim 6, wherein the reinforcing fibers

comprise carbon fibers.

8. The termination arrangement recited in any one of Claims 1 to 7, wherein at least a portion of the conductive strands have a cross-sectional shape that is polygonal.

9. The termination arrangement recited in any one of Claims 1 to 8, wherein at least a portion of the conductive strands have a cross-sectional shape that is non-polygonal.

10. The termination arrangement recited in any one of Claims 1 to 9, wherein the conductive strands comprise aluminum strands.

11. The termination arrangement recited in Claim 10, wherein the conductive strands comprise hardened aluminum strands.

12. The termination arrangement recited in any one of Claims 1 to 9, wherein the conductive strands comprise copper strands.

13. The termination arrangement recited in any one of Claims 1 to 12, wherein the compression sheath structure does not extend substantially beyond the compressed portion of a distal end of the termination arrangement.

14. The termination arrangement recited in any one of Claims 1 to 7, wherein the compression sheath structure comprises a plurality of individual cylindrical tubes, wherein each of the individual cylindrical tubes is disposed over an end of an individual composite rod.

15. The termination arrangement recited in Claim 14, wherein the strength member comprises a central composite rod and a plurality of outer composite rods surrounding the central rod, and wherein one of the individual cylindrical tubes is disposed over an end of each of the outer composite rods.

16. The termination arrangement recited in Claim 15, wherein one of the individual cylindrical tubes is disposed over an end of the central composite rod.

17. The termination arrangement recited in Claim 14, wherein the individual

cylindrical tubes comprise closed cylindrical tubes.

18. The termination arrangement recited in Claim 14, wherein the individual cylindrical tubes comprise tubes having a slot along a length thereof to facilitate placement of the cylindrical tubes over the composite rods.

19. The termination arrangement recited in Claim 14, wherein the individual cylindrical tubes have a wall thickness of at least about 2 mm.

20. The termination arrangement recited in Claim 19, wherein the individual cylindrical tubes have a wall thickness of not greater than about 12 mm.

21. The termination arrangement recited in any one of Claims 1 to 7, wherein the compression sheath structure comprises a unitary body having a plurality of apertures longitudinally-extending through the body and defining walls between adjacent apertures, wherein the apertures are configured to operatively receive the individual composite rods within the apertures.

22. The termination arrangement recited in Claim 21, wherein the unitary body has a length of at least about 400 mm.

23. The termination arrangement recited in Claim 21, wherein the unitary body has a length of not greater than about 1 meter.

24. The termination arrangement recited in Claim 21, wherein the walls between adjacent apertures have a minimum wall thickness of at least about 2 mm.

25. The termination arrangement recited in Claim 24, wherein the walls between adjacent apertures have a minimum wall thickness of not greater than about 12 mm.

26. The termination arrangement recited in Claim 21, wherein the unitary body has a substantially circular cross-section.

27. The termination arrangement recited in any one of Claims 1 to 7, wherein the compression sheath structure comprises a unitary body comprising a fluted interior

circumference comprising a plurality of longitudinally-extending grooves that are sized and shaped to operatively separate adjacent composite rods that are placed in the grooves.

28. The termination arrangement recited in any one of Claims 1 to 7, wherein the compression sheath structure comprises a longitudinally-extending central aperture and a plurality of longitudinally-extending channels radially spaced away from the central aperture that are sized and shaped to operatively separate adjacent composite rods that are placed in the channels.

29. The termination arrangement recited in Claim 28, wherein the compression sheath structure comprises a unitary body including the central aperture and the channels.

30. The termination arrangement recited in Claim 28, wherein the compression sheath structure comprises a plurality of individual channel elements that may be combined to form the central aperture and the longitudinally-extending channels.

31. The termination arrangement recited in any one of Claims 1 to 7, wherein the compression sheath structure is structurally independent from the composite strength member.

32. The termination arrangement recited in any one of Claims 1 to 7, wherein the compression sheath structure is fabricated from a material selected from the group consisting of a metallic material, a polymeric material, and a composite material.

33. The termination arrangement recited in Claim 32, wherein the compression sheath structure is fabricated from a metallic material.

34. The termination arrangement recited in Claim 33, wherein the compression sheath structure is fabricated from aluminum.

35. The termination arrangement recited in Claim 34, wherein the compression sheath structure is fabricated from annealed aluminum.

36. The termination arrangement recited in any one of Claims 1 to 7, wherein the connector comprises an eye bolt.

37. The termination arrangement recited in any one of Claims 1 to 7, wherein the termination arrangement further comprises a jumper plate.

38. A method for securing an overhead electrical cable to a dead-end structure, the overhead electrical cable having a composite strength member and conductive strands surrounding the composite strength member, the strength member comprising a plurality of individual composite rods that are operatively combined to form the composite strength member, the method comprising the steps of:

placing a compression sheath structure over the individual composite rods at a proximal end of the overhead electrical cable;

placing an outer metallic sleeve over at least the proximal end of the overhead electrical cable and the compression sheath; and

compressing at least a portion of the outer metallic sleeve onto the conductive strands.

39. The method recited in Claim 38, wherein the step of placing a compression sheath structure over the individual composite rods comprises placing at least first and second individual cylindrical tubes over ends of at least first and second individual composite rods respectively.

40. The method recited in Claim 39, wherein the strength member comprises a central composite rod and a plurality of outer composite rods surrounding the central composite rod, and wherein the step of placing at least first and second individual cylindrical tubes over ends of at least first and second individual composite rods respectively comprises placing an individual cylindrical tube over an end of each of the outer composite rods.

41. The method recited in Claim 40, wherein the step of placing at least first and second individual cylindrical tubes over ends of at least first and second individual composite rods respectively comprises placing an individual cylindrical tube over an end of each of the composite rods.

42. The method recited in Claim 39, wherein the individual cylindrical tubes are

fabricated from aluminum.

43. The method recited in Claim 42, wherein the individual cylindrical tubes are fabricated from annealed aluminum.

44. The method recited in Claim 39, wherein the individual cylindrical tubes are fabricated from a polymer.

45. The method recited in Claim 38, wherein the step of placing a compression sheath structure over the individual composite rods comprises placing a unitary body having a plurality of apertures longitudinally-extending therethrough over the strength member, wherein ends of the individual composite rods are disposed within the apertures.

46. The method recited in Claim 45, wherein the unitary body is fabricated from aluminum.

47. The method recited in Claim 46, wherein the unitary body is fabricated from annealed aluminum.

48. The method recited in Claim 45, wherein the unitary body is fabricated from a polymer.

49. The method recited in Claim 38, wherein the compression sheath structure comprises a unitary body comprising a fluted interior circumference comprising a plurality of longitudinally-extending grooves that are sized and shaped to operatively separate adjacent composite rods that are placed in the grooves.

50. The method recited in Claim 38, wherein the compression sheath structure comprises a longitudinally-extending central aperture and a plurality of longitudinally-extending channels radially spaced away from the central aperture that are sized and shaped to operatively separate adjacent composite rods that are placed in the channels.

51. The method recited in Claim 50, wherein the compression sheath structure comprises a unitary body including the central aperture and the channels.

52. The method recited in Claim 50, wherein the compression sheath structure comprises a plurality of individual channel elements that may be combined to form the central aperture and the longitudinally-extending channels.

53. The method recited in Claim 38, wherein the compressing step comprises applying a pressure of at least about 15 tons to the outer metallic sleeve.

54. The method recited in Claim 38, further comprising the step of securing a proximal end of the composite strength member to a connector.

55. The method recited in Claim 54, further comprising the step of anchoring the connector to a dead-end structure.

56. A kit comprising components that are configured to be assembled into a termination arrangement for securing an overhead electrical cable to a dead-end structure, the overhead electrical cable having a composite strength member comprising a plurality of individual composite rods that are operatively combined to form the composite strength member and having conductive strands surrounding the composite strength member, the kit comprising:

- a connector configured to anchor the termination arrangement to a dead-end structure;

- an outer metallic sleeve configured to surround the proximal end of the overhead electrical cable; and

- a compression sheath structure that is configured to be disposed over the individual composite rods along at least the length of the outer metallic housing,

- wherein the compression sheath structure comprises a plurality of individual cylindrical tubes, wherein each of the individual cylindrical tubes is disposed over an end of an individual composite rod.

57. A kit comprising components that are configured to be assembled into a termination arrangement for securing an overhead electrical cable to a dead-end structure, the overhead electrical cable having a composite strength member comprising a plurality of

individual composite rods that are operatively combined to form the composite strength member and having conductive strands surrounding the composite strength member, the kit comprising:

- a connector configured to anchor the termination arrangement to a dead-end structure;

- an outer metallic sleeve configured to surround the proximal end of the overhead electrical cable; and

- a compression sheath structure that is configured to be disposed over the individual composite rods along at least the length of the outer metallic housing,

- wherein the compression sheath structure comprises a unitary body having a plurality of apertures longitudinally-extending through the body and defining walls between adjacent apertures, wherein the apertures are configured to operatively receive the individual composite rods within the apertures.

58. A kit comprising components that are configured to be assembled into a termination arrangement for securing an overhead electrical cable to a dead-end structure, the overhead electrical cable having a composite strength member comprising a plurality of individual composite rods that are operatively combined to form the composite strength member and having conductive strands surrounding the composite strength member, the kit comprising:

- a connector configured to anchor the termination arrangement to a dead-end structure;

- an outer metallic sleeve configured to surround the proximal end of the overhead electrical cable; and

- a compression sheath structure that is configured to be disposed over the individual composite rods along at least the length of the outer metallic housing,

- wherein the compression sheath structure comprises a unitary body comprising a fluted interior circumference comprising a plurality of longitudinally-extending grooves that are sized and shaped to operatively separate adjacent

composite rods that are placed in the grooves.

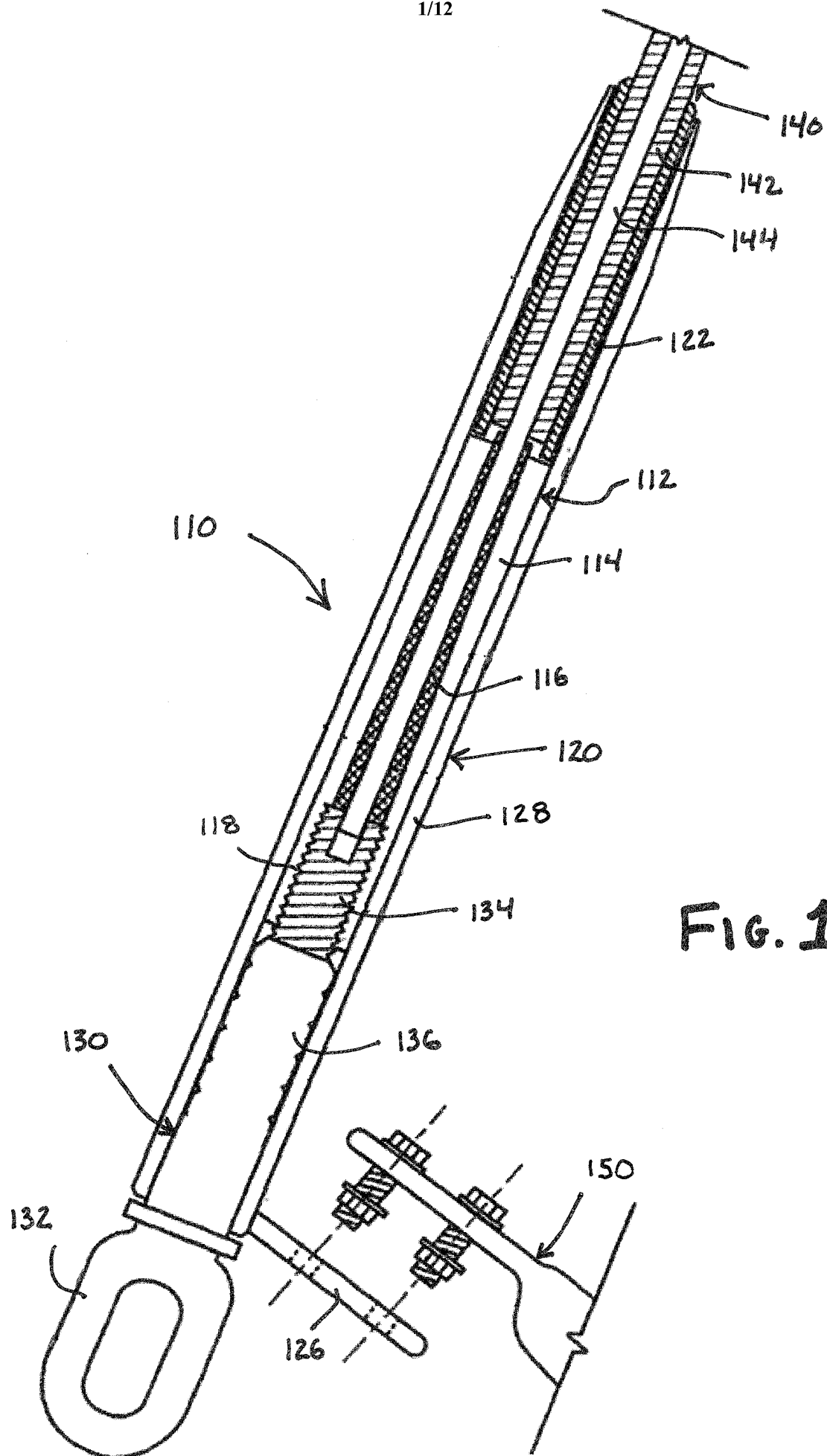
59. A kit comprising components that are configured to be assembled into a termination arrangement for securing an overhead electrical cable to a dead-end structure, the overhead electrical cable having a composite strength member comprising a plurality of individual composite rods that are operatively combined to form the composite strength member and having conductive strands surrounding the composite strength member, the kit comprising:

- a connector configured to anchor the termination arrangement to a dead-end structure;

- an outer metallic sleeve configured to surround the proximal end of the overhead electrical cable; and

- a compression sheath structure that is configured to be disposed over the individual composite rods along at least the length of the outer metallic housing,

- wherein the compression sheath structure comprises a longitudinally-extending central aperture and a plurality of longitudinally-extending channels radially spaced away from the central aperture that are sized and shaped to operatively separate adjacent composite rods that are placed in the channels.



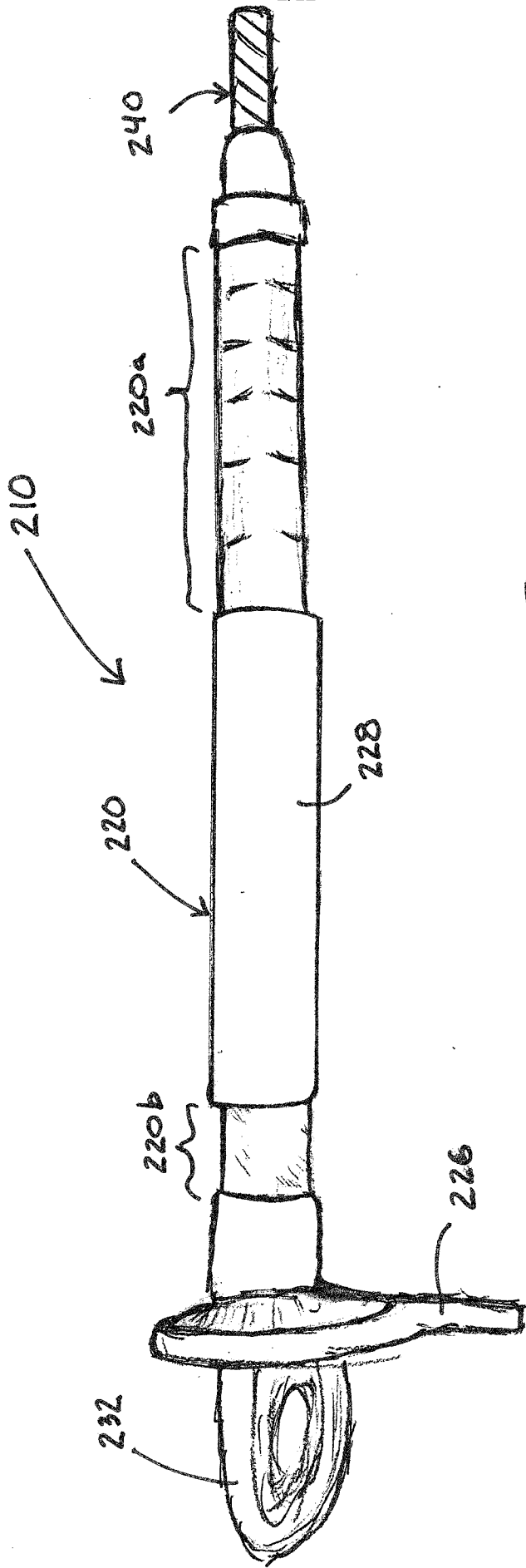


Fig. 2

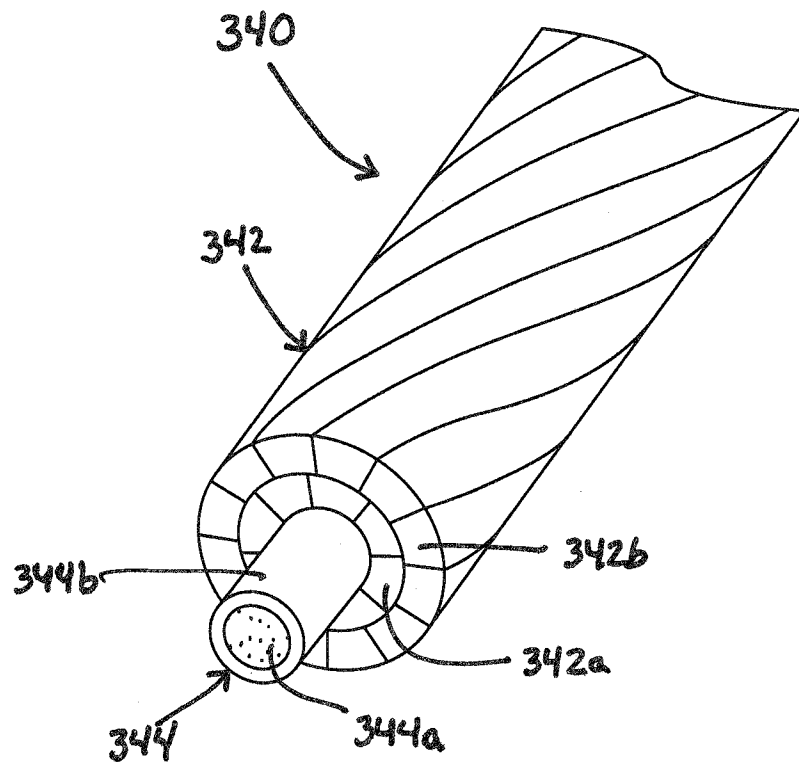


FIG. 3



FIG. 4A

FIG. 4B

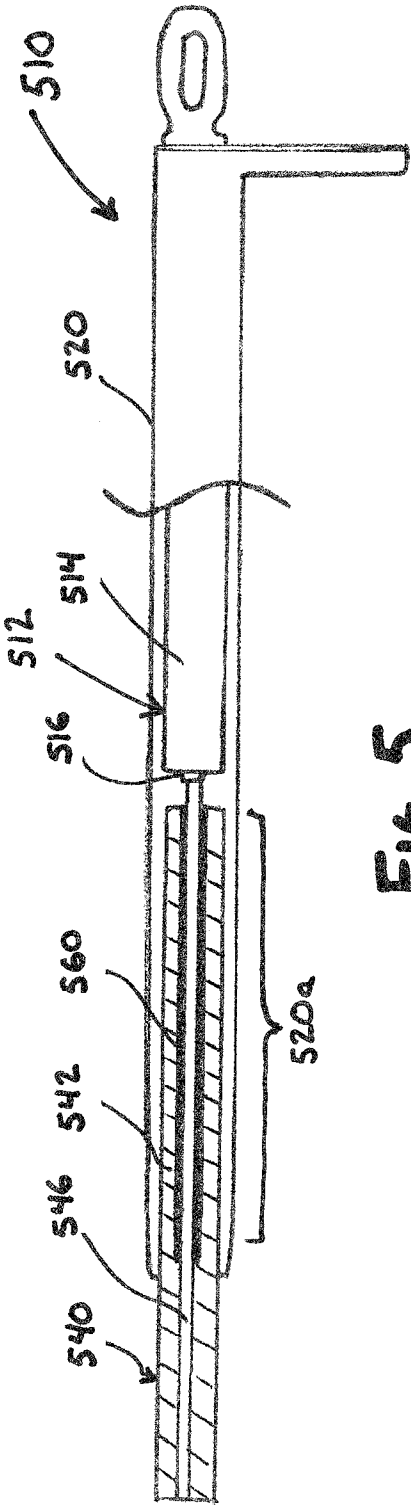


FIG. 5

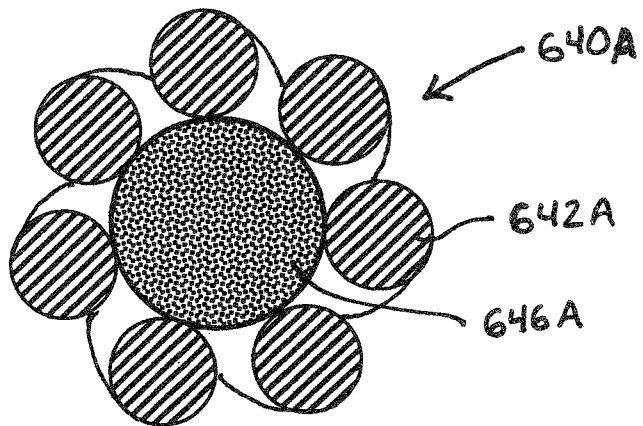


FIG. 6A

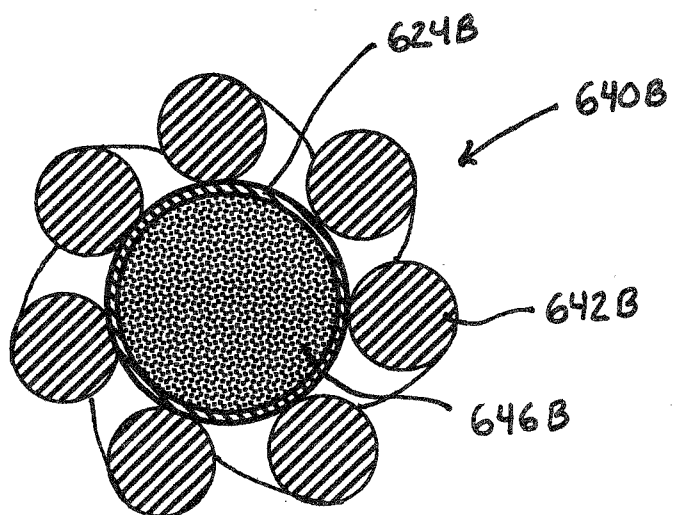


FIG. 6B

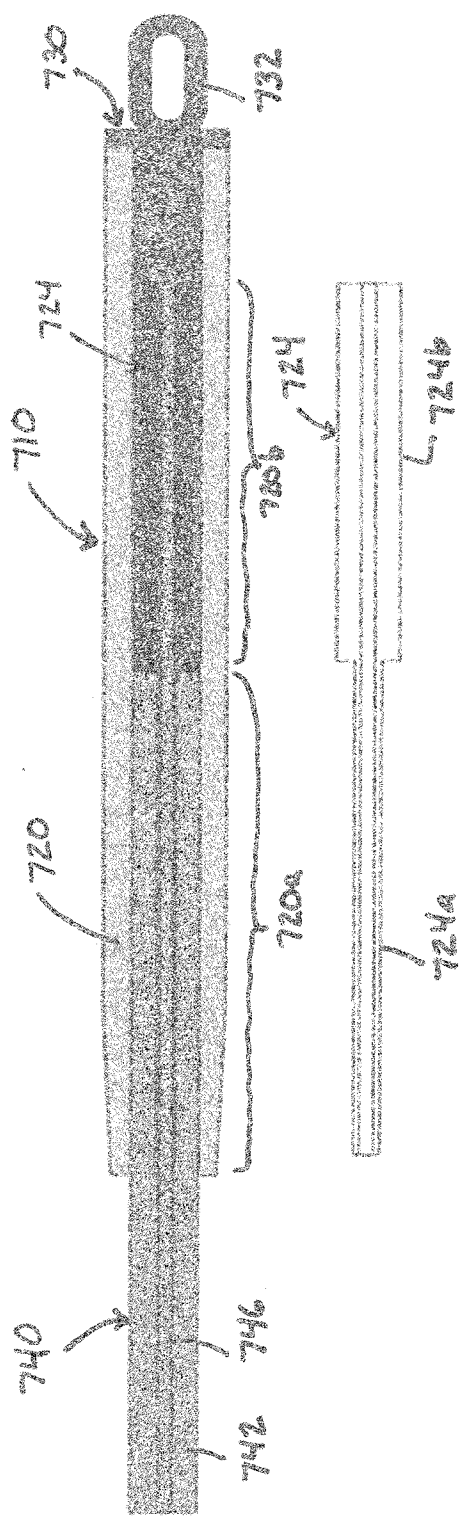


FIG. 7

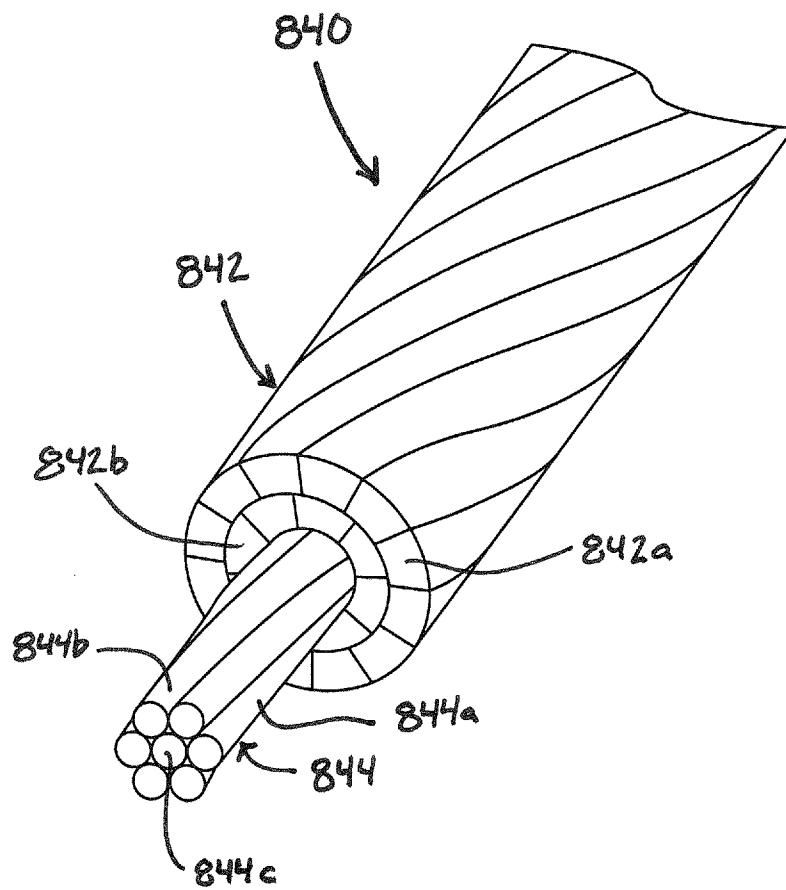
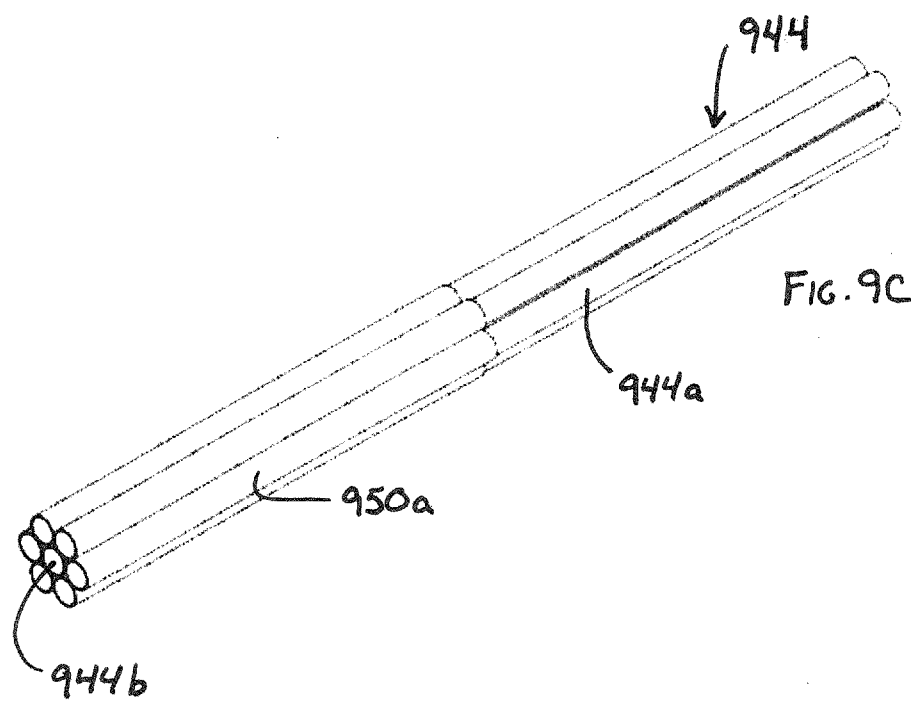
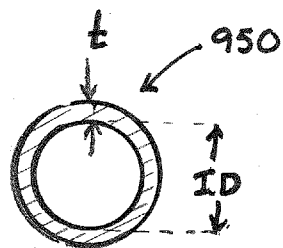
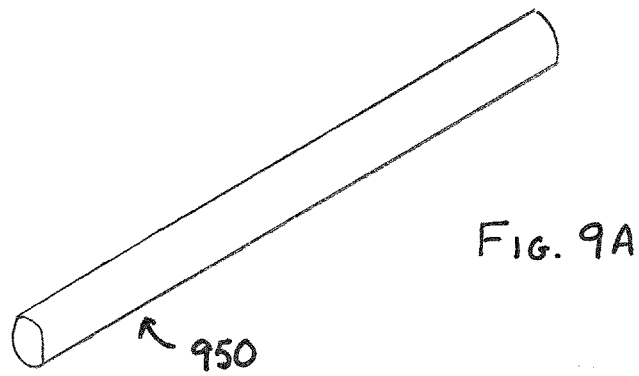


FIG. 8



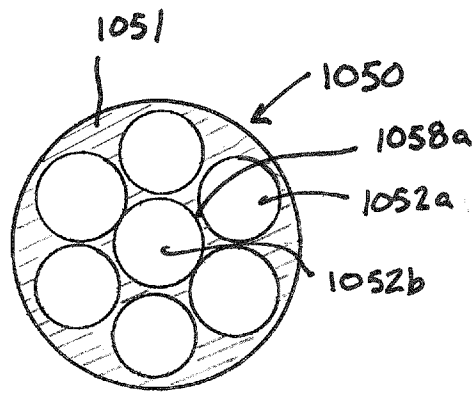


FIG. 10A

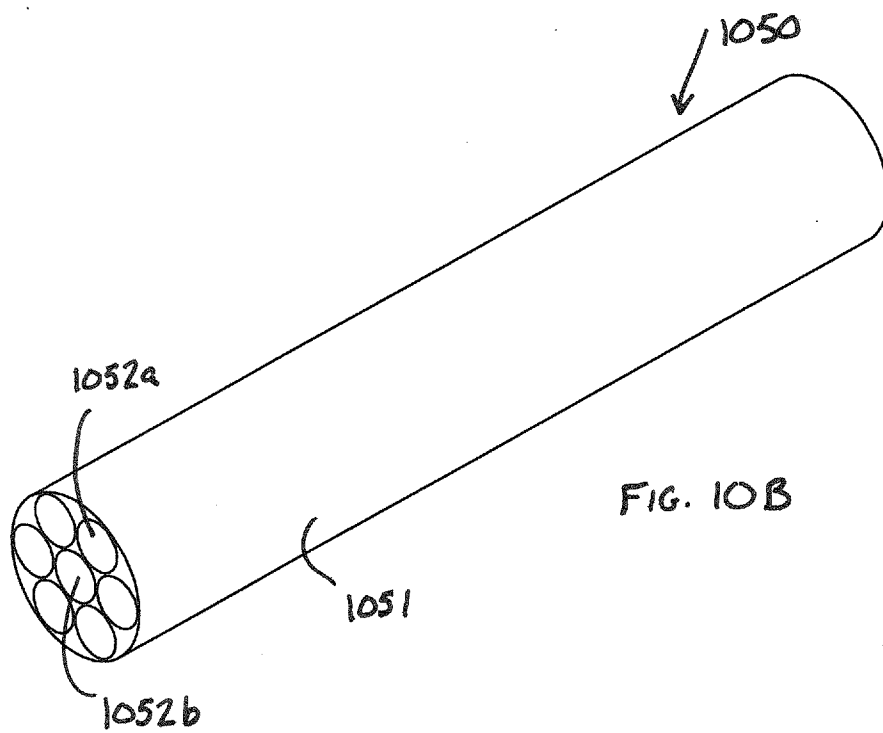


FIG. 10B

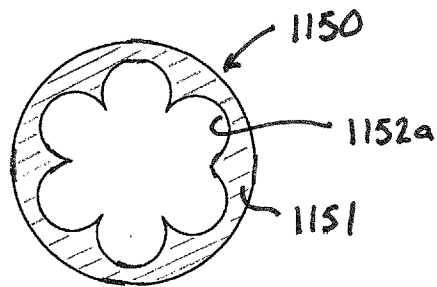


FIG. 11A

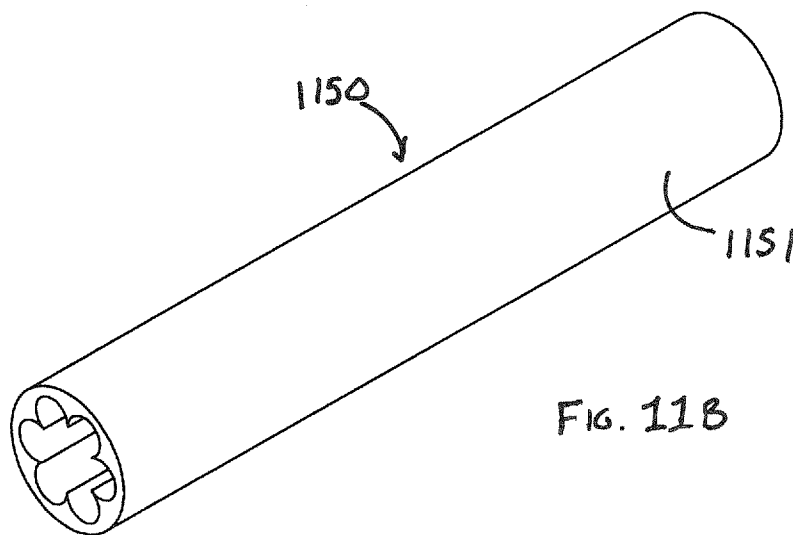
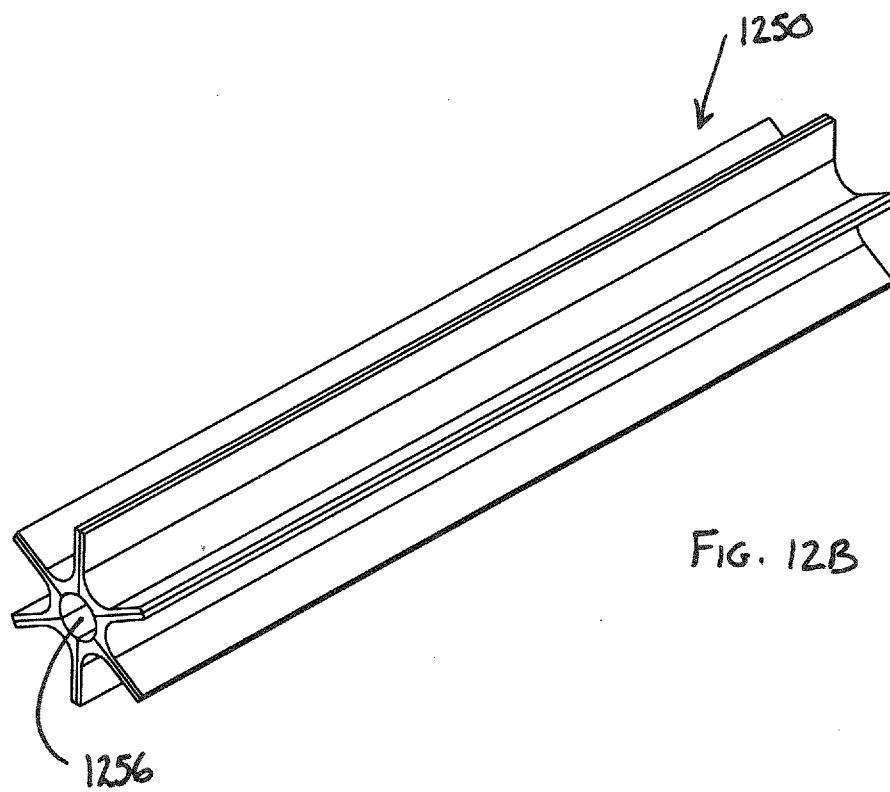
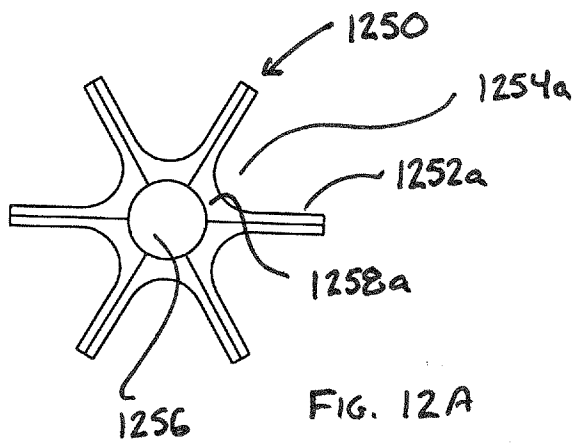


FIG. 11B



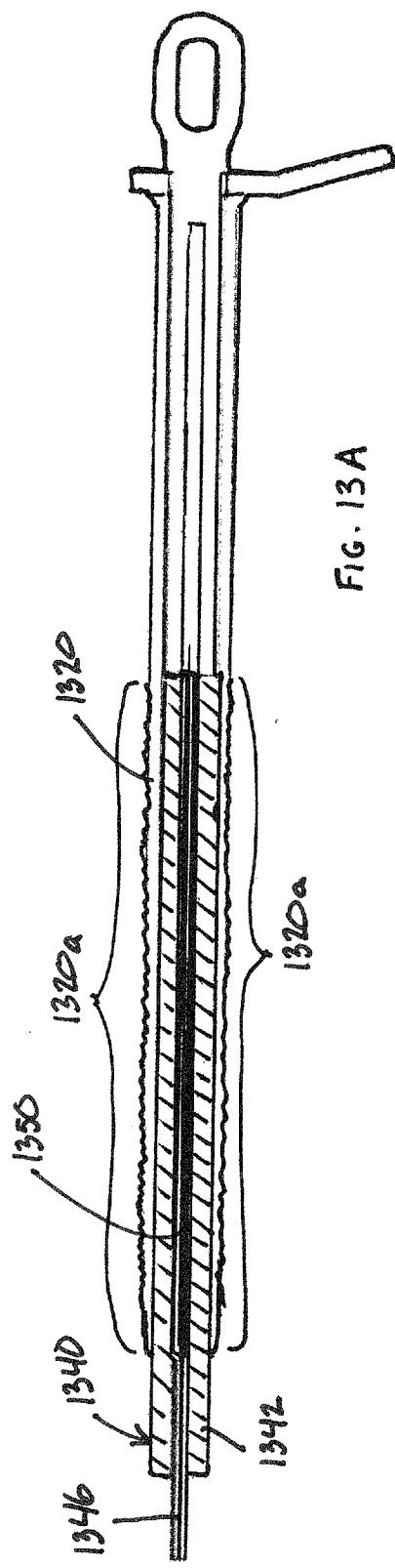


FIG. 13A

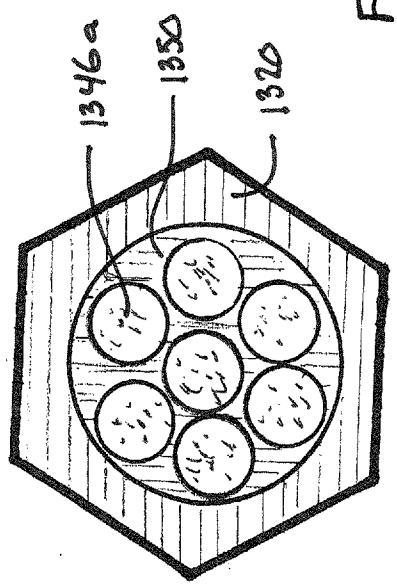


FIG. 13B