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(71) Applicant: **CORNING CABLE SYSTEMS LLC** [US/US]; 800 17th Street NW, Hickory, North Carolina 28602 (US).

(72) Inventors; and
(71) Applicants : **HOUSER, Christopher Shawn** [US/US]; 1880 Wellington Ave, Newton, North Carolina 28658 (US). **LEONARD, Ronald Alan** [US/US]; 6866 Hwy NC 18, Connelly Springs, North Carolina 28612 (US). **SMITH, Matthew Wade** [US/US]; 301 Lower Creek Drive NE, Lenoir, North Carolina 28645 (US). **WILSON, James McKinnley** [US/US]; 5001 Poplar View Lane, Granite Falls, North Carolina 28630 (US).

(74) Agent: **CARROLL, Michael E Jr.**; Corning Cable Systems LLC, Intellectual Property Department, SP-TI-3-1, Corning, New York 14831 (US).

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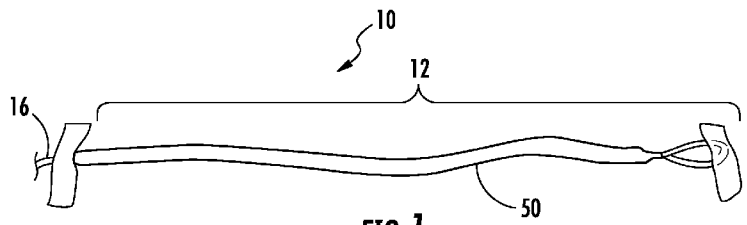

FIG. 1

(57) Abstract: Cable assemblies having small form-factor pulling grips and methods for making the same are disclosed. The cable assembly includes a cable having at least one furcation body attached to a portion of the cable with one or more furcation legs extending from the furcation body, a pulling element, and a protective sleeve. The pulling element is formed from the at least one strength member of the cable and includes a pulling loop, where the pulling element extends beyond one or more of furcation legs. The protective sleeve is disposed directly about a portion of the cable assembly and has a non-cinch configuration about the cable assembly. Non-cinch configuration means that the protective sleeve does not squeeze down and clamp about the cable assembly when a pulling force is applied to the pulling grip, but instead the pulling forces are transferred to the cable assembly using strength members of the fiber optic cable.

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CABLE ASSEMBLY HAVING A SMALL FORM-FACTOR PULLING GRIP AND METHODS FOR MAKING THE SAME

RELATED APPLICATIONS

[0001] This application claims the benefit of priority under 35 U.S.C. § 119 of U.S. Provisional Application Serial No. 61/591,499 filed on January 27, 2012 the content of which is relied upon and incorporated herein by reference in its entirety.

FIELD

[0002] The disclosure is directed to cable assemblies having pulling grips for installing cable assemblies into pathways such as ducts, conduit, or the like. More specifically, the disclosure is directed to cable assemblies having a small form-factor pulling grip for installing the cable assembly into relatively small pathways.

BACKGROUND

[0003] Optical fiber is increasingly being used for a variety of applications, including but not limited to broadband voice, video, and data transmission. Optical networks may use fiber optic cables in variety of outdoor or indoor applications and each application has it own special needs. Indoor applications typically have the challenges of restricted space for routing the fiber optic cables to the desired location especially in existing buildings. By way of example, many existing buildings have existing conduit, ducts, or the like for routing communication cables in the building. In order to protect fiber optic cable assemblies pulling grips are typically used when installing pre-terminated fiber optic cable assemblies (i.e., the connectors are already attached to the cable assembly) into pathways, conduits and/or duct systems.

[0004] Conventional pulling grip solutions for protecting the fiber optic cable and/or connectors of pre-terminated fiber optic cable assemblies are designed for installation into pathways having ample space such as large diameter conduits. However, larger conduits are more expensive and time consuming to install in existing high rise units and space may still not allow installation of larger conduits or ducts. Moreover, many existing installations are restricted to the use of the existing pathways for the cable assemblies due to space, time, and/or cost restraints.

[0005] Further, many of the existing conduit or duct systems in high-rise buildings use smaller sized pathways that were initially intended for electrical cables and/or have existing cables installed, thereby providing limited space for routing fiber optic cables assemblies therein. Unlike electrical cables, it is often preferred to install pre-terminated fiber optic cables so the craft has plug and play connectivity in the field instead of having the difficult and time-consuming task of terminating and polish optical fiber connectors in the field.

[0006] These small existing pathways make installing the fiber optic cables challenging to install without damaging the fiber optic cable and/or connectors of the cable assembly. Additionally, many times it is desired to install several cable assemblies into existing pathways which makes use of conventional pulling grip solutions difficult or not possible.

[0007] Conventional pulling grip solutions typically use a relatively large rigid tube or rigid housing. Specifically, the connectors attached to the legs of the cable assembly are installed into the rigid tube or rigid housing for protecting the same during the pulling installation. However, the rigid tube or rigid housing takes up much of the space available within the existing conduit, duct, or the like, thereby limiting the number of cable assemblies that can be pulled into the pathway. Consequently, there is an unresolved need for a robust and reliable cable assembly having a pulling grip with a small form-factor for use where space is restricted.

SUMMARY

[0008] The disclosure is directed to cable assemblies having a small form-factor pulling grip along with methods for making the same. One aspect is directed to a cable assembly having a pulling grip including a cable having at least one optical fiber, at least one strength member, and a cable jacket, wherein a furcation body is attached to an end of the cable and one or more furcation legs extend from the furcation body. A pulling element is formed from the at least one strength member of the cable and extends beyond one or more furcation legs and includes a pulling loop. A protective sleeve is disposed directly about a portion of the cable assembly, and the protective sleeve has a non-cinch configuration about the cable assembly.

[0009] Another aspect is directed to a method of forming a cable assembly having a pulling grip including the steps of providing a cable having at least one optical fiber, at least one strength member, and a cable jacket, wherein a furcation body is attached to an end of the cable and one or more furcation legs extends from the furcation body; forming a pulling element from the at least one strength member of the cable so that the pulling element extends beyond the one or more furcation legs and includes a pulling loop; and positioning a protective sleeve directly about a portion of the cable assembly and securing the protective sleeve so it has a non-cinch configuration about the cable assembly.

[0010] Another aspect is directed to a fiber optic cable assembly including a cable having at least one optical fiber, at least one strength member, and a cable jacket, wherein a furcation body is attached to an end of the cable and one or more furcation legs extend from the furcation body. The furcation body includes a first tube disposed within a second tube, wherein the first tube is potted for securing and potting the optical fibers.

[0011] Additional features and advantages will be set forth in the detailed description which follows, and in part will be readily apparent to those skilled in the art from that description or recognized by practicing the same as described herein, including the detailed description that follows, the claims, as well as the appended drawings.

[0012] It is to be understood that both the foregoing general description and the following detailed description present embodiments that are intended to provide an overview or framework for understanding the nature and character of the claims. The accompanying drawings are included to provide a further understanding of the disclosure, and are incorporated into and constitute a part of this specification. The drawings illustrate various embodiments and together with the description serve to explain the principles and operation.

BRIEF DESCRIPTION OF THE FIGURES

[0013] **FIG. 1** is a perspective view of a portion of a fiber optic cable assembly having a pulling grip installed on one end;

[0014] **FIG. 2** shows a perspective view of the fiber optic cable assembly of **FIG. 1** with the protective sleeve removed showing the details of one end of the cable assembly; and

[0014] **FIG. 3** shows a cross-section of an explanatory fiber optic cable;

[0015] **FIGS. 4-16** depict explanatory steps for forming the furcation body on a portion of the fiber optic cable of **FIG. 3**;

[0016] **FIGS. 17 and 18** depict explanatory steps for forming the pulling loop of the pulling element of the explanatory cable assembly;

[0017] **FIG. 19** illustrates an end portion of another exemplary fiber optic cable being prepared for furcation and making a cable assembly similar to **FIG. 2** by cutting and removing a portion of a cable jacket and exposing optical fibers subunits that form furcation legs and strength members disposed inside the fiber optic cable;

[0018] **FIG. 20** illustrates the exposed strength member end portion in **FIG. 19** twisted and taped;

[0019] **FIG. 21** illustrates the twisted and taped strength member end portion in **FIG. 4** cut to the desired length;

[0020] **FIG. 22** illustrates preparing to insert the strength member end portion in **FIG. 5** into a tube;

[0021] **FIG. 23** illustrates pushing the strength member end portion through the tube in **FIG. 22** and pushing the tube to the cable jacket on the fiber optic cable illustrated in **FIG. 3**;

[0015] **FIG. 24** illustrates the tube in **FIG. 23** being optionally secured to the strength members.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0016] Reference will now be made in detail to exemplary embodiments of the disclosure, examples of which are illustrated in the accompanying drawings. Whenever possible, like reference numbers will be used to refer to like components or parts.

[0017] The cable assemblies and methods disclosed herein include a pulling grip having small-form factors for installing the cable assemblies into relatively small pathways, conduits, ducts or the like. The cable assemblies may include an extended

pulling loop formed by strength members of the fiber optic cable along with a protective sleeve disposed directly about a portion of the cable assembly for creating a low-profile assembly suitable for the use in small diameter pathways, conduits, ducts or the like. In particular, the protective sleeve has a non-cinch configuration about the cable assembly meaning it does not squeeze down and clamp about the cable assembly when a pulling force is applied to the pulling grip, but instead pulling forces are transferred to the cable assembly using strength members of the fiber optic cable. Further, the cable assemblies disclosed eliminate the use of bulky protective tubing or housings for protecting the fiber optic connectors of the cable assembly as used in conventional fiber optic cable pulling grips.

[0018] Consequently, the cable assembly discussed herein use small-form factor pulling grips so that the one or more cable assemblies may be installed into relatively small ducts, passageways, conduit or the like. By way of example, the cable assemblies and pulling grips disclosed having a small footprint may allow up to six cable assemblies to be installed into a single one-inch conduit, which is not feasible with bulky conventional pulling grips. Typically, conventional pulling grips for cable assemblies are bulky and use a rigid tubular element (i.e., rigid protective tube) between the cable assembly and the mesh disposed about a portion of the cable assembly for cinching down onto the tubular element for transferring a pulling force to the cable assembly. In other words, the rigid tubular members are used as a buffer for inhibiting the mesh from tightening directly onto the cable assemblies such as the furcation legs and connector and causing damage. Thus, the rigid tubular elements require a relatively large amount of free-space for pulling the cable assembly into the conduit or duct. Reference will now be made in detail to the preferred embodiments, examples of which are illustrated in the accompanying drawings. Whenever possible, like reference numbers will be used to refer to like components or parts.

[0019] **FIG. 1** is a perspective view of a portion of an explanatory fiber optic cable assembly **10** having a pulling grip **12** formed on one end of a fiber optic cable **16**. Pulling grip **12** has a portion formed from fiber optic cable **16** and a portion that is not formed by fiber optic cable **16**. Specifically, the pulling grip **12** includes a pulling element **14** formed from at least one strength member (not visible) of the fiber optic cable

16 and extends beyond one or more furcation legs when a protective sleeve **50** of pulling grip **12** is installed on the cable assembly **10**. The pulling element **14** may also include a pulling loop **16** having a portion that is also formed by the at least one strength member of the fiber optic cable **16**. Moreover, sleeve **50** is a portion of the pulling grip **12** that is not formed by fiber optic cable **16** and sleeve **50** is disposed directly about a portion of the cable assembly **10**. Sleeve **50** includes a mesh or the like that has a non-cinch configuration so that it does tighten onto the cable assembly, which can damage or destroy portions of the fiber optic cable assembly **10** during the installation of the same. Sleeve **50** may also comprise other materials that have a non-cinch configuration for protecting the cable assembly and inhibit snagging. As used herein, a non-cinch configuration means the sleeve does not squeeze down and clamp about the cable assembly for transferring pulling forces to the cable assembly. Since sleeve **50** is disposed directly about a portion (i.e. the furcation legs) of the cable assembly **10** it allows the fiber optic cable assembly with pulling grip **12** to have a relatively small footprint for installation into small pathways, conduits, ducts or the like while still providing suitable protection to the fiber optic cable assembly **10**. In other words, cable assembly **10** does not include a protective tube (i.e., rigid or corrugated) disposed about the furcation legs under the protective sleeve **50**, thereby allowing a small form-factor for the pulling grip **12**.

[0020] **FIG. 2** depicts explanatory fiber optic cable assembly **10** with the sleeve **50** of the pulling grip **12** removed to show the construction of the fiber optic cable assembly **10** and **FIG. 3** depicts a cross-sectional view of fiber optic cable **16**. As shown, cable assembly **10** includes a furcation body **50** attached to an end of the fiber optic cable **16** and one or more furcation legs **30** extending from the furcation body **50**. As shown, the cable assembly **10** may optionally include one or more connectors **32** attached to the furcation legs **30** as depicted in **FIG. 2** for providing plug and play connectivity. In other words, a cable assembly having pre-terminated connectors allows the craft to quickly and easily connect the cable assembly as desired. Although, explanatory fiber optic cable assembly **10** is shown with three connectors **32**, other embodiment can have other suitable numbers of connectors. Likewise, fiber optic cable **16** may have any suitable number of optical fibers as desired. By way of example, the fiber optic cable **16** of **FIG.**

2 includes thirty-six optical fibers that are distributed into three furcation legs **30** each having twelve-fibers with each leg having an twelve-fiber connector attached (i.e., a multi-fiber connector). Other arrangements are also possible with fiber optic cable **16** such as distributing the twenty-four optical fibers into two furcation legs **30** each having twelve-fibers with each leg having a twelve-fiber connector attached. Of course, any suitable cable may be used with the concepts disclosed herein.

[0021] As best shown in **FIG. 3**, fiber optic cable **16** includes at least one optical fiber **20**, at least one strength member **22**, and a cable jacket **24**. Fiber optic cable **16** can include any suitable optical fibers in any suitable configuration such as loose fibers, buffered, ribbonized or the like. Likewise, fiber optic cable **16** can have any suitable strength member such as fiberglass, aramid yarns such as Kevlar®, or even a glass-reinforced plastic (GRP). Fiber optic cable 16 is an interconnect fiber optic cable that is not as robust as distribution cables (i.e., the cable can not withstand large pulling forces like distribution cables; consequently, being able to apply pulling forces directly to the strength members of the cable inhibits damage during the installation process.

[0022] **FIGS. 4-16** depict explanatory steps for forming the furcation body **50** on a portion of fiber optic cable **16**. **FIG. 4** depicts a portion of the cable jacket **24** after being ring cut at the desired location on fiber optic cable using a suitable tool. Before ring cutting the cable jacket a grommet **21** as shown in **FIG. 12** may be threaded onto fiber optic cable **16** and slid out of the way. As shown, after being ring cut a free end **24a** of the cut cable jacket **24** is slid away from the cut location so that the optical fibers **20** can be separated from the strength members **22** at the exposed location and then the optical fibers **20** are pulled out of the free end **24a**. In this embodiment, the free end **24a** and strength members **22** are pulled to the side and used for making a pulling element **14** as discussed herein. **FIG. 5** show a protective structure **27** threaded about optical fibers **20** so it can be inserted into an end **24b** of cable jacket **24** so that the end **24b** can be slit on opposite sides while inhibiting damage to the optical fibers **20** as shown in **FIG. 6**.

[0023] Thereafter, **FIG. 7** shows the strength members **22** are divided into two groups and arranged into the slits in end **24b** of cable jacket **24** so that a heat shrink 40 can be arranged and secured about end **24b** and the strength members **22**. Next, a first tube **51** of the proper size is threaded onto the optical fibers **20** and slid over a portion of

heat shrink **40** as shown in **FIG. 8**. First tube **51** forms a portion of the furcation body **50** used for securing and potting the optical fibers as discussed below.

[0024] In this embodiment, the furcation legs **30** are formed using a discrete structure configured as fan-out leg **60**, but other configurations are possible for the furcation legs **30**. The fan-out leg 60 may include a fan-out tube **60a** and a plurality of strength members **60b** such as aramid yarns partially disposed within fan-out tube **60a**. One or more fan-out legs **60** are then slid over the select optical fibers **20** as desired in preparation of potting the optical fibers **20** within first tube **51** for forming a portion the furcation body **50** as shown in **FIG. 9**. By way of example, the furcation body **50** may have two furcation legs **30** extending therefrom with each furcation leg having eight optical fibers terminated by a multi-fiber connector. Of course, cable assemblies can have different counts for the furcation legs and/or optical fiber in the furcation legs. Likewise, the connectors terminated by the furcation legs can be single-fiber or multi-fiber connectors.

[0025] As depicted in **FIG. 10** first tube **51** is then filled with a suitable first potting material such as an epoxy (not numbered) for securing the optical fibers within the furcation body **50**. First tube **51** may be clear or translucent to visually aid the craft in determining if the tube is filled with epoxy and no significant air pockets are formed in the epoxy, but the use of opaque materials is possible. Thereafter, the one or more fan-out tubes **60a** of the fan-out legs **60** are inserted into the other end of the first tube **51** before the epoxy cures for forming a portion the furcation body **50** that secures optical fibers **20** as depicted in **FIG. 11**. Moreover, the ends of strength members **60b** are pulled to the side of the fan-out tube **60a** as shown.

[0026] **FIG. 12** shows a top view of the partially assembled furcation body **50** on the fiber optic cable **16** with the previously installed grommet **21** slid back into view on the cable jacket **24**. The strength members **60b** and fan-out tube **60a** of the fan-out leg **60** can be held together using a tape to inhibit movement of the components as the remainder of the furcation body **50** is created. If desired indicia centering marks may be made on the cable jacket **24** on one end and the fan-out leg(s) **60** and free end **24a** on the other end for positioning (i.e., centering) a second tube **53** about the first tube **51** of the furcation

body **50** as shown in **FIG. 13**. In other words, the furcation body **50** has the first tube **51** disposed within second tube **53**.

[0027] The strength members **60b** of the fan-out leg **60** can have an adhesive applied so that they maintain their desired position within the second tube **53** during manufacture and while being filled (i.e., potted) with a suitable materials such as an epoxy. Next grommet **21** is slid into an end of second tube **53** as shown to inhibit the potting material from escaping as it is being filled and the free end **24a** and fan-out leg **60** are partially disposed within the second tube **53** before potting. Second tube **53** may be clear or translucent so the technician can observe the filling of the tube **53** with the potting material and verify that air pockets and the like are eliminated during the filling process. **FIG. 14** shows second tube **53** being potted and **FIG. 15** shows furcation plug **50** after completion. Thereafter, an optional heat shrink **62** may be applied about the furcation plug **50** as shown in **FIG. 16.**

[0014] **FIGS. 17and 18** show the details for forming the pulling loop **16** of pulling element **14** of the cable assembly **10** from strength members **22** and free end **24a** that was previously ring cut from the cable. As depicted, the end of tube **56** is formed into a loop and a portion of the strength members **22** are optionally twisted and/or braided about the pulling element **14** (i.e., about free end **24a**) as shown. Thereafter, a securing device **16a** such as a heat shrink tubing is used for securing the strength members **22** to a portion of the pulling element **14**. In this embodiment, the optical fibers were arranged into separate groups and threaded into a fan-out legs **60** for forming a furcation leg **30** for protecting the optical fibers **26**.

[0015] With embodiments having fiber optic cables with subunits the jacket of the subunit can form the respective furcation legs **30** so that the separate and discrete fan-out legs are not needed, but instead provide by the cable. Thereafter, the furcation body **50** may be formed at the end portion of fiber optic **18**. The furcation body **50** can have any suitable construction useful for the cable design. For instance, the furcation body **50** can simply be one or more heat shrinks for securing the pulling element and fibers at the furcation location. In other embodiments, the furcation body **50** may be formed by molding or be a premolded shell that fits about end portion **18** and is filled with epoxy or the like for fixing the structure. One or more fiber optic connectors **32** may be optionally

attached to the furcation legs **30** as desired to construction a fiber optic cable assembly as shown in **FIG. 2**.

[0028] Completing the cable assembly **10** having pulling grip **12** is accomplished by threading protective sleeve **50** directly about a portion of cable assembly **10**. Specifically, the pulling element **14** formed from at least one strength member of the cable is positioned so as to extend beyond the one or more furcation legs **30**. In this embodiment, the pulling element **14** extends beyond the protective sleeve **50** so it is available to attach a pulling rope or string, fish-tape, or the like. In this embodiment, pulling element **14** is formed with a pulling loop **16** on the end for easy attachment by the craft. Sleeve **50** is be secured at each end to the cable assembly **10** and is positioned to protect the furcation legs **30** and/or connectors **32** of the assembly. By way of example, sleeve **50** is secured using a heat shrink at each end portion. As shown, a first end of the sleeve covers a portion of the furcation body **50** and the pulling loop extends beyond the second end of the sleeve **50**.

[0029] Of course, other methods are available for creating one or more furcation bodies on fiber optic cables. The preparation and installation of furcation bodies **50** on other fiber optic cable constructions may vary depending on cable construction involved, but essentially produce a similar furcation body **50** attached to an end of the fiber optic cable having one or more furcation legs extending from the furcation body. By way of example, furcation bodies can be made using an overmolded process or the like.

[0030] **FIGS. 19-24** show an alternative explanatory method for preparing a portion of the fiber optic cable assembly from a different design of a fiber optic cable **16'**. Although, the concepts of the present application are below are described below are shown with a cable configuration having individual subunits within the cable jacket **24**, the concepts of the pulling grip may be used with any suitable fiber optic cable. As used herein, a subunit cable has several smaller cable units disposed within the larger fiber optic cable and the subunits can each form a furcation leg **30** of the fiber optic cable assembly as desired.

[0031] Similar to the previous fiber optic cable assembly, the finished fiber optic cable assembly includes pulling element **14** extending from furcation body **50** and being formed from strength members **22** of the fiber optic cable **16'**. In other words, the pulling

grip **12** of the finished cable assembly includes the pulling element **14** formed from at least one strength member **22** of the fiber optic cable 16' and extends beyond one or more furcation legs **30** when a protective sleeve **50** of pulling grip **12** is installed on the cable assembly such as shown in **FIG. 1**. As best shown in **FIG. 19**, fiber optic cable **16'** includes at least one optical fiber **20**, at least one strength member **22**, and a cable jacket **24**. Fiber optic cable **16'** has optical fibers **20** disposed within one or more subunits of the cable that includes a subunit jacket (not numbered) with strength members (not visible) therein that respectively forms individual furcation legs **30**. Fiber optic cable **16'** can include any suitable optical fibers in any suitable configuration such as loose fibers, buffered, ribbonized or the like. Likewise, fiber optic cable **16'** can have any suitable strength member such as fiberglass, aramid yarns such as Kevlar®, or even a glass-reinforced plastic (GRP) depending on the desired cable design.

[0032] The pulling element **14** is formed from the strength members **22** of fiber optic cable **16'** disposed outward of the individual furcation legs **30** that are exposed after cutting a portion of cable jacket **24**. As illustrated in **FIG. 19**, preparing the fiber optic cable **16'** includes removing a portion of the cable jacket **24** from an end portion **18** of the fiber optic cable **16'**, thereby exposing end portions of the subunits that will form furcation legs **30** and the strength member end portions **21** from the end of the cable. By way of non-limiting example, a suitable length of cable jacket such as between twenty-four to thirty-six inches of the cable jacket **24** may be removed from the end portion **18** of the fiber optic cable **16**; however, other suitable longer or shorter lengths are possible. As before, a ring cutter may be used to remove the end portion of the cable jacket **24** from the end portion **18** of the fiber optic cable **16'**. After the end portion of the cable jacket **24** is removed, the strength member **22** and cable subunits that will form furcation legs **30** are be separated, as illustrated by **FIG. 19**.

[0014] In this embodiment, before the strength members **22** are formed into the pulling element **14**, the strength member end portions **21** may optionally be twisted as illustrated in **FIG. 20**. Twisting the strength member end portions **21** may more easily allow threading of the strength member end portions **21** through a strength member tube, as discussed in more detail below, when forming the pulling element **14**. To prevent the twist disposed in the strength member end portion **21** from unraveling, a portion **50** of the

strength member **22** can be secured with tape **52** or other securing means, as illustrated in **FIG. 21**. As an option, the strength member **22** may be taped to a rod to secure the strength member **22** prior to taping or securing the portion **50**. A first end **54** of the strength member end portion **21** adjacent the tape **52** can then be cut to provide the strength member end portion **21** in the desired length prior to forming the pulling element **14**.

[0015] Before forming the pulling element **14** from the strength member end portion **21**, it may be desired to optionally dispose the strength member end portion **21** into a strength member tube **56**, as illustrated in **FIGS. 22** and **23**. The strength member tube **56** may serve to protect the strength members **22** from damage when a pulling load is placed on the pulling element formed from the strength member end portion **21**. For example, the strength member tube **56** may be a heat shrink tube that is heat shrunk around the strength member end portion **21** to firmly secure the strength member tube **56** around the strength member end portion **21**. **FIG. 22** illustrates the strength member end portion **21** from **FIG. 21** prior to being inserted into the strength member tube **56**. Unlike the previous fiber optic cable **16**, fiber optic cable **16'** uses a separate, discrete component for covering the strength members, whereas fiber optic cable **16** used the portion of the cable jacket that was ring cut.

[0016] **FIG. 23** illustrates disposing the strength member tube **56** over the strength member end portion **21** and sliding the strength member tube **56** back towards the end portion **18** of the fiber optic cable **16**. Providing the strength member tube **56** is optional and maybe used as desired. Likewise, the strength member tube **56** can be any suitable tube; although a heat shrink tube is one preferred way of protecting the strength members **22**.

[0017] By way of example, **FIG. 24** illustrates the strength member tube **56** after being heat shrunk onto the strength members **22**. As one non-limiting example, the strength member tube **56** in **FIGS. 22** and **23** may be heated to a temperature between 100 and 200 degrees Celsius for between two (2) and four (4) minutes to heat shrink and secure the strength member tube **56** to the strength members **22**. The optical fibers **26** (or fiber sub-units) can be bent back towards the cable jacket **24** to keep them out of the way as illustrated in **FIG. 24** as desired. Next, the furcation body **50** can be formed about end

portion **18** using a preformed furcation body filled with an epoxy or the like and the ends of fucation legs can be terminated with fiber optic connectors to complete the cable assembly. Thereafter, the pulling loop **16** can be formed on pulling element **14** and the protective sleeve **50** is disposed directly about a portion of the cable assembly and securing the protective sleeve **50** so it has a non-cinch configuration about the cable assembly.

[0018] Although the disclosure has been illustrated and described herein with reference to preferred embodiments and specific examples thereof, it will be readily apparent to those of ordinary skill in the art that other embodiments and examples can perform similar functions and/or achieve like results. All such equivalent embodiments and examples are within the spirit and scope of the disclosure and are intended to be covered by the appended claims. It will also be apparent to those skilled in the art that various modifications and variations can be made without departing from the spirit and scope of the claims.

We claim:

1. A cable assembly having a pulling grip, the cable assembly comprising:

a cable having at least one optical fiber, at least one strength member, and a cable jacket, wherein a furcation body is attached to an end of the cable and one or more furcation legs extend from the furcation body;

a pulling element formed from the at least one strength member of the cable, wherein the pulling element extends beyond one or more furcation legs and includes a pulling loop; and

a protective sleeve disposed directly about a portion of the cable assembly, wherein the protective sleeve has a non-cinch configuration about the cable assembly.

2. The cable assembly of claim 1, wherein the protective sleeve comprises a mesh.

3. The cable assembly of any of claims 1 or 2, wherein the at least one strength member of the cable forms a portion of the pulling loop.

4. The cable assembly of any of claims 1-3, wherein the at least one strength member of the cable is twisted for forming a portion of the pulling loop.

5. The cable assembly of any of claims 1-4, wherein the at least one strength member of the cable is an aramid yarn.

6. The cable assembly of any of claims 1-5, wherein a first end of the protective sleeve covers a portion of the furcation body and the pulling loop extends beyond the second end of the protective sleeve.

7. The cable assembly of any of claims 1-6, one or more of the furcation legs being formed from a subunit of the cable.

8. The cable assembly of any of claims 1-7, wherein the protective sleeve is in contact with a portion of the cable assembly.

9. The cable assembly of any of claims 1-8, wherein the furcation body has a first tube disposed within a second tube.

10. The cable assembly of any of claims 1-9, wherein the assembly does not include a protective tube disposed about the one or more furcation legs within the protective sleeve.

11. A method of forming a cable assembly having a pulling grip, comprising the steps of:

providing a cable having at least one optical fiber, at least one strength member, and a cable jacket, wherein a furcation body is attached to an end of the cable and one or more furcation legs extends from the furcation body;

forming a pulling element from the at least one strength member of the cable so that the pulling element extends beyond the one or more furcation legs and includes a pulling loop; and

positioning a protective sleeve directly about a portion of the cable assembly and securing the protective sleeve so it has a non-cinch configuration about the cable assembly.

12. The method of claim 11, further including the step of twisting a portion of the at least one strength member that forms the pulling loop.

13. The method of any of claims 11 or 12, further including the step of forming a portion of the pulling loop from the at least one strength member of the cable.

14. A fiber optic cable assembly, comprising:

a cable having at least one optical fiber, at least one strength member, and a cable jacket, wherein a furcation body is attached to an end of the cable and one or more furcation legs extend from the furcation body;

wherein the furcation body includes a first tube disposed within a second tube, wherein the first tube is potted for securing and potting the optical fibers.

15. The fiber optic cable assembly of claim 14, further including a pulling element formed from the at least one strength member of the cable, wherein the pulling element extends beyond one or more furcation legs and includes a pulling loop; and

a protective sleeve disposed directly about a portion of the cable assembly, wherein the protective sleeve has a non-cinch configuration about the cable assembly.

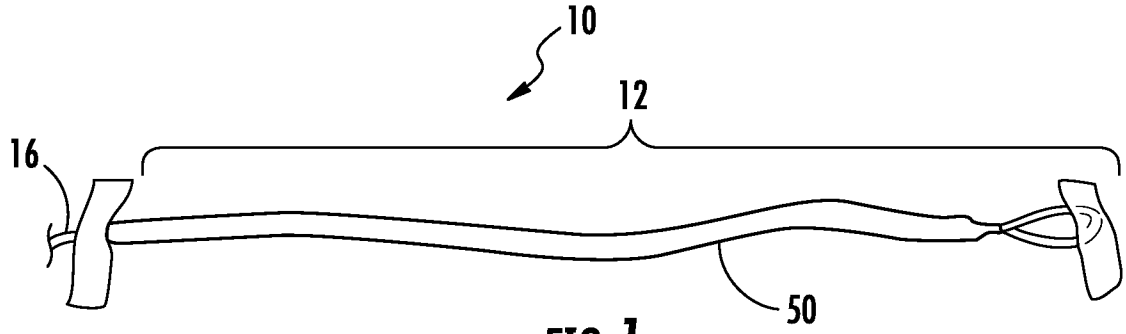

FIG. 1

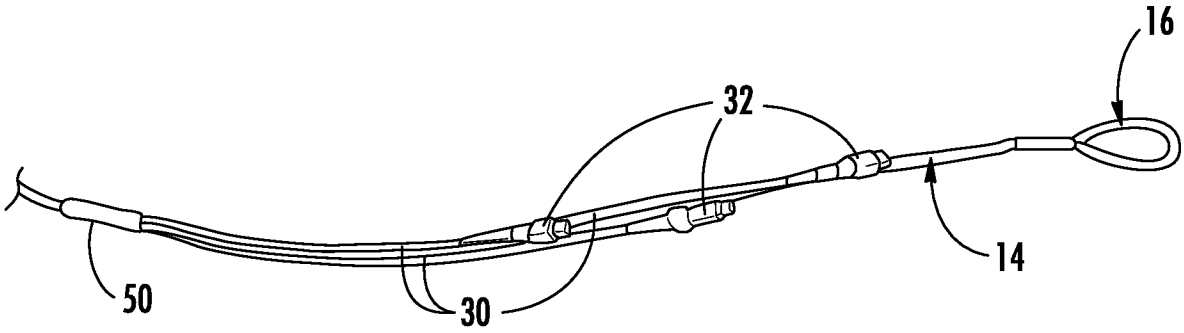

FIG. 2

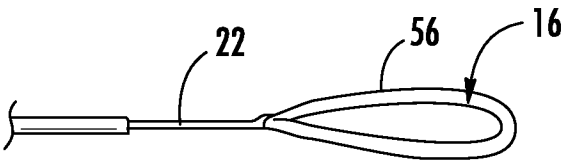

FIG. 17

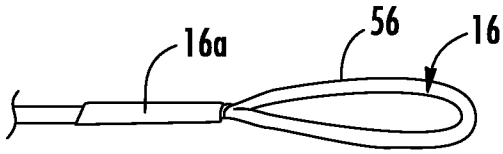

FIG. 18

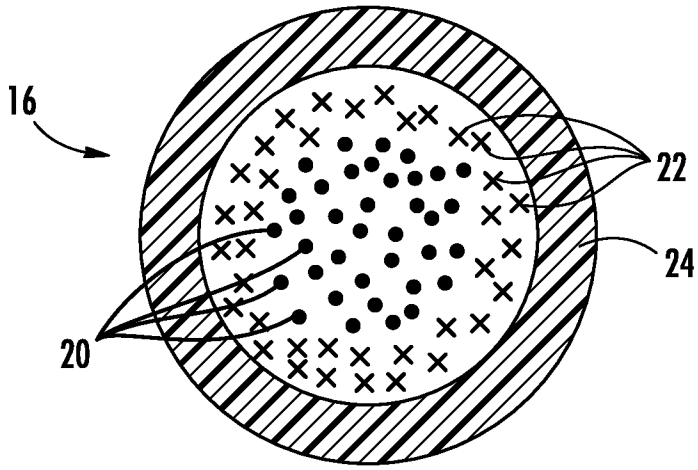

FIG. 3

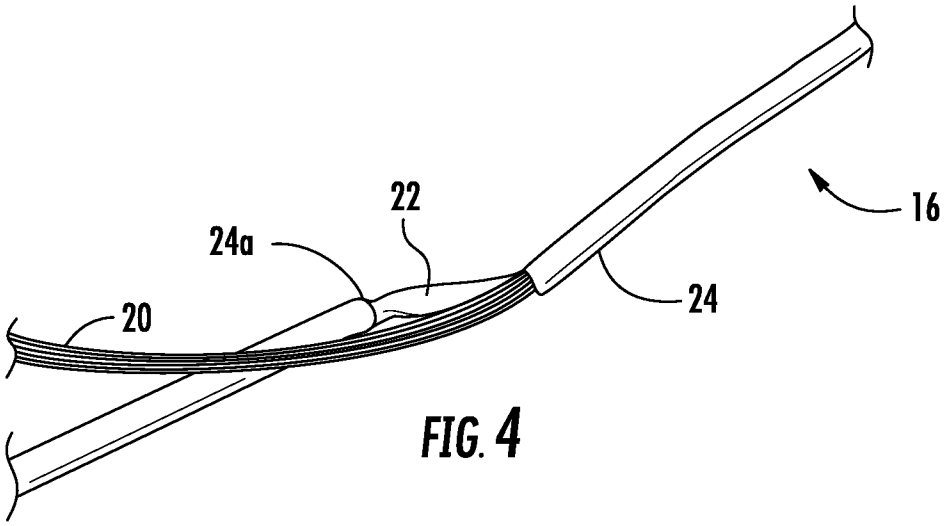

FIG. 4

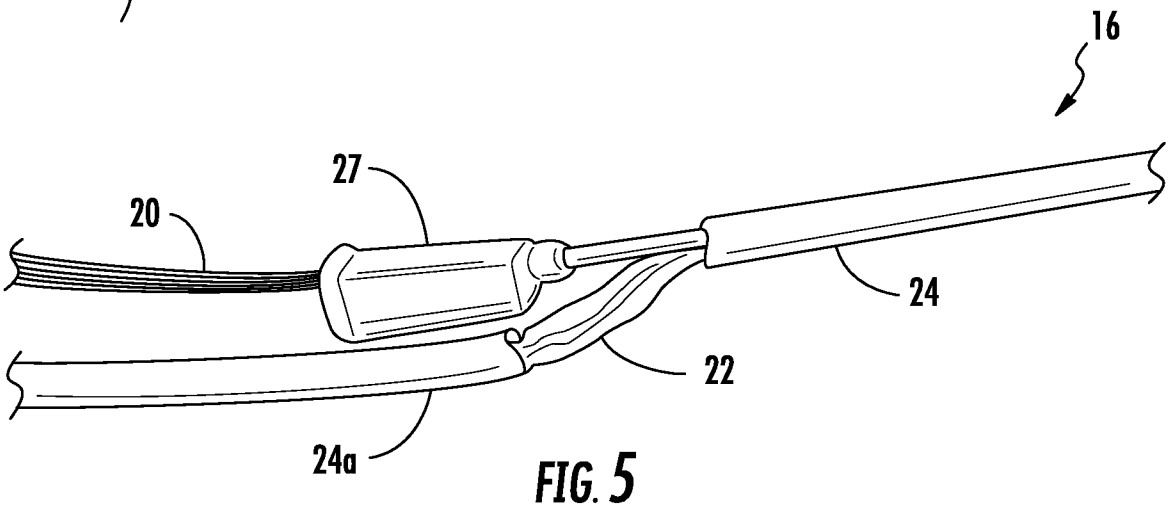

FIG. 5

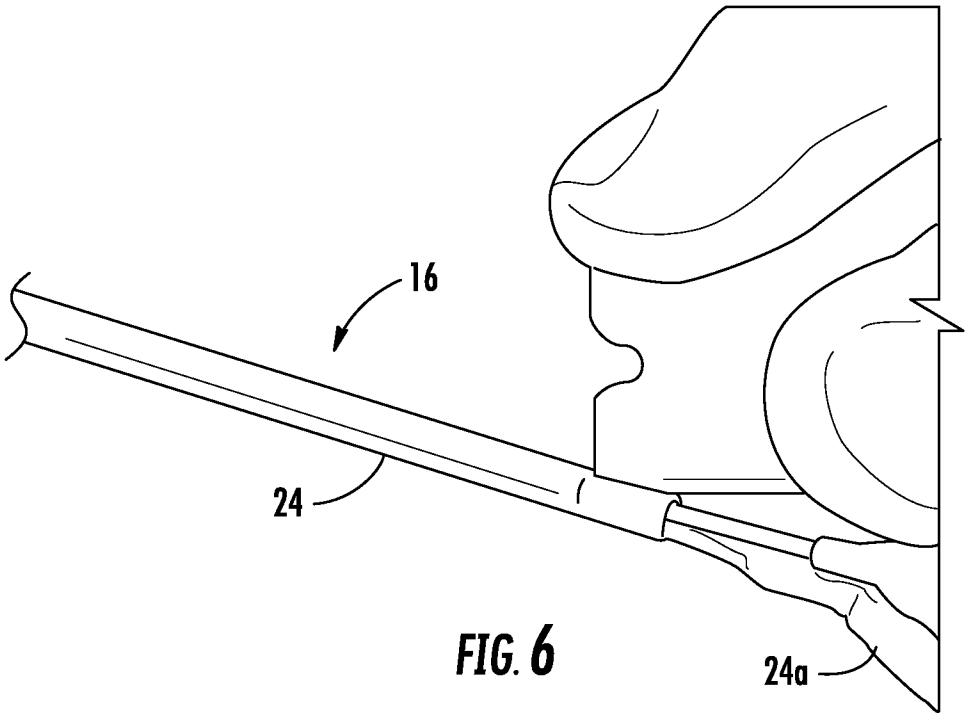

FIG. 6

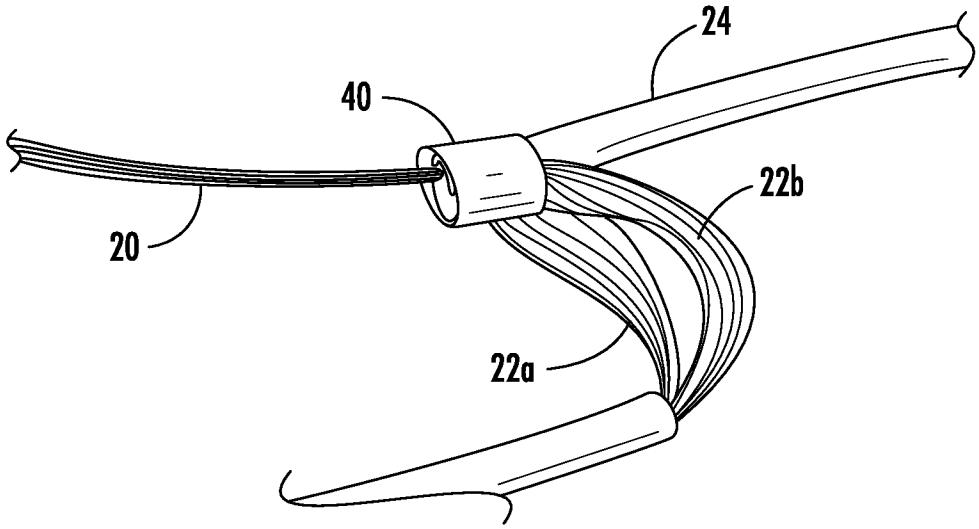

FIG. 7

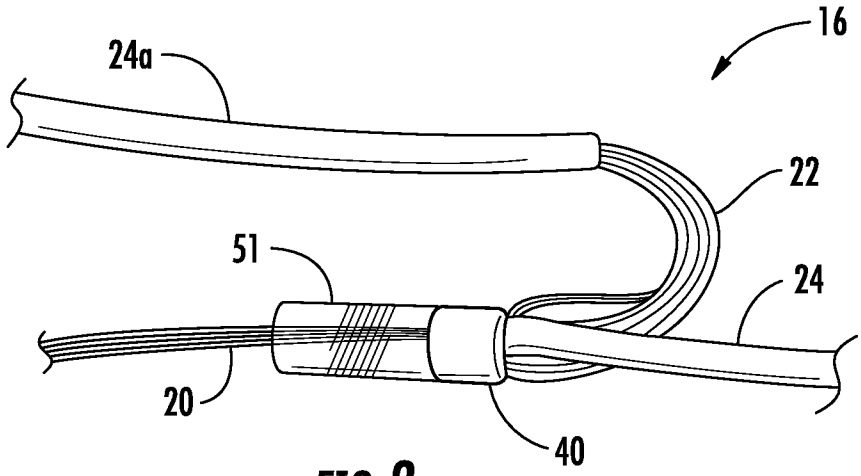

FIG. 8

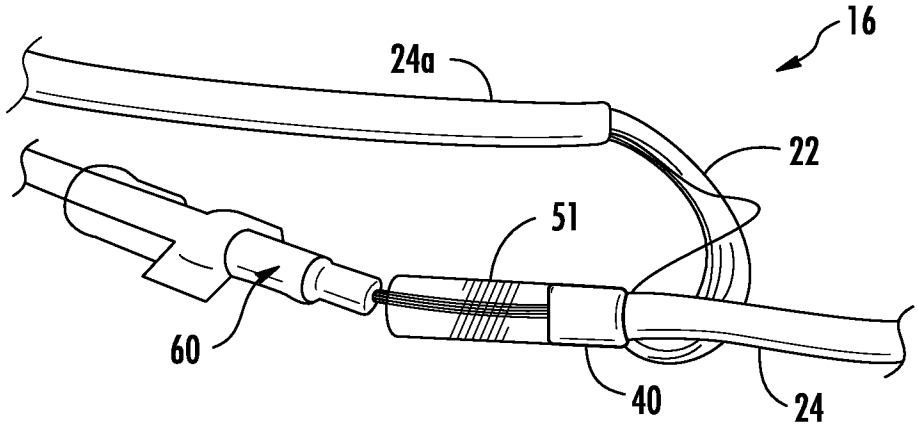

FIG. 9

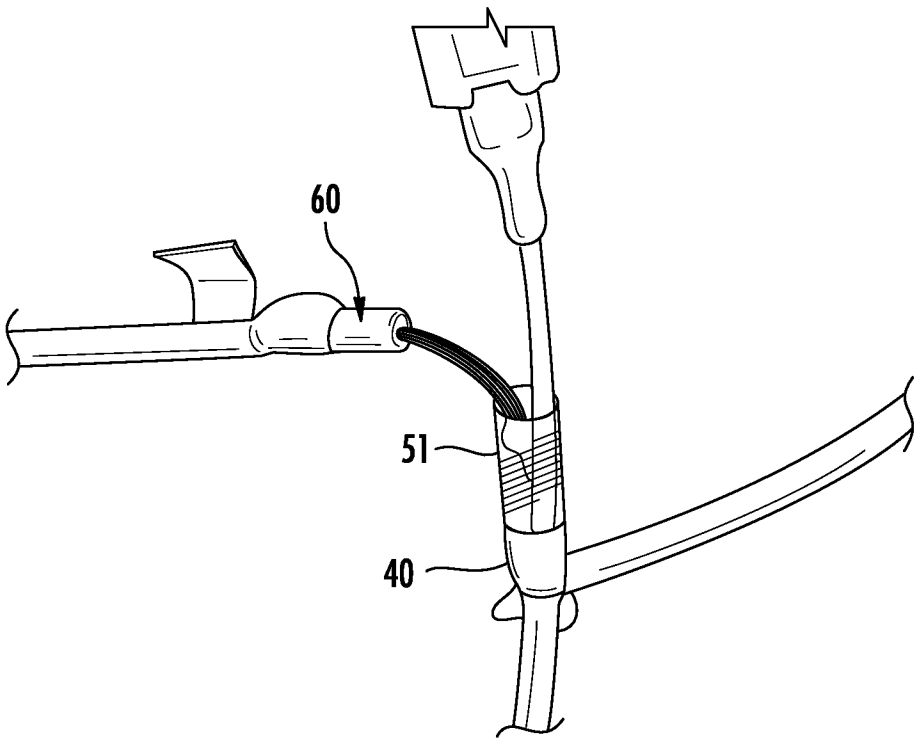

FIG. 10

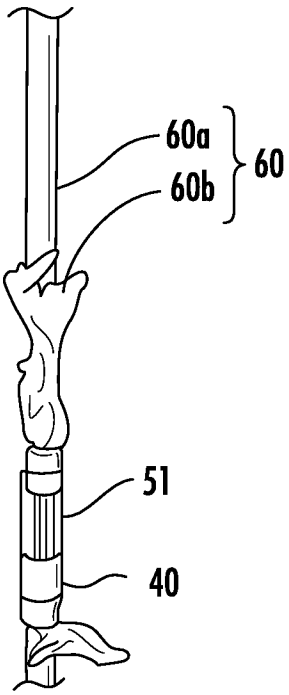

FIG. 11

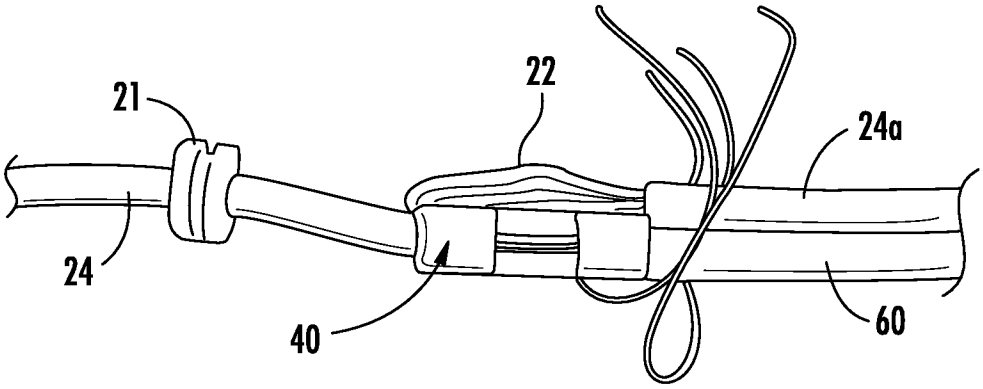

FIG. 12

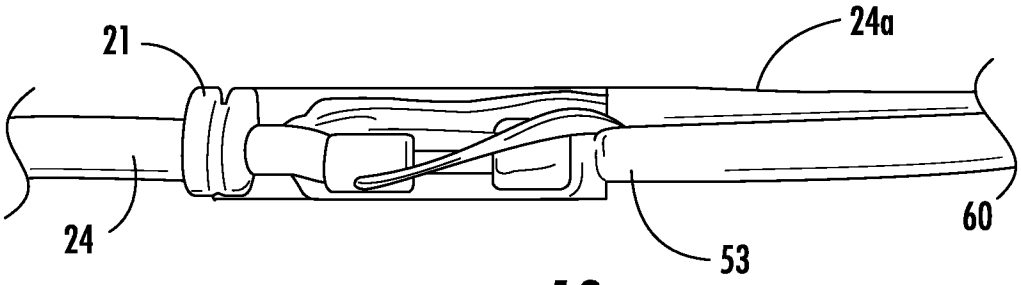

FIG. 13

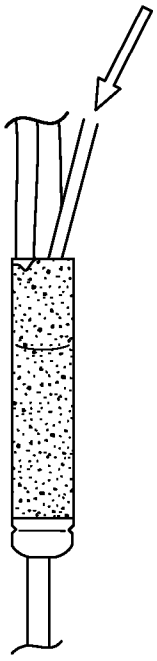

FIG. 14

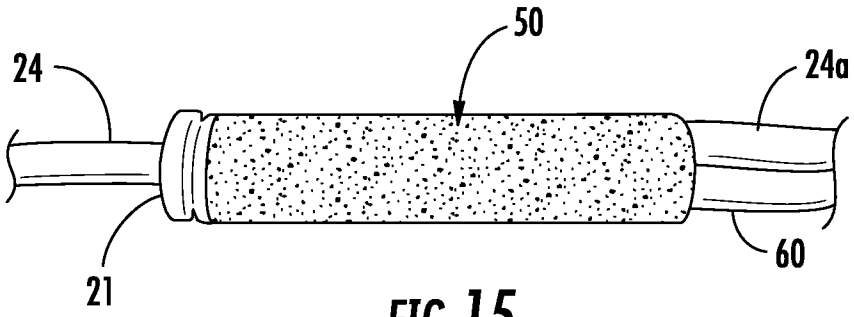

FIG. 15

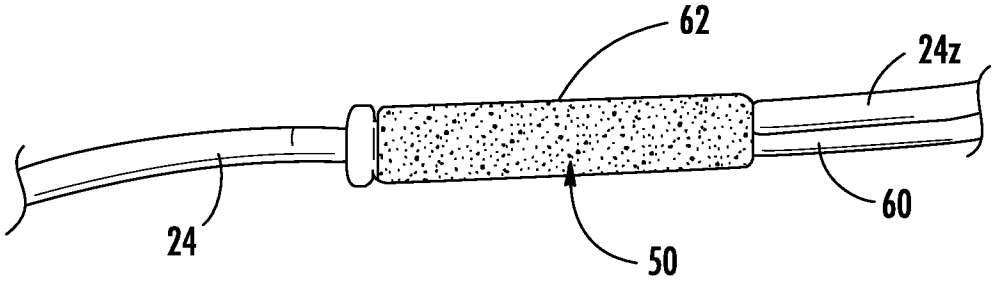

FIG. 16

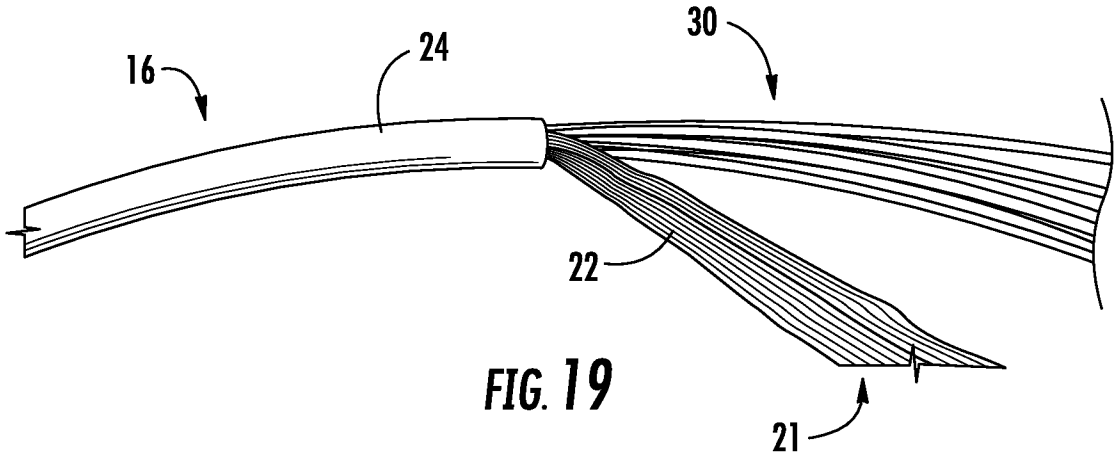

FIG. 19

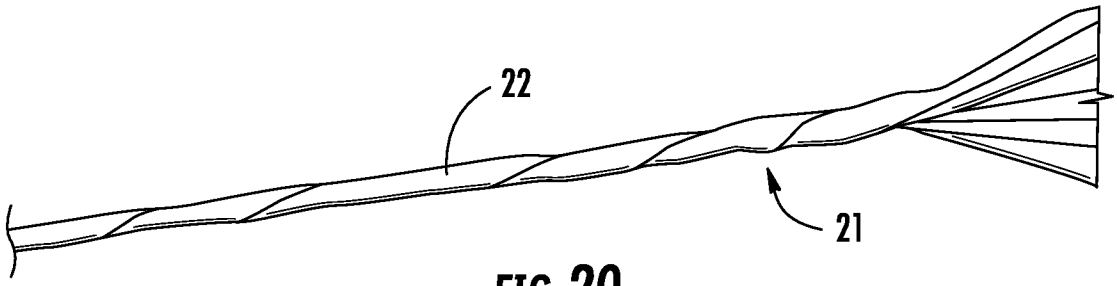

FIG. 20

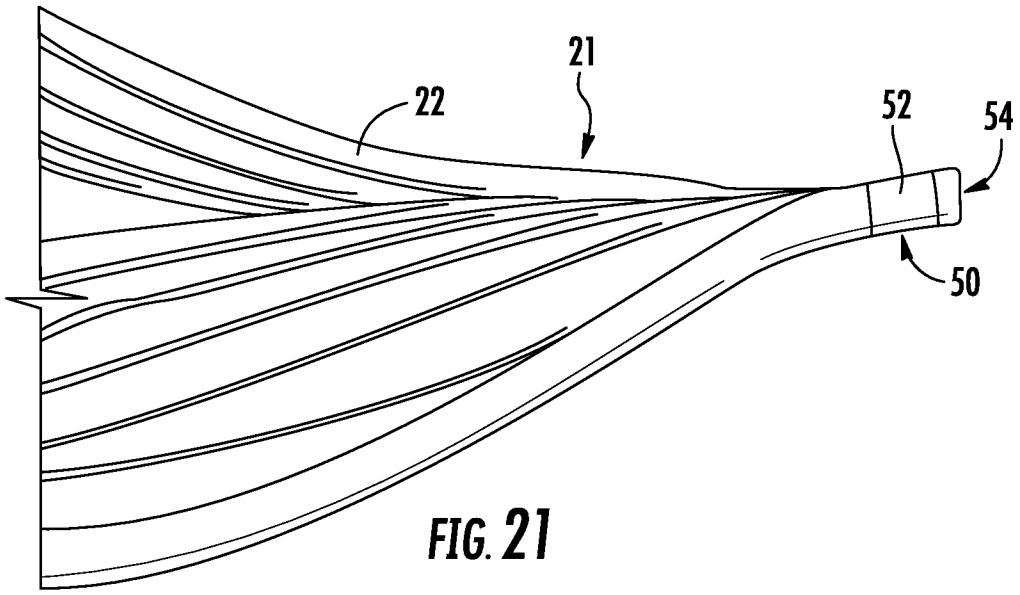

FIG. 21

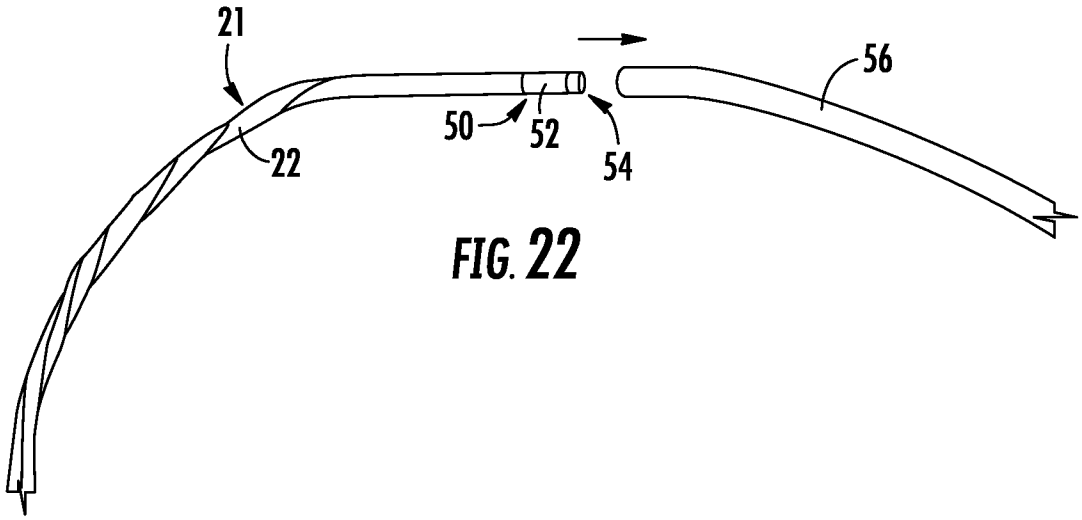

FIG. 22

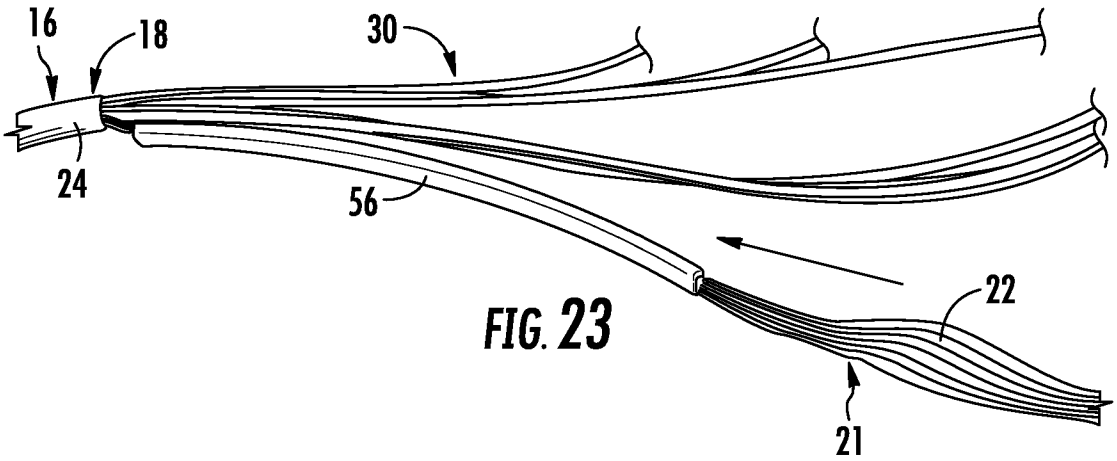

FIG. 23

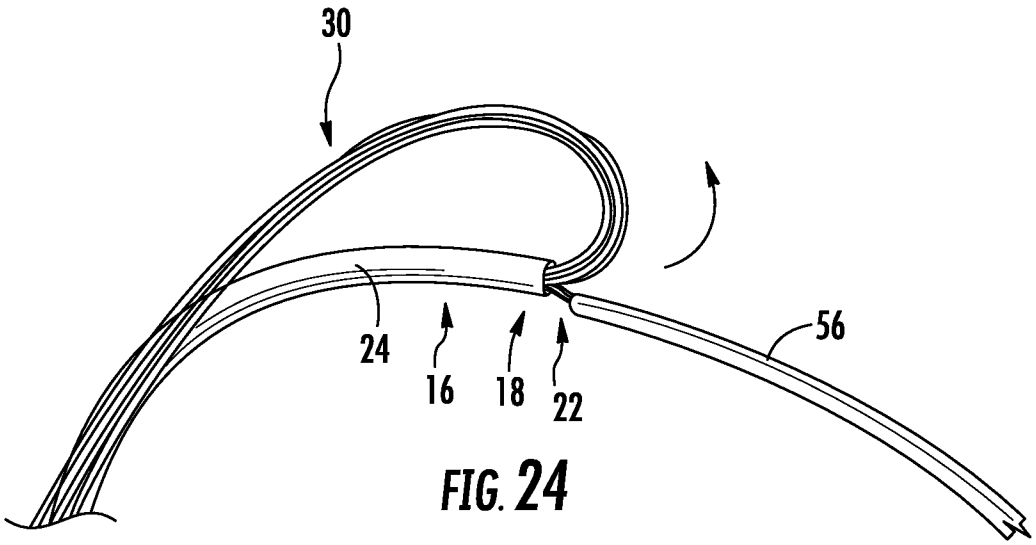

FIG. 24

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/022364

A. CLASSIFICATION OF SUBJECT MATTER
INV. G02B6/44
ADD.

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 practicable, 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.
X Y	JP 2002 333561 A (MITSUBISHI CABLE IND LTD) 22 November 2002 (2002-11-22) figure 2 figure 9 paragraph [0018] - paragraph [0032] -----	1,3-8, 10-13 2
Y	US 5 480 203 A (FAVALORA MARK L [US] ET AL) 2 January 1996 (1996-01-02) column 5, line 11 - line 15 -----	2

☐ Further documents are listed in the continuation of Box C.

☒ 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 application or patent 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
19 April 2013	08/07/2013

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	Orignac, Xavier

1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/022364

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-8, 10-13

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-8, 10-13

a cable assembly having a pulling grip, the cable assembly comprising:
a cable having at least one optical fiber, at least one strength member, and a cable jacket, wherein a furcation body is attached to an end of the cable and one or more furcation legs extend from the furcation body;
a pulling element formed from the at least one strength member of the cable, wherein the pulling element extends beyond one or more furcation legs and includes a pulling loop; and
a protective sleeve disposed directly about a portion of the cable assembly, wherein the protective sleeve has a non-cinch configuration about the cable assembly, characterised in that the protective sleeve comprises a mesh.

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2. claims: 9, 14, 15

a fiber optic cable assembly, comprising:a cable having at least one optical fiber, at least one strength member, and a cable jacket, wherein a furcation body is attached to an end of the cable and one or more furcation legs extend from the furcation body;characterised in that the furcation body includes a first tube disposed within a second tube, wherein the first tube is potted for securing and potting the optical fibers.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2013/022364

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2002333561 A	22-11-2002	JP 4087579 B2	21-05-2008
		JP 2002333561 A	22-11-2002
US 5480203 A	02-01-1996	CA 2136280 A1	19-07-1995
		US 5480203 A	02-01-1996