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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
13 September 2007 (13.09.2007)

PCT

(10) International Publication Number
WO 2007/103439 A2

(51) International Patent Classification:
G02B 6/44 (2006.01)

(21) International Application Number: PCT/US2007/005837

(22) International Filing Date: 6 March 2007 (06.03.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

60/781,622	9 March 2006 (09.03.2006)	US
11/491,428	21 July 2006 (21.07.2006)	US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, 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, 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, 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, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, 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:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: MID-SPAN BREAKOUT WITH HELICAL FIBER ROUTING

(57) Abstract: A mid-span breakout arrangement includes a distribution cable and a tether cable. The distribution cable has a breakout access location. The tether cable is secured to the distribution cable adjacent the breakout access location. The breakout further includes at least one length of optical fiber helically wrapped around the distribution cable along the breakout access location. The length of optical fiber is coupled to the distribution cable and to the tether cable.

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MID-SPAN BREAKOUT WITH HELICAL FIBER ROUTING

Technical Field

The principles disclosed herein relate to fiber optic cable systems. More particularly, the present disclosure relates to fiber optic cable systems having main cables and branch cables.

Background of the Invention

Passive optical networks are becoming prevalent in part because service providers want to deliver high bandwidth communication capabilities to customers. Passive optical networks are a desirable choice for delivering high-speed communication data because they may not employ active electronic devices, such as amplifiers and repeaters, between a central office and a subscriber termination. The absence of active electronic devices may decrease network complexity and/or cost and may increase network reliability.

Figure 1 illustrates a network 100 deploying passive fiber optic lines. As shown in figure 1, the network 100 may include a central office 110 that connects a number of end subscribers 115 (also called end users 115 herein) in a network. The central office 110 may additionally connect to a larger network such as the Internet (not shown) and a public switched telephone network (PSTN). The network 100 may also include fiber distribution hubs (FDHs) 130 having one or more optical splitters (e.g., 1-to-8 splitters, 1-to-16 splitters, or 1-to-32 splitters) that generate a number of individual fibers that may lead to the premises of an end user 115. The various lines of the network can be aerial or housed within underground conduits (e.g., see conduit 105).

The portion of network 100 that is closest to central office 110 is generally referred to as the F1 region, where F1 is the "feeder fiber" from the central office. The F1 portion of the network may include a distribution cable having on the order of 12 to 48 fibers; however, alternative implementations may include fewer or more fibers. The portion of network 100 that includes an FDH 130 and a number of end users 115 may be referred to as an F2 portion of network 100. Splitters used in an FDH 130 may accept a feeder cable having a number of fibers and may split those incoming fibers into, for example, 216 to 432 individual distribution fibers that may be associated with a like number of end user locations.

Referring to Figure 1, the network 100 includes a plurality of breakout locations 125 at which branch cables (e.g., drop cables, stub cables, etc.) are separated out from main cables (e.g., distribution cables). Breakout locations can also be referred to as tap locations or branch locations and branch cables can also be referred to as breakout cables. At a breakout location, fibers of the branch cables are typically spliced to selected fibers of the main cable.

Branch cables can manually be separated out from a main cable in the field using field splices. Field splices are typically housed within sealed splice enclosures. Manual splicing in the field is time consuming and expensive. In some prior systems, the spliced fibers are positioned to lay straight on one side of the distribution cable. Bending of the distribution cable can cause the fiber to stretch or relax depending on orientation. Bending can cause either fiber breakage or excessive insertion loss due to macrobending.

Stub cables are typically branch cables that are routed from breakout locations to intermediate access locations such as a pedestals, drop terminals or hubs. Intermediate access locations can provide connector interfaces located between breakout locations and subscriber locations. A drop cable is a cable that typically forms the last leg to a subscriber location. For example, drop cables are routed from intermediate access locations to subscriber locations. Drop cables can also be routed directly from breakout locations to subscriber locations hereby bypassing any intermediate access locations.

Summary of the Invention

Certain aspects of the disclosure relate to mid-span breakout configurations for pre-terminated fiber optic distribution cables.

A variety of additional inventive aspects will be set forth in the description that follows. The inventive aspects can relate to individual features and to combinations of features. It is to be understood that both the forgoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the broad inventive concepts upon which the embodiments disclosed herein are based.

Brief Description of the Drawings

Figure 1 shows a prior art passive fiber optic network;

Figure 2 shows an example of the distribution cable including six separate buffer tubes each containing twelve fibers;

Figure 3 depicts an example tether as having a flat cable configuration;

Figure 4 illustrate a mid-span breakout location on the distribution cable of Figure 2;

Figure 5 illustrates optical fibers wrapping around the buffer tubes of the distribution cable at the mid-span breakout location of Figure 4;

Figure 6 illustrates the optical fibers wrapping around the buffer tubes of the distribution cable along a helical path in a fiber guide at the mid-span breakout location of Figure 4;

Figure 7 illustrates a protective sleeve covering the breakout location of Figure 4; and

Figure 8 illustrates an over-mold enclosing and sealing the protective sleeve of Figure 7.

Detailed Description of the Preferred Embodiment

The present disclosure relates to mid-span breakout arrangements provided on distribution cables. In particular, the present disclosure relates to a mid-span breakout arrangement including optical fibers helically wound around the distribution cable.

Referring now to the figures in general, a typical distribution cable includes a relatively large number of fibers (e.g., 72, 144 or more fibers). The fibers are typically segregated into separate groups with each group contained within a separate buffer tube. For example, Figure 2 shows an example of the distribution cable 220 including six separate buffer tubes 222 each containing twelve fibers 224. The buffer tubes 222 may be gel filled. The distribution cable 220 also includes a central strength member 226 for reinforcing the cable 220, and an outer strength member 228 such as Kevlar for also reinforcing the cable. The distribution cable 220 further includes an outer jacket 230 that encloses the buffer tubes 222. Ripcords 232 can be provided for facilitating tearing away portions of the jacket 230 to access the fibers 224 within the jacket 230. While distribution cables typically have a large number of fibers, the various aspects of the present disclosure are also applicable to distribution cables having fewer numbers of fibers (e.g., 2 or more fibers).

A typical mid-span breakout location is provided at an intermediate point along the length of a distribution cable. Commonly a tether (e.g., a drop cable or a stub cable) branches out from the distribution cable at the breakout location. The tether cable most commonly has a fewer number of fibers as compared to the number of fibers provided within the distribution cable. In an example embodiment, the tether has no more than twelve fibers. The tether includes fibers that extend between first and second ends. The first ends of the tether fibers are preferably spliced to selected fibers of the distribution cable at the breakout location. The second ends of the tether fibers can be either connectorized or unconnectorized.

For example, Figure 3 depicts an example tether 242 as having a flat cable configuration. The flat cable configuration includes a central buffer tube 262 containing one to twelve fibers (e.g., either loose or ribbonized). Strength members 264 (e.g., flexible rods formed by glass fiber reinforced epoxy) are positioned on opposite sides of the central buffer tube 262. An outer jacket 266 surrounds the strength members 264 and the buffer tube 262. The outer jacket 266 includes an outer perimeter having an elongated transverse cross-sectional shape. An additional strength layer 265 (e.g., Kevlar) can be positioned between the buffer tube 262 and the outer jacket 266. As shown at Figure 3, the transverse cross-sectional shape includes oppositely positioned, generally parallel sides 268 interconnected by rounded ends 270.

Referring now to Figure 4, fibers from the tether 242 are connected to fibers from the distribution cable 220 at a mid-span breakout location 241. A breakout assembly 240 is positioned at the mid-span breakout location 241 on the distribution cable 220. A tether 242 branches outwardly from the distribution cable 220 at the mid-span breakout location 241. When the tether 242 is secured to the distribution cable 220, the tether 242 should preferably be able to withstand a pullout force of at least 100 pounds. To meet this pullout force requirement, a retention block 258 is used to strengthen the mechanical interface between the tether 242 and the distribution cable 220.

The breakout location 241 shown in Figure 4 includes a splice location 244 where selected fibers 224_{dc} of the distribution cable 220 (e.g., typically less than twelve fibers) are spliced to corresponding fibers 224_t of the tether 242. The breakout assembly 240 includes a splice sleeve 246 positioned over the spliced fibers, and a splice holder 248 configured to secure the splice sleeve 246 to the distribution cable 220.

Referring now to Figures 5 and 6, the spliced optical fibers 224_{dc}, 224_t are wrapped around the distribution cable 220 to lessen the fiber path length difference during bending of the distribution cable 220. Wrapping the optical fibers 224_{dc}, 224_t in this way can inhibit fiber breakage and insertion loss. In some embodiments, the optical fibers 224_{dc}, 224_t are helically wrapped around the distribution cable after being connected together. In other embodiments, each set of optical fibers 224_{dc}, 224_t is first wrapped around an appropriate section of the distribution cable 220 and then connected to one another.

In some embodiments, as shown in Figure 6, the breakout arrangement 240 includes fiber guides 250A, 250B that direct the fibers 224_{dc} and 224_t to wrap around the distribution cable 220 in a helical pattern. In some embodiments, the fiber guides 250A, 250B include tubes having precut grooves or slits. The grooves or slits extend in a helical or other suitable pattern around the tubes. Examples of materials that can be used to form the fiber guides 250A, 250B include plastic, rubber, polyurethane, polyvinylchloride, resin, and other such suitable materials. In other embodiments, the fiber guides 250A, 250B include strips of material helically wrapped around the distribution cable 220.

Referring to Figures 7 and 8, the fiber breakout assembly 240 can be sealed and protected from environmental conditions and other contaminants. Figure 7 illustrates a protective sleeve 252 (e.g., a shell) covering the breakout location 241. The spliced fibers 224_{dc}, 224_t are enclosed within the sleeve 252. In some embodiments, one end 254 of the sleeve 252 overlaps the jacket 230 of the distribution cable 220 and the opposite end 256 of the sleeve 252 overlaps the retention block 258 through which the fibers 224_t of the tether 242 pass.

Figure 8 illustrates an over-mold 260 enclosing and sealing the protective sleeve 252 and the retention block 258. In certain embodiments, a wrap of heat resistant tape can provide an intermediate layer between the protective sleeve 252 and the over-mold 260. The protective sleeve 252 and over-mold layer 260 are preferably sufficiently flexible to allow the pre-terminated cable (i.e., the distribution cable 220 with the tethers terminated 242 thereto) to be readily stored on a spool.

Before leaving the factory or manufacturing plant, the breakout location 241 on the distribution cable 220 can be prepared. First two or more ring cuts are provided on the jacket 230 of the distribution cable 220 for facilitating stripping away a portion of the jacket 230. A buffer tube 222 is then selected and two window cuts are made in the selected buffer tube 222. The upstream window location is then used to sever the number of fibers desired to be broken out. The desired number of fibers is then pulled from the buffer tube 222 at the downstream window location 223 (see Figure 5).

The fibers 224_{dc}, 224_{t} can be fused using standard fusion splicing techniques. Once the fibers 224_{dc}, 224_{t} are spliced together, a splice sleeve 246 can be placed over the splice location 241 to protect the splice. To more evenly distribute the fiber path length along the breakout location 241, the splice sleeve 246 and the optical fibers 224_{dc}, 224_{t} are wrapped in a helical pattern around the buffer tubes 226 of the distribution cable 220.

In some embodiments, fiber guides 250A, 250B are installed on the distribution cable 220 to aid in winding the fused optical fibers 224_{dc}, 224_{t}. To install the fiber guides 250A, 250B, in some embodiments, the fiber guides 250A, 250B are wound around the distribution cable 220. In one example embodiment, material is wrapped around the distribution cable 220 leaving a helical groove along the length of the breakout location 241. The spliced fibers 224_{dc}, 224_{t} are laid in the groove by wrapping the splice sleeve 246 around the distribution cable 220. In other embodiments, the distribution cable 220 is fed through tubular fiber guides 250A, 250B until the fiber guides 250A, 250B reach the breakout location 241.

After the splice has been completed and the optical fibers 224_{dc}, 224_{t} have been helically wrapped around the distribution cable 220, the splice can be secured to the distribution cable 220 with a splice holder 248. Thereafter, a protective sleeve 252 or cover is positioned over the breakout location 241. The protective sleeve 252 is sized to extend across the entire length of exposed distribution cable 220 where the jacket 230 has been removed. A trailing end of the protective sleeve 252 overlaps the retention block 258 and a leading end of the protective sleeve 252 overlaps a jacketed portion of the main distribution cable 220.

Once the protective sleeve 252 has been mounted over the exposed portion of distribution cable 220, a heat resistant or insulating tape can be wrapped around the breakout location 241. Thereafter, an over-molding process can be used to apply a sealing (i.e., or over-mold) layer 260 of polymeric material around the exterior of the breakout location 241. Preferably, the over-mold layer 260 extends from a position forward of the leading end of the protective sleeve 252 to a position rearward of the retention block 258. In this manner, the over-mold layer 260 functions to seal and protect the underlying components of the breakout location 241.

The above specification, examples and data provide a complete description of the manufacture and use of the composition of the invention. Since many embodiments of the invention can be made without departing from the spirit and scope of the invention, the invention resides in the claims hereinafter appended.

WE CLAIM:

1. A mid-span breakout arrangement comprising:

a distribution cable having a breakout access location;

a tether cable secured to the distribution cable adjacent the breakout access location; and

at least one length of optical fiber helically wrapped around the distribution cable along the breakout access location, the length of optical fiber being optically coupled to the distribution cable and to the tether cable.

2. The arrangement of claim 1, wherein the length of optical fiber includes an optical fiber from the distribution cable fused to an optical fiber from the tether cable.

3. The arrangement of claim 2, further comprising a retention block adapted to strengthen a mechanical interface between the tether cable and the distribution cable.

4. The arrangement of claim 1, further comprising at least one fiber guide installed on the distribution cable, each fiber guide including a helical path along which the length of optical fiber is arranged.

5. The arrangement of claim 4, wherein the fiber guide includes material wrapped around the distribution cable leaving a helical groove along a length of the breakout location.

6. The arrangement of claim 4, wherein the fiber guide includes a tube having a precut groove.

7. The arrangement of claim 1, further comprising a protective sleeve positioned at the breakout location, the protective sleeve enclosing the length of optical fiber.

8. The arrangement of claim 1, further comprising a heat resistant tape wrapped around the breakout access location.

9. The arrangement of claim 1, further comprising a sealing layer of polymeric material applied around an exterior of the breakout access location.

10. A method comprising:

removing an outer jacket from a distribution cable at a breakout location;

accessing an optical fiber from the distribution cable;

fusing the optical fiber from the distribution cable to an optical fiber of a tether cable to form a fused length of optical fiber; and

helically wrapping the fused length of optical fiber around the distribution cable.

11. The method of claim 10, further comprising:

positioning a protective sleeve around the fused length of optical fiber.

12. The method of claim 10, further comprising:

applying a sealing layer of polymeric material applied around an exterior of the breakout access location.

13. The method of claim 10, wherein removing the outer jacket of the distribution cable includes stripping the outer jacket to form a stripped region, wherein the fused length of optical fiber is helically wrapped around the stripped region.

14. The method of claim 10, wherein the distribution cable includes buffer tubes, and wherein the fused length of optical fiber is wrapped helically around the buffer tubes.

15. The method of claim 10, further comprising:

installing a retention block onto the distribution cable.

16. The method of claim 1, further comprising:

installing at least one fiber guide on the distribution cable, each fiber guide including a helical path along which the fused length of optical fiber is arranged.

17. The method of claim 16, wherein installing the fiber guide includes wrapping material around the distribution cable to leave a helical groove along a length of the breakout location.

18. The method of claim 16, wherein installing the fiber guide includes installing a tube around buffer tubes of the distribution cable, the tube having a precut, helical groove.

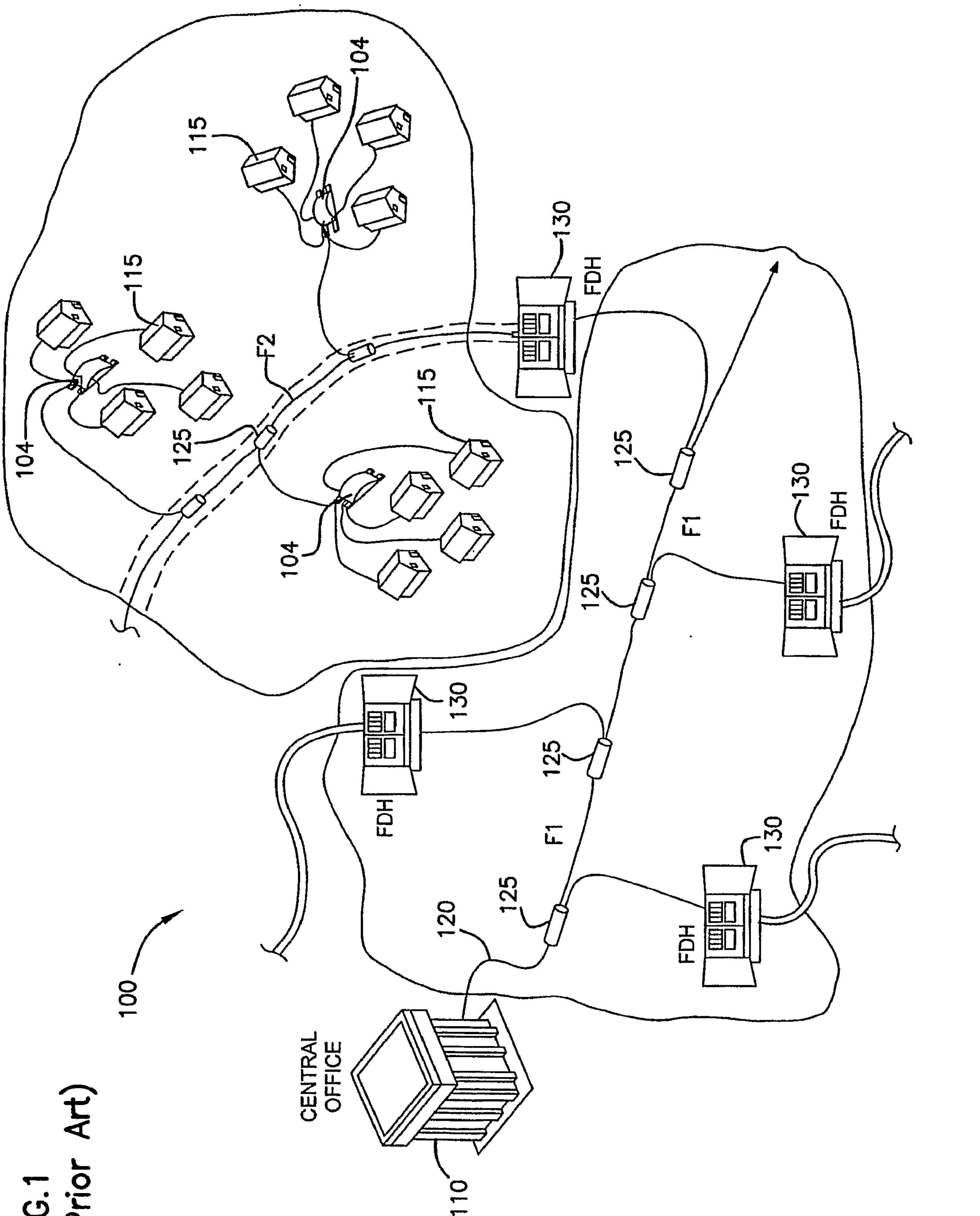
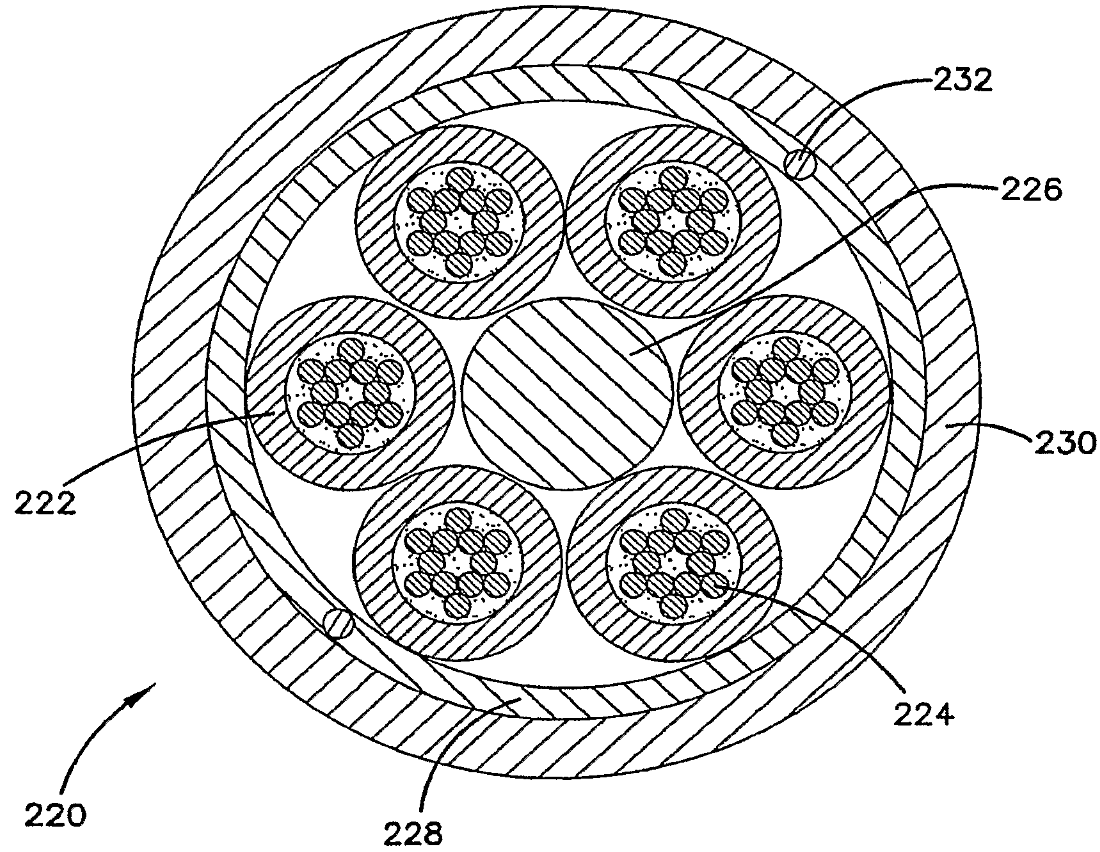


FIG.1
(Prior Art)

FIG.2



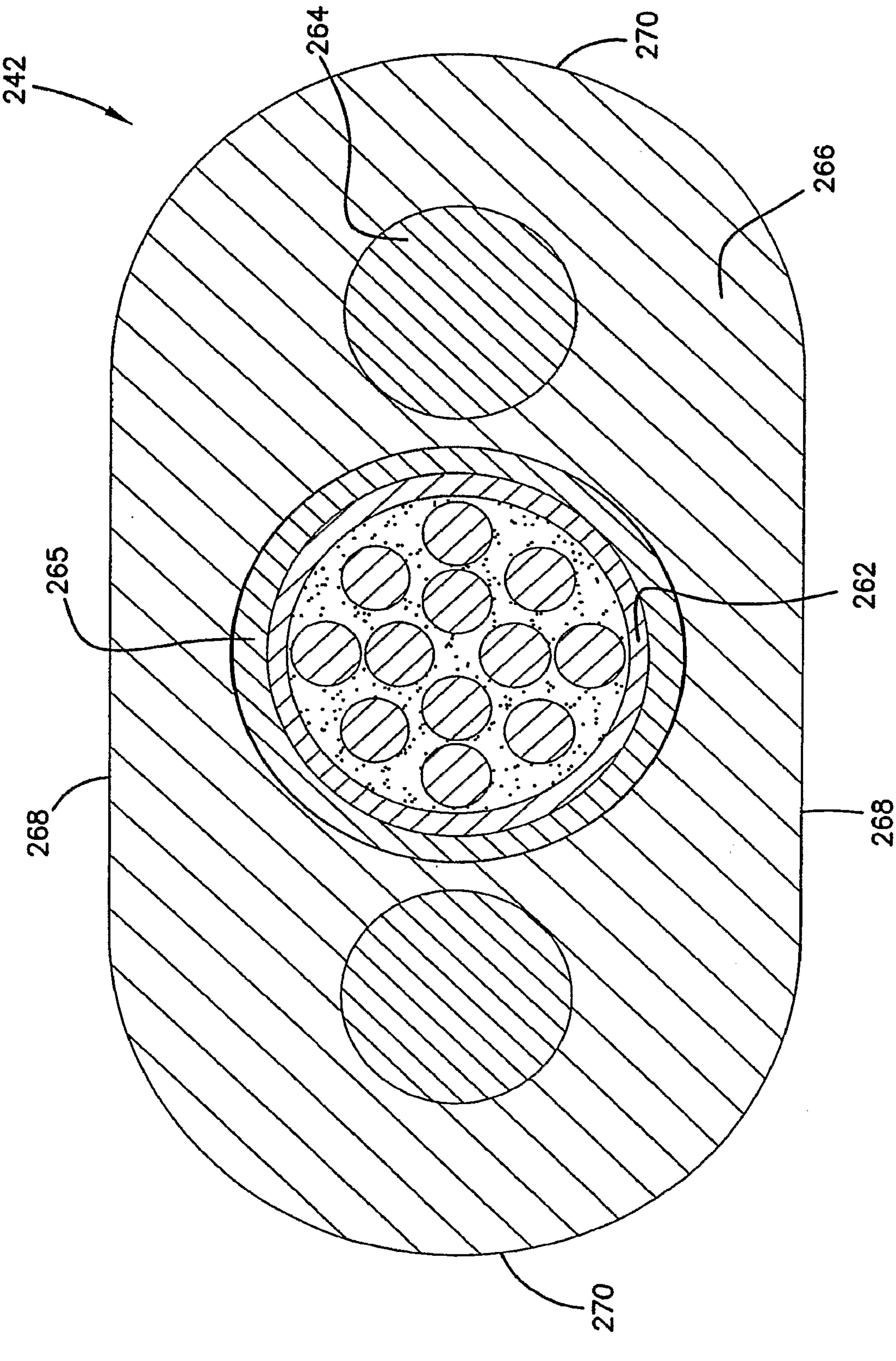


FIG.3

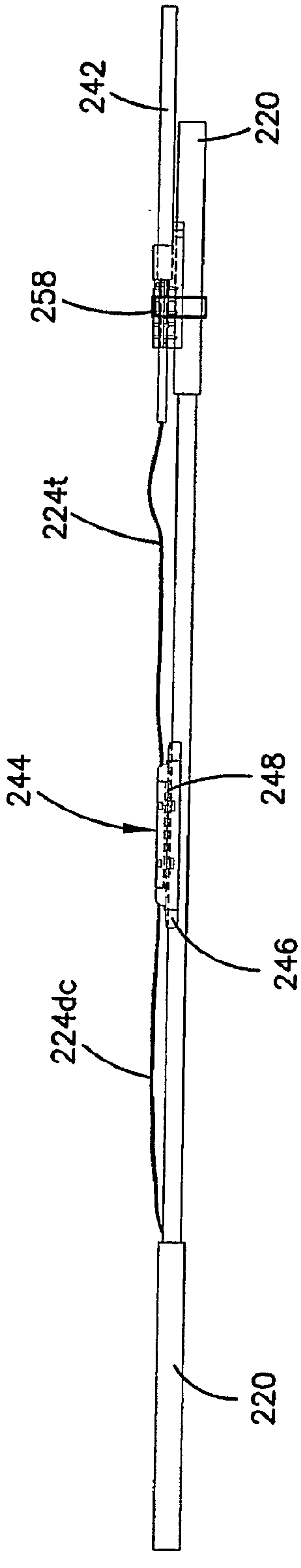


FIG.4

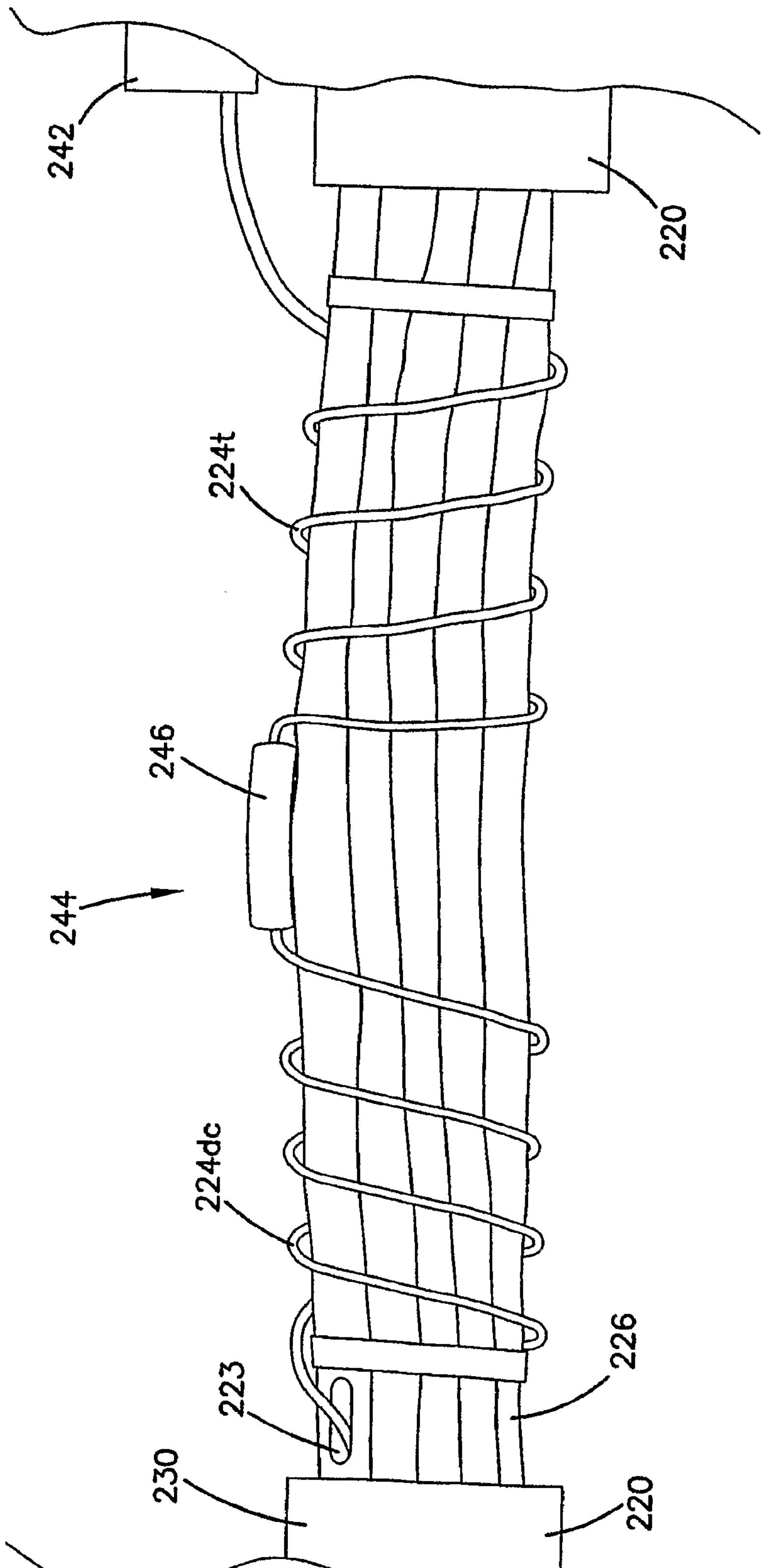


FIG.5

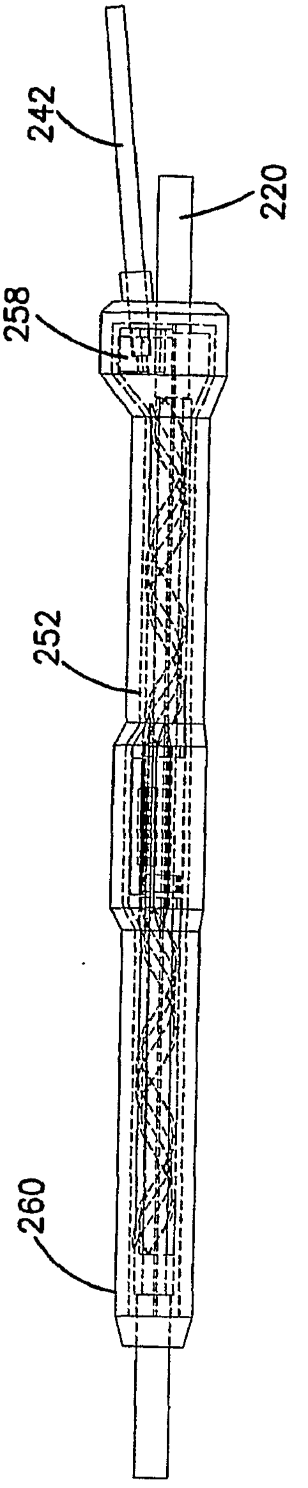


FIG.8

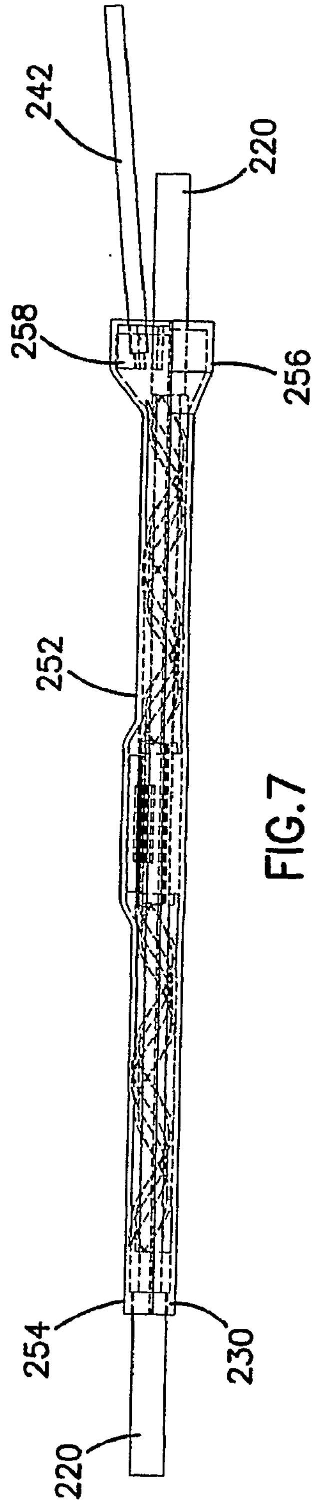


FIG.7

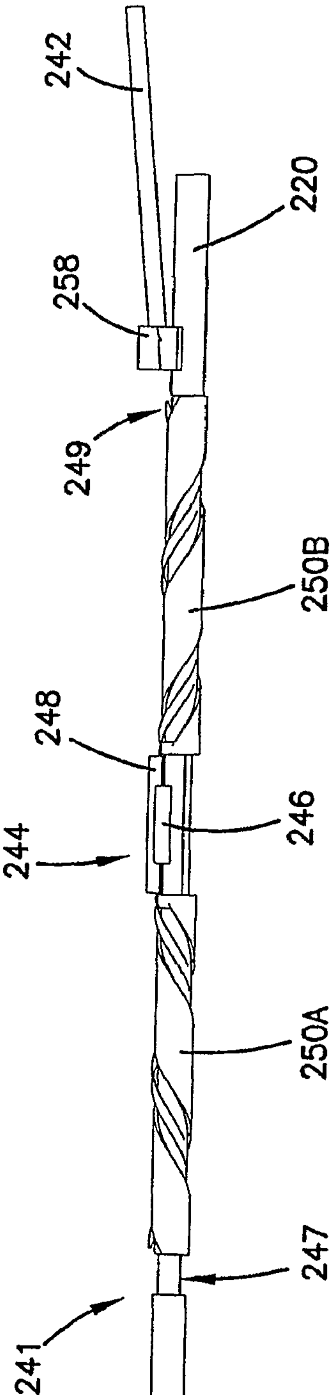


FIG.6