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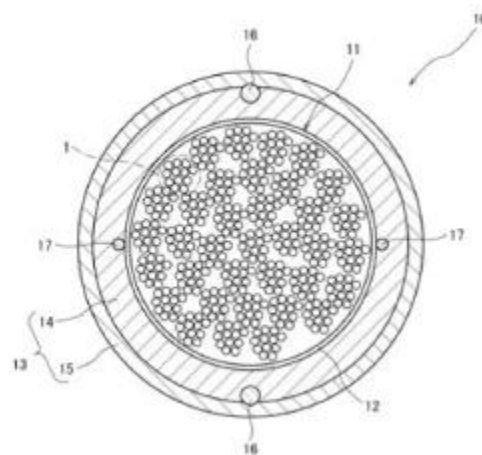
(54) [Title of Invention] FIBER OPTIC CABLE

[Abstract]

[Problem] To provide a slotless fiber optic cable that can be easily passed through a duct.

[Resolution Means] A slotless fiber optic cable 10 being provided with a plurality of fiber optic cores, a fiber optic tape core having fiber optic cores arranged side by side (illustrated by the intermittent tape core 1), or an assembly core 11 consolidating the plurality of fiber optic cores and a fiber optic tape core; and a cable outer cover 13 provided around the assembly core. The cable outer cover is provided with an inner layer 14 provided outside the assembly core and an outer layer 15 provided outside the inner layer. The density of the material used for the outer layer is $0.942 \text{ (g/cm}^3\text{)}$ or greater, and the density of the material used for the inner layer is less than $0.942 \text{ (g/cm}^3\text{)}$.

[Selected Drawing] FIG. 1



[Scope of Patent Claims]

[Claim 1]

A slotless fiber optic cable comprising a plurality of fiber optic cores, a fiber optic tape core having fiber optic cores arranged side by side, or an assembly core consolidating the plurality of fiber optic cores and a fiber optic tape core; and a cable outer cover provided around the assembly core; wherein

the cable outer cover has an inner layer provided outside the assembly core and an outer layer provided outside the inner layer,

the density of a material used for the outer layer is $0.942 \text{ (g/cm}^3\text{)}$ or greater, and the density of the material used for the inner layer is less than $0.942 \text{ (g/cm}^3\text{)}$.

[Claim 2]

The fiber optic cable according to claim 1, wherein the ratio of the cross-sectional area of the outer layer to the total cross-sectional area of the cable outer cover is 60 (%) or less.

[Claim 3]

The fiber optic cable according to claim 1 or claim 2, wherein the ratio of the cross-sectional area of the outer layer to the total cross-sectional area of the cable outer cover is 20 (%) or greater.

[Claim 4]

The fiber optic cable according to any one of claim 1 to claim 3, wherein the product of the synthetic tensile elastic modulus of the cable outer cover and the total cross-sectional area of the cable outer cover is 60,000 (N) or less when the tensile elastic modulus of the material comprising the inner layer and the outer layer is the synthetic tensile elastic modulus of the cable outer cover.

[Claim 5]

The fiber optic cable according to any one of claim 1 to claim 4, wherein the fiber optic tape core has connected portions and unconnected portions intermittently formed in the longitudinal direction between a plurality of fiber optic cores arranged in parallel.

[Detailed Description of Invention]

[Technical field]

[0001]

The present disclosure relates to an fiber optic cable.

[Background Art]

[0002]

In addition to faster communication and increased information volume due to the spread of information communication such as the Internet, optical networks are being built to accommodate two-way communication and high-capacity communication. In such optical networks, FTTH (Fiber-To-The-Home) has been launched to provide high-speed communication services by directly connecting telecommunications companies with households via optical fiber, and the amount of communication has been increasing year by year. Accordingly, there is a need for fiber optic cables that have a smaller diameter and higher density. Patent Document 1 discloses the structure of a slotless fiber optic cable. Slotless fiber optic cables have the advantage of being smaller in diameter, lighter in weight, and easier to achieve higher density because they do not have slots such as those found in slotted fiber optic cables.

[Prior Art Literature]

[Patent Documents]

[0003]

[Patent Document 1] JP 2010-8923 A

[Summary of Invention]

[Problem to Be Solved by Invention]

[0004]

As described above, slotless fiber optic cables are easy to make lighter and are therefore suitable for fiber optic cables for pneumatic feeding (also called microduct cables). However, because fiber optic cables for pneumatic feeding provide air at a predetermined pressure into a duct and pass through a duct while the cable is being pushed, it is desirable for such cables to be easy to pass through a duct.

[0005]

In light of the above, an object of the present disclosure is to provide a slotless fiber optic cable that is easy to pass through a duct.

[Means For Solving Problem]

[0006]

The fiber optic cable according to one aspect of the present disclosure is a slotless fiber optic cable provided with a plurality of fiber optic cores, a fiber optic tape core having fiber optic cores arranged side by side, or an assembly core consolidating the plurality of fiber optic cores and a fiber optic tape core; and a cable outer cover provided around the assembly core; wherein the cable outer cover has an inner layer provided outside the assembly core and an outer layer provided outside the inner layer, the density of a material used for the outer layer is $0.942 \text{ (g/cm}^3\text{)}$ or greater, and the density of the material used for the inner layer is less than $0.942 \text{ (g/cm}^3\text{)}$.

[Effect of Invention]

[0007]

According to the above, it is possible to provide a slotless fiber optic cable that can be easily passed through a duct.

[Brief Description of Drawings]

[0008]

[FIG. 1] is a cross-sectional view illustrating an example of a fiber optic cable according to one aspect of the present disclosure.

[FIG. 2] is a diagram illustrating an example of the structure of an intermittent tape core.

[FIG. 3] is a table describing the specifications and evaluation results of each sample.

[FIG. 4] is a diagram describing the relationship between the change in low temperature loss and the HDPE area ratio.

[FIG. 5] is a diagram describing the relationship between the change in low temperature loss and the ES product.

[FIG. 6] is a diagram describing the relationship between bending rigidity and HDPE area ratio.

[Embodiments of Invention]

[0009]

[Description of Embodiments of Present Disclosure]

First, the details of the embodiments of the present disclosure will be described in a list. The fiber optic cable according to the present disclosure is (1) a slotless fiber optic cable provided with a plurality of fiber optic cores, a fiber optic tape core having fiber optic cores arranged side by side, or an assembly core consolidating the plurality of fiber optic cores and a fiber optic tape core; and a cable outer cover provided around the assembly core; wherein the cable outer cover has an inner layer provided outside the assembly core and an outer layer provided outside the inner layer, the density of a material used for the outer layer is $0.942 \text{ (g/cm}^3\text{)}$ or greater, and the density of the material used for the inner layer is less than $0.942 \text{ (g/cm}^3\text{)}$. Due to being a slotless fiber optic cable, it is easier to make smaller in diameter, lighter in weight, and easier to achieve higher density when compared

to a slotted fiber optic cable. Additionally, the cable outer cover is composed of two layers, an inner layer and an outer layer, and the density of the material used for the outer layer is higher than that of the inner layer. Specifically, when the outer layer is configured by, for example, high-density polyethylene (HDPE), the coefficient of friction is lower than that of low-density polyethylene (LDPE) normally used, and it is easier to pass through a duct. Moreover, even when the air pressure supplied into the duct is high or the cable is pushed into the duct, the cable is sufficiently resilient because the outer layer is hard.

[0010]

(2) In one aspect of the fiber optic cable of the present disclosure, the ratio of the cross-sectional area of the outer layer to the total cross-sectional area of the cable outer cover is 60 (%) or less. Because the ratio of the cross-sectional area of the outer layer to the total cross-sectional area of the cable outer cover is 60 (%) or less, even when the outer layer is configured by HDPE, it is possible to prevent an increase in loss at low temperatures.

(3) In one aspect of the fiber optic cable of the present disclosure, the ratio of the cross-sectional area of the outer layer to the total cross-sectional area of the cable outer cover is 20 (%) or greater. Because the ratio of the cross-sectional area of the outer layer to the total cross-sectional area of the cable outer cover is 20 (%) or greater, the bending rigidity becomes $0.3 \text{ (N}\cdot\text{m}^2)$ or greater, it becomes easier for the cable to pass through the duct, and the cable can sufficiently withstand pneumatic feeding.

[0011]

(4) In one aspect of the fiber optic cable of the present disclosure, the product of the synthetic tensile elastic modulus of the cable outer cover and the total cross-sectional area of the cable outer cover is 60,000 (N) or less when the tensile elastic modulus of the material comprising the inner layer and the outer layer is the synthetic tensile elastic modulus of the cable outer cover. Because the product of the synthetic tensile elastic modulus of the cable outer cover and the total cross-sectional area of the cable outer cover is 60,000 (N) or less, even when the outer layer is configured by HDPE, it is possible to prevent an increase in loss at low temperatures.

(5) In one aspect of the fiber optic cable of the present disclosure, the fiber optic tape core has connecting portions and unconnected portions intermittently formed in the longitudinal direction between a plurality of fiber optic cores arranged in parallel. Using such an intermittent tape core makes it possible to provide a slotless fiber optic cable that combines fiber optic cores in high density while maintaining a narrow cable outer diameter.

[0012]

[Details of Embodiments of Present Disclosure]

Preferable embodiments of the fiber optic cable according to the present disclosure will be described below with reference to attached drawings.

FIG. 1 is a cross-sectional view illustrating an example of a fiber optic cable according to one aspect of the present disclosure, and FIG. 2 is a diagram illustrating an example of the structure of an intermittent tape core.

[0013]

The fiber optic cable 10 illustrated in FIG. 1 is slotless and has, for example, a round assembly core 11 and a cable outer cover 13 formed around the assembly core 11.

The assembly core 11 houses, for example, a plurality of twelve-core intermittent tape cores 1. Note that in addition to intermittent tape cores, it is also possible to house a plurality of single-core fiber optic cores bundled together.

[0014]

Intermittent tape cores consist of a plurality of fiber optic cores arranged in parallel, and the adjacent fiber optic cores are intermittently connected to each other by connected and unconnected portions. FIG. 2 (A) illustrates intermittent tape cores in an open position in the arrangement direction, and FIG. 2 (B) illustrates a B-B line arrow cross-sectional view of FIG. 2 (A) respectively, wherein the intermittent tape cores 1 in the figure are configured by twelve tape cores being intermittently connected every two cores.

[0015]

As illustrated in FIG. 2 (B), a tape covering 5 made from ultraviolet curing resin or the like is provided around each fiber optic core 2, and for example, cores that have two cores integrated are intermittently connected by connected portions 3 and unconnected portions 4. At the connected portions 3, adjacent tape coverings 5 touch, and at the unconnected portions 4, adjacent tape coverings 5 are separated without being connected.

Because free deformation is possible within the assembly core 11 using such an intermittent tape core, it is possible to combine fiber optic cores 2 in high density while maintaining a narrow cable outer diameter.

[0016]

The optical fiber cores housed in this intermittent tape core are created by applying a color coating on the outer side of a wire called an optical fiber wire, the optical fiber wire being created by applying a coating having a coating outer diameter of approximately 250 (μm) on a glass fiber having a standard outer diameter of 125 (μm), but the fiber optic core is not limited to such, and may be a small diameter fiber having a coating diameter of around 165 (μm) or 200 (μm). Note that the intermittent tape core need not have a connected portion and an unconnected portion for each of the two cores, and may be intermittently connected by, for example, a connected portion and an unconnected portion for each core.

[0017]

It should be noted that the plurality of intermittent tape cores 1 may be twisted together to form a unit, and a plurality of units may be combined. In addition, a plurality of intermittent tape core wires may be bundled with a bundle material or the like, or bundled with a bundle material or the like for each unit.

On the other hand, as illustrated in FIG. 1, the assembly core 11 of the fiber optic cable 10 is vertically attached or horizontally wound with, for example, a water absorption tape 12 to form a round shape.

[0018]

The outer side of the water absorption tape 12 is covered by a cable outer cover 13 configured by two types of polyethylene (PE).

In the cable outer cover 13 (inner layer 14 described hereafter), for example, two tension members (also referred to as tensile strength bodies) 16 for maintaining strength in the longitudinal direction and for example, two tear strings 17 for tearing the cable outer cover 13 in the cable longitudinal direction are longitudinally attached and embedded during extrusion molding of the cable outer cover 13 (inner layer 14).

[0019]

A wire material having a bearing capacity against tension and compression, for example, steel wire or FRP (Fiber Reinforced Plastics), are used for the tension members 16, and for example, these are provided on both sides of the assembly core 11.

The tear strings 17 are provided having one on each side interposing the assembly core 11 at a position on a line perpendicular to the line connecting the centers of the two tension members 16.

The tear strings 17 are cross-sectionally circular string-shaped members in which, for example, a resin material such as nylon or polyester is used, and is aligned along the radial direction of the assembly core 11, for example, on the same straight line.

[0020]

As illustrated in FIG. 1, the cable outer cover 13 is formed of two layers, an inner layer 14 and an outer layer 15. The inner layer 14 contacts the assembly core 11, and the outer layer 15 is provided outside the inner layer 14 and covers the outside of the tension member 16.

[0021]

Because the microduct cable is pneumatically fed in a duct, it is desirable to reduce the coefficient of friction of the cable surface in order to extend the pneumatic feeding distance in the duct. Therefore, the material used for the outer layer 15 has a density $0.942 \text{ (g/cm}^3\text{)}$ or greater and $0.98 \text{ (g/cm}^3\text{)}$ or less (for example, $0.95 \text{ (g/cm}^3\text{)})$ and a tensile elastic modulus between 700 and 1,200 (MPa). It should be noted that those having a density of $0.942 \text{ (g/cm}^3\text{)}$ or greater are also referred to as high-density polyethylene (HDPE).

[0022]

In this manner, the outer layer 15 of the cable outer cover 13 is configured by HDPE, and the coefficient of friction is low, so the cable is easy to pass through the duct. Moreover, when the outer layer 15 is configured by HDPE, even when the air pressure supplied into the duct is high or the cable is pushed into the duct, the outer layer is firm enough to withstand.

However, when the cable outer cover 13 is configured only by HDPE, the tensile elastic modulus is high, so the material contracts at low temperatures, the fiber optic cores 2 in the assembly core 11 are compressed, causing bending, and loss increases. In this case, with the type of tension member 16 that is embedded in the cable outer cover 13 as illustrated in FIG. 1, it is also difficult to make the tension member thicker, and it is not possible to counter the contracting of the cover.

Therefore, the material used for the inner layer 14 has a density of $0.91 \text{ (g/cm}^3\text{)}$ or greater and less than $0.942 \text{ (g/cm}^3\text{)}$ (for example, $0.93 \text{ (g/cm}^3\text{)})$ and a tensile elastic modulus of 100 to 600 (MPa), which is less likely to contract at low temperatures and prevents an increase in loss at low temperatures. It should be noted that when the density is less than $0.942 \text{ (g/cm}^3\text{)}$, these are referred to as low density polyethylene (LDPE) for convenience to distinguish them from HDPE.

[0023]

FIG. 3 is a table describing the specifications and evaluation results of each sample. For the fiber optic cable 10 having an outer diameter of $\phi 12 \text{ (mm)}$ or $\phi 16 \text{ (mm)}$, the outer cover thickness of the LDPE (tensile elastic modulus of 300 (MPa)) of the inner layer 14 and the outer cover thickness of the HDPE (tensile elastic modulus of 1,050 (MPa)) of the outer layer 15 were respectively changed, and the surface friction coefficient, the change in loss at low temperatures, the synthetic tensile elastic modulus, and the synthetic tensile elastic modulus $\times$ outer covering total cross-sectional area value (also referred to the ES product) were found, and an evaluation was performed as to whether the various conditions are suitable for the fiber optic cable for pneumatic feeding (A if suitable, B if not).

[0024]

The surface friction coefficient is the friction coefficient of the cable surface of the fiber optic cable 10. The change in loss at low temperatures (dB/km) is the change in loss when the fiber optic cable 10 is left under low temperatures (-40°C). The synthetic tensile elastic modulus (MPa) is the tensile elastic modulus of a material having the inner layer 14 and the outer layer 15 combined and converted into one member, and is obtained using the cross-sectional area ratio of the inner layer 14 and the outer layer 15. The ES product (N) is the product of the synthetic tensile elastic modulus

(MPa) and the outer covering total cross-sectional area value (mm^2), and is one of the indicators of the strength of the cable outer cover 13. The synthetic tensile elastic modulus corresponds to "the synthetic tensile modulus of the cable outer cover" according to the present disclosure, and the outer covering total cross-sectional area value corresponds to "the total cross-sectional area of the cable outer cover" according to the present disclosure.

[0025]

When the outer diameter of the cable (the outer diameter of the fiber optic cable 10) is $\phi 12$ (mm), the inner diameter of the cable (the outer diameter of the assembly core 11) is $\phi 8$ (mm), the LDPE outer cover thickness is 2 (mm), and the HDPE outer cover thickness is 0 (mm) (referred to as sample 1), the LDPE cross-sectional area is 62.8 (mm^2), the HDPE cross-sectional area is 0 (mm^2), and the HDPE area ratio is 0 (%). Note that the HDPE area ratio corresponds to "the ratio of the cross-sectional area of the outer layer to the total cross-sectional area of the cable outer cover" according to the present disclosure. In sample 1, the ES product was 18,850 (N) and the change in loss at low temperatures was low at 0.05 (dB/km), but the surface friction coefficient was large at 0.5 and it was difficult for the cable to pass through the duct, so it was determined as not suitable for a fiber optic cable for pneumatic feeding (evaluation B). It should be noted that in sample 1, the bending rigidity was 0.1 ($\text{N}\cdot\text{m}^2$), and even at this point, it was insufficient to pass through.

[0026]

Meanwhile, when the cable outer diameter is $\phi 12$ (mm), the inner diameter of the cable is $\phi 8$ (mm), the LDPE outer cover thickness is 1 (mm), and the HDPE outer cover thickness is 1 (mm) (referred to as sample 2), the LDPE cross-sectional area is 28.3 (mm^2), the HDPE cross-sectional area is 34.6 (mm^2), and the HDPE area ratio is 55 (%). In sample 2, the surface friction coefficient was 0.15, the ES product was 44,768 (N), and the change in loss at low temperatures was 0.15 (dB/km). In this case, the surface friction coefficient became small, and the change in loss at low temperatures was at a prescribed reference value of 0.2 (dB/km) or less, so it was determined as suitable for a fiber optic cable for pneumatic feeding (evaluation A). It should be noted that in sample 2, the bending rigidity was 0.85 ($\text{N}\cdot\text{m}^2$) and was insufficient to pass through.

[0027]

Next, when the cable outer diameter is $\phi 12$ (mm), the inner diameter of the cable is $\phi 8$ (mm), the LDPE outer cover thickness is 0 (mm), and the HDPE outer cover thickness is 2 (mm) (referred to as sample 3), the LDPE cross-sectional area is 0.0 (mm^2), the HDPE cross-sectional area is 62.8 (mm^2), and the HDPE area ratio is 100 (%). In sample 3, the surface friction coefficient was 0.15, the ES product was larger than 60,000 (N) at 65,973 (N). Therefore, because the change in loss at low temperatures was 0.22 (dB/km) and did not meet the condition of being at the prescribed reference value of 0.2 (dB/km) or less, increased loss at low temperatures could not be avoided, and it was therefore determined as unsuitable for a fiber optic cable for pneumatic feeding (evaluation B). It should be noted that in sample 3, the bending rigidity was 1.5 ($\text{N}\cdot\text{m}^2$).

[0028]

When the cable outer diameter is $\phi 16$ (mm), the cable inner diameter is $\phi 12$ (mm), the LDPE outer cover thickness is 2 (mm), and the HDPE outer cover thickness is 0 (mm) (referred to as sample 4), the LDPE cross-sectional area is 88.0 (mm^2), the HDPE cross-sectional area is 0 (mm^2), and the HDPE area ratio is 0 (%). In sample 4, the ES product was 26,389 (N) and the change in loss at low temperatures was 0.05 (dB/km), but the surface friction coefficient became large at 0.5 and it was difficult for the cable to pass through the duct, so it was determined as not suitable for a fiber optic cable for pneumatic feeding (evaluation B). It should be noted that in sample 4, the bending rigidity was 0.1 ($\text{N}\cdot\text{m}^2$), and even at this point, it was insufficient to conduct the wire.

[0029]

Meanwhile, when the cable outer diameter is $\phi 16$ (mm), the inner diameter of the cable is $\phi 12$ (mm), the LDPE outer cover thickness is 1.1 (mm), and the HDPE outer cover thickness is 0.9 (mm) (referred to as sample 5), the LDPE cross-sectional area is $45.3 \text{ (mm}^2\text{)}$, the HDPE cross-sectional area is $42.7 \text{ (mm}^2\text{)}$, and the HDPE area ratio is 49 (%). In sample 5, the surface friction coefficient was 0.15, the ES product was 58,410 (N), and the change in loss at low temperatures was 0.18 (dB/km). In this case, the surface friction coefficient became small, and the change in loss at low temperatures was at a prescribed reference value of 0.2 (dB/km) or less, so it was determined as suitable for a fiber optic cable for pneumatic feeding (evaluation A). It should be noted that in sample 5, the bending rigidity was $0.7 \text{ (N}\cdot\text{m}^2\text{)}$.

[0030]

Next, when the cable outer diameter is $\phi 16$ (mm), the inner diameter of the cable is $\phi 12$ (mm), the LDPE outer cover thickness is 0 (mm), and the HDPE outer cover thickness is 2 (mm) (referred to as sample 6), the LDPE cross-sectional area is $0 \text{ (mm}^2\text{)}$, the HDPE cross-sectional area is $88.0 \text{ (mm}^2\text{)}$, and the HDPE area ratio is 100 (%). In sample 6, the surface friction coefficient was 0.15, the ES product was larger than 60,000 (N) at 92,363 (N). Therefore, because the change in loss at low temperatures was 0.25 (dB/km) and did not meet the condition of being at the prescribed reference value of 0.2 (dB/km) or less, increased loss at low temperatures could not be avoided, and it was therefore determined as unsuitable for a fiber optic cable for pneumatic feeding (evaluation B). It should be noted that in sample 6, the bending rigidity was $1.5 \text{ (N}\cdot\text{m}^2\text{)}$.

[0031]

FIG. 4 is a diagram describing the relationship between the change in loss at low temperatures and the HDPE area ratio.

As the HDPE area ratio decreases, the change in loss at low temperatures also gradually decreases. It is understood that when the HDPE area ratio is 60 (%) or less, the change in loss at low temperatures is kept at or below the predetermined reference value (0.2 (dB/km)).

When the HDPE area ratio is 60 (%) or less in this manner, even when the outer layer 15 is configured by HDPE, it is possible to prevent an increase in loss at low temperatures.

[0032]

FIG. 5 is a diagram describing the relationship between the change in loss at low temperatures and the ES product.

As the ES product decreases, the change in loss at low temperatures also gradually decreases. It is understood that when the ES product is 60,000 (N) or less, the change in loss at low temperatures is kept at or below the predetermined reference value (0.2 (dB/km)).

When the ES product is 60,000 (N) or less in this manner, even when the outer layer 15 is configured by HDPE, it is possible to prevent an increase in loss at low temperatures.

[0033]

FIG. 6 is a diagram describing the relationship between bending rigidity and HDPE area ratio.

As the HDPE area ratio increases, the bending rigidity also gradually increases. It is understood that when the HDPE area ratio is 20 (%) or greater, the bending rigidity is at or greater than the predetermined reference value of $0.3 \text{ (N}\cdot\text{m}^2\text{)}$.

Therefore, when the HDPE area ratio is 20 (%) or greater, it becomes easier to pass the cable through the duct and the cable can sufficiently withstand pneumatic feeding.

[0034]

It should be considered that the presently disclosed embodiments are exemplary in all respects and not restrictive. The scope of the present disclosure is intended to be indicated by the scope of

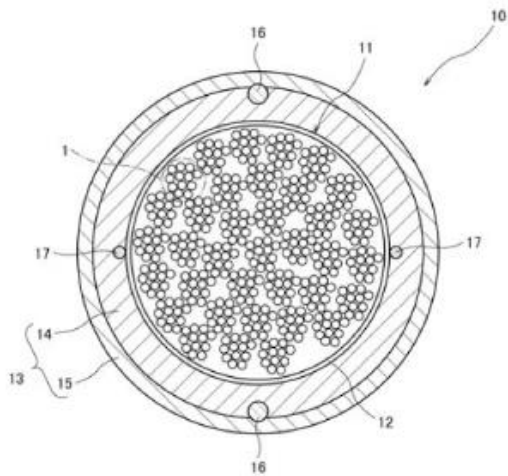
patent claims, not the meanings described above, and includes all modifications within the same meaning and scope as the scope of patent claims.

[Description of Reference Numerals]

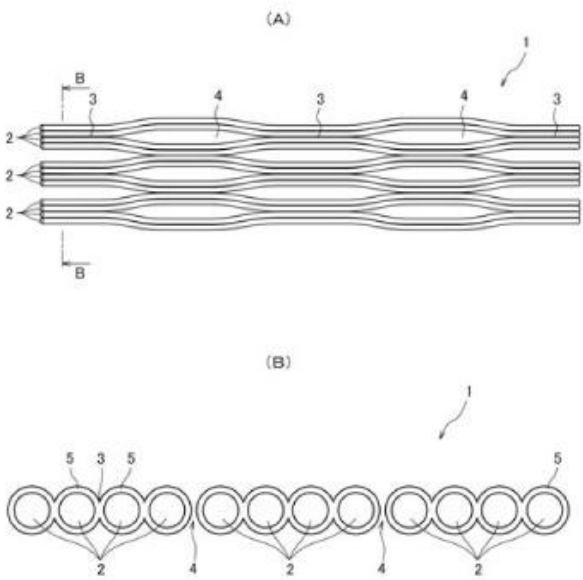
[0035]

1... intermittent tape core, 2... fiber optic core, 3... connected portion, 4... unconnected portion, 5... tape covering, 10... fiber optic cable, 11... assembly core, 12... water absorption tape, 13... cable outer cover, 14... inner layer, 15... outer layer, 16... tension member, 17... tear string, E... synthetic tensile elastic modulus, S... outer covering total cross-sectional area value.

[FIG. 1]



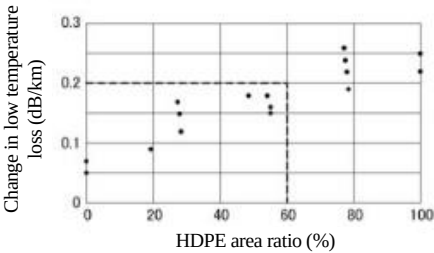
[FIG. 2]



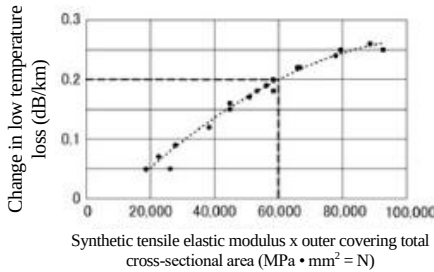
[FIG. 3]

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6
Cable inner diameter (mm)	8	8	8	12	12	12
LDPE outer covering thickness (mm)	2	1	0	2	1.1	0
LDPE cross-sectional area (mm ²)	62.8	28.3	0	88.0	45.3	0
LDPE tensile elastic modulus (MPa)	300	300	300	300	300	300
HDPE outer covering thickness (mm)	0	1	2	0	0.9	2
HDPE cross-sectional area (mm ²)	0	34.6	62.8	0	42.7	88.0
HDPE area ratio (%)	0	55	100	0	49	100
HDPE tensile elastic modulus (MPa)	1,050	1,050	1,050	1,050	1,050	1,050
Cable outer diameter (mm)	12	12	12	16	16	16
Surface coefficient of friction	0.5	0.15	0.15	0.5	0.15	0.15
Change in low temperature loss (dB/km)	0.05	0.15	0.22	0.05	0.18	0.25
Synthetic tensile elastic modulus (MPa)	300	713	1,050	300	664	1,050
Synthetic tensile elastic modulus x outer covering total cross-sectional area (N)	18,850	44,768	65,973	26,389	58,410	92,363
Evaluation	B	A	B	B	A	B

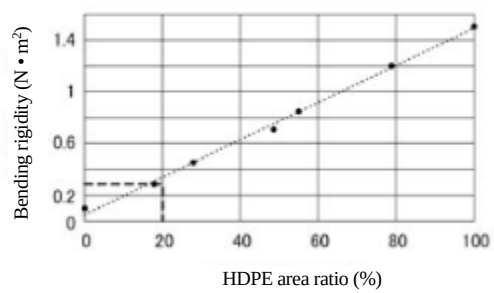
[FIG. 4]



[FIG. 5]



[FIG. 6]



Continued from First Page

F Term Reference

CERTIFICATE OF TRANSLATION

I, Leanna Marquart, hereby certify that the document identified below, translated from Japanese into English, is true and accurate to the best of my knowledge and belief.

Reference: JP 2021-60438A

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.



Signature

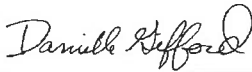
Leanna Marquart

Printed Name

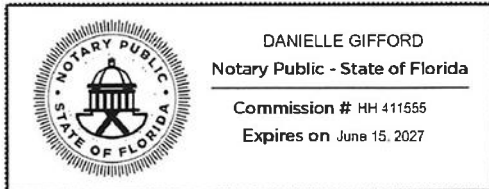
State of Florida County of Clay

Sworn to before me this

30th day of October, 2024 before me by means of online notarization by Leanna Marquart.



Signature, Notary Public Danielle Gifford



___ Personally Known OR ___ ☒ Produced Identification

Type of Identification Produced DRIVER LICENSE

Stamp, Notary Public

Notarized remotely online using communication technology via Proof.