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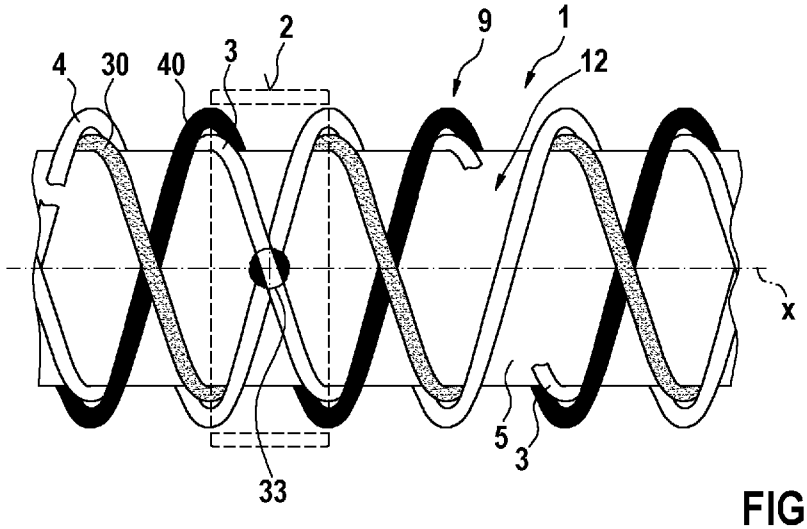

FIG. 3

(57) **Abstract:** The present invention relates to an implantable electrode lead (1), comprising: at least one electrode pole (2), at least one electrical conductor (3, 30), which is electrically conductively connected to the at least one electrode pole (2), and at least one longitudinally extended electrical insulator (4, 40). According to the present invention, the at least one electrical conductor (3, 30) is helically wound in a first direction of rotation about a longitudinal axis (x) of the electrode lead (1), and in that the at least one electrical insulator (4, 40) is helically wound in a second direction of rotation, opposite to the first direction of rotation, about the longitudinal axis (x).

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Braid-supported helical leads for implantable electrode leads

The present invention relates to an implantable electrode lead.

Currently, two different types of leads to electric poles are mainly used in implantable electrodes, namely helical leads based on wire-shaped electrical conductors and comparatively straight leads based on rope-shaped electrical conductors.

Due to their plastic deformability, wires can be wound into helical leads relatively easily; however, precisely because of their plastic deformability, they are limited to the smallest possible pitches, as otherwise the fatigue strength suffers. Rope-shaped leads, on the other hand, are only slightly plastically deformable and therefore exhibit increased fatigue strength, but for this reason cannot be wound into coils. However, it is also possible to form rope-shaped leads into coils by supporting them in a dimensionally stable manner with additional electrical leads that are guided in a direction of rotation opposite to that of the rope-shaped leads.

Especially for electrode leads used in the therapy of tachycardia, which necessitates the delivery of high-voltage pulses for shock therapy, a minimum lead spacing is important and should not be undercut to avoid flashover voltages between leads. However, ensuring this minimum spacing with lead wires arranged in a cross pattern is proving to be extremely challenging.

Based on the above, the problem to be solved by the present invention is to provide an improved implantable electrode lead with helical leads.

This task is solved by an implantable electrode lead having the features of claim 1. Advantageous embodiments of the invention are stated in the corresponding dependent claims and are described below.

According to claim 1, an implantable electrode lead is disclosed, comprising:

- at least one electrode pole,
- at least one electrical conductor connected to the at least one electrode pole in an electrically conducting fashion, and
- at least one longitudinally extended electrical insulator,

wherein according to the invention,

the at least one electrical conductor is helically wound in a first direction of rotation about a longitudinal axis of the electrode lead, and wherein the at least one electrical insulator is helically wound in a second direction of rotation about the longitudinal axis opposite to the first direction of rotation.

Particularly, said direction of rotation corresponds to the kind of helix (left-handed or right-handed) of the electrical conductor and electrical insulator, respectively. Particularly, the first direction of rotation can mean that the at least one electrical conductor forms a left-handed helix. Since the at least one electrical insulator comprises the opposite direction of rotation it forms a right-handed helix. Likewise, if in turn the at least one electrical conductor forms a right-handed helix, at least one electrical insulator forms a left-handed helix. Thus, opposite direction of rotation means opposite chirality (left-handed helix versus right-handed helix). Thereby the opposite direction of rotation is understood with respect to the longitudinal axis of the implantable electrode from the proximal to the distal end.

The structure, particularly braid, formed by said electrical conductor(s) and insulator(s) has the particular advantage of allowing to transfer torque while having a robust and flexible electrode lead at the same time.

In other words, the invention circumvents the problem described in the introduction by designing the braid-like structure in such a way that the electrically conductive leads are

each helically shaped in only one direction and are supported in their helical form exclusively by insulators wound in opposite directions thereto.

The minimum distance between the electrical conductors can thus be achieved in a simplified manner by running insulators in parallel between the electrical conductors without allowing crossing points between the electrical conductors. In other words, electrical conductors run in parallel and do not cross each other. Electrical conductors are only crossed by insulators. Thereby the crossing of electrical conductors is avoided and a braid is established at the same time.

In principle, this concept is not limited to electrode leads for tachycardia treatment, but can also be applied to other electrode leads or catheters, particularly where cross-arranged conductors may be undesirable, e.g., to avoid subclavian crush syndrome, and structures allowing to transfer torque are desired.

In particular, the described method, with the possibility to scale the number of leads, can be used for catheters in electrophysiology, where many electrode leads are needed in a very small space. Conventional lead concepts with single wires quickly reach their limits here, if high-resolution mapping and differentiated temperature monitoring are to take place simultaneously during ablation at many positions, e.g. to realize linear lesions in a one-shot procedure.

According to a preferred embodiment of the present invention, the implantable electrode comprises an electrically insulating tube extending along said longitudinal axis. The at least one electrical conductor and the at least one electrical insulator are arranged on the tube (i.e. helically wound on the tube in said opposite directions of rotation). In case the implantable electrode lead comprises a plurality of electrical conductors and a plurality of electrical insulators, these conductors and insulators are also arranged on the tube (i.e. helically wound on the tube in the respective direction of rotation).

According to an embodiment of the present invention, the electrical insulator(s) is(are) configured to be radially elastic. This embodiment provides a smaller overall diameter of the

implantable lead. The insulator(s) could be compressed radially at the crossing points with the conductor(s).

According to a preferred embodiment of the invention, the implantable electrode lead comprises a further electrical conductor helically wound in the first direction of rotation about the longitudinal axis.

Further, according to a preferred embodiment of the invention, the further electrical conductor is electrically conductively connected to a further electrode pole of the implantable electrode lead.

Furthermore, in a preferred embodiment of the invention, the implantable electrode lead comprises a further electrical insulator helically wound in the second direction of rotation about the longitudinal axis.

Further, according to a preferred embodiment, the electrical conductors are helically wound in the first direction of rotation, while the crossing electrical insulators (e.g. filaments) are helically wound in the opposite second direction of rotation. In this way, preferably, the conductors are fixed in position but can run completely parallel in the braid without overlapping. In further embodiments, the electrical conductors running in parallel may also alternate with insulators in addition. However, according to a preferred embodiment of the present invention, the electrical conductors do not cross one another in a braid formed by the electrical conductors and the electrical insulators.

According to a preferred embodiment of the invention, the respective electrode pole is a ring electrode.

Furthermore, according to a preferred embodiment of the invention, the respective electrical conductor is a rope comprising a plurality of strands, preferably a plurality of twisted or braided strands. Preferably, according to an embodiment, the respective strand comprises at least one wire (and may comprise merely a single wire). According to yet a further preferred

embodiment, the respective strand comprises a plurality of wires, particularly of twisted wires.

Further, according to a preferred embodiment of the invention, the respective rope comprises seven strands, preferably at least seven strands, more preferably exactly seven strands, the respective strand comprising seven twisted wires, particularly exactly seven twisted wires.

Furthermore, according to a preferred embodiment of the invention, the respective rope comprises 19 strands, preferably at least 19 strands, more preferably exactly 19 strands, the respective strand comprising one wire, particularly exactly one wire (i.e. a single wire).

According to yet another preferred embodiment of the invention, the respective rope comprises 7 strands, preferably at least 7 strands, more preferably exactly 7 strands, the respective strand comprising one wire, particularly exactly one wire (i.e. a single wire).

Further, in a preferred embodiment of the present invention, the respective wire comprises or is formed out a material selected from the list comprised of: Silver, an alloy comprising nickel and cobalt, MP35N.

Here MP35N is an alloy comprising about 35wt% nickel, 35wt% cobalt, 20wt% chromium; and 10wt% molybdenum.

According to a preferred embodiment of the invention, the respective wire comprises a core comprising a first metal and a sheath surrounding the core, the sheath being formed out of a different second metal. In a preferred embodiment, the first metal is silver, and the second metal is an alloy comprising nickel and cobalt, preferably MP35N (see above).

Furthermore, according to a preferred embodiment of the invention, the respective rope is covered with an electrically insulating cladding, preferably in form of an electrically insulating coating. In a preferred embodiment, the cladding (particularly coating) covering the respective rope is formed out of or comprises a material selected from the list comprised of the following materials: ETFE (ethylene tetrafluoroethylene), PFA (perfluoroalkoxy

polymers), polyurethane (PU), polyester urethanes (PEU), polyether urethanes (PEEU), polycarbonate urethanes (PCU), silicone-based polycarbonate urethanes (PCU), polycarbonate polyurea urethanes (PCHU), polydimethylsiloxane urethanes (PSU), polyisobutylene urethanes (PIU), polyisobutylene-based copolymers (PIC), polyether block amides, PEBA, PEBAX, polyimides (PI), fluorinated hydrocarbons, ethylene-tetrafluoroethylene copolymer (ETFE), polytetrafluoroethylene, polysulfone (PSU), polyethylene (PE), polypropylene (PP), polyamides (PA), silicone, polyimides (PI), fluorinated hydrocarbons, polytetrafluoroethylene (PTFE), tetrafluoroethylene (TFE), perfluoro(ethylene-propylene) (FEP), PEEK.

Further, in a preferred embodiment of the invention, the implantable electrode lead comprises an electrically insulating layer covering the at least one electrical conductor and the at least one electrical insulator, particularly all electrical conductors and insulators of the braid.

Furthermore, according to a preferred embodiment of the present invention, the implantable electrode lead is configured to be screwed into human or animal tissue, preferably in form of a septum, preferably to sense and/or stimulate in the vicinity of the left bundle branch (LBB), wherein the helically wound at least one electrical conductor and the helically wound at least one electrical insulator are configured to transfer torque upon screwing the implantable electrode lead into said tissue.

According to yet another preferred embodiment of the present invention, the respective electrical insulator is formed as a plastic thread.

In the following, embodiments and further features and advantages of the invention at hand will be described with reference to the Figures, wherein

Fig. 1 shows a section of an embodiment of an implantable electrode lead according to the invention,

Fig. 2 shows the section shown in Fig. 1, with an outer insulating tube and the electrode poles not shown, so that underlying electrical conductors or insulators are visible.

Fig. 3 shows a section of a further embodiment of an implantable electrode lead according to the invention, wherein an outer electrically insulating layer covering the conductors and insulators is not shown,

Fig. 4 shows a cross section of an electrical conductor in form of a rope of an embodiment of an implantable electrode lead according to the invention,

Fig. 5 shows a cross section of an electrical conductor in form of a rope of an embodiment of an implantable electrode lead according to the invention, and

Fig. 6 shows a cross section of an electrical conductor in form of a rope of an embodiment of an implantable electrode lead according to the invention.

Fig. 1 shows in connection with Fig. 2 an embodiment of an implantable electrode lead 1, e.g. for the therapy of tachycardia, according to the present invention, the lead 1 comprising at least one electrode pole 2, at least one electrical conductor 3, which is electrically conductively connected to the at least one electrode pole 2, and comprising at least one longitudinally extended electrical insulator 4. According to the invention, the at least one electrical conductor 3 is helically wound in a first direction of rotation about a longitudinal axis x of the electrode lead 1, and that the at least one electrical insulator 4 is helically wound in a second direction of rotation opposite to the first direction of rotation about the longitudinal axis x.

The implantable electrode lead 1 may further comprise an insulating tube 5, e.g. made of silicone, having an inner diameter of e.g. 0.83 mm and an outer diameter of e.g. 1.13 mm. In the inner lumen of the hose 5, a coiled lead of wire may be arranged (not shown), which may be connected to a helical fixation at the distal end. The at least one conductor 3 and the at least one insulator 4 are arranged on the hose 5.

Preferably, multiple conductors 3 and insulators 4 are provided, as will be explained below with reference to Figures 1 and 2.

Preferably, at least two electrical conductors 3, each in the form of a rope-shaped insulated electrical lead with a diameter of, for example, 0.36 mm, are wound in parallel over the insulating tube 5 with two thread-shaped insulators 4' of, for example, polyurethane (PU) with diameters of, for example, 0.15 mm, or at least 0.15 mm, the two electrical conductors 3 being braided in parallel in one direction of rotation, at least one PU thread 4' in each case being located between the conductors 3 and at least 4 PU threads being braided in the opposite direction of rotation, for example (in Fig. 2, 6 PU threads or insulators 4 are laid in the opposite direction of rotation as an example).

The electrical conductors 3 are, for example, in one case, a high-impedance conductor 3 (e.g. MP35N), which may be in electrical connection in particular with a ring electrode 2 of the electrode line 1, which may be used to detect an electrical activity, and a low-impedance conductor 3, e.g. in the form of a DFT rope with a silver core, e.g. with electrical connection to a shock coil (not shown).

An electrically insulating layer 6, particularly an insulating hose 6 (e.g. silicone or PU) with an inside diameter of e.g. at least 2.15 mm and with an outside diameter of e.g. 2.5 mm is preferably mounted over the braiding of the conductors 3 and insulators 4, 4'. In addition, a PU hose can be mounted over the silicone hose.

For other types of tachycardia electrodes, e.g. electrodes with two shock coils or two additional sensing electrodes in the atrium (DX electrodes), the number of electrical conductors 3 can be increased accordingly.

To simplify contacting of the braided electrical conductors 3 with the outer electrode poles 2 or shock coils, the electrical conductors 3 can be provided with appropriate contact surfaces before the braiding process, e.g. in the form of electrically conductive tabs, which can be

welded directly to the electrode poles 2. Subsequent stripping would be eliminated accordingly.

If the diameter of the electrically conductive lead wires 3 is to be reduced without increasing the electrical resistances to the same extent, two or more thinner rope-shaped lead wires can be braided in parallel with the same direction of rotation instead of one rope-shaped lead wire and connected together to an electrode pole 2.

Instead of using a filamentary insulating fiber 4 as part of the braid, insulating tubing can be used instead, which increases the overall diameter of the electrode less but at the same time ensures increased spacing between the electrical conductors 3 due to an elliptical deformation.

Fig. 3 shows a further embodiment of an implantable lead 1 according to the present invention, comprising a braid 9 of at least two electrical conductors 3, 30 wound in parallel in a helical fashion in a first direction of rotation (e.g. on a an electrically insulating carrier, e.g. tube 5), wherein at least two electrical insulators 4, 40 are helically wound in an opposite second direction of rotation (also in parallel). In other words, the conductors 3, 30 and insulators 4, 40 have opposite chiralities.

Preferably, the conductors 3, 30 used in the braid 9 running in parallel are ropes, which can be formed according to one of the embodiments shown in Figs. 4 to 6. Particularly, electrically conductive ropes are used for electrode leads especially when low resistances are required. This is particularly the case with tachycardia electrodes, where very high currents have to be transmitted. A tachycardia electrode has a resistance that is only between 1 and 10 ohms. If it were greater, the electrode would heat up during the shock. In addition, the voltage drop in the line would then be so large that the devices would have to provide significantly higher voltages.

For long-term implantation, copper as a particularly low-resistance metal is ruled out for reasons of biocompatibility. Instead, silver is preferably used as wire material, but because of its mechanical weaknesses, it is preferably supported by the very stable and corrosion-

resistant MP35N (35wt% nickel; 35wt% cobalt; 20wt% chromium; and 10wt% molybdenum). A mechanically stable wire made of MP35N can contain a core of silver, which lowers the conductivity drastically. The wire can be wound into either a helix for mechanical loading in an electrode. A straight wire would break quickly in an electrode. Coiling has the disadvantage that the lead length and thus the resistance is relatively high. Alternatively, a wire 11 can be drawn very thin and many wires 11 combined into a rope. Such a rope is mechanically extremely stable against bending load changes (in some cases even more stable than a helix), it has an extremely low resistance because it can connect the conductors by the shortest path.

According to the embodiment shown in Fig. 4, ropes 3, 3', 30 that are preferably used (e.g. in the embodiments of Figs 1 to 3) are 7x7 ropes, i.e. seven wires 11 that may be formed out of the above-described materials, are twisted into a strand 10. Seven such strands 10 are in turn twisted into a rope 3, 3', 30.

Somewhat simpler are the 1x19 ropes as shown in Fig. 5. Here, a rope 3, 3', 30 can be formed out of 19 strands 10 each comprising a single wire 11. Such ropes may also be used for tachycardia electrodes and neuroelectrodes.

Finally, Fig. 6 shows an embodiment of a rope 3, 3', 30 suitable for thin neuroelectrodes, wherein here the rope comprises seven strands, each strand 10 formed from a single wire 11.

According to an embodiment, these ropes 3, 3', 30 are either made of solid MP35N wires - then they have a relatively high resistance, which is sufficient for sensing and stimulation, or they contain wires with a silver core, and are then very low resistance. The silver content can vary and determines the compromise between low resistance and mechanical stability. Wires with a silver core are used especially for tachy probes and neuroprobes. For neuroprobes, the silver core is less important because of high energies than because these ropes are very thin and still need to be conductive.

Preferably, the respective rope 3, 3', 30 shown in Figs. 4 to 6 is preferably electrically insulated, i.e. surrounded by an electrically insulating cladding 7. This cladding 7 can be a

coating. A corresponding material of the cladding/coating 7 is typically made of ETFE (ethylene tetrafluoroethylene) or PFA (perfluoroalkoxy polymers). Other claddings/coatings are also conceivable: Polyurethane (PU), polyester urethanes (PEU), polyether urethanes (PEEU), polycarbonate urethanes (PCU), silicone-based polycarbonate urethanes (PCU) bond better with silicone during extrusion, polycarbonate polyurea urethanes (PCHU), polydimethylsiloxane urethanes (PSU), polyisobutylene urethanes (PIU), polyisobutylene-based copolymers (PIC), polyether block amides (PEBA, e.g. PEBAX), polyimides (PI), fluorinated hydrocarbons, ethylene-tetrafluoroethylene copolymer (ETFE), polytetrafluoroethylene, polysulfone (PSU), polyethylene (PE), polypropylene (PP), polyamides (PA), silicone, polyimides (PI), fluorinated hydrocarbons, polytetrafluoroethylene (PTFE), tetrafluoroethylene (TFE), perfluoro(ethylene-propylene) (FEP), PEEK.

Due to said electrical insulation by means of cladding 7 electrolyte bridges between conductors 3, 30 can be prevented from forming when body fluid enters.

The concept according to the invention is to be used especially with tachycardia electrodes, which, unlike conventional tachycardia electrodes- are intended to be screwed into the septum to sense and stimulate close to the LBB (left bundle branch). Typically, electrodes that are actively fixed in the tissue use a helix for fixation. This helix has a length of e.g. 2mm. A longer helix is also conceivable. However, if the LBB has to be reached at a depth of e.g. 8mm, the helix would have to be partially insulated in order not to unnecessarily dissipate (waste) current over the full length during stimulation. It seems easier to leave the helix short and let the electrode body follow the helix into the septum until the helix reaches the LBB. A classic helical electrode is fixed by transferring the rotation at the connector pin to the helix via an inner conductor helix, which then extends out of the helix body and anchors itself in the tissue. This technique is useful for classical electrode applications because it prevents potential perforation of the cardiac tissue. The inner conductor has a limited torque that allows the helix to be very easily screwed into the tissue until the electrode head (housing) is in contact with the tissue. For a normal RA or RV implantation, this is useful to protect against perforation, because if the free heart wall is perforated, the electrode

tip will penetrate into the pericardium, where it will cause tamponade on the one hand and will not be able to stimulate on the other hand.

In the present application, however, the septum is to be penetrated deliberately by the electrode so that preferably the deep LBB is reached. Torque transmission through the inner conductor (e.g. arranged in tube 5) is only moderately suitable because very many turns would be required to allow the electrode to penetrate. Therefore, the screw that can be screwed out is often omitted and a fixed screw is used, which is rotated by holding on to the electrode lead 1 and turning the electrode lead 1. A higher torque can be applied due to the braid 9 than with an inner helix. However, it is also conceivable to unscrew the helix with the connector pin, preload the inner conductor by overtightening the connector pin, and then implant the electrode lead 1 by turning it.

Tachycardia electrodes are popularly constructed with a multilumen tubing as the electrode body. Even the multilumen tubing cannot transmit much torque because the soft tubing material (silicone or polyurethane) twists easily.

However, the braid 9 of conductors 3, 30 and insulators 4, 40 arranged in opposite directions transmits the torque very well. The disadvantage of a braid is that the filaments may cross each other. If the filaments consist of feed conductors, there is a risk that the insulation will be compressed at the crossing points. Even if the conductors do not touch, there is a risk of breakdown when the shock is applied, especially in tachycardia applications.

In the present embodiment, therefore, the conducting ropes 3, 30 are guided in one direction of rotation (chirality), while the crossing insulators 4, 40 (e.g. plastic filaments) consist of insulating materials and are guided in the opposite direction of rotation (opposite chirality). In this way, the conductors 3, 30 are fixed in position but run completely parallel in the braid 9 without overlapping (c.f. e.g. Fig. 3). In further embodiments, the conductors 3, 30 running in parallel may also alternate with insulators in addition. However, one of the advantageous features of this embodiment is that conductors 3, 30 do not cross in the braid 9.

Furthermore, an electrically insulating layer 6 is preferably applied to the braid 9 (not shown in Fig. 3 so that conductors 3, 30 / insulators 4, 40 are visible) to prevent e.g. direct exposure to blood. A raw braid structure 9 would grow very much into the heart and vessels. This would make explantation of the electrodes very difficult. A tubing (e.g., polyurethane, silicone, or a copolymer) 6 can be used as a covering 6. In one embodiment, this tubing 6 is connected very tightly to the braid 9. This has the advantage that the electrode lead 1 is particularly easy to grip and turn by hand. The torque applied by the fingers is transmitted directly to the braid 9. This condition can be e.g. achieved by over-extruding the insulating layer 6 made of polyurethane or a copolymer or of silicone.

According to a further embodiment, a reflow process can be utilized. In this process, a tube 6 made of a thermoplastic is pushed over the braid 9 and shrunk in a heat process, melting it into the braid structure 9. The electrical conductors 3, 30 are routed continuously in the braid, which means that the conductor 3 of a ring electrode 2 that is connected at connection point 33 to the ring electrode 2 (cf. Fig. 3), for example, also runs under a shock coil (a tachycardia electrode arranged in the form of a coil configured for delivering high-voltage energy). This could lead to a short-circuit in the event of a run.

According to an embodiment, the conductor 3 can be interrupted, e.g. for one mesh size as shown in Fig. 3 showing a corresponding gap 12, so that this conductor 3 is electrically inactive below the shock coil, but the actual braiding remains connected and its mechanical properties are almost unaffected.

Preferably, plastic threads can be used as insulators 4, 40; these form the braid 9 in the opposite direction of rotation (chirality) to the electrical conductors 3, 30. At the crossing points, the threads lay very flat due to their thread structure and the thread tension. The plastic threads used as insulators 4, 40 are configured to be radially elastic.

This has the considerable advantage that the inner and outer diameters can be kept small, since only the cross-section of the electrical conductor 3, 30 (e.g. the diameter of the cable, but not of the filament) is included in the intended wall thickness of the braid 9.

The present invention simplifies the production of an implantable electrode lead, can be advantageously applied to electrode leads of various types, and avoids crossing points of conductors, which increases safety against high-voltage flashovers. Furthermore, the number of leads can be increased. Further, at the same time, the braid formed from the crossing electrical conductors and electrical insulators allows to transfer torque in an advantageous fashion.

Claims

1. An implantable electrode lead (1), comprising:
   - at least one electrode pole (2),
   - at least one electrical conductor (3, 30), which is electrically conductively connected to the at least one electrode pole (2), and
   - at least one longitudinally extended electrical insulator (4, 40)

   characterized in that

   the at least one electrical conductor (3, 30) is helically wound in a first direction of rotation about a longitudinal axis (x) of the electrode lead (1), and in that the at least one electrical insulator (4, 40) is helically wound in a second direction of rotation, opposite to the first direction of rotation, about the longitudinal axis (x).

2. The implantable electrode lead according to claim 1, wherein the implantable electrode lead comprises a further electrical conductor (30) helically wound in the first direction of rotation about the longitudinal axis (x).

3. The implantable electrode lead according to claim 2, wherein the further electrical conductor (30) is electrically conductively connected to a further electrode pole (2) of the implantable electrode lead (1).

4. The implantable electrode lead according to one of the preceding claims, wherein the implantable electrode lead comprises a further electrical insulator (40) helically wound in the second direction of rotation about the longitudinal axis.

5. The implantable electrode lead according one of the preceding claims, wherein the respective electrode pole (2) is a ring electrode.

6. The implantable electrode lead, wherein the respective electrical conductor (3, 3', 30) is a rope comprising a plurality of strands (10).

7. The implantable electrode lead according to claim 6, wherein the respective strand (10) comprises at least one wire (11).

8. The implantable electrode lead according to claim 6 or 7, wherein the respective rope comprises seven strands (10), the respective strand (10) comprising seven twisted wires (11).

9. The implantable electrode lead according to claim 6 or 7, wherein the respective rope comprises 19 strands (10), the respective strand (10) comprising one wire (11).

10. The implantable electrode lead according to claim 6 or 7, wherein the respective rope comprises 7 strands (10), the respective strand (10) comprising one wire (11).

11. The implantable electrode lead according to one of the claims 7 to 10, wherein the respective wire comprises or is formed out a material selected from the list comprised of: Silver, an alloy comprising nickel and cobalt, MP35N.

12. The implantable electrode lead according to one of the claims 7 to 11, wherein the respective wire comprises a core comprising a first metal and a sheath surrounding the core, the sheath being formed out of a different second metal.

13. The implantable electrode lead according to one of the claims 6 to 12, wherein the respective rope is covered with an electrically insulating cladding (7).

14. The implantable electrode lead according to one of the preceding claims, wherein the implantable electrode lead comprises an electrically insulating layer (6) covering the at least one electrical conductor (3, 3', 30) and the at least one electrical insulator (4, 40).

15 The implantable electrode lead according to one of the preceding claims, wherein the implantable electrode lead (1) is configured to be screwed into human or animal tissue, wherein a braid (9) comprising the helically wound at least one electrical conductor

(3, 30) and the helically wound at least one electrical insulator (4, 40) is configured to transfer torque upon screwing the implantable electrode lead (1) into said tissue.

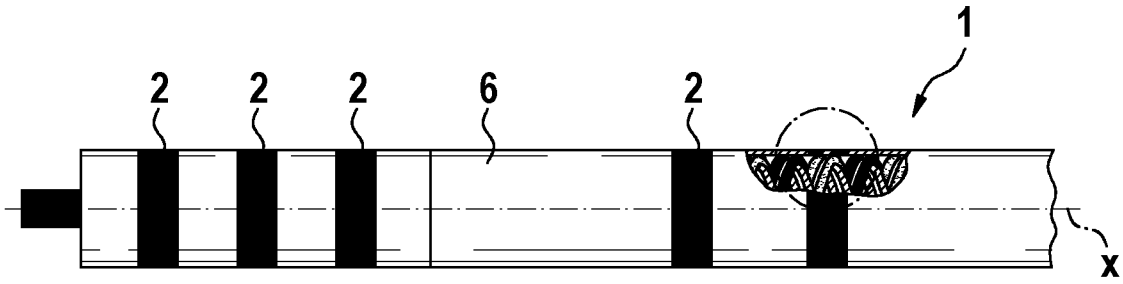

FIG. 1

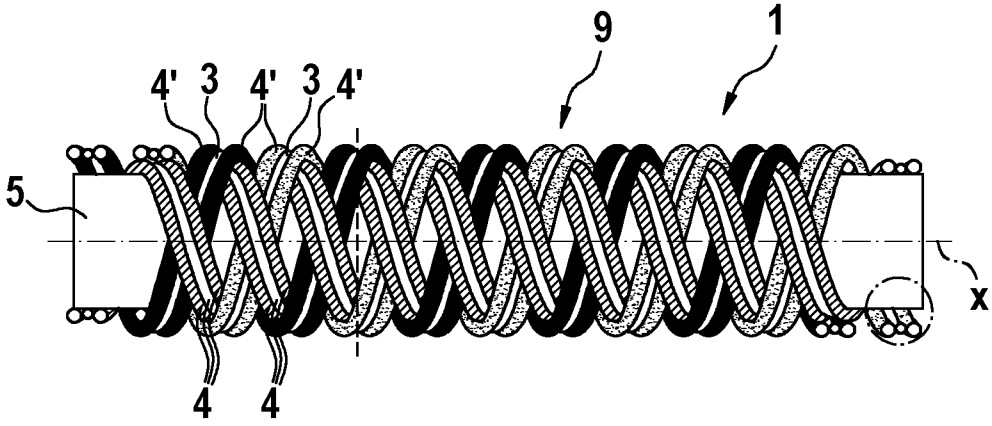

FIG. 2

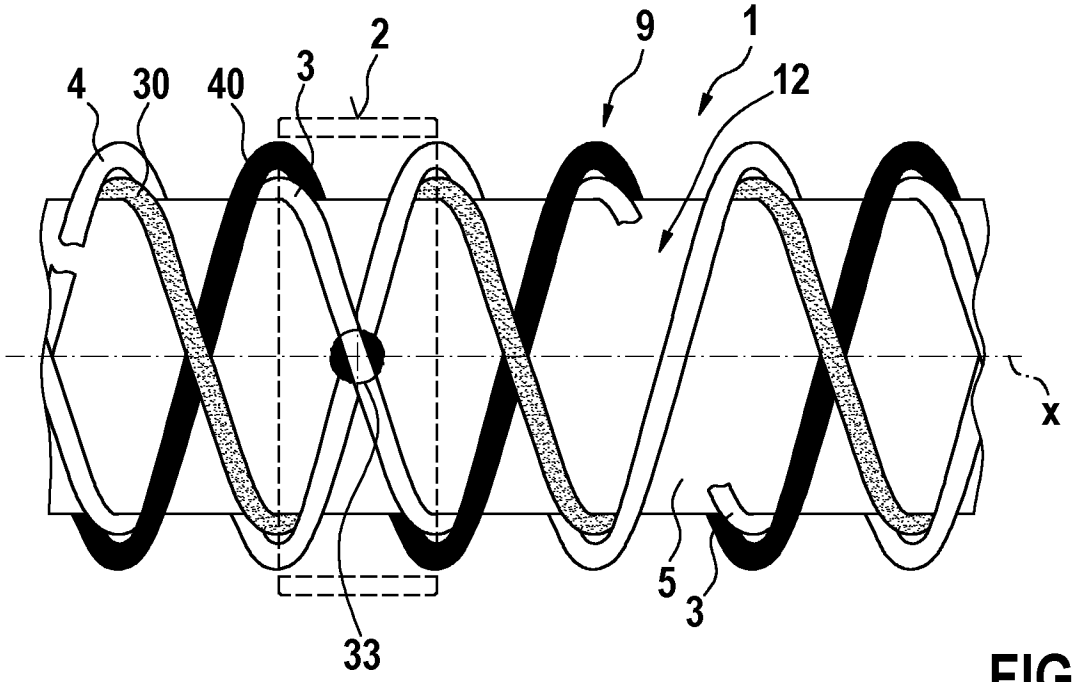

FIG. 3

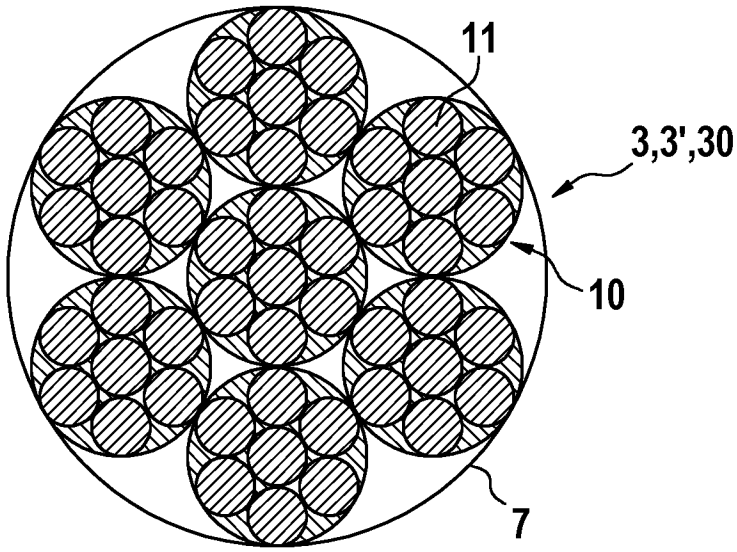

FIG. 4

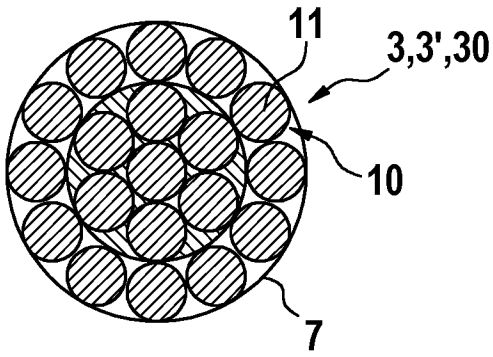

FIG. 5

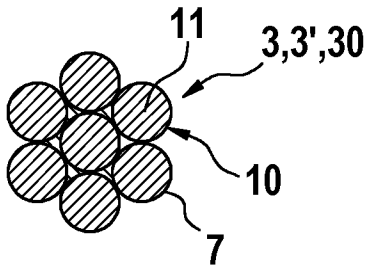

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2022/072204

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61N1/05
ADD.

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)
A61N

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)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2020/260342 A1 (BIOTRONIK SE & CO KG [DE]) 30 December 2020 (2020-12-30) abstract; figures 1-4 page 3, lines 9-20 page 5, lines 15-22 page 8, lines 13-16 page 14, line 27 - page 15, line 9 page 16, lines 4-22	1-15
X	US 9 517 335 B2 (BIOTRONIK SE & CO KG [DE]) 13 December 2016 (2016-12-13) the whole document	1
X	EP 2 564 892 A1 (GREATBATCH LTD [US]) 6 March 2013 (2013-03-06) the whole document	1

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
31 October 2022	09/11/2022

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Pereda Cubián, David

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2022/072204

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 935 449 A1 (QUAN EMERTEQ CORP [US]) 25 June 2008 (2008-06-25) the whole document -----	1

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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