

HARDWARE FOR ENABLING INTERFACE WITH OPTICAL FIBERS IN AN OVERHEAD ELECTRICAL CABLE

FIELD

[0001] This disclosure relates to the field of overhead electrical cables, and particularly to hardware components that are used to install and support overhead electrical cables for the transmission and/or distribution of electricity. This disclosure particularly relates to hardware components that enable the passage of optical fibers from the overhead electrical cable through the hardware for subsequent connection to interfacing equipment such as interrogation equipment or telecommunications equipment.

DESCRIPTION OF THE DRAWINGS

[0002] **FIG. 1** illustrates a portion of an overhead electrical transmission line.

[0003] **FIG. 2** illustrates a cross-sectional view of an assembled termination apparatus according to the prior art.

[0004] **FIG. 3** illustrates a perspective view of an assembled and crimped termination apparatus according to the prior art.

[0005] **FIGS. 4A - 4B** illustrate overhead electrical cables including optical fibers coupled to a strength member.

[0006] **FIG. 5** illustrates a termination apparatus according to an embodiment the present disclosure.

[0007] **FIG. 6** illustrates a termination apparatus according to an embodiment of the present disclosure.

[0008] **FIG 7** illustrates a termination apparatus according to an embodiment of the present disclosure.

[0009] **FIG. 8** illustrates a termination apparatus according to an embodiment of the present disclosure.

[0010] **FIGS. 9A** and **9B** illustrate a termination apparatus according to an embodiment of the present disclosure.

[0011] **FIGS. 10A** to **10C** illustrate a termination apparatus according to an embodiment of the present disclosure.

[0012] **FIG. 11** illustrates a termination apparatus according to an embodiment of the present disclosure.

[0013] **FIGS. 12A** and **12B** illustrate a gripping assembly according to an embodiment of the present disclosure.

[0014] **FIGS. 13A** to **13C** illustrate a termination apparatus according to an embodiment of the present disclosure.

[0015] **FIGS. 14A** to **14C** illustrate a spacer clip that is useful in a termination apparatus according to the present disclosure.

[0016] **FIG. 15** illustrates the use of a spacer clip in a termination apparatus according to the present disclosure.

[0017] **FIGS. 16A** to **16B** illustrate a termination apparatus according to an embodiment of the present disclosure.

[0018] **FIGS. 17A** and **17B** illustrate a termination apparatus according to an embodiment of the present disclosure.

[0019] **FIG. 18** illustrates an embodiment of a splice assembly according to the present disclosure.

[0020] **FIG. 19** illustrates an exploded view of a splice assembly according to an embodiment.

[0021] **FIGS. 20A** and **20B** illustrate an embodiment of a splice assembly according to the present disclosure.

[0022] **FIGS. 21A and 21B** illustrate an embodiment of a splice assembly that incorporates an optical fiber ring.

[0023] **FIG. 22** illustrates an embodiment of a splice assembly according to the present disclosure.

[0024] **FIGS. 23A to 23D** illustrate a splice assembly incorporating a bobbin system and a method for constructing the splice assembly according to an embodiment of the present disclosure.

DESCRIPTION

[0025] **FIG. 1** illustrates a portion of an overhead electrical transmission line **100** for the transmission of electricity. Overhead electrical transmission and distribution lines are constructed by elevating electrical cables above the terrain using support towers (e.g., pylons) such as support towers **102a/102b/102c**. The transmission and distribution lines may span many miles, requiring extremely long lengths of electrical cable, e.g., where many electrical cable segments are joined for electrical and mechanical continuity, and many support towers. Some of the support towers are referred to as dead-end towers or anchor towers, such as tower **102a**. Such towers are located at termination points, e.g., power substations or locations where the electrical line is routed underground. Dead-end towers such as tower **102a** may also be required where the electrical line changes direction (e.g., makes a turn), crosses a roadway or other structure where there is a high risk of damage or injury if the cable fails, or at regular intervals in a long, straight line path. In such instances, the overhead electrical cable must be terminated (e.g., severed), secured to the dead-end tower under high tension and electrically connected to an adjacent overhead electrical cable. As illustrated in **FIG. 1**, electrical cable segment **110a** is secured (e.g., anchored) to tower **102a** using a dead-end termination apparatus **120** (e.g., a tension clamp) and is electrically connected to an adjacent electrical cable segment **110b** through an electrical jumper **104**. The electrical cable segments **110a/110b** are insulated from the support tower **102a** by an insulator string **106**.

[0026] Another termination structure is referred to as a splice. While the length of a single segment of overhead cable may cover several thousand feet, a power grid may

require several hundred miles of electrical cable. To span these distances, the linemen must often splice (e.g., couple) two shorter cable segments together. Thus, one or more splices may be placed between two dead ends of an overhead cable installation. The splice functions as both a mechanical junction that holds the two ends of the cables together and an electrical junction allowing the electric current to flow through the splice. As illustrated in **FIG. 1**, a splice **150** operatively connects electrical cable segment **110c** to electrical cable segment **110d** to form a mechanical junction and a continuous electrical pathway.

[0027] **FIG. 2** illustrates a cross-section of an assembled termination apparatus (e.g., a dead-end) according to the prior art for use with a bare overhead electrical cable such as dead-end **120** in **FIG. 1**. The termination apparatus **220** illustrated in **FIG. 2** is similar to that 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.

[0028] Broadly characterized, the termination apparatus **220** illustrated in **FIG. 2** includes a gripping assembly **221** and a connector **222** for anchoring the termination apparatus **220** to a dead-end structure, e.g., to a tower as illustrated in **FIG. 1** with a fastener **223** disposed at a proximal end of the termination apparatus **220**. At the distal end of the termination apparatus **220**, opposite the fastener **223**, the termination apparatus **220** is operatively connected to an overhead electrical cable **210** that includes an electrical conductor **211** (e.g., comprising conductive strands) that surrounds and is supported by a strength member **214**, e.g., a fiber-reinforced composite strength member.

[0029] The gripping assembly **221** tightly grips the strength member **214** to secure the overhead electrical cable **210** to the termination apparatus **220**. As illustrated in **FIG. 2**, the gripping assembly **221** includes a compression-type fitting (e.g., a wedge-type fitting), specifically a collet **224** having a lumen **225** (e.g., a bore) that surrounds and grips onto the strength member **214**. The collet **224** is disposed in a collet housing **226**, and as the electrical cable **210** is tensioned (e.g., is pulled onto support towers), friction develops between the strength member **214** and the collet **224** as the collet **224** is pulled further into the collet housing **226**. The conical (outer) shape of the collet **224** and the mating

inner funnel shape of the collet housing **226** increase the compression on the strength member **214**, ensuring that the strength member **214** does not slip out of the collet **224** and therefore that the overhead electrical cable **210** is secured to the termination apparatus **220**.

[0030] As illustrated in **FIG. 2**, an outer sleeve **227** is disposed over the gripping assembly **221** and an end of the electrical cable **210**. The outer sleeve **227** includes a conductive sleeve body **228** to facilitate electrical conduction between the electrical conductor **211** and a jumper plate **229**. An inner sleeve **230** (e.g., a conductive inner sleeve) may be placed between the conductor **211** and the conductive body **228** to facilitate the electrical connection between the conductor **211** and the conductive body **228**. The conductive body **228** may be fabricated from aluminum, and the jumper plate **229** may be welded onto the conductive body **228**, for example. The jumper plate **229** is configured to attach to a connector plate **231** to facilitate electrical conduction between the electrical conductor **211** and another conductor, e.g., another electrical cable (not illustrated) that is in electrical communication with the connector plate **231**.

[0031] The connector **224** includes a fastener **223** (e.g., an eyebolt) and gripping element mating threads **232** disposed at a gripping element end **233** of the connector body **234**. The gripping element mating threads **232** are configured to operatively mate with connector mating threads **235** of the collet housing **226** to facilitate movement of the connector **224** against the collet **224**, pushing the collet **224** into the collet housing **226**, when the threads **235** and **232** are engaged and the connector **224** is rotated relative to the collet housing **226**. This strengthens the compressive grip of the collet **224** onto the strength member **214**, further securing the overhead electrical cable **210** to the termination apparatus **220**. The fastener **223** is configured to be attached to a dead-end structure, e.g., to a dead-end tower, to secure the termination apparatus **220** and therefore the electrical cable **210**, to the dead-end structure. See **FIG. 1**.

[0032] **FIG. 3** illustrates a perspective view of a termination apparatus, similar to the termination apparatus of **FIG. 2**, that has been crimped (e.g., compressed) onto an overhead electrical cable. The termination apparatus **320** includes a connector having a fastener **323** that extends outwardly from a proximal end of an outer sleeve **327**. A jumper

plate **329** is integrally formed with the outer conductive sleeve body **328** for electrical connection to a connection plate (e.g., see **FIG. 2**). As illustrated in **FIG. 3**, the outer sleeve body **328** is crimped over (e.g., onto) two regions of the underlying structure, namely crimped sleeve body region **328a** and crimped sleeve body region **328b**. The crimped sleeve body region **328a** is generally situated over an intermediate portion of the underlying connector (e.g., see **FIG. 2**), and the crimped sleeve region **328b** is generally situated over a portion of the overhead electrical cable **310**. The compressive forces placed onto the outer sleeve body **328** during the crimping operation are transferred to the underlying components, i.e., to the connector under the crimped region **328a** and to portion of the overhead electrical cable **310** under the crimped region **328b** to permanently secure the termination apparatus **320** to the electrical cable **310**.

[0033] The termination apparatus broadly described with respect to **FIGS. 2** and **3** can be utilized with various bare overhead electrical cable configurations. The termination apparatus illustrated in **FIGS. 2** and **3** are particularly useful with overhead electrical cables having a fiber-reinforced composite strength member. For example, a compression wedge gripping element, e.g., having a collet disposed in a collet housing (e.g., **FIG. 2**), enables a fiber-reinforced composite strength member to be gripped under a high compressive force without significant risk of fracturing the composite material.

[0034] **FIG. 4A** illustrates an overhead electrical cable **410A** that includes a strength member **414A** fabricated from a fiber-reinforced composite material. The electrical cable **410A** also includes a conductor **411A** comprising a first layer **412Aa** of conductive strands that are helically wrapped around (e.g., stranded around) the strength member **414A**. A second layer **412Ab** of conductive strands are wrapped around the first layer **412Aa**. The conductive strands may be fabricated from conductive metals such as copper or aluminum, and for use in overhead electrical cables are typically fabricated from aluminum, i.e., pure aluminum or aluminum alloys. The conductive metals, e.g., aluminum, may not have sufficient mechanical properties (e.g., sufficient tensile strength) to be self-supporting without excessive sag when strung between support towers to form an overhead electrical line for transmission and/or distribution of electricity as illustrated in **FIG. 1**. Therefore, the strength member **414A** physically supports or reinforces the

electrical conductor **411A** when the overhead electrical cable **410A** is strung between support towers under high mechanical tension.

[0035] The strength member **414A** illustrated in **FIG. 4A** is a fiber-reinforced composite strength member, e.g., comprising a plurality of reinforcing fibers disposed in a binding matrix. As illustrated in **FIG. 4**, the strength member includes a high strength section **415A** (e.g., an inner section) comprising high strength and substantially continuous reinforcing fibers (e.g., carbon fibers) disposed in a polymer binding matrix (e.g., a thermoset or thermoplastic binding matrix). An insulative layer **416A** (e.g., an outer layer) surrounds the inner section **415A** to prevent galvanic corrosion that may result from intimate contact between the carbon fibers and the aluminum. For example, the insulative layer may be fabricated from an electrically insulative polymer such as a thermoplastic material. Alternatively, or in addition to a polymer layer, the insulative layer may include substantially continuous reinforcing glass fibers in a polymer binding matrix, for example. An overhead electrical cable of this configuration is available under the trademark ACCC® (CTC Global Corp., Irvine, CA), and is described in U.S. Patent No. 7,368,162 by Hiel et al., which is incorporated herein by reference in its entirety. In addition, the strength member may include a layer of aluminum, e.g., disposed between the insulative layer **416A** and the first conductive layer **412Aa**. See, for example, US Patent No. 10,395,794 by Meyer et al. which is incorporated herein by reference in its entirety.

[0036] Such fiber-reinforced composite strength members may include a single fiber-reinforced composite strength element (e.g., a single rod) as is illustrated in **FIG. 4A**. Alternatively, the composite strength member may be comprised of a plurality of individual fiber-reinforced composite strength elements (e.g., individual rods) that are operatively combined (e.g., twisted or stranded together) to form the strength member as is illustrated in **FIG. 4B**. 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 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. Other configurations and materials (e.g., other fibers and/or matrix materials) may be used for the fiber-reinforced composite strength member.

[0037] Referring back to **FIG. 4A**, the electrical cable **410A** also includes at least one optical fiber that is associated with the electrical cable **410A**. As illustrated, the cable **410A** includes two (e.g., a plurality of) optical fibers, namely optical fibers **417Aa** and **417Ab**, that are embedded within the strength member **414A**. More particularly, the optical fiber **417Aa** may be characterized as being embedded within the high strength inner section **415A** and the optical fiber **417Ab** may be characterized as being embedded between the inner section **417A** and the insulative layer **417A**. It will be appreciated that such optical fibers may be associated with the electrical cable **410A** by being placed in other positions, such as being disposed on the outer surface of the strength member **414A**, e.g., between the strength member **414A** and the first conductive layer **412Aa**.

[0038] Referring to **FIG. 4B**, a similar overhead electrical cable **410B** is illustrated. As noted above, the electrical cable **410B** includes a strength member **414B** having a plurality of strength elements (e.g., strength element **414Ba**) that are combined (e.g., helically wrapped) to form the strength member **414B**. In this case, one or more optical fibers, such as optical fiber **417Bb**, are associated with the electrical cable **410B**, e.g., disposed between individual strength elements in addition to or as an alternative to embedded optical fibers such as optical fiber **417Ba**. As with the cable illustrated in **FIG. 4A**, optical fibers may be placed in other positions throughout the cross-section of the electrical cable **410B**.

[0039] In any of the foregoing configurations, the optical fibers are typically disposed along the entire length of the electrical cable. The optical fibers may be disposed in a substantially linear fashion or may be non-linear, e.g., may be twisted or wrapped around the strength member. Such optical fibers may be utilized for communications (e.g., for data transfer) and/or may be utilized to interrogate (e.g., to inspect) the electrical cable to determine a condition of the electrical cable, i.e., as an interrogation element. For example, BOTDR (Brillouin optical time domain reflectometry) may be used to assess the temperature of the electrical cable and/or the stress state of the strength member along

the length of the cable. One example of optical fibers being used in an overhead electrical cable for interrogation purposes is illustrated in International Patent Publication No. WO 2019/168998 by Dong et al., which is incorporated herein by reference in its entirety.

[0040] No matter the function of the optical fibers, it will be necessary to access at least one of the ends of the fibers, e.g., to reliably introduce light (e.g., coherent light from a laser) into the ends of the optical fibers, and to detect and/or analyze light emanating from the same or an opposite end of the optical fibers. However, as can be seen in **FIGS. 2 and 3**, when the overhead electrical cable is terminated at a dead end, (e.g., using a termination apparatus described above, the end of the strength member, and therefore the ends of the optical fibers, can no longer be accessed to pass a signal into an end of the optical fibers and/or to detect a light signal emanating from an end of the optical fibers.

[0041] It is one object of the present disclosure to provide hardware such as a termination apparatus for use with an overhead electrical cable that enables access to such optical fibers associated with the electrical cable, even after the overhead electrical cable has been installed, e.g., after a span of the overhead electrical cable has been strung and terminated.

[0042] **FIG. 5** illustrates one embodiment of a termination apparatus (e.g., a dead-end) for use with an overhead electrical cable that enables one or more optical fibers to be accessed from outside of the apparatus. As illustrated in **FIG. 5**, the dead-end **520** includes a gripping assembly **521** that grips a strength member **514** of an overhead electrical cable **510**, e.g., so that the electrical cable **510** may be securely held at very high tension. Similar to the termination apparatus illustrated in **FIG. 1**, the gripping assembly **521** may be characterized as a compression wedge, particularly having a collet **524** and a collet housing **526** that is configured to receive the collet **524** within the housing **526**.

[0043] The gripping assembly **521** includes a gripping assembly channel **537** (e.g., a groove or elongate notch) disposed along an external surface of the gripping assembly **521**, particularly along an external surface of the collet housing **526**. The channel **537** is configured (e.g., sized and shaped) to secure one or more optical fibers, such as optical

fiber **517**, within the channel **537**, e.g., to contain and protect the optical fiber **517** between gripping assembly **521** and an internal surface of the conductive sleeve body **528**. As illustrated in **FIG. 5**, the gripping assembly channel **537** runs along the outer surface of the gripping assembly **521** (e.g., of the collet housing **526**) from one end of the gripping assembly **521** to the opposite end of the gripping assembly **521**. Characterized another way, the channel **537** is disposed along at least that portion of the gripping assembly **521** that is in direct contact with the conductive sleeve body **528**. Also, the gripping assembly channel **537** is disposed in a substantially linear manner along the gripping assembly **521**. Although a linear configuration is more easily manufactured and implemented, it will be appreciated that the channel **537** may be non-linear if desired, e.g., may be helically disposed around the gripping assembly. In any event, the channel **537** enables the conductive sleeve body **528** to be crimped down upon the gripping assembly **521** (see **FIG. 3**) with the optical fiber **517** undergoing little or no compression such that the optical fiber **517** will be undamaged.

[0044] A connector **522** is operatively attached to the gripping assembly **521** and includes a connector body **534**. The connector body **534** includes a connector body channel **538** disposed along (e.g., formed in) an external surface of the connector body **534**. As with the gripping assembly channel **537**, the connector body channel **538** is configured (e.g., sized and shaped) to secure, e.g., contain and protect, one or more optical fibers, e.g., optical fiber **517** within the channel **538**. The connector body channel **538** is disposed along at least that portion of the connector body **534** that is in direct contact with the conductive sleeve body **528** and may be disposed along the entire length of the connector body **534**. As with the gripping assembly channel **537**, the connector body channel **538** may be disposed along the connector body **534** in a substantially linear manner as illustrated in **FIG. 5** or may be disposed along the connector body **534** in a non-linear manner.

[0045] The connector **522**, e.g., the connector body **534** may include connector body threads and the collet housing **526** may include connector mating threads that mate with (e.g., are threadably engaged with) the collet housing threads to secure the collet housing **526** to the connector **522**, e.g., as illustrated in **FIG 2** above, although other means of

securing the gripping assembly **521** to the connector **522** are contemplated. Further, a gripping device and a connector may be integrally formed, i.e., as a single unit.

[0046] To enable the termination apparatus **520** to be secured to a tower (see **FIG. 1**), the termination apparatus includes a fastener **523**, e.g., that is operatively attached to or is integrally formed with the connector body **534** as is illustrated in **FIG. 5**. A gasket **539** may separate the fastener **523** from the outer sleeve **527** to reduce the ingress of moisture and other foreign elements into the termination apparatus **520**. As illustrated in **FIG. 5**, the fastener **523** is an eyebolt (e.g., having a single closed loop). However, other types of fasteners are contemplated, including a clevis-type fastener having two prongs with apertures enabling a clevis pin to be placed through the prongs. See, for example, US Patent No. 2,668,280 by Dupre and US Patent No. 6,338,590 by Stauske et al., each of which is incorporated herein by reference in its entirety.

[0047] As noted above, an outer sleeve **527** having a conductive sleeve body **528** defining a cavity is placed over the gripping assembly **521** and over the connector body **534**. The outer sleeve **527** may be crimped (e.g., compressed) onto the underlying structure, e.g., onto the connector body **534** and onto the electrical cable **510** as is illustrated in **FIG. 2**.

[0048] The termination apparatus **520** illustrated in **FIG. 5** also includes a strain relief guide **540** that is configured to contain and redirect the optical fiber from the electrical cable **510** to the gripping assembly channel **537**. In this regard, the strain relief guide **540** illustrated in **FIG. 5** includes a tapered shape, e.g., in the nature of a cone or funnel. The strain relief guide **540** may be fabricated from a pliable material, such as an elastomeric material, for example. The strain relief guide **540** is configured to ensure that the optical fiber **517** is not subject to small radius bends that may damage or otherwise be detrimental to the efficacy of the optical fiber **517**.

[0049] The optical fiber **517** extends from the termination apparatus **520** through a fiber egress aperture **541**. The fiber egress aperture **541** is configured (e.g., sized and shaped) to enable one or a plurality of optical fibers through the aperture **541**. Thus, a connection may be made to the optical fiber **517**, such as a connection to an OTDR, BOTDR, or similar interrogation device, or to a telecommunications device.

[0050] **FIG. 6** illustrates a perspective view of a connector and gripping assembly according to an embodiment, e.g., that may be utilized in the termination apparatus illustrated in **FIG. 5**. The gripping assembly **621** is secured to a strength member **614** using a collet **624** and collet housing **626** arrangement. An optical fiber **617** is wrapped around the strength member **614**, and may be utilized for interrogation (i.e., as a sensing element) and/or may be used for telecommunications (e.g., data transfer). The optical fiber **617** is disposed within a gripping assembly channel **637a** which runs along the length of the gripping assembly **621**, i.e., along the length of an outer surface of the collet housing **626**. The collet housing **626** includes a plurality of gripping assembly channels **637a/637b/637c** which may accommodate a plurality of optical fibers, or may be used with a single optical fiber, e.g., for purposes of alignment. Similarly, the connector **622** includes a connector body channel **638** linearly disposed along the surface of the connector body **634**. The optical fiber extends **617** from the connector **622** through a fiber egress aperture **641**.

[0051] **FIG. 7** illustrates a cross-sectional view of an alternative embodiment of a termination apparatus according to the present disclosure. The termination apparatus **720** includes a gripping assembly **721** in the form of a collet **724** and collet housing **726** that grip onto the strength member **714**. In this embodiment, one or more optical fiber(s) **717** extend through the collet **724** with the strength member **714**. In this regard, the connector body **734** includes a port **742** (e.g., a bore) extending longitudinally through the connector body **734** including a first flange **743a** which may be integrally formed with the connector body **734**. The fastener **723** includes a second flange **743b** that is secured to the first flange **743a** by a plurality of flange bolts such as flange bolt **744a**. The optical fibers **717** extend through the connector body port **742** and through a fiber egress aperture **741** disposed through the second flange **743b** so that an end of the optical fibers **717** may be accessed. In this embodiment, the optical fibers **717** may be inserted through the aperture **741** before the flange **743b** is secured to the flange **743a** using bolts **744a**. A grommet (e.g., a rubber grommet) may be utilized to reduce the bending strain on the optical fibers **717** as they exit the aperture **741**.

[0052] The foregoing embodiments illustrate termination apparatus wherein the optical fibers extend through and/or around the gripping assembly and the connector body and exit the termination apparatus near the fastener end. Alternatively, the termination apparatus may be configured to direct the optical fibers out of the termination apparatus at a location between the end of the electrical cable and the gripping assembly, i.e., so that the optical fibers do not pass through or around the gripping assembly or the connector. Further, it may be desirable to splice the optical fibers (e.g., a fusion splice or a mechanical splice) to one or more connecting optical fibers within the termination apparatus, e.g., to seal the splices within the termination apparatus.

[0053] **FIG. 8** illustrates one such embodiment of a termination apparatus **820**. The termination apparatus **820** includes a gripping assembly **821** and a connector **822** having an integrally formed fastener **823** substantially as described above, with the exception of the optical fibers channels and apertures described with respect to **FIGS. 5-7**. As is illustrated in **FIG. 8**, the end of the electrical cable **810**, i.e., of the electrical conductor **811**, is spaced apart from the forward end of the gripping assembly **821** defining a working space **845** (e.g., bound by the conductive sleeve body **828**) through which the strength member **814** extends to the gripping assembly **821**. Each optical fiber such as optical fiber **817a** associated with and extending from the electrical cable **810** is operatively connected to a second optical fiber **817b**. The connection may be made using a splice, such as a fusion splice **846**. The second optical fiber **817b** is operatively connected to an optical fiber socket **847**, which is at least partially disposed through a port (e.g., an aperture) in the conductive sleeve body **828**. For example, the optical fibers **817b** and the socket **847** may be provided as a pre-constructed device configured for this purpose. The socket **847** illustrated in **FIG. 8** is also configured to attach to an optical fiber jumper **848**, e.g., on an opposite side of the socket. Although described herein as a socket **847**, the socket may be any device that provides a pathway (e.g., an operational light signal pathway) through the sleeve body **828**. For example, the socket **847** may comprise a splice box. The socket **847** may also comprise a cord connector, e.g., a strain relief grip that reduces tension on the optical fiber **817b** and provides a liquid tight seal around the optical fiber. The jumper **848** includes an appropriate fitting **849** and an armored cable

850 containing optical fibers. The fitting **849** is configured to operatively mate with the socket **847**, e.g., to connect optical fibers **817b** to optical fibers in the armored cable **850**. An insulator string **851** may be operatively connected to the armored cable **850** if a reduction in voltage on the optical fibers is desired and/or to prevent tracking.

[0054] The termination apparatus illustrated in **FIG. 8** may provide a number of advantages, particularly in terms of the installation of the termination apparatus **820** including operative connection of the optical fiber **817a** to the exterior of the termination apparatus. For example, once the optical fiber **817a** is separated from the end of the strength member **814**, the strength member may be cut to its final length. The gripping assembly **821** (e.g., the collet and collet housing) may then be attached to and secured upon the strength member **814** following standard procedures. The loose optical fiber **817a** may then be fusion spliced to the second optical fiber **817b** which is pre-attached to the optical fiber socket **847**. Optionally, protective buffer tubes may be placed over the optical fibers to protect optical fibers within the working space **845**. The termination apparatus may then be assembled, i.e., the outer sleeve **827** may be positioned and crimped over the electrical cable **810** and the connector body **834**. It is noteworthy that these steps may be performed on the ground, e.g., it is not necessary that the steps be performed while the overhead electrical cable is affixed (but not tensioned) high on a tower. The assembled termination assembly may then be lifted to the attachment point on the tower and attached to its insulator string. See **FIG.1**. At that point, the prefabricated optical fiber jumper **848** may be connected by being inserted into the optical fiber socket **847** either before or after the electrical line is tensioned.

[0055] **FIGS. 9A** and **9B** illustrate an alternative embodiment of a termination apparatus **920**. The termination apparatus **920** is substantially similar to the termination apparatus illustrated in **FIG. 8** with the exception of the configuration of the outer sleeve **927**. As illustrated in **FIGS. 9A** and **9B**, the conductive sleeve body is constructed from two portions **928a** and **928b**. The two portions **928a/928b** are configured to operatively join at a location **928c** that is disposed over, or is adjacent to, the working space **945** where the optical fibers **917a** and **917b** are located. At the joining location **928c** the two portions of the conductive sleeve body operatively fit together, e.g., in the nature of a lap

joint as illustrated in **FIGS. 9A** and **9B**. After being placed together, the two portions **928a** and **928b** may be bonded to each other by crimping or a similar technique to provide a strong physical bond and an electrical pathway through the conductive sleeve body. One advantage of the embodiment illustrated in **FIGS. 9A** and **9B** is that the optical fibers **917a** and **917b** may be spliced or otherwise worked upon in the working space **945** before the sleeve portion **928b** is mated with and bonded to the sleeve portion **928a**.

[0056] **FIGS. 10A** to **10C** schematically illustrate another embodiment of a termination apparatus **1020** that is similar in construction to the termination apparatus illustrated in **FIGS. 9A** and **9B**. In this embodiment, the two mating conductive sleeve body portions **1028a** and **1028b** are configured to join at a location **1028c** that is disposed over the connector **1022** leaving the entire working space **1045** exposed (e.g., easily accessible) before the sleeve portion **1028b** is mated to the sleeve portion **1028a**. See **FIG 10B**. As with the termination apparatus illustrated in **FIGS. 9A** and **9B**, this construction may enable the optical fibers **1017a** and **1070b** to be spliced or otherwise worked upon before the sleeve portions **1028a/1028b** are mated and bonded or otherwise affixed together.

[0057] **FIG. 11** illustrates a further embodiment of a termination apparatus similar to those illustrated in **FIGS. 9A** and **9B** and in **FIGS. 10A** to **10C**. In the embodiment illustrated in **FIG. 11**, the conductive sleeve body portion **1128a** includes an end portion having an increased outer diameter **1128d** to receive an end of the sleeve portion **1128b** therein.

[0058] In the embodiments illustrated in **FIG. 9A** through **FIG. 11**, the conductive sleeve body, e.g., the outer sleeve, is segmented (e.g., partitioned or bifurcated) to facilitate access to the optical fibers and related components prior to final assembly of the termination apparatus. It will be appreciated that modifications may be made to the illustrated embodiments within the scope of the present disclosure. For example, the two portions of the conductive sleeve body may be joined using threaded bolts or other mechanical fasteners. Further, in each of the illustrated embodiments the conductive sleeve body is segmented through the longitudinal axis of the sleeve. However, the outer sleeve may be segmented along a longitudinal axis, e.g., in the nature of a clam shell.

[0059] **FIGS. 12A** and **12B** illustrate an embodiment of a gripping assembly according to the present disclosure, where **FIG. 12A** is a perspective view and **FIG. 12B** is a cross-

sectional view. For example, the gripping assembly illustrated in **FIGS. 12A** and **12B** may be utilized in the embodiments illustrated in **FIG. 5** and **FIG. 6**. The gripping assembly includes a collet **1224** and a mating collet housing **1226**. The collet housing **1226** includes two gripping assembly channels **1237a** and **1237b** that are configured to secure one or more optical fibers therein as illustrated in **FIG. 5** and **FIG. 6**. Although illustrated as comprising two such channels, the collet housing may include one or any number of such channels.

[0060] According to another embodiment of the present disclosure, a termination apparatus is constructed with a window port through the conductive sleeve body to permit access to the optical fiber(s) through the window port, e.g., so that the optical fiber may be manipulated through the window port. The window port may be sealed from the environment using a window port cover, e.g., a removable window port cover. **FIGS. 13A** to **13C** illustrate different views of one example of such a termination apparatus. The termination apparatus **1320** securely grips an overhead electrical cable **1310**, e.g., in a manner illustrated above with respect to **FIGS. 8** to **11**. The outer sleeve **1327** includes a conductive sleeve body **1328** which is placed over and surrounds the gripping element **1321** and the connector **1322**. A window port **1354** is formed through the conductive sleeve body **1328** to enable access to the optical fiber **1317** within the conductive sleeve body **1328**. In this manner, the termination apparatus **1320** may be fully assembled in the field and the optical fiber **1317** may be accessed through the window port to manipulate the optical fiber **1317**, e.g., to place the optical fiber through a ferrule **1356**, enabling the optical fiber to be accessed after the window port cover **1355** is placed back over the window port **1354**, e.g., using bolts or a similar fastener. In addition, the conductive sleeve body **1328** illustrated in **FIGS. 13A-13C** includes a dimple **1353** (e.g., an indentation) formed in the sleeve. Such a dimple **1353** is configured to prevent movement of the inner sleeve **1330** that is disposed between the conductor **1311** and the conductive body **1328** to facilitate the electrical connection between the conductor **1311** and the conductive body **1328**.

[0061] As illustrated in **FIG. 13C**, the connector **1322** is formed in two sections that are operatively joined using a spacer clip **1357** that is disposed between the two

connector sections. **FIGS. 14A to 14C** illustrate different views of such a spacer clip **1457**. The spacer clip **1457** is generally cylindrical in form, e.g., having a generally cylindrical and open side wall **1460**. An access slot **1461** formed in the cylindrical side wall **1460** enables access to a working space **1445**, e.g., where the optical fiber may be partially disposed in the working space **1445** when the termination apparatus is assembled (See **FIG. 13C**). Button notches **1459a** to **1459d** are provided in the side wall to enable the spacer clip **1457** to be operatively secured to the two sections of the connector. The ends of the working space **1445** are partially confined by interior wall segments **1462a** and **1462b** which are configured to hold the two connector segments when the termination apparatus is assembled. The spacer clip **1457** may be fabricated from a high-strength material such as steel, e.g., stainless steel.

[0062] **FIG. 15** illustrates a close-up cross-sectional view of a portion of the termination apparatus illustrated in **FIGS. 13A to 13C**, particularly illustrating the assembly of the spacer clip with the two sections of the connector. The two connector sections **1534a** (gripping assembly end) and **1534b** (fastener end) each include a button **1563a** and **1563b** that is placed within the spacer clip **1557**, e.g., where the buttons **1563a/1563b** are inserted through the button notches **1559a/1559b** and secured against the interior wall segments of the spacer clip **1557**. In this manner, the optical fiber **1517** passes through and can be manipulated within the working space **1545** defined by the spacer clip **1557**.

[0063] Other variations of the foregoing embodiments are envisioned by the present disclosure. For example, **FIGS. 16A** and **16B** illustrate a termination apparatus **1620** that is similar in construction to the termination apparatus described above with respect to **FIGS. 13A to 13C**, e.g., including a window port **1654** and a window port cover **1655**. As illustrated in **FIGS. 16A** and **16B**, the window port cover **1655** is semi-cylindrical and covers a larger portion of the circumference of the conductive sleeve body **1628**. This enables the underlying port **1654** to be larger, e.g., to also extend over a larger circumference of the conductive sleeve body **1628**.

[0064] **FIGS. 17A** and **17B** illustrate a termination apparatus **1720** that is also similar in construction to the termination apparatus illustrated in **FIGS. 13A to 13C**. In this

embodiment, the jumper plate **1729** is affixed to the conductive sleeve body **1728** at a position between the electrical cable **1710** and the port where the optical fiber **1717** exits the termination apparatus. As a result, the electricity will flow from the electrical cable **1710** and be directed to the next cable segment by the jumper plate **1729** before reaching the exit point of the optical fiber, reducing the electrical potential experienced by the optical fiber **1717** and therefore reducing the opportunity for damage to or faulty readings from the optical fiber **1717**. It will be appreciated that the placement of the jumper plate in this manner, e.g., in front of the optical fiber exit point, can be applied to any of the embodiments of a termination arrangement disclosed herein.

[0065] The embodiments illustrated in **FIGS. 5 to 17** are presented as examples of termination apparatus, components of termination apparatus and methods for terminating an electrical cable. These embodiments are intended to be illustrative and non-limiting, and the embodiments are subject to a number of modifications. For example, the foregoing embodiments illustrate a gripping assembly in the form of a wedge clamp, e.g., in the form of a collet disposed in a collet housing. However, the gripping assembly may take other forms, such as a crimp-style gripping assembly, where the strength member is placed in a tube and the tube is radially crimped (e.g., compressed) onto the strength member. One example of this style of gripping assembly is illustrated in US Patent No. 6,805,596 by Quesnel et al. (AFL) which is incorporated herein by reference in its entirety. The gripping assembly illustrated by Quesnel et al. is integrally formed with a connector and comprises a steel tube for receiving the strength member therein. An aluminum sleeve is placed between the strength member and the steel tube, and the steel tube is then crimped onto the strength member.

[0066] The foregoing embodiments are directed to termination apparatus that permit the egress of optical fibers, e.g., so that the optical fibers may be isolated and selectively interrogated or used for telecommunication purposes. As described with respect to **FIG. 1**, many electrical transmission and distribution lines also include splices wherein two electrical cable segments are electrically and mechanically joined together, e.g., at a location between two support towers. Many of the concepts disclosed above for the

egress of one or more optical fibers from a termination apparatus can be applied to a splice to ensure continuity of the optical fiber through the splice.

[0067] **FIG. 18** illustrates one embodiment of a splice assembly according to the present disclosure. The splice assembly **1820** electrically and mechanically joins two overhead electrical cable segments **1810a** and **1810b**. The electrical connection is facilitated by a conductive sleeve body **1828** that is in electrical contact with each cable segment **1810a/1810b** such that electricity may pass from one cable to the other through the conductive sleeve. On the interior of the splice assembly **1820**, the two cable segments **1810a** and **1810b** are mechanically joined by a connector **1822**. Specifically, the connector **1822** mechanically joins two gripping assemblies **1821a** and **1821b** that grip the strength members **1814a** and **1814b** of cable segments **1810a** and **1810b** respectively. As illustrated in **FIGS. 18A** and **18B**, an optical fiber segment **1817c** joins an optical fiber associated with electrical cable **1810a** to an optical fiber associated with electrical cable **1810b**, e.g., through optical fiber sockets **1847a** and **1847b**. As illustrated in **FIG. 18A**, the conductive sleeve body **1828** is formed using two segments **1828a** and **1828b** that are longitudinally split along a portion of the length of the conductive body **1828**, e.g., in a dovetail fashion. In this manner, the interior of the splice **1820**, including the optical fibers, may be accessed and manipulated after the two cable segments **1810a** and **1810b** are mechanically joined. Thereafter, the two conductive body segments **1828a** and **1828b** may be assembled to complete the splice assembly **1820**.

[0068] In another embodiment, the splice assembly may include a spacer clip arrangement similar to the spacer clip arrangement illustrated in **FIGS. 13** to **15** above. **FIG. 19** illustrates an exploded view of such a splice assembly. The splice assembly **1920** mechanically and electrically joins two electrical cable segments **1910a** and **1910b**. A conductive sleeve **1928** provides an electrical connection between the cable segments **1910a** and **1910b**. Gripping assemblies **1921a** and **1921b** are secured to electrical cable segments **1910a** and **1910b** respectively, i.e., by gripping onto the respective strength members. Each of the gripping assemblies **1921a** and **1921b** includes a button **1963a** and **1963b** that is configured to be secured within the spacer clip **1957**, e.g., by being passed through button notches in the spacer clip **1957**. See **FIGS. 14** to **15**. Thus, as

with the termination arrangements disclosed above with respect to **FIGS. 13 to 15**, the spacer clip **1957** advantageously provides a working space for the manipulation of optical fibers within the splice assembly **1920**, e.g., through a window port as illustrated in **FIGS. 13A to 13C**.

[0069] **FIGS. 20A and 20B** illustrate a further embodiment of a splice assembly that incorporates window ports for access to and/or routing of optical fiber(s). The splice assembly **2020** includes two window ports **2054a** and **2054b** through the conductive body **2028** that enable access to the interior of the splice assembly. The window ports **2054a** and **2054b** are located on opposite sides of a connector **2022** that joins the gripping assemblies **2021a** and **2021b**. The window ports **2054a** and **2054b** are also located near the ends of the electrical cable segments **2010a** and **2010b** to enable ease of access to the optical fibers that extend from the electrical cables. As illustrated in **FIG. 20**, an optical fiber segment **2017c** is operatively connected to the optical fibers extending from the electrical cables **2010a** and **2010b**, e.g., using a fiber splice, and is routed through the window ports **2054a** and **2054b** to avoid passing through the gripping assemblies and the connector. As with the termination apparatus disclosed above, removable window port covers **2055a** and **2055b** cover and seal the window ports **2054a** and **2054b** and permit access to the interior of the splice assembly during and after assembly of the splice.

[0070] **FIGS. 21A and 21B** illustrate another embodiment of a splice assembly that incorporates an optical fiber ring to enable optical fiber(s) to be passed through the interior of the splice assembly. **FIG. 21A** illustrates the optical fiber ring **2165**. The ring **2165** is generally round and includes at least one, and preferably more than one, optical fiber retaining notch **2166a** in the circumference of the ring **2165**. The retaining notch **2166a** is configured, e.g., is sized and shaped, to hold an optical fiber that passes through the notch **2166a**. The retaining ring **2165** may be fabricated from an elastic material such as a high temperature elastomer. As illustrated in **FIG. 21B**, a plurality of rings **2165a** to **2165d** may be placed around the gripping assemblies **2121a** and **2121b**, e.g., at the opposite ends of each gripping assembly. Thus, the rings **2165a** to **2165d** are sized and shaped to closely fit, e.g., to friction fit, over the exterior of the gripping assemblies. The optical fiber notches will then be positioned to enable one or more optical fibers to pass

over the gripping assemblies **2121a** and **2121b** and through the splice while reducing the chance of damage to the optical fibers.

[0071] **FIGS. 22A** and **22B** illustrate another embodiment of a splice assembly according to the present disclosure. The splice assembly **2220** mechanically and electrically joins two cable segments **2210a** and **2210b**. Specifically, the connector **2222** mechanically joins two gripping assemblies **2221a** and **2221b** that grip the strength members **2214a** and **2214b** of cable segments **2210a** and **2210b** respectively. The connector **2222** includes two portions **2222a** and **2222b** that are threadably connected by mating threads **2267a** and **2267b** disposed on the two connector portions **2222a** and **2222b**. One threaded portion **2267b** associated with connector portion **2222b** is configured to rotate freely about its longitudinal axis to mate to the threaded portion **2267a** on the connector portion **2222a**. That is, the threaded portion **2267b** is configured to rotate and mate to threads **2267a** without requiring the entire connector portion **2222b** to also rotate.

[0072] As illustrated in **FIG. 22B**, optical fiber segment **2217a** associated with cable **2210a** is operatively spliced to optical fiber **2217c** associated with electrical cable **2210b**, and optical fiber **2217b** is operatively spliced to optical fiber **2217d**. The splices, e.g., fusion splices, are contained within the connector **2222**, and specifically are contained within a bore **2269** that extends through the connector **2222**. As a result, the splices connecting the optical fibers may be made before threadably mating the two portions **2222a/2222b** of the connector **2222**. Specifically, the optical fibers **2217a** and **2217b** may be inserted through the bore **2269** in the first portion **2222a** and the optical fibers **2222b** may be inserted through the bore **2269** in the second portion **2222b**. After the splices are completed, the two connector portions **2222a** and **2222b** may be brought together and threadably connected with the splices being contained within the bore **2269**. Because the threads **2267b** rotate freely, the mating of the two connector portions **2222a** and **2222b** will not cause stresses, e.g., torsional stresses, to be placed on the optical fibers or the splices during construction of the splice assembly **2220** on the electrical line.

[0073] **FIGS. 23A** to **23C** illustrate a splice assembly including a take-up bobbin system that is configured to protect and manage an optical fiber between the inner and

outer splice hardware components. **FIG. 23A** illustrates a partial cross-section of a splice assembly **2320** incorporating such a bobbin system **2370**. The bobbin system **2370** is comprised of three components, namely two cone fittings **2371a** and **2371b** located at the respective ends of gripping assemblies **2321a** and **2321b**, and a take-up bobbin **2372** disposed between the two cone fittings **2371a** and **2371b**, e.g., over a connector **2322**.

[0074] The cone fittings **2371a/2371b** are configured to guide one or more optical fibers from the strength members, e.g., from the surface of the strength members, over the edge of the gripping assemblies **2321a/2321b** while maintaining a minimum bend radius in the optical fibers to reduce the likelihood that the optical fibers will be damaged during assembly. Referring to **FIG. 23B**, the cone fitting **2371a** comprises a bore **2372** having an inner diameter **2373id** configured (e.g., sized and shaped) to align the cone fitting **2371** to the strength member, e.g., to be placed over an end of the strength member. An inner radius surface **2371ir** is configured to guide the optical fiber up from the strength member while maintaining a minimum bend radius. An outer radius surface **2371or** is configured to guide the filament down, e.g., substantially tangent to the exterior surface of the gripping assembly. A surface cut feature **2375**, e.g., a notch, is configured to guide the optical fiber into a helix around the outer diameter of the gripping assembly **2321a** while also maintaining a minimum bend radius for the optical fiber. A forked protrusion **2376** prevents the optical fiber from catching on flat surfaces of the gripping assembly **2321a**, such as on housing wrench flats. A swivel joint **2374** enables rotation of the outer radius surface **2371or** relative to the surface cut feature **2375**, allowing the outer radius surface **2371or** and the surface cut feature **2375** to be brought into alignment, e.g., into clock alignment. The cone fitting has an outer diameter that is small enough to fit within the conductive sleeve **2328**, but large enough to prevent strain between the cone fitting **2371**, the optical fiber and the conductive sleeve **2328**.

[0075] Referring to **FIG. 23C**, The take-up bobbin **2372** is configured to control the geometry, e.g., the bending, of the optical fiber(s) to maintain a minimum a bend radius. In this regard, the bobbin **2372** includes a clip feature **2378** to locate a splice, e.g., a fusion splice to join two optical fibers. An inner diameter **2372id** is matched to the gripping assembly, enabling the bobbin **2372** to clip into place and freely rotate about its

longitudinal axis. An inner lip feature **2379** is configured to locate the bobbin **2372** on the end of the gripping assembly. A surface cut feature **2380** is configured to guide the optical fiber into a helix around the outer diameter of the gripping assembly, accounting for the width of the fusion splice sleeve, while maintaining a minimum bend radius. An outer diameter **2372od** of the bobbin **2372** is small enough to fit within the conductive sleeve **2328**, but large enough to prevent strain between the bobbin **2372**, the optical fiber and the conductive sleeve **2328**.

[0076] **FIG. 23D** schematically illustrates a method for the use of the bobbin system according to the present disclosure. The conductor **2311a** of the electrical cable segment **2310a** is trimmed from the strength member **2314a**, e.g., leaving a length of the strength member **2314a** and the optical fiber **2317a** exposed. The conductive sleeve (not illustrated) is slid over the electrical cable **2311a**. The optical fiber **2317a** is separated from the strength member **2314a**, e.g., is peeled away from the surface of the strength member. A similar process is carried out to strip the electrical cable segment on the opposite side and to separate the optical fiber. Cone fittings **2371a** and **2371b** are installed on both ends of the strength members and the optical fibers **2317a** and **2317b** are threaded through the cone fittings **2371a** and **2371b**. The strength members are then trimmed, leaving the ends of the optical fibers **2317a** and **2317b** free from the strength members.

[0077] The splice assembly components, e.g., the gripping assemblies **2321a** and **2321b** and connector **2322** are installed while leaving the optical fibers **2317a** and **2317b** free. The two free ends of the optical fibers **2317a** and **2317b** are then spliced, e.g., forming a fusion splice **2346**. Since the free length of the spliced optical fibers **2317a** and **2317b** exceeds the length of the splice assembly **2310a**, the optical fibers hang in a loop below the splice assembly. To manage the excess length of the optical fibers, the take-up bobbin **2372** is installed onto the connector **2322**, and the fusion splice **2346** is clipped into the center of the bobbin. The cone fittings **2371a** and **2371b** are then pressed onto the ends of the gripping assemblies and the bobbin **2372** is rotated around the connector axis until substantially all slack is out of the optical fibers **2317a** and **2317b**.

[0078] The foregoing embodiments illustrate the termination apparatus and splice assemblies, components and methods being implemented with a fiber-reinforced composite strength member having a single strength element. However, these embodiments may also be implemented with multi-element strength members (e.g., **FIG. 4B**), whether fabricated from a fiber-reinforced composite material or from traditional materials such as steel as in an ACSR (aluminum conductor steel reinforced) configuration or an ACSS (aluminum conductor steel supported) configuration. The embodiments may also be implemented with an aluminum multi-element strength member, such as in a AAAC (all aluminum alloy conductor) configuration. In addition, the embodiments may be implemented with an OPGW (optical ground wire).

[0079] Certain components of the foregoing termination apparatus and splice assemblies may be fabricated from high strength metals such as steel, including stainless steel. These include the gripping assemblies, e.g., the collet and housing components, and the connectors. Components requiring higher electrical conductivity, such as the conductive sleeves, may be fabricated from aluminum for example.

[0080] While various embodiments of termination apparatus, splice and methods for the termination and splicing of an overhead electrical cable 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 apparatus for use with an overhead electrical cable, comprising:

a gripping assembly configured to grip a strength member of an overhead electrical cable, the gripping assembly comprising a gripping assembly channel disposed along an external surface of the gripping assembly that is configured to secure one or more optical fibers within the gripping assembly channel; and

a connector integrally formed with or configured to be operatively attached to the gripping assembly and comprising a connector body and a connector body channel disposed along an external surface of the connector body that is configured to secure the one or more optical fibers within the connector body channel.

2. The termination apparatus recited in Claim 1, wherein the gripping assembly comprises a compression wedge.

3. The termination apparatus recited in Claim 2, wherein the compression wedge comprises a collet and a collet housing that is configured to receive the collet within the collet housing.

4. The termination apparatus recited in Claim 3, wherein the gripping assembly channel is disposed on an outer surface of the collet housing.

5. The termination apparatus recited in and one of Claims 3 or 4, wherein the connector body comprises connector body threads and wherein the collet housing comprises collet housing threads, wherein the connector body threads are configured to mate with the collet housing threads to threadably secure the collet housing to the connector body.

6. The termination apparatus recited in any one of Claims 1 to 5, wherein the gripping assembly channel runs from one end of the gripping assembly to a second end of the gripping assembly.

7. The termination apparatus recited in Claim 6, wherein the gripping assembly channel runs along the external surface of the gripping assembly in a substantially linear manner.

8. The termination apparatus recited in any one of Claims 1 to 7, wherein the connector body channel runs from a first end of the connector body to a second end of the connector body.

9. The termination apparatus recited in Claim 8, wherein the connector body channel runs along the external surface of the connector body in a substantially linear manner.

10. The termination apparatus recited in any one of Claims 1 to 9, further comprising an outer conductive sleeve comprising a conductive body and a cavity within the conductive body, wherein the conductive body is configured to be placed over the gripping assembly and over the connector when the gripping assembly is operatively attached to the connector.

11. The termination apparatus recited in any one of Claims 1 to 10, comprising a fastener operatively attached to the connector body.

12. The termination apparatus recited in Claim 11, wherein the fastener is integrally formed with the connector body.

13. The termination apparatus recited in any one of Claims 11 or 12, wherein the fastener comprises an eyebolt.

14. The termination apparatus recited in any one of Claims 1 to 13, further comprising a strain relief guide having a guide aperture that is configured to redirect an optical fiber from an electrical cable to the gripping assembly channel.

15. The termination apparatus recited in any one of Claims 1 to 14, further comprising an optical fiber aperture that is configured to facilitate passage of an optical fiber through the aperture.

16. The termination apparatus recited in Claim 15, wherein the optical fiber aperture is disposed at an end of the connector.

17. A termination apparatus securing an overhead electrical cable having a strength member, an electrical conductor surrounding the strength member and one or more optical fibers associated with the electrical cable, the apparatus comprising:

a gripping assembly gripping the strength member, the gripping assembly comprising a gripping assembly channel disposed along an external surface of the gripping assembly;

a connector integrally formed with or operatively attached to the gripping assembly and comprising a connector body and a connector body channel disposed along an external surface of the connector body;

at least a first optical fiber disposed within the gripping assembly channel and within the connector body channel.

18. The termination apparatus recited in Claim 17, wherein the gripping assembly comprises a compression wedge.

19. The termination apparatus recited in Claim 18, wherein the compression wedge comprises a collet and a collet housing that receives the collet within the collet housing.

20. The termination apparatus recited in Claim 19, wherein the gripping assembly channel is disposed on an outer surface of the collet housing.

21. The termination apparatus recited in and one of Claims 19 or 20, wherein the connector body comprises connector body threads and wherein the collet housing comprises collet housing threads, wherein the connector body threads are operatively engaged with the collet housing threads to threadably secure the collet housing to the connector body.

22. The termination apparatus recited in any one of Claims 17 to 21, wherein the gripping assembly channel runs from one end of the gripping assembly to a second end of the gripping assembly.

23. The termination apparatus recited in Claim 22, wherein the gripping assembly channel runs along the external surface of the gripping assembly in a substantially linear manner.

24. The termination apparatus recited in any one of Claims 17 to 23, wherein the connector body channel runs from a first end of the connector body to a second end of the connector body.

25. The termination apparatus recited in Claim 24, wherein the connector body channel runs along the external surface of the connector body in a substantially linear manner.

26. The termination apparatus recited in any one of Claims 17 to 25, further comprising an outer conductive sleeve comprising a conductive body and a cavity within the conductive body, wherein the conductive body is disposed over the gripping assembly and over the connector.

27. The termination apparatus recited in any one of Claims 17 to 26, comprising a fastener operatively attached to the connector body.

28. The termination apparatus recited in Claim 27, wherein the fastener is integrally formed with the connector body.

29. The termination apparatus recited in any one of Claims 27 or 28, wherein the fastener comprises an eyebolt.

30. The termination apparatus recited in any one of Claims 17 to 29, further comprising a strain relief guide having a guide aperture that redirects the optical fiber from the electrical cable to the gripping assembly channel.

31. The termination apparatus recited in any one of Claims 17 to 30, further comprising an optical fiber aperture, wherein the optical fiber passes through the aperture to enable access to an end of the optical fiber.

32. The termination apparatus recited in Claim 31, wherein optical fiber aperture is disposed at an end of the connector.

33. A termination apparatus securing an overhead electrical cable having a strength member, an electrical conductor surrounding the strength member and one or more optical fibers associated with the electrical cable, the apparatus comprising:

a gripping assembly gripping the strength member;

a connector integrally formed with or operatively attached to the gripping assembly and comprising a connector body and a connector body bore extending through the connector body; and

at least a first optical fiber disposed through the connector body bore.

34. A termination apparatus for use with an overhead electrical cable having a central strength member and an electrical conductor disposed over the strength member, comprising:

a gripping assembly configured to grip the strength member of the overhead electrical cable;

a connector integrally formed with or configured to be operatively attached to the gripping assembly;

an outer sleeve comprising a sleeve body defining a cavity therein, wherein the sleeve body comprises an aperture therethrough that is positioned to be disposed between the gripping assembly and an end of the electrical conductor when the outer sleeve is operatively crimped over the gripping assembly and the connector; and

an optical fiber socket configured to be operatively placed within the aperture to provide an optical fiber connection through the outer sleeve.

35. A gripping assembly configured for use with a termination arrangement for an overhead electrical cable having a strength member, an electrical conductor surrounding the strength member and one or more optical fibers associated with the electrical cable, the gripping assembly comprising:

a lumen disposed through the gripping assembly, the lumen being configured to operatively receive the strength member of the electrical cable therein; and

a channel disposed on an outer surface of the gripping assembly and running from a first end of the gripping assembly to a second end of the gripping assembly, the channel being configured to receive the one or more optical fibers therein.

36. The gripping assembly recited in Claim 35, wherein the lumen is disposed in a collet and the channel is disposed on an outer surface of a collet housing that is configured to operatively receive the collet therein.

37. A splice assembly mechanically and electrically connecting two line segments of an overhead electrical line, the splice assembly comprising:

a first gripping assembly operatively gripping a first line segment of the overhead electrical line and a second gripping assembly operatively gripping a second line segment of the overhead electrical line, each of the first and second gripping assemblies comprising a button on an end of the gripping assembly opposite the electrical cable segment;

a spacer clip operatively joining the first gripping assembly to the second gripping assembly, the spacer clip comprising an access slot providing access to a working space within the spacer clip and comprising two button notches in a sidewall of the spacer clip, wherein the gripping assembly buttons are placed through the button notches and are secured by the spacer clip; and

a conductive sleeve body disposed over the gripping assemblies and the spacer clip, the conductive sleeve body electrically connecting a conductor of the first cable segment to a conductor of the second cable segment.

38. The splice assembly recited in Claim 37, comprising a window port disposed through the conductive sleeve body.

39. The splice assembly recited in Claim 38, comprising a window port cover removably covering the window port.

40. The splice assembly recited in any one of Claims 37 to 39, wherein each of the first overhead electrical cable segment and the second overhead cable segment comprises at least one optical fiber associated with the overhead cable segment, wherein the optical fiber of the first segment is operatively joined to the optical fiber of the second segment within the splice assembly.