Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2589872 C 2013/09/24

(11)(21) 2 589 872

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(86) Date de dépôt PCT/PCT Filing Date: 2005/12/06
(87) Date publication PCT/PCT Publication Date: 2006/06/22
(45) Date de délivrance/Issue Date: 2013/09/24
(85) Entrée phase nationale/National Entry: 2007/06/01
(86) N° demande PCT/PCT Application No.: US 2005/043975
(87) N° publication PCT/PCT Publication No.: 2006/065574
(30) Priorité/Priority: 2004/12/17 (US11/015,324)

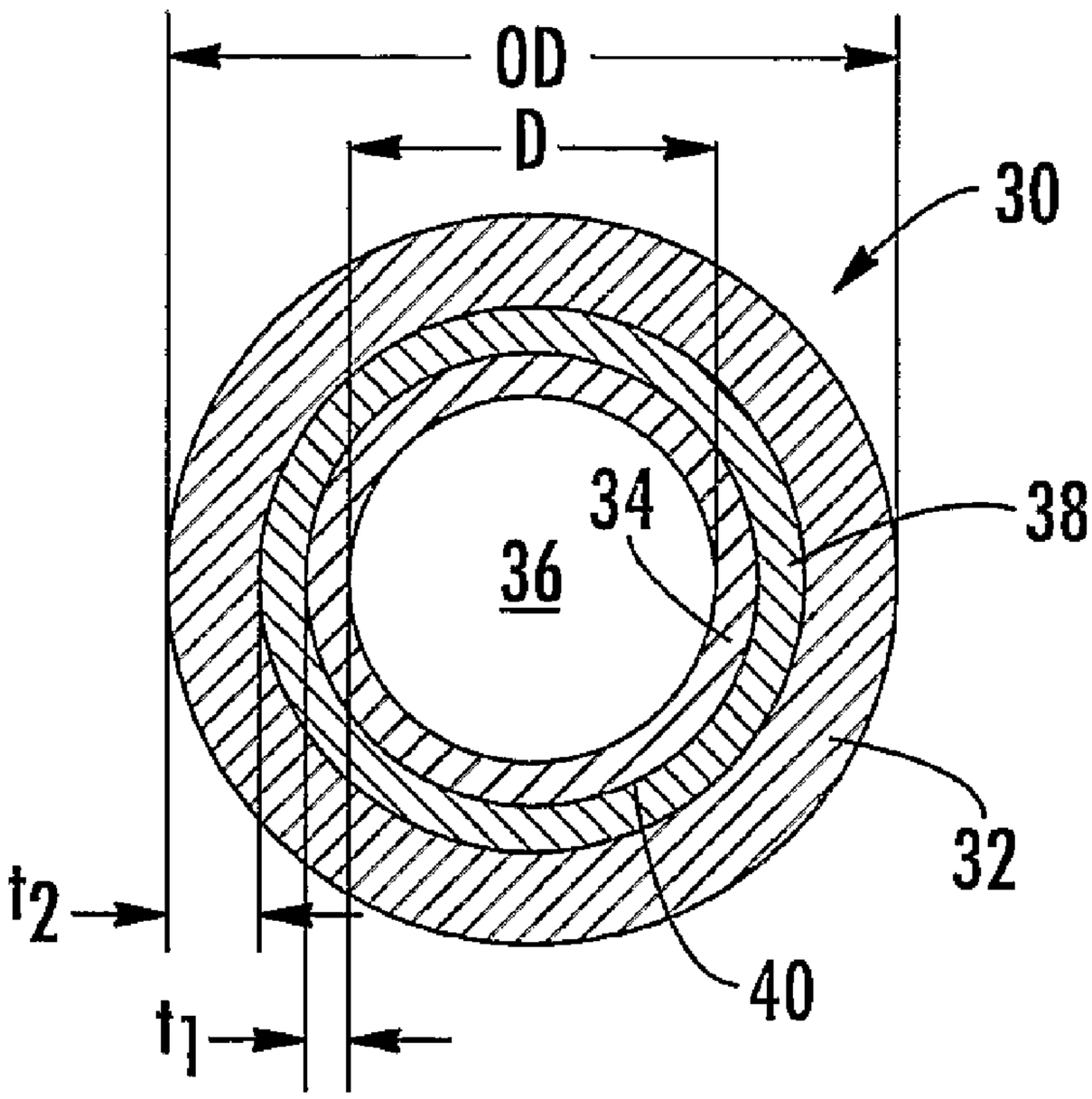
(51) Cl.Int./Int.Cl. *G02B 6/44* (2006.01)

(72) Inventeurs/Inventors:
RHONEY, BRIAN K., US;
EASTON, MARTYN N., US;
HUDSON, H. EDWARD, II, US

(73) Propriétaire/Owner:
CORNING CABLE SYSTEMS LLC, US

(74) Agent: GOWLING LAFLEUR HENDERSON LLP

(54) Titre : BOITIER DE PROTECTION POUR FIBRES OPTIQUES ET ENSEMBLE DE SORTANCE L'UTILISANT
(54) Title: PROTECTIVE CASING FOR OPTICAL FIBERS AND A FAN-OUT ASSEMBLY USING SAME



(57) Abrégé/Abstract:
A robust protective casing is provided that includes an inner tubing having a passageway therethrough, an outer tubing, and a plurality of flexible strength members disposed between the inner and outer tubing. The protective casing has a wall tubing thickness ratio of the inner tubing wall thickness to the outer tubing wall thickness of about .05 or less while still inhibiting the kinking of the protective casing during relatively small bend radii. Additionally, an outer diameter of the protective casing is relatively small while still allowing the routing of a standard sized 900 micron tight-buffered optical fiber through the passageway. Thus, the protective casing is advantageous in applications where limited space is available space. A fan-out assembly using the protective casings is also described.

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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
22 June 2006 (22.06.2006)

PCT

(10) International Publication Number
WO 2006/065574 A3

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

(21) International Application Number:
PCT/US2005/043975

(22) International Filing Date:
6 December 2005 (06.12.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
11/015,324 17 December 2004 (17.12.2004) US

(71) Applicant *(for all designated States except US)*: **CORNING CABLE SYSTEMS LLC** [US/US]; Post Office Box 489, 800 17th Street, NW, Hickory, NC 28601 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **RHONEY, Brian, K.** [US/US]; 4851 Sage Meadow Circle, Hickory, North Carolina 28601 (US). **EASTON, Martyn, N.** [GB/US]; 604 Foxridge Court, Lenoir, North Carolina 28645 (US). **HUDSON, H., Edward, II** [US/US]; 3204 6th Avenue, NE, Conover, North Carolina 28613 (US).

(74) Agent: **CARROLL, Michael, E., Jr.**; Post Office Box 489, 800 17th Street, NW, Hickory, North Carolina 28601 (US).

(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, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

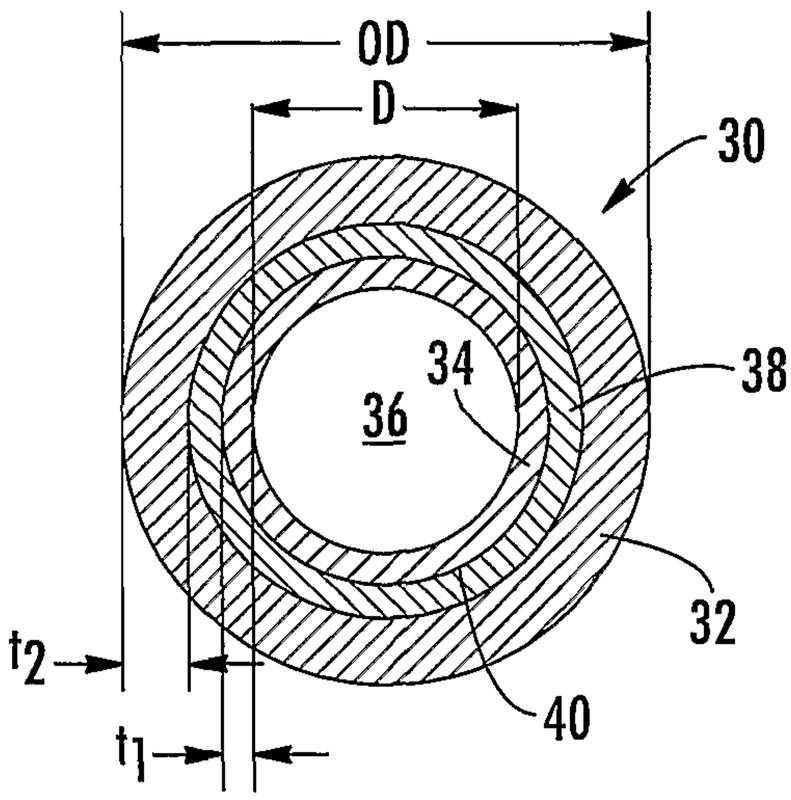
(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, 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:
— *with international search report*

(88) Date of publication of the international search report:
31 August 2006

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: PROTECTIVE CASING FOR OPTICAL FIBERS AND A FAN-OUT ASSEMBLY USING SAME



(57) Abstract: A robust protective casing is provided that includes an inner tubing having a passageway therethrough, an outer tubing, and a plurality of flexible strength members disposed between the inner and outer tubing. The protective casing has a wall tubing thickness ratio of the inner tubing wall thickness to the outer tubing wall thickness of about .05 or less while still inhibiting the kinking of the protective casing during relatively small bend radii. Additionally, an outer diameter of the protective casing is relatively small while still allowing the routing of a standard sized 900 micron tight-buffered optical fiber through the passageway. Thus, the protective casing is advantageous in applications where limited space is available space. A fan-out assembly using the protective casings is also described.

WO 2006/065574 A3

PROTECTIVE CASING FOR OPTICAL FIBERS AND A FAN-OUT ASSEMBLY USING SAME

FIELD OF THE INVENTION

The present invention relates to a protective casing for optical fibers, and more particularly, a protective casing that allows optical fibers to be routed into, through, and stored in smaller spaces and a fan-out assembly using the protective casings. The protective casing according to the present invention allows tight-buffered fibers and bare optical fibers to fit therein while maintaining a relatively small footprint, providing the strength needed to protect the optical fibers, and allows forming of relatively small bend radii and winding on a reel without kinking and damaging the optical fibers.

BACKGROUND OF THE INVENTION:

There are conventional furcation tubes for protecting standard sized tight-buffered optical fibers having an outer diameter of 900 microns (0.900 mm). These conventional furcation tubes are also suitable for protecting bare optical fibers, i.e., optical fibers having an outer diameter of 250 microns (0.250 mm). However, the outside diameter of the conventional furcation tubes are so relatively large that they become impractical to be used in, for instance, premise networks, where space is at a premium. In other words, the available space cannot accommodate the desired number of furcation tubes. If the outside diameter of the conventional furcation tubes were to be reduced to accommodate the space requirements and still allow tight-buffered optical fibers to fit therethrough, the walls of the protective casing become too weak, thereby allowing the protective casings to kink when bent into the required radii or wound on a reel. This kinking of the furcation tube can induce induce high stress levels, which can cause undesirable damage to the optical fibers and/or reducing of, or eliminating, of the light transmission along the optical fibers.

Fig. 1 depicts one such conventional furcation tubing **10** that is currently used for standard sized tight-buffered optical fibers having an outer diameter of 900 microns (0.9 mm). Furcation tubing **10** has an outer tubing **12**, which is typically a PVC jacket and has a relatively large outer diameter of about 2900 microns (2.9 mm). A layer of aramid yarns **14** acting as flexible strength members are disposed between outer tubing **12** and an inner tubing **16**. Inner tubing **16** has a central passageway **18** that is about 1070 microns (1.07 mm) in diameter for allowing the standard sized tight-buffered optical fiber to pass therethrough. The

inner tubing **16** is typically made from PDVF (Polyvinylidene fluoride) or TFE (tetrafluoroethylene). To prevent the protective casing **10** from collapsing during use, the inner tubing **16** requires a relatively thick wall thickness of about 400 microns (0.4 mm). However, this required wall thickness for inner tubing **16** causes the relatively large overall size of the protective casing, i.e., 2900 microns (2.9 mm) and limits the number of furcation tubes that can pass through a given space.

Other conventional furcation tubes having smaller outer diameters are known, but in order to prevent kinking the furcation tubes and/or undesired optical attenuation require inner diameters that are too small for accommodating the standard sized tight-buffered optical. Generally speaking, these smaller conventional furcation tubes include an inner tubing having a relatively thick wall thickness to inhibit kinking and/or undesirable optical attenuation. By way of example, U.S Pat. No. 5,201,020 discloses a protective tubing having an outside diameter of 900 microns and an inner diameter of about 500 microns. Consequently, the protective tubing is suitable for bare optical fibers, but is not suitable for receiving tight-buffered optical fibers having an outer diameter of 900 microns.

Accordingly, the present invention is directed to a protective casing that substantially obviates one or more of the problems and disadvantages in the prior art. Additional features and advantages of the invention will be set forth in the description that follows, and in part will be apparent from the description, or may be learned by practice of the invention. The objectives and other advantages of the invention will be realized and attained by the apparatus and process particularly pointed out in the written description and claims, as well as the appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the invention and are incorporated in and constitute a part of the specification. The drawings illustrate several embodiments of the invention and together with the description serve to explain the principles of the invention.

Fig. 1 is a cross sectional view of a representative prior art protective casing;

Fig. 2 is a cross sectional view of a protective casing according to one embodiment of the present invention;

Fig. 3 is a perspective view of a fan-out insert plug with several protective casings according to the present invention attached thereto; and

Fig. 4 is a perspective view of a portion of fan-out assembly showing a body with the fan-out insert plug of Fig. 3 attached according to one embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Fig. 2 illustrates one embodiment of a protective casing **30** according to the present invention. Protective casing **30** includes an outer tubing **32**, an inner tubing **34** with a passageway **36** therethrough, and a layer of strength members **38**. Outer tubing **32** is preferably PVC, but other suitable materials are possible. Outer tubing **32** has an outer diameter OD of about 2000 microns (2.00 mm) and has a wall thickness t_2 that is preferably about 240 microns (0.24 mm). Inner tubing **34** preferably has a wall thickness t_1 of about 100 microns (0.1 mm) with passageway **36** therethrough being about 1000 microns (1.02mm) in diameter D, thereby making it suitable to receive a standard-sized 900 micron tight-buffered optical fiber. Thus, the present invention is advantageous because it solves the long-standing need for increasing the number of standard tight-buffered optical fiber protective casing runs in a given limited space. In other words, protective casing **30** has an outer diameter that is about thirty 30 percent smaller than previous furcation tubes used for standard tight-buffered optical fibers. Moreover, even though inner tubing **34** has a relatively thin wall thickness, protective casing **30** is a robust structure that inhibits kinking when bent into small radii and avoids damaging optical fibers therein, thereby preserving optical performance.

Inner tubing **34** requires a level of predetermined hoop strength for the relatively small wall thickness used so that it does not kink when bent into a small radii, thereby providing protection to the optical fiber therein. Additionally, preferred materials for inner tubing **34** must balance hoop strength with acceptable properties that allow protective casing **30** to also be flexible, yet strong enough to prevent kinking and withstand the environments into which they are installed. For example, suitable preferred materials should have a flexural strength of about 20,000 psi and/or a flexural modulus of about 500,000 psi using ASTM D790, a compressive strength of about 22,000 psi using ASTM D695, and a tensile strength of about 16,500 psi. Materials may also have a suitable resistance to chemicals and solvents and along with suitable temperature performance. By way of example, materials for inner tubing **34** can include suitable grades of polyetherimide, polyetheretherketone, or fluoroplastic THV. One suitable inner tubing **34** is a polyetherimide tubing such as commercially available from Zeus, Inc., of Orangeburg, SC made from ULTEM®. The materials mentioned above as well as others with similar characteristics can be appropriate for

use with the protective casing **30** having the characteristics of the present invention. Passageway **36** of inner tubing **34** is depicted having a round cross-section, but other appropriate shapes are possible. For instance, the concepts of the present invention are also suitable for a rectangular protective casing suitable for receiving ribbons.

Outer diameter OD of the protective casing **30**, which corresponds to the outer surface of the outer tubing **32**, is about 2mm and the diameter D of the passageway **36** is about 1 mm. Consequently, the ratio of a cross sectional area of the passageway **36** to the cross sectional area of the protective casing **30** is about 0.25 (0.25 mm^2/1.00 mm^2). The ratio of the cross sectional areas could be less than 0.25 if the passageway **36** were slightly smaller or the protective casing **30** were slightly larger. Likewise, the ratio could be larger than 0.25; however, in either case the protective casing should inhibit kinking in relatively small bend radii. Additionally, passageway **36** has limits on its size if it is intended for receiving a standard sized tight-buffered optical fiber having a 900 micron diameter. Of course, the concepts of the present invention can be applied to protective casings suitable for a standard sized bare optical fiber, i.e. 250 microns, or buffered fibers having diameters smaller than 900 microns such as 700 or 500 microns with, for instance, respective passageways of 350, 600, or 800 microns. In these embodiments, a smaller passageway is permissible, but the protective casing would not be suitable for the 900 microns tight-buffered optical fiber. The outer diameter OD of the protective casing **30** could also be made larger, to further reduce the ratio of the areas, but generally speaking larger outer diameters for protective casings are not desired for applications with limited space, but they are possible within the concepts of the invention.

Generally speaking, the wall thickness t_1 of inner tubing **34** is smaller than the wall thickness t_2 of outer tubing **32.** In the embodiment shown, the wall thickness t_2 of the outer tubing **32** is preferably about 240 microns (0.24 mm) and the wall thickness t_1 of the inner tubing **34** is about 100 microns (0.1 mm), meaning that a ratio of the inner tubing wall thickness to the outer wall thickness is preferably about 0.4. Protective casings of the invention preferably have a ratio of wall thicknesses (t_1 /t_2) of about 0.5 or less, more preferably about 0.45 or less. Using an inner tubing wall thickness that are about one-half the size of the outer tubing wall thickness allows for a compact footprint for the protective casing. Of course variations are possible, but whatever wall thickness ratio used or desired, the structure should be robust enough to protect the optical fiber therein. In other words, the wall thickness ratio is adjustable according to needs of a given application.

Protective casing **30** also includes at least one tensile strength member. In this case, the layer of strength members **38** is positioned between the outer tubing **32** and the inner tubing **34** for carrying any applied tensile load. Preferably, the strength members are aramid fibers or fiberglass fibers that allow flexibility while providing the necessary tensile strength, but other materials are possible. In the embodiment shown, the layer of strength members **38** is preferably eight strands of 380 denier aramid yarn that are wrapped about the outer surface **40** of the inner tubing **34** during manufacture. While there are preferably eight strands, more or fewer strands and/or different deniers of the strength members **38** may be used. Additionally, strength members **38** may not completely surround the outer surface **40** of the inner tubing **34** as depicted and still fall within the scope of the present invention. For example, the strength members **38** may only be placed on opposite sides of the protective casing. Similary, there may be three or four discreet placements of the strength members **38** around the outer surface **40**. One explanatory embodiment uses two or three strands of a larger 1400 denier aramid strength members spaced in discrete radial locations about the inner tubing.

Protective casing **30** may be used by itself or as a part of a cable or other assemblies as shown in Figs. 3 and 4. Typically, when large numbers of the protective casings **30** are used they are usually attached to a fan-out insert plug **50**, thereby providing a dense array. When a fiber optic cable is terminated with several connectors rather than with a single connector, a fan-out assembly is often used, thereby giving the assembly the flexibility to route the individual connectors to the desired location. In order to appropriately route the optical fibers from the fiber optic cable to the connectors, an insert plug may be used to control and manage the protective casings containing the optical fibers. Fig. 3 illustrates one embodiment of fan-out insert plug **50** having several protective casings **30** attached thereto. Typically, protective casings **30** have a friction-fit within fan-out insert plug **50**, but they are attachable in other manners. Fan-out insert plug **50** has a first end **52** into which optical fibers from the fiber optic cable are inserted. A second end **54** has openings with an inner diameter that corresponds to the outer diameter of the protective casing **30** so that the protective casings **30** can be inserted therein. While fan-out insert plug **50** has a specific configuration in Fig. 3, any appropriate configuration of the fan-out insert plug **50** is within the scope of the invention. Also, while the protective casings **30** are inserted into the holes in the fan-out insert plug **50**, they are attachable to a fan-out insert plug in any manner such as adhesive, ultrasonically welding, or attached by an appropriate structure, etc.

Fan-out insert plug **50** having the protective casing is generally attached to a larger cable assembly **62** as shown in Fig. 4. While the specific layout of cable assemblies can vary depending on the location of the installation and application, the number of optical fibers to be branched out, and the need for protection of the optical fibers, the fan-out insert plug **50** is typically attached to a body **60** of the cable assembly **62**. As depicted, body **60** is an elongated structure with multiple fan-out insert plugs **50** attached to one end thereof in a radial manner; however, other configurations of the body and the location and method of attaching the fan-out insert plugs to that body also fall within the scope of the present invention. Generally speaking, the body **60** of the cable assembly is the main structure to which the components of the assembly are attached. For example, the central member of a fiber optic cable, the shell or cover of the fan-out, the compression pieces, the strength members, etc., are generally attached to the body. Thus, the present invention allows the routing of the optical fibers of a cable in a smaller footprint than was previously possible with the conventional furcation tubes suitable for 900 micron tight-buffered optical fibers.

It will be apparent to those skilled in the art that various modifications and variations can be made with the protective casing and/or assemblies of the present invention without departing from the spirit or 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 protective casing for an optical waveguide fiber comprising:

an inner tubing, the inner tubing having an inner surface and an outer surface defining an inner tubing wall thickness therebetween, the inner tubing wall thickness being about 100 microns and the inner surface of the inner tubing having a round profile with a diameter of about 1000 microns;

an outer tubing, the outer tubing having an inner surface and an outer surface defining an outer tubing wall thickness therebetween, a wall tubing thickness ratio of the inner tubing wall thickness to the outer tubing wall thickness being about 0.5 or less, wherein the outer tubing has an outer diameter of about 2000 microns; and

a plurality of flexible strength members, the plurality of flexible strength members being disposed between the outer surface of the inner tubing and the inner surface of the outer tubing.

2. The protective casing of claim 1, the inner tubing being a polyetherimide material.

3. The protective casing of claim 1, the plurality of flexible strength members being aramid fibers.

4. The protective casing of claim 1, the outer tubing being a PVC material.

5. The protective casing of claim 1, the protective casing attached to a fan-out insert plug.

6. The protective casing of claim 1, the protective casing being a portion of a fan-out assembly.

7. The protective casing of claim 1, the inner tubing defining a passageway along the protective casing with the passageway having a cross-sectional area and an outer surface of the outer tubing defining a cross-sectional area of the protective casing, wherein a cross-

sectional ratio is defined as the cross-sectional area of the passageway to the cross-sectional area of the protective casing, the cross-sectional ratio being about 0.25 or less.

8. A protective casing for an optical waveguide fiber comprising:

an inner tubing, the inner tubing having an inner surface and an outer surface defining an inner tubing wall thickness therebetween, the inner surface of the inner tubing defining a passageway along the protective casing, the passageway having a cross-sectional area, the inner tubing wall thickness being about 100 microns and the inner surface of the inner tubing having a round profile with a diameter of about 1000 microns;

an outer tubing, the outer tubing having an inner surface and an outer surface, the outer surface of the outer tubing defining a cross-sectional area of the protective casing, wherein a cross-sectional ratio is defined as the cross-sectional area of the passageway to the cross-sectional area of the protective casing, the cross-sectional ratio being about 0.25 or less, the outer tubing having an outer diameter of about 2000 microns; and

at least one flexible strength member, the flexible strength member being disposed between the outer surface of the inner tubing and the inner surface of the outer tubing.

9. The protective casing of claim 8, the inner tubing being a polyetherimide material.

10. The protective casing of claim 8, the plurality of flexible strength members being aramid fibers.

11. The protective casing of claim 8, the outer tubing being a PVC material.

12. The protective casing of claim 8, the protective casing attached to a fan-out insert plug.

13. The protective casing of claim 8, the protective casing being a portion of a fan-out assembly.

14. A fan-out assembly comprising:

at least one a protective casing, the at least one protective casing comprising:

an inner tubing, the inner tubing having an inner surface and an outer surface defining an inner tubing wall thickness therebetween, the inner tubing wall thickness being about 100 microns and the inner surface of the inner tubing having a round profile with a diameter of about 1000 microns;

an outer tubing, the outer tubing having an inner surface and an outer surface defining an outer tubing wall thickness therebetween, a wall tubing thickness ratio of the inner tubing wall thickness to the outer tubing wall thickness being about 0.5 or less, wherein the outer tubing has an outer diameter of about 2000 microns; and

a plurality of flexible strength member, the flexible strength member being disposed between the outer surface of the inner tubing and the inner surface of the outer tubing;

a fan-out insert plug attached to the at least one protective casing; and

a body attached to the fan-out insert plug.

15. The protective casing of claim 14, the inner tubing being a polyetherimide material.

16. The protective casing of claim 14, the inner tubing defining a passageway along the protective casing with the passageway having a cross-sectional area and an outer surface of the outer tubing defining a cross-sectional area of the protective casing, wherein a cross-sectional ratio is defined as the cross-sectional area of the passageway to the cross-sectional area of the protective casing, the cross-sectional ratio being about 0.25 or less.

1/1

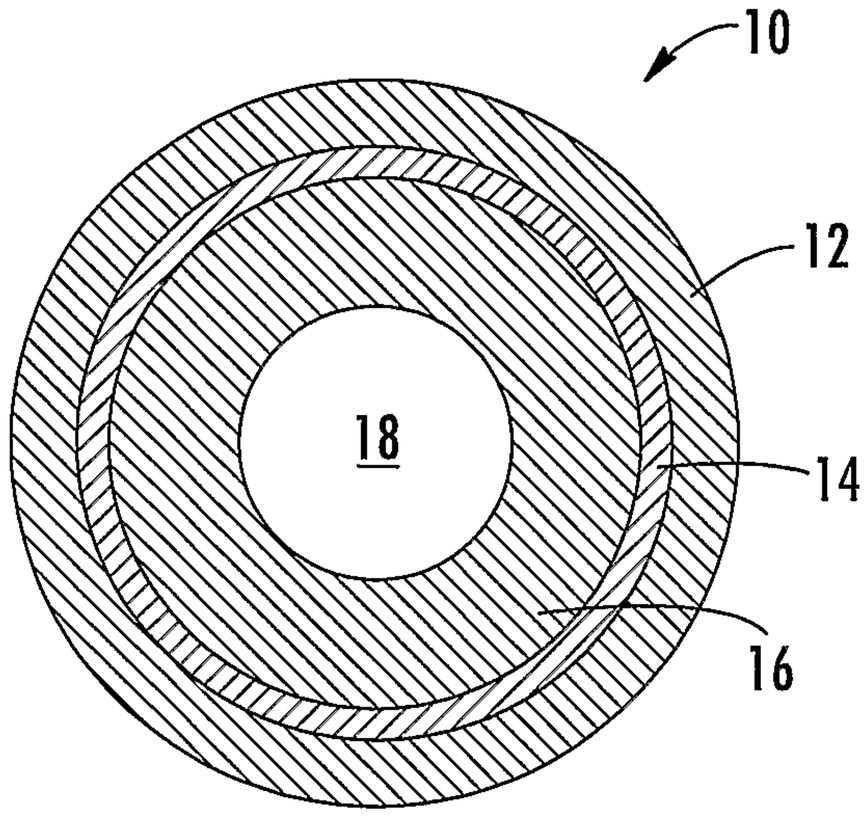


FIG. 1
(PRIOR ART)

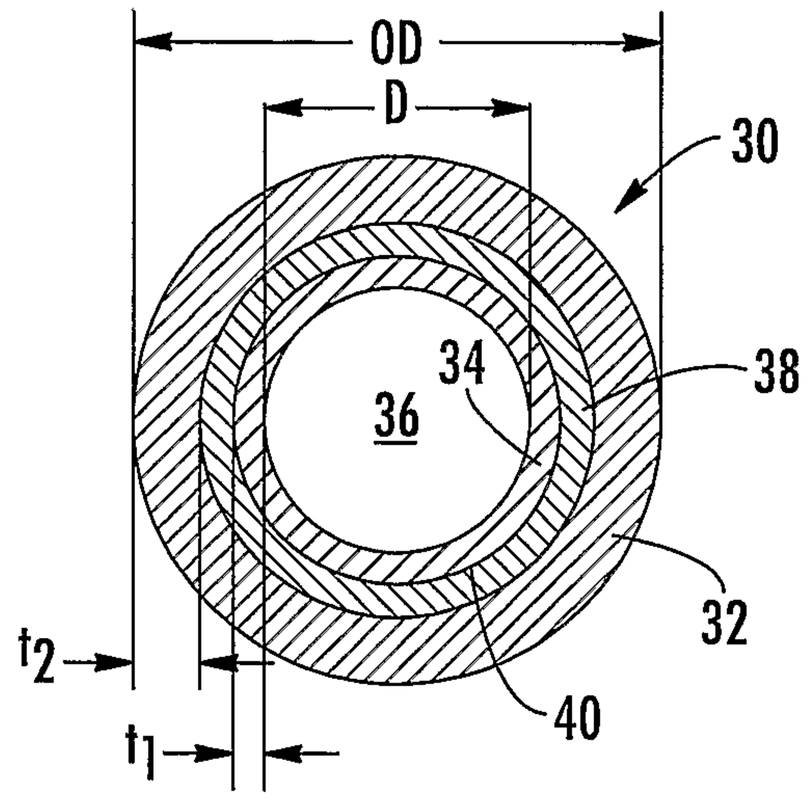


FIG. 2

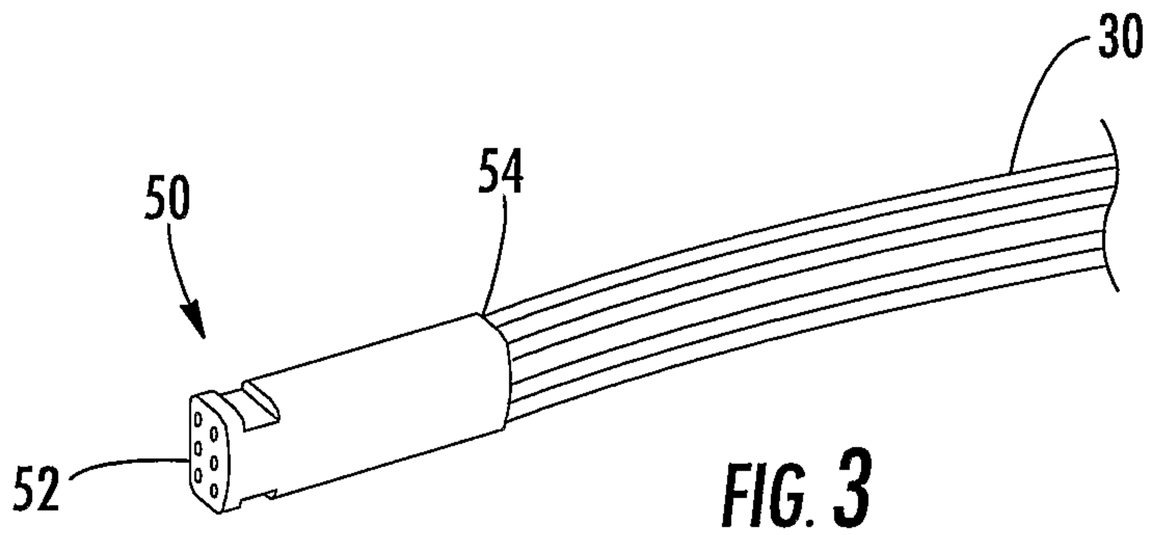
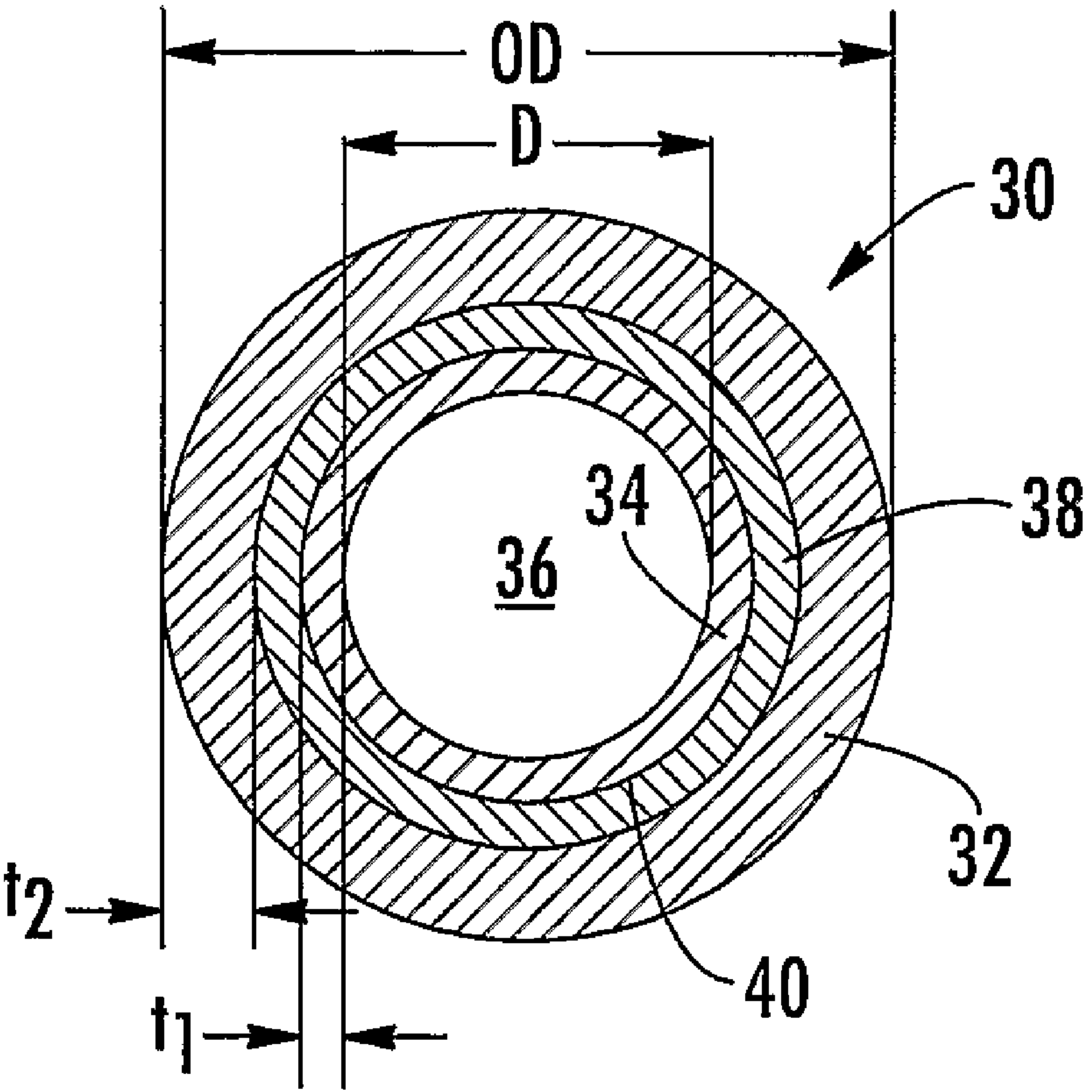


FIG. 3

FIG. 4


OD
D
30
34
38
36
32
40
t2
t1