

PHOTOELECTRIC COMPOSITE MEDIUM-VOLTAGE SHORE POWER CABLE AND MANUFACTURING METHOD THEREOF

[0001] The disclosure relates to a technical field of power cables, in particular to a photoelectric composite medium-voltage shore power cable and manufacturing method thereof.

BACKGROUND

[0002] Transportation by ship is advantageous because of large loading capacity and low cost. In recent years, the cargo throughput of major coastal ports has developed significantly. The cargo is loaded and unloaded by cranes, gantry cranes, shore-based cranes, and other large mobile loading and unloading equipment, which require shore power cables to provide higher power transmission capacity. The heavy oil and diesel fuel used by ships produces a large amount of sulfide and nitrogen oxides during combustion, causing pollution to the surrounding environment, so ships which are docked in port can instead connect by cable to a shore-based power supply. With the development of digital intelligent monitoring and communication functions, the current single-function shore power cable is lagging behind the current needs of development.

SUMMARY

[0003] In view of the above, a photoelectric composite medium-voltage shore power cable in one embodiment is disclosed together with a manufacturing method thereof, to provide a higher power transmission capacity. A bending radius of the cable is smaller, to improve the flexibility of the cable, and the current-carrying capacity of the cable is increased while achieving optical communication transmission function.

[0004] The photoelectric composite medium-voltage shore power cable includes a cable core, an inner sheath layer, a strengthening layer, and an outer layer. The cable core, the inner sheath layer, the strengthening layer, and the outer sheath layer are in that order from the inside to the outside of the cable. The inner sheath layer is wrapped around the cable core; the strengthening layer is wrapped around the inner sheath layer; and the outer sheath layer is wrapped around the strengthening layer.

[0005] The cable core includes three power cores and a flexible optical unit; the three power cores are positioned in parallel and in contact with each other and are in a flat shape; gaps are formed

between every two adjacent power cores and the inner sheath layer;The flexible optical unit is positioned in the gap and is in contact with two adjacent power cores.

[0006] Alternatively, the cable core further includes a flexible grounding core; the flexible optical unit and the flexible grounding core are positioned in different gaps, and the flexible grounding core is in contact with two adjacent power cores.

[0007] Alternatively, there are two flexible grounding cores, the flexible grounding cores are in different gaps formed between two different adjacent power cores and the inner sheath layer.

[0008] Alternatively, each of the power core includes a flexible power conductor core, a semi-conductive tape conductor shielding layer, a semi-conductive extruded conductor shielding layer, a high performance rubber insulation layer, a semi-conductive extruded insulation shielding layer, a semi-conductive tape insulation shielding layer, and a wire braided flexible insulation shielding layer positioned in that order from the inside to the outside of the power core.

[0009] Alternatively, technologies of conductor codirectional grouping stranding and integral double stranding in the same direction is applied in the flexible power conductor core.

[0010] Alternatively, the flexible grounding core includes a ground conductor core and a semi-conductive rubber insulation layer sequentially positioned from the inside to the outside of the flexible grounding core; the semi-conductive rubber insulation layer is in contact with two adjacent power cores.

[0011] Alternatively, the inner sheath layer is a flame-retardant thermoplastic elastomer inner sheath layer, the strengthening layer is a flexible high-strength fiber woven reinforcement layer, and the outer sheath layer is an oil-resistant flame-retardant outer sheath layer.

[0012] Alternatively, the flexible optical unit includes a high temperature resistant single-mode/multi-mode fiber, a flexible high-strength fiber reinforced core, and a flame-retardant thermoplastic sheath layer.

[0013] Alternatively, the cable core further includes a flexible control core unit; the flexible optical unit, the flexible grounding core, and the flexible control wire core unit are in different gaps, and the flexible control core unit is in contact with two adjacent power cores.

[0014] Alternatively, the flexible control core unit includes a control conductor core, a flexible rubber insulation layer, and an aluminum-plastic composite tape wrapping shielding layer.

[0015] A manufacturing method of the photoelectric composite medium-voltage shore power cable is disclosed in an embodiment of the present disclosure, the manufacturing method includes:

[0016] providing three power cores;

[0017] the three power cores are positioned in parallel and side by side;

[0018] embedding a flexible optical unit in the gap formed between adjacent power cores, and the flexible optical unit is in contact with two adjacent power cores;

[0019] extruding a flame-retardant thermoplastic elastomer on a surface of the flatted-circle structure formed by the three power cores and the flexible optical unit to form an inner sheath layer;

[0020] weaving flexible high-strength fibers on the inner sheath layer to form a strengthening layer;

[0021] extruding an oil-resistant flame-retardant material on the strengthening layer to form an outer sheath layer.

[0022] In the present disclosure, three power cores are positioned in parallel and in contact with each other and are in a flatted-circle structure, and gaps are formed between adjacent power cores. The flexible optical unit is embedded in the gap and is contact with the adjacent power cores. So that a higher power transmission capacity of the cable can be provided, bending radius of the cable is reduced, thus flexibility of the cable can be improved, and the current-carrying capacity of the cable can be increased while achieving the optical communication transmission function.

BRIEF DESCRIPTION OF DRAWINGS

[0023] Many aspects of the disclosure can be better understood with reference to the following drawings. The drawings in the following description are some embodiments of the present disclosure. Ordinary technicians can obtain other drawings based on these drawings without creative work.

[0024] FIG. 1 is a schematic view of a photoelectric composite medium-voltage shore power cable in an embodiment of the present disclosure.

[0025] FIG. 2 is a flowchart of a manufacturing method of the photoelectric composite medium-voltage shore power cable in an embodiment of the present disclosure.

[0026] The following specific embodiments will further illustrate the present disclosure in conjunction with the above-mentioned drawings.

DESCRIPTION OF MAIN COMPONENTS OR ELEMENTS

Main components and reference numbers thereof:

- photoelectric composite medium-voltage shore power cable 1;
- cable core 10;
- inner sheath layer 20;
- strengthening layer 30;

outer sheath layer 40;
power cord 11;
flexible optical unit 12;
gap 110;
flexible grounding core 13;
flexible power conductor core 111;
semi-conductive tape conductor shielding layer 112;
semi-conductive extruded conductor shielding layer 113;
high performance rubber insulation layer 114;
Semi-conductive extruded insulation shielding layer 115;
semi-conductive tape insulation shielding layer 116;
wire braided flexible insulation shielding layer 117;
grounding conductor core 131;
semi-conductive rubber insulation layer 132;
high temperature resistant single-mode/multi-mode fiber 121;
flexible high-strength fiber reinforced core 122;
flame-retardant thermoplastic sheath layer 123;
flexible control core unit 14;
control conductor core 141;
flexible rubber insulation layer 142;
Aluminum-plastic composite tape wrapping shielding layer 143.

DETAILED DESCRIPTION

[0027] To illustrate the above objectives, features and advantages of the present disclosure more clearly, the present disclosure will be described in detail below with reference to the accompanying drawings and specific embodiments. It should be noted that the embodiments of the application and the features in the embodiments can be combined with each other if there is no conflict.

[0028] In the following description, many specific details are explained for full understanding of the present disclosure. The described embodiments are only a part of the embodiments of the present disclosure, rather than all the embodiments. Based on the embodiments of the present disclosure, all other embodiments obtained by those of ordinary skill in the art without creative work shall fall within the protection scope of the present disclosure.

[0029] Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one skilled in the art. The terms used herein are only for describing specific embodiments, and are not intended to limit the present disclosure.

[0030] FIG. 1 a schematic view of a photoelectric composite medium-voltage shore power cable in an embodiment of the present disclosure. The photoelectric composite medium-voltage shore power cable 1 includes a cable core 10, an inner sheath layer 20, a strengthening layer 30, and an outer sheath layer 40. The cable core 10, the inner sheath layer 20, the strengthening layer 30, and the outer sheath layer 40 are positioned in that order from the inside to the outside of the cable. The inner sheath layer 20 is wrapped around the cable core 10. The strengthening layer 30 is wrapped around the inner sheath layer 20. The outer sheath layer 40 is wrapped around the strengthening layer 30. The cable core 10 includes three power cores 11 and a flexible optical unit 12. Three of the power cords 11 are positioned in parallel and in contact with each other, thus in a flattened-circle shape. Gaps 110 are formed between every two adjacent power cords 11 and the inner sheath layer 20. The flexible optical unit 12 is positioned in the gap 110 and is in contact with two adjacent power cores 11.

[0031] In the present embodiment, the cable core 10 further includes a flexible grounding core 13. The flexible optical unit 12 and the flexible grounding core 13 are in different gaps 110, and the flexible grounding core 13 is in contact with two adjacent power cores 11. The cable disclosed reduces the bending radius of the cable, improves the flexibility of the cable, and improves the current-carrying capacity of the cable while providing a grounding function.

[0032] In the present embodiment, the quantity of the flexible grounding core 13 is two, therefore, grounding wire of the cable may be a two-core ground wire. Two of the flexible grounding cores 13 are in different gaps 110 formed between two different adjacent power cores 11 and the inner sheath layer 20. In the present disclosure, the large size of a single grounding core can be avoided, and the overall external size of the photoelectric composite medium-voltage shore power cable 1 is not increased.

[0033] In the present embodiment, each of the power core 11 includes a flexible power conductor core 111, a semi-conductive tape conductor shielding layer 112, a semi-conductive extruded conductor shielding layer 113, a high performance rubber insulation layer 114, a semi-conductive extruded insulation shielding layer 115, a semi-conductive tape insulation shielding layer 116, and a wire braided flexible insulation shielding layer 117. The semi-conductive tape conductor shielding layer 112 and the semi-conductive extruded conductor shielding layer 113 form a combined conductor shielding structure, which improves the uniformity of the electric field distribution on a surface of the power conductor core. The semi-conductive extruded insulation shielding layer 115 is extruded and closely attached to an outer surface of the high performance rubber insulation layer 114, which improves the uniformity of the electric field distribution on the outer surface of the high

performance rubber insulation layer 114. Three-layer co-extrusion and continuous cross-linking technology is applied on the semi-conductive extruded conductor shielding layer 113, the high performance rubber insulation layer 114 and the semi-conductive extruded insulation shielding layer 115, to ensure concentricity and cross-linking uniformity, as well as the uniformity and stability of electric field distribution in the high performance rubber insulation layer 114. The semi-conductive tape insulation shielding layer 116 and the wire braided flexible insulation shielding layer 117 are in contact. The semi-conductive extruded insulation shielding layer 115, the semi-conductive tape insulation shielding layer 116, and the wire braided flexible insulation shielding layer 117 form an outer insulating shielding layer to ensure the uniformity of the electric field distribution on the outer surface of the high performance rubber insulation layer 114 and good induced current conductivity of the cable.

[0034] In the present embodiment, the flexible power conductor core 111 includes a stranded flexible copper wire conductor. The technologies of conductor codirectional grouping stranding and integral double stranding in the same direction are applied in the flexible power conductor core 111. In the present embodiment, five types of annealed oxygen-free copper wires of the flexible power conductor core 111 adopt codirectional grouping and integral backward twisting, and the twisting pitch is controlled to be 10-15 times the outer diameter of the conductor. The present disclosure effectively eliminates the internal stress of the optoelectronic composite medium-voltage shore power cable 1 through the twisting method of codirectional grouping and integral backward twisting, avoiding twisting of the finished product, and improving the flatness of wire core arrangement and overall flatness of cable.

[0035] The semi-conductive tape conductor shielding layer 112 includes an overlapping wrapping structure, and an overall average thickness of the semi-conductive tape conductor shielding layer 112 is about 0.1 to 0.3 mm. The semi-conductive extruded conductor shielding layer 113 adopts extrusion technology, and a thickness of the semi-conductive extruded conductor shielding layer 113 is about 0.6 to 1.0 mm. The high performance rubber insulation layer 114 includes an EPR (Ethylene Propylene Rubber) insulation material, which has the characteristics of high electrical performance, flexibility, low smoke, and is halogen-free. The semi-conductive extruded insulation shielding layer 115 includes a peelable semi-conductive layer electrical material, and the thickness of the semi-conductive extruded insulation shielding layer 115 is about 0.8 to 1.2 mm. The semi-conductive tape insulation shielding layer 116 includes an overlapping wrapping structure, and the overall average thickness of the semi-conductive tape insulation shielding layer 116 is about 0.1 to 0.3 mm. A multi-strand flexible tinned copper wire braiding technology is applied to the wire

braided flexible insulation shielding layer 117, and the braided coverage density of the wire braided flexible insulation shielding layer 117 is $\geq 90\%$.

[0036] In the present embodiment, the flexible grounding core 13 includes a ground conductor core 131 and a semi-conductive rubber insulation layer 132 sequentially positioned from the inside to the outside. The semi-conductive rubber insulation layer 132 is in contact with the two adjacent power cores 11. In the present embodiment, five types of annealed oxygen-free copper wires of the ground conductor core 131 all adopt codirectional grouping stranding and integral double stranding in the same direction, and the stranding pitch is controlled to be 10-15 times the outer diameter of the conductor. In the present disclosure, the semiconductor conductivity of the semi-conductive rubber insulation layer 132 achieves conduction between the flexible grounding core 13 and the wire braided flexible insulation shielding layer 117.

[0037] In the present embodiment, the inner sheath layer 20 is a flame-retardant thermoplastic elastomer inner sheath layer, the strengthening layer 30 is a flexible high-strength fiber woven reinforcement layer, and the outer sheath layer 40 is an oil-resistant flame-retardant outer sheath layer. The flame-retardant thermoplastic elastomer inner sheath layer is extruded outside the braided shielding layer of three insulated wire cores arranged in a flat and parallel manner. To fully cover and protect the wire cores, an extruded thickness of the inner sheath layer is at least 0.8-1.2 mm. The flexible high-strength fiber woven reinforcement layer includes a multi-strand flexible high-strength fiber woven structure, and the woven coverage density of the flexible high-strength fiber woven reinforcement layer is $\geq 60\%$. The oil-resistant flame-retardant outer sheath layer is extruded outside the flexible high-strength fiber woven reinforcement layer, and an extruded thickness of the outer sheath layer is at least 1.0 to 1.4 mm. In the present embodiment, if the photoelectric composite medium-voltage shore power cable 1 is a thermosetting sheathed cable, the entire photoelectric composite medium-voltage shore power cable 1 needs to be continuously vulcanized uniformly through high-temperature steam, so that material of the outer sheath is fully grafted and cross-linked. In the present disclosure, the semi-conductive tape conductor shielding layer 112, the semi-conductive extruded conductor shielding layer 113, the high performance rubber insulation layer 114, the semi-conductive extruded insulation shielding layer 115, the semi-conductive tape insulation shielding layer 116, the flame-retardant thermoplastic elastomer inner sheath layer, the flexible high-strength fiber woven reinforcement layer, and the oil-resistant flame-retardant outer sheath layer are all non-metallic materials. The photoelectric composite medium-voltage shore power cable 1 has flame-retardant properties.

[0038] In the present embodiment, the flexible optical unit 12 includes a high temperature resistant single-mode/multi-mode fiber 121, a flexible high-strength fiber reinforced core 122, and a flame-retardant thermoplastic sheath layer 123. In the present disclosure, the semi-conductive tape conductor shielding layer 112, the semi-conductive extruded conductor shielding layer 113, the high performance rubber insulation layer 114, the semi-conductive extruded insulation shielding layer 115, the semi-conductive tape insulation shielding layer 116, the flame-retardant thermoplastic elastomer inner sheath layer, the flexible high-strength fiber woven reinforcement layer, the oil-resistant flame-retardant outer sheath layer, the semi-conductive rubber insulation layer 132, the flexible high-strength fiber reinforced core 122, and the flame-retardant thermoplastic sheath layer 123 are all non-metallic materials. Therefore, the photoelectric composite medium-voltage shore power cable 1 has flame-retardant properties.

[0039] In the present embodiment, the cable core 10 further includes a flexible control core unit 14. The flexible optical unit 12, the flexible grounding core 13, and the flexible control wire core unit 14 are in different gaps 110, and the flexible control core unit 14 is in contact with two adjacent power cores 11. In the present disclosure, bending radius of the cable is reduced, flexibility and current-carrying capacity of the cable improved while achieving the control signal transmission function.

[0040] In the present embodiment, the flexible control core unit 14 includes a control conductor core 141, a flexible rubber insulation layer 142, and an aluminum-plastic composite tape wrapping shielding layer 143. The control conductor core 141 applies a multi-strand backtwist stranding technology of conductor. In the present embodiment, 5 types of annealed oxygen-free copper wire of the control conductor core 141 are made with multi-strand untwisted stranding technology, and the stranding pitch is controlled to be between 10 to 15 times the outer diameter of the conductor. In the present disclosure, the semi-conductive tape conductor shielding layer 112, the semi-conductive extruded conductor shielding layer 113, the high performance rubber insulation layer 114, the semi-conductive extruded insulation shielding layer 115, the semi-conductive tape insulation shielding layer 116, the flame-retardant thermoplastic elastomer inner sheath layer, the flexible high-strength fiber woven reinforcement layer, the oil-resistant flame-retardant outer sheath layer, the semi-conductive rubber insulation layer 132, the flexible high-strength fiber reinforced core 122, the flame-retardant thermoplastic sheath layer 123, the flexible rubber insulation layer 142, and the aluminum-plastic composite tape wrapping shielding layer 143 are all non-metallic materials. Therefore, the photoelectric composite medium-voltage shore power cable 1 including the flexible control core unit 14 has flame-retardant properties.

[0041] Fig. 2 is a flow chart of a manufacturing method of the photoelectric composite medium-voltage shore power cable of the present disclosure. The manufacturing method of the photoelectric composite medium-voltage shore power cable includes following steps:

[0042] S21: Provide three power cores.

[0043] S22: The three power cores are positioned side by side and in contact with each other.

[0044] S23: The flexible optical unit is embedded in the gap formed between adjacent power cores, and is in contact with the two adjacent power cores.

[0045] S24: Extruding a flame-retardant thermoplastic elastomer on a surface of the flattened-circle structure formed by the three power cores and the flexible optical unit to form an inner sheath layer.

[0046] S25: Weaving flexible high-strength fibers on the inner sheath layer to form a strengthening layer.

[0047] S26: Extruding an oil-resistant flame-retardant material on the strengthening layer to form an outer sheath layer.

[0048] In the present embodiment, the manufacturing method of the photoelectric composite medium voltage shore power cable includes:

[0049] Provide high temperature resistant single-mode/multi-mode fiber;

[0050] Winding a flexible high-strength fiber on the surface of the high-temperature resistant single-mode/multi-mode optical fiber to form a flexible high-strength fiber reinforced core;

[0051] A flame-retardant thermoplastic sheath is extruded on the surface of the flexible high-strength fiber reinforced core to form a flame-retardant thermoplastic sheath layer.

[0052] In the present embodiment, the step of the flexible optical unit being embedded in the gap formed between two adjacent power cores and contacting the two adjacent power cores includes:

[0053] The flexible grounding core and the flexible optical unit are embedded in different gaps formed between any two adjacent power cores among the three power cores, and the flexible grounding core and the flexible optical unit is in contact with two adjacent power cores.

[0054] The step of extruding a sheath on a surface of the flattened-circle structure formed by the three power cores and the flexible optical unit to form an inner sheath layer includes:

[0055] A sheath is extruded on the surface of the flattened-circle structure formed by the three power cores, the flexible optical unit, and the flexible grounding core to form an inner sheath layer.

[0056] In the present embodiment, the manufacturing method of the photoelectric composite medium voltage shore power cable includes:

[0057] Two of the flexible grounding cores being in different gaps formed between adjacent power cores.

[0058] In the present embodiment, the manufacturing method of the photoelectric composite medium voltage shore power cable includes:

[0059] Providing flexible power core;

[0060] Wrapping a semi-conductive shielding tape on a conductor surface of the flexible power core to form a semi-conductive tape conductor shielding layer;

[0061] Extruding a semi-conductive shielding layer on the surface of the semi-conductive tape conductor shielding layer to form a semi-conductive extruded conductor shielding layer;

[0062] Extruding high performance rubber insulation material on the surface of the semi-conductive extruded conductor shielding layer to form a high performance rubber insulation layer;

[0063] Extruding a semi-conductive insulating shield on the surface of the high performance rubber insulation layer to form a semi-conductive extruded insulation shielding layer;

[0064] Wrapping a semi-conductive shielding tape on the surface of semi-conductive extruded insulation shielding layer to form a semi-conductive tape insulation shielding layer;

[0065] Weaving flexible metal wire on the surface of the semi-conductive tape insulation shielding layer to form a wire braided flexible insulation shielding layer.

[0066] In the present embodiment, the manufacturing method of the photoelectric composite medium voltage shore power cable includes:

[0067] Provide flexible grounding core;

[0068] Extruding semi-conductive rubber insulation material on a conductor surface of the flexible grounding core to form a semi-conductive rubber insulation layer, and the semi-conductive rubber insulation layer is in contact with two adjacent power cores.

[0069] In the present embodiment, the step of the flexible optical unit being embedded in the gap between adjacent power cores and being in contact with the two adjacent power cores includes:

[0070] The flexible control core unit, the flexible grounding core, and the flexible optical unit are embedded in different gaps among the three power cores, and the flexible control core unit, the flexible grounding core, and the flexible optical unit are in contact with the adjacent power cores;

[0071] The step of extruding the sheath on the surface of the flatted-circle structure formed by the three power cord cores and the flexible optical unit to form an inner sheath layer includes:

[0072] Extruding the sheath on the flatted-circle structure surface formed by the three power cores, the flexible optical unit, the flexible grounding core, and the flexible control core unit forming an inner sheath layer.

[0073] In the present embodiment, the manufacturing method of the photoelectric composite medium voltage shore power cable includes:

[0074] Provide flexible control core unit;

[0075] Extruding flexible rubber insulation material on the conductor surface of the flexible control core unit to form a flexible rubber insulation layer;

[0076] Wrapping an aluminum-plastic composite shielding tape around the surface of the flexible rubber insulation layer to form an aluminum-plastic composite tape wrapping shielding layer.

[0077] The manufacturing method of the photoelectric composite medium-voltage shore power cable can be achieved in other ways, the description of the photoelectric composite medium-voltage shore power cable in FIG. 1 is not repeated here.

[0078] In the present disclosure, three of the power cords 11 are positioned side by side and in contact with each other and are in a flattened-circle structure, and gaps 110 are formed between every two adjacent power cores 11. The flexible optical unit 12 is embedded in the gap 110 and is contact with the adjacent power cores 11. The flattened-circle section of the flexible optical unit 12 and the three power cord cores 11 provides a higher power transmission capacity, reduces the bending radius of the cable, improves the flexibility of the cable, and increases the current-carrying capacity of the cable while achieving optical communication transmission function. In the present disclosure, the flexible power conductor core 111, the high performance rubber insulation layer 114, the flame-retardant thermoplastic elastomer inner sheath layer, the metal wire braided flexible insulation shielding layer 117, and the flexible high-strength fiber woven reinforcement layer further improve the flexibility of the cable.

[0079] The flame-retardant performance of the photoelectric composite medium-voltage shore power cable 1 in the present disclosure can meet the requirements of being tightly positioned in bundles according to the actual laying conditions. The requirements include: non-metal content of the cable being more than 7 liters per meter, and a burning height of the cable not exceeding 2.5 meters after burning for 40 minutes at a flame temperature of 800 degrees Celsius. Oil resistance performance of the cable can meet the requirements of IIRM902 mineral oil after 24 hours of oil resistance testing at 100 degrees Celsius. The requirements include: a change rate of the surface strength and elongation of the cable sheath not exceeding 35%; a low smoke performance meeting the minimum light transmittance of 60%; and a halogen-free performance satisfying the acid gas content of combustion $\leq 0.5\%$, fluorine content $\leq 0.1\%$, pH value ≥ 4.3 , and electrical conductivity $\leq 10 \mu\text{S} / \text{mm}$.

[0080] It should be noted that the above embodiments are only used to illustrate specific aspects of the present disclosure, and are not limitations. Those skilled in the art will appreciate that the instant

disclosure can be technically modified and can accept equivalent substitutions without departing from the spirit and scope of the claims.

CLAIMS

WHAT IS CLAIMED IS:

1. A photoelectric composite medium-voltage shore power cable, wherein:

the photoelectric composite medium-voltage shore power cable comprising a cable core, an inner sheath layer, a strengthening layer, and an outer layer positioned in that order from the inside to the outside of the cable; the inner sheath layer is wrapped around the cable core; the strengthening layer is wrapped around the inner sheath layer; the outer sheath layer is wrapped around the strengthening layer;

the cable core comprises three power cores and a flexible optical unit; the three power cores are positioned side by side and in contact with each other and are in a flatted-circle shape; gaps are formed between every two adjacent power cores and the inner sheath layer; the flexible optical unit is positioned in the gap and is in contact with two adjacent power cores.

2. The photoelectric composite medium-voltage shore power cable of claim 1, wherein: the cable core further comprises a flexible grounding core; the flexible optical unit and the flexible grounding core are in different gaps, and the flexible grounding core is in contact with two adjacent power cores.

3. The photoelectric composite medium-voltage shore power cable of claim 2, wherein: the quantity of the flexible grounding core is two, two flexible grounding cores are in different gaps.

4. The photoelectric composite medium-voltage shore power cable of claim 2, wherein: each of the power core comprises a flexible power conductor core, a semi-conductive tape conductor shielding layer, a semi-conductive extruded conductor shielding layer, a high performance rubber insulation layer, a semi-conductive extruded insulation shielding layer, a semi-conductive tape insulation shielding layer, and a wire braided flexible insulation shielding layer positioned in order from the inside to the outside of the power core.

5. The photoelectric composite medium-voltage shore power cable of claim 4, wherein the flexible grounding core comprises a ground conductor core and a semi-conductive rubber insulation layer that are sequentially positioned from the inside to the outside of the flexible grounding core; the semi-conductive rubber insulation layer is in contact with the two adjacent power cores.

6. The photoelectric composite medium-voltage shore power cable of claim 5, wherein the inner sheath layer is a flame-retardant thermoplastic elastomer inner sheath layer, the strengthening layer is a flexible high-strength fiber woven reinforcement layer, and the outer sheath layer is an oil-resistant flame-retardant outer sheath layer.

7. The photoelectric composite medium-voltage shore power cable of claim 6, wherein the flexible optical unit comprises a high temperature resistant single-mode/multi-mode fiber, a flexible high-strength fiber reinforced core, and a flame-retardant thermoplastic sheath layer.

8. The photoelectric composite medium-voltage shore power cable of claim 7, wherein: the cable core further comprises a flexible control core unit; the flexible optical unit, the flexible grounding core, and the flexible control wire core unit are in different gaps, and the flexible control core unit is in contact with two adjacent power cores.

9. The photoelectric composite medium-voltage shore power cable of claim 8, wherein: the flexible control core unit comprises a control conductor core, a flexible rubber insulation layer, and an aluminum-plastic composite tape wrapping shielding layer.

10. A manufacturing method of a photoelectric composite medium-voltage shore power cable, wherein, the manufacturing method comprising:

providing three power cores;

three power cores are positioned in parallel and in contact and are in a flattened-circle structure;

embedding a flexible optical unit in a gap formed between the two adjacent power cores, and the flexible optical unit is in contact with the two adjacent power cores;

extruding a flame-retardant thermoplastic elastomer on a surface of the flattened-circle structure formed by the three power cores and the flexible optical unit to form an inner sheath layer;

weaving flexible high-strength fibers on the inner sheath layer to form a strengthening layer;

extruding an oil-resistant flame-retardant material on the strengthening layer to form an outer sheath layer.