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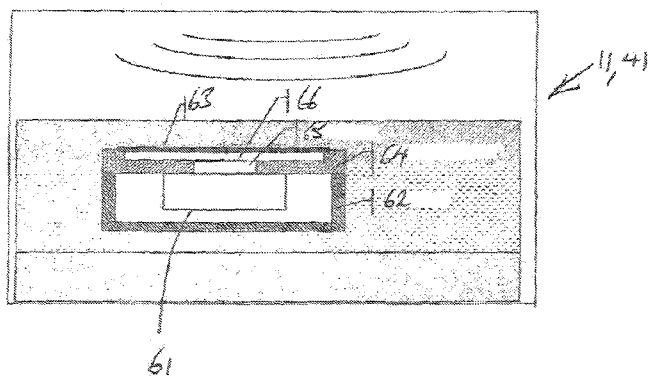

FIG. 5

(57) Abstract: A prosthesis comprising of at least one sensor implantable In an implantee for detecting airborne sound and at least one or more or other body sounds and converting said airborne sounds and said body sounds into one or more output signals; a processor for receiving and processing said one or more output signals into at least one first processed signal representative of airborne sound and at least one second processed signal representative of said body sounds; at least one stimulation module that receives and processes the first processed signal into a first stimulating signal representative of the detected airborne sound; and, a health analysing module that receives and processes the at least one second processed signal and outputs information representative of at least one bodily condition of the implantee.

BODY NOISE DETECTION USING AN IMPLANTABLE MICROPHONE

Field of the Invention

The present invention relates to an auditory prosthesis and in particular to an auditory prosthesis having one or more implantable microphones of other sensors.

Background of the Invention

A range of auditory prostheses are available for persons having varying degrees of hearing loss. One type of auditory prosthesis is that commonly known as a cochlear implant. Cochlear implants can comprise an external component, such as a speech processor unit, and an implantable component, such as a receiver/stimulator unit. The external component typically comprises a casing, a microphone, a speech processor that converts detected sounds into coded signals and a power source. The implantable component receives the coded signals and power from the external component and outputs a stimulation signal to an electrode assembly which applies electrical stimulation to the auditory system of the implantee producing a hearing sensation corresponding to the original detected sound.

Communication between the external component and the implantable component can be provided by a radio frequency (RF) magnetic induction link comprising an inductively coupled external antenna coil and an internal implanted antenna coil. This RF link provides transcutaneous transmission of the coded signals to, and also typically from, the implantable component and can also serve to provide power to the implantable component. Implantable components having an onboard rechargeable battery have also been proposed. Such prostheses can utilise more than one type of external component or work together with other external or implantable components.

Totally implantable devices have also been developed which rely on placing one or more of the components that are normally on the external component within the implantable component. In the case of cochlear implant systems, such totally implantable systems have envisaged placing the microphone, speech processor and a power source on or in the housing of the implantable component.

Any discussion of documents, acts, materials, devices, articles or the like which has been included in the present specification is solely for the purpose of providing a

context for the present invention. It is not to be taken as an admission that any or all of these matters form part of the prior art base or were common general knowledge in the field relevant to the present invention as it existed before the priority date of each claim of this application.

Summary of the Invention

Throughout this specification the word "comprise", or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated element, integer or step, or group of elements, integers or steps, but not the exclusion of any other element, integer or step, or group of elements, integers or steps.

According to a first aspect, the present invention is a prosthesis comprising:

at least one sensor implantable in an implantee for detecting airborne sound and at least one or more or other body sounds and converting said airborne sounds and said body sounds into one or more output signals;

a processor for receiving and processing said one or more output signals into at least one first processed signal representative of airborne sound and at least one second processed signal representative of said body sounds;

at least one stimulation module that receives and processes the first processed signal into a first stimulating signal representative of the detected airborne sound; and

a health analysing module that receives and processes the at least one second processed signal and outputs information representative of at least one bodily condition of the implantee.

In one embodiment, the prosthesis can have just one implantable sensor for detecting airborne sound and the at least one or more or other body sounds. In another embodiment, the prosthesis can rely on multiple sensors. At least one of the sensors can comprise a microphone. In one embodiment, the microphone can be constructed by coupling a transducer to a cavity covered by a diaphragm. The transducer can be a pressure sensitive transducer and be formed from, for example, an electret or piezoelectric material. The diaphragm can be formed from titanium or titanium alloy.

In one embodiment where there is more than one sensor, each sensor can be the same, for example each sensor can be a microphone. In another embodiment, one or more of the sensors can be different to the other sensors of the prosthesis. One of the

sensors can be a vibration sensor. Still further, multiple phased array sensors can be used as part of the prosthesis.

In one embodiment, the prosthesis can comprise an implantable component having a housing. The housing can be hermetically sealed and be formed of a biocompatible material, such as titanium. The housing can contain or support at least one of said at least one sensors.

In another embodiment, one, some or all of the sensors can be positioned outside the housing. In this embodiment, one or more sensors can be mounted on a first separate component. The first separate component can be connected to the housing by a cable so as to allow transmission of the output signals from the one or more sensors to the housing. It will be appreciated that a wireless link could also exist between the housing and the first separate component. In a further embodiment, one or more sensors can be supported on the housing and one or more sensors can be positioned on the first separate component. In yet another embodiment, the prosthesis can utilise one or more separate components, having one or more sensors, in addition to said first separate component. Said additional separate components can be connected to the housing by one or more cables and/or a wireless link.

In a still further embodiment, the housing can contain the processor. The housing can also contain the stimulation module. Still further, the housing can contain the health analysing module.

In another embodiment, prosthesis can comprise one or more external components. The external component can comprise a housing. The external component can house the health analysing module. The external component can also house the processor. In a further embodiment, the health analysing module can be in a first external housing and the processor in a second external housing. In one embodiment, the housing for the processor can be a behind-the-ear (BTE) unit. In another embodiment, the housing for the processor and/or health analysing module can be worn on the body and/or clipped to clothing, for example a belt.

When an external component is available and mounted appropriately, the implantable components can work in conjunction with that external component. For example, if the external component has a microphone and/or processor, the output of

the external processor can be used instead of the on-board microphone and/or processor. When the external component comprises or has an on-board and suitable power source, the implantable component can be configured to preferentially draw power from the external component to power its operation and/or re-charge the on-board power source.

In one embodiment, the output signals representative of the airborne sound and the body noise delivered to the processor are analysed by an adaptive algorithm. The algorithm can detect certain sound patterns typical of being body induced noise, for example sounds of swallowing, breathing, chewing and/or talking. This pattern analysis can then be used to filter at least part of the noise component before presenting the first processed signal to the stimulation module.

The detected body noise data as recognized by the pattern analysis can then be delivered as the second processed signal to the health analysing module.

The stimulation module can be part of a cochlear implant system. In this embodiment, the first stimulating signal can be delivered to a cochlea of an implantee. The delivery of the first stimulating signal can be delivered by one or more electrode arrays. At least one electrode array can comprise an intracochlear electrode array. The electrode array can comprise a carrier member having a plurality of electrodes thereon. The electrodes can be supported in a longitudinal array. In one embodiment, the carrier member can comprise a biocompatible elastomeric member. The elastomeric member can be a silicone. Each electrode can be formed from a biocompatible electrically conductive material, such as platinum. The electrodes can comprise platinum rings. Each of the electrodes can have at least one wire, for example two, extending from each electrode back towards the trailing end of the carrier member and then through a cable that extends back to the housing of the implantable component. One or more feedthroughs can be provided in the housing of implantable component to allow signal transmission between the housing and the carrier member.

The carrier can have 22 electrodes. In another embodiment, the carrier can have 30 electrodes. Other numbers of electrodes can be utilised, including less than 20 electrodes, between 20 and 30 electrodes, and more 30 electrodes.

In another embodiment, the implantable component can have a second electrode assembly extending from the housing. The second electrode assembly may have one or more electrodes. This electrode assembly can be mounted within or external the cochlea of the implantee.

In another embodiment, the stimulation module can comprise an actuator arrangement configured to provide direct stimulation to one or more hearing structures of the implantee representative of the original detected sound. The actuator can comprise at least one extracochlear actuator and be configured to provide excitation to fluid-filled inner-ear spaces of the implantee. In another embodiment, the actuator can comprise at least one intracochlear array of actuators. The actuator can comprise one or more mechanical actuation elements. The first stimulation module can comprise a direct acoustic cochlear actuator (DACS) unit.

In a still further embodiment, the stimulation module can comprise a bone anchored hearing aid (or BAHA), including an implantable BAHA. The hearing aid can comprise a bone transmitting vibrator that is connected directly to the bone using a skin-penetrating and bone-anchored implant of a suitable biocompatible material, for example titanium.

In a still further embodiment, the health analysing module can have a storage device for storing said at least one second processed signal and/or said information representative of a bodily condition of the implantee. In another embodiment, the health analysing module can have a display device that allows the module to output said representative information. The representative information can be selected from the group comprising heart beat, breathing rate, chewing information, snoring detection, sleep apnoea detection, and a record of noise exposure of the implantee. The health analysing module can further incorporate a comparator that compares the representative information with predetermined ranges or values. Still further, said information can be transferable from the health analysing module to a computer running software instructions that allows storage, manipulation and display of the representative information.

In one embodiment, the health analysing module can be incorporated into a personal digital assistant (PDA) device. The PDA can allow entry of user-specified information for use by the device. The user-specified information can include the

implantee's age, weight and/or height. The PDA can output instructions and/or information to the implantee and/or a third party, such as a caregiver, based on the representative information. For example, the PDA may output information on the physical state of the recipient. It may also output instructions to increase or discontinue exercise if a detected breathing rate and/or heart rate is determined to be inside or outside, respectively, a desired range. The PDA may also trigger an audible or vibratory alarm to the implantee on detection of snoring or sleep apnoea. Analysis of chewing sounds can be used to determine when and/or what an implantee is eating and so provide a means of analysing an implantee's diet.

In one embodiment where the processor is part of an implantable component and the health analysing module is part of an external component, a transcutaneous wireless link can be provided between the processor and the health analysing module. The wireless link can be provided by respective antennae on the implantable and external components. The respective antennae can comprise antenna coils. Such antenna coils can be provided by one or more coils of an electrically conductive materials, such as platinum. These coils can be embedded in an elastomeric support, such as a silicone. Suitable magnets can be provided at or near the centre of the respective coils to allow transcutaneous alignment of the coils.

In a still further embodiment, other transducers may be implantable within the implantee and/or positionable on the implantee and output signals to the health analysing module. Other such transducers can comprise an accelerometer which detects if an implantee has fallen or dropped down, a temperature sensor to monitor body temperature, and a blood pressure sensor. Other such sensors can be envisaged.

In one embodiment, the processor can use the detection of the body sounds to enhance discrimination of the airborne sound from the total sound detected by the one or more sensors.

According to a second aspect, the present invention is a prosthesis comprising:

at least one sensor implantable in an implantee for detecting airborne sound and at least one or more or other body sounds and converting said airborne sounds and said body sounds into one or more output signals;

a vibration sensor for detecting body-induced vibration and outputting signals representative of detected vibrations;

a processor for receiving and processing said one or more output signals from said at least one sensor and said signals representative of detected vibrations into at least one first processed signal representative of airborne sound and at least one second processed signal representative of said body sounds;

at least one stimulation module that receives and processes the first processed signal into a first stimulating signal representative of the detected airborne sound; and

a health analysing module that receives and processes the at least one second processed signal and outputs information representative of at least one bodily condition of the implantee.

In this aspect, the prosthesis can have one, some or all of the features as defined herein with reference to other aspects and embodiments.

The present invention utilises what is currently a problem with implantable devices having a subcutaneous microphone or other transducer (ie detection of body-induced noise) as an input into a device that can be used to detect and display health information about the implantee.

Brief Description of the Drawings

By way of example only, embodiments of the invention are now described with reference to the accompanying drawings, in which:

Fig. 1 is a block diagram of one embodiment of a prosthesis according to the present invention;

Fig. 2 is a block diagram of one embodiment of the pattern analysis undertaken by the prosthesis according to the present invention;

Fig. 3 is a block diagram of another embodiment of a prosthesis using adaptive filtering;

Fig. 4 is a block diagram of yet another embodiment of a prosthesis using adaptive filtering; and

Fig. 5 is a diagrammatic representation of one embodiment of a subcutaneous microphone according to the present invention.

Preferred Mode of Carrying out the Invention

One embodiment of a prosthesis according to the present invention is depicted generally as 10 in Fig. 1. The prosthesis comprises an implantable sensor 11 which in this embodiment is an implantable subcutaneous microphone such as is described in more detail in Fig. 5. The sensor 11 can detect airborne sound and at least one or more or other body sounds 13 and converts these airborne sounds and body sounds into one or more output signals using an analogue to digital signal processor 14.

The prosthesis 10 further comprises a processor 15 for receiving and processing the one or more output signals into at least one first processed signal 16 representative of airborne sound and at least one second processed signal 17 representative of the body sounds.

The prosthesis 10 further comprises a stimulation module 18 and a health analysing module 19. The stimulation module 18 receives and processes the first processed signal 16 into a first stimulating signal representative of the detected airborne sound 12. The health analysing module 19 receives and processes the at least one second processed signal 17 via a wireless link 21 and outputs information representative of at least one bodily condition of the implantee.

As depicted in Fig. 1, the prosthesis 10 can have just one implantable sensor 11 for detecting the airborne sound 12 and the one or more body sounds 13.

As depicted in Fig. 4, in another embodiment, the prosthesis, which is here depicted generally as 40, can rely on two sensors 41. While two sensors 41 are depicted, it will be appreciated that more than two sensors could be used in the prosthesis 40, with the sensors 41 separated by a distance (depicted as 42) and so providing a multiple phased array. Each of the sensors can comprise a subcutaneous microphone, such as that depicted in Fig. 5. In one embodiment, the phased array can be used to subtract body induced vibrations from the detected airborne signal.

While each sensor 41 can be the same, one or more of the sensors can be different to the other sensors of the prosthesis 40.

As depicted in Fig. 3, in another embodiment, the prosthesis, which is here depicted generally as 50, can use a vibration sensor 51. The output of the vibration sensor 51 can be used by the processor 15 to partially or fully cancel the detected body noise from the total sound detected by the microphone 11. The output of the vibration sensor 51 can also be used to gain information about the bodily condition of the implantee or be used in conjunction with the output of the microphone 11 to enhance the pattern analysis conducted on the detected sound.

The prostheses (10, 40, 50) can each rely on an implantable component having a housing. The housing can be hermetically sealed and be formed of a biocompatible material, such as titanium. The housing can contain an on-board power supply.

In one arrangement, such an implantable housing can contain or support at least one of said at least one sensors (11, 41, 51). In another embodiment, one, some or all of the sensors (11, 41, 51) can be positioned outside the housing. In this embodiment, one or more sensors can be mounted on a first separate component. The first separate component can be connected to the housing by a cable so as to allow transmission of the output signals from the one or more sensors to the housing. It will be appreciated that a wireless link could also exist between the housing and the first separate component. In a further embodiment, one or more sensors can be supported on the housing and one or more sensors can be positioned on the first separate component. In yet another embodiment, the prosthesis can utilise one or more separate components, having one or more sensors, in addition to the first separate component. Said additional separate components can be connected to the housing by one or more cables and/or a wireless link.

The housing of the implantable component can contain the processor 15. In one embodiment, the housing of the implantable component can also contain one or more components of the stimulation module 18. It is also envisaged that the housing of the implantable component could contain one or more components of the health analysing module 19.

While many components of the prosthesis are implantable, the prosthesis (10, 40, 50) can comprise one or more external components. The external component can again comprise a housing, with the housing containing at least the health analysing module 19. In one embodiment, the external component could also house the processor 15. In yet a further embodiment, the health analysing module 19 could be provided in a first external housing and the processor 15 in a second external housing. In this case, the housing for the processor 15 could be a behind-the-ear (BTE) unit. In another embodiment, the housing for the processor 15 and/or health analysing module 19 can be worn on the body and/or clipped to clothing, for example a belt.

When an external component is available and mounted appropriately, the implantable components of the prosthesis (10, 40, 50) can work in conjunction with that external component. For example, if the external component has a microphone and/or processor, the output of the external processor can be used instead of the on-board microphone (11, 41) and/or processor (15). When the external component comprises or has an on-board and suitable power source, the implantable component can be configured to preferentially draw power from the external component to power its operation and/or re-charge an on-board power source.

As depicted in Fig. 5, the subcutaneous microphone (11, 41) can be constructed by coupling a transducer 61 to a casing 62 covered by a diaphragm 63. The transducer 61 can be a pressure sensitive transducer and be formed from, for example, an electret or piezoelectric material. The diaphragm 63 can be formed from titanium or titanium alloy. The diaphragm 63 can be mounted on a supporting member 64 having a coupling hole 65. The diaphragm 63, supporting member 64 and casing 62 together define an acoustic volume 66. The thickness and/or diameter of the diaphragm 63 and the volume of the cavity 66 can all be varied to optimise the signal level output by the microphone after implantation.

The output signals from the microphone 11 and representative of the airborne sound and the body noise that are delivered to the processor 15 are analysed by an adaptive algorithm. As depicted by Fig. 2, the algorithm can detect certain sound patterns typical of being body induced noise, for example sounds of swallowing, breathing, chewing and/or talking. This pattern analysis can then be used to filter at least part of the noise component before presenting the first processed signal 16 to the stimulation module 18.

The detected body noise data as recognized by the pattern analysis can then be delivered as the second processed signal 17 to the health analysing module 19.

The health analysing module 19 can have a processor 22 running an algorithm that further discriminates the detected body noise into signals representative of particular body noises. In the depicted embodiment, the processor 22 discriminates the detected body noise into the noise of breathing 23, the noise of chewing 24 and the noise of heart beat 25. Others can be envisaged. The health analysing module 19 further incorporates a comparator 26 that compares the representative information (23, 24, 25) with predetermined ranges or values. Based on this comparison, the module 19 can then output information using a visual display and/or auditory device 27 that is useful to the implantee or a third party, such as a caregiver, about the health of the implantee.

The health analysing module 19 can have an on-board power supply and/or a storage device for storing the incoming signals and/or the information that is output by the module that is representative of a bodily condition of the implantee. The representative information can be selected from the group comprising heart beat, breathing rate, chewing information, snoring detection, sleep apnoea detection, and a record of noise exposure of the implantee.

Still further, the information can be transferable from the health analysing module 19 to a computer running software instructions that allows storage, manipulation and display of the representative information.

In one embodiment, the health analysing module 19 can be incorporated into a personal digital assistant (PDA) device. Such a device can be worn on the body or clothing. For example, it can be clipped to a belt or worn around the wrist, in the same manner as a wrist watch. The PDA device can allow entry of user-specified information for use by the device. The user-specified information can include the implantee's age, weight and/or height. The PDA device can output instructions and/or information to the implantee and/or a third party, such as a caregiver, based on the representative information. For example, the PDA device may output information on the physical state of the recipient. It may also output instructions to increase or discontinue exercise if a detected breathing rate and/or heart rate is determined to be

inside or outside, respectively, a desired range. The PDA device may also trigger an audible or vibratory alarm to the implantee on detection of snoring or sleep apnoea. Analysis of chewing sounds can be used to determine when and/or what an implantee is eating and so provide a means of analysing an implantee's diet.

Where the processor 15 is part of an implantable component and the health analysing module 19 is part of an external component (such as a PDA device), the transcutaneous wireless link 21 can be provided between the processor 15 and the health analysing module 19. The wireless link can be provided by respective antennae on the implantable and external components. The respective antennae can comprise antenna coils. Such antenna coils can be provided by one or more coils of an electrically conductive materials, such as platinum. These coils can be embedded in an elastomeric support, such as a silicone. Suitable magnets can be provided at or near the centre of the respective coils to allow transcutaneous alignment of the coils.

In a still further embodiment, other transducers may be implantable within the implantee and/or positionable on the implantee and output signals to the health analysing module 19. Other such transducers can comprise an accelerometer which detects if an implantee has fallen or dropped down, a temperature sensor to monitor body temperature, and a blood pressure sensor. Other such sensors can be envisaged.

In addition to being used to provide information about the bodily condition of the implantee, the processor 15 can use the detection of the body sounds 13 to enhance discrimination of the airborne sound 12 from the total sound detected by the one or more sensors 11, 41.

The stimulation module 18 can be part of a cochlear implant system. In this embodiment, the first stimulating signal can be delivered to a cochlea of an implantee. The delivery of the first stimulating signal can be delivered by one or more electrode arrays. At least one electrode array can comprise an intracochlear electrode array. The electrode array can comprise a carrier member having a plurality of electrodes thereon. The electrodes can be supported in a longitudinal array. In one embodiment, the carrier member can comprise a biocompatible elastomeric member. The elastomeric member can be a silicone. Each electrode can be formed from a biocompatible electrically conductive material, such as platinum. The electrodes can comprise platinum rings. Each of the electrodes can have at least one wire, for example two, extending from each

electrode back towards the trailing end of the carrier member and then through a cable that extends back to the housing of the implantable component. One or more feedthroughs can be provided in the housing of implantable component to allow signal transmission between the housing and the carrier member.

The carrier can have 22 electrodes. In another embodiment, the carrier can have 30 electrodes. Other numbers of electrodes can be utilised, including less than 20 electrodes, between 20 and 30 electrodes, and more 30 electrodes.

In another embodiment, the implantable component can have a second electrode assembly extending from the housing. The second electrode assembly may have one or more electrodes. This electrode assembly can be mounted within or external the cochlea of the implantee.

In another embodiment, the stimulation module 18 can comprise an actuator arrangement configured to provide direct stimulation to one or more hearing structures of the implantee representative of the original detected sound. The actuator can comprise at least one extracochlear actuator and be configured to provide excitation to fluid-filled inner-ear spaces of the implantee. In another embodiment, the actuator can comprise at least one intracochlear array of actuators. The actuator can comprise one or more mechanical actuation elements. The first stimulation module can comprise a direct acoustic cochlear actuator (DACS) unit.

In a still further embodiment, the stimulation module 18 can comprise a bone anchored hearing aid (or BAHA), including an implantable BAHA. The hearing aid can comprise a bone transmitting vibrator that is connected directly to the bone using a skin-penetrating and bone-anchored implant of a suitable biocompatible material, for example titanium.

It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in the specific embodiments without departing from the scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive.

CLAIMS:

1. A prosthesis comprising:

at least one sensor implantable in an implantee for detecting airborne sound and at least one or more or other body sounds and converting said airborne sounds and said body sounds into one or more output signals;

a processor for receiving and processing said one or more output signals into at least one first processed signal representative of airborne sound and at least one second processed signal representative of said body sounds;

at least one stimulation module that receives and processes the first processed signal into a first stimulating signal representative of the detected airborne sound; and

a health analysing module that receives and processes the at least one second processed signal and outputs information representative of at least one bodily condition of the implantee.

2. The prosthesis of claim 1 wherein the prosthesis has just one implantable sensor for detecting airborne sound and the at least one or more or other body sounds.

3. The prosthesis of claim 1 wherein the prosthesis uses multiple implantable sensors.

4. The prosthesis of claim 2 wherein the sensor is a microphone.

5. The prosthesis of claim 3 wherein at least one of the sensors is a microphone.

6. The prosthesis of claim 3 wherein all of the sensors are a microphone.

7. The prosthesis of claim 6 wherein each microphone is the same.

8. The prosthesis of claim 3 wherein one of the sensors is a vibration sensor.

9. The prosthesis of claim 3 wherein multiple phased array sensors are used.

10. The prosthesis of any one of the preceding claims comprising an implantable component having a housing.

11. The prosthesis of claim 10 wherein the housing is hermetically sealed and formed of a biocompatible material, such as titanium.

12. The prosthesis of claim 10 or claim 11 wherein the housing contains or supports at least one of said at least one sensors.

13. The prosthesis of claim 10 or claim 11 wherein one, some or all of the sensors are positioned outside the housing.

14. The prosthesis of claim 13 wherein one or more sensors are mounted on a first separate component.

15. The prosthesis of claim 14 wherein the first separate component is connected to the housing by a cable so as to allow transmission of the output signals from the one or more sensors to the housing.

16. The prosthesis of claim 14 wherein a wireless transmission link exists between the housing and the first separate component.

17. The prosthesis of claim 14 wherein one or more sensors are supported on the housing and one or more sensors are positioned on the first separate component.

18. The prosthesis of claim 14 wherein the prosthesis comprises one or more separate components, having one or more sensors, in addition to said first separate component.

19. The prosthesis of claim 18 wherein said additional separate components are connected to the housing by one or more cables and/or a wireless link.

20. The prosthesis of any one of claims 10 to 19 wherein the housing contains the processor.

21. The prosthesis of claim 20 wherein the housing also contains the stimulation module and/or the health analysing module.

22. The prosthesis of any one of claims 1 to 20 wherein the prosthesis comprises one or more external components, the external component comprising a housing.

23. The prosthesis of claim 22 wherein the external component houses the health analysing module.

24. The prosthesis of claim 23 wherein the external component also houses the processor

25. The prosthesis of claim 23 wherein a second external housing houses the processor.

26. The prosthesis of claim 25 wherein the housing for the processor is a behind-the-ear (BTE) unit.

27. The prosthesis of any one of the preceding claims wherein the health analysing module has a storage device for storing said at least one second processed signal and/or said information representative of a bodily condition of the implantee.

28. The prosthesis of any one of the preceding claims wherein the health analysing module has a display device that allows the module to output said representative information.

29. The prosthesis of any one of the preceding claims wherein the representative information is selected from the group comprising heart beat, breathing rate, chewing information, snoring detection, sleep apnoea detection, and a record of noise exposure of the implantee.

30. The prosthesis of claim 29 wherein the health analysing module further incorporates a comparator that compares the representative information with predetermined ranges or values.

31. The prosthesis of claim 29 wherein said information is transferable from the health analysing module to a computer running software instructions that allows storage, manipulation and display of the representative information.

32. The prosthesis of any one of the preceding claims wherein the health analysing module is incorporated into a personal digital assistant (PDA) device.

33. The prosthesis of claim 32 wherein the PDA device allows entry of user-specified information for use by the PDA device.

34. The prosthesis of claim 33 wherein the user-specified information is selected from the group comprising the implantee's age, weight and/or height.

35. The prosthesis of any one of claims 32 to 34 wherein the PDA device outputs instructions and/or information to the implantee and/or a third party, such as a caregiver, based on the representative information.

36. The prosthesis of claim 1 wherein the processor is part of an implantable component and the health analysing module is part of an external component, a transcutaneous wireless link being provided between the processor and the health analysing module.

37. The prosthesis of claim 36 wherein a wireless link is provided by respective antennae on the implantable and external components, the respective antennae comprising antenna coils.

38. The prosthesis of any one of the preceding claims wherein other transducers are implantable within the implantee and/or positionable on the implantee and which output signals to the health analysing module.

39. The prosthesis of claim 38 wherein said other such transducers are selected from a group comprising an accelerometer which detects if an implantee has fallen or dropped down, a temperature sensor to monitor body temperature, and a blood pressure sensor.

40. The prosthesis of any one of the preceding claims wherein the output signals representative of the airborne sound and the body noise delivered to the processor are analysed by an adaptive algorithm.

41. The prosthesis of claim 40 wherein the algorithm detects certain sound patterns typical of being body induced noise and uses these to filter at least part of the noise component before presenting the first processed signal to the stimulation module, the detected body noise data as recognized by the pattern analysis being delivered as the second processed signal to the health analysing module.

42. The prosthesis of claim 41 wherein the body induced sounds are selected from the group comprising sounds of swallowing, breathing, chewing and/or talking.

43. The prosthesis of any one of the preceding claims wherein the stimulation module is part of a cochlear implant system.

44. The prosthesis of claim 43 wherein the delivery of the first stimulating signal is delivered by one or more electrode arrays.

45. The prosthesis of any one of claims 1 to 42 wherein the stimulation module comprises a direct acoustic cochlear actuator (DACS) unit, or a bone anchored hearing aid (BAHA), including an implantable BAHA.

46. A prosthesis comprising:

at least one sensor implantable in an implantee for detecting airborne sound and at least one or more or other body sounds and converting said airborne sounds and said body sounds into one or more output signals;

a vibration sensor for detecting body-induced vibration and outputting signals representative of detected vibrations;

a processor for receiving and processing said one or more output signals from said at least one sensor and said signals representative of detected vibrations into at least one first processed signal representative of airborne sound and at least one second processed signal representative of said body sounds;

at least one stimulation module that receives and processes the first processed signal into a first stimulating signal representative of the detected airborne sound; and

a health analysing module that receives and processes the at least one second processed signal and outputs information representative of at least one bodily condition of the implantee.

47. The steps, features, integers, compositions and/or compounds disclosed herein or indicated in the specification of this application individually or collectively, and any and all combinations of two or more of said steps or features.

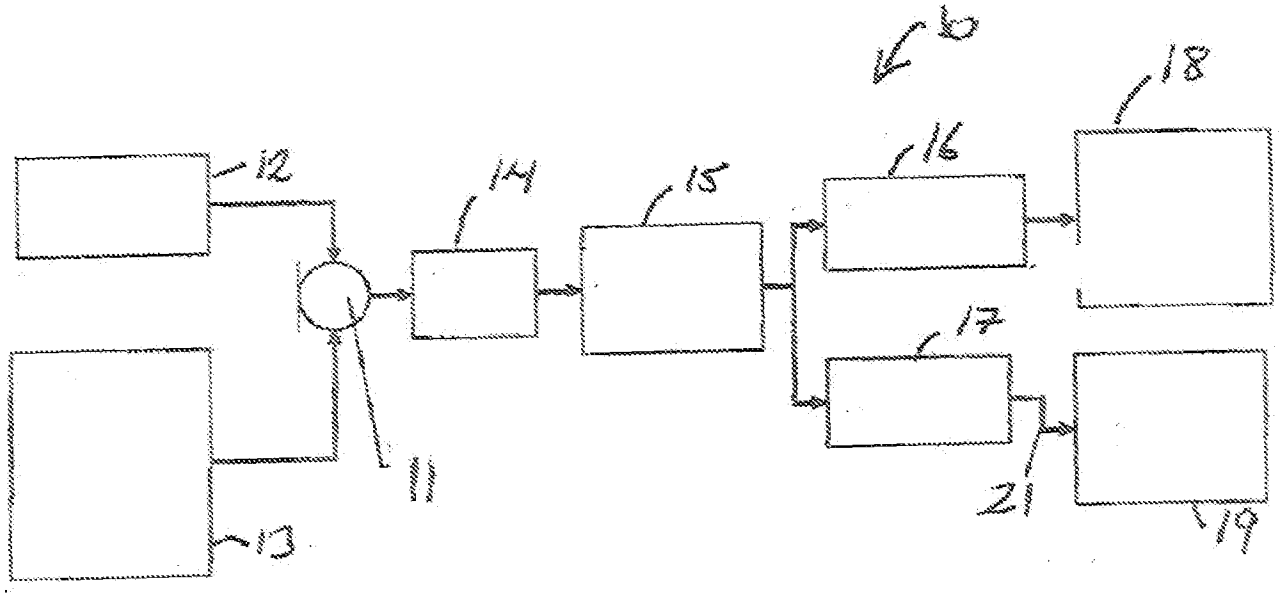

FIG. 1

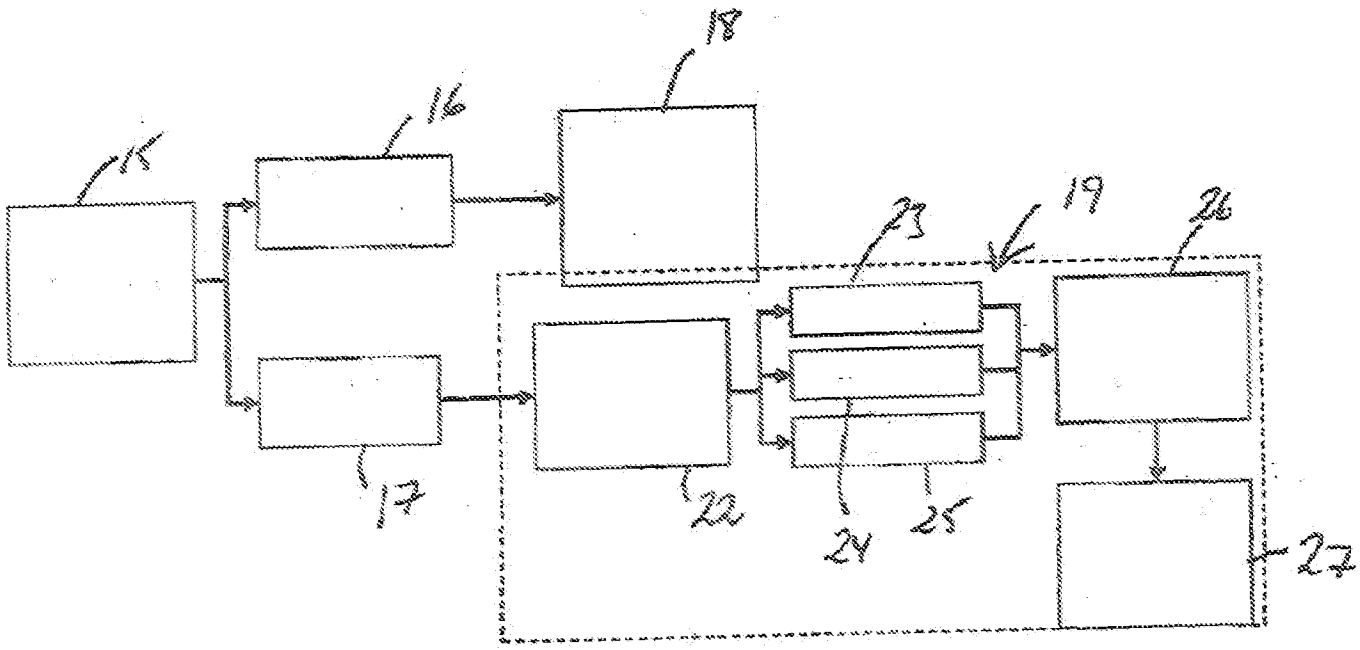

FIG. 2

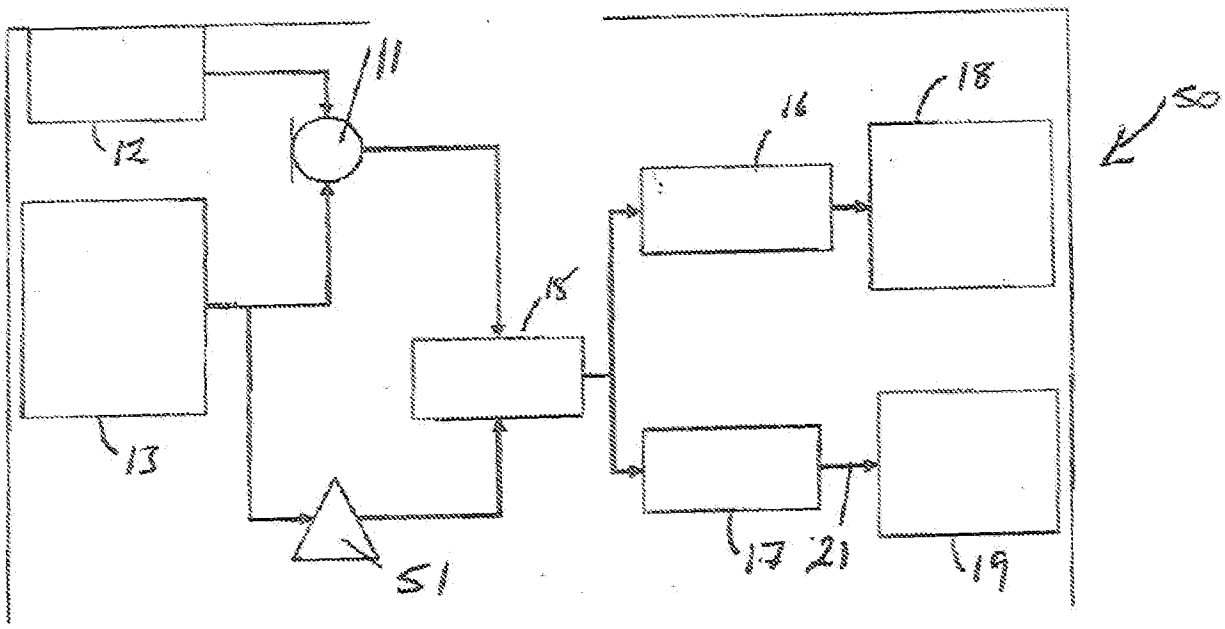

FIG. 3

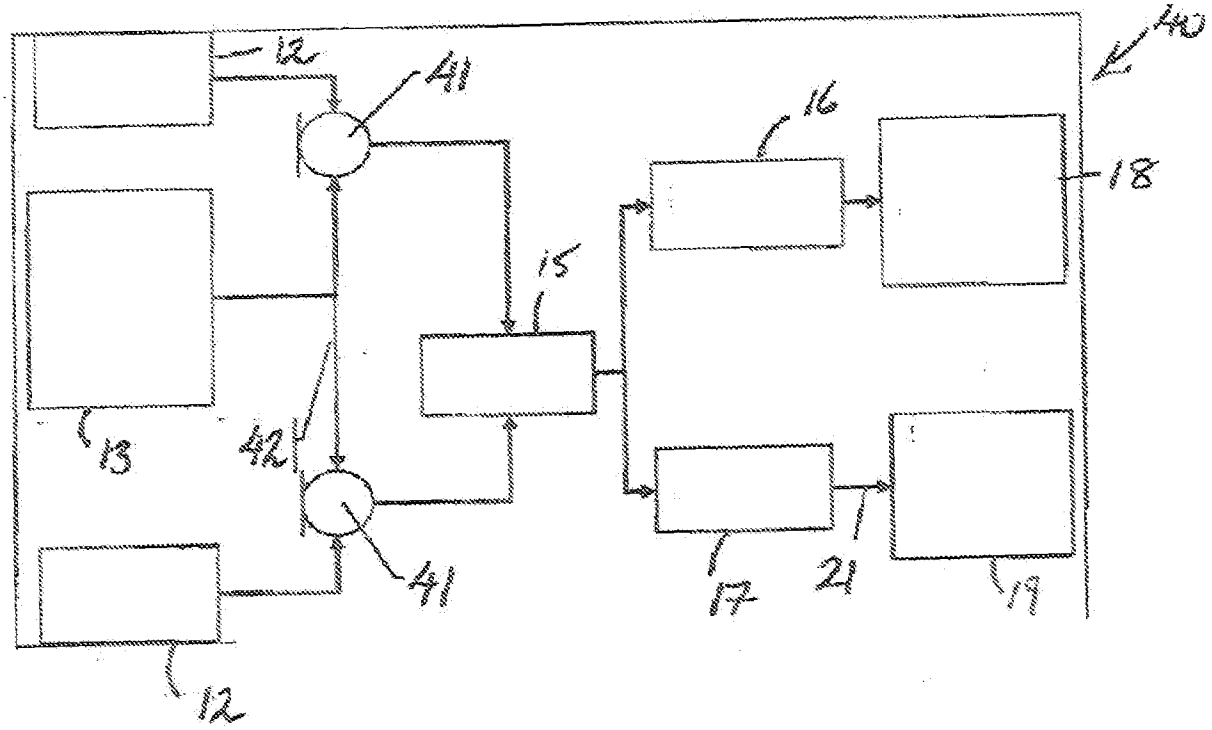

FIG. 4

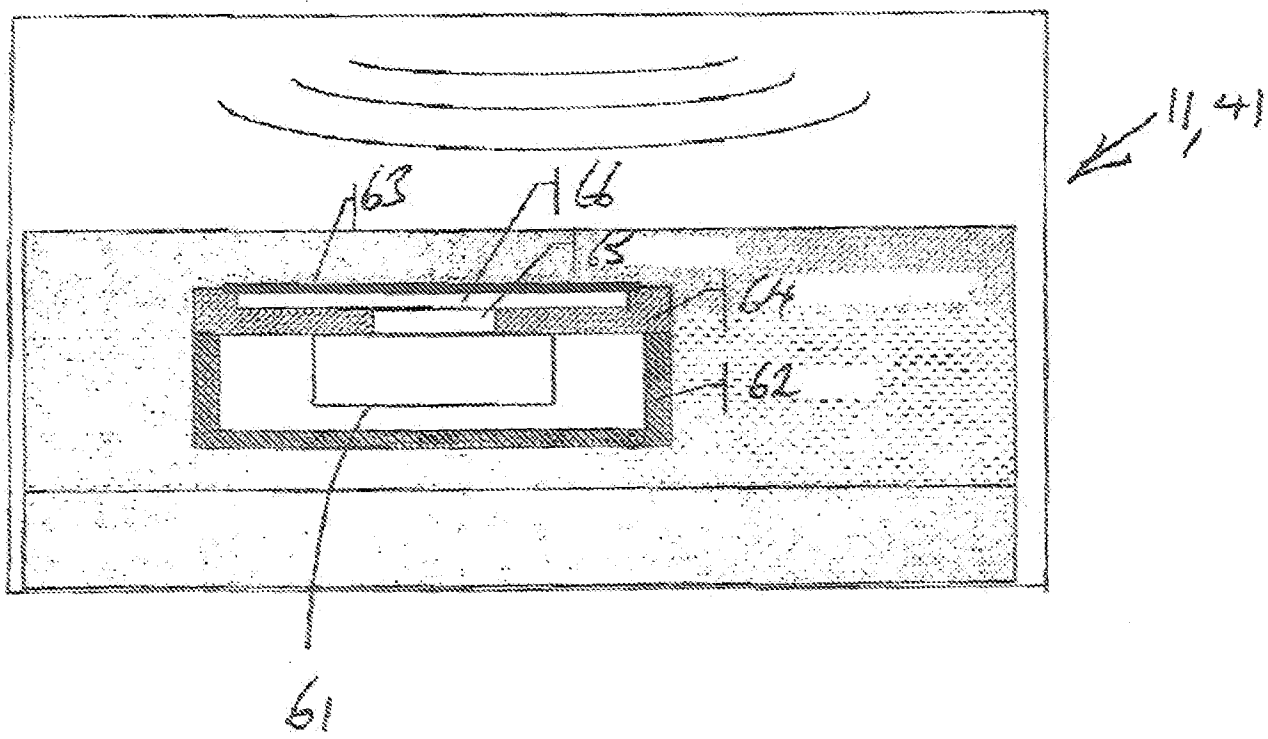

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2009/001044

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

A61F 11/00 (2006.01) ***A61B 5/00*** (2006.01) ***H04R 25/00*** (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPODOC, WPI: IPC, ECLA A61N 1/-, H04R 25/-, A61F 11/-, A61B 5/-, A61B 18/- & Keywords (Cochlear, ear, auditory, prosthesis, sensor, microphone, vibrate, airborne, aerial, swallow, talk, snoring) and like terms
PubMed: Keywords (auditory, sensor, noise suppression, microphone) and like terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2008 – 136556 A (IBOX: KK et al.) 19 June 2008, (machine translation, retrieved 11 September 2009 from internet) <URL: http://www4.ipdl.inpit.go.jp/Tokujitu/PAJdetail.ipdl?N0000=60&N0120=01&N2001=2&N3001=2008-136556 Whole Document	1 – 41 and 42 – 45
Y	WO 2007/098577 A1 (SARINGER RESEARCH INC.) 07 September 2007 Page 3, lines 1 – 14,	42 and 46 1 and 42
Y	US 2006/0206014 A1 (ARIAV) 14 September 2006 Para [0007] – [0011]	1 and 46

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 September 2009	21 SEP 2009
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. +61 2 6283 7999	Authorized officer **VIJAY SINGH** AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No : +61 2 6283 2665

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	ZURCHER et al., 'Development of Middle Ear Acoustic Sensor for Fully Implantable Cochlear Prosthesis', The 3rd International Workshop on Network Sensing Systems (INSS' 06, May 2006, pages 49 – 54 Whole Document	
A	WO 2008/032791 A1 (OSAKA BIOSCIENCE INSTITUTE) 20 March 2008 Whole document	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2009/001044

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claim No.: **47**
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

Claim 47 does not comply with Rule 6.3(a) because the definition of the matter for which protection is sought is not in terms of the technical features of the invention.

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU2009/001044

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member	
WO	2007098577	US	2007239225
US	2006206014	NONE	
WO	2008032791	JP	2008067911

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX