(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
2 April 2009 (02.04.2009)

PCT

(10) International Publication Number
WO 2009/042066 A1

(51) International Patent Classification:
G02B 6/38 (2006.01)

(21) International Application Number:
PCT/US2008/010864

(22) International Filing Date:
18 September 2008 (18.09.2008)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/995,568 27 September 2007 (27.09.2007) US
11/983,066 7 November 2007 (07.11.2007) US

(71) Applicant *(for all designated States except US)*: **CORNING CABLE SYSTEMS LLC** [US/US]; Intellectual Property Department, SP-TI-3-1, Corning, NY 14831 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **BARNES, Ray, S.** [US/US]; 16 Sienna Drive, Hickory, NC 28601 (US). **MCEVOY, Kristine, A.** [US/US]; 15436 Adlong Drive, Fort Worth, TX 76262 (US). **MEEK, David, W.** [US/US]; 10038 Stoneleigh Drive, Fort Worth, TX 76126 (US). **SEMMLER, Scott, E.** [US/US]; 1309 Vanderbilt Drive, Roanoke, TX 76248 (US).

(74) Agent: **CARROLL, Michael, E., Jr.**; 800 17th Street NW, P.O. Box 489, Hickory, NC 28603-0489 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

(54) **Title:** STRAIN-RELIEF ASSEMBLIES AND METHODS FOR A FIELD-INSTALLABLE FIBER OPTIC CONNECTOR

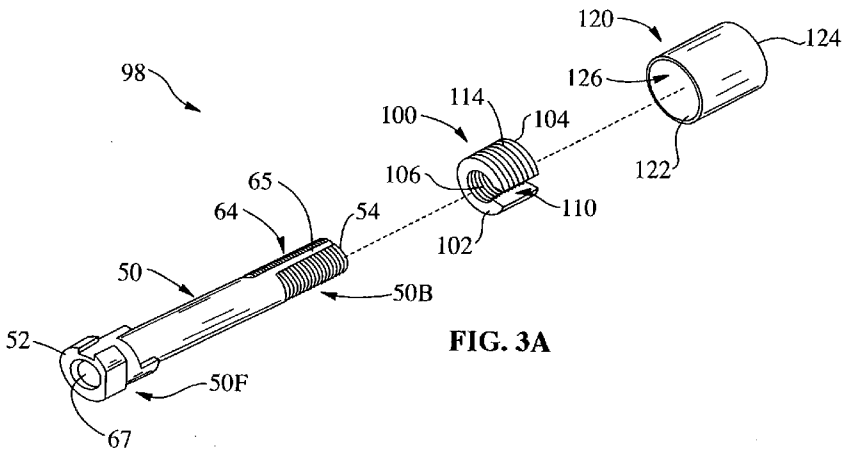


FIG. 3A

(57) **Abstract:** A strain-relief assembly for a field-installable fiber optic connector is disclosed, wherein the assembly includes a ferrule holder (50), an intermediate sleeve (100), and a crimp sleeve (120). The ferrule holder back section holds a buffered section of a fiber optic cable, while the ferrule holder front end holds a ferrule and a splice assembly. A stub fiber is held within the ferrule and the splice assembly so as to interface with a section of field optical fiber protruding from the buffered section. The intermediate sleeve engages and generally surrounds a portion of the ferrule holder back section and thus surrounds a portion of the buffered layer. An intermediate sleeve handler may be used to handle the intermediate sleeve and attached the intermediate sleeve to the ferrule holder back section. Stress-relief strands from the fiber optic cable are flared around the outer surface of the intermediate sleeve. A crimp sleeve is placed over the intermediate sleeve to hold the ends of the stress-relief strands in place. The crimp sleeve is then crimped, which fixes the strand ends in place and also fixes the intermediate sleeve in place on the ferrule back section.

WO 2009/042066 A1

STRAIN-RELIEF ASSEMBLIES AND METHODS FOR A FIELD-INSTALLABLE FIBER OPTIC CONNECTOR

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates generally to fiber optic cables, and in particular, to an assembly for providing strain-relief for field-installable connectors for fiber optic cables.

Technical Background

[0002] Optical fibers are widely used in a variety of applications, including the telecommunications industry in which optical fibers are employed in a number of telephony and data transmission applications. Due, at least in part, to the extremely wide bandwidth and the low noise operation provided by optical fibers, the use of optical fibers and the variety of applications in which optical fibers are used are continuing to increase. For example, optical fibers no longer serve as merely a medium for long distance signal transmission, but are being increasingly routed directly to the home or, in some instances, directly to a desk or other work location.

[0003] The ever increasing and varied use of optical fibers has spurred the use of field installable optical fiber connectors. Field installable optical fiber connectors are used to terminate the ends of optical fibers, and enable quicker connection and disconnection than fusion splicing. A typical connector holds the end of each optical fiber in a ferrule. The connector aligns the core of the two fibers so that light can pass between the fiber ends, and provides a mechanical coupling to hold the two fiber ends together. Connectors have traditionally been one of the main concerns in using fiber optic systems because they introduce loss and because different connector types were typically not compatible. While the use of connectors was once problematic, manufacturers have standardized and simplified them greatly. This increasing user-friendliness has contributed to the increase in the use of fiber optic systems.

[0004] Current field installable connectors are designed to be installed and strain relieved on fiber cables or fiber smaller than 2.9 mm. Common cable/fiber sizes are 900 μm tight-buffered fiber and 2.9 mm jacketed cable. A typical 2.9 mm jacketed cable consists of 900 μm tight-buffered fiber surrounded by aramid yarn and a thin walled jacket. A need exists for fiber optic cables having larger fiber optic cables. Unfortunately, installing field-installable connectors directly onto larger fiber optic cables is problematic given conventional connector designs. Therefore, a need exists for new fiber optic connectors adapted for larger fiber optic cables, as well as standard fiber optic cables that may comprise additional and/or alternative structures.

SUMMARY OF THE INVENTION

[0005] An aspect of the invention is a strain-relief assembly for a field-installable fiber optic connector configured to support a fiber optic cable having a buffered portion and strain-relief strands. The assembly includes a ferrule holder having a back section with an open back end and configured to accommodate the buffered optical fiber portion. The assembly also includes an intermediate sleeve configured to surround and engage a portion of the ferrule holder back section. The assembly also has a crimp sleeve having an inner surface and that covers the intermediate sleeve. The strain-relief strands are arranged between the crimp sleeve inner surface and the intermediate sleeve outer surface. The crimp sleeve is crimped to capture the strain-relief strands between the crimp sleeve and the intermediate sleeve.

[0006] Another aspect of the invention is a method of providing strain-relief in a connector for a fiber optic cable that has an optical fiber section, a buffer section, strain-relief strands, and a protective jacket. The method includes inserting the optical fiber section and the buffered section into a back section of a ferrule holder. The method also includes providing an intermediate sleeve having inner and outer surfaces, and engaging the intermediate sleeve with the ferrule holder back section to surround the ferrule holder back section. The method also includes placing a plurality of the strain-relief strands over the intermediate sleeve outer surface. The method further includes placing a crimp sleeve around the intermediate sleeve and the strain-relief strands and then crimping the crimp sleeve so as to secure the strain-relief strands and to fix the intermediate sleeve onto the ferrule holder back section. The method optionally includes

using an intermediate sleeve handler that facilitates installing the intermediate sleeve onto the ferrule holder back section.

[0007] Another aspect of the invention is a strain-relieved connector for a fiber optic cable that has an optical fiber with a front end, a buffered layer, and strain-relief strands. The connector includes a ferrule holder having a front section with an open front end and a back section having an open back end, wherein the open front and back ends are connected by a ferrule holder channel. A ferrule and a splice assembly are arranged in the ferrule holder front end, the ferrule and splice assembly having respective central channels. A fiber stub is held within the ferrule and splice assembly channels, wherein the fiber stub has a back end residing in the splice assembly channel. The buffered layer is held in the ferrule holder back section so that the fiber stub back end interfaces with the optical fiber front end within the splice assembly channel. The connector also includes an intermediate sleeve that engages and surrounds a portion of the ferrule holder back end section so as to surround the buffered layer held therein. The connector also has a crimp sleeve that is arranged around the intermediate sleeve so as to hold the ends of the strain-relief strands between the crimp sleeve and the intermediate sleeve. When the crimp sleeve is crimped, it fixes the strain-relief strands between the crimp sleeve and the intermediate sleeve and also fixes the intermediate sleeve to the ferrule holder back end.

[0008] Another aspect of the invention is an intermediate sleeve handler for holding and handling the aforementioned intermediate sleeve. The handler includes a C-shaped sleeve having an inner surface, an outer surface, front and back end faces, and a central hole having an central axis and connecting the front and back end faces and sized to press fit the intermediate sleeve. A gap in the outer surface connects to the central hole and defines the C-shape of the handler. The gap is sized to fit over a buffered section of a fiber optic cable so that it can be placed on and off of the fiber via the exposed buffered section between the lead-in tube and the fiber optic cable. The handler includes a shelf arranged in the central hole that serves as a stop when the intermediate sleeve is press-fit into the central hole.

[0009] Additional features and advantages of the invention will be set forth in the detailed description that follows, and in part will be readily apparent to those skilled in the art from that

description or recognized by practicing the invention as described herein, including the detailed description that follows, the claims, as well as the appended drawings.

[0010] It is to be understood that both the foregoing general description and the following detailed description present embodiments of the invention, and are intended to provide an overview or framework for understanding the nature and character of the invention as it is claimed. The accompanying drawings are included to provide a further understanding of the invention, and are incorporated into and constitute a part of this specification. The drawings illustrate various embodiments of the invention, and together with the description, serve to explain the principles and operations of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] **FIG. 1** is an exploded side view of an example embodiment of a fiber optic connector ("connector") according to the present invention that employs the strain-relief assembly of the present invention;

[0012] **FIG. 2** is a side view of the connector of **FIG. 1** in the process of being connected to the oversized fiber optic cable shown in **FIG.1**;

[0013] **FIG. 3A** is an elevated perspective view of the intermediate sleeve, the crimp sleeve and the ferrule holder of the strain-relief assembly of the present invention;

[0014] **FIG. 3B** is a close-up perspective view of the example embodiment of the intermediate sleeve in which the sleeve is C-shaped and threaded, and which has a grooved outer surface;

[0015] **FIG. 4** is a side view similar to **FIG. 2**, but showing the intermediate sleeve threaded onto the threaded back section of the ferrule holder while the crimp sleeve holds the strain-relief strands out of the way against the fiber optic cable;

[0016] **FIG. 5** is an elevated perspective view of the connector showing the strain-relief strands flared around the intermediate sleeve;

[0017] **FIG. 6** is a side view similar to **FIG. 4**, illustrating the connector with the crimp sleeve surrounding the intermediate sleeve and holding strain-relief strands in place on the intermediate sleeve, and also showing the crimping force applied to the crimp sleeve.

[0018] **FIG. 7** is an elevated perspective view of the connector similar to **FIG. 5**, showing the crimp sleeve in place over the intermediate sleeve at the threaded end of the ferrule holder;

[0019] **FIG. 8** is a side view similar to **FIG. 6**, showing the housing and the boot placed over the front and back ends of the connector, respectively;

[0020] **FIG. 9** is an elevated perspective view similar to **FIG. 7**, showing the connector with the housing and boot in place;

[0021] **FIG. 10** is perspective view of the intermediate sleeve handler of the present invention, along with the intermediate sleeve prior to being inserted into the central hole of the handler; and

[0022] **FIG. 11** is a perspective view similar to that of **FIG. 10**, but with the intermediate sleeve being held within the handler.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0023] Reference is now made in detail to the present preferred embodiments of the invention, examples of which are illustrated in the accompanying drawings. Whenever possible, the same reference numbers and symbols are used throughout the drawings to refer to the same or like parts. Use of the terms "front," "forward," "rear," "rearward," "back," and "backward" are relative terms used for the sake of illustration.

[0024] **FIG. 1** is an exploded view of an example embodiment of a fiber optic connector ("connector") **8** according to the present invention that employs the strain-relief assembly of the present invention. In an example embodiment, fiber optic connector **8** includes many aspects in common with the fiber optic connector described in U.S. Patent No. 7,270,487.

[0025] Connector **8** has a front section **8F** and back section **8B**. Cartesian **X-Y** axes are shown for the sake of reference. **FIG. 2** is a side view of the connector of **FIG. 1** in the process of being connected to an oversized fiber optic cable **150**.

[0026] Connector **8** is designed for use with an oversized fiber optic cable **150** that has an optical fiber **151** made up of a field fiber **152** surrounded by one or more protective coatings **152C** (e.g. a 250 μm and a 900 μm coating). Field fiber **152** is surrounded by a strain-relief layer **156** having strain-relief strands **157**, and a protective outer jacket **158** that surrounds the

strain-relief layer. Using known techniques, fiber optic cable **150** as shown in **FIG. 1** has been prepared for field-connectorization with connector **8**. Fiber optic cable so prepared includes a field optical fiber section **152S** with an end **153**, a buffer section **154S**, and exposed strain-relief strands **157**.

[0027] In an example embodiment, field optical fiber **152** has a 125 μm diameter. Also in an example embodiment, buffer layer **154** has a diameter in the range from about 250 μm to about 1 mm diameter (e.g., 900 μm), and a strain-relief layer that includes strain-relief strands **157**. In an example embodiment, strain-relief strands **157** are aramid yarn and are exposed in about 15 mm lengths when cable **150** is being prepared for connectorizing. Further, in the example embodiment, protective outer jacket **158** has an annular thickness of about 2 mm. In an example embodiment, fiber optic cable **150** has an overall diameter of about 4.8 mm or greater, which by present-day standards is considered "oversized." In another example embodiment, optical fiber **151** is a bend-insensitive fiber, such as a so-called "holey" fiber or a nanostructured fiber. Examples of such optical fibers are described in, for example, U.S. Pat. No. 6,243,522, pending U.S. patent application serial number 11/583,098 filed October 18, 2006, and provisional U.S. patent application serial numbers 60/817,863 filed June 30, 2006; 60/817,721 filed June 30, 2006; 60/841,458 filed August 31, 2006; 60/841,490 filed August 31, 2006; and 60/879,164, filed January 08, 2007 (hereinafter, "the Corning nanostructure fiber patents and patent applications"), all of which are assigned to Corning Incorporated.

[0028] Connector **8** includes a ferrule **10,** which in an example embodiment includes an outer surface **12**, front and back ends **14** and **16**, and a central channel **18** open at ends **14** and **16**. Central channel **18** is sized to accommodate an optical fiber such as field optical fiber **152**.

[0029] Connector **8** also includes a splice assembly **20**, which in an example embodiment accommodates a mechanical splice, that includes an upper member **21A** and a lower member **21B**. Upper member **21A** includes an outer surface **22A**, an inner surface **23A**, and front and back ends **24A** and **26A**. Likewise, lower member **21B** includes an outer surface **22B**, an inner surface **23B**, and front and back ends **24B** and **26B**. Upper and lower members are brought together so that inner surfaces **23A** and **23B** define a central through channel **28** sized to

accommodate a field optical fiber such as field fiber **152**. Ferrule **10** and splice assembly **20** are arranged end-to-end, as shown in **FIG. 2**.

[0030] Connector **8** further includes an optical fiber section **40** having respective front and back ends **42** and **44**. Optical fiber section **40** resides in channels **18** and **28** of ferrule **10** and splice assembly **20**, with fiber end **42** being generally flush with ferrule front end **14** and fiber end **44** residing in channel **28**. Optical fiber section **40** serves as a "stub" fiber for the connector and so is referred to hereinafter as "stub fiber" **40**.

[0031] Connector **8** further includes a ferrule holder **50** having a front section **50F** and a back section **50B**. Front section **50F** includes an open front end **52**, and back section **50B** that includes an open back end **54**. Ferrule holder **50** includes an outer surface **56** and a central channel (also called a "ferrule bore") **58** open at front end **52** and back end **54**. In an example embodiment, outer surface **56** includes a smooth region **62** and an outer threaded region (i.e., outer threads) **64**. In an example embodiment, outer threads may include one or more slots **65** (**FIG. 3A**) to key a cam **212** (not shown in **FIG. 1**; see **FIG. 7**).

[0032] Ferrule holder **50** is shown in **FIG. 1** and in other figures as having a flared outer surface **56** for the sake of illustration. However, outer surface **56** need not be flared, such as shown in **FIG. 3A**, discussed below.

[0033] In an example embodiment, ferrule holder **50** is made of metal such as nickel silver (NiAg), which is stronger than conventional plastic ferrule holders. Ferrule channel **58** includes a front section **66** having an opening **67** at front end **52** and corresponding to surface region **62** and sized to accommodate ferrule sections **10** and splice assembly **20**. Channel **58** also includes a narrower back section **70** having an opening **71** at back end **54**. Threads **64** are formed on ferrule back section **70**, which in an example embodiment is sized to accommodate a lead-in tube, discussed below. Ferrule holder **50** holds ferrule **10** and splice assembly **20** in front section **66**, with front end **14** of ferrule **10** extending out from ferrule holder front end **52**, as shown in **FIG. 2**.

[0034] Connector **8** also includes a lead-in tube **80** that has a front end **82**, a flared back end **84**, and a central channel **88** open at the front and back ends. Central channel **88** is sized to accommodate buffer section **154S** of fiber optic cable **150**. Lead-in tube **80** resides within ferrule

holder back channel **70**, with flared end **84** extending from ferrule holder back end **54** (**FIG. 2**). Flared end **84** facilitates the insertion of field optical fiber section **152S** into ferrule channels **18** and **28**, and buffered fiber section **154S** into the lead-in tube. When so inserted, end **153** of field optical fiber section **152S** abuts end **44** of stub fiber **40** within channel **28** of splice assembly **20** to define a mechanical splice, as illustrated in the inset of **FIG. 2**. Also, buffered fiber section **154S** resides within lead-in tube **80**, also as shown in **FIG. 2**.

[0035] Connector **8** also includes a strain relief assembly **98**, a perspective close-up view of which is shown in **FIG. 3A**. Strain relief assembly **98** includes ferrule holder **50** and an intermediate sleeve **100** having front and back end faces **102** and **104**, a central axis A_S, and a central hole **106** centered around axis A_S and defined by an inner surface **107**. In an example embodiment illustrated in **FIG. 3B**, intermediate sleeve **100** is C-shaped and includes inner threads **108**. The C-shaped intermediate sleeve **100** includes a gap **110** open to central hole **106** that defines the C-shape. Gap **110** is sized to fit over buffered portion **154**. This allows intermediate sleeve **100** to be slipped over the exposed buffered portion **154** between the end of lead-in tube **80** and fiber optic cable **150** so it can be added to connector **8** at ferrule back section **50B**, as described below.

[0036] Hole **106** and inner threads **108** are sized so that intermediate sleeve **100** can threadedly engage the outer threads **64** of ferrule holder back section **50B** and be secured thereto. In an example embodiment, intermediate sleeve **100** has an outer surface **112** with one or more grooves **114** running parallel to the front and back end faces **102** and **104**, as shown. One or more grooves **114** are configured to facilitate gripping strain-relief strands **157** to provide additional strain relief, as described in greater detail below. In an example embodiment, intermediate sleeve **100** is made of aluminum. Also in an example embodiment, intermediate sleeve **100** is about 3.5 mm long and about 5 mm in diameter.

[0037] For the sake of discussion, intermediate sleeve **100** is discussed below in connection with its C-shaped threaded embodiment. Other embodiments can also be used for intermediate sleeve **100**, such as for example, a non-threaded version that is otherwise fixable to the ferrule holder end (which also need not be threaded), such as through the use of a snap-connect or via an adhesive or glue. Other embodiments of intermediate sleeve **100** include a clam-shell type

design (not shown) that opens up to fit around and engage ferrule back section **50B**. Still further embodiments of the present invention comprise alternative intermediate sleeves to facilitate the gripping of the strain-relief strands **157** to provide strain relief.

[0038] Strain relief assembly **98** also includes a crimp sleeve **120** having respective front and back ends **122** and **124**, and a central opening **126** sized so that the crimp sleeve can slide over the outside of intermediate sleeve **100**. Crimp sleeve is preferably made of a relatively soft metal such as copper so that it can be crimped over intermediate sleeve **100**. Still further embodiments of the present invention comprise crimp sleeves and/or intermediate sleeves of alternative materials suitable for engaging one another and/or for providing strain relief.

[0039] Once fiber optic cable is prepared for connectorizing as shown in **FIG. 1**, but with a fiber coating **152C** removed to lengthen field fiber section **152S**. Strain relief assembly **98** is then ready to be incorporated into the connector. In **FIG. 2**, strain-relief strands **157** are not included for ease of illustration. **FIG. 4** shows strain-relief strands **157** as being temporarily held back against cable **150** by crimp sleeve **120**.

[0040] At the point of assembly shown in **FIG. 2**, lead-in tube **80** can be crimped onto buffered layer **154** to provide initial stress relief while the parts making up strain-relief assembly **98** are added to the connector.

[0041] With continuing reference to **FIG. 2** and as discussed above, intermediate sleeve **100** slips on over the exposed buffer layer **154** between lead-in tube **80** and fiber optic cable **150**. Intermediate sleeve **100** is then placed on ferrule holder back section **50B**, where inner threads **108** engage outer threads **64**. Intermediate sleeve **100** is then threaded onto ferrule holder back section **50B** and surrounds a portion thereof, thereby also surrounding a portion of buffer layer **154** held in the ferrule back section. Once intermediate sleeve **100** is in place as shown in **FIG. 4**, crimp sleeve **120** is moved to release strain-relief strands **157** held thereby. Strain-relief strands 157 are then flared around grooved outer surface **112**, as shown in **FIG. 5**. Note that in **FIG. 5**, connector **8** includes an inner housing **210** that covers ferrule holder front end **50F** and cam **212** covering ferrule holder **50** at back section **50B** but adjacent intermediate sleeve **100** and forward thereof.

[0042] With reference now to **FIG. 6**, crimp sleeve **120** is moved from its holding place on cable **150** to cover intermediate sleeve **100**. This traps strain-relief strands **157** between the intermediate sleeve and the crimp sleeve, with grooves **114** on outer surface **112** of the intermediate sleeve serving to hold the strand ends in place.

[0043] Also as shown in **FIG. 6**, in the next step crimp sleeve **120** is crimped (e.g., hexagonally crimped), as illustrated by arrows **200**. This squeezes the intermediate sleeve and the crimp sleeve together, which serves to hold strain-relief strands **157** in place and provide stress relief. It also causes gap **110** to at least partially close in certain embodiments of the present invention, which serves to secure the intermediate sleeve to the ferrule holder, thereby providing further strain relief at back end **8B** of connector **8**.

[0044] **FIG. 7** is an elevated perspective view of the connector similar to **FIG. 5**, showing an inner housing **210** in place at the connector front end **8F** and crimp sleeve **120** in place over intermediate sleeve **100** at ferrule holder back section **50B**.

[0045] Once intermediate sleeve **100** and crimp sleeve **120** are crimped in place on ferrule holder back section **50B**, a protective boot **220**, temporarily stored over cable **150**, is slid over connector back end **8B**, as shown in the side view of **FIG. 8** and the elevated perspective view of **FIG. 9**. **FIG. 9** also shows an outer housing or "shroud" **230** arranged over the inner housing **210** (see **FIG. 7** and **FIG. 8**) at connector front end **8F**.

Intermediate sleeve handler

[0046] Because intermediate sleeve **100** is relatively small (e.g., about 5mm in diameter), it may prove difficult to handle when installing strain-relief assembly **98** onto connector **8**. Accordingly, with reference to **FIG. 10**, the present invention includes an intermediate-sleeve handler ("handler") **300** used to handle intermediate sleeve **100**. Handler **300** has front and back end faces **302** and **304** and a central hole **306** centered on a central axis A_H. Handler **300** includes a shelf **307** between the central hole and back end face that serves as a stop against which intermediate sleeve **100** abuts when placed within the handler central hole, as discussed below. Handler **300** has a smooth inner surface **308**, an outer surface **309**, and a gap **310** in the outer surface and that opens to the central hole to define a C-shape for the handler. Inner surface

308 includes opposing lips **311** on opposite sides of gap **310**. In an example embodiment, handler **300** includes one or more grooves **312** that facilitate gripping and handling the handler. Gap **310** is sized so that it fits over the buffered section of a fiber optic cable.

[0047] Handler hole **306** is sized so that intermediate sleeve **100** can be easily pressed into the central hole at the handler front end face **302** with one of the intermediate sleeve end faces (e.g., back end face **104**) coming to a rest against shelf **307**, and so that handler axis A_H and intermediate sleeve axis A_S are aligned, as shown in **FIG. 11**.

[0048] It is important that handler gap **310** line up with intermediate sleeve gap **110**, as best illustrated in **FIG. 11**. This can be done using a fixture in the factory, or by keying the intermediate sleeve and the installation handler. One way to key these two components is by providing flat sections **117** on the intermediate sleeve outer surface adjacent gap **110**, and by providing corresponding flat sections (lips) **311** on handler inner surface **108** so that these respective flat surfaces engage when the respective gaps line up. This engagement also serves to cause intermediate sleeve **100** to rotate along with handler **300** when the handler is rotated (e.g., when threading the intermediate sleeve onto the ferrule holder back section), rather than having the intermediate sleeve rotate independently within the handler.

[0049] To install intermediate sleeve **100** onto the back of connector **8** using handler **300**, handler front face **302** faces ferrule back section **50B**. Next, the aligned handler and intermediate sleeve gaps **310** and **110** are slid over the exposed buffer section **154** between the flared back end **84** of lead-in tube **80** and oversized cable **150**. Intermediate sleeve **100** is then threaded onto ferrule holder back section **50F** using handler **300**. Handler **300** is then pulled back towards cable **150** and away from connector **8** until is it back at the exposed buffer section **154**, where it can be removed via gap **310**. Since intermediate sleeve is held in position on ferrule holder back section **50B** by the engaged threads and was held within handler **300** only with a slight press fit, the handler and intermediate sleeve easily disengage when the handler is pulled away from the ferrule back section.

[0050] The present invention has the advantage that it allows for proper installation and strain relief of a field-installable fiber optic connector directly on a fiber optic cable, such as an

oversized fiber optic cable, as opposed to being installed on the tight-buffered fiber portion inside the cable. This results in a more stable fiber optic cable termination.

[0051] It will be apparent to those skilled in the art that various modifications and variations can be made to the present invention without departing from the spirit and scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. A strain-relief assembly for a field-installable fiber optic connector having a back end configured for connection to a fiber optic cable having a buffered portion and strain-relief strands, the strain-relief assembly comprising:

a ferrule holder having a back section with an open back end and configured to accommodate the buffered optical fiber portion;

an intermediate sleeve having an outer surface and configured to generally surround and engage a portion of the ferrule holder back section;

a crimp sleeve having an inner surface, wherein the crimp sleeve covers the intermediate sleeve with the strain-relief strands arranged between the crimp sleeve inner surface and the intermediate sleeve outer surface; and

wherein the crimp sleeve grips the strain-relief strands between the crimp sleeve and the intermediate sleeve.

2. A connector assembly for a fiber optic cable, comprising:

the strain relief assembly of Claim 1, wherein the ferrule holder has a front end and the fiber optic cable comprises an optical fiber; and

a ferrule arranged in the ferrule holder front end, the ferrule having a channel that holds a stub optical fiber having an end residing within the ferrule channel and that interfaces with an end of the optical fiber of the fiber optic cable when the fiber optic cable is connected to the connector.

3. A strain-relieved connector assembly for a fiber optic cable that has an optical fiber with a front end, a buffered portion, and strain-relief strands, the strain-relieved connector comprising:

a ferrule holder having a front section with an open front end and a back section having an open back end, wherein the open front and back ends are connected by a ferrule holder channel;

a ferrule and a splice assembly arranged in the ferrule holder front end, the ferrule and splice assembly having respective central channels;

a fiber stub held within the ferrule and splice assembly channels, wherein the fiber stub has a back end residing in the splice assembly channel;

the buffered layer held in the ferrule holder back section so that the fiber stub back end interfaces with the optical fiber front end within the splice assembly channel;

an intermediate sleeve that engages and generally surrounds a portion of the ferrule holder back end section so as to generally surround the buffered layer held therein; and

a crimp sleeve arranged around the intermediate sleeve so as to hold ends of the strain-relief strands between the crimp sleeve and the intermediate sleeve,

wherein the crimp sleeve grips thestrain-relief strand ends between the crimp sleeve and the intermediate sleeve,

wherein the crimp sleeve fixes the intermediate sleeve to the ferrule holder back end.

4. The assembly of Claim 1 or 3, wherein the crimp sleeve is adapted to be crimped to grip the strain-relief strands between the crimp sleeve and the intermediate sleeve

5. , The assembly of Claim 1 or 3, wherein the intermediate sleeve deforms when the crimp ring is crimped so as to permanently fix the intermediate sleeve to the ferrule holder back section.

6. The assembly of Claim 1 or 3, wherein the intermediate sleeve has a gap so that the intermediate sleeve is C-shaped, with the gap being sized fit over the buffered portion.

7. The assembly of Claim 1 or 3, wherein:

the ferrule holder back end has outer threads; and

the intermediate sleeve has interior threads that match the outer threads so that the intermediate sleeve can threadedly engage the ferrule back section.

8. The assembly of Claim 1 or 3, wherein the intermediate sleeve outer surface includes grooves that assist in securing the strands between the intermediate sleeve and the crimp sleeve.

9. The assembly of Claim 1 or 3, wherein the intermediate sleeve comprises aluminum and the crimp sleeve comprises copper.

10. The connector of Claim 2 or 3, further including:
an outer housing that covers the ferrule holder front end; and
a boot that covers the ferrule holder back end.

11. A method of providing strain-relief in a connector for a fiber optic cable that has an optical fiber section, a buffer section, strain-relief strands, and a protective jacket, the method comprising:
inserting the optical fiber section and buffered section into a back section of a ferrule holder;
engaging an intermediate sleeve having inner and outer surfaces with the ferrule holder back section so as to generally surround the ferrule holder back section;
placing a plurality of the strain-relief strands over the intermediate sleeve outer surface;
placing a crimp sleeve around the intermediate sleeve and the strain-relief strands; and
crimping the crimp sleeve so as to secure the strain-relief strands and to fix the intermediate sleeve onto the ferrule holder back section.

12. The method of Claim 11, wherein the intermediate sleeve is threaded and the back section of the ferrule holder is threaded, and including threadedly engaging the intermediate sleeve with the ferrule holder.

13. The method of Claim 11, wherein the intermediate sleeve includes a gap that forms a C-shaped intermediate sleeve, and wherein said crimping causes the gap to at least partially close.

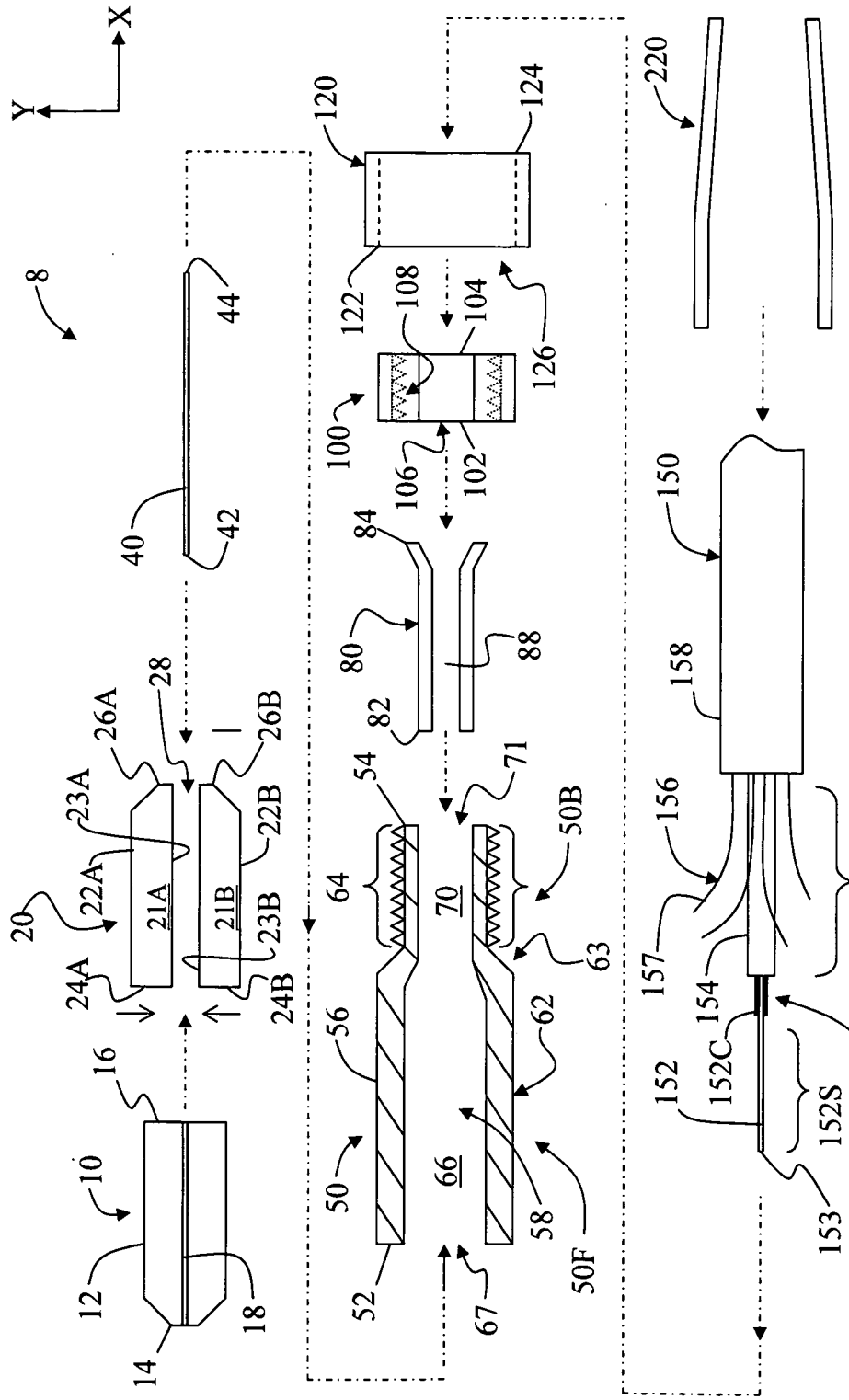

X
Y
8
10
12
14
16
18
20
21A
21B
22A
22B
23A
23B
24A
24B
26A
26B
28
40
42
44
50
50B
50F
52
54
56
58
62
63
64
66
67
70
71
80
82
84
88
100
102
104
106
108
120
122
124
126
150
151
152
152C
152S
153
154
154S
156
157
158
220

FIG. 1

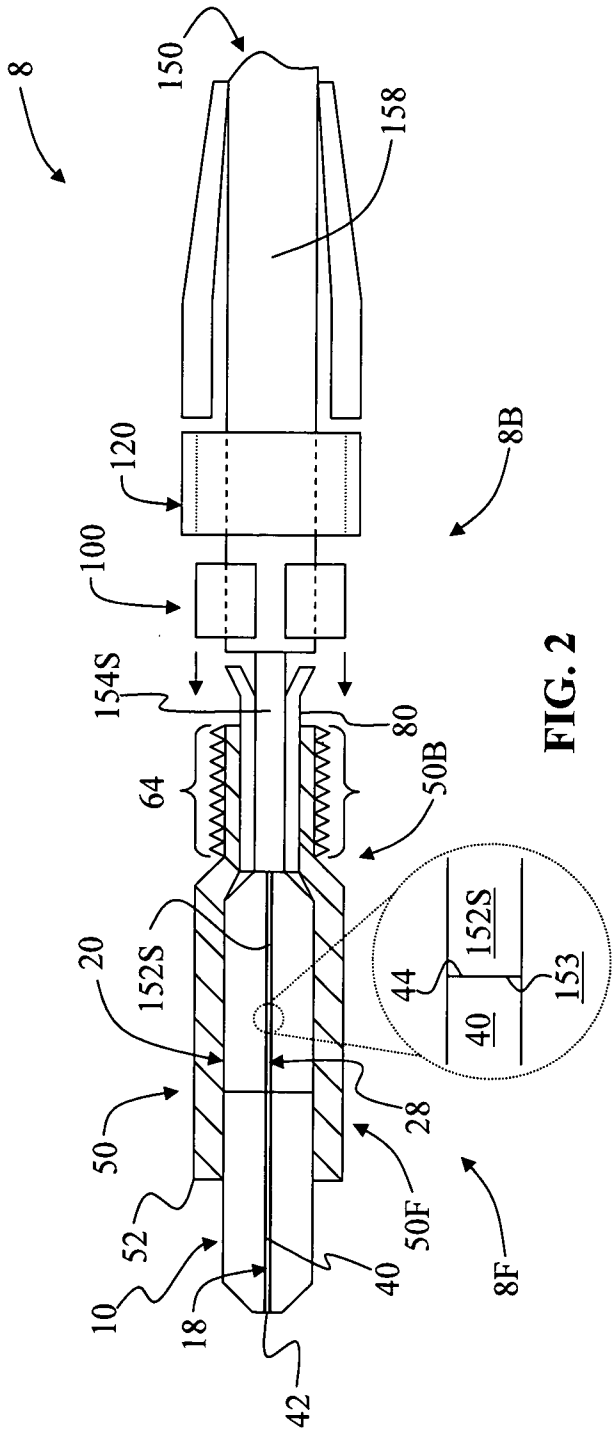

8
150
158
120
8B
100
154S
80
64
50B
20
152S
44
152S
40
153
50
28
52
50F
10
40
8F
18
42

FIG. 2

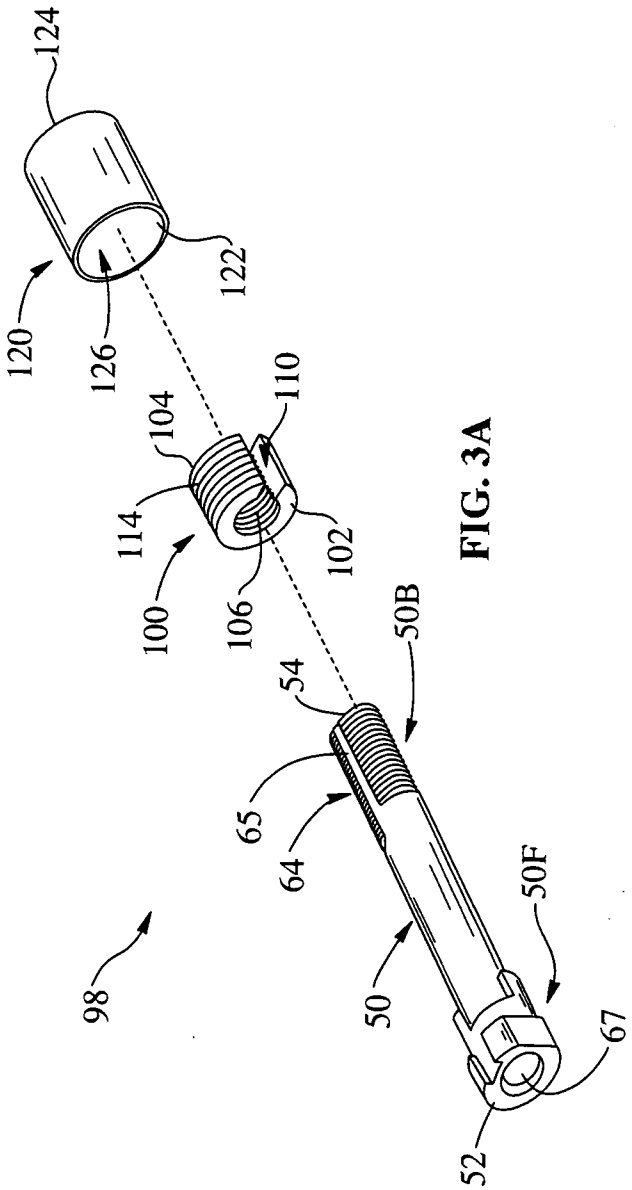

124
120
126
122
104
110
114
100
106
102
50B
54
65
64
50F
98
50
67
52

FIG. 3A

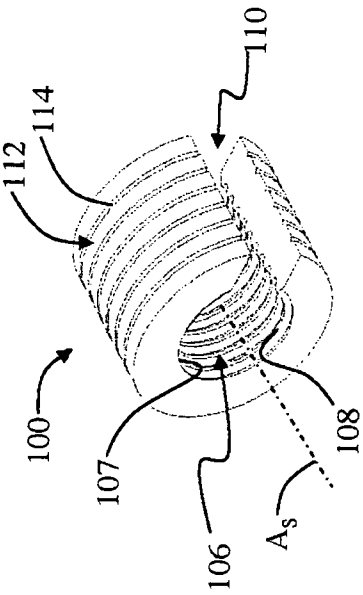

110
112
114
100
107
106
108
A_s

FIG. 3B

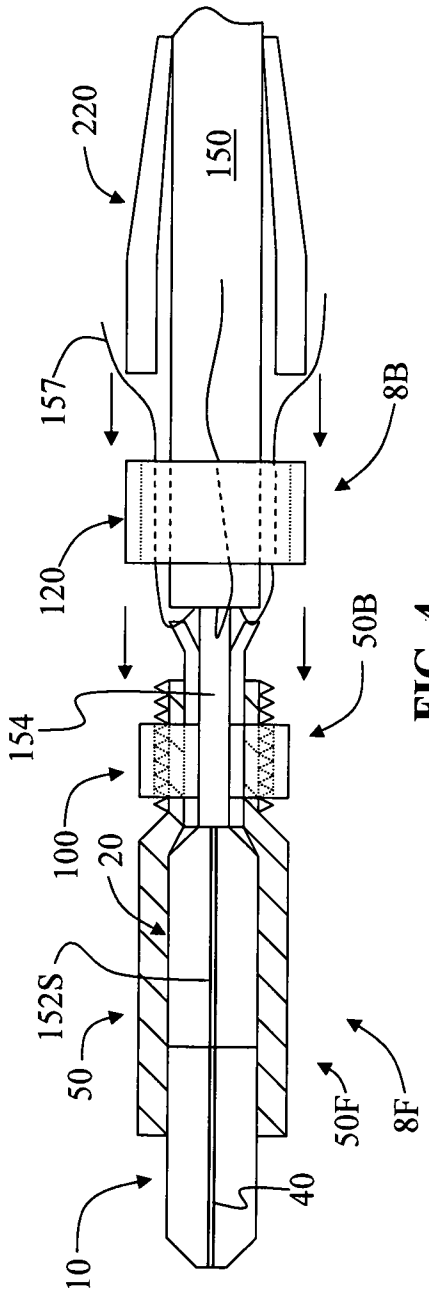

220
150
157
8B
120
50B
154
100
20
152S
50
50F
8F
40
10

FIG. 4

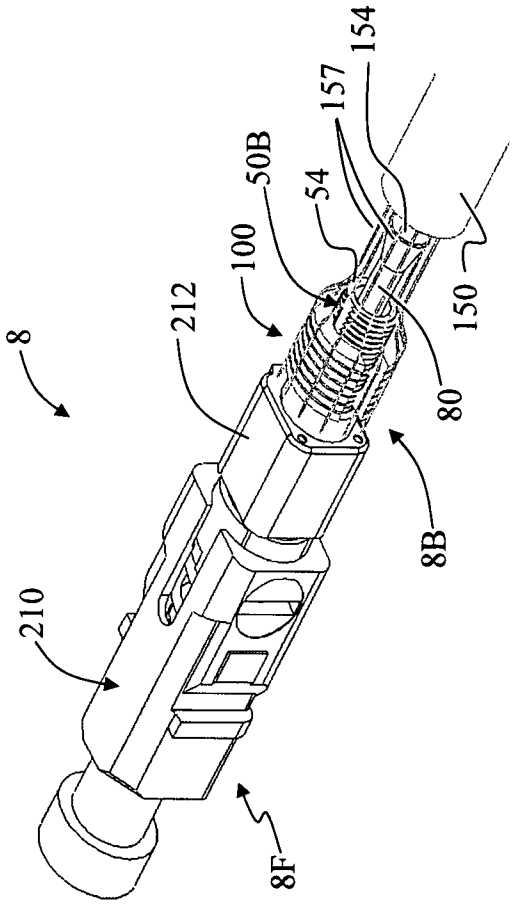

8
212
100
50B
54
157
154
150
80
8B
210
8F

FIG. 5

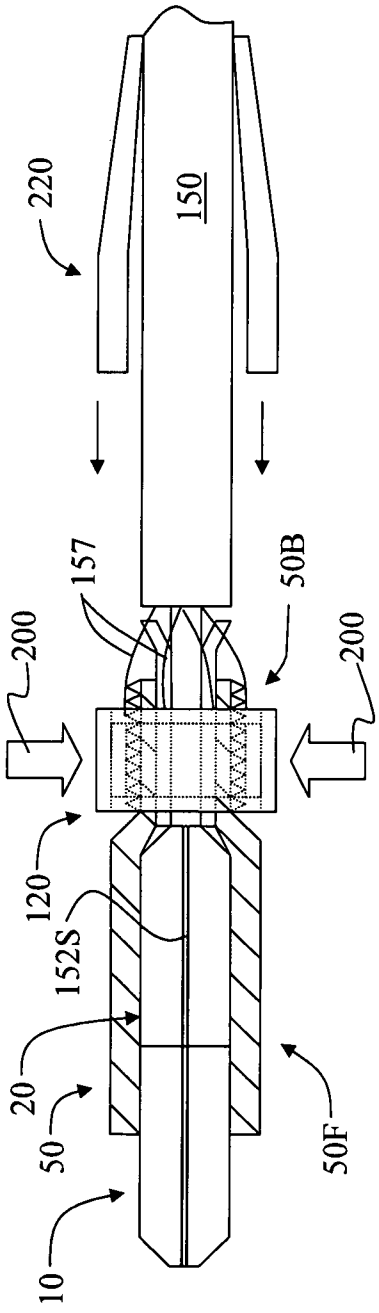

220
150
157
50B
200
200
120
152S
20
50
10
50F

FIG. 6

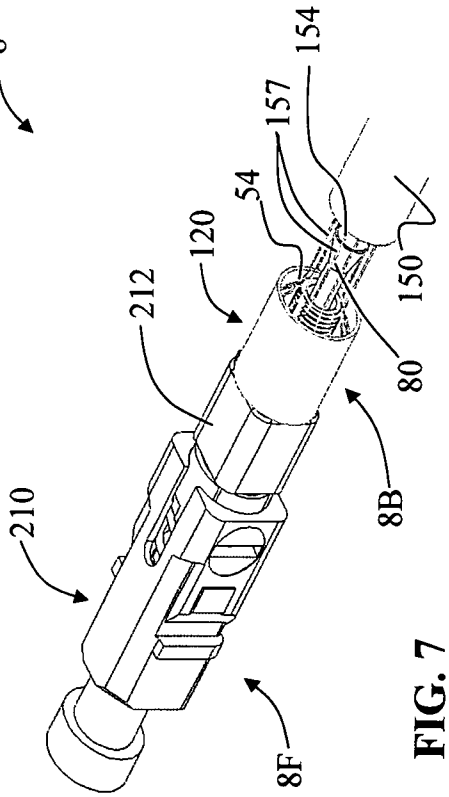

8
154
157
54
120
212
150
80
8B
210
8F

FIG. 7

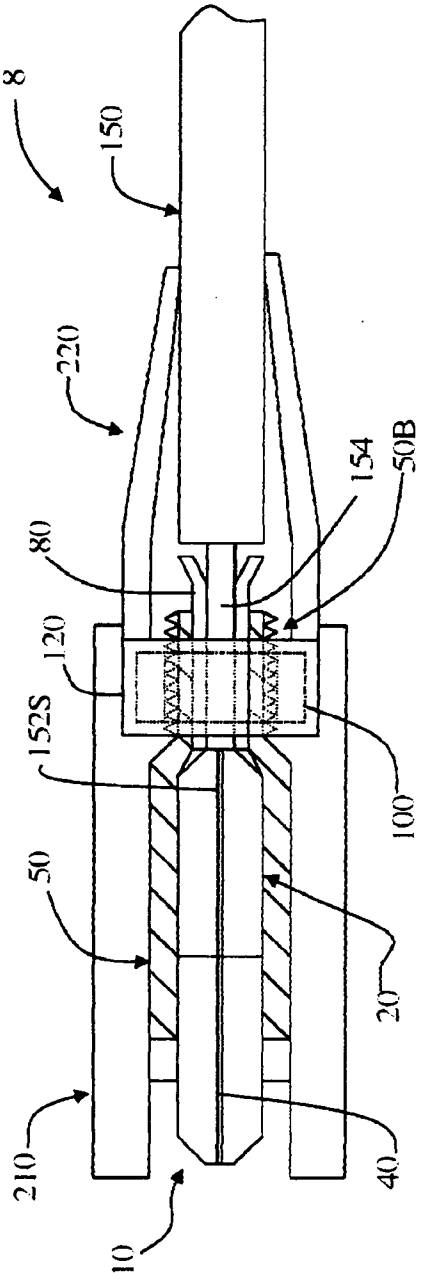


FIG. 8

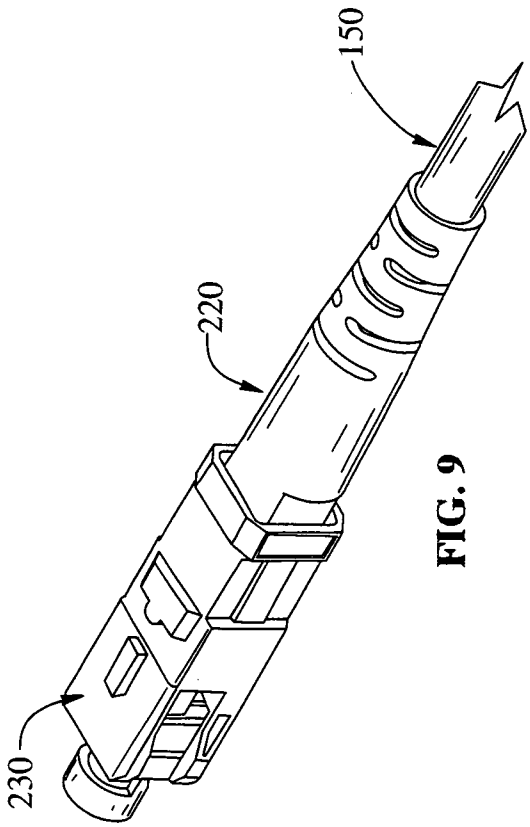


FIG. 9

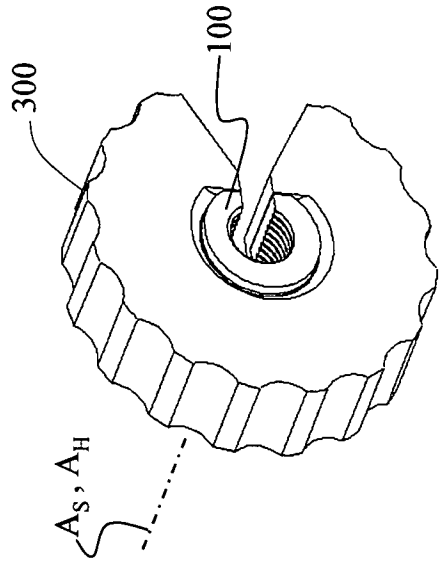

300
100
A_S, A_H

FIG. 11

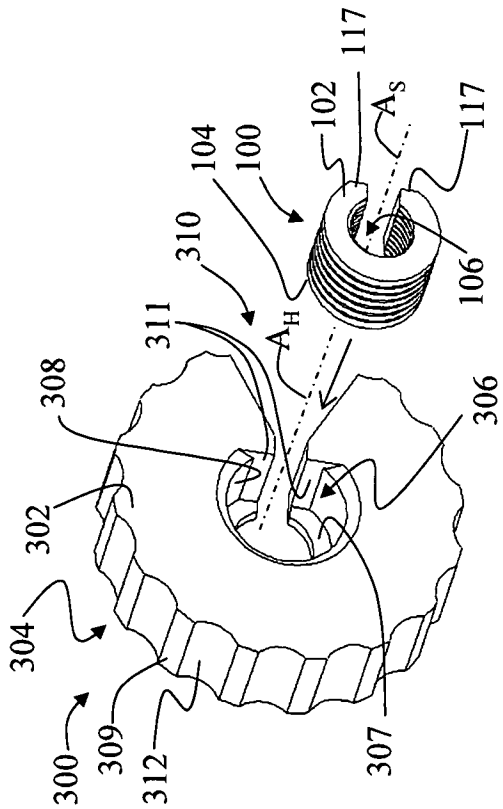

117
102
A_S
117
104
100
310
106
311
A_H
308
306
302
304
300
309
312
307

FIG. 10

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2008/010864

A. CLASSIFICATION OF SUBJECT MATTER
INV. G02B6/38

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2005/244108 A1 (BILLMAN BRADLEY S [US] ET AL) 3 November 2005 (2005-11-03) cited in the application the whole document	1-5,7-12
A		6,13
Y	US 5 222 169 A (CHANG PETER C [US] ET AL) 22 June 1993 (1993-06-22) the whole document	1-5,7-12
A		6,13
Y	US 5 202 942 A (COLLINS DANIEL R [US] ET AL) 13 April 1993 (1993-04-13) the whole document	1-5,7-12
A		6,13

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 February 2009	06/03/2009

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Fax: (+31–70) 340–3016	Frisch, Anna Maria

1

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2008/010864

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 98/19192 A (WHITAKER CORP [US]) 7 May 1998 (1998-05-07) the whole document	1-5,7-12
A		6,13
A	US 4 593 972 A (GIBSON LLOYD H [US]) 10 June 1986 (1986-06-10) column 4, line 36 - line 66; figure 1	6,13

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2008/010864

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2005244108 A1	03-11-2005	NONE	
US 5222169 A	22-06-1993	CN 2163388 Y	27-04-1994
US 5202942 A	13-04-1993	DE 69326709 D1	18-11-1999
		DE 69326709 T2	18-05-2000
		EP 0563995 A1	06-10-1993
WO 9819192 A	07-05-1998	AU 5241798 A	22-05-1998
		DE 19782073 T0	23-09-1999
		GB 2333859 A	04-08-1999
		JP 2002515137 T	21-05-2002
		US 5835653 A	10-11-1998
US 4593972 A	10-06-1986	NONE	