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(54) **IMPLANTABLE MEDICAL DEVICE WITH INTEGRATED ACOUSTIC TRANSDUCER**

IMPLANTIERBARES MEDIZINPRODUKT MIT INTEGRIERTEM AKUSTISCHEM WANDLER

DISPOSITIF MEDICAL IMPLANTABLE PRESENTANT UN TRANSDUCTEUR ACOUSTIQUE INTEGRE

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(56) References cited:
US-A- 6 140 740 **US-A1- 2004 204 744**
US-B1- 6 477 406 **US-B1- 6 554 761**

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Description

Field Of Invention

[0001] The present invention relates to the field of diagnostic and therapeutic medical implants and data communication between them

Background

[0002] Communication between diagnostic and/or therapeutic medical device implants within the body can be highly beneficial. One example is the information exchange between an implantable sensor and an implantable pulse generator (IPG), that uses the sensed information for optimizing its operation. Published U.S. Patent Application US 2004-0204744 A1 discloses using an intra-body acoustic communication link for this purpose. As taught in that publication, in order to minimize energy consumption, the sensor implant is left deactivated (i.e., not powered on) until an acoustic wave pulse received from another implanted device activates the sensor implant using acoustic switch technology. Two possible transducer configurations applicable for this concept are disclosed in this published application.

[0003] Acoustic transducers integrated in implantable medical device are known. For example, U.S. Patent 6,477,406 discloses several acoustic transducer configurations used for listening to sounds produced by the heart. However, these transducers were designed only for receiving acoustic signals, and not for transmitting acoustic signals. Moreover, the transducer configurations of this patent are optimized to low sound frequencies in a range of 5-300 Hz, while for acoustic communication much higher frequencies are used, e.g., in an ultrasonic range of 20 kHz-10 MHz. In particular, US patent 6,477,406 does not teach an acoustic transducer that can effectively produce ultrasonic transmission or to serve as an effective receiver at high acoustic frequencies.

[0004] Acoustic communication was also suggested for data exchange between an implantable device and external unit, such as disclosed in US Patent 5,113,859. However, this patent also does not teach or describe an acoustic transducer capable of performing the communication, nor is there any transducer disclosed or described that is capable of transmitting ultrasonic signals at a level sufficient for activating an acoustic switch and or communicating with a second implant.

Summary Of The Invention

[0005] In one embodiment, an implantable medical device comprises a hermetically sealed housing having a housing wall with an interior surface. An ultrasonic acoustic transducer comprising one or more piezoelectric discs is fixed to the interior surface of the housing wall, such that the housing wall acts as a diaphragm in response to induced movement by the one or more piezoelectric material discs. The one or more piezoelectric discs may comprise, for example, a material selected from the group of materials comprising piezoelectric crystal, electro-active ceramics, ceramic-polymer composite, PVDF, and PVDF copolymer. The transducer is preferably configured to operate at a resonance frequency that is between 20-200 KHz.

[0006] In embodiments of the invention, the device further comprises an annular ring attached to the interior wall of the surface of the housing wall and surrounding the one or more discs. The device may also further include a membrane interposed between the interior wall surface and the piezoelectric discs, wherein the membrane has a substantially greater thickness than the enclosure wall. For example, in one embodiment, the membrane is mounted on a pedestal, the pedestal attached to the wall surface and having a smaller diameter than the piezoelectric discs.

[0007] In some embodiments, the interior wall may comprise an indent portion defining a recess, wherein the transducer is mounted to the wall within the recess. In some embodiments, the one or more piezoelectric discs comprise two discs, and further comprising an electrode positioned between the piezoelectric discs, wherein a respective electrical lead is coupled to each of the two discs and the electrode. An an amplifier integrated with the one or more piezoelectric discs in order to minimize parasitic effects and noises.

[0008] In some embodiments, the one or more transducer discs may comprise a single disc attached about an outer circumference of the disc to a support structure, the support structure attached to the enclosure wall surface and elevating the transducer disc from the wall so as to allow the disc to flex into a space defined between the disc and the enclosure wall. The support structure may comprise, for example, a membrane interposed between the interior wall surface and the piezoelectric disc. In such embodiments, the membrane may be mounted on a pedestal, the pedestal attached to the wall surface, wherein the pedestal has a smaller diameter than does the piezoelectric disc. In embodiments of the invention, the transducer may be a flexural type or a flex-tension type acoustic transducer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

Figs. 1a-1d depict embodiments which do not form part of the invention, of an exemplary acoustic transducer constructed on an internal housing surface of an active medical implant device, such as an IPG or a drug pump.

Figs. 2a-2b and 3a-3c depict alternate acoustic transducer designs coupled to an internal housing surface of an active medical implant device.

Fig. 4 depicts exemplary configurations of an acous-

tic transducer integrated on an end of an implantable acoustic lead, whereby the line-of-sight of the transducer(s) may be optimized relative to the location of a second implant.

Fig. 5 depicts an alternate configuration of an acoustic lead, in which acoustic waves are transmitted (or received) at a distal end of a lead tube serving as a wave guide, and in which the acoustic transducer is located close to (or within) an active medical implant device and coupled to the lead tube.

Fig. 6 depicts a further alternate configuration in which an acoustic lead is fixed to another lead using an elastic band.

Detailed Description Of The Illustrated Embodiments

[0010] The present invention is directed to an (active) implantable medical device such as a pacemaker, implantable cardioverter defibrillator (ICD), Cardiac Rhythm Therapy (CRT), a standalone hemodynamic monitor, or implantable drug pump, which communicates with another implanted device (not shown), or an extracorporeal device (not shown), using an acoustic communication link. Towards this end, the active implantable device is provided with an acoustic transducer capable of transmitting an acoustic pulse sufficient for activating an acoustic switch in the receiving device, such as described in US 6,628,989. For this purpose, an acoustic pulse that is at least 0.1 msec wide, and at least a 50 Pa peak pressure is preferred. For example, a pulse of 0.5 msec and 500 Pa may be used in one embodiment. The acoustic transducer is preferably capable of transmitting acoustic pulses at a pressure of at least 0.05 Pa (measured at 20 cm in vitro) and receiving signals of 0.05 Pa. The frequency range at which the system can operate is preferably within a range of 20 KHz - 3 MHz. In order to maximize the efficiency of the transducer, it is preferably designed to operate at its resonance frequency.

[0011] In one embodiment which does not form part of the invention, the acoustic transducer is constructed on an internal surface of the implantable device housing, typically a hermetically sealed enclosure, with a portion of the enclosure housing wall coupled to the transducer and acting as a vibrating diaphragm. Fig. 1a discloses one such acoustic transducer, in which a pair of piezoelectric discs 160 are coupled to an internal flat surface of a hermetic implant enclosure wall 110, wherein the portion 135 of the wall 110 to which the transducer discs 160 are attached acts as a vibrating diaphragm.

[0012] Piezoelectric materials are well known and the proposed design of the transducer can use any material from the group including: electrostrictive ceramic, piezoelectric ceramic, piezoelectric ceramic-polymer composite and piezoelectric polymers. The proposed design can employ one or more piezoelectric discs with an electrode there between discs. For example, transducer 160 has two discs surrounding an electrode 155. This structure allows for electrical connection of the piezoelectric discs in series, in parallel, or in a combination of the two, using electrical contacts to the disc electrodes. Three respective leads 130, 140 and 150 are provided for this purpose, which allows for optimization of the transducer 160 for performing specific tasks.

[0013] The voltage available in an IPG is usually relative low, produced from its internal 2-3 volts battery. For transmitting an acoustic signal required for activating an acoustic switch, a relatively high voltage may be required (for example, several hundred volts). Using multiple, thin discs of piezoelectric material connected in parallel will produce the equivalent acoustic power of a single, thicker disc, but at a substantially lower voltage. For example, two piezoelectric discs that are each 0.5 mm thick, connected in parallel, will produce a similar acoustic power as a 1 mm thick piezoelectric disc at half the voltage. However, if one wishes to optimize the receiving sensitivity of the transducer, serial connection of the thin piezoelectric discs will result in a higher voltage signal per a given acoustic signal, than a single thick disk. The ceramics may also be connected anti-parallel, to produce a bending moment as a piezoelectric bimorph.

[0014] For producing the transmitted acoustic signal, the proposed acoustic transducer should be efficient and durable. Preferably, the transducers should work at their resonance frequency in order to optimized the efficiency and sensitivity of the transducer. The acoustic transducer of Fig. 1a belongs to a family known as flexural transducers. Its resonance frequency depends on several parameters, including the type, thickness and diameter of the piezoelectric material 160, the material and thickness of the diaphragm 135, and the material, diameter, thickness, and height of a rigid ring 170 attached to the wall surface 110 surrounding the transducer and defining the diaphragm 135. For example, an acoustic transducer with the following parameters will have a resonance frequency of about 40 KHz: piezoelectric ceramic discs (160) that are 1 mm thick and 10 mm diameter; titanium diaphragm (135) that is 1 mm thick and 13 mm in diameter; and a surrounding titanium ring (170) of at least 1 mm in height with an outer diameter of 20 mm. Changing the resonance frequency can be done by modifying the various parameters as will be appreciated by those skilled in the art of acoustic transducer design.

[0015] The piezoelectric discs 160 can be coupled to the diaphragm by various known methods including using an adhesive, an electrically conductive adhesive, gel or liquid coupling, or by a direct fabrication of the piezoelectric material 160 on the diaphragm 135. In Fig. 1a, the diaphragm 135 is part of a hermetic enclosure wall 110, with its vibrational modes defined by its thickness and by the material and dimensions of the concentric rigid ring 170 attached to it. The ring 170 can be attached to the diaphragm using, for example, welding, brazing, diffusion bonding, adhesive or machining.

[0016] An alternate configuration (shown in Fig. 1b) is achieved by forming a groove 105 in the enclosure wall 110, and attaching the piezoelectric discs 160 to a very

thin diaphragm portion 135 of the wall, i.e., within the grove. This embodiment is more suitable where the enclosure wall 110 is relatively thick. Another alternative, (shown in Fig. 1c) is to producing an indent 107 in the wall 110 by stamping or coining, or by attachment of a separate diaphragm member 137, including a concentric ring portion 125. The parts can be attached by any conventional method, such as, e.g., welding, brazing, diffusion bonding, adhesive or machining. For optimizing the receiving sensitivity of the transducer, a separate disc of a piezoelectric material with high acoustic sensitivity can be used, such as a layer of PVDF, attached to the piezoelectric ceramic discs 160 used for transmission. Another way to improve the receiving signal to noise is by integrating an amplifier 165 to the disc structure 160 (shown in Fig. 1d), in order to minimize parasitic effects and noises. It will be appreciated that the addition of the amplifier shown in Fig. 1d may be equally applicable to the other embodiments disclosed and described herein.

[0017] In an embodiment of the invention, a transducer whose properties are substantially independent of the enclosure wall is preferred. Various IPGs and other active medical devices may have different enclosure material, thickness and thermal treatment as well as tolerances on each of this parameters. The resonance frequency and as a result the performance of a transducer that uses the wall of the enclosure as a diaphragm may vary significantly due to these changes, or the wall properties may be unsuited to yield the desired transducer properties.

[0018] For these reasons it is advantageous to have a transducer in which the acoustic performance is governed by the transducer structure detached from the enclosure wall. An example of such a design is given in Fig. 2a, in which the piezoelectric discs 160 are mounted on a separate membrane, that is itself mounted to the enclosure wall surface 110. In the illustrated embodiment, the membrane 132 may be metallic and has an integrally formed annular ring portion 120 that surrounds the piezoelectric discs 160 in a manner similar to ring 170 in the embodiments of Figs. 1a and 1d.

[0019] For example, in an IPG, the enclosure wall is usually made of titanium, with a wall thickness of about 0.125mm - 0.5mm. On the other hand, the metallic membrane 132 and the piezoelectric ceramic discs are preferably each about 1 mm thick, i.e. such that the influence of the relatively thin enclosure wall 110 on the performance of transducer is substantially small. Other thickness and diameters of materials can be used as will be apparent to those skilled in the art of designing acoustic transducers.

[0020] Fig. 2b depicts a variation of the embodiment of Fig. 2a. The natural mode of vibration of a transducer surface may include areas which vibrate in opposite directions, which may harm the acoustic performance. It is possible to optimize the motion transferred to the metallic casing by mounting the transducer on a pedestal 136, such that only surfaces which move together are coupled to the enclosure wall 110. For example, in Fig. 2b, the membrane enclosure 132 (including therein the transducer discs 160) is coupled to the enclosure wall 110 by a metallic or polymeric material disc 136, whose diameter is less than that of the transducer disc(s). In such configuration, only the motion of the center portion of the transducer couples to the wall 110 and to the acoustic medium, while the motion of the edge, which may be of opposite polarity, is not. As will be apparent, other methods of attachment can be designed to fit to specific transducer and enclosure structures.

[0021] Another family of transducers that can be useful for embodiments of the invention is shown in Fig. 3, and is known as a "flex-tensional" transducer. This device is based upon the principles of the flextensional actuator design. Specifically, an actuator having an electro-active substrate 520 is used, the actuator having at least one and preferably pair of planar or domed surfaces driving end caps. The use of flextensional principles provides significant improvements in implantable output actuators as the available space in the implantable device enclosure is limited. The use of the inventive output actuator described herein allows for movement of a piezo to translate into a proportionally larger movement of the flextensional actuator.

[0022] The lever action of the end caps in the flextensional devices also decreases the effective impedance of the piezo to match optimally the impedance of the body part being driven. Two configurations are presented, one (shown in Fig. 3a) in which the transducer 520 is attached about an outer circumference of the disc 520 to a support structure 510, the support structure 510 being attached to the enclosure wall surface 110 and elevating the transducer disc 520 there from, so as to allow the disc 520 to flex into a space 530 defined between the disc 520 and the enclosure wall 110. A pair of electrical leads are provided, one (142) coupled to the transducer disc 520, and the other (152) to the support structure 510. A second configuration design (shown in Fig. 3b) is where an additional metallic membrane 535 is provided for attaching the support structure 510 to the enclosure wall 110, the membrane 520 being substantially stiffer than the enclosure wall 110, thereby minimizing the influence of the wall 110 on the performance of transducer. The embodiment of Fig. 3c incorporates the features of both Figs. 2b and 3b, wherein the metallic membrane 535 is itself mounted to a metallic center pedestal 136.

[0023] The embodiments described above use several transducer configurations, however other transducer configurations and or variations and or modifications of the concepts herein taught may appear to those skill in the pertinent art. Integrating the acoustic transducer within the medical device enclosure is practically transparent to the implanting physician. Also in this configuration the hermetic enclosure protects the transducer and its electronic from the environment. However, usually the implantation location of the active medical device is limited due to its size and the wish to minimize the implantation

procedure invasiveness. As a result the implantation site can be sub-optimal for acoustic communication. For example, an IPG is most often implanted under the skin beneath the collar bone. Due to anatomy and the physical fact that acoustic waves can not cross the lungs any communication between the IPG and a second implant located within the heart may be sub-optimal.

[0024] Fig. 4 illustrates another embodiment which does not form part of the invention, in which the linkage between the location of the IPG 305 and that of the transducer is disconnected. As shown in Fig. 4, an acoustic transducer, alternately 320 or 330, may be located at the tip of a lead 300, referred to herein as an "acoustic lead." The acoustic lead 300 can be similar to an electrical lead commonly used in IPGs (e.g., for pacing). In a embodiment which does not form part of the invention, the acoustic lead 300 is not positioned within the heart, but rather in a vein leading to the right atrium, e.g. the subclavian vein, the cephalic vein, the right or left brachiocephalic vein, the superior or inferior vena cava or the internal jugular vein. The connection of the said acoustic lead 300 to the IPG 305 can be via a standard electrical hermetic feed through 303 of the IPG 305.

[0025] Implantation of the acoustic lead 300 can be performed using the same catheterization techniques used for implanting IPG electrical leads. However, instead of entering the right atrium (and in some cases the heart right ventricle), the acoustic lead can preferably be located external to the heart, and preferably in a location with a direct "line of sight" between the lead acoustic source and the second implant. Many of the risks involved in implanting an IPG electrical lead, such as thrombus formation or damage to the heart valve, may be avoided by not entering the heart or passing through the heart valve. The fixation of the acoustic lead 300 may be accomplished, for example, by a radial anchoring of the device to a wall of the vessel using a stent-like device, or with a screw or hook-type fixation to the vessel wall.

[0026] Alternatively, an acoustic lead can be fixed to another lead using, for example, an elastic band 640, as shown in Fig. 6. In this configuration, a first electrical lead 630 extending from an IPG 660 is implanted (for example) for pacing in the patient's right ventricle 610. A guide wire, and preferably a catheter, are threaded into an elastic band 640 attached on or around the first electrical lead 630. An acoustic lead 650 may then be implanted over the wire or the catheter. This proposed procedure should be considered only as an example, and other techniques and methods of implanting and fixating an acoustic lead will be apparent to those skilled in the art.

[0027] An acoustic transducer 655 is integrated at the tip of the acoustic lead 650 and can be of any type of transducer. For example, Fig. 4 shows the exemplary use of two designs discussed previously, a flexural configuration 310, and a flex-tensional design 330. Preferably the transducer electrical contacts and leads to the IPG are isolated from body fluids. Since the impedance of the transducer will be similar in magnitude to the impedance of the IPG leads (on the order of several hundreds of ohms), the same isolation techniques used for standard IPG leads can also be used for the acoustic lead. Also, the diaphragm of the transducer 350 can be coated with the same polymeric material of the lead, e.g. polyurethane or silicone. However, care should be taken that gas bubbles will not be preserved in this layer, so as to not to attenuate the acoustic wave transmission.

[0028] Another embodiment which does not form part of the invention, including another acoustic lead configuration, is shown in Fig. 5. In this embodiment, the acoustic lead is based on an acoustic wave-guide 450 coupled on one end to an acoustic transducer 400. In this configuration, the acoustic waves propagate along, and exit on a far end 405 of, the wave guide 450. The acoustic transducer can be external to the IPG (as shown in Fig. 5), or integrated within the IPG enclosure (not shown). Preferably a funnel shaped structure or a gradual change of the material properties through which the sound waves propagate (420 to 430) is used to optimize the coupling of the transducer to the wave-guide by matching their mechanical impedances. This configuration allows the usage of a larger transducer for producing the acoustic waves, while still directing the acoustic energy to an optimized location, using a small size, catheterization compatible wave-guide. Again, the transducer can be of any desired type and configuration.

[0029] The design of the wave-guide 450 should ensure that a substantial part of the acoustic energy produced by the acoustic transducer module 400 will be emitted at the lead far end 405. The material of which the wave-guide is preferably made of, or filled with, a good acoustic conductor. Liquids, including water and saline, or polymers, such as polyurethane, nylon, or rubber, can be used for this purpose. The wall 430 of the lead 450 should serve as a reflector for the acoustic waves to prevent leakage of the acoustic energy out of the wave-guide. The wall 430 can be made of a substantially rigid material such as a metal tube, or a polymer tube radially reinforced with metal or glass fibers.

[0030] Alternatively, the waveguide 450 may consist of a flexible metal tube or wire, which conducts the acoustic vibrations via longitudinal waves. Such metal wire or tube may be encased in a thin solid or gas-containing cladding, which insulates it mechanically from the surrounding fluid. The far end of the wave-guide 405 serves as an acoustic wave source acoustically coupled to the body. For example, a thin membrane 440, e.g., made of a polymer or a metal, may serve as the acoustic diaphragm. This acoustic membrane 440 may be resonant at the desired frequency of operation, in order to increase its effectiveness as an acoustic radiator. Alternately, the far end of the lead may contain a resonant structure, such as a mechanical structure or a Helmholtz resonator, coupled to the membrane 440.

[0031] All the above-disclosed, implantable transducers can, in addition to activation and communication with a second implant, also be used for acoustically energiz-

ing and charging the second implant. Preferably, the acoustic lead designs of Figs. 4 and 5 should be used for this purpose, taking advantage of the optimized location of the transducer in these configurations relative to the second implant. The possible line of sight between the lead transducer and the second implant, combined with the possible small distance between them, which can be between a few millimeters to several centimeters, can significantly reduce the required energy for charging the second implant battery or capacitor. The charging can be done using energy from the IPG battery, or from an extracorporal power source (either telemetrically, or by making a small incision at the IPG implantation site), disengaging the acoustic lead from the IPG controller, connecting the acoustic lead to an external power source, and using the acoustic energy produced by the acoustic lead to charge the battery within the second implant.

[0032] Preferably, the battery capacity of the second implant is such that charging will be not be required for a duration longer than that of the IPG battery. Upon the replacement of the IPG controller, the acoustic lead can be connected to an external power source for charging the second implant battery. Alternatively, an acoustic catheter can be used for acoustically charging the second implant. This catheter can be built similar to the acoustic lead, with an acoustic transducer at its tip or by serving as an acoustic wave-guide. The acoustic catheter can be introduced to the body in a similar technique used for right heart catheterization. This procedure is usually carried out via the femoral vein and internal jugular subclavian vein, using a standard guide wire based catheterization or by a floating balloon (e.g., a Swan-Ganz catheter). The procedure can be guided using fluoroscopy or pressure pattern measurements. Since the acoustic source on the catheter can be located very close to the second implant, the charging process is preferably very efficient and local.

Claims

1. An implantable medical device, comprising:

a pulse generator (305), a hermetically sealed housing having a housing wall (110) with an interior surface; and
an ultrasonic acoustic transducer comprising one or more piezoelectric discs (160) disposed within the housing and coupled to a metallic membrane (132,535),
wherein the housing wall (110) acts as a diaphragm in response to induced movement by the one or more piezoelectric material discs (160),
characterized in
that the membrane (132,535) is interposed between the interior surface of the housing wall (110) and the piezoelectric discs (160), the membrane (132) coupling the piezoelectric discs (160) to the interior surface of the housing wall (110);
wherein the transducer is configured to operate at a resonance frequency that is within the range of 20 KHz to 200 KHz.

2. The device of claim 1, wherein the one or more piezoelectric discs (160) comprises a material selected from the group of materials comprising piezoelectric crystal, electro-active ceramics, ceramic-polymer composite, PVDF, and PVDF copolymer.

3. The device of any of claims 1-2, further comprising an annular ring (120) attached to the interior surface of the housing wall (110) and surrounding the one or more discs (160).

4. The device of any of claims 1-3, wherein the membrane (132,535) has a greater thickness than a thickness of the housing wall (110).

5. The device of claim 4, wherein the membrane (132,535) is mounted on a pedestal (136), the pedestal (136) attached to the interior surface of the housing wall (110), the pedestal (136) having a smaller diameter than a diameter of the one or more piezoelectric discs (160).

6. The device of any of claims 1-5, wherein the one or more piezoelectric discs (160) comprise two discs, and further comprising an electrode (155) positioned between the piezoelectric discs (160).

7. The device of claim 6, further comprising a respective electrical lead (130,140,150) coupled to each of the two discs (160) and the electrode (155).

8. The device of any of claims 1-7, further comprising an amplifier (165) integrated with the one or more piezoelectric discs (160) in order to minimize parasitic effects and noises.

9. The device of any of claims 1-8, wherein the membrane (132,535) is mounted on a pedestal (136), the pedestal (136) attached to the interior surface of the housing wall (110), the pedestal (136) having a smaller diameter than a diameter of the piezoelectric disc (160).

10. The device of any of claims 1-8, wherein the transducer is a flexural type acoustic transducer.

11. The device of any of claims 1-9, wherein the transducer is a flex-tension type acoustic transducer.

Patentansprüche

1. Implantierbare medizinische Vorrichtung, aufweisend:

   einen Impulsgenerator (305), ein hermetisch abgedichtetes Gehäuse, das eine Gehäusewand (110) mit einer inneren Oberfläche hat; und
   einen akustischen Ultraschallwandler, aufweisend eine oder mehrere piezoelektrische Scheiben (160), die innerhalb des Gehäuses angeordnet und mit einer metallischen Membran (132, 535) gekoppelt sind,
   wobei die Gehäusewand (110) als ein Diaphragma als Antwort auf induzierte Bewegung durch die eine oder die mehreren piezoelektrischen Materialscheiben (160) wirkt,
   dadurch gekennzeichnet,
   dass die Membran (132, 535) zwischen der inneren Oberfläche der Gehäusewand (110) und den piezoelektrischen Scheiben (160) angeordnet ist, welche Membran (132) die piezoelektrischen Scheiben (160) mit der inneren Oberfläche der Gehäusewand (110) koppelt;
   wobei der Wandler ausgebildet ist, bei einer Resonanzfrequenz, die innerhalb des Bereichs von 20 KHz bis 200 KHz liegt, zu operieren.

2. Vorrichtung nach Anspruch 1, bei der die eine oder die mehreren piezoelektrischen Scheiben (160) ein Material aufweisen, das ausgewählt ist aus der Gruppe von Materialien aufweisend piezoelektrischen Kristall, elektroaktive Keramik, Keramik-Polymer-Verbundmaterial, PVDF und PVDF-Copolymer.

3. Vorrichtung nach einem der Ansprüche 1 bis 2, weiterhin aufweisend einen Ring (120), der an der inneren Oberfläche der Gehäusewand (110) angebracht ist und die eine oder die mehreren Scheiben (160) umgibt.

4. Vorrichtung nach einem der Ansprüche 1 bis 3, bei der die Membran (132, 535) eine größere Dicke als eine Dicke der Gehäusewand (110) hat.

5. Vorrichtung nach Anspruch 4, bei der die Membran (132, 535) auf einem Sockel (136) befestigt ist, wobei der Sockel (136) an der inneren Oberfläche der Gehäusewand (110) befestigt ist und der Sockel (136) einen kleineren Durchmesser als einen Durchmesser der einen oder der mehreren piezoelektrischen Scheiben (160) hat.

6. Vorrichtung nach einem der Ansprüche 1 bis 5, bei der die eine oder die mehreren piezoelektrischen Scheiben (160) zwei Scheiben aufweisen und weiterhin eine Elektrode (155) aufweisen, die zwischen den piezoelektrischen Scheiben (160) angeordnet ist.

7. Vorrichtung nach Anspruch 6, weiterhin aufweisend einen jeweiligen elektrischen Leiter (130, 140, 150), der mit jeder der beiden Scheiben (160) und der Elektrode (155) gekoppelt ist.

8. Vorrichtung nach einem der Ansprüche 1 bis 7, weiterhin aufweisend einen Verstärker (165), der mit der einen oder den mehreren piezoelektrischen Scheiben (160) integriert ist, um parasitäre Wirkungen und Störungen zu minimieren.

9. Vorrichtung nach einem der Ansprüche 1 bis 8, bei der die Membran (132, 535) auf einem Sockel (136) befestigt ist, wobei der Sockel (136) an der inneren Oberfläche der Gehäusewand (110) angebracht ist und der Sockel (136) einen kleineren Durchmesser als einen Durchmesser der piezoelektrischen Scheibe (160) hat.

10. Vorrichtung nach einem der Ansprüche 1 bis 8, bei der der Wandler ein akustischer Wandler vom Biegungstyp ist.

11. Vorrichtung nach einem der Ansprüche 1 bis 9, bei der der Wandler ein akustischer Wandler vom Biegungsspannungstyp ist.

Revendications

1. Dispositif médical implantable comprenant :

   un générateur d'impulsions (305), un boîtier hermétiquement fermé ayant une paroi de boîtier (110) avec une surface intérieure ; et
   un transducteur acoustique ultrasonique comprenant un ou plusieurs disques piézoélectriques (160) disposés à l'intérieur du boîtier et couplés à une membrane métallique (132, 535), dans lequel la paroi de boîtier (110) sert de diaphragme en réponse au mouvement induit par le ou les disques en matériau piézoélectrique (160),
   caractérisé en ce que la membrane (132, 535) est intercalée entre la surface intérieure de la paroi de boîtier (110) et les disques piézoélectriques (160), la membrane (132) couplant les disques piézoélectriques (160) à la surface intérieure de la paroi de boîtier (110) ;
   dans lequel le transducteur est configuré pour fonctionner à une fréquence de résonance qui est de l'ordre de 20 KHz à 200 KHz.

2. Dispositif selon la revendication 1, dans lequel le ou les disques piézoélectriques (160) comprennent un matériau choisi dans le groupe des matériaux com-

prenant le cristal piézoélectrique, les céramiques électro-actives, les composites de polymère céramique, le PVDF et le copolymère de PVDF.

3. Dispositif selon l'une quelconque des revendications 1 à 2, comprenant en outre une bague annulaire (120) fixée sur la surface intérieure de la paroi de boîtier (110) et entourant le ou les disques (160).

4. Dispositif selon l'une quelconque des revendications 1 à 3, dans lequel la membrane (132, 535) a une plus grande épaisseur qu'une épaisseur de la paroi de boîtier (110).

5. Dispositif selon la revendication 4, dans lequel la membrane (132, 535) est montée sur un socle (136), le socle (136) étant fixé sur la surface intérieure de la paroi de boîtier (110), le socle (136) ayant un plus petit diamètre qu'un diamètre des un ou plusieurs disques piézoélectriques (160).

6. Dispositif selon l'une quelconque des revendications 1 à 5, dans lequel le ou les disques piézoélectriques (160) comprennent deux disques, et comprenant en outre une électrode (155) positionnée entre les disques piézoélectriques (160).

7. Dispositif selon la revendication 6, comprenant en outre un fil de sortie électrique (130, 140, 150) respectif couplé à chacun des deux disques (160) et à l'électrode (155).

8. Dispositif selon l'une quelconque des revendications 1 à 7, comprenant en outre un amplificateur (165) intégré avec le ou les disques piézoélectriques (160) afin de minimiser les effets et les bruits parasites.

9. Dispositif selon l'une quelconque des revendications 1 à 8, dans lequel la membrane (132, 535) est montée sur un socle (136), le socle (136) étant fixé sur la surface intérieure de la paroi de boîtier (110), le socle (136) ayant un plus petit diamètre qu'un diamètre du disque piézoélectrique (160).

10. Dispositif selon l'une quelconque des revendications 1 à 8, dans lequel le transducteur est un transducteur acoustique de type à flexion.

11. Dispositif selon l'une quelconque des revendications 1 à 9, dans lequel le transducteur est un transducteur acoustique de type à flexion - tension.

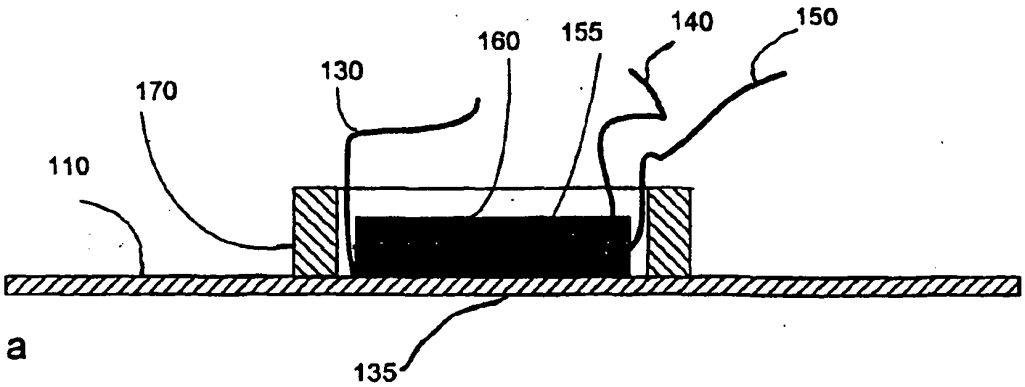

Figure 1a

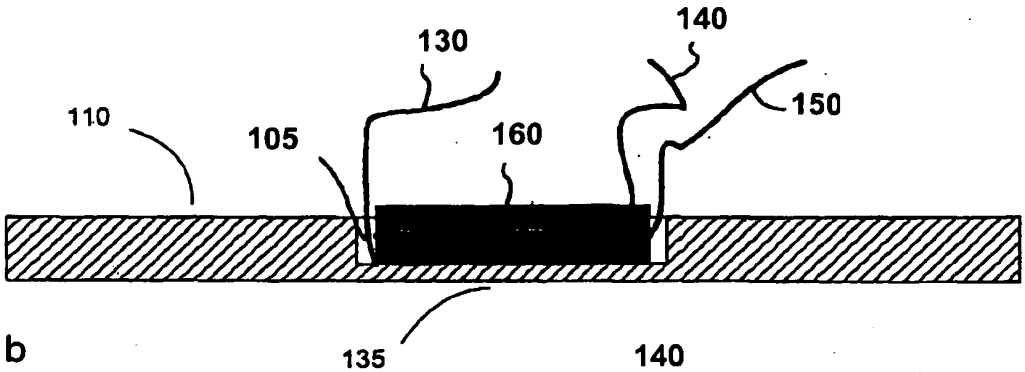

Figure 1b

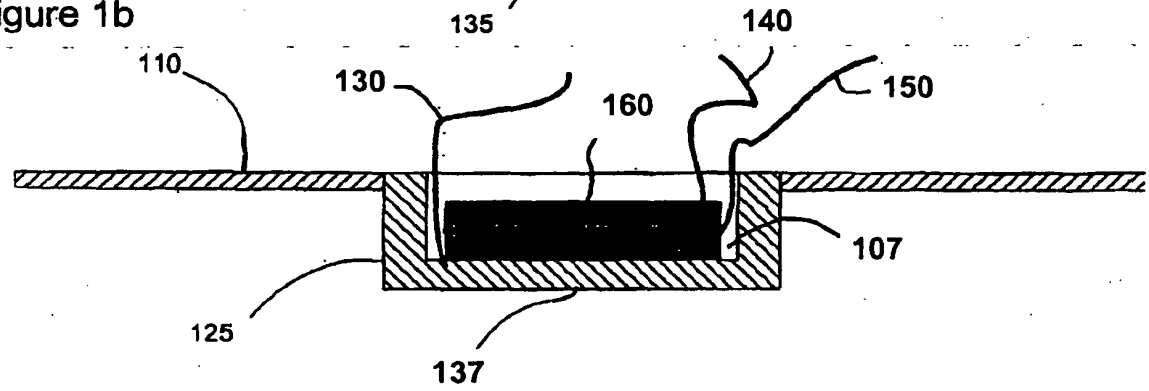

Figure 1c

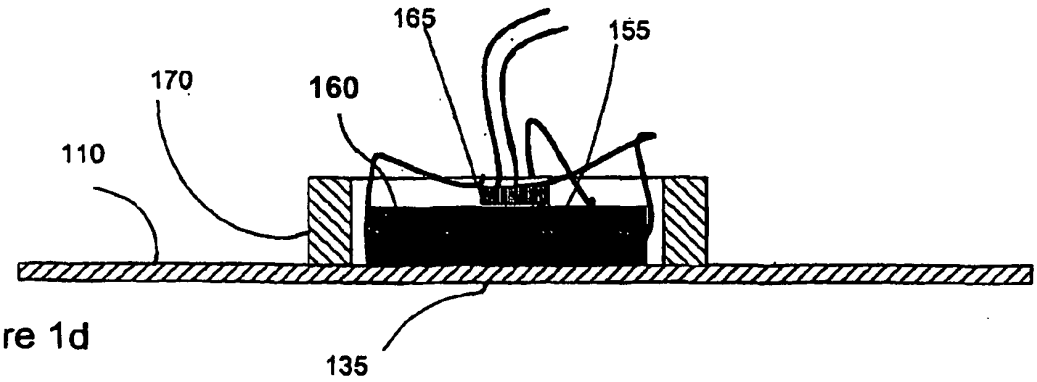

Figure 1d

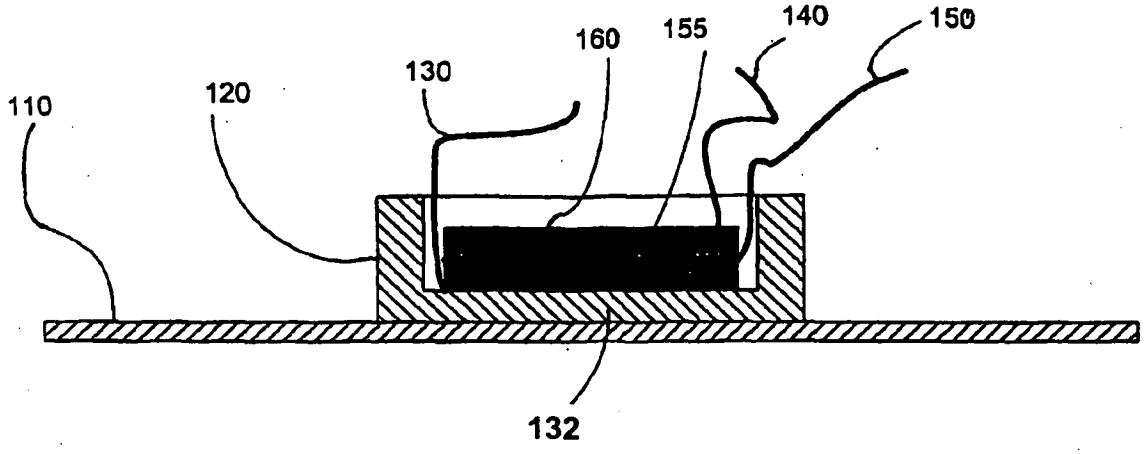

Figure 2a

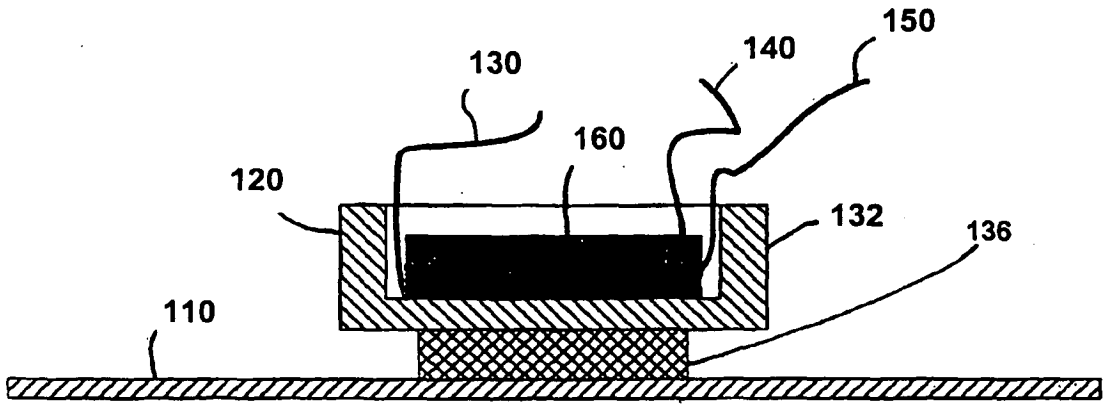

Figure 2b

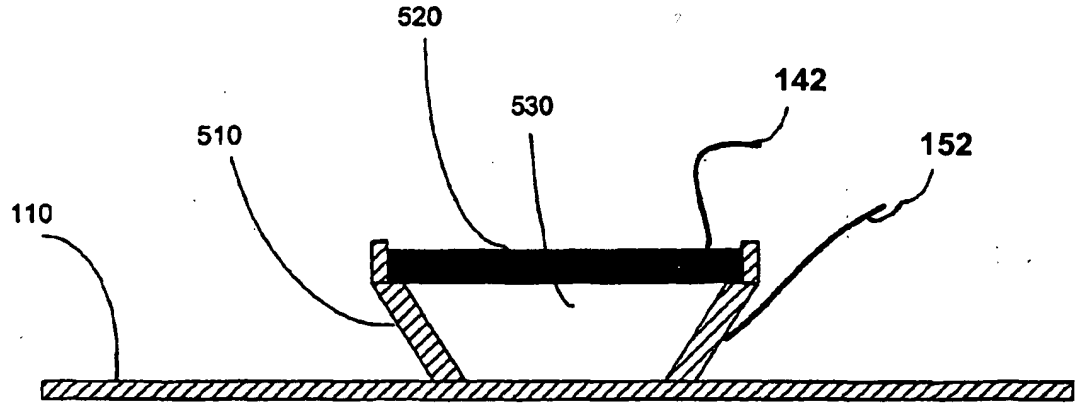

Figure 3a

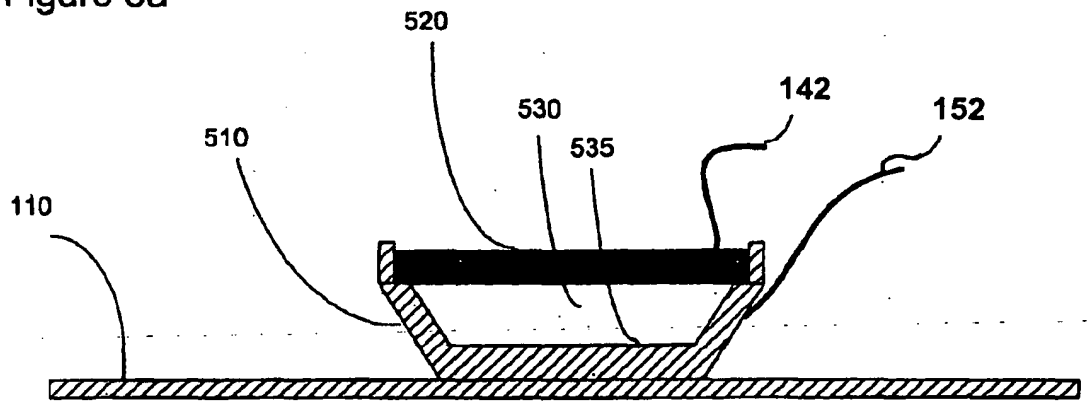

Figure 3b

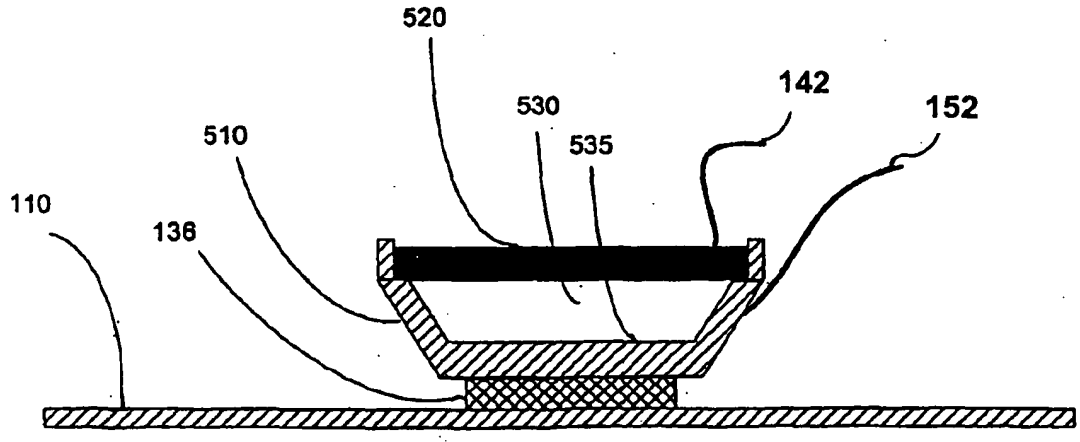

Figure 3c

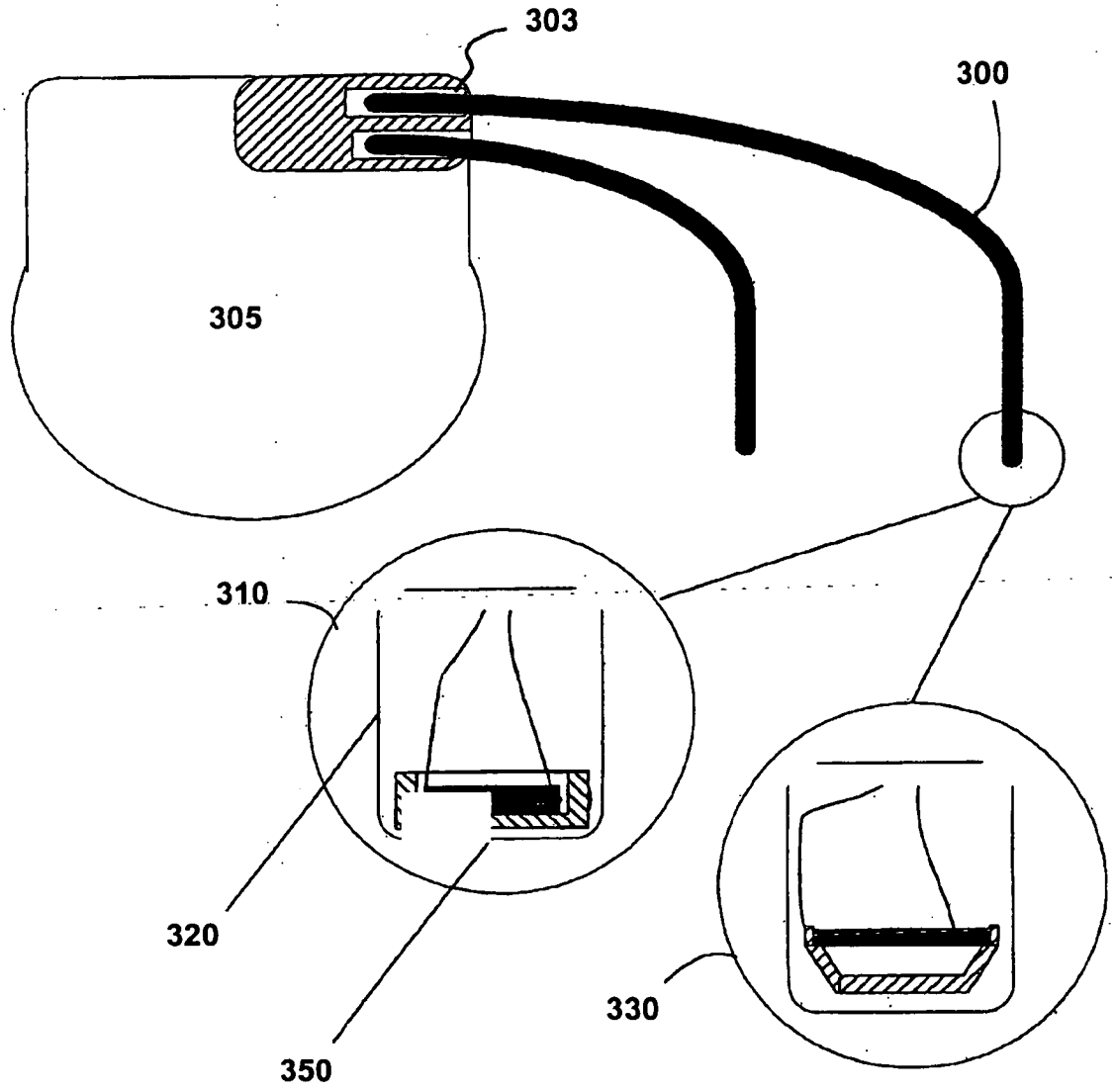

Figure 4

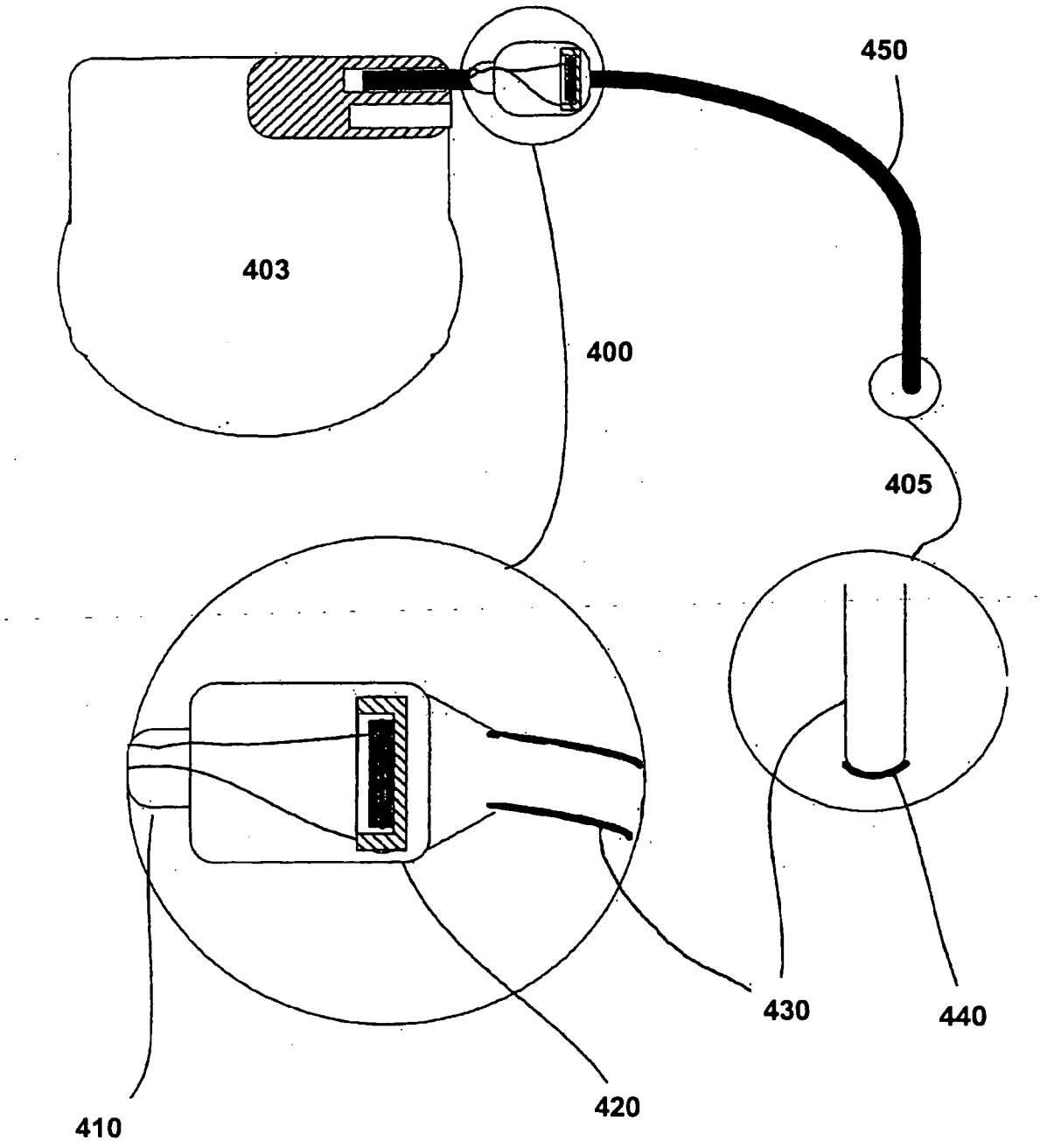

Figure 5

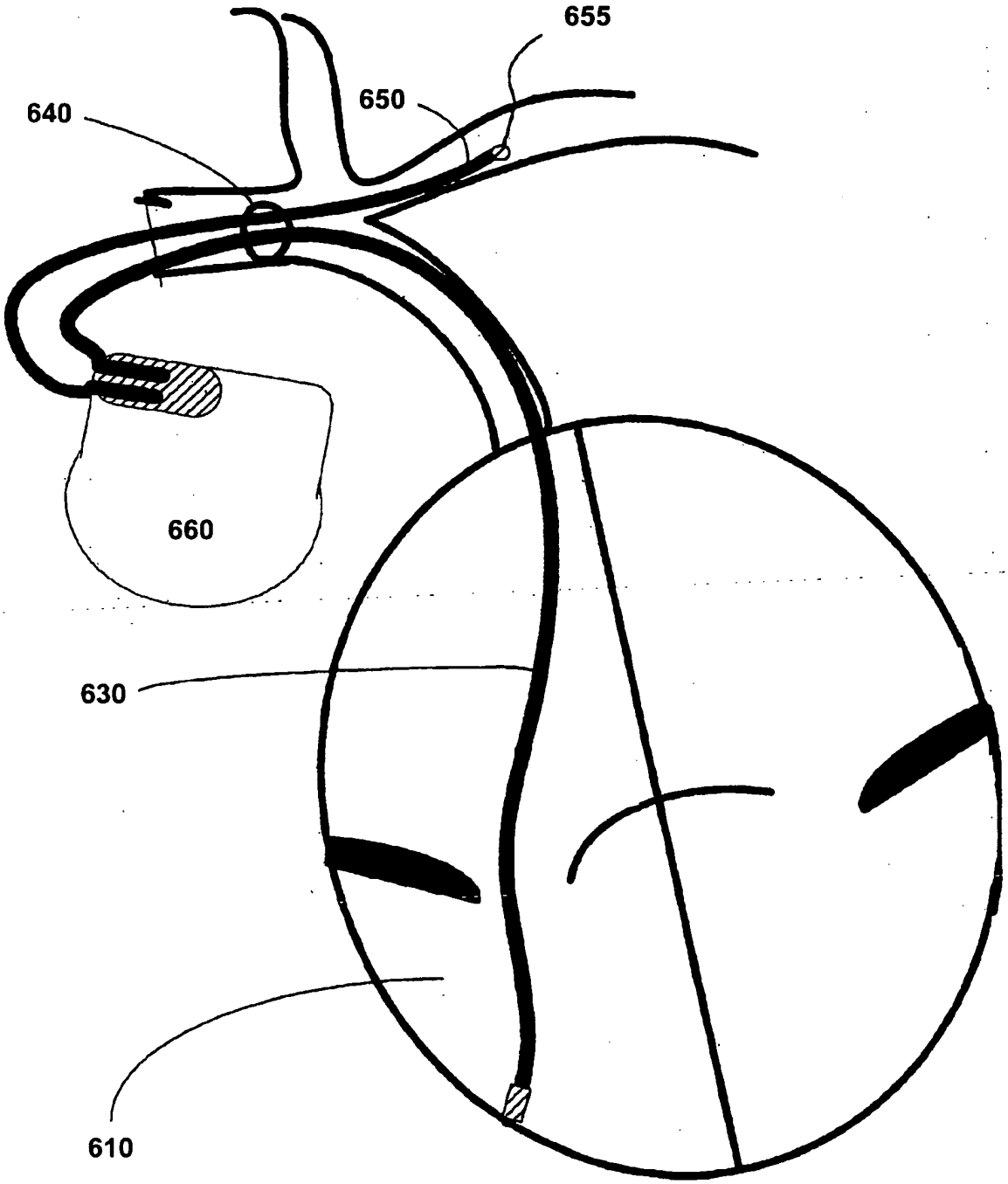

Figure 6

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 20040204744 A1 **[0002]**
- US 6477406 B **[0003]**
- US 5113859 A **[0004]**
- US 6628989 B **[0010]**

专利名称(译)	带有集成声换能器的植入式医疗设备		
公开(公告)号	EP1838210B1	公开(公告)日	2010-10-13
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[标]申请(专利权)人(译)	REMON医疗TECH		
申请(专利权)人(译)	REMON MEDICAL TECHNOLOGIES LTD.		
当前申请(专利权)人(译)	REMON MEDICAL TECHNOLOGIES LTD.		
[标]发明人	PENNER ABRAHAM DORON EYAL		
发明人	PENNER, ABRAHAM DORON, EYAL		
IPC分类号	A61B5/00 H04R17/00 A61N1/372 B06B1/06		
CPC分类号	A61N1/37217 A61B5/0028 A61B5/0031 A61N1/372 A61N1/3785		
优先权	60/630801 2004-11-24 US		
其他公开文献	EP1838210A1		
外部链接	Espacenet		

摘要(译)

可植入医疗装置包括气密密封壳体和超声声换能器，所述壳体具有带有内表面的壳体壁，所述换能器包括固定到所述壳体壁的内表面的一个或多个压电盘，使得所述壳体壁用作隔膜响应于一个或多个压电材料盘的诱导运动。