US006963686B2

(12) **United States Patent**
Moon

(10) **Patent No.: US 6,963,686 B2**
(45) **Date of Patent: Nov. 8, 2005**

(54) **OPTICAL FIBER CABLE FOR AIR-BLOWN INSTALLATION**

(75) Inventor: **Seung-Hyun Moon**, Kumi (KR)

(73) Assignee: **Samsung Electronics Co., Ltd.**, Suwon-si (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/764,115**

(22) Filed: **Jan. 23, 2004**

(65) **Prior Publication Data**

US 2004/0240810 A1 Dec. 2, 2004

(30) **Foreign Application Priority Data**

May 27, 2003 (KR) 10-2003-0033754

(51) **Int. Cl.**[7] **G02B 6/44**

(52) **U.S. Cl.** **385/113**; 385/111

(58) **Field of Search** 385/113, 111, 385/109

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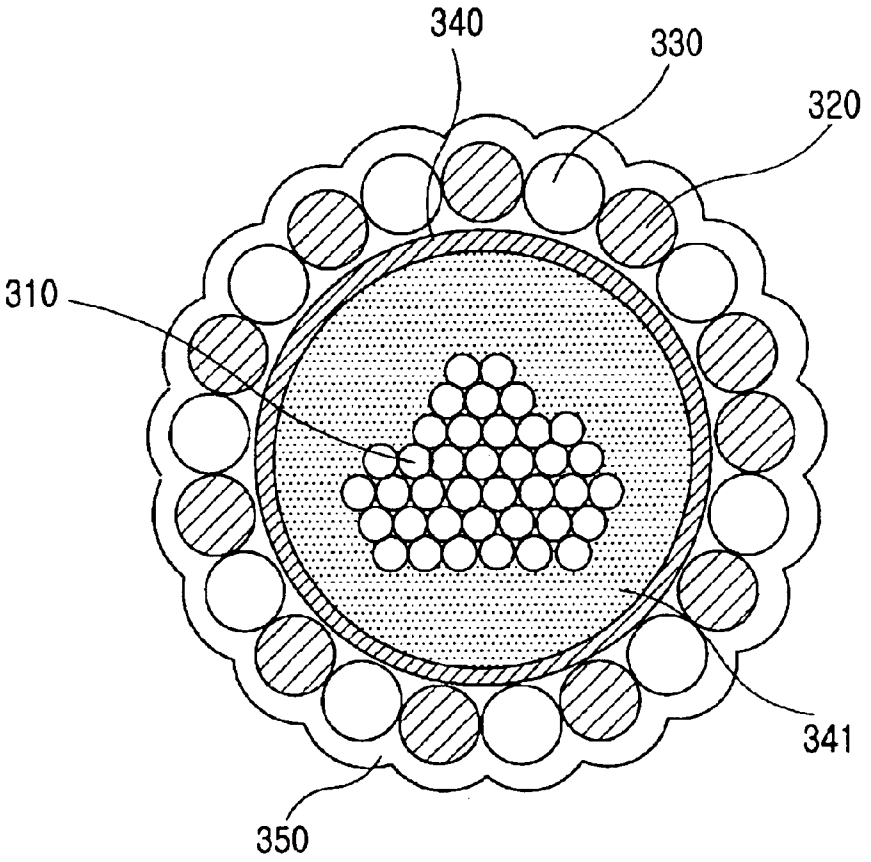
Primary Examiner—Hae Moon Hyeon
(74) *Attorney, Agent, or Firm*—Cha & Reiter, L.L.C.

(57) **ABSTRACT**

An optical fiber cable for air-blown installation includes optical fibers acting as a medium for transmitting optical signals; a tube binding the optical fibers; string fillers surrounding the outer periphery of the tube at a predetermined spacing, tensile members positioned between the string fillers to surround the outer periphery of the tube for improving the tensile force of the optical fiber cable; and an outer sheath formed in a flexuous shape to surround the outer circumferences of the string fillers and the tensile members.

14 Claims, 4 Drawing Sheets



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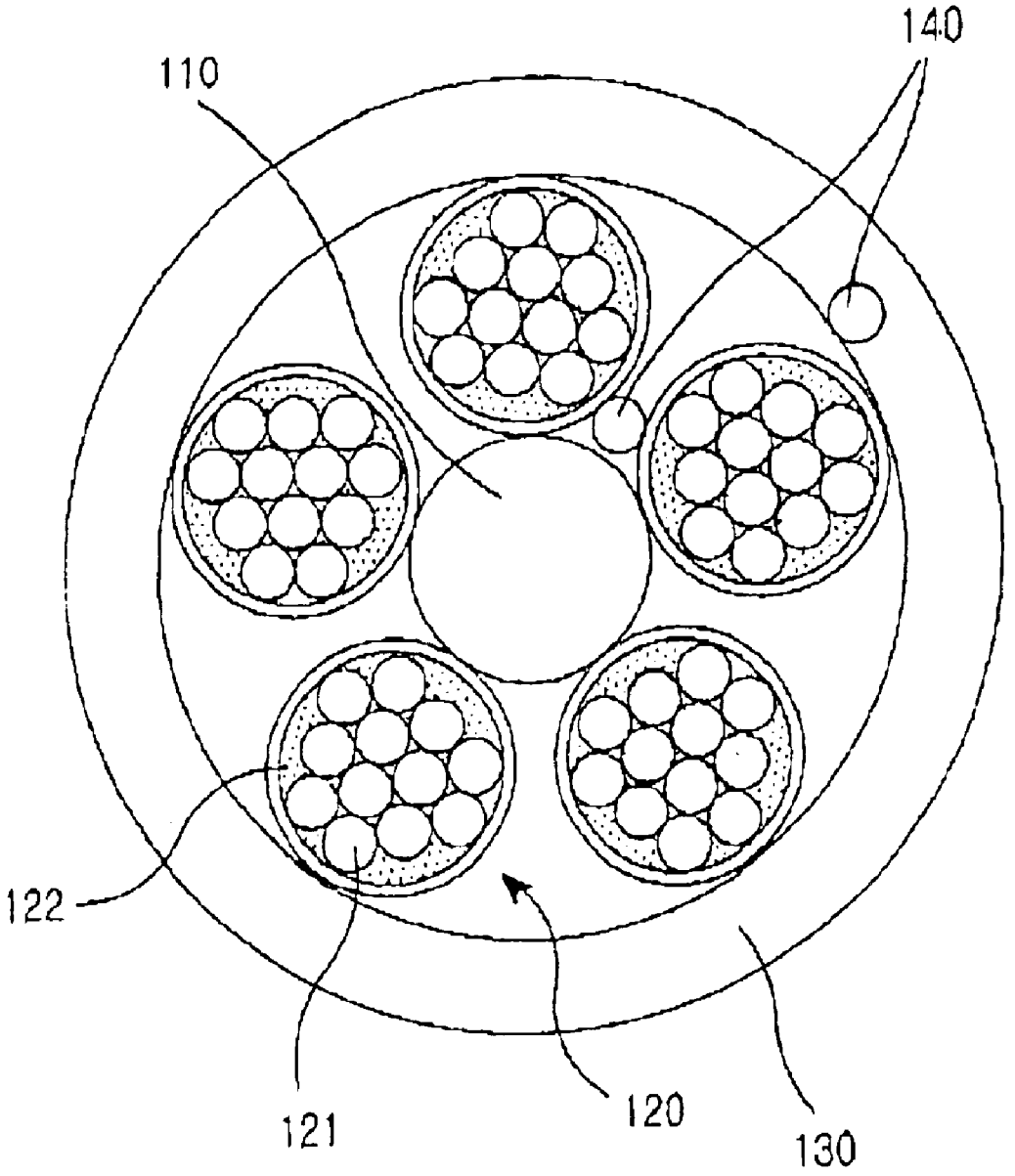

FIG. 1
(PRIOR ART)

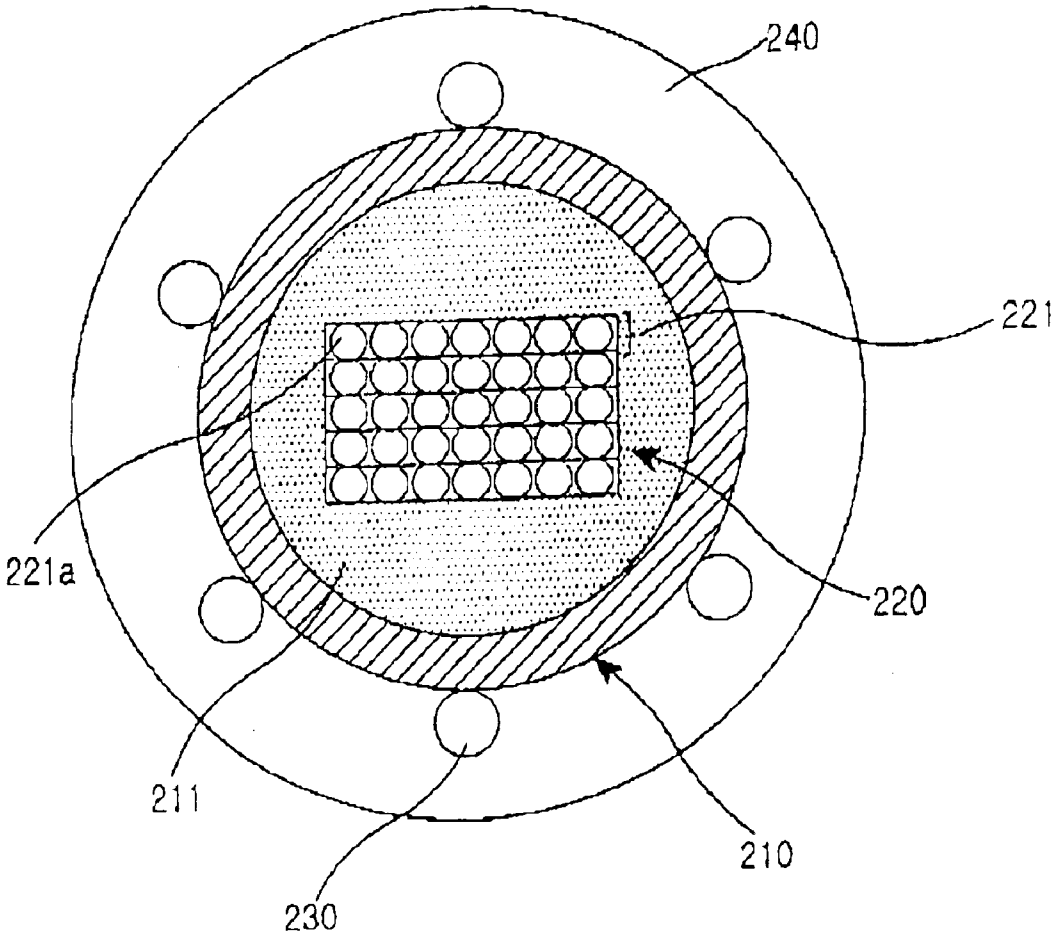

FIG. 2
(PRIOR ART)

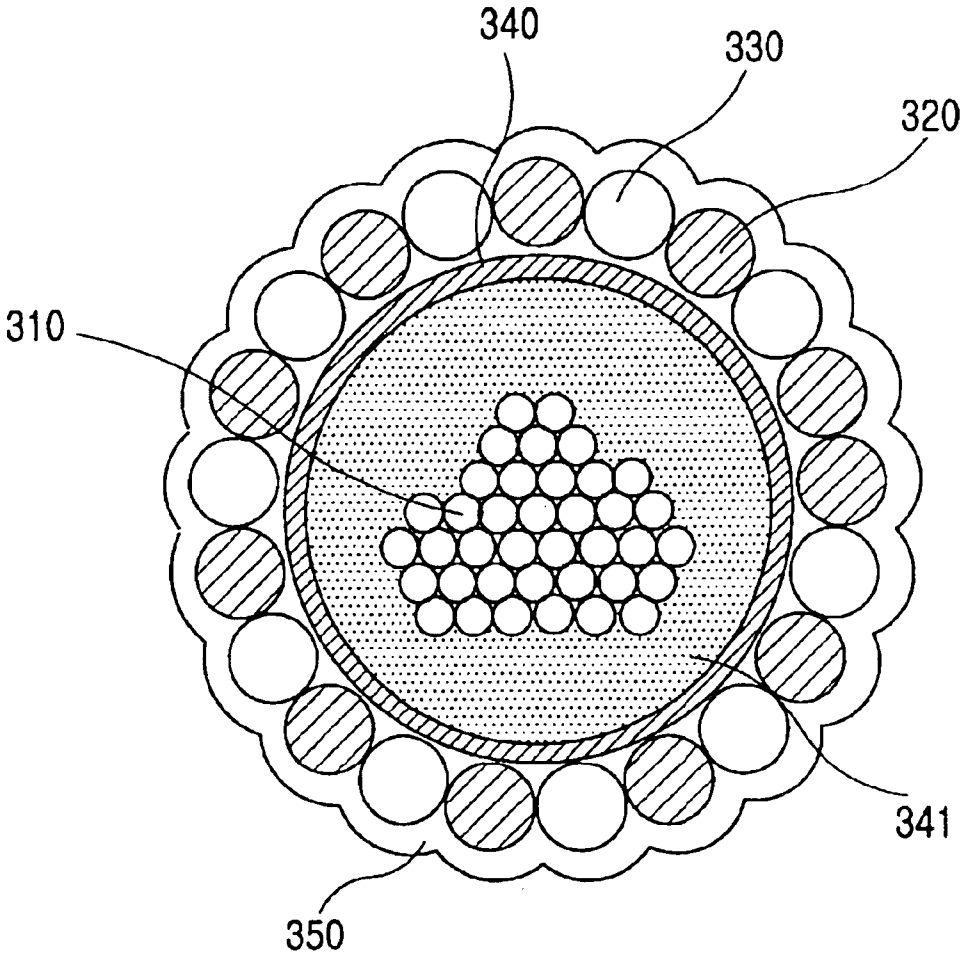

FIG.3

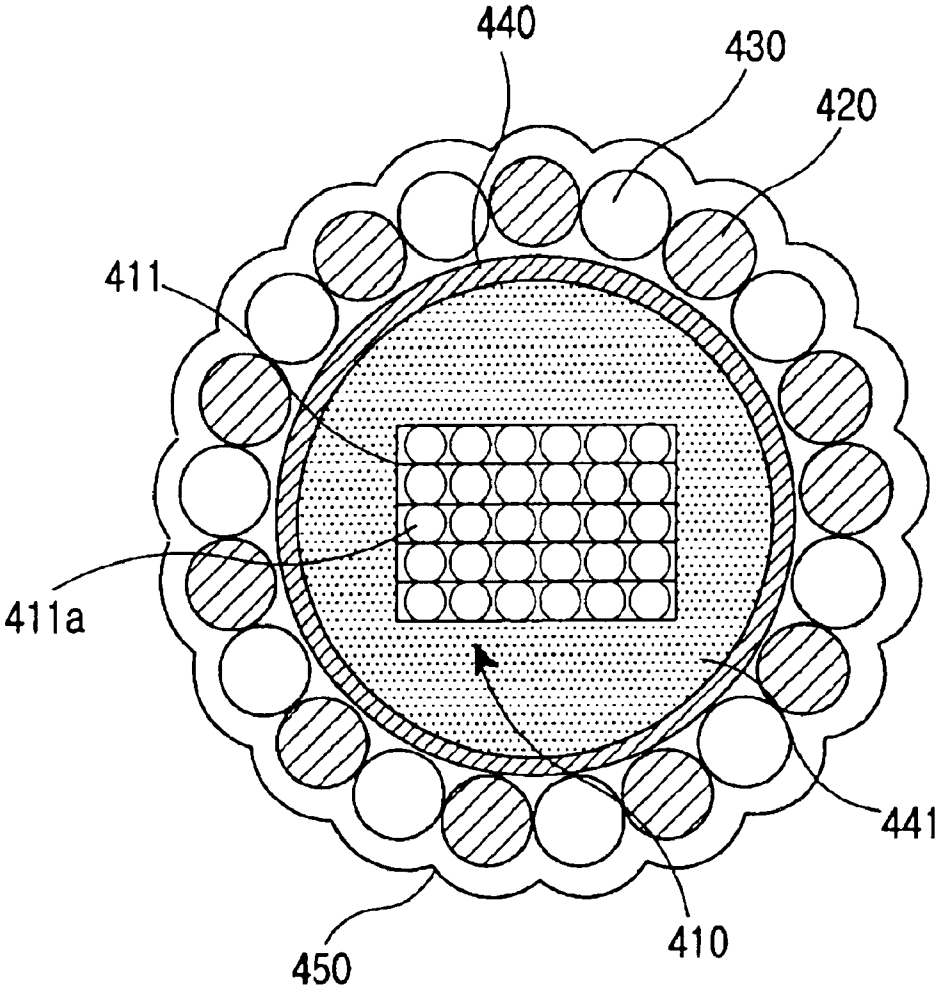

FIG.4

OPTICAL FIBER CABLE FOR AIR-BLOWN INSTALLATION

CLAIM OF PRIORITY

This application claims priority to an application entitled "optical fiber cable for air-blown installation," filed with the Korean Intellectual Property Office on May 27, 2003 and assigned Ser. No. 2003-33754, the contents of which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an optical fiber cable, and more particularly to an optical fiber cable for air-blown installation between a telephone office and a subscriber network.

2. Description of the Related Art

An optical fiber cable serves as a medium for transmitting optical signals through optical fibers. It includes optical fibers, tensile members, a waterproof member and an outer sheath to protect and improve the physical characteristics of the stranded optical fibers. The optical fiber is a glass wire which is made from material such as silica, mainly from quartz, and is easy to handle and install since its diameter is as small as that of a hair. The optical fiber includes a core for transmitting light therein, a clad for confining the light propagating within the core, and a sheath for surrounding the clad.

Optical fiber has have many advantages over coaxial cable, but is problematic in that optical fiber is susceptible to physical and environmental effects. Accordingly, optical fiber cables, which have superior physical characteristics and installation efficiency in comparison with those of the optical fiber, have become widespread. Specifically, indoor optical fiber cables are generally used as networks for connecting telephone offices as well as means for connecting subscribers.

FIG. **1** shows a prior art optical fiber cable having a central tensile member **110** positioned at the center thereof, a plurality of tubes **120** arranged about the central tensile member **110**, an outer sheath **130** binding the tubes **120** and the central tensile member **110**. The cable further includes rip codes **140** positioned in an empty space between the tubes **120** and on the inner wall of the outer sheath **130**.

The central tensile member **110** provides the optical fiber cable with a tension-resistant force and is positioned at the center thereof. The central tensile member **110** may be made from a material such as an FRP (fiberglass reinforced plastic).

Each of the tubes **120** has a plurality of tight-coated optical fibers **120** stranded therein and a filler **122** such as strands of aramid yarn to occupy the empty space. The filler prevents moisture from penetrating into the tubes **120** and relieves any shock applied to the optical fibers **121**.

The outer sheath **130** is positioned at the outermost side of the optical fiber cable and is made of a polymer compound such as a PVC (polyvinyl chloride) or a PE (polyethylene). The outer sheath **130** is formed by an extrusion process.

The rip codes **140** are positioned in the empty space between the tubes **120** or on the inner wall of the outer sheath **130** to easily peel off the optical fiber cable. The rip codes **140** may be made of aramid yarn or glass yarn.

Shortcomings of the above-described optical fiber cable include undesired contraction during a change in external surroundings, such as a sudden temperature drop. Also, tensile force during installation in insufficient, because the cable is limited to a single central tensile member.

In an effort to overcome the above-mentioned problem, an optical fiber cable having a plurality of tensile members has been proposed. FIG. **2** shows an optical fiber cable that includes a ribbon tube **210** mounted at the center thereof, a plurality of tensile members **230** positioned around the ribbon tube **210** at a predetermined spacing, and an outer sheath **240** binding the ribbon tube **210** and the tensile members **230**.

Within the ribbon tube **210** is a bundle **220** of ribbon optical fibers surrounded by a filler **211**. The bundle **220** of ribbon optical fibers is formed by laminating ribbon optical fibers **211** having multi-cores. The ribbon optical fibers **221** are formed by arranging a plurality of optical fibers **221***a* in a line, applying an UV curing agent thereon, and curing the agent. The empty space of the ribbon tube **210** is filled with a filler **211**, such as a jelly compound, acting as a waterproof substance.

The tensile members **230** are positioned on the outer periphery of the ribbon tube **210** at a predetermined spacing and provide the ribbon tube **210** with a tension-resistant force. The outer sheath **240**, positioned at the outermost side of the optical fiber cable, is formed by an extrusion process.

However, the optical fiber cable cannot be easily installed in a crooked pipeline or a curved pipeline due to poor flexibility caused by the tensile members.

SUMMARY OF THE INVENTION

The present invention, which has been made to solve the above-mentioned problems, provides an optical fiber cable, which can be easily installed and which resists deformation that might otherwise be induced by external surroundings, such as contraction caused by a temperature drop.

In one aspect of the present invention, an optical fiber cable includes optical fibers acting as a medium for transmitting optical signals, a tube binding the optical fibers, string fillers surrounding an outer periphery of the tube at a predetermined spacing, tensile members and an outer sheath. The tensile members are positioned between the string fillers to surround the outer periphery of the tube and improve the tensile force of the optical fiber cable. The string fillers and tensile members are curved in cross-section and have respective radially outer surfaces that collectively define an outer surface for the string fillers and tensile members as positioned around the tube. The outer sheath is formed in a flexuous shape to surround the outer surface of the string fillers and tensile members.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other aspects, features and advantages of the present invention will be more apparent from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. **1** is a sectional view of an optical fiber cable comprising a plurality of tubes according to the prior art;

FIG. **2** is a sectional view of an optical fiber cable comprising a bundle of ribbon optical fibers;

FIG. **3** is a sectional view of an optical fiber cable with a uni-tube structure that features a plurality of optical fibers according to a preferred embodiment of the present invention; and

FIG. **4** is a sectional view of an optical fiber cable featuring a bundle of ribbon optical fibers in accordance with another embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Hereinafter, optical fiber cables for air-blown installation according to preferred embodiments of the present invention will be described with reference to the accompanying drawings. In the following description of the present invention, detailed description of known functions and configurations incorporated herein will be omitted for clarity.

FIG. **3** shows the constitution of an optical fiber cable with a uni-tube structure featuring a plurality of optical fibers according to a preferred embodiment of the present invention. The optical fiber cable includes a plurality of optical fibers **310** acting as a medium for transmitting optical signals; a tube **340** binding the optical fibers **310**; a plurality of string fillers **330** surrounding the outer periphery of the tube **340**; a plurality of tensile members **320** positioned between the string fillers **330** to surround the outer periphery of the tube **340**; and an outer sheath **350**.

The optical fibers **310** act as a medium for transmitting optical signals and are mounted within the tube **340**. The empty space between the tube **340** and the optical fibers **310** is filled with a gel filler **341**, such as a jelly compound.

The optical fiber cable according to the present invention is also applicable to a tube structure of a "dry" type or a "tight buffer" type, whose tube is not filled with a gel filler.

The string fillers **330** surround the outer periphery of the tube **340** at a predetermined spacing. The string fillers **330** are composed of a polymer material so that the optical fiber cable is provided with a tensile force and is kept in a flexible state at the same time.

The tensile members **320** are positioned between the string fillers **330** to surround the outer periphery of the tube **340** for improving the tensile force of the optical fiber cable. The tensile members **320** are composed of a mixture of an FRP and an UV curing agent. The content of the FRP in the total mixture is less than 95%. This provides the optical fiber cable with a tensile force which is necessary during air-blown installation and, at the same time, improves flexibility for easy installation.

The string fillers **330** and the tensile members **320** are stranded in an S-Z form or in a helical form along the outer periphery of the tube **340**. This improves the tension-resistant force and tensile force against any physical impact from outside. The arrangement and number of the string fillers **330** and the tensile members **320** can be modified in a variety of way according to their applications. Detailed descriptions on the optical fiber cable whose tubes are arranged in the S-Z form, as mentioned above, is described in U.S. Pat. No. 4,828,352 to Heinrich A. Kraft, entitled "S-Z STRANDED OPTICAL CABLE", the whole contents of which are incorporated herein by reference. Accordingly, detailed description on the string fillers and tubes stranded in the S-Z form has been omitted.

The outer sheath **350** is formed into a flexuous shape by an extrusion process to surround the outer circumferences of the string fillers **330** and the tensile members **320**, so that the air-blown installation of the optical fiber cable can be easily performed. As shown, the string fillers **330** and tensile members **320** are curved in cross-section, and have respective radially outer surfaces that collectively define an outer surface for the fillers and members as positioned around the tube. The outer sheath **350** is formed with an outer surface that in cross-section is flexuous in correspondence with the outer surface of the fillers and members. The outer sheath **350** may be made from material such as a PE polymer-based material.

FIG. **4** shows an optical fiber cable featuring a bundle of ribbon optical fibers according to another embodiment of the present invention. The optical fiber cable includes: a bundle **410** of ribbon optical fibers; a tube **440** binding the bundle **410** of optical fibers; a plurality of string fillers **430** surrounding the outer periphery of the tube **440**; a plurality of tensile members **420** positioned between the string fillers **430** to surround the outer periphery of the tube **440**; and an outer sheath **450** formed in a flexuous shape.

The bundle **410** of ribbon optical fibers is formed by laminating ribbon optical fibers **411**, applying an UV curing agent thereon, and curing the agent. The ribbon optical fibers **411** are formed by arranging the optical fibers **411***a* in a line, applying an UV curing agent thereon, and curing the agent. The bundle **410** of ribbon optical fibers is mounted within the tube **440**.

The tube **440** binds the bundle **410** of ribbon optical fibers. The empty space between the tube **440** and the bundle **410** of ribbon optical fibers is filled with a gel filler **441**, such as a jelly compound. The tube **440** may be composed of a polymer compound such as a PVC.

The string fillers **430** surround the outer periphery of the tube **440** at a predetermined spacing. The string fillers **430** may be composed of a polymer material. The string fillers **430** provide the optical fiber cable with a tensile force and keep it in a flexible state at the same time.

The tensile members **420** are positioned between the string fillers **430** to surround the outer periphery of the tube **440** for improving the tensile force of the optical fiber cable. The tensile members **420** are composed of a mixture of an FRP and an UV curing agent.

The string fillers **430** and the tensile members **420** are stranded in an S-Z form or in a helical form along the outer periphery of the tube **440**. This improves the tension-resistant force and tensile force against any physical impact from outside.

The outer sheath **450** is formed into a flexuous shape by an extrusion process to surround the outer circumferences of the string fillers **430** and the tensile members **420**, so that air-blown installation of the optical fiber cable can be performed easily. The outer sheath **450** is positioned at the outermost side of the optical fiber cable and may be made of a polymer compound such as a PVC or a PE. The outer sheath **450** is formed by an extrusion process. The outer sheath **450** may have rip codes (not shown) mounted adjacent its inner wall to easily peel off the optical fiber cable.

The inventive construction which interposes string fillers, made of a polymer material, between tensile members positioned on the outer periphery of a tube advantageously prevents contracting of the optical fiber cable due to a temperature drop. The design also allows the cable to maintain its flexibility, which is necessary during installation. Furthermore, the flexuous shape of the outer sheath affords easy air-blown installation of the optical fiber cable.

While the invention has been shown and described with reference to certain preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. An optical fiber cable for air-blown installation, comprising:

a plurality of optical fibers acting as a medium for transmitting optical signals;

a tube having a radially outer surface binding the optical fibers;

a plurality of string fillers surrounding an outer periphery of the tube at a predetermined spacing;

a plurality of tensile members positioned between the string fillers to surround the outer periphery of the tube for improving the tensile force of the optical fiber cable, the string fillers and tensile members being curved in cross-section, having respective radially outer surfaces that collectively define an outer surface for the string fillers and tensile members as positioned around the tube, and being stranded in an S-Z form along the tube outer surface; and

an outer sheath formed in a flexuous shape to surround said outer surface for the string fillers and tensile members.

2. The cable of claim **1**, wherein the outer sheath is formed with an outer surface that in cross-section is flexuous in correspondence with said outer surface of the string fillers and tensile members.

3. The cable of claim **2**, wherein the tube, string fillers and tensile members are formed generally circular in cross-section.

4. The cable of claim **1**, wherein the string fillers and the tensile members are stranded in a helical form along the tube outer surface.

5. The cable of claim **1**, wherein the tensile members are made from a mixture of fiberglass reinforced plastic (FRP) in the range of less than 95% and an UV curing agent.

6. The cable of claim **1**, wherein the string fillers are made from a polymer material which provides the optical fiber cable with expandability and a tension-resistant force.

7. The cable of claim **1**, wherein the outer sheath is made from a polyethylene (PE) polymer-based material.

8. The cable of claim **1**, wherein an empty space between the tube and the optical fibers is filled with a gel filler.

9. An optical fiber cable for air-blown installation, comprising:

a bundle of optical fibers formed by laminating a plurality of optical fiber ribbons acting as a medium for transmitting optical signals;

a tube having a radially outer surface binding the bundle of optical fibers;

a plurality of string fillers surrounding an outer periphery of the tube at a predetermined spacing;

a plurality of tensile members positioned between the string fillers to surround the outer periphery of the tube for improving the tensile force of the optical fiber cable, the string fillers and tensile members being curved in cross-section and having respective radially outer surfaces that collectively define an outer surface for the string fillers and tensile members as positioned around the tube, and being stranded in a helical or S-Z form along the tube outer surface; and

an outer sheath formed in a flexuous shape to surround said outer surface for the string fillers and tensile members.

10. The cable of claim **9**, wherein an empty space between the tube and the optical fibers is filled with a gel filler.

11. The cable of claim **9**, where the outer sheath is formed with an outer surface that in cross-section is flexuous in correspondence with said outer surface of the string fillers and tensile members.

12. The cable of claim **11**, wherein the tube, string fillers and tensile members are formed generally circular in cross-section.

13. A method for forming an optical fiber cable for air-blown installation, comprising the steps of:

providing a plurality of optical fibers acting as a medium for transmitting optical signals;

providing a tube binding the optical fibers;

surrounding, with a plurality of string fillers, an outer periphery of the tube at a predetermined spacing;

positioning a plurality of tensile members positioned between the string fillers to surround the outer periphery of the tube for improving the tensile force of the optical fiber cable, the string fillers and tensile members being curved in cross-section and having respective radially outer surfaces that collectively define an outer surface for the string fillers and tensile members as positioned around the tube;

stranding the string fillers and tensile members along stranded in a S-Z form along the tube outer surface; and

providing an outer sheath formed in a flexuous shape to surround said outer surface for the string fillers and tensile members.

14. The method of claim **13**, wherein the outer sheath providing step comprises the step of forming the outer sheath with an outer surface that in cross-section is flexuous in correspondence with said outer surface of the string fillers and tensile members.

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