

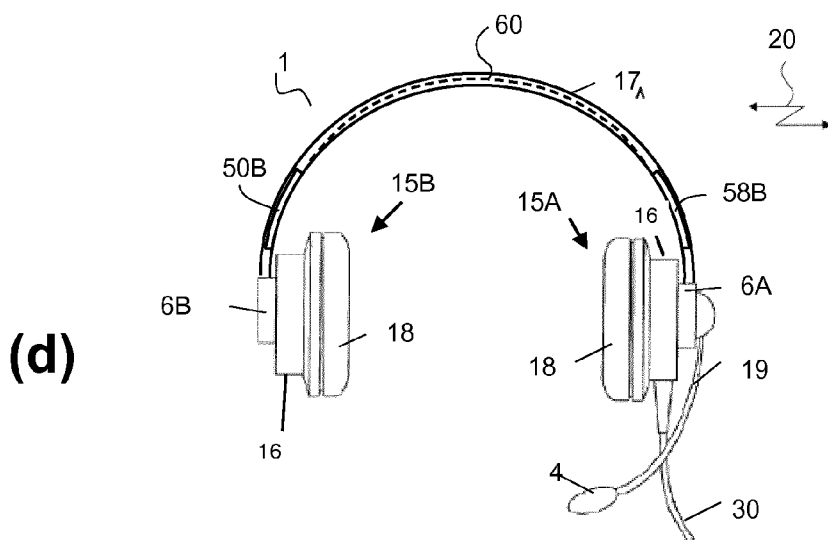


- (51) International Patent Classification:
H04S 7/00 (2006.01) G01C 21/36 (2006.01)
H04R 1/10 (2006.01)
- (21) International Application Number:
PCT/EP2013/056931
- (22) International Filing Date:
2 April 2013 (02.04.2013)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
12162631.1 30 March 2012 (30.03.2012) EP
13/437,826 2 April 2012 (02.04.2012) US
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- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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(54) Title: A HEARING DEVICE WITH AN INERTIAL MEASUREMENT UNIT



(57) Abstract: A new hearing device is provided with an inertial measurement unit for determination of yaw of the orientation of a user's head, when the hearing device is worn in its intended operational position on the user's head. The hearing device may further comprise a geographical position unit for determining the geographical position of the user and the hearing device may comprise an antenna for the geographical position unit, the antenna being positioned at least partly in a wearing style element, such as in a headband and/or a neckband, of the hearing device.

Fig. 1



- (84) Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).
- Published:**
- *with international search report (Art. 21(3))*
 - *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

A HEARING DEVICE WITH AN INERTIAL MEASUREMENT UNIT

FIELD OF THE INVENTION

A new hearing device is provided with an inertial measurement unit for determination of yaw of the orientation of a user's head, when the hearing device is worn in its
5 intended operational position on the user's head.

BACKGROUND OF THE INVENTION

Typically, present GPS-units cannot determine orientation of a vehicle or person until the vehicle or person has moved a certain distance. Upon movement, orientation is determined as the direction defined by two successive positions along the
10 movement. This principle works well in a car, but is not convenient for a person walking. During walking, the user of the GPS-unit is often disoriented due to the delay caused by having to walk some distance before the GPS-unit determines orientation with relation to a map of the surroundings displayed by the GPS-unit, and information on orientation is often lost again when the user stops to watch the map.

15 SUMMARY OF THE INVENTION

There is a need for an improved way of determining orientation of a human.

Thus, a hearing device is provided that is configured to be head worn by a user for emission of sound towards at least one of the ears of the user, and accommodating an inertial measurement unit positioned for determining head yaw when the user
20 wears the hearing device in its intended operational position. The inertial measurement unit being configured to connect to a geographical position unit for determining the geographical position of the user. The hearing device may comprise an antenna for the geographical position unit, the antenna being positioned at least partly in a wearing style element, such as in a headband and/or a neckband, of the
25 hearing device. Head yaw may be the yaw of the orientation of the head of the user,

According to a further aspect of the invention a system with a display and a geographical position unit receiver is provided, the system further comprising a hearing device as herein described, the system further comprising a controller that is configured to display a map on the display, the map including a position determined
30 based on signals received by the geographical position unit receiver. The map may have an orientation in accordance with a head yaw value provided by the hearing device.

In a further aspect of the present invention, a system with a display unit, a geographical position unit and a hearing device is provided. The hearing device being configured to be head worn for emission of sound towards at least one of the ears of a user and accommodating an inertial measurement unit positioned for
5 determining head yaw when the user wears the hearing device in its intended operational position. The system further comprises a controller that is configured to display a map on the display unit. The map may include a position determined based on signals received by the geographical position unit, and may be provided with an orientation in accordance with a head yaw value provided by the hearing device. The
10 position may be determined based on signals received from satellites communicating with the geographical position unit in any conventional way, and thus the position, such as a current position of a user wearing the hearing device, may be calculated for example by trilateration. The map may thus include a position whose determination may be based on signals received by the geographical position unit.

15 According to a further aspect of the present invention, a hearing device configured to be head worn for emission of sound towards at least one of the ears of a user is provided. The hearing device being configured to connect to a geographical position unit for determining the geographical position of the user and the hearing device may comprise an antenna for the geographical position unit, the antenna may be
20 positioned at least partly in a wearing style element, such as in a headband and/or a neckband, of the hearing device. The hearing device may comprise the geographical position unit or the geographical position unit may be a device external to the hearing device.

The hearing device has one or more loudspeakers for emission of sound towards
25 one or both ears of the user, when the hearing device is worn by the user in its intended operational position on the user's head. It should be noted that in the field of hearing aids, the loudspeakers are termed receivers.

The hearing device may be an Ear-Hook, In-Ear, On-Ear, Over-the-Ear, Behind-the-Neck, Helmet, Headguard, etc, headset, headphone, earphone, ear defenders,
30 earmuffs, etc.

Further, the hearing device may be a binaural hearing aid, or a monaural hearing aid, such as a BTE, a RIE, an ITE, an ITC, a CIC, etc, monaural or binaural hearing aid.

The new hearing device may have any wearing style, and may comprise any corresponding wearing style element, such as a headband, a neckband, an ear hook,

a helmet, a headguard, etc. For example, the hearing device may comprise a headband carrying one or two earphones. The headband is intended to be positioned over the top of the head of the user as is well-known from conventional headsets and headphones with one or two earphones. The inertial measurement unit may be
5 accommodated in the headband of the hearing device.

The new hearing device may have a neckband carrying one or two earphones. The neckband is intended to be positioned behind the neck of the user as is well-known from conventional neckband headsets and headphones with one or two earphones. The inertial measurement unit may be accommodated in the neckband of the hearing
10 device.

The inertial measurement unit and/or the geographical position unit may be provided in one or both of the earphones.

The orientation of the head of the user is defined as the orientation of a head reference coordinate system with relation to a reference coordinate system with a
15 vertical axis and two horizontal axes at the current location of the user.

A head reference coordinate system is defined with its centre located at the centre of the user's head, which is defined as the midpoint of a line drawn between the respective centres of the eardrums of the left and right ears of the user.

The x-axis of the head reference coordinate system is pointing ahead through a
20 centre of the nose of the user, its y-axis is pointing towards the left ear through the centre of the left eardrum, and its z-axis is pointing upwards.

Head yaw is the angle between the current x-axis' projection onto a horizontal plane at the location of the user and a horizontal reference direction, such as Magnetic North or True North, head pitch is the angle between the current x-axis and the
25 horizontal plane, and head roll is the angle between the y-axis and the horizontal plane. Throughout the present disclosure, the x-axis, y-axis, and z-axis of the head reference coordinate system, are denoted the head x-axis, the head y-axis, and the head z-axis, respectively.

The inertial measurement unit may comprise one or more sensors, such as one or
30 more accelerometers, one or more gyroscopes, a magnetometer, an electronic compass, etc., and any combination thereof to determine movement of the head, and more particularly, to determined head displacement factors, such as head yaw, head pitch and/or head roll.

The inertial measurement unit may comprise an electronic compass for determining head yaw when the user wears the hearing device in its intended operational position on the user's head.

5 The inertial measurement unit may comprise accelerometers for determination of displacement of the hearing device.

The inertial measurement unit may determine head yaw based on determinations of individual displacements of two or more accelerometers positioned with a mutual distance for sensing displacement in the same horizontal direction when the user wears the hearing device. Such a determination is accurate when head pitch and
10 head roll do not changed during change of the yaw value. In some embodiments, head yaw may be determined by using one accelerometer.

Alternatively, or additionally, the inertial measurement unit may determine head yaw utilizing a first gyroscope, such as a solid-state or MEMS gyroscope positioned for sensing rotation of the head x-axis projected onto a horizontal plane at the user's
15 location with respect to a horizontal reference direction.

Similarly, the inertial measurement unit may have further accelerometers and/or further gyroscope(s) for determination of head yaw, head pitch and/or head roll, when the user wears the hearing device in its intended operational position on the user's head.

20 In order to facilitate determination of head yaw with relation to e.g. True North or Magnetic North of the earth, the inertial measurement unit may further include a compass, such as a magnetometer or an electronic compass.

Thus, the inertial measurement unit may have one, two or three axis sensors that provide information of head yaw, head yaw and head pitch, or head yaw, head pitch,
25 and head roll, respectively.

The inertial measurement unit may further have sensors that provide information on one, two or three dimensional displacement.

The inertial measurement unit may further comprise a geographical position unit for determining the geographical position of a user, the geographical position unit may
30 comprise a GPS unit, such as A-GPS, such as S-GPS, an EGNOS unit, a GLONASS unit, a NAVSTAR unit, a Galileo unit, a Compass navigation unit, a Beidou unit, or any combination thereof.

For example, a geographical position unit may be a GPS-unit for determining the geographical position of the user, when the user wears the hearing device in its intended operational position on the head, based on satellite signals in the well-known way. Hereby, the user's current position and orientation can be provided to
5 the user based on data from the hearing device.

The hearing device may accommodate an antenna for a geographical position unit , the antenna being configured for reception of geographical position signals, whereby reception of geographical position signals is improved in particular in urban areas where, presently, reception of geographical position signals can be difficult.

10 The antenna for the geographical position unit may be accommodated in a headband or a neckband of the hearing device.

The hearing device may have an antenna interface for connection of the antenna with an external geographical position unit, e.g. a hand-held geographical position unit, a Smartphone, a Personal Digital Assistant (PDA), a tablet PC, a laptop PC, a
15 notebook PC, etc, whereby reception of geographical position unit signals by the hand-held geographical position unit is improved in particular in urban areas where, presently, reception of geographical position unit signals by hand-held geographical position units can be difficult.

The hearing device may furthermore comprise a splitter for splitting the antenna
20 between a geographical position unit provided in the hearing device and the antenna interface.

The hearing device may further comprise a processor with inputs connected to the one or more sensors of the inertial measurement unit, and configured for determining and outputting values for head yaw, and optionally head pitch and optionally head
25 roll, when the user wears the hearing device in its intended operational position on the user's head.

The processor may further have inputs connected to displacement sensors of the inertial measurement unit, and configured for determining and outputting values for displacement in one, two or three dimensions of the user when the user wears the
30 hearing device in its intended operational position on the user's head.

Thus, the hearing device may be equipped with a complete attitude heading reference system (AHRS) for determination of the orientation of the user's head that has either solid-state or MEMS gyroscopes, accelerometers and magnetometers on

all three axes. The processor of the AHRS provides digital values of the head yaw, head pitch, and head roll based on the sensor data.

The hearing device may comprise a data interface for transmission of data from the inertial measurement unit and/or the geographical position unit to an external device,
5 e.g. via the processor.

The processor may be connected with the inertial measurement unit and/or the geographical position unit and may be configured to process data from sensor(s) of the inertial measurement unit into head yaw, head pitch and/or head roll values.

In some embodiments, the data from sensor(s) of the inertial measurement unit may
10 be provided as control signals to the processor and/or an external device to provide hands-free control of the hearing device and/or any device connected to the processor. For example, the sensor(s) of the inertial measurement units may provide control signals to the processor and/or a device having a user interface. The control signal received by the user interface may provide a hands-free controlling of devices,
15 such as smart phones, geographical position units, such as GPS units, digital player units, tablets, computers, etc. The control signals may comprise head displacement factors, such as specific or predetermined sequences of head displacements when the user wears the hearing device in its intended operational position on the user's head.

20 The data interface may be a wired interface, e.g. a USB interface, or a wireless interface, such as a Bluetooth interface, e.g. a Bluetooth Low Energy interface.

The hearing device may comprise an audio interface for reception of an audio signal from an external device.

The audio interface may be a wired interface or a wireless interface.

25 The data interface and the audio interface may be combined into a single interface, e.g. a USB interface, a Bluetooth interface, etc.

The hearing device may for example have a Bluetooth Low Energy data interface for exchange of head jaw values and control data, and a wired audio interface for transmission of sound signals.

30 The hearing device may comprise an ambient microphone for receiving ambient sound for user selectable transmission towards at least one of the ears of the user.

The hearing device may comprise at least one voice microphone for picking up the user's voice, and the voice microphone may be configured to provide a voice signal to the processor to provide a voice control signal or the voice signal may via the audio interface be provided to an external device configured for two-way
5 communication.

In the event that the hearing device provides a sound proof, or substantially, sound proof, transmission path for sound emitted by the loudspeaker(s) of the hearing device towards the ear(s) of the user, the user may be acoustically disconnected in an undesirable way from the surroundings. This may for example be dangerous
10 when moving in traffic.

The hearing device may have a user interface, e.g. a push button, so that the user can switch the microphone on and off as desired thereby connecting or disconnecting the ambient microphone and one loudspeaker of the hearing device.

The hearing device may have a mixer with an input connected to an output of the ambient microphone and another input connected to another source of an audio
15 signal, e.g. an external device supplying an audio signal, and an output providing an audio signal that is a weighted combination of the two input audio signals.

The user input may further include means for user adjustment of the weights of the combination of the two input audio signals, such as a dial, or a push button for
20 incremental adjustment.

The hearing device may have a threshold detector for determining the loudness of the ambient signal received by the ambient microphone, and the mixer may be configured for including the output of the ambient microphone signal in its output
25 signal only when a certain threshold is exceeded by the loudness of the ambient signal.

Further ways of controlling audio signals from an ambient microphone and a voice microphone is disclosed in US 2011/0206217 A1.

In one or more embodiments, a system with a display unit, a geographical position unit and a hearing device may be provided. The hearing device may be configured to
30 be head worn for emission of sound towards at least one of the ears of a user and accommodating an inertial measurement unit positioned for determining head yaw when the user wears the hearing device in its intended operational position. The system further comprises a controller that is configured to display a map on the display unit. The map may include a position determined based on signals received

by the geographical position unit, and may be provided with an orientation in accordance with a head yaw value provided by the hearing device.

The hearing device may comprise a data interface for transmission of data from the inertial measurement unit and/or the geographical position unit to the display unit.

5 The controller may be provided in the display unit.

The system may further comprise at least a first and a second antenna for the geographical position unit. The controller may be configured to switch from the first antenna to the second antenna or vice versa when a signal strength for the first antenna or the second antenna respectively, is below a predetermined threshold
10 strength.

The inertial measurement unit may comprise at least one self-calibrating sensor, alternatively or additionally, the system may be calibrated by indicating by a user when his or her head x-axis is kept in a known direction, such as kept North, such as true North.

15 It is envisaged that one or more sensors as provided in the inertial measurement unit may be calibrated using the display unit, the one or more sensors comprises one or more gyroscopes, one or more accelerometer and/or an electronic compass or any combination thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

20 Below, the invention will be described in more detail with reference to the exemplary embodiments illustrated in the drawings, wherein

Fig. 1 shows four embodiments of the new hearing device,

Fig. 2 shows (a) a head reference coordinate system and (b) head yaw,

Fig. 3 shows (a) head pitch and (b) head roll,

25 Fig. 4 is a block diagram of one embodiment of the new hearing device,

Fig. 5 is a block diagram of another embodiment of the new hearing device, and

Fig. 6 illustrates one exemplary use of the new hearing device.

The new hearing device will now be described more fully hereinafter with reference to the accompanying drawings, in which various embodiments are shown. The
30 accompanying drawings are schematic and simplified for clarity, and they merely show details which are essential to the understanding of the new hearing device,

while other details have been left out. The new hearing device may be embodied in different forms not shown in the accompanying drawings and should not be construed as limited to the embodiments and examples set forth herein. Rather, these embodiments and examples are provided so that this disclosure will be
5 thorough and complete, and will fully convey the scope of the invention to those skilled in the art.

Similar reference numerals refer to similar elements in the drawings.

Fig. 1 (a) shows an embodiment of the new hearing device 1 having a housing similar to and worn in the same way as a conventional Bluetooth headset of the type
10 especially intended for use with a Bluetooth enabled mobile phone.

The illustrated new hearing device 1 has an earphone 15, which is arranged at the outer ear 25 of a user 31. In this embodiment, the earphone 15 is attached by inserting a non-visible earbud in the ear. However, other attachment devices, such as an ear hook, ear loop, a headband, could be used. A Bluetooth transceiver in the
15 earphone 15 is wirelessly connected by a Bluetooth link 20 to a Bluetooth transceiver in a hand-held device (not shown), e.g. a mobile phone, an Ipad, a geographical position unit, such as a GPS unit, a smart phone, a tablet PC, a remote control for the hearing device, etc. The earphone housing 16 is elongate and points in the direction of the mouth of the user 31. At the free end of the earphone housing 16
20 closest to the mouth, the earphone 15 is provided with a conventional voice microphone 4 for picking up the user's voice during two-way communication via the mobile phone (not shown). At the opposite end of the earphone 15, an ambient microphone 6 is provided for picking up ambient sounds, which the user 31 can select to mix with the sound received from the mobile phone (not shown) as
25 disclosed further above. The inertial measurement unit (not visible) is accommodated in the earphone housing 16. The user interface of the hearing device 1 is not visible, but may include one or more push buttons, and/or one or more dials as is well-known from conventional Bluetooth headsets. The operation of the illustrated new hearing device 1 is explained further below in connection with Figs. 4 and 5.

30 Fig. 1 (b) shows an embodiment of the new hearing device 1 with a headband 17 and an earphone housing 16 similar to conventional headsets originally designed for office use and operating according to the DECT standard together with a headset base.

The illustrated new hearing device 1 comprises a headband 17 with an earphone 15
35 at one end and an end piece 32 at the other end. A microphone boom 19 extends

from the earphone 15 in the direction of the user's mouth during use, and a voice microphone 4 is provided at the free end of the microphone boom 19. An ambient microphone 6 is provided on the earphone 15.

5 A Bluetooth transceiver in the earphone 15 is wirelessly connected by a Bluetooth link 20 to a Bluetooth transceiver in a hand-held device (not shown), e.g. a mobile phone, an Ipod, a geographical position unit, such as a GPS unit, a smart phone, a remote control for the hearing device, etc.

10 The user 31 can select to mix ambient sounds picked up by the ambient microphone 6 with sound received from the hand-held device (not shown) as disclosed further above.

An inertial measurement unit 50 is accommodated in housing mounted on or integrated with the headband 17 and interconnected with components in the earphone housing 16 through wires running internally in the headband 17 between the inertial measurement unit 50 and the earphone 15.

15 The user interface of the hearing device 1 is not visible, but may include one or more push buttons, and/or one or more dials as is well-known from conventional Bluetooth headsets. The operation of the illustrated new hearing device 1 is explained further below in connection with Figs. 4 and 5.

20 Fig. 1 (c) shows an embodiment of the new hearing device 1 having a headband 17 carrying two earphones 15A, 15B similar to a conventional corded headset with two earphones 15A, 15B interconnected by a headband 17.

Each earphone 15A, 15B of the illustrated hearing device comprises an ear pad 18 for enhancing the user comfort and blocking out ambient sounds during listening or two-way communication.

25 A microphone boom 19 with a voice microphone 4 at the free end extends from the first earphone 15A. The housing of the first earphone 15A comprises a first ambient microphone 6A and the housing of the second earphone 15B comprises a second ambient microphone 6B.

30 A cord 30 extends from the first earphone 15A to a hand-held device (not shown), e.g. a mobile phone, an Ipod, a geographical position unit, such as a GPS unit, a smart phone, a remote control for the hearing device, etc.

The user 31 can select to mix ambient sounds picked up by the ambient microphones 6A, 6B with sound received from the hand-held device (not shown) as disclosed further above.

When mixed-in, sound from the first ambient microphone 6A is directed to the speaker of the first earphone 15A, and sound from the second ambient microphone 6B is directed to the speaker of the second earphone 15B. Thus, the user experiences a spatial effect, whereby he is able to hear from which direction ambient sounds are coming.

An inertial measurement unit 50 is accommodated in a housing mounted on or integrated with the headband 17 and interconnected with components in the earphone housing 16 through wires running internally in the headband 17 between the inertial measurement unit 50 and the earphone 15.

The user interface of the hearing device 1 is not visible, but may include one or more push buttons, and/or one or more dials as is well-known from conventional headsets.

Fig. 1 (d) shows another embodiment of the new hearing device 1 having a headband 17 carrying two earphones 15A, 15B similar to the first embodiment shown in Fig. 1 (c).

An inertial measurement unit 50B and a geographical position unit 58B are mounted at or integrated with the headband 17, and interconnected with components in the earphone housing 16 through wires running internally in the headband 17 between the inertial measurement unit 50B and the earphone 15, and between the geographical position unit 58B and the earphone 15. It is seen that the inertial measurement unit 50B and the geographical position unit 58B may be mounted as separate elements, but it is envisaged that the geographical position unit may also be provided as a part of the inertial measurement unit.

An antenna 60 for the geographical position unit is mounted at or integrated with the headband 17, and interconnected with components in the earphone housing 16 through wires running internally in the headband 17 between the geographical position unit 58B, the antenna 60 and the earphone 15. The antenna may be any antenna suitable for receiving a signal for the geographical position unit, such as an active antenna, such as a wire antenna, such a wire antenna of any form, etc. The antenna may have a center frequency about 1.5 GHz, such as around 1.575 GHz.

The user interface of the hearing device 1 is not visible, but may include one or more push buttons, and/or one or more dials as is well-known from conventional headsets. The operation of the illustrated new hearing device 1 is explained further below in connection with Figs. 4 to 6.

- 5 The orientation of the head of the user is defined as the orientation of a head reference coordinate system with relation to a reference coordinate system with a vertical axis and two horizontal axes at the current location of the user.

Fig. 2(a) shows a head reference coordinate system 100 that is defined with its centre 110 located at the centre of the user's head 32, which is defined as the
10 midpoint 110 of a line 120 drawn between the respective centres of the eardrums (not shown) of the left and right ears 33, 34 of the user.

The x-axis 130 of the head reference coordinate system 100 is pointing ahead through a centre of the nose 35 of the user, its y-axis 112 is pointing towards the left ear 33 through the centre of the left eardrum (not shown), and its z-axis 140 is
15 pointing upwards.

Fig. 2(b) illustrates the definition of head yaw 150. Head yaw 150 is the angle between the current x-axis' projection x' 132 onto a horizontal plane 160 at the location of the user, and a horizontal reference direction 170, such as Magnetic North or True North.

- 20 Fig. 3(a) illustrates the definition of head pitch 180. Head pitch 180 is the angle between the current x-axis 130 and the horizontal plane 160.

Fig. 3(b) illustrates the definition of head roll 190. Head roll 190 is the angle between the y-axis and the horizontal plane.

- Fig. 4 shows electronic parts of the new hearing device 1 that may be incorporated
25 into any of the embodiments shown in Fig. 1, and other embodiments.

The illustrated hearing device 1 comprises electronic components including one or two loudspeakers 15A, 15B for emission of sound towards one or both ears of the user (not shown), when the hearing device 1 is worn by the user in its intended operational position on the user's head.

- 30 It should be noted that in addition to the embodiments shown in Fig. 1, the hearing device may be of any known type including an Ear-Hook, In-Ear, On-Ear, Over-the-Ear, Behind-the-Neck, Helmet, Headguard, etc, headset, headphone, earphone, ear defenders, earmuffs, etc.

Further, the hearing device may be a binaural hearing aid, or a monaural hearing aid, such as a BTE, a RIE, an ITE, an ITC, a CIC, etc, monaural or binaural hearing aid.

The hearing device further has a voice microphone 4 accommodated in an earphone housing or provided at the free end of a microphone boom mounted to an earphone housing.

The hearing device 1 further has one or two ambient microphones 6A, 6B, e.g. at each ear, for picking up ambient sounds.

The hearing device has an inertial measurement unit 50 positioned for determining head yaw, head pitch, and head roll, when the user wears the hearing device in its intended operational position on the user's head.

The illustrated inertial measurement unit 50 has tri-axis MEMS gyros 56 that provide information on head yaw, head pitch, and head roll in addition to tri-axis accelerometers 54 that provide information on three dimensional displacement of the hearing device 1.

Optionally, the inertial measurement unit 50 also has a GPS-unit 58 for determining the geographical position of the user, when the user wears the hearing device in its intended operational position on the head, based on satellite signals in the well-known way. Hereby, the user's current position and orientation can be provided to the user based on data from the hearing device.

Optionally, the hearing device accommodates a GPS-antenna configured for reception of GPS-signals, whereby reception of GPS-signals is improved in particular in urban areas where, presently, reception of GPS-signals can be difficult.

In a hearing device 1 without the GPS-unit 58, the hearing device 1 has an interface for connection of the GPS-antenna with an external GPS-unit, e.g. a hand-held GPS-unit, whereby reception of GPS-signals by the hand-held GPS-unit is improved in particular in urban areas where, presently, reception of GPS-signals by hand-held GPS-units can be difficult.

The illustrated inertial measurement unit 50 also has a magnetic compass in the form of a tri-axis magnetometer 52 facilitating determination of head yaw with relation to the magnetic field of the earth, e.g. with relation to Magnetic North.

The hearing device 1 has a processor 80 with input/output ports connected to the sensors of the inertial measurement unit 50, and configured for determining and

outputting values for head yaw, head pitch, and head roll, when the user wears the hearing device in its intended operational position on the user's head.

The processor 80 may further have inputs connected to displacement sensors of the inertial measurement unit, and configured for determining and outputting values for displacement in one, two or three dimensions of the user when the user wears the hearing device in its intended operational position on the user's head, for example to be used for tracking in the event that GPS-signals are lost.

Thus, the illustrated hearing device 1 is equipped with a complete attitude heading reference system (AHRS) for determination of the orientation of the user's head that has MEMS gyroscopes, accelerometers and magnetometers on all three axes. The processor provides digital values of the head yaw, head pitch, and head roll based on the sensor data.

The hearing device 1 has a data interface 20 for transmission of data from the inertial measurement unit after processing by the processor 80 to an external device, e.g. a GPS-unit. The data interface 20 is a Bluetooth Low Energy interface.

The hearing device 1 further has a conventional wired audio interface for audio signals from the voice microphone 4 and for audio signals to the loudspeakers 15A, 15B as is well-known in the art.

This combination of a low power wireless interface for data communication, and a wired interface for audio signals provides a superior combination of high quality sound reproduction and low power consumption of the hearing device 1.

The hearing device 1 has a user interface 21, e.g. with push buttons and dials as is well-known from conventional headsets, for user control and adjustment of the hearing device 1 and possibly external devices interconnected with the hearing device 1.

Fig. 5 shows electronic parts of the new hearing device 1 that may be incorporated into any of the embodiments shown in Fig. 1, and other embodiments.

The illustrated hearing device 1 comprises electronic components including one or two loudspeakers 15A, 15B for emission of sound towards one or both ears of the user (not shown), when the hearing device 1 is worn by the user in its intended operational position on the user's head.

The hearing device further has an inertial measurement unit 50B comprising a tri-axis MEMS gyros 56 that provide information on head yaw, head pitch, and head roll in

addition to tri-axis accelerometers 54 that provide information on three dimensional displacement of the hearing device 1.

The illustrated inertial measurement unit 50B also has a magnetic compass in the form of a tri-axis magnetometer 52 facilitating determination of head yaw with relation to the magnetic field of the earth, e.g. with relation to Magnetic North.

The hearing device further has a geographical position unit 58B for determining the geographical position of the user, when the user wears the hearing device in its intended operational position on the head, based on satellite signals in the well-known way received by an antenna 60. The antenna 60 is connected to the geographical position unit 58 via an antenna interface 40. Hereby, the user's current position and orientation can be provided to the user based on data from the hearing device.

Fig. 6 illustrates an exemplary use of the new hearing device 1 together with a smart phone 200, e.g. an Iphone, an Android phone, a Windows phone, etc., such as any smart phone having any operating software. The hearing device 1 is connected to the smart phone 200 with a chord 30 providing a wired audio interface between the two units 1, 200 for transmission of speech and music from the smart phone 200 to the hearing device 1, and speech from the voice microphone 4 (not shown) to the smart phone 200 as is well-known in the art.

As indicated in Fig. 6 by the various exemplary GPS-images 210 displayed on the smart phone display 220, a GPS-app is also executed by the smart phone in addition to the smart phone 200 playing music, and performing telephone calls when required. Spoken guiding instructions from the GPS-app are transmitted to the hearing device 1 through the audio interface 30 as is well-known in the art, e.g. during reception of spoken instructions, other audio signals intended for the loudspeakers 15A, 15B are muted.

The GPS-app is configured for data communication with the hearing device 1 through a Bluetooth Low Energy wireless interface 20 available in the smart phone 200 and the hearing device 1, e.g. for reception of head yaw from the inertial measurement unit 50 of the hearing device 1. In this way, the GPS-app can control display of maps on the display of the smart phone 200 in accordance with orientation of the head of the user as projected onto a horizontal plane, i.e. typically corresponding to the plane of the map. For example, the map may be displayed with the position of the user at a central position of the display, and the head x-axis pointing upwards.

The user may calibrate directional information by indicating when his or her head x-axis is kept in a known direction, for example by pushing a certain push button when looking due North, typically True North. The user may obtain information on the direction due True North, e.g. from the position of the Sun on a certain time of day, or
5 the position of the North Star, or from a map, etc.

CLAIMS

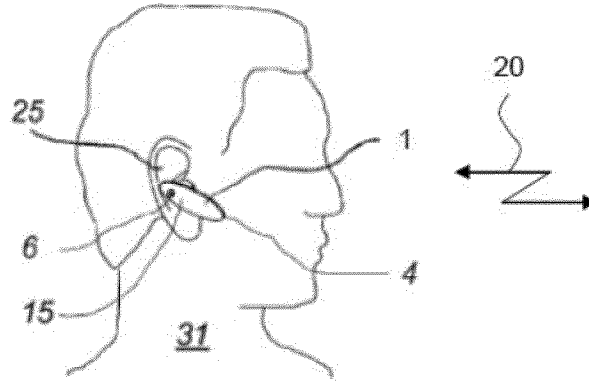
1. A hearing device configured to be head worn for emission of sound towards at least one of the ears of a user and accommodating an inertial measurement unit positioned for determining head yaw when the user wears the hearing device in its intended operational position and being configured to connect to a geographical position unit for determining the geographical position of the user, wherein the hearing device comprises an antenna for the geographical position unit, the antenna being positioned at least partly in a wearing style element, such as in a headband and/or a neckband, of the hearing device.
5
2. A hearing device according to claim 1, wherein the hearing device comprises the geographical position unit.
10
3. A hearing device according to any of claims 1 or 2, wherein the geographical position unit is provided in an external device.
4. A hearing device according to any of the previous claims, comprising a headband intended to be positioned across the top of the head of the user, when the user wears the hearing device in its intended operational position on the user's head, and wherein the antenna is accommodated by the headband.
15
5. A hearing device according to claim 4, wherein the inertial measurement unit is accommodated by the headband.
6. A hearing device according to any of claims 1-3, comprising a neckband intended to be positioned behind the neck of the user, when the user wears the hearing device in its intended operational position on the user's head, and wherein the antenna is accommodated by the neckband.
20
7. A hearing device according to claim 6, wherein the inertial measurement unit is accommodated by the neckband.
25
8. A hearing device according to any of the previous claims, comprising an antenna interface for connection of the antenna with an external geographical position unit.
9. A hearing device according to claim 8, comprising a splitter for splitting the antenna between a geographical position unit provided in the hearing device and the antenna interface.
30

10. A hearing device according to any of the previous claims, wherein the inertial measurement unit comprises one or more gyroscopes for determining one or more head displacement factors, including head yaw, head pitch and head roll.
- 5 11. A hearing device according to any previous claims, wherein the inertial measurement unit comprises one or more accelerometers for determining one or more displacement factors, such as head yaw, head pitch and head roll, when the user wears the hearing device in its intended operational position on the user's head.
- 10 12. A hearing device according to any of the previous claims, wherein the inertial measurement unit comprises at least one accelerometer for determining displacement of the user, when the user wears the hearing device in its intended operational position on the user's head.
13. A hearing device according to any of the previous claims, wherein the inertial measurement unit comprises a plurality of accelerometers with mutually orthogonal measurement axes.
- 15 14. A hearing device according to any of the previous claims, wherein the inertial measurement unit comprises an electronic compass for determining head yaw, when the user wears the hearing device in its intended operational position on the user's head.
- 20 15. A hearing device according to any of the previous claims, wherein the geographical position unit comprises a GPS unit, such as A-GPS, such as S-GPS, an EGNOS unit, a GLONASS unit, a NAVSTAR unit, a Galileo unit, a Compass navigation unit, a Beidou unit, or any combination thereof.
- 25 16. A hearing device according to any of the previous claims, comprising a data interface for transmission of data from the inertial measurement unit and/or the geographical position unit to an external device.
17. A hearing device according to claim 16, wherein the data interface is a wireless interface, such as a Bluetooth interface, such as a Bluetooth Low Energy interface.
- 30 18. A hearing device according to any of the previous claims, wherein the hearing device further comprises a processor that is connected with the inertial measurement unit and/or the geographical position unit and is configured to process data from sensor(s) of the inertial measurement unit into head yaw, head pitch and/or head roll values.

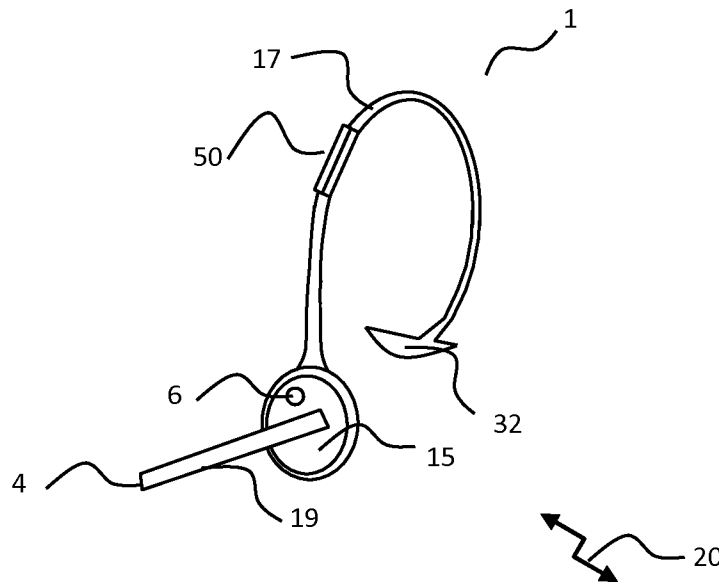
19. A hearing device according to claim 18, wherein the processor is configured to provide the head yaw values relative to north.
20. A hearing device according to any of claims 18 and 19, wherein the data interface is configured for transmission of data from the processor to an external device.
- 5 21. A hearing device according to any of the previous claims, comprising an audio interface, such as a wired interface, for reception of an audio signal from an external device.
22. A hearing device according to any of the previous claims, comprising an ambient microphone for receiving ambient sound for user selectable transmission towards at
10 least one of the ears of the user.
23. A hearing device according to any of the previous claims, wherein the hearing device comprises at least one voice microphone for picking up the user's voice, the voice microphone configured to provide a voice signal
24. A hearing device according to any of the previous claims, wherein the data from
15 sensor(s) of the inertial measurement unit are provided as control signals to the processor and/or an external device.
25. A hearing device according to any of the previous claims, comprising one or two earphones, wherein the inertial measurement unit and/or the geographical position unit is provided in one or both of the earphones.
- 20 26. A system with a display and a geographical position unit receiver and a hearing device according to any of the previous claims, comprising a controller that is configured to display a map on the display, the map including a position determined based on signals received by the geographical position unit receiver, with an orientation in accordance with a head yaw value provided by the hearing device.
- 25 27. A system with a display unit and a geographical position unit and a hearing device, the hearing device being configured to be head worn for emission of sound towards at least one of the ears of a user and accommodating an inertial measurement unit positioned for determining head yaw when the user wears the hearing device in its intended operational position, the system comprising a controller
30 that is configured to display a map on the display unit, the map including a position determined based on signals received by the geographical position unit, with an orientation in accordance with a head yaw value provided by the hearing device.

28. A system according to claim 27, wherein the hearing device comprises a data interface for transmission of data from the inertial measurement unit and/or the geographical position unit to the display unit.
29. A system according to any of claim 27-28, wherein the controller is provided in
5 the display unit.
30. A system according to any of claims 27-29, wherein the system further comprises at least a first and a second antenna for the geographical position unit, and wherein the controller is configured to switch from the first antenna to the second antenna or vice versa when a signal strength for the first antenna or the
10 second antenna respectively, is below a predetermined threshold strength.
31. A system according to any of claims 27-30, wherein the inertial measurement unit comprises at least one self-calibrating sensor.
32. A system according to any of claims 27-31, wherein the system may be calibrated by indicating by a user when his or her head x-axis is kept in a known
15 direction, such as kept North.
33. A system according to any of claims 27-32, wherein one or more sensors as provided in the inertial measurement unit are calibrated using the display unit.
34. A system according to any of claim 27-32, wherein the one or more sensors comprises one or more gyroscopes, one or more accelerometer and/or an electronic
20 compass or any combination thereof.
35. A system according to any of claims 27-34, comprising a hearing device according to any of claims 1-25.

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(a)



(b)

Fig. 1

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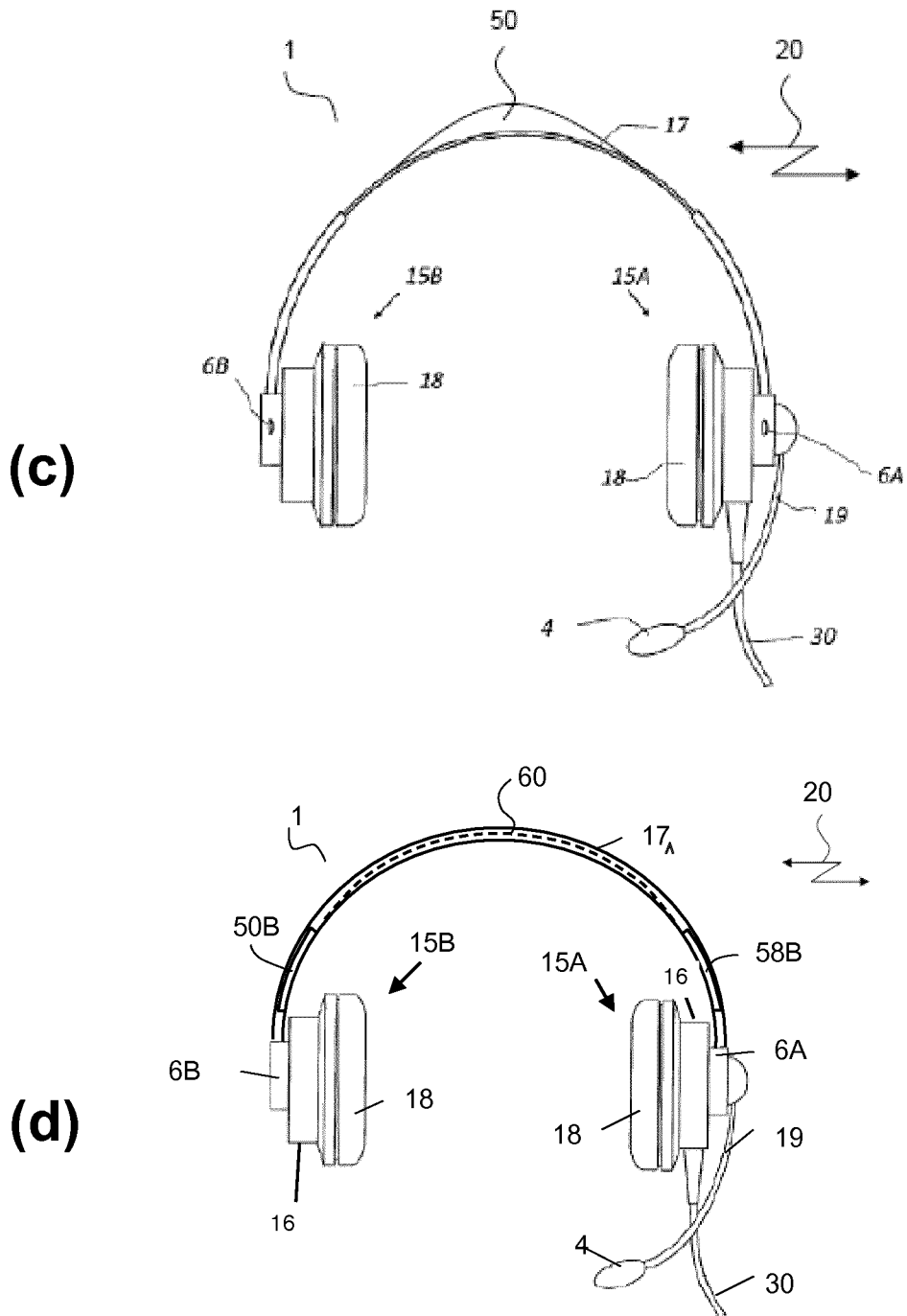
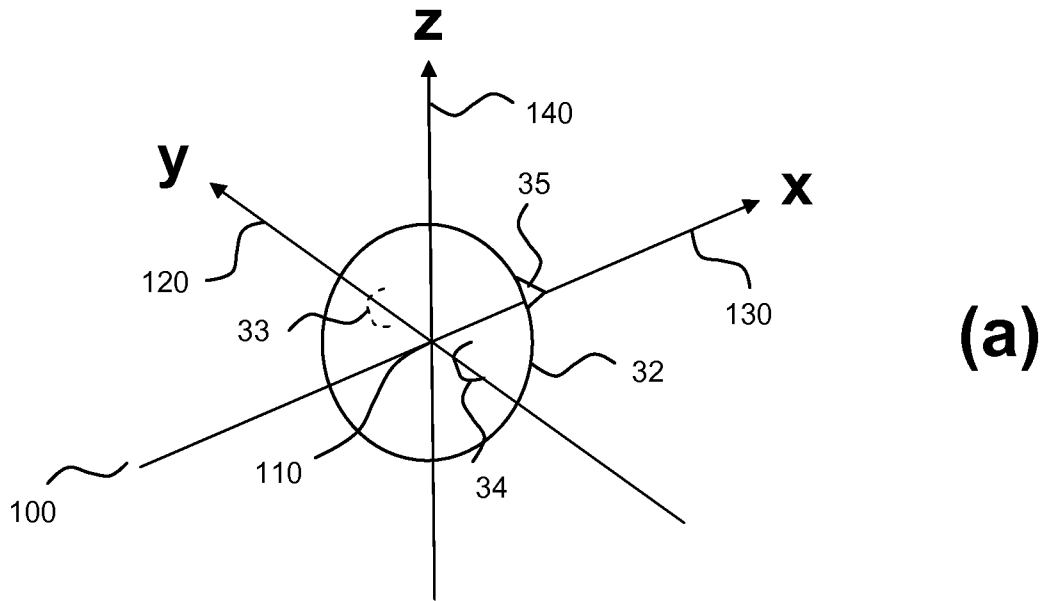
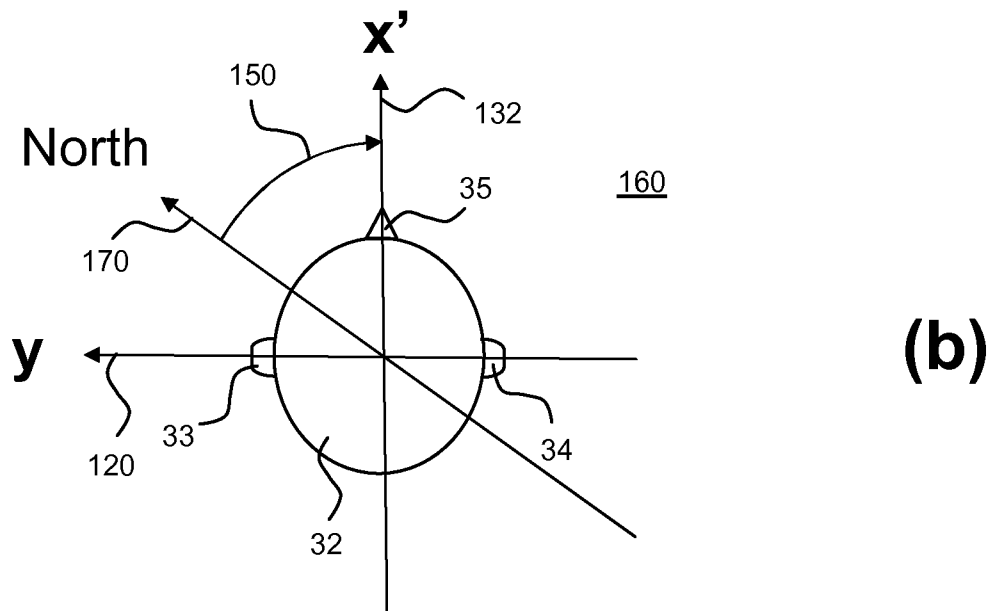


Fig. 1

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(a)



(b)

Fig. 2

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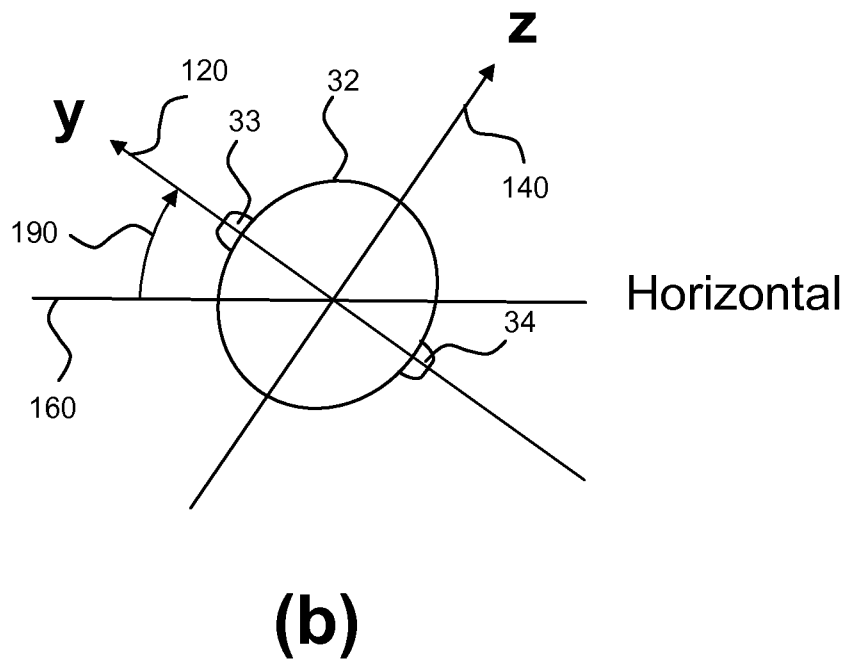
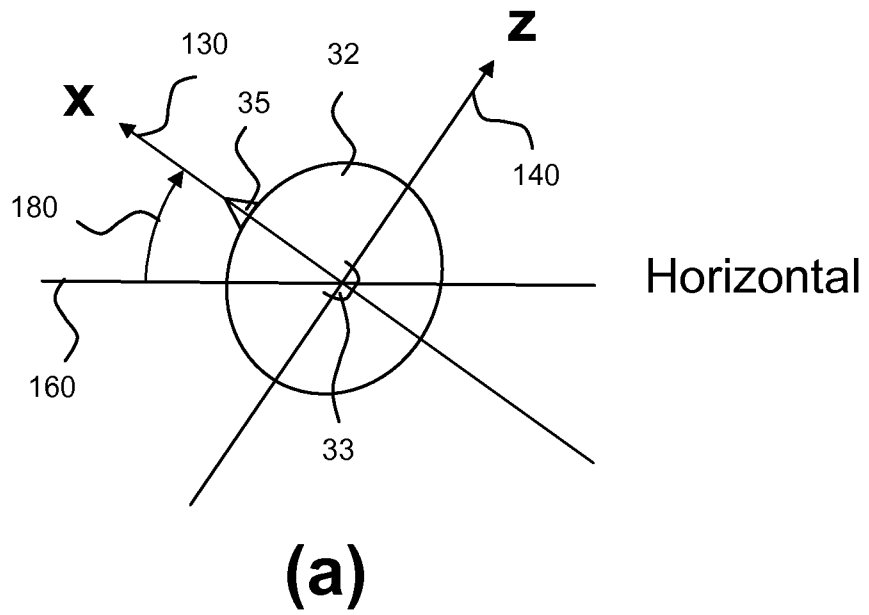


Fig. 3

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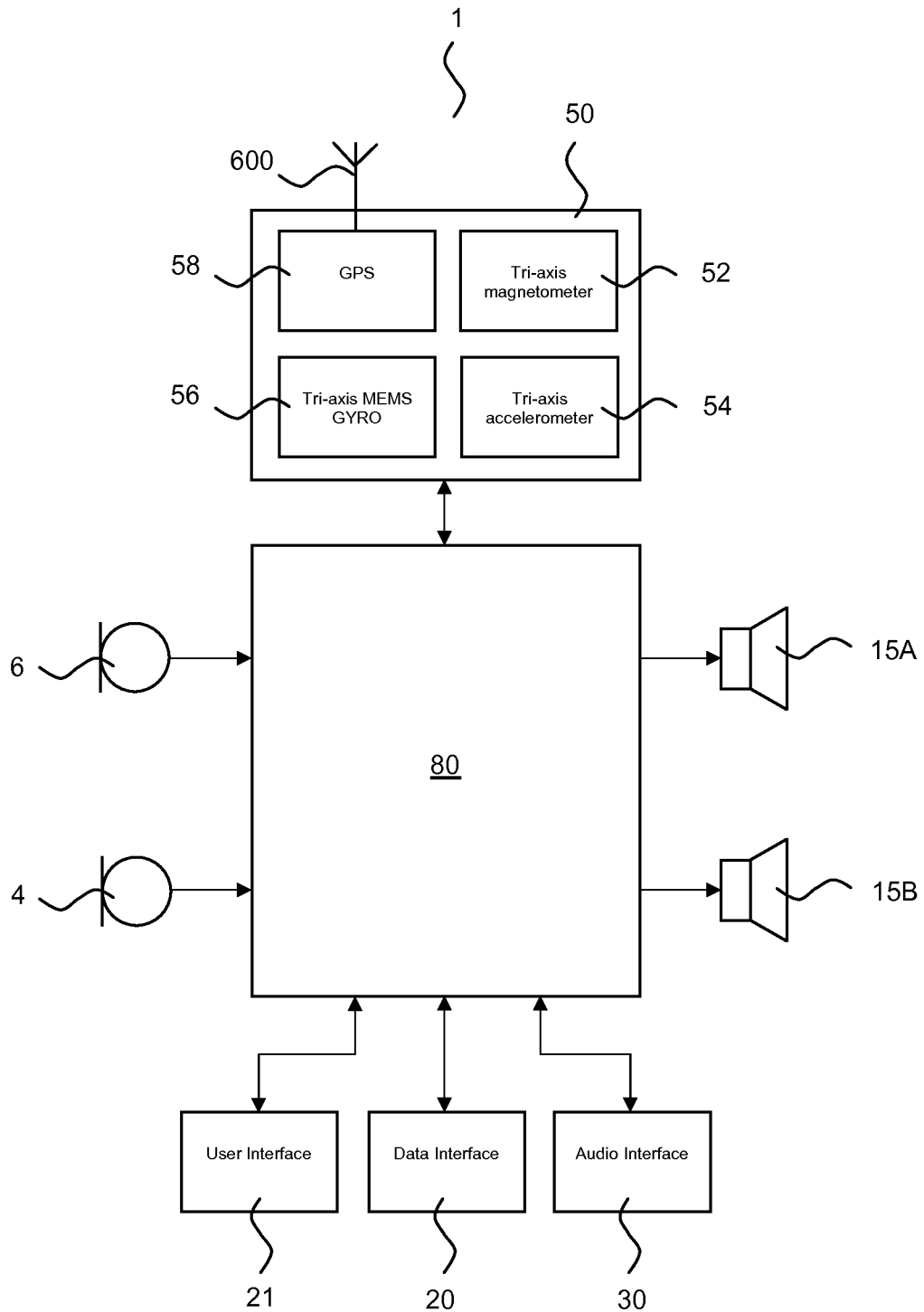


Fig. 4

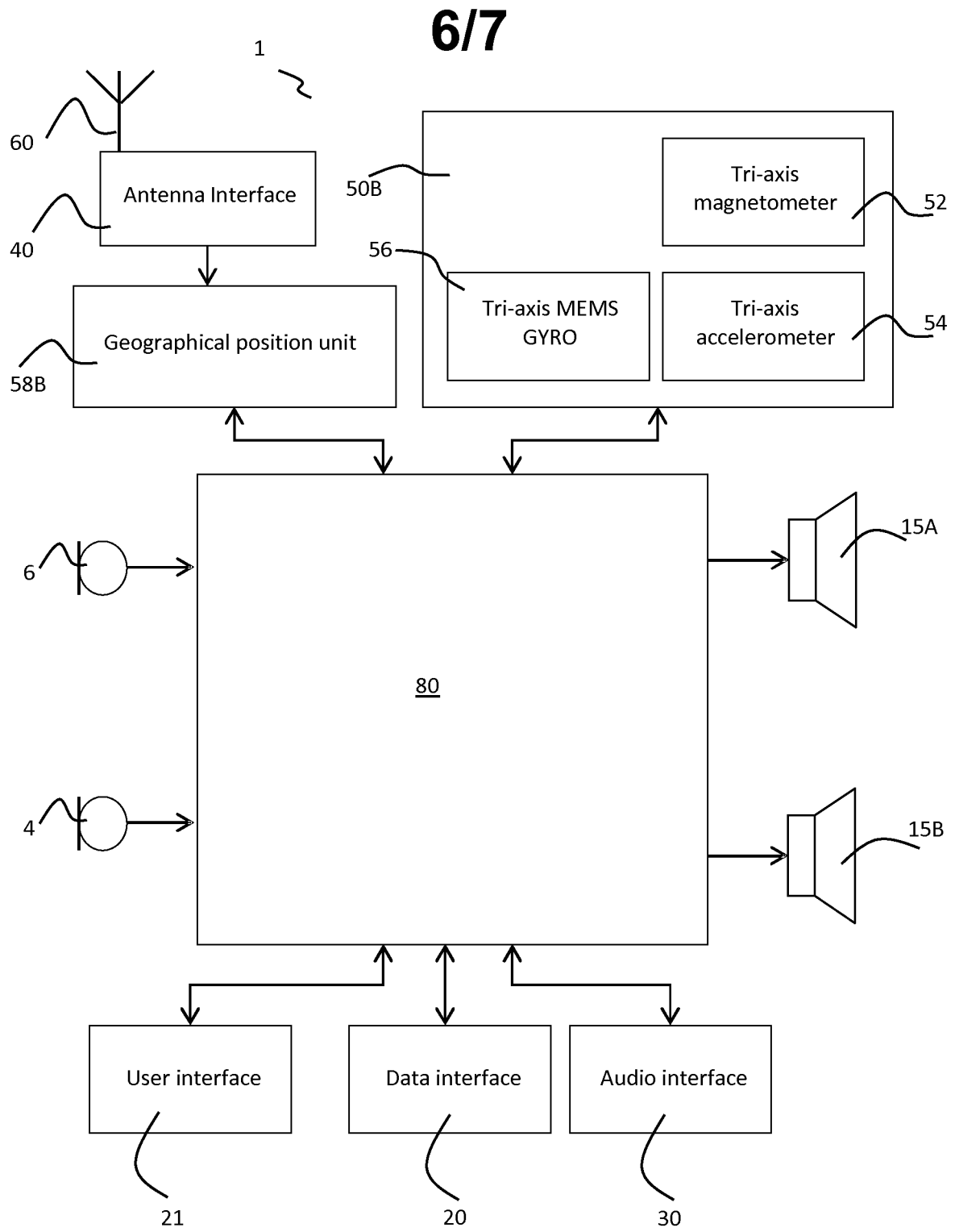


Fig. 5

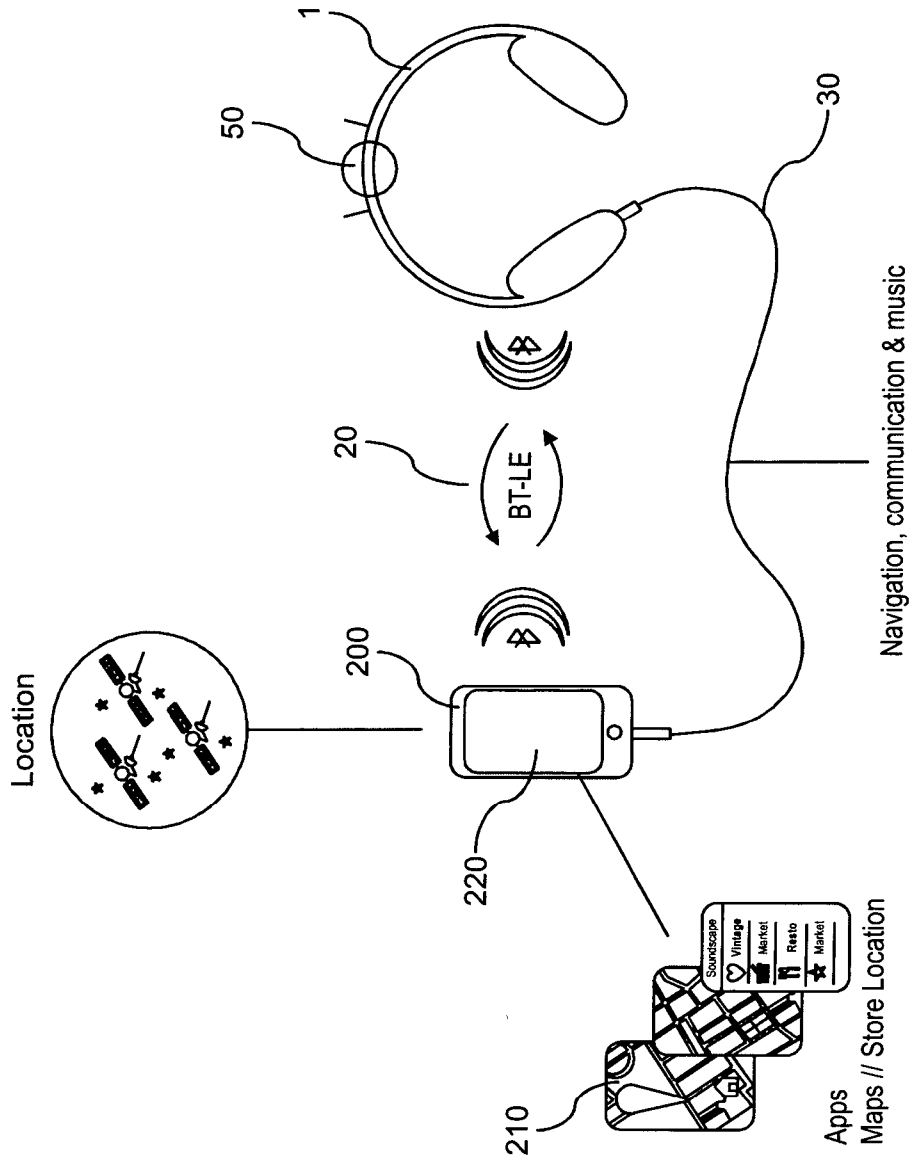


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/056931

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04S7/00 H04R1/10 G01C21/36
ADD.
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)
H04S G01C H04R
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)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 01/55833 A1 (LAKE TECHNOLOGY LTD [AU]; LAYTON LEONARD CHARLES [AU]; MCGRATH DAVID S) 2 August 2001 (2001-08-02) abstract; figures page 1, line 15 - page 4, line 24 page 6, line 1 - line 21 page 8, line 24 - page 10, line 31 page 14, line 15 - page 15, line 3 -----	1-35
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Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents :

<p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier application or patent but published on or after the international filing date</p> <p>"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)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p>	<p>"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</p> <p>"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</p> <p>"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</p> <p>"&" document member of the same patent family</p>
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Date of the actual completion of the international search 26 July 2013	Date of mailing of the international search report 02/08/2013
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Scappazzoni, E
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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