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(54) **Title**: A TRANSITION JOINT

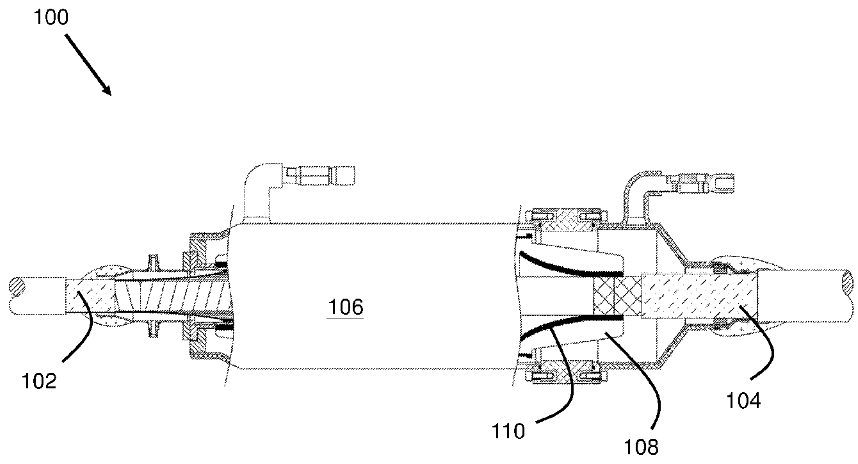

Fig. 1

(57) **Abstract**: A transition joint connects an oil-filled cable to a solid dielectric cable and includes a connector, a fiber glass tube (210), a pre-moulded joint body (108,228), and a copper housing (106). The fiber glass tube (210) circumferentially surrounds an end segment of the oil-filled cable (102,220). The pre-moulded joint body (108,228) circumferentially surrounds a first deflector (214), a second deflector (215) and a high voltage (HV) electrode (316).The copper housing (106) circumferentially surrounds the pre-moulded joint body to form an outermost layer of the transition joint (100,200). The transition joint that includes the pre-moulded joint body has a reduced size, while the time for connecting the two types of cables using the transition joint is decreased.

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A TRANSITION JOINT

FIELD OF THE INVENTION

The present invention relates to a transition joint that connects an oil-filled cable to a solid dielectric cable.

BACKGROUND

Oil-filled high voltage power cables have been used since 1920's and their performance have been very satisfactory. Since 1980's, solid dielectric power cables have been developed and have gradually replaced oil-filled power cables. Different transition joints are used to connect oil-filled cables and solid dielectric cables. It may not be easy and efficient to use currently available transition joints for connecting oil-filled cables and solid dielectric cables.

In view of the demand for efficiently connecting these two types of power cables, improvements in transition joints are desired.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a transition joint in accordance with an example embodiment.

Figure 2 shows a longitudinal view of a transition joint in accordance with an example embodiment.

Figure 3 shows a pre-moulded joint body of a transition joint in accordance with an example embodiment.

Figures 4 shows a fiber glass tube of a transition joint in accordance with an example embodiment.

SUMMARY OF THE INVENTION

One example embodiment is a transition joint that connects an oil-filled cable to a solid dielectric cable. The transition joint includes a connector, a fiber glass tube, a pre-moulded joint body, and a copper housing. The connector fixes an end segment of the oil-filled cable and an end segment of the solid dielectric cable to form a transition joint core. The fiber glass tube, capped by the metal cap at a first end, inserts onto the end segment of the oil-filled cable at a second end and circumferentially surrounds the end segment of the oil-filled cable inside the transition joint. The pre-moulded joint body circumferentially surrounds a first deflector at a tapered first end, circumferentially surrounds a second deflector at a tapered second end, and circumferentially surrounds a high voltage (HV) electrode at a middle section. The copper housing circumferentially surrounds the pre-moulded joint body to form an outermost layer of the transition joint.

Other example embodiments are discussed herein.

DETAILED DESCRIPTION

Example embodiments relate to apparatus and methods that connect an oil-filled cable to a solid dielectric cable that includes a transition joint that includes a pre-moulded joint body and fiber glass tube. The fiber glass tube acts as an insulator to segregate the oil-filled cable from the pre-moulded joint body and other parts of the transition joint.

Paper insulated oil-filled cable have been used as high voltage power cables since the 1920's, where the performance of oil-filled cables have been highly satisfactory. Users faced difficulties in using oil-filled cables due to the complicated technology, highly skilled requirement for joining oil-filled cables, and oil leakages after prolonged working period imposed problems. In case of oil leakages, continuous pumping of oil into the ground is necessary to maintain the operation of the oil-filled cable. This would cause pollution to the environment.

As it is more simplified and user-friendly to install solid dielectric cables, solid dielectric cables have gradually replaced oil-filled cables since the 1980's. In this respect, manufacturing facilities for oil-filled cables are also reducing. Oil-filled cables are now generally used for extra high voltage cables with voltage load above 220kV or submarine cables.

As the working lifespan of power cables is in the range of 30 to 50 years, or even more, and that oil-filled cables are still operating satisfactorily, it would be a waste of resources if healthy circuits using oil-filled cables are to be scrapped. Thus, transition joints are developed to connect the existing oil-filled cables to newly installed solid dielectric cables.

Generally, the design of conventional transition joint is based on:

1. The stop joint technique for oil-filled cable with two insulators back to back inside a container;
2. Using an epoxy resin element as the transition between the two types of cables, the pre-fabricated joint technique for solid dielectric cable

requires a compression unit and a stress cone on one side and paper stress cone on the oil-filled cable side;

3. A straight though connection with O-ring is used to segregate and prevent oil form the oil-filled cable from penetrating into the solid dielectric cable side.

Conventional transition joints are bulky, and it is complicated and time consuming to use conventional transition joint for connecting these two types of cables.

An example embodiment includes a simplified approach using a specially designed pre-moulded joint body that covers both the oil-filled cable and the solid dielectric cable. In one example embodiment, a transition joint that includes the pre-moulded joint body has a reduced size, while the time for connecting the two types of cables using the transition joint is decreased.

In an example embodiment, the pre-moulded joint body can control the electric field inside the transition joint. In another example embodiment, with the use of pre-moulded joint body, the main components of the transition joint can be factory tested and such testing routine is similar to that for other XLPE cable joints. Therefore, reliability of the installation of transition joint is much improved.

By way of example, the length of the transition joint is significantly reduced. In one example embodiment, the transition joint is about half the length of that of conventional transition joint. In one example embodiment, installation for the transition joint is simple and fast.

In an example embodiment, the transition joint passes internal development high voltage alternating current (HVAC) tests for 132 kV voltage level requirements under heat cycles and impulses.

An example embodiment includes a system that connects an oil-filled cable to a solid dielectric cable. The system comprises a solid metal connector, a hollow insulator, an electric field controller, a silicon rubber joint body, and a copper sleeve. The solid metal connector fixes an end portion of the oil-filled cable and an end portion of the solid dielectric cable to form a core. The hollow insulator connects with the solid metal connector at a first end and inserts onto the end portion of the oil-filled cable at a second end, and that the hollow insulator concentrically surrounds the end portion of the oil-filled cable within the system. The electric field controller concentrically surrounds the hollow insulator and the solid metal connector, and controls an electric field within the system. The silicon rubber joint body concentrically surrounds the electric field controller. The copper sleeve concentrically surrounds the silicon rubber joint body.

In one example embodiment, the electric field controller includes a first deflector that is concentrically enclosed within the silicon rubber joint body. The first deflector concentrically surrounds the hollow insulator at a first end of the silicon rubber joint body.

In another example embodiment, the electric field controller includes a second deflector that is concentrically enclosed within the silicon rubber joint body. The second deflector concentrically surrounds the hollow insulator at a first end of the silicon rubber joint body.

In one example embodiment, the electric field controller includes a high voltage (HV) electrode that concentrically surrounds the core.

In an example embodiment, the electric field controller concentrically surrounds the first end of the hollow insulator.

By way of example, the hollow insulator is made of fiber glass.

In one example embodiment, the system includes a T-shaped intermediate flange and a bottom flange. The T-shaped intermediate flange and the bottom flange dispose at a first end of the copper sleeve and abut against the second end of the hollow insulator to fix the copper sleeve with the hollow insulator.

In one example embodiment, the hollow insulator fixes to the silicon rubber joint body with an epoxy resin at the second end of the hollow insulator.

Figure 1 shows a transition joint 100 that connects an oil-filled cable 102 and a solid dielectric cable 104 in accordance with an example embodiment. A part of the transition joint 100, where the transition joint 100 connects with the oil-filled cable 102, is wrapped around by a copper housing 106 as shown in the example embodiment of Figure 1. Thus, some elements of the transition joint 100 that involve in connecting with the oil-filled cable are not illustrated in Figure 1. The copper housing 106 forms an outermost layer of the transition joint 100 and shields the transition joint 100 from insulation. In one example embodiment, the copper housing 106 surrounds circumferentially the entire transition joint.

In one example embodiment, the oil-filled cable has a voltage load of at least 110 kV. By way of example, the oil-filled cable has a voltage load of 132 kV.

In one example embodiment, the solid dielectric cable is made of cross-linked polyethylene (XPLE) and has a voltage load of at least 110kV. By way of example, the solid dielectric cable has a voltage load of 132 kV.

The transition joint 100 includes, directly beneath the copper housing 106, a pre-moulded joint body 108 that is tapered at both ends, and a deflector 110 that locates at and wraps around a segment of the solid dielectric cable 104. The pre-moulded joint body 108 is made of elastic material with good tensile strength, such that it can provide support to the transition joint 100 without the use of supporting elements, such as compression units, inside the transition joint 100.

By way of example, the pre-moulded joint body 108 is made of silicon rubber. In another example, the pre-moulded joint body 108 is made of ethylene-propylene rubber (EPR).

In one example embodiment, the transition joint 100 passes internal development high voltage alternating current (HVAC) tests for 132 kV voltage level requirements under heat cycles and impulses.

Figure 2 shows a transition joint 200 that connects an oil-filled cable 202 to a solid dielectric cable 204 in accordance with an example embodiment. The transition joint 200 is tapered at both ends and has a cylindrical form. The transition joint 200 includes a connector 206, a fiber glass tube 210, a high voltage (HV) electrode 212, a first deflector 214, a second deflector 215, and a pre-moulded joint body 216. A copper housing 218 serves as an outermost layer of the transition joint 200.

In one example embodiment, the end segment of the oil-filled cable 220 includes a head section 220A and a tail section 220B. In another example embodiment, the end segment of the solid dielectric cable 222 includes a head section 222A and a tail section 222B.

The connector 206 fixes an end segment of the oil-filled cable 220 and an end segment of the solid dielectric cable 222 to form a transition joint core, such that the oil-filled cable 202 mechanically and electrically connects to the solid dielectric cable 204.

In one example embodiment, an oil-filled cable connector 230 connects the end segment of the oil-filled cable 220 to the connector 206, so that the oil-filled cable 202 securely connects to the connector 206. An indenting support tube 232 is embedded within the oil-filled cable conductor 230 for maintaining an oil path inside the oil-filled cable 202. In one example embodiment, the indenting support tube 232 is made of stainless steel.

The fiber glass tube 210 is capped, at a first end 252, with the connector 206. The fiber glass tube 210 inserts, at a second end 254, onto the end segment of the oil-filled cable 220 and circumferentially surrounds the end segment of the oil-filled cable 220. In one example embodiment, the fiber glass tube 210 is fixed, at the second end 254, to the pre-moulded joint body 216 with epoxy resin. The fiber glass tube 210 segregates the oil-filled cable 220 from the transition joint 200 and prevents oil inside the oil-filled cable 202 from spilling out and leaking into the transition joint 200. In one example embodiment, the fiber glass tube 210 acts as an oil-barrier for the pre-moulded joint body 216 to protect the pre-moulded joint body 216 from coming into contact of any oil that may leak out from the oil-filled cable 202. By way of example, the fiber glass tube 210 is cylindrical in shape.

In one example embodiment, the oil-filled cable 202 is impregnated with paper rolls 260 and further wrapped by paper stress cones 262 on top of the paper rolls 260. The paper stress cones 262 provide an additional insulation to the oil-filled cable 202.

The HV electrode 212 is made of semiconducting material and circumferentially surrounds the transition joint core. The first end of the fiber glass tube 252 is also wrapped around by the HV electrode 212. The HV electrode 212 controls an electric field within the transition joint 200 so that the transition joint 200 functions properly at all voltage loads and that the transition joint 200 can endure a longer working lifespan.

The first deflector 214 is made of semiconducting material and locates at a first end of the pre-moulded joint body 226. The first deflector 215 has a tapered head section that wraps closely around the fiber glass tube 210, and opens outwardly towards the center of the transition joint 200 to ensure a homogenous distribution of electric fields.

The second deflector 215 is made of semiconducting material, and locates at a second end of the pre-moulded joint body 228. The second deflector 215 also has a tapered head section that wraps closely around the end segment of solid dielectric cable 222, and opens outwardly towards the center of the transition joint 200 such that a homogeneous distribution of electric field can be guaranteed.

The pre-moulded joint body 216 is made of elastic material with good tensile strength and is tapered at both ends. The pre-moulded joint body 216 circumferentially surrounds the first deflector 214 at the tapered first end 226, and the second deflector 215 at the tapered second end 228 respectively. The HV electrode 212 is entirely embedded and encircled within a middle section of the pre-moulded joint body 216.

By way of example, the pre-moulded joint body 216 is made of silicon rubber. In another example, the pre-moulded joint body 216 is made of ethylene-propylene rubber (EPR).

The copper housing 218 surrounds the entire transition joint circumferentially to form the outermost layer of the transition joint 200 and provides mechanical protection to the transition joint 200. In one example embodiment, an inner surface of the copper housing 218 is entirely covered with a cable sheath insulator 266.

In one example embodiment, the transition joint 200 includes a cable gland 264 that connects to a first end of the copper housing 250 and that circumferentially surrounds the tail section of the end segment of the oil-filled cable 220B. The cable gland 264 seals the end segment of the oil-filled cable 220 and prevents moisture water from entering the end segment of the oil-filled cable 220. In another example embodiment, the cable gland 264 includes two cylindrical nipples 244A – 244B disposed on each side of the cable gland 264.

By way of example, the transition joint includes a cable gland that connects a second end of the copper housing and that circumferentially surrounds the tail section of the end segment of the solid dielectric cable. The cable gland seals the end segment of the solid dielectric cable and prevents moisture water from entering the end segment of the solid dielectric cable. In one example embodiment, the cable gland includes two nipples disposed on each side of the cable gland.

In one example embodiment, a first lead sheath 236 fixes a tapered end of the cable gland 264 with the tail section of the end segment of the oil-filled cable 220B at a first end of the transition joint 238, such that the first lead sheath 236 fully encloses the cable gland 264 and the end segment of the oil-filled cable 220. Thus, the transition joint 200 securely seals to the end segment of the oil-filled cable 220 at the first end of the transition joint 238.

In one example embodiment, a T-shaped intermediate flange 246 and a bottom flange 248 are disposed at the first end of the copper housing 250 and abut against the second end of the fiber glass tube 254 to fix the copper housing 218 with the fiber glass tube 210. By way of example, the intermediate flange 246 is made of H62 copper and the bottom flange 248 is made of copper.

In one example embodiment, a second lead sheath 240 fixes a second end of the copper housing 268 with the tail section of the end segment of the solid dielectric cable 222B at a second end of the transition joint 242, such that the second lead sheath 240 fully encloses the copper housing 218 and the end segment of the solid dielectric cable 222. Thus, the transition joint 200 securely seals to the end segment of the solid dielectric cable 222 at the second end of the transition joint 242.

In one example embodiment, a copper braid 256 connects the second end of the copper housing 268 to the tail section of the end segment of the solid dielectric cable 222B at the second end of the transition joint 242, such that the transition joint 200 securely seals to the end segment of the solid dielectric cable 222 at the second end of the transition joint 242. The copper braid 256 prevents moisture water from entering the solid dielectric cable 204.

In one example embodiment, an insulating ring 258 is installed onto the transition joint 200 at the second tapered end of the pre-moulded transition joint 228 to provide segregation of sheath connections between the oil-filled cable 202 and the solid dielectric cable 204. By way of example, the insulating ring 258 is made of epoxy material.

In one example embodiment, a layer of copper braid and taping 270 circumferentially installs on a middle section of the pre-moulded joint body 216.

Figure 3 shows a pre-moulded joint body 300 of a transition joint in accordance with an example embodiment. For ease of illustration, an oil-filled cable and a solid dielectric cable are omitted in this example embodiment.

The pre-moulded joint body 300 includes a first tapered end 302, a second tapered end 304, and a cylindrically shaped middle body 306 that is sandwiched between the first tapered end 302 and the second tapered end 304.

A first deflector 308, made of semiconducting material, locates at the first tapered end 302. In one embodiment, the first deflector 308 has a tapered head section 310 that closely surrounds a fiber glass tube 312, and a tail section 314 that diverges outwardly from the head section 310. With this specific configuration, the first deflector 308 ensures a homogenous distribution of electric fields at the first end of the pre-moulded joint body 302. By way of example, the head section of 310 circumferentially a first end of the fiber glass tube 324.

In one example, the fiber glass tube 312 is cylindrical in shape.

A high voltage (HV) electrode 316 is embedded within the middle body 306 and circumferentially surrounds an end of the fiber glass tube 312. By way of example, the HV electrode 316 circumferentially surrounds a second end of the fiber glass tube 326.

A second deflector 318, made of semiconducting material, locates at the second tapered end 304. In one embodiment, the second deflector 318 has a tapered head section 320, and a tail section 322 that diverges outwardly from the head section 310.

Figure 4 shows a fiber glass tube 400 of a transition joint in accordance with an example embodiment. For ease of illustration, an oil-filled cable is omitted in this example embodiment.

The fiber glass tube 400 is cylindrical in shape and includes a first end 402 that connects to a connector 404, and a second end 406 that connects to a T-shaped flange 408. The T-shaped flange 408 and the connector 404 securely fixes the fiber glass tube 400 within the transition joint. By way of example, the fiber glass tube 400 is a hollow insulator.

In one example embodiment, the fiber glass tube 400 inserts onto an end segment of an oil-filled cable (not shown) at the second end 406.

As used herein, a “transition joint” is a cable joint that connects different types of cables, or cables made of different materials. Examples of a cable include, but are not limited to, an oil-filled cable, a cable having fluids or gas insulation materials, a solid dielectric cable, and a cross-linked polyethylene (XPLE) cable.

As used herein, the term “oil” includes all types of fluids or viscous materials used in cable constructions.

As used herein, the term “tube” is not limited to an object having a circular cross-section, but also includes a hollow and elongated member of any cross-section.

For controlling an electric field within a transition joint, edges and/or surfaces of a deflector, an insulating ring, a pre-moulded joint body, and a high voltage (HV) electrode may be preferably rounded.

CLAIMS

What is claimed is:

1. A transition joint that connects an oil-filled cable to a solid dielectric cable, the transition joint comprising:

a connector that fixes an end segment of the oil-filled cable and an end segment of the solid dielectric cable to form a transition joint core;

a fiber glass tube that is capped by the connector at a first end, that inserts onto the end segment of the oil-filled cable at a second end, and that circumferentially surrounds the end segment of the oil-filled cable inside the transition joint;

a pre-moulded joint body that circumferentially surrounds a first deflector at a tapered first end, that circumferentially surrounds a second deflector at a tapered second end, and that circumferentially surrounds a high voltage (HV) electrode at a middle section; and

a copper housing that circumferentially surrounds the pre-moulded joint body to form an outermost layer of the transition joint.

2. The transition joint of claim 1, wherein the pre-moulded joint body is made of an elastic material.

3. The transition joint of claim 1, wherein the first deflector includes a tapered head section to circumferentially surround the fiber glass tube at the first end of the pre-moulded joint body.

4. The transition joint of claim 1, wherein the second deflector includes a tapered head section to circumferentially surround the end segment of the solid dielectric cable at the second end of the pre-moulded joint body.

5. The transition joint of claim 1, wherein the HV electrode circumferentially surrounds the transition joint core.

6. The transition joint of claim 1, wherein the HV electrode circumferentially surrounds the first end of the fiber glass tube.

7. The transition joint of claim 1, wherein the fiber glass tube is fixed to the pre-moulded joint body with an epoxy resin at the second end of the fiber glass tube.

8. The transition joint of claim 1, further comprising:

a T-shaped intermediate flange that disposes at a first end of the copper housing and abuts against the second end of the fiber glass tube; and

a bottom flange that disposes at the first end of the copper housing and abuts against the second end of the fiber glass tube;

wherein the T-shaped intermediate flange and the bottom flange fix the fiber glass tube with the copper housing.

9. The transition joint of claim 1, wherein the fiber glass tube is hollow.

10. A system that connects an oil-filled cable to a solid dielectric cable, the system comprising:

a solid metal connector that fixes an end portion of the oil-filled cable and an end portion of the solid dielectric cable to form a core;

a hollow insulator that connects with the solid metal connector at a first end, that inserts onto the end portion of the oil-filled cable at a second end, and that concentrically surrounds the end portion of the oil-filled cable within the system;

an electric field controller that concentrically surrounds the hollow insulator and the solid metal connector and that controls an electric field within the system;

a silicon rubber joint body that concentrically surrounds the electric field controller; and

a copper sleeve that concentrically surrounds the silicon rubber joint body.

11. The system of claim 10, wherein the electric field controller includes a first deflector that is concentrically enclosed within the silicon rubber joint body, and that concentrically surrounds the hollow insulator at a first end of the silicon rubber joint body.

12. The system of claim 10, wherein the electric field controller includes a second deflector that is concentrically enclosed within the silicon rubber joint body, and that concentrically surrounds a portion of the end segment of the solid dielectric cable at a second end of the silicon rubber joint body.

13. The system of claim 10, wherein the electric field controller includes a high voltage (HV) electrode that concentrically surrounds the core.

14. The system of claim 10, wherein the electric field controller concentrically surrounds the first end of the hollow insulator.

15. The system of claim 10, wherein the hollow insulator is made of fiber glass.

16. The system of claim 10, wherein the hollow insulator is fixed to the silicon rubber joint body with an epoxy resin at the second end of the hollow insulator.

17. The system of claim 10, further comprising:

a T-shaped intermediate flange that disposes at a first end of the copper sleeve and abuts against the second end of the hollow insulator; and

a bottom flange that disposes at the first end of the copper sleeve and abuts against the second end of the hollow insulator;

wherein the T-shaped intermediate flange and the bottom flange fix the hollow insulator with the copper sleeve.

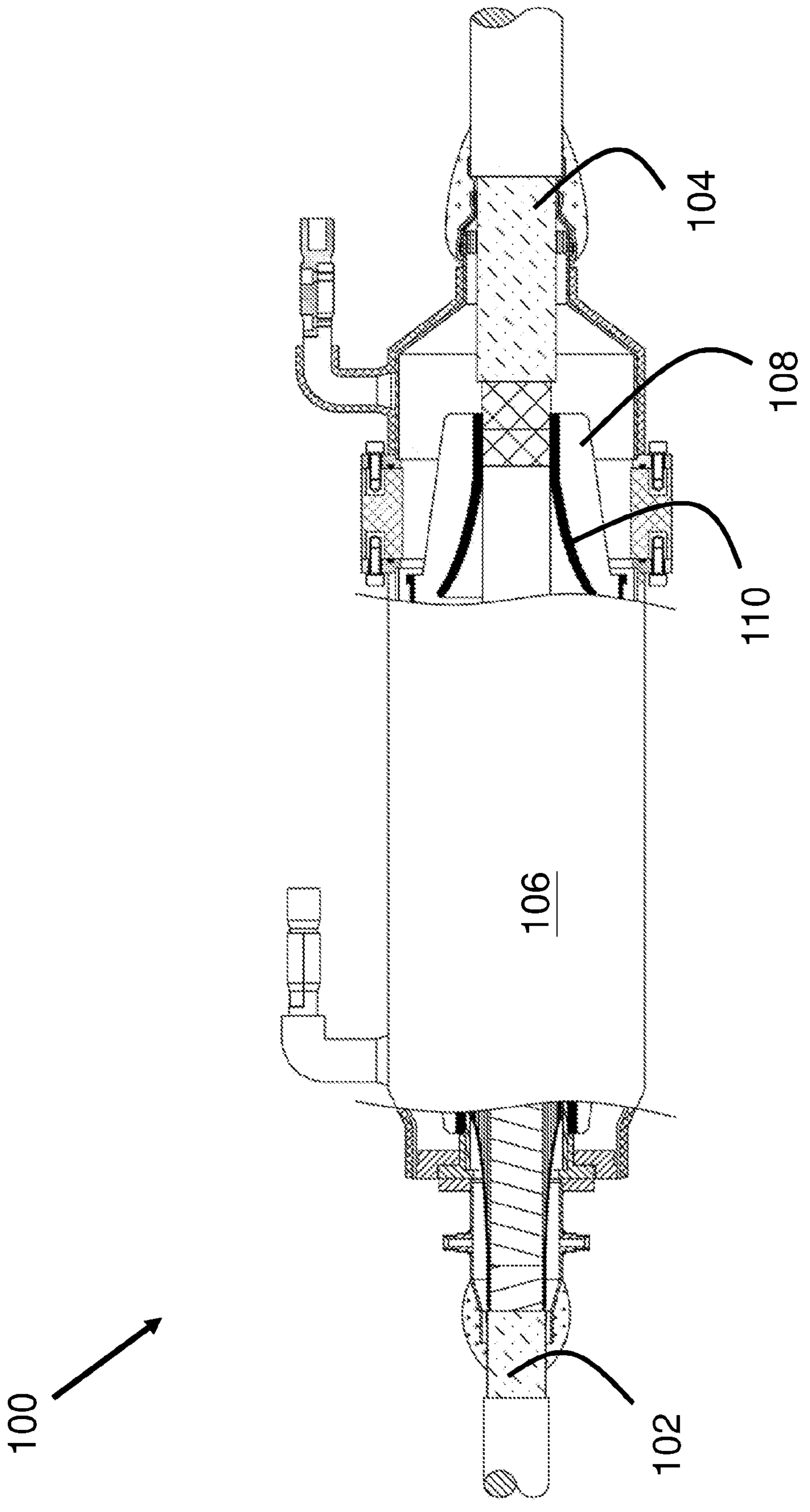

Fig. 1

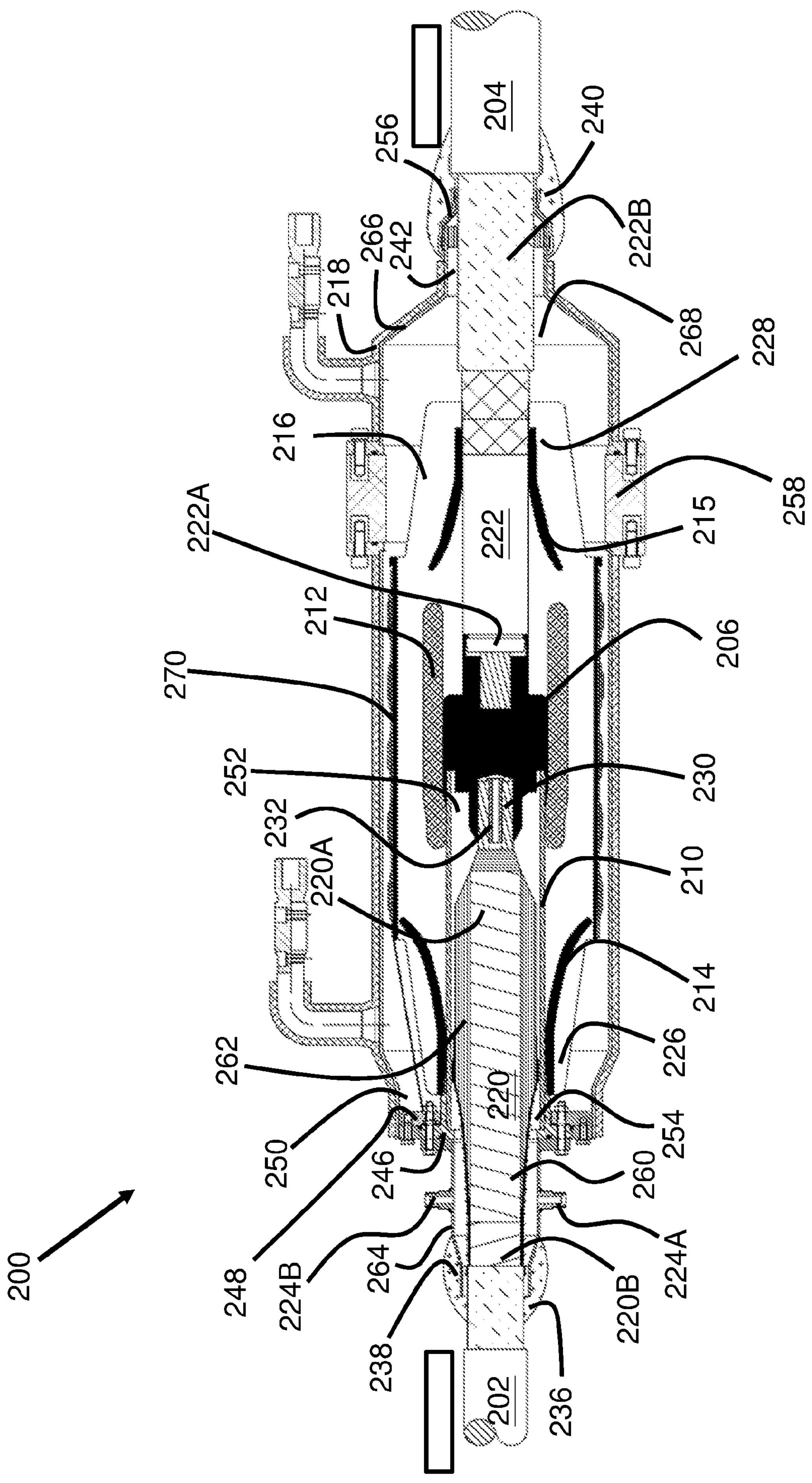
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Fig. 2

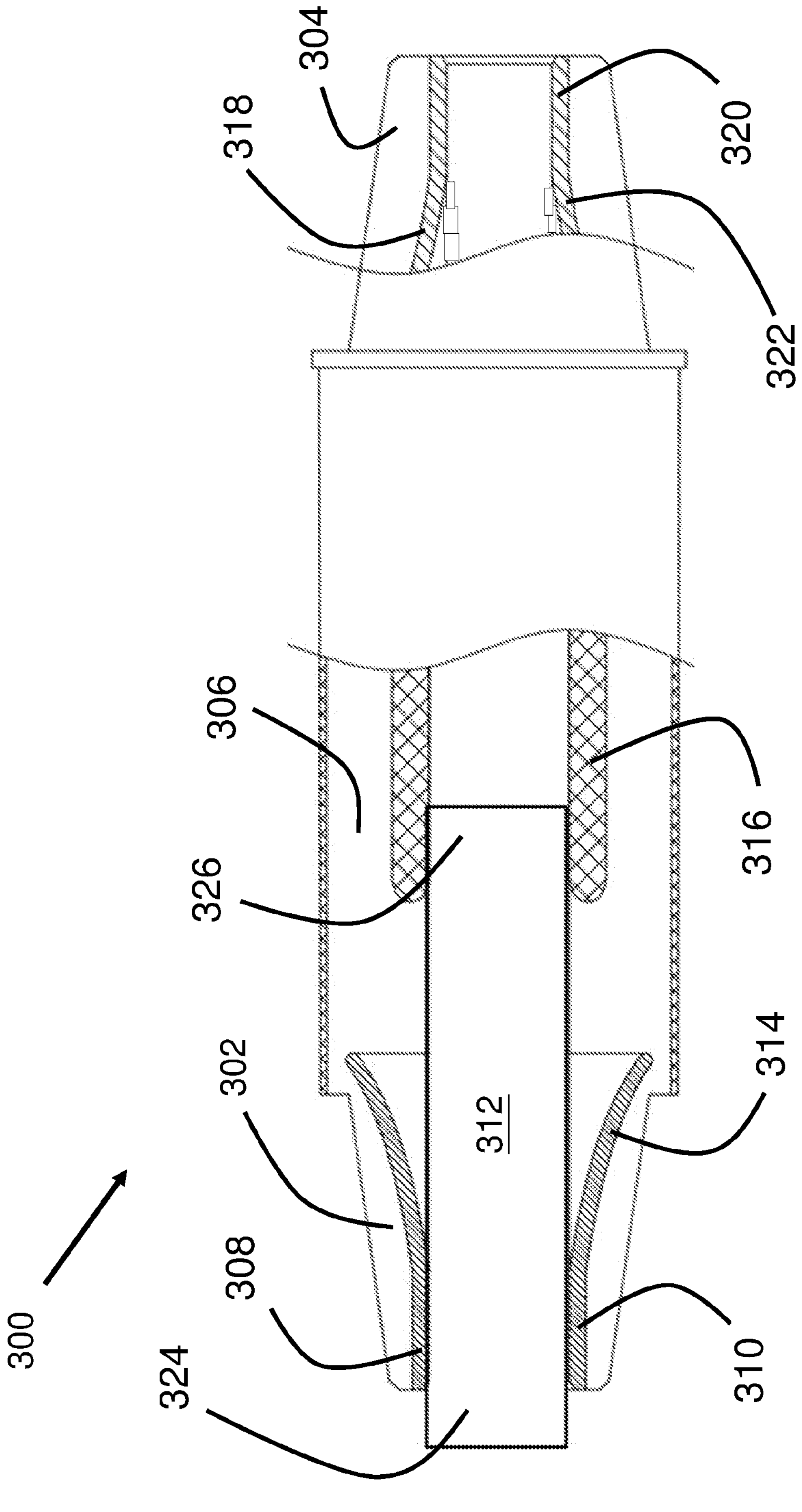

Fig. 3

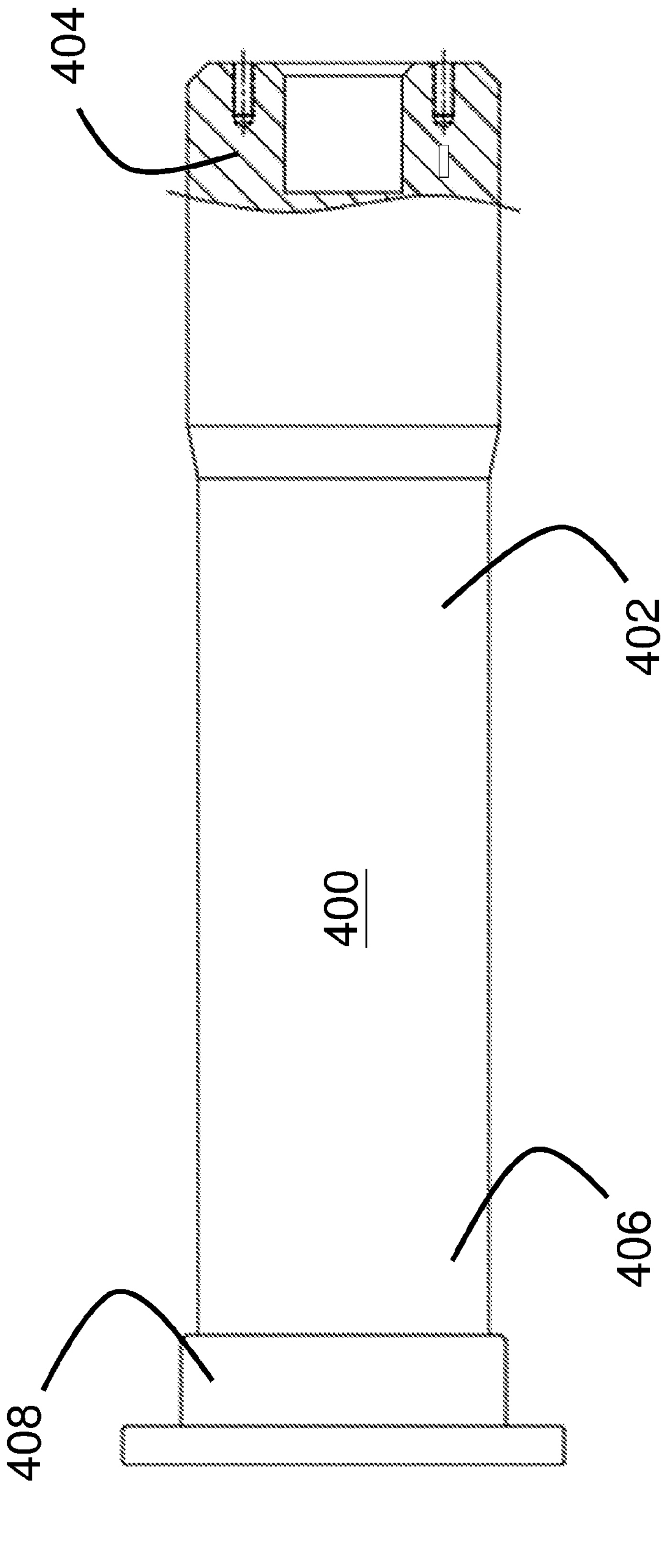

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2016/054937

A. CLASSIFICATION OF SUBJECT MATTER

H02G 15/08(2006.01)i；H02G 15/24(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)

H02G15

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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

CNABS,CNTXT,VEN,SIPOABS,transition,joint,cable,connector

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 19856025 A1 (FELTEN & GUILLEAUME KABELWERK) 21 June 2000 (2000-06-21) description， column 4， line 14 to column 6， line 23 and claim1-7 and figures 1 to 3	1-17
A	GB 2323481 A (PIRELLI GENERAL PLC) 23 September 1998 (1998-09-23) the whole document	1-17
A	US 2006169475 A1 (UTILX CORP) 03 August 2006 (2006-08-03) the whole document	1-17
A	DE 19805068 A1 (ABB PATENT GMBH) 12 August 1999 (1999-08-12) the whole document	1-17
A	EP 0936715 A2 (ABB PATENT GMBH) 18 August 1999 (1999-08-18) the whole document	1-17

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search	Date of mailing of the international search report
15 November 2016	**06 December 2016**

Name and mailing address of the ISA/CN	Authorized officer
STATE INTELLECTUAL PROPERTY OFFICE OF THE P.R.CHINA **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088** **China**	**ZHAO,Guiqin**
Facsimile No. **(86-10)62019451**	Telephone No. **(86-10)010-62085093**

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
DE	19856025	A1	21 June 2000	DE	19856025	C2	02 November 2000
GB	2323481	A	23 September 1998	EP	0865136	A1	16 September 1998
				CA	2231934	A1	14 September 1998
				US	6281431	B1	28 August 2001
				GB	9705380	D0	30 April 1997
US	2006169475	A1	03 August 2006	US	2004256137	A1	23 December 2004
				US	2002046865	A1	25 April 2002
DE	19805068	A1	12 August 1999	EP	0936715	A2	18 August 1999
				EP	0936715	A3	02 May 2001
				EP	0936715	B1	30 August 2006
				DE	59813702	D1	12 October 2006
EP	0936715	A2	18 August 1999	DE	19805068	A1	12 August 1999
				EP	0936715	A3	02 May 2001
				EP	0936715	B1	30 August 2006
				DE	59813702	D1	12 October 2006