

CABLE

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

5 [0001] The invention relates to a cable.

2. DESCRIPTION OF THE RELATED ART

[0002] Cables (flexible cables) used for wiring in various transportation equipment such as cranes and transporting carriages are generally provided with a core assembly formed by twisting plural cores each composed of a conductor and an insulation layer that encloses
10 the conductor, and a sheath that encloses the core assembly. Some of such cables are constructed such that the insulation layer is formed of EP rubber etc. and the sheath as the outermost layer of the cable is formed of a rubber material that has elasticity as well as excellent mechanical strength (see e.g. JP-A-2016-084449).

15 SUMMARY OF THE INVENTION

[0004] The cable disclosed by JP-A-2016-084449 may have a problem that the cable outer diameter is likely to increase because the insulation layer is formed of a material, such as an EP rubber, that is difficult to form into a thin layer.

[0005] It is an object of the invention to provide a cable that has a reduced diameter while
20 securing a flex resistance thereof.

[0006] According to an embodiment of the invention, a cable comprises:

a core assembly formed by twisting a plurality of cores each comprising a conductor and an insulation layer that encloses the conductor; and

a sheath that encloses the core assembly,
25 wherein the insulation layer comprises a fluorine-based resin, and
wherein a lubricant layer is formed between the core assembly and the sheath.

[0007] Effects of the invention

According to an embodiment of the invention, a cable can be provided that has a reduced diameter while securing a flex resistance thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Next, the present invention will be explained in more detail in conjunction with appended drawings, wherein:

5 **FIG.1** is a schematic radial cross sectional view showing an example of a cable in an embodiment of the present invention;

FIG.2 is a schematic configuration diagram illustrating an example of the cable in the embodiment of the invention; and

FIG.3 is a partially enlarged cross sectional view showing an example of the cable
10 in the embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0009] Embodiment of the invention

(1) Configuration of cable

15 A configuration of a cable in an embodiment of the invention will be described below in conjunction with the drawings.

[0010] As shown in **FIG.1**, a cable **1** in the present embodiment has a core assembly **3** which is formed by twisting plural (e.g., twenty-four) cores **2** together. The core assembly **3** has, e.g., a first layer (inner layer) **2F** and a second layer (outer layer) **2S**. The
20 first layer **2F** is composed of nine cores **2a** arranged so that the shortest distance between the center of the cable **1** and the center of the core **2** (pitch diameter) is R_1 , and the second layer **2S** is composed of fifteen cores **2b** arranged so that the shortest distance is R_2 which is greater than R_1 .

[0011] Each core **2** has, e.g., a conductor **21** and an insulation layer **22** provided to
25 enclose the conductor **21**, i.e., to cover the outer surface of the conductor **21**.

[0012] The conductor **21** used here can be, e.g., a stranded conductor formed by twisting strands of copper wires or copper alloy wires. The copper wire is more preferable to have high conductivity, while the copper alloy wire is more preferable to have high tensile strength.

[0013] The insulation layer **22** is preferably formed of a material which has high insulating properties (high dielectric strength), is excellent in mechanical strength and can be formed into a thin layer. As such a material, it is possible to use a fluorine-based resin such as ethylene tetrafluoroethylene (ETFE) or polyvinylidene fluoride (PVDF). The insulation layer **22** formed of such a fluorine-based resin also has high sliding properties. The insulation layers **22** of all the cores **2** constituting the core assembly **3** are preferably formed of the same material.

[0014] The thickness of the insulation layer **22** is preferably, e.g., **1** to **1.5** times the diameter of the strand (the outer diameter of one strand) constituting the conductor **21** (stranded conductor). When the thickness of the insulation layer **22** is less than the outer diameter of the strand, the insulation layer **22** is too thin to have enough mechanical strength and may be cracked after being repeatedly bent, resulting in short life. By forming the insulation layer **22** so as to have a thickness which is not less than the outer diameter of the strand, it is possible to obtain necessary and sufficient mechanical strength, and furthermore, to have desired dielectric strength and thereby to obtain desired insulating properties (electrical insulating performance). Thus, insulation breakdown can be prevented even when high voltage of, e.g., not less than **600V** is applied. However, when the thickness of the insulation layer **22** is more than **1.5** times the outer diameter of the strand, the insulation layer **22** is too thick and the diameter of each core **2** may become large. By forming the insulation layer **22** so as to have a thickness which is not more than **1.5** times the outer diameter of the strand, it is possible to reduce the diameter of each core **2** while maintaining necessary and sufficient mechanical strength (flex resistance). The diameter of each core **2** can be smaller than that of, e.g., a core having an insulation layer formed of ethylene-propylene (EP) rubber.

[0015] To obtain the cable **1** having a true circular shape in cross section, an insert (filler, insulation yarn, insulating spacer, etc., and for example, hemp yarn) **4** having insulating properties may be provided, if required, in the center of the core assembly **3**. That is, the cores **2** are preferably arranged to enclose the insert **4** (so that the insert **4** is located in the center). The insert **4** here may be regarded as part of the core assembly **3**.

[0016] The plural cores **2** constituting the core assembly **3** may be bound (longitudinally or spirally wrapped and covered all together) with, e.g., a tape (binding tape, wrapping tape) **5**, etc. The tape **5** is provided to bundle the plural cores **2**. As the tape **5**, it is possible to use a tape of which base material (base fabric, cloth) is, e.g., a woven fabric or non-woven fabric formed of rayon fiber such as spun rayon yarn, polyester fiber, nylon fiber, cotton fiber or polypropylene fiber, etc. The tape **5** is preferably configured such that sliding properties are different between the front and back surfaces. This feature will be described later.

[0017] An outer covering (sheath) **6** is provided around the core assembly **3** (around the tape **5** in case that the tape **5** is provided) so that the outer surface of the core assembly **3** is covered. The sheath **6** is the outermost later of the cable **1**. To increase abrasion resistant performance or shock resistant performance, etc., of the cable **1** or to make the cable **1** easily rubbed, the sheath **6** is molded solid without hollow such that the core assembly **3** (e.g., the plural conductive wires **2b** which form the second layer) bites into the sheath **6** via the tape **5**.

[0018] The sheath **6** preferably has higher elasticity, i.e., higher scratch resistance than the insulation layer **22**. The term "having high elasticity" as used herein means that elastic modulus is high. The sheath **6** is preferably formed of a material having a high elasticity as well as excellent mechanical strength. As such a material, it is possible to use a rubber material such as chloroprene (CR). It is thereby possible to prevent cracks on the sheath **6** (breakage of the sheath **6**) even if an external stress such as friction, mechanical shock or rubbing is applied to the cable **1** when, e.g., the cable **1** used outdoor such as port and harbor is subjected to a gust of wind associated with approaching or passing typhoon (storm) and hits another cable **1** or a peripheral device such as cable reel, or when the cable **1** is wound up onto or unwound from a cable reel.

[0019] The thickness of the sheath **6** is preferably, e.g., **0.8** to **1.2** times the outer diameter of one core **2** (the outer diameter of the insulation layer **22** of the core **2**). When the thickness of the sheath **6** is less than **0.8** times the outer diameter of the core **2**, the sheath **6** is too thin and may have lower elasticity than the insulation layer **22**. By having the

thickness which is not less than **0.8** times the outer diameter of the core **2**, the sheath **6** can have higher elasticity than the insulation layer **22**. That is, scratch resistance of the sheath **6** can be increased and the sheath **6** can have higher mechanical strength. However, when the thickness of the sheath **6** is increased to more than **1.2** times the outer diameter of the core **2**, the outer diameter of the cable **1** becomes large. By forming the sheath **6** so as to have a thickness which is not more than **1.2** times the outer diameter of the core **2**, it is possible to reduce the size and weight of the cable **1** while maintaining desired scratch resistance and desired mechanical strength.

[0020] In the cable **1**, a lubricant (lubricant layer) **7** (described later) is provided between the core assembly **3** and the sheath **6** so that sliding occurs between the core assembly **3** and the sheath **6**. Sliding properties between the core assembly **3** and the sheath **6** are increased by providing the lubricant (lubricant layer) **7**. "High sliding properties" means having a low coefficient of friction and slidable. In more detail, it means that at least one of the coefficient of static friction and the coefficient of kinetic friction is lower than when the lubricant (lubricant layer) **7** is not provided.

[0021] To increase sliding properties between the core assembly **3** and the sheath **6**, it is preferable to apply the lubricant **7** between the core assembly **3** and the sheath **6**, for example as shown in **FIG.2**. Alternatively, the lubricant **7** may be applied to the outer surfaces of the cores **2**, or may be mixed in the material used to form the insulation layers **22** of the cores **2**. As the lubricant **7**, it is possible to use, e.g., fluorinated oil, silicone oil and talc powder.

[0022] The tape **5** is wound around the core assembly **3** so that a front surface **5a** of the tape **5** faces outside (outward of the cable **1**) and a back surface **5b** of the tape **5** faces the core assembly **3** (the cores **2**). In such a case that the tape **5** is provided to cover all the plural cores **2** together, the tape **5** is configured so that sliding occurs between the core assembly **3** and the tape **5** and does not occur between the tape **5** and the sheath **6**. For example, the tape **5** is preferably configured that the front surface **5a** is a surface with low sliding properties (with high stickiness) and the back surface **5b** is a surface with high sliding properties (with low stickiness). In detail, for example as shown in **FIG.3**, it is

preferable that a surface of the tape 5 in contact with the sheath 6 (the front surface 5a of the tape 5) be adhered to the sheath 6, and a surface of the tape 5 in contact with the core assembly 3 (the back surface 5b of the tape 5) has sliding properties. As such, the tape 5 preferably has different sliding properties (stickiness) between the front and back surfaces.

5 The lubricant 7 may be applied to each core 2, or may be applied to the outer surface of the core assembly 3 after the cores 2 are formed into the core assembly 3.

[0023] It is preferable to apply the lubricant 7 only to the back surface 5b of (the base fabric of) the tape 5 so that only the back surface 5b of the tape 5 has sliding properties, i.e., so that the back surface 5b of the tape 5 does not adhere to the core assembly 3 (see

10 **FIG.3).**

[0024] In addition, it is preferable to apply a material having low sliding properties, such as crude rubber, only to the front surface 5a of (the base fabric of) the tape 5 so that the front surface 5a of the tape 5 adheres to the sheath 6. The rubber material is preferably applied so as to penetrate the meshes of the base fabric of the tape 5. In addition, in case
15 that that the front surface 5a of the tape 5 is configured to adhere to the sheath 6, it is more preferably that the same material as that used to form the sheath 6 be applied to the front surface 5a of the tape 5 to further increase the adhesion between the front surface 5a of the tape 5 and the sheath 6.

[0025] As the tape 5 having different sliding properties between the front and back
20 surfaces, it is possible to use, e.g., a rubber-coated fabric tape formed by applying the lubricant 7 to one main surface of the base fabric of the tape 5 and crude rubber to another main surface of the base fabric. The crude rubber is softened by heat during formation of the sheath 6 and thus can have good adhesion to the sheath 6.

[0026] (2) Effects of the present embodiment

25 In the present embodiment, one or several effects described below are obtained.

[0027] (a) By providing slidability between the core assembly 3 and the sheath 6, the cores 2 constituting the core assembly 3 do not move individually (separately) but the entire core assembly 3 moves as one-piece inside the cable 1 (the sheath 6) when the cable 1 is bent. In addition, the sheath 6 and the entire core assembly 3 move diffidently, i.e.,

the entire core assembly 3 moves independently regardless of the movement of the sheath

6. Furthermore, the core assembly 3 also moves in the same manner when the cables 1 hits each other or the cable 1 hits a peripheral device such as cable reel, or when an external stress such as friction, rubbing or mechanical shock is applied to the cable 1

5 during winding-up or unwinding of the cable 1 onto or from a cable reel.

[0028] As a result, when the cable 1 is subjected to bending or an external stress (hereinafter, also described as “when the cable 1 is subjected to bending, etc.”), snap or breakage of the cores 2 due to kink can be prevented. Kink on the core 2 means that the core 2 is twisted, distorted, strained, knotted, snapped or crushed etc. By preventing twist
10 or curl of the core assembly 3 as described above, it is possible to improve flex resistance of the cable 1. It is also possible to improve bendability (flexibility) of the cable 1.

[0029] By contrast, if the core assembly does not move as one-piece but each core moves separately when the cable is subjected to bending, etc., certain cores may become out of alignment. When the cable is subjected to, e.g., bending, the certain cores may protrude
15 outward (toward the outer periphery) of the cable inside the bent portion. Since other components such as tape and sheath, etc., are provided around the cores, the protruding cores are pushed back by such components. Thus, the cores are likely to kink.

[0030] That is, by providing slidability between the core assembly 3 and the sheath 6, flex resistance of the entire cable 1 can be maintained at high level.

20 In addition, since a fluorine-based resin is used to form the insulation layer 22, the insulation layer 22 can have a smaller thickness than, e.g., an insulation layer formed of EP rubber, while maintaining insulating properties and mechanical strength which are equivalent to those of the insulation layer formed of EP rubber. As a result, it is possible to reduce a diameter of each conductive wire 2 without reducing the (radial)
25 cross-sectional area of the conductor 21. Thus, the core assembly 3 which is formed by twisting plural cores 2 can have a reduced diameter. Meanwhile, the thickness of the sheath 6 depends on the diameter of each core 2 as described above. Therefore, the thickness of the sheath 6 can be reduced when the diameter of each core 2 is reduced. As a result, the diameter of the cable 1 can be reduced. Furthermore, the weight of the cable 1

can be also reduced as a result of reducing the diameter of the cable 1.

[0031] As an example, a conductor having a cross-sectional area equivalent to **3.5SQ** was formed by twisting (bunch-strand) sixty-five strands each having an outer diameter of **0.26 mm**. An insulation layer having a thickness of **0.32 mm (1.23 times the strand diameter)** was formed by covering the outer surface of the conductor with ETFE, thereby obtaining a core having an outer diameter of **3.06 mm**. Then, talc as a lubricant was applied to the outer surface of the core. Twenty four of such cores and a center insert (filler) were prepared and twisted together to form a core assembly. At this time, the cores were arranged so that the core assembly had an inner layer composed of nine cores and an outer layer composed of fifteen cores. Then, the rubber-coated fabric tape described above was bound around the core assembly (plural cores). After that, a sheath having a thickness of **2.6 mm (0.85 times the outer diameter of the core)** was formed by covering the outer surface of the tape with CR (solid cover without hollow), thereby obtaining a cable. The cable had an outer diameter of **24 mm** and a weight of **1180 kg/km**. Meanwhile, an insulation layer having a thickness of **0.8 mm** was formed by covering the outer surface of the same conductor having a cross-sectional area equivalent to **3.5SQ** with EP rubber to form a core having an outer diameter of **4.02 mm**, twenty four of such cores and a center insert (filler) were twisted together to form a core assembly, a tape was bound around the core assembly, and then, the sheath having a thickness of **3.4 mm (0.85 times the outer diameter of the core)** was formed by covering the outer surface of the tape with CR, thereby obtaining a cable. This cable, i.e., the cable formed using the cores having the EP rubber insulation layer, had an outer diameter of **31 mm** and a weight of **1530 kg/km**. As such, the inventors confirmed that the cable can have a smaller diameter and a lighter weight when using ETFE to form the insulation layer than when using EP rubber to form the insulation layer.

[0032] By providing slidability between the core assembly 3 and the sheath 6 as well as by using a fluorine-based resin to form the insulation layer 22 as described above, it is possible to reduce cable diameter while maintaining flex resistance of the cable.

[0033] (b) In addition, even in case that the core assembly 3 has two layers of the cores 2

(the first layer 2F and the second layer 2S) or the insulation layer 22 is formed of a slidable material with low coefficient of friction such as ETFE as in the present embodiment, providing slidability between the core assembly 3 and the sheath 6 allows the entire core assembly 3 to move as one-piece before the cores 2 start to move separately when the cable 1 is subjected to bending, etc. As a result, it is possible to prevent kink on the cores 2.

[0034] (c) By applying the lubricant 7 (providing the lubricant layer) between the core assembly 3 and the sheath 6, the entire core assembly 3 can easily move as one-piece when the cable 1 is subjected to bending, etc. Thus, kink on the cores 2 can be reliably prevented. In addition, since it is only necessary to apply the lubricant 7, the lubricant layer can be easily provided. Furthermore, when talc is used as the lubricant 7 to form the lubricant layer, it is possible to reliably provide slidability between the core assembly 3 and the sheath 6, and in addition to this, the manufacturing cost of the cable 1 is reduced since talc is easily available.

[0035] (d) In case that the tape 5 is provided to cover all the plural cores 2 together, adhering the surface of the tape 5 in contact with the sheath 6 (the front surface 5a of the tape 5) to the sheath 6 prevents the tape 5 from moving in the axial direction of the core assembly 3 (the cable 1) inside the sheath 6 when the cable 1 is subjected to bending, etc. Therefore, it is possible to prevent creases from being formed on the tape 5 inside the sheath 6 even when the cable 1 is repeatedly bent or an external stress is repeatedly applied to the cable 1, resulting in that breakage of the sheath 6 or cracks on the sheath 6 can be prevented.

[0036] By contrast, if the tape is not adhered to the sheath, the tape may move in the axial direction of the core assembly inside the sheath when the cable is subjected to bending. In this case, the tape may be displaced to one side (unevenly gathered in one position, become loose) when the cable 1 is repeatedly bent. As a result, the shape of the gathered tape (creases) is transferred to the surface of the sheath, causing breakage of the sheath or cracks on the sheath.

[0037] (e) Even in case that the tape 5 is provided, the one-piece form of the core assembly 3 can be maintained inside the sheath 6 when the cable 1 is subjected to bending,

etc., since the lubricant 7 (lubricant layer) is provided so that the back surface 5b of the tape 5 has sliding properties. In case that the back surface 5b of the tape 5 has sliding properties, the entire core assembly 3 can move as one-piece and the tape 5 moves together with the sheath 6 when the cable 1 is subjected to bending. As a result, it is possible to improve flex resistance of the cable 1. In other words, it is possible to obtain at least the above-described effect (a) even when the tape 5 is provided.

[0038] By contrast, if both the front and back surfaces of the tape do not have sliding properties, i.e., if the tape is adhered to the sheath as well as to the core assembly, the entire core assembly cannot move as one-piece inside the sheath when the cable is subjected to bending.

[0039] (f) For adhering the front surface 5a of the tape 5 to the sheath 6, the tape 5 and the sheath 6 can be integrated by applying the same rubber material as the sheath 6 to the front surface 5a of the tape 5. This increases adhesion between the front surface 5a of the tape 5 and the sheath 6. It is thereby possible to reliably obtain the above-described effect (d).

[0040] (g) By applying the lubricant 7 to the outer surface of the insulation layer 22 of each core 2, it is possible to increase sliding properties between the cores 2. It is thereby possible to prevent kink on the cores 2 more reliably.

[0041] (h) Sliding properties realized by the lubricant 7 can be well maintained. That is, when the cable 1 is subjected to bending, etc., the lubricant 7 moves inside the sheath 6 (inside the tape 5) and circulates evenly throughout inside the sheath 6 (inside the tape 5). It is thereby possible to ensure sliding properties between the core assembly 3 and the sheath 6 all the time. As a result, it is possible to maintain at least the above-described effect (a) for a long period of time.

[0042] (i) By using the same material to form the insulation layers 22 of all the cores 2 constituting the core assembly 3, i.e., by forming the cores 2 to have the same coefficient of friction, all the cores 2 of the core assembly 3 can behave (move) in the same manner when the cable 1 is subjected to bending, etc. It is thereby possible to reliably prevent each core 2 from moving separately and thus to reliably prevent certain cores 2 from

becoming out of alignment when the cable 1 is subjected to bending, etc. As a result, it is possible to prevent kink on the cores 2 more reliably.

[0043] (j) When the cable 1 has a smaller diameter, the cable 1 receives wind in a smaller area in case that the cable 1 is used for, e.g., outdoor wiring. This makes the cable 1 less likely to struggle against wind even when the cable 1 is used outdoor and subjected to strong wind. It is thus possible to prevent an accident such as wire breakage of the cable 1 caused by, e.g., falling or hitting a building. As a result, the cable can have a longer life.

[0044] (k) In addition, in the core assembly 3 formed by twisting plural cores 2, (volume of) gaps formed between the cores 2 can be reduced by reducing a diameter of each core 2. As a result, it is possible to increase a specific weight of the cable 1. The cable 1 is more unlikely to struggle against wind when having a larger specific weight. It is thereby possible to reliably obtain the effect (j).

[0045] (l) In addition, it is possible to further increase bendability (flexibility) of the entire cable 1 by reducing the diameter of the each core 2. It is thereby possible to prevent kink on the cores 2 more reliably.

[0046] (m) By reducing the weight of the cable 1, it is possible to reduce load applied to the cable 1 when the cable 1 is subjected to bending. This reduces the above-described external stress which is applied to the cable 1 when the cable 1 is subjected to bending. As a result, it is possible to suppress a decrease in lifetime of the cable 1.

[0047] (n) In addition, since the diameter and weight of the cable 1 are reduced, the cable 1 can be suitably used for wiring in various transportation equipment such as cranes and transporting carriages, allowing various transportation equipment to have higher performance or various devices including cable reel, etc., to have a smaller size. In addition, other effects such as space saving to store the cable 1 or reduction in the transportation cost are also obtained.

[0048] (o) Meanwhile, when connecting the cable 1, the sheath 6 at an end of the cable 1 is sometimes stripped. By increasing sliding properties between the core assembly 3 and the sheath 6 so that the core assembly 3 can be adhered to the sheath 6, workability when

connecting the cable 1 in such a case can be improved since the sheath 6 can be easily stripped.

[0049] (p) The cable 1 in the present embodiment can be suitably used for outdoor wiring in an environment in which strong wind blows due to approaching or passing typhoon, etc.

5 In addition, the cable 1 in the present embodiment can be suitably used in a harsh environment in which the cable 1 is repeatedly bent, rubbed against a pulley or cable reel, or subjected to repeated friction. In detail, the cable 1 in the present embodiment is particularly effective for use in port and harbor or for wiring in various transportation equipment used in the industrial field such as steel industry.

10 [0050] For example, in a port crane or a large crane used in a steel plant, etc., the cable 1 in the present embodiment can be suitably used for wiring in traverse curtain where a certain length of cable is fixed and repeatedly bent.

[0051] In addition, for example, in the above-mentioned large crane, the cable 1 in the present embodiment can be suitably used for wiring in hoist spreader where a certain
15 length of cable is repeatedly wound into a coil shape or drawn straight.

[0052] In addition, for example, in the above-mentioned large crane, the cable 1 in the present embodiment can be suitably used for wiring in running reel where a certain length of cable is repeatedly wound up or drawn out.

[0053] Now, for reference, a conventional cable using a core with an insulation layer
20 formed of EP rubber is described. The insulation layer formed of EP rubber has a higher coefficient of friction and is less slidable than the insulation layer formed of a fluorine-based resin. Also, the insulation layer formed of EP rubber adheres to the sheath formed of a rubber material such as CR.

[0054] However, in the cable using plural cores each having an EP rubber insulation layer,
25 the cores may separately move when the cable is subjected to bending. Especially in case that the core assembly has two layers of cores as in the present embodiment, at least some of the cores constituting the outer layer in the core assembly are adhered to the sheath but the cores constituting the inner layer are not adhered to the cores constituting the outer layer. Therefore, in some cases, the cores constituting the outer layer and the cores

constituting the inner layer move differently, i.e., the cores move separately when the cable is subjected to bending, etc. This may result in misalignment of the cores. In addition, when using a rubber material such as EP rubber, it is difficult to reduce the cover thickness due to the nature of rubber. The diameter of each core is thus large, resulting in a large
5 cable diameter.

[0055] On the other hand, in the present embodiment, sliding properties between the core assembly and the sheath is increased. Therefore, even in case that the core has two or more layers of conductive wires or the insulation layer is formed of ETFE which is more slidable than EP rubber, the entire core assembly can move as one-piece in the sheath when
10 the cable is subjected to bending. This prevents the core from kinking. In addition, since it is easy to form a thin layer when using the fluorine-based resin such as ETFE, the diameter of each core can be reduced by using ETFE to form the insulation layer, and as a result, the diameter of the cable can be reduced.

[0056] Other embodiments of the invention

15 Although the embodiment of the invention has been described, the invention is not to be limited to the embodiment described above and can be appropriately modified without departing from the gist thereof.

[0057] Although the lubricant layer formed by applying a lubricant to the back surface of the tape has been described as an example in the embodiment, it is not limited thereto.
20 That is, the lubricant layer may be formed by applying a lubricant to the outer surface of each core or the outer surface of the core assembly, or may be formed by mixing silicone oil, etc., to a material used to form the insulation layer of the core.

[0058] In addition, for example, the core assembly may not be collectively covered with the tape. Even in such a cable, the same effects as those of the embodiment are obtained
25 by increasing sliding properties between the core assembly and the sheath.

[0059] In addition, for example, it is not limited to the core assembly having two layers of cores (the first and second layers). The core assembly may have three or more layers of cores, or may have one layer of cores.

[0060] Preferred embodiments of the invention

Preferred embodiments of the invention will be described below.

[0061] [1] An aspect of the invention provides a cable, comprising:

a core assembly formed by twisting a plurality of cores each comprising a conductor and an insulation layer provided to enclose the conductor; and

5 a sheath provided to enclose the core assembly,

wherein the insulation layer comprises a fluorine-based resin, and a lubricant layer is provided between the core assembly and the sheath.

[0062] [2] In the cable described in [1], preferably, the coefficient of static friction between the core assembly and the sheath is lower than the coefficient of static friction

10 between the cores.

[0063] [3] In the cable described in [1] or [2], preferably, the coefficient of kinetic friction between the core assembly and the sheath is lower than the coefficient of kinetic friction between the cores.

[0064] [4] In the cable described in any one of [1] to [3], preferably, the lubricant layer is formed by applying a lubricant between the core assembly and the sheath.

[0065] [5] The cable described in any one of [1] to [4], preferably comprises:

a tape bound around the core assembly,

wherein a surface of the tape in contact with the sheath is adhered to the sheath, and the lubricant layer is arranged on another surface of the tape.

20 [0066] [6] In the cable described in any one of [1] to [5], preferably, the lubricant layer comprises talc that is applied to the outer surface of the core assembly.

[0067] [7] In the cable described in [5], preferably, the surface of the tape in contact with the sheath is adhered to the sheath, and the lubricant is applied to the surface of the tape in contact with the core assembly.

25 [0068] [8] In the cable described in any one of [1] to [7], preferably, the insulation layers of all the cores constituting the core assembly are formed of the same material.

[0069] [9] In the cable described in any one of [1] to [8], preferably, the sheath has a higher elasticity than the insulation layer.

[0070] [10] In the cable described in any one of [1] to [9], preferably, the cable is used in

an environment involving exposure to strong wind.

CLAIMS:

- 1 **1.** A cable, comprising:
 - 2 a core assembly formed by twisting a plurality of cores each comprising a
 - 3 conductor and an insulation layer that encloses the conductor; and
 - 4 a sheath that encloses the core assembly,
 - 5 wherein the insulation layer comprises a fluorine-based resin, and
 - 6 wherein a lubricant layer is formed between the core assembly and the sheath.

- 1 **2.** The cable according to claim **1**, further comprising a tape bound around the core
2 assembly,
 - 3 wherein one surface of the tape is in direct contact with the sheath, and
 - 4 wherein the lubricant layer is formed on an other surface of the tape.

- 1 **3.** The cable according to claim **1** or **2**, wherein the lubricant layer comprises a talc that is
2 applied to an outer surface of the core assembly.

- 1 **4.** The cable according to any one of claims **1** to **3**, wherein the sheath has a higher
2 elasticity than the insulation layer.