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(54) **CONNECTOR FOR TELECOMMUNICATION ENCLOSURES**

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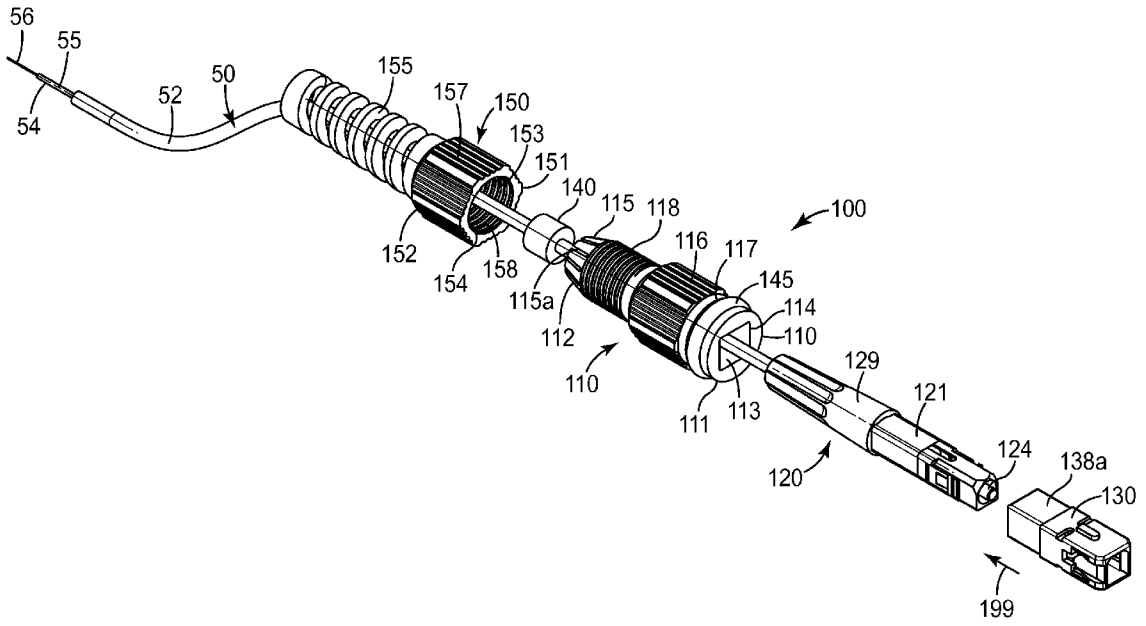
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USPC **385/81**

(57) **ABSTRACT**

An optical fiber connector is described herein for inserting a telecommunication cable into a telecommunication enclosure in order to make an optical connection when the connector is inserted into a port structure of a telecommunication enclosure. The exemplary connector has a main body with an interior passageway extending from a first end to a second end of the main body and a compressible portion at the second end of the main body, a compression member attachable to the second end of the optical fiber connector over the compressible portion, a optical connection portion disposed at least partially within the interior, and an outer housing disposed over the connection portion wherein the outer housing has an external shape mateable with a standard format optical coupling.



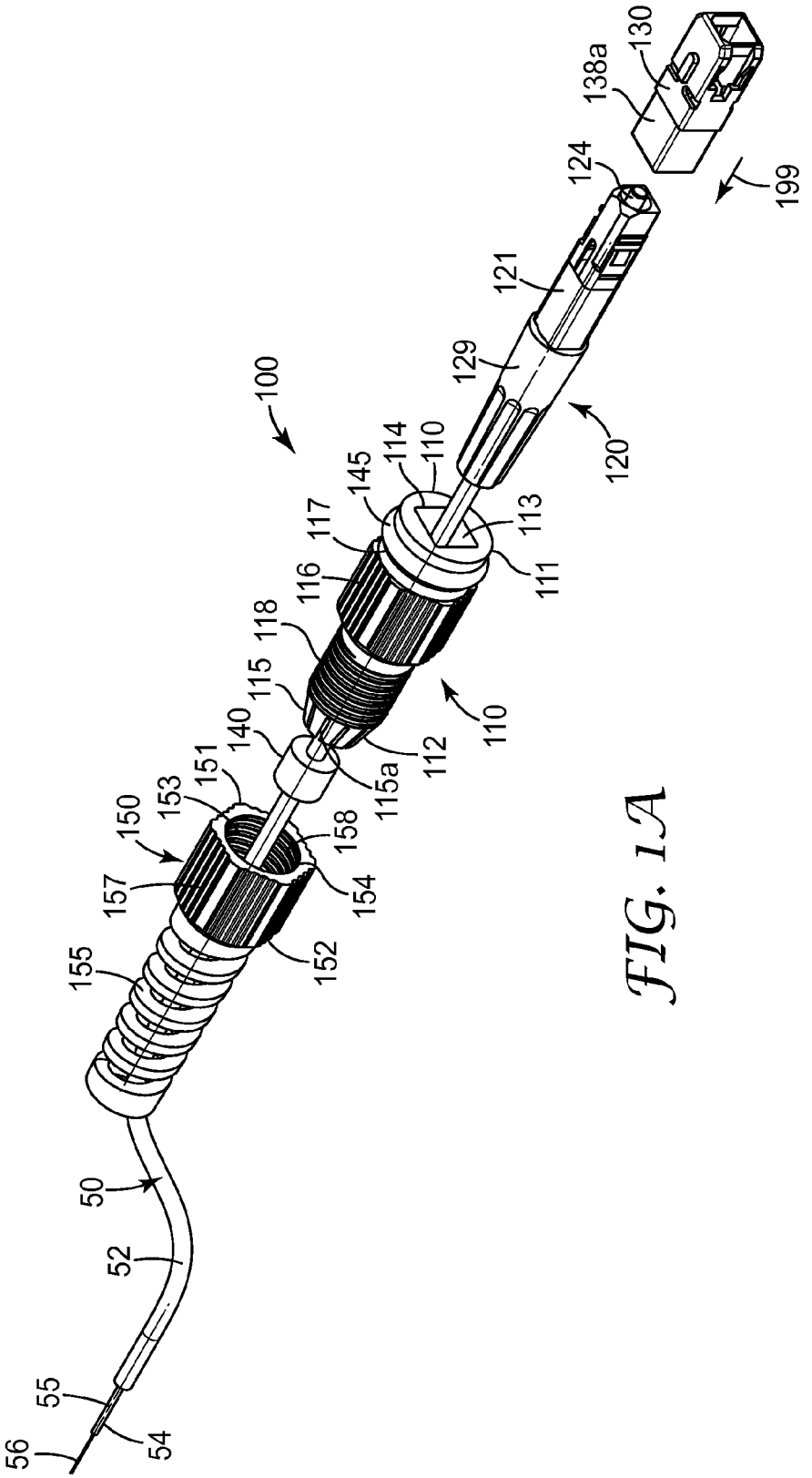

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FIG. 1A

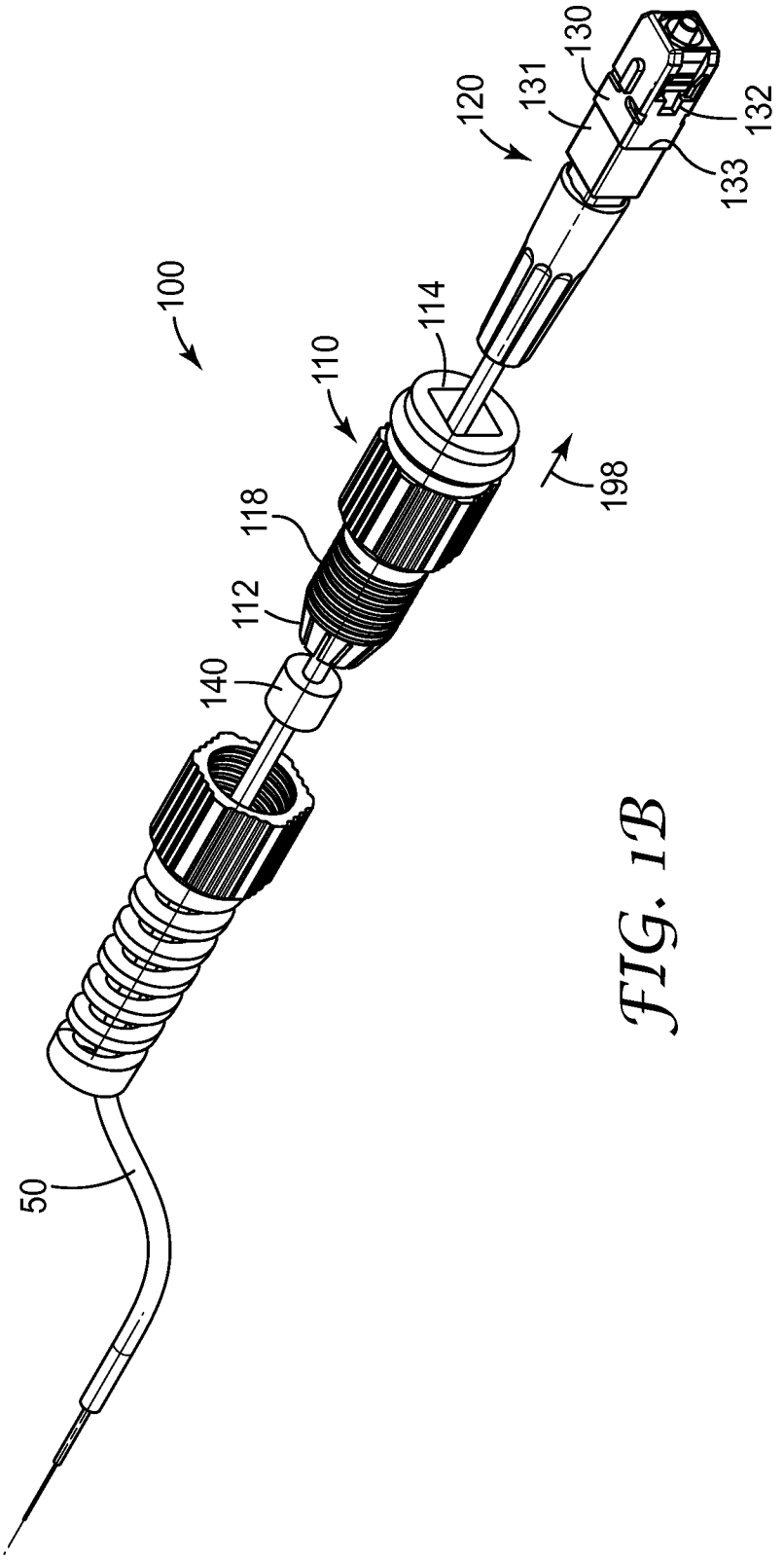


FIG. 1B

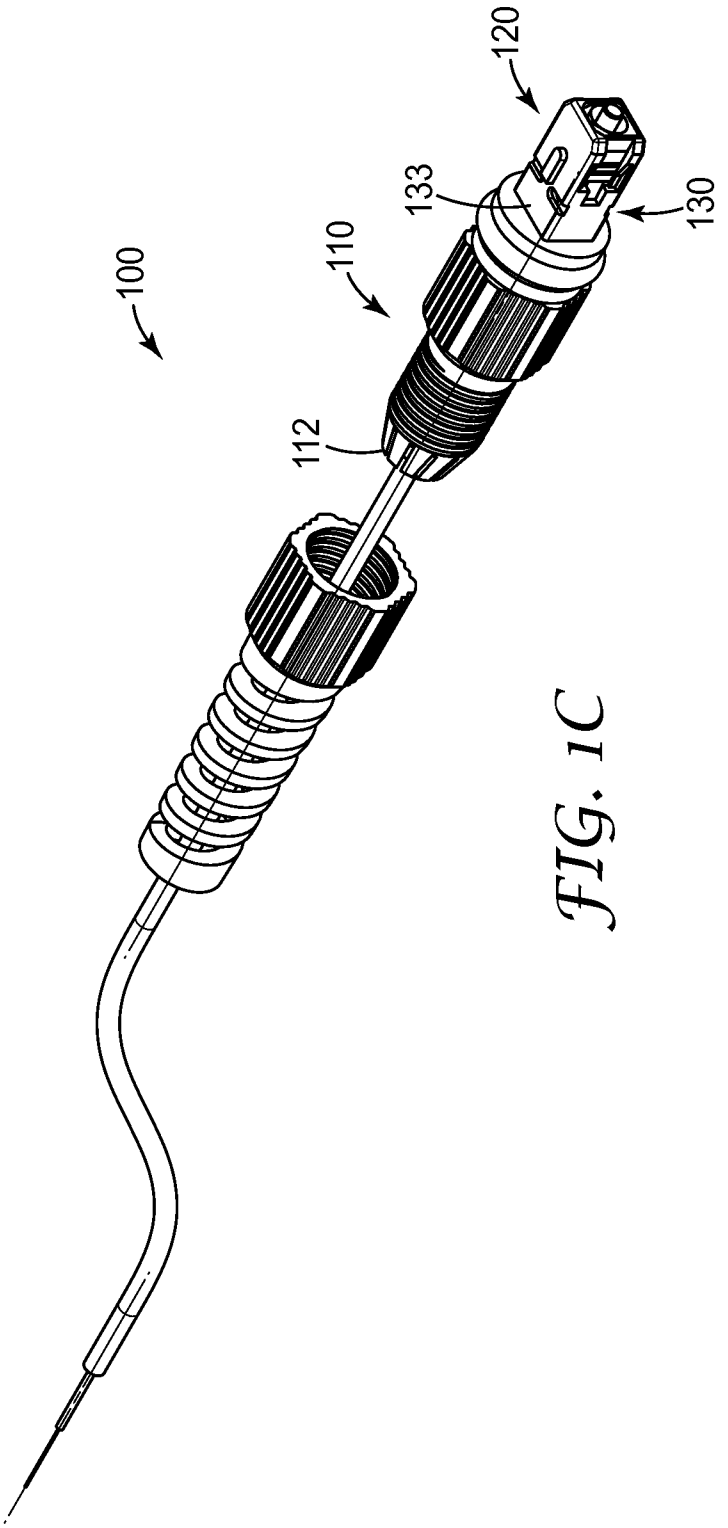


FIG. 1C

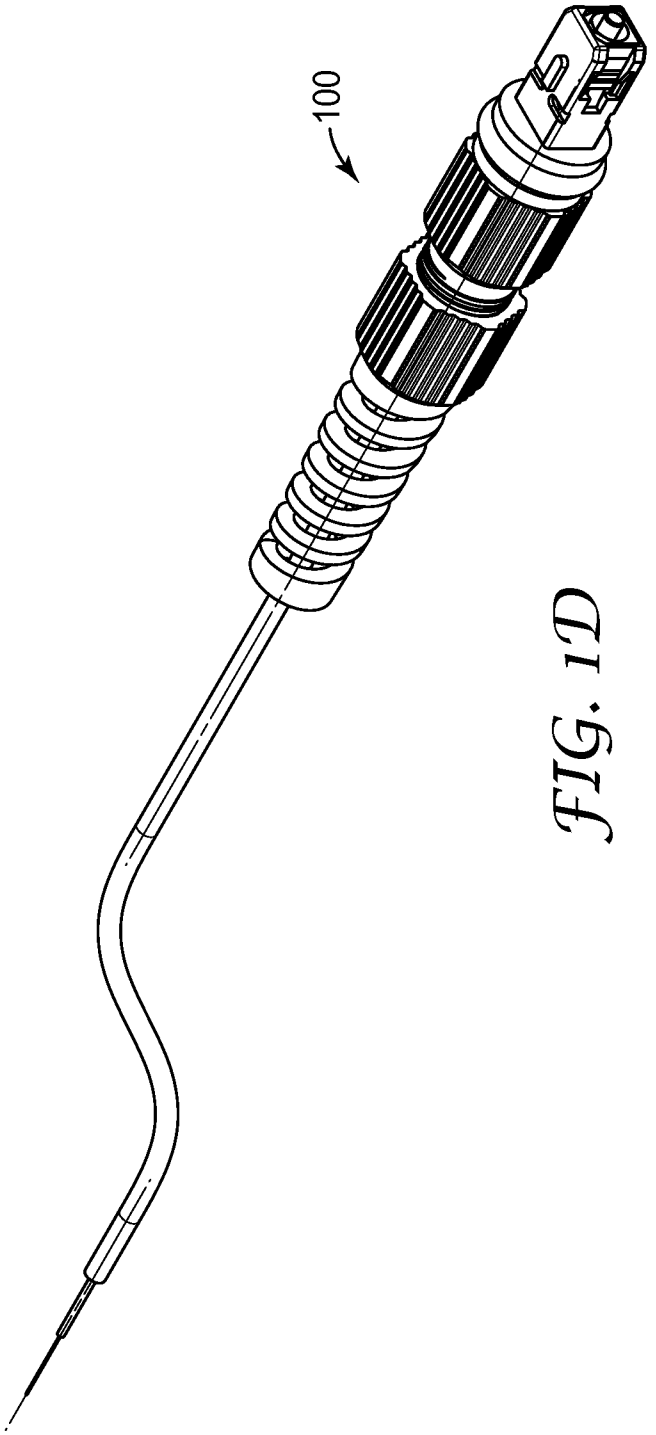


FIG. 1D

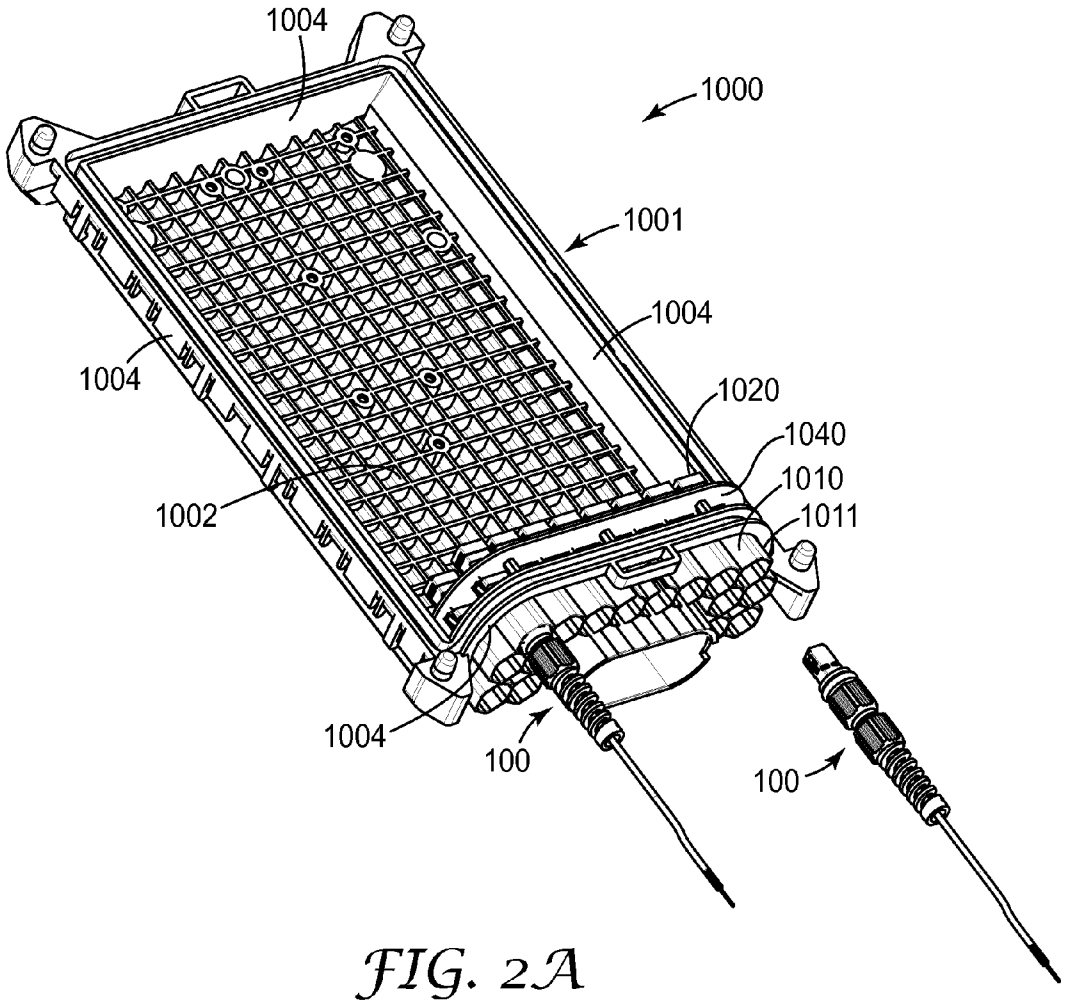

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FIG. 2A

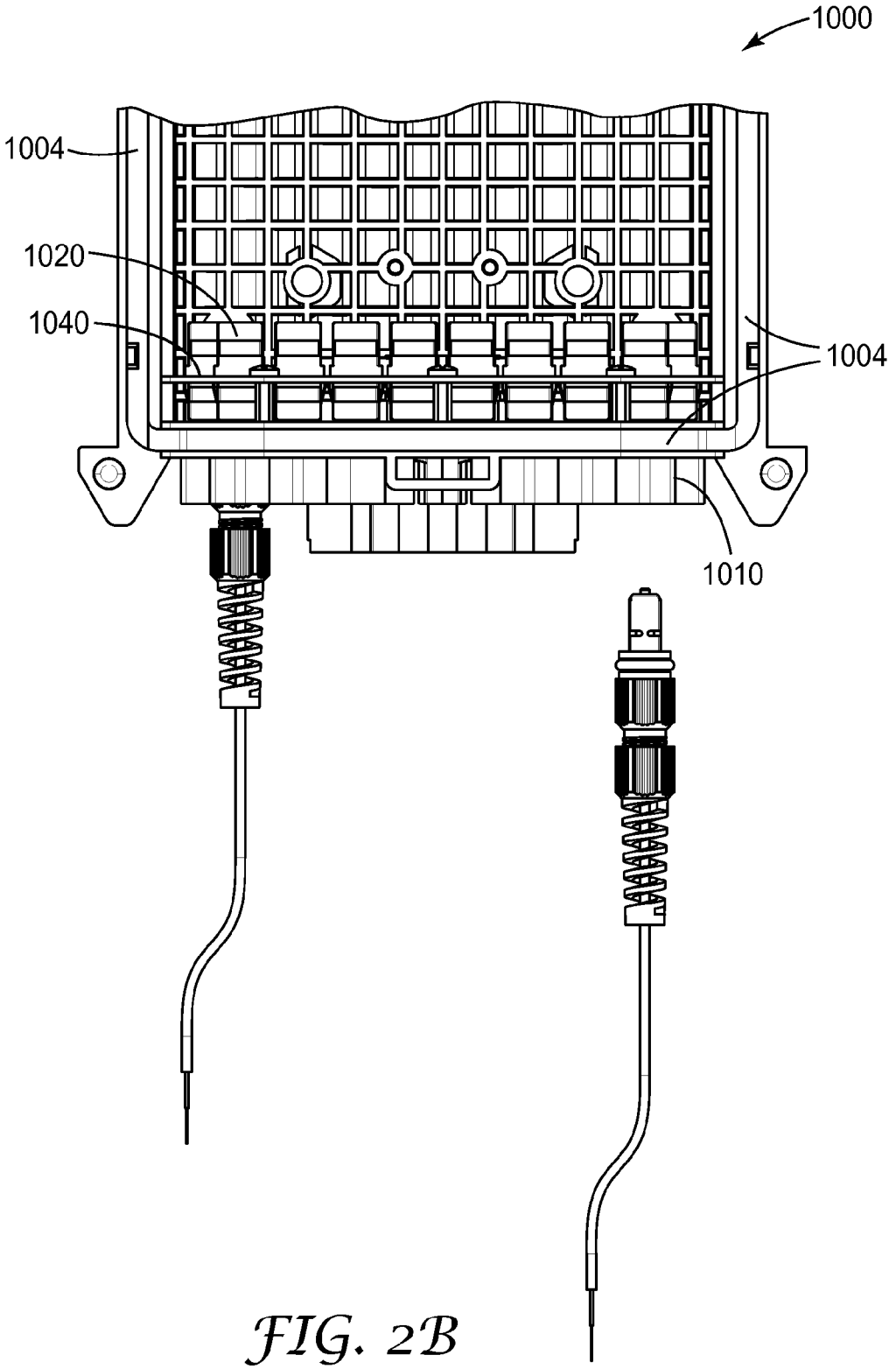


FIG. 2B

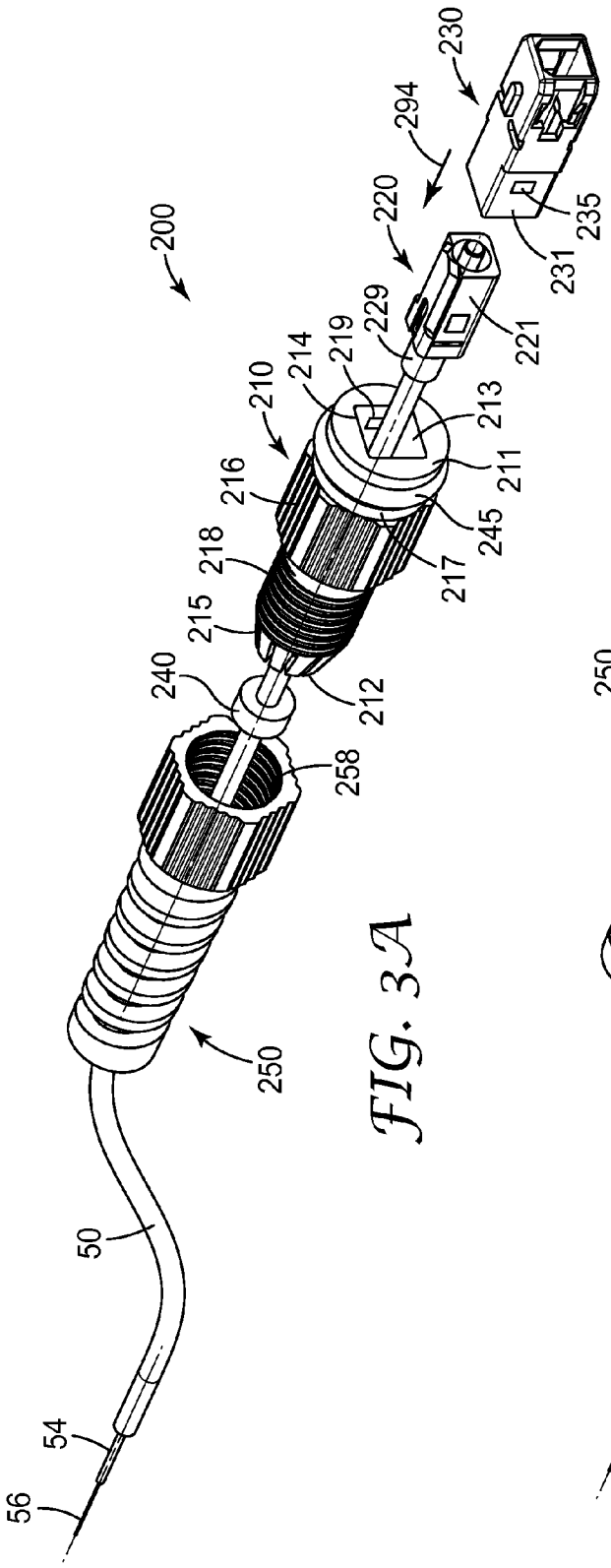

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FIG. 3A

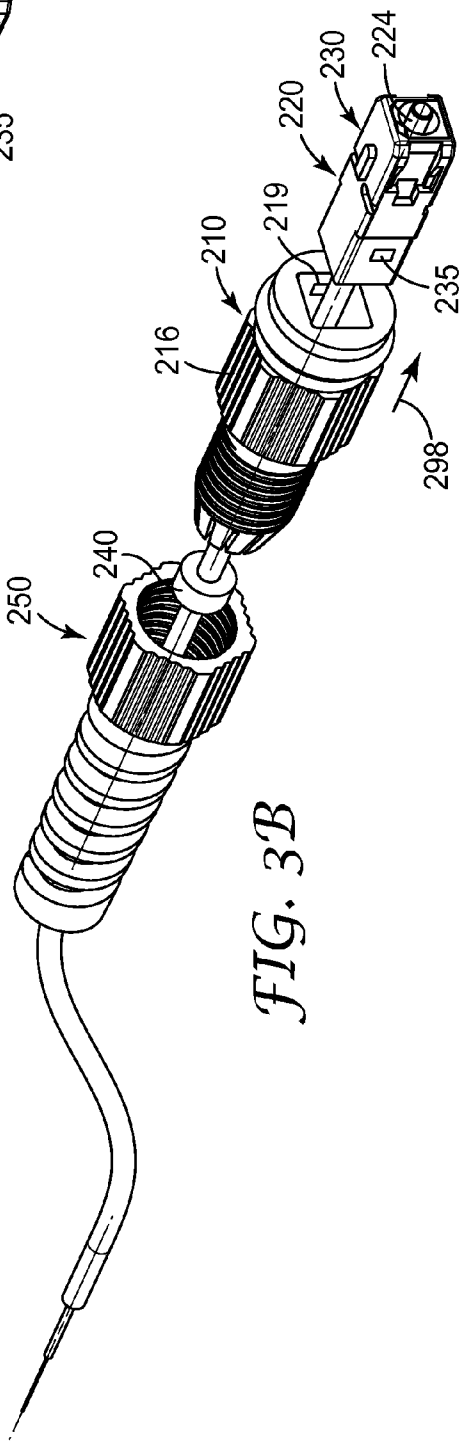

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FIG. 3B

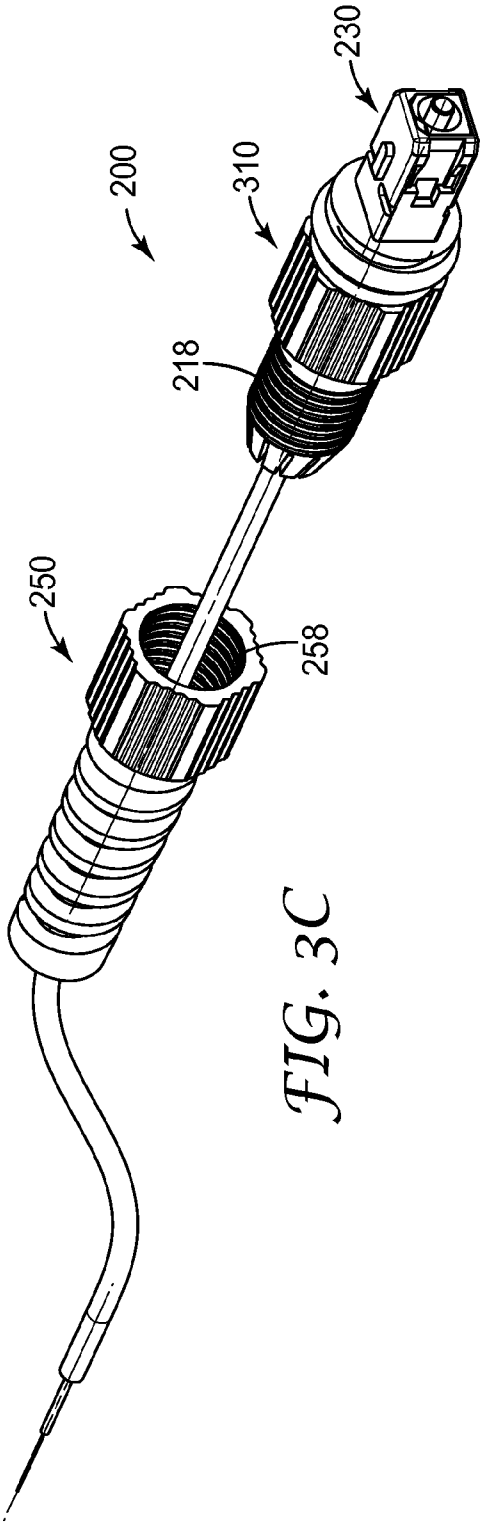


FIG. 3C

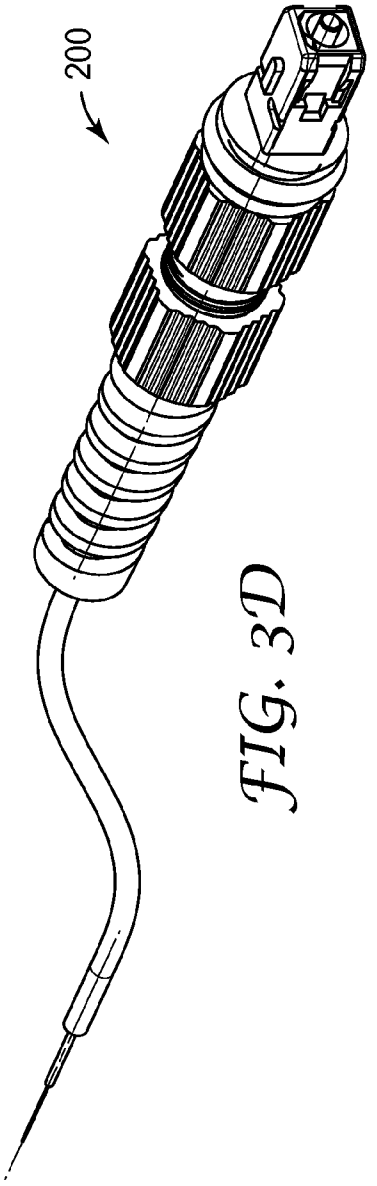


FIG. 3D

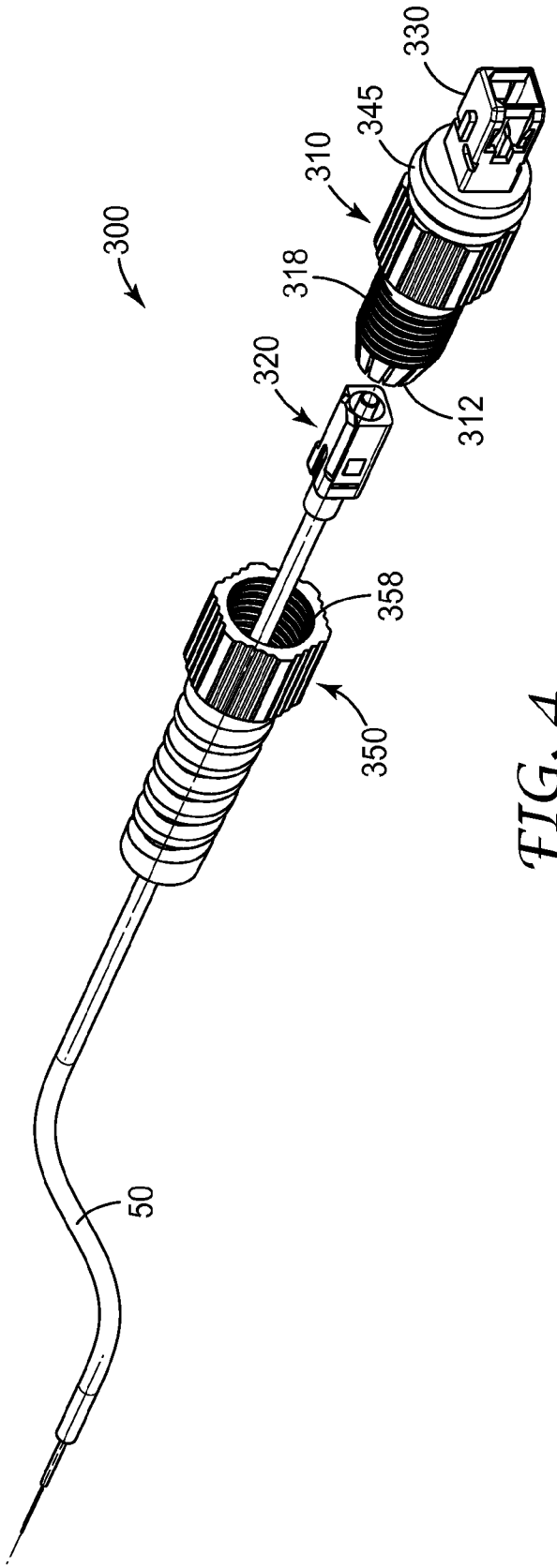


FIG. 4

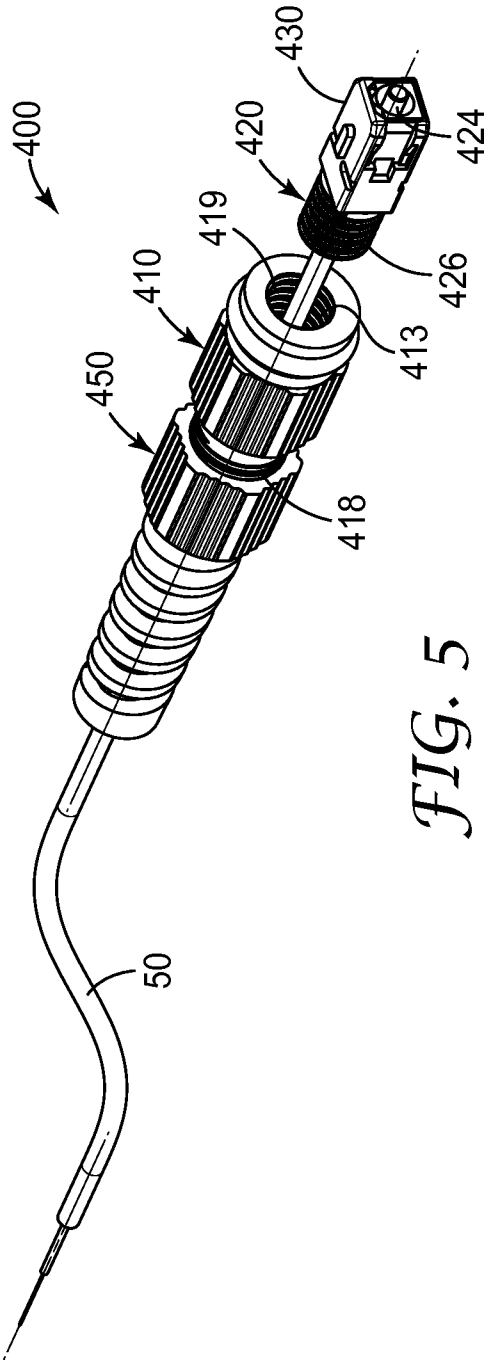


FIG. 5

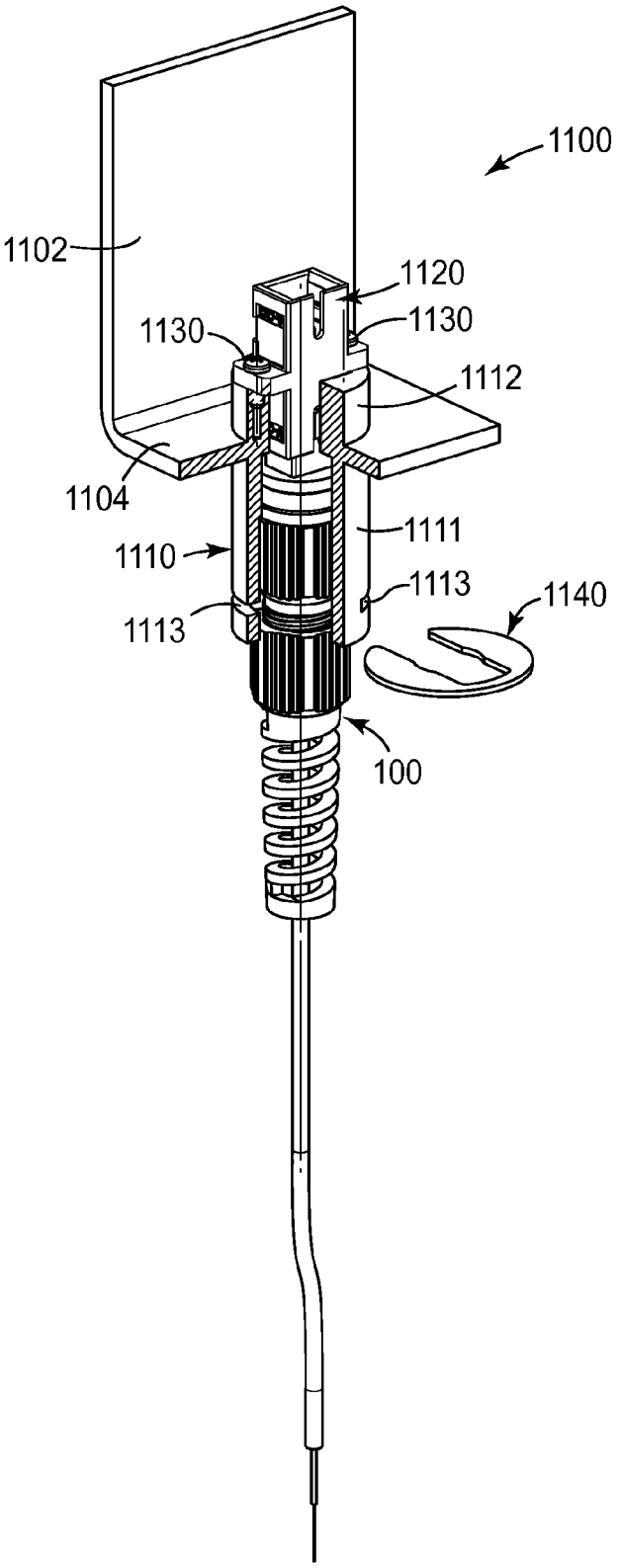

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FIG. 6A

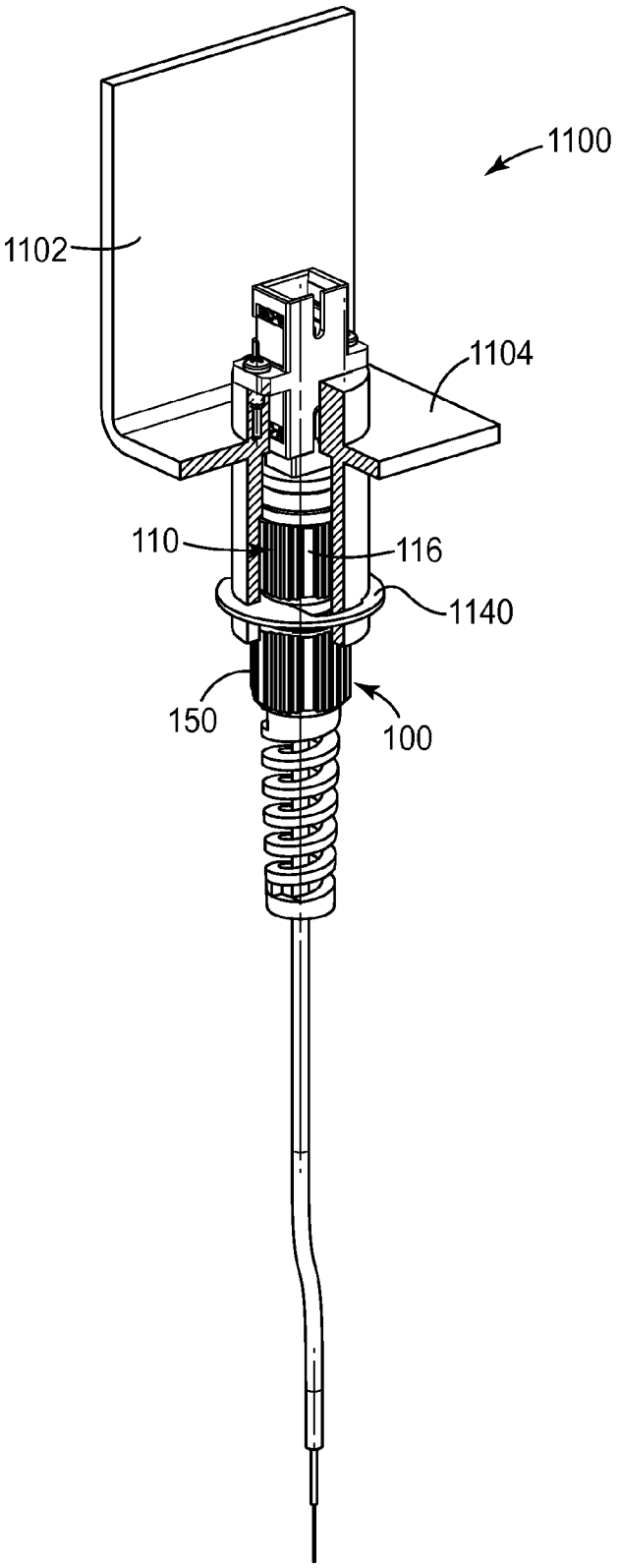


FIG. 6B

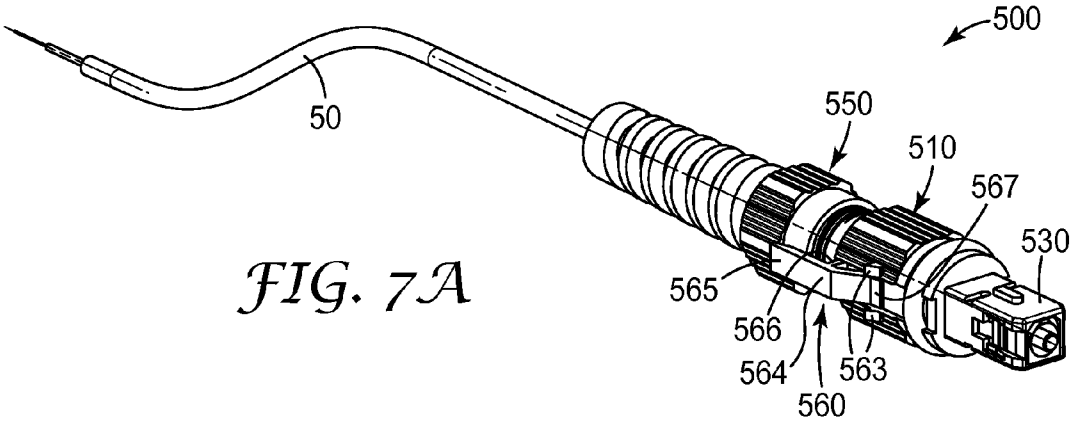

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FIG. 7A

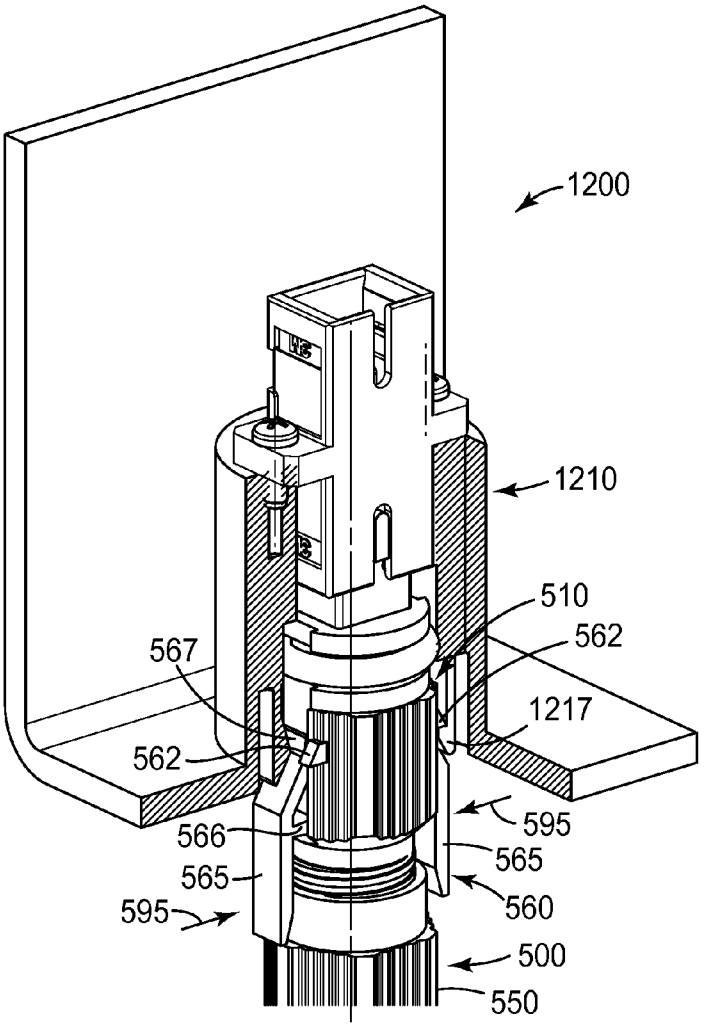

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FIG. 7B

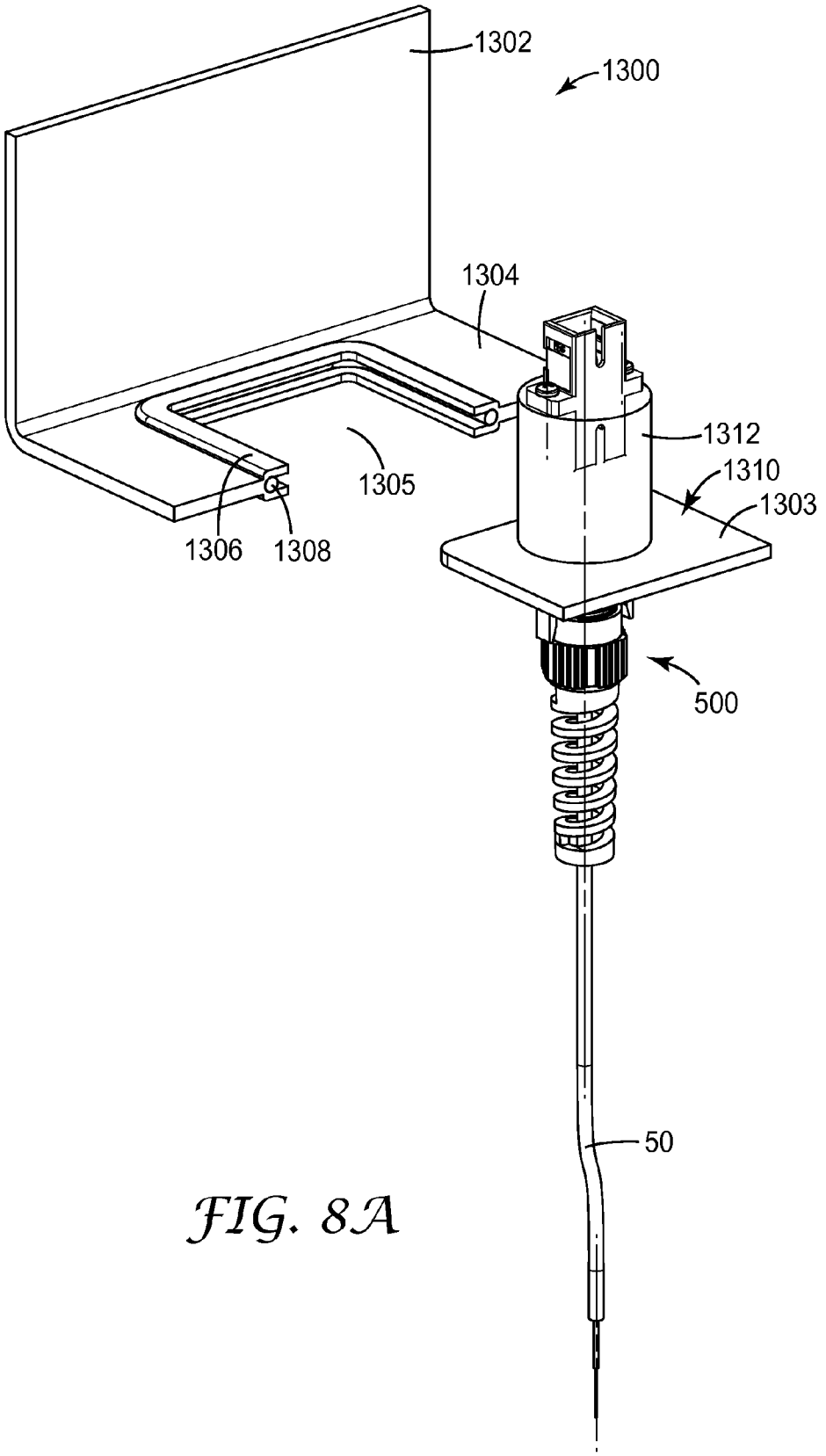


FIG. 8A

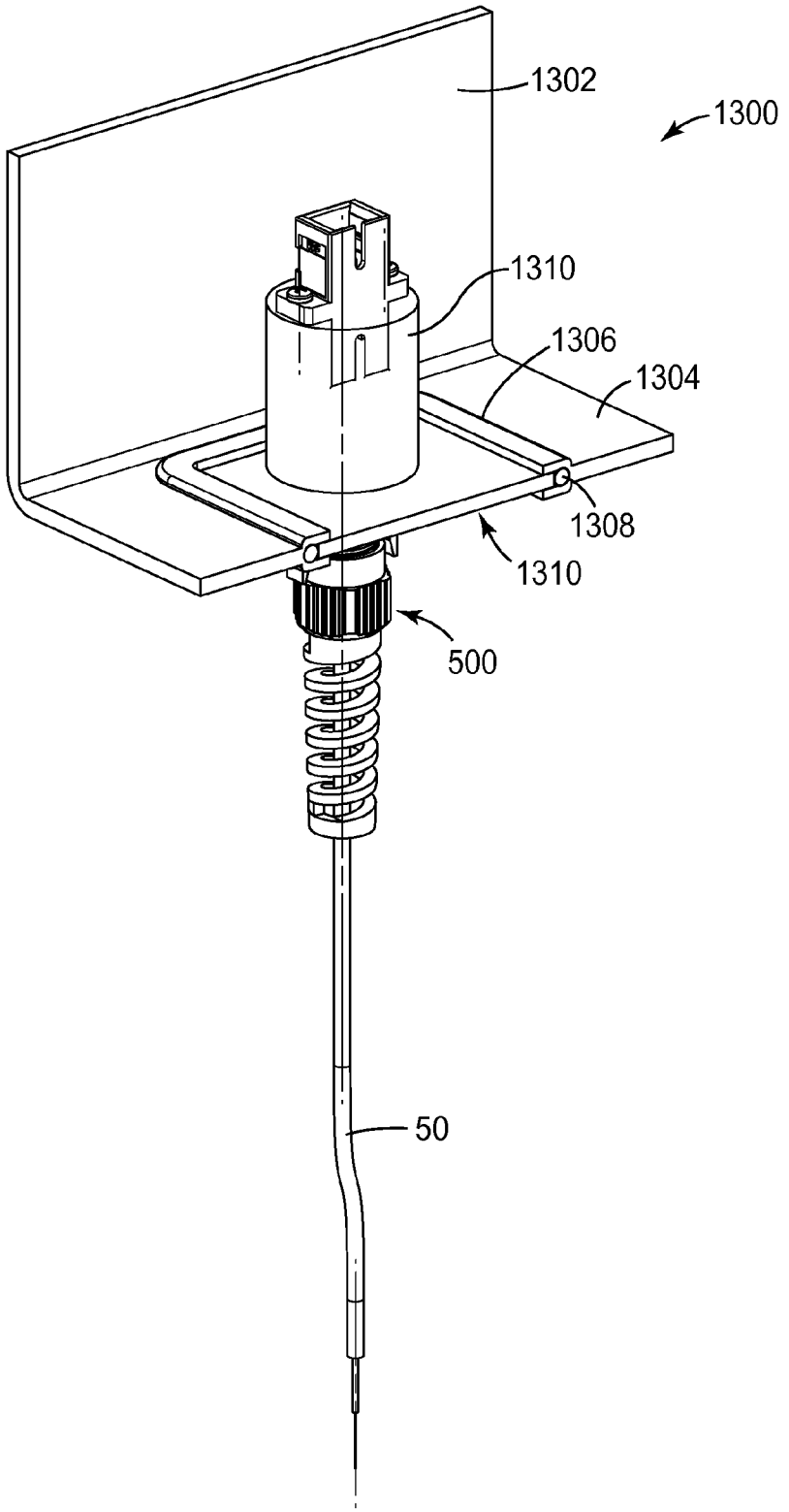


FIG. 8B

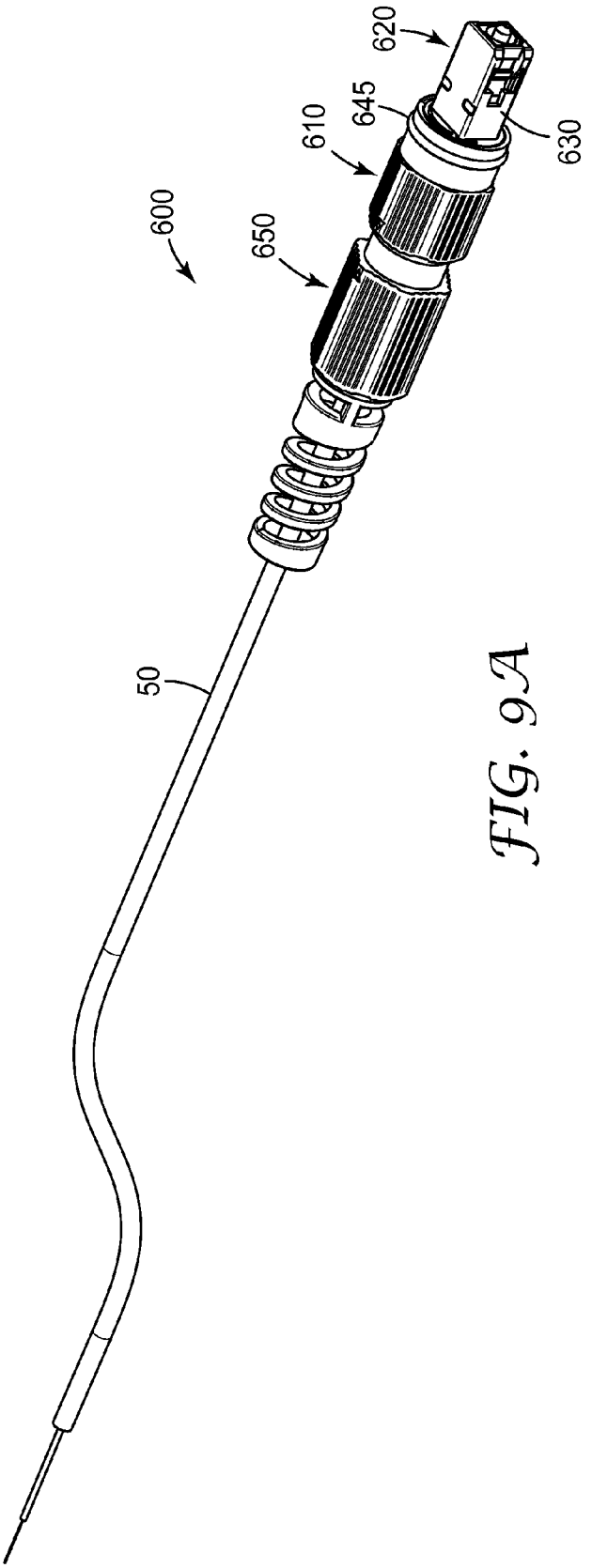


FIG. 9A

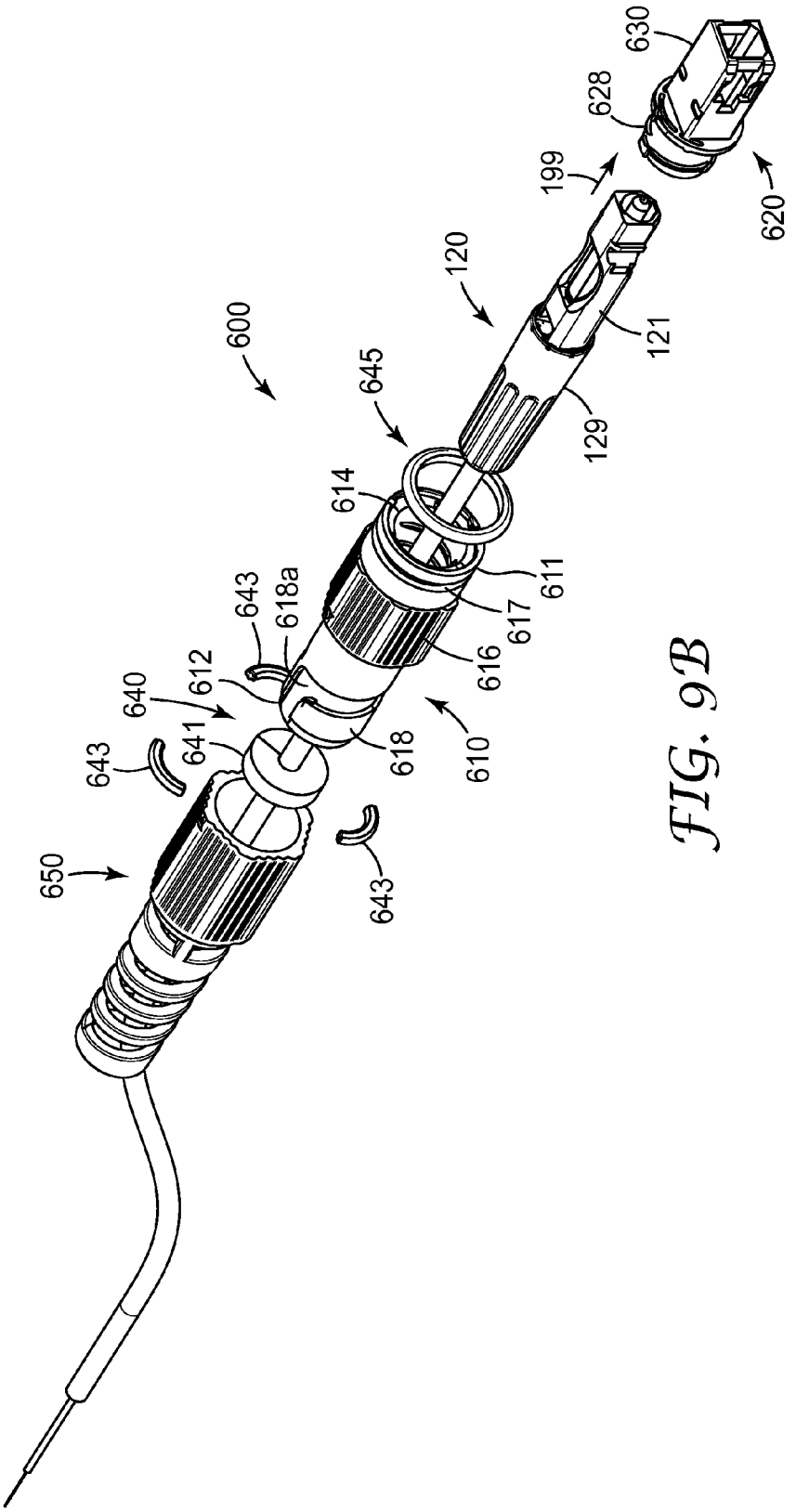

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FIG. 9B

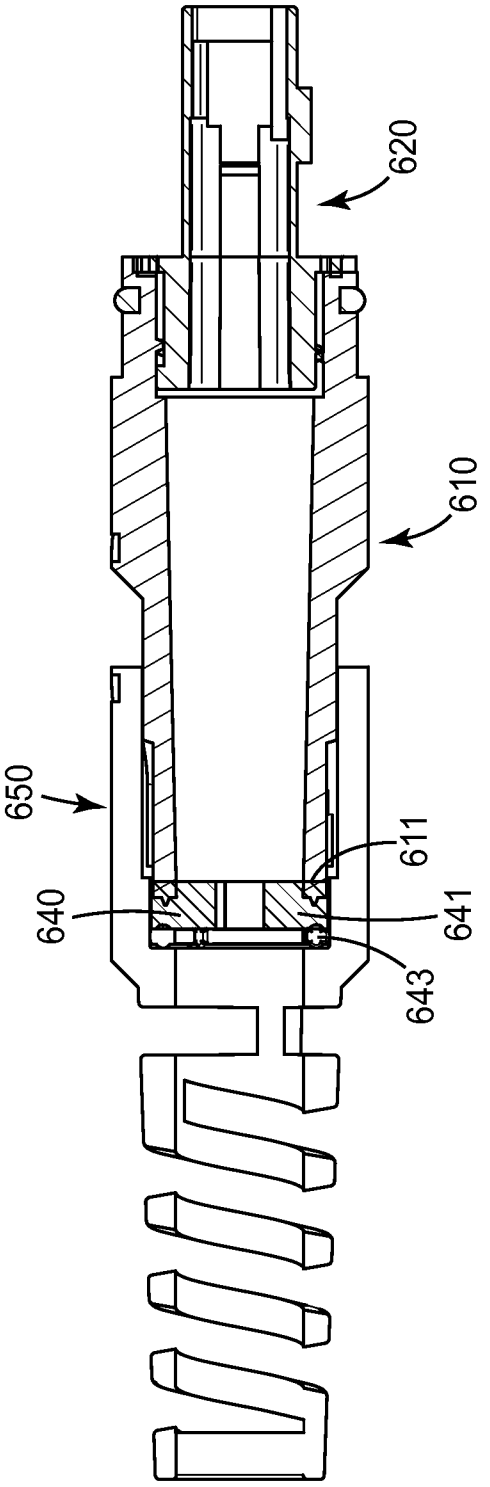


FIG. 9C

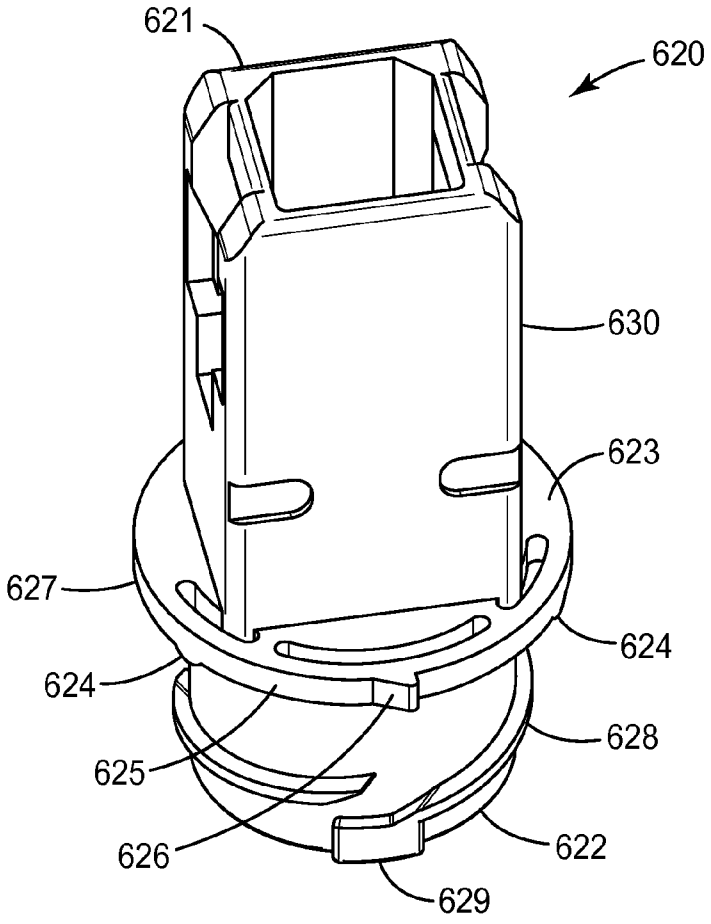


FIG. 10A

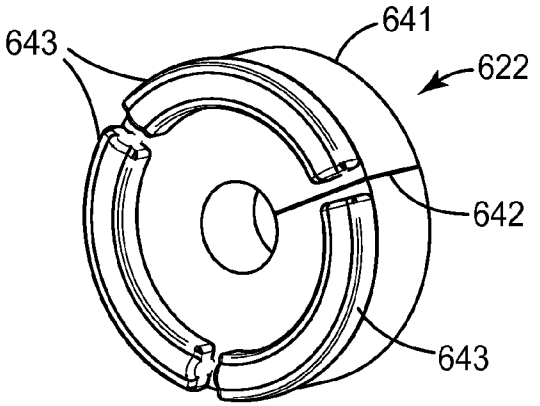


FIG. 10C

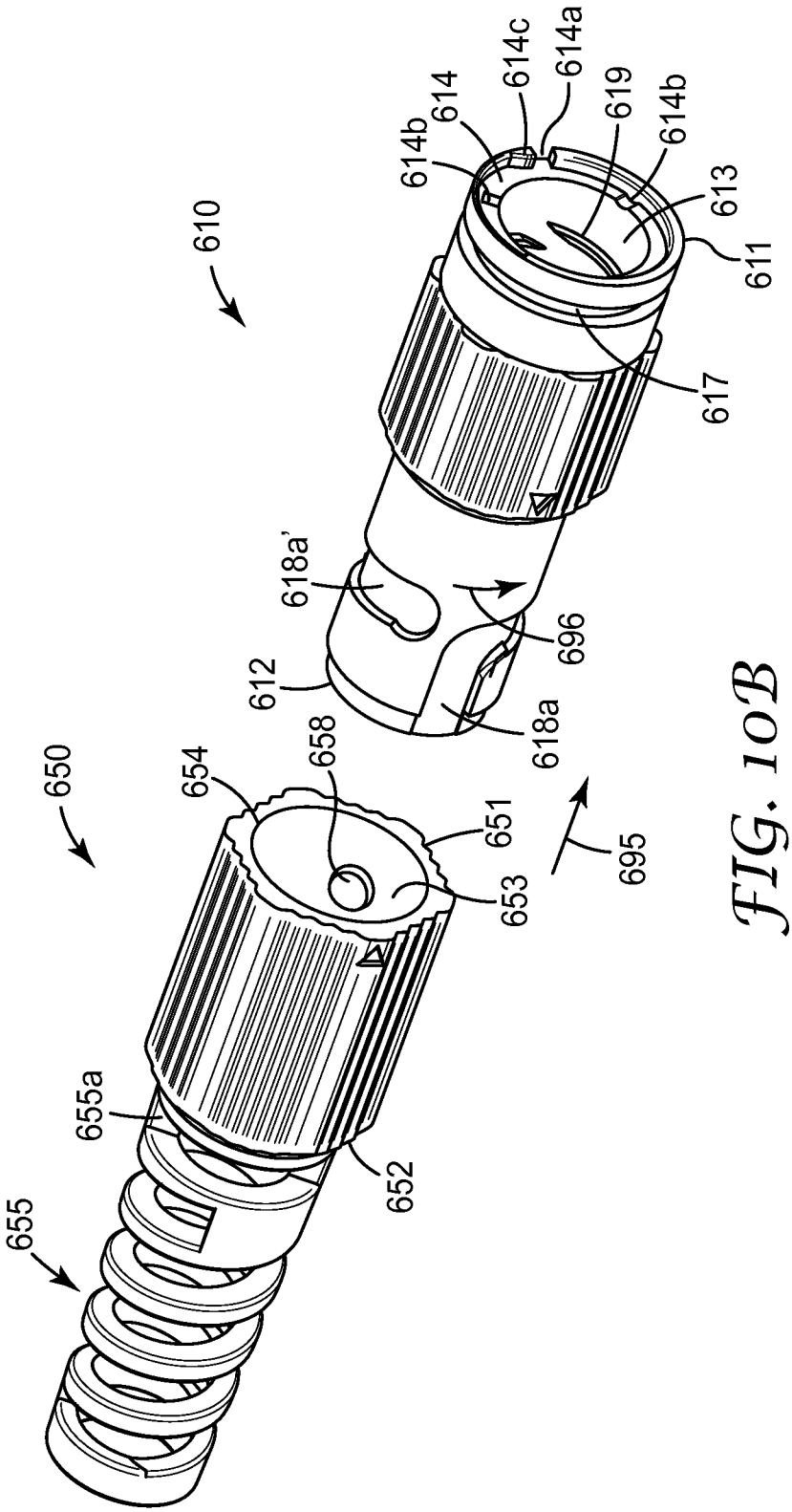

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FIG. 10B

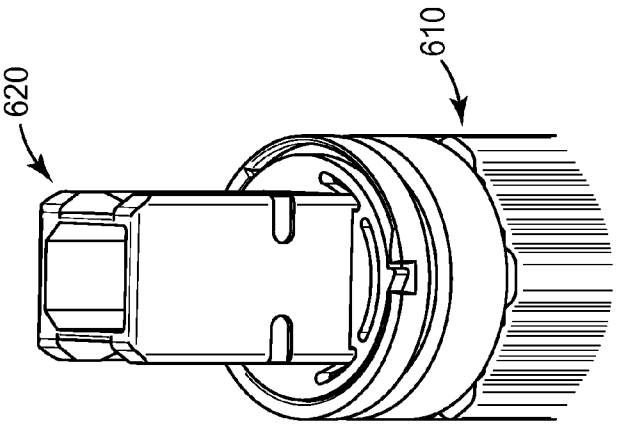


FIG. 11C

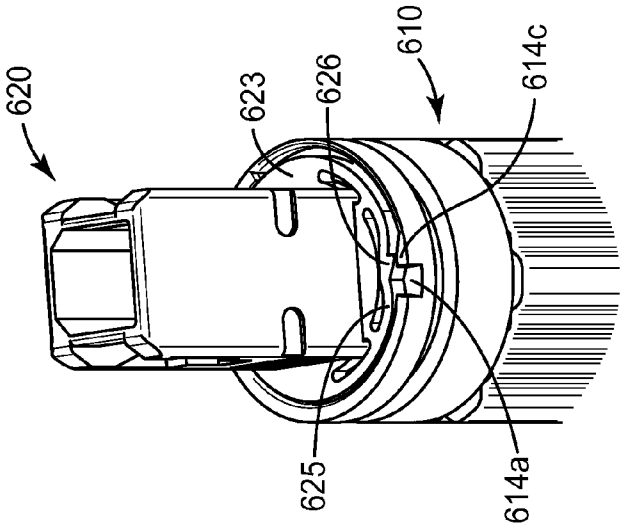


FIG. 11B

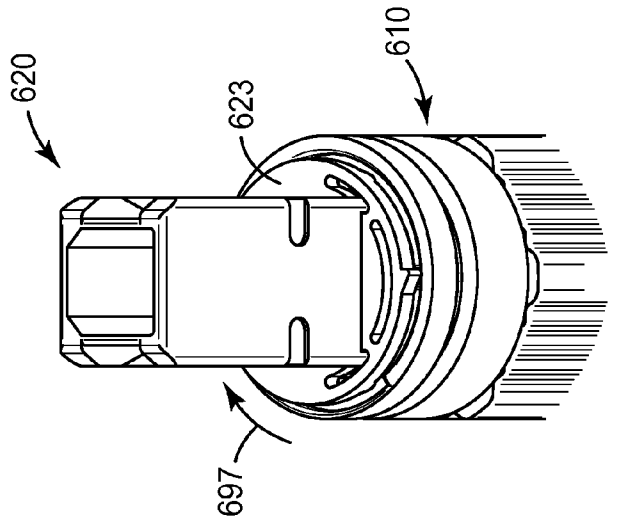


FIG. 11A

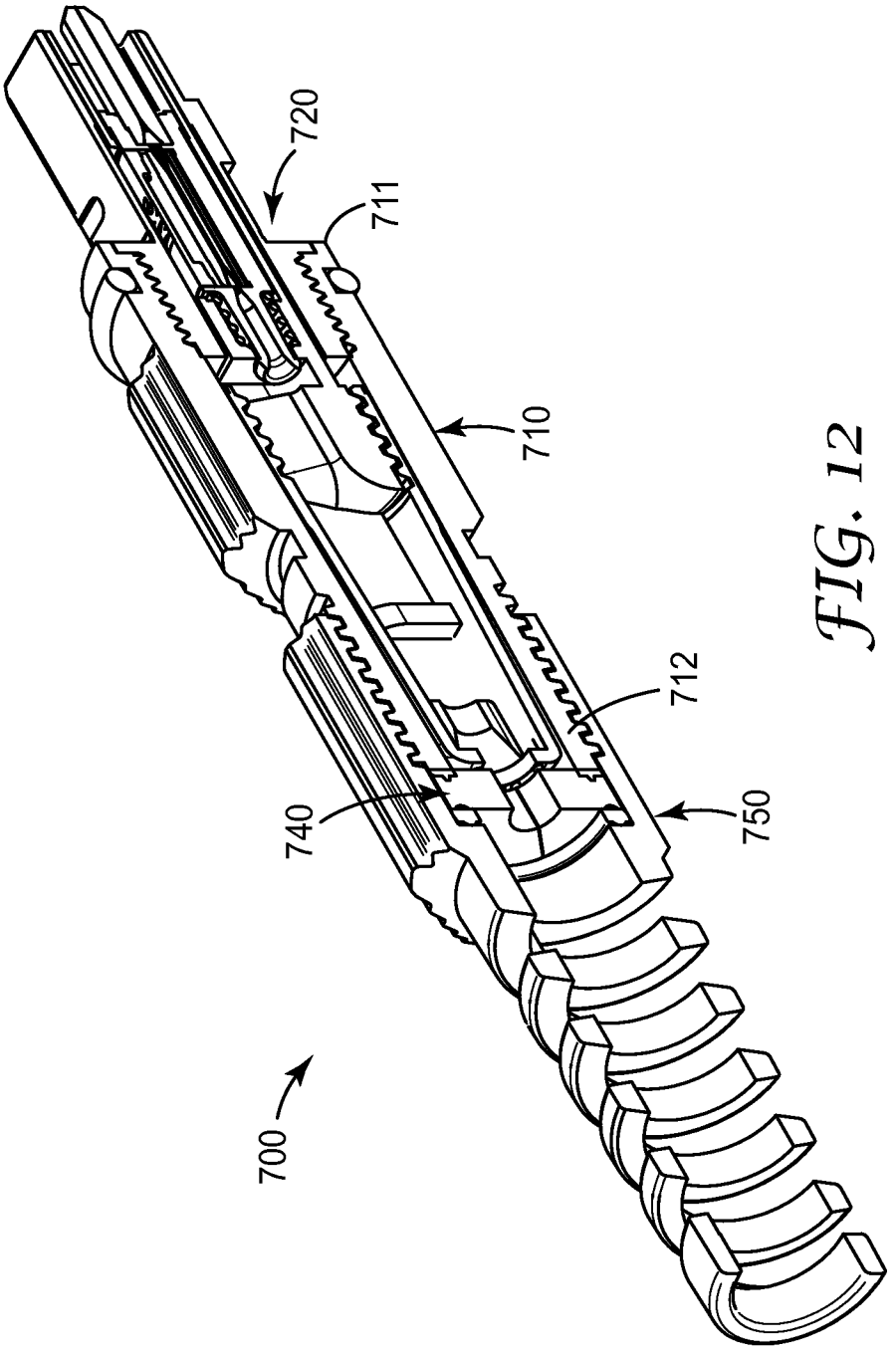


FIG. 12

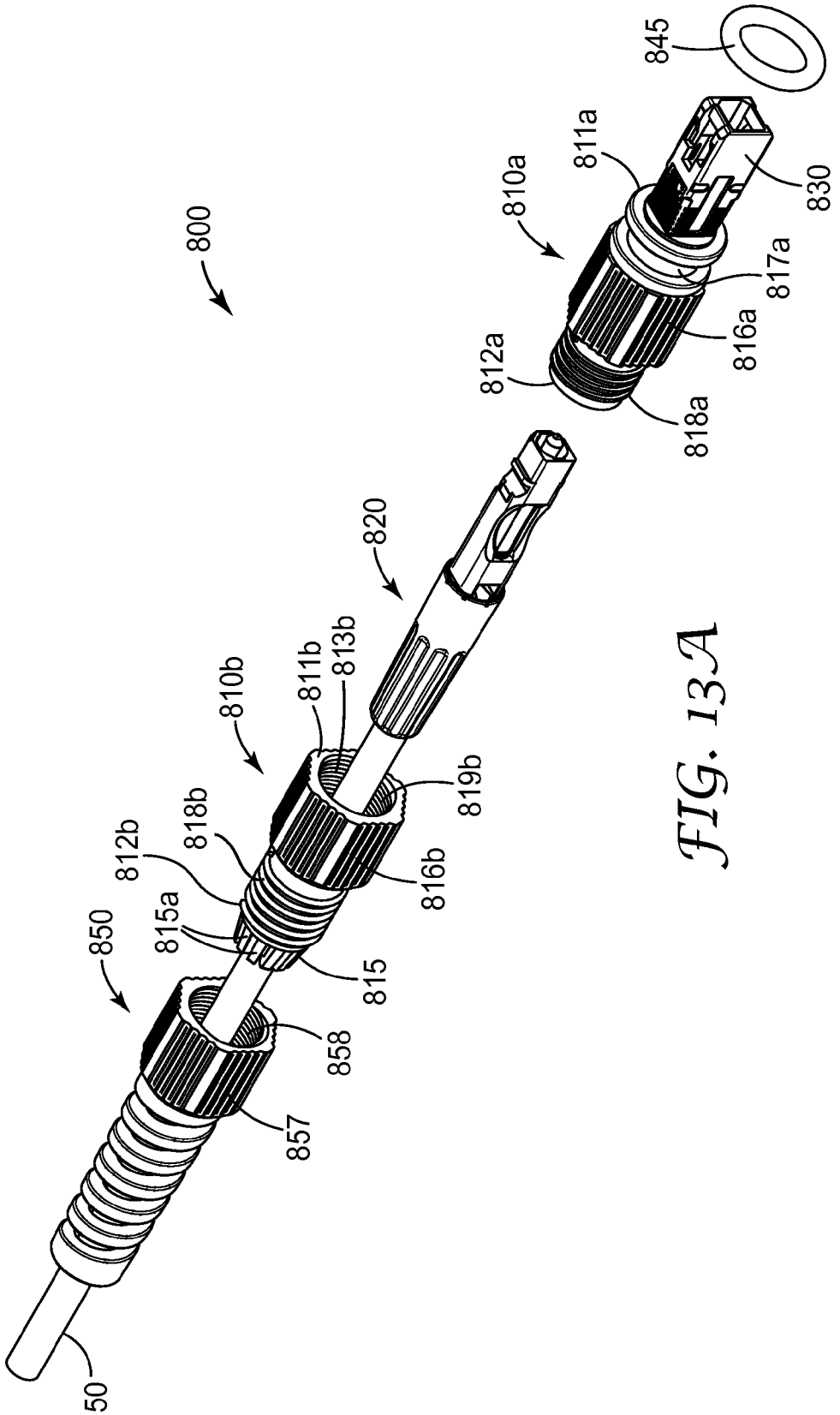

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FIG. 13A

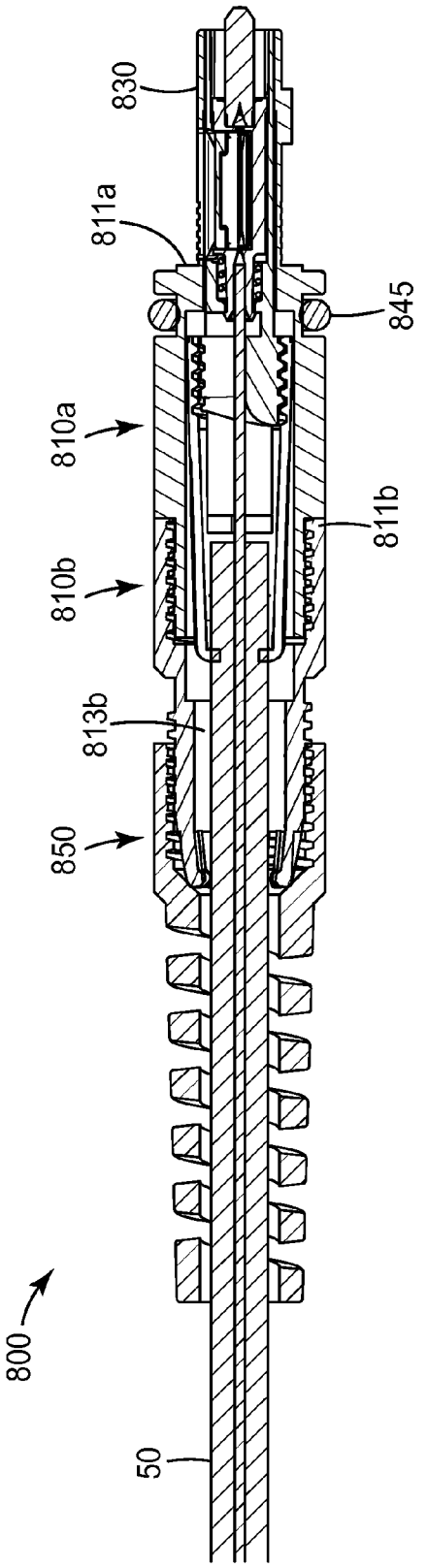


FIG. 13B

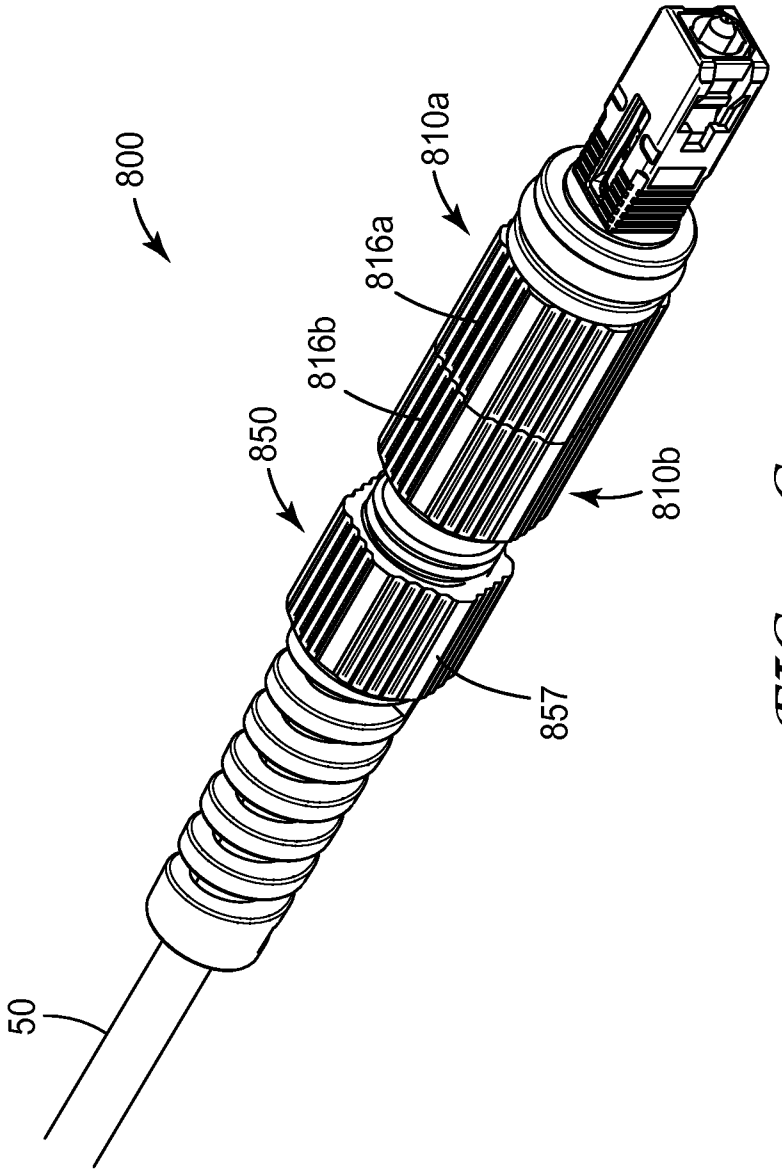


FIG. 13C

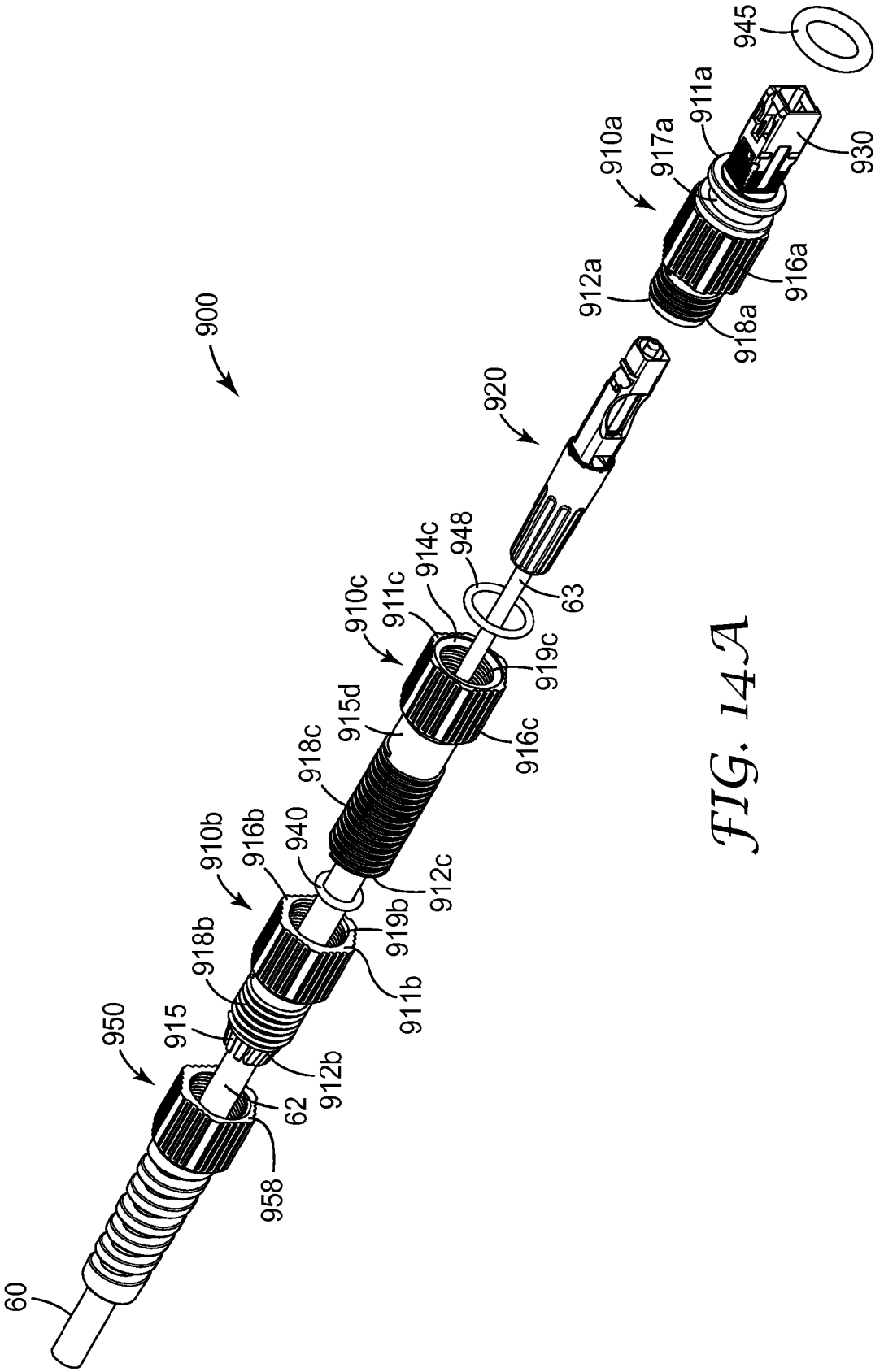

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FIG. 14A

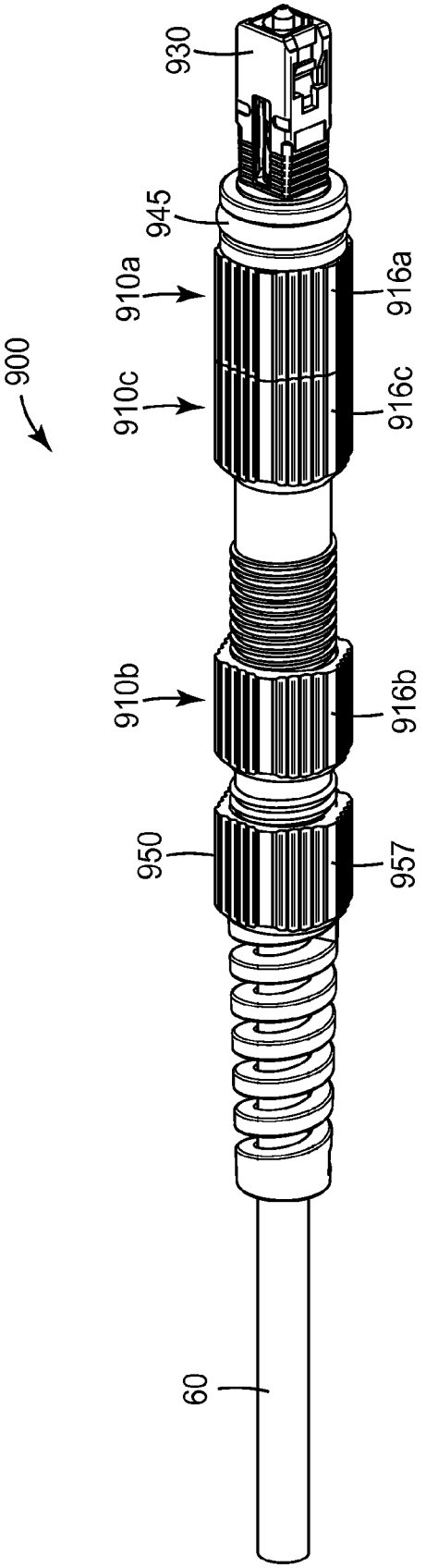


FIG. 14B

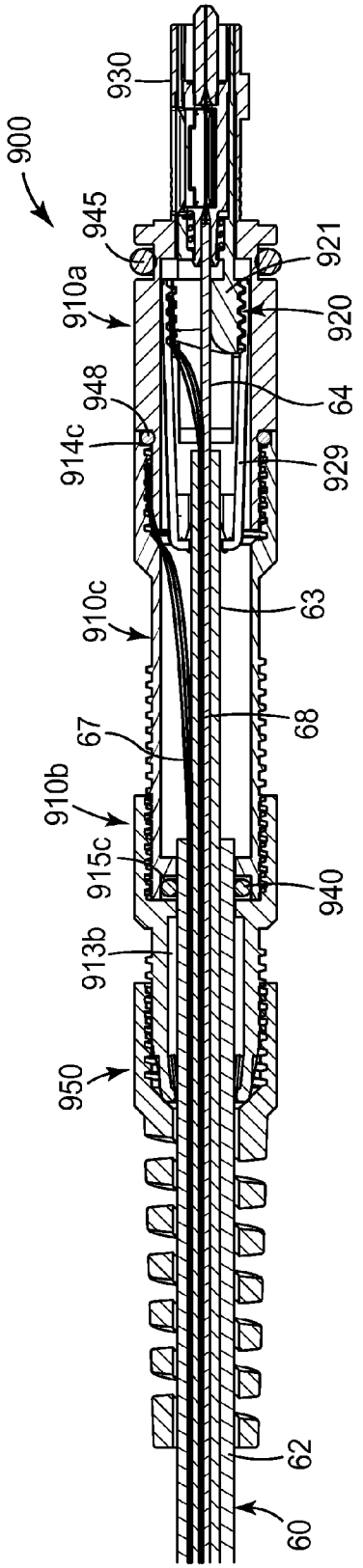


FIG. 14C

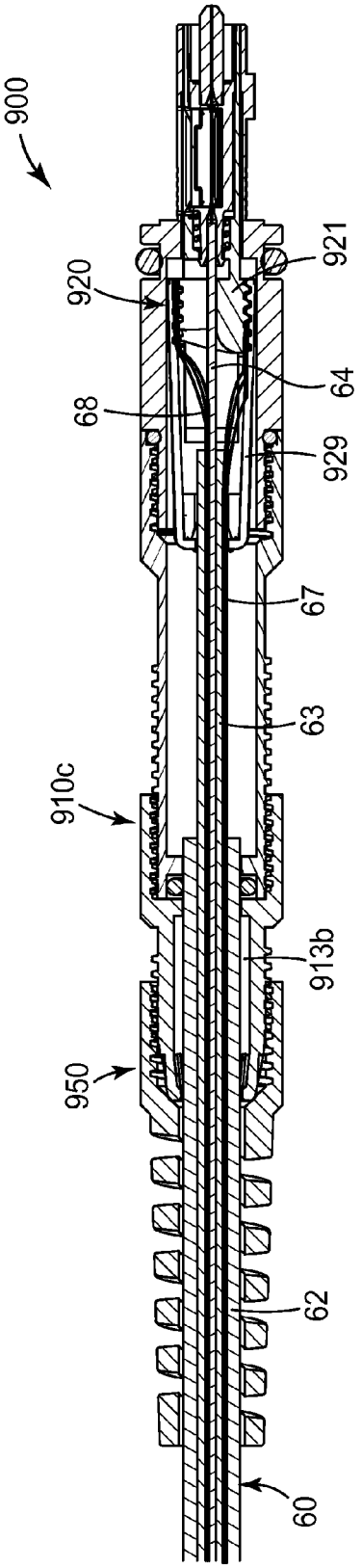


FIG. 14D

CONNECTOR FOR TELECOMMUNICATION ENCLOSURES

FIELD OF THE INVENTION

[0001] The present invention relates to optical fiber connector for telecommunication enclosures. Specifically, the exemplary optical fiber connector can be plugged into a standard optical connector adapter through a port of the telecommunication enclosure.

BACKGROUND OF THE INVENTION

[0002] Telecommunication cables are ubiquitous and used for distributing all manner of data across vast networks. The majority of cables are electrically conductive cables (typically copper), although the use of optical fiber cables is growing rapidly in telecommunication systems as larger and larger amounts of data are transmitted. Additionally, as data transmissions increase, the fiber optic network is being extended closer to the end user which can be a premise, business, or a private residence.

[0003] As telecommunication cables are routed across data networks, it is necessary to periodically open the cable so that one or more telecommunication lines therein may be spliced, thereby allowing data to be distributed to other cables or "branches" of the telecommunication network. At each point where a telecommunication cable is opened, it is necessary to provide a telecommunication enclosure to protect the exposed interior of the cable. The cable branches may be further distributed until the network reaches individual homes, businesses, offices, and so on. These networks are often referred to as fiber to the X (FTTX) networks which can include fiber to the premise (FTTP), fiber to the home (FTTH) and fiber to the antenna (FTTA) networks.

[0004] In an FTTH network, optical fiber is brought to the end user and connected to the optical network terminal (ONT) unit mounted on a wall at the end user. The ONT converts this optical signal into conventional electrical signals to provide voice (telephone), Internet (data) and video signals to the end user.

[0005] Fiber terminals are one type of telecommunication enclosure that is typically located near an end user in a FTTP network to distribute the final service to the end user. Typical fiber terminals are designed to drop services (to provide service connections) to a small number of premises having typically between four to twelve end users. The last service connection from the fiber terminal is made to the ONT, located at the end user using a drop cable. Typically, an optical connector attached to the terminal end of an optical fiber of the cable is preferred to allow quick, reliable field installation.

[0006] There are two basic methods of introducing an optical fiber into a telecommunication or enclosure. In the first method, the cable passes through an inlet let device fitted into a port of the telecommunication enclosure. The optical connection interface is made within the enclosure by either an optical connector or an optical splice. Conventional watertight optical fiber connectors are described in U.S. Pat. No. 6,487,344 and U.S. Patent Publication No. 2011/0033157 which can be inserted into a port in the wall of a telecommunication enclosure.

[0007] The second method is to provide a weatherproof optical connection interface in or near a wall of the telecommunication using a sealed hardened connector that is factory mounted on the terminal end of an optical fiber cable and mating optical coupling mounted within a port or in the wall of the telecommunication enclosure, such as described in U.S. Pat. Nos. 6,648,520 and 7,090,406. This method has the advantage that service connections may be made without having to open the telecommunication enclosure in the field, but cleaning the optical interface and the need for specialized parts (e.g. the mating optical coupling) makes this approach less desirable.

SUMMARY OF THE INVENTION

[0008] An optical fiber connector is described herein for inserting a telecommunication cable into a telecommunication enclosure.

[0009] In a first exemplary embodiment, the optical connector is a field mountable optical fiber connector wherein the connector is designed to make an optical connection when it is inserted into a port structure of a telecommunication enclosure. The exemplary field mount connector has a main body with an interior passageway extending from a first end to a second end of the main body and a compressible portion at the second end of the main body, a compression member attached to the second end of the optical fiber connector over the compressible portion, and an optical connection portion disposed at least partially within the interior passageway and having an outer housing that has an external shape mateable with a standard format optical coupling.

[0010] In a second exemplary embodiment, the optical connector is a factory mountable optical fiber connector wherein the connector is designed to make an optical connection when it is inserted into a port structure of a telecommunication enclosure. The exemplary factory mount connector has a main body with an interior passageway extending from a first end to a second end of the main body and a compressible portion at the second end of the main body, a compression member attached to the second end of the optical fiber connector over the compressible portion, a optical connection portion disposed at least partially within the interior, and an outer housing disposed over the connection portion wherein the outer housing has an external shape that can be mated with a standard format optical coupling.

[0011] In a third exemplary embodiment, the optical connector can be either factory of field terminated and is designed to make an optical connection when it is inserted into a port structure of a telecommunication enclosure. The exemplary optical fiber connector has a main body having an interior passageway extending from a first end to a second end of the main body, a compression member attachable to the second end of the main body to compress an internal sealing member between the second end of the main body and the compression member; and an optical connection portion disposed at least partially within the interior passageway; and having an outer housing that has an external shape mateable with a standard format optical coupling.

[0012] The above summary of the present invention is not intended to describe each illustrated embodiment or every implementation of the present invention. The figures and the detailed description that follows more particularly exemplify these embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The present invention will be further described with reference to the accompanying drawings, wherein:

[0014] FIGS. **1**A-**1**D show four views of a first embodiment of an exemplary optical fiber connector according to an aspect of the present invention;

[0015] FIGS. **2**A-**2**B show the exemplary optical fiber connector of the present invention plugged into a standard optical connector adapter through a port of the telecommunication enclosure;

[0016] FIGS. **3**A-**3**D show four views of a second embodiment of an exemplary optical fiber connector according to an aspect of the present invention;

[0017] FIG. **4** shows a view of a third embodiment of an exemplary optical fiber connector according to an aspect of the present invention;

[0018] FIG. **5** shows a view of a forth embodiment of an exemplary optical fiber connector according to an aspect of the present invention;

[0019] FIGS. **6**A and **6**B shows a method of securing the exemplary optical fiber connector of the present invention into a standard optical connector adapter through a port of the telecommunication enclosure;

[0020] FIGS. **7**A-**7**B show two views of a fifth embodiment of an exemplary optical fiber connector according to an aspect of the present invention;

[0021] FIGS. **8**A-**8**B show another method of securing the exemplary optical fiber connector of the present invention into a standard optical connector adapter through a port of the telecommunication enclosure;

[0022] FIGS. **9**A-**9**C show three views of a sixth embodiment of an exemplary optical fiber connector according to an aspect of the present invention;

[0023] FIGS. **10**A-**10**C show detail views of the components of the optical fiber connector of FIGS. **9**A-**9**C;

[0024] FIGS. **11**A-**11**C show detail views of the connection of an optical connection portion to the main body of the optical fiber connector of FIGS. **9**A-**9**C;

[0025] FIG. **12** is a sectional view showing a seventh embodiment of an exemplary optical fiber connector according to an aspect of the present invention;

[0026] FIGS. **13**A-**13**C show three views of a eighth embodiment of an exemplary optical fiber connector according to an aspect of the present invention; and

[0027] FIGS. **14**A-**14**D show four views of a ninth embodiment of an exemplary optical fiber connector according to an aspect of the present invention.

[0028] While the invention is amenable to various modifications and alternative forms, specifics thereof have been shown by way of example in the drawings and will be described in detail. It should be understood, however, that the intention is not to limit the invention to the particular embodiments described. On the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF THE DRAWINGS

[0029] In the following detailed description of the preferred embodiments, reference is made to the accompanying drawings, which illustrate specific embodiments in which the invention may be practiced. The illustrated embodiments are not intended to be exhaustive of all embodiments according to the invention. It is to be understood that other embodiments may be utilized and structural or logical changes may be made without departing from the scope of the present invention. The following detailed description, therefore, is not to be taken in a limiting sense, and the scope of the present invention is defined by the appended claims.

[0030] Exemplary embodiments herein provide an optical fiber connector for use in telecommunication enclosures. Specifically, the exemplary optical fiber connector can be plugged into a standard optical connector adapter through a port of the telecommunication enclosure. Particular advantages of the design of the present optical fiber connector include a lower cost than conventional hardened connectors which require a specialized mating optical coupling and field installable and factory installable versions of the exemplary optical fiber connector. The small size of the exemplary optical fiber connector allows more connections to be made in a similarly sized telecommunication enclosure as a result of a higher port density when compared to conventional ruggedized connector systems. In addition, the exemplary optical fiber connector can be easier to handle and faster to install than some conventional ruggedized connectors which require that the connector be screwed into a specialized receptacle in the port of a telecommunication enclosure.

[0031] The exemplary fiber optic connector can be used in FTTx optical fiber networks. In one exemplary aspect, the exemplary optical fiber connector can be used to connect an end user to a remote fiber terminal in a fiber to the premise network. In another aspect of the invention, the exemplary fiber optic connector can be used to connect an antenna on a cellular tower to equipment in a base station located at the foot of the tower.

[0032] The exemplary optical fiber connector may be fitted to the terminal end of a communication cable and inserted into a port in a telecommunication enclosure to provide an optical connection interface within the communication enclosure. Depending on the communication network architecture, the telecommunication enclosure may be a buried closure, an aerial closure or terminal, a fiber distribution hub or an optical network terminal in the outside plant or a wall mount communication box, fiber distribution hub, a wall mount patch panel, or an optical network terminal in premise applications. The exemplary fiber optic connector can provide an environmental seal when installed in a telecommunications enclosure. By providing an environmental seal, the inlet device can be designed to provide a watertight or water resistant seal and/or to prevent dust, bugs or any other foreign substance from entering the enclosure.

[0033] In one exemplary embodiment (see e.g. FIG. **1**A), the telecommunication cable can be a fiber optic cable **50**. The fiber optic cable typically includes a semi-rigid outer sheath or jacket **52** surrounding at least one optical fiber **54** and can include one or more strength members. The optical fibers may be enclosed in one or more loose buffer tubes or may be provided as one or more optical fiber ribbon cables. One to twelve optical fibers may reside in the loose buffer tube surrounded by a water-blocking gel or grease. Each of the ribbon cables may have from one to about twenty-four optical fibers. Each optical fiber has a polymeric coating **55** that surrounds and protects the glass fiber **56**. Examples of exemplary optical fiber cables include ResiLink ADF™ All-Dielectric Flat Drop Cable available from Pirelli Cables and Systems (Columbia, N.C.) or EZ DROP cable from Draka (Claremont, N.C.), fiber reinforced plastic (FRP) optical cable available from Shenzhen SDG Information Company, Ltd. (Shenzhen, China), SE*-LW* FTTH All Purpose Optical Drop Cables and SE-8 PureAccess™ Single Mode Optical Fiber each of which is available from Sumitomo Electric (Research Triangle Park, N.C.), Mini DP Flat Drop Cable available from OFS (Northcross, Ga.). The strength members may be either semi-rigid rods or a collection of loose fibers or floss, e.g. made of aramid fibers or glass.

[0034] In an alternative aspect, the communication cable can be an electrical cable in which case the connection portion of the exemplary connector will be an appropriate style of electrical connector such as an RJ-style plug connector, a USB connector or a coaxial connector, for example.

[0035] Referring to FIGS. **1A-1D**, an exemplary optical fiber connector **100** includes a main body **110** having a first end **111** and a second end **112**, a compression member **150** attachable to the second end of the main body and an optical connection portion **120** attachable to the first end of the main body. The compression member applies a radial force to the second end of the optical fiber connector's main body. The optical fiber connector **100** may be formed of plastic by conventional methods, for example by injection molding.

[0036] The main body **110** includes an internal sealing member **140** shaped to be received within the second end of the main body, and an external sealing member **145** disposed near the first end of the main body. The main body may be generally cylindrical in shape and includes an interior passageway **113** that extends along the length of the main body from the first end **111** to the second end **112** of the main body. The main body includes a passage entry **114** at the first end **111** of the interior passageway and a passage exit (not shown) at the second end **112** of the interior passageway **113** that may be configured to accommodate certain categories of telecommunication cables including single fiber drop cables and/or multi-fiber cables.

[0037] The passage entry **114** of the interior passageway **113** is configured to accept and secure optical connection portion **120** to/in the first end **111** of the main body. As such, the passage entry can be shaped to closely conform to an outer perimeter portion of the optical connection portion. As shown in FIGS. **1A** and **1B**, the passage entry has a rectangular opening configured to closely match the outer perimeter portion **131** of the outer housing **130** of optical connection portion **120**. The opening of the passage entry can alternatively be circular, elliptical, oval, hexagonal or another polygonal shape.

[0038] In an exemplary aspect, the first end of the main body will reside inside the telecommunication enclosure when the optical fiber connector has been fully inserted into a port of a telecommunication enclosure, and the second end of the main body may be located within the port of the telecommunication enclosure when the optical fiber connector has been fully inserted into a port of a telecommunication enclosure. In another exemplary aspect, the second end of the main body can be disposed within the port structure of a telecommunication enclosure such that only a portion of the connection interface extends into the cavity of the enclosure. While in yet another embodiment, the standard telecommunication optical coupling can be mounted such that it partially extends into the port structure of the telecommunication enclosure resulting in the optical connection interface being proximate to the exit passageway of the port entry structure.

[0039] In an exemplary embodiment, the main body **110** can have a gripping surface **116** on the external surface of the main body. The external gripping surface may have a hexagonally shaped cross-section to facilitate gripping of the cable securing device with a tool or by hand. The gripping surface region may have other geometric configurations such as a cylindrical shape, a rectangular shape or other polygonal shape. Additionally, the gripping surface may be textured (e.g. a ridged or cross-hatched texture) to further facilitate gripping of the cable securing device.

[0040] A groove **117** may be located between external gripping surface **116** and the first end **111** of main body **110** to receive an external sealing member **145** such as an o-ring. This external sealing member can provide an environmental seal between the optical fiber connector and a port of a telecommunication enclosure when the optical fiber connector is fully seated therein. In an alternative aspect, the external sealing member and the main body of the optical connector can be formed using a 2K molding process.

[0041] The main body **110** can have an external threaded portion **125** located between external gripping surface **116** and the second end **112** of the main body. The external threaded portion **118** cooperates with a corresponding internal threaded portion **158** of compression member **150** to cause a compressible portion **115** of the main body **110** to conform to an outer surface of the communication cable fitted in the optical fiber connector. In an alternative aspect, the compression member may be attached to the second end of the main body by an interference fit or other mechanical attachment method.

[0042] The compressible portion **115** is formed at the second end **112** of the main body. The compressible portion **115** may be reduced in size (diameter) when an external radial force is exerted on it such as by application of compression member **150**. The compressible portion **115** can have a plurality of spaced apart projections **115***a* extending from the main body near the second end thereof. In an exemplary aspect, each projection can have a barb (not shown) and/or a plurality of teeth (not shown) disposed near its interior end (i.e. the side of the projection that faces the interior passageway **113** of the main body). The barbs can penetrate the sheath of a telecommunication cable when compression member **150** is secured to the second end of the main body. The compression member can exert a radial force on the spaced apart projections **115***a* pushing them inward and pushing the barbs into sheath of the telecommunications cable.

[0043] In an exemplary aspect, the compressible portion **115** can gave a generally truncated conical shape with the compression member having a corresponding shape to cause the spaced apart projections to be squeezed together such that they exert a compressive force around the cable and/or internal sealing member seated in the interior passageway of the compression portion.

[0044] In one exemplary aspect, an internal sealing member **140** may be fitted into the interior passageway **113** in the compressible portion **115** of the main body **110** to improve the sealing and cable gripping capability of the optical fiber connector to a telecommunication cable as may be needed in buried, subterranean or other outdoor telecommunication enclosure installations. The telecommunication cable **50** passes through the internal sealing member **140** when the cable is installed into the optical fiber connector **100**. The tightening of the compression member over the collapsible portion of the main body compresses the internal sealing member. Additionally, the gripping action of the internal sealing member on the cable can help secure connector portion **120** to main body **110** as will be described in more detail below.

[0045] In premise applications, such as insertion of cables into junction boxes within a building, an optical fiber connector may have reduced environmental sealing requirements. In these instances, the internal sealing member can be omitted.

In this case, the compressible portion of the main body can directly grip the telecommunication cable inserted therethrough.

[0046] Compression member **150** has an interior chamber **153** extending between the first side **151** and a second side **152**. The interior chamber **153** has a first opening **154** at the first end **151** to accept the second end **112** of main body **110**. The chamber **153** has a smaller second opening (not shown) at the second end **152** of compression member **150** to accommodate the passage of a telecommunication cable therethrough. The chamber **153** has an internal threaded portion **158** that can correspond to the external thread **118** on the second end of the main body to allow the compression member to be secured to the main body of the optical connector.

[0047] In an exemplary embodiment, compression member **150** can have a gripping surface **157** on its external surface that corresponds to the position of the internal threaded portion **158**. The external gripping surface may be a hexagonally shaped cross-section to facilitate gripping of the cable securing device with a tool or by hand. The gripping surface region may have other geometric configurations such as a circular cross-section, a rectangular cross-section or other polygonal cross-section. Additionally, the gripping surface may be textured (e.g. a ridged or cross-hatched texture) to further facilitate gripping of the cable securing device.

[0048] In addition, compression member **150** can include an integral bend control boot **155** disposed on the second end **152** of the compression member. The bend control boot prevents the telecommunication cable from exceeding its minimum bend radius which could result in degradation of the signal being carried on the telecommunication cable. In an alternative aspect, a compression member that does not include a bend control boot can be used with low bend radius cables or bend resistant cables. Examples of compression members that do not include bend control boots can be found in FIGS. **4**A, and **4**C-**4**E of commonly owned U.S. Patent Publication No. 2011/0033157, incorporated herein by reference.

[0049] Optical connection portion **120** of the exemplary optical fiber connector can be secured to the first end **111** of main body **110**. In the exemplary embodiment shown in FIGS. **1**A-**1**D, the combination of optical connection portion **120** and outer housing **130** can be a field mountable fiber optic connector. Utilizing a field mountable fiber optic connector in optical connector **100** allows for a sealed optical connection to be made by plugging optical connector **100** into a standard optical connector adapter through a port of the telecommunication enclosure. An exemplary field mountable fiber optic connector is described in commonly owned U.S. Patent Publication No. 2011/0044588, incorporated herein by reference in its entirety.

[0050] Field mountable fiber optic connector useable as the connection portion with exemplary connector **100** includes an outer housing **130** that is configured to mate with a standard optical coupling, a backbone **121** to retain a collar body (not shown) within the outer housing, and a boot **129**. Field mountable fiber optic connector (i.e. outer housing) is configured as having an SC format. However, as would be apparent to one of ordinary skill in the art given the present description, optical connection portions (i.e. the outer housings and corresponding internal components of standard optical fiber connectors) having other standard formats, such as MT, MPO, ST, FC, and LC connector formats, can also be used with the exemplary connector structure described herein and are considered to be within the scope of the present disclosure.

[0051] The collar body includes a fiber stub secured in ferrule **124** by an epoxy or other suitable adhesive, and a mechanical splice device. The ferrule can be formed from a ceramic, glass, plastic, or metal material to support the optical fiber stub inserted and secured therein. In a preferred aspect, ferrule **124** is a ceramic ferrule. The optical fiber stub is inserted through ferrule **124**, such that a first fiber stub end slightly protrudes from or is coincident or coplanar with the end face of the ferrule. Preferably, this first fiber stub end is factory polished (e.g., a flat or angle-polish, with or without bevels). A second end of the fiber stub extends part-way into the interior of the connector **100** and is spliced to the terminal end of optical fiber **56** of an optical fiber cable (such as optical fiber cable **50**). Preferably, the second end of the fiber stub can be cleaved (flat or angled, with or without bevels). The fibers stub can comprise standard single mode or multimode optical fiber, such as SMF 28 (available from Corning Inc.). Ferrule **124** can be secured to the collar body via an epoxy or other suitable adhesive.

[0052] The splice device is held within a splice element housing portion of the collar body. In an exemplary embodiment, splice device can be a mechanical splice device (also referred to as a splice), such as a 3M™ FIBRLOK™ mechanical fiber optic splice device, available from 3M Company, of Saint Paul, Minn.

[0053] The backbone can include a fiber jacket clamping portion to clamp a jacket portion that surrounds a portion of the terminated optical fiber upon actuation. The boot can actuate the fiber jacket clamping portion of the backbone upon attachment to the backbone. The optical fiber connector can be terminated in the field without the need to use a separate termination platform or tool.

[0054] Exemplary optical fiber connector **100** is assembled by first sliding compression member **150**, the internal sealing member **140** and boot **129** over the fiber cable **50** for later use.

[0055] Optical connection portion **120** can be mounted onto the terminal end of optical fiber cable **50** by a method that is analogous to the assembly method of the field mountable connector described in U.S. Patent Publication No. 2011/0044588 with the exception that outer housing is not attached to the backbone at this point in time.

[0056] Optical connection portion **120** can be partially pre-assembled such that the collar body with ferrule **124** secured therein is held within backbone **121**. This step may be performed prior to the field termination process or during the field termination process.

[0057] For field termination, optical fiber cable **50** is prepared by cutting of a portion of the fiber cable jacket **52** and stripping off a coated portion **55** of the optical fiber **54** near the terminating fiber end to leave a bare glass fiber portion **56** and cleaving (flat or angled) the fiber end to match the orientation of the pre-installed fiber stub. In an exemplary aspect, about 50 mm of the jacket **52** can be removed, leaving about 25 mm of stripped fiber. For example, a commercial fiber cleaver such as an Ilsintech MAX CI-01 or the Ilsintech MAX CI-08, available from Ilsintech, Korea (not shown) can be utilized to provide a flat or an angled cleave. No polishing of the fiber end is required, as a cleaved fiber can be optically coupled to the fiber stub in the splice device. The prepared end of optical fiber cable **50** is inserted through the rear end of the backbone **121** of the partially pre-assembled optical connection portion.

In this manner, the prepared fiber end can be spliced to the fiber stub with the mechanical splice device housed in the collar body within backbone **121**. The fiber cable **50** is continually inserted until the coated portion **55** of the fiber begins to bow (which occurs as the end of fiber **56** meets the fiber stub with sufficient end loading force). The splice device is actuated while the fibers are subjected to an appropriate end loading force. The fiber jacket can then be released, thereby removing the fiber bow.

[0058] The boot **129** (which is previously placed over fiber cable **50**) is then pushed axially toward the backbone **121** and screwed onto the backbone mounting section to secure the boot in place to complete the mounting of exemplar optical connection portion **120** onto optical fiber cable **50**.

[0059] Next, optical connection portion **120** is slid through interior passage way **113** of main body **110**. Outer housing **130** is snapped on the front end of the backbone **121** of optical connection portion **120** by sliding in a direction indicated by arrow **199** until the outer housing is secured in place as shown in FIG. **1**B. In an alternative aspect, the main body of the connector can be threaded onto the optical cable before the optical connection portion is mounted on the terminal end of the optical fiber.

[0060] The main body **110** of optical connector **100** is slid along optical fiber cable in a direction indicated by arrow **198** until a lip **133** the outer housing **130** abuts against passage entry **114** of the main body **110** as shown in FIG. **1**C.

[0061] The internal sealing member is pushed along optical fiber cable **50** and slid into the second end **112** of the main body and the compression portion is slid forward and compression member **150** is secured to the main body by engaging internally threaded portion **158** of the compression member with the corresponding external thread portion **118** on the second end **112** of the main body **110** to yield the fully assembled optical connector **100** as shown in FIG. **1**D. The tightening of the compression member **150** over the collapsible portion of the main body compresses the internal sealing member which anchors the main body between the lip of the outer shell of connector portion **120** and the internal sealing member gripping the cable within the main body. In an alternative embodiment, the optical connection portion can be adhesively connected to the main body or mechanically secured to the main body.

[0062] Field mountable optical connector **100** can advantageously allow the length of the optical fiber cable to be adjusted in the field to avoid waste and the need to store excess lengths of unneeded cable.

[0063] FIGS. **2**A and **2**B are two views showing the securing the exemplary optical fiber connector **100** into a standard optical connector coupling **1020** within a portion of a telecommunication enclosure **1000** when the optical connector is inserted through a port of the enclosure. The telecommunication enclosure can be a terminal enclosure such as BPEO S1 16 S7 (Stock number N501714A) available from 3M Company (St. Paul, Minn.).

[0064] The exemplary terminal closure **1000** of FIGS. **2**A and **2**B includes a base **1001** and a cover or main body (not shown) removably securable to the base. The base of the telecommunication enclosure shown in the figures includes a bottom wall **1002** and a plurality of side walls **1004** extending approximately perpendicularly from the bottom wall and adjoined to one another at the corners of the enclosure. At least one of the side walls can include at least one port structure **1010** for receiving a fiber optic connector of the present invention. The exemplary port structure can be a hexagonal port structure having an exterior portion **1011** disposed outside of the enclosure. The exemplary port structure can have other geometric configurations such as a generally cylindrical or tubular shape, a rectangular shape or other polygonal shape.

[0065] When optical connector **100** is fully inserted into the port structure **1010**, the external sealing member **145** of the optical connector provides a water tight seal between the internal circumference of the port structure and the optical connector. The internal sealing member housed within the main body of the connector provides a seal between the main body of the connector and the optical fiber cable passing therethrough.

[0066] A standard telecommunication optical coupling **1020** can be attached to a standard patch panel **1040** anchored to the back wall **1002** of the telecommunication enclosure **1000** by a mechanical fastener (not shown) or other anchoring mechanism. The patch panel is disposed proximate to the side wall **1004** with the port structures **1010**. The standard optical couplers are mounted in the patch panel such that they align with the port structures of the enclosure allowing an optical connection to be made when optical connector **100** is fully inserted into the port structure.

[0067] An exemplary factory mountable optical fiber connector **200** is shown in FIGS. **3**A-**3**D. Optical fiber connector **200** is similar to the main body of the field mountable optical fiber connector **100** (FIGS. **1**A-**1**D) described previously, except that the optical connection portion **220** comprises a factory mounted optical connection portion. Optical fiber connector **200** includes a main body **210** having a first end **211** and a second end **212**, a compression member **250** attachable to the second end of the main body and an optical connection portion **220** attachable to the first end of the main body. The compression member applies a radial force to the second end of the optical fiber connector main body. The optical fiber connector **200** may be formed of plastic by conventional methods, for example by injection molding.

[0068] The main body includes an internal sealing member **240** shaped to be received within the second end of the main body, and an external sealing member **245** disposed near the first end of the main body. The main body may be generally cylindrical in shape and includes an interior passageway **213** that extends from a passage entry **214** at the first end **211** of the main body to a passage exit (not shown) at the second end **212** of the main body. The passage entry **214** is configured to accept and secure optical connection portion **220** to/in the first end **211** of the main body. As such, the passage entry can be shaped to closely conform to an outer perimeter portion **231** of the optical connection portion. As shown in FIGS. **3**A and **3**B, the passage entry has a rectangular opening configured to closely match the outer perimeter portion **231** of the outer housing **230** of optical connection portion **220**. The opening of the passage entry can alternatively be circular, elliptical, oval, hexagonal or another polygonal shape.

[0069] In addition, one or more catches **219** can be disposed within interior passageway **213**. The catches which engage with openings or detents **235** on the outer housing **230** to secure the optical connection portion **220** to the first end **211** of main body **210** of optical connector **200** when the optical connection portion is disposed in the outer housing.

[0070] In an exemplary embodiment, the main body **210** can have a gripping surface **216** on the external surface of the

main body. The gripping surface may be textured (e.g. a ridged or cross-hatched texture) to further facilitate gripping of the cable securing device.

[0071] An external sealing member **245** can be disposed in a groove **217** in the main body external gripping surface **216** and the first end **211** of main body **210**. This external sealing member can provide an environmental seal between the optical fiber connector and a port of a telecommunication enclosure when the optical fiber connector is fully seated therein.

[0072] The main body **210** can further include an external threaded portion **218** located between external gripping surface **216** and the second end **212** of the main body **210**. The external threaded portion **218** cooperates with a corresponding internal threaded portion **258** of a compression member **250**, which is analogous to compression member **150** shown in FIGS. **1**A-**1**D. The compression member causes compressible portion **215** of the main body **210** to conform to an outer surface of the communication cable and/or the internal sealing member when the compression member is secured to the main body.

[0073] The optical connection portion **220** of exemplary optical fiber connector **200** can be a factory mounted fiber optic connector body **221** that is secured to the terminal end of fiber optic cable **50**. For example, optical connection portion **220** is configured to engage with an SC format outer housing **230**. However, as would be apparent to one of ordinary skill in the art given the present description, optical connection portion and the outer housings could be configured to have other standard formats, such as MT, MPO, ST, FC, and LC connector formats.

[0074] Exemplary optical fiber connector **200** is assembled by first sliding compression member **250** and the internal sealing member **240** over the fiber optic cable **50** for later use.

[0075] The terminal end of the optical fiber cable is stripped and cleaved to reveal the bare glass portion **56** of optical fiber **54**. This prepared end of the optical fiber cable can be inserted into the fiber optic connector body **221** of optical connection portion **220** until the terminal end of the bare glass portion extend beyond the end face of ferrule **224**. The optical fiber can be adhesively or mechanically secured in fiber optic connector body **221**. The excess length of fiber protruding from the end face of the fiber is removed. The end face of the fiber can be finished using a standard factory polish technique (e.g., a flat or angle-polish, with or without bevels).

[0076] A mini-boot **229** is attached to the back end of the fiber optic connector body **221** to facilitate handling of the optical connection portion **220** through the remainder of the optical connector assembly process.

[0077] Next, optical connection portion **220** is slid through interior passage way **213** of main body **210**. Outer housing **230** is snapped on the front end of the fiber optic connector body **221** of optical connection portion **220** by sliding in a direction indicated by arrow **299** until the outer housing is secured in place as shown in FIG. **1**B. Alternatively, the main body can be pre-threaded onto the optical fiber cable prior to the mounting of the optical connection portion onto the terminal end of the optical fiber.

[0078] The main body **210** of optical connector **200** is slid along optical fiber cable in a direction indicated by arrow **298** until the catches **219** within the interior passageway **213** engage with the detents **235** on the outer housing **230** of the optical connection portion **220**.

[0079] The internal sealing member is pushed along optical fiber cable **50** and slid into the second end **212** of the main body and compression member **250** is secured to the main body by engaging internally threaded portion **258** of the compression member with the corresponding external thread portion **218** on the second end **212** of the main body **210** to yield the fully assembled optical connector **200** as shown in FIG. **3**D. The tightening of compression member **250** over the collapsible portion of the main body compresses the internal sealing member and secures the main body to the sheath of the optical fiber cable **50**.

[0080] In another aspect of the current invention, the main body and compression member of the present invention can be used with a factory prepared pre-terminated optical fiber cable having a standard factory mounted optical connector (e.g. a SC connector, and LC connector, and FC connector, etc.). In this aspect, the standard factory mounted optical connector is analogous to combination of (the optical connection portion with the outer housing attached). The outer housing can be removed from the connection portion so that the connection portion can be fed through the compression member and the main body. The outer housing is then reattached over the connection portion and the main is slid forward until a lip on the outer housing abuts against the passage entry of the main body. An internal sealing member having a longitudinal slit can be slipped over the cable and slid into the second end of the main body. The compression member is attached over the second end of the main body to yield an optical fiber connector of the current invention.

[0081] FIG. **4** shows another embodiment of an exemplary factory mountable optical fiber connector **300**. Optical fiber connector **300** is similar to factory mounted optical fiber connector **200** (FIGS. **3**A-**3**D) described previously, except that in this embodiment the outer housing **330** is integrally formed with main body **310**.

[0082] Connector **300** is assembled by first sliding compression member **350** and the internal sealing member, if used, over the fiber optic cable **50** for later use.

[0083] Optical connection portion **320** is mounted onto optical fiber cable in a method similar to that described with respect to optical fiber connector **200**.

[0084] Next, optical connection portion **320** is slid through interior passage way (not shown in FIG. **4**) of main body **310** and snapped in to outer housing **330** which is integrally formed on the first end of the main body.

[0085] Compression member **350** is slid forward and secured to the main body by engaging internally threaded portion **358** of the compression member with the corresponding external thread portion **318** on the second end **312** of the main body **310** to yield the fully assembled optical connector **300**.

[0086] The integrally formed main body and outer housing can also be utilized with a field mount connector similar to that shown in FIG. **1**A-**1**D to reduce the number of parts that the field technician has to keep of track when installing the connector in the field.

[0087] In FIG. **5**, alternative connector **400** includes an optical connection portion **420** that can be threadably engaged with main body **410**. Optical connector **400** has a shorter outer housing **430** which leaves a portion of optical connection portion **420** opposite the ferrule **424** exposed. The exposed portion of the optical connection portion **420** has an external thread **426** disposed on the end opposite ferrule **424**. The external thread on the exposed portion of the optical connection portion is configured to engage with an internal

thread **419** disposed in the interior passageway **413** that extends through the main body.

[0088] In this embodiment, the compression member **450**, the internal sealing member, if used, and main body are slid over the fiber cable **50** before terminating the optical fiber cable. The cable is prepared and the optical connection portion can be mounted on the fiber by either adhesively or mechanically securing the optical fiber within the optical connection portion. The end face of fiber can be factory polished with either a flat or beveled finish.

[0089] The main body **410** is moved forward over the back end of the optical connection portion **420** until the threads **419** within the interior passageway **413** of the main body engage with the external threads **426** of the optical connection portion. The main body can then be screwed onto the optical connection portion until it is securely engaged. Next, the internal sealing member, if used, can be slid into the second end of the main body and the compression portion is slid forward and compression member **450** is secured to the main body by engaging internally threaded portion of the compression member with the corresponding external thread portion **418** on the second end of the main body **410** to yield the fully assembled optical connector **400**.

[0090] FIGS. **6**A and **6**B show a method of securing the exemplary optical fiber connector (e.g. optical connectors **100**, **200**, **300**, **400**) having a port connection mechanism to a standard optical connector adapter through a port of the telecommunication enclosure. The figures show a portion of a telecommunication enclosure **1100**. The telecommunication enclosure can be a terminal enclosure such as BPEO closure, a fiber dome closure, or another suitable outside plant fiber closure, each of which is available from 3M Company (St. Paul, Minn.) as well as other vendors.

[0091] The portion of the telecommunication enclosure **1100** shown in the figures includes a first wall section **1102** and a second wall section **1104** extending approximately perpendicularly from the first wall section. The second wall section is shown having one port structure **1110** for receiving a fiber optic connector of the present invention. The exemplary port structure can be a cylindrical port structure having an exterior portion **1111** disposed outside of the enclosure and an interior portion **1112** extending into the enclosure from the second wall. The exemplary port structure can have other geometric configurations such as a hexagonal prism, a rectangular prism or other polygonal prism.

[0092] When optical connector **100** is inserted into the port structure **1110**, the external sealing member **145** of the optical connector provides an environmental seal between the internal circumference of the port structure and the optical connector. The internal seal housed within the main body of the connector provides a seal between the main body of the connector and the optical fiber cable passing therethrough.

[0093] A standard telecommunication optical coupling **1120** can be attached to the top of the interior potion of the port structure by a mechanical fastener such as a screw **1130** or rivet that pass through fastening holes located in the central flange of the optical coupling, by an adhesive or via an interference fit wherein the top lip of the port structure has a pair of posts to engage with the fastening holes of the standard telecommunication optical coupling.

[0094] The port structure **1110** also includes a pair of slots or channels **1113** disposed on opposite sides of the exterior portion of the port structure. When an exemplary optical fiber connector **100** is installed in the port structure and engaged with the standard optical coupling, a port connection mechanism (i.e. a spring clip **1140** or staple) can be inserted in the slots to secure the exemplary fiber optic connector within the port structure. In an exemplary aspect, a U-shaped spring clip can be used as shown in the figure having two spaced apart arms extending from a joining section. When the spring clip is installed in the slots of the port structure as shown in FIG. **6**B, the arms embrace the optical connector between the gripping surface **116** of the main body **110** and the compression member **150**.

[0095] This optical connector retention method helps transfer any loads exerted on the optical fiber cable to the port structure of the telecommunication enclosure to provide a stable optical connection.

[0096] FIG. **7**A shows yet another embodiment of an optical connector **500** that includes a port connection mechanism. Optical fiber connector **500** includes a main body **510**, a compression member **550** attachable to the second end of the main body and an optical connection portion (not shown) contained within an outer housing **530** that is attachable to the first end of the main body. Optical fiber connector **500** is similar to optical fiber connectors **100**, **200** and or **300** (FIGS. **1**A-**1**D, **3**A-**3**D and **4**) described previously, except that in this embodiment the main body **510** includes an integrally formed port connection mechanism **560**.

[0097] The port connection mechanism **560** includes a plurality of protrusions **562** extending from the exterior surface of the main body that are configured to mate with a receiving element **1217** within the port structure **1210** of telecommunication enclosure **1200** as shown in FIG. **7**B and a release lever **565** which is configured to move the receiving elements away from the main body **510**, freeing the protrusions so that connector **500** can be easily removed from the port structure. Release lever **565** can be connected to the main body of optical connector **500** by its fulcrum **566**. A release arm **567** extends toward the front of the connector and an actuation arm extends from the fulcrum toward the back end of the connector near the compression member **550**. When a force is applied to the actuation arms **565** in a direction indicated by arrows **595** the release lever pivots **567** around the fulcrum **566** moving the release arms away from the main body. The release arms engage with the receiving elements, pushing them away from the main body and disengaging the receiving elements from the protrusions to allow optical connector to be extracted from port structure **1210**.

[0098] FIGS. **8**A and **8**B show optical fiber connector **500** mounted in a different telecommunication enclosure port structure **1310**. Telecommunication enclosure **1300** of FIGS. **8**A and **8**B can be an optical network terminal, a network interface device or a distribution box. An exemplary distribution box that can utilize this port structure is described in PCT Publication No. WO 2012/074688, and is incorporated herein by reference.

[0099] The telecommunication enclosure **1300** of which only a portion is shown in FIGS. **8**A and **8**B includes a bottom wall **1302**, a plurality of side walls **1304** extending from the base, a cover (not shown) which is removably securable to the base wherein at least one of the side walls includes a removable side wall portion **1303**. In the particular embodiment, removable side wall portion **1303** includes a port structure **1310** for receiving a fiber optic connector of the present invention. The exemplary port structure can be a cylindrical port structure having an interior portion **1312** that extends into the enclosure from the side wall when the removable wall

portion is installed in the enclosure. In an alternative aspect, removable side wall portion **1303** includes a plurality of port structures. The exemplary port structure can have other geometric configurations such as a hexagonal prism, a rectangular prism or other polygonal prism. The internal features of the port structure can be similar to port structure **1210** shown in FIG. **7**B if the port structure is to be used in combination with fiber optic connector **500**.

[0100] The side walls **1304** can include a number of openings **1305** having and inwardly facing channel **1306** formed around the perimeter of the opening to accept the removable wall segments. An optional gasket **1308** can be disposed in the bottom of channel **1306** when a high degree of environmental protection is needed. FIG. **8**A shows a view of a portion of a side wall **1304** having the removable wall portion **1303** removed from opening **1305**, while FIG. **8**B shows the removable wall segment installed in channel **1305** of sidewall **1304**.

[0101] FIGS. **9**A-**9**C show three views of another embodiment of an exemplary optical fiber connector **600**. Optical fiber connector **600** includes a main body **610** having a first end **611** and a second end **612**, a compression member **650** attachable to the second end of the main body and an optical connection portion **620** attachable to the first end of the main body. The compression member anchors an internal sealing member **640** between the compression member and the second end of the main body to provide an environmental seal between the optical fiber connector **600** and the telecommunications cable to which it is connected. Optical fiber connector **600** may be formed of plastic by conventional methods, for example by injection molding.

[0102] The main body **610** may be generally cylindrical in shape and includes an interior passageway **613** (FIG. **10**B) that extends along the length of the main body from the first end **611** to the second end **612** of the main body. The main body includes a passage entry **614** at the first end **611** of the interior passageway and a passage exit (not shown) at the second end **612** of the interior passageway **613** that may be configured to accommodate certain categories of telecommunication cables including single fiber drop cables and/or multi-fiber cables.

[0103] The passage entry **614** of the interior passageway **613** is configured to accept and secure optical connection portion **620** to/in the first end **611** of the main body **610**. As such, the passage entry can be shaped to closely conform to an outer perimeter portion of the optical connection portion.

[0104] In the exemplary embodiment of FIGS. **9**A-**9**B, the main body **610** can have a gripping surface **616** on the external surface of the main body similar to that already described for optical fiber connector **100** of FIGS. **1**A-**1**D. A groove **617** may be located between external gripping surface **616** and the first end **611** of main body **610** to receive an external sealing member **645** such as an o-ring. This external sealing member can provide an environmental seal between the optical fiber connector and a port of a telecommunication enclosure when the optical fiber connector is fully seated therein.

[0105] The main body **610** can have an external connection portion **618** located between external gripping surface **616** and the second end **612** of the main body **610**. The external connection portion **618** includes at least one bayonet channel **618***a* that cooperates with at least one internal peg **658** (FIG. **10**B) disposed within the open end of compression member **650**. In the exemplary embodiment of optical fiber connector **600**, the main body includes two bayonet channels **618***a*, **618***a*' (FIG. **10**B) disposed on opposite sides of the main body and compression member **650** has two internal pegs **658** (although only one can be seen in the figures) that are configured to engage with the bayonet channels. Thus the compression member (having the internal sealing member disposed therein) is slid over the second end of the main body to secure the compression member to the main body. The internal pegs ride in the bayonet channel as the compression member is pushed forward (as indicated by directional arrow **695** in FIG. **10**B) over the second end of the main body and is rotated (as indicated by directional arrow **696** in FIG. **10**B) to secure the compression member to the second end of the main body. The internal sealing member is compressed longitudinally between the compression member and the second end of the main body as shown in FIG. **9**C. Utilizing a bayonet style securing mechanism as described above may be advantageous in reducing torsional stresses applied to the telecommunication cable when the compression member is secured to the main body of the exemplary optical fiber connector.

[0106] In one exemplary aspect, an internal sealing member **640** can include an elastomeric portion **641** and a segmented rigid portion **643** as shown in FIG. **10**C. The elastomeric portion provides the sealing and cable gripping capability to the optical fiber connector to a telecommunication cable passing through the sealing member and the segmented rigid portion serves as skids to allow the compression member to rotate freely when the compression member is being secured to the second end of the main body of the exemplary optical fiber connector. Additionally, internal sealing member **640** may have a radial slit **642** to allow the telecommunication cable to be slipped into the internal sealing member from the edge of the sealing member. When this is done the segmentation of the segmented rigid portion allows the sealing member to flex so the slit can be opened to allow insertion. The internal sealing member can be formed by a two step molding process when the segmented rigid portion is formed of a rigid plastic material such as poly carbonate or polybutylene terephthalate, for example, or by an insert molding process when the rigid portion is formed of a rigid plastic material or metal.

[0107] In an exemplary aspect, the elastomeric portion of the internal sealing member can be formed from one of an ethylene propylene diene monomer (EPDM) rubber, a silicone rubber, a polyurethane elastomers or rubbers, natural rubber, a fluoroelastomer or other suitably soft resilient materials.

[0108] In an alternative aspect, the segmented rigid portion can be replaced by a slit ring made of either plastic or metal that can either be integrally formed with the internal sealing member or can be a separate piece which is positioned between the internal sealing member and the compression member during assembly of the exemplary connector.

[0109] Referring to FIG. **10***b*, compression member **650** has an interior chamber **653** extending between the first side **651** and a second side **652**. The interior chamber **653** has a first opening **654** at the first end **651** to accept the second end **612** of main body **610**. The interior chamber **653** has a smaller second opening (not shown) at the second end **652** of compression member **650** to accommodate the passage of a telecommunication cable therethrough. The compression member can further include at least one internal peg **658** disposed within interior chamber **653** that cooperates with a corresponding bayonet channel **618***a* on the main body **610** of the

optical fiber connector to secure the compression member to the main body and compress the internal sealing member therebetween.

[0110] In an alternative aspect, the bayonet channels can be formed within interior chamber of the compression member and the corresponding peg(s) that mate with the bayonet channels can be formed near the second end of the main body. Thus the positioning of the bayonet channels and corresponding pegs should not be considered a limitation to exemplary optical connector **600**.

[0111] In addition, compression member **650** can further include an integral bend control boot **655** disposed on the second end **652** of the compression member. The bend control boot prevents a telecommunication cable from exceeding its minimum bend radius which could result in degradation of the signal being carried on the telecommunication cable. The bend control boot can include a tie bar **655***a* to provide strain relief to the telecommunication cable passing through the optical fiber connector when the telecommunication cable is attached to the tie bar by a cable tie or other securing mechanism.

[0112] The optical connection portion **620** can be secured to the main body **610** of optical fiber connector **600** via a threaded attachment mechanism. Optical connection portion **620** can include an external connection portion having an external thread **628** adjacent to the second end **612** thereof and an outer housing **630** at the first end **611** of the optical connection portion. The outer housing is configured to hold the internal components of a standard optical fiber connector (e.g. the backbone **121**, collar body (not shown), ferrule **124** and boot **129**) within the outer housing. For example, optical connection portion **620** is configured with an SC format outer housing **630**. However, as would be apparent to one of ordinary skill in the art given the present description, optical connection portion and the outer housings could be configured to have other standard formats, such as MT, MPO, ST, FC, and LC connector formats as well as utilizing other connector styles such as factory mounted connectors.

[0113] The external thread **628** of the optical connection portion **620** is configured to engage with an internal thread **619** disposed in the interior passageway **613** that extends through the main body **610** of optical connector **600**. In the exemplary aspect shown in FIGS. **9**A-C, and **10**A-B, a coarse external thread **628** and corresponding internal thread **619** are used to provide for a secure attachment of the optical connection portion to the main body while at the same time minimizing the torsional effects on the cable within the connection due to this attachment. In an exemplary aspect, the optical connection portion can be attached to the main body by engaging the threads and rotating the optical connection portion 120° with respect to the main body, although other degrees of rotation are a matter of design choice.

[0114] In an exemplary aspect, optical connection portion **620** can further include a positioning rib that ensures that the optical connection portion is inserted into the main body **610** in the proper orientation when engaging the external threads disposed on the optical connection portion with the internal threads within the main body.

[0115] In addition, optical connection portion **620** can have an abutment plate **623** disposed between outer housing **630** and the external connection portion. The abutment plate **623** ensures proper positioning of the connection portion with respect to the main body of the optical fiber connector. Abutment plate **623** can have a plurality of detents **624** extending from its surface that is adjacent to the external connection portion of the optical connection portion. The detents assist the craft in knowing when the optical connection portion is properly mounted in to the main body of the audible click by providing an audible click when the detents come to rest in matching divots **614***b* formed in the outward facing surface of passage entry **614**. The abutment plate **623** can further include a locking nose **626** projecting from the edge **627** of the abutment plate. The locking nose is configured to engage with a notch **614***a* in the lip of the passage entry **614** to secure the optical connection portion to the main body. In an exemplary aspect, locking nose **626** can be disposed on a flexible bridge **625** to allow clearance for the nose to slide within the lip of the passage entry when the optical connection portion is secured to the main body.

[0116] Exemplary optical fiber connector **600** is assembled by first sliding compression member **650**, the internal sealing member **640** and boot **129** over the fiber cable **50** for later use.

[0117] For field termination, optical fiber cable **50** is prepared by cutting of a portion of the fiber cable jacket **52** and stripping off a coated portion **55** of the optical fiber **54** near the terminating fiber end to leave a bare glass fiber portion **56** and cleaving (flat or angled) the fiber end to match the orientation of the pre-installed fiber stub, as described previously.

[0118] The prepared end of optical fiber cable **50** is inserted through the rear end of the backbone **121** of a partially pre-assembled optical connection portion **620** that includes the collar body with ferrule **124** secured within the backbone. In this manner, the prepared fiber end can be spliced to the fiber stub with the mechanical splice device within the collar body within backbone **121**. The fiber cable **50** is continually inserted until the coated portion of the fiber begins to bow (which occurs as the end of fiber meets the fiber stub with sufficient end loading force). The splice device is actuated while the fibers are subjected to an appropriate end loading force. The fiber jacket can then be released, thereby removing the fiber bow.

[0119] The boot **129** (which is previously placed over fiber cable **50**) is then pushed axially toward the backbone **121** and screwed onto the backbone mounting section to secure the boot in place to complete the mounting of the partially pre-assemble optical connection portion onto optical fiber cable **50**. The partially pre-assemble optical connection portion is then secured in outer housing **630** to complete the assembly of connection portion **620**.

[0120] Referring to FIGS. **11**A-**11**C, the main body **610** is moved forward over the back end of the optical connection portion **620** until abutment plate **623** is adjacent to the passage entry **614** (best seen in FIG. **10**B). The optical connection portion is rotated in the direction indicated by arrow **697**. Locking nose **626** slides within the passage entry until it encounters deflection wedge **614***c*. The deflection wedge pushes on the locking nose **626** causing flexible bridge **625** to flex as shown in FIG. **11**B until the pressure is released when the locking nose **626** enters notch **614***a* in the lip of the passage entry **614** and the detents on the bottom face of the abutment plate slide into matching divots in passage entry **614** with an audible click marking the final securing of the optical connection portion **620** to the main body **610** of the optical connector as shown in FIG. **11**C.

[0121] The internal sealing member is pushed along optical fiber cable **50** and slid until it is in contact with the second end **612** of the main body. Compression member **650** is slid forward and secured to the main body by engaging the compres-

sion member with the second end **612** of the main body **610** to yield the fully assembled optical connector **600** as shown in FIG. **9**A. The tightening of the compression member **650** to the main body compresses the internal sealing member. In an alternative embodiment, the internal sealing member can be fitted over the cable just prior to securing the compression member to the main body by inserting the cable into the sealing member by through the radial slit in the internal sealing member.

[0122] FIG. **12** shows another embodiment of an exemplary optical fiber connector **700** that is similar to optical fiber connector **600** described previously with the exception that the main body **710** is threadably coupled to compression member **750** rather than utilizing the bayonet connection mechanism shown in FIGS. **9**A-**9**C. Specifically, the main body **710** has a first end **711** and a second end **712**, a compression member **750** attachable to the second end of the main body and an optical connection portion **720** threadably attachable to the first end of the main body. The compression member anchors internal sealing member **740** between the compression member and the second end of the main body to provide an environmental seal between the optical fiber connector **700** and the telecommunications cable to which it is connected. Optical fiber connector **700** may be formed of plastic by conventional methods, for example by injection molding.

[0123] In some applications, it can be beneficial to have a more modular connector design where the critical functions are separated into separate connector components as shown in reference to optical fiber connector **800** in FIGS. **13**A-**13**C. FIG. **13**A is an exploded view of optical fiber connector **800**. FIG. **13**B is a sectional view of optical fiber connector **800**, and FIG. **13**C is a view of a fully assembled optical fiber connector **800**. Exemplary optical fiber connector **800** can be used in applications where a lower degree of environmental protection is required such as in an indoor application or a protected outdoor application (e.g. to provide an external connection to a fiber distribution box disposed in a protected breezeway or garage), or to provide an external connection to fiber links disposed within an free-breathing aerial enclosure or terminal.

[0124] In this embodiment, the connector body is divided into a first body portion **810***a* and a second body portion **810***b*. The first body portion houses optical connection portion **820** (which is similar to optical connection portion **120** of the optical fiber connector **120** described previously), while the second body portion can include compressible portion **815** to grip the sheath of the telecommunication cable **50** and/or facilitate centering of the cable in optical fiber connector **800**.

[0125] First body portion **810***a* can have a first end **811***a* and a second end **812***a*. Outer housing **830** can be disposed at the first end of the first body portion, via one of the attachment mechanisms described previously (e.g. via a snap fit as described with reference to FIG. **1**B, mechanical connection means as described with reference to FIG. **3**A, via threaded connection as described with reference to FIGS. **5** and **9**B) or can integrally molded with the first body portion (as described with reference to FIG. **4**). Optical connection portion **820** can be inserted through interior passage way (not shown) of the first body portion **810***a* until it engages with the outer housing disposed on the first end of the first body portion to secure the optical connection portion within the first body portion.

[0126] In an exemplary embodiment, the first body portion can have a gripping surface **816***a* on the external surface of the first body portion. The external gripping surface may have a hexagonally shaped cross-section to facilitate gripping of the cable securing device with a tool or by hand. The gripping surface may be textured (e.g. a ridged or cross-hatched texture) to further facilitate gripping of the first body portion.

[0127] A groove **817***a* may be located between external gripping surface **816***a* and the first end **811***a* of first body portion **810***a* to receive an optional external sealing member **845** such as an o-ring. This optional external sealing member can provide an environmental seal between the optical fiber connector and a port of a telecommunication enclosure, if required, when the optical fiber connector is fully seated therein.

[0128] The first body portion **810***a* can include external threads **818***a* adjacent to the second end **812***a* of the first body portion. External threads **818***a* cooperates with a corresponding internal threaded portion **819***b* disposed adjacent to the first end **811***b* of the second body portion **810***b*.

[0129] Second body portion **810***b* can have a first end **811***b* and a second end **812***b*. The second body portion can have an internal threaded portion **819***b* disposed in interior passageway **813***b* adjacent to the first end **811***b* of the second body portion and a compressible portion **815** disposed adjacent to the second end **812***b* of the second body portion. Compressible portion **815** may be reduced in size (diameter) when an external radial force is exerted on it such as by application of compression member **850**.

[0130] The compressible portion **815** can have a plurality of spaced apart projections **815***a* extending from the second body portion **810***b* near the second end **812***b* thereof. In an exemplary aspect, each projection can have a barb (not shown) and/or a plurality of teeth (not shown) disposed near its interior end (i.e. the side of the projection that faces the interior passageway **813***b* of the second body portion). The barbs can penetrate the sheath of a telecommunication cable when compression member **850** is secured to the second end of the second body portion. The compression member **850** can exert a radial force on the spaced apart projections **815***a* pushing them inward and pushing the barbs into the sheath of the telecommunications cable **50**.

[0131] The second body portion **810***b* can include external threads **818***b* adjacent to the second end **812***b* of the second body portion. External threads **818***b* cooperates with a corresponding internal threaded portion **858** of compression member **850** (which is analogous to compression member **150** shown in FIG. **1**A).

[0132] In an exemplary embodiment, the second body portion **810***b* can have a gripping surface **816***b* on the external surface adjacent to the second body portion. The external gripping surface may have a hexagonally shaped cross-section to facilitate gripping of the cable securing device with a tool or by hand. The gripping surface may be textured (e.g. a ridged or cross-hatched texture) to further facilitate gripping of the first body portion.

[0133] In an exemplary aspect, the gripping surfaces **816***a*, **816***b*, **857** of the first body portion **810***a*, the second body portion **810***b* and compression member **850**, respectively, are aligned when optical fiber connector **800** is fully assembled as shown in FIG. **13**C.

[0134] In an alternative aspect one or more internal sealing members can be disposed in optical fiber connector **800** when a higher level of environmental protection is required. A first internal sealing member can be disposed between the first and second body portions to seal this junction point and a second

internal sealing member may be inserted into the second end of the second body portion to provide an environmental seal between the cable and the optical fiber connector.

[0135] While exemplary optical fiber connector **800** comprises two body portions, embodiments containing more than two body portions are contemplated and will be discussed below in additional detail with respect to FIGS. **14**A-**14**C. In each embodiment having a plurality of body portions, the first body portion will usually house the connector portion, while any additional body portions can have a variety of functionalities such as environmental sealing, strain relief/cable clamping, spatial extension to accommodate a long connectors, etc.

[0136] FIG. **14**A is an exploded view of optical fiber connector **900**. FIG. **13**B is a view of a fully assembled optical fiber connector **900**, and FIGS. **14**C and **14**D are sectional views of optical fiber connector **900** showing two alternative methods of securing the strength members of optical cable **60** to optical fiber connector **900**.

[0137] In this embodiment, the connector body is divided into a first body portion **910***a*, a second body portion **910***b* and a third or intermediate body portion **910***c*. The first body portion **910***a* houses optical connection portion **920** (which is similar to optical connection portion **120** of the optical fiber connector **100** described previously) while the second body portion can include compressible portion **915** to grip the sheath of the telecommunication cable **60** and/or facilitate centering of the cable in optical fiber connector **900**. The intermediate body portion **910***c* provides for a special expansion of optical fiber connector **900**.

[0138] First body portion **910***a* can have a first end **911***a* and a second end **912***a*. Outer housing **930** can be disposed at the first end of the first body portion, via one of the attachment mechanisms described previously (e.g. via a snap fit as described with reference to FIG. **1**B, mechanical connection means as described with reference to FIG. **3**A, via threaded connection as described with reference to FIGS. **5** and **9**B) or can integrally molded with the first body portion (as described with reference to FIG. **4**). Optical connection portion **920** can be slipped though the compression nut **950**, the intermediate and second body portions and any internal sealing members and inserted through interior passage way (not shown) of the first body portion **910***a* until it engages with the outer housing disposed on the first end of the first body portion to secure the optical connection portion within the first body portion.

[0139] In an exemplary embodiment, first body portion **910***a* can have a gripping surface **916***a* on the external surface of the first body portion. The external gripping surface may have a hexagonally shaped cross-section to facilitate gripping of the cable securing device with a tool or by hand. The gripping surface may be textured (e.g. a ridged or cross-hatched texture) to further facilitate gripping of the first body portion.

[0140] A groove **917***a* may be located between external gripping surface **916***a* and the first end **911***a* of first body portion **910***a* to receive an optional external sealing member **945** such as an o-ring. This optional external sealing member can provide an environmental seal between the optical fiber connector and a port of a telecommunication enclosure, if required, when the optical fiber connector is fully seated therein.

[0141] The first body portion **910***a* can include external threads **918***a* adjacent to the second end **912***a* of the first body portion. External threads **918***a* cooperate with a corresponding internal threaded portion **919***c* disposed adjacent to the first end **911***c* of the intermediate body portion **910***b*.

[0142] The intermediate body portion **910***c* can includes an extension portion **915***d* adjacent to the second end **912***c* of the intermediate body portion and a gripping surface **916***a* on the external surface of the first body portion **910***a* adjacent to its first end **911***c*. The gripping surface **916***c* of the intermediate body portion can have the same configuration as the gripping surface **916***a* of the first body portion or in this case gripping surface **916***c* can have a hexagonal cross section. The extension portion **915***d* can be varied in length according to the length of the optical connection portion and any open portion of cable **60** where the cable sheath has been removed.

[0143] An intermediate sealing member **948** can be disposed in a stepped opening **914***c* at the first end of the intermediate body portion **910***c* (between the first end and internal threads **919***c*). The intermediate sealing member can be compressed between the first body portion **910***a* and the intermediate body portion **910***c* when the internal threads **919***c* on the intermediate body portion are tightened against the external threads **918***a* disposed adjacent to the second end **912***a* of the first body portion as shown in FIGS. **14**C and **14**D. The internal sealing member **948** can be an o-ring or a split grommet as described previously. In this way, intermediate sealing member **948** prevents ingress of environmental contaminants into optical fiber connector **900** though the joint between the first body portion and the intermediate body portion.

[0144] Intermediate body portion **910***c* can also include a sealing member receiving pocket **915***c* at the second end **912***c* of the interior passage way. Receiving pocket **915***c* is configured to accept internal sealing member **940**. The internal sealing member **940** can provide a barrier to environmental contaminants between the sheath of the cable and optical fiber connector **900** when the internal sealing member is compressed between the intermediate body portion **910***c* and the second body portion **910***b* when the internal threads **919***b* of the second body portion are tightened against the external threads **918***c* disposed adjacent to the second end **912***c* of the intermediate body portion **910***c*.

[0145] The intermediate body portion **910***c* includes external threads **918***c* adjacent to the second end **912***c* of the intermediate body portion. External threads **918***c* cooperate with a corresponding internal threaded portion **919***b* disposed adjacent to the first end **911***b* of the second body portion **910***b*.

[0146] Second body portion **910***b* can have a first end **911***b* and a second end **912***b*. The second body portion can have an internal threaded portion **919***b* disposed in interior passageway **913***b* adjacent to the first end **911***b* of the second body portion and a compressible portion **915** disposed adjacent to the second end **912***b* of the second body portion. Compressible portion **915** is similar to compressible portion **815** of optical fiber connector **800** as described previously and can be reduced in size (diameter) when an external radial force is exerted on it such as by application of compression member **950**. The compressible portion **915** can have a plurality of spaced apart projections extending from the second body portion **910***b* near the second end **912***b* thereof. In an exemplary aspect, each projection can have a barb and/or a plurality of teeth disposed near its interior end (i.e. the side of the projection that faces the interior passageway **913***b* of the second body portion). The barbs can penetrate the sheath of a telecommunication cable when compression member **950** is secured to the second end of the second body portion. The compression member **950** can exert a radial force on the

spaced apart projections, pushing them inward and pushing the barbs into sheath **62** of the telecommunications cable **60**.

[0147] The second body portion **910***b* can include external threads **918***b* adjacent to the second end **912***b* of the second body portion. External threads **918***b* cooperates with a corresponding internal threaded portion **958** of compression member **950** (which is analogous to compression member **150** shown in FIG. **1**A). The compression member **950** can exert a radial force on the spaced apart projections pushing them inward and pushing the barbs into sheath **62** of the telecommunications cable **60**.

[0148] In an exemplary embodiment, the second body portion **910***b* can have a gripping surface **916***b* on the external surface adjacent to the second body portion. The gripping surface **916***b* of the second body portion can have the same configuration as the gripping surfaces **916***a*, **916***c* of the first body portion and the intermediate body portion or in this case gripping surface **916***b* can have a hexagonal cross section.

[0149] In an exemplary aspect, the gripping surfaces **916***a*, **916***b*, **916***c*, **957** of the first body portion **910***a*, the second body portion **910***b*, the intermediate body portion **910***c*, and compression member **950**, respectively, can be aligned when optical fiber connector **900** is fully assembled as shown in FIG. **14**B to yield a small ruggedized, low profile optical fiber connector.

[0150] In an exemplary aspect, the strength members of optical fiber cable **60** can be anchored to optical fiber connector **900**. Optical fiber cable **60** can include one or more buffer coated optical fibers **64** surrounded by a first layer of glass or aramid fiber strength members **68** surrounded by a tube **63** or jacket layer. A second layer of glass or aramid fiber strength members **67** surrounds tube and is enclosed by a semi-rigid outer sheath **62** and can include one or more additional more rigid strength members (not shown). In an exemplary aspect cable **60** can be a Series 1129 Acoptic® FTTH Outdoor Cable, available from Acome (Paris, France).

[0151] In a first exemplary embodiment, the first layer of strength members **68** is captured in the threaded connect region between the backbone **921** and boot **929** of optical connection portion **920** and the second layer of strength members **67** is captured in the threaded connect region between the first body portion **910***a* and the intermediate body portion **910** of optical fiber connector **900** as illustrated in FIG. **14**C.

[0152] In a second exemplary embodiment, the first layer of strength members **68** and the second layer of strength members **67** are captured in the threaded connect region between the backbone **921** and boot **929** of optical connection portion **920** of optical fiber connector **900** as illustrated in FIG. **14**C.

[0153] The exemplary fiber optic connectors, described herein, illustrate several advantages over conventional hardened connectors. In one aspect the exemplary optical fiber connector can be field terminated by utilizing a suitable field mountable optical connection portion. In another aspect, the exemplary optical fiber connector can be factory mounted utilizing a factory mounted connection portion. In addition, the exemplary optical fiber connector can be assembled on the end of a pre-terminated cable by incorporating the pre-terminated optical connection structure into the exemplary optical fiber connector disclosed herein.

[0154] Although specific embodiments have been illustrated and described herein for purposes of description of the preferred embodiment, it will be appreciated by those of ordinary skill in the art that a wide variety of alternate or equivalent implementations may be substituted for the specific embodiments shown and described without departing from the scope of the present invention. Those with skill in the art will readily appreciate that the present invention may be implemented in a very wide variety of embodiments. This application is intended to cover any adaptations or variations of the embodiments discussed herein.

1. A field mountable optical fiber connector to be received in a port structure of a telecommunication enclosure, the connector comprising:

a main body having an interior passageway extending from a first end to a second end of the main body and a compressible portion at the second end of the main body;

a compression member attachable to the second end of the optical fiber connector over the compressible portion; and

an optical connection portion disposed at least partially within the interior passageway and having an outer housing that has an external shape mateable with a standard format optical coupling.

2. The connector of claim **1**, wherein the optical connection portion comprises a field mountable fiber optic connector.

3. The connector of claim **2**, wherein the field mountable fiber optic connector comprises a collar that holds a fiber stub and a mechanical splice device, a backbone to retain a collar body within the outer housing, and a boot that threadably engages with the backbone.

4. (canceled)

5. The connector of claim **1**, further comprising a port connection mechanism.

6. The connector of claim **5**, wherein the port connection mechanism comprises a spring clip.

7. (canceled)

8. The connector of claim **1**, wherein the optical connection portion is secured in the interior passageway of the main body by the outer housing.

9. The connector of claim **8**, wherein the main body further comprises one or more catches within the interior passageway of the main body that secures a portion of the outer housing within the interior passageway.

10. A factory mountable optical fiber connector to be received in a port structure of a telecommunication enclosure, the connector comprising:

a main body having an interior passageway extending from a first end to a second end of the main body and a compressible portion at the second end of the main body;

a compression member attachable to the second end of the main body over the compressible portion; and

an optical connection portion disposed at least partially within the interior passageway; and

having an outer housing that has an external shape mateable with a standard format optical coupling.

11. (canceled)

12. The connector of claim **10**, further comprising a port connection mechanism.

13. (canceled)

14. The connector of claim **12**, wherein the port connection mechanism comprises a plurality of protrusions extending from an exterior surface of the main body and a release lever.

15. The connector of claim **10**, wherein the optical connection portion is secured in the interior passageway of the main body by the outer housing.

16. (canceled)

17. The connector of claim **15**, wherein the main body includes an internal thread in the first end of the interior passageway that engages with an external thread one the optical connection portion to secure the optical connection portion to the first end of the main body.

18. An optical fiber connector to be received in a port structure of a telecommunication enclosure, the connector comprising:

a main body having an interior passageway extending from a first end to a second end of the main body;

a compression member attachable to the second end of the main body to compress an internal sealing member between the second end of the main body and the compression member; and

an optical connection portion disposed at least partially within the interior passageway; and having an outer housing that has an external shape mateable with a standard format optical coupling.

19. The connector of claim **18**, wherein the compression member is secured to the second end of the main body via a bayonet style closure mechanism.

20. The connector of claim **18**, wherein the optical connection portion is secured in the interior passageway of the main body by the outer housing via a threaded closure mechanism.

21. The connector of claim **18**, wherein the main body comprises at least two body portions.

22. The connector of claim **21**, wherein the main body comprises a first body portion housing the connector portion and a second connector portion to grip the sheath of an optical fiber cable passing therethrough.

23. The connector of claim **21**, wherein the main body comprises a first body portion housing the connector portion and a second connector portion to grip the sheath of an optical fiber cable passing therethrough and an intermediate body portion that provides an environmental seal between the cable and the connector.

25. The connector of claim **1**, further comprising an optical fiber cable terminated by the optical fiber cable connector where in the optical fiber cable includes a plurality of strength members secured within the optical connector portion.

26. (canceled)

27. The connector of claim **1**, wherein the main body comprises at least two body portions and wherein the connector further comprising an optical fiber cable terminated by the optical fiber cable connector where in the optical fiber cable includes a plurality of first strength members secured within the optical connector portion and a plurality of second strength members,

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