HU000033706T2

(19) **HU**

(11) Lajstromszám: **E 033 706**

(13) **T2**

MAGYARORSZÁG
Szellemi Tulajdon Nemzeti Hivatala

EURÓPAI SZABADALOM
SZÖVEGÉNEK FORDÍTÁSA

(21) Magyar ügyszám: **E 14 709899**
(22) A bejelentés napja: **2014. 02. 26.**

(51) Int. Cl.: ***H01B 1/02*** *(2006.01)*
H01B 11/18 *(2006.01)*

(96) Az európai bejelentés bejelentési száma:
EP 20140709899
(97) Az európai bejelentés közzétételi adatai:
EP 2965327 A1 **2014. 09. 12.**
(97) Az európai szabadalom megadásának meghirdetési adatai:
EP 2965327 B1 **2016. 12. 21.**

(86) A nemzetközi (PCT) bejelentési szám:
PCT/EP 14/053757
(87) A nemzetközi közzétételi szám:
WO 14135419

(30) Elsőbbségi adatok:
AN20130048 **2013. 03. 06.** **IT**

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(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 965 327 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
21.12.2016 Bulletin 2016/51

(21) Application number: **14709899.0**

(22) Date of filing: **26.02.2014**

(51) Int Cl.:
H01B 1/02 *(2006.01)* ***H01B 11/18*** *(2006.01)*

(86) International application number:
PCT/EP2014/053757

(87) International publication number:
WO 2014/135419 (12.09.2014 Gazette 2014/37)

(54) **COAXIAL CABLE**

KOAXIALKABEL

CÂBLE COAXIAL

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **06.03.2013 IT AN20130048**

(43) Date of publication of application:
13.01.2016 Bulletin 2016/02

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EP 2 965 327 B1

Description

[0001] The present patent application for industrial invention relates to a coaxial cable.

[0002] As it is known, a coaxial cable comprises a central conductive wire intended to transport an electrical signal, a peripheral shield intended to be connected to a mass to shield the interference on the central conductive wire, a dielectric material interposed between the central conductive wire and the peripheral shield to insulate the central conductive wire of the peripheral shield, and an insulating sheath that surrounds the peripheral shield. The peripheral shield is generally composed of conductive wires that form a mesh, also called "bonding jumper".

[0003] The central conductive wire and the wires of the bonding jumper of coaxial cables that are available on the market are generally made of pure copper.

[0004] The use of solid copper for the central conductive wire and the wires of the bonding jumper guarantees the best operation of the product because of the excellent capacity of copper to be crossed by a signal. In fact, copper has a high conductivity, and therefore a low electrical resistance and a low Ohmic loss. However, a solid copper conductive wire involves very high production costs because of the high price of copper and of its huge uncontrollable fluctuations (especially in the short term).

[0005] In order to overcome the problem of high costs, other types of coaxial cables are known, which are provided with a central conductive wire and/or wires of the bonding jumper made of pure aluminum. Because of its lower specific gravity, aluminum has a considerably lower price than copper, but, at the same time, has a lower performance because of its low resistance to oxidation and high electrical resistance (low conductivity, and therefore high Ohmic loss). Moreover, an aluminum wire, which is less ductile than copper, does not have the same versatility because its minimum drawing dimensions are higher than in a copper wire, which is not appreciated by the market in view of the growing trend for miniaturization.

[0006] "Copper Clad Aluminum" (CCA) conductive wires are known in order to solve these drawbacks, at least partially.

[0007] EP1469486A1 discloses a conductive wire in which the core and the mass are made of CCA concentric sheets folded in a tubular shape. This type of cable finds a special application in the TV industry (therefore static applications) and cannot be applied in large consumption dynamic sectors, such as the automotive industry, for a series of factors related to the complexity of the production process and to the mechanical properties of the tubular conductive wires made with bent copper sheets. In fact, such type of cable is too expensive, has a limited flexibility, and is subject to breakage during bending tests.

[0008] GB1310334A discloses a coaxial cable in which the central conductive wire is made with a single wire that can be made of CCA, insulated from the external metal sheet, which represents the shielding, by a series of plastic disks. This type of cable cannot be applied in the standard connectors of the automotive industry without making very high investments to modify the connectors.

[0009] This solution is mechanically very weak and prevents the cable from being connected with other elements, such as clips (which would deform the internal structure of the cable when the clip is pulled), or other connections because the bonding operation (element that keeps the cables together) occurs with tensions and tractions that change the geometry of the cable, thus altering its performance.

[0010] This type of coaxial cable is not suitable for the automotive sector and is typically used for static applications that require a low resistance at repeated bending cycles.

[0011] US6265667B1 disclosed a coaxial cable with a central conductive unit and a bonding jumper made of multiple CCA wires. In particular, the central conductive unit can comprise multiple CCA twisted wires. The patent document describes how to prevent the oxidation of the metals used for the cable. While on one side it extends the life of the product (which can be stocked for a long time and can be transported in extreme conditions), on the other side the anti-oxidation substance limits the electrical conductivity and weldability of the metal parts that must be suitably cleaned before being machined in order to obtain the best qualitative result for a special operation such as welding. The process is expensive and impaired by quality problems for products that need to be assembled in large series.

[0012] The purpose of the present invention is to remedy the drawbacks of the prior art by providing a coaxial cable that is efficient, efficacious and at the same time inexpensive and simple to make.

[0013] This purpose is achieved according to the invention, with the characteristics claimed in the attached independent claim 1.

[0014] Advantageous embodiments appear from the dependent claims.

[0015] The coaxial cable of the invention comprises:

- a central conductive unit intended to transport a signal,
- a shield, comprising a plurality of wires disposed as a mesh, intended to be connected to a mass in order to shield the central conductive unit,
- a dielectric material disposed between the central conductive unit and the shield to insulate the central conductive unit from the shield, and
- an insulation sheath disposed around the shield.

[0016] The central conductive unit and the shield comprise a plurality of wires made with an aluminum core coated with a copper coating.

[0017] The wires of the shield comprise a tin external coating.

[0018] Additional characteristics of the invention will

appear evident from the detailed description below that refers to the attached drawings, which have an illustrative, not limitative purpose only, wherein:

Fig. 1 is a partially sectioned perspective view of the coaxial cable according to the invention;
Fig. 2 is a perspective view of the core of the coaxial cable of Fig. 1;
Fig. 3 is a cross-sectional view of the coaxial cable of Fig. 1;
Fig. 3A is an enlarged view of a detail of Fig. 3, showing a single conductive wire of the core; and
Fig. 3B is an enlarged view of a detail of Fig. 3, showing a single conductive wire of the bonding jumper.

[0019] Referring to the figures, the coaxial cable of the invention is disclosed and generally indicated with reference numeral (100).

[0020] Referring now to Figs. 1 and 3, the coaxial cable (100) comprises:

- a central conductive unit (1),
- a dielectric material (2) disposed around the central conductive unit (1),
- a shield (4) disposed around the dielectric material (2), and
- an insulation sheath (5) disposed around the shield (4).

[0021] The coaxial cable (100) optionally comprises a second shield (3) between the dielectric material (2) and the first shield (4).

[0022] The central conductive unit (1) is intended to transport electrical signals. The central conductive unit (1) comprises a plurality of suitably disposed conductive wires (10).

[0023] Referring to Fig. 3A, each conductive wire (10) of the central conductive unit is made with copper clad aluminum (CCA) technology and comprises an aluminum core (11) and a copper coating (12).

[0024] The conductive wire (10) has a total diameter that can vary from 0.1mm to 1mm, preferably 0.27 mm, according to the application. The aluminum core (11) has a diameter of 90-97%, preferably 95% of the total diameter of the wire and the thickness of the copper coating is 10-7%, preferably 5% of the total diameter of the wire.

[0025] Optionally, each wire of the central conductive wire can be additionally covered with a tin external layer (13) with thickness equal to 0.5% - 2% of the total diameter of the wire. The tin external layer (13) is used to make the conductive wire immune from oxidation and keep its weldability characteristics unaltered over time.

[0026] Referring to Fig. 2, the central conductive unit (1) is composed of a straight central conductive wire (10a) and a plurality of peripheral conductive wires (10b) wound around the central conductive wire (10a) in a spiral beam. The spiral beam formed of the peripheral conductive wires (10a) develops by winding along the straight central conductive wire (10a) using it as axis of the spiral.

[0027] The figures illustrate an embodiment of the central conductive unit (1) that comprises seven wires, i.e. one central wire and six peripheral wires.

[0028] The peripheral wires (10b) are wound to the central wire (10a) forming a spiral beam with winding pitch of 15-20mm. The winding pitch of the spiral can have different values, according to the dimensions of the wire and to the number of wires used to make the central conductive unit (1).

[0029] Such a manufacturing technique of the central conductive unit (1) can be industrially automated with the use of suitable machines and with low production costs.

[0030] Such a disposition of the conductive wires (10) of the central conductive unit is used to improve the mechanical performance of the central conductive unit (1). As a matter of fact, a solid one-wire conductive wire or a linear beam of parallel wires, cannot withstand a high number of repeated bends of the coaxial cable (100), which are due to the manipulation, production and installation required in special applications, such as in the automotive sector.

[0031] The coaxial cable (100) of the invention, wherein the central conductive wire (1) is obtained with such a manufacturing technique, is more flexible, more resistant to bends in any direction and easier to compress during the crimping of connectors.

[0032] It must be noted that the central conductive unit (1) of the coaxial cable according to the invention is not provided with twisted wires, i.e. wires that are mutually twisted for the entire length of the cable. The central conductive unit (1) of multi-wire type is obtained with a process according to which the remaining wires are disposed around a central wire by means of bending, not twisting. This allows obtaining a compact beam of wires and avoiding the presence of air between the wires.

[0033] The dielectric material (2) is made of expanded polyethylene or polypropylene, and has a diameter comprised between 1.5 and 3 mm, preferably 2.1 mm.

[0034] Referring to Figs. 1 and 3, the coaxial cable (100) advantageously has two shield levels (4, 3).

[0035] The first shield (4) comprises a plurality of conductive wires (40) twisted in such manner to form a mesh intended to be connected to a mass. For this reason the first shield (4) is also known as bonding jumper (4).

[0036] Referring to Fig. 3B, each conductive wire (40) of the bonding jumper is of CCA type and comprises an aluminum core (41), an intermediate copper coating (42) and a tin external coating (43).

[0037] The bonding jumper (4) is composed of a set of wires (40) that are twisted with a suitable twist pitch. Each wire (40) can have a total diameter that, according to the specific application, can vary from 0.1 mm to 0.2 mm with a thickness of the copper coating (42) equal to 6% of the total diameter. The copper layer (42) is additionally covered with the tin layer (43) in a percentage that can vary from 0.5% to 2% of the total wire diameter according to the specific application.

[0038] The tin coating (43) aplied to the CCA wires of the bonding jumper is necessary when the cable is exposed to extremely severe working environments, such as places with humid warm conditions, saline fog or repeated intense heat. The tin coating (43) allows keeping the wire resistivity constant over time, without any impedance and attenuation alteration. Moreover, being free of oxidation, tin guarantees the perfect weldability of the bonding jumper over time.

[0039] For example, a wire (40) of the bonding jumper with 0.13mm total diameter in the cable (100) has the following structure:

max. diameter of the aluminum wire (41) = 0.12mm,
min. thickness of the copper coating (42) = 0.004mm,
min. thickness of the tin coating (43) = 0.001 mm.

[0040] The bonding jumper (4) is made of a mesh of twisted wires (40). The wires are grouped in spindles of 5 wires each. A total of 16 spindles are used to make the mesh. Each spindle is made of 5 wires with 0.13mm diameter (each wire). The twist pitch of the spindles to make the mesh is 28mm.

[0041] The second shield (3) surrounds the dielectric material (2). The second shield (3) is composed of a sheet of aluminum-based composite material with 0.05 mm thickness. Advantageously, the second shield (3) comprises a multilayer sheet comprising a polyester film interposed between two aluminum layers.

[0042] The dielectric material (2) and the second shield (3) (if present) have a percentage of optical coverage higher than 90%.

[0043] The external sheath (5) is made of lead-free anti-migrating PVC.

[0044] The cable (100) of the invention has the following mechanical characteristics:

- Minimum static bend radius 5 times the external diameter; and
- Minimum dynamic radius of curvature 15 times the external diameter.

[0045] The cable (100) passes the following laboratory tests:

- 3000h exposure to +85°C / -40°C temperatures; and
- reliability of 30,000 bend cycles in accordance with standard ISO 14572.

[0046] The coaxial cable (100) of the invention has the following advantages:

1) The copper coating (12, 42) applied on the aluminum core (11, 41) of the wires (10, 40) of the central conductive unit and of the bonding jumper protects aluminum from oxidation and considerably increases the wire conductive capacity.
2) The tin coating (13, 43) on the copper coating (12, 42) of the wires (10, 40) of the central conductive unit and of the bonding jumper gives contact resistance stability over time, especially during the connection of the bonding jumper (4) to a connector; therefore such tin coating is more advantageous especially on the wires of the bonding jumper (4) that are more severely exposed to the external operating environment.
3) Moreover, such innovation allows for reducing the total weight of the product because, having a specific gravity three times lower than copper, the CCA has a weight lower by 60% than pure copper, thus meeting the demand for lightness of the automotive market.
4) The market quotations of aluminum, which practically represents the total volume of a CCA wire, are more stable than copper. Moreover, with the same volume, having a specific gravity that is three times lower, it weighs less and therefore costs less than a pure copper wire.

[0047] Consequently, the cable (100) of the invention has the same electrical performance and the same corrosion resistance as a coaxial cable with core and bonding jumper made of pure copper and advantageously has a considerably lower total weight, as well as lower production costs.

Claims

1. A coaxial cable (100) comprising:

- a central conductive unit (1) intended to transport a signal,
- a shield (4) a plurality of wires (40) disposed as a mesh, intended to be connected to a mass in order to shield the central conductive unit,
- a dielectric material (2) disposed between the central conductive unit (1) and the shield (4) to insulate the central conductive unit (1) from the shield (4), and
- an insulation sheath (5) disposed around the shield (4),

wherein said central conductive unit (1) and shield (4) comprise a plurality of wires (10, 40) made with an aluminum core (11, 41) coated with a copper coating (12, 42),
characterized in that
said wires (40) of the shield (4) comprise a tin external coating (43).

2. The coaxial cable (100) of claim 1, wherein the thickness of said tin external coating (43) varies from 0.5% to 2% of the total diameter of the shield wire (4).

3. The coaxial cable (100) of claim 1 or 2, wherein said

wires (10) of the central conductive unit (1) comprise a tin external coating (13).

4. The coaxial cable (100) of claim 3, wherein the thickness of said tin external coating (13) varies from 0.5% to 2% of the total diameter of the wire of the central conductive unit (1).

5. The coaxial cable (100) according to any one of the preceding claims, wherein said wires (10) of the central conductive unit (1) comprises a straight central conductive wire (10a) and a plurality of peripheral conductive wires (10b) wound around the central conductive wire (10a) in a spiral beam.

6. The coaxial cable (100) of any one of the preceding claims, also comprising a second shield (3) interposed between said dielectric material (2) and said shield (4) for ground connection.

7. The coaxial cable (100) of claim 6, wherein said second shield (3) comprises a sheet of aluminum-based composite material.

8. The coaxial cable (100) of claim 7, wherein said second shield (3) comprises a multilayer sheet comprising a polyester film interposed between two aluminum layers.

9. The coaxial cable (100) of any one of the preceding claims, wherein the thickness of said copper coating (12) varies from 7% to 10% of the total diameter of the wire of the central conductive unit (1).

10. The coaxial cable (100) of any one of the preceding claims, wherein the thickness of said copper coating (42) varies from 7% to 10% of the total diameter of the wire of the shielding (4).

Patentansprüche

1. Koaxialkabel (100), umfassend:

   - eine zentrale leitfähige Einheit (1), die dazu bestimmt ist, ein Signal zu übertragen,
   - eine Abschirmung (4), die mehrere Drähte (40) umfasst, die maschenförmig angeordnet und dazu bestimmt sind, an eine Masse zur Abschirmung der zentralen leitfähigen Einheit angeschlossen zu werden,
   - ein dielektrisches Material (2), das zwischen der zentralen leitfähigen Einheit (1) und der Abschirmung (4) angeordnet ist, um die zentrale leitfähige Einheit (1) von der Abschirmung (4) zu isolieren, und
   - eine isolierende Ummantelung (5), die rund um die Abschirmung (4) angeordnet ist,

   wobei die zentrale leitfähige Einheit (1) und die Abschirmung (4) mehrere Drähte (10, 40) umfassen, die mit einem Aluminiumkern (11, 41) hergestellt und mit einer Kupferbeschichtung (12, 42) versehen sind,
   dadurch gekennzeichnet, dass
   die Drähte (40) der Abschirmung (4) eine Außenbeschichtung aus Zinn (43) umfassen.

2. Koaxialkabel (100) nach Anspruch 1, wobei die Dicke der Außenbeschichtung aus Zinn (43) zwischen 0,5 % und 2 % des Gesamtdurchmessers des Drahtes der Abschirmung (4) variiert.

3. Koaxialkabel (100) nach Anspruch 1 oder 2, wobei die Drähte (10) der zentralen leitfähigen Einheit (1) eine Außenbeschichtung aus Zinn (13) umfassen.

4. Koaxialkabel (100) nach Anspruch 3, wobei die Dicke der Außenbeschichtung aus Zinn (13) zwischen 0,5 % und 2 % des Gesamtdurchmessers des Drahtes der zentralen leitfähigen Einheit (1) variiert.

5. Koaxialkabel (100) nach einem beliebigen der vorstehenden Ansprüche, wobei die Drähte (10) der zentralen leitfähigen Einheit (1) einen geraden, zentralen, leitfähigen Draht (10a) und mehrere periphere leitfähige Drähte (10b) umfassen, die um den zentralen leitfähigen Draht (10a) in einem spiralförmigen Bündel gewickelt sind.

6. Koaxialkabel (100) nach einem beliebigen der vorstehenden Ansprüche, umfassend ferner eine zweite Abschirmung (3), die zwischen dem dielektrischen Material (2) und der Abschirmung (4) für den Masseanschluss angeordnet ist.

7. Koaxialkabel (100) nach Anspruch 6, wobei die zweite Abschirmung (3) eine Folie aus Aluminiumbasis-Verbundwerkstoff umfasst.

8. Koaxialkabel (100) nach Anspruch 7, wobei die zweite Abschirmung (3) eine Mehrschichtfolie umfassend einen Polyesterfilm zwischen zwei Aluminiumschichten umfasst.

9. Koaxialkabel (100) nach einem beliebigen der vorstehenden Ansprüche, wobei die Dicke der Kupferbeschichtung (12) zwischen 7 % und 10 % des Gesamtdurchmessers des Drahtes der zentralen leitfähigen Einheit (1) variiert.

10. Koaxialkabel (100) nach einem beliebigen der vorstehenden Ansprüche, wobei die Dicke der Kupferbeschichtung (42) zwischen 7 % und 10 % des Gesamtdurchmessers des Drahtes der Abschirmung (4) variiert.

Revendications

1. Câble coaxial (100) comprenant:

   - un groupe conducteur central (1) destiné à transporter un signal,
   - un blindage (4) comprenant une pluralité de fils (40) disposés à maille, destiné à être branché à une masse pour blinder le groupe conducteur central,
   - un matériel diélectrique (2) disposé entre le groupe conducteur central (1) et le blindage (4) pour isoler le groupe conducteur central (1) du blindage (4), et
   - une gaine isolante (5) disposée autour du blindage (4),

   où ledit groupe conducteur central (1) et ledit blindage (4) comprennent une pluralité de fils (10, 40) réalisés avec un noyau en aluminium (11, 41) revêtu par un revêtement en cuivre (12, 42),
   caractérisé en ce que
   lesdits fils (40) du blindage (4) comprennent un revêtement externe en étain (43).

2. Câble coaxial (100) selon la revendication 1, où l'épaisseur du dit revêtement externe en étain (43) varie du 0,5% au 2% du diamètre total du fil du blindage (4).

3. Câble coaxial (100) selon la revendication 1 ou 2, où lesdits fils (10) du groupe conducteur central (1) comprennent un revêtement externe en étain (13).

4. Câble coaxial (100) selon la revendication 3, où l'épaisseur du dit revêtement externe en étain (13) varie du 0,5% au 2% du diamètre total du fil du groupe conducteur central (1).

5. Câble coaxial (100) selon l'une quelconque des revendications précédentes, où lesdits fils (10) du groupe conducteur central (1) comprennent un fil conducteur central (10a) droit et une pluralité de fils conducteurs périphériques (10b) qui s'enroulent autour du fil conducteur central (10a) en un faisceau à spirale.

6. Câble coaxial (100) selon l'une quelconque des revendications précédentes, comprenant également un second blindage (3) interposé entre ledit matériel diélectrique (2) et ledit blindage (4) de branchement à la masse.

7. Câble coaxial (100) selon la revendication 6, où ledit second blindage (3) comprend une feuille de matériel composite, à base d'aluminium.

8. Câble coaxial (100) selon la revendication 7, où ledit second blindage (3) comprend une feuille multicouche comprenant un film de polyester interposé entre deux couches d'aluminium.

9. Câble coaxial (100) selon l'une quelconque des revendications précédentes, où ledit revêtement en cuivre (12) varie du 7 au 10% du diamètre total du fil du groupe conducteur central (1).

10. Câble coaxial (100) selon l'une quelconque des revendications précédentes, où ledit revêtement en cuivre (42) varie du 7 au 10% du diamètre total du fil du blindage (4).

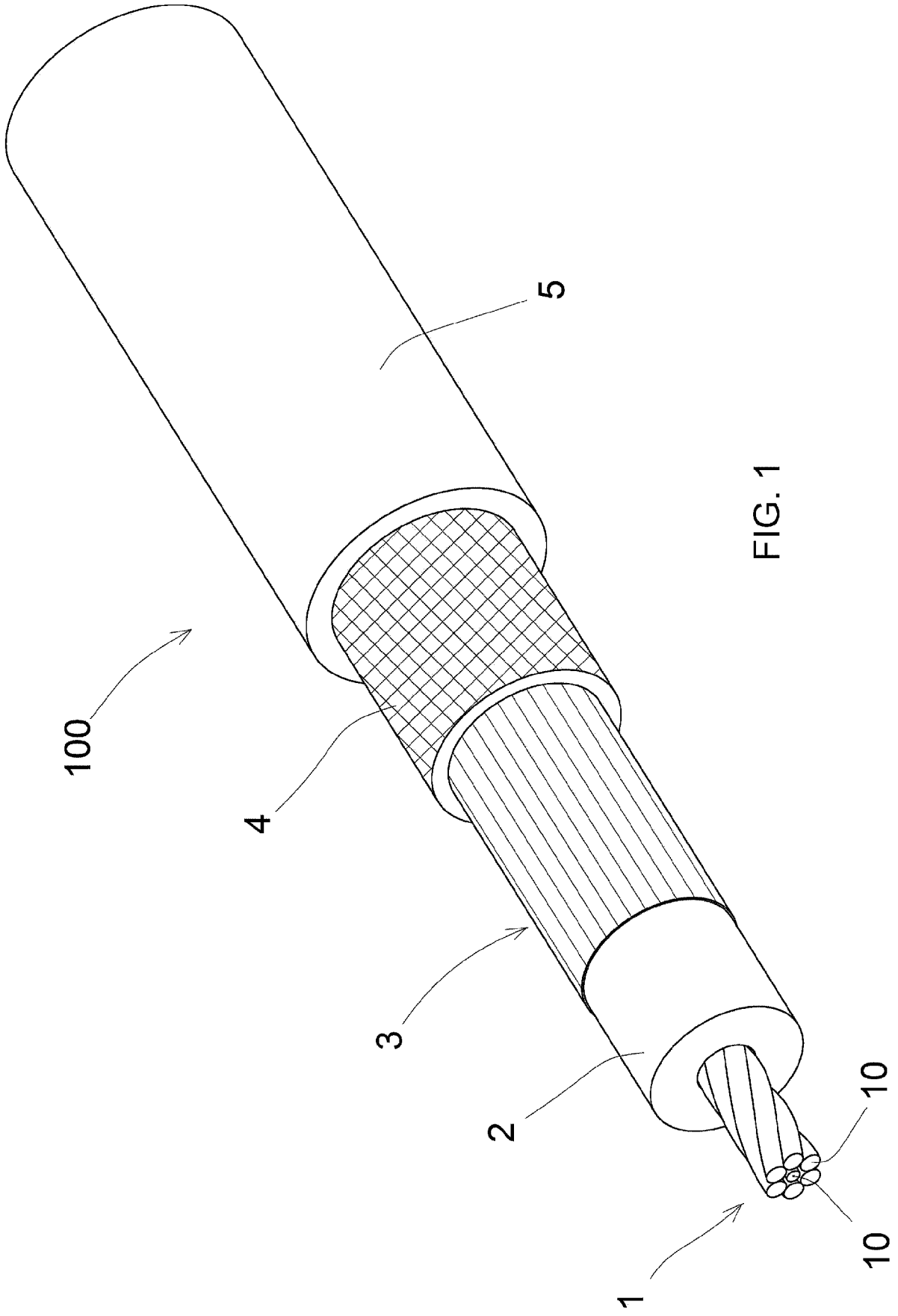

FIG. 1

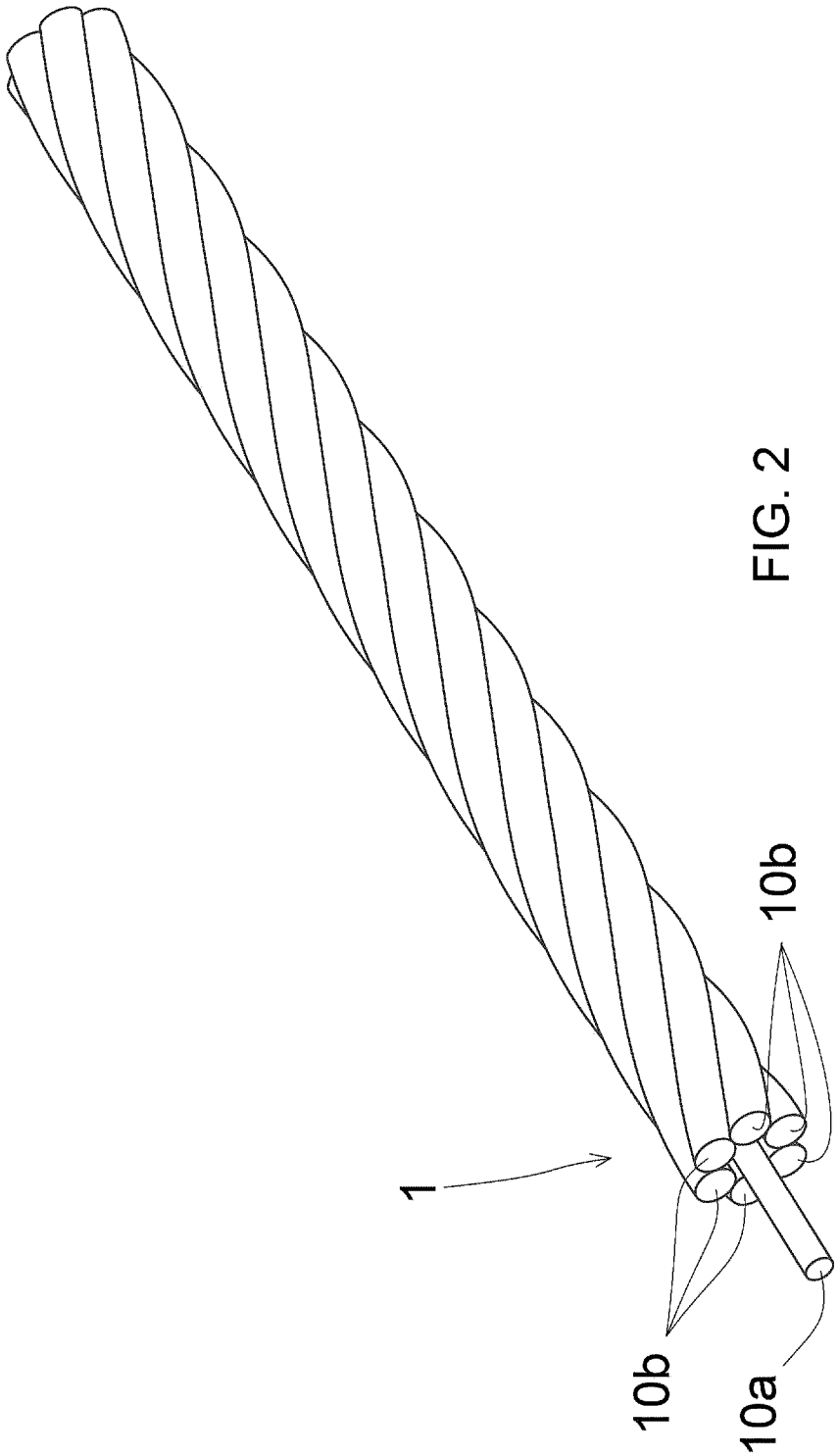

FIG. 2

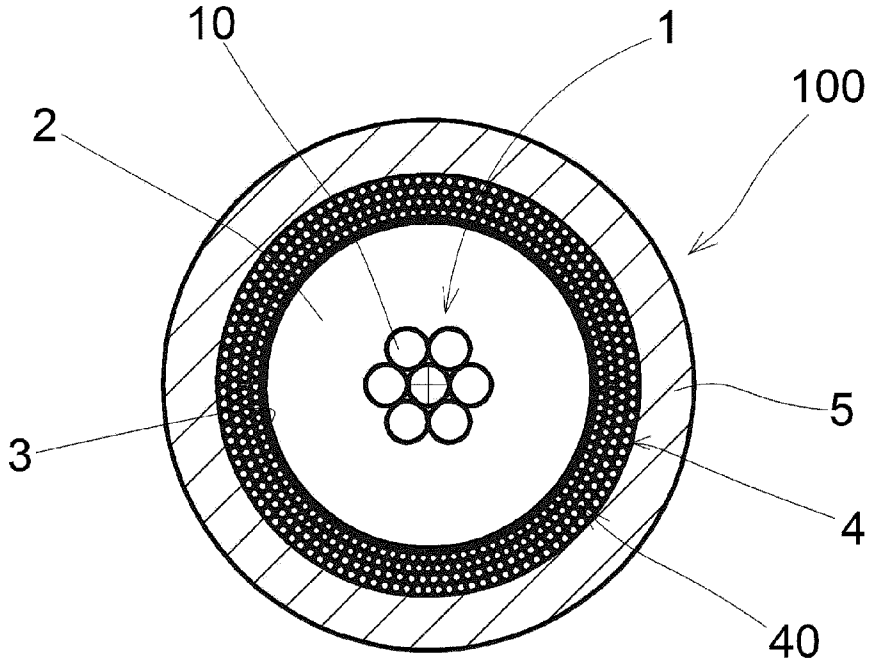

FIG. 3

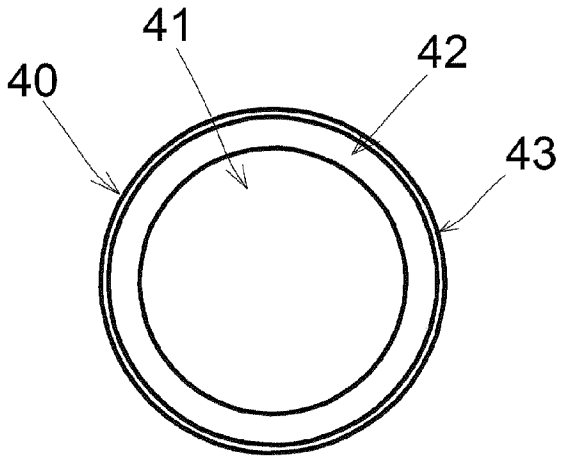

FIG. 3B

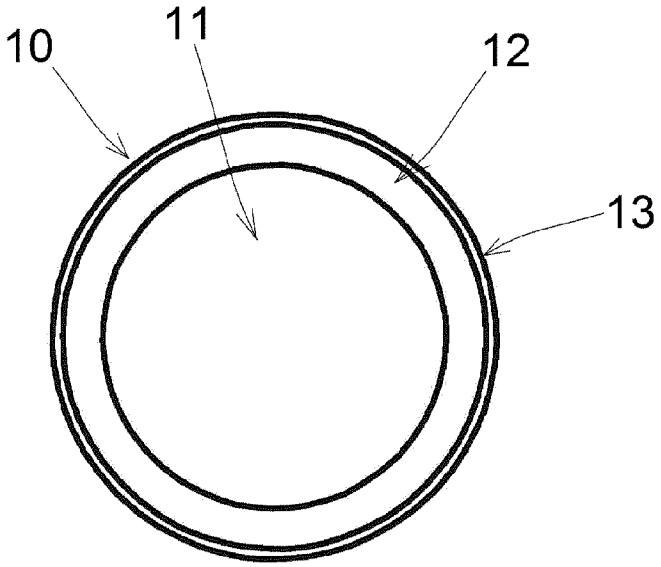

FIG. 3A

REFERENCES CITED IN THE DESCRIPTION

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- GB 1310334 A **[0008]**
- US 6265667 B1 **[0011]**

EP 2 965 327

KOAXIÁLIS KÁBEL

Szabadalmi igénypontok

1. Koaxiális kábel (100), amely tartalmaz:

- egy központivezető-egységet (1) jel átvitelére,
- árnyékolást (4) hálószerűen elrendezett huzalokból (40), földeléshez kapcsoláshoz a központivezető-egység árnyékolása érdekében,
- dielektromos anyagot (2) a központivezető-egység (1) és az árnyékolás (4) között, a központivezető-egység (1) elszigeteléséhez az árnyékolástól (4), és
- szigetelő köpenyt (5) az árnyékolás (4) körül,

továbbá a központivezető-egység (1) és az árnyékolás (4) rézbevonattal (12, 42) ellátott alumíniummaggal (11, 41) rendelkező huzalokból (10, 40) áll,

azzal jellemezve, hogy

az árnyékolás (4) huzaljai (40) külső ónbevonattal (43) vannak ellátva.

2. Az 1. igénypont szerinti koaxiális kábel (100), amelynél a külső ónbevonat (43) vastagsága az árnyékolóhuzal (4) teljes átmérőjének 0,5 és 2%-a között van.

3. Az 1. vagy 2. igénypont szerinti koaxiális kábel (100), amelynél a központivezető-egység (1) huzaljai (10) külső ónbevonattal (13) vannak ellátva.

4. A 3. igénypont szerinti koaxiális kábel (100), amelynél a külső ónbevonat (13) vastagsága a központivezető-egység (1) huzalja teljes átmérőjének 0,5 és 2%-a között van.

5. Az előző igénypontok bármelyike szerinti koaxiális kábel (100), amelynél a központivezető-egység (1) huzaljai (10) egy egyenes központi vezetőképes huzalból (10a) és spirál alakú kötegben a központi vezetőképes huzal (10a) köré csavart számos periférikus vezetőképes huzalból (10b) állnak.

6. Az előző igénypontok bármelyike szerinti koaxiális kábel (100), amely egy második árnyékolást (3) is tartalmaz a dielektromos anyag (2) és a földeléshez kapcsolható árnyékolás (4) között.

7. A 6. igénypont szerinti koaxiális kábel (100), amelynél a második árnyékolás (3) alumíniumalapú kompozit anyagú fóliából áll.

8. A 7. igénypont szerinti koaxiális kábel (100), amelynél a második árnyékolás (3) egy többrétegű fólia, amely két alumíniumréteg között elhelyezett poliészterfóliából áll.

9. Az előző igénypontok bármelyike szerinti koaxiális ká-

bel (100), amelynél a rézbevonat (12) vastagsága a központivezető-egység (1) huzalja teljes átmérőjének 7 és 10%-a között van.

10. Az előző igénypontok bármelyike szerinti koaxiális kábel (100), amelynél a rézbevonat (42) vastagsága az árnyékolás (4) huzalja teljes átmérőjének 7 és 10%-a között van.

A meghatalmazott:

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