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

(11) EP 1 511 446 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
**01.08.2012 Bulletin 2012/31**

(21) Application number: **03734408.2**

(22) Date of filing: **06.06.2003**

(51) Int Cl.:
***A61B 5/07*** *(2006.01)* ***A61F 2/06*** *(2006.01)*

(86) International application number:
**PCT/US2003/017662**

(87) International publication number:
**WO 2003/103542 (18.12.2003 Gazette 2003/51)**

(54) **ENDOPROSTHESIS HAVING PRESSURE, TEMPERATURE, AND FLOW SENSORS**

ENDOPROTHESE MIT DRUCK-, TEMPERATUR- UND FLUSSSENSOREN

ENDOPROTHESE COMPRENANT DES CAPTEURS DE PRESSION, DE TEMPERATURE ET DE FLUX

(84) Designated Contracting States:
**DE FR GB IE**

(30) Priority: **07.06.2002 US 165200**

(43) Date of publication of application:
**09.03.2005 Bulletin 2005/10**

(73) Proprietor: **ENDOVASCULAR TECHNOLOGIES, INC.**
**Menlo Park, CA 94025-1436 (US)**

(72) Inventors:
- **HAYASHI, Reid**
  **Santa Cruz, CA 95062 (US)**
- **CONCEMI, Alfred**
  **Wilton, New York 12831 (US)**

(74) Representative: **Hauck Patent- und Rechtsanwälte**
**Neuer Wall 50**
**20354 Hamburg (DE)**

(56) References cited:
**EP-A- 0 897 690**
**WO-A-83/03348**
**WO-A-99/42176**
**WO-A-02/098296**
**US-A- 5 967 986**
**US-B1- 6 416 474**
**US-B1- 6 442 413**



EP 1 511 446 B1

Printed by Jouve, 75001 PARIS (FR)

## Description

BACKGROUND OF THE INVENTION

**[0001]** This invention relates to the treatment of body lumens and, more particularly, to the endovascular placement of a prosthetic graft within vasculature for the purpose of repairing the same.

**[0002]** Ruptured abdominal aortic aneurysms (AAA) are a leading cause of death in the United States. Treatment options to repair AAA include conventional open surgery and implantation of an endovascular graft. Conventional open surgical repair of AAA involves major abdominal surgery with associated high rates of morbidity. Endovascular grafts have been developed to endoluminally bypass abdominal aortic aneurysms through minimally invasive surgery. Many patients that are unacceptable surgical risks for open repairs are eligible for endovascular graft implantation. Deployment of transfemoral, endovascular grafts to treat AAA is appealing for many reasons: avoidance of an abdominal incision, lack of aortic cross clamping, the potential for regional anesthesia, and a shortened hospital stay.

**[0003]** Untreated AAA has been shown to continue to expand until rupture, with an associated high mortality rate. Implantation of endovascular grafts have also been associated with high complication rates, including perioperative death, conversion to open repair, the need for further intervention, the need for hemodialysis, a failure to cure the AAA, and wound complications.

**[0004]** The inability to obtain or maintain a secure seal between the vessel wall and the endovascular graft is a complication unique to endovascular aneurysm exclusion. Because the term "leak" has been associated with aneurysm rupture following conventional surgery, the term "endoleak" has been proposed as a more definitive description of this complication. It is believed that persistent endoleaks result in continued aneurysm expansion, which may eventually lead to aneurysm rupture. Aneurysms that have been successfully excluded have shown a tendency towards a reduction in aneurysm diameter. Failure to properly exclude the aneurysm from systemic arterial blood pressure keeps the patient at risk of impending rupture. Endoleaks have been classified according to the source of the leaks. Current classifications of endoleaks include four categories. Type I endoleaks are "perigraft" or "graft-related" leaks that involve a persistent channel of blood flow due to inadequate or ineffective sealing at the ends of the endovascular graft, or between overlapping components of a modular system. Type II endoleaks are retrograde flow into the aneurysm sac from patent lumbar arteries, the inferior mesenteric artery, or other collateral vessels. Type III endoleaks result from fabric tears, graft disconnection, or graft disintegration. Finally, Type IV endoleaks are flow through the graft fabric associated with graft wall porosity or permeability. Preoperative patent side branches are not a good predictor of postoperative endoleaks.

**[0005]** A number of reported cases of aneurysm rupture following implantation of an endovascular graft have been reported. Some of the ruptures occurred in patients without a documented endoleak.

**[0006]** A number of studies have focused on measurement of pressure within the aneurysm sac following implantation of an endovascular graft, both in the human patient, an animal model, or an in vitro model. Properly implanted endovascular grafts have been shown to reduce the pressure within the aneurysm sac while an endoleak, with or without detectable blood flow, continues to pressurize the sac at pressures equivalent to the systemic arterial pressure. Animal studies utilizing a predictable rupturing aneurysm model have shown that non-excluded aneurysms will rupture. Thrombosed aneurysm sacs may still receive pressurization from a sealed endoleak and this continued pressurization keeps the aneurysm at risk for rupture.

**[0007]** Current methods of patient follow-up include arteriography, contrast-enhanced spiral computed tomography (CT), duplex ultrasonography, abdominal X-ray, and intravascular ultrasound. All of these methods are costly and involve invasive procedures that have associated morbidity. None of the imaging methods are completely successful in detecting endoleaks. Therefore, the potential exists for an endoleak to go undetected until eventual rupture. An increase in aneurysm diameter is detectable, and should be considered an indication of endoleak. To avoid aneurysm rupture an increase in aneurysm diameter must be detected in a timely fashion to identify patients in need of corrective surgical procedures.

**[0008]** An endovascular graft with the ability to measure pressure within the aneurysm sac and provide feedback to the physician could identify those patients with persistent pressurization of their aneurysm, and subsequent risk of rupture.

**[0009]** Some physicians are advocating that the follow-up examinations of AAA patients focus on pressure measurements, but that this is not currently clinically feasible.

**[0010]** From EP 0 897 690 A1 a device is known for introduction into a human or animal body, specifically to be positioned in an aneurysmal sac in an artery between the wall of the artery and the wall of an endoprosthesis, comprising at least a pressure sensor and a transponder for wireless transmitting data available from the pressure sensor.

**[0011]** There exists a need for an endovascular graft that facilitates non-invasive measurement of pressure, as well as other pertinent parameters, within the aneurysm sac and along the endovascular graft itself as a means for identifying patients at risk for aneurysm rupture after the endovascular graft is implanted. The present invention addresses these and other needs.

## SUMMARY OF THE INVENTION

**[0012]** The invention pertains to a modular endoluminal prosthesis according to claim 1. Briefly and in general terms, the present invention is embodied in an endovascular graft with sensors attached thereto. The device will have the ability to be delivered endovascularly and measure pertinent parameters within the excluded AAA. The endovascular graft would have the ability to transmit data about intra- sac parameters to an external monitoring device. Patient follow-up would be less costly (conducted in the physician office), non-invasive, and more accurate, allowing prompt intervention in those patients most at risk for acute rupture. The invention would also allow for more frequent patient follow-up, increasing the potential to diagnose and treat aneurysms at risk before acute rupture. The invention is applicable to all applications of endovascular grafts to treat aneurysmal segments of blood vessels. It is contemplated that the invention may be used with all shapes of endovascular grafts known within the art.

**[0013]** In one embodiment, sensors are attached to the endovascular graft at the superior end, inferior end and midsection. Measurements of pertinent parameters and comparison of those measurements may allow early identification of areas of the patient's vasculature at risk for aneurysm rupture, thrombus formation, infection, inflamation or other anomalies without the need for invasive procedures.

**[0014]** In another embodiment, a pattern of sensors are attached to the endovascular graft such that they cover the interior and exterior of the graft. The pattern of sensors allow a complete profile of pertinent parameters along the endovascular graft to be obtained. Such a profile may provide more accurate identification of anomalies.

**[0015]** Sensors with pressure measurement capability may be used to detect pressure changes external the endovascular graft, in the aneurysm sac or in blood flow through the interior of the endovascular graft indicative of graft failure, graft kinking, or endoleak due to an inadequate seal between the endovascular graft and the vasculature. Sensors with temperature measurement capability may be used to detect temperature differentials associated with "hot spots" related to inflamation, infection or thrombus formation in the vessel. Sensors with the capability to measure oxygen and other blood constituents such as enzymes, proteins, and nutrients, may be used to detect minute blood flow indicative of endoleak. Sensors with the capability to measure electrical potential may be used to detect differences in potential associated with areas of the vessel at risk for thrombus formation.

**[0016]** An antenna or other data transmitter and a power source may be attached external the endovascular graft, allowing a physician or technician to monitor graft and vessel health without the need for an invasive procedure. The transmitter transmits measurements made by the sensors to a receiver located outside the patient's body.

**[0017]** Other features and advantages of the present invention will become apparent from the following detailed description taken in conjunction with the accompanying drawings, which illustrate, by way of example, the principles of the invention.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0018]**

FIG. 1 is a partial cross-sectional view of an example showing a generally tubular cndovascular graft implanted across an aneurysm sac;

FIG. 2 is a partial cross-sectional view of an embodiment of the invention showing a partially assembled bifurcated endovascular graft; and

FIGS. 3 is a perspective view of another example showing a bifurcated endovascular graft having an array of sensors on the external and internal surfaces of the graft material.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0019]** As shown in the exemplary drawings and for purposes of illustration, the invention is embodied in a prosthetic endovascular graft implant having the ability to measure pertinent parameters inside and outside the graft material and transmit the measurements to a receiver located external the patient within whom the endovascular graft is implanted. In one aspect, the invention includes a graft with sensors mounted on the external and internal surface that measure parameters such as pressure, temperature or voltage. In another aspect the invention includes a transmitter and energy source which facilitate transmission of parameters measured by the sensors to a receiver located outside the patient's body.

**[0020]** Referring to FIG. 1, an example is shown in which a generally tubular, including flared or tapered, endovascular graft 10 having a superior end 12 and inferior end 14 is implanted in a body vessel 30 across an aneurysm sac 32 with the superior end 12 secured above the aneurysm and the inferior end 14 secured below the aneurysm. The endovascular graft 10 has sensors 16 attached external the superior 12 and inferior 14 ends, Additionally, the endovascular graft 10 has sensors 18 attached internal the superior 12 and inferior 14 ends. Furthermore, the endovascular graft 10 has sensors 20 attached external the midsection. Moreover, the endovascular graft 10 has a transmitter 22 and power source 24 attached external the graft material in the area where the graft traverses the aneurysm sac 32. The sensors 16,18, 20 measure pertinent parameters inside and outside the endovascular graft and the power source 24 provides power for the transmitter 22 which transmits the meas-

urements to a receiver (not shown) located outside the patient's body.

**[0021]** The transmitter 22, power source 24 and receiver (not shown) may be of any type known in the art of surgical implants or other systems utilizing miniaturized power sources and transmitters. The power source 24 and transmitter 22, for example, may be of the type used in pacemaker technology or passive power sources such as ultrasonically chargeable capacitors.

**[0022]** The sensors 16, 18, 20 shown in FIG. 1 may measure pressure. These measurements may be used as an aid in endovascular graft 10 placement or to identify anomalies that occur after endovascular graft 10 implantation before aneurysm rupture occurs.

**[0023]** The sensors 16 external the superior 12 and inferior 14 ends of the endovascular graft 10 may be used to detect changes in pressure resulting from blood leakage between the endovascular graft 10 and the vessel wall 30, an cndoleak resulting from an inadequate seal between them. It is contemplated that sensors 17 may be located around the entire circumference of the superior 12 and inferior 14 ends of the endovascular graft 10, thereby allowing the exact location of an endoleak to be determined.

**[0024]** The sensors 18 internal the superior 12 and inferior 14 ends of the endovascular graft 10 may be used to measure inlet and outlet pressure of blood flow therethrough. A pressure drop indicates an anomaly such as kinking of the endovascular graft 10 or endoleak due to fabric tears or graft material disintegration. It is also contemplated that sensors 19 may be located around the entire circumference of the superior 12 and inferior 14 ends of the endovascular graft 10.

**[0025]** The sensors 20 external the midsection of the endovascular graft 10 may be used to measure pressure resulting from blood flow into the aneurysm sac 32, an indication that endoleak has occurred and there is a risk of aneurysm rupture. Because the sensors 20 are located in the area of the aneurysm sac 32, there are multiple sensors 20 disbursed over the graft material outer wall since local thrombus or calcification may shield one or more of the sensors 20 from blood pressure and render their measurements erroneous.

**[0026]** Referring to FIG. 2, the embodiment of the invention shown in FIG. 1 is applied to a bifurcated endovascular graft 110 of the type known within the art. The bifurcated endovascular graft 110 is assembled in-vivo from a tubular trunk portion 40 and two limb portions 50 (only one is shown). The bifurcated endovascular graft 110 is implanted in a body vessel 30 across an aneurysm sac 32 and into the contra-lateral 34 and ipsi-lateral 36 arteries using methods known within the art.

**[0027]** The trunk portion 40 has a superior end 42 adapted to be secured above the aneurysm and an inferior end 44 adapted to accept the limb portions 50. The trunk portion 40 has a transmitter 22, power source 24, and sensors 16, 17, 18, 19, 20 similar to those described with reference to FIG. 1.

**[0028]** Each limb portion 50 has a superior end 52 adapted to mate with the trunk portion 40 inferior end 44 and an inferior end 54 adapted to be secured to the ipsi-lateral 34 or contra-lateral 36 iliac artery. Each limb portion 50 also has a transmitter 122, power source 124, and sensors 116, 117, 118, 119, 120 similar to those described with reference to FIG. 1. The transmitter 122 and power source 124 facilitate transmission of parameters measured by the sensors 116, 117, 118, 119, 120 to a receiver (not shown) outside the patient's body.

**[0029]** The functions of some of the sensors are slightly different than those previously described with reference to a tubular endovascular graft. The sensors 116 external the superior 52 end of a limb portion 50 may be used to detect pressure changes resulting from blood leakage between the limb portion 50 and the trunk portion 40, an endoleak resulting from an inadequate seal between the limb portion 50 superior end 52 and trunk portion 40 inferior end 14. The sensors 116 external the inferior 54 end of a limb portion 50 may be used to detect pressure changes resulting from blood leakage between the limb portion 50 and the ipsi-lateral 34 or contra-lateral 36 iliac artery wall, an endoleak resulting from an inadequate seal between the limb portion 50 inferior end 54 and vessel 30. The sensors 118 internal the superior 52 and inferior 54 ends of a limb portion 50 may be used to measure inlet and outlet pressure of blood flow therethrough, with a pressure drop indicating an anomaly such as kinking of the limb portion 50 or endoleak due to fabric tears or graft material disintegration. The sensors 120 external the midsection of the limb portion 50 may be used to measure pressure resulting from blood flow between the limb portion 50 and the wall of the ipsi-lateral 34 or contra-lateral 36 iliac artery, an indication that endoleak has occurred due to inadequate mating of the limb portion 50 superior end 52 and the trunk portion 40 inferior end 44.

**[0030]** Alternatively, the sensors of the invention shown in FIGS. 1 and 2 may measure temperature. Differences in temperature may identify "hot spots" associated with infection, inflammation, thrombus formation or other anomalies that indicate an increased risk for aneurysm rupture. Methods known in the art of pathology and physiology may be used to relate temperature to changes in the vessel walls within which the endovascular graft is implanted.

**[0031]** Alternatively, the sensors of the invention shown in FIGS. 1 and 2 may detect blood flow by measuring oxygen or other constituents, such as enzymes, proteins and nutrients, which are altered by the presence of blood flow. Such sensors may allow detection of minute blood flow, often missed by conventional imaging modalities, and, therefore, allow endoleaks to be detected earlier. One method is to obtain a baseline of the constituents upon implantation of the endovascular graft. Thereafter, changes in the amount of the measured constituents may be used to identify anomalies.

**[0032]** Alternatively, the sensors of the invention shown in FIGS. 1 and 2 may measure electrical potential.

Changes in electrical potential may identify areas of the patient's vasculature that are at risk for thrombus formation.

**[0033]** It is contemplated that the number of transmitters, power sources and sensors shown in FIGS. 1 and 2 may be varied to meet the requirements of the individual patient. It is further contemplated that sensors which measure different pertinent parameters may be used together. Moreover, it is contemplated that the invention shown in FIGS. 1 and 2 may be utilized in any type of endovascular graft implant known in the art.

**[0034]** Referring to FIG. 3, another example is shown in which miniature sensors 216,218 are arranged as an array covering the interior and exterior of the surface of the endovascular graft 210. The array of sensors 216,218 provides a complete profile of pertinent parameters over the entire surface of the endovascular graft and, therefore, facilitates better identification of anomalies. The transmitter 222, power source 224 and external receiver (not shown) allow the measured parameters to be received and monitored outside the patient's body. The array of sensors 216,218 may spiral around the graft material in between the weaves of fabric and consist of a strip of sensors, continuous strip of wire or other apparatus known in the art.

**[0035]** It is contemplated that the location and number of transmitters, power sources and sensors shown in FIG. 3 may be varied to meet the requirements of the individual patient. It is further contemplated that the array of sensors 216,218 may contain sensors capable of measuring pressure, temperature, blood flow, electrical potential, or any combination thereof. Moreover, it is contemplated that the example shown in FIG. 3 may be utilized in any type of endovascular graft implant known in the art.

## Claims

**1.** A modular endoluminal prosthesis for repairing vasculature in an area of an aneurysm sac, comprising:

a first endovascular graft component (40);
a second endovascular graft component (50) having a superior end (52) adapted to mate invivo with an inferior end (44) of the first endovascular graft component (40), the second cndovascular graft component (50) having one or more sensors (116) attached at the superior end (52) of the second endovascular graft component (50), wherein the sensors (116) of the second endovascular graft component (50) detect parameters in the aneurysm sac relating to an endoleak between the first endovascular graft component (40) and the second endovascular graft component (50).

**2.** The prosthesis of claim 1, further comprising:

one or more power sources (24, 124) attached to external surfaces of the first and second endovascular graft components (40, 50); and
one or more transmitting devices (22, 122) attached to the first and second endovascular graft components (40, 50), each transmitting device (22, 122) capable of transmitting signals containing the parameters measured by one or more sensors (116) to a location outside a patient's body.

**3.** The prosthesis of claim 1, the first endovascular graft component (40) further comprising one or more sensors (16) attached thereto.

**4.** The prosthesis of claim 2, further comprising one or more receiving devices located outside a patient's body, each receiving device capable of receiving signals transmitted by one or more transmitters (22, 122).

**5.** The prosthesis of claim 1, wherein one of the first and second endovascular graft components (40, 50) is generally tubular and each have a superior end, an inferior end and a midsection.

**6.** The prosthesis of claim 1, wherein at least one sensor (16, 116) is located on an internal surface of one of the first and second endovascular graft components (40, 50).

**7.** The prosthesis of claim 1, wherein sensors (16, 116) cover substantially a circumferential area of an internal surface of one of the first and second endovascular graft components (40, 50).

**8.** The prosthesis of claim 1, wherein at least one sensor (16, 116) is located on an external surface of one of the first and second endovascular graft components (40, 50).

**9.** The prosthesis of claim 1, wherein sensors (16, 116) cover substantially a circumferential area of an external surface of one of the first and second endovascular graft components (40, 50).

**10.** The prosthesis of claim 1, wherein one or more sensors (16, 116) are located on an external surface of one or more of the endovascular graft components (40, 50) at a midsection thereof.

**11.** The prosthesis of claim 2, wherein each power source (24, 124) is attached to a midsection of one of the first and second endovascular graft components (40, 50).

**12.** The prosthesis of claim 2, wherein each transmitter

(22, 122) is attached to a midsection of one of the first and second endovascular graft components (40, 50).

**13.** The prosthesis of claim 1, wherein the modular endoluminal prosthesis has a trunk portion (40) and two or more limb portions (50).

**14.** The prosthesis of claim 13, wherein at least one sensor (16) is located on an internal surface of the first endovascular graft component (40).

**15.** The prosthesis of claim 13, wherein sensors (16) cover substantially a circumferential area of an internal surface of the first endovascular graft component (40).

**16.** The prosthesis of claim 13, wherein at least one sensor (116) is located on an external surface of each limb portion (50).

**17.** The prosthesis of claim 13, wherein sensors (16) cover substantially a circumferential area of an external surface of the modular endoluminal prosthesis at superior and inferior ends of each limb portion (50).

**18.** The prosthesis of claim 13, wherein one or more sensors (16) are located external the first endovascular graft component (40) at a midsection of each limb portion (50).

**19.** The prosthesis of claim 1, wherein one or more of the sensors (16, 116) measure pressure.

**20.** The prosthesis of claim 1, wherein one or more of the sensors (16, 116) measure temperature.

**21.** The prosthesis of claim 1, wherein one or more of the sensors (16, 166) measure a constituent altered by the presence of minute amounts of blood flow.

**22.** The prosthesis of claim 21, wherein the constituent measured is oxygen.

**23.** The prosthesis of claim 21, wherein the constituent measured is an enzyme.

**24.** The prosthesis of claim 21, wherein the constituent measured is a protein.

**25.** The prosthesis of claim 21, wherein the constituent measured is a nutrient.

**26.** The prosthesis of claim 1, wherein one or more of the sensors (16, 116) measure electrical potential.

**27.** The prosthesis of claim 1, wherein one or more of the sensors (16, 116) measure a parameter related to the attachment between the first and second endovascular graft components (40, 50).

**Patentansprüche**

**1.** Modulare endoluminale Prothese zum Reparieren des Gefäßsystems in einem Gebiet eines Aneurismasacks, umfassend:

eine erste endovaskuläre Graftkomponente (40),
eine zweite endovaskuläre Graftkomponente (50) mit einem oberen Ende (52), die dazu angepasst ist, in vivo in ein unteres Ende der (44) der ersten endovaskulären Graftkomponente (40) zu passen, wobei die zweite endovaskuläre Graftkomponente (50) einen oder mehrere Sensoren (116) aufweist, die an dem oberen Ende (52) der zweiten endovaskulären Graftkomponente (50) angebracht sind und wobei die Sensoren (116) der zweiten endovaskulären Graftkomponente (50) Parameter in dem Aneurismasack ermitteln, die ein Endoleak zwischen der ersten endovaskulären Graftkomponente (40) und der zweiten endovaskulären Graftkomponente (50) betreffen.

**2.** Prothese gemäß Anspruch 1, ferner umfassend:

eine oder mehrere Energiequellen (24, 124), die an äußeren Oberflächen der ersten und der zweiten endovaskulären Graftkomponente (40, 50) angebracht sind; und
eine oder mehrere Übertragungseinrichtungen (22, 122), die an der ersten und der zweiten endovaskulären Graftkomponente (40, 50) angebracht sind, wobei jede Übertragungseinrichtung (22, 122) in der Lage ist, Signale an einen Ort außerhalb eines Patientenkörpers zu übertragen, welche die von einem oder mehreren Sensoren (116) gemessenen Parameter enthalten.

**3.** Prothese gemäß Anspruch 1, wobei die erste endovaskuläre Graftkomponente (40) ferner einen oder mehrere daran angebrachte Sensoren (16) umfasst.

**4.** Prothese gemäß Anspruch 2, ferner umfassend eine oder mehrere an einem Ort außerhalb eines Patientenkörpers befindliche Empfangseinrichtungen, wobei jede Empfangseinrichtung in der Lage ist, von einer oder mehreren Übertragungseinrichtungen (22, 122) übertragene Signale zu empfangen.

**5.** Prothese gemäß Anspruch 1, wobei eine aus der ersten und zweiten endovaskulären Graftkomponente (40, 50) allgemein röhrenförmige ist und beide

ein oberes Ende, ein unteres Ende und einen mittleren Abschnitt aufweisen.

**6.** Prothese gemäß Anspruch 1, wobei mindestens ein Sensor (16, 116) sich an einer inneren Oberfläche von einer aus der ersten und der zweiten endovaskulären Graftkomponente (40, 50) befindet.

**7.** Prothese gemäß Anspruch 1, wobei Sensoren (16, 116) eine Umfangsfläche einer inneren Oberfläche von einer aus der ersten und der zweiten endovaskulären Graftkomponente (40, 50) im wesentlichen bedecken.

**8.** Prothese gemäß Anspruch 1, wobei mindestens ein Sensor (16, 116) sich an einer äußeren Oberfläche von einer aus der ersten und der zweiten endovaskulären Graftkomponente (40, 50) befindet.

**9.** Prothese gemäß Anspruch 1, wobei Sensoren (16, 116) eine Umfangsfläche einer äußeren Oberfläche von einer aus der ersten und der zweiten endovaskulären Graftkomponente (40, 50) im wesentlichen bedecken.

**10.** Prothese gemäß Anspruch 1, wobei ein oder mehrere Sensoren (16, 116) sich an einer äußeren Oberfläche von einer oder mehreren endovaskulären Graftkomponenten (40, 50) an einem mittleren Abschnitt davon befinden.

**11.** Prothese gemäß Anspruch 2, wobei jede Energiequelle (24, 124) an einem mittleren Abschnitt von einer aus der ersten und der zweiten endovaskulären Graftkomponente (40, 50) befestigt ist.

**12.** Prothese gemäß Anspruch 2, wobei jede Übertragungseinrichtung (22, 122) an einem mittleren Abschnitt von einer aus der ersten und der zweiten endovaskulären Graftkomponenten (40, 50) befestigt ist.

**13.** Prothese gemäß Anspruch 1, wobei die modulare endoluminale Prothese einen Stammteil (40) und zwei oder mehrere Astteile (50) aufweist.

**14.** Prothese gemäß Anspruch 13, wobei mindestens ein Sensor (16) sich an einer inneren Oberfläche der ersten endovaskulären Graftkomponenten (40) befindet.

**15.** Prothese gemäß Anspruch 13, wobei Sensoren (16) eine Umfangsfläche einer inneren Oberfläche der ersten endovaskulären Graftkomponenten (40) im wesentlichen bedecken.

**16.** Prothese gemäß Anspruch 13, wobei mindestens ein Sensor (116) sich an einer äußeren Oberfläche von jedem Astteil (50) befindet.

**17.** Prothese gemäß Anspruch 13, wobei Sensoren (16, 116) eine Umfangsfläche einer äußeren Oberfläche der modularen endoluminalen Prothese an oberen und unteren Enden von jedem Astteil (50) im wesentlichen bedecken.

**18.** Prothese gemäß Anspruch 13, wobei ein oder mehrere Sensoren (16) sich außerhalb der ersten endovaskulären Graftkomponente (40) an einem mittleren Abschnitt von jedem Astteil (50) befinden.

**19.** Prothese gemäß Anspruch 1, wobei einer oder mehrere der Sensoren (16, 116) Druck messen.

**20.** Prothese gemäß Anspruch 1, wobei einer oder mehrere der Sensoren (16, 116) Temperatur messen.

**21.** Prothese gemäß Anspruch 1, wobei einer oder mehrere der Sensoren (16, 116) einen Bestandteil messen, der durch die Anwesenheit geringfügiger Mengen von Blutfluss verändert wird.

**22.** Prothese gemäß Anspruch 21, wobei der gemessene Bestandteil Sauerstoff ist.

**23.** Prothese gemäß Anspruch 21, wobei der gemessene Bestandteil ein Enzym ist.

**24.** Prothese gemäß Anspruch 21, wobei der gemessene Bestandteil ein Protein ist.

**25.** Prothese gemäß Anspruch 21, wobei der gemessene Bestandteil ein Nährstoff ist.

**26.** Prothese gemäß Anspruch 1, wobei einer oder mehrere der Sensoren (16, 116) elektrisches Potential messen.

**27.** Prothese gemäß Anspruch 1, wobei einer oder mehrere der Sensoren (16, 116) einen Parameter messen, der die Bindung zwischen der ersten und der zweiten endovaskulären Graftkomponente (40, 50) betrifft.

**Revendications**

**1.** Prothèse endoluminaire modulaire pour réparer la vasculature dans la région d'un sac anévrismal, comportant:

un premier composant de greffon endovasculaire (40),
un deuxième composant de greffon endovasculaire (50) avec une extrémité supérieure (52), adaptée à bien aller dans une extrémité inférieu-

re (44) du premier composant de greffon endovasculaire (40) in vivo, le deuxième composant de greffon endovasculaire (50) comportant un ou plusieurs capteurs (116), qui sont fixés dans l'extrémité supérieure (52) du deuxième composant de greffon endovasculaire (50), les capteurs (116) du deuxième composant de greffon endovasculaire (50) détectant des paramètres dans le sac anévrismal qui se rapportent à une endofuite entre le premier composant de greffon endovasculaire (40) et le deuxième composant de greffon endovasculaire (50).

**2.** Prothèse selon la revendication 1, comportant en outre:

une ou plusieurs sources d'énergie (24, 124) fixées sur des surfaces extérieures du premier et du deuxième composant de greffon endovasculaire (40, 50); et
un ou plusieurs dispositifs transmetteurs (22, 122) fixés sur le premier et le deuxième composant de greffon endovasculaire (40, 50), chaque dispositif transmetteur (22, 122) étant capable à transmettre des signaux qui contiennent les paramètres mesurés par un ou plusieurs capteurs (116) vers un endroit à l'extérieur d'un corps de patient.

**3.** Prothèse selon la revendication 1, dans laquelle le premier composant de greffon endovasculaire (40) comporte en outre un ou plusieurs capteurs (16) fixés sur celui-ci.

**4.** Prothèse selon la revendication 2, comportant en outre un ou plusieurs dispositifs récepteurs situés à l'extérieur d'un corps de patient, chaque dispositif récepteur étant capable à recevoir des signaux transmis par un ou plusieurs dispositifs transmetteurs (22, 122).

**5.** Prothèse selon la revendication 1, dans laquelle un des composants de greffon endovasculaires (40, 50) premier et deuxième est généralement tubulaire, et chacun d'eux a une extrémité supérieure, une extrémité inférieure et une partie centrale.

**6.** Prothèse selon la revendication 1, dans laquelle au moins un capteur (16, 116) se trouve sur une surface intérieure d'un des composants de greffon endovasculaires (40, 50) premier et deuxième.

**7.** Prothèse selon la revendication 1, dans laquelle des capteurs (16, 116) essentiellement recouvrent une aire circonférentielle d'une surface intérieure d'un des composants de greffon endovasculaires (40, 50) premier et deuxième.

**8.** Prothèse selon la revendication 1, dans laquelle au moins un capteur (16, 116) se trouve sur une surface extérieure d'un des composants de greffon endovasculaires (40, 50) premier et deuxième.

**9.** Prothèse selon la revendication 1, dans laquelle des capteurs (16, 116) essentiellement recouvrent une aire circonférentielle d'une surface extérieure d'un des composants de greffon endovasculaires (40, 50) premier et deuxième.

**10.** Prothèse selon la revendication 1, dans laquelle un ou plusieurs capteurs (16, 116) se trouvent sur une surface extérieure d'un ou plusieurs des composants de greffon endovasculaires (40, 50) dans une partie centrale de ceux-ci.

**11.** Prothèse selon la revendication 2, dans laquelle chaque source d'énergie (24, 124) est fixée sur une partie centrale d'un des composants de greffon endovasculaires (40, 50) premier et deuxième.

**12.** Prothèse selon la revendication 2, dans laquelle chaque dispositif transmetteur (22, 122) est fixé sur une partie centrale d'un des composants de greffon endovasculaires (40, 50) premier et deuxième.

**13.** Prothèse selon la revendication 1, dans laquelle la prothèse endoluminaire modulaire a une partie de tronc (40) et deux ou plusieurs parties de branche (50).

**14.** Prothèse selon la revendication 13, dans laquelle au moins un capteur (16) se trouve sur une surface intérieure du premier composant de greffon endovasculaire (40).

**15.** Prothèse selon la revendication 13, dans laquelle des capteurs (16) essentiellement recouvrent une aire circonférentielle d'une surface intérieure du premier composant de greffon endovasculaire (40).

**16.** Prothèse selon la revendication 13, dans laquelle au moins un capteur (116) se trouve sur une surface extérieure de chaque partie de branche (50).

**17.** Prothèse selon la revendication 13, dans laquelle des capteurs (16, 116) essentiellement recouvrent une aire circonférentielle d'une surface extérieure de la prothèse endoluminaire modulaire dans les extrémités supérieure et inférieure de chaque partie de branche (50).

**18.** Prothèse selon la revendication 13, dans laquelle un ou plusieurs capteurs (16) se trouvent au dehors du premier composant de greffon endovasculaire (40) dans une partie centrale de chaque partie de branche (50).

**19.** Prothèse selon la revendication 1, dans laquelle un ou plusieurs des capteurs (16, 116) mesurent la pression.

**20.** Prothèse selon la revendication 1, dans laquelle un ou plusieurs des capteurs (16, 116) mesurent la température.

**21.** Prothèse selon la revendication 1, dans laquelle un ou plusieurs des capteurs (16, 116) mesurent un ingrédient qui est changé par la présence de quantités minimales de flux de sang.

**22.** Prothèse selon la revendication 21, dans laquelle l'ingrédient mesuré est de l'oxygène.

**23.** Prothèse selon la revendication 21, dans laquelle l'ingrédient mesuré est un enzyme.

**24.** Prothèse selon la revendication 21, dans laquelle l'ingrédient mesuré est un protéine.

**25.** Prothèse selon la revendication 21, dans laquelle l'ingrédient mesuré est un nutriment.

**26.** Prothèse selon la revendication 1, dans laquelle un ou plusieurs des capteurs (16, 116) mesurent du potentiel électrique.

**27.** Prothèse selon la revendication 1, dans laquelle un ou plusieurs des capteurs (16, 116) mesurent un paramètre relatif à la jonction entre les composants de greffon endovasculaires (40, 50) premier et deuxième.

FIG. 1

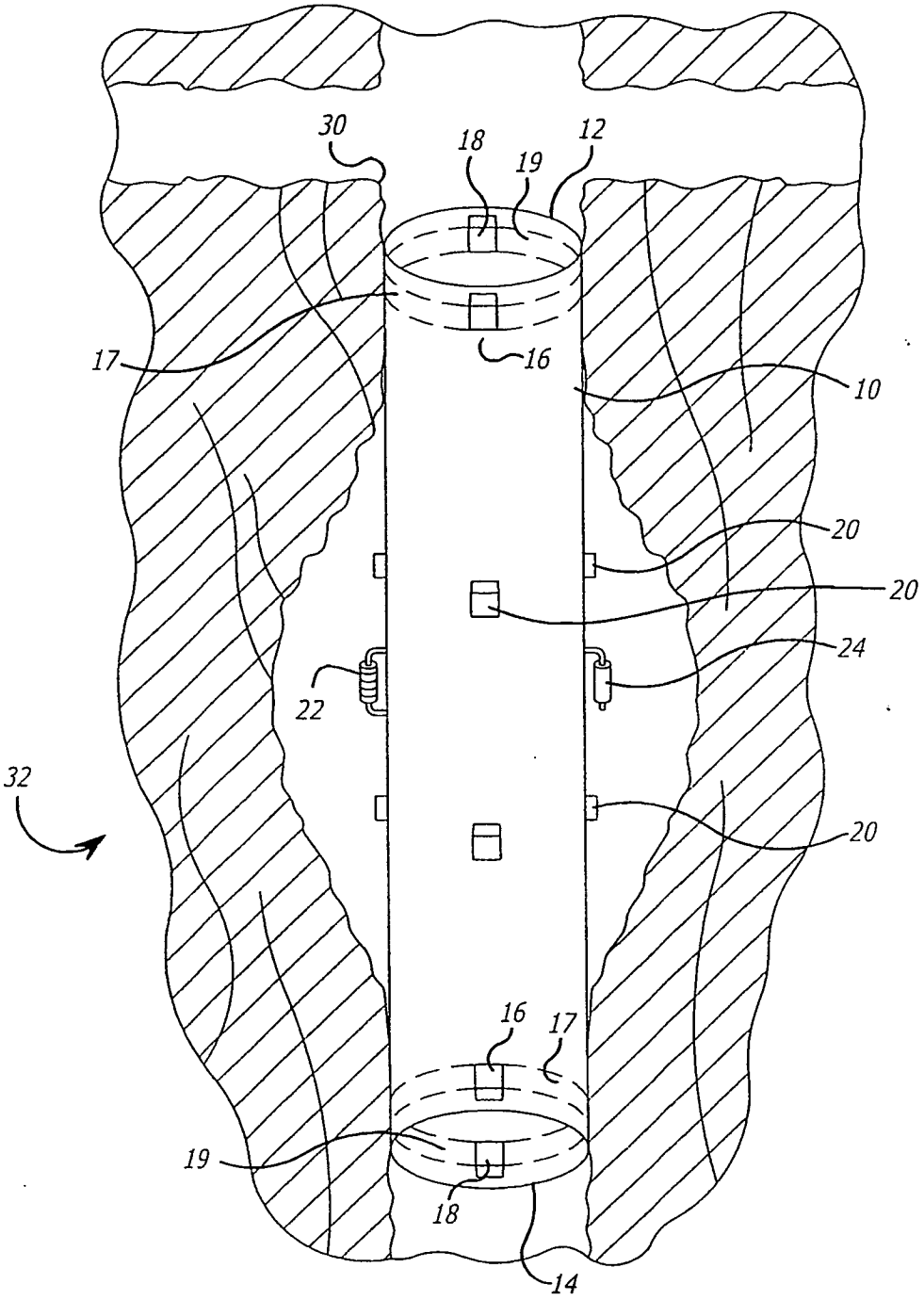


FIG. 2

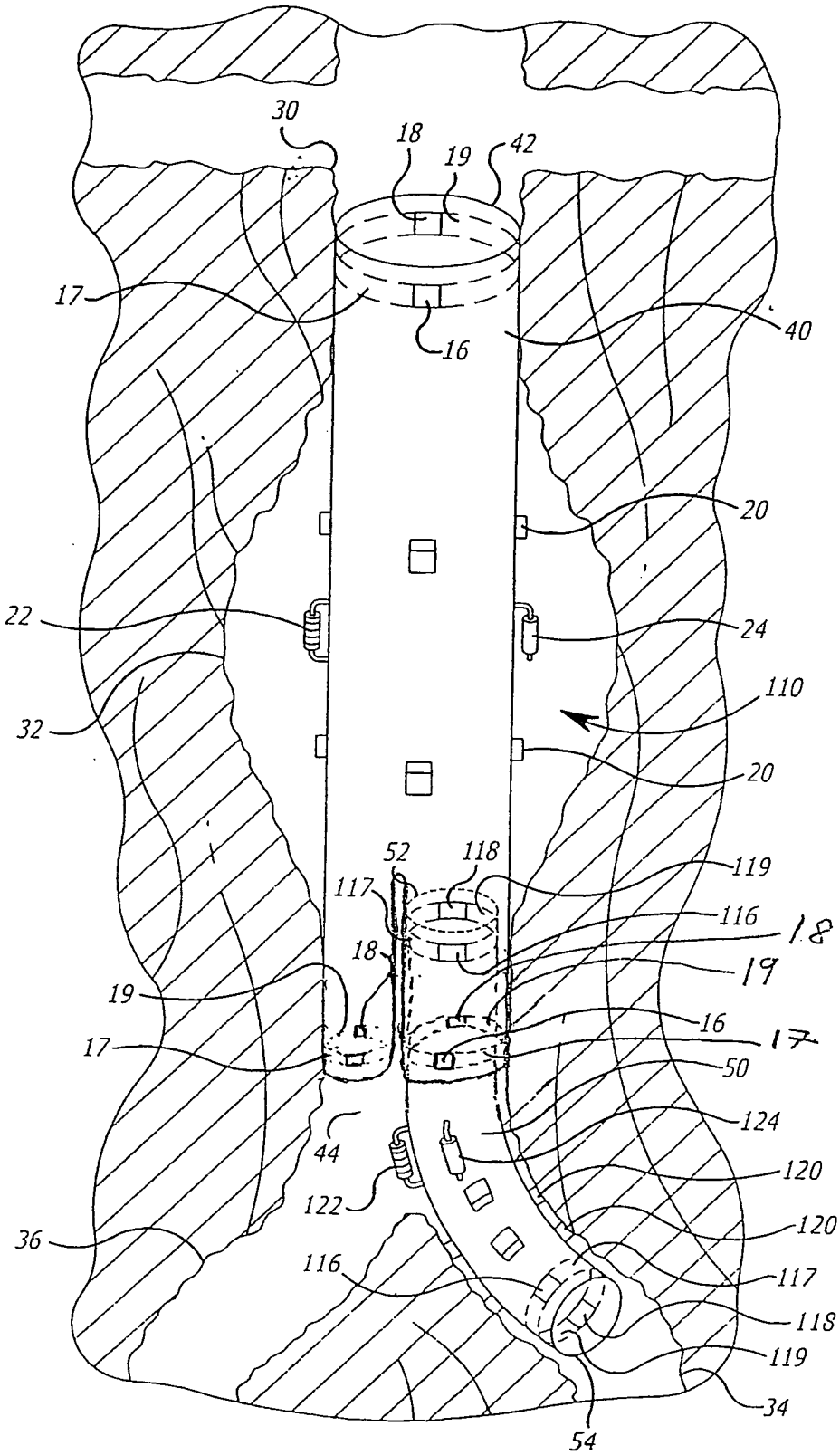
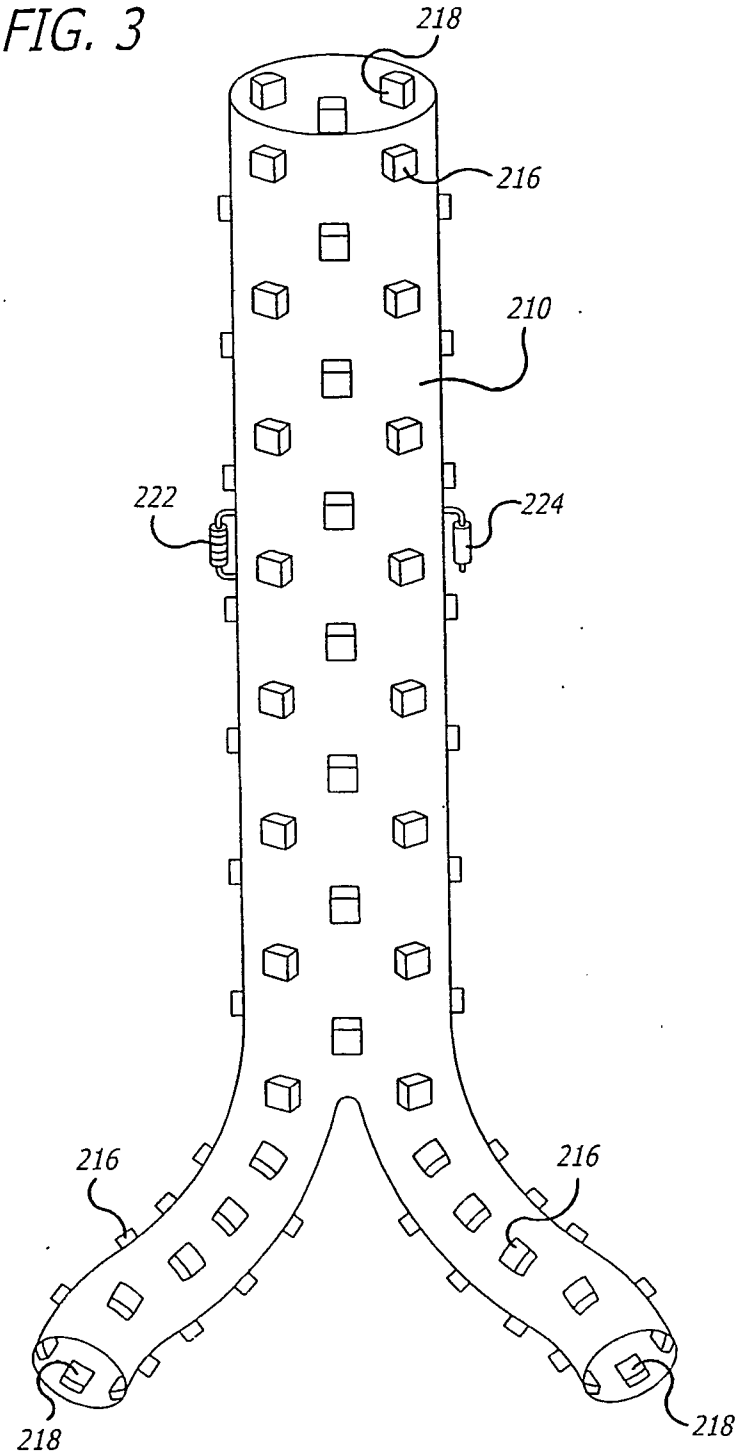

30
18
19
42
17
16
40
20
22
24
110
32
20
52
118
119
117
116
18
18
19
19
16
17
17
50
124
44
120
122
120
36
116
117
118
119
34
54

FIG. 3



## REFERENCES CITED IN THE DESCRIPTION

*This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.*

### Patent documents cited in the description


- EP 0897690 A1 **[0010]**

| | | | |
|---|---|---|---|
| 专利名称(译) | 内置假体具有压力，温度和流量传感器 | | |
| 公开(公告)号 | EP1511446B1 | 公开(公告)日 | 2012-08-01 |
| 申请号 | EP2003734408 | 申请日 | 2003-06-06 |
| [标]申请(专利权)人(译) | 血管内TECH | | |
| 申请(专利权)人(译) | 血管内TECHNOLOGIES，INC. | | |
| 当前申请(专利权)人(译) | 血管内TECHNOLOGIES，INC. | | |
| [标]发明人 | HAYASHI REID<br>CONCEMI ALFRED | | |
| 发明人 | HAYASHI, REID<br>CONCEMI, ALFRED | | |
| IPC分类号 | A61B5/07 A61F2/06 A61B5/00 A61B5/0215 A61B5/026 A61F2/02 | | |
| CPC分类号 | A61B5/076 A61B5/01 A61B5/02014 A61B5/0215 A61B5/026 A61B5/1459 A61F2/07 A61F2/89 A61F2002/065 A61F2002/075 A61F2250/0002 Y10S623/912 | | |
| 代理机构(译) | HAUCK专利和律师 | | |
| 优先权 | 10/165200 2002-06-07 US | | |
| 其他公开文献 | EP1511446A1<br>EP1511446A4 | | |
| 外部链接 | Espacenet | | |


摘要(译)

一种血管内移植物，其一个或多个传感器连接到其内部和外部表面，一个或多个电源连接到其外表面，一个或多个发射器连接到其外表面，传感器能够测量相关参数，每个发射器能够传输包含位于患者体外的一个或多个接收装置的相关参数的信号。传感器可以测量压力，温度，血流量，电势或其任何组合。传感器可以附接在移植物材料上的特定位置，从而从脉管系统内的关键点提供相关参数，或者可以附接以在移植物材料的内部和外部表面上形成传感器阵列，从而提供完整的轮廓。在血管内移植物覆盖的整个脉管系统中的相关参数。