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(54) **POWER DISTRIBUTION ASSEMBLY**

STROMVERTEILERBAUGRUPPE

ENSEMBLE DE DISTRIBUTION D'ENERGIE

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US-A- 3 914 009	

- **PATENT ABSTRACTS OF JAPAN vol. 2000, no. 15, 6 April 2001 (2001-04-06) & JP 2000 357420 A (FURUKAWA), 26 December 2000 (2000-12-26)**

EP 1 291 992 B9

Description

Technical Field

[0001] The present invention relates to an electric distributor assembly preferable for movable means such as vehicles including automobiles, which are required to be lightened, and in particular, to an electric distributor assembly comprising an aluminum twisted cable conductor and an aluminum terminal attached to the cable conductor (hereafter, the term "aluminum or aluminum metal" is often noted as "Al").

Background Art

[0002] Copper assemblies have conventionally been used as distribution assemblies for automobiles in the form of harness wires, battery cables, and others mounted thereon. Each assembly has not only a distribution cable of which conductors are copper twisted wires but also copper terminals coupled to the cable. In such circumstances, a recent trend is that a new type of automobile of which drive power is partly or entirely supplied by electric power has been under development. One key factor in the development is what type of electric distributor assembly should be used. It has been considered that an Al assembly comprising a distribution cable made of Al-twisted wires and Al terminals coupled to the cable should be used for such electric distributor assembly, because there is an advantage of being lighter in weight which stems from aluminum metal.

[0003] However, the Al assembly has various problems. In other words, using the Al-made assembly for a long time causes a thick oxide layer generated between connected boundary faces of the Al twisted-wire conductor and each Al terminal. Additionally, in a corrosive environment, the Al-made assembly is easier to be corroded. If being placed in such a corrosive environment, contact resistance between the Al-made twisted-wire conductor and the Al terminal increases little by little, thus a connection characteristic therebetween being spoiled in course of time.

[0004] To overcome those problems, plating the Al-made twisted wires with a corrosion resistant metal like Ni was conceived, but it has not been practiced because of the problems as suggested in the following.

(1) Plating a large-diameter Al wire with Ni before drawing it into a strand to be twisted is excellent in productivity, but the plated layer is apt to be peeled off or broken.
(2) Plating Ni on strands to be twisted leads to poor productivity.
(3) Plating Ni on a connected part of each Al terminal connected with the conductor of each Al-made twisted wire tends to cause corrosion because the plating solution permeates among the wires.

Additionally, the Al electric distributor assembly is poor in flexibility because of the its large diameter of the wire, thus making handling of the distribution cable difficult and causing cracks within the terminal when the assembly is formed or mounted on the vehicles.

[0005] Patent abstract of JP 2000 357420 A describes an electric power cable for an automobile of low costs which is capable of reducing the body in weight and of preventing an aluminum bus bar from corroding in use. For this purpose, a specific electric power cable is disclosed; wherein a stranded cable of a highty conductive aluminum alloy wire is covered with frame resistant polyolefin resin layers and a shield layer composed of a braided body on an aluminum basis.

[0006] In US-A-3 914 009 an electric contact device is described having an electrical conductivity of at least 57 % under IACS (International Annealed Copper Standard) and increased thermal stability, bendability, ductility, creep resistance, tensile and yield strength, and fatigue resistance when compared to conventional aluminum alloy connectors. The elongation of the electric contact device consisting of the compositions specified in US-A-3 914 009 does not provide for an elongation of 20 % or more.

[0007] US-A-3 717 842 discloses a method of connecting conventional electric terminals having at least non-aluminum portion, such as nickel-plated steel, to solid or stranded aluminum (alloy) wires so that aluminum oxide on the surface of the strands does not prevent a satisfactory electrical contact. Such terminals have a channel portion with extending tabs so that the wire can be placed in the open channel, and the tabs are crimped to close the channel and hold the wire in electrical connection with the terminal. In US-A-3 717 842, there is lacking a statement that the non-aluminum unitary electrical terminal has an particularly great elongation, and a fortiori that the non-aluminum unitary electrical terminal has an elongation of 20 % or more.

[0008] In US-A-3 717 842, it is only mentioned marginally that also an aluminium alloy terminal with a non-aluminium coating can be used. In US-A-3 717 842, there is nothing enclosed concerning the composition of the aluminum metal or aluminum alloy of the aluminium (alloy) wires.

[0009] An object of the present invention is to provide a distribution cable assembly for movable means whose cable is easier to be handled, whose terminals are excellent in workability, and which has an excellent connection characteristic between an Al twisted-wire conductor of the cable and each Al terminal.

Disclosure of the Invention

[0010] A first embodiment of the present invention is an electric distributor assembly comprising a distribution cable composed of an insulation-coated twisted-wire conductor and a connecting terminal connected to one end of the conductor, wherein

- the twisted-wire conductor is made of an aluminum metal or an aluminum alloy of which conductivity is 50 % or more under IACS,
- the connecting terminal connected to the twisted-wire conductor is made of an aluminum metal or aluminium alloy having an elongation of 20% or more and consisting of Zr : 0.03 to 0.4 wt % and Si: 0.05 to 0.15 wt %, and the balance consisting of Al and unavoidable impurities, and
- the twisted wire conductor and the connecting terminals are connected by pressure welding accompanied by ultrasonic vibrations.

[0011] A second embodiment of the present invention is an electric distributor assembly comprising a distribution cable composed of an insulation-coated twisted-wire conductor and a connecting terminal connected to one end of the conductor, wherein

- the twisted-wire conductor is made of an aluminum metal or aluminum alloy of which conductivity is 50% or more under IACS,
- the connecting terminal connected to the twisted-wire conductor is made of an aluminum metal aluminium alloy having an elongation of 20% or more and consisting of Mg : 0.3 to 1.8 wt %, Si: 0.15 to 1.5 wt %, Fe : 0.1 to 1.0 wt %, and Cu : 0.05 to 0.5 wt % and further including in total 0:03, to 0.6 wt % of one or more elements selected from Mn, Cr and Ti, and the balance consisting of Al and unavoidable impurities, and
- the twisted wire conductor and the connecting terminal are connected by pressure welding accompanied by ultrasonic vibrations.

[0012] A third embodiment of the present invention is an electric distributor assembly in which the aluminum alloy composing the twisted-wire conductor consists of Zr: 0.03 to 0.4 wt %, Fe : 0.05 to 0.2 wt %, and Si: 0.05 to 0.2 wt % and further includes in total 0.003 to 0.05 wt% of one or more element selected from Be, Sr, Mg, Ti and V, and the balance consists of Al and unavoidable impurities.

[0013] A fourth embodiment of the present invention is an electric distributor assembly in which the terminal is coated on its surface with Ni metal or an nickel alloy with a thickness of 5 μm or less.

[0014] A fifth embodiment of the present invention is an electric distributor assembly comprising an electromagnetic shielding metal layer covering an outer surface the insulation-coated twisted-wire conductor and further an insulation-coated layer covering the outer surface of the electromagnetic shielding metal layer.

[0015] A sixth embodiment of the present invention is an electric distributor assembly in which the electromagnetic shielding metal layer is composed of a reticulated member made of aluminum metal or aluminum alloy.

Brief Description of the Drawings

[0016] In the accompanying drawings:

Fig. 1(a) is a cross section showing an embodiment of a distribution cable of the electric distributor assembly according to the present invention and Fig. 1(b) is a cross section showing another embodiment of a distribution cable of the electric distributor assembly according to the present invention;

Fig. 2(a) is a perspective view showing a connected state of a metal terminal employed by one embodiment of the electric distributor assembly according to the present invention and Fig. 2(b) is a developed perspective view of a metal terminal having grooves or serrations on its inner surface, shown according to another embodiment of the present invention;

Fig. 3 is a perspective view showing further another embodiment of a metal terminal mounted in the electric distributor assembly according to the present invention; and

Fig. 4 exemplifies how to press a metal terminal with ultrasonic vibrations, the terminal being mounted in the electric distributor assembly according to the present invention.

Detailed Description of the Preferred Embodiments

[0017] A distribution cable 1, which is part of the electric distributor assembly of the present invention, includes an Al twisted-wire conductor 2 as shown in Fig. 1(a) or 1(b). Specifially, Fig. 1(a) shows the conductor 2 of which an outer surface is coated with an insulating layer 3. On the other hand, Fig. 1(b) shows the conductor 2 whose outer surface is coated with a series of layers consisting of an insulating layer 3, magnetic shielding layer 4, and a further insulating layer 5 layered one on another in this order.

[0018] The Al twisted-wire conductor 2 defined by the present invention includes an ordinary Al twisted-wire conductor made by twisting a plurality of Al strands as well as any conductor fabricated from a plurality of Al strands, such as a conductor comprising combined Al strands.

[0019] The reason why the present invention requires the Al twisted-wire conductor to have a conductivity of 50 % or more under IACS (International Annealed Copper Standard) can be explained as follows. In cases where the conductivity is less than 50 % under IACS, supplying desired amounts of current through the Al twisted-wire conductor requires the conductor with a larger outer diameter, which deteriorates the flexibility of the conductor. A larger outer diameter is opposed to a trend of lightening in weight the assembly, thereby increasing cost in material. The flexibility of the Al twisted-wire conductor is ensured by making the Al strand thinner down to 0.8 mm or less in diameter.

[0020] A metal terminal, which constitutes part of the electric distributor assembly according to the present invention, can be produced using aluminum metal, or aluminum alloy, which are higher in electric conductivity. In addition, from a view point to reduce the weight, it is preferable to use aluminum metal or aluminum alloy as a material for the terminal. As shown in Fig. 2(a), an open barrel type of terminal 6 is provided as the metal terminal, which has a grasping member 61 for grasping the Al twisted-wire conductor 2.

[0021] In the open barrel type of terminal 6 shown in Fig. 2(b), there are formed a plurality of grooves or serrations 63 on the inner surface of a grasping element 62, which is to be pressed onto the Al twisted-wire conductor 2. The grooves or serrations are made parallel to the direction orthogonal to the longitudinal direction of the conductor 2. In a press working operation, those grooves or serrations operate to allow both of the conductor 2 and the grooves or serrations 63 to engage with each other, which brings forth an advantage that the metal terminal 6 is prevented from being pulled easily from the Al-made twisted-wire conductor 2. Fig. 3 shows another embodiment of the metal terminal, wherein a terminal 7 is integrally coupled with a tube type of grasping element 71 on which a rectangular location 72 is formed by pressing for contact.

[0022] The connection of the grasping member 61 or 62 with the twisted-wire conductor 2 is shown in Fig. 2(a) or Fig. 2(b). Such connection, which is normally performed in an ordinary temperature condition, is realized by using a press machine 8, which is called pressure welding as a general term. Practically, as shown in Fig. 4, a reception base 81 of the machine 8 accepts the grasping member 61 or 62 in which the twisted-wire conductor 2 is placed. Then a press head 82 thereof is pressed, with ultrasonic vibrations, onto the grasping member 61 or 62 on the base 81. The frequency of ultrasonic wave is preferably 10 to 30 kHz, by way of example. Meanwhile, the method of pressing shown in Fig. 4 is just one example and does not limit the scope of the present invention

[0023] In the present invention, for the metal terminal to be made from aluminum metal or aluminum alloy, it is provided that the elongation thereof is set to an amount of 20 % or more. The reason is that if the elongation is less than 20 %, the workability is poor, so that cracks may be caused within the Al terminal in forming the metal to the terminal or in bonding the terminal onto the Al twisted-wire conductor by pressure welding.

[0024] The present invention uses the pressure welding as bonding technique to attach the metal terminal to the Al twisted-wire conductor. The reason that the pressure welding is used is that its attachment operation is easier in handling and provides an excellent productivity. In addition, the reason that the pressure welding is done with vibrations generated by ultrasonic waves in the present invention is as follows. Giving vibrations derived from the ultrasonic waves can destroy the oxide layers of both of the each strand itself of the conductor and the terminal. Hence, the twisted strands themselves are mutually bonded to form as single conductor and both the twisted-wire conductor and the metal terminal are metal-bonded to each other. Those metal bonding reduce contact resistance, providing a good connection characteristic in a stable manner.

[0025] In the present invention, any aluminum metal or aluminum alloy can be used as the Al twisted-wire conductor as for the distribution cable, if it has 50% or more conductivity under IACS. In particular, a preferable component composition of the Al alloy is as follows: the Al alloy consists of; Zr: 0.03 to 0.4 wt %, Fe: 0.05 to 0.2 wt %, and Si 0.05 to 0.2 wt % and further includes in total 0.003 to 0.05 wt % of one or more elements selected from Be, Sr, Mg, Ti and V, and the balance thereof consists of Al and unavoidable impurities.

The Al alloy thus composed is excellent in strength, conductivity, creep resistance, and others, so it can be used best. The Al alloy also has the advantage that its oxide layer grows at slower speeds. Thus, contact resistance among the strands of the Al twisted-wire conductor is kept lower for a longer time, providing a higher, stable conductivity in course of time.

[0026] In the Al alloy, Zr is partly solved in matrix and partly precipitated, with the result that creep resistance is raised. The reason that Zr is regulated to a content of ranging from 0.03 to 0.4 wt % is that if the content is less than 0.03 wt %, the advantages of the Al alloy are not fully realized, while it exceeds 0.4 wt %, the conductivity is fairly reduced.

[0027] Si is employed to promote precipitation of Zr, thereby raising both of conductivity and the characteristic of creep resistance. The reason that Si is confined to a content of 0.05 to 0.2 wt % is derived from the fact that its content of less than 0.05 wt % gives no sufficient advantage, whilst that higher than 0.2 wt % reduces the conductivity. Fe is employed to increase heat resistance. Why Fe is limited to a content of 0.05 to 0.2 wt % is derived from the fact that its content of less than 0.05 wt % gives no sufficient advantage, whilst that higher than 0.2 wt % reduces the conductivity.

[0028] One or more elements selected from Be, Sr, Mg, Ti and V contribute to raising the strength of the Al alloy by solution and precipitation and to raising the conductivity and creep resistance characteristics by promoting the deposition of the Zr. The elements are selected in total to a content of 0.003 to 0.05 wt %. This is because the total content of less than 0.003 wt% gives no sufficient advantage, whilst that higher than 0.05 wt % causes the advantage to be saturated.

[0029] The Al alloy can be formed into twisted strands through conventional techniques. By way of example, the melt of the Al alloy is formed into a cast by continuous casting and the cast is hot-rolled to hot-rolled materials. And the hot-rolled material is formed into twisted strands by cold working. It is preferred that an aging treatment is performed on the hot-rolled materials during the cold working or after the cold working so that the strength and conductivity thereof are adjusted to desired values.

[0030] In the present invention, it is provided that, as the metal terminal, any Al or Al alloy of which elongation is 20 % or more is used. The component composition of the alloy according to the first embodiment is an Al-Zr-Si alloy that consists of :

Zr : 0.03 to 0.4 wt % and Si: 0.05 to 0.15 wt %, and the balance consists of Al and unavoidable impurities.

[0031] In the above Al-Zr-Si alloy, Zr, which increases the creep resistance of the alloy, is confined to a content of 0.03 to 0.4 wt %. This is because the content of less than 0.03 wt % gives no sufficient advantage, while that higher than 0.4 wt % reduces its conductivity.

[0032] Adding Si promotes the precipitation of Zr to increase the conductivity of the creep resistance characteristic of the terminal. The reason why the content of Si is 0.05 to 0.15 wt % is that the content of less than 0.05 wt % gives no sufficient advantage, white that higher than 0.15 wt % reduces the conductivity of the alloy.

[0033] Furthermore, it is provided to use another Al alloy as the metal terminal according to the second embodiment, which consists of;

Mg :0.3 to 1.8 wt %, Si : 0.15 to 1.5 wt %, Fe : 0.1 to 1.0 wt %, and Cu : 0.05 to 0.5 wt %, which can further includes one or more elements in a total content of 0.03 to 0.6 wt % selected from a group of Mn, Cr, and Ti, and the balance of which consists of Al and unavoidable impurities. This alloy has an electric conductivity of 40 % IACS or more and a high creep strength, and hence the alloy is preferably used for the metal terminal.

[0034] In this Al-Mg-Si-Fe-Cu family alloy, Mg and Si react to each other so as to form a compound to raise the creep resistance characteristic. The reason that the content of Mg is limited to 0.3 to 1.8 wt % and Si is limited to 0.15 to 1.5 wt % is that either element of the content of less than each lower limit gives no sufficient advantage, while that higher than each upper limit reduces the conductivity of the alloy.

[0035] Fe contained in this alloy undergoes solution or deposition to enhance the creep resistance characteristic of the alloy. The reason the content of Fe is 0.1 to 1.0 wt % relies on the fact that the content of less than 0.1 wt % gives no sufficient advantage, while that higher than 1.0 wt % reduces the conductivity of the alloy.

[0036] Cu contained in this alloy is also soluble in the matrix and precipitated so that it improves the creep resistance characteristic of the alloy. The reason that the content of Cu is regulated to 0.05 to 0.5 wt % is that the content of less than 0.05 wt % gives no sufficient advantage, while that higher than 0.5 wt % reduces the conductivity of the alloy.

[0037] In the present invention, an Al alloy, from which the terminal is made, is machined into tubing material, rod material, bar material, or others. Then such material undergoes bending, cutting, stamping, and/or others so that a terminal is formed.

[0038] The tubing material, rod material, bar material, or others is formed by following method:

(1) a conform-extruding of the hot drawing;
(2) a cold rolling of the conform-extruded material; and
(3) a continuously casting of an Al alloy into a billet, hot extruding or hot rolling the cast alloy, cold rolling the extruded or rolled alloy, then cutting the cold-rolled alloy into a terminal having a predetermined size.

In the working of the alloy based on the foregoing forming methods, it is preferred that an aging treatment be performed in a proper manner in the course of the working or at the final stage of the working, so that the terminal is formed with higher conductivity and higher strength.

[0039] Meanwhile in the present invention, a Ni, and a Ni alloy of which substantial component is Ni, which is for example a Ni-P alloy or a Ni-B alloy, is preferably coated on the surface of the alloy without such problems in the production process as stated above. Because this coating improves the corrosion resistance of the terminal, the terminal can be used even in a corrosive environment. Galvanic corrosion, which might be occurred between the terminal and an external device to which the terminal is connected, can be avoided as well. In the present invention the thickness of the coating layer is limited to a thickness of 5 μm or less because of the following reasons. If such thickness is over 5 μm, there is a possibility that cracks occur within the terminal when an Al twisted conductor and the terminal are pressed for welding together. If the crack actually appears, the advantages of the pressure are spoiled. In order to coat the terminal with Ni, any method chosen from various methods, such as electroplating, electroless plating, pressure welding by rolling and physical deposition, can be used.

[0040] Some vehicles require a distribution cable to additionally be coated with a metal magnetic shielding layer, such as an Al net or a copper net, and a plurality of insulation layers. The magnetic shielding layer is used for shielding an electromagnetic field to be generated when electricity is supplied through the cable. The assembly according to the present invention is still effective for such a cable, that is, still advantageous regardless of such outer insulation structures of the distribution cable. This is because the magnetic shielding layer and a plurality of insulation layers, which are overlapped as outer layers on a distribution cable, will not change a function of delivering electricity through the cable. The insulation layers are formed with layers made from synthetic resin, such as vinyl chloride or polyolefin.

Examples

[0041] The present invention will now be explained in detail by examples.

Example 1

[0042] An Al alloy consisting of; Zr : 0.1 wt %, Fe : 0.1 wt %, Si : 0.1 wt % , Ti : 0.003 wt % and the balance is made up of Al and unavoidable impurities, was first prepared. This Al alloy was then prepared using a conventional procedure, and the prepared melt was subject to continuous casting and rolling so as to produce a rough-drawn wire (a hot-drawn material). This wire then underwent cold wire drawing to form a strand of 0.32 mm in diameter. 25-piece strands were then twisted together to form a twisted member. 19-piece twisted members were then further twisted together so that an Al twisted-wire conductor (represented by a reference A). This Al twisted-wire conductor was then subjected to coating of PVC by extrusion at a thickness of 1 mm, with the result that the distribution cable shown in Fig. 1(a) was made.

[0043] Moreover, a first Al alloy consisting of Zr : 0.1 wt %, Si : 0.1 wt % and the balance made up of Al and unavoidable impurities, and a second Al alloy consisting of Mg : 0.5 wt %, Si : 0.35 wt %, Fe : 0.1 wt %, Cu : 0.1 wt %, Mn : 0.1 wt %, and the balance made up of Al and unavoidable impurities were first prepared. Each of the first and second Al alloys was prepared and, then the melt of the first and second alloy were subject to continuous casting rolling so as to produce a rough-drawn wire. Each wire was used as a feed stock and subject to conform-extruding to extrude a plate of 45 mm in width and 2.5 mm in thickens. Each plate was cold-rolled into a plate of which thickness is 2.3 mm, and then this cold-rolled plate was annealed at 350 degrees in centigrade for 6 hours. The annealed plates were respectively subjected to press working and bending in this order, so that two types of open barrel terminals formed into the size BA 608 designated by the JIS (Japanese Industrial Standard) were made. Of such two type of terminals, one, represented by a reference Z, is made from the foregoing Al-Zr-Si alloy, and the other, represented by a reference M, from the foregoing Al-Mg-Si-Fe-Cu-Mn alloy (refer to Figs. 2(a) and 2(b)).

[0044] Then, the foregoing terminals (Z and M) were individually welded to the Al twisted-wire conductor (A) applying ultrasonic vibration (at a condition of 1400 W for 1 sec.), thereby two types of assemblies (A/Z and A/M) were manufactured.

Comparative Example 1

[0045] An Al twisted-wire conductor, represented by a reference B, was first manufactured from a conventional Al alloy that consists of Mg : 4 wt %, Mn : 0.4 wt %, Fe : 0.5 wt %, Si : 0.4 wt %, Zn : 0.25 wt %, and the balance made up of Al and unavoidable impurities. The remaining manufacturing conditions were set to the same as those in the foregoing example 1, thus two types of assemblies (B/Z and B/M) were manufactured in the similar way.

Comparative Example 2

[0046] Although no ultrasonic vibrations were applied when the terminal Z or M was welded onto the Al twisted-wired conductor A, two types of assemblies were manufactured in a similar manner to that in the example1.

Comparative Example 3

[0047] Although no ultrasonic vibrations were applied when the terminal Z or M was welded onto the Al twisted-wired conductor B, two types of assemblies were manufactured in a similar manner to that in the example1.

[0048] Each of the assemblies manufactured in the example 1 and comparative example 1 to 3 underwent an energizing cycle test in which electric power of 4 kVA is turned on and off at 1, 10, 50, 100, 500 and 1000 cycles, respectively. After turning on and off at each cycle, electric resistance was measured between a certain location a on the terminal and a location b on the distribution cable, the location b being located 100 mm apart from the location a (refer to Fig. 2(a)). The life of the assemblies was measured as the number of energizing cycles obtained when the resistance exceeded an amount 1.5 times larger than its initial resistance. The results of the test are shown in Table 1.

Table 1:

EC: electric conductivity

Classification		No. of specimen	Al twisted-wire conductor		Al terminal		Ultrasonic vibrations during welding	Life (The number of energizing cycles obtained when resistance exceeds 1.5 times larger than its initial resistance.)
			type	EC %	type	EC %		
The present invention	Example 1	1	A	59	Z	59	applied	1000 or more
		2	A	59	M	53	applied	1000 or more
Comparative Examples	Comparative Example 1	3	B	30	Z	60	applied	500 or less, but 101 or more
		4	B	30	M	52	applied	500 or less, but 101 or more
	Comparative Example 2	5	A	59	Z	59	non-applied	50 or less, but 11 or more
		6	A	59	M	52	non-applied	50 or less, but 11 or more
	Comparative Example 3	7	B	30	Z	59	non-applied	1
		8	B	30	M	52	non-applied	1

[0049] As is clear from Table 1, the assemblies according to the present invention (specimen Nos. 1 and 2) showed excellent terminal/cable connection characteristics. After the test at 1000 cycles, those assemblies according to the present invention exhibited an electric resistance which is not more than 1.08 times larger than its initial value of electric resistance.

[0050] In contrast, the specimens of Nos. 3 and 4 manufactured in the comparative example 1 showed only a shorter life of 500 to 100 times with respect to energizing cycles, because the conductivity of the Al twisted-wire conductor was lower. In the case of the specimens of Nos. 5 and 6 manufactured in the comparative example 2 showed a mere shorter life of 50 to 10 times with respect to energizing cycles, because no ultrasonic vibrations were applied in the welding. Further, In the case of the specimens of Nos. 7 and 8 manufactured in the comparative example 3 showed only an extremely shorter life of 1 times with respect to energizing cycles, because the Al twisted-wire conductor is lower in conductivity and no ultrasonic vibrations were applied in the welding.

Comparative Example 4

[0051] An Al alloy billet was first manufactured which consists of Mg : 4.0 wt %, Mn : 0.4 wt %, Fe : 0.5 wt %, Si : 0.4 wt %, Zn : 0.25 wt % and balance made up of Al and unavoidable impurities. This Al alloy billet was hot-rolled into a material of which thickness is 5 mm, and then this rolled material was cold-rolled into that of a thickness of 2.3 mm. After being annealed, this cold-rolled was slit into a material of 45 mm in width, then the slit material was subjected to pressure welding and bending in this order so as to produce an Al terminal. This Al terminal was welded onto the foregoing Al twisted-wire conductor A with ultrasonic vibrations applied. However, the elongation of this terminal was only 18 percents, which caused a crack within the terminal in the welding operation.

Example 2

[0052] The two Al terminals Z manufactured in the example 1 were further subject to electroplating with Ni performed on the terminal at a thickness of 3 μm and to electroless plating with Ni-P alloy performed on the terminal at a thickness of 3 μm, respectively. Each of those Ni-plated Al terminals is welded onto the Al twisted-wire conductor A with ultrasonic vibrations applied (1400 W x 1 sec.), so that two types of assemblies were produced.

Comparative Example 5

[0053] The three Al terminals Z manufactured in the example 1 were further subject to electroplating with Ni performed on the terminal at a thickness of 10 μm, to electroless plating of Ni-P performed on the terminal at a thickness of 10 μm, and to electroplating with Sn performed on the terminal at a thickness of 3 μm, respectively. Those plated Al terminals were used to produce three types of assemblies in a similar way with that in the example 2.

[0054] A 96-hours neutral salt spray test defined by JIS Z2371 was performed with each assembly manufactured in the example 2 and comparative example 5. After the spray test, the assemblies underwent the cycle test in the same way as that employed in the example 1 so that the life of each assembly was examined. For comparison, the life of terminals with no plating was also examined in the same way as above. The results of the test are shown in Table 2.

[0055] As is clearly understood from Table 2, the assemblies according to the present invention (specimen Nos. 11 and 12) showed excellent terminal/cable connection characteristics. After the test at 1000 cycles, those assemblies according to the present invention exhibited electric resistance whose value was nearly 1.11 times larger than its initial value of electric resistance.

[0056] By contrast, the specimens of Nos. 13 and 14 of the comparative example 5 caused cracks therein in welding due to the thicker Ni-plated layer. Corrosive mediums penetrated into the cracks caused erosion, resulting in peeling off the Ni-plated layer.

[0057] Hence those specimens exhibited life no more than 1000 or less cycles but 501 or more cycles, which was the same as the specimen of No. 16 with no Ni-plated layer. Incidentally, it is considered that there are no problems in practicality if assemblies show life of 501 or more cycles through the test. The specimen of No. 15 was poor in the corrosion resistance of Sn plating, and showed life of 500 or less cycles but 101 or more cycles because the terminal reacted with the copper alloy.

Table 2:

EC: electric conductivity										
Classification		No. of Specimen	Al twisted wire conductor		Al terminal				Ultrasonic vibrations during welding	Life(The number of energizing cycles obtained when resistance exceeds 1.5 times larger than its initial resistance.)
			Type	EC %	Type	EC%	surface treatment	Thickness μm		
The present invention	Example 2	11	A	59	Z	59	Ni electroplating	3	applied	1000 or more
		12	A	59	Z	59	Ni-P electroless plating	3	applied	1000 or more
Comparative Examples	Comparative Example 5	13	A	59	Z	59	Ni electroplating	10	applied	1000 or less, but 501 or more
		14	A	59	Z	59	Ni-P electroless plating	10	applied	1000 or less, but 501 or more
		15	A	59	Z	59	Sn electroplating	3	applied	500 or less, but 101 or more
		16	A	59	Z	59	Non-plating	0	applied	1000 or less, but 501 or more

Industrial Availability

[0058] As described above, the assembly according to the present invention employs a construction wherein a metal terminal is attached to an Al twisted-wire conductor employed as the conductor of a distribution cable, so that the cable is lightened. The Al twisted-wire conductor can be made thinner in diameter, because its conductivity is 50 % or more under IACS, providing an excellent flexibility. Thus the cable is easier to handle. On the other hand, the metal terminal is made from an aluminum metal or aluminum alloy of which elongation is 20 % or more. Therefore, no cracks will be caused when forming the terminal and welding the terminal onto conductor. This metal terminal is welded onto the Al twisted-wire terminal under the application of ultrasonic vibrations, which will cause oxide layers formed on both of the conductor and the terminal to be destroyed. Thus, in pressure welding, the metal materials themselves of the conductor and the terminal come to be exposed and made to directly contact with each other, providing a superior connection characteristic with stability. In addition, coating Ni on the terminal is able to provide a satisfactory use even under a corrosive environment. Accordingly, the assembly has such remarkable advantages when used in industrial applications.

Claims

1. An electric distributor assembly comprising a distribution cable (1) composed of an insulation-coated twisted-wire conductor (2) made of an aluminium metal or aluminium alloy and a connecting terminal (7) connected to an end of the twisted-wire conductor (2),
wherein the twisted-wire conductor (2) is made of an aluminium metal or aluminium alloy having an electric conductivity of 50 % or more under IACS, and
said twisted-wire conductor (2) and said connecting terminal (7) are connected by pressure welding with ultrasonic vibrations, **characterised in that**
said connecting terminal (7) connected to said twisted-wire conductor (2) is made of an aluminium metal or aluminium alloy having an elongation of 20% or more and consisting of Zr : 0.03 to 0.4 wt % and Si : 0.05 to 0.15 wt %, and the balance consisting of Al and unavoidable impurities.

2. An electric distributor assembly comprising a distribution cable (1) composed of an insulation-coated twisted-wire conductor (2) made of an aluminium metal or aluminium alloy and a connecting terminal (7) connected to an end of the twisted-wire conductor (2),
wherein the twisted-wire conductor (2) is made of an aluminium metal or aluminium alloy having an electric conductivity of 50 % or more under IACS, and
said twisted-wire conductor (2) and said connecting terminal (7) are connected by pressure welding with ultrasonic vibrations, **characterised in that**
said connecting terminal (7) connected to said twisted-wire conductor (2) is made of an aluminium metal or aluminium alloy having an elongation of 20% or more and consisting of Mg : 0.3 to 1.8 wt %, Si : 0.15 to 1.5 wt %, Fe : 0.1 to 1.0 wt %, and Cu : 0.05 to 0.5 wt % and further including in total 0.03 to 0.6 wt % of one or more elements selected from Mn, Cr and Ti, and the balance consisting of Al and unavoidable impurities.

3. An electric distributor assembly according to claims 1 or 2,
characterised in that said aluminium alloy composing said twisted-wire conductor (2) consists of Zr : 0.03 to 0.4 wt %, Fe : 0.05 to 0.2 wt %, and Si : 0.05 to 0.2 wt % and further including in total 0.003 to 0.05 wt % of one or more elements selected from Be, Sr, Mg, Ti and V, and the balance consisting of Al and unavoidable impurities.

4. An electric distributor assembly according to any of claims 1 to 3,
characterised in that said connecting terminal (7) is coated on a surface thereof with Ni or an Ni alloy whose main component is Ni with a thickness of 5 μm or less.

5. An electric distributor assembly according to any of claims 1 to 4,
characterised in that said electric distributor assembly comprises an electromagnetic shielding metal layer (4) for covering an outer surface of said insulation-coated twisted-wire conductor (2) and further an insulation-coated layer (5) covering the outer surface of said electromagnetic shielding metal layer (4).

6. An electric distributor assembly according to claim 5,
characterised in that said electromagnetic shielding metal layer (4) is composed of a reticulated member made of an aluminium metal or an aluminium alloy.

Patentansprüche

1. Elektrisches Verteilersystem mit einem Verteilerkabel (1), das aus einem isolierbeschichteten verdrillten Drahtleiter (2), der aus einem Aluminiummetall oder einer Aluminiumlegierung hergestellt ist, und einer Verbindungsklemme (7) besteht, die an ein Ende des verdrillten Drahtleiters (2) angeschlossen ist,
wobei der verdrillte Drahtleiter (2) aus einem Aluminiummetall oder einer Aluminiumlegierung mit einer elektrischen Leitfähigkeit von 50% oder darüber nach IACS hergestellt ist, und
der verdrillte Drahtleiter (2) und die Verbindungsklemme (7) durch Druckschweißung mit Ultraschallschwingungen verbunden sind,
dadurch gekennzeichnet, dass
die am verdrillten Drahtleiter (2) angeschlossene Verbindungsklemme (7) aus einem Aluminiummetall oder einer Aluminiumlegierung hergestellt ist, das eine Dehnung von 20% oder darüber hat und aus Zr: 0,03 bis 0,4 Gew.-% und Si: 0,05 bis 0,15 Gew.-% besteht, und der Rest aus Al und unvermeidbaren Unreinheiten besteht.

2. Elektrisches Verteilersystem mit einem Verteilerkabel (1), das aus einem isolierbeschichteten verdrillten Drahtleiter (2), der aus einem Aluminiummetall oder einer Aluminiumlegierung hergestellt ist, und einer Verbindungsklemme (7) besteht, die an ein Ende des verdrillten Drahtleiters (2) angeschlossen ist,
wobei der verdrillte Drahtleiter (2) aus einem Aluminiummetall oder einer Aluminiumlegierung mit einer elektrischen Leitfähigkeit von 50% oder darüber nach IACS hergestellt ist, und
der verdrillte Drahtleiter (2) und die Verbindungsklemme (7) durch Druckschweißung mit Ultraschallschwingungen verbunden sind,
dadurch gekennzeichnet, dass
die am verdrillten Drahtleiter (2) angeschlossene Verbindungsklemme (7) aus einem Aluminiummetall oder einer Aluminiumlegierung hergestellt ist, das eine Dehnung von 20% oder darüber hat und aus Mg: 0,3 bis 1,8 Gew.-%, Si: 0,15 bis 1,5 Gew.-%, Fe: 0,1 bis 1,0 Gew.-% und Cu: 0,05 bis 0,5 Gew.-% besteht, und darüber hinaus insgesamt 0,03 bis 0,6 Gew.-% eines Elements oder mehrerer Elemente umfasst, die aus Mn, Cr und Ti ausgewählt sind, und der Rest aus Al und unvermeidbaren Unreinheiten besteht.

3. Elektrisches Verteilersystem nach Anspruch 1 oder 2,
dadurch gekennzeichnet, dass die Aluminiumlegierung, aus der sich der verdrillte Drahtleiter (2) zusammensetzt, aus Zr: 0,03 bis 0,4 Gew.-%, Fe: 0,05 bis 0,2 Gew.-% und Si: 0,05 bis 0,2 Gew.-% besteht und darüber hinaus insgesamt 0,003 bis 0,05 Gew.-% eines Elements oder mehrerer Elemente umfasst, die aus Be, Sr, Mg, Ti und V ausgewählt sind, und der Rest aus Al und unvermeidlichen Unreinheiten besteht.

4. Elektrisches Verteilersystem nach einem der Ansprüche 1 bis 3,
dadurch gekennzeichnet, dass die Verbindungsklemme (7) auf einer Fläche mit Ni oder einer Ni-Legierung beschichtet ist, dessen Hauptbestandteil Ni mit einer Dicke von 5 μm oder darunter ist.

5. Elektrisches Verteilersystem nach einem der Ansprüche 1 bis 4,
dadurch gekennzeichnet, dass das elektrische Verteilersystem eine elektromagnetisch abschirmende Metallschicht (4), um eine Außenfläche des isolierbeschichteten verdrillten Drahtleiters (2) abzudecken, und darüber hinaus noch eine isolierbeschichtete Schicht (5) umfasst, welche die Außenschicht der elektromagnetisch abschirmenden Metallschicht (4) abdeckt.

6. Elektrisches Verteilersystem nach Anspruch 5,
dadurch gekennzeichnet, dass sich die elektromagnetisch abschirmende Metallschicht (4) aus einem netzförmig angelegten Teil zusammensetzt, das aus einem Aluminiummetall oder einer Aluminiumlegierung hergestellt ist.

Revendications

1. Ensemble distributeur électrique comprenant un câble de distribution (1) composé d’un conducteur en fil torsadé avec revêtement isolant (2) fabriqué en un métal aluminium ou un alliage d’aluminium et une borne de connexion (7) connectée à une extrémité du conducteur en fil torsadé (2),
dans lequel le conducteur en fil torsadé (2) est fabriqué en un métal aluminium ou un alliage d’aluminium ayant une conductivité de 50 % ou plus sous IACS et ledit conducteur en fil torsadé (2) et ladite borne de connexion (7) sont connectés par soudage par pression avec vibrations ultrasonores, **caractérisé en ce que**
ladite borne de connexion (7) connectée au dit conducteur en fil torsadé (2) est fabriquée en un métal aluminium

ou un alliage d'aluminium ayant une élongation de 20 % ou plus et consistant en Zr : 0,03 à 0,4 % en poids et Si : 0,05 à 0,15 % en poids et le reste consistant en Al et en impuretés inévitables.

2. Ensemble distributeur électrique comprenant un câble de distribution (1) composé d'un conducteur en fil torsadé avec revêtement isolant (2) fabriqué en un métal aluminium ou un alliage d'aluminium et une borne de connexion (7) connectée à une extrémité du conducteur en fil torsadé (2),
dans lequel le conducteur en fil torsadé (2) est fabriqué en un métal aluminium ou un alliage d'aluminium ayant une conductivité de 50 % ou plus sous IACS et ledit conducteur en fil torsadé (2) et ladite borne de connexion (7) sont connectés par soudage par pression avec vibrations ultrasonores, **caractérisé en ce que**
ladite borne de connexion (7) connectée au dit conducteur en fil torsadé (2) est fabriquée en un métal aluminium ou un alliage d'aluminium ayant une élongation de 20 % ou plus et consistant en Mg : 0,3 à 1,8 % en poids, Si : 0,15 à 1,5 % en poids, Fe : 0,1 à 1,0 % en poids et Cu : 0,05 à 0,5 % en poids et incluant en outre au total 0,03 à 0,6 % en poids d'un ou de plusieurs éléments sélectionnés parmi le Mn, le Cr et le Ti et le reste consistant en Al et en impuretés inévitables.

3. Ensemble distributeur électrique selon l'une quelconque des revendications 1 ou 2,
caractérisé en ce que ledit alliage d'aluminium composant ledit conducteur en fil torsadé (2) consiste en Zr : 0,03 à 0,4 % en poids, Fe : 0,05 à 0,2 % en poids et Si : 0,05 à 0,2 % en poids et inclut en outre au total 0,003 à 0,05 % en poids d'un ou de plusieurs éléments sélectionnés parmi le Be, le Sr, le Mg, le Ti et le V, le reste consistant en A1 et en impuretés inévitables.

4. Ensemble distributeur électrique selon l'une quelconque des revendications 1 à 3,
caractérisé en ce que ladite borne de connexion (7) est revêtue sur une surface de Ni ou un alliage de Ni dont le composant principal est Ni en une épaisseur de 5 μm ou moins.

5. Ensemble distributeur électrique selon l'une quelconque des revendications 1 à 4,
caractérisé en ce que ledit ensemble distributeur électrique comprend une couche métallique de blindage électromagnétique (4) recouvrant une surface extérieure dudit conducteur (2) en fil torsadé avec revêtement isolant et, en outre, une couche de revêtement isolant (5) couvrant la surface extérieure de ladite couche métallique de blindage électromagnétique (4).

6. Ensemble distributeur électrique selon la revendication 5,
caractérisé en ce que ladite couche métallique de blindage électromagnétique (4) est composée d'un élément réticulé fabriqué en un métal aluminium ou un alliage d'aluminium.

FIG. 1(a)

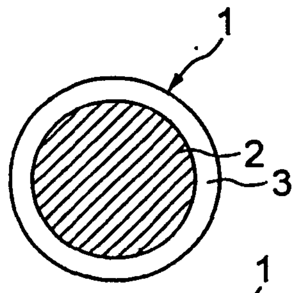


FIG. 1(b)

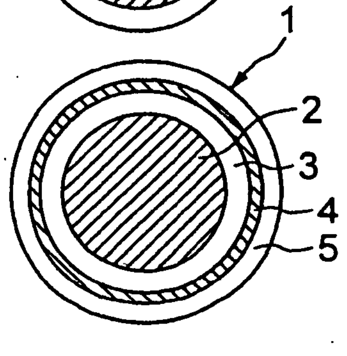


FIG. 2(a)

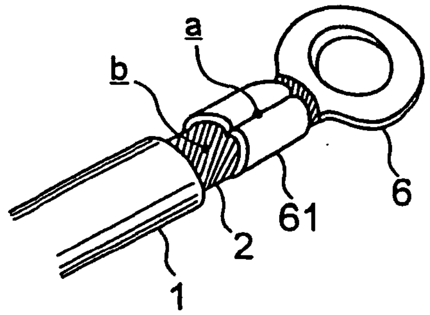


FIG. 2(b)

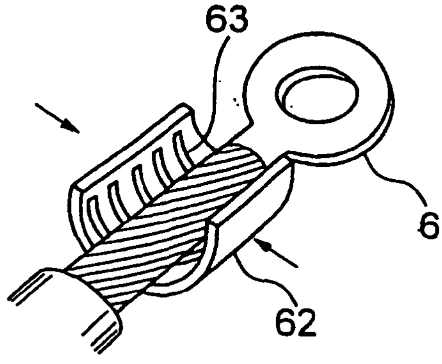


FIG. 3

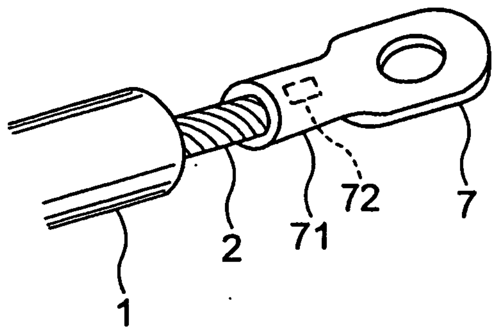
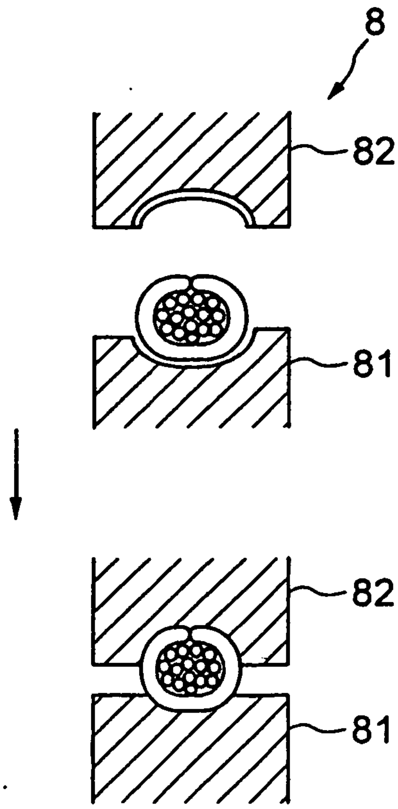


FIG. 4



REFERENCES CITED IN THE DESCRIPTION

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