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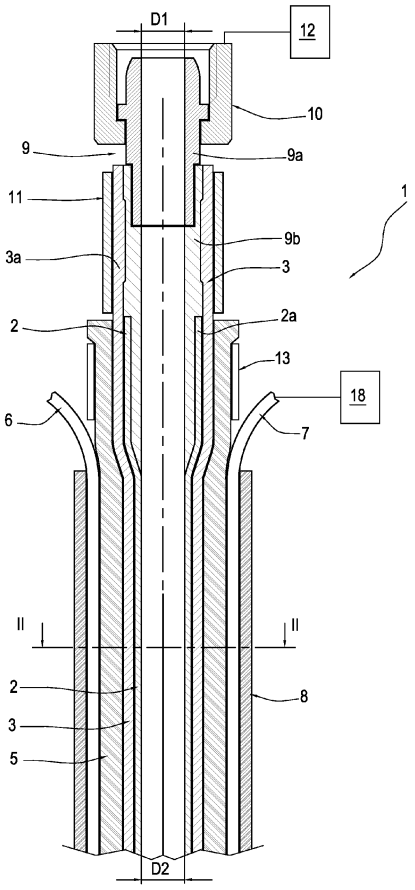
(54) **Plasma torch**

(57) A high voltage plasma torch comprises an electrode, a nozzle, a system for circulation of a gas and a power cable; the power cable comprises a gas transit duct (2), a conducting braid (3) for electrically connecting the electrode to the negative pole of a current generator, a second wire (7) for connecting the nozzle to the positive pole of the current generator, a protective outer sheath (8); the conducting braid (3) is positioned outside the duct (2) and an insulating coating (5) for use with high voltages is placed on top of the conducting braid (3) to isolate it from the rest of the power cable (1).

FIG.1



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Description

[0001] This invention relates to a plasma torch and in particular to a plasma torch with high frequency starting comprising a power cable.

[0002] Prior art power cables for the above-mentioned torches, not described in detail, with high frequency starting, usually comprise a tube in which the gas used to feed the torch flows and a wire, normally bare, without insulation, for supplying the torch electricity, the wire being inside the tube.

[0003] Outside the tube through which the gas flows there is a second wire for closing, as described below, a torch electric power circuit.

[0004] Outside the tube there are usually also further service wires, for example for alarm or safety systems.

[0005] More particularly, the wire inside the gas duct connects the torch electrode to the negative pole of a power generator, while the wire outside the tube connects the torch nozzle to the positive pole of the same generator.

[0006] The outside of the power cable made in that way is covered by a protective insulating sheath.

[0007] When the torch is started, the electrode and the nozzle are supplied with a high voltage, greater than around 8-10 kV, respectively through the inner wire and through the outer wire of the gas transit tube, which is suitably prepared, in such a way as to ionise the gas in the torch plasma generation chamber and strike the pilot arc.

[0008] Once struck between the electrode and the nozzle, the pilot arc is kept on by the inner and outer wires of the gas tube, suitably supplied with a voltage between around 100V and 300V and a currently typically between 15A and 30A.

[0009] In practice, the pilot arc is "transferred" from the nozzle to the part being worked on through which it closes again on the generator while, simultaneously, the nozzle is isolated from the respective power circuit. The arc is powered by the central wire along which a cutting current of up to 200A flows.

[0010] At the ends of the tube there are end pieces or connectors which allow, in particular, electrical connection of the inner wire to the generator, also forming a system for connecting the tube to a gas source.

[0011] One disadvantage of such a type of cable is that the electric power wire for the electrode, positioned inside the gas transit tube, causes a rise in the temperature of the latter, in particular during cutting when the cutting current is between 100A and 200A.

[0012] In that way, the torch is supplied with hot gas which helps to heat up the torch, compromising its performance, in particular in terms of wear on the components.

[0013] That disadvantage is particularly felt above all in torches which have high cutting currents, in which heat dispersal is a primary problem.

[0014] Another disadvantage is due to the electric end pieces positioned in the gas transit tube which cause significant drops in the pressure of the gas. To overcome such pressure drops, considerable adjustments are needed to the compressors used to supply the gas.

[0015] In this context, the main technical purpose of this invention is to provide a plasma torch with high frequency starting which is free of the above-mentioned disadvantages.

[0016] Therefore, the aim of this invention is to provide a torch comprising a power cable in which the gas is not heated by the electrical wires.

[0017] Another aim of this invention is to provide a plasma torch comprising a power cable which allows improved torch performance.

[0018] Another aim of this invention is to provide a plasma torch comprising a power cable in which drops in the gas pressure are greatly reduced. Another aim of this invention is to provide a plasma torch equipped with a power cable in which the wires even supplied with a high voltage are effectively isolated, as well as having compact dimensions and a smaller diameter.

[0019] The technical purpose indicated and at least the aims specified are substantially achieved by a plasma torch with high frequency starting comprising the features described in independent claim 1 and in one or more of the dependent claims. Further features and advantages of this invention are more apparent from the non-limiting description of a preferred, non-limiting embodiment of a plasma torch with high frequency starting as illustrated in the accompanying drawings, in which:

- Figure 1 is a longitudinal section of a portion of a power cable for plasma torches with high frequency starting according to this invention;
- Figure 2 is a cross-section, partly in blocks, according to line II - II, of the cable of Figure 1;
- Figure 3 is a schematic longitudinal section of a second embodiment of a cable according to this invention;
- Figure 4 is a schematic cross-section of a cable of the type shown in Figure 3, according to this invention.

[0020] With reference to Figures 1, 2, 3 and 4, the numeral 1 denotes in its entirety a power cable for plasma torches in accordance with this invention. The cable 1 is designed to power plasma torches with high frequency/voltage starting and with arc transfer.

[0021] An example of a plasma torch for which the cable 1 is intended is described in application BO2009A00049 which is referred to herein in its entirety for the purposes of a complete description, although the torch is not part of this invention.

[0022] Basically, that type of torch comprises an electrode, a nozzle which in conjunction with the electrode delimits a plasma generation chamber, a gas circulation system for supplying the gas to the plasma generation

chamber, a circuit for supplying electricity to the electrode, which allows its connection to the negative pole (cathode) of a current generator, and a circuit for supplying electricity to the nozzle for connecting it to the positive pole (anode) of the generator.

[0023] In the plasma generation chamber the gas is ionised by a high voltage (greater than 8-10 kV) applied across the electrode and the nozzle in such a way that an electric arc or pilot arc can be struck. Once struck in this way, the arc is transferred to the part being worked on during cutting and is kept on by applying, across the electrode and the nozzle, a voltage of between around 300 Volts with no load and 100 Volts corresponding to cutting currents of between around 100A and 200A.

[0024] The cable 1 according to this invention is designed to convey gas to the torch and to supply electricity to the power circuits of the electrode and the nozzle even at high voltage.

[0025] The cable 1 comprises a central tube or duct 2 for gas transit.

[0026] A wire 3 is associated with the outside of the tube 2 for powering the torch electrode.

[0027] In the preferred embodiment illustrated in Figures 1 and 2, the wire 3 is in the form of a metal braid, usually copper, covering the duct 2.

[0028] Hereinafter reference is specifically made to the wire 3 as a braid, in the preferred embodiment, without in any way restricting the scope of the invention.

[0029] The use of a conducting braid allows the overall diameter of the cable 1 to be kept within acceptable values particularly useful if the torch is operated manually.

[0030] As explained below, in practice, the copper braid 3 is subject to the above-mentioned high voltage and cutting current.

[0031] Therefore, in particular, the braid 3 comprises wires 4 sized to withstand the arc striking voltages which are normally greater than 8 - 10 kV and cutting currents of between 100A and 200A.

[0032] The braid 3 is designed to connect the torch electrode power circuit to the cathode of the current generator.

[0033] For the sake of simplicity, hereinafter reference is also made to the braid 3 as a wire for electrically connecting the electrode to the current generator.

[0034] An intermediate insulating coating 5 covers the braid 3, guaranteeing that it is electrically isolated from the rest of the cable 1.

[0035] It is important to notice that, as already indicated, when the gas is ionised in the plasma generation chamber, the braid 3 is subject to the high voltage and therefore the coating 5 has technical features such that it guarantees suitable insulation of the braid 3, that is to say, it is an insulating coating 5 for use with high voltages.

[0036] In general, the braid 3 forms wire means (i.e. conducting means, i.e. means for conducting electrical current) for powering the torch electrode.

[0037] In alternative embodiments, the cable 1 comprises at least one wire 15, in place of the braid 3, forming the electrical connection between the generator and the electrode, as illustrated for example in Figures 3 and 4.

[0038] Since said wire means are subject to the high voltage, it is essential both for cable integrity and for operator safety to guarantee the isolation between the braid 3 or the corresponding wires and the other components of the cable 1, as described in more detail below.

[0039] In the embodiment in Figures 1 and 2, braid 3 isolation is guaranteed by the coating 5 for use with high voltages.

[0040] As shown in Figures 1 and 2, on the outside of the coating 5, the cable 1 comprises a plurality of service wires 6.

[0041] For example, a first wire and a second wire 6a, 6b are designed to control torch starting, while a third wire and a fourth wire 6c, 6d are dedicated to operation of a safety system, substantially known, not described because it is not part of this invention, for safely dismantling the torch or its components, for example for the regular substitution of wear parts.

[0042] The cable 1 also comprises at least one wire 7 which allows reclosing of the high voltage arc starting circuit and allows the pilot arc to be kept on. In the embodiment illustrated in Figures 1 and 2, the wire 7 is positioned on the coating 5. Schematically, an arc striking circuit comprises the braid 3, or the corresponding wires, connected to the negative pole of the generator, the electrode, powered by the braid 3, the gas present in the plasma generation chamber between the electrode and the nozzle, the nozzle which is connected, by the wire 7, to the positive pole of the current generator.

[0043] In practice, by means of the wire 7, the nozzle allows closing of the electrode power circuit on the generator.

[0044] Therefore, the wire 7 is designed to connect the torch nozzle power circuit to the anode of the current generator both for high voltage arc striking and for keeping the pilot arc lit.

[0045] The cable 1 also comprises an outer sheath 8 covering in particular the wires 6 and the wire 7, providing mechanical and electrical protection for the cable 1.

[0046] It should be noticed that between the sheath 8 and the coating 5 for use with high voltages, where the wires 6 and 7 are located, a material for filling the free spaces is preferably inserted.

[0047] The filler material is shown by way of example in Figure 2 with a plurality of filling insulating wires 14, partly illustrated with dashed lines.

[0048] In particular with reference to Figures 3 and 4, it should be noticed that in the embodiments illustrated, as already indicated, the wire 3 is formed by a plurality of wires 15 preferably formed by a plurality of twisted strands 16.

[0049] Preferably, as illustrated in particular in Figure 4, the cable comprises a pair of pilot arc power wires 7.

[0050] Advantageously, the wires 15 are positioned outside the gas transit duct 2.

[0051] As illustrated in Figure 4, the wires 6, 7 are also

positioned outside the duct 2 and are kept separate from each other and from the wires 15 by insulating filler material 17.

[0052] Preferably, the wire 3 insulation is alternatively an air gap around the wire 3.

[0053] In other words, in the embodiment in Figures 3 and 4 the high voltage wire 3 insulation comprises the insulating filler material 17.

[0054] The insulation for the wire 3 and/or the wires 15 also comprises one or more air chambers around the wire 3 and/or the wires 15.

[0055] In practice, electrical isolation of the wire 3 is guaranteed by the presence of air around the wire 3.

[0056] The material 17 therefore forms the insulating means for the wire 3, like the coating 5.

[0057] The material 17 preferably comprises a plurality of wires 18 made of an insulating material which extend along the duct 2.

[0058] Advantageously, with reference to Figure 4, the wires 7 are positioned on the opposite side to the wires 15 relative to the duct 2, to optimise electrical isolation between them.

[0059] As shown in Figure 1, at one end of the cable 1 there is a connecting head 9 for connecting the cable 1 to a gas source, not illustrated, and to the negative pole of the current generator, schematically illustrated with a block labelled 12. Looking at the head 9 in further detail, it can be seen how the head comprises a first tubular stretch 9a with an internal diameter D1 substantially equal to the internal diameter D2 of the duct 2.

[0060] A second stretch 9b forms a single body with the first stretch 9a, forming the head 9 in its entirety.

[0061] The duct 2 and the braid 3 are connected on the head outside the stretch 9b, which is also tubular. As shown in Figure 3, the wire 3, or the wires 15, close to the head 9 is unwound from its twisted configuration or the strands 16 are separated.

[0062] The strands 16 are wrapped around the head 9, in particular at the portion 9b of it.

[0063] In that way, at the head 9 the wires 15 are wrapped around the head 9.

[0064] In other words, the strands 16 are distributed around the head 9 and fixed to it.

[0065] The cable 1 comprises a ring 11 for fixing the braid 3 to the head 9.

[0066] In other words, the braid 3 is fixed to the head 9 and has electrical continuity with it.

[0067] In the embodiment shown in Figures 3 and 4, the strands 16 wrapped around the head 9 are fixed to it by the ring 11 and have electrical continuity with it.

[0068] The braid 3 and the duct 2 have a respective end portion 3a and 2a widened for fitting on the outside of the tubular stretch 9b.

[0069] As illustrated in Figures 1 and 3, the duct 2 is also fitted to the head 9 and is locked to it by a second fixing ring 13.

[0070] It should be noticed that, in the embodiment in Figure 1, the ring 13 also constrains the insulating coating 5 to the head 9.

[0071] It should be noticed that, in the embodiment in Figure 3, the ring 13 also constrains the sheath 8 to the head 9.

[0072] It should also be noticed that the wires 6 and 7 are not retained by the sheath 8. That is to say, they preferably come out of the sheath substantially at the ring 13 then can connect, respectively, to the corresponding devices, not illustrated, and to the positive pole of the current generator, schematically illustrated for greater clarity with a block labelled 18.

[0073] Fitted on the head 9 at the stretch 9a there is a nut 10 for fixing the cable 1 to the negative pole of the current generator, schematically illustrated for simplicity with the block labelled 12.

[0074] The cable described allows gas to be supplied to the torch at a temperature lower than in the prior art solutions, since the wires subject to the cutting current do not pass inside the gas duct, but instead pass outside it.

[0075] The head, suitably connected both to the gas transit tube and to the electrode power wire, does not hinder the gas transit, thus reducing the drops in gas pressure and allowing the introduction of gas with pressures lower than those of the prior art solutions.

[0076] Use of the braid allows the maximum outer dimension of the power cable to be contained.

[0077] The braid coating for use with high voltages makes the cable particularly safe and suitable for use with torches with high frequency starting, since the wires subject to the high voltage are effectively insulated.

[0078] If the electrode power wire consists of twisted strands and is kept isolated by the filler material from the other wires of the torch which are positioned outside the duct, then the gas duct does not hinder gas transit and the insulation of the high voltage wires allows its use in torches with high frequency starting.

[0079] It should be noticed that this invention also makes available a cable designed to power the electrode, the nozzle and the circulation system, that is to say, a power cable for the electrode, the nozzle and the circulation system.

[0080] Said cable comprises a gas transit duct 2, first wire means 3, 4, 15, 16 (i.e. conducting means, i.e. means for conducting electrical current) for electrically connecting the electrode to the negative pole 12 of the generator, second wire means 7 (i.e. conducting means, i.e. means for conducting electrical current) for connecting the nozzle to the positive pole 18 of the current generator, and a protective outer sheath 8.

[0081] The first wire means 3, 4, 15, 16 are positioned outside the duct 2, the cable comprising electrical insulation means 5, 14, 17 for the first wire means 3, 4, 15, 16, for insulating the first wire means 3, 4, 15, 16.

[0082] It should be noticed that this invention makes available a cable (designed to power the electrode, the nozzle and the circulation system, that is to say, a power cable for the electrode, the nozzle and the circulation

system) according to what is indicated below.

[0083] Said cable comprises:

- a gas transit duct 2,
- first wire means 3 for electrically connecting the electrode to the negative pole of a current generator,
- second wire means 7, positioned outside the gas transit duct 2 and inside the sheath 8, for connecting the nozzle to the positive pole of the current generator,
- a protective outer sheath 8.

[0084] The second means 7 comprise at least one wire having a compact cross-section.

[0085] The first wire means 3 are positioned outside the duct 2 and inside the sheath 8.

[0086] The cable also comprises an insulating coating for use with high voltages, surrounding the first wire means 3 for insulating the first wire means 3. According to another aspect, it is possible to fit a plurality of service wires 6 outside the duct 2 and inside the sheath 8.

[0087] The cable is illustrated, by way of example, in Figure 4.

Claims

1. A plasma torch with high voltage starting, comprising an electrode, a nozzle, a system for circulation of a gas, a current generator with a positive pole (18) and a negative pole (12) for powering the electrode and the nozzle, the torch further comprising a power cable for the electrode, the nozzle and the circulation system, said cable comprising a gas transit duct (2), first wire means (3, 4, 15, 16) for electrically connecting the electrode to the negative pole (12) of the generator, second wire means (7) for connecting the nozzle to the positive pole (18) of the current generator, a protective outer sheath (8), the torch being **characterised in that** the first wire means (3, 4, 15, 16) are positioned outside the duct (2), the cable comprising electrical insulation means (5, 14, 17) for the first wire means (3, 4, 15, 16), for insulating the first wire means (3, 4, 15, 16).

2. The plasma torch according to claim 1, **characterised in that** the electrical insulating means (5, 14, 17) comprise an insulating coating (5) for use with high voltages which is placed on top of the first wire means (3, 4, 15, 16).

3. The torch according to claim 2, **characterised in that** the first wire means (3, 4, 15, 16) comprise a metal braid (3) surrounding the duct (2).

4. The torch according to any of the claims from 1 to 3, **characterised in that** the second wire means (7) are positioned between the electrical insulation means (5, 14, 17) and the sheath (8).

5. The torch according to any of the foregoing claims, **characterised in that** the second wire means (7) comprise at least one power wire (7) for the nozzle, the power wire (7) for the nozzle being connectable to the nozzle and to the positive pole of the current generator.

6. The torch according to any of the foregoing claims, **characterised in that** it comprises a plurality (6a, 6b, 6c, 6d) of service wires positioned between the electrical insulation means (5, 14, 17) and the sheath (8).

7. The torch according to any of the foregoing claims, **characterised in that** it comprises a head (9) for introducing the gas into the duct (2), the first wire means (3, 4, 15, 16) being fitted on the head (9).

8. The torch according to claim 7, **characterised in that** the head (9) has an internal diameter (D1) substantially equal to the internal diameter (D2) of the duct (2), said duct (2) and the first wire means (3, 4, 15, 16) being fitted on the outside of the head (9).

9. The torch according to claim 7 or 8, **characterised in that** the second wire means (7) come out of the sheath (8) at the head (9).

10. The torch according to claims 6 and 7, **characterised in that** the plurality (6a, 6b, 6c, 6d) of service wires come out of the sheath (8) at the head (9).

11. The torch according to claims 2 and 7, **characterised in that** the insulating coating (5) for use with high voltages engages on the head (9).

12. The torch according to any of the foregoing claims, **characterised in that** the first wire means (3, 4, 15, 16) comprise at least one wire (15) formed by a plurality of twisted strands (16), the strands (16) being positioned outside the duct (2).

13. The torch according to claim 12, **characterised in that** the electrical insulation means (5, 14, 17) comprise air around the wire (15) formed by a plurality of twisted strands (16).

14. The torch according to claim 12 or 13, **characterised in that** the electrical insulation means (5, 14, 17) comprise an insulating filler material (17) positioned outside the duct (2).

15. The torch according to claims 7 and 13, **characterised in that** at the head (9) the strands (16) are unwound from the respective wire (15) and are wrapped around the head (9).

16. The torch according to any of the foregoing claims, **characterised in that** the second wire means (7) are positioned on the opposite side to the first wire means (3, 4, 15, 16) relative to the duct (2).

FIG.1

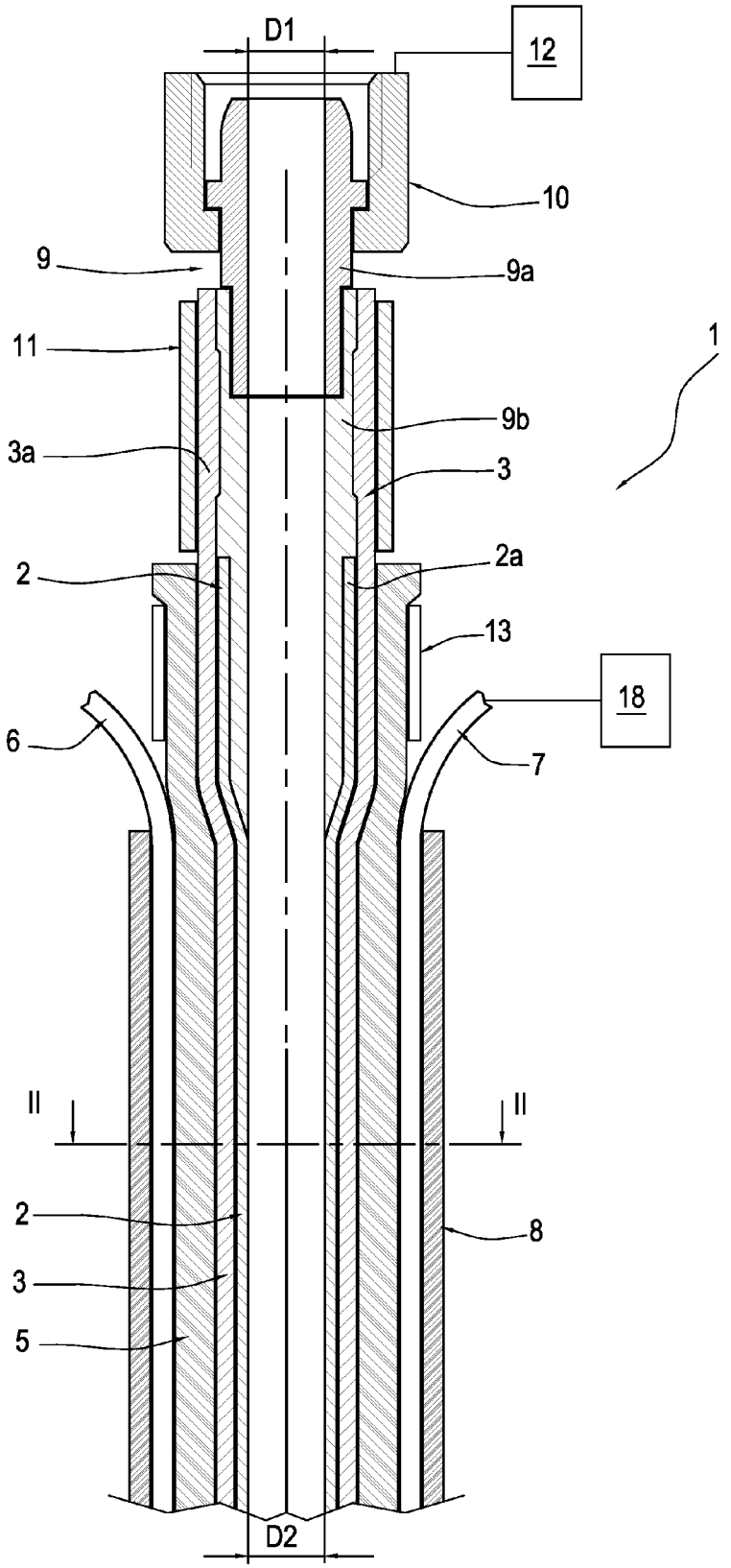

FIG.2

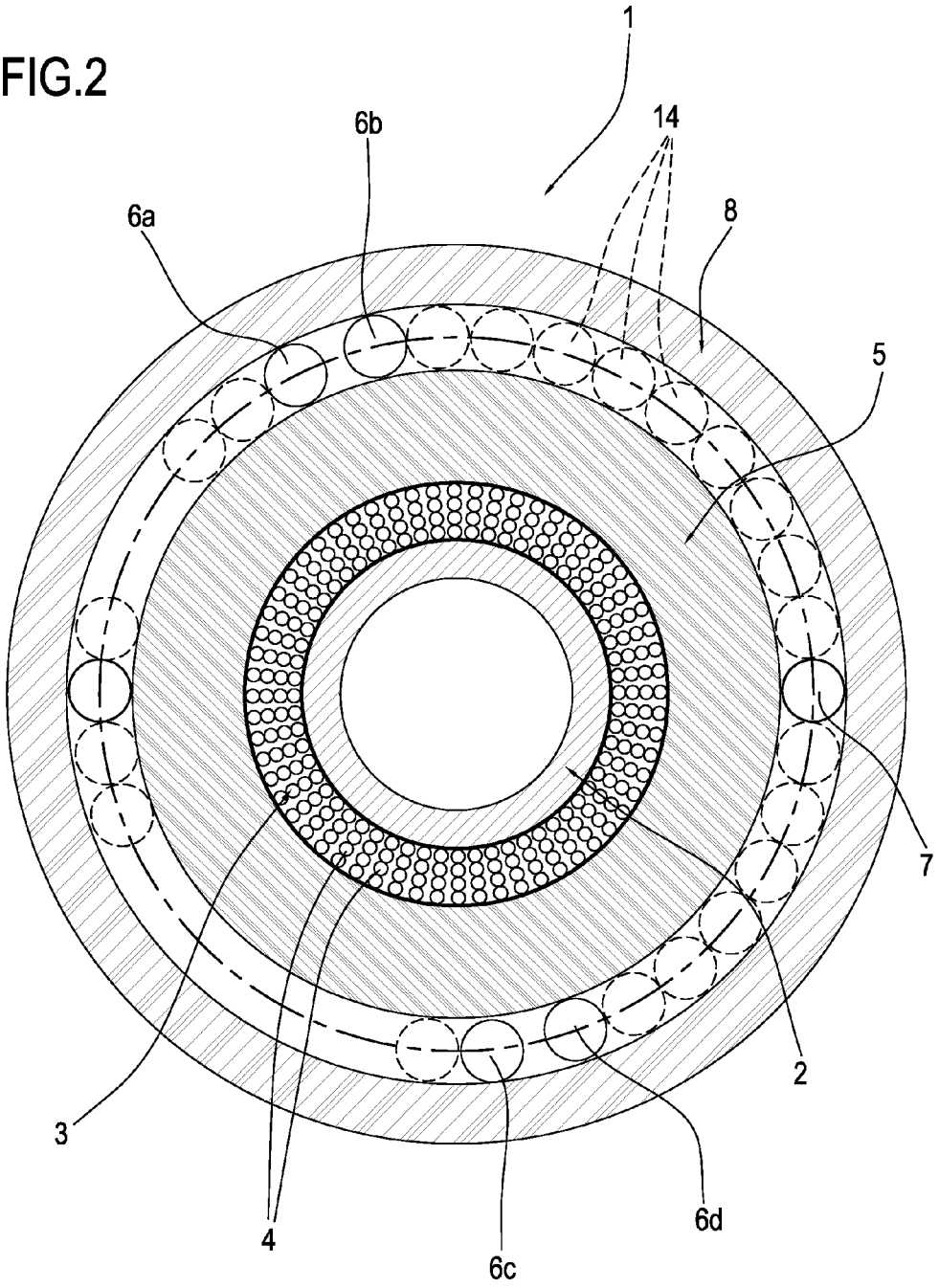

FIG.3

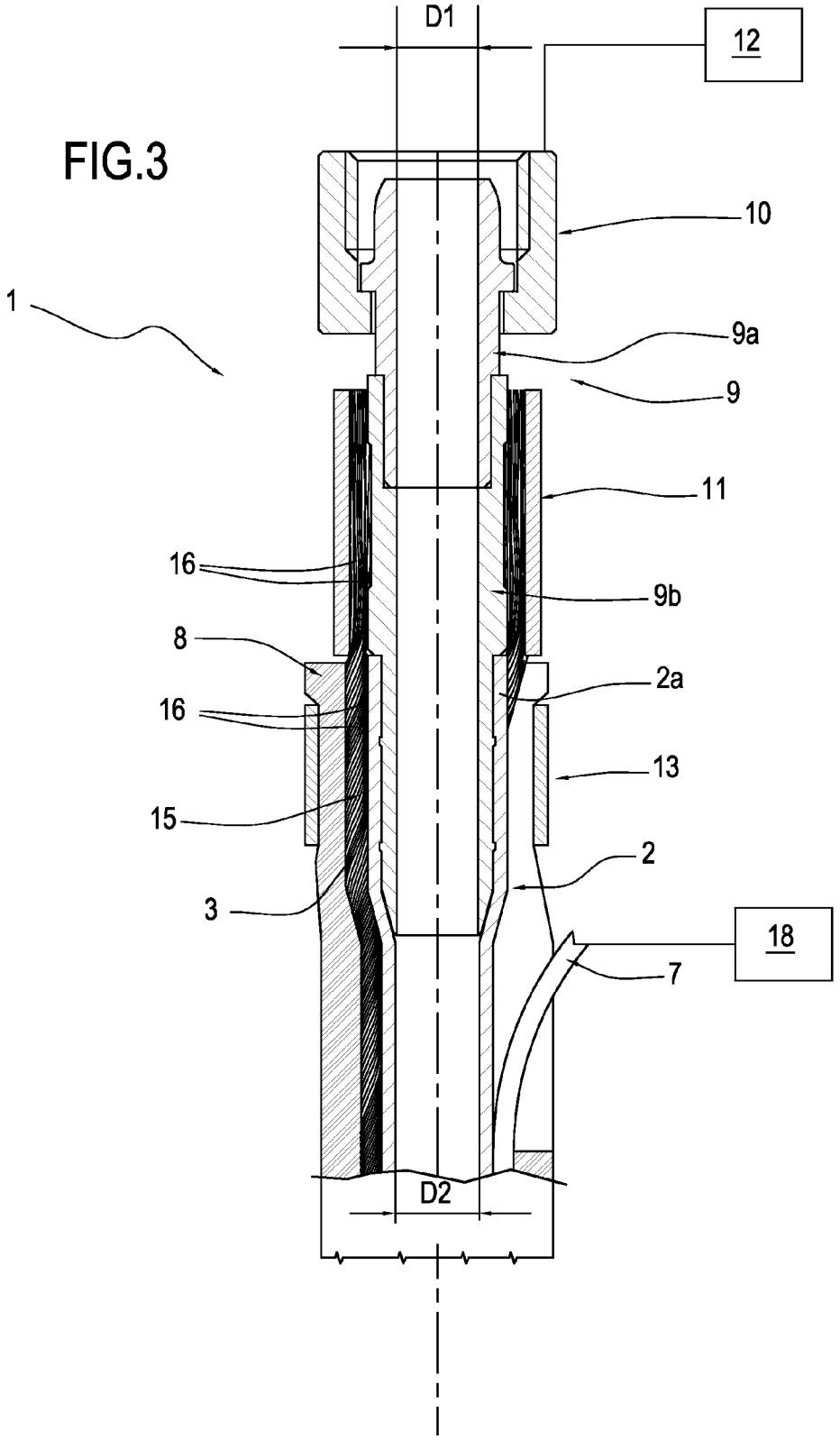

FIG.4