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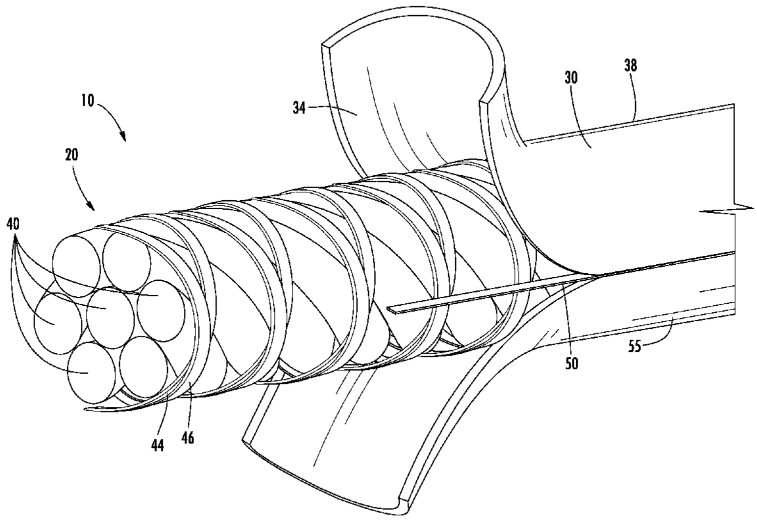


*FIG. 1*

(57) **Abstract**: Cables are constructed with extruded discontinuities in the cable jacket that allow the jacket to be torn to provide access to the cable core. The discontinuities can be longitudinally extending strips of material in the cable jacket.

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# FIBER OPTIC CABLES WITH ACCESS FEATURES AND METHODS OF MAKING FIBER OPTIC CABLES

## RELATED APPLICATIONS

[001] This application claims the priority of U.S. Prov. App. No. 61/330,038, filed April 30, 2010, the entire contents of which are hereby incorporated by reference.

[002] This application is related to U.S. Prov. App. No. 61/416,684, filed November 23, 2010.

## BACKGROUND

[003] Fiber optic cables typically include one or more optical fibers surrounded by a protective polymer jacket. The jacket must be robust enough to endure various environmental conditions, yet must also allow field technicians to access the enclosed optical fibers without undue effort and time. Various solutions have been proposed to provide access to optical fibers in a cable core, including the inclusion of ripcords and other means. U.S. Patent 5,970,196 includes large inserts that can be removable from a cable jacket to allow access to the cable core. The inserts are so large, however, that mechanical performance of the cable may suffer as the size of the inserts allow large sections of the cable/tube jacket to bend and flex in dissimilar modes.

[004] U.S. Patent 7,187,830 discloses the creation of voids filled with liquid or gas, but such voids may also adversely affect structural integrity of some cable jacket types, as well as providing paths for water ingress.

## SUMMARY

[005] According to one embodiment, a cable comprises a core and a jacket surrounding the core. The jacket comprises a main portion of a first material, and at least one discontinuity of a second material. The discontinuity extends along a length of the cable, and the bond between the main portion and the discontinuity allows the jacket to be separated at the discontinuity to provide access to the core. The discontinuity may constitute a relatively small portion of the overall jacket area and may remain integral with the jacket after access.

[006] According to a first aspect, the main portion and the discontinuity can be extruded together so that the first and second materials flow together during extrusion, and bond together during cooling. The second material can flow into a trough formed in the first material during extrusion.

[007] According to a second aspect, the second material of the discontinuities can include selected quantities of the first material to enhance bonding between the main portion and the discontinuities.

[008] Those skilled in the art will appreciate the above stated advantages and other advantages and benefits of various additional embodiments reading the following detailed description with reference to the below-listed drawing figures.

## BRIEF DESCRIPTION OF THE DRAWINGS

[009] According to common practice, the various features of the drawings discussed below are not necessarily drawn to scale. Dimensions of various features and elements in the drawings may be expanded or reduced to more clearly illustrate the embodiments of the invention.

[010] **FIG. 1** is a partial cutaway view of a fiber optic cable according to a first embodiment.

[011] **FIG. 2** is a cross section of the cable jacket illustrated in **FIG. 1**.

[012] **FIG. 3** is an isolated cross-sectional view of one of the discontinuities in the cable jacket of **FIG. 2**.

[013] **FIG. 4** is a cutaway view of a coextrusion apparatus used to manufacture cables with discontinuities.

[014] **FIG. 5** is a cutaway view of the coextrusion apparatus of **FIG. 4** illustrating extrudate material flow.

[015] **FIG. 6** illustrates a ring that can be used to modify conventional cable jacketing devices to form discontinuities.

[016] **FIG. 7** is a partial cutaway view of a fiber optic cable according to a second embodiment.

## DETAILED DESCRIPTION

[017] **FIG. 1** is a partial cutaway view of a fiber optic cable **10** according to a present embodiment. The cable **10** comprises a core **20** surrounded by a jacket **30**. The jacket **30** has an interior surface **34** that faces the core **20**, and an exterior surface **38**. The jacket **30** can be formed primarily from polymer materials, and can be generally referred to as "polymeric." In this specification, the term "polymer" includes materials such as, for examples, copolymers, and polymer materials including additives such as fillers. The core **20** can be, for example, an assembly or arrangement having data-transmission and/or power-transmission capabilities. In the illustrated embodiment, the core **20** includes a bundle of optical fibers **40** bundled within contrahelically wound binders **44, 46**.

[018] The jacket **30** includes a separation feature that facilitates access to the core **20**. In the exemplary embodiment, the separation feature is a pair of discontinuities **50** that extend along the length of the cable **30**. In this specification, the term "discontinuity" indicates a portion of the jacket **30** of different material composition than the main portion of the jacket **30**, the main portion being indicated by reference number **55**. The main portion **55** can essentially be an annular hoop surrounding the core **20**, with the discontinuities **50** extending longitudinally through the main portion **55** along the length of the cable **10**. According to one aspect, the discontinuities **50** provide lines of weakness that allow the jacket to be separated **30** as shown in **FIG. 1**. The discontinuities **50** can conform to the profile of the main portion **55** so that the jacket **30** is a relatively uniform annulus.

[019] **FIG. 2** is a cross-section of the jacket **30** in isolation, taken on a plane perpendicular to a length of the cable **10**. In the exemplary embodiment, the discontinuities **50** are bonded to the main portion of the jacket **55** when the jacket **30** is extruded. The main portion **55** and the discontinuities **50** can be formed from extrudable polymers, so that as the extrudate used to form the main portion **55** and the discontinuities **50** cools and solidifies, the extrudates become bonded at an interface **54** on each side of a discontinuity **50**. When the discontinuities **50** are formed while extruding in the same step as the main portion **55** of the jacket, the bond between discontinuity **50** and the remainder of the jacket **30** can be generally described as enabled by polymer chain entanglement as the jacket **30** solidifies. The jacket **30** accordingly comprises a cohesive composite structure. In **FIG. 2** the interfaces **54** are shown as clear delineations, while in practice there may be a transition region between the materials of

the main portion **55** and the discontinuities **50**. The curved "T" shape of the discontinuities **50** in **FIG. 2** are a result of one extrusion process that can be used to form the discontinuities, but other shapes are possible.

**[020]** The discontinuities **50** can be relatively narrow strips in the jacket **30**, and may occupy relatively small portions of the jacket cross-sectional area $\mathbf{A_J}$. For example, the discontinuities **50** can have cross-sectional areas $\mathbf{A_D}$ that are less than 10% of $\mathbf{A_J}$, and as low as less than 5% or 3% of $\mathbf{A_J}$. In the illustrated embodiment, the discontinuities **50** each have cross-sectional areas $\mathbf{A_D}$ that are about 3% of $\mathbf{A_J}$. In **FIGS. 1** and **2**, two discontinuities **50** are formed in the jacket **30** to facilitate opening of the jacket as shown in **FIG. 1**. Depending on the form that the core **20** takes, the number, spacing, shape, composition and other aspects of the discontinuities **50** can be varied. For example, a single discontinuity in the jacket **30** may be sufficient to allow the cable jacket **30** to be opened away from the core **20**. The discontinuities in **FIG. 1** are shown as rectangular strips for the purposes of illustration. In practice, the discontinuities may have curved or irregular shapes, and the discontinuities will generally fracture so that they remain attached to the main portion of the jacket.

**[021]** **FIG. 3** is an isolated view of one of the discontinuities **50** in the jacket **30**. In the illustrated embodiments, the width **W** of the discontinuity **50** is much greater near the exterior surface **38** of the jacket **30** than at the radially inward portion of the discontinuity **50**. The discontinuities **50** can accordingly form a small, visible portion of the exterior surface of the cable jacket **30**. This is due to the manufacturing process used to form the exemplary jacket, in which the extrudate used to form the discontinuity **50** was introduced from the direction **60**, into the exterior of the jacket, and inwardly into the extrudate material used to form the main portion **55**. The discontinuities **50** are thus progressively narrower as they extend radially inwardly. The discontinuity extends a depth **D** into the jacket **30**, which has a thickness **T**. In this embodiment, the discontinuity **50** extends essentially from the exterior surface **38** to the interior surface **34** of the jacket **30**. The depth **D** need not equal the thickness **T**, however. For example, discontinuities having depths **D** of at least 80% of the thickness **T** may be effective in providing tear locations for tearing the jacket **30**. Discontinuities having depths **D** of at least 50% of the thickness **T** may also be effective in providing access locations for tearing the jacket **30**. Depending on the jacket cross-section and materials used, discontinuities having depths **D** of at least 30% may be effective in facilitating access to the core.

[022] The width **W** illustrated in **FIG. 3** can correspond to a maximum width of the discontinuity **50**. The width **W** is a measurement taken generally along the circumference of the jacket **30**, or more specifically taken perpendicular to a radius bisecting a discontinuity **50**. The width **W** can also be expressed as an arc length described in degrees. For example, the maximum width **W** of the discontinuity **50** shown in embodiment shown in **FIG. 3** can be in the range of 0.5 - 2.0 mm. Stated alternatively, at its maximum width **W**, a discontinuity can traverse less than 20 degrees of arc along the circumference of the jacket **30** for small cable diameters. A discontinuity can traverse less than 10 degrees of arc for larger cables.

[023] If an extremely thin, "film" type embodiment of discontinuity **50** is included, the maximum width **W** of a discontinuity can be in the range of 0.2 mm or less, and may be about 0.1 mm, corresponding to 1 degree of arc or less. Stated alternatively, at its maximum width **W**, a discontinuity can traverse less than 2 degrees of arc along the circumference of the jacket **30**.

[024] The materials and processes used to form the main portion **55** and the discontinuities **50** can be selected so that the interfaces **54** allow for relatively easy access to the core **20** by tearing the jacket **30** as shown in **FIG. 1**. The cable **10** may be constructed to meet other requirements for robustness, such as requirements for the jacket **30** stay intact under tensile loads, twisting, in temperature variations, and when subjected to other known cable test criteria, such as, for example, ICEA 460, and GR20.

[025] The main portion **55** in the illustrated jacket **30** was extruded from medium density polyethylene (MDPE), and the discontinuities **50** were extruded from polypropylene (PP). The jacket **30** was formed in a coextrusion process so that the main portion **55** and the discontinuities **50** bonded during cooling to form relatively strong bonds at the interfaces **54**. A cable formed in the process (not shown) also included water-swellable tape in the core **20** under binder threads. The cable jacket **30** was robust yet relatively low pull forces were sufficient to shear the jacket **30** along the discontinuities **50**.

[026] Without being bound by theory, Applicants believe the bond between polypropylene and polyethylene may be caused by one or both of quantities of ethylene

that are compounded in the polypropylene bonding with the polyethylene (PE), and molecular entanglement between the PE and PP. According to this understanding, the amount of ethylene in the PP extrudate can be increased to increase the bond between the discontinuities and the remainder of the jacket. In general, if the main portion **55** of the jacket **30** is formed from a first polymer material, and the discontinuities are formed from a second polymer material, the discontinuities can include from 0.5% - 20% by weight of the first polymer material.

[027] If a narrow, thin film discontinuity **50** is included in the jacket, the content of the first polymer in the discontinuity can be similar to the embodiment of **FIG. 2**. One embodiment of a thin film discontinuity contains PP with about 9% PE. Higher PE contents, such as to up 20% PE, are also possible. PE contents of less than 0.2% in PP may result in insufficient bonding between the main portion and a discontinuity.

[028] The inclusion of discontinuities **50** in the jacket **30** allows for a cable access procedure not available in conventional cables. Referring to **FIGS. 1** and **2**, the cable **10** can be accessed by scoring the end of an intact cable in the vicinity of the discontinuities **50**. The cable end can be scored by, for example, a pair of snips, a knife, or some other bladed instrument. One or both sides of the torn jacket **30** can then be pulled back as shown in **FIG. 1**, with the jacket **30** tearing along the planes being created by the presence of the discontinuities **50**. One or both sides of the jacket **30** can be pulled back to a desired length along the cable **10** to provide access to the core **20**. The discontinuities are generally small enough so that they fracture and adhere to respective sides of the main portion **55** of the jacket **30**. Discontinuities extending along the entire length of the cable **10** are effective in providing access to the core **20** according to this method. Shorter discontinuity lengths may also be effective however. For example, discontinuities having lengths of at least 10 centimeters along the length of the cable may be sufficient. The discontinuities **50** can be of different color than the main portion **55** so that they can be easily located and visible from the cable exterior. If the discontinuities **50** extend for a length along the jacket that is less than the entire length of the cable, different coloring of the discontinuities **50** can aid a technician in finding a location on the cable **30** to gain access.

[029] The cable **10** can be manufactured using existing coextrusion equipment subject to minor modifications. For example, extruders from the Davis-Standard line of wire and cable extruders can be used to form a cable jacket according to the present

embodiments. For example, a 1-1/2 inch (40 mm) barrel diameter extruder and a larger barrel diameter extruder, such as a 3, 4, or 4-1/2 inch extruder available from Davis-Standard, can be screwed into a crosshead in a configuration that would conventionally be used to extrude a cable jacket with the larger extruder, and a to extrude a stripe on the exterior of the cable jacket with the smaller extruder. In a conventional process, the stripe extrudate material is deposited on the surface of the jacket extrudate. According to the present embodiment, the flow of extrudate in the jacket extruder is diverted at the location or locations where the stripe extrudate material is introduced to the jacket extrudate. The diversion of the jacket extrudate creates a depression or trough in the flow of jacket extrudate, into which the extrudate material used to form a discontinuity is introduced. The jacket extrudate along with the with discontinuities formed therein then contracts and solidifies around a fiber optic core advancing through the crosshead.

[030] **FIG. 4** illustrates a cutaway section view of a coextrusion apparatus **100** that can be screwed into a crosshead and used to manufacture a cable according to the present embodiments. The arrows in **FIG. 4** illustrate the flow direction of extrudate. **FIG. 5** illustrates the coextrusion apparatus **100** including representations of the extrudate materials forming the jacket **30**. The apparatus **100** can generally be constructed from commercially available components used in a cable jacketing line with the capability to extrude stripes on a cable jacket, except for the modification described below. Referring to **FIGS. 4** and **5**, the apparatus **100** includes a first input port **110** that receives a first molten extrudate material **112** that is used to form the main portion **55** of the jacket **30**. A second input port **120** allows introduction of a second molten extrudate material **122** used to form the discontinuities **50**. A cavity **130** houses a tip (not shown) that in part defines the shape of the extrusion cone **136**, and the ultimate form of the cable jacket.

[031] **FIG. 6** illustrates a ring **150** that is inserted in the apparatus **100** that enables formation of the discontinuities in the flow of the first extrudate material **112**. The ring **150** includes two projections **152** that act to divert the flow of the first extrudate **112**. The projections **152** divert the flow of the first extrudate **112** and create a trough or depression in the extrudate flow, into which the second extrudate material **122** flows as shown in **FIG. 5**.

[032] Referring to **FIG. 5**, to form a fiber optic cable **10**, a cable core (not shown) is advanced along the centerline **102** of the apparatus **100**. First extrudate material **112** is pumped into the first input port **110**, which then advances through channels in the

apparatus **100** and travels over the tip (not shown). The projections **152** divert the flow of extrudate **112** and create troughs. At these locations, the second extrudate material **122** is introduced into the troughs. The second extrudate material **122** therefore flows as a liquid in the flow of first extrudate material **112** as the jacket is extruded. The extrusion cone **136**, which is comprised of the first and second extrudate materials **112, 122**, cools and solidifies around the core to form the jacket **30**.

[033] **FIG. 7** is a partial cutaway view of a fiber optic cable **310** according to a second embodiment. The cable **310** comprises a core **320** surrounded by a jacket **330**, similar to the embodiment shown in **FIG. 1**. The jacket **330** includes a pair of discontinuities **350** that extend along the length of the cable **330**. In this embodiment, the discontinuities **350** are relatively close together (e.g., within 90 degrees of each other) so that a narrow strip of jacket **330** can be peeled away from the core **320**.

[034] The cable jacket main portions **55, 355** and the discontinuities **50, 350** described in this specification can be made from various polymer materials. Either main portion or discontinuity may be made from polypropylene (PP), polyethylene (PE), or blends of materials such as a blend of PE and ethylene vinyl acetate (EVA), flame-retardant material such as flame-retardant polyethylene, flame-retardant polypropylene, polyvinyl chloride (PVC), or polyvinylidene fluoride PVDF, filled materials such as polybutylene terephthalate (PBT), a polycarbonate and/or a polyethylene (PE) material and/or an ethylene vinyl acrylate (EVA) or other blends thereof having fillers like a chalk, talc, or the like, and other materials such as a UV-curable acrylates.

[035] In the exemplary embodiments, the first material may comprise at least 80% of a first polymer, polyethylene, by weight, and the second material comprises at least 70% of a second polymer, polypropylene, by weight and at least 0.5% of the first polymer polyethylene by weight. Higher amounts by weight of the first polymer may be included in the second material, such as at least 1.0%, or at least 2%.

[036] In an alternative embodiment, polypropylene can be used as the first polymer primary component of the main portion of the jacket, and polyethylene can be used as the primary component in the discontinuities. In this case, amounts of polypropylene can be added to the polyethylene discontinuities to promote bonding between the discontinuities and the main portion.

**[037]** In general, the desirable separation properties disclosed in this specification may be obtained by coextruding the discontinuities from a different material than the material used to form the main portion of the jacket. As an alternative method, the discontinuities may be made from the same material as the remainder of the jacket, but subjected to different curing conditions, for example.

**[038]** The illustrated cores are capable of conveying fiber optic communication signals. In additional to optical fibers, or as an alternative to optical fibers, electrical conductors can be included in the cable core, so that the core is capable of conveying electrical communication signals.

**[039]** Many modifications and other embodiments, within the scope of the claims will be apparent to those skilled in the art. For instance, the concepts of the present invention can be used with any suitable fiber optic cable design and/or method of manufacture. Thus, it is intended that this invention covers these modifications and embodiments as well those also apparent to those skilled in the art.

What is claimed is:

1. A cable, comprising:

a core; and

a jacket surrounding the core, the jacket comprising:

a main portion of a first extruded polymeric material; and

at least one discontinuity of a second extruded polymeric material in the main portion, the discontinuity extending along a length of the cable, and the first material being different from the second material, wherein

the bond between the discontinuity and the main portion allows the jacket to be separated at the discontinuity to provide access to the core,

a cross-sectional area of each discontinuity is less than five per cent of a cross-sectional area of the jacket, and

the jacket is applied about the core by extruding the first material and the second material together.

2. The cable of claim 1, wherein the discontinuity extends along the entire length of the cable.

3. The cable of claim 1, wherein the jacket has an interior surface that faces the core and an exterior surface, the discontinuity forming a portion of the exterior surface.

4. The cable of claim 3, wherein the discontinuity extends radially inward from the exterior surface a distance of at least fifty per cent of a thickness of the jacket.

5. The cable of claim 3, wherein the discontinuity extends radially inward from the exterior surface to the interior surface of the jacket.

6. The cable of claim 1, wherein the core includes at least one optical fiber.

7. The cable of claims 1-6, wherein a cross-sectional area of each discontinuity is less than three per cent of a cross-sectional area of the jacket.

8. The method of claims 1-6, wherein the first extruded polymeric material is comprised of at least eighty per cent by weight of a first polymer, and wherein the second extruded polymeric material is comprised of at least seventy per cent by weight of a second polymer and at least 0.5 per cent by weight of the first polymer.

9. The cable of claim 8, wherein the first polymer is polyethylene and second polymer is polypropylene.

10. The cable of claims 1-6, wherein the at least one discontinuity includes two discontinuities that are spaced from one another in the jacket.

11. The cable of claims 1-6, wherein the at least one discontinuity has a maximum width that traverses less than 20 degrees of arc along a circumference of the jacket.

12. The cable of claims 1-6, wherein the at least one discontinuity has a maximum width measured perpendicular to a radius passing through the discontinuity that is less than 2 mm.

13. The cable of claims 1-6, wherein the at least one discontinuity has a maximum width measured perpendicular to a radius passing through the discontinuity that is less than 0.2 mm.

14. A method of making a cable, comprising:

advancing a core including a plurality of optical fibers in a first direction; and

extruding a jacket around the core, the extruding comprising:

introducing a first polymeric extrudate material into the extrusion apparatus;

forming at least one trough in a flow of the first extrudate material;

introducing a second polymeric extrudate material into the trough to form at least one discontinuity in the first extrudate material; and

allowing the first and second extrudate material to draw down and cool around the core, wherein the first and second material form a jacket around the core, wherein the second extrudate material flows in a flow of the first extrudate material as the jacket is extruded and the second extrudate material bonds to the first extrudate material as the first and second materials cool.

15. The method of claim 14, wherein a projection extends into a flow path of the first extrudate material to form the at least one trough.

16. The method of claim 14, wherein the jacket has an interior surface that faces the core and an exterior surface, the discontinuity forming a portion of the exterior surface.

17. The method of claim 16, wherein the discontinuity extends radially inward from the exterior surface a distance of at least fifty per cent of a thickness of the jacket.

18. The method of claims 14-17, wherein a cross-sectional area of each discontinuity is less than ten per cent of a cross-sectional area of the jacket.

19. The method of claims 14-17, wherein a cross-sectional area of each discontinuity is less than five per cent of a cross-sectional area of the jacket.

20. The method of claims 14-17, wherein the first polymeric extrudate material is comprised of at least eighty per cent by weight of a first polymer, and wherein the second polymeric extrudate material is comprised of at least seventy per cent by weight of a second polymer and at least 0.5 per cent by weight of the first polymer.

21. The method of claim 20, wherein the first polymer is polyethylene and second polymer is polypropylene.

22. The method of claims 14-21, wherein forming at least one trough in the flow of the first extrudate material comprises forming two spaced troughs.

23. The method of claims 14-22, wherein the first extrudate material forms a main portion and the second extrudate material forms a discontinuity having a maximum width that traverses less than 20 degrees of arc along a circumference of the jacket.

24. A method of making a cable, comprising:

advancing a core in a first direction, the core being capable of conveying communication signals; and

extruding a jacket around the core, the extruding comprising:

introducing a first polymeric extrudate material into the extrusion apparatus;

introducing a second polymeric extrudate material into the first polymeric extrudate material to form at least one discontinuity in the first extrudate material; and

allowing the first and second extrudate material to draw down and cool around the core, wherein the first and second material form a jacket around the core, wherein

the second extrudate material flows in a flow of the first extrudate material as the jacket is extruded and the second extrudate material bonds to the first extrudate material as the first and second materials cool, and

a cross-sectional area of each discontinuity is less than five per cent of a cross-sectional area of the jacket.

25. The method of claim 24, wherein the jacket has an interior surface that faces the core and an exterior surface, the discontinuity forming a portion of the exterior surface and extending radially inward from the exterior surface a distance of at least thirty per cent of a thickness of the jacket.

26. The method of claim 24, wherein the discontinuity has a depth that is at least fifty per cent of a thickness of the jacket.

27. A cable, comprising:

a core comprising a plurality of optical fibers; and

a jacket surrounding the core, the jacket comprising:

a main portion of a first polymeric extruded material;

a first discontinuity of a second polymeric extruded material in the main portion, the discontinuity extending along a length of the cable, and the first material being different from the second material; and

a second discontinuity of the second polymeric extruded material in the main portion and spaced from the first discontinuity, wherein

a bond between the discontinuities and the main portion allows the jacket to be separated at the discontinuities to provide access to the core,

the discontinuities have a depth that is at least thirty per cent of a thickness of the jacket, and

the first polymeric extruded material comprises at least eighty per cent polyethylene by weight, and the second polymeric extruded material comprises at least seventy per cent polypropylene by weight and at least 0.5 per cent polyethylene by weight.

28. A cable, comprising:

a core including at least one optical fiber; and

a jacket surrounding the core, the jacket comprising:

a main portion of a first extruded polymeric material; and

at least one thin film discontinuity of a second extruded polymeric material in the main portion, the discontinuity extending along a length of the cable, and the first material being different from the second material, wherein

the bond between the discontinuity and the main portion allows the jacket to be separated at the discontinuity to provide access to the core,

wherein the at least one thin film discontinuity has a maximum width that traverses less than 2 degrees of arc along a circumference of the jacket, and

the jacket is applied about the core by extruding the first material and the second material together.

29. The cable of claim 28, wherein the discontinuity extends radially inward a distance of at least fifty per cent of a thickness of the jacket.

30. The cable of claim 28, wherein the first extruded polymeric material is polyethylene and second extruded polymeric material is polypropylene.

31. A cable, comprising:

a core comprising a plurality of optical fibers; and

a jacket surrounding the core, the jacket comprising:

a main portion of a first polymeric extruded material; and

at least one discontinuity of a second polymeric extruded material in the main portion, the discontinuity extending along a length of the cable, and the first material being different from the second material, wherein

a bond between the discontinuities and the main portion allows the jacket to be separated at the discontinuities to provide access to the core,

the discontinuities have a depth that is at least thirty per cent of a thickness of the jacket, and

the first polymeric extruded material comprises at least eighty per cent of a first polymer by weight, and the second polymeric extruded material comprises at least seventy per cent of a second polymer by weight and at least 1 per cent of the first polymer by weight.

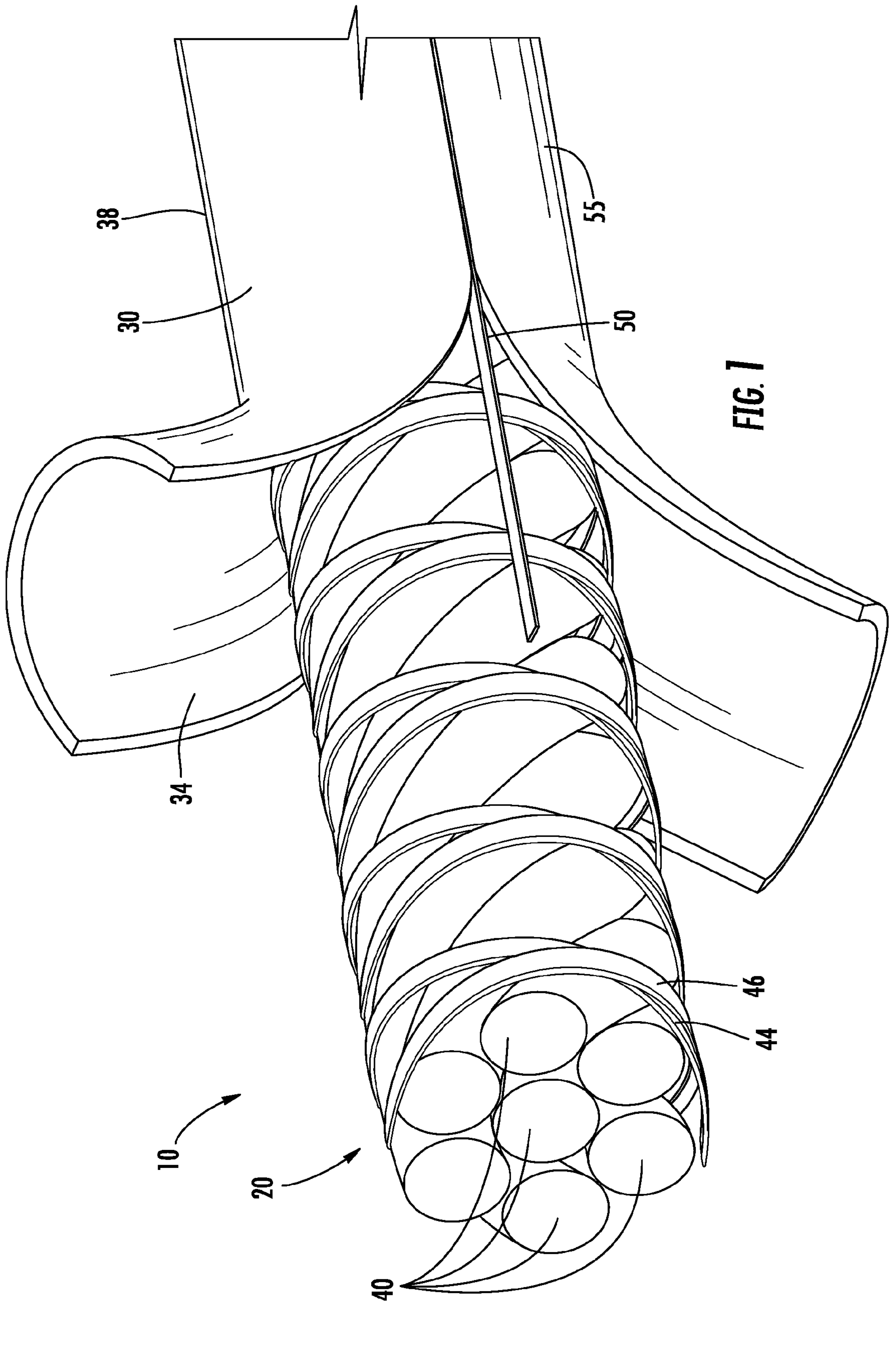


FIG. 1

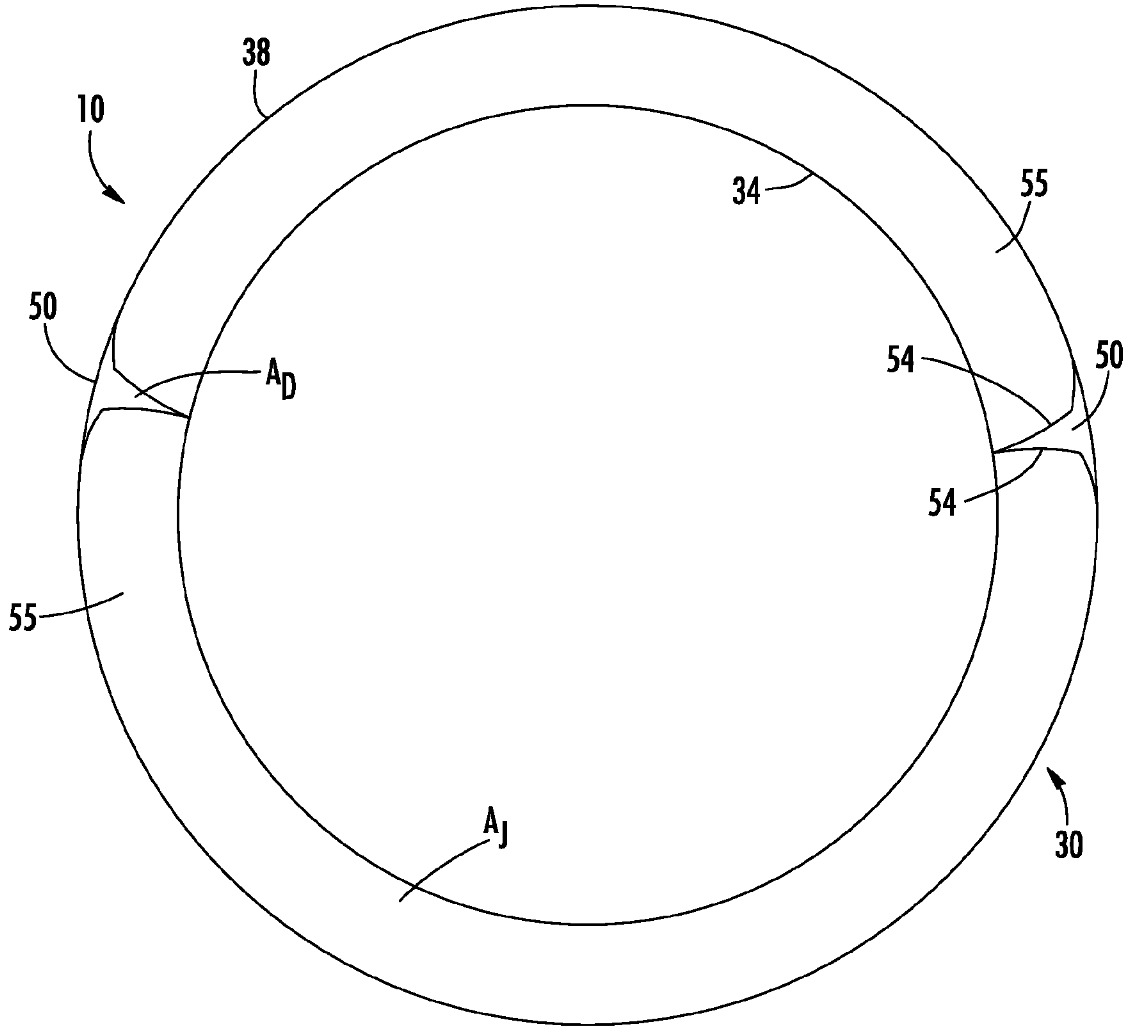


FIG. 2

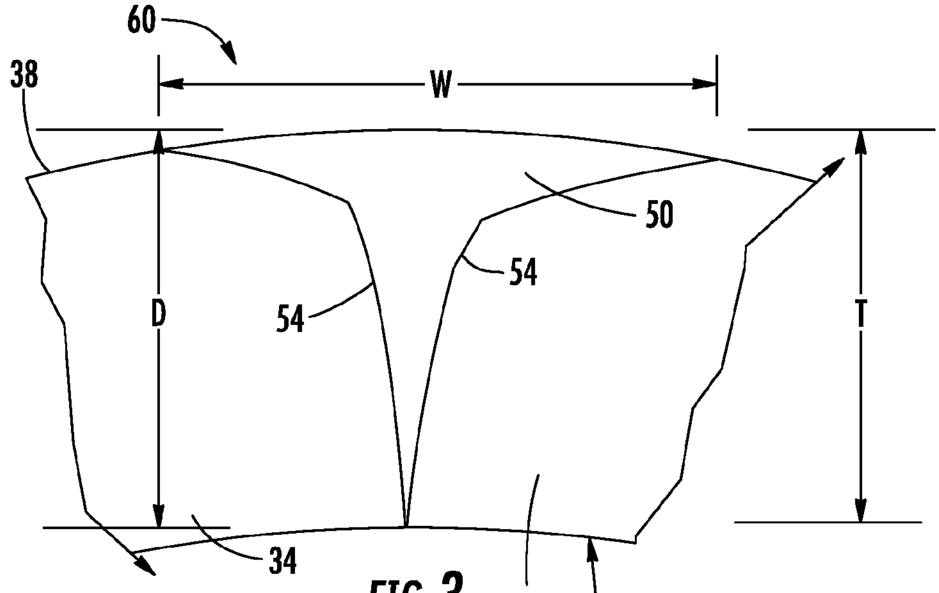


FIG. 3

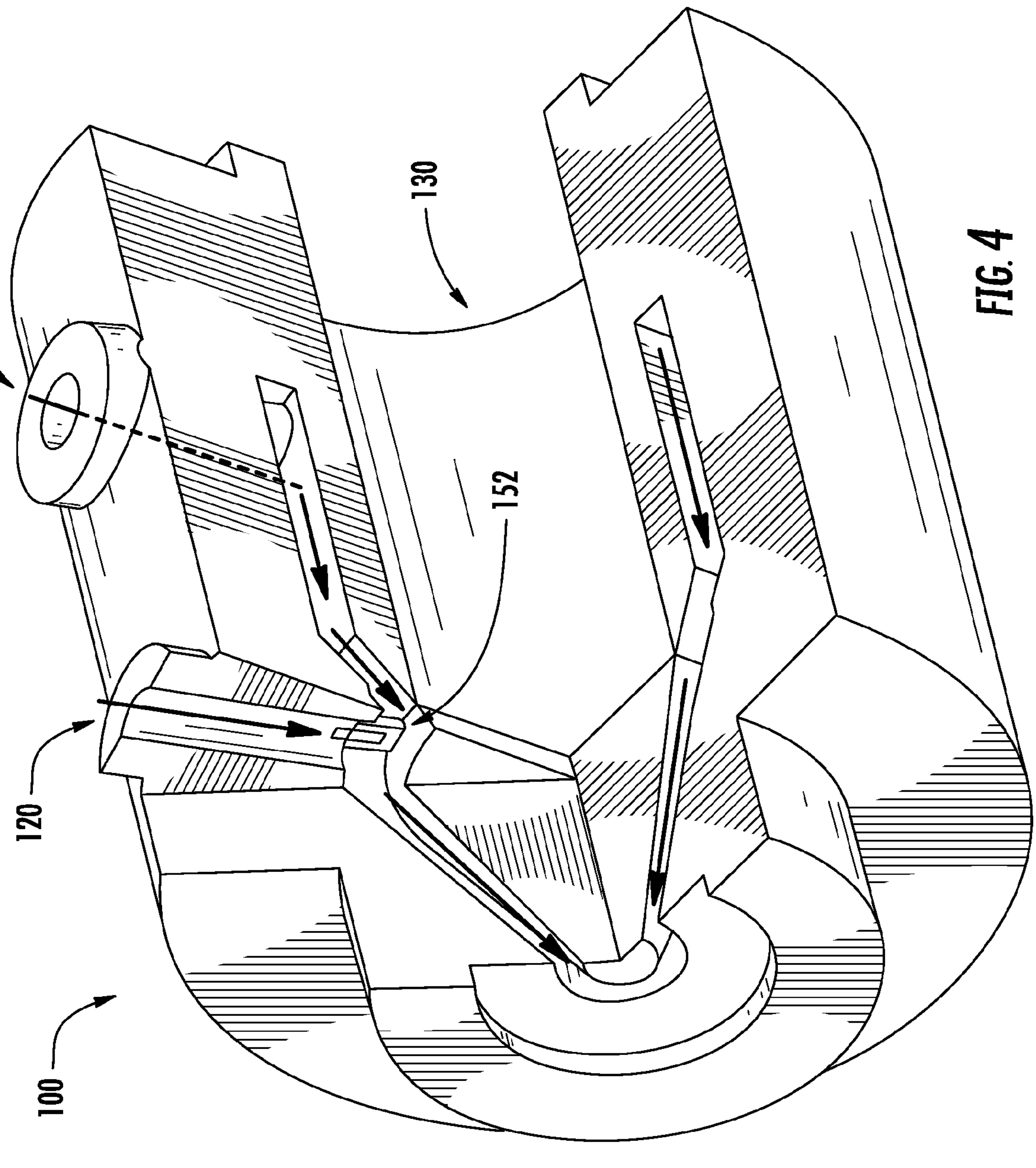


FIG. 4

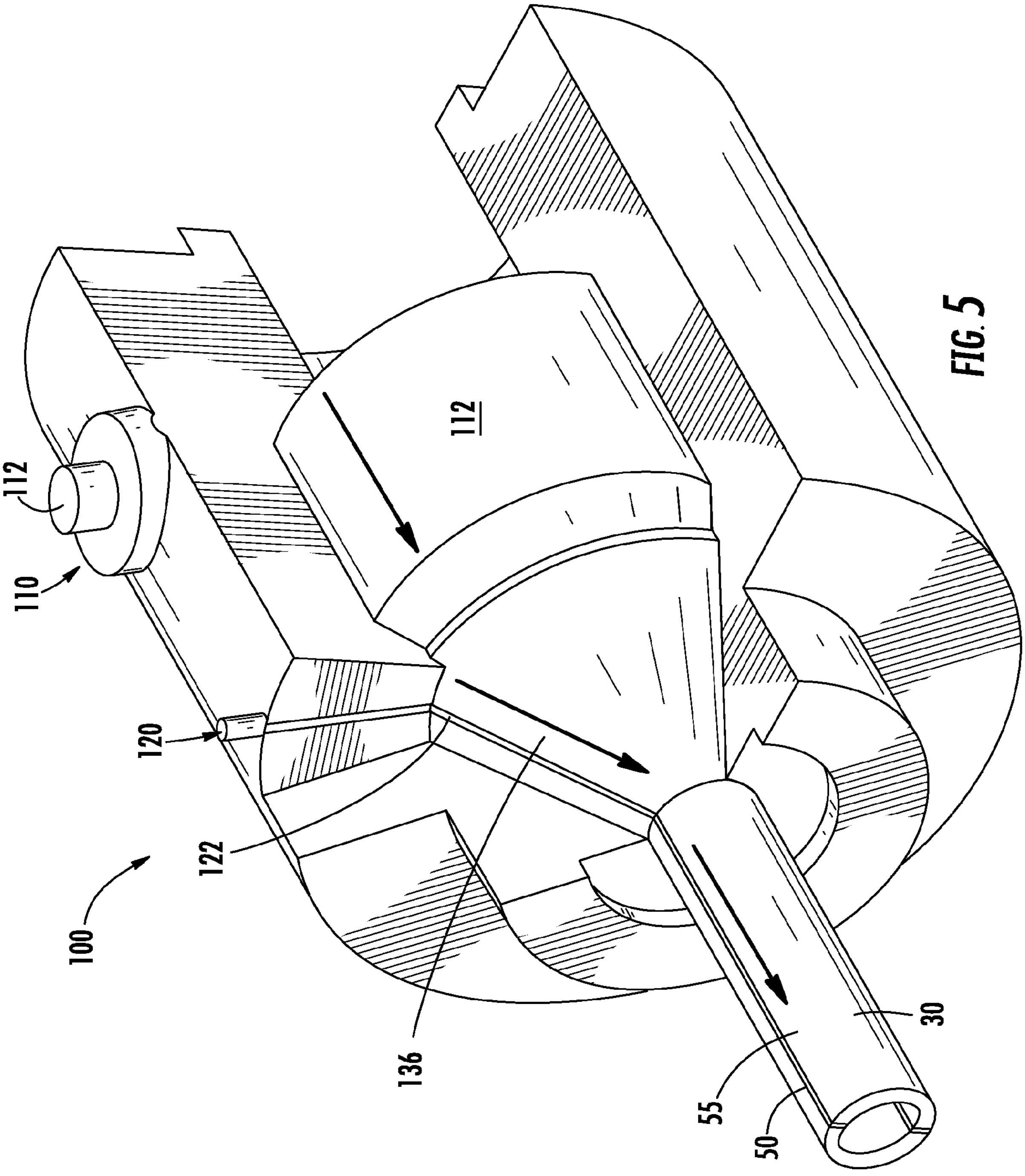


FIG. 5

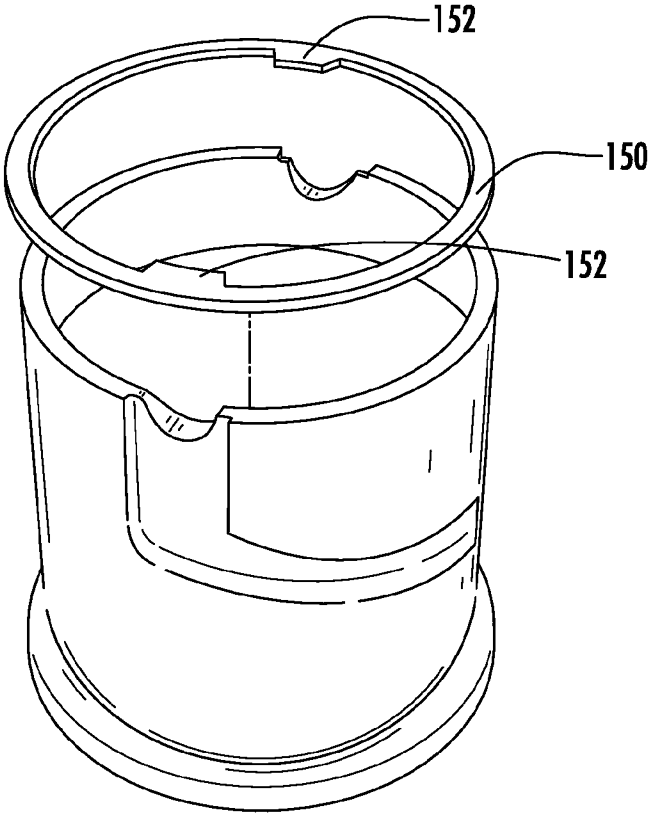


FIG. 6

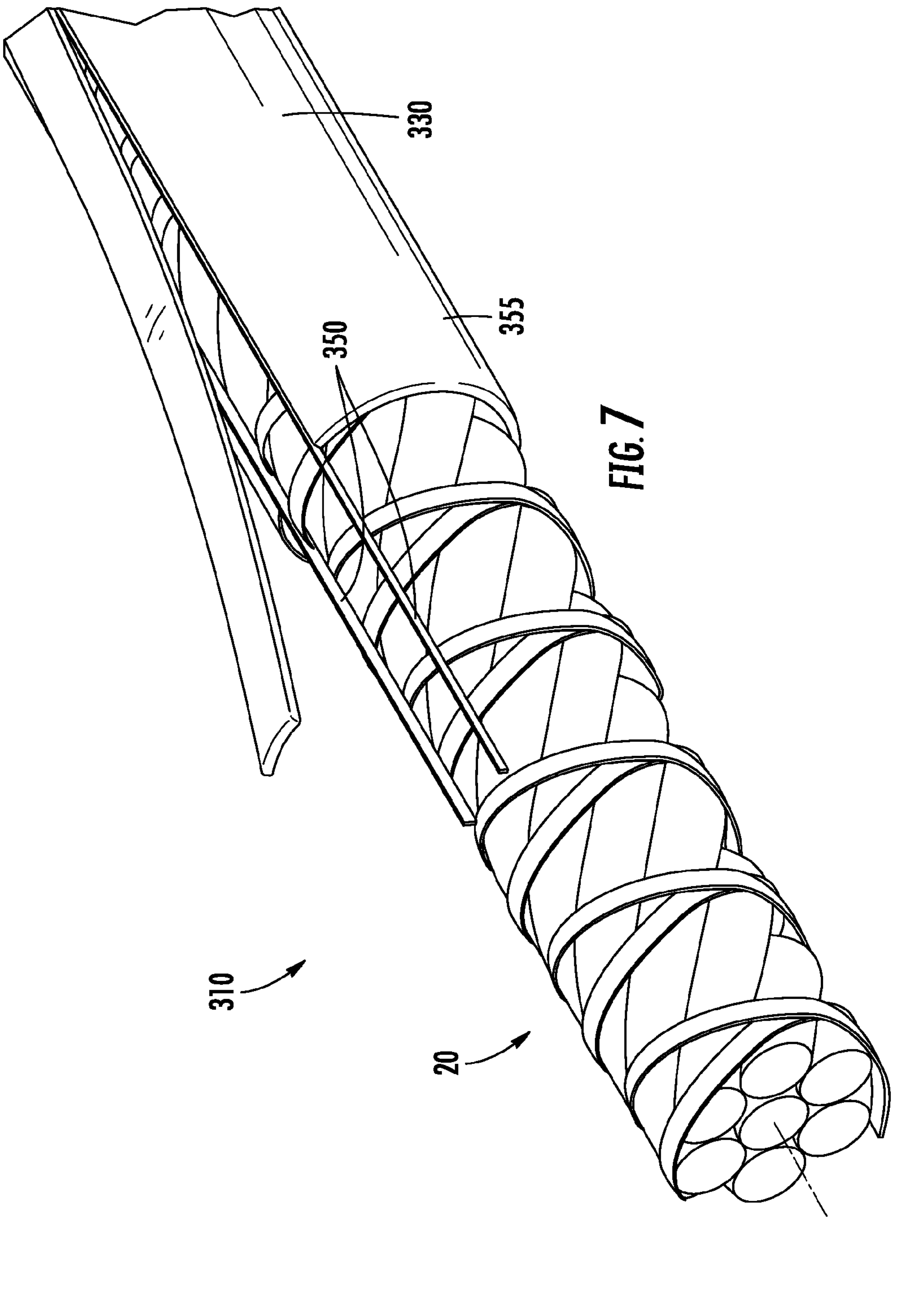


FIG. 7

# INTERNATIONAL SEARCH REPORT

International application No
PCT/US2011/034309

A. CLASSIFICATION OF SUBJECT MATTER
INV. B29C47/02 G02B6/44 H01B13/14
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)
B29C G02B H01B

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y | JP 9 230184 A (MITSUBISHI CABLE IND LTD) 5 September 1997 (1997-09-05)<br>abstract; figure 1 | 1-7, 10-13, 28,29 |
| X | US 5 970 196 A (GREVELING JOHANNES IAN [US] ET AL) 19 October 1999 (1999-10-19) cited in the application | 1-4,6,10 |
| Y | column 4, line 1 - column 5, line 3; figures 3,6,7,10,11 | 24-26 |
| Y | US 4 248 824 A (HATTOP PETER H) 3 February 1981 (1981-02-03) column 4, line 37 - column 5, line 51; figure 1 | 24-26 |

-/--

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

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 14 July 2011 | 08/09/2011 |

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

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

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2011/034309

**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.:

1-7, 10-13, 24-26, 28, 29

**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.

# INTERNATIONAL SEARCH REPORT

| International application No |
| --- |
| PCT/US2011/034309 |

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
| --- | --- | --- |
| Y | Corning Cable Systems: "CORNING CABLE SYSTEMS GENERIC SPECIFICATION FOR CONNECTORIZATION-GRADE OPTICAL FIBRE RIBBONS, November 2002, Revision 4", , 1 November 2002 (2002-11-01), pages 1-4, XP002650267, Retrieved from the Internet: URL:http://CCSwebapps.corning.com/web/library/AENOTES.NSF/$ALL/PGSF06/$FILE/PGSF06.pdf [retrieved on 2011-07-13] page 1; figure 1; table 2 ----- | 1-7, 10-13, 28,29 |

## INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2011/034309

| Patent document cited in search report | | Publication date | Patent family member(s) | | Publication date |
|---|---|---|---|---|---|
| JP 9230184 | A | 05-09-1997 | NONE | | |
| US 5970196 | A | 19-10-1999 | CA | 2247674 A1 | 22-03-1999 |
| US 4248824 | A | 03-02-1981 | CA | 1149035 A1 | 28-06-1983 |

**FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210**

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

1. claims: 1-7, 10-13, 24-26, 28, 29

   Subject 1 relates to a cable with a polymer jacket having a discontinuity formed therein being made of a different polymer and occupying less than five percent of jacket cross sectional area, to further details concerning width, thickness, and extension of the discontinuity in the jacket, and to a corresponding method of production.

   ---

2. claims: 8, 9, 27, 30, 31

   Subject 2 also relates to a cable with a polymer jacket having a discontinuity formed therein being made of a different polymer and occupying less than five percent of jacket cross sectional area, and to details concerning the polymer materials used.

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3. claims: 14-23

   Subject 3 relates to a method of producing a cable polymer jacket having a having a discontinuity formed therein being made of a different polymer by extrusion and trough forming.

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