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(54) **TERMINAL-EQUIPPED ELECTRIC WIRE**

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(57) **ABSTRACT**

A terminal-equipped electric wire includes an electric wire in which a core wire made of aluminum or an aluminum alloy is covered with a covering, and a terminal fitting made of copper or a copper alloy and crimped to an end portion of the electric wire in which the core wire is exposed. The terminal fitting includes a pair of crimp pieces. End portions of the pair of the crimped portions are crimped in a state where the end portions of the pair of the crimped portions are overlapped with each other, so as to cover a surrounding of the electric wire from a leading end of the core wire to a part of the covering. At least the pair of the crimp pieces have top surfaces, bottom surfaces and side surfaces covered with anti-corrosive plated layers.

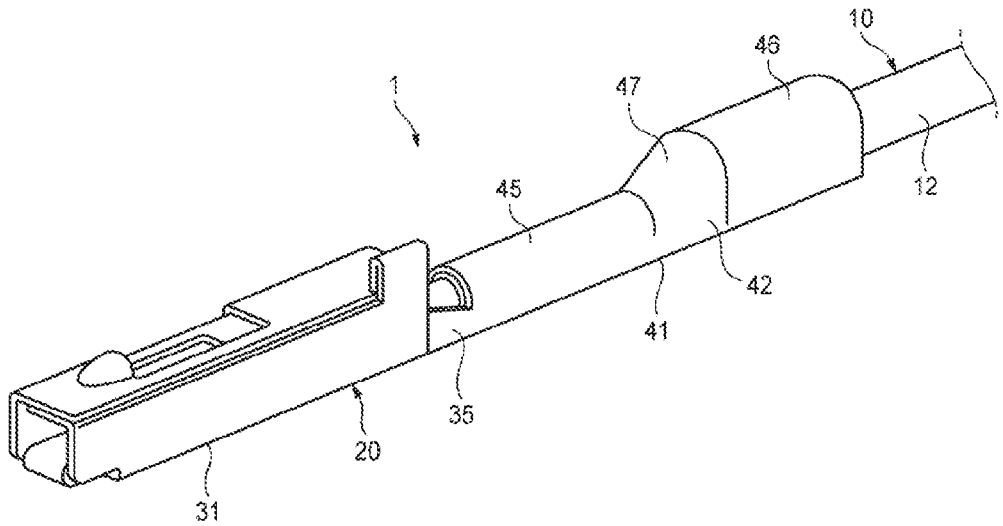


FIG. 1

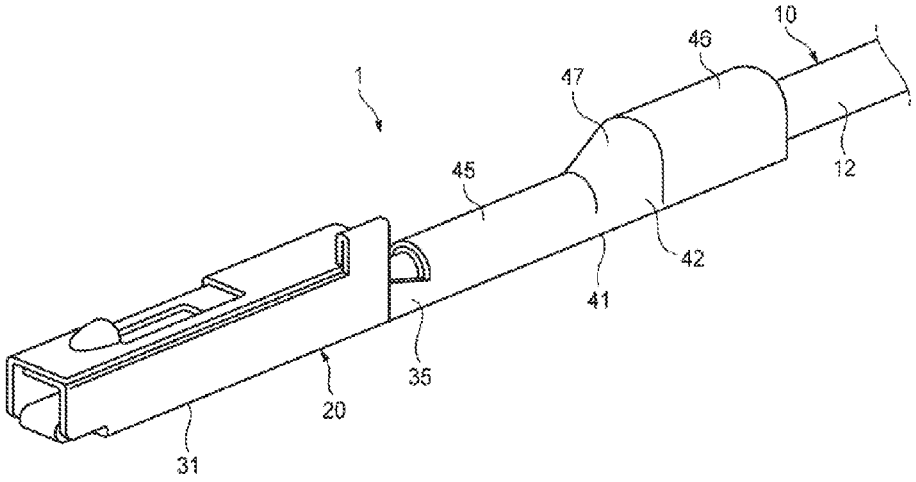


FIG. 2

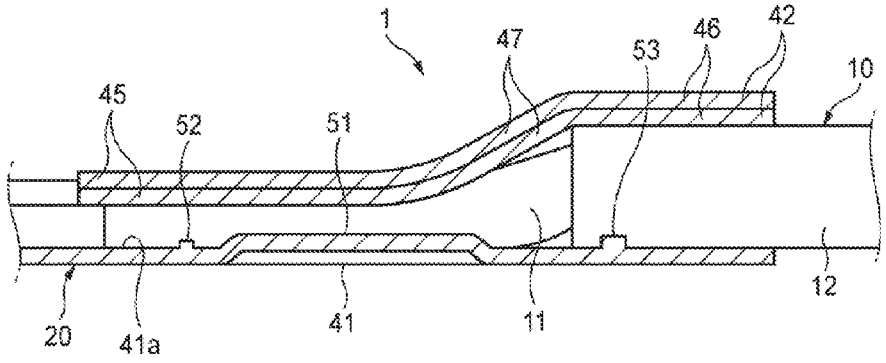


FIG. 3

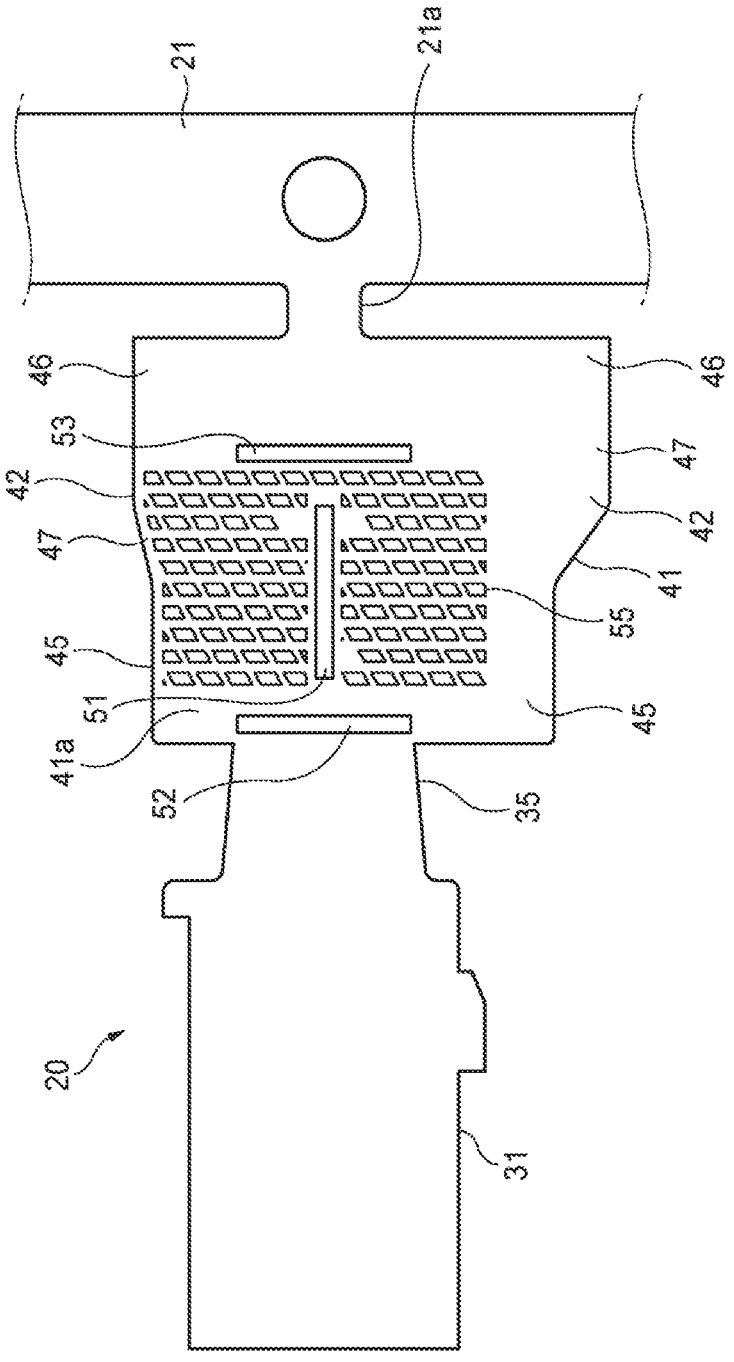


FIG. 4

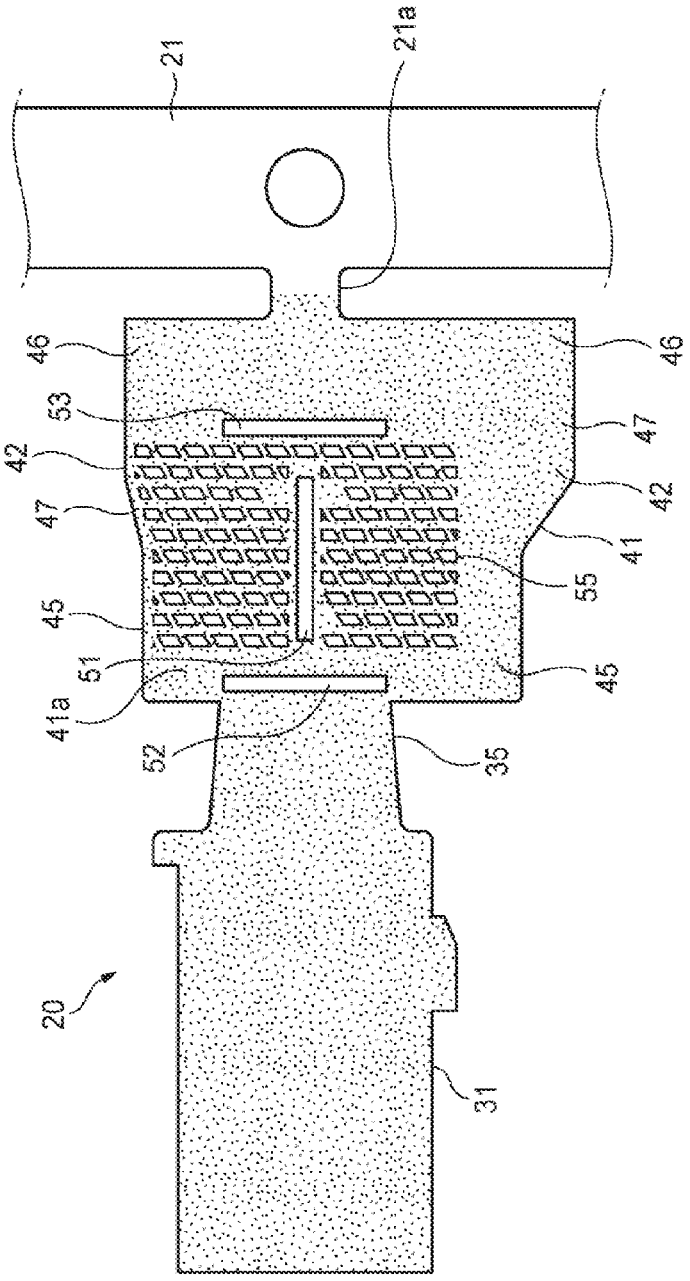


FIG.5

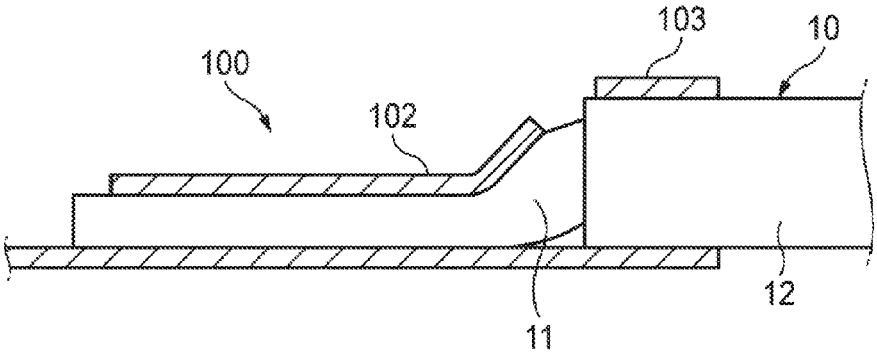


FIG.6

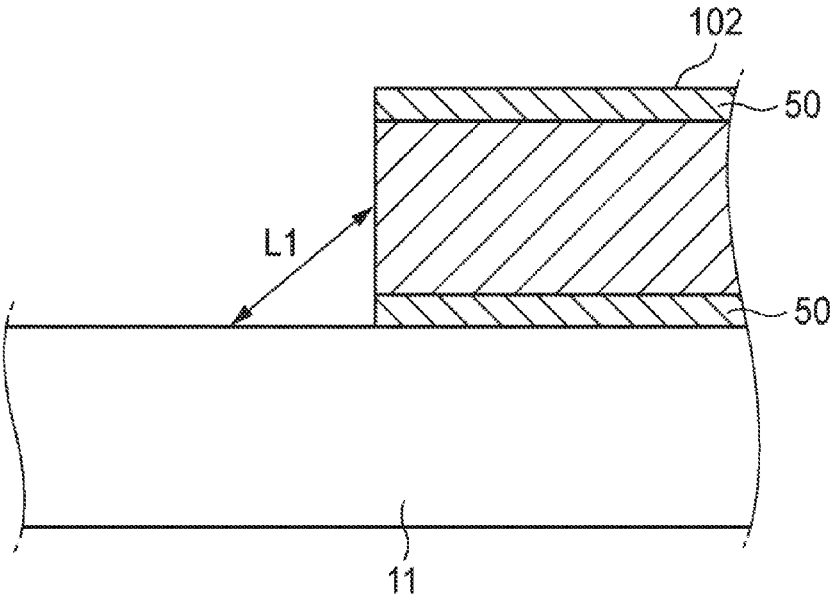


FIG. 7

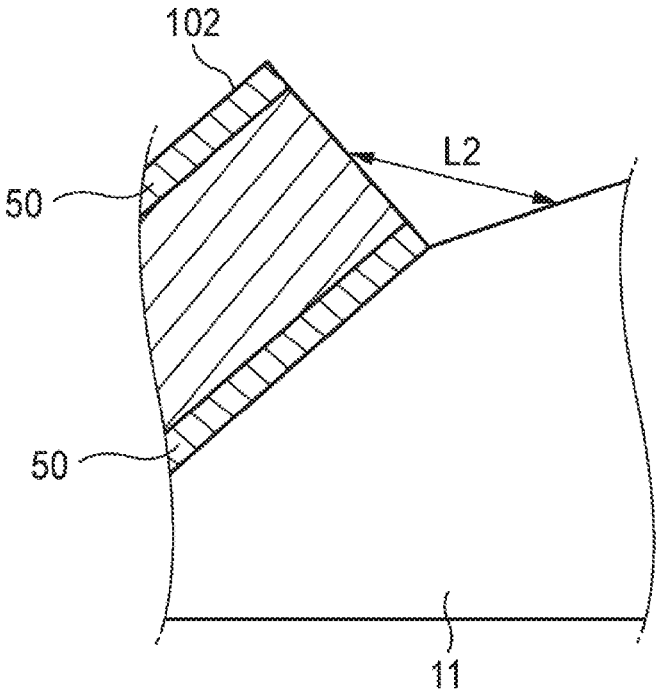


FIG. 8

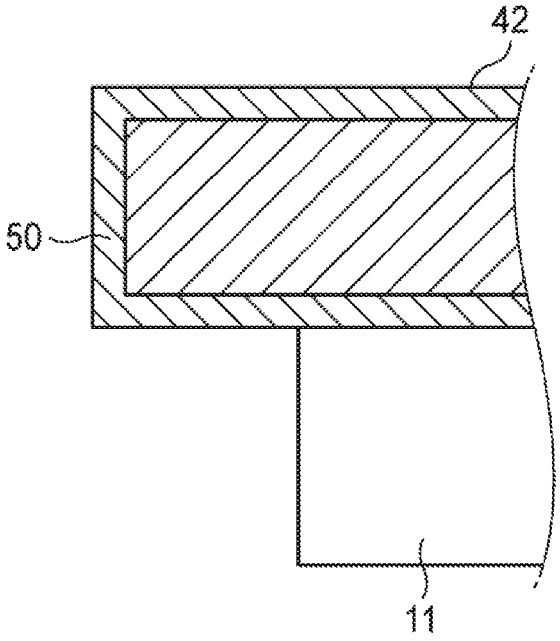


FIG.9

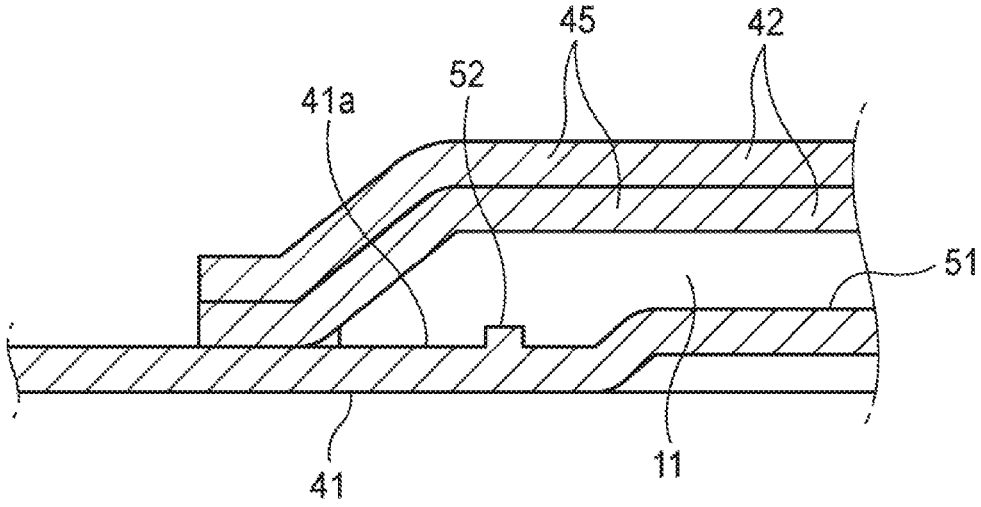


FIG.10A

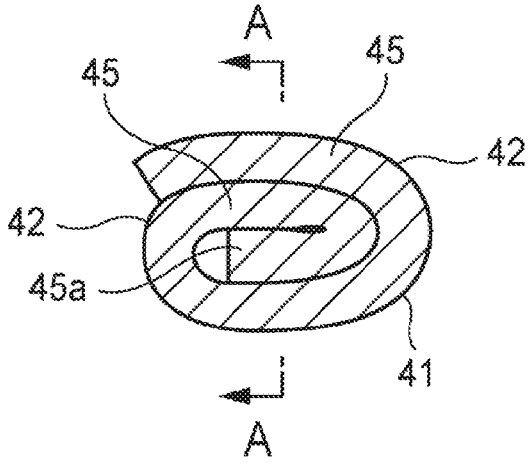
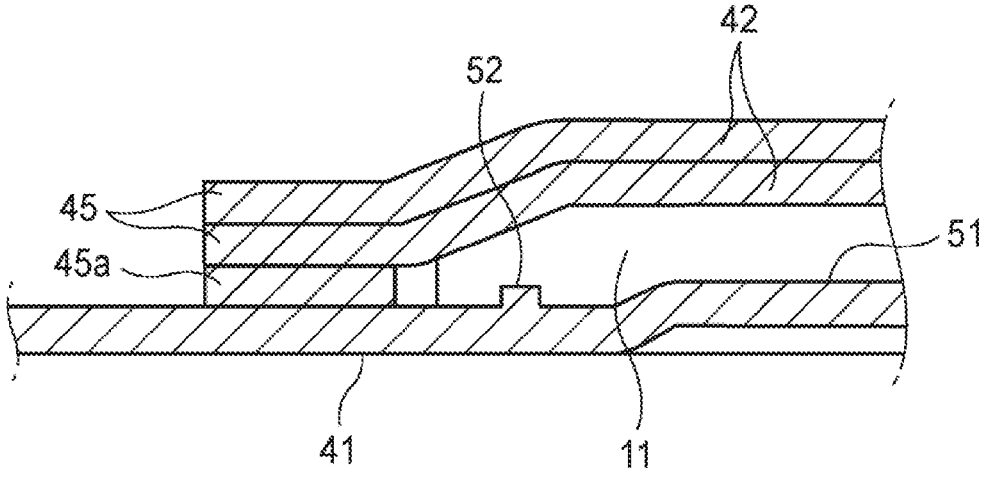


FIG.10B



TERMINAL-EQUIPPED ELECTRIC WIRE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from Japanese Patent Application No. 2016-172014 filed on Sep. 2, 2016, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates to a terminal-equipped electric wire to an end portion of which a terminal fitting is connected.

Description of Related Art

[0003] For example, as a wire harness routed in a vehicle, a terminal-equipped electric wire where a terminal fitting made of copper or a copper alloy is crimped to an electric wire having a core wire made of aluminum or an aluminum alloy is used for weight reduction. In this terminal-equipped electric wire, there is a possibility that adhering water becomes an electrolyte between the core wire and the terminal fitting, which are different metals, of the electric wire to cause galvanic corrosion.

[0004] For this reason, it is performed to inhibit corrosion by forming a plated layer or an insulating layer on the surface in the portion where the terminal fitting is crimped to the electric wire (for example, see Patent Documents 1 to 3).

[0005] [Patent Document 1] JP-A-2013-127907

[0006] [Patent Document 2] JP-A-2013-218866

[0007] [Patent Document 3] JP-A-2013-182861

[0008] According to a related art, in a terminal-equipped electric wire, there is a possibility that water enters into a core wire from between a crimp position of the core wire and the crimp position of a covering portion of a terminal fitting and this leads to corrosion of the core wire. For this reason, it is desired to further improve corrosion resistance while reducing costs.

SUMMARY

[0009] One or more embodiments provide a terminal-equipped electric wire excellent in corrosion resistance while reducing costs.

[0010] In accordance with one or more embodiments, a terminal-equipped electric wire is characterized by the following (1) to (4):

[0011] (1) A terminal-equipped electric wire includes an electric wire in which a core wire made of aluminum or an aluminum alloy is covered with a covering and a terminal fitting made of copper or a copper alloy and crimped to an end portion of the electric wire in which the core wire is exposed. The terminal fitting includes a pair of crimp pieces. End portions of the pair of the crimped portions are crimped in a state where the end portions of the pair of the crimped portions are overlapped with each other, so as to cover a surrounding of the electric wire from a leading end of the core wire to a part of the covering. At least the pair of the crimp pieces have top and bottom surfaces and side surfaces thereof covered with an anti-corrosive plated layer.

[0012] (2) The terminal-equipped electric wire according to (1),

[0013] wherein the anti-corrosive plated layer is a tin-plated layer.

[0014] (3) The terminal-equipped electric wire according to (1) or (2),

[0015] wherein the terminal fitting includes a projected portion projecting toward the electric wire in a longitudinal direction of the electric wire and extending in a first position in which the terminal fitting is crimped to the core wire.

[0016] (4) The terminal-equipped electric wire according to any one of (1) to (3),

[0017] wherein the terminal fitting includes a second projected portion projecting toward the electric wire and extending in a direction orthogonal to the longitudinal direction of the electric wire in a second position in which the terminal fitting is crimped to the core wire, and a third projected portion projecting toward the electric wire and extending in the direction orthogonal to the longitudinal direction of the electric wire in a third position in which the terminal fitting is crimped to the covering.

[0018] In the terminal-equipped electric wire of the structure of the above (1), the surrounding from the leading end of the core wire over to a part of the covering is covered with a pair of crimp pieces the end portions of which are laid one on the other. Therefore, the entrance of water into the boundary portion between the core wire and the covering can be suppressed. Moreover, since the top and bottom surfaces and side surfaces of the crimp pieces are covered with the anti-corrosive plated layer, the occurrence of galvanic corrosion between the core wire and the terminal fitting can be suppressed. Therefore, the corrosion resistance of the core wire of the electric wire made of aluminum or an aluminum alloy can be enhanced while costs are reduced, so that the reliability of the connection between the electric wire and the terminal fitting can be enhanced.

[0019] In the terminal-equipped electric wire of the structure of the above (2), by forming the tin-plated layer as the anti-corrosive plated layer on the terminal fitting, the occurrence of galvanic corrosion between the core wire and the terminal fitting can be easily suppressed.

[0020] In the terminal-equipped electric wire of the structure of the above (3), by the projected portion pressing the core wire in the direction of the length, the strength of crimping of the core wire by the crimp pieces can be enhanced in the direction of the length. Thereby, the entrance of water into the core wire is suppressed, so that corrosion resistance can be further enhanced.

[0021] In the terminal-equipped electric wire of the structure of the above (4), by the projected portion digging into the core wire and the covering in the circumferential direction, the strength of crimping with the core wire and the strength of crimping with the covering can be further enhanced. Thereby, the entrance of water into the crimp position of the core wire is suppressed, so that corrosion resistance can be further enhanced.

[0022] According to the present invention, a terminal-equipped electric wire excellent in corrosion resistance while costs is reduced.

[0023] The present invention has been briefly described above. Further, details of the present invention will be further clarified by reading through the mode for carrying out the invention (hereinafter, referred to as "embodiment") described below with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] FIG. **1** is a perspective view of a terminal-equipped electric wire according to the present embodiment.

[0025] FIG. **2** is a cross-sectional view of a terminal fitting of the terminal-equipped electric wire according to the present embodiment.

[0026] FIG. **3** is a plan view of a chainlike terminal fitting after stamping.

[0027] FIG. **4** is a plan view of the chainlike terminal fitting after plating.

[0028] FIG. **5** is a cross-sectional view of a terminal fitting of a terminal-equipped electric wire according to a comparative example.

[0029] FIG. **6** is a schematic cross-sectional view of the leading end portion of a core wire of the terminal-equipped electric wire according to the comparative example.

[0030] FIG. **7** is a schematic cross-sectional view of the boundary portion between the core wire and a covering of the terminal-equipped electric wire according to the comparative example.

[0031] FIG. **8** is a schematic cross-sectional view of the leading end portion of the core wire of the terminal-equipped electric wire according to the present embodiment.

[0032] FIG. **9** is a cross-sectional view of the leading end portion of the core wire of the terminal fitting explaining a modification.

[0033] FIGS. **10**A and **10**B are views explaining another modification, FIG. **10**A is a cross-sectional view in a direction orthogonal to the axial direction of a conductor crimp portion of the terminal fitting, and FIG. **10**B is an A-A cross-sectional view of FIG. **10**A.

DETAILED DESCRIPTION

[0034] Exemplary embodiments will be described with reference to the drawings.

[0035] FIG. **1** is a perspective view of a terminal-equipped electric wire according to the present embodiment. FIG. **2** is a cross-sectional view of a terminal fitting of the terminal-equipped electric wire according to the present invention.

[0036] As shown in FIGS. **1** and **2**, the terminal-equipped electric wire **1** according to the present embodiment is provided with an electric wire **10** and a terminal fitting **20**. To an end portion of the electric wire **10**, the terminal fitting **20** is crimped to establish electric connection. The terminal-equipped electric wire **1** constitutes, for example, a wire harness routed in a vehicle such as a car.

[0037] The electric wire **10** is an insulating electric wire having a core wire **11** and a resin-made covering **12** covering the core wire **11**. The core wire **11** is made of aluminum or an aluminum alloy, and is formed by twisting a plurality of strands together. By thus forming the core wire **11** of the electric wire **10** of aluminum or an aluminum alloy, the terminal-equipped electric wire **1** is reduced in weight, so that the wire harness formed of this terminal-equipped electric wire **1** is reduced in weight. The terminal-equipped electric wire **1** with a reduced weight is particularly suitable for use in vehicles such as electric cars and hybrid cars where wire harnesses are heavily used.

[0038] The terminal fitting **20** has an electric connection portion **31** in the front and has an electric wire connection portion **41** in the rear. The electric connection portion **31** and the electric wire connection portion **41** are coupled together by a coupling portion **35**.

[0039] FIG. **3** is a plan view of a chainlike terminal fitting after stamping. FIG. **4** is a plan view of the chainlike terminal fitting after plating.

[0040] As shown in FIG. **3**, the terminal fitting **20** is formed by performing press working (stamping and bending) on a metal plate. The terminal fitting **20** is made of a metal material different from that of the core wire **11** of the electric wire **10** made of aluminum or an aluminum alloy. Specifically, the terminal fitting **20** is formed by using as the base material a metal plate made of copper, a copper alloy or the like. The terminal fitting **20** is stamped into a state where it is coupled to a beltlike carrier **21** so as to range in a chain form. Then, when crimped to the electric wire **10**, it is cut at a portion **21***a* of coupling with the carrier **21** to be separated from the carrier **21**.

[0041] After stamped by press working, as shown in FIG. **4**, the terminal fitting **20** is plated to prevent corrosion before crimped to the electric wire **10**. In the present example, the terminal fitting **20** before crimped to the electric wire **10** is plated with tin (Sn). Thereby, the terminal fitting **20** is provided with a tin-plated layer **50** so as to cover the top and bottom surfaces and the side surfaces formed of cut surfaces formed by press working.

[0042] The electric connection portion **31** is formed in a tubular shape that is open at the leading end, and into the open portion of this electric connection portion **31**, the counterpart terminal fitting is inserted to establish electric connection.

[0043] The electric wire connection portion **41** is electrically connected by being crimped to an end portion of the electric wire **10**. The electric wire connection portion **41** has a pair of crimp pieces **42**. The front side of each crimp piece **42** is a conductor crimp portion **45**, and the rear side thereof is a covering crimp portion **46**. The part of each crimp piece **42** between the conductor crimp portion **45** and the covering crimp portion **46** is a connecting portion **47**. The upper surface side, which is one surface, of the electric wire connection portion **41** is a mounting surface **41***a* where the end portion of the electric wire **10** is placed, and the crimp pieces **42** are bent in such a manner as to wrap the end portion of the electric wire **10** with the end portion of the electric wire **10** being placed on the mounting surface **41***a*. Thereby, the crimp pieces **42** are crimped to the end portion of the electric wire **10** by the end portions thereof being crimped so as to be laid one on the other.

[0044] Moreover, the electric wire connection portion **41** has a pressing projected portion **51** (projected portion), a front projected portion **52** (projected portion) and a rear projected portion **53** (projected portion) formed thereon. The pressing projected portion **51** is provided substantially in the center in the direction of the width of the electric wire connection portion **41**, and is formed in the direction of the length of the electric wire **10**. The front projected portion **52** is provided on the front side of the electric wire connection portion **41**, and the rear projected portion **53** is provided on the rear side of the electric wire connection portion **41**. The front projected portion **52** and the rear projected portion **53** are both formed in the direction of the width of the electric wire connection portion **41**. These pressing projected portion **51**, front projected portion **52** and rear projected portion **53** all protrude from the mounting surface **41***a* where the end portion of the electric wire **10** is placed toward the inside which is the side of the electric wire **10**.

[0045] Further, on the electric wire connection portion **41**, a serration **55** having a plurality of holes is formed on the inner surface which is the mounting surface **41***a*.

[0046] The electric wire connection portion **41** of the terminal fitting **20** is crimped to the end portion of the electric wire **10** by crimping the crimp pieces **42**. Specifically, under a condition where the end portion of the electric wire **10** where the core wire **11** is exposed is placed on the mounting surface **41***a* of the electric wire connection portion **41**, the crimp pieces **42** are bent in such a manner as to wrap the end portion of the electric wire **10** and crimped so that the end portions thereof are laid one on the other. By doing this, the conductor crimp portions **45** of the crimp pieces **42** are crimped so as to cover the core wire **11** of the electric wire **10**, the covering crimp portions **46** thereof are crimped so as to cover the covering **12** of the electric wire **10**, and further, the connecting portions **47** thereof are crimped so as to cover the boundary portion between the core wire **11** and the covering **12** of the electric wire **10**. Moreover, the electric wire **10** is brought into a condition where the part on the front side of the leading end of the core wire **11** is covered with the conductor crimp portion **45**. This brings the electric wire **10** into a condition where the entire area from the leading end of the core wire **11** over to a part of the covering **12** is covered with the electric wire connection portion **41**.

[0047] Moreover, when the crimp pieces **42** of the electric wire connection portion **41** are crimped to the end portion of the electric wire **10**, by the pressing projected portion **51** pressing the core wire **11** of the electric wire **10** in the direction of the length of the electric wire **10**, the strength of crimping of the core wire **11** by the conductor crimp portions **45** of the crimp pieces **42** is enhanced in the direction of the length. Moreover, in a part near the leading end of the core wire **11** of the electric wire **10**, by crimping the crimp pieces **42**, the front projected portion **52** digs into the core wire **11** in the circumferential direction, so that the crimping strength near the leading end of the core wire **11** is further enhanced. Thereby, the entrance of water into the core wire **11** from the front side of the electric wire connection portion **41** is suppressed. Further, in the part of the covering **12** of the electric wire **10**, the rear projected portion **53** digs into the covering **12** in the circumferential direction, so that the crimping strength at the covering **12** is enhanced. Thereby, the entrance of water into the gap between the covering crimp portions **46** and the covering **12** from the rear side of the electric wire connection portion **41** is also suppressed.

[0048] Moreover, when the crimp pieces **42** are crimped to the electric wire **10**, the serration **55** formed on the mounting surface **41***a* of the electric wire connection portion **41** digs into the core wire **11**. Thereby, the oxide coating on the surface of the core wire **11** is removed, so that excellent conduction state between the electric wire **10** and the terminal fitting **20** is obtained.

[0049] Now, a terminal-equipped electric wire according to a comparative example will be described.

[0050] FIG. **5** is a cross-sectional view of a terminal fitting of the terminal-equipped electric wire according to the comparative example. FIG. **6** is a schematic cross-sectional view of the leading end portion of a core wire of the terminal-equipped electric wire according to the comparative example. FIG. **7** is a schematic cross-sectional view of the boundary portion between the core wire and a covering of the terminal-equipped electric wire according to the comparative example. FIG. **8** is a schematic cross-sectional view of the leading end portion of the core wire of the terminal-equipped electric wire according to the present embodiment.

[0051] As shown in FIG. **5**, the terminal fitting **100** according to the comparative example has a conductor crimp portion **102** crimping the core wire **11** and a covering crimp portion **103** crimping the covering portion, and these conductor crimp portion **102** and covering crimp portion **103** are separated from each other. Moreover, after a metal plate of copper or a copper alloy as the base material is plated with tin (Sn), the terminal fitting **100** is cut and bent by press working, and then, is crimped to the electric wire **10**. The electric wire **10** to which the terminal fitting **100** is crimped is exposed at the boundary portion between the core wire **11** and the covering **12**, and further, the leading end portion of the core wire **11** is not covered with the conductor crimp portion **102** but is exposed.

[0052] In the terminal-equipped electric wire according to the comparative example having the structure as described above, as shown in FIG. **6**, a different metals adjoining portion formed of the core wire **11** and the base material with an extremely small creepage distance L**1** is formed at the leading end portion of the core wire **11**, and as shown in FIG. **7**, a different metals adjoining portion formed of the core wire **11** and the base material with an extremely small creepage distance L**2** is also formed at the boundary portion between the core wire **11** and the covering **12**.

[0053] Therefore, in this comparative example, galvanic corrosion can occur by water adhering to the different metals portions of the core wire **11** made of aluminum or an aluminum alloy and the base material of the terminal fitting **100** made of copper or a copper alloy.

[0054] On the contrary, in the terminal-equipped electric wire **1** according to the present embodiment, the surrounding from the leading end of the core wire **11** over to a part of the covering **12** is covered with the pair of crimp pieces **42** the end portions of which are laid one on the other. Therefore, the entrance of water into the boundary portion between the core wire **11** and the covering **12** can be suppressed. Moreover, since the top and bottom surfaces and side surfaces of the crimp pieces **42** are covered with the tin-plated layer **50** (anti-corrosive plated layer) as shown in FIG. **8**, the occurrence of galvanic corrosion between the core wire **11** and the terminal fitting **20** can be suppressed. Therefore, in the terminal-equipped electric wire **1** according to the present embodiment, the corrosion resistance of the core wire **11** made of aluminum or an aluminum alloy can be enhanced while costs are reduced, so that the reliability of the connection between the electric wire **10** and the terminal fitting **20** can be enhanced.

[0055] Moreover, in a position of the terminal fitting **20** where it is crimped to the core wire **11**, the pressing projected portion **51** is formed in the direction of the length of the electric wire **10**. Therefore, by the pressing projected portion **51** pressing the core wire **11** in the direction of the length, the strength of crimping of the core wire **11** by the crimp pieces **42** can be enhanced in the direction of the length. Thereby, the entrance of water into the core wire **11** is suppressed, so that corrosion resistance can be further enhanced.

[0056] Further, in a position of the terminal fitting **20** where it is crimped to the core wire **11** and in a position thereof where it is crimped to the covering **12**, the front

projected portion **52** and the rear projected portion **53** are formed in the direction of the width which is a direction orthogonal to the direction of the length of the electric wire **10**. Therefore, by the front projected portion **52** digging into the core wire **11** in the circumferential direction and the rear projected portion **53** digging into the covering **12** in the circumferential direction, the strength of crimping with the core wire **11** and the strength of crimping with the covering **12** are further enhanced. Thereby, the entrance of water into the crimp position of the core wire **11** is suppressed, so that corrosion resistance can be further enhanced.

[0057] The present invention is not limited to the above-described embodiment and modifications, improvements and the like are possible as appropriate. Besides, the materials, shapes, dimensions, numbers, disposition positions and the like of the elements of the above-described embodiment are arbitrary as long as the present invention is attained, and are not limited.

[0058] For example, as shown in FIG. **9**, the crimp pieces **42** may be crushed so as to eliminate the gap at the leading end of the core wire **11** at the front part of the electric wire connection portion **41**. By doing this, the exposure of the leading end of the core wire **11** can be eliminated, so that corrosion resistance can be enhanced.

[0059] Moreover, as shown in FIGS. **10**A and **10**B, a blocking piece **45***a* that enters into the leading end of the core wire **11** when crimped may be formed at the front part of the conductor crimp portion **45** at, of the pair of crimp pieces **42**, one crimp piece **42** that is rolled inward. By doing this, the exposure of the leading end of the core wire **11** can be eliminated by blocking the leading end side of the core wire **11** by the blocking piece **45***a*, so that corrosion resistance can be enhanced.

[0060] Now, features of the above-described embodiment of the terminal-equipped electric wire according to the present invention are briefly summarized and listed in the following [1] to [4]:

[0061] [1] A terminal-equipped electric wire (**1**) comprising an electric wire (**10**) in which a core wire (**11**) made of aluminum or an aluminum alloy is covered with a covering (**12**), and a terminal fitting (**20**) made of copper or a copper alloy and crimped to an end portion of the electric wire (**10**) in which the core wire (**11**) is exposed,

[0062] wherein the terminal fitting (**20**) includes a pair of crimp pieces (**42**),

[0063] wherein end portions of the pair of the crimped portions are crimped in a state where the end portions of the pair of the crimped portions are overlapped with each other, so as to cover a surrounding of the electric wire (**10**) from a leading end of the core wire (**11**) to a part of the covering, and

[0064] wherein at least the pair of the crimp pieces (**42**) have top surfaces, bottom surfaces and side surfaces which are covered with anti-corrosive plated layers (**50**).

[0065] [2] The terminal-equipped electric wire according to [1],

[0066] wherein the anti-corrosive plated layer (**50**) is a tin-plated layer.

[0067] [3] The terminal-equipped electric wire according to [1] or [2],

[0068] wherein the terminal fitting (**20**) includes a first projected portion (the pressing projected portion **51**) projecting toward the electric wire (**10**) in a longitudinal direction of the electric wire (**10**) in a first position in which the terminal fitting (**20**) is crimped to the core wire (**11**).

[0069] [4] The terminal-equipped electric wire according to any of [1] to [3],

[0070] wherein the terminal fitting (**20**) includes a second projected portion (the front projected portion **52**) projecting toward the electric wire (**10**) in a direction orthogonal to the longitudinal direction of the electric wire (**10**) in a second position in which the terminal fitting (**20**) is crimped to the core wire (**11**), and a third projected portion (the rear projected portion **53**) projecting toward the electric wire (**10**) in the direction orthogonal to the longitudinal direction of the electric wire (**10**) in a third position in which the terminal fitting (**20**) is crimped to the covering (**12**).

DESCRIPTION OF REFERENCE NUMERALS AND SIGNS

[0071] **1**: Terminal-equipped electric wire
[0072] **10**: Electric wire
[0073] **11**: Core wire
[0074] **12**: Covering
[0075] **20**: Terminal fitting
[0076] **42**: Crimp piece
[0077] **50**: Tin-plated layer (anti-corrosive plated layer
[0078] **51**: Pressing projected portion (projected portion)
[0079] **52**: Front projected portion (projected portion)
[0080] **53**: Rear projected portion (projected portion)

What is claimed is:

1. A terminal-equipped electric wire comprising:
an electric wire in which a core wire made of aluminum or an aluminum alloy is covered with a covering, and a terminal fitting made of copper or a copper alloy and crimped to an end portion of the electric wire in which the core wire is exposed,
wherein the terminal fitting includes a pair of crimp pieces,
wherein end portions of the pair of the crimped portions are crimped in a state where the end portions of the pair of the crimped portions are overlapped with each other, so as to cover a surrounding of the electric wire from a leading end of the core wire to a part of the covering, and
wherein at least the pair of the crimp pieces have top surfaces, bottom surfaces and side surfaces which are covered with anti-corrosive plated layers.

2. The terminal-equipped electric wire according to claim **1**,
wherein the anti-corrosive plated layers are tin-plated layers.

3. The terminal-equipped electric wire according to claim **1**,
wherein the terminal fitting includes a first projected portion projecting toward the electric wire and extending in a longitudinal direction of the electric wire in a first position in which the terminal fitting is crimped to the core wire.

4. The terminal-equipped electric wire according to claim **1**,
wherein the terminal fitting includes a second projected portion projecting toward the electric wire and extending in a direction orthogonal to the longitudinal direction of the electric wire in a second position in which the terminal fitting is crimped to the core wire, and a

third projected portion projecting toward the electric wire in the direction orthogonal to the longitudinal direction of the electric wire and extending in a third position in which the terminal fitting is crimped to the covering.

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