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Wire harness

Abstract

The wires **20** each include a stranded conductor **21**, and an insulation covering **26** that covers the stranded conductor **21**. One end portions of the plurality of wires **20** are held by a first holding portion **31** of the first terminal block **30**, and the other end portions of the plurality of wires **20** are held by a second holding portion **41** of the second terminal block **40**. A connection orientation of the wire harness **10** is an orientation in which the plurality of wires **20** are bent between the first holding portion **31** and the second holding portion **41**, and in which a twist occurs in the plurality of wires **20**. A stranding direction of the stranded conductors **21** of half or more of the plurality of wires **20** is a direction in which stranding of the stranded conductors **21** is tightened by the twist.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

(1) This application is based on and claims priority from Japanese Patent Application No. 2021-189248, filed on Nov. 22, 2021, with the Japan Patent Office, the disclosure of which is incorporated herein in its entirety by reference.

TECHNICAL FIELD

(2) The present disclosure relates to a wire harness.

BACKGROUND

(3) Japanese Patent Laid-open Publication No. 2020-098786 discloses a device wiring assembly including a plurality of device wiring members each including a plurality of conductors and two connection portions provided at opposite ends of each of the conductors, wherein the device wiring members are wired in a bent state in a device including a device body and a device case that accommodates the device body.

SUMMARY

(4) It is desirable that a wire harness such as the device wiring assembly disclosed in Japanese Patent Laid-open Publication No. 2020-098786 can be easily bent between one end and the other end thereof in a direction in which a twist occurs in wires.

(5) Therefore, an object of the present disclosure is to provide a technique that can facilitate bending of a wire harness between one end and the other end thereof in a direction in which a twist occurs in wires.

(6) A wire harness according to the present disclosure is a wire harness including: a plurality of wires each including a stranded conductor, and an insulation covering that covers the stranded conductor; a first terminal block including a first holding portion that holds one end portions of the plurality of wires, and a plurality of first terminals each electrically connected to the one end portion of a corresponding wire of the plurality of wires; and a second terminal block including a second holding portion that holds the other end portions of the plurality of wires, and a plurality of second terminals each electrically connected to the other end portion of a corresponding wire of the plurality of wires, wherein the plurality of wires are arranged side by side between the first holding portion and the second holding portion in a direction intersecting a direction connecting the first holding portion to the second holding portion, when an orientation in which the plurality of wires extend straight between the first holding portion and the second holding portion is defined as a first orientation, a connection orientation in which the first terminal block and the second terminal block are connected to the respective connection partners is a second orientation in which the plurality of wires are bent between the first holding portion and the second holding portion, and in which a twist occurs in the plurality of wires are bent from the first orientation, and a stranding direction of the stranded conductors of half or more wires of the plurality of wires is a direction in which stranding of the stranded conductors is tightened by the twist occurring when the plurality of wires are bent from the first orientation to the second orientation.
(7) According to the present disclosure, it is possible to facilitate bending of a wire harness between one end and the other end thereof in a direction in which a twist occurs in wires.
(8) The foregoing summary is illustrative only and is not intended to be in any way limiting. In addition to the illustrative aspects, embodiments, and features described above, further aspects, embodiments, and features will become apparent by reference to the drawings and the following detailed description.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) FIG. **1** is a perspective view showing a wire harness according to an embodiment.
(2) FIG. **2** is a side view showing the wire harness according to the embodiment.
(3) FIG. **3** is a front view showing the wire harness according to the embodiment.
(4) FIG. **4** is a cross-sectional view showing a wire.
(5) FIG. **5** is an explanatory view showing an S-stranded conductor.
(6) FIG. **6** is an explanatory view showing a Z-stranded conductor.
(7) FIG. **7** is a front view showing the wire harness in a first orientation.
(8) FIG. **8** is a front view showing a wire harness according to a first modification.
(9) FIG. **9** is a front view showing a wire harness according to a second modification.
DETAILED DESCRIPTION
(10) In the following detailed description, reference is made to the accompanying drawings, which form a part hereof. The illustrative embodiments described in the detailed description, drawings, and claims are not meant to be limiting. Other embodiments may be utilized, and other changes may be made, without departing from the spirit or scope of the subject matter presented here.
Description of Embodiments of the Present Disclosure
(11) First, aspects of the present disclosure will be listed and described.
(12) A wire harness according to the present disclosure is as follows.
(13) (1) A wire harness wire harness including: a plurality of wires each including a stranded conductor, and an insulation covering that covers the stranded conductor; a first terminal block including a first holding portion that holds one end portions of the plurality of wires, and a plurality of first terminals each electrically connected to the one end portion of a corresponding wire of the

plurality of wires; and a second terminal block including a second holding portion that holds the other end portions of the plurality of wires, and a plurality of second terminals each electrically connected to the other end portion of a corresponding wire of the plurality of wires, wherein the plurality of wires are arranged side by side between the first holding portion and the second holding portion in a direction intersecting a direction connecting the first holding portion to the second holding portion, when an orientation in which the plurality of wires extend straight between the first holding portion and the second holding portion is defined as a first orientation, a connection orientation in which the first terminal block and the second terminal block are connected to the respective connection partners is a second orientation in which the plurality of wires are bent between the first holding portion and the second holding portion, and in which a twist occurs in the plurality of wires are bent from the first orientation, and a stranding direction of the stranded conductors of half or more wires of the plurality of wires is a direction in which stranding of the stranded conductors is tightened by the twist occurring when the plurality of wires are bent from the first orientation to the second orientation. When the stranding direction of the stranded conductors is a direction in which the stranding of the stranded conductors is loosened by a twist occurring when the plurality of wires are bent from the first orientation to the second orientation, the insulation coverings impede the loosening of the stranded conductors. Therefore, a strong force is required to bend the wires. In contrast, when the stranding direction of the stranded conductors is a direction in which the stranding of the stranded conductors is tightened by a twist occurring when the plurality of wires are bent from the first orientation to the second orientation, the insulation coverings are prevented from impeding loosening of the stranding of the stranded conductors, thus making it possible to bend the wires with a weak force. This makes it possible to facilitate bending of the wire harness between one end and the other end thereof in a direction in which a twist occurs in the wires.

(14) (2) In the wire harness according to (1), the second orientation may be an orientation in which the plurality of wires are bent about an axis extending in a side-by-side arrangement direction of the plurality of wires, and in which the one end portion and the other end portion of each of the plurality of wires are shifted from each other in the side-by-side arrangement direction by an amount greater than or equal to a diameter of the wire. When the plurality of wires are bent from the first orientation to such a second orientation, a twist also occurs in the plurality of wires. In this case as well, it is possible to facilitate bending of the wire harness between one end and the other end thereof in a direction in which a twist occurs in the wires.

(15) (3) In the wire harness according to (2), in the second orientation, an angle formed by a direction in which the plurality of wires extend from the first holding portion and a direction in which the plurality of wires extend from the second holding portion may be 60 degrees or more and 120 degrees or less, and the side-by-side arrangement direction of the plurality of wires in the first holding portion and the side-by-side arrangement direction of the plurality of wires in the second holding portion are parallel to each other. In this case as well, it is possible to facilitate bending of the wire harness between one end and the other end thereof in a direction in which a twist occurs in the wires.

(16) (4) In the wire harness according to any one of (1) to (3), a stranding direction of the stranded conductors of all of the plurality of wires may be a direction in which the twist occurring when the plurality of wires are bent from the first orientation to the second orientation tightens stranding of the stranded conductors. With this configuration, none of the plurality of wires is a wire in which the stranding direction of the stranded conductor is a direction in which the stranding of the stranded conductor is loosened by a twist occurring when the plurality of wires are bent from the first orientation to the second orientation, thus making it possible to facilitate bending of the wire harnesses between one end and the other end thereof in a direction in which a twist occurs in the wires.

(17) (5) In the wire harness according to any one of (1) to (4), the number of the plurality of wires

may be three or more. In this case as well, it is possible to facilitate bending of the wire harness between one end and the other end thereof in a direction in which a twist occurs in the wires.
(18) (6) In the wire harness according to any one of (1) to (5), the insulation coverings may each have a Shore A hardness of 40 to 100, as measured using a durometer compliant with JIS K 6253. In the case of a relatively hard insulation covering having a Shore A hardness of 40 to 100, fastening of the stranded conductors by the insulation coverings is further tightened, and the stranded conductors are much less likely to be twisted in the direction in which they are loosened. In this case as well, the connection orientation is the orientation in which the stranded conductors of half or more of the wires are twisted in the direction in which they are tightened, and therefore the wire harness is likely to assume the connection orientation.
(19) (7) In the wire harness according to any one of (1) to (6), the insulation coverings may each be made of a crystalline resin. With this configuration, the insulation coverings are likely to be hard as compared with an insulation covering made of an amorphous resin. In this case as well, the connection orientation is the orientation in which the stranded conductors of half or more of the wires are twisted in the direction in which they are tightened, and therefore the wire harness is likely to assume the connection orientation.
(20) (8) In the wire harness according to any one of (1) to (7), the stranded conductors may each have a cross-sectional area of 10 sq or more and 50 sq or less, and a wire length between the first holding portion and the second holding portion may be 100 mm or more and 300 mm or less. With this configuration, even in the case of using wires having a relatively large diameter and a relatively short length, the connection orientation is an orientation in which the stranded conductors of half or more of the wires are twisted in the direction in which they are tightened, and therefore the wire harness is likely to assume the connection orientation.
(21) (9) In the wire harness according to any one of (1) to (8), each of the first holding portion and the second holding portion may be a resin molded portion insert-molded using the plurality of wires as insert components. With this configuration, each of the first holding portion and the second holding portion can firmly hold the plurality of wires.
Details of Embodiments of the Present Disclosure
(22) Specific examples of the wire harness according to the present disclosure will be described below with reference to the drawings. It should be noted that the present disclosure is not limited to these examples, but is defined by the claims, and is intended to include all modifications which fall within the scope of the claims and the meaning and scope of equivalents thereof.
Embodiment
(23) A wire harness according to an embodiment will be described below. In the drawings, portions of configurations are shown exaggerated or simplified in some cases for convenience of description. Also, dimensional proportions of the portions may be different from the actual dimensional proportions in the drawings. Being “perpendicular” as used herein includes not only a state of being exactly perpendicular, but also a state of being substantially perpendicular. Being substantially perpendicular refers to, for example, a state in which an angle formed by two directions ranges from 80 degrees to 90 degrees, preferably from 85 degrees to 90 degrees. Being “parallel” as used herein includes not only a state of being exactly parallel, but also a state of being substantially parallel. Substantially parallel refers to, for example, a state in which an angle formed by two directions is 10 degrees or less, preferably 5 degrees or less.
(24) FIG. **1** is a perspective view showing a wire harness **10** according to an embodiment. FIG. **2** is a side view showing the wire harness **10** according to the embodiment. FIG. **2** shows portions of devices B**1** and B**2** serving as mounting targets. FIG. **3** is a front view showing the wire harness **10** according to the embodiment.
(25) Overall Configuration of Wire Harness **10**
(26) An overall configuration of the wire harness **10** will now be described. The wire harness **10** includes a plurality of wires **20**, a first terminal block **30**, and a second terminal block **40**. The first

terminal block **30** includes a first holding portion **31** and a plurality of first terminals **32**. The first holding portion **31** holds one end portions of the plurality of wires **20**. Each of the plurality of first terminals **32** is electrically connected to one end portion of the corresponding one of the plurality of wires **20**. The second terminal block **40** includes a second holding portion **41** and a plurality of second terminals **42**. The second holding portion **41** holds the other end portions of the plurality of wires **20**. Each of the plurality of second terminals **42** is electrically connected to the other end portion of the correspond one of the plurality of wires **20**. The plurality of wires **20** electrically connects the first terminal block **30** and the second terminal block **40** to each other.

(27) The first terminal block **30** is fixed to a first device B**1**. The second terminal block **40** is fixed to a second device B**2**. The first device B**1** and the second device B**2** are electrically connected to each other via the wire harness **10**. That is, the plurality of wires **20**, the first terminal block **30**, and the second terminal block **40** constitute a wiring component that electrically connects the first device B**1** and the second device B**2** to each other. The devices B**1** and B**2** are in-vehicle devices. For example, the devices B**1** and B**2** are disposed in proximity to each other in a vehicle, and the wire harness **10** is formed relatively short. For example, the first device B**1** is an inverter, and the second device B**2** is a travel driving motor of an electric automobile or a hybrid vehicle. In the present embodiment, the plurality of wires **20** are high-voltage wires, and the first terminal block **30** and the second terminal block **40** are high-voltage terminal blocks.

(28) The orientation of the wire harness **10** shown in FIGS. **1** to **3** is a connection orientation. The connection orientation is an orientation of the harness **10** in a usage state. Here, the connection orientation is an orientation in a state in which the first terminal block **30** and the second terminal block **40** are respectively fixed to the first device B**1** and the second device B**2** disposed at predetermined positions of the vehicle.

(29) The configurations of each of the portions will be described more specifically.

(30) Wire **20**

(31) The plurality of wires **20** are arranged side by side between the first holding portion **31** and the second holding portion **41** in a direction intersecting a direction connecting the first holding portion **31** to the second holding portion **41**. One end portions of the plurality of wires **20** are held in a parallel state by the first holding portion **31**, and the other end portions of the plurality of wires **20** are held in a parallel state by the second holding portion **41**. Accordingly, portions of the plurality of wires **20** that are located between the first holding portion **31** and the second holding portion **41** are also held in a parallel state. In the present specification, as shown in FIG. **1**, the side-by-side arrangement direction of the plurality of wires **20** in the first holding portion **31** may be referred to as an X direction, and two directions orthogonal to the X direction may be referred to as an Y direction and a Z direction.

(32) In the connection orientation, the plurality of wires **20** are bent in a direction intersecting the side-by-side arrangement direction. The wire harness **10** is brought into the connection orientation by being bent from an orientation in which the plurality of wires **20** extend straight. The details of the orientations of the wire harness **10**, including the connection orientation, will be described later.

(33) One end portions of the plurality of wires **20** are restrained by the first holding portion **31**, and make the same movement as the first holding portion **31** when the first holding portion **31** moves. The other end portions of the plurality of wires **20** are restrained by the second holding portion **41**, and make the same movement as the second holding portion **41** when the second holding portion **41** moves. Here, portions of the plurality of wires **20** that are located between the first holding portion **31** and the second holding portion **41** are not provided with any member that restrains the plurality of wires **20**. The first holding portion **31** and the second holding portion **41** have a higher rigidity than that of the wires **20**. When the first holding portion **31** and the second holding portion **41** move relative to each other, the wire harness **10** is deformed such that the wires **20** are bent. Portions of the plurality of wires **20** that are located between the first holding portion **31** and the second holding portion **41** make movements according to movements of the first holding portion

31 and the second holding portion **41**. When the first holding portion **31** and the second holding portion **41** move relative to each other, the mode of bending of the portions of the plurality of wires **20** that are located between the first holding portion **31** and the second holding portion **41** is determined by the rigidity or the like of the plurality of wires **20**. The portions of the plurality of wires **20** that are located between the first holding portion **31** and the second holding portion **41** may be provided with a member that restrains the plurality of wires **20**.

(34) Here, the number of the plurality of wires **20** is six. However, the number of the plurality of wires **20** is not limited thereto, and may be set as appropriate according to devices to which they are to be connected, the use, and the like. For example, the number of the plurality of wires **20** may be two, or may be three. The number of the plurality of wires **20** may be more than three. The number of the plurality of wires **20** may be nine or less.

(35) Here, the second device B**2** is an alternating-current motor, and the plurality of wires **20** transmit an alternating current. The alternating current may be a single-phase alternating current, or may be a multiphase alternating current. For example, six wires **20** may be used as two sets of three wires in order to accommodate a three-phase alternating current. However, the type of the power transmitted by the plurality of wires **20** can be set according to the devices B**1** and B**2** to which the wire harness **10** is connected, and the plurality of wires **20** may transmit a direct current.

(36) Each of the plurality of wires **20** includes a stranded conductor **21** and an insulation covering **26** that covers the stranded conductor **21**. The stranded conductor **21** and the insulation covering **26** will be described with further reference to FIGS. **4** to **6**. FIG. **4** is a cross-sectional view showing a wire **20**. FIG. **5** is an explanatory view showing an S-stranded conductor **21**. FIG. **6** is an explanatory view showing a Z-stranded conductor **21**. Note that in FIG. **4**, the stranding direction of each of the members is indicated by the arrow. In FIGS. **5** and **6**, stranded conductors **21** each composed of two elemental wires **22** are shown for the ease of illustration.

(37) Each stranded conductor **21** includes a plurality of elemental wires **22**. Each of the elemental wires **22** is made of copper, a copper alloy, aluminium, an aluminium alloy, or the like. The stranded conductor **21** is formed by a plurality of stranded elemental wires **22**. Here, the methods of stranding the plurality of elemental wires **22** include S-stranding and Z-stranding. The stranding directions of the plurality of elemental wires **22** in S-stranding and Z-stranding are opposite to each other. As shown in FIG. **5**, S-stranding is a method in which, when the longitudinal direction of the stranded conductor **21** extends in the up-down direction, the elemental wires **22** extend in the form of a right-handed (clockwise) spiral from the upper side toward the lower side. As shown in FIG. **6**, Z-stranding is a method in which, when the longitudinal direction of the stranded conductor **21** extends in the up-down direction, the elemental wires **22** extend in the form of a left-handed (counterclockwise) spiral from the upper side toward the lower side. In the following, an S-stranded conductor **21** and a wire **20** including the S-stranded conductor **21** may be denoted by reference numerals having a suffix “S”, and be referred to as a stranded conductor **21**S, and a wire **20**S, respectively. A Z-stranded conductor **21** and a wire **20** including the Z-stranded conductor **21** may be denoted by reference numerals having a suffix “Z”, and be referred to as a stranded conductor **21**Z and a wire **20**Z, respectively. When there is no need to distinguish between S-stranding and Z-stranding for a stranded conductor **21** and a wire **20**, the stranded conductor **21** and the wire **20** may be simply referred to as a stranded conductor **21** and a wire **20**, respectively.

(38) There are two directions in which the stranded conductor **21** is twisted. One of the two directions is the same direction as a direction in which the plurality of elemental wires **22** are stranded, and the other of the two directions is a direction opposite to the direction in which the plurality of elemental wires **22** are stranded. When the stranded conductor **21** is twisted in the same direction as the direction in which the plurality of elemental wires **22** are stranded, the plurality of elemental wires **22** are tightened. When the stranded conductor **21** is twisted in a direction opposite to the direction in which the plurality of elemental wires **22** are stranded, the plurality of elemental wires **22** are loosened. The stranding directions of the plurality of elemental wires **22** of the

stranded conductor **21**S and the stranded conductor **21**Z are opposite to each other. Therefore, when the stranded conductor **21**S and the stranded conductor **21**Z are twisted in the same direction, the plurality of elemental wires **22** of one of the stranded conductor **21**S and the stranded conductor **21**Z are tightened when the plurality of elemental wires **22** of the other are loosened, and vice versa. In other words, the stranded conductor **21**Z is loosened when twisted in the same direction as the direction in which the stranded conductor **21**S is tightened, and the stranded conductor **21**Z is tightened when twisted in the same direction as the direction in which the stranded conductor **21**S is loosened.

(39) The cross-sectional area of the stranded conductor **21** is not particularly limited, and can be set as appropriate according to the device to which the stranded conductor **21** is to be connected, the current value, the voltage value, and so forth. Here, since the stranded conductor **21** is used as a high-voltage wire **20**, a stranded conductor having a relatively large diameter is used as the stranded conductor **21**. For example, the cross-sectional area of the stranded conductor **21** ranges from 10 sq to 50 sq. sq is a standard for a conductor cross-sectional area defined in accordance with a JIS standard, and means a square mm. Within the range of a current that is allowed according to the cross-sectional area, the material, and the like of the conductor, the conductor may be used for various electricity transmission applications.

(40) When the stranded conductor **21** has a large diameter, the number of elemental wires **22** may become large. When the number of elemental wires **22** becomes large, the stranded conductor **21** may have a so-called parent-child strand configuration. Specifically, a plurality of elemental wires **22** are divided into a plurality of groups each including two or more elemental wires **22**. In each of the groups, two or more elemental wires **22** are stranded into a child strand **23**. A plurality of child strands **23** are further stranded into a parent strand. The parent strand is used as a stranded conductor **21**. For example, in the example shown in FIG. **4**, seven elemental wires **22** are stranded into a child strand **23**, and 19 child strands **23** are stranded into a stranded conductor **21** (parent strand). Note that, in the example shown in FIG. **4**, the elemental wires **22** are depicted in one child strand **23**, and illustrations of the elemental wires **22** have been omitted in the other child strands **23**. Of course, the number of elemental wires **22** constituting each child strand **23**, and the number of child strands **23** constituting each stranded conductor **21** are not limited thereto, and can be set as appropriate. The stranded conductor **21** may not have a parent-child strand configuration. In the stranded conductor **21**, all the elemental wires **22** may be collectively stranded.

(41) When the stranded conductor **21** has a parent-child strand configuration, the stranding direction of the child strands and the stranding direction of the parent strands may be the same, or may be different from each other. When the stranding direction of the child strands and the stranding direction of the parent strands are the same, the stranding direction is set as the stranding direction of the stranded conductor **21**. For example, as in the case of the example shown in FIG. **4**, when the stranding direction of the child strands and the stranding direction of the parent strands are opposite to each other, the stranding direction of the parent strands is set as the stranding direction of the stranded conductor **21**. The reason is that the stranding direction of the parent strands is more closely related to the tightening and the loosening of the plurality of elemental wires **22** when the stranded conductor **21** is twisted, than the stranding direction of the child strands is. That is, whether the plurality of elemental wires **22** are tightened or loosened when the stranded conductor **21** is twisted mainly depends on the stranding direction of the parent strands.

(42) The stranded conductor **21** may be a composite stranded conductor including a plurality of layers of parent strands in the radial direction. For example, in the example shown in FIG. **4**, a set of six child strands **23**B and a set of twelve child strands **23**C are each stranded into a parent strand around one child strand **23**A disposed on the central axis. The six child strands **23**B constitute a first layer **24** on the inner side, and the twelve child strands **23**C constitute a second layer **25** on the outer side. All of the stranding directions of the parent strands of the layers may be the same, or the stranding directions of the parent strands of some layers may be opposite to the stranding directions

of the parent strands of some other layers. For example, as in the example shown in FIG. **4**, when all of the stranding directions of the parent strands of the layers are the same, the stranding direction is set as the stranding direction of the stranded conductor **21**. When the stranding directions of the parent strands of some layers are opposite to the stranding directions of the parent strands of some other layers, the stranding direction of the parent strands of the outermost layer is set as the stranding direction of the stranded conductor **21**. The reason is that the stranding direction of the parent strands of the outermost layer is more closely related to the tightening and the loosening of the plurality of elemental wires **22** when the stranded conductor **21** is twisted, than the stranding direction of the parent strands of a layer located inward of the outermost layer is. That is, whether the plurality of elemental wires **22** are tightened or loosened when the stranded conductor **21** is twisted mainly depends on the stranding direction of the parent strands of the outermost layer.

(43) Each insulation covering **26** is made of an insulating resin, for example. Here, the insulation covering **26** is made of a crystalline resin. Such a crystalline resin may be, for example, a polyolefin-based resin such as polyethylene (PE) and polypropylene (PP). However, the insulation covering **26** may be made of an amorphous resin. Such an amorphous resin may be, for example, a polyamide-based resin such as nylon, or polyvinyl chloride or the like.

(44) The hardness of the insulation covering **26** is not particularly limited, and can be set as appropriate according to the material and the thickness or the like. Here, the insulation covering **26** is formed relatively hard to the extent that does not make it difficult for the wire **20** to undergo bending deformation into the connection orientation. For example, the insulation covering **26** may have a Shore A hardness of 40 or more and 100 or less, as measured using a durometer compliant with JIS K 6253.

(45) The insulation covering **26** may be formed, for example, by extrusion molding a softened resin material around the stranded conductor **21**. As shown in FIG. **4**, such a resin material may fill the gaps between the parent strands of the outermost layer, and the entire inner surface of the insulation covering **26** may be in contact with the parent strands of the outermost layer. This reduces the room for the parent strands of the outermost layer to loosen, and the wire **20** is more likely to be twisted in the direction in which the stranded conductor **21** is tightened than in the direction in which the stranded conductor **21** is loosened. However, the insulation covering **26** may have a circular inner surface, and only a portion of the inner surface of the insulation covering **26** may be in contact with the parent strands of the outermost layer. In this case, another portion of the inner surface of the insulation covering **26** may not be in contact with the parent strands of the outermost layer, and a gap may be formed between the other portion of the inner surface of the insulation covering **26** and the parent strands of the outermost layer.

(46) First Terminal Block **30**

(47) The first terminal **32** includes a first wire connection portion **32***a* and a first device connection portion **32***b*. The first wire connection portion **32***a* is a portion that is connected to one end portion of each wire **20**. The first device connection portion **32***b* is a portion that is connected to the first device B**1**. For example, the first wire connection portion **32***a* is provided at one end portion of the first terminal **32**, and the first device connection portion **32***b* is provided at the other end portion of the first terminal **32**. The mode of connection between the first wire connection portion **32***a* and the wire **20** is not particularly limited, and can be set as appropriate. Examples thereof include crimping, ultrasonic welding, and resistance welding. The mode of connection between the first device connection portion **32***b* and the first device B**1** is not particularly limited, and can be set as appropriate. Examples thereof include fitting using a male terminal and a female terminal, and screwing.

(48) The first holding portion **31** is made of resin, for example. The first holding portion **31** is formed by being molded using one end portions of the plurality of wires **20** as insert components. The first holding portion **31** is a resin molded portion insert-molded using the plurality of wires **20**

as insert components. Here, the plurality of first terminals **32** are also used as insert components. Accordingly, the plurality of first terminals **32** are held in a parallel state by the first holding portion **31**. A connection portion between each first wire connection portion **32***a* and the corresponding wire **20** is provided inside the first holding portion **31**. Accordingly, at each of the one end portions of the plurality of wires **20**, a portion from which the insulation covering **26** has been detached for connection to the first wire connection portion **32***a* is covered and insulated by the first holding portion **31**. The first holding portion **31** is formed in a tubular shape, for example, and an opening **31***h* is formed inside the first holding portion **31**. The first device connection portion **32***b* extends in the opening **31***h*.

(49) The first terminal block **30** may be provided with a member such as a base member **33**, for example. The base member **33** is formed by pressing a metal plate, for example. An elliptic through hole is formed in a central portion of the base member **33**, and the first holding portion **31** is formed in a single piece with a peripheral edge portion of the through hole.

(50) The base member **33** extends from an outer peripheral portion of the first holding portion **31**. While the base member **33** is in contact with a casing of the first device B**1**, the base member **33** is fixed to the first device B**1** through screwing or the like. The casing of the first device B**1** is grounded to the vehicle body. Accordingly, the base member **33** is grounded via the casing of the first device B**1**. In this manner, while the first terminal block **30** is fixed to the first device B**1**, the first device connection portion **32***b* is connected to a terminal of the first device B**1**. The first terminal block **30** may be provided with a shield shell or the like that is electrically connected to the base member **33**.

(51) Second Terminal Block **40**

(52) The second terminal **42** includes a second wire connection portion **42***a* and a second device connection portion **42***b*. The second wire connection portion **42***a* is a portion that is connected to the other end portion of each wire **20**. The second device connection portion **42***b* is a portion that is connected to the second device B**2**. For example, the second wire connection portion **42***a* is provided at one end portion of the second terminal **42**, and the second device connection portion **42***b* is provided at the other end portion of the second terminal **42**. The mode of connection between the second wire connection portion **42***a* and the wire **20** is not particularly limited, and can be set as appropriate. Examples thereof include crimping, ultrasonic welding, and resistance welding. The mode of connection between the second device connection portion **42***b* and the second device B**2** is not particularly limited, and can be set as appropriate. Examples thereof include fitting using a male terminal and a female terminal, and screwing.

(53) The second holding portion **41** is made of resin, for example. The second holding portion **41** is formed by being molded using the other end portions of the plurality of wires **20** as insert components. The second holding portion **41** is a resin molded portion insert-molded using the plurality of wires **20** as insert components. Here, the plurality of second terminals **42** are also used as insert components. Accordingly, the plurality of second terminals **42** are held in a parallel state by the second holding portion **41**. A connection portion between each second wire connection portion **42***a* and the corresponding wire **20** is provided inside the second holding portion **41**. Accordingly, at each of the other end portions of the plurality of wires **20**, a portion from which the insulation covering **26** has been detached for connection to the second wire connection portion **42***a* is covered and insulated by the second holding portion **41**. The second holding portion **41** is formed in a tubular shape, for example, and an opening **41***h* is formed inside the second holding portion **41**. The second device connection portion **42***b* extends inside the opening **41***h*.

(54) Here, a portion from which the insulation covering **26** has been detached does not exist in a portion of each wire **20** that is located between the first holding portion **31** and the second holding portion **41**. The stranded conductor **21** is covered by the insulation covering **26** over the entire length and the entire circumference between the first holding portion **31** and the second holding portion **41**. The stranded conductor **21** is not exposed between the first holding portion **31** and the

second holding portion **41**.
(55) The second terminal block **40** may be provided with another member such as a fixing portion **43**. The fixing portion **43** is made of resin, for example. The fixing portion **43** is formed in a shape, such as a plate shape, that protrudes from the circumference of the second holding portion **41**. The fixing portion **43** is a resin portion molded separately from the second holding portion **41**, and may be combined with the second holding portion **41**. The fixing portion **43** may be molded in a single piece with the second holding portion **41**.
(56) The fixing portion **43** is fixed to the second device B**2** through screwing or the like. In this case, a through hole for screwing is formed in the fixing portion **43**. A tubular collar may be embedded in the through hole. The collar may be made of a material, such as metal, that has high rigidity than the resin that forms the fixing portion **43**.
(57) The fixing portion **43** may hold a plurality of relay terminals. One end portion of each of the relay terminals may be connected to the second device connection portion **42***b*,and the other end portion of each of the relay terminals may be connected to a terminal of the second device B**2**. Note that the second device connection portion **42***b* may be connected to the terminal of the second device B**2** without any relay terminal interposed therebetween.
(58) Relationship Between Orientation of Wire Harness **10** and Stranding of Wires **20**
(59) The relationship between the orientation of the wire harness **10** and the stranding of the wires **20** will be described with further reference to FIG. **7**. FIG. **7** is a front view showing the wire harness **10** in a first orientation **11**.
(60) As shown in FIG. **7**, an orientation in which the plurality of wires **20** extend straight between the first holding portion **31** and the second holding portion **41** is defined as the first orientation **11** of the wire harness **10**. In the first orientation **11**, the first terminal block **30** and the second terminal block **40** are not shifted from each other in the X direction. The interval between the adjacent wires **20** in the first holding portion **31** and the interval between the adjacent wires **20** in the second holding portion **41** are the same. Accordingly, in the first orientation **11**, the plurality of wires **20** are close to a state of being precisely parallel.
(61) The wire length between the first holding portion **31** and the second holding portion **41** is not particularly limited, and can be set as appropriate. The interval between the first holding portion **31** and the second holding portion **41** in the first orientation **11** is equal to the wire length between the first holding portion **31** and the second holding portion **41**. For example, the wire length between the first holding portion **31** and the second holding portion **41** may range from 100 mm to 300 mm. When the wire length between the first holding portion **31** and the second holding portion **41** is short, the wire harness **10** is difficult to be bent. When the wire length between the first holding portion **31** and the second holding portion **41** is long, the effect of bending is less likely to be exerted on the portions restrained by the first holding portion **31** and the second holding portion **41**.
(62) As described above, the orientation of the wire harness **10** shown in FIGS. **1** to **3** is the connection orientation in which the first terminal block **30** and the second terminal block **40** are connected to the respective connection partners. The connection orientation is not the first orientation **11**, but a second orientation **12**. The second orientation **12** is an orientation in which the plurality of wires **20** are bent between the first holding portion **31** and the second holding portion **41**, and in which a twist occurs in the plurality of wires **20** when the plurality of wires **20** are bent from the first orientation **11**.
(63) The second orientation **12** may be an orientation in which the plurality of wires **20** are bent about an axis extending in the side-by-side arrangement direction of the plurality of wires **20**, and in which one end portion and the other end portion of each of the plurality of wires **20** are shifted from each other in the side-by-side arrangement direction by an amount greater than or equal to the diameter of the wire **20**. Such a second orientation **12** is an orientation in which L-shaped bending and offset movement are combined. Specifically, in FIG. **2**, the orientation of the wire harness **10** indicated by the dashed double-dotted line is the first orientation **11**, and the orientation of the wire

harness **10** indicated by the solid line is the second orientation **12**. As indicated by the solid line in FIG. **2**, in the second orientation **12**, the plurality of wires **20** are bent about an axis extending in the X direction. The plurality of wires **20** are bent in an L-shape. In FIG. **3**, the orientation of the wire harness **10** indicated by the solid line is the second orientation **12**. In FIG. **3**, the wire harness **10** indicated by the dashed double-dotted line shows a state in which one end portion and the other end portion of the wire **20** are not shifted from each other in the X direction. As indicated by the solid line in FIG. **3**, in the second orientation **12**, one end portion and the other end portion of each of the plurality of wires **20** are shifted from each other in the X direction by an amount greater than or equal to the diameter of the wire **20**. The plurality of wires **20** make an offset movement in the side-by-side arrangement direction between the one end portions and the other end portions.

(64) In the second orientation **12**, the angle formed by a direction in which the plurality of wires **20** extend from the first holding portion **31** and a direction in which the plurality of wires **20** extend from the second holding portion **41** may range from 60 degrees to 120 degrees. Such an angle is the angle in a side view shown in FIG. **2**. FIG. **2** shows a case where the angle formed by the direction (the Z direction in FIG. **2**) in which the plurality of wires **20** extend from the first holding portion **31** and the direction (the Y direction in FIG. **2**) in which the plurality of wires **20** extend from the second holding portion **41** is perpendicular. In the second orientation **12**, the side-by-side arrangement direction of the plurality of wires **20** in the first holding portion **31** and the side-by-side arrangement direction of the plurality of wires **20** in the second holding portion **41** may be parallel to each other. FIG. **1** shows a case where the side-by-side arrangement direction (the X direction in FIG. **1**) of the plurality of wires **20** in the first holding portion **31** and the side-by-side arrangement direction (the X direction in FIG. **1**) thereof in the second holding portion **41** are parallel to each other.

(65) The stranding direction of the stranded conductors **21** of half or more of the plurality of wires **20** is a direction in which the stranding of the stranded conductors **21** is tightened by a twist occurring when the plurality of wires **20** are bent from the first orientation **11** to the second orientation **12**. Here, the stranding direction of the stranded conductors **21** of all of the plurality of wires **20** is a direction in which a twist occurring when the plurality of wires **20** are bent from the first orientation **11** to the second orientation **12** tightens the stranding of the stranded conductors **21**.

(66) For example, the second orientation **12** shown in FIG. **3** is an orientation in which the first holding portion **31** is shifted from the second holding portion **41** in the positive X direction when the wire harness **10** in the second orientation **12** is observed from the inner circumferential side relative to bending about an axis extending in the X direction, and also observed such that the first holding portion **31** is located above the second holding portion **41**. When the connection orientation of the wire harness **10** is the second orientation **12** shown in FIG. **3**, the S-stranded wires **20** are oriented such that the stranding of the stranded conductors **21** is tightened by a twist occurring when the S-stranded wires **20** are bent from the first orientation **11** to the second orientation **12**, and the Z-stranded wires **20** are oriented such that the stranding of the stranded conductors **21** is loosened by a twist occurring when the Z-stranded wires **20** are bent from the first orientation **11** to the second orientation **12**. Therefore, when the connection orientation of the wire harness **10** is the second orientation **12** shown in FIG. **3**, half or more of the wires **20** may be S-stranded wires **20**, and it is preferable that all of the wires **20** are S-stranded wires **20**.

(67) FIG. **8** is a front view showing a wire harness **110** according to a first modification.

(68) The orientation of the wire harness **110** in FIG. **8** is a second orientation **112**. The second orientation **112** of the wire harness **110** shown in FIG. **8** is different from the second orientation **12** of the wire harness **10** according to the embodiment. Specifically, the second orientation **112** of the wire harness **110** shown in FIG. **8** is an orientation in which the wire harness **110** makes an offset movement in the X direction reversely to that in the second orientation **12** of the wire harness **10** according to the embodiment. The second orientation **112** shown in FIG. **8** is an orientation in

which the first holding portion **31** is shifted from the second holding portion **41** in the negative X direction when the wire harness **110** of the second orientation **112** is observed from the inner circumferential side relative to bending about an axis extending in the X direction, and also observed such that the first holding portion **31** is located above the second holding portion **41**.

(69) When the connection orientation of the wire harness **110** is the second orientation **112** shown in FIG. **8**, the S-stranded wires **20**S are oriented such that the stranding of the stranded conductors **21**S is loosened by a twist occurring when the S-stranded wires **20**S are bent from the first orientation **11** to the second orientation **112**, and the Z-stranded wires **20**Z are oriented such that the stranding of the stranded conductors **21**Z is tightened by a twist occurring when the Z-stranded wires **20**Z are bent from the first orientation **11** to the second orientation **112**. Therefore, when the connection orientation of the wire harness **110** is the second orientation **112** shown in FIG. **8**, half or more of the wires **20** may be Z-stranded wires **20**Z, and it is preferable that all of the wires **20** are Z-stranded wires **20**Z.

(70) The wire harnesses **10** and **110** are manufactured, for example, in the first orientation **11**, and are transported to locations where they are mounted to the devices B**1** and B**2**, while being in the first orientation **11**. Then, at the locations where the wire harnesses **10** and **110** are mounted to the devices B**1** and B**2**, the wire harnesses **10** and **110** are bent from the first orientation **11** to the second orientation **12** or **112** and mounted to the devices B**1** and B**2**.

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(71) When the stranding direction of the stranded conductors **21** is a direction in which the stranding of the stranded conductors **21** is loosened by a twist occurring when the plurality of wires **20** are bent from the first orientation **11** to the second orientation **12** or **112**, the insulation coverings **26** impede loosening of stranding of the stranded conductors **21**, and therefore a strong force is required to bend the wires **20**. In this respect, with the wire harnesses **10** and **110** configured as described above, the stranding direction of the stranded conductors **21** is a direction in which the stranding of the stranded conductors **21** is tightened by a twist occurring when the plurality of wires **20** are bent from the first orientation **11** to the second orientation **12** or **112**. Therefore, the insulation coverings **26** are prevented from impeding loosening of the stranding of the stranded conductors **21**, thus making it possible to bend the wires **20** with a weak force. This makes it possible to facilitate bending of each of the wire harnesses **10** and **110** between one end and the other end thereof in a direction in which a twist occurs in the wires **20**.

(72) Each of the second orientations **12** and **112** is an orientation in which the plurality of wires **20** are bent about an axis extending in a side-by-side arrangement direction, and in which one end portion and the other end portion of each of the plurality of wires **20** are shifted from each other in the side-by-side arrangement direction by an amount greater than or equal to the diameter of the wire **20**. When the plurality of wires **20** are bent from the first orientation **11** to such a second orientation **12** or **112**, a twist also occurs in the plurality of wires **20**. In this case as well, it is possible to facilitate bending of each of the wire harnesses **10** and **110** between one end and the other end thereof in a direction in which a twist occurs in the wires **20**.

(73) In each of the second orientations **12** and **112**, an angle formed by a direction in which the plurality of wires **20** extend from the first holding portion **31** and a direction in which the plurality of wires **20** extend from the second holding portion **41** ranges from 60 degrees to 120 degrees, and the side-by-side arrangement direction of the plurality of wires **20** in the first holding portion **31** and the side-by-side arrangement direction of the plurality of wires **20** in the second holding portion **41** are parallel to each other. In this case as well, it is possible to facilitate bending of each of the wire harnesses **10** and **110** between one end and the other end thereof in a direction in which a twist occurs in the wires **20**.

(74) The stranding direction of the stranded conductors **21** of all of the plurality of wires **20** is a direction in which the twist occurring when the plurality of wires **20** are bent from the first orientation **11** to the second orientation **12** or **112** tightens the stranding of the stranded conductors

21. With this configuration, none of the plurality of wires **20** is a wire **20** in which the stranding direction of the stranded conductor **21** is a direction in which the stranding of the stranded conductor **21** is loosened by a twist occurring when the plurality of wires **20** are bent from the first orientation **11** to the second orientation **12** or **112**, thus making it possible to facilitate bending of each of the wire harnesses **10** and **110** between one end and the other end thereof in a direction in which a twist occurs in the wires **20**.

(75) The number of the plurality of wires **20** is three or more. In this case as well, it is possible to facilitate bending of each of the wire harnesses **10** and **110** between one end and the other end thereof in a direction in which a twist occurs in the wires **20**.

(76) The insulation coverings **26** each have a Shore A hardness of 40 to 100, as measured using a durometer compliant with JIS K 6253. In the case of a relatively hard insulation covering **26** having a Shore A hardness of 40 to 100, fastening of the stranded conductors **21** by the insulation coverings **26** is further tightened, and the stranded conductors **21** are much less likely to be twisted in the direction in which they are loosened. In this case as well, the connection orientation is the orientation in which the stranded conductors **21** of half or more of the wires **20** are twisted in the direction in which they are tightened, and therefore each of the wire harnesses **10** and **110** is likely to assume the connection orientation.

(77) The insulation coverings **26** are each made of a crystalline resin. With this configuration, the insulation coverings **26** are likely to be hard as compared with an insulation covering **26** made of an amorphous resin. In this case as well, the connection orientation is the orientation in which the stranded conductors **21** of half or more of the wires **20** are twisted in the direction in which they are tightened, and therefore the wire harnesses **10** and **110** are likely to assume the connection orientation.

(78) The stranded conductors **21** each have a cross-sectional area of 10 sq to 50 sq, and the wire length between the first holding portion **31** and the second holding portion **41** ranges from 100 mm to 300 mm. With this configuration, even in the case of using wires **20** having a relatively large diameter and a relatively short length, the connection orientation is an orientation in which the stranded conductors **21** of half or more of the wires **20** are twisted in the direction in which they are tightened, and therefore each of the wire harnesses **10** and **110** is likely to assume the connection orientation.

(79) Each of the first holding portion **31** and the second holding portion **41** is a resin molded portion insert-molded using the plurality of wires **20** as insert components. With this configuration, each of the first holding portion **31** and the second holding portion **41** can firmly hold the plurality of wires **20**. In addition, one end portions of the plurality of wires **20** are likely to make the same movement as the first holding portion **31**, and the other end portions of the plurality of wires **20** are likely to make the same movement as the second holding portion **41**.

APPENDIX

(80) FIG. **9** is a front view showing a wire harness **210** according to a second modification.

(81) The wire harness **210** is different from the wire harnesses **10** and **110** described above in that a plurality of (two in this case) first terminal blocks **230** are provided. In this manner, the wires **20** may be branched due to the wire harness including one first terminal block or second terminal block, and a plurality of the other terminal blocks. In this case as well, when the plurality of wires **20** are arranged side by side, and the above-described relationship between the first orientation **11** and the second orientation **12** or **112** holds for at least one set of a first terminal block **230** and a second terminal block **40**, the same effects as the embodiment can be achieved. Note that in each of the first terminal blocks **230**, the number of first terminals **32** is three, and the first holding portion **231** is sized so as to accommodate the three first terminals **32**. The rest of the configuration of the first terminal block **230** may be the same as that of the first terminal block **30** described above.

(82) Furthermore, the direction of twisting of the wires **20** may vary as in the case of the wire harness **210**. That is, in the wire harness **210**, one first terminal block **230**A is shifted in the positive

X direction, and the other first terminal block **230**B is shifted in the negative X direction. In this case, of a plurality of (three in this case) wires **20** connecting one first terminal block **230**A to the second terminal block **40**, half or more of the wires **20** may be S-stranded wires **20**S, and it is preferable that all of the wires **20** are S-stranded wires **20**S, as in the case of the wire harness **10** according to the embodiment. Of a plurality of (three in this case) of wires **20** connecting the other first terminal block **230**B to the second terminal block **40**, half or more of the wires **20** may be Z-stranded wire **20**Z, and it is preferable that all of the wires **20** are Z-stranded wires **20**Z, as in the case of the wire harness **110** according to the first modification.

(83) In addition, although the first holding portions **31** and **231** each have been described thus far as being a molded resin portion insert-molded using the wires **20** as insert components, this is not an essential configuration. For example, the first holding portions **31** and **231** may each be a separate molded article molded without using the wires **20** as insert components. For example, the first holding portion **31** may be a holding member formed by a bar-shaped member having formed therein grooves to which the wires **20** are to be fitted. Such a holding member is mounted to the wires **20** from a lateral side of the wires **20**. For example, the first holding portion **31** may be a housing having formed therein cavities into which the wires **20** are to be inserted. The wires **20** are inserted into the cavities of the housing from distal ends thereof. Members for fixing the wires **20**, such as rubber rings or back retainers, may be attached to the above-described holding member or housing.

(84) Note that the configurations described in the embodiments and the modifications may be combined as appropriate as long as there are no mutual inconsistencies.

(85) From the foregoing, it will be appreciated that various exemplary embodiments of the present disclosure have been described herein for purposes of illustration, and that various modifications may be made without departing from the scope and spirit of the present disclosure. Accordingly, the various exemplary embodiments disclosed herein are not intended to be limiting, with the true scope and spirit being indicated by the following claims

Claims

1. A wire harness comprising: a plurality of wires each including a stranded conductor, and an insulation covering that covers the stranded conductor; a first terminal block including a first holding portion that holds one end portions of the plurality of wires, and a plurality of first terminals each electrically connected to the one end portion of a corresponding wire of the plurality of wires; and a second terminal block including a second holding portion that holds the other end portions of the plurality of wires, and a plurality of second terminals each electrically connected to the other end portion of a corresponding wire of the plurality of wires, wherein the plurality of wires are arranged side by side between the first holding portion and the second holding portion in a direction intersecting a direction connecting the first holding portion to the second holding portion, when an orientation in which the plurality of wires extend straight between the first holding portion and the second holding portion is defined as a first orientation, a connection orientation in which the first terminal block and the second terminal block are connected to the respective connection partners is a second orientation in which the plurality of wires are bent between the first holding portion and the second holding portion, and in which a twist occurs in the plurality of wires are bent from the first orientation, and a stranding direction of the stranded conductors of half or more wires of the plurality of wires is a direction in which stranding of the stranded conductors is tightened by the twist occurring when the plurality of wires are bent from the first orientation to the second orientation.

2. The wire harness according to claim 1, wherein the second orientation is an orientation in which the plurality of wires are bent about an axis extending in a side-by-side arrangement direction of the plurality of wires, and in which the one end portion and the other end portion of each of the

plurality of wires are shifted from each other in the side-by-side arrangement direction by an amount greater than or equal to a diameter of the wire.

3. The wire harness according to claim 2, wherein, in the second orientation, an angle formed by a direction in which the plurality of wires extend from the first holding portion and a direction in which the plurality of wires extend from the second holding portion ranges from 60 degrees to 120 degrees, and the side-by-side arrangement direction of the plurality of wires in the first holding portion and the side-by-side arrangement direction of the plurality of wires in the second holding portion are parallel to each other.

4. The wire harness according to claim 1, wherein a stranding direction of the stranded conductors of all of the plurality of wires is a direction in which the twist occurring when the plurality of wires are bent from the first orientation to the second orientation tightens stranding of the stranded conductors.

5. The wire harness according to claim 1, wherein the number of the plurality of wires is three or more.

6. The wire harness according to claim 1, wherein the insulation coverings each have a Shore A hardness of 40 to 100, as measured using a durometer compliant with JIS K 6253.

7. The wire harness according to claim 1, wherein the insulation coverings are each made of a crystalline resin.

8. The wire harness according to claim 1, wherein the stranded conductors each have a cross-sectional area of 10 sq to 50 sq, and a wire length between the first holding portion and the second holding portion ranges from 100 mm to 300 mm.

9. The wire harness according to claim 1, wherein each of the first holding portion and the second holding portion is a resin molded portion insert-molded using the plurality of wires as insert components.