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(54) GUIDE WIRE WITH SELF WETTING TUBE

FÜHRUNGSDRAHT MIT SELBSTBENETZENDEM ROHR

FIL-GUIDE AVEC TUBE À HUMIDIFICATION AUTOMATIQUE

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Description

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The present application claims the benefit of U.S. Provisional Application No. 62/121,243, filed on February 26, 2015.

BACKGROUND

[0002] The present disclosure relates to devices for making pressure or other measurements inside a living body, and in particular to a sensor/guide device having a guide wire and a distal sensor for pressure measurement in stenotic vessels.

[0003] Examples of such devices are described, for example, in Swedish Patents SE 441725, SE 453561, SE 454045, SE 460396, and SE 469454, in European Publication EP 0387453, and in U.S. Patent No. 6,167,763.

[0004] U.S. Patent No. 6,167,763 describes a device in which a pressure sensor is mounted in a cantilevered configuration. In one configuration, a tube extends around the pressure sensor. An opening is provided in the tube above the pressure sensor to allow the pressure sensor to be exposed to a surrounding medium, the pressure of which is to be measured. While this device has many benefits over previous devices, the present inventors discovered that an unstable pressure column can form above the sensor membrane of the pressure sensor due to insufficient wetting when the device is immersed in a liquid. Without being bound by theory, it is believed that instability in the pressure signal is caused by air remaining in the tube. This air influences the pressure column above the sensor membrane due to time dependent motion as a result of the inverse proportionality between capillary pressure and radius, as shown in the Young-Laplace equation, which describes the capillary pressure difference sustained across the interface between two static fluids due to surface tension. WO 00/69323 (A2), WO2011/161212 (A1), as well as US2015/032011 (A1) are important documents to understand the background of the invention.

[0005] Thus, there is a need for an improved sensor/guide device having a guide wire and a distal sensor for pressure measurement in stenotic vessels.

SUMMARY

[0006] In another configuration, a guide wire for biological pressure measurement includes a tube extending along a longitudinal axis of the guide wire; and a pressure sensor for biological pressure measurement, at least a portion of the pressure sensor being mounted within the tube. The pressure sensor comprises a pressure sensor membrane facing a top side of the tube. The tube includes at least six openings, including: a first distal opening located on a top side of the tube, a second distal opening located on a right side of the tube, offset right of the first distal opening in a circumferential direction, a third distal opening located on a left side of the tube, offset left of the first distal opening in a circumferential direction, a first proximal opening located on a top side of the tube proximal of the first distal opening, a second proximal opening located on a right side of the tube, offset right of the first proximal opening in a circumferential direction, and a third proximal opening located on a left side of the tube, offset left of the first proximal opening in a circumferential direction.

[0007] In one aspect, the tube includes exactly six openings: the first, second, and third distal openings, and the first, second, and third proximal openings, such that a bottom of the tube does not include any openings.

[0008] In one aspect, the pressure sensor is disposed in the tube such that, in a top view of the guide wire, an entirety of the pressure sensor membrane is visible through the distal opening.

[0009] In one aspect, the second and third distal openings are each offset by 90° in opposite circumferential directions from the first distal opening, and the second and third proximal openings are each offset by 90° in opposite circumferential directions from the first proximal opening.

[0010] In one aspect, widths of the first distal opening and first proximal opening are greater than widths of the second and third distal openings and second and third proximal openings.

[0011] In one aspect, proximal ends of each of the distal openings are at a same longitudinal position of the guide wire, and distal ends of each of the distal openings are at a same longitudinal position of the guide wire, and proximal ends of each of the proximal openings are at a same longitudinal position of the guide wire, and distal ends of each of the proximal openings are at the same longitudinal position of the guide wire.

[0012] In one aspect, each of the distal and proximal openings has a generally rectangular shape.

[0013] In one aspect, each of the distal and proximal openings has a generally rectangular shape with rounded corners.

[0014] In one configuration, a guide wire for biological pressure measurement comprises a tube extending along a longitudinal axis of the guide wire; and a pressure sensor for biological pressure measurement, at least a portion of the pressure sensor being mounted within the tube. The tube includes at least one concave distal opening extending proximally from a distal edge of the tube.

[0015] In one aspect, the at least one concave distal opening is configured to allow a fluid to enter the tube from a region outside the tube via the at least one concave distal opening and flow past the pressure sensor before exiting the tube.

[0016] In one aspect, the tube further includes at least one proximal opening located proximal of the at least one concave distal opening.

[0017] In one aspect, at least a portion of the at least one concave distal opening is located in a longitudinal cylindrical segment that opposes a side surface of the pressure sensor.

[0018] In one aspect, the at least a portion of the at least one concave distal opening is located distal of the pressure sensor.

[0019] In one aspect, the tube further includes at least one proximal opening located proximal of the at least one concave distal opening, and at least a portion of the at least one concave distal opening and at least a portion of the at least one proximal opening are located in a longitudinal cylindrical segment that opposes a side surface of the pressure sensor.

[0020] In one aspect, the at least one concave distal opening includes at least two concave distal openings.

[0021] In one aspect, the at least one concave distal opening includes at least two concave distal openings: a first concave distal opening and a second concave distal opening, and the tube further includes at least two proximal openings: a first proximal opening located proximal of the first concave distal opening, and a second proximal opening located proximal of the second concave distal opening.

[0022] In one aspect, the at least one concave distal opening includes at least two concave distal openings: a first concave distal opening and a second concave distal opening, an entirety of the first concave distal opening is located in a first longitudinal half of the tube that opposes a first side of the pressure sensor, and an entirety of the second concave distal opening is located in a second longitudinal half of the tube that opposes a second side of the pressure sensor.

[0023] In one aspect, a depth of the at least one concave distal opening is within 10% of a distance between the tube and a side surface of the pressure sensor.

[0024] In one aspect, the at least one distal opening has a single rounded edge.

[0025] In one aspect, the at least one concave distal opening has at least one straight edge.

[0026] In one aspect, the guide wire further comprises a wire on which the pressure sensor is mounted, the wire including a recess over which a distal portion of the pressure sensor extends. The tube further includes at least one proximal opening located proximal of the at least one concave distal opening. The at least one proximal opening is located in a cylindrical section of the tube that is adjacent to a proximal end of the recess.

[0027] In one aspect, the guide wire further comprises a wire on which the pressure sensor is mounted, the wire including a recess over which a distal portion of the pressure sensor extends. The pressure sensor is cantilevered from a shelf portion of the wire.

[0028] In one aspect, the pressure sensor is an absolute pressure sensor.

[0029] In one aspect, the guide wire further comprises a radiopaque tip.

[0030] In another embodiment, a guide wire for biological pressure measurement comprises a tube extending along a longitudinal axis of the guide wire; and a pressure sensor for biological pressure measurement, at least a portion of the pressure sensor being mounted within the tube. The tube includes at least one distal opening, and at least one proximal opening located proximal of the at least one distal opening.

[0031] In one aspect, the tube includes a first cylindrical section having a first diameter, and a second cylindrical section having a second diameter that is larger than the first diameter, and at least a portion of the at least one distal opening is located at a distal end of the second cylindrical section.

[0032] In one aspect, the tube includes a cylindrical section, and a tapered section located at a distal end of the cylindrical section, and at least a portion of the at least one distal opening is located in the tapered section.

[0033] In one aspect, the tube includes a first cylindrical section having a first diameter, a second cylindrical section having a second diameter that is larger than the first diameter, and a tapered transition section located between the first cylindrical section and the second cylindrical section, and at least a portion of the at least one distal opening is located in the tapered transition section.

[0034] In one aspect, the tube includes an ovoid section, and at least a portion of the at least one distal opening is located at a distal end of the ovoid section.

[0035] In one aspect, the tube includes a first cylindrical section having a first diameter, and a second cylindrical section having a second diameter that is larger than the first diameter, at least a portion of the at least one distal opening is located at a distal end of the second cylindrical section, and at least a portion of the at least one proximal opening is located at a proximal end of the second cylindrical section.

[0036] In one aspect, the tube includes a cylindrical section, a first tapered section located at a distal end of the cylindrical section, and a second tapered section located at a proximal end of the cylindrical section, at least a portion of the at least one distal opening is located in the first tapered section, and at least a portion of the at least one proximal opening is located in the second tapered section.

[0037] In one aspect, the tube includes an ovoid section, at least a portion of the at least one distal opening is located at a distal end of the ovoid section, and at least a portion of the at least one proximal opening is located at a proximal end of the ovoid section.

[0038] In one aspect, the at least one distal opening has a single rounded edge.

[0039] In one aspect, the at least one distal opening has at least one straight edge.

[0040] In one aspect, the guide wire further comprises a wire on which the pressure sensor is mounted, the wire including a recess over which a distal portion of the pressure sensor extends. The at least one proximal opening is located in a cylindrical section of the tube that is adjacent to a proximal end of the recess.

[0041] In one aspect, the guide wire further comprises a wire on which the pressure sensor is mounted, the wire including a recess over which a distal portion of the pressure sensor extends. The pressure sensor is cantilevered from a shelf portion of the wire.

[0042] In one aspect, the pressure sensor is an absolute pressure sensor.

[0043] In one aspect, the guide wire further comprises a radiopaque tip.

[0044] In another configuration, a method comprises providing a guide wire for biological pressure measurement comprising: a tube extending along a longitudinal axis of the guide wire; and a pressure sensor for biological pressure measurement, at least a portion of the pressure sensor being mounted within the tube, wherein the tube includes at least one concave opening extending proximally from a distal edge of the tube; and disposing the guide wire into a vessel of an individual such that a fluid enters the tube from a region outside the tube via the at least one distal opening and flows past the pressure sensor before exiting the tube.

[0045] In another configuration, a method comprises providing a guide wire for biological pressure measurement comprising: a tube extending along a longitudinal axis of the guide wire; and a pressure sensor for biological pressure measurement, at least a portion of the pressure sensor being mounted within the tube, wherein the tube includes at least one first opening, and at least one second opening located proximal of the at least one first opening; and disposing the guide wire into a vessel of an individual such that a fluid enters the tube from a region outside the tube via the at least one first opening and flows past the pressure sensor before exiting the tube via the at least one second opening.

[0046] In another embodiment, a guide wire for biological pressure measurement includes a tube extending along a longitudinal axis of the guide wire; and a pressure sensor for biological pressure measurement, at least a portion of the pressure sensor being mounted within the tube. The tube includes at least one distal opening. A hydrophilic material is coated on at least one of an internal surface of the tube, and a surface of the pressure sensor.

[0047] In one aspect, the pressure sensor comprises a pressure sensor membrane, and the hydrophilic material is further coated on a surface of the pressure sensor membrane.

[0048] In one aspect, the hydrophilic material comprises at least one of polyethylene glycol, polyvinyl alcohol, polyvinylpyrrilidone, carboxymethyl cellulose, hydroxypropyl cellulose, a polysaccharide, and a salt.

[0049] In one aspect, the hydrophilic material comprises polyethylene glycol.

[0050] In one aspect, the hydrophilic material comprises 20,000 g/mol polyethylene glycol.

[0051] In another configuration, a method includes providing a guide wire for biological pressure measurement comprising: a tube extending along a longitudinal axis of the guide wire; and a pressure sensor for biological pressure measurement, at least a portion of the pressure sensor being mounted within the tube. The tube includes at least one distal opening. A hydrophilic material is coated on at least one of an internal surface of the tube, and a surface of the pressure sensor. The method further includes providing a liquid within the tube, whereby the hydrophilic material dissolves and causes an influx of the liquid into the tube.

[0052] In one aspect, the pressure sensor comprises a pressure sensor membrane, and the hydrophilic material is further coated on a surface of the pressure sensor membrane.

[0053] In one aspect, the hydrophilic material comprises at least one of polyethylene glycol, polyvinyl alcohol, polyvinylpyrrilidone, carboxymethyl cellulose, hydroxypropyl cellulose, a polysaccharide, and a salt.

[0054] In one aspect, the hydrophilic material comprises polyethylene glycol.

[0055] In one aspect, the hydrophilic material comprises 20,000 g/mol polyethylene glycol.

BRIEF DESCRIPTION OF THE DRAWINGS

[0056]

FIG. 1 is a side cross-sectional view of a prior art guide wire including a tube and pressure sensor.

FIG. 2 a side cross-sectional view of a sensor portion of the prior art guide wire shown in FIG. 1.

FIG.3 is a right side perspective view of a guide wire according to an exemplary construction.

FIG. 4 is a left-side perspective view the guide wire shown in FIG. 3.

FIG. 5 is a top view of the guide wire shown in FIG. 3.

FIG. 6 is a top view of a portion of the guide wire shown in FIG. 3, with internal elements shown in dashed lines.

FIG. 7 is a side view of a guide wire according to another exemplary construction of the present invention, in which a tube includes a distal tapered section, with internal elements shown in dashed lines.

FIG. 8 is a top view of the guide wire shown in FIG. 7.

FIG. 9 is a side view of a guide wire according to another exemplary construction of the present disclosure, in which a tube includes a distal tapered section and a proximal tapered section, with internal elements shown in dashed lines.

FIG. 10 is a top view of the guide wire shown in FIG. 9.

FIG. 11 is a side view of a guide wire according to another exemplary construction of the present disclosure, in which a tube includes an ovoid section, with internal elements shown in dashed lines.

FIG. 12 is a top view of the guide wire shown in FIG. 11.

FIG. 13 is a perspective view of the guide wire according to another exemplary configuration, in which a tube includes six openings.

FIG. 14 is a perspective view of the tube of the guide wire shown in FIG. 13.

FIG. 15 is a top view of the guide wire shown in FIG. 13

FIG. 16 is a side view of the tube of the guide wire shown in FIG. 13.

DETAILED DESCRIPTION

[0057] Referring generally to the figures, a guide wire used for biological pressure measurements is shown and described. The guide wire may generally include a tube (sometimes termed a "jacket") and pressure sensor. The tube may generally include at least one distal opening, such as a concave distal opening. In various configurations, the guide wire may include one distal opening and one proximal opening, two concave distal openings and two proximal openings, or otherwise. The use of the concave distal opening may suppress the formation of air pockets in the guide wire surrounding the sensor, thereby permitting a more accurate pressure sensor reading. In other words, the guide wire is "self-wetting" in that the pressure or other sensor is wetted when the guide wire is inserted in a vessel.

[0058] Referring to FIG. 1, a cross section of a prior art guide wire 1 is shown. The guide wire 1 includes a solid wire 16 disposed in a portion of a proximal tubing portion 17. The solid wire 16 may, for example, be machined by centering grinding. The solid wire 16 may form the distal portion of the wire guide 1 and extend beyond the distal end of the proximal tube portion 17, where said proximal tube portion 17 is connected to or integrally formed with a spiral portion 18.

[0059] A pressure sensor 19 is mounted on the wire 16. The pressure sensor 19 may be an absolute pressure sensor, such as the one disclosed in Swedish patent application No. 9600334-8. The pressure sensor 19 may include a membrane 29 (shown in FIG. 2) made of, for example, polysilicon and a piezoresistive element. Between the wire 16 and the spiral portion 18, one or more leads 30 may run from the electronic circuitry of the pressure sensor 19. The wire 16, may act as a portion of one of the leads 30, as in FIG. 1.

[0060] The membrane 29 of the pressure sensor 19 may be mounted such that bending artifacts are minimized or eliminated (e.g., ensuring that the edges of the chip do not come into contact with the surrounding tube).

[0061] The pressure sensor 19 is protected by a short section of a tube 21, having an aperture 22 through which a surrounding medium interacts with the pressure sensor 19. The guide wire 1 further includes, at the very distal end of the guide wire, an X-ray non-transparent spiral 23, made, for example, of platinum, and used for location purposes, and a safety wire 24 for securing the distal part of the spiral 23. In one configuration, the non-transparent spiral 23 is a radiopaque coil.

[0062] In one construction, the wire 16 is made of stainless steel. In other constructions, the wire 16 may be made of a shape memory metal. The proximal tubing 17 and the spiral 18 may be coupled so as to be utilized as an electrical shield.

[0063] Referring to FIG. 2, a prior art sensor arrangement of the guide wire 1 is illustrated. The solid wire 16 may be machined (e.g., by grinding, spark erosion, or laser techniques) to form a groove in which the sensor element is mounted in a cantilevering fashion. The groove provides a free space for the sensor 19 and membrane 29, allowing air, blood, or other pressure exerting mediums to enter the interior of the guide wire 1 and act on the sensor, which in turn delivers a signal representative of the exerted pressure.

[0064] The groove may consist of two portions. A first portion of the groove may serve as a shelf 27 for receiving the proximal part of the sensor chip and holding the sensor in place. The second portion 28 may be an open space over which the cantilever extends, which allows the distal part of the sensor chip to protrude freely, even in a case where the wire tip is bent or deflected.

[0065] As shown in FIGS. 1 and 2, a tube 21 is provided around the guide wire 1, the tube including an opening 22 used to expose the sensor chip to a surrounding medium (e.g., fluid) in order to measure the pressure of the medium.

[0066] The prior art constructions of FIGS. 1 and 2 illustrate a single aperture or opening 22 in the guide wire through which the pressure sensor 19 is exposed to the surrounding medium. However, as discussed above, the presence of air in and around the guide wire 1 may cause unstable sensor readings.

[0067] Referring generally to FIGS. 3-12, examples of a guide wire according to the present invention will be described. The guide wire generally includes a tube that has at least one distal opening and at least one proximal opening. By implementing embodiments of the present invention, air in the vicinity of the sensor may be displaced when the guide wire is immersed in a liquid, thereby leading to more accurate sensor readings. The distal opening may allow a fluid to enter the tube and flow past the pressure sensor before exiting the tube at the proximal opening (or vice versa).

[0068] In each of the constructions described below, the guide wire may further include a proximal tube portion 17, a spiral portion 18, an X-ray non-transparent spiral 23, leads 30, etc., as generally described with respect to FIG. 1 and discussed in U.S. Patent No. 6,167,763.

[0069] FIGS. 3-6 depict a guide wire 2 according to a first construction. FIG. 3 is a right-side perspective view of a guide wire 2 according to the first construction. FIG. 4 is a left-side perspective view the guide wire 2 shown in FIG. 3. FIG. 5 is a top view of the guide wire shown in FIG. 3. FIG. 6 is a top view of a portion of the guide wire shown in FIG. 3, with internal elements shown in dashed lines.

[0070] The guide wire 2 includes a tube 21 and pressure sensor apparatus 19.

[0071] The tube 21 includes at least one distal opening 31 (for example, two distal openings 31a, 31b as shown in FIG. 5). In the example shown in FIGS. 3-6, the distal opening 31 is a concave distal opening 31 that extends proximally from the distal edge 61 of the tube 21. The term "concave distal opening" as it is used in this disclosure, means that the distal opening 31 is defined by a concave edge 62 of the tube 21. The term "concave" does not imply any particular shape, as long as the concave edge 62 is formed inwardly from the distal edge 61. For example, the concave edge 62 may be rounded, as shown in FIGS. 3-6, or may be formed of multiple straight edges, or a combination of rounded and straight edges. Where the tube 21 includes two of the concave distal openings 31, the concave distal openings 31 separate the distal end of the tube into multiple convex distal sections 63, as shown in FIGS. 3-6. More than two distal openings 31 may be included in the tube 21.

[0072] The distal opening 31 may be configured such that a fluid may enter the tube 21 from a region outside of the tube 21 via the distal opening 31 (such that the distal opening 31 is an inlet opening). The fluid may then flow past the pressure sensor 19 before exiting the tube 21 via at least one proximal opening 32, for example, two proximal openings 32a, 32b as shown in FIG. 5, (such that the proximal opening 32 is an outlet opening). The proximal opening 32 may be located proximal of the distal opening 31. In other constructions, the proximal opening 32 may be an inlet opening and the distal opening 31 may be an outlet opening, depending on the direction in which fluid is flowing relative to the guide wire.

[0073] The distal opening 31 and proximal opening 32 are shown located in a longitudinal segment of the tube 21 that opposes a side surface of the pressure sensor 19. The phrase "longitudinal cylindrical segment" refers to a segment of the tube 21 formed by slicing the tube 21 using a longitudinal plane. For example, when the tube 21 includes two distal openings 31a, 31b and two proximal openings 32a, 32b, a first distal opening 31a and a first proximal opening 32a may be located in a first longitudinal half of the tube 21 that opposes a first side of the pressure sensor 19, and a second distal opening 31b and a second proximal opening 32b may be located in a second longitudinal half of the tube 21 that opposes a second side of the pressure sensor 19, as shown in FIGS. 5 and 6. The two distal openings 31a, 31b may be located in a first longitudinal half and second longitudinal half of the tube 21, respectively, such that the openings 31 oppose a first side and second side of the pressure sensor 19.

[0074] In the construction of FIGS. 3-6, the pressure sensor 19 is shown oriented upwards, and the distal opening 31 and proximal opening 32 are located such that a side of the pressure sensor 19 is exposed. The two distal openings 31 are opposite one another such that the right side of the pressure sensor 19 is exposed in the first distal opening 31a, and the left side of the pressure sensor 19 is exposed in the second distal opening 31b. However, in other configurations, the entirety of the distal opening 31 may be located distal of the pressure sensor 19 (i.e., when the guide wire is inserted in a vessel, the position of opening 31 is deeper than the position of the pressure sensor 19).

[0075] The distal opening 31 is shown with a depth (d) between a major diameter of the tube 21 and a deepest point of the opening 31, when viewed from the side, as shown in FIG. 6. In one configuration, the depth of the concave distal opening 31 may be approximately equal to a distance between the tube 21 and the side surface of the pressure sensor 19. The term "approximately equal" may be interpreted as, for example, within plus or minus 10%.

[0076] Referring to FIG. 6, a top view of the guide wire is illustrated, with internal elements shown in dashed lines. The guide wire includes a tube 21 including two concave distal openings 31a, 31b, and two proximal openings 32a, 32b. The openings 31 and 32 are shown to include a single rounded edge. The pressure sensor 19 is positioned such that fluids may enter the guide wire at the concave distal openings 31a, 31b in a direction 40 and leave at the proximal openings 32a, 32b, in a direction 42, flowing over the pressure sensor 19 along the way. Fluid typically flows in the directions 40, 42 when the guide wire is flushed prior to use. However, when the guide wire is guide wire is inserted into a vessel, blood would typically flow in directions opposite the directions 40, 42 shown in the Figures.

[0077] The guide wire further includes a solid wire 16 as described with reference to FIG. 1. The pressure sensor 19 is mounted on the solid wire 16 such that a distal portion of the pressure sensor 19 extends beyond the solid wire 16 into the groove. The solid wire 16 may include a shelf 27 (shown in greater detail in FIGS. 8, 10, and 12) configured to hold the pressure sensor 19 in place, proximal from the two openings 31, 32. The pressure sensor 19 is cantilevered from the shelf portion 27 of the wire (i.e., only one end of the pressure sensor 19 is coupled to the guide wire). A second portion 28 of the groove is shown as an open space around the pressure sensor 19 in which fluids may flow through the guide wire. The proximal openings 32 may be located, for example, near the distal end of the shelf 27 (i.e., the distal portion of the second portion 28 of the groove).

[0078] The guide wire is further shown to include an electrical lead 30 running parallel with the pressure sensor 19. The electrical lead 30 may run from the electronic circuitry associated with the guide wire to the guide wire components (e.g., the pressure sensor 19). The wire 16 may act as a portion of a second electrical lead 30.

[0079] While the devices shown in the figures include a cantilevered pressure sensor 19, construction of the present disclosure are not limited to include such sensors. Rather, in configurations of the present disclosure, the pressure sensor 19 may be any appropriate sensor which can be used to take pressure measurements.

[0080] FIGS. 7 and 8 depict a guide wire according to a second construction, in which a tube 73 includes a distal tapered section, with internal elements shown in dashed lines. FIG. 7 is a side view of a guide wire according to the second construction. FIG. 8 is a top view of the guide wire shown in FIG. 7.

[0081] In the second embodiment, the guide wire includes two distal openings 71a, 71b and two proximal openings 72a, 72b, the distal opening 71a and proximal opening 72a being located opposite the distal opening 71b and proximal opening 72b. The openings 71, 72 are provided such that a side portion of the pressure sensor 19 is exposed in the openings. Each proximal opening 72 is located proximal from its corresponding distal opening 71. The two distal openings 71 may be located in a first longitudinal half and second longitudinal half of the tube 73, respectively, such that the openings 71 oppose a first side and second side of the pressure sensor 19. For example, the two distal openings 71 are opposite one another such that the right side of the pressure sensor 19 is exposed in the first distal opening 71a, and the left side of the pressure sensor 19 is exposed in the second distal opening 71b. In other embodiments, the distal openings 71 and proximal openings 72 may be otherwise positioned, and/or additional openings may be included.

[0082] The second construction is similar to the first embodiment except, in the second construction, the tube 73 includes a first cylindrical section 73a and a second cylindrical section 73b that has a diameter larger than a diameter of the first cylindrical section 73a. The tube 73 further includes a tapered transition section 73c located between the first cylindrical section 73a and the second cylindrical section 73b.

[0083] At least a portion of each of the distal openings 71a, and 71b is located at a distal end of the second cylindrical section 73b, as shown in FIGS. 7 and 8. For example, a portion of each of the distal openings 71a, 71b may be formed in the second cylindrical section 73b, and a portion of each of the distal openings 71a, 71b may be formed in the tapered transition section 73c, as shown in FIGS. 7 and 8.

[0084] In other configurations, a portion of each of the distal openings 71a, 71b may also be formed in the first cylindrical section 73a. The distal openings 71a, and 71b may be concave distal openings, as discussed above with respect to FIGS. 3-6. In still other configurations, the first cylindrical section 73a may be omitted altogether.

[0085] As the guide wire is inserted into a vessel, a fluid may flow into the distal openings 71a, 71b in a direction 40, flow over the pressure sensor 19, and flow out of the guide wire through the proximal openings 72a, 72b in a direction 42 (or vice versa).

[0086] FIGS. 9 and 10 depict a guide wire according to a third construction, in which a tube 52 includes a distal tapered section and a proximal tapered section. FIG. 9 is a side view of a guide wire according to the third construction, with internal elements shown in dashed lines. FIG. 10 is a top view of the guide wire shown in FIG. 9.

[0087] In the third embodiment, the guide wire includes two distal openings 81a, 81b and two proximal openings 82a, 82b, the distal opening 81a and proximal opening 82a being located opposite the distal opening 81b and proximal opening 82b. The openings 81, 82 are provided such that a side portion of the pressure sensor 19 is exposed in the openings. Each proximal opening 82 is located proximal from its corresponding distal opening 81. The two distal openings 81 may be located in a first longitudinal half and second longitudinal half of the tube 52, respectively, such that the openings 81 oppose a first side and second side of the pressure sensor 19. For example, the two distal openings 81 are opposite one another such that the right side of the pressure sensor 19 is exposed in the first distal opening 81a, and the left side of the pressure sensor 19 is exposed in the second distal opening 81b. In other embodiments, the distal openings 81 and proximal openings 82 may be otherwise positioned, and/or additional openings may be included.

[0088] The tube 52 of the guide wire in FIGS. 9 and 10 includes a first cylindrical section 52a and a second cylindrical section 52b that has a diameter larger than a diameter of the first cylindrical section 52a. The tube 52 further includes a distal tapered transition section 52c and a proximal tapered transition section 52d, the distal tapered transition section 52c being located distal of the second cylindrical section 52b, and the proximal tapered transition section 52d being located proximal of the second cylindrical section 52b. The tube 52 may further include a third cylindrical section 52e, as shown in FIGS. 9 and 10. Where the tube 52 includes a third cylindrical section 52e, the second cylindrical section 52b may have a diameter that is larger than a diameter of the third cylindrical section 52e.

[0089] At least a portion of each of the distal openings 81a, and 81b is located at a distal end of the second cylindrical section 52b. For example, a portion of each of the distal openings 81a, 81b may be formed in the second cylindrical section 52b, and a portion of each of the distal openings 81a, 81b may be formed in the tapered transition section 52c, as shown in FIGS. 9 and 10. At least a portion of each of the proximal openings 82a, 82b is located at a proximal end of the second cylindrical section 52b. For example, a portion of each of the proximal openings 82a, 82b may be formed in the second cylindrical section 52b, and a portion of each of the proximal openings 82a, 82b may be formed in the tapered transition section 52d, as shown in FIGS. 9 and 10.

[0090] In other configurations, a portion of each of the distal openings 81a, 81b may also be formed in the first cylindrical section 52a. The distal openings 81a, and 81b may be concave distal openings, as discussed above with respect to FIGS. 3-6. In still other configurations, the first cylindrical section 52a may be omitted altogether.

[0091] In yet other configurations, a portion of each of the proximal openings 82a, 82b may also be formed in the third cylindrical section 52e. The proximal openings 82a, 82b may be concave proximal openings, in which case the proximal openings 82a, 82b would be formed similarly to the concave distal openings discussed above with respect to FIGS. 3-6, except that the proximal openings 82a, 82b would extend from a proximal edge of the tube 52, rather than the distal edge. In still other configurations, the third cylindrical section 52e may be omitted altogether.

[0092] As the guide wire is inserted into a vessel, a fluid may flow into the distal openings 81a, 81b in a direction 40, flow over the pressure sensor 19, and flow out of the guide wire through the proximal openings 82a, 82b in a direction 42 (or vice versa).

[0093] FIGS. 11 and 12 depict a guide wire according to a fourth construction, in which a tube 56 includes an ovoid section. FIG. 11 is a side view of a guide wire according to the fourth construction, with internal elements shown in dashed lines. FIG. 12 is a top view of the guide wire shown in FIG. 11.

[0094] In the fourth embodiment, the guide wire includes two distal openings 91a, 91b and two proximal openings 92a, 92b, the distal opening 91a and proximal opening 92a being located opposite the distal opening 91b and proximal opening 92b. The openings 91, 92 are provided such that a side portion of the pressure sensor 19 is exposed in the openings. Each proximal opening 92 is located proximal from its corresponding distal opening 91. The two distal openings 91 may be located in a first longitudinal half and second longitudinal half of the tube 56, respectively, such that the openings 91 oppose a first side and second side of the pressure sensor 19. For example, the two distal openings 91 are opposite one another such that the right side of the pressure sensor 19 is exposed in the first distal opening 91a, and the left side of the pressure sensor 19 is exposed in the second distal opening 91b. In other embodiments, the distal openings 91 and proximal openings 92 may be otherwise positioned, and/or additional openings may be included.

[0095] The tube 56 of the guide wire in FIGS. 11 and 12 includes an ovoid section 56a. The tube 56 may also include a first cylindrical section 56b located distal of the ovoid section 56a and a second cylindrical section 56c located proximal of the ovoid section 56a, as shown in FIGS. 11 and 12. The maximum diameter of the ovoid section 56a may be larger than the diameters of the first and second cylindrical sections 56b and 56c. The minimum diameter of the ovoid section 56a may be substantially equal to the diameters of the first and second cylindrical sections 56b and 56c.

[0096] At least a portion of each of the distal openings 91a, and 91b is located at a distal end of the ovoid section 56a. For example, a portion of each of the distal openings 91a, 91b may be formed in the ovoid section 56a. At least a portion of each of the proximal openings 92a, 92b is located at a proximal end of the ovoid section 56a. For example, a portion of each of the proximal openings 92a, 92b may be formed in the ovoid section 56a.

[0097] In other constructions, a portion of each of the distal openings 91a, 91b may also be formed in the first cylindrical section 56b. The distal openings 91a, and 91b may be concave distal openings, as discussed above with respect to FIGS. 3-6. In still other constructions, the first cylindrical section 56b may be omitted altogether.

[0098] In yet other embodiments, a portion of each of the proximal openings 92a, 92b may also be formed in the second cylindrical section 56c. The proximal openings 92a, 92b may be concave proximal openings, in which case the proximal openings 92a, 92b would be formed similarly to the concave distal openings discussed above with respect to FIGS. 3-6, except that the proximal openings 92a, 92b would extend from a proximal edge of the tube 56, rather than the distal edge. In still other embodiments, the second cylindrical section 56c may be omitted altogether.

[0099] FIGS. 13-16 depict a guide wire and a tube 101 thereof according to a fifth construction, in which the tube 101 includes six openings 102a, 102b, 102c, 103a, 103b, and 103c in its circumferential wall. FIG. 13 is a perspective view of the guide wire according to the fifth construction. FIG. 14 is a perspective view of the tube 101 of the guide wire of the fifth construction. FIG. 15 is a top view of the guide wire of the fifth construction. FIG. 16 is a side view of the tube 101 of the guide wire of the fifth construction. It has been found that the construction shown in FIGS. 13-16 yields a particularly effective flow through the tube 101, and largely inhibits formation of air pockets/bubbles in the tube 101 during use.

[0100] In the fifth embodiment, the tube 101 of the guide wire includes three distal openings 102a, 102b, 102c and three proximal openings 103a, 103b, 103c. The distal opening 102a and proximal opening 103a are located on a top side of the tube 101, which is a side that is faced by the pressure sensor membrane 29. The distal opening 102b and proximal opening 103b are on a right side of the tube 101. The distal opening 102c and proximal opening 103c are on a left side of the tube 101. The six openings allow for multiple liquid entrance points and multiple air evacuation points, and also aids in the application of a hydrophilic coating to an interior of the tube 101, as discussed in more detail below.

[0101] In a preferred construction, the tube 101 includes exactly six openings in its circumferential wall, so that a bottom side of the tube 101 does not include any openings. This allows for a core wire to be located at the bottom side of the guide wire without obstructing any of the openings in the circumferential wall of the tube.

[0102] The pressure sensor 19 is preferably disposed in the tube 101 such that, in a top view of the guide wire, an entirety of the pressure sensor membrane is visible through the distal opening 102a. The distal openings 102b and 102c are preferably located at the left and right sides of the distal opening 102a. Preferably centers of the distal openings 102b and 102c are each offset by 90° in opposite circumferential directions from a center of the distal opening 102a.

[0103] The proximal opening 103a is located proximal of the distal opening 102a. The proximal openings 103b and 103c are preferably located at the left and right sides of the proximal opening 103a. Preferably, centers of the proximal openings 103b and 103c are each offset by 90°

in opposite circumferential directions from a center of the proximal opening 103a.

[0104] The distal opening 102a is larger than the distal openings 102b, 102c. The proximal opening 103a is larger than the proximal openings 103b, 103c. Preferably, the distal opening 102a and proximal opening 103a have widths that are greater than widths of the distal openings 102b, 102c and proximal openings 103b, 103c, the widths being defined in directions perpendicular to a longitudinal direction of the guide wire. A width of the distal opening 102a and proximal opening 103a may be, for example, in a range of 0.14 to 0.32 mm, preferably 0.17 to 0.29 mm, and more preferably 0.178 to 0.278 mm. A width of the distal openings 102b, 102c and proximal openings 103b, 103c may be, for example, in a range of 0.03 to 0.21 mm, preferably 0.06 to 0.18 mm, and more preferably 0.071 to 0.171 mm.

[0105] A distance between the distal opening 102a and the distal openings 102b, 102c may be, for example, in a range of 0.03 to 0.21 mm, preferably 0.06 to 0.18 mm, and more preferably 0.071 to 0.171 mm. A distance between the proximal opening 103a and the proximal openings 103b, 103c may be, for example, in a range of 0.03 to 0.21 mm, preferably 0.06 to 0.18 mm, and more preferably 0.071 to 0.171 mm.

[0106] An overall length of the tube 101 may be, for example, in a range of 1.90 to 2.1 mm, and preferably 1.95 to 2.05 mm. A distance from a proximal end of the tube 101 to proximal ends of the proximal openings 103a, 103b, 103c may be, for example, in a range of 0.130 to 0.330 mm, and preferably 0.180 to 0.280 mm. A distance from a proximal end of the tube 101 to the distal ends of the proximal openings 103a, 103b, 103c may be, for example, in a range of 0.785 to 0.985 mm, and preferably 0.835 to 0.935 mm. A distance from a proximal end of the tube 101 to proximal ends of the distal openings 102a, 102b, 102c may be, for example, in a range of 1.015 to 1.215 mm, and preferably 1.065 to 1.165 mm. A distance from a proximal end of the tube 101 to distal ends of the distal openings 102a, 102b, 102c may be, for example, in a range of 1.670 to 1.870 mm, and preferably 1.720 to 1.820 mm.

[0107] The proximal ends of each of the distal openings 102a, 102b, 102c are preferably at the same longitudinal position of the guide wire, and the distal ends of each of the distal openings 102a, 102b, 102c are preferably at the same longitudinal position of the guide wire. Similarly, the proximal ends of each of the proximal openings 103a, 103b, 103c are preferably at the same longitudinal position of the guide wire, and the distal ends of each of the proximal openings 103a, 103b, 103c are preferably at the same longitudinal position of the guide wire.

[0108] Each of the openings 102a, 102b, 102c, 103a, 103b, 103c has a generally rectangular shape, preferably a rectangular shape with rounded corners.

[0109] The overall length of the guide wire may be, for example, between 1.5 m and 2 m, and preferably about 1.75 meters. The tube 21, 52, 56, 73, 101 may have an overall diameter of, for example, between 0.30 and 0.40 mm, and preferably about 0.35 mm. In embodiments that have a reduced diameter tube portion, the diameter of this portion may be, for example, between 0.20 and 0.30 mm, and preferably about 0.25 mm.

[0110] In another embodiment, surfaces of the tube and/or pressure sensor (optionally including the pressure sensor membrane) can be treated with a hydrophilic material, to promote influx of liquid (such as water, blood, or saline solution) into the tube to contact the pressure sensor membrane. Coating surfaces of the tube and/or pressure sensor with a hydrophilic material can allow for more stable sensor signals, by reducing air moving through the tube. When submerged in a liquid, the hydrophilic material may dissolve within a few seconds, causing an influx of liquid into the tube and thereby removing air from (or preventing the introduction of air into) the tube.

[0111] For example, an inner surface of the tube (such as tubes 21, 52, 56, 73) may be coated with a hydrophilic material. Alternatively or additionally, a surface of the pressure sensor (such as pressure sensor 19) may be coated with a hydrophilic material. Alternatively or additionally, a surface of the pressure sensor membrane (such as pressure sensor membrane 29) may be coated with a hydrophilic material. The jacket may be partially or completely filled with the hydrophilic material. The hydrophilic material may be a material comprising, for example, polyethylene glycol (PEG), polyvinyl alcohol (PVA), polyvinylpyrrilidone (PVP), carboxymethyl cellulose (CMC), hydroxypropyl cellulose (HPC), a polysaccharide, and/or a salt. Preferably, the hydrophilic material is 20,000 g/mol PEG, which has been found to be more stable at elevated aging temperatures than lower molecular weight PEG. Preferably, a PEG dose is in a range of 6 μg to 20 μg. The hydrophilic material comprising PEG may be applied by, for example, by dispensing or vacuum filling a mixture of 3%-10% PEG (preferably 5% PEG) dissolved in 90%-97% ethanol (preferably 95% ethanol) inside the tube. A PEG application of 0.2 μL of a 5% PEG solution (which will yield a PEG dose in the desired range of 6 μg to 20 μg) is preferred. The mixture can be dried using, for example, a heat lamp, so that the ethanol evaporates, leaving a PEG coating on an interior of the tube and/or on the sensor membrane. The application of a hydrophilic material to the interior of the six-opening tube 101 of the fifth construction, described above, has been found to be particularly effective in terms of preventing air from accumulating in the tube 101.

[0112] It should be understood that even more variations of tube shapes and opening alignments are possible. For example, the tubes may include any number of cylindrical sections of different diameters, and may include any number of tapered sections or other sections to transition between the cylindrical sections. The sections of the tubes may be of any shape (e.g., rectangular, ovoid, spherical, etc.). The distal openings and proximal openings may be located in any of the sections of the tube such that fluids flow into the guide wire at a distal end of the guide wire though the distal openings, and flows over the pressure sensor 19 and through the proximal openings (or vice versa).

[0113] The invention being thus described, it will be clear that the same may be varied in many ways. Such variations are not to be regarded as a departure from the scope of the disclosure. The scope of protection is defined by the appended claims.

Claims

1. A guide wire (1) for biological pressure measurement comprising:

a tube (21) extending along a longitudinal axis of the guide wire, wherein the tube has an internal surface defining a space in the tube; and
a pressure sensor (19) configured for biological pressure measurement, at least a portion of the pressure sensor being mounted in the space in the tube,
wherein the tube includes at least one distal opening configured to allow fluid to enter the space in the tube, and
characterized in that,
a dissolvable hydrophilic material is coated on at least one of the internal surface of the tube, and/or a surface of the pressure sensor.

2. The guide wire of claim 1, wherein the pressure sensor comprises a pressure sensor membrane, and the hydrophilic material is coated on a surface of the pressure sensor membrane.

3. The guide wire of claim 1 or 2, wherein the hydrophilic material comprises at least one of polyethylene glycol, polyvinyl alcohol, polyvinylpyrrilidone, carboxymethyl cellulose, hydroxypropyl cellulose, a polysaccharide, and/or a salt.

4. The guide wire of any one of claims 1-3, wherein the hydrophilic material comprises polyethylene glycol.

5. The guide wire of any one of claims 1-4, wherein the hydrophilic material comprises 20,000 g/mol polyethylene glycol.

6. A method comprising:

providing the guide wire according to any one of claims 1-5; and
submerging the tube in fluid, allowing the hydrophilic material to dissolve and
cause the fluid to flow into the space in the tube, wherein the method is performed prior to use of the guide wire in a living body.

7. The guide wire of claim 1, wherein the tube has three distal openings (102a, 102b, 102c), including:

a first distal opening located on a top side of the tube,
a second distal opening located on a right side of the tube, offset right of the first distal opening in a circumferential direction,
a third distal opening located on a left side of the tube, offset left of the first distal opening in a circumferential direction;
moreover wherein the tube has three proximal openings (103a, 103b, 103c), including:

a first proximal opening located on the top side of the tube proximal of the first distal opening,
a second proximal opening located on the right side of the tube, offset right of the first proximal opening in a circumferential direction, and
a third proximal opening located on the left side of the tube, offset left of the first proximal opening in a circumferential direction.

8. The guide wire of claim 7, wherein:

the pressure sensor comprises a pressure sensor membrane, and
wherein the pressure sensor is disposed in the tube such that, in a top view of the guide wire, an entirety of the pressure sensor membrane is visible through the first distal opening.

9. The guide wire of claim 7, wherein centers of the second and third distal openings are each offset by 90° in opposite circumferential directions from the first distal opening.

10. The guide wire of claim 7, wherein the first distal opening is larger than the second distal opening and larger than the third distal opening.

11. The guide wire of claim 10, wherein a width of the first distal opening in a direction perpendicular to a longitudinal direction of the guide wire is larger than a width of the second distal opening in a direction perpendicular to the longitudinal direction of the guide wire and larger than a width of the third distal opening in a direction perpendicular to the longitudinal direction of the guide wire.

12. The guide wire of claim 11, wherein the width of the first distal opening is in a range of 0.14 to 0.32 mm, a width of the second distal opening is in a range of 0.03 to 0.21 mm, and a width of the third distal opening is in a range of 0.03 to 0.21 mm.

13. The guide wire of claim 7, wherein proximal ends of each of the distal openings are at a same longitudinal position of the guide wire, and distal ends of each of the distal openings are at a same longitudinal position of the guide wire.

14. The guide wire of claim 7, wherein each of the distal openings has a generally rectangular shape.

15. The guide wire of claim 7, wherein each of the distal openings has a generally rectangular shape with rounded corners.

Patentansprüche

1. Führungsdraht (1) zur Messung biologischen Drucks umfassend:

ein Rohr (21), das sich entlang einer Längsachse des Führungsdrahts erstreckt, wobei das Rohr eine Innenfläche aufweist, die einen Raum in dem Rohr definiert; und
einen Drucksensor (19), der zur Messung biologischen Drucks ausgelegt ist,
wobei zumindest ein Abschnitt des Drucksensors in dem Raum im Rohr montiert ist,
wobei das Rohr zumindest eine distale Öffnung umfasst, die ausgelegt ist, um zu ermöglichen, dass Flüssigkeit in den Raum im Rohr eintreten kann, und
dadurch gekennzeichnet, dass
ein auflösbares hydrophiles Material auf zumindest einer der Innenfläche des Rohrs, und/oder einer Oberfläche des Drucksensors, beschichtet ist.

2. Führungsdraht nach Anspruch 1, wobei der Drucksensor eine Drucksensormembran umfasst, und das hydrophile Material auf einer Oberfläche der Drucksensormembran beschichtet ist.

3. Führungsdraht nach Anspruch 1 oder 2, wobei das hydrophile Material zumindest eines aus Polyethylenglycol, Polyvinylalkohol, Polyvinylpyrrilidon, Carboxymethylcellulose, Hydroxypropylcellulose, einem Polysaccharid und/oder einem Salz umfasst.

4. Führungsdraht nach einem der Ansprüche 1-3, wobei das hydrophile Material Polyethylenglycol umfasst.

5. Führungsdraht nach einem der Ansprüche 1-4, wobei das hydrophile Material 20.000 g/mol Polyethylenglycol umfasst.

6. Verfahren umfassend:

Bereitstellen des Führungsdrahts nach einem der Ansprüche 1-5; und
Eintauchen des Rohrs in Flüssigkeit, wodurch ermöglicht wird, dass sich das hydrophile Material auflöst und bewirkt wird, dass die Flüssigkeit in den Raum im Rohr fließt,
wobei das Verfahren vor der Verwendung des Führungsdrahts in einem lebenden Körper durchgeführt wird.

7. Führungsdraht nach Anspruch 1, wobei das Rohr drei distale Öffnungen (102a, 102b, 102c) aufweist, umfassend:

eine erste distale Öffnung, die an einer Oberseite des Rohrs angeordnet ist,
eine zweite distale Öffnung, die an einer rechten Seite des Rohrs, zur ersten distalen Öffnung in einer Umfangsrichtung nach rechts versetzt, angeordnet ist,
eine dritte distale Öffnung, die an einer linken Seite des Rohrs, zur ersten distalen Öffnung in einer Umfangsrichtung nach links versetzt, angeordnet ist,
ferner wobei
das Rohr drei proximale Öffnungen (103a, 103b, 103c) aufweist, umfassend:

eine erste proximale Öffnung, die an der Oberseite des Rohrs, proximal zur ersten distalen Öffnung, angeordnet ist,
eine zweite proximale Öffnung, die an der rechten Seite des Rohrs, zur ersten proximalen Öffnung in einer Umfangsrichtung nach rechts versetzt, angeordnet ist, und
eine dritte proximale Öffnung, die an der linken Seite des Rohrs, zur ersten proximalen Öffnung in einer Umfangsrichtung nach links versetzt, angeordnet ist.

8. Führungsdraht nach Anspruch 7, wobei:

der Drucksensor eine Drucksensormembran umfasst, und
wobei der Drucksensor in dem Rohr derart angeordnet ist, dass, von oben auf den Führungsdraht betrachtet, eine Gesamtheit der Drucksensormembran durch die erste distale Öffnung sichtbar ist.

9. Führungsdraht nach Anspruch 7, wobei Mittelpunkte der zweiten und der dritten distalen Öffnung jeweils um 90° in entgegengesetzten Umfangsrichtungen von der ersten distalen Öffnung versetzt sind.

10. Führungsdraht nach Anspruch 7, wobei die erste distale Öffnung größer als die zweite distale Öffnung und größer als die dritte distale Öffnung ist.

11. Führungsdraht nach Anspruch 10, wobei eine Weite der ersten distalen Öffnung in einer zu einer Längsrichtung des Führungsdrahts senkrechten Richtung größer als eine Weite der zweiten distalen Öffnung in einer zur Längsrichtung des Führungsdrahts senkrechten Richtung und größer als eine Weite der dritten distalen Öffnung in einer zur Längsrichtung des Führungsdrahts senkrechten Richtung ist.

12. Führungsdraht nach Anspruch 11, wobei die Weite der ersten distalen Öffnung im Bereich von 0,14 bis 0,32 mm liegt, eine Weite der zweiten distalen Öffnung im Bereich von 0,03 bis 0,21 mm liegt, und eine Weite der dritten distalen Öffnung im Bereich von 0,03 bis 0,21 mm liegt.

13. Führungsdraht nach Anspruch 7, wobei proximale Enden von jeder der distalen Öffnungen sich an einer gleichen Längsposition des Führungsdrahts befinden, und distale Enden von jeder der distalen Öffnungen sich an einer gleichen Längsposition des Führungsdrahts befinden.

14. Führungsdraht nach Anspruch 7, wobei jede der distalen Öffnungen eine im Allgemeinen rechteckige Form aufweist.

15. Führungsdraht nach Anspruch 7, wobei jede der distalen Öffnungen eine im Allgemeinen rechteckige Form mit abgerundeten Ecken aufweist.

Revendications

1. Fil de guidage (1) pour la mesure de la pression biologique, comprenant :

un tube (21) s'étendant le long d'un axe longitudinal du fil de guidage, le tube ayant une surface intérieure définissant un espace dans le tube; et

un capteur de pression (19) configuré pour la mesure de pression biologique, au moins une partie du capteur de pression étant montée à l'intérieur du tube,

dans lequel le tube comprend au moins une ouverture distale configurée pour permettre au fluide d'entrer dans l'espace du tube, et

caractérisé en

ce qu'un matériau hydrophile est appliqué sur au moins l'une d'une surface intérieure du tube et / ou d'une surface du capteur de pression.

2. Fil de guidage selon la revendication 1, dans lequel le capteur de pression comprend une membrane de capteur de pression, et le matériau hydrophile est appliqué sur une surface de la membrane du capteur de pression.

3. Fil de guidage selon la revendication 1 ou la revendication 2, dans lequel le matériau hydrophile comprend au moins l'un parmi le polyéthylène glycol, l'alcool polyvinylique, la polyvinyle pyrrilidone, la carboxyméthylcellulose, l'hydroxypropylcellulose, un polysaccharide et / ou un sel.

4. Fil de guidage selon l'une quelconque des revendications 1 à 3, dans lequel le matériau hydrophile comprend du polyéthylène glycol.

5. Fil de guidage selon l'une quelconque des revendications 1 à 4, dans lequel le matériau hydrophile comprend 20.000 g / mol de polyéthylène glycol.

6. Procédé comprenant :

la fourniture du fil guidage selon l'une quelconque des revendications 1 à 5 ; et

l'immersion du tube en fluide, permettant au matériau hydrophile de se dissoudre et amener un fluide à s'écouler dans l'espace du tube,

dans lequel le procédé est réalisé avant l'usage du fil de guidage dans un corps vivant.

7. Fil de guidage selon la revendication 1, dans lequel le tube comporte trois ouvertures distales (102a, 102b, 102c), comprenant :

une première ouverture distale située sur un côté supérieur du tube,

une deuxième ouverture distale située sur un côté droit du tube, décalée à droite de la première ouverture distale dans une direction circonférentielle,

une troisième ouverture distale située sur un côté gauche du tube, décalée à gauche de la première ouverture distale dans une direction circonférentielle,

dans lequel en outre

le tube comporte trois ouvertures proximales (103a, 103b, 103c), comprenant

une première ouverture proximale située sur le côté supérieur du tube proximal de la première ouverture distale,

une deuxième ouverture proximale située sur le côté droit du tube, décalée à droite de la première ouverture proximale dans une direction circonférentielle, et

une troisième ouverture proximale située sur le côté gauche du tube, décalée à gauche de la première ouverture proximale dans une direction circonférentielle.

8. Fil de guidage selon la revendication 7, dans lequel :

le capteur de pression comprend une membrane de capteur de pression, et

dans lequel le capteur de pression est disposé dans le tube de telle sorte que,
dans une vue de dessus du fil de guidage, une totalité de la membrane du capteur de pression soit visible à travers la première ouverture distale.

9. Fil de guidage selon la revendication 7, dans lequel les centres des deuxième et troisième ouvertures distales sont chacune décalées de 90° dans des directions circonférentielles opposées par rapport à la première ouverture distale.

10. Fil de guidage selon la revendication 7, dans lequel la première ouverture distale est plus large que la deuxième ouverture distale et plus large que la troisième ouverture distale.

11. Fil de guidage selon la revendication 10, dans lequel une largeur de la première ouverture distale dans une direction perpendiculaire à une direction longitudinale du fil de guidage est plus large qu'une largeur de la deuxième ouverture distale dans une direction perpendiculaire à la direction longitudinale du fil de guidage et plus large qu'une largeur de la troisième ouverture distale dans une direction perpendiculaire à la direction longitudinale du fil de guidage.

12. Fil de guidage selon la revendication 11, dans lequel la largeur de la première ouverture distale est dans une plage de 0,14 à 0,32 mm, une largeur de la deuxième ouverture distale est dans une plage de 0,03 à 0,21 mm, et une largeur de la troisième ouverture distale est dans une plage de 0,03 à 0,21 mm.

13. Fil de guidage selon la revendication 7, dans lequel des extrémités proximales de chacune des ouvertures distales sont à une même position longitudinale du fil de guidage, et des extrémités distales de chacune des ouvertures distales sont à une même position longitudinale du fil de guidage.

14. Fil de guidage selon la revendication 7, dans lequel chacune des ouvertures distales a une forme généralement rectangulaire.

15. Fil de guidage selon la revendication 7, dans lequel chacune des ouvertures distales a une forme généralement rectangulaire avec des coins arrondis.

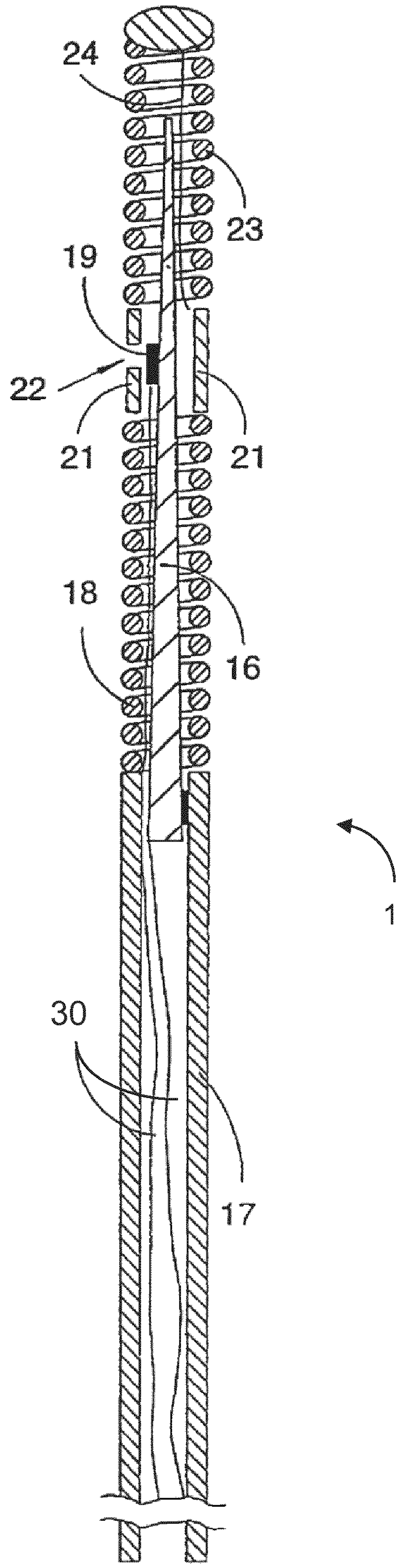


FIG. 1
(Prior Art)

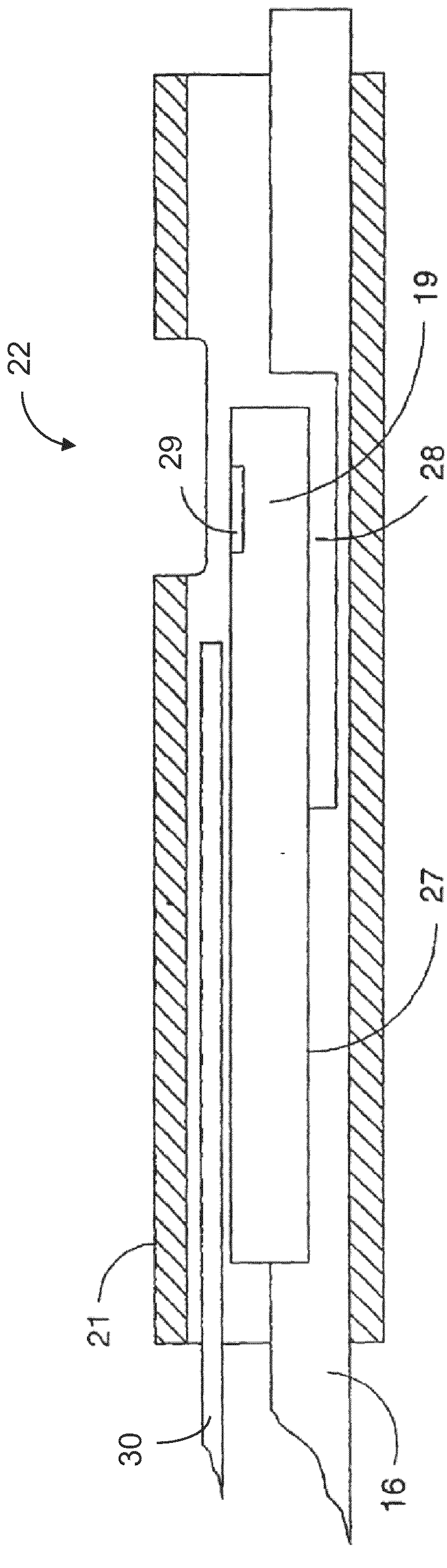
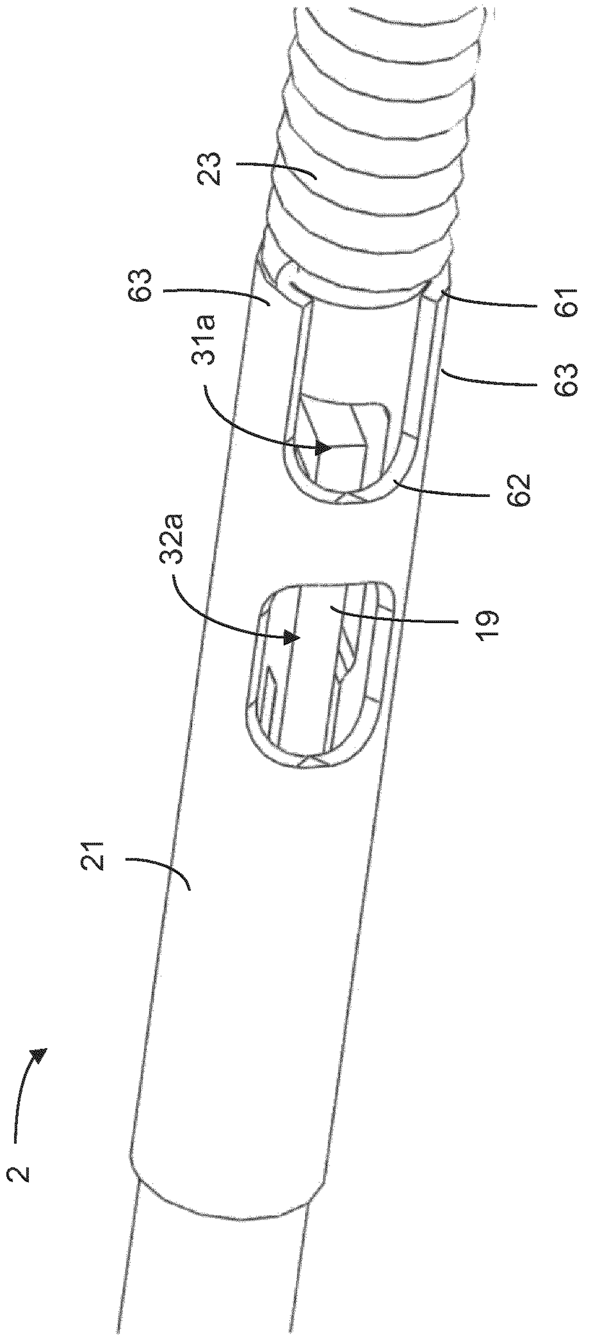


FIG. 2
(Prior Art)

FIG. 3



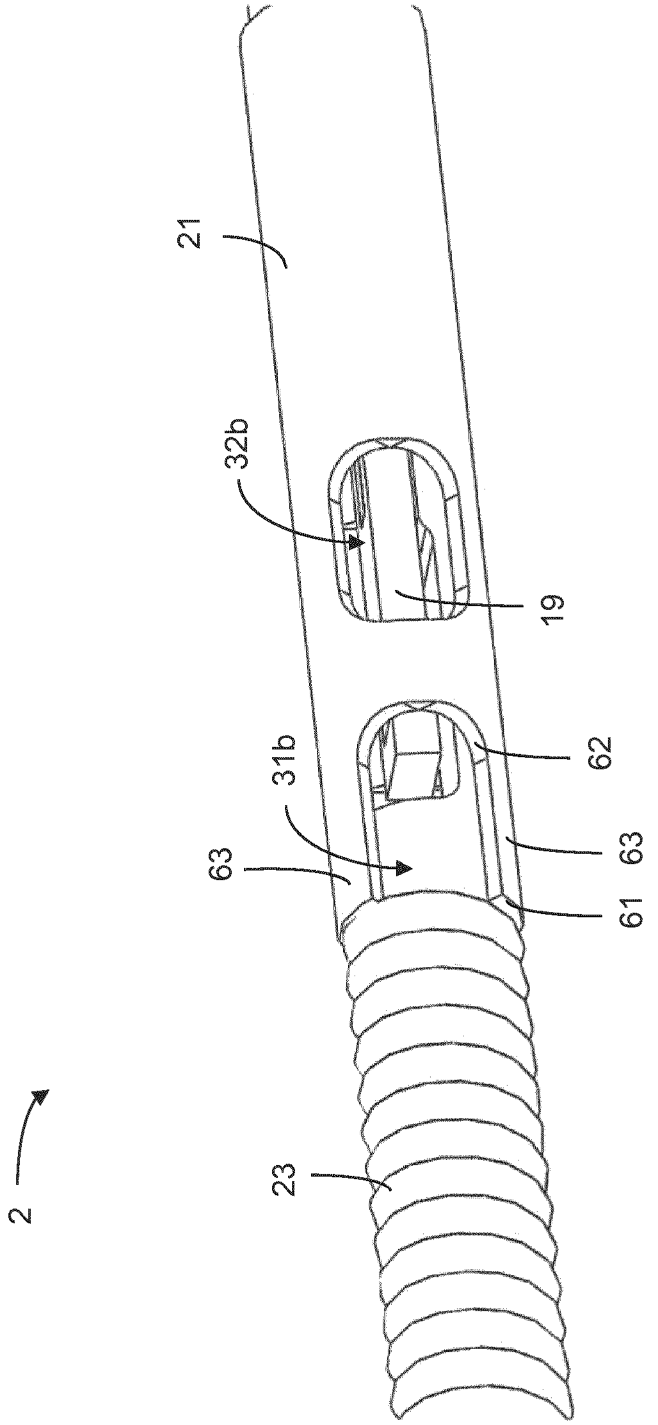


FIG. 4

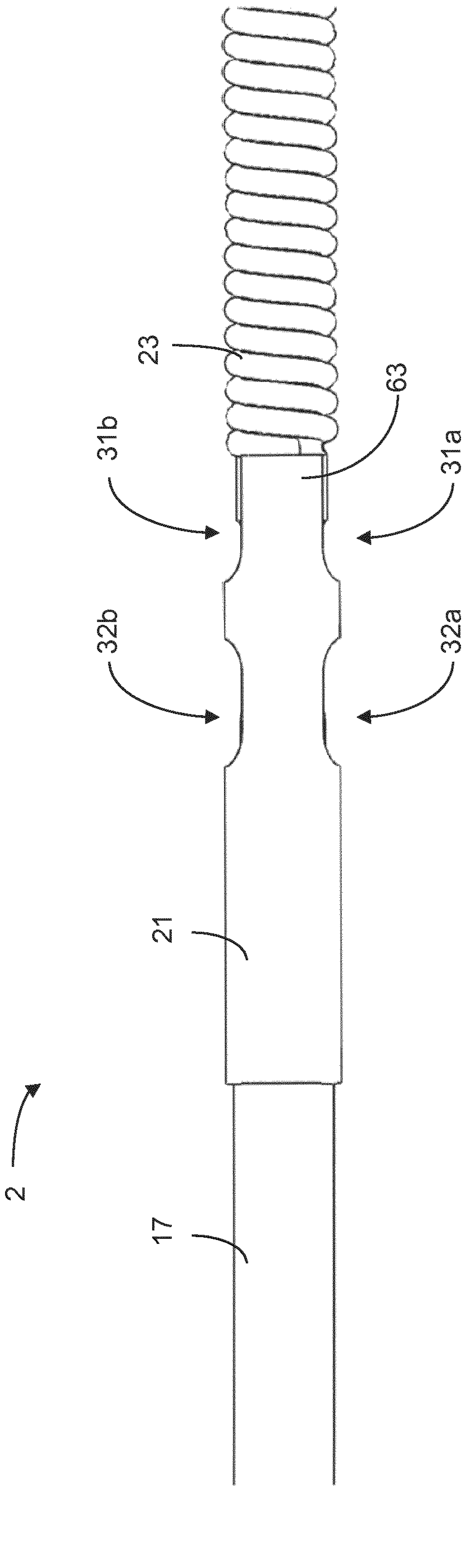
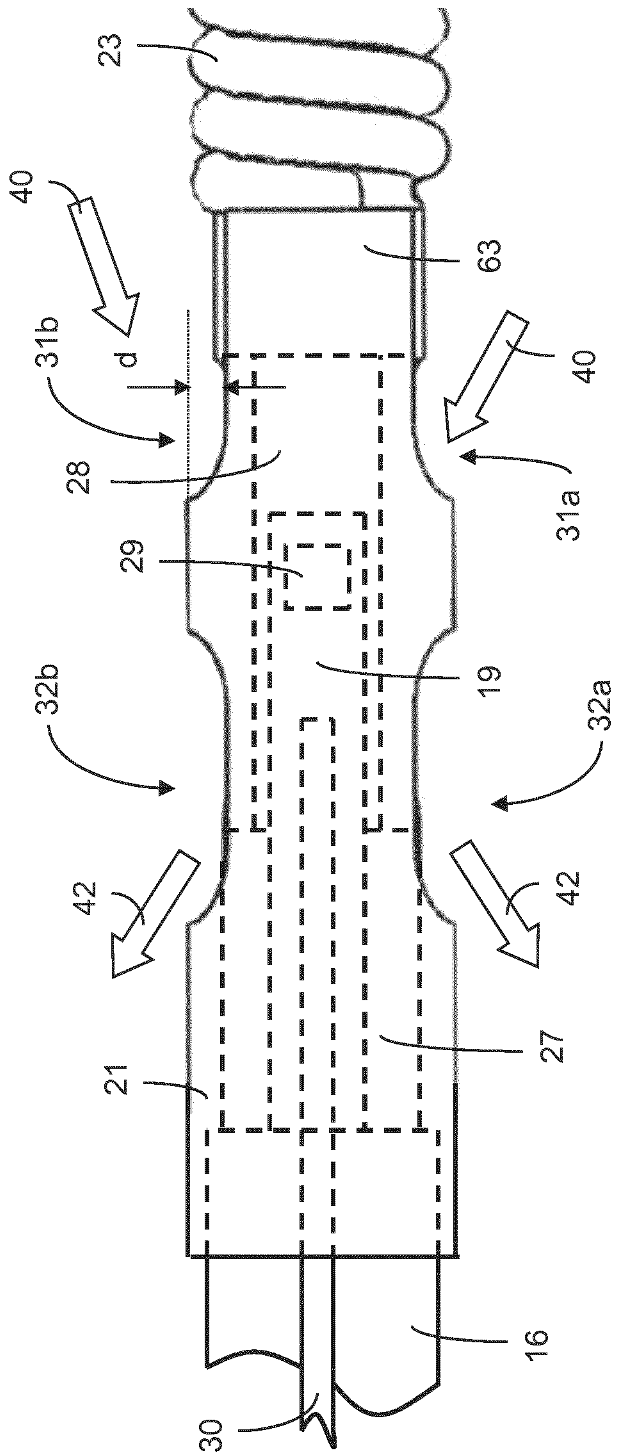


FIG. 5

FIG. 6



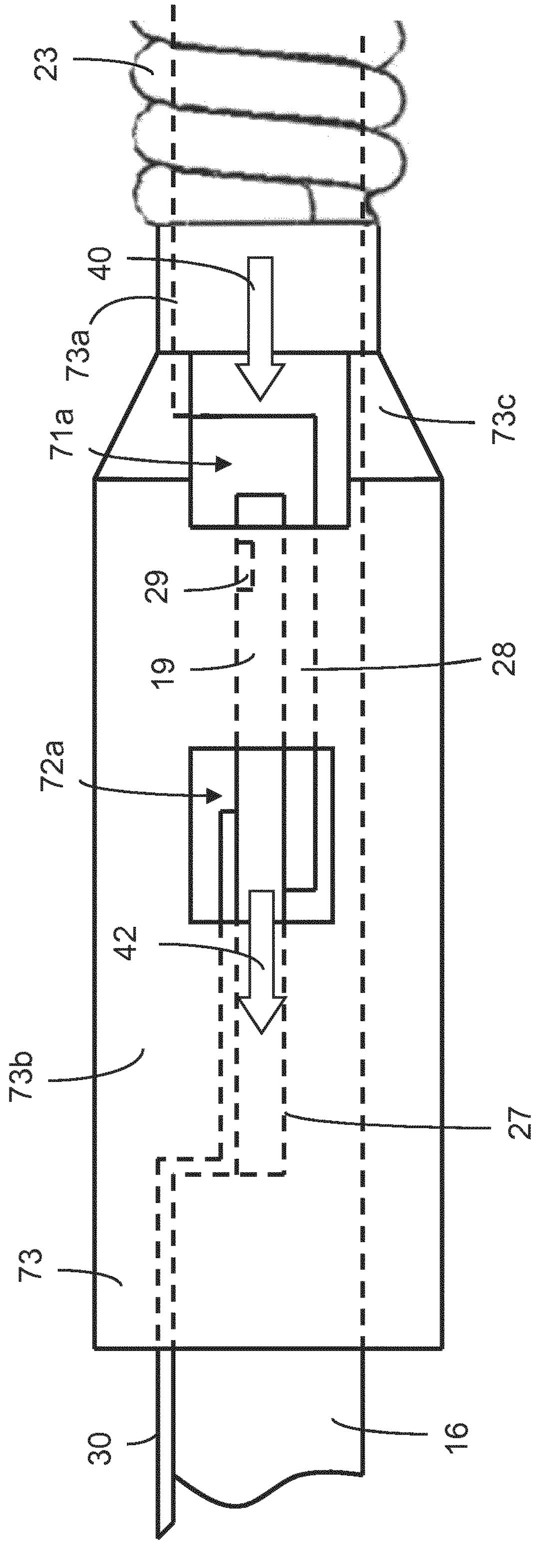

23
40
73a
71a
73c
29
19
28
72a
42
73b
27
73
30
16

FIG. 7

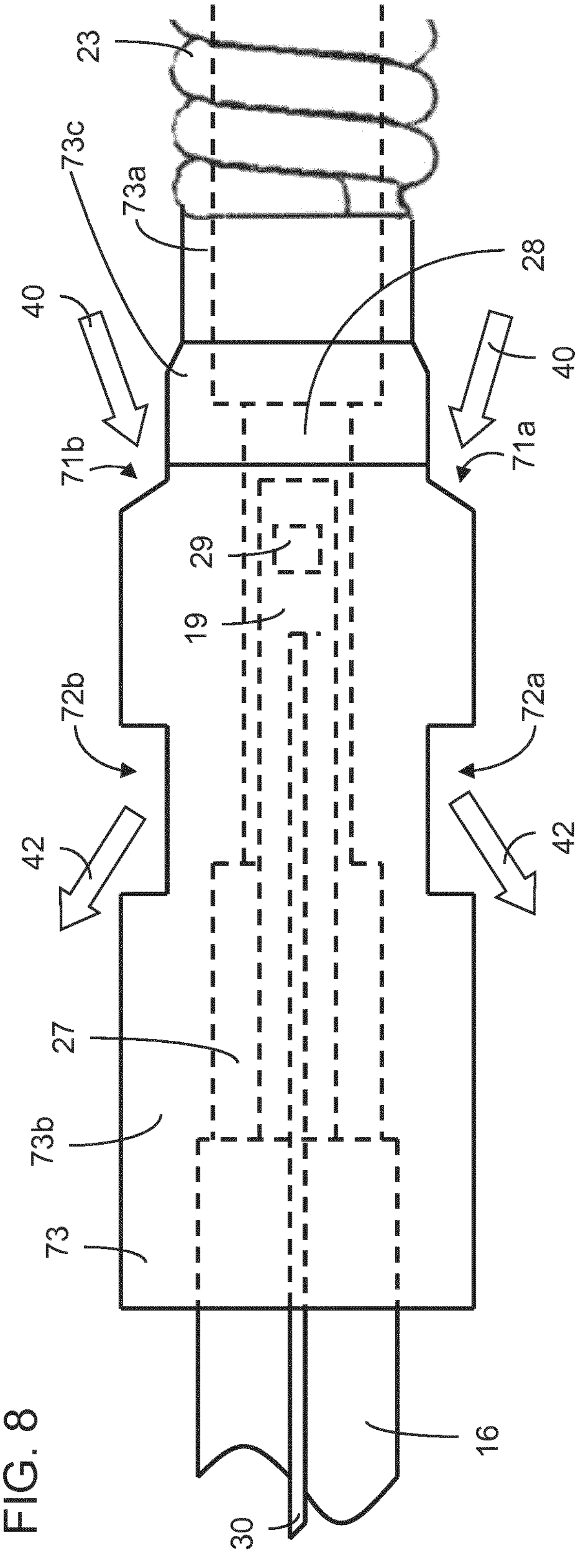

23
73c
73a
28
40
40
71b
71a
29
19
72b
72a
42
42
27
73b
73
16
30

FIG. 8

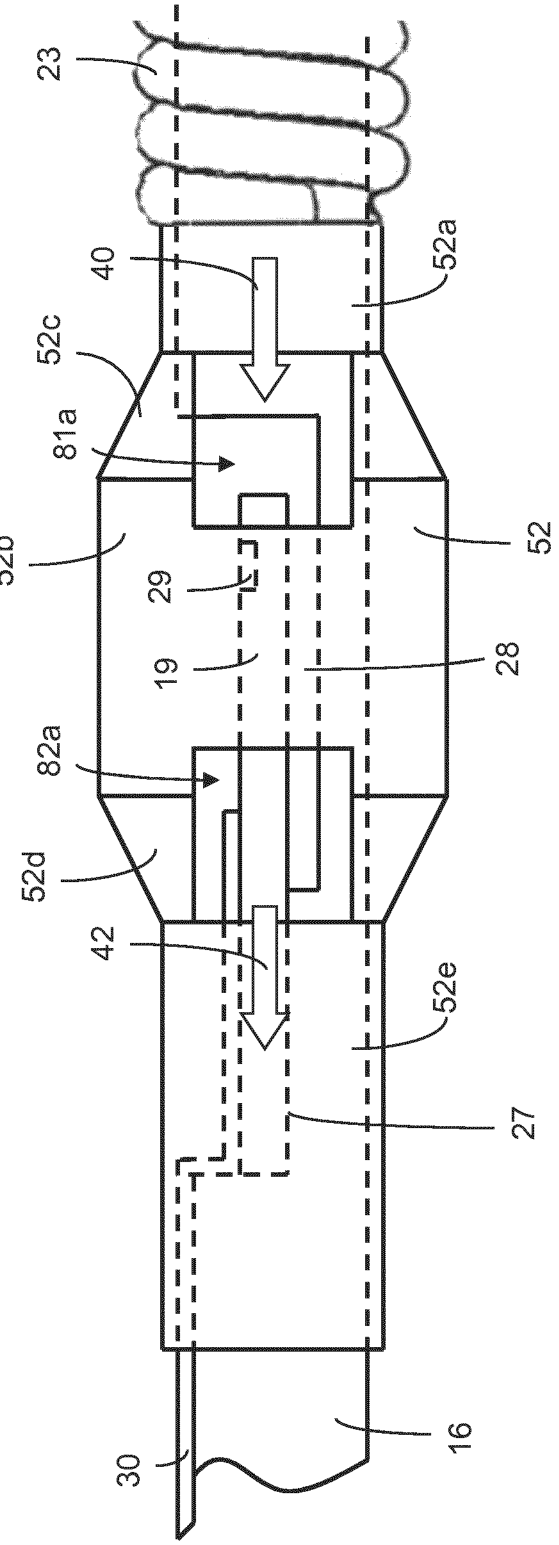

23
40
52a
52c
81a
52b
52
29
19
28
82a
52d
42
52e
27
30
16

FIG. 9

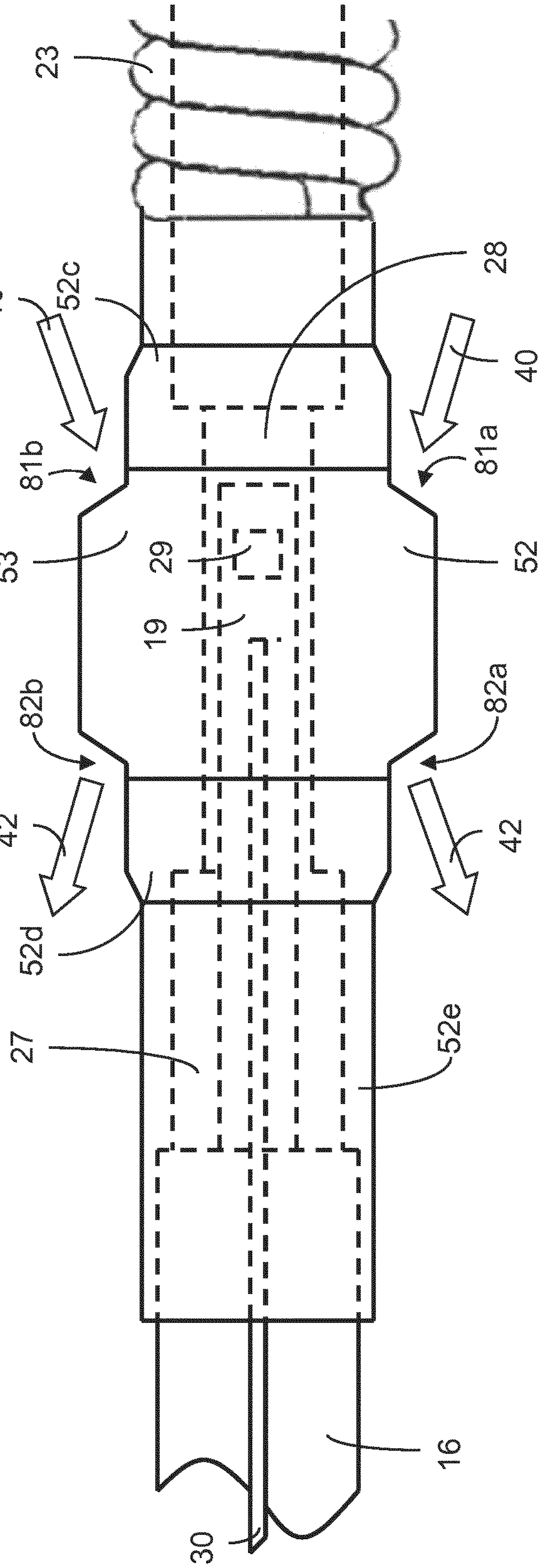

23
28
40
52c
40
81b
81a
53
29
52
19
82b
82a
42
42
52d
27
52e
30
16

FIG. 10

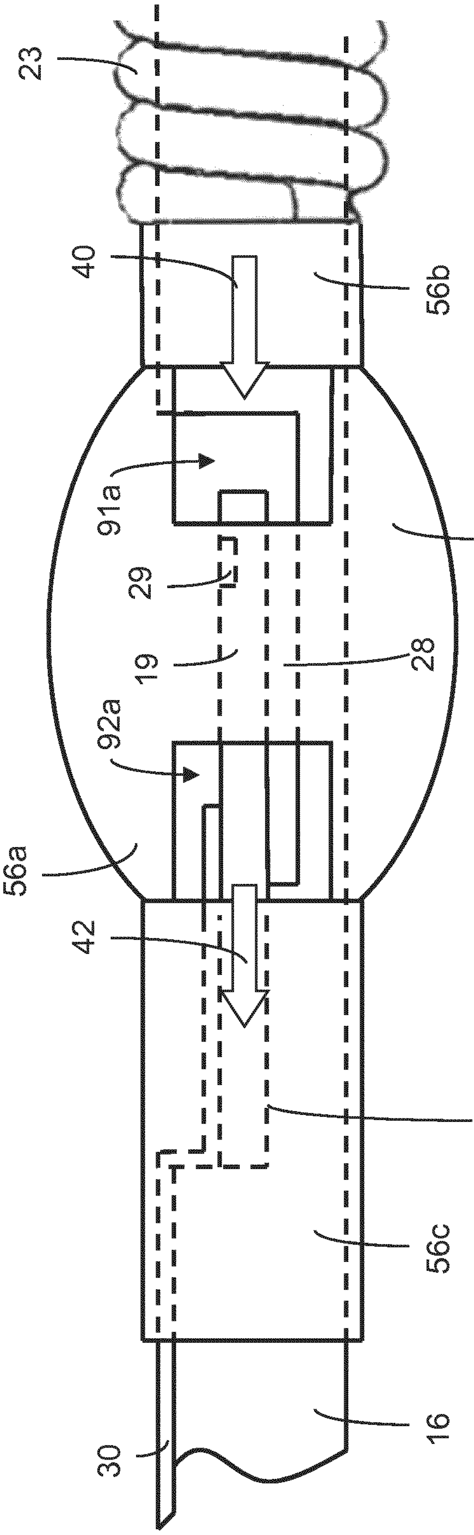

23
40
56b
91a
56
29
19
28
92a
56a
42
27
56c
30
16

FIG. 11

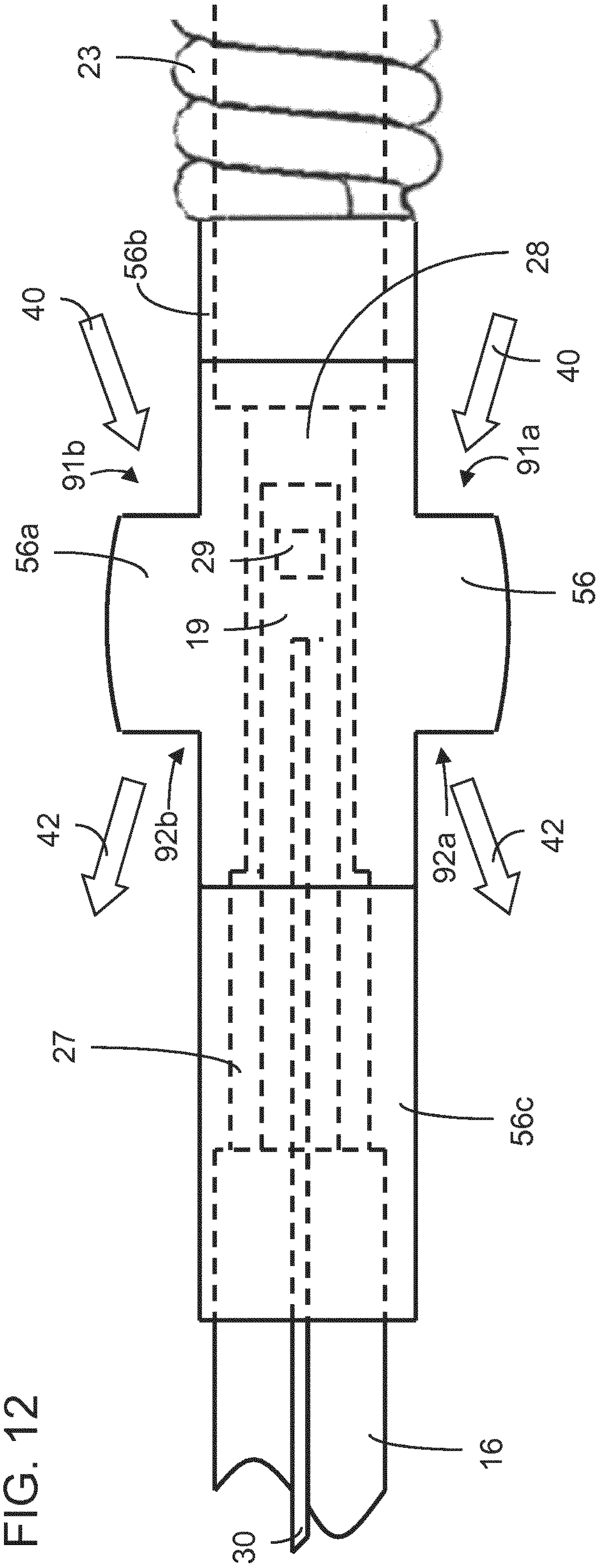

23
56b
28
40
40
91b
91a
56a
29
56
19
42
92b
92a
42
27
56c
16
30

FIG. 12

FIG. 13

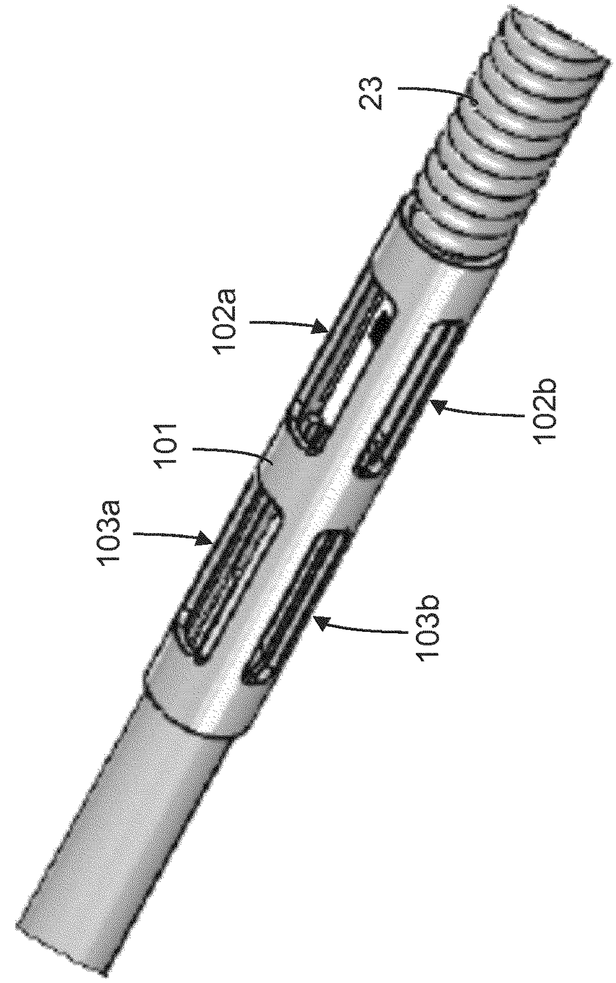


FIG. 14

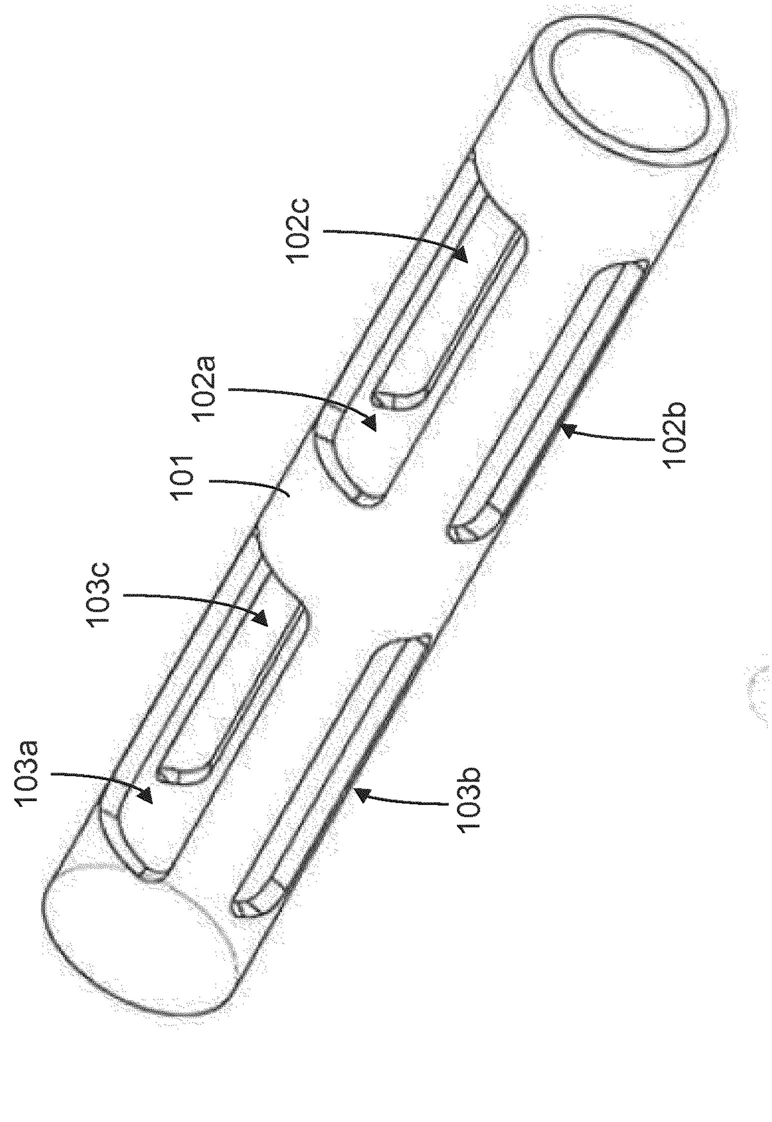
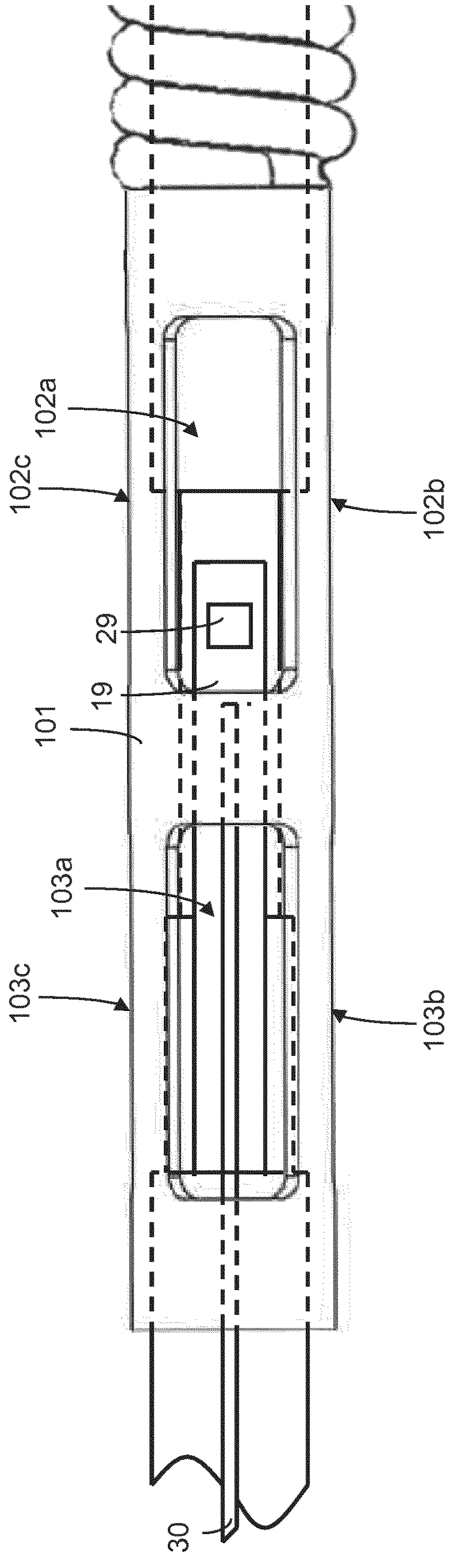


FIG. 15



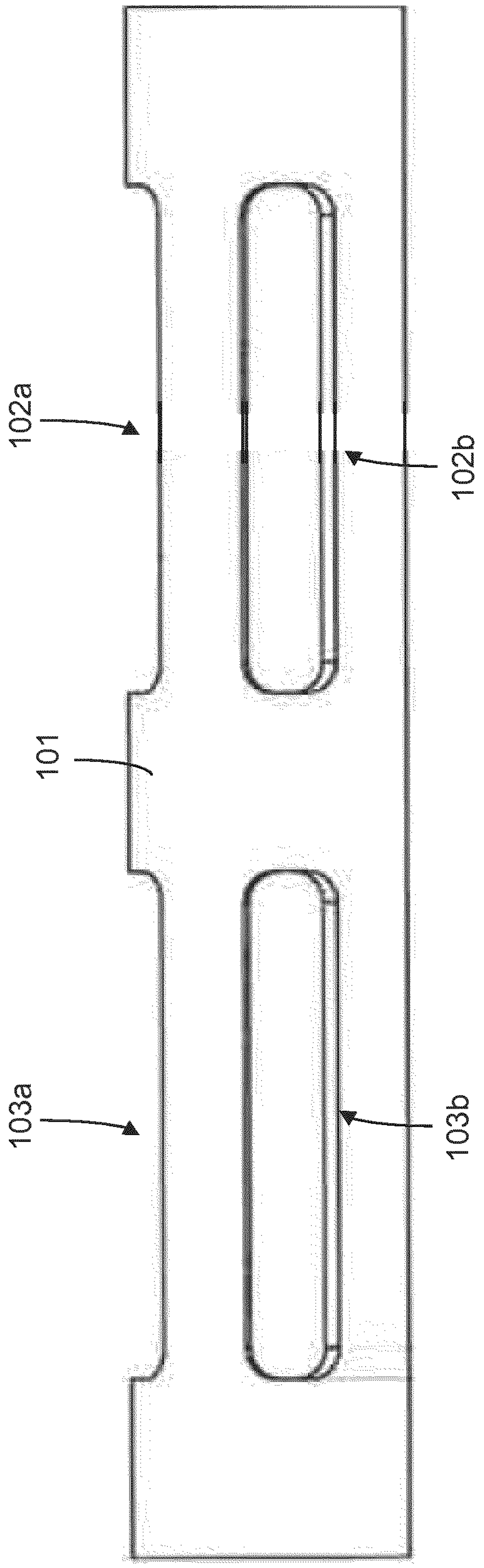


FIG. 16

REFERENCES CITED IN THE DESCRIPTION

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外部链接 [Espacenet]

摘要(译)

一种用于生物压力测量的导线，包括沿该导线的纵轴延伸的管； 用于生物压力测量的压力传感器，压力传感器的至少一部分安装在管内。 压力传感器包括面对管的顶侧的压力传感器膜。 管的周壁包括至少六个开口：第一远侧开口，位于管的右侧的第二远侧开口，位于管的左侧的第三远侧开口，第一近侧开口，第二近侧开口，第二远侧开口，第二远侧开口，第二远侧开口和第二远侧开口。 位于所述管的右侧的近侧开口和位于所述管的左侧的第三近侧开口。 第一远侧开口大于第二和第三远侧开口，并且第一近侧开口比第二和第三近侧开口大。

FIG. 1
(Prior Art)