(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
23 November 2006 (23.11.2006)

PCT

(10) International Publication Number
WO 2006/122836 A2

(51) International Patent Classification:
H04R 25/00 (2006.01)

(21) International Application Number:
PCT/EP2006/008370

(22) International Filing Date: 25 August 2006 (25.08.2006)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant *(for all designated States except US)*: **PHONAK AG** [CH/CH]; Laubisrütistrasse 28, CH-8712 Stäfa (CH).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **MARQUIS, François** [CH/CH]; Champ de la Meille A, CH-1608 Oron-le-Chatel (CH). **HÄNGGI, Stefan** [CH/CH]; Ryf 18b, CH-3280 Murten (CH). **BÄCHLER, Herbert** [CH/CH]; Gruebstrasse 11, CH-8706 Meilen (CH).

(74) Agents: **SCHORER, Reinhard** et al.; Schwan - Schwan - Schorer, Bauerstrasse 22, 80796 München (DE).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

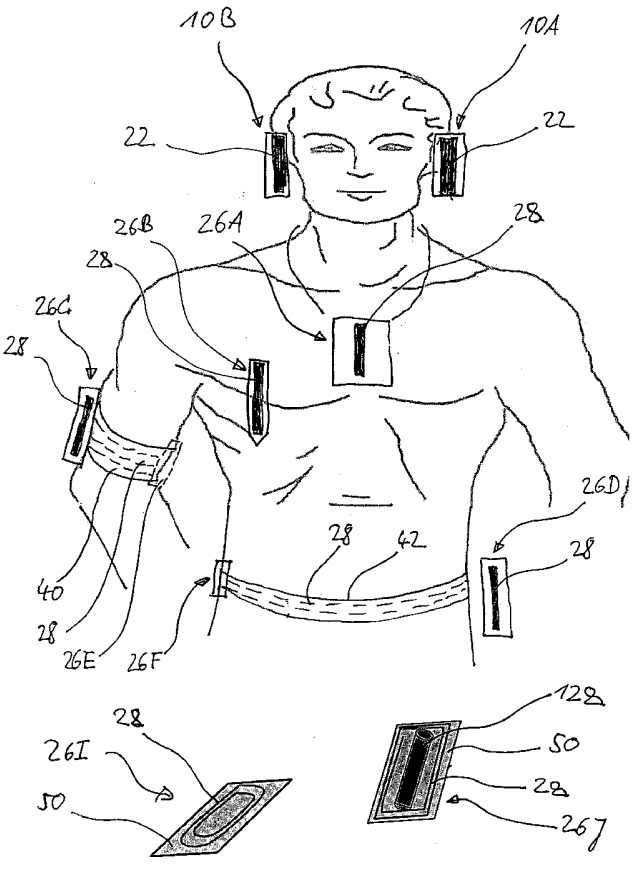
(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *upon request of the applicant, before the expiration of the time limit referred to in Article 21(2)(a)*

[Continued on next page]

(54) **Title:** SYSTEM FOR BINAURAL HEARING ASSISTANCE



(57) **Abstract:** The invention relates to a system for providing binaural hearing assistance to a user, comprising a left ear unit (10, 10A) to be worn at or in the user's left ear, a right ear unit (10, 10B) to be worn at or in the user's right ear, each of the left ear unit and the right ear unit comprising means (18) for stimulating the user's hearing and an inductive antenna (22) for enabling bidirectional communication between the left ear unit and the right ear unit via an inductive link, which antenna has an axial symmetry axis which is oriented substantially vertically and which is substantially parallel to the antenna of the other one of the left ear unit and right ear unit, the system further comprising at least one device (26, 26A, 26B, 26C, 26D, 26E, 26F) to be worn by the user which comprises an inductive antenna (28) for enabling communication between the device and at least one of the left ear unit and the right ear unit via an inductive link, which antenna has an axial symmetry axis which is oriented substantially vertically and which is substantially parallel to the antennas of the left ear unit and right ear unit.

WO 2006/122836 A2

— *without international search report and to be republished upon receipt of that report*
— *without classification; title and abstract not checked by the International Searching Authority*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

System for binaural hearing assistance

The present invention relates to a system for providing binaural hearing assistance to a user comprising a left ear unit to be worn at or in the user's left ear and a right ear unit to be worn at or in the user's right ear, wherein each of the left ear unit and the right ear unit comprises means for stimulating the user's hearing and an inductive antenna for enabling bidirectional communication between the units via an inductive link.

DE 10 2004 016 573 B1 relates to such a binaural system wherein two in-the-ear (ITE) hearing aids are provided with antenna coils in such a manner that the symmetry axes are oriented substantially horizontally and coaxially with respect to each other when the hearing aids are worn in the user's ear canals in order to optimize the inductive coupling between the two antennas. This is particularly important in view of the relatively restricted power budget of hearing aids. A similar binaural system is described in DE 10 2004 019 353 B3.

It is also known to provide hearing aids with a coil antenna which is oriented substantially vertical in order to pick up the inductive signals produced by the coil of the receiver of a telephone headset. Such inductive coils in hearing aids are known as "T-coils". Examples for hearing aids equipped with T-coils are found in US 2006/0029248 A1, US 5,557,673 and DE 10 2004 017 832 B3.

A vertical antenna integrated into the housing of a behind the ear (BTE) hearing aid for bidirectional communication with a remote programming device is described in DE 101 15 896 A1, wherein the hearing device may be part of a binaural system. The receiver/transmitter unit connected to the antenna is removed from the hearing aid during times when no communication with the remote programming unit is necessary.

DE 102 36 940 B3 relates to a hearing aid comprising an antenna coil wound around the housing of the hearing aid microphone or the hearing aid loudspeaker for communication with a remote device. The hearing aid may be part of a binaural system.

US 6,594,370 B1 relates to a wireless communication system comprising two ear pieces which communicate wirelessly with a remote processor unit worn at the neck. A necklace is provided into which patch antenna arrays are integrated for establishing a wireless link to the ear pieces.

It is also known to design a remote control for hearing aids as a wrist watch-like device, wherein the antenna for providing a wireless link to the hearing aid is integrated within the band of the wrist-watch. An examples for such a remote control is given in DE 36 42 828 A1.

It is an object of the invention to provide for a binaural hearing assistance system wherein bidirectional communication between the left ear unit and the right ear unit and in addition communication with a body worn device is enabled at a relatively small power budget.

According to the invention this object is achieved by a system as defined in claim 1 and in claim 16, respectively.

The solution according to claim 1 is beneficial in that, by arranging the antennas of the right ear unit and the left ear unit in a substantially vertical, parallel orientation and by arranging the antenna of the body-worn device in a substantially vertical orientation parallel to the antennas of the of the right ear unit and the left ear unit, the inductive coupling between the body-worn device and the right ear unit and/or left ear unit is optimized while still an acceptable inductive coupling between the right ear unit and the left ear unit is achieved. Although the efficiency of the inductive coupling between the right ear unit and the left ear unit is reduced compared to the case of a horizontal axially aligned arrangement of the antennas, the overall performance of the system can be improved by such vertical antenna arrangement. One reason is that the inductive coupling to the body-worn device can be improved due to the fact that usually a vertical antenna arrangement can be realized more easily in the body-worn device than a horizontal antenna arrangement. Another reason is that for a vertical antenna arrangement the left ear unit and the right ear unit usually allows for more antenna space, so that the reduced inductive coupling can be compensated by an extended length of the antennas. Such extended antennas can be realized particularly easy for BTE hearing aids.

The solution according to claim 16 is beneficial in that, by orienting the antennas of the left ear unit and the right ear unit substantially horizontally and substantially aligned to each other and by orienting the antenna of the body-worn device substantially horizontally and substantially parallel to the antennas of the left ear unit and the right ear unit, an optimized inductive coupling both between the left ear unit and the right ear unit and the body-worn device is achieved.

Preferred embodiments of the invention are defined in the dependent claims.

Examples of the invention will be illustrated by reference to the attached drawings, wherein:

Fig. 1 is a schematic view of a first embodiment of a binaural system according to the invention comprising a left ear unit and the right ear unit and several examples of body-worn devices;

Fig. 2 is a view like Fig. 1 of a second embodiment;

Fig. 3 is a block diagram of an example of a left ear/right ear unit to be used in the embodiment of Fig. 1 or 2; and

Fig. 4 is a block diagram of an example of remote device to be used in the embodiment of Fig. 1 or 2.

Fig. 3 shows a hearing aid 10 which may be used as a left ear unit 10A and a right ear unit 10B, respectively, of the binaural hearing assistance system of Fig. 1 or Fig. 2. The hearing aid 10 comprises a microphone 12 for picking up ambient sound, a central audio signal processing unit 14, a power amplifier 16 and a loudspeaker 18.

The hearing aid 10 further comprises a receiver/transmitter unit 20 and an inductive antenna 22 for establishing a wireless inductive link for bidirectional communication with the other one of the hearing aids 10 in order to realize a binaural system. The hearing aids 10A, 10B may exchange audio signals captured by the microphone 12 of the other one of the hearing aids 10A, 10B. Alternatively or in addition, the hearing aids 10A, 10B may exchange control data generated by the audio signal processing unit 14 according to the audio signals from the microphone 12 or control data received by the central audio signal processing 14 from a control panel 24 provided at the hearing aid or from a remote control of the hearing aid.

The audio signal processing unit 14 usually will be able to perform auditory scene analysis in order to adapt the audio signal processing to the presently detected auditory scene, for example, in order to adjust the amplification and/or the degree of acoustic beam forming to the auditory scene (usually the microphone 12 will be a microphone arrangement consisting of at least two microphones which are spaced apart for acoustic beam forming). To this end, the audio signal processing unit 14 usually will select one audio program from a plurality of different audio programs depending on the presently captured audio signals.

In order to determine the present auditory scene, audio signal processing unit 14 in addition to the audio signals from the microphone 12 also may take into account audio signals received by the receiver/transmitter unit 20 from the other one of the hearing aids 10A, 10B, i.e. audio signals captured by the microphone 12 of the other one of the hearing aids 10A, 10B, in order to render the result of the auditory scene analysis more reliable. Moreover, information regarding the presently selected audio program may be exchanged between the hearing aids 10A, 10B, and such information regarding the presently selected audio program of the other one of the hearing aids 10A, 10B may be taken into account when selecting the audio program.

It is to be understood that the hearing aid 10 will include elements in addition to that shown in Fig. 3, such as a battery, a data/program memory, etc.

An example of a binaural hearing system is found in EP 1 651 005 A2.

The antenna 22 preferably is. a coil which may comprise an elongated core such as a ferrite core or which may a simple air coil. The antenna 22 of at least one of the hearing aids 10A, 10B, in addition to establishing a bidirectional inductive link to the other one of the hearing aids 10A, 10B, also serves to establish an inductive link to a remote device 26 which is to be worn at the user's body.

In the embodiment of Fig. 1 the antenna 22 of the hearing aid 10A, 10b is oriented substantially vertical in such a manner that it is substantially parallel to the antenna 22 of the other one of the hearing aids 10A, 10B. In this case, the hearing aids 10A, 10B preferable are of the BTE type, with the antennas 22 substantially extending in the longitudinal direction of the hearing aid housing.

The communication between the hearing aid 10 and the remote device 26 via the inductive link may be unidirectional from the remote device 26 to the hearing aid 10, or it may be bidirectional if necessary. The remote device 26 may be a remote control for the hearing aid 10 in order to transmit manual control commands to the audio signal processing unit 14, and/or it may serve as an audio signal source for supplying audio signals to be reproduced by the loudspeaker 18 to the hearing aid 10. In the latter case, the remote device 26 may be a music player, such as an MP3 player, and/or a radio broadcast receiver. Alternatively, the remote device 26 may comprise a microphone for capturing audio signals from ambient sound

and/or it may be electrically connected to an audio signal source to be worn at the user's body, such as a radio frequency (RF) receiver unit or a mobile phone.

Fig. 4 is a block diagram of an example of such a remote device 26 which comprises an inductive antenna 28, which preferably comprises a coil which preferably has an elongated core such as a ferrite core, a transmitter unit 30, a central processing unit 32, an audio signal source 34 (for example, a digital audio data storage medium), a control panel 36 and an audio signal input 38. The control panel 36 serves for manual input of control commands for the hearing aid 10. The audio signal input 38 serves to connect the remote device 26 to an audio signal source, such as a radio frequency receiver or a mobile phone, via a wired connection or a wireless interface. The remote device 26 also may comprise a microphone 52 for capturing ambient sound.

Fig. 1 shows examples of a binaural hearing assistance system comprising two hearing aids 10A and 10B wherein the antenna 22 is oriented substantially vertically and some examples of remote devices 26A to 26F which are designed in such a manner that the antenna 28 is oriented substantially vertically – and thus essentially parallel to the antennas 22 of the hearing aids 10A, 10B - when the hearing aids 10A, 10B and the remote devices 26 are worn according to specification.

As a first example, a remote device 26A is shown which is to be worn around the user's neck in such a manner that due to the action of gravity the antenna 28 of the device 26A is oriented essentially vertical.

A device 26B has a pen-shaped housing which is to be worn in, for example, a shirt pocket, with the antenna 28 extending along the longitudinal axis of the housing.

A device 26C is to be fixed at the user's upper arm by a band 40 extending around the user's upper arm, with the antenna 28 extending perpendicular to the band 40.

A device 26D is designed to be worn at a belt 42 worn by the user, with the antenna 28 extending in the direction perpendicular to the belt 42.

The above-described devices 26A to 26D have an antenna 28 which may be designed as a coil comprising an elongated core such as a ferrite core. However, in some cases the antenna 28 may be designed as air coil. For example, an inductive antenna may be integrated within the band 40 in such a manner that an air coil is wound around the user's upper arm when the band

40 is worn by the user. This embodiment is shown in dashed lines in Fig. 1, with the remote device being designated by 26E. According to another example, the air coil may be integrated within the belt 42 in such a manner that the air coil is wound around the user's hip when the belt 42 is worn by the user. This device is designated by 26F.

According to Fig. 1 the system in addition may comprise a remote desktop device 26I comprising a printed circuit board 50 into which an inductive antenna 28 is embedded which is formed by conductor turns within the plane of the printed circuit board 50, wherein desktop device 26I is designed in such a manner that the printed circuit board 50 is oriented parallel to the plane in which the desktop device 26I is placed.

The system also may comprise a handheld device 26J comprising a printed circuit board 50 into which a first inductive antenna 28 is embedded which is formed by conductor turns within the plane of the printed circuit board 50 and a second inductive antenna 128, preferably comprising a coil having an elongated core, having an axial symmetry axis which is oriented along or parallel to a longitudinal axis of the handheld device 26J. Preferably, the axial symmetry of the second antenna 128 is oriented in or parallel to the plane of the printed circuit board 50.

In Fig. 2 an alternative embodiment of a binaural hearing assistance system is shown wherein the antennas 22 of the hearing aids 10A, 10B are oriented essentially horizontally and aligned with respect to each other. In this case, a remote device 26G may be used which is to be worn at the user's chest, where it may be fixed, for example, by an appropriate band (not shown), wherein the antenna 28 is oriented essentially horizontally and parallel to the antennas 22 of the hearing aids 10A, 10B. According to another example, the remote device 26H may have a wrist watch-like design, with the band 44 of the wrist watch serving as an air coil, i.e. the coil will be integrated within the band 44 in such a manner that it is bound around the user's wrist.

In the case of Fig. 2 the hearings aids 10A, 10B preferably are of the ITE type, with the antennas 22 extending in the longitudinal direction of the hearing aid housing.

Claims

1. A system for providing binaural hearing assistance to a user, comprising a left ear unit (10, 10A) to be worn at or in the user's left ear, a right ear unit (10, 10B) to be worn at or in the user's right ear, each of the left ear unit and the right ear unit comprising means (18) for stimulating the user's hearing and an inductive antenna (22) for enabling bidirectional communication between the left ear unit and the right ear unit via an inductive link, which antenna has an axial symmetry axis which is oriented substantially vertically and which is substantially parallel to the antenna of the other one of the left ear unit and right ear unit, the system further comprising at least one device (26, 26A, 26B, 26C, 26D, 26E, 26F) to be worn by the user which comprises an inductive antenna (28) for enabling communication between the device and at least one of the left ear unit and the right ear unit via an inductive link, which antenna has an axial symmetry axis which is oriented substantially vertically and which is substantially parallel to the antennas of the left ear unit and right ear unit.

2. The system of claim 1, wherein each of the left ear unit (10, 10A) and the right ear unit (10, 10b) is a hearing aid (10) comprising a microphone (12) for capturing audio signals from ambient sound which are processed by an audio signal processing unit (14) and are supplied to the stimulating means (18).

3. The system of claim 2, wherein each of the left ear unit (10, 10A) and the right ear unit (10, 10B) is a BTE hearing aid (10).

4. The system of one of the preceding claims, wherein the device (26, 26A) is to be worn around the user's neck.

5. The system of one of claims 1 to 3, wherein the device (26, 26B) has a pen-shaped housing, with the antenna (28) extending along the axis of the housing, and wherein the pen-shaped housing is adapted to be fixed to the user's clothing.

6. The system of one of claims 1 to 3, wherein the device (26, 26D) is a belt-worn device, with the antenna (28) extending perpendicular to the belt (42).

7. The system of one of claims 1 to 3, wherein the device (26, 26C) is adapted to be fixed at the user's upper arm by a band (40), with the antenna (28) extending perpendicular to the band.

8. The system of one of the preceding claims, wherein the antenna (28) of the device (26, 26A, 26B, 26C, 26D) comprises a coil.

9. The system of claim 8, wherein the coil of the antenna (28) of the device (26, 26A, 26B, 26C, 26D) surrounds an elongated core.

10. The system of one of claims 1 to 3, wherein the device (26, 26F) to be worn by the user is attached to a belt (42), wherein the antenna (28) is integrated within the belt in such a manner that it is wound as an air coil around the user's hip.

11. The system of one of claims 1 to 3, wherein the device (26, 26E) to be worn by the user is attached to a band (40) to be worn around the user's upper arm, wherein the antenna (28) is integrated within the band in such a manner that it is wound as an air coil around the user's upper arm.

12. The system of one of the preceding claims, wherein the system comprises a desktop device (26I) comprising a printed circuit board (50) into which an inductive antenna (28) is embedded which is formed by conductor turns within the plane of the printed circuit board, wherein the printed circuit board is oriented parallel to a plane on which the desktop device is to be placed.

13. The system of one of the preceding claims, wherein the system comprises a handheld device (26J) comprising a printed circuit board (50) into which a first inductive antenna (28) is embedded which is formed by conductor turns within the plane of the printed circuit board and a second inductive antenna (128) having an axial symmetry axis which is oriented along or parallel to a longitudinal axis of the handheld device.

14. The system of claim 13, wherein the axial symmetry axis of the second antenna (128) is oriented in or parallel to the plane of the printed circuit board (50) .

15. The system of one of claims 13 and 14, wherein the second antenna (128) comprises a coil.

16. A system for providing binaural hearing assistance to a user, comprising a left ear unit (10, 10A) to be worn at or in the user's left ear, a right ear unit (10, 10B) to be worn at or in the user's right ear, each of the left ear unit and the right ear unit comprising means (18) for stimulating the user's hearing and an inductive antenna (22) for enabling bidirectional communication between the left ear unit and the right ear unit via an

inductive link, which antenna has an axial symmetry axis which is oriented substantially horizontally and which is substantially aligned to the antenna of the other one of the left ear unit and right ear unit, the system further comprising at least one device (26, 26G, 26H) to be worn by the user which comprises an inductive antenna (28) for enabling communication between the device and at least one of the left ear unit and the right ear unit via an inductive link, which antenna has an axial symmetry axis which is oriented substantially horizontally and which is substantially parallel to the antennas of the left ear unit and right ear unit.

17. The system of claim 16, wherein each of the left ear unit (10, 10A) and the right ear unit (10, 10B) is a hearing aid (10) comprising a microphone (12) for capturing audio signals from ambient sound which are processed by an audio signal processing unit (14) and are supplied to the stimulating means (18).

18. The system of one of claims 16 and 17, wherein the device to be worn by the user is a wrist watch-like device (26, 26H), wherein the antenna (28) is integrated within the wrist band (44) in such a manner that it is wound as an air coil around the user's wrist.

19. The system of one of claims 16 and 17, wherein the device (26, 26G) to be worn by the user is to be worn at the user's chest and wherein the antenna (28) of the device comprises a coil.

20. The system of one of the preceding claims, wherein the antenna (22) of each of the left ear unit (10, 10A) and the right ear unit (10, 10B) comprises a coil.

21. The system of claim 20, wherein the coil of the antenna (22) of each of the left ear unit (10, 10A) and the right ear unit (10, 10B) surrounds an elongated core.

22. The system of one of the preceding claims, wherein the means for stimulating the user's hearing is a loudspeaker (18) oriented towards the user's ear drum.

23. The system of one of the preceding claims, wherein the communication between the device (26, 26A, 26B, 26C, 26D, 26E, 26F, 26G, 26H) and the left ear unit (10, 10A) and/or right ear unit (10, 10B) is bidirectional.

24. The system of one of the preceding claims, wherein the device (26, 26A, 26B, 26C, 26D, 26E, 26F, 26G, 26H) to be worn by the user serves as a remote control for the left ear unit (10, 10A) and the right ear unit (10, 10B).

25. The system of one of claims 1 to 23, wherein the device (26, 26A, 26B, 26C, 26D, 26E, 26F, 26G, 26H) to be worn by the user serves as a remote audio signal source for the left ear unit (10, 10A) and the right ear unit (10, 10B).

26. The system of claim 25, wherein the device (26, 26A, 26B, 26C, 26D, 26E, 26F, 26G, 26H) is a music player and/or a radio.

27. The system of one of claims 1 to 23, wherein the device (26, 26A, 26B, 26C, 26D, 26E, 26F, 26G, 26H) comprises a microphone (52) for capturing audio signals from ambient sound which are transmitted to the right ear unit (10, 10A) and/or the left ear unit (10, 10B).

28. The system of one of claims 1 to 23, wherein the device (26, 26A, 26B, 26C, 26D, 26E, 26F, 26G, 26H) is adapted to be electrically connected to an audio signal source to be worn at the user's body.

29. The system of claim 28, wherein the audio signal source is a radio frequency receiver unit or a mobile phone.

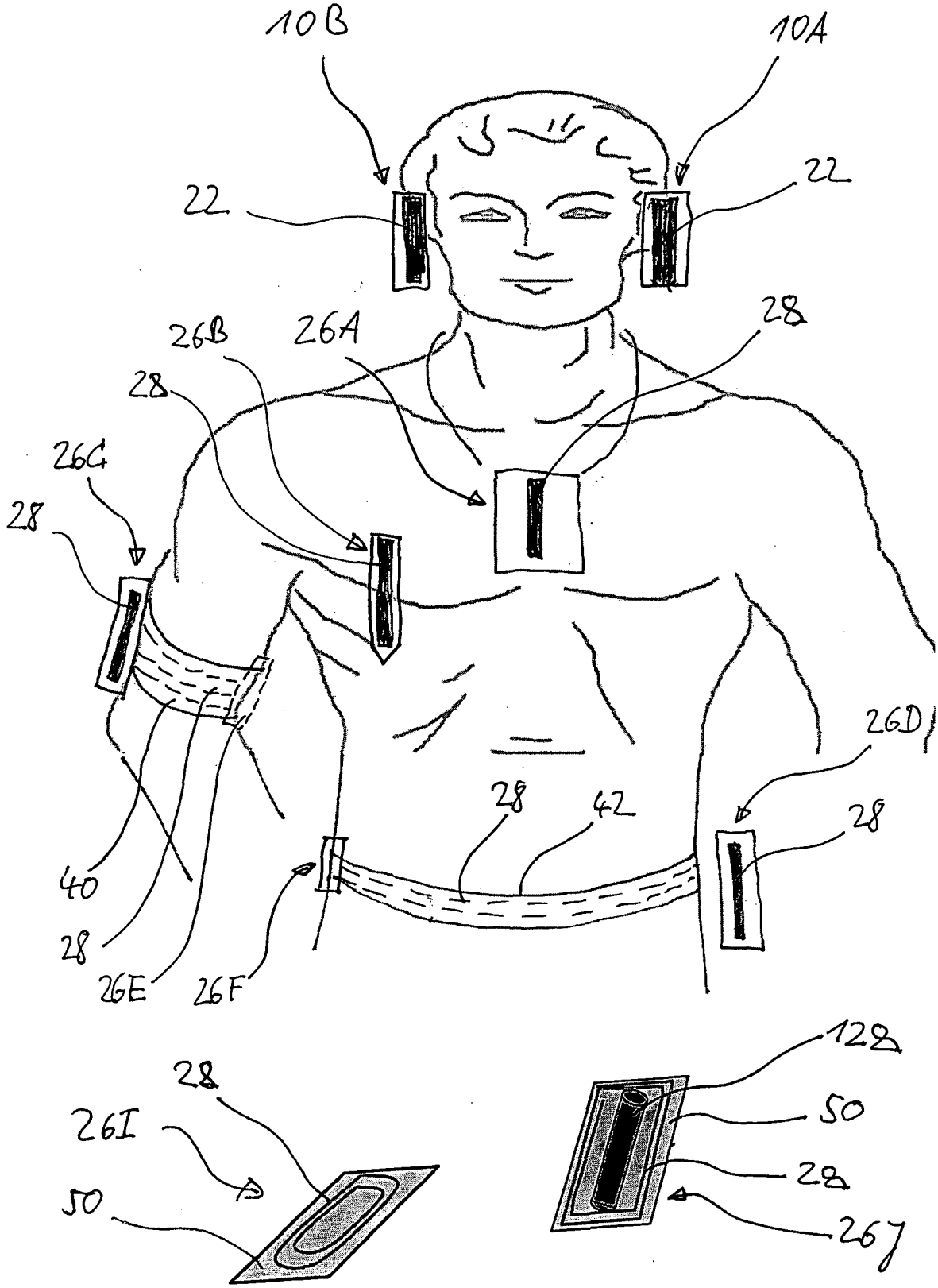

10B
10A
22
22
28
26B
26A
28
26C
28
26D
28
42
28
40
28
26E
26F
28
26I
50
128
50
28
26J

Fig. 1

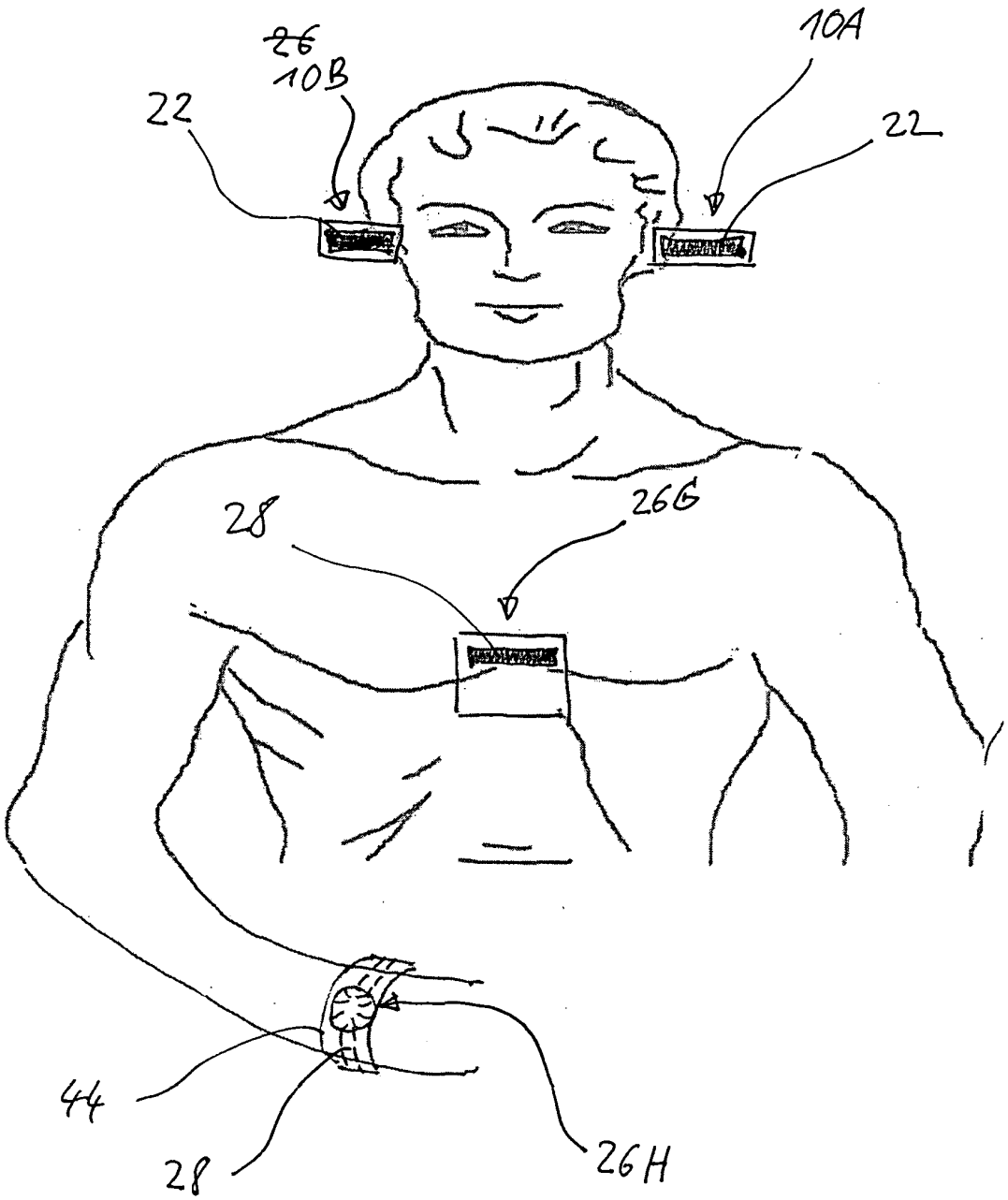


Fig. 2

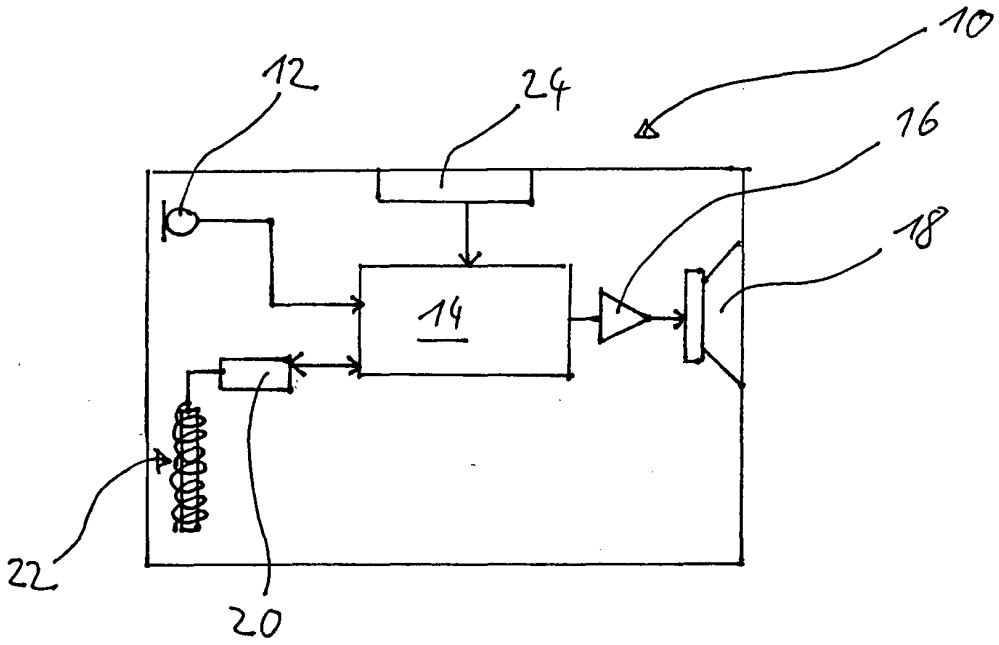


Fig. 3

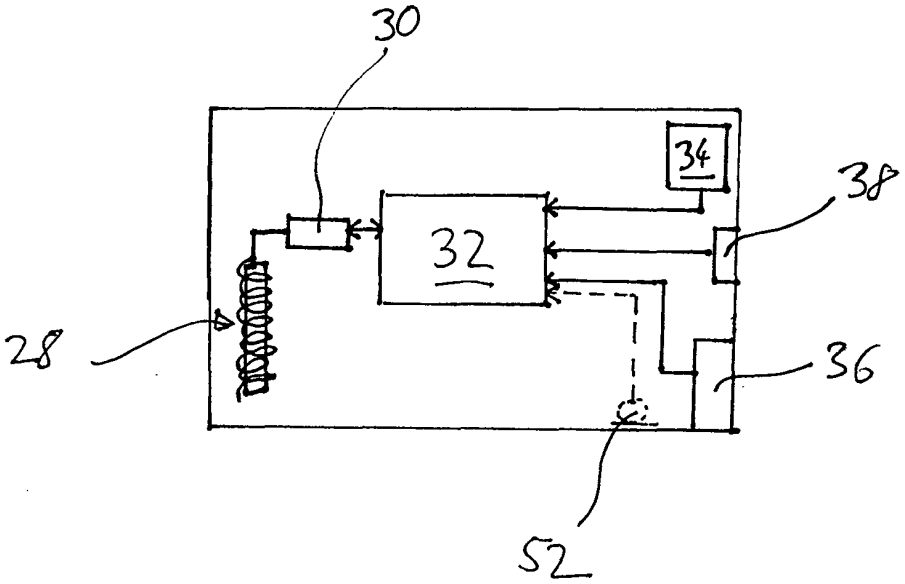


Fig. 4