

EXTENSION CABLE CONNECTION STRUCTURE FOR TEMPERATURE MEASUREMENT MEANS AND METHOD FOR CONNECTING EXTENSION CABLE

Technical Field

[0001]

The present invention relates to a connection structure for connecting a temperature measurement means such as a thermocouple covered with a sheath tube, for example, with an extension cable, and a method for connecting the extension cable.

Background Art

[0002]

As an extension cable connection structure of this kind, there is a conventionally known structure in which, to prevent insulation breakdown or the like due to entry of moisture into the sheath, a pair of element wires in a sheath thermocouple and a pair of conductive wires in compensation lead wires, are coupled, and the pair of coupling parts is inserted into a metal sleeve, and then a thermosetting resin sealing material such as an epoxy resin or the like is charged into the sleeve and hardened in the sleeve to fix the coupling parts and maintain insulation in the metal sleeve (for example, refer to Patent Document 1, Fig. 13), or the pair of coupling parts is covered with bosses made of a thermosetting resin such as silicon putty or a silicon rubber (for example, refer to Patent Document 1, Fig. 14). In such structures, however, there is a fear that, at routing of the compensation lead

wires, when an unexpected tension stress or bending stress acts on the structure, an external force is exerted on the internal coupling parts to break or short-circuit the coupling parts. Accordingly, there is demand that both the structure for covering the coupling parts and the internal coupling parts have strength enough to resist an unexpected tension stress and bending stress.

[0003]

Besides the foregoing structures, there is known a structure in which; the pair of coupling parts is surrounded by an insulating material such as a thermosetting silicon rubber, and then the insulating material is molded using a synthetic resin or the like (generally insert molding) to cover the coupling parts (Patent Document 2); and a structure in which the pair of coupling parts is held in guide grooves of an insulator made of a polyphenylene sulfide resin, and then the insulator or the like is molded using a molding resin (generally insert molding) to cover the coupling parts (Patent Document 3). According to such connection structures, no force acts on the coupling parts or the like even under a pressure or the like during the insert molding. This makes it possible to provide the connection structures with moisture-proof performance to some extent by the means of the constituent resins or the like while preventing short-circuit or the like. However, to produce a structure for covering the conductive wires and the element wires by these synthetic resins, it is necessary to conduct the molding at significantly high temperatures. As a result, a large difference in thermal expansion is generated between the synthetic resin covering the coupling parts and the metal tube sheath on the thermocouple element wires

at cooling after the molding, and thus there is a fear that adhesion is lowered between the synthetic resin covering the coupling parts and the outer peripheral surface of the sheath, thereby to deteriorate the moisture-proof property.

[0004]

In the structure as described in Figs. 13 and 14 of Patent Document 1, the sealing material and the bosses are made of a thermosetting resin, and it is thus necessary to use a high heat-resistance resin or the like for an outer jacket of the compensation lead wires. Accordingly, there is a problem that it is not possible to use general-purpose compensation lead wires with a low heat-resistance outer jacket, which are used currently in general. Further, in the structures described in Patent Document 2 and 3, it is necessary to use separate insulating materials and insulators, which leads to increased parts count and complicated manufacturing process and results in variation of quality. Further, the foregoing structures bring about increase in manufacturing costs, and thus there is demand for a connection structure that can be efficiently manufactured at lower costs.

Citation List

Patent Literatures

[0005]

Patent Document 1: JP-B No. H07-48056

Patent Document 2: JP-UM-A No. S58-8135

Patent Document 3: JP-UM-B No. H03-21462

Summary of Invention

Technical Problem

[0006]

In light of the foregoing circumstances, an object of the present invention is to provide a connection structure that does not require a complicated manufacturing process, reliably prevents disconnection of conductive wires due to a pressure on insert molding, a repeatedly applied tension stress or bending stress during use of a sheath thermocouple to maintain stable performance of the thermocouple, and has more excellent moisture-proof and dust-proof properties than conventional structures.

Solution to Problem

[0007]

The inventor has found out through earnest studies that the foregoing problem can be solved by configuring a connection structure such that a connection part is molded by hot-melt molding using a thermoplastic polyamide resin, and conductive wires at the connection structure are formed as twisted wires if needed and welded to element wires. Accordingly, the inventor has completed the present invention.

[0008]

The summary of the present invention is as follows:

(1) An extension cable connection structure for a temperature measurement means, the connection structure being formed by connecting one pair of element wires derived from a sheath base end of the temperature measurement means to one pair of conductive wires derived from a leading

end of an outer jacket on an extension cable, wherein a connection part made of a thermoplastic polyamide resin and molded by hot-melt molding covers a section from the sheath base end to the extension cable leading end through one pair of coupling parts coupling the pair of element wires and the pair of conductive wires, a connection part made of a thermoplastic polyamide resin and molded by hot-melt molding is placed such that the pair of element wires, the pair of coupling parts, and the pair of conductive wires, are each separated from one another.

(2) The extension cable connection structure for a temperature measurement means according to (1), wherein the outer jacket at the extension cable leading end has a tubular structure made of a thermoplastic resin with a glass-transition temperature of 125°C or less.

(3) The extension cable connection structure for a temperature measurement means according to (1) or (2), wherein the sheath base end is provided with a protrusion for locking the connection part.

(4) The extension cable connection structure for a temperature measurement means according to any of (1) to (3), wherein the coupling parts are formed by welding the element wires and the conductive wires.

(5) The extension cable connection structure for a temperature measurement means according to any of (1) to (4), wherein the conductive wires are twisted wires, and the coupling parts are formed by further twisting ends of the conductive wires in a direction of twisting so as to be closely attached to each other and welding the element wires to the ends of the conductive wires.

(6) The extension cable connection structure for a temperature

measurement means according to (5), wherein the coupling parts are formed by welding the closely attached leading ends of the conductive wires and further welding the element wires to the welded parts of the conductive wires.

(7) The extension cable connection structure for a temperature measurement means according to any of (1) to (3), wherein the coupling parts are formed by a conductive member for swaging and fixing the element wires and the conductive wires.

(8) An extension cable connection method for a temperature measurement means, the temperature measurement means having a connection structure formed by connecting one pair of element wires derived from a sheath base end of the temperature measurement means to one pair of conductive wires derived from a leading end of an outer jacket on an extension cable, wherein a connection part made of a thermoplastic polyamide resin and molded by hot-melt molding covers a section from the sheath base end to the extension cable leading end through one pair of coupling parts coupling the pair of element wires and the pair of conductive wires, a connection part made of a thermoplastic polyamide resin and molded by hot-melt molding is placed such that the pair of element wires, the pair of coupling parts, and the pair of conductive wires, are each separated from one another.

(9) The extension cable connection method for a temperature measurement means according to (8), wherein the coupling parts are formed by welding the element wires and the conductive wires.

(10) The extension cable connection method for a temperature

measurement means according to (8) or (9), wherein the conductive wires are twisted wires, and the coupling parts are formed by further twisting ends of the conductive wires in a direction of twisting so as to be closely attached to each other and welding the element wires to the ends of the conductive wires.

(11) The extension cable connection method for a temperature measurement means according to (10), wherein the coupling parts are formed by welding the closely attached leading ends of the conductive wires and further welding the element wires to the welded parts of the conductive wires.

Advantageous Effects of Invention

[0009]

In the thus configured extension cable connection structure for a temperature measurement means according to the invention of the subject application, the connection part covering the connection structure is molded by hot-melt molding using thermoplastic polyamide. In the hot-melt molding using a thermoplastic polyamide resin, the thermoplastic polyamide resin itself serves as an adhesive, and it is thus possible to provide favorable adhesion between the thermoplastic polyamide resin and the conductive wires and the thermocouple element wires. Further, the connection part can be molded by a metal mold kept at a low temperature, and it is thus possible to make an extremely small difference in thermal expansion between the sheath and the synthetic resin constituting the connection part after cooling. Accordingly, it is possible to maintain a favorable

closely-attached state of an outer peripheral surface of the sheath base end and the synthetic resin in the connection part while suppressing occurrence of a clearance between the two due to the difference in thermal expansion after cooling. This significantly improves the connection structure in moisture-proof and insulating properties. Keeping the closely-attached state also contribute to enhancement in strength of connection between the conductive wires and the thermocouple element wires. In addition, the present invention allows injection molding under an extremely low pressure as compared to normal injection molding, whereby it is possible to reduce a risk that the conductive wires move and cause a short-circuit during molding to deteriorate performance of the sheath thermocouple.

[0010]

In this arrangement, a material for the outer jacket covering the conductive wires may be a thermoplastic resin with a glass-transition temperature of 125°C or less. Accordingly, the outer jacket melts during molding of the connection part by hot-melt molding and then solidifies after cooling, and thus the resin constituting the outer jacket adheres more firmly to the conductive wires. This further enhances the connection structure in moisture-proof property.

[0011]

The sheath base end is provided with the protrusion for locking the connection part to prevent the sheath from coming out of the connection part.

[0012]

The coupling parts are formed to be thinner by welding the element wires and the conductive wires. This provides not only the effect of

improving ease of handling the sheath thermocouple but also the effect of suppressing occurrence of a clearance between the outer peripheral surface of the sheath base end and the synthetic resin in the connection part due to a difference in thermal expansion during injection molding and cooling of the connection part, thereby further enhancing the connection structure in moisture-proof and dust-proof properties.

[0013]

The ends of the conductive wires as twisted wires are further twisted in the direction of twisting so as to be closely attached to each other and then the thermocouple element wires are welding and coupling to the ends of the conductive wires, thereby to join each of the metal wires constituting the twisted wires integrally to the thermocouple element wires. Accordingly, it is possible to keep the resistance to current flowing through the sheath thermocouple at a constant value and maintain stable performance of the sheath thermocouple. This contributes to uniform quality of manufactured products.

[0014]

The ends of the conductive wires formed by further twisting the twisted wires in the direction of twisting are welded such that the metal wires constituting the twisted wires are integrated, and then are welded to the thermocouple element wires. Accordingly, each of the metal wires constituting the twisted wires can be integrally coupled to the element wires in a more stable manner. This makes it possible to expect quality stability. In addition, the conductive wires and the thermocouple element wires can be firmly coupled to each other, and the sheath thermocouple can be made

strong enough to resist an unexpected tension stress and bending stress during use. This also results in improved durability of the connection structure.

Brief Description of the Drawings

[0015]

Fig. 1 (a) is a partially cutaway cross sectional view of one example of an embodiment of an extension cable connection structure according to the present invention, and Fig. 1 (b) is a cross section view of Fig. 1 (a) taken along line I - I;

Fig. 2 is a partially cutaway cross sectional view of another example of the embodiment of the extension cable connection structure according to the present invention;

Fig. 3 is a partially cutaway cross sectional view of another example of the embodiment of the extension cable connection structure according to the present invention; and

Fig. 4 is a flowchart of partially cutaway cross sectional views describing a method for manufacturing one example of the embodiment of the extension cable connection structure according to the present invention.

Description of Embodiments

[0016]

An embodiment of an extension cable connection structure according to the present invention will be described with reference to Figs. 1 (a), 1 (b), 2, and 3. In the examples shown in Figs. 2 and 3, the same components as

those in the example shown in Fig. 1 are given the same reference numerals as those in the example shown in Fig. 1, and descriptions thereof are omitted. An extension cable connection structure 1 shown in Fig. 1 and an extension cable connection structure 2 shown in Fig. 2 are substantially different in shapes of connection parts 40 and 50, structures of coupling parts 30a and 30b, and 60a and 60b, presence or absence of a folding prevention part 51, which are described later. In addition, the extension cable connection structure 2 shown in Fig. 2 and an extension cable connection structure 3 shown in Fig. 3 are substantially different in structures of coupling parts 60a and 60b, and 70a and 70b described later.

[0017]

In the extension cable connection structure 1 of this embodiment, as shown in Figs. 1 (a) and 1 (b), one pair of element wires 13a and 13b is derived from a sheath base end 12 of a sheath thermocouple 10 as a temperature measurement means, one pair of conductive wires 23a and 23b is derived from a leading end 22 of an outer jacket 21 on a compensation conductive wire 20 as an extension cable, and one pair of coupling parts 30a and 30b is configured to connect the element wires 13a and 13b and the conductive wires 23a and 23b, respectively. In addition, a connection part 40 covers an entire section ranging from the sheath base end 12 to the extension cable leading end 22 such that the element wires 13a and 13b, the conductive wires 23a and 23b, and the coupling parts 30a and 30b, are each separated from one another. In the present invention, the connection part 40 is molded by hot-melt molding using a thermoplastic polyamide resin.

[0018]

In this embodiment, the sheath thermocouple 10 is used as a temperature measurement means. Besides, the sheath thermocouple 10 can also be applied to a temperature measurement resistor or the like. The sheath thermocouple 10 may be any of conventionally publicly known sheath thermocouples in which one pair of thermocouple element wires 13a and 13b is stored in a stainless-steel sheath 11, an inorganic insulating material such as magnesia powder is charged into the sheath 11, the element wires 13a and 13b are pulled out of the sheath base end 12, and a resin sealing member is charged into the sheath base end 12.

From the viewpoint of preventing the sheath 11 from coming out of the connection part 40, a protrusion 14 may be provided on an outer peripheral surface of a portion of the sheath 11 disposed in the connection part 40. In the examples shown in Figs. 1 and 2, the protrusion 14 is formed as one protruding thread going around the outer peripheral surface of the sheath 11. However, the protrusion 14 is not limited to this, but a plurality of protruding threads may be provided or one or two or more protrusions may be partly provided on the peripheral surface of the sheath 11 without going around the peripheral surface of the sheath 11.

[0019]

The compensation conductive wire 20 may be any of a wide variety of publicly-known compensation conductive wires conventionally used as an extension cable of the sheath thermocouple 10 in which one pair of conductive wires 23a and 23b covered with an inner coat is stored in an outer jacket 21 made of a synthetic resin. The conductive wires 23a and 23b may be single wires or twisted wires. However, it is considered that the

conductive wires 23a and 23b are repeatedly bent during use of the sheath thermocouple 10, and thus from the viewpoint of providing the sheath thermocouple 10 with durability to withstand a bending stress, the conductive wires 23a and 23b are desirably formed as twisted wires.

[0020]

There is no particular limit on material for the outer jacket, and any thermoplastic resin with a glass-transition temperature of 125°C or less can be used as material for the outer jacket. Examples of such a thermoplastic resin include polyvinyl chloride resin, ABS resin, polyester such as polybutylene terephthalate or polyethylene terephthalate, polyamide, polyurethane, and the like, but the material for the outer jacket is not limited to these materials. In addition, there is no particular lower limit on the glass-transition temperature of the thermoplastic resin, but the glass-transition temperature is preferably 30°C or more, more preferably 50°C or more. Examples of such a thermoplastic resin include polyvinyl chloride resin, ABS resin, polyester such as polybutylene terephthalate or polyethylene terephthalate, polyamide, and the like, but the thermoplastic resin is not limited to these materials. Further, from the viewpoint of suppressing costs by the use of a general extension cable, the material for the outer jacket is preferably polyvinyl chloride.

In addition, there is no particular limit on the structure of the outer jacket, but the structure of the outer jacket may be any of publicly-known structures, for example, a tubular structure. The tubular structure may have a tubular shape covering the entire conductive wires 23a and 23b, or may have an almost tubular shape covering partially the conductive wires

23a and 23b (for example, a coil shape with arbitrarily varied pitches or the like). Further, the tubular structure in the present invention may be a structure with one tubular part covering the conductive wires 23a and 23b in an integral manner, or may be a structure with two tubular parts covering separately the conductive wires 23a and 23b.

[0021]

In the example of the embodiment shown in Figs. 1 (a) and 1 (b), the thermocouple element wires 13a and 13b and the conductive wires 23a and 23b are each fitted into both ends of metal sleeves as a conductive member, and are fixed by swaging and electrically connected via the conductive member to the connection parts 30a and 30b. Alternatively, the conductive wires and the thermocouple element wires may be fixed by welding instead of swaging, or the thermocouple element wires and the conductive wires may be directly coupled using sleeves to configure the coupling parts 60a and 60b as shown in Fig. 2, or the thermocouple element wires and the conductive wires may be directly coupled by welding or by any other joint method. Using the structure of the coupling parts as shown in Fig. 2 makes it possible to decrease the entire length (length along a long axis shown in Fig. 1 (a) and 2).

[0022]

Besides, the thermocouple element wires 13a and 13b and the conductive wires 23a and 23b may be coupled by welding as shown in Fig. 3. In particular, when the conductive wires 23a and 23b are formed as twisted wires, the wires are preferably coupled by welding as shown in Fig. 3.

[0023]

Next, the procedure for forming the coupling parts 70a and 70b by welding the thermocouple element wires 13a and 13b and the conductive wires 23a and 23b made from the twisted wires 33a and 33b (refer to Fig. 4 (a)) as shown in Fig. 3, will be described with reference to Fig. 4. First, the ends of the conductive wires 23a and 23b are further twisted in the direction of original twisting to form twisted parts 43a and 43b, whereby the plurality of metal wires constituting the twisted wires are closely attached to each other (refer to Fig. 4 (b)). The thermocouple element wires 13a and 13b may be welded and coupled to the ends of the twisted parts 43a and 43b. Alternatively, after formation of welded parts 53a and 53b, the thermocouple element wires 13a and 13b may be further welded and coupled to the welded parts 53a and 53b. In this case, first, the metal wires constituting the twisted wires at the ends of the twisted parts 43a and 43b are melted and integrated by welding to form the welded parts 53a and 53b. The welded parts 53a and 53b may be formed in an almost ball shape as shown in Fig. 4 (c). However, the shape of the welded parts 53a and 53b is not limited to this as far as the plurality of metal wires constituting the twisted wires is integrated at least at ends of the twisted parts 43a and 43b. Then, the ends of the thermocouple element wires 13a and 13b are joined or overlapped with the welded parts 53a and 53b, and then coupled to the welded parts 53a and 53b by welding with a welding machine, thereby to form the coupling parts 70a and 70b (refer to Fig. 4 (c)). The welding machine used here may be any of a wide variety of publicly-known welding machines.

[0024]

As shown in Figs. 3 and 4, the twisted wires are used as the

conductive wires 23a and 23b to form the twisted parts 43a and 43b and then form the welded parts 53a and 53b, and after that, the thermocouple element wires 13a and 13b are coupled via the welded parts 53a and 53b. Accordingly, using the conductive wires 23a and 23b as twisted wires, not single wires, makes it possible to provide advantageously the sheath thermocouple 10 with resistance to a bending stress during use, and couple each of the metal wires constituting the twisted wires 33a and 33b to the thermocouple element wires 13a and 13b in a reliable manner. As a result, resistance to current flowing through the sheath thermocouple 10 can be kept at a constant value. Accordingly, it is possible to maintain stable performance of the sheath thermocouple 10, and enhance the connection structure according to the present invention in strength against a tension stress and a bending stress.

[0025]

The connection parts 40 and 50 are made from a thermoplastic polyamide resin. The thermoplastic polyamide resin usable in the present invention can be subjected to hot-melt molding described later. Such a thermoplastic polyamide resin may be a resin disclosed in JP-B No. H06-84431, or a resin obtained by subjecting dimeric fat acid produced from natural fat acid to condensation polymerization with diamine, for example. Such a thermoplastic polyamide resin has high adhesion to metals constituting sheaths, element wires, and conductive wires, and various resins constituting the outer jacket or the like of the extension cable, and thus is excellent in moisture-proof, dust-proof, and insulating properties. Especially, the thermoplastic polyamide resin preferably has a dimeric fatty

acid with a carbon number of 30 to 45, in particular 36. Accordingly, the connection parts 40 and 50 are improved in flexibility and are further enhanced in moisture-proof property and adhesion.

The thermoplastic polyamide resin used in the present invention is preferably characterized in that the molecular mass is 8,000 to 12,000, the softening point is 80 to 150°C, and the viscosity at 210°C is 2,000 to 4,000 Pa · s.

The foregoing thermoplastic polyamide resin may be, for example, a thermoplastic polyamide resin that is sold under the trade name "Macromelt (registered trademark)" by Henkel AG & Co. KGaA.

[0026]

In the present invention, the connection parts 40 and 50 are molded by hot-melt molding using the foregoing thermoplastic polyamide resin. The hot-melt molding in the present invention relates to a kind of so-called insert molding by which a molded article is placed in a metal mold and integrated with a resin. In the hot-melt molding using a thermoplastic polyamide resin as in the present invention, the resin can be injected under an injection pressure of 0.2 to 5 MPa that is extremely lower than that in normal injection molding. Accordingly, no force or a quite-small force acts on the element wires, the coupling parts, and the conductive wires placed in the metal mold even under a pressure during the insert molding or the like. This eliminates the need to use any member to prevent occurrence of a short-circuit at the pair of element wires 13a and 13b, the coupling parts 30a, 30b, 60a, and 60b, and the conductive wires 23a and 23b, as shown in Figs. 1 (a), 1 (b), and 2. It is thus possible to reduce a parts count, make the

connection structure light-weight and small-sized, and simplify the manufacturing process for the connection structure. In addition, since it is not necessary to use a metal mold with a complicated structure to prevent occurrence of a short-circuit at the wires or the like, it can be expected that the metal mold is easily cleaned each after molding, occurrence of molding failure is suppressed, and products with unified quality are manufactured with efficiency.

In contrast, in the case of insert molding with general injection, it is necessary to inject a resin under a high pressure. Accordingly, the element wires, the coupling parts, and the conductive wires placed in the metal mold are moved by the injected resin or the like to develop a short-circuit or be exposed to the outside. It is thus extremely difficult to realize the connection structures as shown in Figs. 1 and 2, and it is impossible to avoid increase of manufacturing costs.

[0027]

In the hot-melt molding of the present invention, the foregoing thermoplastic polyamide resin is used and thus the molding temperature can be lowered as compared to the case of using a thermosetting resin such as silicon resin. This makes it possible to use a general-purpose extension cable with an outer jacket of a polyvinyl chloride, for example, as described above.

[0028]

In addition, in the foregoing hot-melt molding using a thermoplastic polyamide resin, the metal mold can be kept at a low temperature of about 40°C, for example. This makes it possible to make an extremely small

difference in thermal expansion between the metal constituting the conductive wires and the thermocouple element wires and the synthetic resin constituting the connection parts after cooling. Accordingly, it is possible to avoid deterioration of adhesion due to a difference in thermal expansion between the outer peripheral surface of the sheath base end and the synthetic resin in the connection parts after cooling, thereby significantly enhancing the connection structure in moisture-proof property. As a result, it is possible to maintain the insulating property of the connection structure, and improve the measurement accuracy of the sheath thermocouple.

[0029]

There is no particular limit on the structure of the connection parts 40 and 50 as far as the entire portions of the connection parts 40 and 50 ranging from the sheath base end 12 through the pairs of the coupling parts 30a and 30b, 60a and 60b, and 70a and 70b coupling the pair of element wires 13a and 13b and the pair of conductive wires 23a and 23b, respectively to the extension cable leading end 22, are covered directly with a thermoplastic polyamide resin. For example, the connection parts 40 and 50 may have any of various shapes such as an almost cylinder, an almost square, and these shapes to which a tapered portion is added as appropriate. The example shown in Fig. 1 is structured such that the width (diameter) orthogonal to the long axis is almost uniform and a tapered portion is provided at the side near the compensation conductive wire 20 so as to be gradually smaller in width with increasing proximity to the compensation conductive wire 20, and a tapered portion is provided at the side near the sheath thermocouple 10 so as to be gradually smaller in width with

increasing proximity to the sheath thermocouple 10, and the gradient of the former tapered portion is smaller than the gradient of the latter tapered portion, as shown in Fig. 1 (a). In addition, the connection parts 40 and 50 have circular cross sections near the coupling parts 30a and 30b as shown in Fig. 1 (b), and the foregoing both tapered portions also have a circular shape. Further, although not shown, the cross sections may have an almost rectangular shape. For example, the connection parts 40 and 50 may be decreased in size at the side along the height (horizontal side shown in Fig. 1 (b)) than at the side along the width (vertical side shown in Fig. 1 (b)), or may be the reverse.

[0030]

As shown in Figs. 2 and 3, the connection part 50 may have a folding prevention part 51 at an end thereof covering the compensation conductive wire 20 to prevent folding and breakage of the compensation conductive wire 20. This configuration may be a configuration widely used for household wall outlets, for example. The folding prevention part may be molded integrally with the connection part 50 or may be provided as a separate member.

The material, structure, and molding method of the connection part 50 shown in Figs. 2 and 3 are generally the same as those of the connection part 40 shown in Fig. 1 except for points described above otherwise, and thus detailed descriptions thereof will be omitted here.

[0031]

The hot-melt molding can be carried out by any of conventionally publicly-known methods.

[0032]

As in the foregoing, the embodiment of the present invention is described. However, the present invention is not limited to the embodiment, but can be carried out in various modes without departing from the gist of the present invention.

[Example 1]

[0033]

The present invention will be described below with reference to an example.

[0034]

(Example 1)

A sheath thermocouple (trade name "THERMIC K ϕ 1.6" produced by Yamari Industries Limited) and a compensation conductive wire (trade name "VX-15" covered with a polyvinyl chloride produced by Yamari Industries Limited) were coupled by swaging using coupling parts (trade name "Crimp Sleeve" produced by Nichifu Co., Ltd.). Then, the coupled unit was placed such that only the portion from the base end of the sheath thermocouple to the leading end of the compensation wire is positioned in a metal mold. After that, a thermoplastic polyamide resin (trade name "Macromelt (registered trademark) produced by Henkel AG & Co. KGaA) was used to perform macro-melt molding in accordance with the predetermined method, thereby to fabricate an extension cable connection structure for a temperature measurement means shown in Fig. 2.

It has been confirmed by a digital multi-meter (produced by Advantest Corporation) that the obtained connection structure had no

disconnection. In addition, the connection structure has no problem in appearance.

[0035]

(Moisture-proof test)

The extension cable connection structure for a temperature measurement means obtained in Example 1 was immersed in water in a container such that a portion from the leading end of the sheath thermocouple through the connection structure to the compensation conductive wire was positioned at a water depth of about 30 cm or the like. Then, the connection structure was measured over time in insulating resistance in conformity with JIS C1605. As a result, it has been confirmed that the extension cable connection structure maintained an insulating resistance of 1000 MΩ or more and had sufficient moisture-proof property in practical use even after lapse of one month.

Reference Signs List

[0036]

- 1 and 2 Extension cable connection structure
- 10 Sheath thermocouple
- 11 Sheath
- 12 Sheath base end
- 13a and 13b Element wire
- 14 Protrusion
- 20 Compensation conductive wire
- 21 Outer jacket

22	Leading end of outer jacket	
23a and 23b	Conductive wire	
33a and 33b	Twisted wire	
43a and 43b	Twisted part	
53a and 53b	Welded part	
30a, 30b, 60a, 60b, 70a, and 70b		Coupling part
40 and 50	Connection part	
51	Folding prevention part	

CLAIMS:

1. An extension cable connection structure for a temperature measurement means, the connection structure being formed by connecting one pair of element wires derived from a sheath base end of the temperature measurement means to one pair of conductive wires derived from a leading end of an outer jacket on an extension cable, wherein a connection part made of a thermoplastic polyamide resin and molded by hot-melt molding covers a section from the sheath base end to the extension cable leading end through one pair of coupling parts coupling the pair of element wires and the pair of conductive wires, a connection part made of a thermoplastic polyamide resin and molded by hot-melt molding is placed such that the pair of element wires, the pair of coupling parts, and the pair of conductive wires, are each separated from one another.
2. The extension cable connection structure for a temperature measurement means according to Claim 1, wherein the outer jacket at the extension cable leading end has a tubular structure made of a thermoplastic resin with a glass-transition temperature of 125°C or less.
3. The extension cable connection structure for a temperature measurement means according to Claim 1 or 2, wherein the sheath base end is provided with a protrusion for locking the connection part.
4. The extension cable connection structure for a temperature

measurement means according to any one of Claims 1 to 3, wherein the coupling parts are formed by welding the element wires and the conductive wires.

5. The extension cable connection structure for a temperature measurement means according to any one of Claims 1 to 4, wherein the conductive wires are twisted wires, and the coupling parts are formed by further twisting ends of the conductive wires in a direction of twisting so as to be closely attached to each other and welding the element wires to the ends of the conductive wires.

6. The extension cable connection structure for a temperature measurement means according to Claim 5, wherein the coupling parts are formed by welding the closely attached leading ends of the conductive wires and further welding the element wires to the welded parts of the conductive wires.

7. The extension cable connection structure for a temperature measurement means according to any one of Claims 1 to 3, wherein the coupling parts are formed by a conductive member for swaging and fixing the element wires and the conductive wires.

8. An extension cable connection method for a temperature measurement means, the temperature measurement means having a connection structure formed by connecting one pair of element wires derived

from a sheath base end of the temperature measurement means to one pair of conductive wires derived from a leading end of an outer jacket on an extension cable, wherein, on a section from the sheath base end to the extension cable leading end through one pair of coupling parts coupling the pair of element wires and the pair of conductive wires, a connection part made of a thermoplastic polyamide resin and molded by hot-melt molding is placed such that the pair of element wires, the pair of coupling parts, and the pair of conductive wires, are each separated from one another.

9. The extension cable connection method for a temperature measurement means according to Claim 8, wherein the coupling parts are formed by welding the element wires and the conductive wires.

10. The extension cable connection method for a temperature measurement means according to Claim 8 or 9, wherein the conductive wires are twisted wires, and the coupling parts are formed by further twisting ends of the conductive wires in a direction of twisting so as to be closely attached to each other and welding the element wires to the ends of the conductive wires.

11. The extension cable connection method for a temperature measurement means according to Claim 10, wherein the coupling parts are formed by welding the closely attached leading ends of the conductive wires and further welding the element wires to the welded parts of the conductive wires.