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(54) **CABLE AND CABLE ASSEMBLY**

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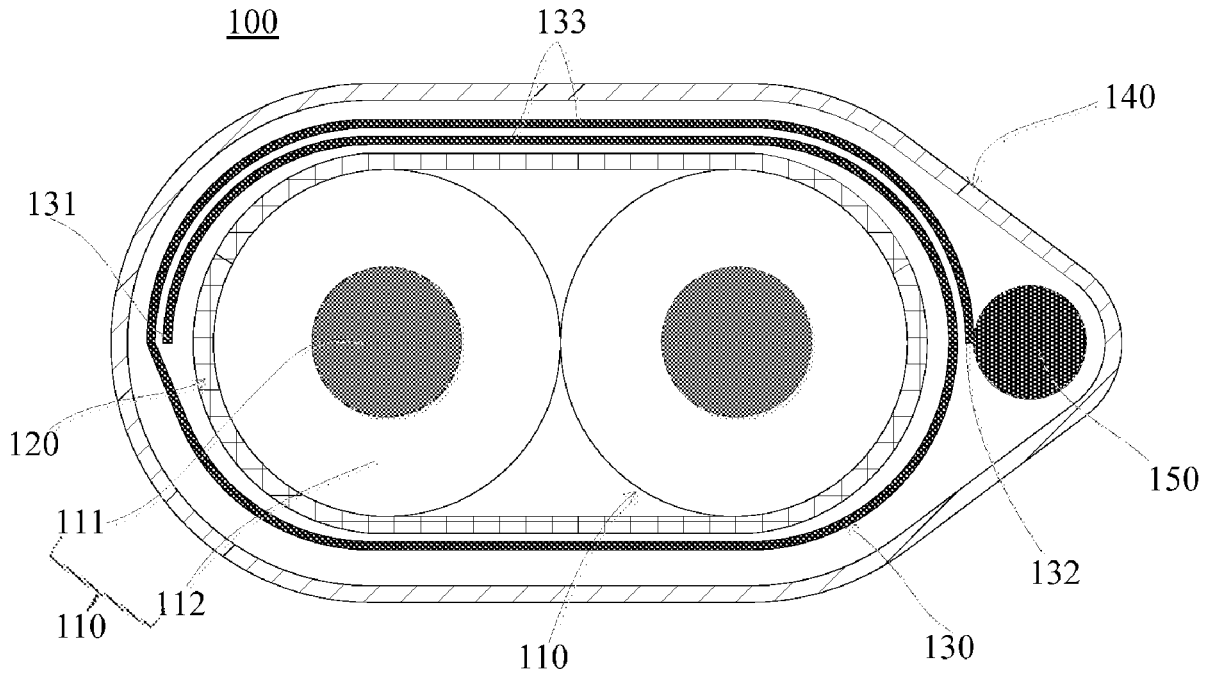
(57) **ABSTRACT**

A cable includes a pair of insulated core wires extending parallel to each other, each of the insulated core wires having a central conductor and a core insulation layer wrapped around the central conductor, an inner insulation layer wrapped around the core insulation layers, a metal shielding layer wrapped around the inner insulation layer, an outer insulation layer wrapped around the metal shielding layer, and a single drain wire disposed between the metal shielding layer and the outer insulation layer. The core insulation layers of the pair of insulated core wires abut against each other at a pair of first sides of the core insulation layers facing toward each other. The single drain wire is located at a second side of the core insulation layer of one of the pair of insulated core wires facing away from the other of the pair of insulated core wires in a radial direction.



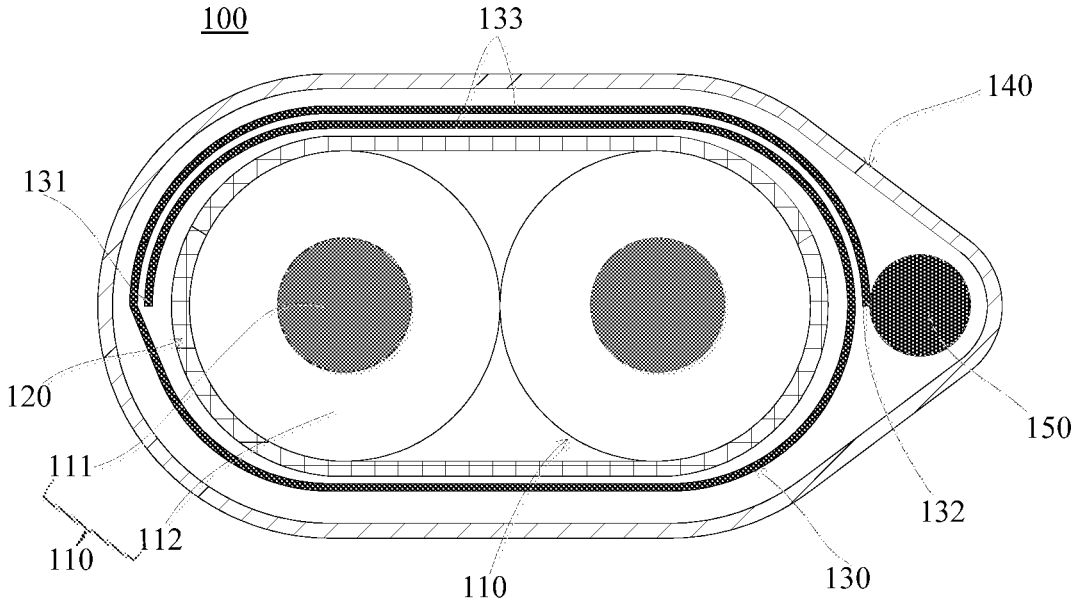


FIG. 1

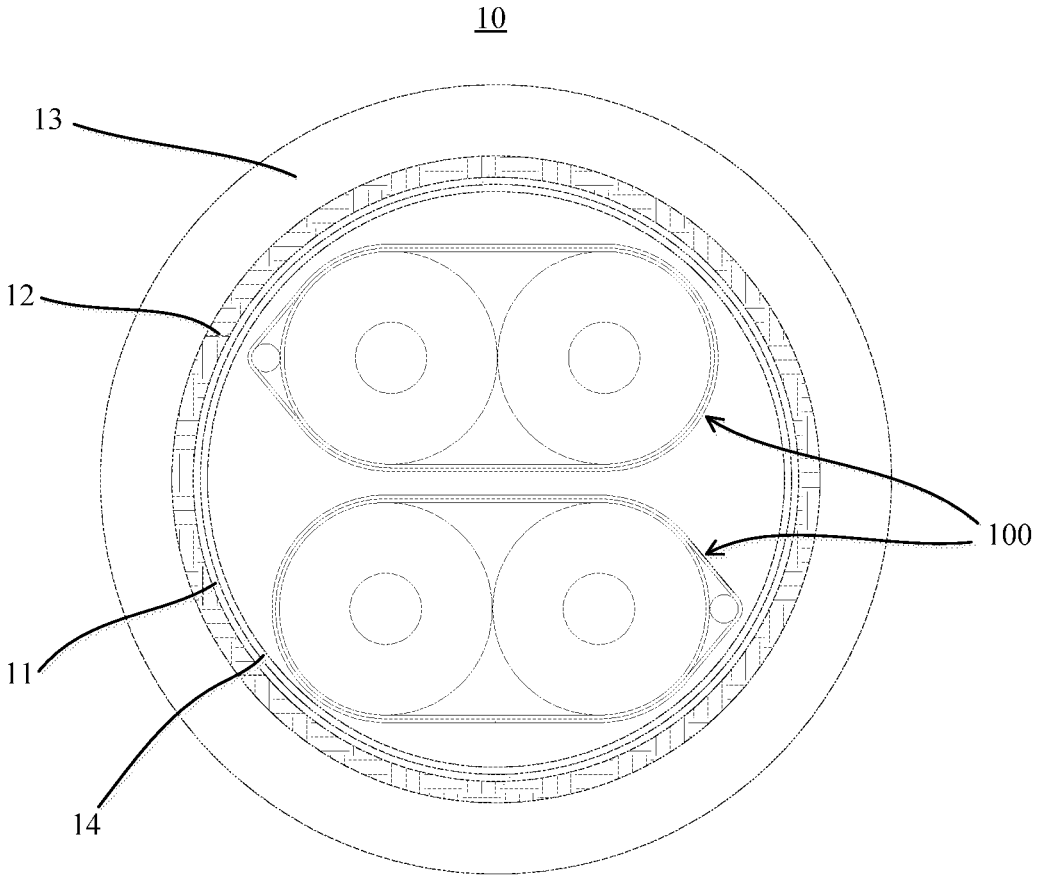


FIG. 2A

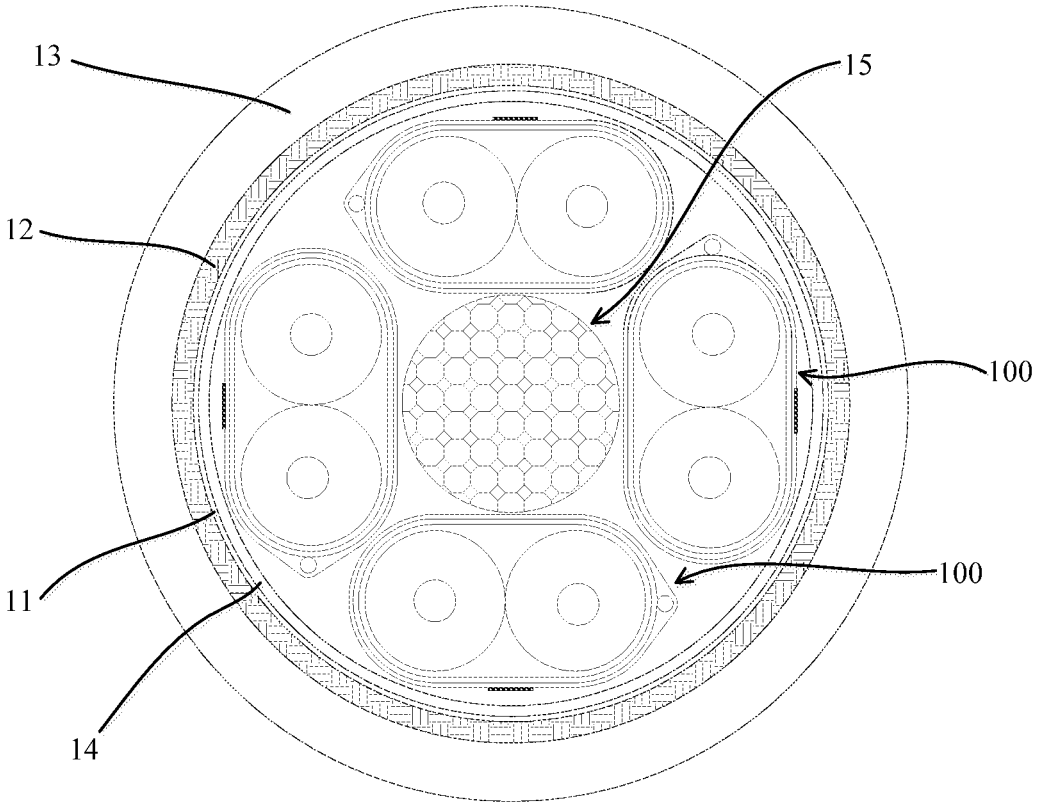


FIG. 2B

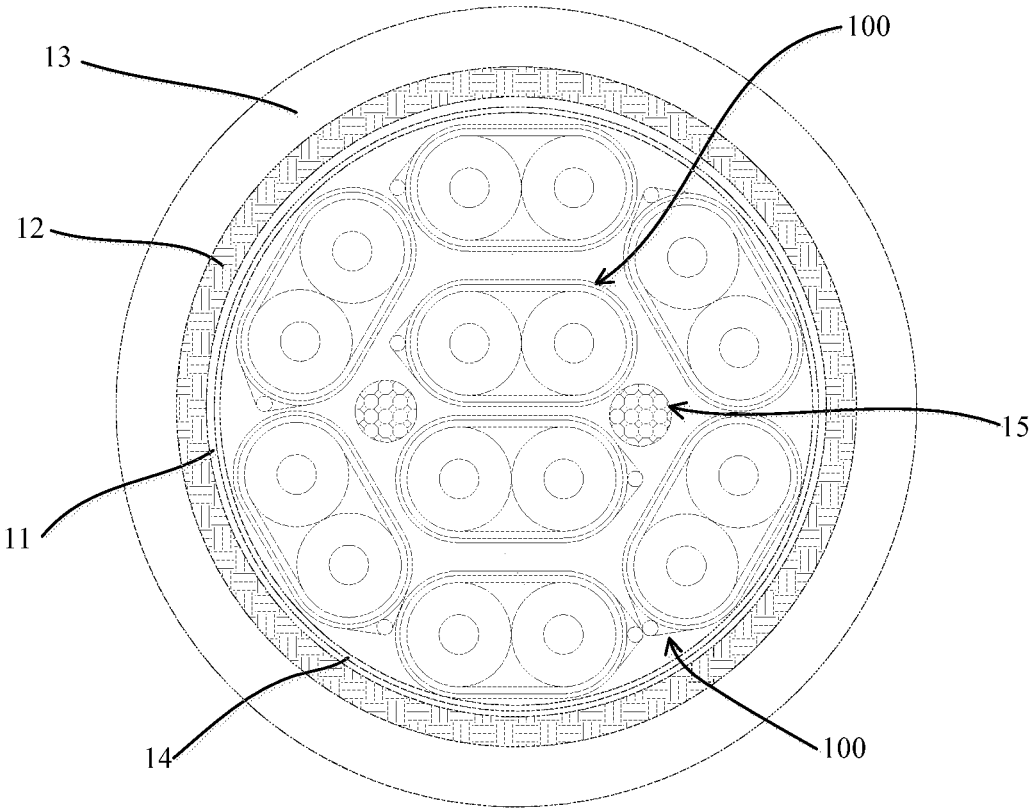


FIG. 2C

CABLE AND CABLE ASSEMBLY

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of the filing date under 35 U.S.C. § 119(a)-(d) of Chinese Patent Application No. 202110183019.4, filed on Feb. 9, 2021.

FIELD OF THE INVENTION

[0002] Embodiments of the present disclosure generally relate to a cable and, more particularly, to a cable such as a twin-axial cable and a cable assembly including the same, enabling data transmission at a high transmission rate.

BACKGROUND

[0003] A conventional high-speed data transmission cable includes a pair of insulated core wires, a drain wire located between the insulated core wires, a metal shielding layer wrapped around the insulated core wires and the drain wire, and an insulation layer wrapped around the metal shielding layer. However, a high-frequency test bandwidth achieved by such conventional cable is low, the insulated core wire is easy displaceable during a bending use and has poor performance stability, and the drain wire is easy to misplace.

SUMMARY

[0004] A cable includes a pair of insulated core wires extending parallel to each other, each of the insulated core wires having a central conductor and a core insulation layer wrapped around the central conductor, an inner insulation layer wrapped around the core insulation layers, a metal shielding layer wrapped around the inner insulation layer, an outer insulation layer wrapped around the metal shielding layer, and a single drain wire disposed between the metal shielding layer and the outer insulation layer. The core insulation layers of the pair of insulated core wires abut against each other at a pair of first sides of the core insulation layers facing toward each other. The single drain wire is located at a second side of the core insulation layer of one of the pair of insulated core wires facing away from the other of the pair of insulated core wires in a radial direction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] The invention will now be described by way of example with reference to the accompanying Figures, of which:

[0006] FIG. **1** is a sectional view of a cable according to an embodiment;

[0007] FIG. **2**A is a sectional view of a cable assembly according to an embodiment;

[0008] FIG. **2**B is a sectional view of a cable assembly according to another embodiment; and

[0009] FIG. **2**C is a sectional view of a cable assembly according to another embodiment.

DETAILED DESCRIPTION OF THE EMBODIMENT(S)

[0010] Embodiments of the present disclosure will be described hereinafter in detail taken in conjunction with the accompanying drawings. In the description, the same or similar parts are indicated by the same or similar reference numerals. The description of each of the embodiments of the present disclosure hereinafter with reference to the accompanying drawings is intended to explain the general inventive concept of the present disclosure and should not be construed as a limitation on the present disclosure.

[0011] In addition, in the following detailed description, for the sake of explanation, numerous specific details are set forth in order to provide a thorough understanding of the disclosed embodiments. It will be apparent, however, that one or more embodiments may also be practiced without these specific details. In other instances, well-known structures and devices are illustrated schematically in order to simplify the drawing.

[0012] As shown in FIG. **1**, according to an exemplary embodiment of the present disclosure, there is provided a cable **100** which is, for example, a twin-axial or differential cable, and is configured to stably transmit data at a relatively high transmission rate, such as a transmission rate higher than 10 Gbps, for example a transmission rate in the range of 20 Gbps-40 Gbps.

[0013] As shown in FIG. **1**, the cable **100** according to an exemplary embodiment of the present disclosure includes a pair of insulated core wires **110** for signal or data transmission. The pair of insulated core wires **110** are arranged to extend parallel to each other in a longitudinal direction, and each of the insulated core wire **110** includes a central conductor **111** and a core insulation layer **112** wrapped around the central conductor **111** in a circumferential direction. For example, the core insulation layer **112** may be in the form of an insulation material strip wound around the central conductor **111** in the longitudinal direction. The central conductor **111** may be made of a high-conductivity material such as a copper conductor, a silver-plated wire, and the core wire insulation layer **112** may be made of an insulation polymer material such as polyolefin.

[0014] As illustrated in FIG. **1**, the cable **100** according to an exemplary embodiment of the present disclosure further includes an inner insulation layer **120**, a metal shielding layer **130** and an outer insulation layer **140** that are sequentially arranged from inside to outside. The inner insulation layer **120** is wrapped around the outer core insulation layers **112** of the pair of insulated core wires **110** to fix the pair of insulated core wires **110**, such that the core insulation layers **112** of the pair of insulated core wires **110** abut against each other on outer circumferential surfaces thereof at first sides or inner sides facing toward each other. Compared with a conventional cable, since the inner insulation layer **120** is additionally provided between the metal shielding layer **130** and the insulated core wires **110** to fix the insulated core wires **110**, the insulated core wires **110** can be prevented from being displaced during use, such as during bending, so as to improve performance stability of the cable **100**.

[0015] For example, the inner insulation layer **120** may be in the form of an insulation material strip and wound around the core insulation layers **112** of the pair of insulated core wires **110** in the longitudinal direction. For example, the inner insulation layer **120** may be bonded to portions of outer circumferential surfaces of the core insulation layers **112** of the pair of insulated core wires **110**, for example, through a thermal fusion. In other examples, the inner insulation layer **120** may be bonded to the portions of the outer circumferential surfaces of the core insulation layers **112** of the pair of insulated core wires **110**, for example, by an adhesive. The inner insulation layer **120** is made of an insulation polymer material. For example, the inner insula-

tion layer **120** may be made of an insulation material such as polytetrafluoroethylene (PTFE), polyethylene terephthalate (PET) or the like.

[0016] In some examples, fillers may be provided within a space defined between the core insulation layers **112** of the pair of insulated core wires **110** and the inner insulation layer **120** so as to provide a flexibility of the cable **100** during bending use and to further avoid the insulated core wires **110** from being displaced during use.

[0017] As shown in FIG. **1**, the metal shielding layer **130** is wrapped around an outer circumferential surface of the inner insulation layer **120** to provide an electromagnetic shielding effect to the insulated core wires **110**. For example, the metal shielding layer **130** may be in the form of a shielding strip and wound around the inner insulation layer **120** in the longitudinal direction. Presence of the inner insulation layer **120** can prevent the metal shielding layer **130** from entering a gap between the insulated core wires **110**. For example, the metal shielding layer **130** may be bonded to the outer circumferential surface of the inner insulation layer **120** through the thermal fusion or by an adhesive. For example, the metal shielding layer **130** may include a conductive layer bonded to the inner insulation layer **120** by an adhesive, or fillers may be provided between the conductive layer **130** and the inner insulation layer **120** so as to further improve the stability of the cable **100**. As an example, the conductive layer of the metal shielding layer **130** is made of aluminum or copper. For example, the conductive layer **130** may be an aluminum/polypropylene strip. However, it would be understood by those skilled in the art that the conductive layer of the metal shielding layer **130** may also be made of other conductive materials in some other embodiments of the present disclosure.

[0018] The outer insulation layer **140** is wrapped around an outer circumferential surface of the metal shielding layer **130**, as shown in FIG. **1**. The outer insulation layer **140** may also be in the form of an insulation material strip and wound around the metal shielding layer **130** in the longitudinal direction. The outer insulation layer **140** may be bonded to the outer circumferential surface of the metal shielding layer **130** through the thermal fusion or by an adhesive. The outer insulation layer **140** may be made of an insulation material such as polyester, polypropylene, polyethylene terephthalate (PET). In some examples, the outer insulation layer **140** may be formed by stacking a plurality of sub-insulation layers to enhance the flexibility of the cable **100** during bending use.

[0019] As shown in FIG. **1**, the cable **100** according to an exemplary embodiment of the present disclosure further includes a single drain wire **150**. The drain wire **150** is disposed between the metal shielding layer **130** and the outer insulation layer **140**, and is located at a second side or an outer side of the core insulation layer **112** of one of the pair of insulated core wires **110** facing away from the other of the pair of insulated core wires **110** in a radial direction, and the second side is opposite to the first side in the radial direction. As an example, a center of the central conductor **111** of each of the pair of insulated core wires **110** is located in the same radial plane as a center of the drain wire **150**, and the center of the drain wire **150** is located outside of the center of the central conductor **111** of the one of the pair of insulated core wires **110** in the radial direction.

[0020] For example, the drain wire **150** may be firmly pressed against the outer circumferential surface of the metal shielding layer **130** by the outer insulation layer **140**. Compared with the related art where the drain wire **150** is located between the pair of insulated core wires **110** and is thus easy to be misplaced or displaced, in embodiments of the present disclosure, the drain wire **150** is disposed at the side of the one of the insulated core wires **110** facing away from the other of the insulated core wires **110**, such that the drain wire **150** is firmly held and is prevented from being displaced during use. Use of the single drain wire **150** can reduce cost, reduce an outer contour of the cable **100**, and facilitate layout and positioning of the cable **100**.

[0021] In some embodiments of the present disclosure, the metal shielding layer **130** may be suitable to be electrically connected with an external ground to double as a drain wire. For example, a conductive surface of the metal shielding layer **130** may be arranged to face outwards, that is, to face toward the outer insulation layer **140**, which facilitates an electrical connection between the metal shielding layer **130** and the external ground. In some examples, the conductive surface of the metal shielding layer **130** or its conductive layer may be in electrical contact with the drain wire **150**, so as to better improve the electromagnetic shielding effect.

[0022] As illustrated in FIG. **1**, the metal shielding layer **130** has a first end **131** and a second end **132** in a radial cross section. The first end **131** and the second end **132** are located at different positions in the circumferential direction, so that the metal shielding layer **130** is formed as a closed ring in the circumferential direction to further improve the electromagnetic shielding effect. Further, no joint or gap is formed in portions of the metal shielding layer **130** between the first end **131** and the second end **132**, so as to prevent the joint or gap from becoming larger during the bending use of the cable **100** which may otherwise result in an incomplete shielding loop. For example, in the embodiment shown in FIG. **1**, the first end **131** and the second end **132** of the metal shielding layer **130** are positioned at radially opposite outer sides of the inner insulation layer **120**, respectively. As an example, the metal shielding layer **130** has overlapping portions **133** between the first end **131** and the second end **132**, thereby further improving the electromagnetic shielding effect.

[0023] According to embodiments of the present disclosure, there is also provided a cable assembly **10** that includes at least two cables **100** described herein and arranged in an outer sheath **13**, as shown in FIGS. **2**A to **2**C. For example, these cables **100** may be twisted or intertwined with each other in the longitudinal direction, and the outer sheath **13** may be in the form of a sleeve, such as a metal tube or a plastic tube, to provide a certain protection function.

[0024] As shown in FIGS. **2**A to **2**C, the cable assembly **10** further includes a first shielding layer **11** and/or a second shielding layer **12** disposed in the outer sheath **13**. The first shielding layer **11** is wrapped or wound around all the cables **100**, and the second shielding layer **12** is wrapped or wound around the first shielding layer **11**. The first shielding layer **11** and/or the second shielding layer **12** may provide an improved electromagnetic shielding effect for the cables **100**, and may be in the form of a layer/strip of metal or other conductive materials.

[0025] In some embodiments, as shown in FIGS. **2**A to **2**C, the cable assembly **10** may further include a buffer layer **14**, which is arranged between all the cables **100** and the first shielding layer **11** to provide external force buffering or vibration reduction effect.

[0026] In some embodiments, as shown in FIGS. **2**B and **2**C, the cable assembly **10** may further include fillers **15** which may at least partially fill a space defined between the cables **100** and/or between the cables **100** and the buffer layer **14** or the shielding layers **11**, **12**.

[0027] The cable assembly **10** may include two or more cables. FIG. **2**A shows that the cable assembly **10** includes two cables **100**, FIG. **2**B shows that the cable assembly **10** includes four cables **100**, and FIG. **2**C shows that the cable assembly **10** includes eight cables **100**. Therefore, more signals, data, or power transmission functions can be provided, and there is no signal interference between the cables **100**.

[0028] Although embodiments of the present disclosure have been shown and described, it would be appreciated by those skilled in the art that changes or modification may be made to these embodiments without departing from the principles and spirit of the present disclosure, the scope of which is defined in claims and their equivalents. In addition, it should be noted that, the word "include", "comprise" or "have" doesn't exclude other elements or steps. In addition, any reference numerals in the claims should not be interpreted as a limitation to the scope of the present disclosure.

What is claimed is:

1. A cable, comprising:

a pair of insulated core wires extending parallel to each other in a longitudinal direction, each of the insulated core wires has a central conductor and a core insulation layer wrapped around the central conductor in a circumferential direction;

an inner insulation layer wrapped around the core insulation layers of the pair of insulated core wires, the core insulation layers of the pair of insulated core wires abut against each other on outer circumferential surfaces thereof at a pair of first sides of the core insulation layers facing toward each other;

a metal shielding layer wrapped around an outer circumferential surface of the inner insulation layer;

an outer insulation layer wrapped around an outer circumferential surface of the metal shielding layer; and

a single drain wire disposed between the metal shielding layer and the outer insulation layer, the single drain wire is located at a second side of the core insulation layer of one of the pair of insulated core wires facing away from the other of the pair of insulated core wires in a radial direction.

2. The cable according to claim **1**, wherein a conductive surface of the metal shielding layer is arranged to face toward the outer insulation layer.

3. The cable according to claim **2**, wherein the conductive surface of the metal shielding layer is in electrical contact with the single drain wire.

4. The cable according to claim **2**, wherein the metal shielding layer has a conductive layer having the conductive surface.

5. The cable according to claim **4**, wherein the conductive layer is bonded to the inner insulation layer by an adhesive.

6. The cable according to claim **4**, wherein a plurality of fillers are provided between the conductive layer and the inner insulation layer.

7. The cable according to claim **1**, wherein a plurality of fillers are provided within a space defined between the core insulation layers of the pair of insulated core wires and the inner insulation layer.

8. The cable according to claim **1**, wherein the metal shielding layer is electrically connected with an external ground.

9. The cable according to claim **1**, wherein a center of the central conductor of each of the pair of insulated core wires is located in a same radial plane as a center of the single drain wire.

10. The cable according to claim **1**, wherein the metal shielding layer has a first end and a second end in a radial cross section, the first end and the second end of the metal shielding layer are located at different positions in the circumferential direction and the metal shielding layer is formed as a closed ring in the circumferential direction.

11. The cable according to claim **10**, wherein the first end and the second end of the metal shielding layer are positioned at radially opposite sides of the inner insulation layer.

12. The cable according to claim **10**, wherein the metal shielding layer has an overlapping portion between the first end and the second end.

13. The cable according to claim **3**, wherein the metal shielding layer has a first end and a second end in a radial cross section, the first end and the second end of the metal shielding layer are located at different positions in the circumferential direction and the metal shielding layer is formed as a closed ring in the circumferential direction.

14. The cable according to claim **8**, wherein the metal shielding layer has a first end and a second end in a radial cross section, the first end and the second end of the metal shielding layer are located at different positions in the circumferential direction and the metal shielding layer is formed as a closed ring in the circumferential direction.

15. The cable according to claim **9**, wherein the metal shielding layer has a first end and a second end in a radial cross section, the first end and the second end of the metal shielding layer are located at different positions in the circumferential direction and the metal shielding layer is formed as a closed ring in the circumferential direction.

16. The cable according to claim **1**, wherein the cable is an electrical cable suitable for data transmission at a rate of 20 Gbps to 40 Gbps.

17. A cable assembly, comprising:

a pair of cables, each of the cables is the cable of claim **1**;

a first shielding layer wrapped around the pair of cables;

a second shielding layer wrapped around the first shielding layer; and

an outer sheath sleeved over an outer circumferential surface of the second shielding layer.

18. The cable assembly according to claim **17**, further comprising a buffer layer arranged between the pair of cables and the first shielding layer.

19. The cable assembly according to claim **17**, further comprising a plurality of fillers at least partially filling a space defined between the pair of cables.

20. The cable assembly according to claim **17**, wherein the cable assembly has two, four, eight or more cables.

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