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(54) **TERMINAL-EQUIPPED ELECTRIC WIRE, METHOD FOR MANUFACTURING TERMINAL-EQUIPPED ELECTRIC WIRE, AND ELECTRIC WIRE**

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CPC ***H01R 4/185*** (2013.01); *H01R 11/12* (2013.01); ***H01R 43/048*** (2013.01)

(57) **ABSTRACT**

A terminal-equipped electric wire has an electric wire including a bonded portion formed at a part of a conductor exposed due to absence of a sheath at a part of the electric wire in a longitudinal direction and in which strands of the conductor are bonded to each other; and a terminal including a wire barrel portion, the wire barrel portion covering at least a part of the bonded portion. The bonded portion includes a load release portion configured to reduce stress applied to the conductor.

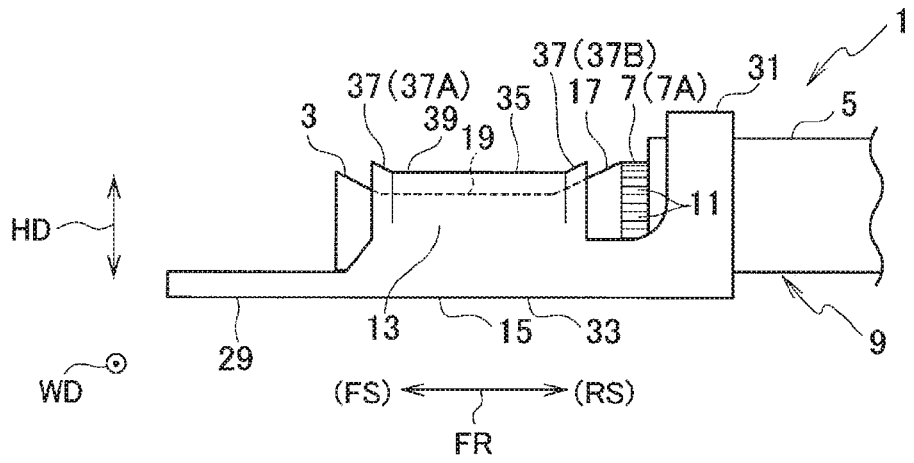


FIG. 1

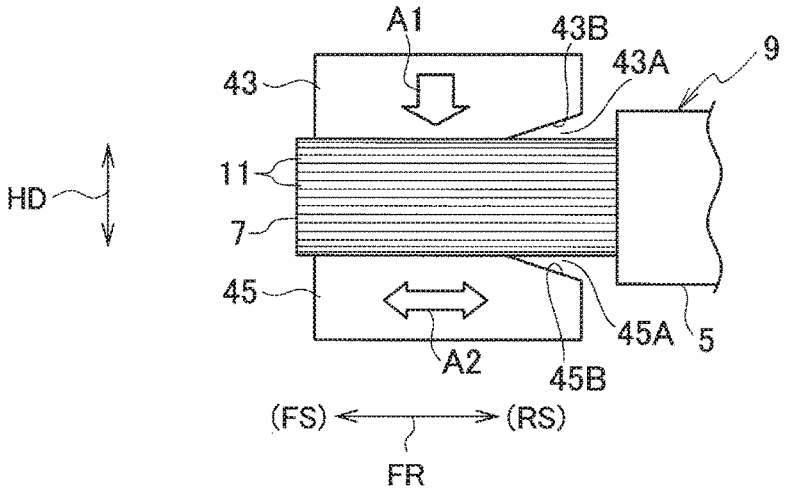


FIG. 2

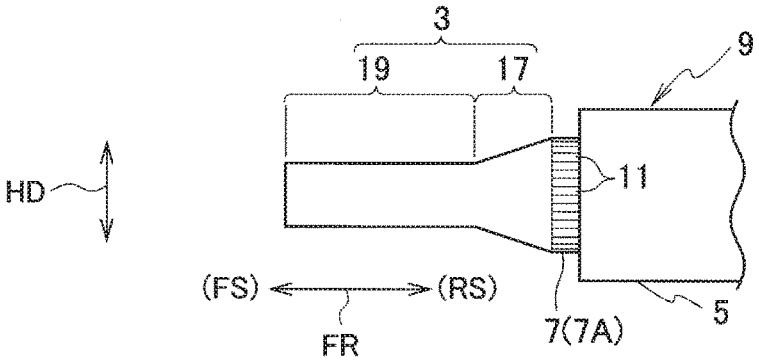


FIG. 3

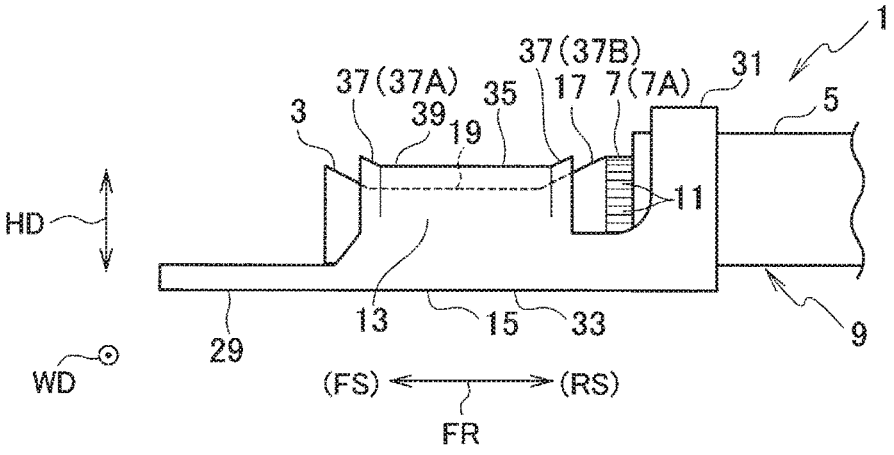


FIG. 4A

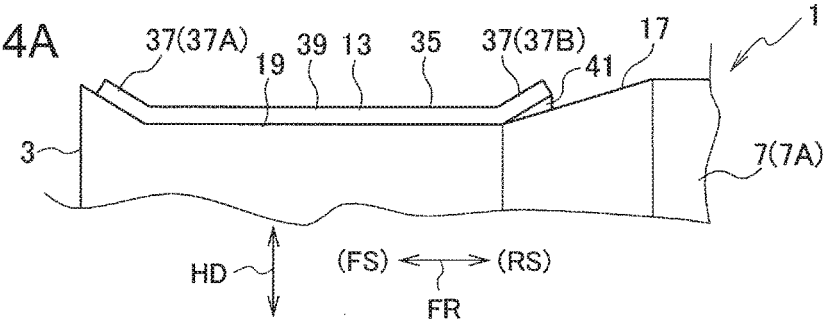


FIG. 4B

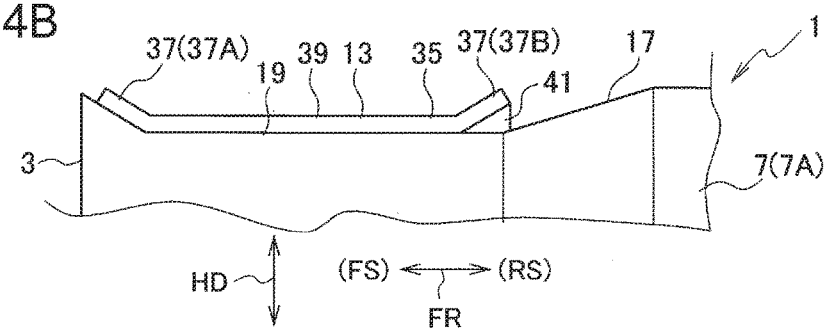


FIG. 4C

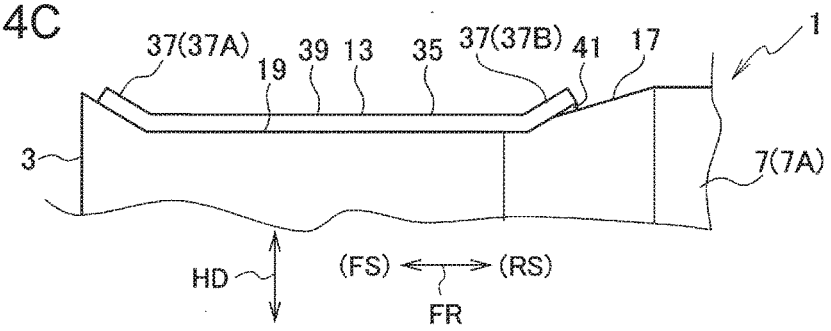


FIG. 4D

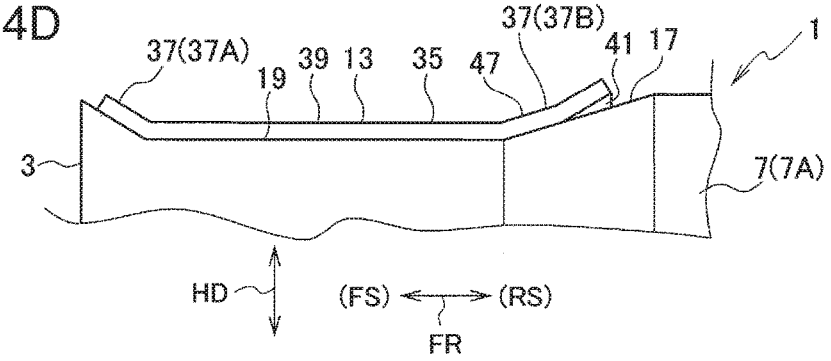


FIG. 5A

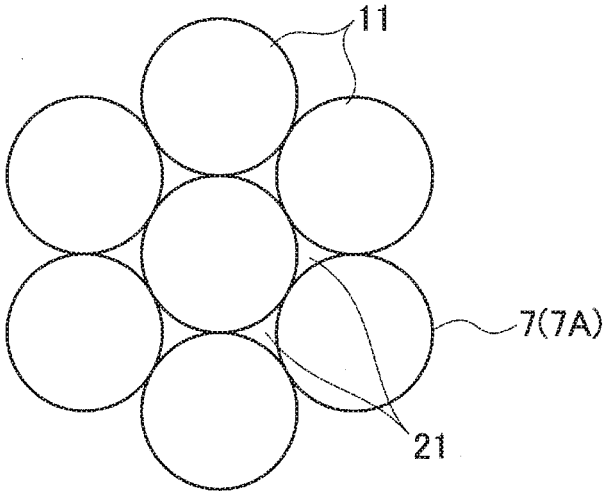


FIG. 5B

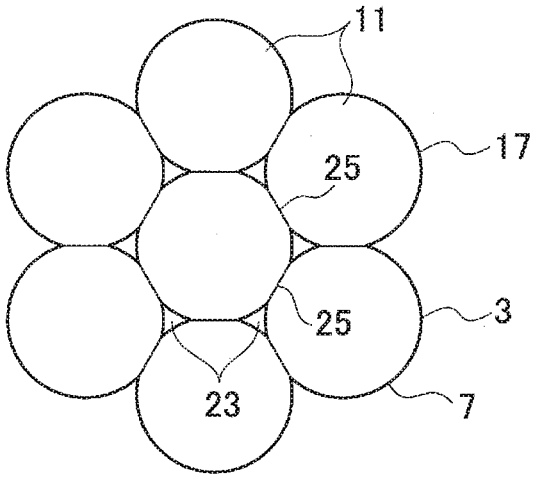


FIG. 5C

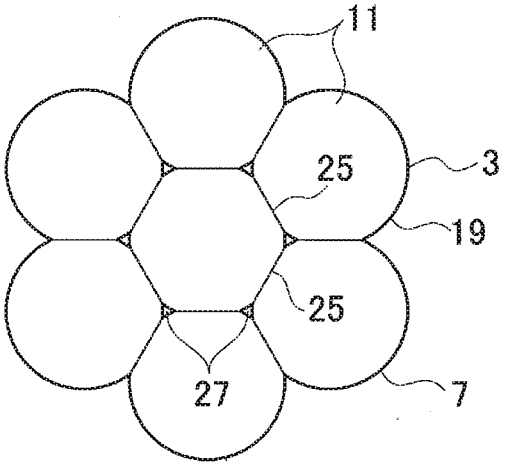


FIG. 6A

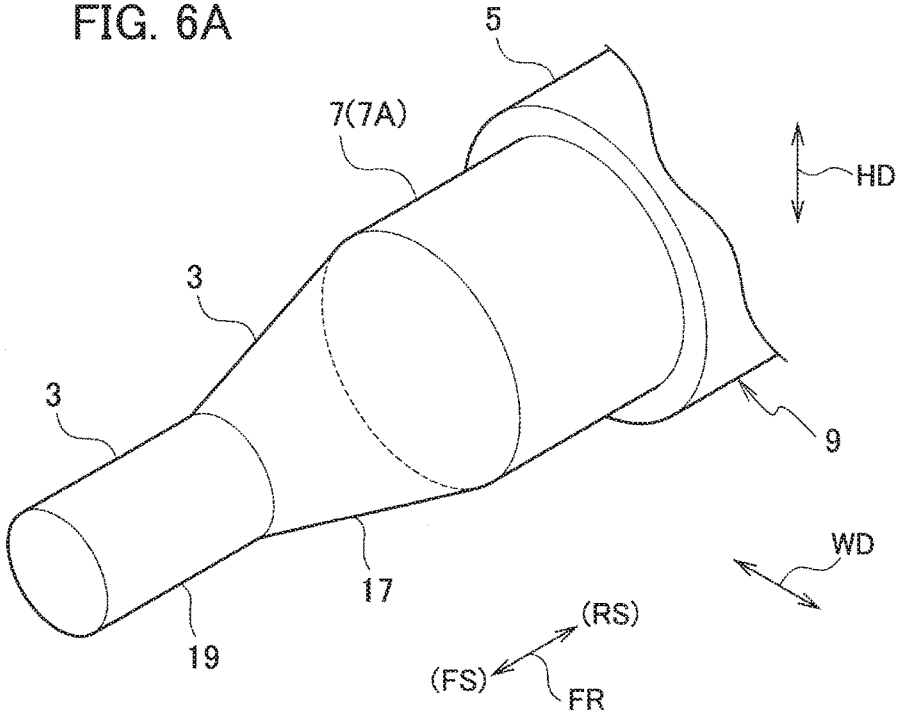


FIG. 6B

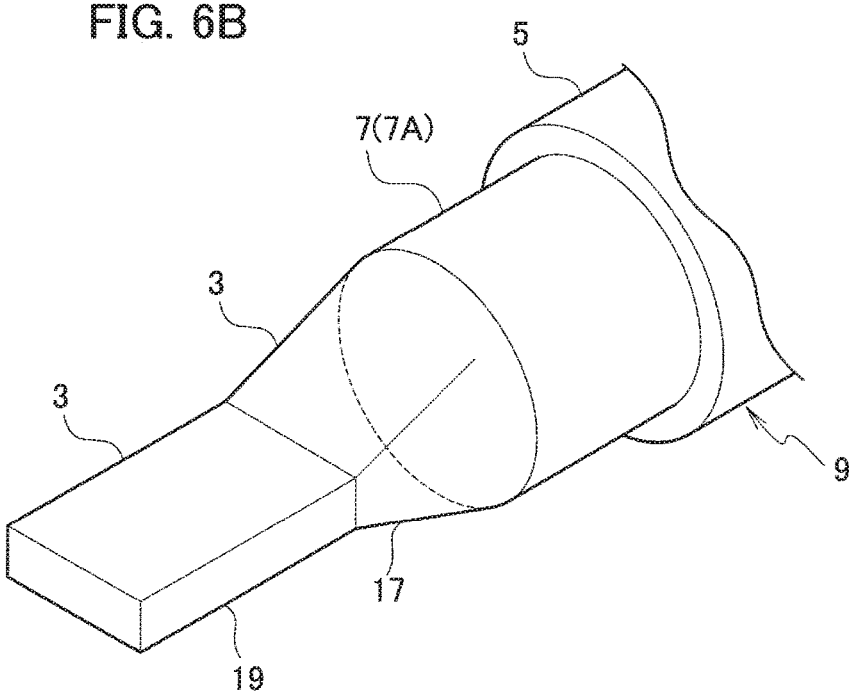


FIG. 7A

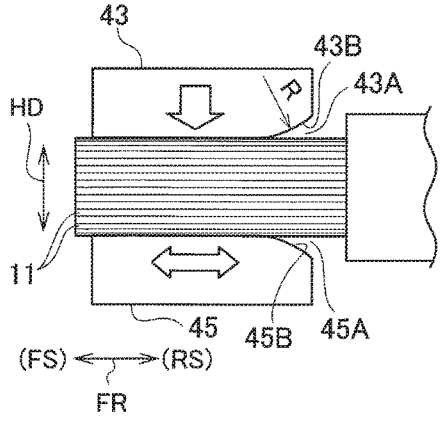


FIG. 7B

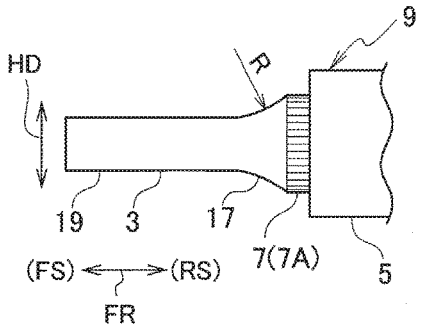


FIG. 8A

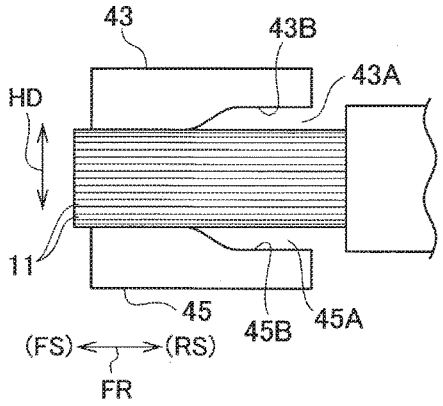


FIG. 8B

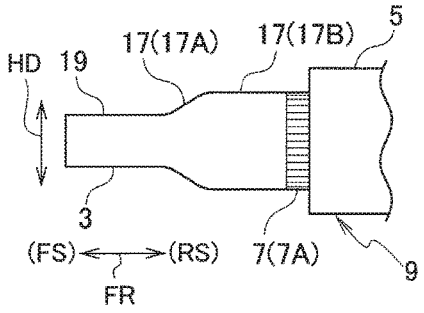


FIG. 9A

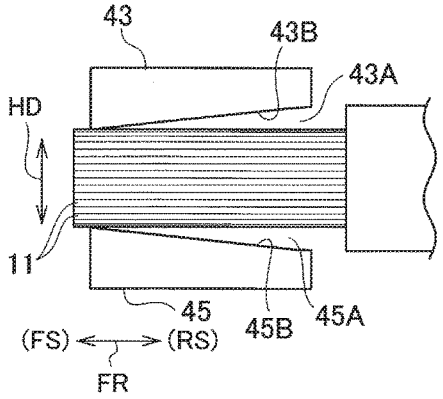


FIG. 9B

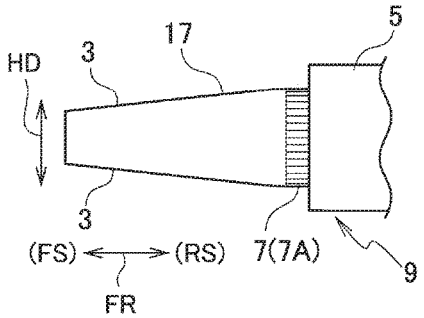


FIG. 10A

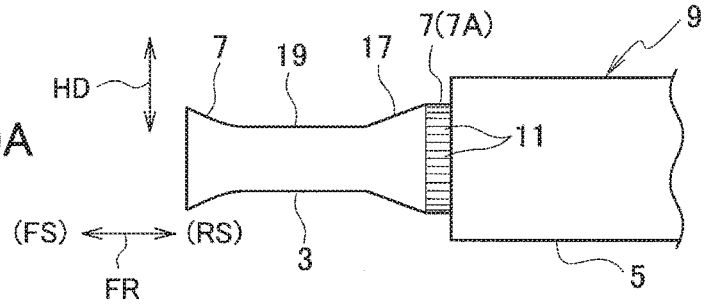


FIG. 10B

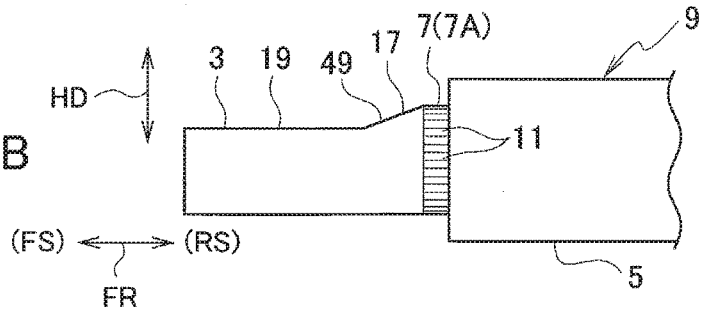


FIG. 10C

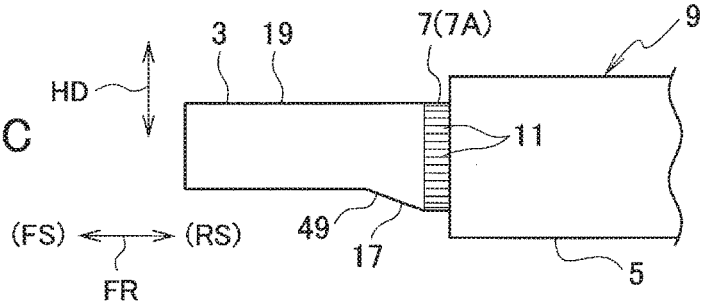


FIG. 10D

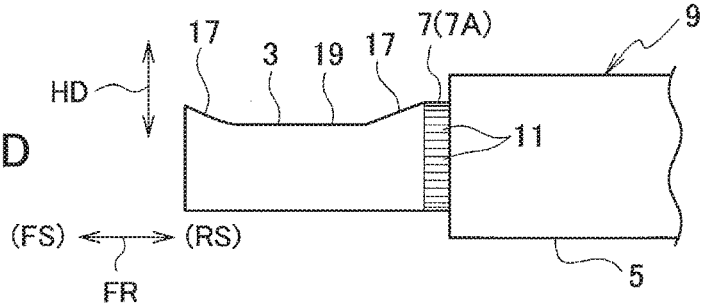


FIG. 10E

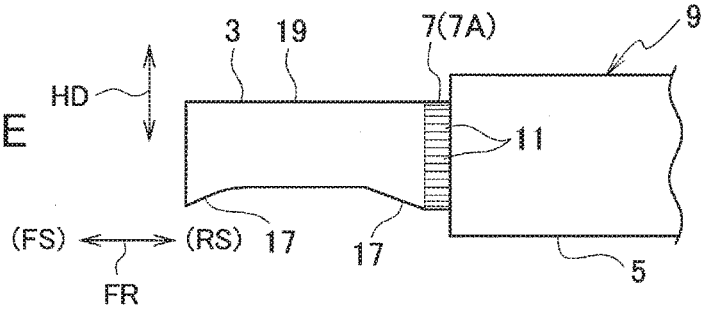
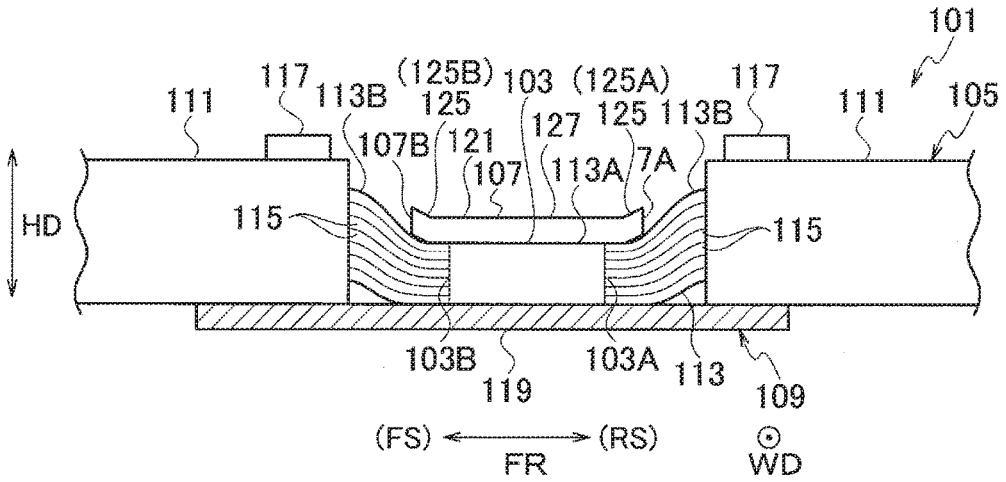


FIG. 11


101
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113B
(125B)
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103
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107B
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(RS)
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FIG. 12

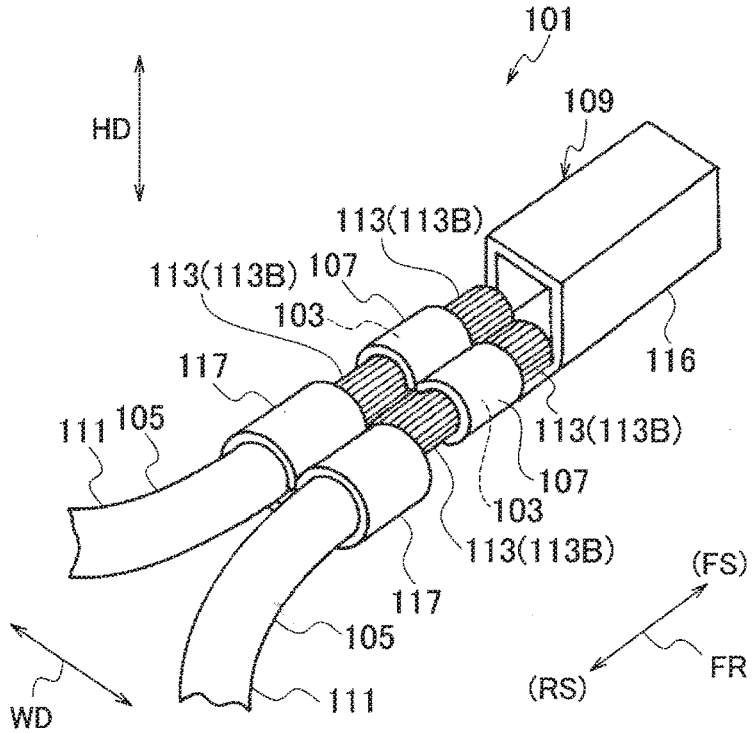
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FIG. 13A

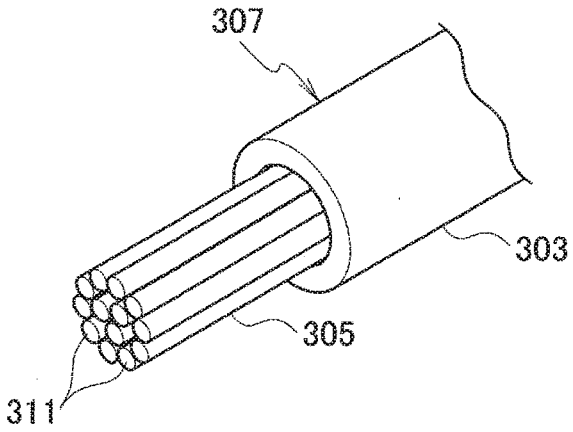


FIG. 13B

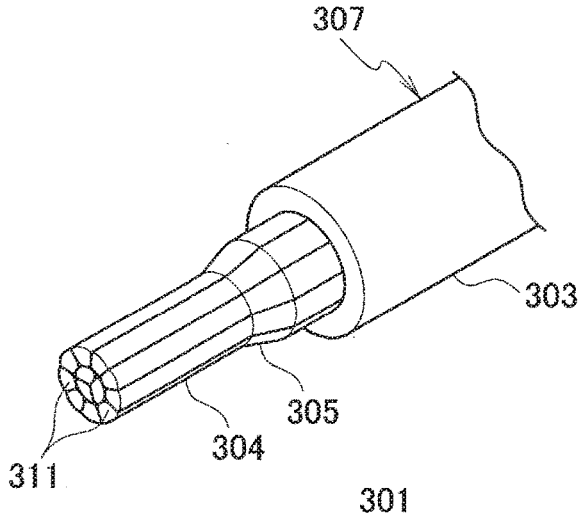


FIG. 13C

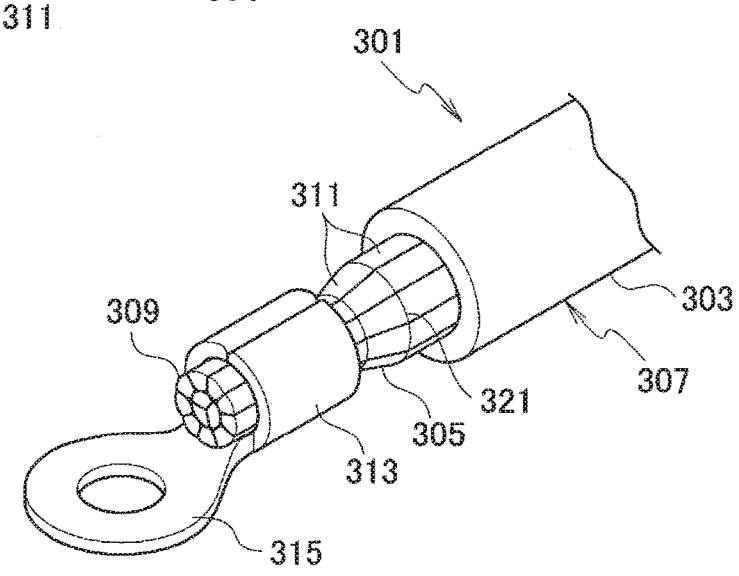


FIG. 14A

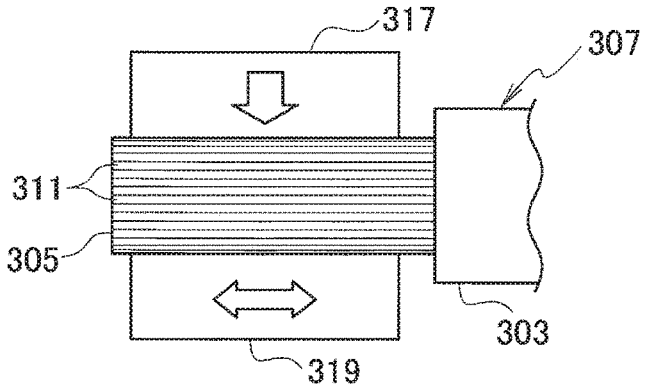


FIG. 14B

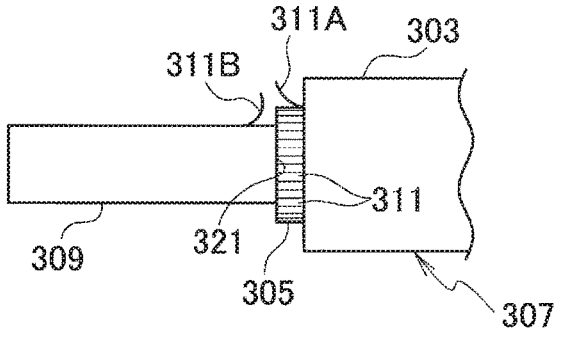
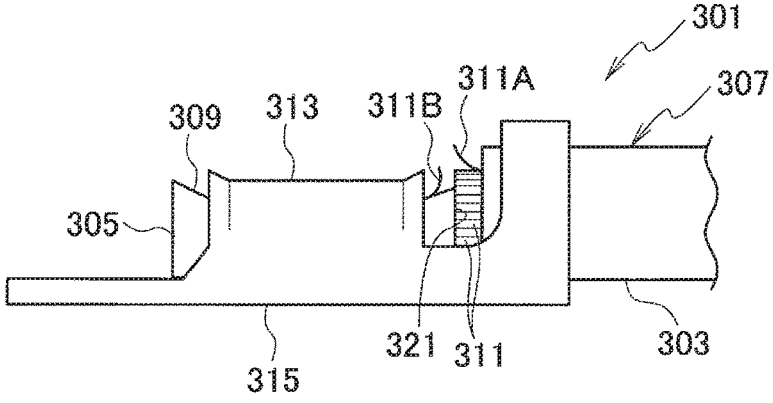


FIG. 14C



TERMINAL-EQUIPPED ELECTRIC WIRE, METHOD FOR MANUFACTURING TERMINAL-EQUIPPED ELECTRIC WIRE, AND ELECTRIC WIRE

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application is based upon and claims the benefit of priority from the prior Japanese Patent Application No. 2017-227438 (filing date: Nov. 28, 2017), the entire contents of which are incorporated herein by reference.

BACKGROUND

Technical Field

[0002] The present invention relates to a terminal-equipped electric wire and the like, in particular, to an electric wire having a partially different form of a bonded portion where a plurality of strands is bonded to each other.

Related Art

[0003] Conventionally, a terminal-equipped electric wire **301** as illustrated in FIGS. **13**A to **13**C is known (see JP 2009-231079 A).

[0004] The terminal-equipped electric wire **301** is formed as follows. First, an exposed conductor **305** at a distal end portion of an electric wire **307** (see FIG. **13**A) in which a sheath **303** is removed to expose the conductor (core wire) **305** at one end is bonded by ultrasonic bonding (see FIGS. **13**B and **14**B).

[0005] That is, the distal end portion of the conductor **305**, including a plurality of strands **311**, is bonded by ultrasonically bonding the respective strands **311**, thereby forming a bonded portion **309**.

[0006] As illustrated in FIG. **14**A, the bonded portion **309** is formed by sandwiching the strands **311** with a predetermined pressure by an anvil **317** and a horn **319** and ultrasonically vibrating the horn **319**.

[0007] As a terminal **315** is fixed to the bonded portion **309** by crimping a wire barrel portion **313**, it is possible to obtain the terminal-equipped electric wire **301** (see FIGS. **13**C and **14**C).

SUMMARY

[0008] Incidentally, the conventional terminal-equipped electric wire **301** has a problem that there is a risk that strand breakage (core wire breakage) may occur at an end (end on a side of the sheath **303**) **321** of the bonded portion **309** (see FIGS. **14**B and **14**C).

[0009] That is, if the bonded portion **309** has a single shape such as prismatic shape or cylindrical shape, the strand **311** is broken as illustrated in FIGS. **14**B and **14**C when the bonded portion **309** is formed or when the wire barrel portion **313** is crimped to crimp the terminal **315** onto the electric wire **307** having the bonded portion **309**. Incidentally, those denoted by reference signs **311**A and **311**B in FIGS. **14**A to **14**C are broken strands.

[0010] More specifically, the bonded portion **309** is compressed so that the conductor **305** is pulled at a rear end portion (a right end portion in FIG. **14**C) of the wire barrel portion **313** when crimping the wire barrel portion **313** or the like, and the strand **311** is broken, for example, at the end (a boundary portion between the bonded portion **309** and a non-bonded portion) **321** of the bonded portion **309**.

[0011] Then, mechanical connection strength between the terminal **315** and the conductor **305** decreases, and an electrical resistance value between the terminal **315** and the conductor **305** increases (performance of a crimped portion deteriorates).

[0012] At the boundary portion **321**, a value of residual stress is increased due to the influence of the bonding process so that the strand **311** is easily broken. Further, a sectional shape (shape of a cross section according to a plane orthogonal to the longitudinal direction) of the strand **311** sharply changes at the boundary portion **321** so that stress concentration is likely to occur.

[0013] As illustrated in FIG. **14**B, the strand breakage sometimes occurs even when only the bonded portion **309** is formed.

[0014] The invention has been made in view of the above problems, and an object of the invention is to provide a terminal-equipped electric wire and the like in which a bonded portion is formed by bonding a part of a conductor and a wire barrel portion of a terminal is fixed to the bonded portion and which is capable of suppressing occurrence of breakage of a strand of the conductor.

[0015] A terminal-equipped electric wire according to first aspect of the present invention has an electric wire including a bonded portion formed at a part of a conductor exposed due to absence of a sheath at a part of the electric wire in a longitudinal direction and in which strands of the conductor are bonded to each other, and a terminal including a wire barrel portion, the wire barrel portion covering at least a part of the bonded portion. The bonded portion is provided with a load release portion configured to reduce stress applied to the conductor.

[0016] The load release portion may be provided in at least one end portion of the bonded portion in the longitudinal direction, and a diameter of the bonded portion may gradually increase toward an end of the, bonded portion in the load release portion.

[0017] A terminal-equipped electric wire according to second aspect of the present invention has an electric wire including a bonded portion formed at a part of a conductor exposed due to absence of a sheath at a part of the electric wire in a longitudinal direction and in which strands of the conductor are bonded to each other, and a terminal including a wire barrel portion, the wire barrel portion covering at least a part of the bonded portion. A diameter of the bonded portion gradually increases toward an end of the bonded portion in an end portion of the bonded portion.

[0018] The terminal-equipped electric wire according to the first aspect or the second. aspect may have one terminal fixed to a plurality of the electric wires.

[0019] A method for manufacturing a terminal-equipped electric wire according to third aspect of the present invention includes forming, in an electric wire, a bonded portion in which strands of a conductor are bonded to each other in at least a part of the conductor in a longitudinal direction exposed due to absence of a sheath at a part of the electric wire in the longitudinal direction. A terminal including a wire barrel portion is fixed to the electric wire such that the wire barrel portion covers at least a part of the bonded portion. At least one end portion of the bonded portion in the longitudinal direction is provided with a load release portion configured to reduce stress applied to the conductor.

[0020] An electric wire according to fourth aspect of the present invention includes a bonded portion, in which strands of a conductor are bonded to each other, formed at least at a part of the conductor in a longitudinal direction exposed due to absence of a sheath at a part of the electric wire in the longitudinal direction. A diameter of the bonded portion gradually increases toward an end. of the bonded portion in an end portion of the bonded portion.

[0021] According to the aspects of the present invention, a terminal-equipped electric wire and the like which is capable of suppressing occurrence of breakage of a strand of the conductor is provided.

BRIEF DESCRIPTION OF DRAWINGS

[0022] FIG. **1** is a view illustrating a bonded portion formation step in a method for manufacturing a terminal-equipped electric wire according to an embodiment of the invention;

[0023] FIG. **2** is a view illustrating an electric wire in which the bonded portion is formed in the bonded portion formation step in the method for manufacturing the terminal-equipped electric wire according to the embodiment of the invention;

[0024] FIG. **3** is a view illustrating the terminal-equipped electric wire according to the embodiment of the invention;

[0025] FIG. **4**A is a view illustrating a relationship between the bonded portion and a wire barrel portion of a terminal in the terminal-equipped electric wire illustrated in FIG. **3**;

[0026] FIG. **4**B is a modification of one illustrated in FIG. **4**A;

[0027] FIG. **4**C is a modification of one illustrated in FIG. **4**A;

[0028] FIG. **4**D is a modification of one illustrated in FIG. **4**A;

[0029] FIG. **5**A is an image view illustrating a configuration of the bonded portion formed in the bonded portion formation step in the method for manufacturing the terminal-equipped electric wire according to the embodiment of the invention;

[0030] FIG. **5**B is an image view illustrating a configuration of the bonded portion formed in the bonded portion formation step in the method for manufacturing the terminal-equipped electric wire according to the embodiment of the invention;

[0031] FIG. **5**C is an image view illustrating a configuration of the bonded portion. formed in the bonded portion formation step in the method for manufacturing the terminal-equipped electric wire according to the embodiment of the invention;

[0032] FIG. **6**A is a perspective view of the electric wire illustrated in FIG. **2**;

[0033] FIG. **6**B is a perspective view illustrating an electric wire in which a bonded portion is formed in a bonded portion formation step in a method for manufacturing a terminal-equipped electric wire according to a first modification;

[0034] FIG. **7**A is a view illustrating a bonded portion formation step in a method for manufacturing a terminal-equipped electric wire according to a second modification;

[0035] FIG. **7**B is a view illustrating an electric wire including the bonded portion formed in FIG. **7**A;

[0036] FIG. **8**A is a view illustrating a bonded portion formation step in a method for manufacturing a terminal-equipped electric wire according to a third modification;

[0037] FIG. **8**B is a view illustrating an electric wire including the bonded portion formed in FIG. **8**A;

[0038] FIG. **9**A is a view illustrating a bonded portion formation step in a method for manufacturing a terminal-equipped electric wire according to a fourth modification;

[0039] FIG. **9**B is a view illustrating an electric wire including the bonded portion formed in FIG. **9**A;

[0040] FIG. **10**A is a view illustrating an electric wire in which a bonded portion is formed by a method for manufacturing a terminal-equipped electric wire according to a fifth modification;

[0041] FIG. **10**B is a view illustrating an electric wire in which a bonded portion is formed by a method for manufacturing a terminal-equipped electric wire according to a sixth modification;

[0042] FIG. **10**C is a view illustrating an electric wire in which a bonded portion is formed by a method for manufacturing a terminal-equipped electric wire according to a. seventh modification;

[0043] FIG. **10**D is a view illustrating an electric wire in which a bonded portion is formed by a method for manufacturing a terminal-equipped electric wire according to an eighth modification;

[0044] FIG. **10**E is a view illustrating an electric wire in which a bonded portion is formed by a method for manufacturing a terminal-equipped electric wire according to a ninth modification;

[0045] FIG. **11** is a view illustrating a terminal-equipped electric wire according to a modification in which a bonded portion is formed at an intermediate portion in the longitudinal direction of an electric wire and a terminal is fixed to the bonded portion;

[0046] FIG. **12** is a view illustrating a terminal-equipped electric wire according to a modification in which one terminal is fixed to a plurality of (for example, two) electric wires;

[0047] FIG. **13**A is a view illustrating a conventional method for manufacturing a terminal-equipped electric wire;

[0048] FIG. **13**B is a view illustrating a conventional method for manufacturing a terminal-equipped electric wire;

[0049] FIG. **13**C is a view illustrating a conventional method for manufacturing a terminal-equipped electric wire;

[0050] FIG. **14**A is a view illustrating the conventional method for manufacturing a terminal-equipped electric wire;

[0051] FIG. **14**B is a view illustrating the conventional method for manufacturing a terminal-equipped electric wire; and

[0052] FIG. **14**C is a view illustrating the conventional method for manufacturing a terminal-equipped electric wire.

DETAILED DESCRIPTION

[0053] First, a method for manufacturing a terminal-equipped electric wire **1** (see FIG. **3**) according to an embodiment of the invention will be described. For convenience of description, it is assumed that a predetermined direction of the terminal-equipped electric wire **1** is the front-rear direction (longitudinal direction of an electric wire **9**), a predetermined direction orthogonal to the front-rear direction is the height direction, and a direction orthogonal to the front-rear direction and the height direction is the width direction.

[0054] The terminal-equipped electric wire **1** is manufactured through a bonded portion formation step (see FIGS. **1**, **2**, and **6**A) and a terminal fixing step (see FIGS. **3** and **4**A).

[0055] In the bonded portion formation step, a bonded portion **3** as illustrated in FIGS. **2** and **6**A is formed. More specifically, the electric wire **9** in which a conductor **7** is exposed as a sheath **5** is not present over a predetermined length at a part (for example, one end portion) in the longitudinal direction (length direction) (for example, as a part of the sheath **5** is removed) is prepared in the bonded portion formation step.

[0056] Subsequently, a plurality of strands **11** forming the conductor **7** is ultrasonically bonded to each other in at least a part of the exposed conductor (exposed conductor) **7** in the longitudinal direction to bond the conductors **7** (the respective strands **11**) to each other in the bonded portion formation step. As a result, the electric wire **9** with the bonded portion is manufactured (see FIGS. **2** and **6**A).

[0057] In the terminal fixing step, a terminal (terminal fitting) **15** provided with a wire barrel portion **13** is fixed to the electric wire (electric wire with the bonded portion) **9** such that the wire barrel portion **13** wraps and covers at least a part of the bonded portion **3** formed in the bonded portion formation step (see FIGS. **3** and **4**A).

[0058] A load release portion (stress reduction portion) **17** configured to reduce stress applied to the conductor **7** is provided in at least a part in the longitudinal direction of the bonded portion **3** formed in the bonded portion formation step as illustrated in FIG. **2** and the like.

[0059] The load release portion **17** is provided to reduce the stress generated at an end of the conductor **7**, for example, the bonded portion **3** when forming the bonded portion **3**. Further, the load release portion **17** is provided to reduce the stress generated at an end of the conductor **7**, for example, the bonded portion **3** when the terminal **15** is fixed to the electric wire **9** such that the wire barrel portion **13** covers the bonded portion **3**.

[0060] As illustrated in FIGS. **2**, **6**A, and **6**B, the load release portion **17** of the bonded portion **3** before fixing of the terminal **15** is formed as a portion (for example, an enlarged diameter portion) whose diameter (outer diameter) gradually changes in the longitudinal direction.

[0061] As illustrated in FIGS. **2**, SA, and **6**B, the load release portion **17** before fixing of the terminal **15** is provided in at least one end portion (for example, a rear end portion) of the bonded portion **3** in the longitudinal direction. In the load release portion **17**, the diameter of the bonded portion **3** gradually increases toward an end of the bonded portion **3**.

[0062] Meanwhile, the electric wire **9** includes the conductor (core wire) **7** formed by gathering the plurality of strands **11** and the sheath (insulator) **5** covering the conductor **7**.

[0063] The strand **11** of the conductor **7** is formed in an elongated cylindrical shape with metal such as copper, aluminum, and an aluminum alloy. The conductor **7** is configured in a form in which the plurality of strands **11** is twisted or a form in which the plurality of strands **11** collectively extends in a straight line.

[0064] The electric wire **9** has flexibility. lei addition, a cross section of a portion of the electric wire **9** where the sheath **5** is present, that is, the cross section taken along a plane orthogonal to the longitudinal direction is formed in a predetermined shape such as a circular shape.

[0065] A cross section of the conductor **7** at the portion of the electric wire **9** where the sheath **5** is present is formed in a substantially circular shape by bundling the plurality of strands **11** with almost no gap. A cross section of the sheath **5** at the portion of the electric wire **9** where the sheath **5** is present is formed in an annular shape having a predetermined width (thickness). The entire inner circumference of the sheath **5** is in contact with the entire outer circumference of the conductor **7**.

[0066] As described above, the plurality of strands **11** for the conductor **7** is ultrasonically bonded to each other such that the conductors **7** are bonded to each other in the bonded portion **3**. For example, the conductor **7** is made into a single wire in the bonded portion **3**.

[0067] As illustrated in FIG. **1**, the ultrasonic bonding between the strands **11** is performed using an anvil **43** and a horn **45**. That is, a pressing force of an arrow A**1** is applied to the conductor **7** (the strand **11**) by the anvil **43**, the conductor **7** is sandwiched between the anvil **43** and the horn **45**, and the horn **45** is ultrasonically vibrated in a direction of an arrow A**2**, thereby ultrasonically bonding the strands **11** to each other.

[0068] The anvil **43** is provided with a load release portion forming portion (a cutout of a wall of the anvil **43**) **43**A configured to form the load release portion **17**, and the horn **45** is also provided with a load release portion forming portion (a cutout of a wall of the horn **45**) **45**A configured to form the load release portion **17**.

[0069] Further, the ultrasonic bonding between the strands **11** using the anvil **43** and the horn **45** is performed in a state where the anvil **43** is further moved closer to the horn **45** from the state illustrated in FIG. **1** (a state where the anvil **43** is further moved in the direction of the arrow A**1** so that the load release portion forming portions **43**A and **45**A are substantially filled with the conductor **7**).

[0070] Although the bonded portion **3** is formed by bonding the strands **11** to each other by ultrasonic bonding in the above description, the bonded portion **3** may be formed by bonding the strands **11** to each other by a bonding means other than the ultrasonic bonding. For example, the bonded portion **3** may be formed in the same manner as in the case of ultrasonic bonding by metallurgically bonding the strands **11** to each other at a temperature equal to or lower than a recrystallization temperature of the strand **11**.

[0071] Further, the bonded portion **3** may be formed by treatment such as cold welding, friction stir welding, friction welding, electromagnetic welding, diffusion bonding, brazing, soldering, resistance welding, electron beam welding, laser welding, and light beam welding other than the ultrasonic treatment.

[0072] As illustrated in FIG. **2** and the like, the bonded portion **3** and the sheath **5** are apart from each other by a predetermined length, for example, in the longitudinal direction of the electric wire **9**. As a result, a plurality of strands (a conductor in a non-bonded state) **7**A, which is in contact with each other but is in a non-bonded state, is exposed between the bonded portion **3** and the sheath **5**.

[0073] Further, the bonded portion **3** includes a body portion **19** and the load release portion **17**. The body portion is positioned on one side (for example, the front side) of the bonded portion **3** in the longitudinal direction of the electric wire **9**, and the load release portion **17** is positioned on the other side (for example, the rear side) of the bonded portion **3** in the longitudinal direction of the electric wire **9**.

[0074] As a result, the body portion **19** of the bonded portion **3** by a predetermined length, the load release portion **17** of the bonded portion **3** by a predetermined length, the conductor **7**A of the non-bonded state, and the conductor **7** covered with the sheath **5** (the portion of the electric wire **9** where the sheath **5** is present) are arranged in this order from the one end to the other end in the longitudinal direction of the electric wire **9** in the electric wire **9** before fixing of the terminal **15**.

[0075] A sectional shape of the body portion **19** of the bonded portion **3** (a sectional shape taken along the plane orthogonal to the longitudinal direction) before fixing of the terminal **15** is formed in a circular shape (the body portion **19** is formed in a cylindrical. shape) as illustrated in FIG. **6**A, but may be formed in another shape such as a rectangular shape as illustrated in FIG. **6**B.

[0076] A cross section (cross section taken along the plane orthogonal to the longitudinal direction) of the conductor **7**A in the non-bonded state before fixing of the terminal **15** is formed, for example, in a circular shape,

[0077] A sectional shape of the load release portion **17** (a sectional shape taken along the plane orthogonal to the longitudinal direction) of the bonded portion **3** before fixing of the terminal **15** gradually shifts from the sectional shape of the body portion **19** of the bonded portion **3** to the sectional shape of the conductor **7**A in the non-bonded state as proceeding from a side of the body portion **19** toward the conductor **7**A in the non-bonded state.

[0078] When viewed from the longitudinal direction of the electric wire **9**, a size of an outer shape of the body portion **19** of the bonded portion **3** is smaller than a size of an outer shape of the conductor **7**A in the non-bonded state, and for example, the body portion **19** of the bonded portion **3** is positioned at the inner side of the conductor **7**A in the non-bonded state. Further, a central axis of the conductor **7**A in the non-bonded state and a central axis of the body portion **19** of the bonded portion **3** coincide with each other.

[0079] As a result, the load release portion **17** of the bonded portion **3** is formed in a tapered shape of, for example, a truncated cone shape.

[0080] In the case where the load release portion **17** of the bonded portion **3** is formed. in the truncated cone shape, an inner space (space where the conductor **7** enters) between the load release portion forming portion **43**A of the anvil **43** and the load release portion forming portion **45**A of the horn **45** is formed in a truncated cone shape coinciding with the shape of the load release portion **17** in a state where the conductor **7** is sandwiched between the anvil **43** and the horn **45**.

[0081] In FIG. **1** which is the cross-sectional view of the anvil **43** and the horn **45**, a surface of the load release portion forming portion **43**A of the anvil **43** is expressed by a linear inclined surface **43**B and a surface of the load release portion forming portion **45**A of the horn **45** is also expressed by a linear inclined surface **4513**.

[0082] Here, a description will be given regarding a state of the strand **11** in the conductor **7**A in the non--bonded state, a state of the strand **11** in the load release portion **17** of the bonded portion **3**, and a state of the strand **11** in the body portion **19** of the bonded portion **3** with reference to FIGS. **5**A to **5**C. Incidentally, FIGS. **5**A to **5**C schematically illustrate the states of the strands **11**.

[0083] The state (state of the cross section taken along the plane orthogonal to the longitudinal direction) of the strand **11** in the non-bonded state conductor **7**A is formed as illustrated in FIG. **5**A.

[0084] In FIG. **5**A, the strands **11** are not plastically deformed but the strands **11** are only in contact with each other, and there is a gap **21** between the respective circular strands **11**.

[0085] The state (state of the cross section taken along the plane orthogonal to the longitudinal direction) of the strand **11** in the load release portion **17** of the bonded portion **3** is formed as illustrated in FIG. **5**B.

[0086] In FIG. **5**B, the strands **11** are plastically deformed so that the strands **11** are bonded to each other at a linear portion **25**, and a gap **23** exists between the respective circular strands **11** that are partially deformed.

[0087] The gap **23** is smaller than the gap **21** illustrated in FIG. **5**A, and the linear portion **25** becomes shorter and the gap **23** becomes larger in the load release portion **17** of the bonded portion **3** from the side of the body portion **19** of the bonded portion **3** toward the conductor **7**A in the non-bonded state.

[0088] The state (state of the cross section taken along the plane orthogonal to the longitudinal direction) of the strand **11** in the body portion **19** of the bonded portion **3** is formed as illustrated in FIG. **5**C.

[0089] In FIG. **5**C, the strands **11** are further plastically deformed so that the strands **11** are bonded to each other at the linear portion **25**, and a gap **27** exists between the respective circular strands **11** that are partially deformed.

[0090] The linear portion **25** illustrated in FIG. **5**C is longer than the linear portion **25** illustrated in FIG. **5**B, and the gap **27** illustrated in FIG. **5**C is smaller than the gap **23** illustrated in FIG. **5**B.

[0091] The terminal **15** is formed, for example, by forming a flat metal material having a constant thickness into a predetermined shape, and then, appropriately folding the material formed into the predetermined shape. Therefore, a thickness of a wall in almost the entire portion of the terminal **15** is constant.

[0092] The terminal **15** has, for example, a mating terminal connection portion **29** to be connected to a mating terminal, the wire barrel portion **13**, and an insulation barrel portion **31** arranged in this order from the front side to the rear side as illustrated in FIG. **3**.

[0093] In the terminal-equipped electric wire **1**, the longitudinal direction of the electric wire **9** or the conductor **7** and the front-rear direction of the wire barrel portion **13** (terminal **15**) coincide with each other. In addition, one end of the electric wire **9** in the longitudinal direction is positioned on the front side, and the other end of the electric wire **9** in the longitudinal direction is positioned on the rear side.

[0094] A cross section (cross section taken along a plane orthogonal to the front-rear direction) of the wire barrel portion **13** before being crimped is formed in, for example, a U shape including a bottom plate portion (arc-shaped bottom plate portion) **33** whose thickness direction is substantially the height direction and a pair of side plate portions **35**. The pair of side plate portions **35** is erected obliquely upward, respectively, from both ends of the bottom plate portion **33** in the width direction. A dimensional value of a portion between the pair of side plate portions **35** gradually increases from the lower side to the upper side.

[0095] A cross section (cross section taken along the plane orthogonal to the front-rear direction) of the insulation barrel portion **31** before being crimped is also formed in the "U" shape similar to the cross section of the wire barrel portion **13**.

[0096] In the terminal-equipped electric wire **1**, the bonded portion **3** and the wire barrel portion **13** are integrated as the wire barrel portion **13** is crimped, and the sheath **5** and the insulation barrel portion **31** are integrated as the insulation barrel portion **31** is crimped. Almost the entire inner surface of a cylinder of the wire barrel portion **13** is brought into contact with the bonded portion **3** with a biasing force by the crimping.

[0097] The crimping of the wire barrel portion **13** or the insulation barrel portion **31** is mainly performed as the pair of side plate portions **35** is plastically deformed so that the wire barrel portion **13** and the insulation barrel portion **31** are formed into a tubular shape (for example, a cylindrical shape). When the wire barrel portion **13** is crimped, the bonded portion **3** is sometimes slightly deformed.

[0098] Here, a relationship between the electric wire **9** and the terminal **15** in the front-rear direction will be described in more detail.

[0099] As described above, the body portion **19** of the bonded portion **3** by the predetermined length, the load release portion **17** of the bonded portion **3**, the conductor **7**A in the non-bonded state, and the conductor **7** covered with the sheath **5** are arranged in this order from the one end (front side) to the other end (rear side) in the longitudinal direction of the electric wire **9**. The conductor **7** covered with the sheath **5** is much longer than the bonded portion **3** or the conductor **7**A in the non-bonded state.

[0100] As illustrated in FIG. **4**A, the wire barrel portion **13** of the terminal **15** is provided with bell mouth portions **37** (a front bell mouth portion **37**A and a rear bell mouth portion **37**B).

[0101] Therefore, the wire barrel portion **13** includes a body portion **39** and the pair of bell mouth portions **37**, and the front bell mouth portion **37**A, the body portion **39**, and the rear bell mouth portion **37**B are arranged in this order from the front side to the rear side in the wire barrel portion **13**.

[0102] In the terminal-equipped electric wire **1**, the body portion **39** of the wire barrel portion **13** is formed into a tubular shape having a constant diameter such as a cylindrical shape. On the other hand, the diameter changes in the bell mouth portion **37**, and a gap **41** is formed between the bell mouth portion **37** and the bonded portion **3**.

[0103] Further, a position of a rear end of the body portion **39** of the wire barrel portion **13** (a position of a boundary between the body portion **39** and the rear bell mouth portion **37**B) and a position of a rear end of the body portion **19** of the bonded portion **3** (a position of a boundary between the body portion **19** and the load release portion **17**) coincide with each other in the front-rear direction in the terminal-equipped electric wire **1** as illustrated in FIGS. **3** and **4**A.

[0104] Further, a front end of the body portion **19** of the bonded portion **3** is positioned at the front side of the wire barrel portion **13** in the front-rear direction in the terminal-equipped electric wire **1**, but the front end of the body portion **19** of the bonded portion **3** may be positioned at the front bell mouth portion **37**A of the wire barrel portion **13** or may be positioned at the rear side of the front bell mouth portion **37**A.

[0105] As illustrated in FIG. **4**B, a position of a rear end of the body portion **39** of the wire barrel portion **13** may be positioned at the front side of a position of a rear end of the body portion **19** of the bonded portion **3** in the front-rear direction. That is, the body portion **39** of the wire barrel portion **13** may be positioned at the inner side of the body portion **19** of the bonded portion **3** in the front-rear direction.

[0106] Further, the position of the rear end of the body portion **39** of the wire barrel portion **13** may be positioned at the rear side (at the load release portion **17**) of the position of the rear end of the body portion **19** of the bonded portion **3** in the front-rear direction as illustrated in FIG. **4**C. In this case, a rear end portion of the body portion **39** of the wire barrel portion **13** bite a front end portion of the load release portion **17** of the bonded portion **3**.

[0107] As illustrated in FIG. **4**D, a load release portion engaging portion **47** having a shape (substantially matching shape) matching with the shape of the load release portion **17** may be provided between the body portion **39** of the wire barrel portion **13** and the rear bell mouth portion **37**B. In this case, the load release portion engaging portion **47** is engaged with the front end portion of the load release portion **17**.

[0108] Further, the front bell mouth portion **37**A and the rear bell mouth portion **3713** may be removed.

[0109] Here, the terminal-equipped electric wire **1** manufactured by the above-described manufacturing method will be described.

[0110] As described above, the terminal-equipped electric wire **1** includes the electric wire **9** and the terminal **15**. The conductor **7** is exposed due to the absence of the sheath **5** over the predetermined length in a part of the electric wire **9** in the longitudinal direction, and the conductor **7** is bonded at a part of the exposed conductor **7** to form the bonded portion **3** over the predetermined length.

[0111] The terminal **15** includes the wire barrel portion **13**, and the wire barrel portion **13** covers at least a part of the bonded portion **3**.

[0112] In the terminal-equipped electric wire **1**, the load release portion **17** configured to reduce the stress of the conductor **7** is provided at the bonded portion **3**.

[0113] In the terminal-equipped electric wire **1**, the load release portion **17** is provided in at least one end of the bonded portion **3**, and the diameter of the load release portion **17** gradually increases toward the end of the bonded portion **3**.

[0114] Since the load release portion **17** is provided in a part of the bonded portion **3** according to the terminal-equipped electric wire **1**, it is possible to suppress occurrence of strand breakage at the conductor **7** when fixing the terminal **15**.

[0115] That is, when the wire barrel portion **13** is or has been swaged to crimp the terminal **15**, a value of the stress generated at the conductor **7** by the load release portion **17** is reduced even if the bonded portion **3** is compressed so that the conductor **7** is pulled at the rear end portion of the wire barrel portion **13**, and the strand breakage at the rear end of the bonded portion **3** is suppressed.

[0116] Then, a decrease of mechanical connection strength between the terminal **15** and the conductor **7** is suppressed, and an increase of an electrical resistance value between the terminal **15** and the conductor **7** is suppressed (deterioration in performance of a crimped portion is suppressed).

[0117] Further, the load release portion (the load release portion before fixing of the terminal **15**) **17** of the bonded

portion **3** is formed as the portion (for example, the enlarged diameter portion) whose diameter (outer diameter) gradually changes in the longitudinal direction. Thus, it is possible to eliminate a sudden change in the diameter of the conductor **7** at the boundary portion between the bonded portion **3** and the conductor **7**A in the non-bonded state and to suppress the occurrence of stress concentration at the boundary portion according to the terminal-equipped electric wire **1**. As a result, it is possible to suppress the breakage of the strand **11** at the boundary portion.

[0118] Further, the load release portion **17** of the bonded portion **3** is provided at the end portion of the bonded portion **3** in the longitudinal direction. Thus, it is possible to more reliably eliminate the sudden change in the diameter of the conductor **7** at the boundary portion between the bonded portion **3** and the conductor **7**A in the non-bonded state and to more reliably suppress the occurrence of stress concentration at the boundary portion according to the terminal-equipped electric wire **1**.

[0119] Meanwhile, the load release portion **17** of the bonded portion **3** is enlarged in diameter at a constant rate toward the end of the bonded portion **3** as illustrated in FIGS. **1**, **2**, **6**A, and **6**B in the above description, but the shape of the load release portion **17** may be appropriately changed as illustrated in FIGS. **7**A to **10**E.

[0120] That is, the inclined surface **43**B of the anvil **43** and the inclined surface **45**B of the horn **45** may be formed in an arc shape having a radius of R as illustrated in FIG. **7**A. As a result, the rate at which the load release portion **17** of the bonded portion **3** is enlarged in diameter also gradually increases toward the end of the bonded portion **3**. As illustrated in FIG. **7**B, the load release portion **17** of the bonded portion **3** of the electric wire **9**, formed using the anvil **43** and the horn **45** illustrated in FIG. **7**A, has a shape matching with the shape of the load release portion forming portion **43**A of the anvil **43** or the load release portion forming portion **45**A of the horn **45**.

[0121] As illustrated in FIGS. **8**A and **8**B, the load release portion **17** may be formed by a first load release portion **17**A and a second load release portion **17**B. The first load release portion **17**A is positioned on the side of the body portion **19** and is formed in a shape (for example, a truncated cone shape) as illustrated in FIG. **1**, FIG. **2**, FIGS. **6**A and **6**B, or FIG. **7**B, and the second load release portion **17**B is formed in a cylindrical shape having an outer diameter substantially equal to or slightly smaller than the outer diameter of the conductor **7**A in the non-bonded state.

[0122] Incidentally, the second load release portion **17**B may be formed in a truncated cone shape. However, when the second load release portion **17**B has the truncated cone shape, it is assumed that a change rate of a diameter of the second load release portion **17**B is lower than that of the first load release portion **17**A.

[0123] As illustrated in FIGS. **9**A and **9**B, the entire load release portion **17** may be formed in a shape (for example, a truncated cone shape) that is gradually enlarged in diameter from the front end toward the rear end.

[0124] As illustrated in FIG. **10**A, the load release portion **17** may be provided at both end portions of the bonded portion **3** in the longitudinal direction. As illustrated in FIG. **10**B, the load release portion **17** may be formed by providing an inclined surface **49** only on a side opposite to the bottom plate portion **33** of the wire barrel portion **13**. As illustrated in FIG. **10**C, the load release portion **17** may be formed by providing the inclined surface **49** only on a side of the bottom plate portion **33** of the wire barrel portion **13**.

[0125] As illustrated in FIG. **10**D, the load release portion **17** in the form illustrated in FIG. **10**B may be provided at both end portions of the bonded portion **3** in the longitudinal direction. As illustrated in FIG. **10**E, the load release portion **17** in the form illustrated in FIG. **10**C may be provided at both end portions in the longitudinal direction of the bonded portion **3**.

[0126] Although the bonded portion **3** is formed at one end portion of the electric wire **9** in the longitudinal direction and the terminal **15** is fixed to the bonded portion **3** in the above description, the bonded portion **3** may be formed at an intermediate portion of the electric wire **9** in the longitudinal direction, and the terminal **15** may be fixed to the bonded portion **3** as illustrated in FIG. **11**.

[0127] More specifically, the terminal **15** may be fixed to the bonded portion **3** of the electric wire in which the conductor **7** covered with the sheath **5** (an one-end-side portion of the electric wire where the sheath is present), a conductor in the non-bonded state (a conductor in the non-bonded state at one end side), the bonded portion **3**, a conductor in the non-bonded state (a conductor in the non-bonded state at the other end side), and the conductor **7** covered with the sheath **5** (an other-end-side portion of the electric wire where the sheath is present) are arranged in this order from one side to the other side in the longitudinal direction of the electric wire **9**.

[0128] The load release portion (load release portion at one end side) **17**, the body portion **19**, and the load release portion (load release portion at the other end side) **17** are arranged in the bonded portion **3** in this order from one side to the other side in the longitudinal direction of the electric wire **9**.

[0129] Further, the single terminal **15** is fixed to the single electric wire **9** in the above description, but one terminal **15** may be fixed to a plurality of (for example, two) electric wires **9** as illustrated in FIG. **12**.

[0130] Further, when one terminal **109** is fixed to a plurality of electric wires **105**, a bonded portion **103** is formed individually in each of conductors **113** of the electric wires **105** and the one terminal **109** may be fixed to each of the electric wires **105**, or alternatively, the conductors **113** of at least two electric wires **105** among the respective electric wires **105** may be collected to form the bonded portion **103** at such a collected portion and the one terminal **109** may be fixed to the respective electric wires **105**.

[0131] Further, when the one terminal **109** is fixed to the plurality of electric wires **105**, at least one electric wire **105** among the respective electric wires **105** may have a form in which the bonded portion **103** is formed at an intermediate portion of the electric wire **105** in the longitudinal direction.

What is claimed is:

1. A terminal-equipped electric wire comprising:

an electric wire including a bonded portion formed at a part of a conductor exposed due to absence of a sheath at a part of the electric wire in a longitudinal direction and in which strands of the conductor are bonded to each other; and

a terminal including a wire barrel portion, the wire barrel portion covering at least a part of the bonded portion,

wherein the bonded portion is provided with a load release portion configured to reduce stress applied to the conductor.

2. The terminal-equipped electric wire according to claim 1, wherein

the load release portion is provided in at least one end portion of the bonded portion in the longitudinal direction, and

a diameter of the bonded portion gradually increases toward an end of the bonded portion in the load release portion.

3. The terminal-equipped electric wire according to claim 1, wherein

one terminal of the terminal is fixed to a plurality of the electric wires.

4. A terminal-equipped electric wire comprising:

an electric wire including a bonded portion formed at a part of a conductor exposed due to absence of a sheath at a part of the electric wire in a longitudinal direction and in which strands of the conductor are bonded to each other; and

a terminal including a wire barrel portion, the wire barrel portion covering at least a part of the bonded portion,

wherein a diameter of the bonded portion gradually increases toward an end of the bonded portion in an end portion of the bonded portion.

5. The terminal-equipped electric wire according to claim 4, wherein

one terminal of the terminal is fixed to a plurality of the electric wires.

6. A method for manufacturing a terminal-equipped electric wire, the method comprising:

forming, in an electric wire, a bonded portion in which strands of a conductor are bonded to each other in at least a part of the conductor in a longitudinal direction exposed due to absence of a sheath at a part of the electric wire in the longitudinal direction; and

fixing a terminal including a wire barrel portion to the electric wire such that the wire barrel portion covers at least a part of the bonded portion,

wherein at least one end portion of the bonded portion in the longitudinal direction is provided with a load release portion configured to reduce stress applied to the conductor.

7. An electric wire comprising

a bonded portion, in which strands of a conductor are bonded to each other, formed at least at a part of the conductor in a longitudinal direction exposed due to absence of a sheath at a part of the electric wire in the longitudinal direction,

wherein a diameter of the bonded portion gradually increases toward an end of the bonded portion in an end portion of the bonded portion.

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