(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 656 901 A1

(12) # EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
27.05.2020 Bulletin 2020/22

(21) Application number: **18832021.2**

(22) Date of filing: **15.06.2018**

(51) Int Cl.:
***D02G 3/38** (2006.01)*
***D02G 3/04** (2006.01)*
***D02G 3/12** (2006.01)*
***D02G 3/28** (2006.01)*
***D02G 3/34** (2006.01)*

(86) International application number:
PCT/JP2018/023008

(87) International publication number:
WO 2019/012916 (17.01.2019 Gazette 2019/03)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **10.07.2017 JP 2017134848**
29.01.2018 JP 2018012300

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(54) **COVERING YARN, TWISTED YARN, AND FIBER STRUCTURE USING SAME**

(57) A covering yarn 1, 4, or 6 includes a metal filament 2 and an organic fiber yarn 3 or 5. The metal filament 2 is arranged as a core, the organic fiber yarn 3 or 5 is arranged as a sheath, and the entire covering yarn is straight. The metal filament 2 has a wire diameter of no greater than 35 μm, and the covering yarn 1, 4, or 6 is electrically conductive. Preferably, the metal filament 2 is at least one filament selected from a tungsten filament, a molybdenum filament, and a stainless steel filament. A twisted yarn of the present invention is constituted by a core yarn, a decorative yarn, and a fixing yarn. The decorative yarn has loops or slack. At least one yarn selected from the core yarn, the decorative yarn, and the fixing yarn is the above-described covering yarn. The entire twisted yarn has real twists. Thus provided are a covering yarn and a twisted yarn that are constituted by fiber yarns that are as soft as ordinary fiber yarns for clothing, have favorable conductivity and ventilation properties, and can be washed at home, and a fiber structure obtained using the covering yarn or the twisted yarn.

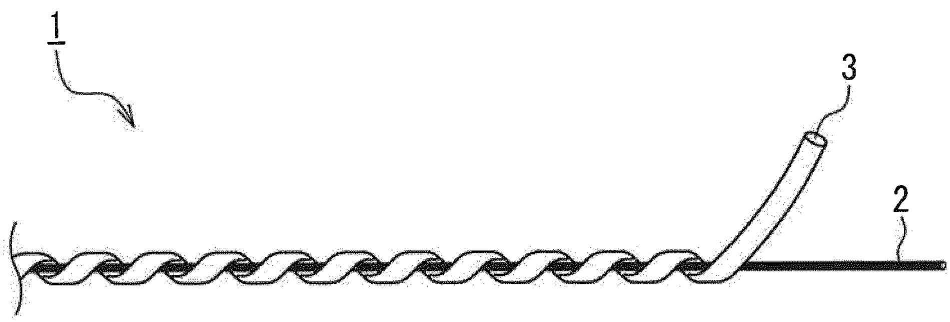

FIG. 1A

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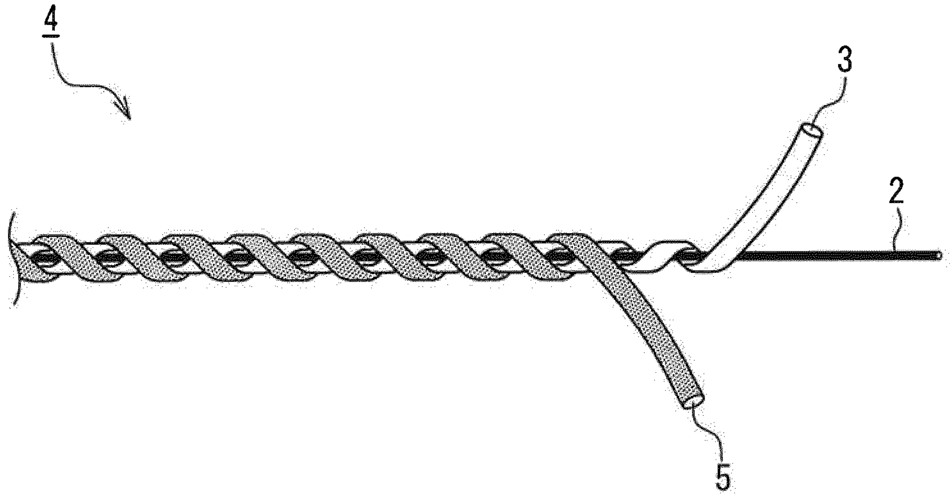

FIG. 1B

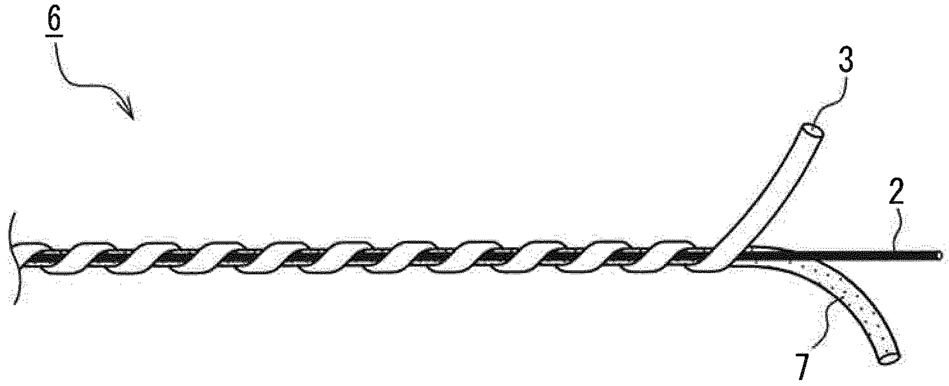

FIG. 1C

Description

Technical Field

[0001] The present invention relates to a covering yarn and a twisted yarn that include a metal filament, and a fiber structure using the covering yarn or the twisted yarn.

Background Art

[0002] In so-called wearable clothing and the like in which an instrument for measuring blood pressure, pulse, etc. is incorporated, electrically conductive yarns or electrically conductive materials are used for electrically connecting the instrument for measuring blood pressure, pulse, etc. to a communication device for transmitting data taken from the instrument to the outside. Patent Document 1 proposes, as electrically conductive yarns, a carbon-based conductive yarn, a plated yarn plated with metal or an alloy, a conductive resin fiber yarn, a metal fiber yarn, and the like. Patent Document 2 proposes a nylon yarn into which conductive carbon fine particles are kneaded. Patent Document 3 proposes a yarn that is obtained by slitting a metal vapor-deposition film obtained by depositing metal, such as gold or silver, on a surface of a polyester film. Patent Document 4 proposes a flexible electrode as an electrode to be used in wearable clothing.

[0003] From the standpoint of safety, heat-resistant gloves are necessary for welding operations, such as arc welding, operations performed in front of a blast furnace or the like, and operations, such as cooking, in which high-temperature objects are handled, and the applicant has proposed producing heat-resistant gloves using designed twisted yarns that include heat-resistant fibers such as an aramid fiber, a polybenzimidazole fiber, a polybenzoxazole fiber, a polybenzazole fiber, a polyamide imide fiber, a melamine fiber, and a polyimide fiber (Patent Document 5). Patent Document 6 proposes knitting gloves using only aramid fiber yarns, and fusing a synthetic resin to palm portions through heating. Further, Patent Document 7 proposes socks that are produced using a double-layer fiber cloth.

Prior Art Documents

Patent Document

[0004]

[Patent Document 1] JP 2016-129115A
[Patent Document 2] JP 2017-201063A
[Patent Document 3] JP 2009-044439A
[Patent Document 4] JP 2015-139506A
[Patent Document 5] JP 2007-023463A
[Patent Document 6] JP 3048633U
[Patent Document 7] JP H11-323608A

Disclosure of Invention

Problem to be Solved by the Invention

[0005] However, conventional electrically conductive yarns have problems in that the yarns are thick and hard, cannot be dyed, and are likely to accumulate sweat. Also, conventional fiber structures have problems regarding heat resistance, heat insulation properties, and the like, and there are demands for higher heat resistance and improved heat insulation properties.

[0006] In order to solve the above-described conventional problems, the present invention provides a covering yarn and a twisted yarn that are constituted by fiber yarns that are as soft as ordinary fiber yarns for clothing, have favorable electrical conductivity and ventilation properties, and can be washed at home, and a fiber structure obtained using the covering yarn or the twisted yarn. Additionally, the present invention provides a covering yarn and a twisted yarn that have improved heat resistance and improved heat insulation properties, and a fiber structure obtained using the covering yarn or the twisted yarn.

Means for Solving Problem

[0007] A covering yarn of the present invention includes a metal filament and an organic fiber yarn. The metal filament is arranged as a core, the organic fiber yarn is arranged as a sheath, and the entire covering yarn is straight. The metal filament has a wire diameter of no greater than 35 μm. The covering yarn is electrically conductive.

[0008] A first twisted yarn of the present invention includes at least two yarns that are twisted together. At least one yarn constituting the twisted yarn is the above-described covering yarn, and another yarn is an organic fiber yarn.

[0009] A second twisted yarn of the present invention is constituted by a core yarn, a decorative yarn, and a fixing yarn. The decorative yarn is a twisted yarn that has loops or slack. At least one yarn selected from the core yarn, the decorative yarn, and the fixing yarn is the above-described covering yarn. The entire twisted yarn has real twists.

[0010] A twisted yarn of the present invention includes the above-described covering yarn including the metal filament and the organic fiber yarn. The organic fiber yarn is a fiber yarn of at least one fiber selected from synthetic fibers, natural fibers, and regenerated fibers. The metal filament has a wire diameter of no greater than 35 μm. The twisted yarn is electrically conductive.

[0011] A fiber structure of the present invention is at least one fiber structure selected from a woven fabric, a knit, a braided material, and a machine-sewing yarn, and includes the above-described covering yarn or the above-described twisted yarn.

Effects of the Invention

[0012] A metal filament that has a small diameter is used in a covering yarn and a twisted yarn of the present invention and a fiber structure obtained using the covering yarn or the twisted yarn, and thus, it is possible to provide a covering yarn and a twisted yarn that are constituted by fiber yarns that are metal wires but are as soft as ordinary fiber yarns for clothing, have favorable conductivity and ventilation properties, and can be washed at home, and also provide a fiber structure obtained using the covering yarn or the twisted yarn. These characteristics are useful for so-called wearable clothing with which blood pressure, heart rate, body temperature, etc. can be measured. Furthermore, the covering yarn and the twisted yarn of the present invention also have high strength, and therefore can also be advantageously used for fishing lines, etc. The fiber structure of the present invention exhibits high heat resistance and excellent heat insulation properties with respect to conductive heat, convective heat, and radiation heat. This is presumably because, if the twisted yarn of the present invention is arranged finely at random in the fiber structure and the fiber structure is constituted only by the metal filament, heat will be dispersed even if the fiber structure is exposed to a high-temperature flame or the like. If the fiber structure is constituted by a metal filament and a flame-retardant fiber yarn, the metal filament and the flame-retardant fiber yarn synergistically serve as barriers and the fiber structure exhibits high heat resistance and excellent heat insulation properties.

Brief Description of Drawings

[0013]

[FIG. 1] FIG. 1A is a plan view of a single covering yarn according to one embodiment of the present invention, FIG. 1B is a plan view of a double covering yarn according to one embodiment of the present invention, and FIG. 1C is a plan view of a single covering yarn in which a plating yarn is arranged along a metal filament that serves as a core yarn.

[FIG. 2] FIG. 2 is a plan view of a designed twisted yarn according to one embodiment of the present invention.

[FIG. 3] FIG. 3 is a photograph showing a conductivity test of a yarn of Example 1 of the present invention.

[FIG. 4] FIG. 4 is a photograph showing a conductivity test of a yarn of Example 2 of the present invention.

[FIG. 5] FIG. 5 is a photograph showing a conductivity test of a yarn of Example 3 of the present invention.

[FIG. 6] FIG. 6 is a photograph showing a conductivity test of a yarn of Example 4 of the present invention.

[FIG. 7] FIG. 7 is a photograph showing a conductivity test of a yarn of Example 5 of the present invention.

[FIG. 8] FIG. 8 is a photograph showing a conductivity test of a yarn of Example 6 of the present invention.

[FIG. 9] FIG. 9 is a schematic plan view of a glove that is knitted using a twisted yarn according to one embodiment of the present invention, from which a water-soluble fiber yarn is dissolved, and that is constituted only by a tungsten filament yarn.

[FIG. 10] FIG. 10 is a photograph (about 0.5-fold magnification) showing the appearance of a twisted yarn according to one embodiment of the present invention.

[FIG. 11] FIG. 11 is a photograph (about 0.4-fold magnification) showing the appearance of a tubular knit obtained using a twisted yarn according to one embodiment of the present invention.

[FIG. 12] FIG. 12 is a photograph (about 0.4-fold magnification) showing the appearance of a tubular knit according to one embodiment of the present invention, from which a water-soluble fiber yarn was dissolved, and that was constituted only by a tungsten filament yarn.

[FIG. 13] FIG. 13 is a photograph (about 0.4-fold magnification) showing the appearance of a tubular knit constituted by a twisted yarn according to one embodiment of the present invention and a meta-aramid-based flame-retardant fiber yarn.

[FIG. 14] FIG. 14 is a schematic cross-sectional view showing a layered structure of a test sample subjected to a heat transfer test in one example of the present invention.

[FIG. 15] FIG. 15 is a schematic cross-sectional view showing a tubular knit of a test sample subjected to a heat transfer test in another example of the present invention.

[FIG. 16] FIG. 16 is a schematic cross-sectional view showing a heat transfer test method that was used in one example of the present invention.

Description of the Invention

[0014] The present invention is a covering yarn that includes a metal filament and an organic fiber yarn. The metal filament is arranged as a core, the organic fiber yarn is arranged as a sheath, and the entire covering yarn is straight (linear). It is difficult to form a fiber structure, such as a twisted yarn, a woven fabric, a knit, or a braided cord, using only a metal filament, but if an organic fiber yarn is wound around the metal filament, the resultant yarn can be supplied to a manufacturing apparatus for twisted yarns, woven fabrics, knits, or braided cords, and can be formed into a sheet-like fiber structure. Examples of organic fibers in the present invention include natural fibers, such as cotton, hemp, wool, and silk, synthetic fibers, such as polyester fibers, nylon fibers, acrylic fibers, vinylon fibers, polyolefin fibers, para-aramid fibers, meta-aramid fibers, polyarylate fibers, and polybenzoxazole fibers, and regenerated fibers, such as rayon. If the metal filament is covered with a water-soluble fiber yarn, it is possible to remove the water-soluble fiber yarn after forming a fiber structure and expose the metal filament to the outside to form an electrical terminal, and therefore such a yarn can be advantageously used for clothing that has electrical conductivity and/or generates heat when supplied with electricity. It is also possible to form a fiber structure that is constituted only by the metal filament.

[0015] The above-described metal filament is preferably at least one filament selected from a tungsten (W) filament, a molybdenum (Mo) filament, and a stainless steel (SUS) filament. Tungsten (W) is used for light emitting portions of incandescent electric lights and discharge lamps. The melting point of tungsten is 3380°C, but a tungsten filament contains small amounts of dopants and therefore has a lower melting point. The melting point of molybdenum (Mo) is 1620°C. Stainless steel (SUS) wires are said to be able to be used within a range of the annealing temperature of 1150°C or less and, for example, a stainless steel wire having a wire diameter of 11 μm is sold by Nippon Seisen Co., Ltd. The wire diameter of the above-described metal filament is preferably 5 to 35 μm, more preferably 5 to 22 pm, and particularly preferably 5 to 15 μm. If the wire diameter is in the above range, a rough and hard feeling is unlikely to be felt even if the metal filament touches the skin. Furthermore, the metal filament is thin, and therefore if the metal filament is covered and/or twisted with an organic fiber yarn, the metal filament is unlikely to be seen, and does not hinder the dyeing properties of the organic fiber yarn and affect its color. Although the metal filament may be a monofilament or a multi filament, a monofilament is easier to handle. If a filament (long fiber yarn) is used, electrical connection can be made at any portion of the fiber structure including both ends thereof.

[0016] One example of water-soluble fiber yarns is water-soluble vinylon, which can be dissolved using hot water or boiling water. The entire covering yarn obtained by winding a water-soluble fiber yarn around the surface of the metal filament is straight. This is because the shape of the metal filament is maintained. The water-soluble vinylon may be a filament yarn or a spun yarn.

[0017] The above-described covering yarn is preferably a single covering yarn or a double covering yarn. Out of these, the single covering yarn is preferable because it can be easily manufactured at a low cost. It is preferable that a water-soluble fiber yarn that serves as a plating yarn is further arranged along the metal filament that serves as a core yarn. If such a plating yarn is arranged, the unity of the metal filament and the covering yarn is improved.

[0018] A first twisted yarn of the present invention includes at least two yarns that are twisted together. At least one yarn constituting the twisted yarn is the above-described covering yarn, and another yarn is an organic fiber yarn.

[0019] A second twisted yarn of the present invention is constituted by a core yarn, a decorative yarn, and a fixing yarn. The decorative yarn is a twisted yarn that has loops or slack. At least one yarn selected from the core yarn, the decorative yarn, and the fixing yarn is the above-described covering yarn. The entire second twisted yarn has real twists. This twisted yarn is also called a designed twisted yarn. With this configuration, processability in weaving machines, knitting machines, and non-woven fabric manufacturing apparatuses can be enhanced. The decorative yarn has loops or slack, and therefore, if the covering yarn including the metal filament is used for the decorative yarn, the above-described metal fiber can be exposed to the outside after the water-soluble fiber yarn is removed. Preferably, the designed twisted yarn is constituted by one strand of the core yarn, a plurality of (preferably, two to six) strands of the decorative yarn, and one strand of the fixing yarn. Preferably, real twists of about 100 to 1000 turns/m are imparted to the entire designed twisted yarn in order to improve handleability.

[0020] A third twisted yarn of the present invention includes a metal filament and an organic fiber yarn. The metal filament is at least one filament selected from a tungsten filament, a molybdenum filament, and a stainless steel filament.

The organic fiber yarn is a fiber yarn of at least one fiber selected from synthetic fibers, natural fibers, and regenerated fibers. The metal filament has a wire diameter of no greater than 35 μm. The twisted yarn is electrically conductive. This twisted yarn does not necessarily have to include a water-soluble fiber yarn. For example, the twisted yarn may be a two-component yarn that is constituted by a tungsten filament and a cotton spun yarn. Since a water-soluble fiber yarn is not used in this twisted yarn, the cost can be reduced accordingly, heat setting can be performed, and good processability can be achieved when forming a fiber structure, such as a woven fabric, a knit, a braided material, or a machine-sewing yarn. In both the twisted yarn and the obtained fiber structure, some portions of the metal filament are exposed to the outside of the yarn, and the exposed portions can be used as electrical terminals. Also, the twisted yarn and the obtained fiber structure are electrically conductive and can generate heat when supplied with electricity. In this twisted yarn, an organic fiber yarn that serves as a plating yarn may be further arranged along the metal filament. If the twisted yarn is combined with a high-strength fiber, such as a high-strength polyethylene fiber or an aramid fiber, the twisted yarn exhibits high strength and can be advantageously used for a fishing line or the like.

[0021] A fiber structure of the present invention is preferably at least one fiber structure selected from a woven fabric, a knit, a braided material, and a machine-sewing yarn. Such a fiber structure can be advantageously used for clothing, electrodes, conductive wires, heat-generating wires, etc. If the fiber structure is used for wearable clothing, for example, the fiber structure may be used in portions of the clothing and can also be used as an electrode or a conductive wire. In a case in which the fiber structure is used as a conductive wire, the fiber structure may be used as is, and may also be shielded or covered with an electrical insulation material in order to prevent current leakage caused by sweat or water. In addition to the above, the fiber structure can also be used as a portion of clothing that protects a heart pacemaker to shield the pacemaker from electromagnetic waves.

[0022] A covering yarn and a twisted yarn of the present invention can be manufactured using a twister, such as a ring twister, a double twister, or a tri-twister. In particular, the ring twister and the double twister are capable of applying tension, enable mass production, and are preferable in terms of cost.

[0023] The following lists examples of advantages of the present invention.

(1) Since a metal wire is used, flaking does not occur and good washing properties can be achieved.
(2) Wearing is unlikely to occur, when compared to a yarn into which a conductive material, such as carbon black, is kneaded.
(3) The metal wire is barely visible, and therefore is unlikely to affect the color of a yarn that is combined with the metal wire.
(4) The metal wire, which is thin, feels soft and is unlikely to pierce the skin even if the metal wire is broken.
(5) If the present invention is used together with a fiber that is likely to produce static electricity, the static electricity can be eliminated. This is useful for static elimination clothes, work clothes, firefighter uniforms, acrylic sweaters, etc.
(6) In particular, if the present invention has the shape of a loop yarn, the present invention is only slightly tight when used as an electrode that is in contact with the body during exercise, and conforms well to the skin surface.
(7) The present invention functions as a conductive wire or a heat-generating wire that generates heat when supplied with electricity.
(8) In wearable clothing, a metal cord, a metal plate, or a metal snap button is used at a connection surface that is connected to a power source or a measuring device, but there are problems such as the shape of the instrument serving as the connection surface being restricted or the connection surface being hard. However, if the covering yarn of the present invention, in particular, a metal loop yarn from which a soluble yarn has been dissolved is used, the connection surface can be formed in the manner of a conductive hook-and-loop fastener, and this is advantageous for solving the above-described problems.

[0024] A fiber structure according to Embodiment 1 of the present invention is a layered structure that is constituted by metal fiber layers that are constituted only by a heat-resistant metal filament, or the metal fiber layers and a flame-retardant fiber layer that has an oxygen index (OI) of at least 26 as measured in accordance with JIS K 7201-2. With this configuration, high heat resistance and excellent heat insulation properties can be exhibited with respect to conductive heat, convective heat, and radiation heat. This is presumably because the designed twisted yarn of the present invention is arranged finely at random in the fiber structure, the water-soluble fiber yarn is removed from the fiber structure, and the metal fiber layers are constituted only by the heat-resistant metal filament, and accordingly, even if the fiber structure is exposed to a high-temperature flame or the like, heat will be dispersed.

[0025] A fiber structure according to Embodiment 2 of the present invention is constituted by a heat-resistant metal filament and a flame-retardant fiber yarn, and therefore can exhibit high heat resistance and excellent heat insulation properties as a result of the heat-resistant metal filament and the flame-retardant fiber yarn synergistically serving as barriers.

[0026] The flame-retardant fiber is preferably at least one fiber selected from para-aramid fibers, meta-aramid fibers, polyarylate fibers, polybenzoxazole fibers, and flame-retardant acrylic fibers.

(1) Para-Aramid Fiber

[0027] Examples of para-aramid fibers include homopolymerized para-aramid fibers, such as "Kevlar" manufactured by DuPont de Nemours, Inc., in the U.S. (the product name is the same for the product manufactured by DU PONT-TORAY CO., LTD. in Japan) and "Twaron" manufactured by Teijin Limited, and copolymerized para-aramid fibers such as "Technora" manufactured by Teijin Limited. These fibers have a tensile strength of 20.3 to 24.7 cN/dtex, a thermal decomposition starting temperature of about 500°C, and an oxygen index (OI) value of 25 to 29.

(2) Meta-Aramid Fiber

[0028] Examples of meta-aramid fibers include "Nomex" manufactured by DuPont de Nemours, Inc., in the U.S. (the product name is the same for the product manufactured by DU PONT-TORAY CO., LTD. in Japan) and "Conex" manufactured by Teijin Limited. These fibers have an oxygen index (OI) of 29 to 30.

(3) Polyarylate Fiber

[0029] One example of polyarylate fibers is "Vectran" manufactured by Kuraray Co., Ltd. This fiber has a strength of 18 to 22 cN/dtex, an elastic modulus of 600 to 741 cN/dtex, a melting point or a decomposition temperature of 300°C, and an oxygen index (OI) of 27 to 28.

(4) Polybenzoxazole Fiber

[0030] One example of polybenzoxazole (PBO) fibers is "Zylon" manufactured by TOYOBO CO., LTD. This fiber has a tensile strength of 37 cN/dtex, an elastic modulus of 270 MPa, a melting point or a decomposition temperature of 670°C, and an oxygen index (OI) of 64.

(5) Flame-Retardant Acrylic Fiber

[0031] It is possible to use acrylic fibers that are obtained by copolymerizing acrylonitrile with a vinyl chloride-based monomer, which is a flame retardant. One example of flame-retardant acrylic fibers is "Protex" manufactured by KANEKA CORPORATION. This fiber has an oxygen index (OI) of 29 to 37.

[0032] The above-described fiber structure is preferably at least one fiber structure selected from a woven fabric, a knit, and a non-woven fabric. These fiber structures can be applied easily to portions in which heat resistance and heat insulation properties are required.

[0033] The following description will be made with reference to the drawings. In the drawings referred to below, the same reference numeral denotes the same portion or component. FIG. 1A is a plan view of a single covering yarn 1 according to one embodiment of the present invention. The single covering yarn 1 is obtained by winding an organic fiber yarn or water-soluble fiber yarn 3 around the surface of a metal filament 2 that serves as a core yarn. FIG. 1B is a plan view of a double covering yarn 4 according to one embodiment of the present invention. The double covering yarn 4 is obtained by winding the organic fiber yarn or water-soluble fiber yarn 3 around the surface of the metal filament 2 that serves as the core yarn, and winding a water-soluble fiber yarn 5 around the surface of the organic fiber yarn or water-soluble fiber yarn 3 in a direction opposite to the winding direction of the water-soluble fiber yarn 3. FIG. 1C is a plan view of a single covering yarn 6 according to one embodiment of the present invention in which a plating yarn 7 is arranged along the metal filament 2 serving as the core yarn.

[0034] FIG. 2 is a plan view of a designed twisted yarn 8 according to one embodiment of the present invention. The designed twisted yarn 8 is manufactured by using the above-described single covering yarn or double covering yarn, arranging a decorative yarn 10 in a slack manner like a float yarn on the surface of a core yarn 9, and fixing the decorative yarn 10 from above using a fixing yarn 11. The entire designed twisted yarn 8 has real twists of about 100 to 1000 turns/m.

[0035] FIG. 9 is a schematic plan view of a glove 12 according to one embodiment of the present invention that is knitted using a designed twisted yarn, from which a water-soluble fiber yarn is dissolved, and that is constituted only by a tungsten filament yarn. This glove 12 is constituted only by the tungsten filament yarn, and accordingly is unburnable and has excellent heat insulation properties. A heat-resistant glove that is constituted by a designed twisted yarn made of aramid fibers may also be worn under the glove 12.

[0036] FIG. 10 is a photograph (about 0.5-fold magnification) showing the appearance of a designed twisted yarn according to one embodiment of the present invention. The yarn has an uneven surface because a decorative yarn bulges outward.

[0037] FIG. 11 is a photograph (about 0.4-fold magnification) showing the appearance of a tubular knit obtained using a designed twisted yarn according to one embodiment of the present invention. The entire tubular knit has a white color because a vinylon yarn, which is the water-soluble fiber yarn 3, is exposed at the surface thereof, and a tungsten filament yarn is located inside the designed twisted yarn.

[0038] FIG. 12 is a photograph (about 0.4-fold magnification) showing the appearance of a tubular knit according to one embodiment of the present invention from which a water-soluble fiber yarn is dissolved and that is constituted only by a tungsten filament yarn. Knitted stitches constituted only by the tungsten filament yarn can be observed. Portions that look like fine naps or loops are decorative yarn portions of the designed twisted yarn. The discolored portion on the left side of the center of the tubular knit is a portion to which a flame of a Meker burner was applied from below by using a convective heat transfer test method shown in FIG. 15 in accordance with ISO9151. Even though a high-temperature flame was applied, the portion was merely discolored and no considerable damage was observed.

[0039] FIG. 13 is a photograph (about 0.4-fold magnification) showing the appearance of a tubular knit that was knitted aligning a designed twisted yarn according to one embodiment of the present invention and a meta-aramid-based flame-retardant fiber yarn in a parallel manner. A structure (product name "ATSUBOUGU") manufactured and sold by the applicant, which was knitted using a designed twisted yarn constituted by a meta-aramid fiber yarn, was used for this tubular knitted fabric.

[0040] FIG. 14 is a schematic cross-sectional view showing a layered structure of a test sample subjected to a heat transfer test in one example of the present invention. This layered structure 13 was obtained by overlaying three tubular knits 14 (six layers) constituted only by a tungsten filament yarn on each other and layering a structure (product name "ATSUBOUGU") manufactured and sold by the applicant, which was knitted using a designed twisted yarn constituted by a meta-aramid fiber yarn, under the tubular knits 14. The entire layered structure 13 was turned upside down, and a flame was applied to the surface of a tubular knit 14 constituted only by the tungsten filament yarn.

[0041] FIG. 15 is a schematic cross-sectional view showing a tubular knit 16, which is a test sample subjected to a heat transfer test in another example of the present invention. The tubular knit 16 was knitted aligning a designed twisted yarn according to one embodiment of the present invention and a meta-aramid-based flame-retardant fiber yarn in a parallel manner, cut into a sheet, and used in the heat transfer test in this state.

[0042] FIG. 16 is a schematic cross-sectional view showing a heat transfer test method that was used in one example of the present invention. In the illustrated heat transfer test apparatus 20, a test sample 25 is set under a heat flow sensor 22, a flame of a Meker burner 21 is applied to the test sample 25 from a position spaced downward from the sample by 50 mm, and times (seconds) it takes for the temperature of the sensor 22 to increase by 24°C and 12°C are measured. Data such as the temperature of the heat flow sensor 22 and the amount of heat is transmitted via a sensor wire 23 to an analyzer. 24 denotes a heat insulation plate.

Examples

[0043] The following describes the present invention more specifically by using examples. The present invention should not be interpreted as being limited to the following examples.

Example 1

[0044] This example is an example of a two-component straight yarn that is constituted by tungsten and cotton. With regard to cotton, the metric count is shown, for example, 80/1 indicates a single yarn of 80 yarn count (the same applies hereinafter).

<Composition>

[0045]

Cotton	30/1×1 strand
Cotton	80/1×1 strand
Tungsten	Wire diameter 11 μm × 1 strand

<Twisting Method>

[0046] Covering twisted yarn

(Core Yarn)

[0047]

Cotton	30/1 × 1 strand
Tungsten	Wire diameter 11 μm × 1 strand

(Fixing Yarn)

[0048]

Cotton	80/1 × 1 strand

(Twist Number)

[0049] 280 turns/m (S twist)

Example 2

[0050] This example is an example of a three-component designed twisted yarn that is constituted by tungsten, cotton, and polyester. With regard to polyester, D represents decitex (the same applies hereinafter).

<Composition: three straight yarns of Example 1 were used for a decorative yarn>

[0051]

Polyester	150 D × 2 strands
Cotton	30/1 × 3 strands
Cotton	80/1 × 3 strands
Tungsten	Wire diameter 11 μm × 3 strands
Polyester	75 D × 1 strand

<Twisting Method>

[0052] Loop yarn (decorative yarn overfeeding rate: 3.5 times)

(Core Yarn)

[0053]

Polyester	150 D × 2 strands

(Decorative Yarn)

[0054]

Cotton	30/1 × 3 strands
Cotton	80/1 × 3 strands
Tungsten	Wire diameter 11 μm × 3 strands

(FixingYarn)

[0055]

Polyester	75 D × 1 strand

(Twist Number)

[0056] 600 turns/m (S twist)

Example 3

[0057] This example is an example of a three-component straight yarn that is constituted by tungsten, polyester, and a soluble yarn.

<Composition>

[0058]

Polyester	150 D × 1 strand
Water-soluble vinylon	28 D × 1 strand
Tungsten	Wire diameter 11 μm × 1 strand

<Twisting Method>

[0059] Covering twisted yarn

(Core Yarn)

[0060]

Polyester	150 D × 1 strand
Tungsten	Wire diameter 11 μm × 1 strand

(FixingYarn)

[0061]

Water-soluble vinylon	28 D × 1 strand

(Twist Number)

[0062] 280 turns/m (S twist)

Example 4

[0063] This example is an example of a three-component designed yarn that is constituted by tungsten, polyester, and a soluble yarn.

<Composition: three straight yarns of Example 3 were used for a decorative yarn>

[0064]

Polyester	150 D × 5 strands
Water-soluble vinylon	28 D × 3 strands
Tungsten	Wire diameter 11 μm × 3 strands
Polyester	75 D × 1 strand

<Twisting Method>

[0065] Loop yarn (decorative yarn overfeeding rate: 3.26 times)

(Core Yarn)

[0066]

Polyester	150 D × 2 strands

(Decorative Yarn)

[0067]

Polyester	150 D × 3 strands
Tungsten	Wire diameter 11 μm × 3 strands
Water-soluble	vinylon 28 D × 3 strands

(Fixing Yarn)

[0068]

Polyester	75 D × 1 strand

(Twist Number)

600 turns/m (S twist)

Example 5

[0069] This example is an example of a two-component straight yarn that is constituted by tungsten and a soluble yarn. Evaluation tests were performed in a state in which water-soluble vinylon was entirely dissolved.

<Composition>

[0070]

Water-soluble vinylon	100 D × 1 strand
Water-soluble vinylon	28 D × 1 strand
Tungsten	Wire diameter 11 μm × 1 strand

<Twisting Method>

[0071] Covering twisted yarn

(Core Yarn)

[0072]

Water-soluble vinylon	100 D × 1 strand
Tungsten	Wire diameter 11 μm × 1 strand

(Fixing Yarn)

[0073]

Water-soluble vinylon	28 D × 1 strand

(Twist Number)

280 turns/m (S twist)

Example 6

[0074] This example is an example of a two-component designed yarn that is constituted by tungsten and a soluble yarn. Evaluation tests were performed in a state in which water-soluble vinylon was entirely dissolved.

<Composition>

(Two strands of the above-described straight yarn were used for a core yarn.)

(Five strands of the above-described straight yarn were used for a decorative yarn.)

(One strand of the above-described straight yarn was used for a fixing yarn.)

[0075]

Water-soluble vinylon	100 D × 8 strands
Water-soluble vinylon	28 D × 8 strands
Tungsten	Wire diameter 11 μm × 8 strands

<Twisting Method>

[0076] Loop yarn (decorative yarn overfeeding rate: 2.8 times)

(Core Yarn)

[0077]

Water-soluble vinylon	100 D × 2 strands
Water-soluble vinylon	28 D × 2 strands
Tungsten	Wire diameter 11 μm × 2 strands

(Decorative Yarn)

[0078]

Water-soluble vinylon	100 D × 5 strands
Water-soluble vinylon	28 D × 5 strands
Tungsten	Wire diameter 11 μm × 5 strands

(Fixing Yarn)

[0079]

Water-soluble vinylon	100 D × 1 strand
Water-soluble vinylon	28 D × 1 strand
Tungsten	Wire diameter 11 μm × 1 strand

(Twist Number)

[0080] 600 turns/m (S twist)

[0081] A conductivity test was performed on each of the yarns obtained in the above Examples 1 to 6.

<LED Lighting Test>

(Content of Experiment)

[0082] Electricity was passed through a test piece of 10 cm to light a red LED.

(Instruments Used)

[0083]

LED: rated voltage 2 V, rated current 20 mA

Resistor: resistor (180 Ω) for 6 V

Power source: two alkaline dry batteries of 1.5 V connected in series

[0084] As shown in Table 1, all of the yarns were electrically conductive. FIGS. 3 to 8 are photographs showing the conductivity test of Examples 1 to 6, respectively. In the photograph shown in FIG. 7 (Example 5), the yarn is too thin and cannot be seen, but it can be confirmed that the yarn is continuous because the LED lamp is lit.

Table 1

	Details of yarn	Evaluation result
Example 1	Straight yarn constituted by tungsten and cotton	Lit
Example 2	Designed yarn constituted by tungsten, cotton, and polyester	Lit
Example 3	Straight yarn constituted by tungsten, polyester, and soluble yarn	Lit
Example 4	Designed yarn constituted by tungsten, polyester, and soluble yarn	Lit
Example 5	Straight yarn constituted by tungsten and soluble yarn (dissolved)	Lit
Example 6	Designed yarn constituted by tungsten and soluble yarn (dissolved)	Lit

[0085] Next, a heat generation experiment was performed using a fiber yarn that was obtained by bundling four strands of the designed twisted yarn of Example 2 (i.e., designed twisted yarn constituted by tungsten, cotton, and polyester) and a fiber yarn that was obtained by bundling four strands of the designed twisted yarn of Example 6 (i.e., designed twisted yarn constituted by tungsten and the soluble yarn, from which the soluble yarn was dissolved).

(Content of Experiment)

[0086] The temperature of a test piece that included a current-passing portion with a length of 10 cm was measured in an atmosphere at a temperature of 16°C.

(Instruments Used)

[0087] Power source: two alkaline dry batteries of 1.5 V connected in series Temperature measuring device: non-contact thermometer "HORIBAIT-540NH"

[0088] As shown in Table 2, it was found that heat was generated in the current-passing portion.

Table 2

	Temperature (°C) of designed twisted yarn of Example 2	Temperature (°C) of designed twisted yarn of Example 6
Current-passing portion	25	24

[0089] Next, the electrical resistance of the designed twisted yarns of Examples 2, 4, and 6 was measured.

(Content of Experiment)

[0090] The electrical resistance of the current-passing portion with a length of 10 cm was measured.

(Instruments Used)

Measuring device: digital multi tester "TDE-200A" available from TRUSCO NAKAYAMA CORPORATION

[0091]

Table 3

	Details	Electrical resistance (Ω)
Example 2	Bundle of four strands of designed yarn constituted by tungsten, cotton, and polyester	27.0
Example 4	Bundle of four strands of designed yarn constituted by tungsten, polyester, and soluble yarn	39.2
Example 6	Bundle of four strands of designed yarn constituted by tungsten and soluble yarn (dissolved)	2.8

Example 7

<Covering Yarn A>

[0092] One strand of a tungsten filament yarn (wire diameter: 20 μm, tensile strength: 3200 to 4000 MPa) and one strand of a water-soluble vinylon yarn of 110 Tex were used as a core. One strand of a water-soluble vinylon yarn of 110 Tex was used as a cover yarn. A covering yarn shown in FIG. 1C was produced using these yarns. The twist number of the covering twisted yarn was 300 turns/m.

<Covering Yarn B>

[0093] One strand of a tungsten filament yarn (wire diameter: 33 μm, tensile strength: 3000 to 3800 MPa) and one strand of a water-soluble vinylon yarn of 110 Tex were used as a core. One strand of a water-soluble vinylon yarn of 110 Tex was used as a cover yarn. A covering yarn shown in FIG. 1C was produced using these yarns. The twist number of the covering twisted yarn was 300 turns/m.

<Designed Twisted Yarn>

[0094] A designed twisted yarn shown in FIGS. 2 and 10 was produced using one strand of the covering yarn A for a core yarn, four strands of the covering yarn A for a decorative yarn, and one strand of the covering yarn A for a fixing yarn. These yarns were supplied to a designed twisted yarn twister, and the overfeeding rate of the decorative yarn was set to three times (300%) relative to the core yarn and the fixing yarn. The twist number in the designed twisted yarn twister was set to 500 turns/m of S twists.

<Tubular Knit>

[0095] A tubular knit was knitted using two strands of the covering yarn B and one strand of the designed twisted yarn. The mass ratio was 17.2 mass% of the covering yarn B and 82.8 mass% of the designed twisted yarn, the tubular knit had an outer diameter of 80 mm, a length of 300 mm, a mass of 40.2 g when knitted, and a mass of 10.0 g after the water-soluble vinylon was dissolved using hot water. FIG. 11 shows a photograph of the knitted tubular knit. After the water-soluble vinylon was dissolved using hot water, the tubular knit was constituted entirely by tungsten (W) (100%).

[0096] Heat resistance tests were performed as described below in the following examples including this example.

<Contact Heat Transfer Test>

[0097] In accordance with ISO12127-1:2007, the time (seconds) it took for the temperature on the back side of a test sample to increase by 10°C was measured at a test temperature of 250°C. The longer the time is, the better heat insulation properties are.

<Convective Heat Transfer Test>

[0098] In accordance with ISO9151, measurement was performed using a method shown in FIG. 16. A test sample was set under a heat flow sensor, a flame was applied to the sample from below using a Meker burner, and times (seconds) it took for the temperature of the sensor to increase by 24°C and 12°C were measured. HTI_{24} represents the time (seconds) it took for the temperature to increase by 24°C, and HTI_{12} represents the time (seconds) it took for the temperature to increase by 12°C. The longer the time is, the better heat insulation properties are. Note that the flame of the burner was initially adjusted such that, when the flame of the burner was applied to the heat flow sensor in a state in which the test sample was not set under the heat flow sensor, the value of the heat flux from the burner to the sensor, which is obtained using the following equation based on the temperature increase of the sensor, was 80 kW/m^2.

$Q = McpR/A$
Q: Heat flux (kW/m^2)
M: Mass (kg) of the sensor (copper)
cp: Heat capacity (0.385 kJ/kg · °C) of the sensor
R: Inclination (°C/s) of straight portion of temperature increase curve of the sensor
A: Surface area (m^2) of the sensor

<Radiation Heat Transfer Test>

[0099] In accordance with ISO69427-2002, B method, measurement was performed with an incident heat flux density of 40 kW/m^2. The longer the time is, the better the heat insulation properties are.

Example 8

[0100] A tubular knit was knitted using one strand of the designed twisted yarn of Example 7 and four strands of a two-fold yarn that was constituted by two strands of a meta-aramid fiber yarn of 20 yarn count (metric count). The mass ratio was 38.5 mass% of the meta-aramid fiber yarn and 61.5 mass% of the designed twisted yarn, the tubular knit had an outer diameter of 80 mm, a length of 150 mm, a mass of 29.5 g when knitted, and a mass of 18.5 g after the water-soluble vinylon was dissolved using hot water. FIG. 13 shows a photograph of the tubular knit.

<Contact Heat Transfer Test>

[0101] In Sample A, three tubular knits (a total of six layers of knitted fabric) that were each obtained in Example 7 and were constituted entirely by the tungsten (W) filament yarn (100%) were arranged on the heat source side, and a layer of a structure (product name "ATSUBOUGU") manufactured and sold by the applicant, which was knitted using a designed twisted yarn constituted by a meta-aramid fiber yarn, was arranged on the sensor side.

[0102] In Sample B, a layer of the tubular knit obtained in Example 8 was arranged on the heat source side, and a layer of a structure (product name "ATSUBOUGU") manufactured and sold by the applicant, which was knitted using a designed twisted yarn constituted by a meta-aramid fiber yarn, was arranged on the sensor side.

[0103] In Sample C (Comparative Example), measurement was performed in a state in which a layer of a knitted fabric that was knitted using three strands of a meta-aramid fiber yarn and one strand of a meta-aramid loop yarn was arranged on the heat source side, and nothing was arranged on the sensor side.

< Convective Heat Transfer Test>

[0104] In Sample D, three tubular knits (a total of six layers of knitted fabric) that were each obtained in Example 7 and were constituted entirely by the tungsten (W) filament yarn (100%) were arranged on the heat source side, and a layer of a structure (product name "ATSUBOUGU") manufactured and sold by the applicant, which was knitted using a designed twisted yarn constituted by a meta-aramid fiber yarn, was arranged on the sensor side.

[0105] In Sample E (Comparative Example), measurement was performed in a state in which a layer of a knitted fabric that was knitted using three strands of a meta-aramid fiber yarn and one strand of a meta-aramid loop yarn was arranged on the heat source side, and nothing was arranged on the sensor side.

[0106] In Sample F, a layer of the tubular knit obtained in Example 8 was arranged on the heat source side, and a layer of a structure (product name "ATSUBOUGU") manufactured and sold by the applicant, which was knitted using a designed twisted yarn constituted by a meta-aramid fiber yarn, was arranged on the sensor side.

<Radiation Heat Transfer Test>

[0107] In Sample G, three tubular knits (a total of six layers of knitted fabric) that were each obtained in Example 7 and were constituted entirely by the tungsten (W) filament yarn (100%) were arranged on the heat source side, and a layer of a structure (product name "ATSUBOUGU") manufactured and sold by the applicant, which was knitted using a designed twisted yarn constituted by a meta-aramid fiber yarn, was arranged on the sensor side. In the tubular knit shown in FIG. 12, which was constituted entirely by the tungsten (W) filament yarn (100%), the discolored portion on the left side of the center is a portion to which a flame of a Meker burner was applied. Although a high-temperature flame was applied, the portion was merely discolored and no considerable damage was observed.

[0108] Results of the above measurements are collectively shown in Tables 4 to 6.

Table 4

	Sample A	Sample B	Sample C (comparative example) tungsten not used
Contact heat transfer time (sec)	36.6	34.6	23.8

Table 5

		Sample D	Sample E (comparative example) tungsten not used	Sample F
Convective heat transfer time (sec)	$HT1_{24}$	33	21	28
	$HT1_{24}$ - HTI_{12}	15	10	12

Table 6

		Sample G
Radiation heat transfer time (sec)	HTI_{12}	23
	HTI_{24}	44
	HTI_{24} - HTI_{12}	21
	Heat transmission rate (%)	7.6

[0109] As shown above, it was confirmed that the fiber structures of Examples exhibit high heat resistance and excellent heat insulation properties with respect to all of the conductive heat, convective heat, and radiation heat.

Example 9

[0110] A glove was knitted using the designed twisted yarn obtained in Example 7 and a glove knitting machine (7 gauge) manufactured by SHIMASEIKI MFG., LTD. The obtained glove was subjected to hot water treatment to remove the water-soluble fiber yarn, and thus a glove constituted entirely by the tungsten (W) filament yarn (100%) was produced. This glove is shown in FIG. 9. A single piece of this glove had a mass of 20 g. A glove (product name "ATSUBOUGU") manufactured and sold by the applicant, which was knitted using a designed twisted yarn constituted by a meta-aramid fiber yarn, was worn on the inner side, the above-described glove constituted entirely by the tungsten (W) filament yarn (100%) was worn on the outer side, and red-hot charcoal was held in the hand, but the glove was not damaged and heat was not felt.

Industrial Applicability

[0111] A fiber structure according to the present invention can be advantageously used for clothing, electrodes, conductive wires, heat-generating wires, etc. If the fiber structure is used for wearable clothing, for example, the fiber structure may be used in portions of clothing and can also be used as an electrode or a conductive wire. In a case in which the fiber structure is used as a heat-generating wire, the fiber structure can be used for heat-generating clothing that generates heat when supplied with electricity from a battery. The fiber structure can also be used as a portion of clothing that protects a heart pacemaker to shield the pacemaker from electromagnetic waves. Furthermore, the fiber structure can also be advantageously used for a fishing line, a rope, etc. Also, the fiber structure according to the present invention can be advantageously used for work gloves for handling high-temperature objects, work gloves for performing welding operations, such as arc welding, operations performed in front of a blast furnace or the like, and operations, such as cooking, in which high-temperature objects are handled, work clothes and fireproof tools for these operations, fire doors, fire protection walls, wall materials of safes, etc.

Description of Reference Numerals

[0112]

1, 6 Single covering yarn
2 Metal filament
3, 5 Organic fiber yarn or water-soluble fiber yarn
4 Double covering yarn
7 Plating yarn
8 Designed twisted yarn
9 Core yarn
10 Decorative yarn
11 Fixing yarn
12 Tungsten filament glove
13 Test sample layered structure
14 Tubular knit constituted by tungsten filament yarn
15 Tubular knit constituted by meta-aramid fiber yarn
16 Tubular knit knitted aligning designed twisted yarn and meta-aramid-based flame-retardant yarn in a parallel manner 20 Heat transfer test apparatus 21 Meker burner
22 Heat flow sensor
23 Sensor wire
24 Heat insulation plate
25 Test sample

Claims

1. A covering yarn comprising a metal filament and an organic fiber yarn, wherein the metal filament is arranged as a core, the organic fiber yarn is arranged as a sheath, and the entire covering yarn is straight,
the metal filament has a wire diameter of no greater than 35 μm, and the covering yarn is electrically conductive.

2. The covering yarn according to claim 1,
wherein the metal filament is a monofilament having a wire diameter of no greater than 22 μm.

3. The covering yarn according to claim 1 or 2,
wherein the metal filament is at least one filament selected from a tungsten filament, a molybdenum filament, and a stainless steel filament.

4. The covering yarn according to any one of claims 1 to 3,
wherein the covering yarn is a single covering yarn or a double covering yarn.

5. The covering yarn according to any one of claims 1 to 4,
wherein an organic fiber yarn is further arranged as a plating yarn along the core yarn.

6. The covering yarn according to claim 5,
wherein the organic fiber yarn serving as the plating yarn is a water-soluble fiber yarn.

7. A twisted yarn comprising at least two yarns that are twisted together, wherein at least one yarn constituting the twisted yarn is the covering yarn according to any one of claims 1 to 6, and another yarn is an organic fiber yarn.

8. A twisted yarn constituted by a core yarn, a decorative yarn, and a fixing yarn, wherein the decorative yarn is a twisted yarn that has loops or slack,
at least one yarn selected from the core yarn, the decorative yarn, and the fixing yarn is the covering yarn according to any one of claims 1 to 6, and
the entire twisted yarn has real twists.

9. The twisted yarn according to claim 8, constituted by one strand of the core yarn, a plurality of strands of the decorative yarn, and one strand of the fixing yarn.

10. A twisted yarn comprising the covering yarn according to any one of claims 1 to 6 that includes the metal filament and the organic fiber yarn,
wherein the organic fiber yarn is a fiber yarn of at least one fiber selected from synthetic fibers, natural fibers, and regenerated fibers,
the metal filament has a wire diameter of no greater than 35 μm, and
the twisted yarn is electrically conductive.

11. The twisted yarn according to claim 10,
wherein the metal filament is exposed at a surface of the twisted yarn.

12. A fiber structure that is at least one fiber structure selected from a woven fabric, a knit, a braided material, and a machine-sewing yarn, the fiber structure comprising
the covering yarn according to any one of claims 1 to 6 or the twisted yarn according to any one of claims 7 to 9.

13. The fiber structure according to claim 12,
wherein the organic fiber yarn is removed from the fiber structure, and the fiber structure is a metal fiber layer that is constituted only by the metal filament.

14. The fiber structure according to claim 12 or 13,
wherein the fiber structure is a layered structure that is constituted by a metal fiber layer and a layer of a flame-retardant fiber that has an oxygen index (OI) of at least 26 as measured in accordance with JIS K 7201-2.

15. The fiber structure according to claim 14,
wherein the flame-retardant fiber is at least one fiber selected from para-aramid fibers, meta-aramid fibers, polyarylate fibers, polybenzoxazole fibers, and flame-retardant acrylic fibers.

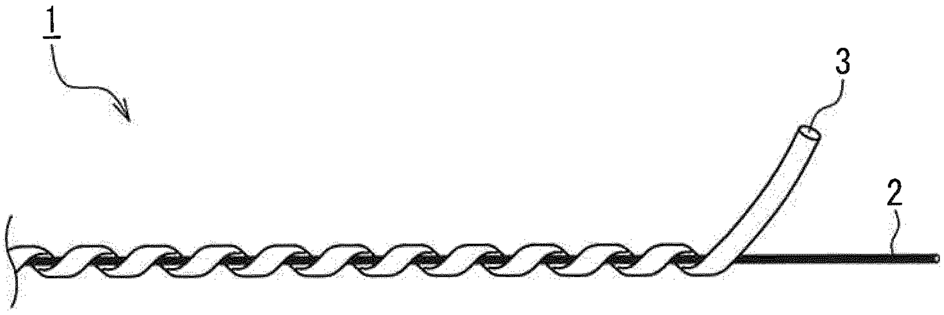

FIG. 1A

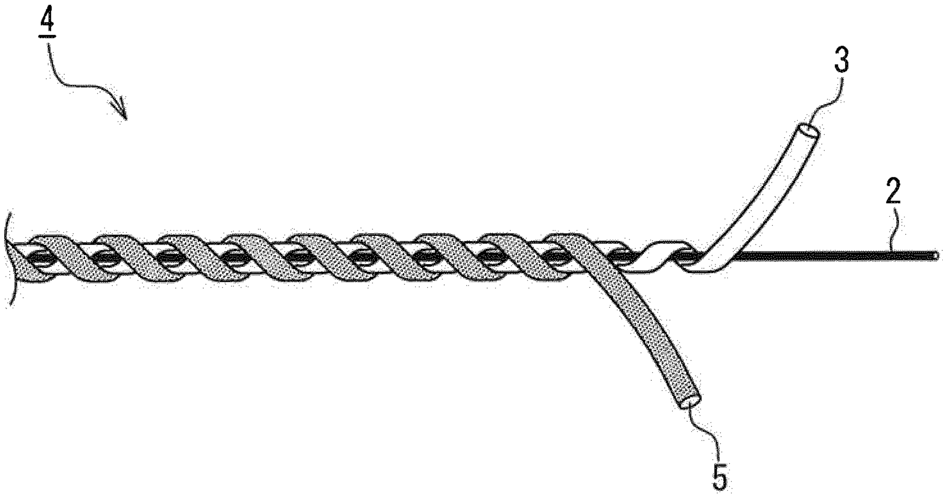

FIG. 1B

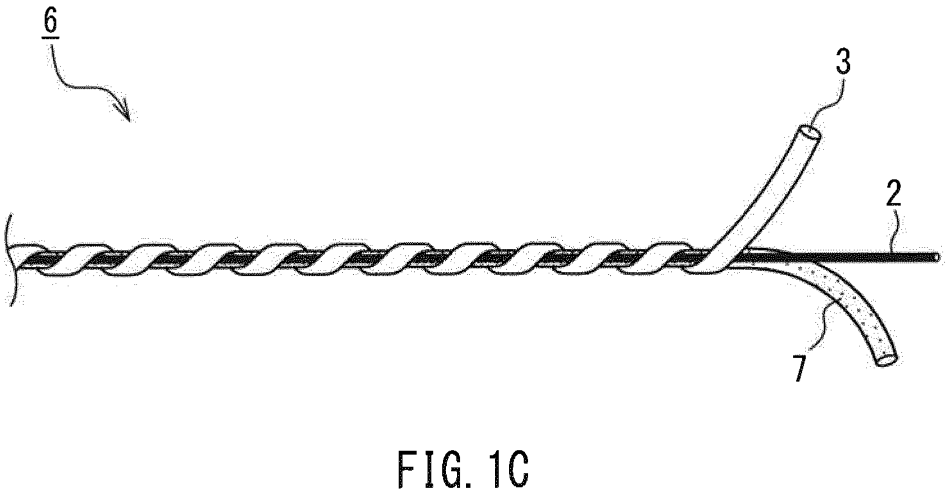

FIG. 1C

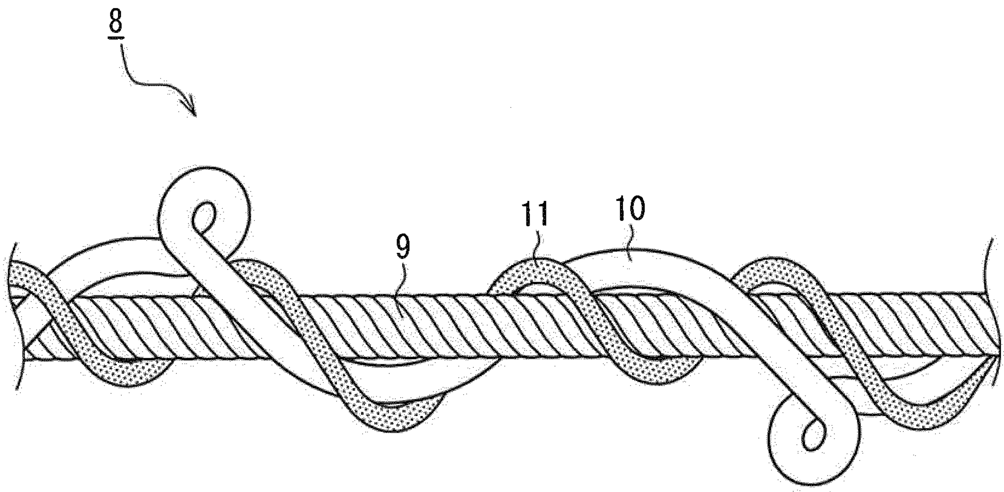

FIG. 2

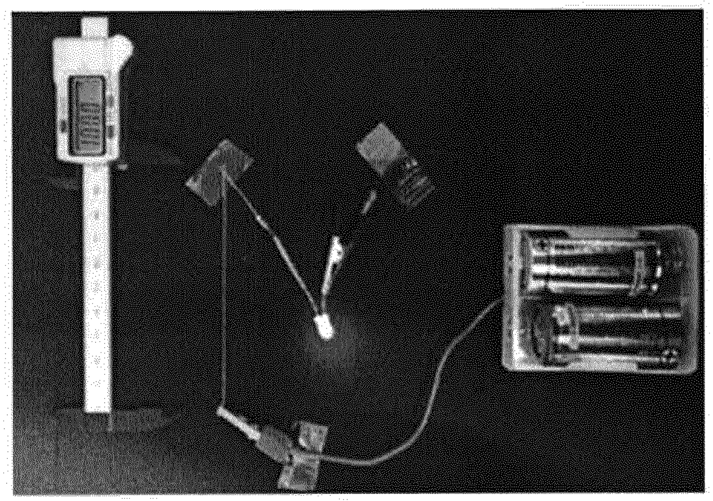

FIG. 3

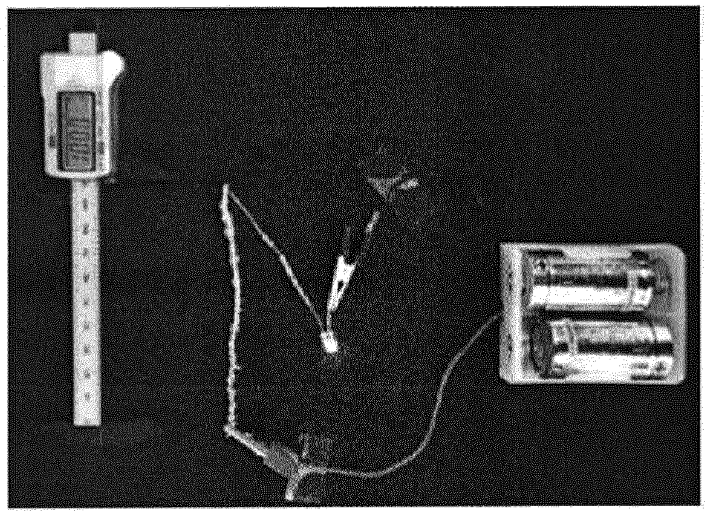

FIG. 4

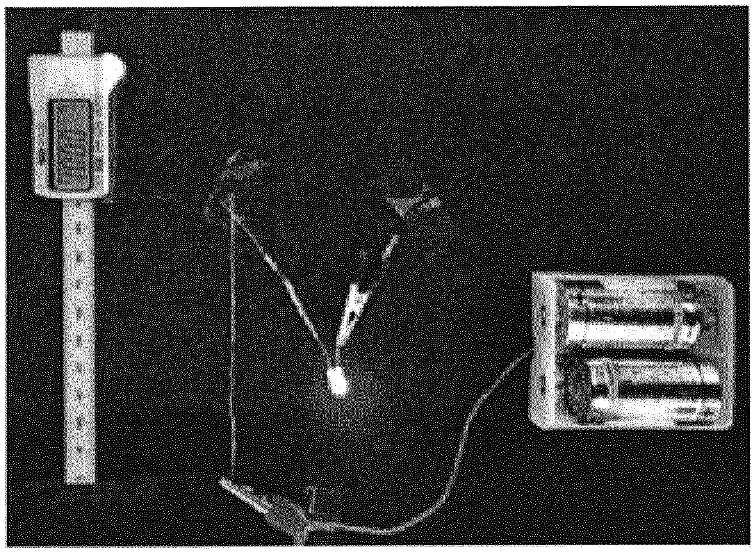

FIG. 5

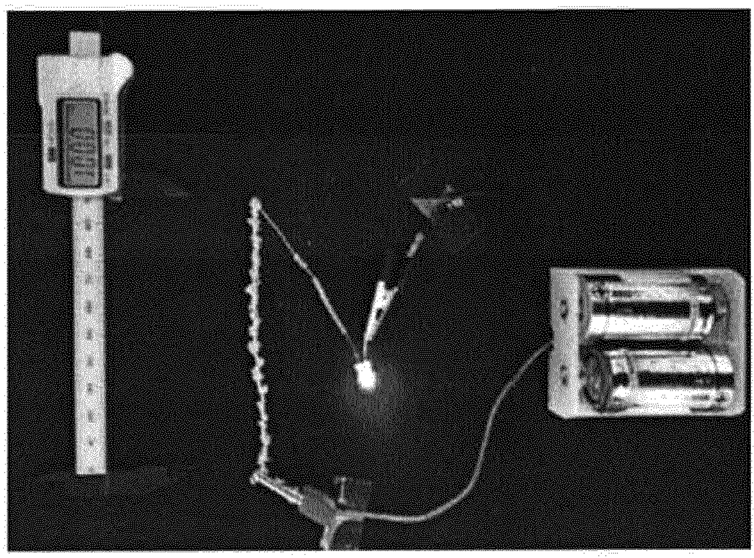

FIG. 6

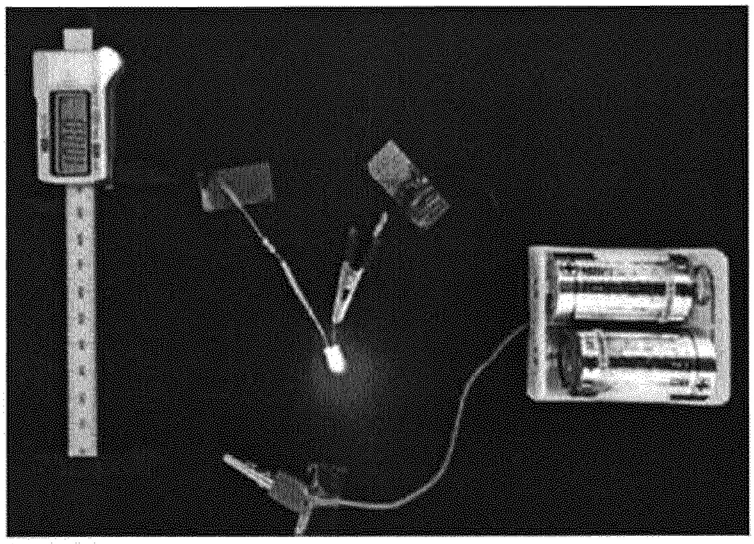

FIG. 7

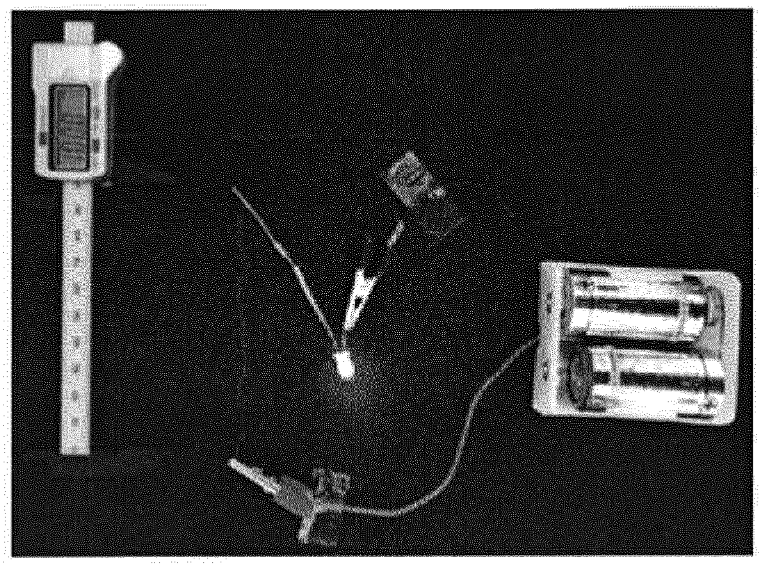

FIG. 8

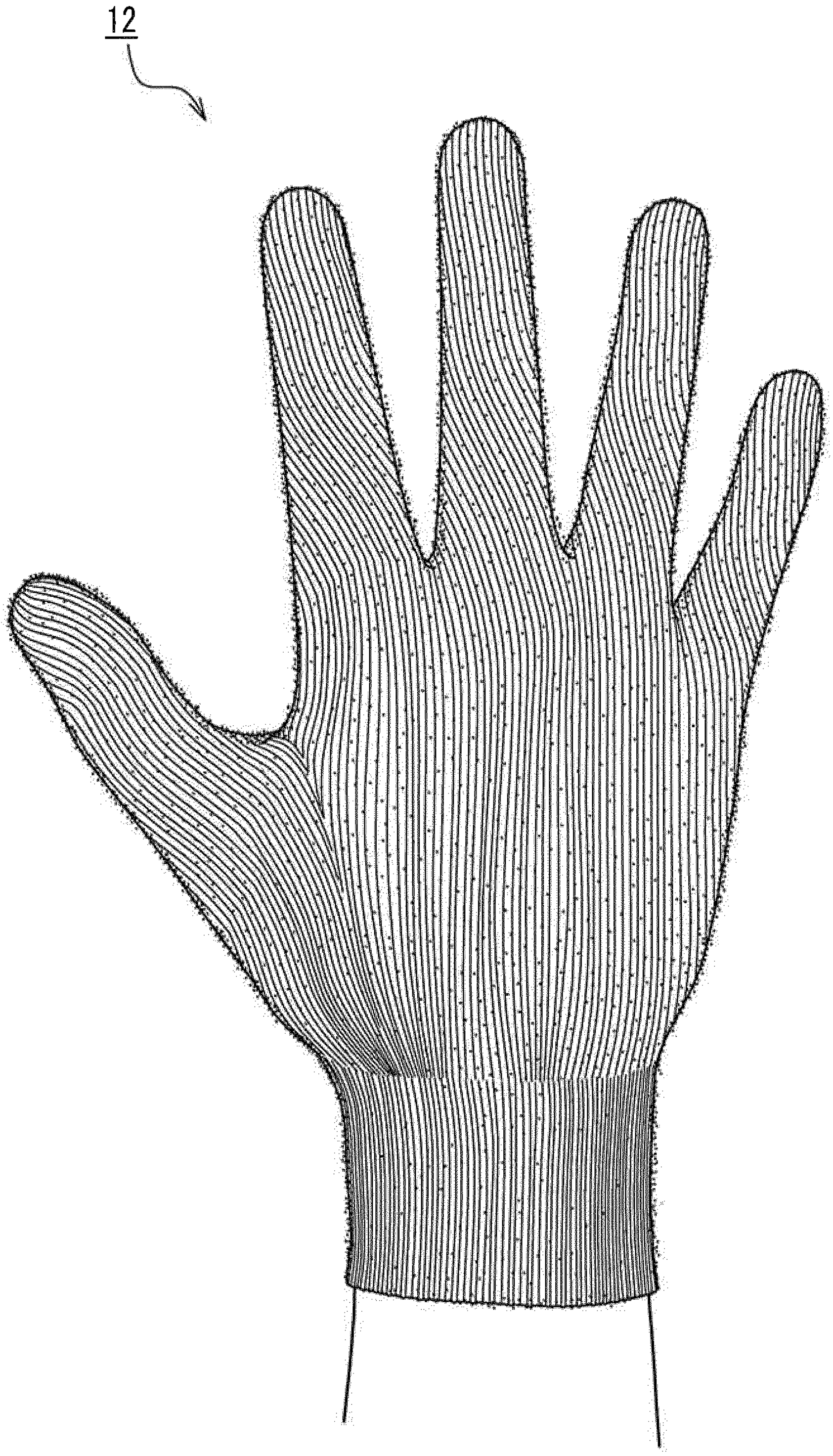

FIG. 9

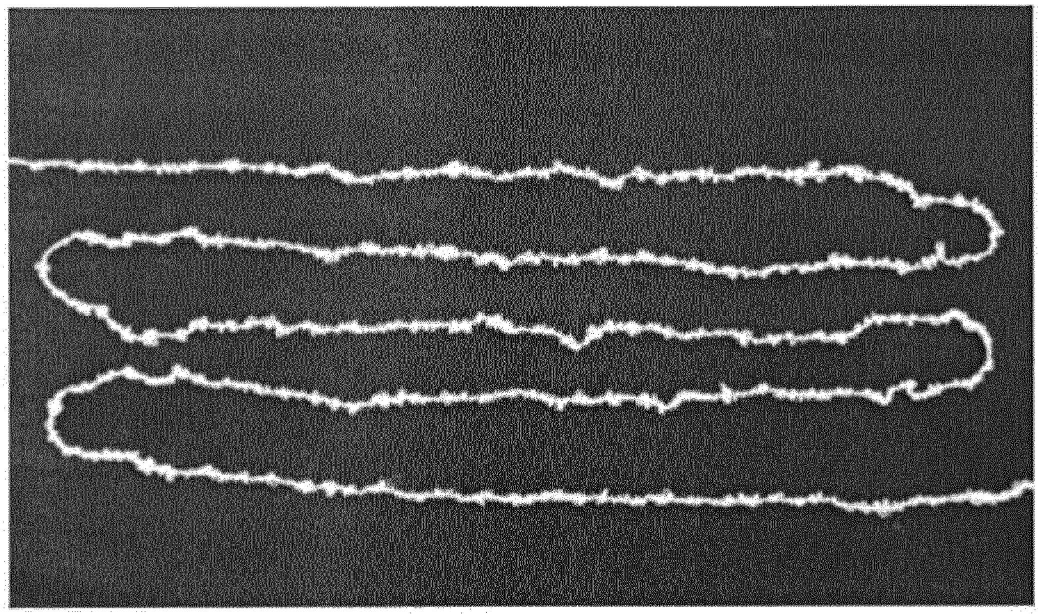

FIG. 10

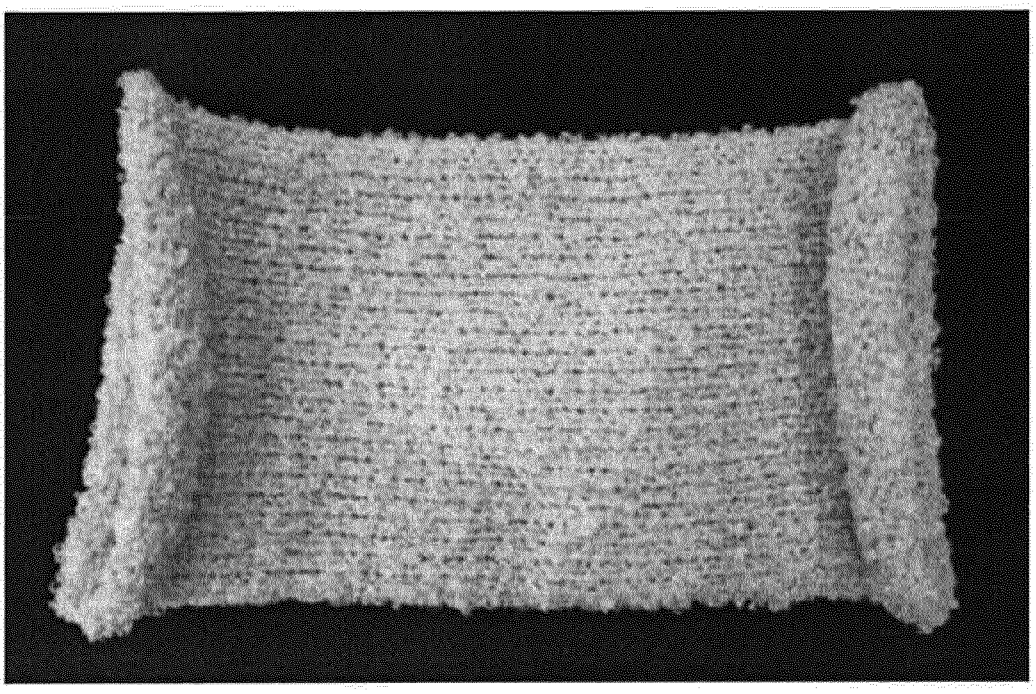

FIG. 11

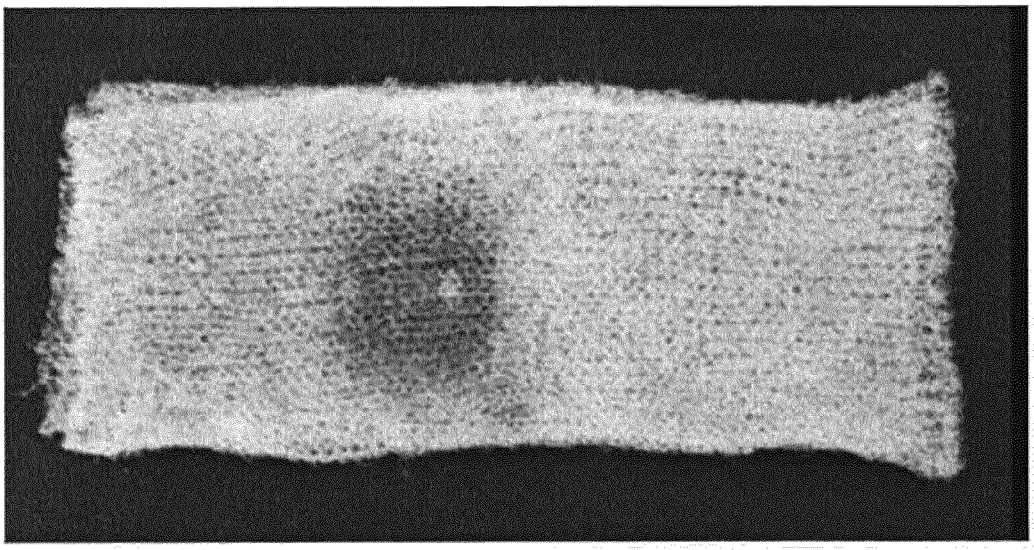

FIG. 12

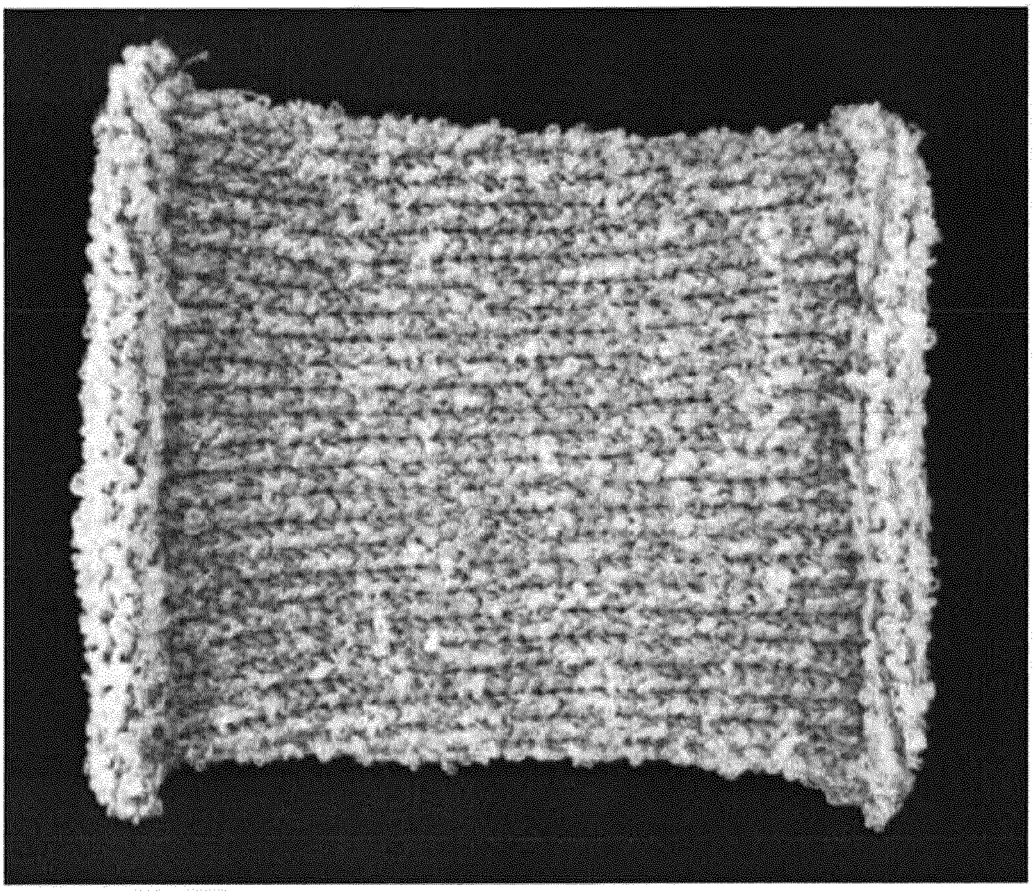

FIG. 13

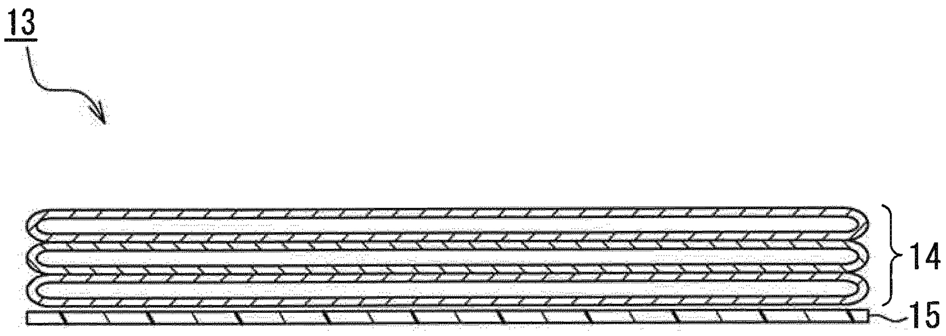

FIG. 14

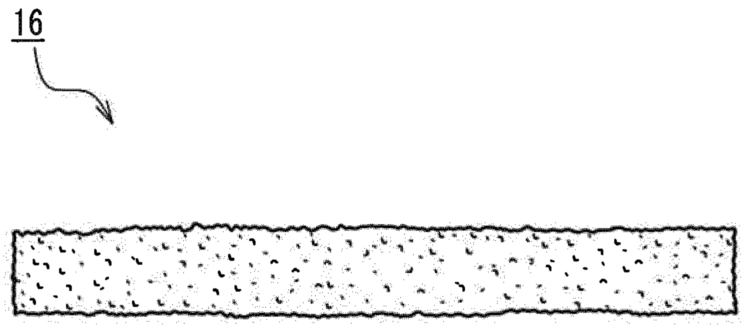

FIG. 15

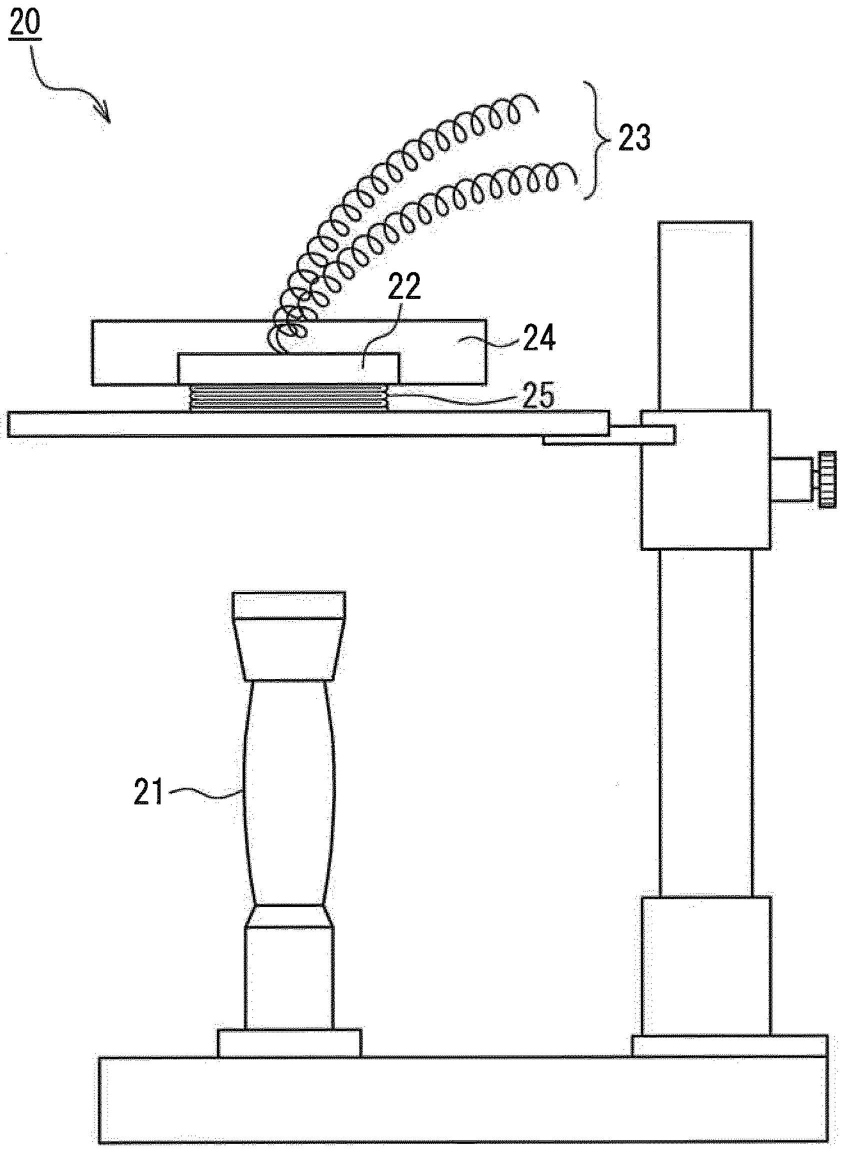

FIG. 16

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2018/023008

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. D02G3/38(2006.01)i, D02G3/04(2006.01)i, D02G3/12(2006.01)i, D02G3/28(2006.01)i, D02G3/34(2006.01)i

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)
Int.Cl. D02G1/00-3/48, D02J1/00-13/00

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2018
Registered utility model specifications of Japan	1996-2018
Published registered utility model applications of Japan	1994-2018

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	JP 5-195366 A (MITSUBISHI RAYON CO., LTD.) 03 August 1993, claims, example 1, paragraph [0008], fig. 3 (Family: none)	1-6, 10-15 7-9

☒ Further documents are listed in the continuation of Box C. ☐ 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 application or patent 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
02 August 2018 (02.08.2018)	14 August 2018 (14.08.2018)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/023008

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	JP 2004-11033 A (IMAI, Yoshio) 15 January 2004, claims, paragraph [0049], drawings (Family: none)	1-5, 10, 12, 14, 15 6-9, 11, 13
X A	WO 2007/015333 A1 (SHOWA GLOVE CO.) 08 February 2007, example 1, page 6, lines 7-13, drawings & EP 1780318 A1, example 1, paragraph [0033], figures & JP 2012-21258 A & JP 2012-140749 A & US 2008/0289312 A1 & US 2008/0098501 A1 & WO 2007/015439 A1 & EP 1911866 A1	1-5, 10, 12, 14, 15 6-9, 11, 13
A	JP 5-156537 A (YAMAGUCHI, Shuichi) 22 June 1993, claims (Family: none)	1-15
A	JP 2009-68138 A (HAYASHI-NENSHI CO., LTD.) 02 April 2009, claims (Family: none)	1-15
P, X P, A	JP 2017-218683 A (PANASONIC IP MANAGEMENT CO., LTD.) 14 December 2017, claims & US 2017/0350044 A1, claims & DE 102017111599 A & CN 107460572 A	1-4, 10-15 5-9

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REFERENCES CITED IN THE DESCRIPTION

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