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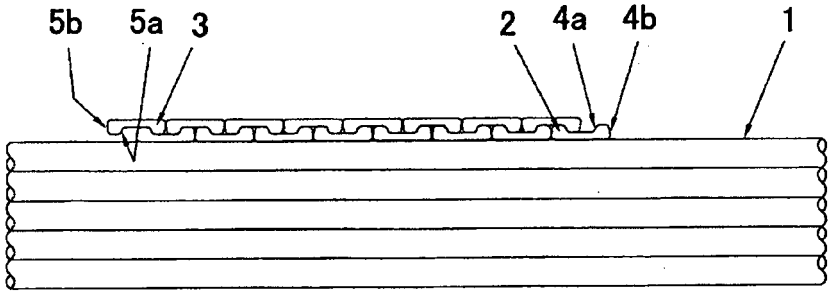
(54) WRAPPING WIRE WITH C-SHAPED CROSS-SECTION, AND CABLE WRAPPING STRUCTURE AND METHOD USING THE SAME

(57) Provided are wrapping wire with a C-shaped cross-section, and cable wrapping structure and method using the same. The wrapping wire, which is spirally wound around the outer circumference of a main cable (1) and has a substantially C-shaped cross-section, is wound so as to form a first layer wherein the open side of the C-shaped cross-section being directed outward of the radial direction of the main cable (1), wrapping wire (2) is spirally wound at a condition where the wound wire parts are adjacent to one another, and a second layer wherein the open side of the C-shaped cross-section being directed inward of the radial direction of the main cable (1), wrapping wire (3) is spirally wound on the first layer at a condition where the wound wire parts are adjacent to one another. The wrapping wires (2, 3) are configured such that inside surfaces (4a, 5a) of arm portions of the C-shaped cross-section are formed obliquely relative to the radial direction of the main cable (1), and interlock to each other in the axial direction of the main cable (1), in a half-pitch displaced state. The problems encountered when using wrapping wire with a Z-shaped cross-section can be all overcome, enabling easy production and cost reduction of the wrapping wire itself, and structural simplification, size reduction and cost reduction of a wrapping machine.

FIG. 2



EP 2 657 407 A1

Description

Technical Field of the Invention

[0001] The present invention relates to a wrapping wire which is spirally wound around a main cable and has a substantially C-shaped cross-section, and cable wrapping structure and cable wrapping method using the wrapping wire with a C-shaped cross-section.

Background Art of the Invention

[0002] For a thick cable formed by bundling many metal wires in parallel with one another (in this application, called as "main cable", for example, a cable for a suspension bridge), in order to perform an anti-corrosion treatment by preventing invasion of water and the like into the interior, it is known that it is effective to wind a wrapping wire around the outer circumference of the main cable without gaps and tightly. However, in case of a structure where a wrapping wire with a circular cross-section is used, there is a fear that, by a condition where the main cable receives a fluctuation of load applied in the axial direction or expansion/contraction caused by thermal expansion is repeated, gaps are generated between contact portions of wound wire parts of the wrapping wire spirally wound and through the gaps, or, cracks are generated in a thick-film painting coated on the outside of the wound wrapping wire originating from the occurrence of the gaps and through the cracks, rainwater and the like enters thereinto, and the anti-corrosion performance may be reduced.

[0003] In order to cope with such a problem, a wrapping structure of a cable for a suspension bridge using a wrapping wire with a substantially Z-shaped cross-section is proposed (Patent document 1). In this cable wrapping structure, as shown in Fig. 4, a wrapping wire 105 with a substantially Z-shaped cross-section formed with hook-shaped engaging portions 103, 104 on both sides of the left hand and right hand is spirally wound around the outer circumference of a main cable 102 formed by bundling many metal wires 101 in parallel with one another (cable for a suspension bridge) at a condition where the insides of the projected parts of the engaging portions 103, 104 are formed obliquely and the projected parts are tightly contacted and engaged with each other. In this cable wrapping structure, because wound parts of wrapping wire 105 with the substantially Z-shaped cross-section, adjacent to each other, are engaged with each other, gaps caused by fluctuation of bridge load or repeated expansion/contraction due to thermal expansion can be prevented from being generated, and cracks in a thick-film painting 106 coated on the outer surface of the wrapping wire 105 can be prevented from being generated.

Prior art documents

Patent documents

[0004]

Patent document 1: JP-B 2,986,288

Summary of the Invention

Problems to be solved by the Invention

[0005] In the above-described cable wrapping structure using the wrapping wire with a substantially Z-shaped cross-section that is disclosed in Patent document 1, although an excellent effect can be exhibited from the viewpoint of improvement of anti-corrosion performance, the following problems are left from the viewpoints of facilitation of production and cost reduction of the wrapping wire itself, prevention of occurrence of inexpedience at the time of wrapping and the like, structural simplification, size reduction and cost reduction of a wrapping machine.

[0006] Although the cross-sectional shape of the wrapping wire with the above-described substantially Z-shaped cross-section is formed usually by rolling process, because it is an asymmetrical cross-sectional shape with left/right hands which has hook-shaped engaging portions on both the left and right sides, the shape of the roll for the rolling process inevitably becomes relatively complicated. Therefore, there occurs a limit in reduction of the cost for producing the wrapping wire including manufacturing cost of the roll, etc., and there left a problem also in facilitation of production of the wrapping wire itself. Further, although plating such as molten zinc plating is usually performed on the surface of wrapping wire as preservation treatment, in the above-described substantially Z-shaped cross-section which has the hook-shaped engaging portions, in that the projection directions of the projected parts are directions opposite to each other, on both sides of left hand and right hand, there is a fear that a defect such as plating bank may occur at a position of any one of the hook-shaped engaging portions.

[0007] Further, since the wrapping wire with the substantially Z- shaped cross- section is being wound such that the wire wound adjacently and successively is wound so as to partially overlap onto the wire wound immediately before when the wire is wound spirally, regardless of single wire winding or double wire winding, also because the wire is being performed with molten zinc plating, if the winding tension is low, the tightening condition of the wire being wound successively becomes poor by the cause of the friction force between the wire parts adjacent to each other, and the winding diameter is liable to gradually become greater. As a result, there is a case where the wound wire expands at a bell- like state and it is placed apart from the main cable. In a conventional method, in order to prevent such an inexpedience, the wire is being

wound at a tension stronger than a certain level, but it is difficult to completely remove the fear of occurrence of the inexpedience on account of the shape of the cross-section of the wire.

[0008] Further, although a wrapping machine is usually set up on the main cable so as to extend across the main cable, because the reaction force of the winding tension acts to the machine, a torque (moment) around the main cable as the center of the torque is always applied to the wrapping machine, and it becomes a force operating so as to make the machine fall down. Although actually various counter measures are taken in order to prevent the falling down, because the winding tension must be set to be great to some extent as described above, the counter measure against the reaction force for preventing the falling down also becomes a relatively complicated and large- sized structure, and the wrapping machine becomes relatively expensive. Further, although a motor is mounted on the wrapping machine for winding the wrapping wire, in order to increase the winding tension, the capacity of the motor inevitably becomes great, and therefore, from this point of view, in the present circumstances it is difficult to make the wrapping machine low-cost.

[0009] Furthermore, as described above, since the winding tension must be set to be great to some extent and it is necessary to apply a tension greater than a certain level to the wrapping wire, in order to prevent breakage of the wire at the time of winding the wire, the cross-sectional area of the wire cannot be smallened so much. Therefore, there occurs a limit in reduction of the amount of the material used for production of the wire, and also from this point of view, cost reduction is difficult in the present circumstances.

[0010] Accordingly, paying attention to the problems in the present circumstances as described above, in particular, the problems in the cable wrapping structure disclosed in Patent document 1 where the wrapping wire with a substantially Z- shaped cross- section is used, an object of the present invention is to provide a wrapping wire with a substantially C- shaped cross- section capable of facilitation of production and cost reduction of a wrapping wire itself, prevention of occurrence of inexpedience at the time of wrapping and the like, structural simplification, size reduction and cost reduction of a wrapping machine as compared with the structure disclosed in Patent document 1, and cable wrapping structure and method using the same.

Means for solving the Problems

[0011] To achieve the above-described object, a wrapping wire with a C-shaped cross-section according to the present invention is a wrapping wire spirally wound around an outer circumference of a main cable formed by bundling many metal wires in parallel with one another, and is characterized in that the wrapping wire has a substantially C-shaped cross-section, the wrapping wire is wound so as to form a first layer wherein an open side of the substantially C-shaped cross-section being directed outward of a radial direction of the main cable, the wrapping wire is spirally wound at a condition where wound wire parts of the wrapping wire are adjacent to one another, and a second layer wherein the open side of the substantially C-shaped cross-section being directed inward of the radial direction of the main cable, the wrapping wire is spirally wound on the first layer at a condition where wound wire parts of the wrapping wire are adjacent to one another, and the substantially C-shaped cross-section is formed such that, at a condition where wound wrapping wire of the first layer and wound wrapping wire of the second layer are displaced substantially by a half pitch in an axial direction of the main cable, an inside surface of an arm portion of the substantially C-shaped cross-section of one of the wound wrapping wires and an inside surface of an arm portion of the substantially C-shaped cross-section of the other wound wrapping wire are formed obliquely relative to the radial direction of the main cable and interlock to each other in the axial direction of the main cable.

[0012] Further, a cable wrapping structure using a wrapping wire with a C- shaped cross- section according to the present invention is characterized in that the cable wrapping structure comprises a first layer wherein the wrapping wire formed in a substantially C- shaped cross-section is spirally wound around an outer circumference of a main cable formed by bundling many metal wires in parallel with one another, at a condition where an open side of the substantially C- shaped cross- section is directed outward of a radial direction of the main cable and wound wire parts of the wrapping wire are adjacent to one another, and a second layer wherein the wrapping wire is spirally wound on the first layer at a condition where the open side of the substantially C- shaped cross-section is directed inward of the radial direction of the main cable, wound wire parts of the wrapping wire are adjacent to one another, and wound wrapping wire of the second layer is displaced substantially by a half pitch relative to wound wrapping wire of the first layer in an axial direction of the main cable, and the cable wrapping structure is configured such that an inside surface of an arm portion of the substantially C- shaped cross- section of the wound wrapping wire of the first layer and an inside surface of an arm portion of the substantially C- shaped cross- section of the wound wrapping wire of the second layer, both formed obliquely relative to the radial direction of the main cable, interlock to each other in the axial direction of the main cable.

[0013] In the above-described wrapping wire with a C-shaped cross-section and cable wrapping structure using the same, it is preferred that the surface of the wrapping wire is plated for preservation and the like. As the plating, molten zinc plating, which has been performed in a conventional technology, can be employed.

[0014] In such a wrapping wire with a C-shaped cross-section according to the present invention and cable

wrapping structure using the same, the wrapping wire with a C-shaped cross-section forming the above-described first layer and the wrapping wire with a C-shaped cross-section forming the above-described second layer are spirally wound being overlapped around the outer circumference of the main cable at a condition where the open sides of the C-shaped cross-sections thereof are faced to each other, the arm portion of the C-shaped cross-section of the wound wrapping wire of the first layer and the arm portion of the C-shaped cross-section of the wound wrapping wire of the second layer are interlocked to each other at their inside surfaces, and wound wire parts adjacent to each other of the wrapping wire in the first layer and wound wire parts adjacent to each other of the wrapping wire in the second layer are maintained at a condition of tight contact with each other in the axial direction of the main cable, respectively. In other words, the wrapping wire of the first layer is maintained in a tight contact condition by the wrapping wire of the second layer, and the wrapping wire of the second layer is maintained in a tight contact condition by the wrapping wire of the first layer, respectively. Then, because the maintaining of this tight contact condition can be achieved irrelevant to fluctuation of load applied to the main cable and expansion/contraction of the main cable ascribed to thermal expansion, both the first layer and the second layer can be maintained at a target wrapping condition causing no gaps.

[0015] Further, since the shape of the cross- section of the above- described wrapping wire is a substantially C- shaped cross section and the shape of this C- shaped cross section can be easily formed to be symmetric in the left/ right hands in its cross- section, as compared with the wire with Z- shaped cross- section in the aforementioned Patent document 1, the shape is simple, and it can be easily produced inexpensively. Even in case of being produced by rolling process, the shape of the roll for the rolling process can be made simpler than that in case of Z- shaped cross- section. Further, since the left and right arm portions extend in a same direction in the C- shaped cross section, even in case where molten zinc plating and the like is performed, a defect such as plating bank hardly occurs from the shape in cross- section.

[0016] Further, in the respective first and second layers, since the wire parts of the wrapping wire with a C-shaped cross- section are disposed adjacent to each other at a condition where the outer side surfaces are tightly contacted with each other, without causing partial overlapping of adjacent wire parts, a state such as one in the structure described in Patent document 1, where the wire parts adjacent to each other are wound being partially overlapped and the wound wire expands at a bell- like condition and it is placed apart from the main cable, does not occur. Therefore, in the present invention, even in a small winding tension, such a fear of occurrence of inexpedience as in the wrapping wire with a Z- shaped cross-section is not present at all.

[0017] Further, from the condition where the winding tension may be small, the reaction force of the winding tension acting to a wrapping machine also becomes small, and the counter measure for the reaction force for preventing falling down of the machine can be carried out relatively easily. Further, as the result, because the machine can also be made small- sized, it can be manufactured more inexpensively than a conventional machine.

[0018] Furthermore, because the winding tension can be small, even if the cross- sectional area of the wire is made small, it is hardly broken. Therefore, since the amount of material used for production of the wrapping wire can be reduced as compared with that in the conventional technology, also from this point of view, it can be produced more inexpensively than the conventional wire with a Z- shaped cross- section.

[0019] The present invention also provides a cable wrapping method. Namely, a cable wrapping method using a wrapping wire with a C-shaped cross-section according to the present invention is characterized in that a first layer is formed such that the wrapping wire formed in a substantially C-shaped cross-section is spirally wound around an outer circumference of a main cable formed by bundling many metal wires in parallel with one another, at a condition where an open side of the substantially C-shaped cross-section is directed outward of a radial direction of the main cable and wound wire parts of the wrapping wire are adjacent to one another, a second layer is formed such that the wrapping wire is spirally wound on the first layer at a condition where the open side of the substantially C-shaped cross-section is directed inward of the radial direction of the main cable, wound wire parts of the wrapping wire are adjacent to one another, and wound wrapping wire of the second layer is displaced substantially by a half pitch relative to wound wrapping wire of the first layer in an axial direction of the main cable, and an inside surface of an arm portion of the substantially C-shaped cross-section of the wound wrapping wire of the first layer and an inside surface of an arm portion of the substantially C-shaped cross-section of the wound wrapping wire of the second layer, both formed obliquely relative to the radial direction of the main cable, are interlocked to each other in the axial direction of the main cable.

[0020] In this cable wrapping method using a wrapping wire with a C-shaped cross-section, the wrapping wire of the first layer and the wrapping wire of the second layer can be wound on the main cable by a single wrapping machine. Namely, immediately after the wrapping wire of the first layer has been wound, the wrapping wire of the second layer can be wound in order. Therefore, even in case where the wrapping formation requires at least the first layer and the second layer, the wrapping time and the like does not particularly increase, and it is possible to easily proceed with the wrapping.

Effect according to the Invention

[0021] Thus, in the wrapping wire with a C- shaped cross- section and cable wrapping structure and method using the same according to the present invention, substantially all the problems in the cable wrapping structure using the wrapping wire with a Z- shaped cross- section disclosed in Patent document 1 can be solved, and facilitation of production and cost reduction of the wrapping wire itself, prevention of occurrence of inexpedience at the time of wrapping and the like, structural simplification, size reduction and cost reduction of a wrapping machine become possible.

Brief explanation of the drawings

[0022]

[Fig. 1] Fig. 1 is a perspective view showing cable wrapping structure and method using a wrapping wire with a C-shaped cross-section according to an embodiment of the present invention.

[Fig. 2] Fig. 2 is a partial sectional view of the cable wrapping structure depicted in Fig. 1.

[Fig. 3] Fig. 3 is an enlarged partial sectional view showing an interlocking state of wrapping wires with C-shaped cross-section of the first layer and the second layer in the cable wrapping structure depicted in Fig. 1.

[Fig. 4] Fig. 4 is a partial sectional view showing a cable wrapping structure using a conventional wrapping wire with a Z-shaped cross-section disclosed in Patent document 1.

Embodiments for carrying out the Invention

[0023] Hereinafter, desirable embodiments of the present invention will be explained referring to figures. Figs. 1 to 3 show a wrapping wire with a C- shaped cross-section according to an embodiment of the present invention, and cable wrapping structure and method using the same. In Fig. 1, symbol 1 indicates a main cable formed by bundling many metal wires 1a in parallel with one another, and around the outer circumference of the main cable 1, the wrapping wire with a C- shaped cross-section according to the present invention is being spirally wound in order as a wrapping wire with a C- shaped cross- section 2 forming a first layer at the inner side in the radial direction of the main cable 1 and as a wrapping wire with a C- shaped cross- section 3 forming a second layer at the outer side of the first layer in the radial direction, by a single wrapping machine (not shown) . These wrapping wires 2, 3 are substantially same wires, both are formed in a substantially C- shaped cross- section, and they are being wound at a condition where the open sides of the substantially C- shaped cross- sections are faced to each other. Namely, the first layer is formed by spirally winding wrapping wire 2 at a condition where the open sides of the substantially C- shaped cross- sections of the wound wire parts thereof are directed outward of the radial direction of main cable 1 and the wound wire parts are adjacent to one another, and the second layer is formed by spirally winding wrapping wire 3 on the first layer at a condition of being displaced by a half pitch relative to the wrapping wire 2 of the first layer and at a condition where the open sides of the substantially C-shaped cross- sections of the wound wire parts thereof are directed inward of the radial direction of the main cable 1 and the wound wire parts are adjacent to one another. To the surfaces of wrapping wires 2, 3, for example, molten zinc plating is performed for preservation and the like.

[0024] As shown in Figs. 2 and 3, wound wrapping wire 2 of the first layer and wound wrapping wire 3 of the second layer are wound at a condition displaced substantially by a half pitch in the axial direction of main cable 1, and in the wound condition, an inside surface 4a of the arm portion of the substantially C-shaped cross-section of one wound wrapping wire, for example, wrapping wire 2, and an inside surface 5a of the arm portion of the substantially C-shaped cross-section of the other wound wrapping wire, for example, wrapping wire 3, are formed obliquely relative to the radial direction of main cable 1 (formed in inclined surfaces), and the substantially C-shaped cross-section is formed so that the inside surfaces 4a, 5a are interlocked to each other in the axial direction of the main cable 1.

[0025] In both the first layer and the second layer, since wrapping wires 2, 3 are being wound in order at a condition where each open side of the substantially C-shaped cross-section is directed toward the same direction (in the first layer, directed outward of the radial direction of main cable 1, and in the second layer, directed inward of the radial direction of the main cable 1), the wound wire parts of the wrapping wires 2, 3 disposed adjacent to each other on the outer circumference of the main cable 1 are adjacent to each other at the same winding figure, respectively. Then, since there is no overlapping part in the adjacent wound wire parts of the wrapping wire 2 and the adjacent wound wire parts of the wrapping wire 3 and they are wound at a condition displaced from each other by a half pitch as described above, the adjacent wound wire parts of the wrapping wire 2 and the adjacent wound wire parts of the wrapping wire 3 are disposed adjacent to each other, respectively, at conditions where outside surfaces 4b of the arm portions of the substantially C-shaped cross-section are tightly contacted with each other and where outside surfaces 5b of the arm portions of the substantially C-shaped cross-section are tightly contacted with each other.

[0026] Then, immediately after wrapping wire 2 of the first layer is wound, wrapping wire 3 of the second layer is being wound such that inside surface 5a formed on the inclined surface of the arm portion of the substantially C- shaped cross- section of the wrapping wire 3 is engaged with inside surface 4a formed on the inclined sur-

face of the arm portion of the substantially C- shaped cross- section of the wrapping wire 2, and therefore, the wrapping wire 3 is being overlapped and wound so as to pull the adjacent wound wire parts of the wrapping wire 2 close to each other and bring the outside surfaces 4b thereof into tight contact with each other. At the same time, by the reaction force received form the wrapping wire 2 side at that time, the adjacent wound wire parts of the wrapping wire 3 are also pulled close to each other, and the outside surfaces 5b thereof are brought into tight contact with each other. Therefore, merely by overlapping and winding wrapping wires 2, 3 with substantially C- shaped cross- sections in order at a predetermined formation, substantially automatically the respective wrapping wires 2, 3 are spirally wound at a condition where gaps are not generated between the adjacent wound wire parts of the wrapping wire 2 and between the adjacent wound wire parts of the wrapping wire 3, and an ideal wrapping structure can be obtained extremely easily.

[0027] In this wrapping structure, because gaps are not generated particularly between the adjacent wound wire parts of the outer-side wrapping wire 3, a desired thick-film painting (not shown in the figure) can also be easily performed. Also in such a case, since the wound wire parts of the wrapping wire 2 adjacently disposed and the wound wire parts interlocked thereto of the wrapping wire 3 adjacently disposed are not basically influenced by fluctuation of the load applied to main cable 1 or expansion/contraction of the main cable 1 originating from thermal expansion, the wrapping structure does not collapse and the desired wrapping formation can be maintained as it is, and therefore, cracks do not occur in the thick-film painting applied thereon.

[0028] Further, as aforementioned, because wrapping wires 2, 3 are formed in a simple shape of a substantially C- shaped cross- section, they can be produced easily and inexpensively as compared with the wire with a Z-shaped cross section disclosed in Patent document 1. The roll used for production by rolling process can also be made simply and inexpensively. Even in case where molten zinc plating and the like is performed, a defect such as plating bank hardly occurs.

[0029] Further, as aforementioned, both the first and second layers can be avoided to fall in a condition where the wire parts adjacent to each other are wound being partially overlapped and the wound wire expands at a bell- like condition and it is placed apart from main cable 1. Therefore, the winding tension may be small. As a result, because the reaction force of the winding tension acting to a wrapping machine also may be small, the counter measure for the reaction force for preventing falling down of the machine can be carried out easily. Further, because the wrapping machine can also be made small- sized, it can be manufactured more inexpensively.

[0030] Furthermore, as aforementioned, as the result of being able to make the winding tension small, it also becomes possible to make the cross- sectional area of the wire small, and it also becomes possible to reduce the amount of material used for production of the wrapping wire, thereby reducing the cost.

Industrial Applications of the Invention

[0031] The wrapping wire with a C-shaped cross-section and the cable wrapping structure and method according to the present invention can be applied to any field required with wrapping around a main cable, in particular, they are suitable for wrapping around a cable for a suspension bridge.

Explanation of symbols

[0032]

1: main cable
1a: metal wire
2: wrapping wire with a C-shaped cross-section forming first layer
3: wrapping wire with a C-shaped cross-section forming second layer
4a, 5a: inside surface of arm portion of C-shaped cross-section
4b, 5b: outer side surface of arm portion of C-shaped cross-section

Claims

1. A wrapping wire with a C-shaped cross-section to be spirally wound around an outer circumference of a main cable formed by bundling many metal wires in parallel with one another, **characterized in that** said wrapping wire has a substantially C-shaped cross-section, said wrapping wire is wound so as to form a first layer wherein an open side of said substantially C-shaped cross-section being directed outward of a radial direction of said main cable, said wrapping wire is spirally wound at a condition where wound wire parts of said wrapping wire are adjacent to one another, and a second layer wherein said open side of said substantially C-shaped cross-section being directed inward of said radial direction of said main cable, said wrapping wire is spirally wound on said first layer at a condition where wound wire parts of said wrapping wire are adjacent to one another, and said substantially C-shaped cross-section is formed such that, at a condition where wound wrapping wire of said first layer and wound wrapping wire of said second layer are displaced substantially by a half pitch in an axial direction of said main cable, an inside surface of an arm portion of said substantially C-shaped cross-section of one of said wound wrapping wires and an inside surface of an arm portion of said substantially C-shaped cross-section of the other wound wrapping wire are formed obliquely

relative to said radial direction of said main cable and interlock to each other in said axial direction of said main cable.

2. The wrapping wire with a C-shaped cross-section according to claim 1, wherein a surface of said wrapping wire is plated.

3. A cable wrapping structure using a wrapping wire with a C-shaped cross-section, **characterized in that** said cable wrapping structure comprises a first layer wherein said wrapping wire formed in a substantially C-shaped cross-section is spirally wound around an outer circumference of a main cable formed by bundling many metal wires in parallel with one another, at a condition where an open side of said substantially C-shaped cross-section is directed outward of a radial direction of said main cable and wound wire parts of said wrapping wire are adjacent to one another, and a second layer wherein said wrapping wire is spirally wound on said first layer at a condition where said open side of said substantially C-shaped cross-section is directed inward of said radial direction of said main cable, wound wire parts of said wrapping wire are adjacent to one another, and wound wrapping wire of said second layer is displaced substantially by a half pitch relative to wound wrapping wire of said first layer in an axial direction of said main cable, and said cable wrapping structure is configured such that an inside surface of an arm portion of said substantially C-shaped cross-section of said wound wrapping wire of said first layer and an inside surface of an arm portion of said substantially C-shaped cross-section of said wound wrapping wire of said second layer, both formed obliquely relative to said radial direction of said main cable, interlock to each other in said axial direction of said main cable.

4. The cable wrapping structure using a wrapping wire with a C-shaped cross-section according to claim 3, wherein a surface of said wrapping wire is plated.

5. A cable wrapping method using a wrapping wire with a C-shaped cross-section, **characterized in that** a first layer is formed such that said wrapping wire formed in a substantially C-shaped cross-section is spirally wound around an outer circumference of a main cable formed by bundling many metal wires in parallel with one another, at a condition where an open side of said substantially C-shaped cross-section is directed outward of a radial direction of said main cable and wound wire parts of said wrapping wire are adjacent to one another, a second layer is formed such that said wrapping wire is spirally wound on said first layer at a condition where said open side of said substantially C-shaped cross-section is directed inward of said radial direction of said main cable, wound wire parts of said wrapping wire are adjacent to one another, and wound wrapping wire of said second layer is displaced substantially by a half pitch relative to wound wrapping wire of said first layer in an axial direction of said main cable, and an inside surface of an arm portion of said substantially C-shaped cross-section of said wound wrapping wire of said first layer and an inside surface of an arm portion of said substantially C-shaped cross-section of said wound wrapping wire of said second layer, both formed obliquely relative to said radial direction of said main cable, are interlocked to each other in said axial direction of said main cable.

6. The cable wrapping method using a wrapping wire with a C-shaped cross-section according to claim 5, wherein said wrapping wire of said first layer and said wrapping wire of said second layer are being wound on said main cable by a single wrapping machine.

FIG. 1

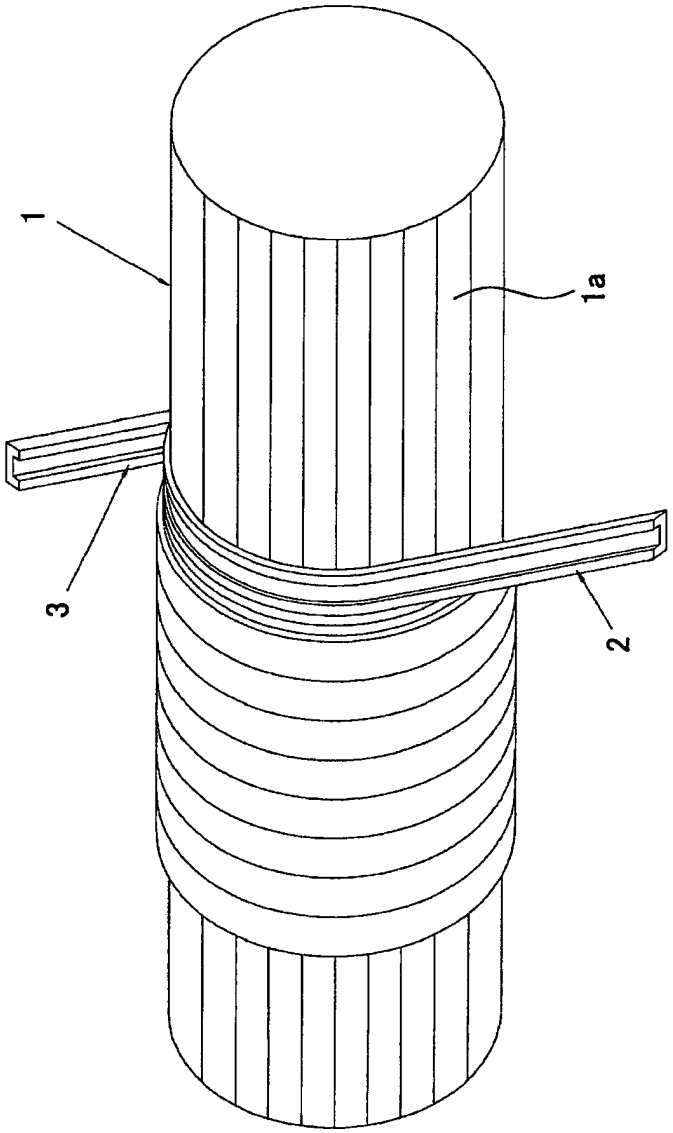


FIG. 2

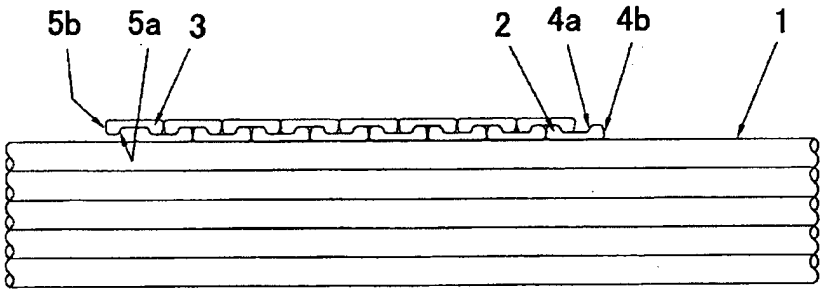


FIG. 3

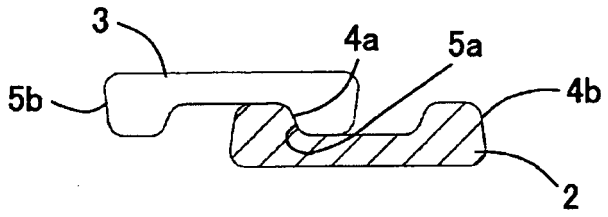
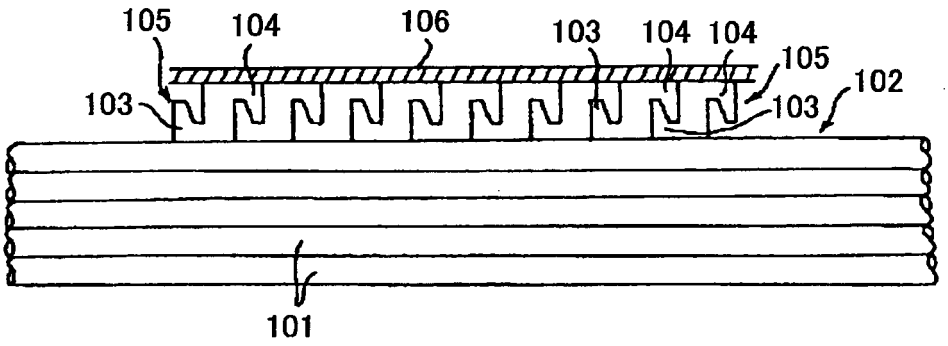


FIG. 4



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/072963

A. CLASSIFICATION OF SUBJECT MATTER
E01D11/02(2006.01)i, *D07B1/06*(2006.01)i, *E01D19/08*(2006.01)i, *E01D19/16*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
E01D11/02, D07B1/06, E01D19/08, E01D19/16

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2011
Kokai Jitsuyo Shinan Koho 1971-2011 Toroku Jitsuyo Shinan Koho 1994-2011

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2986288 B2 (Nippon Steel Corp. et al.), 06 December 1999 (06.12.1999), entire text; all drawings (Family: none)	1-6
A	JP 11-508005 A (Freyssinet International Stup), 13 July 1999 (13.07.1999), entire text; all drawings & EP 833994 A & WO 1997/000361 A1 & FR 2735511 A & NO 975904 A & AU 6361796 A & CA 2225166 A	1-6
A	WO 00/06852 A1 (Freyssinet International (STUP)), 10 February 2000 (10.02.2000), entire text; all drawings & FR 2781829 A & AU 5044999 A	1-6

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
29 March, 2011 (29.03.11)	12 April, 2011 (12.04.11)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/072963

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4719945 A (Fabricated Plastics, Inc.), 19 January 1988 (19.01.1988), entire text; all drawings & CA 1289486 A	1-6

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2986288 B **[0004]**