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**Furuta et al.**(10) **Pub. No.: US 2013/0243985 A1**(43) **Pub. Date: Sep. 19, 2013**(54) **WOVEN TEXTILE AND PROTECTIVE  
SLEEVE FOR WIRE HARNESS USING THE  
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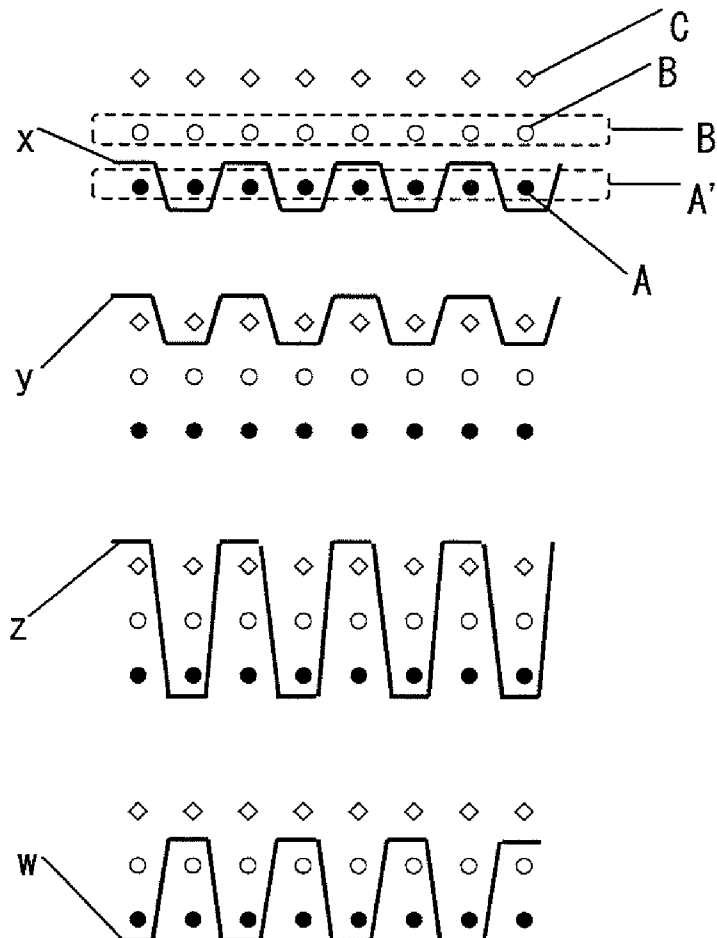
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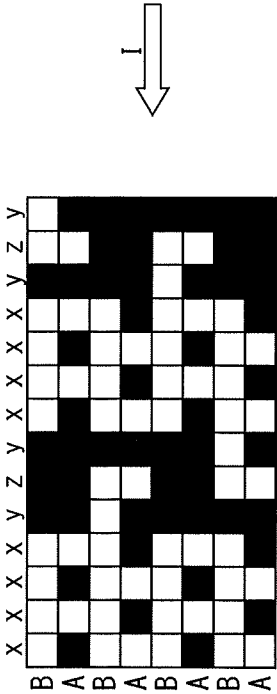
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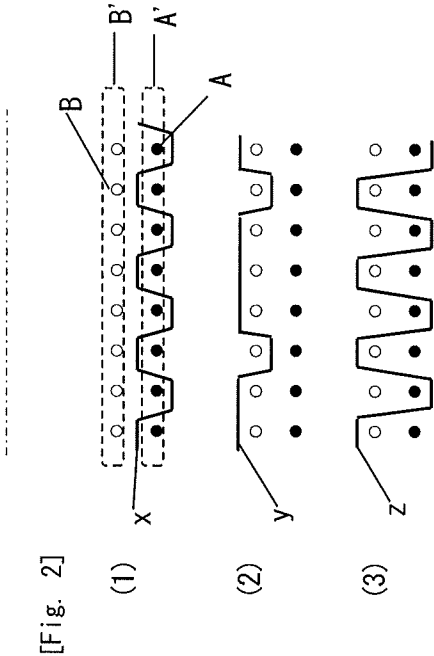
(57) **ABSTRACT**

A two- or more ply flat woven textile in which a texture A including a yarn A and a texture B including a yarn B are interwoven, wherein the yarn A and the yarn B are both a warp yarn or both a weft yarn, and shrinkage percentage of the yarn A (SA (%)) and shrinkage percentage of the yarn B (SB (%)) satisfies a specific range. The woven textile, when heat is applied, is spontaneously formed into a tube with a sufficient overlap in the circumferential direction. The tube provides easy insertion of lead wires and is able to protect the lead wires reliably without exposing the inserted lead wires.

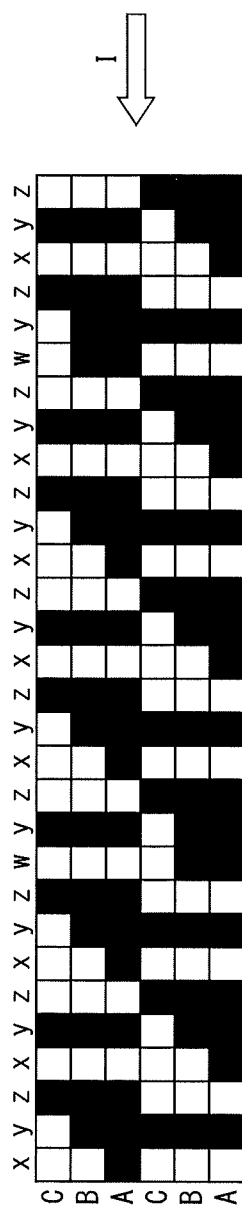


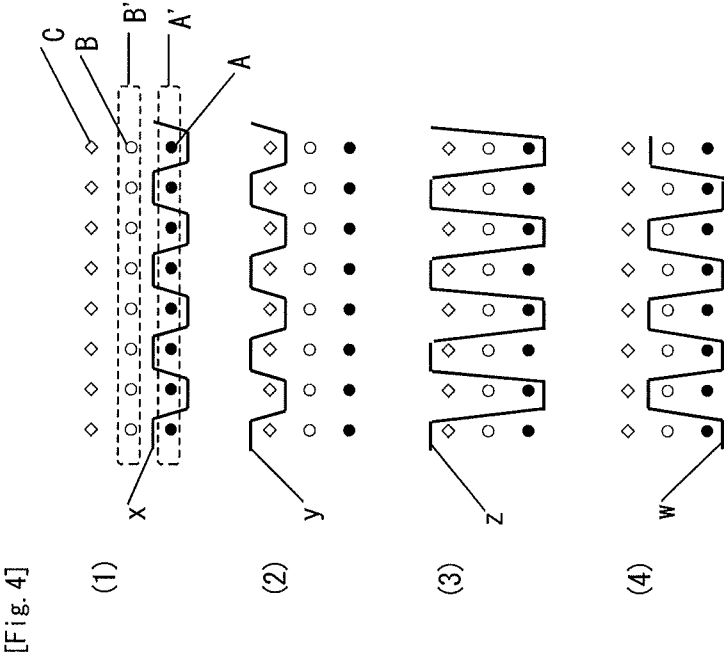
[Fig. 1]





[Fib. 3]





# WOVEN TEXTILE AND PROTECTIVE SLEEVE FOR WIRE HARNESS USING THE SAME

## TECHNICAL FIELD

[0001] This disclosure relates to a woven textile and a protective sleeve for a wire harness using the same.

## BACKGROUND

[0002] Conventionally, in processing a flat woven textile into a tube, the method in which a woven textile is set at a tubular metal mold and formed into a tube by heat set has been generally used. To form a woven textile into a tube using that processing method, a technique in heat setting is required. The processing cost is high and, therefore, it is difficult to provide a tube at low cost.

[0003] With increasing use of electrical appliances, the amount of wire used increases and, accordingly, the amount of protective sleeve for a wire harness used tends to increase. Protective sleeves for a wire harness are classified into two types: the open type having a slit in the length direction and the closed type having a complete tubular shape. In the case of the closed type, the operation of attaching or detaching a lead wire must be performed from an opening at either end. Therefore, operating efficiency is low. Thus, the open-type is preferably used. However, the open-type requires tube formation using a metal mold or half wrapping using adhesive tape and, in addition, lead wires can be exposed after protection due to the slit opening.

[0004] Thus, a protective sleeve for a wire harness obtained by attaching a ring to an open-type protective sleeve to prevent the opening of a slit has been proposed (JP 06-70425 A).

[0005] Further, as a tapeless protective sleeve for a wire harness, a method of obtaining a tubular open-type protective sleeve by laminating two sheets has been proposed (JP 2007-297749 A). That method allows production of a protective sleeve for a wire harness that does not use tape or a ring.

[0006] Further, a protective sleeve for a wire harness that has an improved abrasion resistance by arranging a monofilament and a multifilament for warp and weft has been proposed (WO 2009/111253 A2).

[0007] However, the method of JP '425 does not improve cost-effectiveness or operability sufficiently because the number of rings to attach increases when wires are long or a pathway has many curves.

[0008] The method of JP '749 does not improve cost-effectiveness or operability sufficiently because, after providing two sheets, one sheet A is stretched and the other sheet B must be laminated in the stretched state less than or equal to the sheet A or unstretched state.

[0009] In the method of WO '253, a tube is formed by heat-curing a flat woven textile in the tubular state or applying tension to a yarn in the process of weaving a woven textile. As mentioned above, such a heat set technique is difficult to implement and requires a high processing cost. Thus, the operability for protecting a long and thin member is very poor.

[0010] It could therefore be helpful to provide a protective sleeve for a wire harness that can reduce production cost, has an unprecedented excellent operability, further has excellent softness, flexibility and the like, and can easily provide functions such as heat-resisting property and flame resistance, and a woven textile used therefor.

## SUMMARY

[0011] The woven textile is a two- or more ply flat woven textile in which a texture A comprising a yarn A and a texture B comprising a yarn B are interwoven,

[0012] wherein the yarn A and the yarn B are both a warp yarn or both a weft yarn;

[0013] shrinkage percentage of the yarn A (SA (%)) and shrinkage percentage of the yarn B (SB (%)) satisfy (1) below; and

[0014] the woven textile, when heat is applied thereto, is formed into a tube such that the longer direction of the yarn A and the yarn B is the circumferential direction and the texture A is located outside the texture B:

$$10\% < (SB - SA) < 60\% \quad (1).$$

[0015] The process of producing a tubular woven textile is a process of producing a tubular woven textile,

[0016] wherein heat is applied to the woven textile so that the woven textile spontaneously rolls up due to the difference in shrinkage percentage between the yarn A and the yarn B to form a tube;

[0017] the longer direction of the yarn A and the yarn B is the circumferential direction of the tube;

[0018] the texture A is located outside the texture B; and

[0019] one end and the opposite end of the woven textile separably overlap each other on the circumference of the tube, wherein the length of the overlapping portion in the circumferential direction is 2% or more of the circumferential length.

[0020] The tubular woven textile is a tubular woven textile formed such that a flat two-ply woven textile in which a front surface texture and a back surface texture are interwoven is rolled up such that the front surface texture is located outside,

[0021] wherein one end and the opposite end of the two-ply woven textile separably overlap each other on the circumference of the tube; and

[0022] in the tubular state described above, the circumferential length of a yarn arranged in the front surface texture (LA) and the circumferential length of a yarn arranged in the back surface texture (LB) satisfy (3) below:

$$10\% < \{(LA - LB)/LA\} \times 100 < 60\% \quad (3).$$

[0023] The protective sleeve for a wire harness uses the tubular woven textile obtained by the process of producing a tubular woven textile or uses the tubular woven textile.

[0024] The woven textile is spontaneously formed into a tube by utilizing the difference in shrinkage between yarns caused when heat is applied and, therefore, heat setting using a metal mold or half wrapping using adhesive tape is not required. Thus, the cost of production of a tubular woven textile can be reduced.

[0025] In addition, when a tube with a sufficient overlap in the circumferential direction is formed by adjusting the conditions of heat to be applied, lead wires inserted into the woven textile will not be exposed from the tube due to the overlap, and the lead wires can be protected sufficiently.

[0026] Further, to form the woven textile into a tube, it is not necessary to use a metal mold, and the woven textile is formed into a tube only by simple heating immediately before being used, for example, in a factory where the tube is used. Thus, the woven textile can be shipped as a flat woven textile before being formed into a tube, and can be efficiently transported.

Furthermore, the woven textile can be stored in a small space compared to a tube in the same amount because it can be stored in piles.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0027] FIG. 1 is a weaving design of our two-ply woven textile.

[0028] FIG. 2 is a schematic view illustrating the arrangement of a warp yarn and a weft yarn in the woven textile of FIG. 1 seen from the longer direction of the weft yarn (the direction of arrow I).

[0029] FIG. 3 is a weaving design of our three-ply woven textile.

[0030] FIG. 4 is a schematic view illustrating the arrangement of a warp yarn and a weft yarn in the woven textile of FIG. 3 seen from the longer direction of the weft yarn (the direction of arrow I).

#### DESCRIPTION OF SYMBOLS

- [0031] A: Yarn A (Weft yarn A)
- [0032] B: Yarn B (Weft yarn B)
- [0033] A': Texture A comprising yarn A
- [0034] B': Texture B comprising yarn B
- [0035] x, y, z and w: Warp yarn

#### DETAILED DESCRIPTION

##### Woven Textile

[0036] The woven textile is a two- or more ply flat woven textile in which a texture A comprising a yarn A and a texture B comprising a yarn B are interwoven. The texture A and the texture B are interwoven such that the longer direction of the yarn A and the longer direction of the yarn B are in the same direction. Namely, the yarn A and the yarn B are both a warp yarn of the woven textile or both a weft yarn of the woven textile.

[0037] For the yarn A and the yarn B, shrinkage percentage of the yarn A (SA (%)) and shrinkage percentage of the yarn B (SB (%)) satisfy  $10\% < (SB - SA) < 60\%$ . When heat is applied to the woven textile, the texture A and the texture B shrink in the longer direction of the yarn A and the yarn B, respectively, and because of such a difference in shrinkage percentage between the yarn A and the yarn B, the texture B comprising the yarn B shrink more than the texture A comprising the yarn A. Consequently, the woven textile bends such that the longer direction of the yarn A and the yarn B is the circumferential direction and the texture A is located outside the texture B. Then, upon heating under appropriate conditions, the woven textile is formed into a tube in which one end and the opposite end of the woven textile overlap each other on the circumference. When the tube is long in the longer direction, a flexible tube made of the woven textile is provided. The overlapping portion of the woven textile is not adhered. Thus, it can be separated to form a gap if a slight force is applied and the gap will close spontaneously if the force is released. For example, the overlapping portion is opened by hand, and wires are placed into the tube through the gap. If the hand is released, the tube returns to the original tube without a gap so that the wires will not be exposed outside the tube. Thus, the tube formed from the woven textile can be suitably used as a protective sleeve for a wire harness. The overlapping portion need not overlap with no gap being

formed and may overlap with a gap through which the wires will not come out being formed.

[0038] For use as an electricity protective sleeve, the amount of overlap on the circumference of the woven textile needs to be appropriate. For that purpose, it is important that the shrinkage percentage of the yarn A (SA (%)) and shrinkage percentage of the yarn B (SB (%)) satisfy  $10\% < (SB - SA) < 60\%$ . When the difference in shrinkage percentage is less than 10%, even if heat is applied to the woven textile, the amount of overlap is too small, resulting in an electricity protective sleeve from which wires are easily exposed. On the other hand, when the difference in shrinkage percentage is not less than 60%, even if the heating conditions are mild, the amount of overlap is too large to easily open a gap for inserting wires, resulting in an electricity protective sleeve with poor operability. The lower limit of the difference in shrinkage percentage is preferably 15% or more, and the upper limit is preferably 50% or less.

[0039] The shrinkage percentage of a yarn is a value measured according to JIS L 1013 8.18, Section (1) Hot-water shrinkage percentage B method (filament shrinkage percentage). First, a yarn with an initial load being applied is marked at two points with a distance between points of 500 mm. Next, the initial load is unloaded, and the yarn is immersed in water at 90° C. for 30 minutes, after which the water is lightly wiped off with absorbent paper or a cloth, and the yarn is dried by wind. The initial load is applied again, and the distance between the two points is measured. Then, the shrinkage percentage (%) is calculated from the following equation. For five randomly selected yarns, the shrinkage percentage is calculated, and the average of the five values is rounded to one decimal place. The average value obtained is the shrinkage percentage of the yarn:

$$\text{Shrinkage percentage (\%)} = \frac{(500 - \text{Length between two points (mm) measured when an initial load is applied after treating with hot water})}{500} \times 100.$$

[0040] The woven textile may be a three- or more ply woven textile in which a texture other than the texture A and the texture B is interwoven as long as the woven textile is not prevented from bending when heat is applied. Such a texture may be interwoven into any places outside the texture A, outside of the texture B, or between the texture A and the texture B. However, from an economic standpoint, a two-ply woven textile in which only the texture A and the texture B are interwoven is preferred.

##### Yarn A, Yarn B

[0041] As a material of the yarn A and the yarn B, any yarn that satisfies the shrinkage percentage mentioned above can be used and synthetic fibers are suitably used. Among the synthetic fibers, polyester is preferably used. For the form of the yarn, a textured yarn, a multifilament yarn, a monofilament yarn and the like are used. Among them, a textured yarn such as a single-heater false-twisted polyester yarn is preferred in view of formability and low cost.

[0042] The yarn A is preferably made of continuous fibers with a single-yarn fiber diameter of 10 to 1000 μm. When the single-yarn fiber diameter is out of this range, the woven textile sometimes cannot be formed into a tube even if the relation of the difference in shrinkage percentage from the yarn B is satisfied. In view of shape stability, formability and

the like, the lower limit of the single-yarn fiber diameter of the yarn A is preferably 150  $\mu\text{m}$  or more, and the upper limit is preferably 600  $\mu\text{m}$  or less.

[0043] The shrinkage percentage of the yarn A is preferably 1 to 55%. When the shrinkage percentage is in the range of 1 to 55%, excellent formability and shape stability are provided. The lower limit of the shrinkage percentage is more preferably 2% or more, and the upper limit is more preferably 35% or less.

[0044] The total fineness of the yarn A is preferably 60 to 600 dtex. When the total fineness is in this range, shape stability and protectability improve.

[0045] The method of obtaining the yarn A is not particularly limited and, for example, in the case of polyester, the yarn A can be obtained by setting the take-up speed in spinning at about 2000 to 7000 m/min.

[0046] The yarn B preferably has a single-yarn fiber diameter of 3 to 500  $\mu\text{m}$ . When the single-yarn fiber diameter is out of this range, the woven textile surface is distorted, which can cause inefficient wiring operation and the like.

[0047] The shrinkage percentage of the yarn B is preferably 10 to 65%. When it is in this range, a woven textile having good formability and, further, good shape stability can be obtained.

[0048] The method of obtaining the yarn B is not particularly limited and, for example, in the case of polyester, the yarn B can be obtained by employing low-speed taking up at a take-up speed in spinning of 1000 to 2000 m/min or using an unstretched yarn or a thick and thin yarn.

#### Nap-Raised Texture

[0049] In the woven textile, it is preferred that a texture like a nap-raised velvet be interwoven into the outermost surface. If a nap-raised texture is interwoven into the outermost surface, scratch-resisting property and heat-resisting property can be improved when the woven textile is used for a protective sleeve for a wire harness. The nap-raised portion may be cut or uncut pile. For the nap-raised portion, it is preferable to use a multifilament with a single-yarn fiber diameter of 80 to 800  $\mu\text{m}$  to maintain rigidity. The nap-raised portion may be formed either by a warp yarn or by a weft yarn. Further, the nap-raised texture may be provided on the surface that is located outside the tube (outside of the texture A) or the surface that is located inside the tube (outside of the texture B) when the woven textile is formed into a tube. When provided on the surface that is located outside the tube, heat generation caused by contact between protective sleeves can be reduced. When provided on the surface that is located inside the tube, the function of protecting lead wires placed in a tube improves.

#### Lowest Melting Point Fiber

[0050] In the woven textile, when the melting point of the fiber with the lowest melting point (hereinafter referred to as the lowest melting point fiber) and the fiber with the second lowest melting point among the fibers used for a warp yarn or a weft yarn is taken as TC ( $^{\circ}\text{C}.$ ) and TD ( $^{\circ}\text{C}.$ ), respectively, it is preferred that  $40^{\circ}\text{C} < (\text{TD} - \text{TC}) < 150^{\circ}\text{C}.$  be satisfied. By arranging such a lowest melting point fiber, the lowest melting point fiber that melts during heat set is fused with surrounding fibers, and effects of prevention of fraying in cutting of the woven textile, further, improvement of shape stability

and the like can be exerted. The lowest melting point fiber may be arranged either in a warp yarn or a weft yarn.

[0051] Examples of the fiber with a low melting point include vinylidene, polyvinyl chloride, nylon, polyethylene, polypropylene, polyurethane, benzoate and the like, from among which such fibers that satisfy the requirements described above can be selected as appropriate and used.

#### PPS Fiber, Meta-Aramid Fiber

[0052] It is also preferred that the woven textile contain a polyphenylene sulfide fiber (hereinafter referred to as a PPS fiber) and a meta-aramid fiber in addition to the yarn A and the yarn B to provide functions such as heat-resisting property and flame resistance.

#### Process for Producing Tubular Woven Textile

[0053] In forming the woven textile into a tube by applying heat, the tube is formed such that one end and the opposite end of the woven textile overlap on the circumference of the tube and the length of the overlapping portion in the circumferential direction is 2% or more of the circumferential length. When the overlapping portion accounts for 2% or more, after lead wires are inserted into the tubular woven textile, the lead wires will be protected sufficiently by the woven textile due to the overlap in the circumferential direction. Further, the inserted lead wires will not protrude from the woven textile. The overlapping portion preferably accounts for not more than 13%. If the overlapping portion accounts for more than 13%, lead wires cannot be readily inserted and the operability can be poor.

[0054] Examples of the method of forming the woven textile into a tube by heat treatment include a method of treatment under such heat treatment conditions that, taking the direction perpendicular to the longer direction of the yarn A and the yarn B as the travel direction, four heat treatment devices are arranged in series in the travel direction; hot air at 90 to 200 $^{\circ}\text{C}.$  is flown into the heat treatment devices; and the woven textile passes through the heat treatment devices in 30 to 190 seconds.

[0055] Alternatively, the woven textile may be protected by heating and shrinking the woven textile in which lead wires are arranged to be formed into a tube.

#### Tubular Woven Textile

[0056] When the woven textile is a two-ply woven textile, the tubular woven textile formed may be a tubular woven textile wherein the length of the yarn A (LA) and the length of the yarn B (LB) in the tubular state satisfy  $10\% < \{(LA - LB)/LA\} \times 100 < 60\%$ . Namely, it is a tubular woven textile formed such that a flat two-ply woven textile in which a front surface texture and a back surface texture are interwoven is rolled up such that the front surface texture is located outside, wherein one end and the opposite end of the two-ply woven textile separately overlap each other on the circumference of the tube and, in the tubular state, the circumferential length of the yarn arranged in the front surface texture (LE) and the circumferential length of the yarn arranged in the back surface texture (LF) satisfy  $10\% < \{(LA - LB)/LA\} \times 100 < 60\%$ . The lower limit of " $\{(LA - LB)/LA\} \times 100$ " is preferably 20% or more, and the upper limit is preferably 60% or less.

[0057] The circumferential length of the yarn arranged in the front surface texture (LA) is a value determined by randomly selecting five circumferential full-width yarns



arranged in the front surface texture and rounding the average value thereof to one decimal place. The circumferential length of the yarn arranged in the back surface texture (LB) is a value determined in the same manner.

#### Protective Sleeve for Wire Harness

**[0058]** The woven textile can be readily formed into a tube, and the tubular woven textile formed has excellent softness flexibility and operability. Further, the woven textile can be provided with shape stability by arranging the lowest melting point fiber that satisfies particular temperature conditions. Furthermore, the woven textile can be readily provided with functions such as heat-resisting property and flame resistance by arranging a PPS fiber or a meta-aramid fiber. Therefore, the woven textile exerts an extremely excellent effect when used particularly as a protective sleeve for a wire harness.

**[0059]** The thickness of the woven textile may be determined depending on the scratch-resisting protection performance required when used as a protective sleeve for a wire harness, and the higher the protection performance required is, the thicker the woven textile is. For example, in the case of a wire harness pathway that requires high protection performance, the woven textile preferably has a gray fabric thickness of 0.5 to 2.0 mm.

#### EXAMPLES

**[0060]** The woven textile will now be described in more detail by way of example. A needle loom was used as a loom to perform weaving.

##### Example 1

**[0061]** As a warp yarn, single-heater false-twist textured polyester yarns of 330 dtex and 167 dtex was used. As a weft yarn, a yarn obtained by drawing together three polyester filaments of 90 dtex with a shrinkage percentage of 15.3% and a polyester monofilament with a shrinkage percentage of 2.0% and a single-yarn fiber diameter of 250  $\mu$ m were used. The weft yarn obtained by drawing together three polyester filaments is the yarn B (hereinafter referred to as the weft yarn B), and the weft yarn of a polyester monofilament is the yarn A (the weft yarn A). These warp yarns and weft yarns were used to weave a two-ply woven textile with a warp yarn density=154 yarns/2.54 cm, a weft yarn beat-up density of 22 yarns/cm, and a gray fabric width of 25.5 mm.

**[0062]** The construction of the two-ply woven textile woven is shown in FIGS. 1 and 2. In each Figure, A and B each represents a weft yarn, and x, y, and z each represents a warp yarn. A is the weft yarn A; B is the weft yarn B; x and y are a single-heater textured polyester yarn of 330 dtex; and z is a single-heater textured polyester yarn of 167 dtex. A' is the texture A comprising the weft yarn A, and B' is the texture B comprising the weft yarn B.

**[0063]** FIG. 1 is a weaving design that represents on one plane the way the two-ply woven textile is woven. FIG. 2 is a schematic view of the woven textile represented by the weaving design of FIG. 1 seen from the longer direction of the weft yarn (the direction of arrow I), and (1), (2), and (3) each shows how the warp yarns x, y, and z are beaten up into the weft yarns A and B.

**[0064]** How to appreciate FIG. 1 is briefly described. The leftmost "BABABABA" indicates that the texture comprising the weft yarn B is located at the front of the page and the texture comprising the weft yarn A is located at the back of the

page. The uppermost "xxxxzy . . ." indicates that the warp yarns x, y, and z are beaten up in the order mentioned. A white cell indicates that, at that part, the warp yarn is located at the back of the page compared to the weft yarn, and a black cell indicates that, at that part, the warp yarn is located at the front of the page compared to the weft yarn. Now looking at every two-cell combination from top to bottom in the warp yarn direction, "(weft yarn B) white cell, (weft yarn A) black cell" indicates that a warp yarn is located at the back of the page compared to the weft yarn B and the front of the page compared to the weft yarn A, that is, between the weft yarn B and the weft yarn A. "(Weft yarn B) white cell, (weft yarn A) white cell" indicates that a warp yarn is located at the back of the page compared to the weft yarn B and the back of the page compared to the weft yarn A, that is, at the back of the woven textile on the page. "(Weft yarn B) black cell, (weft yarn A) black cell" indicates that a warp yarn is located at the front of the page compared to the weft yarn B and the front of the page compared to the weft yarn A, that is, at the front of the woven textile on the page. In other words, FIG. 1 is a plan view illustrating each pattern of beating up of a warp yarn shown in FIG. 2.

##### Example 2

**[0065]** A two-ply woven textile was woven in the same manner as in Example 1 except using as the weft yarn B a yarn obtained by drawing together three polyester filaments of 90 dtex with a shrinkage percentage of 20.5% and as the weft yarn A a polyester monofilament with a shrinkage percentage of 6.7% and a single-yarn fiber diameter of 250  $\mu$ m.

##### Example 3

**[0066]** A two-ply woven textile was woven in the same manner as in Example 1 except using as the weft yarn B a yarn obtained by drawing together three polyester filaments of 90 dtex with a shrinkage percentage of 49.3% and as the weft yarn A a polyester monofilament with a shrinkage percentage of 2.0% and a single-yarn fiber diameter of 250  $\mu$ m.

##### Example 4

**[0067]** A two-ply woven textile was woven in the same manner as in Example 1 except using as the weft yarn B a yarn obtained by drawing together three polyester filaments of 90 dtex with a shrinkage percentage of 60.8% and as the weft yarn A a polyester monofilament with a shrinkage percentage of 2.0% and a single-yarn fiber diameter of 250  $\mu$ m.

##### Example 5

**[0068]** A two-ply woven textile was woven in the same manner as in Example 3 except using as the weft yarn B a yarn obtained by drawing together three polyester filaments of 90 dtex with a shrinkage percentage of 49.3% (melting point: 255° C.) and one low melting point fiber of 100 dtex with a melting point of 110° C. "Elder" (available from TORAY INDUSTRIES, INC.). A tube that prevents fraying of yarns in inserting wires or cutting the woven textile and has further improved shape stability could be provided.

##### Example 6

**[0069]** As a warp yarn, a single-heater false-twist textured polyester yarn of 330 dtex was used. As a weft yarn, a yarn obtained by drawing together three polyester filaments of 90

dtex with a shrinkage percentage of 49.3% and a polyester monofilament with a shrinkage percentage of 2.0% and a single-yarn fiber diameter of 250  $\mu$ m were used. The weft yarn obtained by drawing together three polyester filaments is the yarn B (hereinafter referred to as the weft yarn B), and the weft yarn of a polyester monofilament is the yarn A (the weft yarn A). These warp yarn and weft yarn were used to weave a two-ply woven textile with a warp yarn density=154 yarns/2.54 cm, a weft yarn beat-up density of 22 yarns/cm, and a gray fabric width of 25.5 mm.

[0070] Further, as a pile fabric, a texture using as a warp yarn a single-heater false-twist textured polyester yarn of 330 dtex, as a pile a polyester filament of 560 dtex, and as a weft yarn a single-heater false-twist textured polyester yarn of 330 dtex was produced, and the polyester filament arranged as a pile was cut to obtain a nap-raised portion.

[0071] Thus, a three-ply (including the pile fabric) woven textile was woven. The construction of the three-ply woven textile woven is shown in FIGS. 3 and 4. In each Figure, A, B, and C each represents a weft yarn, and x, y, and w each represents a warp yarn. A is the weft yarn A; B is the weft yarn B; C is the single-heater textured polyester yarn of 330 dtex arranged as a weft yarn to produce a pile fabric; x, y, and z are all a single-heater textured polyester yarn of 330 dtex; and z is the polyester filament of 560 dtex arranged as a pile.

[0072] FIG. 3 is a weaving design that represents on one plane the way the two-ply woven textile is woven. FIG. 4 is a schematic view of the woven textile represented by the weaving design of FIG. 3 seen from the longer direction of the weft yarn (the direction of arrow I), and (1), (2), (3), and (4) each shows how the warp yarns x, y, z, and w are beaten up into the weft yarns A, B, and C. How to appreciate FIG. 3 is the same as how to appreciate FIG. 1, and thus detailed descriptions are omitted. It should only be noted that the texture comprising the weft yarn C is located at the frontmost of the page; the texture comprising the weft yarn A is located at the backmost of the page; the texture comprising the weft yarn B is located between these two textures; and every three-cell combination is looked from top to bottom in the warp yarn direction.

#### Example 7

[0073] A two-ply woven textile was woven in the same manner as in Example 3 except using as a warp yarn a polyphenylene sulfide fiber of 330 dtex and 167 dtex.

[0074] x and y in FIGS. 1 and 2 are polyphenylene sulfide fibers of 330 dtex, and z is a polyphenylene sulfide fiber of 167 dtex.

#### Comparative Example 1

[0075] A two-ply woven textile was woven in the same manner as in Example 1 except using as the weft yarn B a yarn obtained by drawing together three polyester filaments of 90 dtex with a shrinkage percentage of 11.3% and as the weft yarn A a polyester monofilament with a shrinkage percentage of 2.0% and a single-yarn fiber diameter of 250  $\mu$ m.

#### Comparative Example 2

[0076] A two-ply woven textile was woven in the same manner as in Example 1 except using as the weft yarn B a yarn obtained by drawing together three polyester filaments of 90 dtex with a shrinkage percentage of 66.1% and as the weft yarn B a polyester monofilament with a shrinkage percentage of 2.0% and a single-yarn fiber diameter of 250  $\mu$ m.

#### Comparative Example 3

[0077] Using the same warp yarn and weft yarn as in Example 3, a single-ply woven textile of plain construction with a warp yarn density=154 yarns/2.54 cm, a beat-up density 22 times/cm, and a gray fabric width of 25.5 mm was woven.

#### Comparative Example 4

[0078] Using the same warp yarn and weft yarn as in Example 3, a single-ply woven textile of 2/2 twill construction with a warp yarn density=154 yarns/2.54 cm, a beat-up density 22 times/cm, and a gray fabric width of 25.5 mm was woven.

#### Evaluation

[0079] From the woven textiles woven in Examples 1 to 7 and Comparative Examples 1 to 4, samples with a length (in the warp yarn direction) of 1000 mm and a width (in the weft yarn direction) of 25.5 mm were collected. Each sample was left to stand in a heat treatment device at 160° C. for 50 seconds. The shape of the woven textile after the heat treatment is shown in Table 1.

TABLE 1

	Shrinkage Percentage of Weft Yarn B (%)	Shrinkage Percentage of Weft Yarn A (%)	Difference in Shrinkage Percentage (%)	Fabric Construction	Overlap in Circumferential Direction (%)	Percentage of Yarn Length Difference (%)
Example 1	15.3	2.0	13.3	Two-ply shown in FIGS. 1 and 2	2.4	12.3
Example 2	20.5	6.7	13.8	Two-ply shown in FIGS. 1 and 2	2.8	14.3
Example 3	49.3	2.0	47.3	Two-ply shown in FIGS. 1 and 2	8.5	32.6
Example 4	60.8	2.0	58.8	Two-ply shown in FIGS. 1 and 2	11.7	53.3
Example 5	49.3	2.0	47.3	Two-ply shown in FIGS. 1 and 2	8.8	32.6
Example 6	49.3	2.0	47.3	Three-ply shown in FIGS. 3 and 4	8.8	(32.6)
Example 7	49.3	2.0	47.3	Two-ply shown in FIGS. 1 and 2	8.8	32.6
Comparative Example 1	11.3	2.0	9.3	Two-ply shown in FIGS. 1 and 2	1.3	9.2
Comparative Example 2	66.1	2.0	64.1	Two-ply shown in FIGS. 1 and 2	14.7	62.2
Comparative Example 3	49.3	2.0	47.3	Plain fabric	Not overlapped	—
Comparative Example 4	49.3	2.0	47.3	Twill fabric	Not overlapped	—

**[0080]** “Percentage of yarn length difference” is a value of  $\{(\text{Length of weft yarn A} - \text{Length of weft yarn B}) / \text{Length of weft yarn A}\} \times 100$  for both of the two-ply woven textiles and the three-ply woven textile. The woven textile in Example 6 is a three-ply, and thus the “percentage of yarn length difference” is described as a reference value because it is not a percentage of yarn length difference between the weft yarn of a front surface texture and the weft yarn of a back surface texture.

**[0081]** Further, ease of operation (operability) in actually inserting lead wires into a woven textile and whether the shape of the woven textile was retained after the insertion operation (shape stability) were examined.

**[0082]** The woven textile in Example 1 was formed into a tube having an overlap in the circumferential direction. However, it had low bendability because of somewhat small difference in shrinkage percentage between the weft yarn A and the weft yarn B. Therefore, the woven textile sometimes did not overlap successfully during the operation of inserting lead wires, and the shape stability was somewhat insufficient. Accordingly, it was necessary to carry out the operation while adjusting the woven textile to overlap the way it was, and the operability was also somewhat insufficient.

**[0083]** The woven textiles in Examples 2 to 7 were all a tube having a sufficient overlap in the circumferential direction and preferred as a protective sleeve for a wire harness. In addition, it was easy to open the overlapping portion to form a gap, and an operation of inserting lead wires could be easily performed. Further, because the tube overlaps the way it was when hands were released, the shape stability was excellent and the wire protectability after the operation was sufficient.

**[0084]** In addition, the woven textiles in Examples 5 to 7 also had characteristics as follows:

**[0085]** The woven textile in Example 5 provided a protective sleeve for a wire harness having particularly good shape stability and operability compared to the woven textile in Example 3 because the low melting point fiber arranged in the woven textile melted and fused with surrounding fibers;

**[0086]** The woven textile in Example 6 was a tube with pile fabric interior, and the nap-raised portion improved lead-wire protection performance; and

**[0087]** The woven textile in Example 7 had an improved heat-resisting property and flame resistance because a polyphenylene sulfide fiber was used as a warp yarn.

**[0088]** In contrast, the woven textile in Comparative Example 1 provided an irregular tube after heat treatment. In addition, the overlap in the circumferential direction disappeared after the operation of inserting lead wires, and there was a problem in protectability for lead wires. Therefore, the inserted lead wires protruded externally, and the operability was poor.

**[0089]** The woven textile in Comparative Example 2 was a tube having a sufficient overlap in the circumferential direction, but because of too large overlap in the circumferential direction, it was difficult to open the overlapping portion to form a gap. Thus, it was difficult to carry out the operation of inserting lead wires. In addition, because of the large overlapping portion, it was a tube lacking in softness.

**[0090]** The woven textiles in Comparative Example 3 and 4 were not formed into a tube and could not protect lead wires.

1. A two- or more ply flat woven textile in which a texture A comprising a yarn A and a texture B comprising a yarn B are interwoven,

wherein said yarn A and said yarn B are both a warp yarn or both a weft yarn;

shrinkage percentage of said yarn A (SA (%)) and shrinkage percentage of said yarn B (SB (%)) satisfy (1); and said woven textile, when heat is applied thereto, is formed into a tube such that a longer direction of said yarn A and said yarn B is a circumferential direction and said texture A is located outside said texture B:

$$10\% < (SB - SA) < 60\% \quad (1).$$

2. The woven textile according to claim 1, wherein a nap-raised texture is interwoven into at least one surface of said woven textile.

3. The woven textile according to claim 1, wherein said yarn A comprises continuous fibers with a single-yarn fiber diameter 10 to 1000  $\mu\text{m}$ .

4. The woven textile according to claim 1, wherein among fibers used for the warp yarn or the weft yarn of the woven textile, a melting point of the fiber with a lowest melting point TC ( $^{\circ}\text{C}$ .) and a melting point of the fiber with a second lowest melting point TD ( $^{\circ}\text{C}$ .) satisfy (2):

$$40^{\circ}\text{C} < (TD - TC) < 150^{\circ}\text{C} \quad (2),$$

5. The woven textile according to claim 1, wherein a polyphenylene sulfide fiber and/or a meta-aramid fiber are further interwoven in addition to said yarn A and said yarn B.

6. The woven textile according to claim 1, which is a protective sleeve for a wire harness.

7. A process of producing a tubular woven textile comprising applying heat to the woven textile according to claim 1 so that said woven textile spontaneously rolls up due to a difference in shrinkage percentage between said yarn A and said yarn B to form a tube;

the longer direction of said yarn A and said yarn B is the circumferential direction of the tube;

said texture A is located outside said texture B; and

one end and an opposite end of said woven textile separably overlap each other on the circumference of the tube, wherein the length of the overlapping portion in the circumferential direction is 2% or more of the circumferential length.

8. The process according to claim 7, wherein said tubular woven textile is a protective sleeve for a wire harness.

9. A tubular woven textile formed such that a flat two-ply woven textile in which a front surface texture and a back surface texture are interwoven is rolled up such that the front surface texture is located outside,

wherein one end and an opposite end of said two-ply woven textile separably overlap each other on the circumference of the tube; and

in said tubular state, a circumferential length of a yarn arranged in said front surface texture (LA) and a circumferential length of a yarn arranged in said back surface texture (LB) satisfy (3):

$$10\% < \{(LA - LB) / LA\} \times 100 < 60\% \quad (3).$$

10. A protective sleeve for a wire harness comprising the tubular woven textile according to claim 9.

11. The woven textile according to claim 2, wherein said yarn A comprises continuous fibers with a single-yarn fiber diameter 10 to 1000  $\mu\text{m}$ .

12. The woven textile according to claim 2, wherein among fibers used for the warp yarn or the weft yarn of the woven textile, a melting point of the fiber with a lowest melting point

TC (° C.) and a melting point of the fiber with a second lowest melting point TD (° C.) satisfy (2):

$$40^{\circ}\text{C} < (TD - TC) < 150^{\circ}\text{C}. \quad (2).$$

**13.** The woven textile according to claim 3, wherein among fibers used for the warp yarn or the weft yarn of the woven textile, a melting point of the fiber with a lowest melting point TC (° C.) and a melting point of the fiber with a second lowest melting point TD (° C.) satisfy (2):

$$40^{\circ}\text{C} < (TD - TC) < 150^{\circ}\text{C}. \quad (2).$$

**14.** The woven textile according to claim 2, wherein a polyphenylene sulfide fiber and/or a meta-aramid fiber are further interwoven in addition to said yarn A and said yarn B.

**15.** The woven textile according to claim 3, wherein a polyphenylene sulfide fiber and/or a meta-aramid fiber are further interwoven in addition to said yarn A and said yarn B.

**16.** The woven textile according to claim 4, wherein a polyphenylene sulfide fiber and/or a meta-aramid fiber are further interwoven in addition to said yarn A and said yarn B.

**17.** The woven textile according to claim 2, which is a protective sleeve for a wire harness.

**18.** The woven textile according to claim 3, which is a protective sleeve for a wire harness.

**19.** The woven textile according to claim 4, which is a protective sleeve for a wire harness.

**20.** The woven textile according to claim 5, which is a protective sleeve for a wire harness.

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