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Cable connection device and power feed control device

Abstract

A cable connection device includes a first holder, a second holder and a support. The first holder is configured to hold a tip part of an end of a cable. The second holder is configured to hold an intermediate part of the end. The support is configured to support the first holder. The second holder is fixed with respect to a power feed control device body. The first holder is supported by the second holder through the support to restrict at least movement of the cable in a pulling direction of the cable.

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Background/Summary

CROSS-REFERENCE OF RELATED APPLICATIONS

(1) This application is the U.S. National Phase under 35 U.S.C. § 371 of International Patent Application No. PCT/JP2021/018631, filed on May 17, 2021, which in turn claims the benefit of Japanese Patent Application No. 2020-112121, filed on Jun. 29, 2020, the entire disclosures of which Applications are incorporated by reference herein.

TECHNICAL FIELD

(2) The present disclosure generally relates to cable connection devices and power feed control devices, and more particularly relates to a cable connection device configured to connect a cable to an electric apparatus, and a power feed control device including the cable connection device.

BACKGROUND ART

(3) Patent Literature 1 is exemplified as one conventional example, which discloses a power feed control device (electric apparatus). The power feed control device in Patent Literature 1 (hereinafter, referred to as a "conventional device") is configured to control feeding power from an external power supply such as a commercial power supply to an electric vehicle. The conventional device is applied to be interposed between: a power plug cable to be connected to the external power supply; and a connector cable to be connected to the electric vehicle.

(4) The connector cable includes a cable body; a charging connector, which is provided at one end of the cable body to be removably connected to a charging inlet of the electric vehicle; a load-side receptacle (cable connection device), which is provided at the other end of the cable body to be removably connected to a load-side connection part of the power feed control device.

CITATION LIST

Patent Literature

(5) Patent Literature 1: JP 2018-125952 A

SUMMARY OF INVENTION

(6) In the load-side receptacle (cable connection device) of the connector cable, relieving tension applied to the cable is needed for protecting the connection with the cable.

(7) It is therefore an object of the present disclosure to provide a cable connection device and a power feed control device, all of which can relieve tension applied to a cable.

(8) A cable connection device according to an aspect of the present disclosure is configured to connect an end of a cable to an electric apparatus. The cable connection device includes: a first holder configured to hold a tip part of the end; a second holder configured to hold an intermediate part of the end; and a support configured to support the first holder. The second holder is fixed with respect to the electric apparatus. The first holder is supported by the second holder through the support to restrict at least movement of the cable in a pulling direction of the cable.

(9) A power feed control device according to an aspect of the present disclosure includes the cable connection device, the cable and the electric apparatus. The electric apparatus is configured to feed power to a load through a power feeding path including the cable, and stop feeding the power to the load in response to that an abnormality is present in the power feeding path.

Description

BRIEF DESCRIPTION OF DRAWINGS

(1) FIG. **1** is a front view of a power feed control device according to an embodiment of the present disclosure;

(2) FIG. **2** is an exploded perspective view of the power feed control device, partially omitted;

(3) FIG. **3** is a block diagram of a power feed control device body, as one of components that constitute the power feed control device;

(4) FIG. **4** is an exploded perspective view of a cable connection device according to an embodiment of the present disclosure;

(5) FIG. **5** is another exploded perspective view of the cable connection device;

(6) FIG. **6** is a partially cross-sectional view of a first holder of the cable connection device; and

(7) FIG. **7** is a cross-sectional view of the cable connection device.

DESCRIPTION OF EMBODIMENTS

(8) Hereinafter, a cable connection device and a power feed control device according to an embodiment of the present disclosure will be described with reference to the drawings. The drawings to be referred to in the following description of the embodiment are all schematic representations. That is to say, the ratio of the dimensions (including thicknesses) of respective constituent elements illustrated on the drawings does not always reflect their actual dimensional ratio. Configurations in the following description of the embodiment are mere examples of the present disclosure and should not be construed as limiting. Various modifications may be made to the embodiment depending on design and the like as long as the effect of the present disclosure is achieved.

(9) (1) Explanations of Power Feed Control Device According to Embodiment

(10) (1-1) Overall Configuration of Power Feed Control Device According to Embodiment

(11) As shown in FIG. **1**, a power feed control device **1** according to an embodiment (hereinafter, simply referred to as the "power feed control device **1**") includes a power feed control device body **10**, a first cable **11**, a second cable **12**, a charging connector **13**, and an inserting plug **14**. The power feed control device **1** is configured to control feeding electric power for charging a battery for motive power, which is installed in an electric vehicle such as an electric car or a plug-in hybrid car.

(12) The inserting plug **14** is configured to be removably inserted into, for example, an outlet installed outdoors and electrically connected to an external power supply (such as a commercial power supply with 100 V or 200 V as an effective value) via the outlet. The inserting plug **14** may include three contactors in total: two contactors **140** and **141** as voltage electrodes; and one contactor **142** as a ground electrode.

(13) The second cable **12** may be implemented as a three-core electric cable (refer to FIG. **3**). The second cable **12** has a first end at which the inserting plug **14** is disposed. The second cable **12** further has a second end that is electrically connected to power feeding paths LP and an electric path LE for grounding, of the power feed control device body **10**.

(14) The charging connector **13** is removably attached to a charging inlet of the electric vehicle to be electrically and mechanically connected to the charging inlet. The first cable **11** has a first end and a second end, and the charging connector **13** is disposed at the second end of the first cable **11**. The first end of the first cable **11** is electrically and mechanically connected to the power feed control device body **10** with a cable connection device **2** according to an embodiment. The first cable **11** may be implemented as a four-core electric cable that includes four electric wires **113** (**113**A, **113**B, **113**C, **113**D) covered with a sheath **114** (refer to FIGS. **3** and **4**).

(15) (1-2) Configuration of Power Feed Control Device Body

(16) The power feed control device body **10** includes a casing **100** having an elongated box shape

(refer to FIGS. **1** and **2**). The casing **100** includes an attachment part **101** to which the cable connection device **2** is attached. The attachment part **101** has a cylindrical shape and is protruded along a longitudinal direction of the casing **100** from a side surface of one end of the casing **100** in the longitudinal direction (refer to FIG. **2**).

(17) The casing **100** is provided to accommodate therein an electric circuit of the power feed control device body **10**. As shown in FIG. **3**, the electric circuit includes a pair of the power feeding paths LP, the electric path LE for grounding, an opening and closing unit **15**, a sensor **16**, a control unit **17** and a power supply unit **18**.

(18) The pair of the power feeding paths LP connect the two electric wires **113**A, **113**B of the four electric wires **113**A to **113**D of the first cable **11** to two core wires (respectively connected to the two contactors **140**, **141** as the voltage electrodes of the inserting plug **14** in one-to-one) of three core wires (conductors) of the second cable **12**. The remaining one core wire of the second cable **12** (i.e., the core wire connected to the contactor **142** as the ground electrode of the inserting plug **14**) is connected to one electric wire **113**C of the first cable **11** via the electric path LE for grounding.

(19) The opening and closing unit **15** includes two switches respectively disposed in the two power feeding paths LP. The two switches may be implemented as electromagnetic relays or semiconductor relays, for example. The opening and closing unit **15** open or close the two switches interlockingly with each other in accordance with a control signal output from the control unit **17**. That is to say, the opening and closing unit **15** open the contacts of the two switches to stop feeding the power to the electric vehicle (load) via the power feeding paths LP, and close the contacts of the two switches to be switched to a state capable of feeding the power to the electric vehicle via the power feeding paths LP.

(20) The sensor **16** may be implemented as a zero-phase current transformer, for example. The sensor **16** detects an unbalanced current flowing through the pair of power feeding paths LP and outputs a detected value of the unbalanced current to the control unit **17**.

(21) The power supply unit **18** includes, for example, a series regulator, a switching regulator or any other circuit and converts an AC voltage supplied via the pair of power feeding paths LP into a DC voltage. The power supply unit **18** supplies, to the control unit **17** and any other units, the DC voltage converted.

(22) The control unit **17** includes, for example, a microcontroller as a main component. The control unit **17** is configured to receive a control pilot (CPLT) signal from an Electronic Control Unit (ECU) for the charging control, installed in the electric vehicle, via the electric wire **113**D of the first cable **11**. The control unit **17** outputs a control signal to the opening and closing unit **15** to close the contacts thereof, when receiving the CPLT signal that includes an instruction to start the power feeding. Also, the control unit **17** is configured to compare the detected value received from the sensor **16** with a prescribed threshold. When finding that the detected value is equal to or more than the threshold, the control unit **17** decides that any abnormality (e.g., electric leakage) has occurred in the electric vehicle. In response to the decision that the abnormality is present, the control unit **17** outputs the control signal to the opening and closing unit **15** to open the contacts thereof to stop feeding the power to the electric vehicle.

(23) (2) Explanations of Cable Connection Device According to Embodiment

(24) As shown in FIGS. **4** and **5**, a cable connection device **2** according to an embodiment (hereinafter, simply referred to as the “cable connection device **2**”) includes a first holder **3**, a second holder **4**, a support **5**, a first sealing part **21**, a second sealing part **22**, a connector **6**, and a cap **7**.

(25) (2-1) First Holder

(26) The first holder **3** is configured to hold a tip part **111** of an end **110** (i.e., the first end) of the first cable **11** (refer to FIG. **6**). The first holder **3** includes a main body **30** (refer to FIGS. **4** and **5**), which is made of a synthetic resin material having electrical insulation and has generally a square pole shape, for example. The main body **30** has four insertion holes **31** into which the four electric

wires **113**A to **113**D are respectively inserted in one-to-one (refer to FIG. **6**). Those four insertion holes **31** are provided to be curved like S-shapes or bent like Z-shapes. The main body **30** of the first holder **3** may be formed to hold the four electric wires **113**A to **113**D by simultaneous molding (insertion molding). In this case, each of the four insertion holes **31** may be formed by an interface between the main body **30** made of the synthetic resin material and a corresponding one of the four electric wires **113**A to **113**D. Alternatively, the main body **30** of the first holder **3** may be configured by coupling two or more synthetic resin molding products. In this case, the two or more synthetic resin molding products may have two or more grooves that form the insertion holes **31** when they are coupled with each other.

(27) Thus, the first holder **3** holds the four electric wires **113**A to **113**D of the first cable **11** with being curved or bent, which can reduce the chance that the electric wires **113**A to **113**D are easily pulled out from the insertion holes **31**, even when a pulling force is applied to the first cable **11**.

(28) (2-2) Second Holder

(29) The second holder **4** is configured to hold an intermediate part **112** of the end **110** of the first cable **11** (refer to FIG. **7**). The second holder **4** includes a main body **40** as a synthetic resin molding product having a disk shape (FIGS. **4** and **5**). The main body **40** has a circular hole **41**, disposed in a center of the main body **40**. The hole **41** is provided to penetrate the center of the main body **40** in a thickness direction (axial direction) of the main body **40** (refer to FIG. **7**).

(30) The main body **40** is provided with two or more protrusions **42** that are protruded from an inner circumferential surface of the hole **41** (refer to FIGS. **5** and **7**). The main body **40** is further provided with two or more claws **43** that are arranged along an edge of the hole **41**. The protrusions **42** and the claws **43** are formed integrally with the main body **40** such that the protrusions **42** are arranged adjacent to each other along a circumferential direction of the hole **41** and the claws **43** are also arranged adjacent to each other along the circumferential direction (refer to FIGS. **4** and **7**).

(31) Each of the two or more claws **43** has a hook-shape (refer to FIG. **7**). The two or more claws **43** are provided to be displaceable to fall toward the hole **41**. The two or more claws **43** are in contact with the sheath **114** of the first cable **11** inserted into the hole **41**, when falling toward the hole **41**. By the two or more claws **43** being in contact with the sheath **114**, the second holder **4** can reduce the chance that the electric wires **113**A to **113**D are easily pulled out from the hole **41**, even when the pulling force is applied to the first cable **11**.

(32) The first cable **11** is positioned to the center of the hole **41** by tips of the two or more protrusions **42** being in contact with the sheath **114** of the first cable **11** inserted into the hole **41** (refer to FIG. **7**). The second holder **4** can cause the two or more claws **43** to be evenly in contact with the sheath **114**, when the first cable **11** is positioned to the center of the hole **41** by the two or more protrusions **42**. Therefore, the second holder **4** can further reduce the chance that the electric wires **113**A to **113**D are pulled out from the hole **41**, even when the pulling force is applied to the first cable **11**.

(33) (2-3) Support

(34) The support **5** is disposed between the first holder **3** and the second holder **4** to be along an axial direction (longitudinal direction) of the first cable **11** and configured to support the first holder **3** (refer to FIG. **7**). The support **5** includes a main body **50** formed like an annular shape, which has a circular hole **51** in the center (refer to FIGS. **4**, **5** and **7**). The main body **50** is provided with a restriction part **52** that is disposed on a first surface (i.e., a surface facing the first holder **3**; the same applies to the following) of the main body **50** (refer to FIG. **5**). The restriction part **52** may be implemented as a recess having a shape that a circle and a quadrangle are connected to each other. The restriction part **52** is provided to fit with a protruded part **32** that is protruded from a first surface (i.e., a surface facing the support **5**; the same applies to the following) of the main body **30** of the first holder **3** (refer to FIGS. **4**, **6** and **7**).

(35) Thus, the support **5** can support the first holder **3** while restricting turning of the first holder **3** along the circumferential direction of the first cable **11**, by the restriction part **52** being fitted with

the protruded part **32**.
(36) The main body **50** is provided with a pair of first protrusion pieces **53** and a pair of second protrusion pieces **54**, which are disposed on the first surface of the main body **50** (refer to FIG. **5**). The pair of first protrusion pieces **53** are disposed at positions of facing each other to interpose the restriction part **52** therebetween. The pair of second protrusion pieces **54** are disposed at positions of facing each other to interpose the restriction part **52** therebetween and disposed at positions between the pair of first protrusion pieces **53**. The pair of first protrusion pieces **53** (along the thickness direction of the main body **50**) are longer than the pair of second protrusion pieces **54**.
(37) The main body **50** is provided with a first housing part **55** and a second housing part **56**, which are disposed in a second surface of the main body **50** (i.e., a surface facing the second holder **4**; the same applies to the following) (refer to FIGS. **4** and **7**). The first housing part **55** is recessed in the thickness direction of the main body **50** to be along the circumference of the main body **50**. The second housing part **56** is implemented as a recess having a cylindrical shape to surround the hole **51**. The first housing part **55** houses therein the first sealing part **21** implemented as an O-ring (refer to FIG. **7**). The second housing part **56** houses therein the second sealing part **22** implemented as an O-ring that has a diameter smaller than that of the first sealing part **21** (refer to FIG. **7**).
(38) (2-4) Connector
(39) The connector **6** includes four contacts **60**, and a housing **61** implemented as a synthetic resin molding product (refer to FIGS. **4** and **5**). The four contacts **60** are respectively fixed to tips of the four electric wires **113**A to **113**D in one-to-one to be electrically connected to conductors of the four electric wires **113**A to **113**D. The housing **61** includes four contact housing parts **610** for housing the four contacts **60** in one-to-one. Each of the four contact housing parts **610** has a square tubular shape, of which both ends are opened.
(40) (2-5) Cap
(41) The cap **7** includes a cap body **70**, a tubular part **71**, and a screw part **72** (refer to FIGS. **4**, **5**, and **7**). The cap body **70** is made of a synthetic resin material and has a cylindrical shape tapered. The tubular part **71** has a cylindrical shape and provided to extend toward the inside of the cap body **70** from a tip of the cap body **70** (refer to FIGS. **4** and **7**). The tubular part **71** has a tip part **710** which is inclined such that its thickness is made thinner toward a tip of the tubular part **71** (refer to FIG. **7**). The screw part **72** is disposed in an inner circumferential surface of a rear end part of the cap body **70** (refer to FIGS. **5** and **7**). The cap body **70** is provided with a peripheral wall **73** that is disposed inside of the tip of the cap body **70** and has a cylindrical shape to surround the tubular part **71**. Note that, a gap **51** is provided between the peripheral wall **73** and the inner circumferential surface of the cap body **70** (refer to FIG. **7**).
(42) The cap **7** in this embodiment is attached to the attachment part **101** provided for the casing **100** of the power feed control device body **10**. The attachment part **101** has a cylindrical shape (refer to FIG. **2**). The attachment part **101** has a rear end part (i.e., a part connecting to the casing **100**), which is provided with a screw part **102** in an outer circumferential surface of the rear end part. The attachment part **101** is provided with two ribs **103**, which are disposed on an inner circumferential surface of the attachment part **101** (refer to FIGS. **2** and **7**). Each rib **103** is protruded linearly from the inner circumferential surface of the attachment part **101** to extend along an axial direction of the attachment part **101**. The two ribs **103** are disposed at 180-degrees rotationally symmetrical positions along the inner circumferential surface of the attachment part **101** (refer to FIG. **7**). Note that, the two ribs **103** are respectively fitted with recesses **540** in one-to-one, which are provided in outside surfaces of the pair of second protrusion pieces **54** of the support **5** (refer to FIG. **7**).
(43) (3) Assembling Procedure of Cable Connection Device
(44) Next, the procedure of assembling the cable connection device **2**, and attaching the cable connection device **2** thus assembled to the end **110** of the first cable **11** will be described. An

assembling worker at first inserts the end **110** of the first cable **11** into the tubular part **71** from the tip of the cap **7**. The assembling worker then inserts the end **110** of the first cable **11** into the hole **41** of the main body **40** of the second holder **4**, the second sealing part **22**, the first sealing part **21**, and the hole **51** of the main body **50** of the support **5** in that order (refer to FIGS. **4** and **5**).
(45) Next, the assembling worker removes part of the sheath **114** from the tip part **111** of the end **110** of the first cable **11**, and then forms the first holder **3** by insert-molding the sheath **114** remained to the tip part **111** and parts of the four electric wires **113**A to **113**D (refer to FIGS. **4** to **6**). The assembling worker respectively fixes the contacts **60** to the tips of the four electric wires **113**A to **113**D in one-to-one, and then houses the contacts **60** in the four contact housing parts **610** of the housing **61** in one-to-one. The assembling worker then fits the protruded part **32** of the first holder **3** and the restriction part **52** of the support **5** with each other to couple the first holder **3** and the support **5**. Furthermore, the assembling worker houses the first sealing part **21** and the second sealing part **22** in the first housing part **55** and the second housing part **56** of the support **5**, respectively, and then inserts the connector **6** into the attachment part **101** of the casing **100**. At that time, the assembling worker fits the two ribs **103** of the attachment part **101** with the recesses **540** of the pair of second protrusion pieces **54** of the support **5**, respectively. Note that, the four contacts **60** of the connector **6**, inserted in the attachment part **101**, are electrically and mechanically connected to four contacts on the reception side, which are housed in the casing **100**.
(46) Next, the assembling worker houses the second holder **4**, the support **5**, the first holder **3** and the connector **6** in the cap body **70** of the cap **7** and then covers the attachment part **101** with the cap **7**. The assembling worker then turns the cap **7** clockwise to screw the screw part **72** provided in the inner circumferential surface of the cap body **70** into the screw part **102** provided in the outer circumferential surface of the attachment part **101**. The assembling worker then attaches the cap **7** to the attachment part **101** and fixes the cable connection device **2** to the power feed control device body **10**. Thus, the assembling worker can connect the first cable **11** to the power feed control device body **10**, using the cable connection device **2**.
(47) (4) Explanations Relating to Retaining and Sealing of Cable Connection Device
(48) The second holder **4** is held between the tip of the attachment part **101** and the tip part **111** of the tubular part **71** of the cap **7** in a state where the cap **7** is attached to the attachment part **101**, thereby the second holder **4** being fixed to the casing **100** (refer to FIG. **7**). The two or more claws **43** of the second holder **4** are pushed by the tip part **111** of the tubular part **71** to fall-down, thereby those claws **43** being in contact with the sheath **114** of the first cable **11**. Therefore, the second holder **4** can hold the intermediate part **112** of the end **110** of the first cable **11**. When the first cable **11** is pulled in a direction away from the power feed control device body **10**, the support **5** is abutted on the second holder **4**. The first holder **3** is supported by the second holder **4** through the support **5** to restrict movement of the first cable **11** in a pulling direction of the first cable **11**. That is to say, the first holder **3** and the second holder **4** of the cable connection device **2** can reduce the chance that the first cable **11** is easily pulled out from the power feed control device body **10**.
(49) Also in the state where the cap **7** is attached to the attachment part **101**, the gap between the attachment part **101** of the casing **100** and the cable connection device **2** (i.e., a space between the support **5** and the attachment part **101**) is generally filled with the first sealing part **21** (refer to FIG. **7**). Therefore, even if liquid such as water has entered through the gap between the cap **7** and the attachment part **101**, the liquid can be prevented from entering the casing **100** by the first sealing part **21**. In addition, in the state where the cap **7** is attached to the attachment part **101**, the gap between the cap **7** and the first cable **11** (i.e., a space between the hole **51** of the support **5** and the sheath **114**) is generally filled with the second sealing part **22** (refer to FIG. **7**). Therefore, even if the liquid has entered the cap **7** through the gap between the tubular part **71** of the cap **7** and the first cable **11**, the liquid can be prevented from entering the casing **100** by the second sealing part **22**.
(50) As described above, the cable connection device **2** includes the first sealing part **21** and the

second sealing part **22**, which can suppress entrance of the liquid such as water into the electric apparatus (power feed control device body **10**).

(51) (5) The Other

(52) The electric apparatus, to which the cable connection device **2** according to an embodiment connects the end of the cable, does not have to be the power feed control device body **10**. The electric apparatus may be also an electric apparatus other than the power feed control device body **10**. The first cable **11** does not have to be the four-core electric cable, but may be also a three-core or less electric cable, or a five-core or more electric cable.

(53) (6) Recapitulation

(54) A cable connection device (**2**) according to a first aspect of the present disclosure is configured to connect an end (**110**) of a cable (first cable **11**) to an electric apparatus (power feed control device body **10**). The cable connection device (**2**) according to the first aspect includes a first holder (**3**), a second holder (**4**) and a support (**5**). The first holder (**3**) is configured to hold a tip part (**111**) of the end (**110**). The second holder (**4**) is configured to hold an intermediate part (**112**) of the end (**110**). The support (**5**) is configured to support the first holder (**3**). The second holder (**4**) is fixed with respect to the electric apparatus. The first holder (**3**) is supported by the second holder (**4**) through the support (**5**) to restrict at least movement of the cable in a pulling direction of the cable.

(55) The cable connection device (**2**) according to the first aspect includes the first holder (**3**) and the second holder (**4**), which can reduce the chance that the cable is easily pulled out from the electric apparatus, in other words, which can relieve tension applied to the cable.

(56) A cable connection device (**2**) according to a second aspect of the present disclosure may be implemented in conjunction with the first aspect. In the cable connection device (**2**) according to the second aspect, the second holder (**4**) preferably includes one or more claws (**43**) disposed to be in contact with a sheath (**114**) in the end (**110**), of the cable.

(57) In the cable connection device (**2**) according to the second aspect, the one or more claws (**43**) are disposed to be in contact with the sheath (**114**) of the cable, which can suitably realize holding of the cable by the second holder (**4**).

(58) A cable connection device (**2**) according to a third aspect of the present disclosure may be implemented in conjunction with the second aspect. In the cable connection device (**2**) according to the third aspect, the second holder (**4**) preferably includes one or more protrusions (**42**) protruded toward the end (**110**) from an inner circumferential surface of a hole (**41**) of the second holder, into which the end (**110**) is inserted.

(59) In the cable connection device (**2**) according to the third aspect, the cable can be positioned with respect to the hole (**41**) and the one or more claws (**43**) can be therefore certainly in contact with the sheath (**114**) of the cable, by causing the tips of the one or more protrusions (**42**) to be in contact with the sheath (**114**) of the cable inserted into the hole (**41**). As a result, the cable connection device (**2**) according to the third aspect can further relieve the tension applied to the cable.

(60) A cable connection device (**2**) according to a fourth aspect of the present disclosure may be implemented in conjunction with the third aspect. The cable connection device (**2**) according to the fourth aspect preferably further includes a cap (**7**) having a tubular shape. The cap (**7**) is preferably provided to accommodate therein the first holder (**3**), the second holder (**4**) and the support (**5**). The one or more claws (**43**) are preferably provided to be in contact with an inner wall surface (tip part **710**) of the cap (**7**) to deform in a direction of approaching the sheath (**114**), while the second holder (**4**) is accommodated in the cap (**7**).

(61) In the cable connection device (**2**) according to the fourth aspect, deforming of the one or more claws (**43**) to be automatically achieved by the second holder (**4**) being accommodated in the cap (**7**), which can improve workability of assembly work.

(62) A cable connection device (**2**) according to a fifth aspect of the present disclosure may be

implemented in conjunction with any one of the first to fourth aspects. In the cable connection device (**2**) according to the fifth aspect, the cable preferably includes two or more electric wires (**113**A to **113**D) covered with a sheath (**114**). The first holder (**3**) preferably has two or more insertion holes (**31**) into which the two or more electric wires (**113**A to **113**D) are respectively inserted in one-to-one.

(63) In the cable connection device (**2**) according to the fifth aspect, holding of the two or more electric wires (**113**A to **113**D) by the first holder (**3**) can be suitably achieved by the two or more electric wires (**113**A to **113**D) being respectively inserted into the two or more insertion holes (**31**) in one-to-one.

(64) A cable connection device (**2**) according to a sixth aspect of the present disclosure may be implemented in conjunction with the fifth aspect. In the cable connection device (**2**) according to the sixth aspect, the two or more insertion holes (**31**) are preferably curved or bent.

(65) In the cable connection device (**2**) according to the sixth aspect, the two or more insertion holes (**31**) are curved or bent, which can further relieve the tension applied to the cable.

(66) A cable connection device (**2**) according to a seventh aspect of the present disclosure may be implemented in conjunction with any one of the first to sixth aspects. The cable connection device (**2**) according to the seventh aspect preferably further includes a first sealing part (**21**) disposed to fill a gap between the support (**5**) and the electric apparatus to prevent liquid from entering through the gap.

(67) In the cable connection device (**2**) according to the seventh aspect, the gap between the support (**5**) and the electric apparatus is filled with the first sealing part (**21**) to prevent liquid from entering through the gap, which can suppress entrance of the liquid such as water into the electric apparatus.

(68) A cable connection device (**2**) according to an eighth aspect of the present disclosure may be implemented in conjunction with any one of the first to seventh aspects. The cable connection device (**2**) according to the eighth aspect preferably further includes a second sealing part (**22**) disposed to fill a gap between the support (**5**) and the end (**110**) to prevent liquid from entering through the gap.

(69) In the cable connection device (**2**) according to the eighth aspect, the gap between the support (**5**) and the end (**110**) is filled with the second sealing part (**22**) to prevent liquid from entering through the gap, which can suppress entrance of the liquid such as water into the electric apparatus.

(70) A cable connection device (**2**) according to a ninth aspect of the present disclosure may be implemented in conjunction with any one of the first to eighth aspects. In the cable connection device (**2**) according to the ninth aspect, the support (**5**) preferably includes a restriction part (**52**) disposed to restrict turning of the first holder (**3**) along a circumferential direction of the cable.

(71) In the cable connection device (**2**) according to the ninth aspect, the turning of the first holder (**3**) along the circumferential direction of the cable is restricted by the restriction part (**52**), which can suppress twisting of the cable.

(72) A cable connection device (**2**) according to a tenth aspect of the present disclosure may be implemented in conjunction with any one of the first to ninth aspects. The cable connection device (**2**) according to the tenth aspect preferably further includes a connector (**6**) configured to be removably inserted in the electric apparatus to electrically connect the cable to the electric apparatus.

(73) The cable connection device (**2**) according to the tenth aspect includes the connector (**6**), which can improve workability of connection work of electrically connecting the cable to the electric apparatus.

(74) A cable connection device (**2**) according to an eleventh aspect of the present disclosure may be implemented in conjunction with any one of the first to tenth aspects. In the cable connection device (**2**) according to the eleventh aspect, the electric apparatus is preferably configured to feed power to a load through a power feeding path (LP) including the cable. The electric apparatus is

preferably configured to stop feeding the power to the load in response to that an abnormality is present in the power feeding path (LP).
(75) In the cable connection device (**2**) according to the eleventh aspect, the cable can be connected to the electric apparatus capable of protecting the load from the abnormality in the power feeding path (LP).
(76) A power feed control device (**1**) according to a twelfth aspect of the present disclosure includes the cable connection device (**2**) according to the eleventh aspect, the cable and the electric apparatus.
(77) The power feed control device (**1**) according to the twelfth aspect includes the cable connection device (**2**), which can relieve tension applied to the cable.
REFERENCE SIGNS LIST
(78) **1** Power Feed Control Device **2** Cable Connection Device **3** First Holder **4** Second Holder **5** Support **6** Connector **7** Cap **10** Power Feed Control Device Body (Electric Apparatus) **11** First Cable (Cable) **21** First Sealing Part **22** Second Sealing Part **31** Insertion Hole **41** Hole **42** Protrusion **43** Claw **52** Restriction Part **110** End **111** Tip Part **112** Intermediate Part **113**A-**113**D Electric Wire **114** Sheath **710** Tip Part LP Power Feeding Path

Claims

1. A cable connection device configured to connect an end of a cable to an electric apparatus, the cable connection device comprising: a first holder configured to hold a tip part of the end; a second holder configured to hold an intermediate part of the end; and a support configured to support the first holder, the second holder being fixed with respect to the electric apparatus, the first holder being supported by the second holder through the support to restrict at least movement of the cable in a pulling direction of the cable, the second holder including one or more claws disposed to be in contact with a sheath in the end of the cable, and the second holder including one or more protrusions protruded toward the end from an inner circumferential surface of a hole of the second holder, into which the end is inserted.
2. The cable connection device of claim 1, further comprising a cap having a tubular shape and provided to accommodate therein the first holder, the second holder and the support, wherein the one or more claws are provided to be in contact with an inner wall surface of the cap to deform in a direction of approaching the sheath, while the second holder is accommodated in the cap.
3. The cable connection device of claim 1, wherein the cable includes two or more electric wires covered with a sheath, and the first holder has two or more insertion holes into which the two or more electric wires are respectively inserted in one-to-one.
4. The cable connection device of claim 3, wherein the two or more insertion holes are curved or bent.
5. The cable connection device of claim 1, further comprising a first sealing part disposed to fill a gap between the support and the electric apparatus to prevent liquid from entering through the gap.
6. The cable connection device of claim 1, further comprising a second sealing part disposed to fill a gap between the support and the end to prevent liquid from entering through the gap.
7. The cable connection device of claim 1, wherein the support includes a restriction part disposed to restrict turning of the first holder along a circumferential direction of the cable.
8. The cable connection device of claim 1, further comprising a connector configured to be removably inserted in the electric apparatus to electrically connect the cable to the electric apparatus.
9. The cable connection device of claim 1, wherein the electric apparatus is configured to feed power to a load through a power feeding path including the cable, and stop feeding the power to the load in response to that an abnormality is present in the power feeding path.
10. A power feed control device, comprising: a cable; an electric apparatus configured to feed

power to a load through a power feeding path including the cable, and stop feeding the power to the load in response to that an abnormality is present in the power feeding path; and a cable connection device configured to connect an end of the cable to the electric apparatus, the cable connection device comprising: a first holder configured to hold a tip part of the end; a second holder configured to hold an intermediate part of the end; and a support configured to support the first holder, the second holder being fixed with respect to the electric apparatus, the first holder being supported by the second holder through the support to restrict at least movement of the cable in a pulling direction of the cable, the second holder including one or more claws disposed to be in contact with a sheath in the end of the cable, and the second holder including one or more protrusions protruded toward the end from an inner circumferential surface of a hole of the second holder, into which the end is inserted.

11. A cable connection device configured to connect an end of a cable to an electric apparatus, the cable connection device comprising: a first holder configured to hold a tip part of the end; a second holder configured to hold an intermediate part of the end; and a support configured to support the first holder, the second holder being fixed with respect to the electric apparatus, the first holder being supported by the second holder through the support to restrict at least movement of the cable in a pulling direction of the cable, the cable including two or more electric wires covered with a sheath, and the first holder has two or more insertion holes into which the two or more electric wires are respectively inserted in one-to-one, the two or more insertion holes are curved or bent.