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(54) Title: HEAD-WORN COMPUTING SYSTEMS

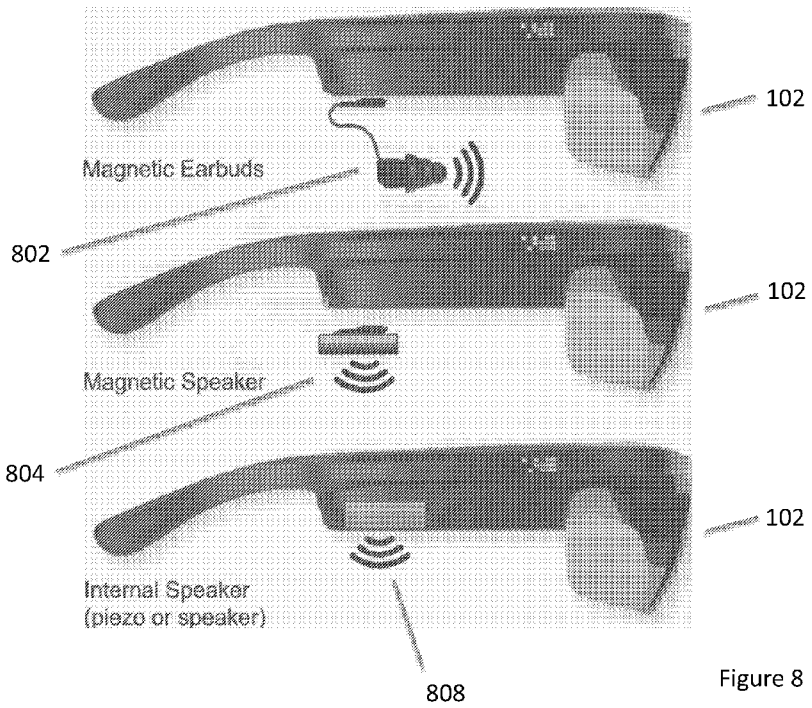

Figure 8

(57) Abstract: Aspects of the present invention relate to a head-worn computing system for language translation. The head-worn computing system of the present invention comprises: a head-worn computer for recording a spoken utterance of a person wearing the head-worn computer and converting the spoken utterance into a language other than a first spoken language represented by the spoken utterance; and

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a speaker of sufficient size to produce sound intensity. The head-worn computer displays, in a see-through head-worn display mechanically supported by the head-worn computer, a visual representation of the first spoken language.

HEAD-WORN COMPUTING SYSTEMS

Cross Reference to Related Applications

[0001] This application claims the benefit of the following U.S. patent applications, which are incorporated by reference herein in their entirety:

[0002] United States Non-Provisional Application No. 14/262,615, filed April 25, 2014 (ODGP-4001-U01); United States Non-Provisional Application No. 14/307,465, filed June 17, 2014 (ODGP-4002-U01); United States Non-Provisional Application No. 14/323,123, filed July 3, 2014 (ODGP-4003-U01); United States Non-Provisional Application No. 14/490,586, filed September 18, 2014 (ODGP-4004-U01); and United States Non-Provisional Application No. 14/659,815, filed March 17, 2015 (ODGP-4007-U01).

Background

Field of the Invention

[0003] This invention relates to head worn computing. More particularly, this invention relates to head-worn computing systems.

Description of Related Art

[0004] Wearable computing systems have been developed and are beginning to be commercialized. Many problems persist in the wearable computing field that need to be resolved to make them meet the demands of the market.

Summary

[0005] Aspects of the present invention relate to head-worn computing systems.

[0006] These and other systems, methods, objects, features, and advantages of the present invention will be apparent to those skilled in the art from the following detailed description of the preferred embodiment and the drawings. All documents mentioned herein are hereby incorporated in their entirety by reference.

Brief Description of the Drawings

[0007] Embodiments are described with reference to the following Figures. The same numbers may be used throughout to reference like features and components that are shown in the Figures:

[0008] Figure 1 illustrates a head worn computing system in accordance with the principles of the present invention.

[0009] Figure 2 illustrates a head worn computing system with optical system in accordance with the principles of the present invention.

[00010] Fig. 3A, Fig. 3B, and Fig. 3C illustrate three views of a head worn computer in accordance with the principles of the present invention.

[00011] Figure 4 illustrates a temple and ear horn in accordance with the principles of the present invention.

[00012] Fig. 5A, Fig. 5B, Fig. 5C, Fig. 5D, Fig. 5E. and Fig. 5F illustrate a temple and ear horn assembly in various states in accordance with the principles of the present invention.

[00013] Figure 6 illustrates an adjustable nose bridge assembly in accordance with the principles of the present invention.

[00014] Figure 7 illustrates an adjustable nose bridge assembly in accordance with the principles of the present invention.

[00015] Figure 8 illustrates speaker assemblies for head-worn computers in accordance with the principles of the present invention.

[00016] Figure 9 illustrates a stiff ear horn with a touch pad for a head-worn computer in accordance with the principles of the present invention.

[00017] Figure 10 illustrates a top plate in accordance with the principles of the present invention.

[00018] Figure 11 illustrates temperature test results of an embodiment of the present invention.

[00019] While the invention has been described in connection with certain preferred embodiments, other embodiments would be understood by one of ordinary skill in the art and are encompassed herein.

Detailed Description of the Preferred Embodiment(s)

[00020] Aspects of the present invention relate to head-worn computing ("HWC") systems. HWC involves, in some instances, a system that mimics the appearance of head-worn glasses or sunglasses. The glasses may be a fully developed computing platform, such as including computer displays presented in each of the lenses of the glasses to the eyes of the user. In embodiments, the lenses and displays may be configured to allow a person wearing the glasses to see the environment through the lenses while also seeing, simultaneously, digital imagery, which forms an overlaid image that is perceived by the person as a digitally augmented image of the environment, or augmented reality ("AR").

[00021] HWC involves more than just placing a computing system on a person's head. The system may need to be designed as a lightweight, compact and fully functional computer display, such as wherein the computer display includes a high resolution digital display that provides a high level of emersion comprised of the displayed digital content and the see-through view of the environmental surroundings. User interfaces and control systems suited to the HWC device may be required that are unlike those used for a more conventional computer such as a laptop. For the HWC and associated systems to be most effective, the glasses may be equipped with sensors to determine environmental conditions, geographic location, relative positioning to other points of interest, objects identified by imaging and movement by the user or other users in a connected group, and the like. The HWC may then change the mode of operation to match the conditions, location, positioning, movements, and the like, in a method generally referred to as a contextually aware HWC. The glasses also may need to be connected, wirelessly or otherwise, to other systems either locally or through a network. Controlling the glasses may be achieved through the use of an external device, automatically through contextually gathered information, through user gestures captured by the glasses sensors, and the like. Each technique may be further refined depending on the software application being used in the glasses. The glasses may further be used to control or coordinate with external devices that are associated with the glasses.

[00022] Referring to Fig. 1, an overview of the HWC system 100 is presented. As shown, the HWC system 100 comprises a HWC 102, which in this instance is configured as glasses to be worn on the head with sensors such that the HWC 102 is aware of the objects and conditions in the environment 114. In this instance, the HWC 102 also receives and interprets control inputs such as gestures and movements 116 of body parts of a user. The HWC 102 may communicate with external user interfaces 104. The external user interfaces 104 may provide a physical user interface to take control instructions from a user of the HWC 102 and the external user interfaces 104 and the HWC 102 may communicate bi-directionally to affect the user's command and provide feedback to the external device 108. The HWC 102 may also communicate bi-directionally with externally controlled or coordinated local devices 108. For example, an external user interface 104 may be used in connection with the HWC 102 to control an externally controlled or coordinated local device 108. The externally controlled or coordinated local device 108 may provide feedback to the HWC 102 and a customized GUI may be presented in the HWC 102 based on the type of device or specifically identified device 108. The HWC 102 may also interact with remote devices and information sources 112 through a network connection 110. Again, the external user interface 104 may be used in connection with the HWC 102 to control or otherwise interact with any of the remote devices 108 and information sources 112 in a similar way as when the external user interfaces 104 are used to control or otherwise interact with the externally controlled or coordinated local devices 108. Similarly, HWC 102 may interpret gestures 116 (e.g captured from forward, downward, upward, rearward facing sensors such as camera(s), range finders, IR sensors, etc.) or environmental conditions sensed in the environment 114 to control either local or remote devices 108 or 112.

[00023] We will now describe each of the main elements depicted on Fig. 1 in more detail; however, these descriptions are intended to provide general guidance and should not be construed as limiting. Additional description of each element may also be further described herein.

[00024] The HWC 102 is a computing platform intended to be worn on a person's head. The HWC 102 may take many different forms to fit many

different functional requirements. In some situations, the HWC 102 will be designed in the form of conventional glasses. The glasses may or may not have active computer graphics displays. In situations where the HWC 102 has integrated computer displays the displays may be configured as see-through displays such that the digital imagery can be overlaid with respect to the user's view of the environment 114. There are a number of see-through optical designs that may be used, including ones that have a reflective display (e.g. LCoS, DLP), emissive displays (e.g. OLED, LED), hologram, TIR waveguides, and the like. In embodiments, lighting systems used in connection with the display optics may be solid state lighting systems, such as LED, OLED, quantum dot, quantum dot LED, etc. In addition, the optical configuration may be monocular or binocular. It may also include vision corrective optical components. In embodiments, the optics may be packaged as contact lenses. In other embodiments, the HWC 102 may be in the form of a helmet with a see-through shield, sunglasses, safety glasses, goggles, a mask, fire helmet with see-through shield, police helmet with see through shield, military helmet with see-through shield, utility form customized to a certain work task (e.g. inventory control, logistics, repair, maintenance, etc.), and the like.

[00025] The HWC 102 may also have a number of integrated computing facilities, such as an integrated processor, integrated power management, communication structures (e.g. cell net, WiFi, Bluetooth, local area connections, mesh connections, remote connections (e.g. client server, etc.)), and the like. The HWC 102 may also have a number of positional awareness sensors, such as GPS, electronic compass, altimeter, tilt sensor, IMU, and the like. It may also have other sensors such as a camera, rangefinder, hyper-spectral camera, Geiger counter, microphone, spectral illumination detector, temperature sensor, chemical sensor, biologic sensor, moisture sensor, ultrasonic sensor, and the like.

[00026] The HWC 102 may also have integrated control technologies. The integrated control technologies may be contextual based control, passive control, active control, user control, and the like. For example, the HWC 102 may have an integrated sensor (e.g. camera) that captures user hand or body gestures 116 such that the integrated processing system can interpret the gestures and generate control commands for the HWC 102. In

another example, the HWC 102 may have sensors that detect movement (e.g. a nod, head shake, and the like) including accelerometers, gyros and other inertial measurements, where the integrated processor may interpret the movement and generate a control command in response. The HWC 102 may also automatically control itself based on measured or perceived environmental conditions. For example, if it is bright in the environment the HWC 102 may increase the brightness or contrast of the displayed image. In embodiments, the integrated control technologies may be mounted on the HWC 102 such that a user can interact with it directly. For example, the HWC 102 may have a button(s), touch capacitive interface, and the like.

[00027] As described herein, the HWC 102 may be in communication with external user interfaces 104. The external user interfaces may come in many different forms. For example, a cell phone screen may be adapted to take user input for control of an aspect of the HWC 102. The external user interface may be a dedicated UI, such as a keyboard, touch surface, button(s), joy stick, and the like. In embodiments, the external controller may be integrated into another device such as a ring, watch, bike, car, and the like. In each case, the external user interface 104 may include sensors (e.g. IMU, accelerometers, compass, altimeter, and the like) to provide additional input for controlling the HWD 104.

[00028] As described herein, the HWC 102 may control or coordinate with other local devices 108. The external devices 108 may be an audio device, visual device, vehicle, cell phone, computer, and the like. For instance, the local external device 108 may be another HWC 102, where information may then be exchanged between the separate HWCs 108.

[00029] Similar to the way the HWC 102 may control or coordinate with local devices 106, the HWC 102 may control or coordinate with remote devices 112, such as the HWC 102 communicating with the remote devices 112 through a network 110. Again, the form of the remote device 112 may have many forms. Included in these forms is another HWC 102. For example, each HWC 102 may communicate its GPS position such that all the HWCs 102 know where all of HWC 102 are located.

[00030] Figure 2 illustrates a HWC 102 with an optical system that includes an upper optical module 202 and a lower optical module 204. While the upper and lower optical modules 202 and 204 will generally be described as separate modules, it should be understood that this is illustrative only and the present invention includes other physical configurations, such as that when the two modules are combined into a single module or where the elements making up the two modules are configured into more than two modules. In embodiments, the upper module 202 includes a computer controlled display (e.g. LCoS, DLP, OLED, etc.) and image light delivery optics. In embodiments, the lower module includes eye delivery optics that are configured to receive the upper module's image light and deliver the image light to the eye of a wearer of the HWC. In figure 2, it should be noted that while the upper and lower optical modules 202 and 204 are illustrated in one side of the HWC such that image light can be delivered to one eye of the wearer, that it is envisioned by the present invention that embodiments will contain two image light delivery systems, one for each eye. It should also be noted that while many embodiments refer to the optical modules as "upper" and "lower" it should be understood that this convention is being used to make it easier for the reader and that the modules are not necessarily located in an upper-lower relationship. For example, the image generation module may be located above the eye delivery optics, below the eye delivery optics, on a side of the eye delivery optics, or otherwise positioned to satisfy the needs of the situation and/or the HWC 102 mechanical and optical requirements.

[00031] An aspect of the present invention relates to the mechanical and electrical construction of a side arm of a head worn computer. In general, when a head worn computer takes the form of glasses, sun-glasses, certain goggles, or other such forms, two side arms are included for mounting and securing the had worn computer on the ear's of a person wearing the head worn computer. In embodiments, the side arms may also contain electronics, batteries, wires, antennas, computer processors, computer boards, etc. In embodiments, the side arm may include two or more sub assemblies. For example, as will be discussed in more detail below, the side arm may include a temple section and an ear horn section. The two sections may, for example, be mechanically arranged

to allow an ear horn section to move such that both side arms can fold into a closed position.

[00032] Fig. 3A, Fig. 3B and Fig. 3C illustrate three separate views of a head worn computer 102 according to the principles of the present invention. Turning to the head worn computer illustrated as Fig. 3A, one side arm of the HWC 102 is folded into its closed position. The ear horn section 308 of the side arm is rotated relative to its temple section 304 to create space relative to the other side arm 310 so when the other side arm is moved into its closed position it can fully close. In a situation where the ear horn did not rotate to create the space (not illustrated) the ear horn would physically interfere with the other side arm 310, when the side arm was in the closed position, and prevent the other side arm 310 from fully closing. The HWC Fig. 3B view illustrates the HWC Fig. 3B with both side arms folded into a fully closed position. Note that the ear horn 308 is in the rotated position with respect to its temple section 304 such that the other arm 310 closed without interfering with the ear horn 308. The HWC Fig. 3C view also illustrates both arms in closed positions with the ear horn 308 rotated to create the space for the other arm 310 to fully close. Fig. 3C also illustrates a portion of the HWC 102 where electronics may be housed in a top mount 312. The top mount may contain electronics, sensors, optics, processors, memory, radios, antennas, etc.

[00033] Figure 4 illustrates a side arm configuration in accordance with the principles of the present invention. In this embodiment, the side arm includes two sub assemblies: the temple section 304 and the ear horn 308. Figure 4 illustrates two views of the side arm assembly, one from an outer perspective and one from a sectioned perspective. The ear horn includes a pin 402 that is designed to fit into a hole 404 and to be secured by connector 408. The connector 408 is rotatable and in one position locks the pin 402 in place and in another position unsecures the pin 402 such that the ear horn 308 can be removed and re-attached to the temple section 304. This allows the detachment and re-attachment of the ear horn 308 from the temple section 304. This also allows for the sale of different ear horns 308 for replacement, of which a variety of colors and patterns may be offered. In embodiments, the temple section 304

may include a battery compartment 410 and other electronics, wires, sensors, processors, etc.

[00034] Fig. 5A, Fig. 5B, Fig. 5C, Fig. 5D, Fig. 5E. and Fig. 5F illustrate several views of a HWC side arm with temple 304 and ear horn 308 sections. The views include outer perspectives and cross sections as well as various states of the security of the ear horn 308 with the temple section 304. One embodiment of an outer perspective and cross-section of a temple assembly and earhorn assembly is shown in Fig. 5A and Fig. 5B, respectively, including connector and pin assembly 510A, wherein the ear horn is in its final secured position and ready to be put on the head of a user Fig. 5C and Fig. 5D illustrate the ear horn 308 and the temple section 304 in a secure, but separated and un-rotated position. The same pin 402 and connector 408 system described in connection with Figure 4 is illustrated in the cross sections of Fig. 5E and Fig. 5F at connector and pin assembly 512. In the secured un-rotated position the pin is pulled internally within the temple section firmly such that it stays in place. Fig. 5C and Fig. 5D illustrate a state where the ear horn 308 is separated from the temple section 304. This state is achieved when pressure is used to pull on the ear horn 308. In embodiments, the pressure is exerted by a user pulling on the ear horn 308, which compresses a spring in the connector and pin assembly 510B that is mechanically associated with the pin 402 in the ear horn 308. The mechanism uses the spring to maintain pressure on the pin 402 to maintain connection with the connector 408 when the connector 408 is in a position to lock the pin 402 in position. Fig. 5E and Fig. 5F illustrates a state where, after the ear horn 308 has been pulled into the state described in connection with Fig. 5C and Fig. 5D, the ear horn 308 is rotated about the pin 402. This puts the ear horn 308 in a rotated position as described herein such that the first arm, with this rotated ear horn 308, does not interfere with the closure of the other arm 310 when the two arms are folded into the closed position. Fig. 5E and Fig. 5F illustrates the connector and pin assembly as continuing to secure the ear horn 308 to the temple 304 in the rotated position.

[00035] An aspect of the present invention relates to an adjustable nose bridge. An adjustable nose bridge may be important with head worn computers, especially those with computer displays, to ensure comfort and

alignment of the displays and/or other portions of the head worn computer. Figure 6 illustrates a HWC 102 with an adjustable nose bridge 602. The nose bridge is adjustable through a mechanism in the HWC 102. In embodiments, the mechanism includes a fixed notched attachment 604, a movable pin 608 adapted to fit into the notches of the notched attachment 604, and a selection device 610 that is attached to the movable pin 608. The movable pin 608 and nose bridge 602 are connected such that the as the movable pin 608 shifts in position the nose bridge 602 moves in position as well. The selection device 610 causes the movable pin 608 to engage and disengage with the fixed notched attachment 604 when presses and allowed to retract. As illustrated in figure 6, the selection device 610 is not in a pressed position so the movable pin 608 is engaged with the notched attachment 604 such that the nose bridge is securely attached in a stable position. Figure 7 illustrates a scenario where the selection device is pressed, or activated, such that the moveable pin 608 is no longer engaged with the fixed notched attachment 604. This allows the nose bridge 602 to move up and down with respect to the rest of the HWC 102. Once the movable pin 608 aligns with a notch of the notched attachment 604, the two parts may engage to re-secure the nose bridge in the HWC 102.

[00036] In embodiments, a side arm of the HWC 102 may include an audio jack (not shown) and the audio jack may be magnetically attachable to the side arm. For example, the temple section 304 or ear horn section 308 may have a magnetically attachable audio jack with audio signal wires associated with an audio system in the HWC 102. The magnetic attachment may include one or more magnets on one end (e.g. on the head phone end or the side arm end) and magnetically conductive material on the other end. In other embodiments, both ends of the attachment may have magnets, of opposite polarization, to create a stronger magnetic bond for the headphone). In embodiments, the audio signal wires or magnetic connection may include a sensor circuit to detect when the headphone is detached from the HWC 102. This may be useful in situations where the wearer is wearing the headphones during a period when there is not constant audio processing (e.g. listening for people to talk with periods of silence). In embodiments, the other side's headphone may play a tone, sound,

signal, etc. in the event a headphone is detached. In embodiments, an indication of the detachment may be displayed in the computer display.

[00037] In embodiments, the HWC 102 may have a vibration system that vibrates to alert the wearer of certain sensed conditions. In embodiments, the vibration system (e.g. an actuator that moves quickly to cause vibration in the HWC 102) may be mounted in a side arm (e.g. the temple section 304, or ear horn 308), in the top mount 312, etc. In embodiments, the vibration system may be capable of causing different vibration modes that may be indicative of different conditions. For example, the vibration system may include a multi-mode vibration system, piezo-electric vibration system, variable motor, etc., that can be regulated through computer input and a processor in the HWC 102 may send control signals to the vibration system to generate an appropriate vibration mode. In embodiments, the HWC 102 may be associated with other devices (e.g. through Bluetooth, WiFi, etc.) and the vibratory control signals may be associated with sensors associated with the other device. For example, the HWC 102 may be connected to a car through Bluetooth such that sensor(s) in the car can cause activation of a vibration mode for the vibration system. The car, for example, may determine that a risk of accident is present (e.g. risk of the driver falling asleep, car going out of its lane, a car in front of the wearer is stopped or slowing, radar in the car indicates a risk, etc.) and the car's system may then send a command, via the Bluetooth connection, to the HWC 102 to cause a vibratory tone to be initiated in the HWC 102.

[00038] Another aspect of the present invention relates to a removable and replaceable speaker assembly for a HWC 102. There are times when different speaker types are desired or when a speaker may malfunction. It is therefore desirable to have a speaker assembly that is removable and replaceable by the user. To facilitate the removal and reattachment of the speaker assembly a magnetic or magnetic attachment system may be included. For example, the speaker assembly and head-worn computer may include magnetic elements such that the speaker can be removed by exerting pressure and replaced by getting the two sections close to one another. In another example, the speaker or head-worn computer may have a button, slider, etc. that can be interacted with to remove the speaker. In embodiments, the speaker

assembly may have a form factor of an ear bud, ear phone, head phone, head set, external ear speaker, etc. In embodiments, the speaker assembly may include a vibratory system to provide haptic feedback to the user. In embodiments, such a removable and replaceable speaker system may be provided to both of the user's ears.

[00039] Figure 8 illustrates several embodiments where HWC 102's are associated with speaker systems. Earbud 802 may be removably attached to the HWC 102 with a magnetic system or mechanical system or combination thereof. Speaker 804 may also be removably attached to the HWC102 in a similar way. The speaker 804 may be positioned to emit sound towards the user's ear but not actually be positioned in the ear. This configuration may provide for greater environmental hearing for the user as the ear would not be blocked by an ear bud, head phone, etc. The speaker 804 may generate audio waves and/or ultrasonic waves that are converted into audio when they are emitted through the air. When ultrasonic transducers are used, more than one frequency transducer may be included. See http://en.m.wikipedia.org/wiki/Sound_from_ultrasound and http://www.holosonics.com for references on generating sound from ultrasound. The speaker and/or piezo vibratory system 808 is depicted as integrated into the temple. In embodiments, this module may be integrated such that it can be removed and replaced and it may also be adapted such that it does not hang below the temple piece. Each of the removable and replaceable speaker systems described herein may include a vibratory system (e.g. piezo electric circuit that is controlled by the HWC 102.

[00040] In embodiments, a head-worn computer may include a temple portion mechanically secured to a computer display and adapted to position the computer display in front of an eye of a user, and the temple portion including a speaker attachment, wherein the speaker attachment is adapted to securely position a speaker assembly and electrically associate the speaker assembly with electronics internal to the head-worn computer and facilitate the user's release and re-securing of the speaker assembly with the temple portion. The speaker attachment may include a magnetic element, moveable mechanical element, etc. or combination thereof to secure and unsecure the speaker system

from the HWC 102. The speaker assembly may have a form factor adapted to be inserted into an outer ear of the user, cover at least a portion of an outer ear of the user, cover substantially all of an outer ear of the user, to position the speaker under the temple assembly and above an ear of the user, to position a speaker under the temple assembly and in front of an ear of the user, angle the speaker towards the ear, etc. The speaker system may further have a vibratory system to provide haptic feedback to the user. The haptic feedback may be coordinated with a game being presented in the computer display, an application running on the HWC 102, etc. In embodiments, a vibratory system is provided in both speaker systems to provide controllable haptic feedback in stereo and/or on both or either side of the user's head.

[00041] In embodiments, the connection between the speaker system and the HWC 102 may be positioned other than under the temple section. It may be positioned on a side, top, bottom, end of a section of the side arm, for example. It may be positioned on the front bridge, for example. In embodiments, the speaker system may be connected to a top or side portion and the speaker may be further positioned to face forward, away from the user's ear. This may be a useful configuration for providing sound to others. For example, such a configuration may be used when the user wants to provide translations to a person nearby. The user may speak in a language, have the language translated, and then spoken through the forward facing speakers.

[00042] The removable nature of the speaker systems may be desirable for breakaway situations so a snag does not tear the glasses from the user or pull hard on the user's ear. The removable nature may also be useful for modularity configurations where the user wants to interchange speaker types or attach other accessories. For example, the user may want ear buds at one point and an open ear speaker configuration at another point and the user may be able to make the swap with ease given this configuration. The port on the HWC 102 may also be adapted for other accessories that include lights or sensors for example. The accessory may have an ambient light sensor to assist with the control of the lighting and contrast systems used in the HWC 102 displays, for example. In embodiments, the speaker port may be used as a charging port for the HWC 102 or data port for the HWC 102.

[00043] An aspect of the present invention relates to a language translation system with a head-worn computer. In embodiments, the head-worn computer includes a microphone and an audio communication system. The microphone is associated with a processor and is used to record a spoken utterance of a person wearing the head-worn computer. The microphone is positioned in the head-worn computer such that the person wearing the head-worn computer can speak in a normal tone and volume and the microphone will record the user's utterances. The head-worn system is further adapted to convert the spoken utterance into a language other than a first spoken language represented by the spoken utterance, forming translated language. For example, if the user is speaking in English, the recorded English spoken words will be recognized and converted into a second language (e.g. Spanish). The converted language can then be played in an audio system such that the converted language is played through an associated speaker system.

[00044] The speaker in the language translation system may be wired or wirelessly connected to the head-worn computer. The speaker also will be of sufficient size and power to produce sound intensity such that a person at a conversational distance can hear the sound at a conversational level. For example, the speaker may produce sound in a range of approximately 30 to 40 db at a distance of 5 feet from the speaker. This is a relatively quiet conversational sound intensity and may be used in a quiet sound level environment. The speaker may produce sound in a range of approximately 40 to 60 db at a distance of 5 feet from the speaker. This is a moderate sound level and may be used in a moderate sound level environment. The speaker may produce sound in a range of approximately 60 to 80 db at a distance from 5 feet of the speaker. This is a relatively loud sound level and may be used in a loud environment. The speaker may be powerful enough for a maximum level (e.g. 80 db) and the audio system may be controllable to a lower level (e.g. 30 db). In embodiments, the sound level from the speaker may be automatically regulated depending on the sound in the environment. In embodiments, the sound level may be manually regulated. A manually regulated system may be regulated through gesture control, an external user interface adapted to regulate aspects of the head-worn computer, a control mounted on the head-worn computer, etc.

The manually regulated system may be regulated by a control on the speaker itself.

[00045] In embodiments, the speaker is adapted to be positioned separately from the head-worn computer at a spot where it can be secured mechanically but to cause the sound to emanate from a direction similar to the direction of the user's speech. For example, the speaker may be mechanically adapted to fit into a shirt pocket of the user. This at least partially conceals the speaker and secures it such that the sound comes from a similar direction as the user's speech. The speaker may be mechanically adapted to clip onto a shirt of the user or otherwise adapted to be properly positioned.

[00046] The head-worn computer may be further adapted to communicate the translated language to the speaker and display, in a see-through head-worn display mechanically supported by the head-worn computer, a visual representation of the first or second language. For example, the visual representation may be a representation of the original language converted based on the utterances such that the person wearing the head-worn computer can see, as a confirmation, the language that was the output of the conversion process. This can help to avoid miscommunications. In the event that the conversion process improperly converted the spoken language, the user would be able to correct the system because the visual representations would give him the indication of improper conversion. As another example, the visual display may represent the converted language. This may help the person wearing the head-worn computer learn the second language. It may also be useful in a situation where the user is trying to speak the second language and just wants help from the head-worn system from time to time. For example, the user may have the language conversion system off, and then turn it on when he finds himself lacking an understanding of how to say something in the second language. Once on, the conversion system can assist him by speaking the converted language to the other person and/or displaying the words or other representations in the see-through display.

[00047] In embodiments, the user may be able to turn the visual representation of the first or second language off. This user control may be helpful in a number of situations. For example, the user may want to rely on the

conversion system and not want the additional distraction of the visual representations of the language presented in his field of view. This may be the case when the user needs to provide greater attention to the other person, situation or environment. The user control may be controlled by a gesture, external user interface, head-worn computer mounted user interface, etc. The user interface may also provide a visual representation of the user interface and/or the state of the user interface in the see-through display.

[00048] Another aspect of the language conversion system in the head-worn computer relates to the control of the audible tone of the second language produced through the speaker system. There may be situations where the use of a custom or predetermined audible tone may be useful. For example, if the audible tone from the speaker approximates the audible tone of the user himself than the system may produce a more personal situation between the user and the listener. For example, the translated language may have an audible spectrum based on the user's spoken utterances. The audible spectrum may be determined through an analysis of the spoken utterance's spectrum. The analysis may result in one of a plurality of pre-determined tones to be used when communicating the translated language to the speaker. For example, selected tone may be a high male tone, mid-tone male, low male tone, high female tone, mid-tone female, low female tone, etc. In embodiments, the user may manually select the tone.

[00049] In embodiments, the audible tone of the spoken utterances is analyzed and categorized by a signature, wherein the signature defines power within spectral ranges. The signature can then be used to modify the tone of the speaker system. For example, the signature may indicate that a high frequency range in the person's voice is not powerful so a spectral filter with a suppression of the range may be applied to the tone produced by the speaker system. A technique generally referred to as voice morphing may be used to approximate the user's voice. See the following published paper for additional information on voice morphing: Eng. Dept., Cambridge Univ., UK, DOI: 10.1109/ICASSP.2004.1325909 Conference: Acoustics, Speech, and Signal Processing, 2004. Proceedings. (ICASSP '04). IEEE International Conference on, Volume: 1.

[00050] Another aspect of the present invention relates to securing the head-worn computer 102 to the user's head in a way that the computer does not slip down the nose of the user, due to the extra front weight of the HWC 102, but does not create discomfort for the user. While some have designed systems that use lateral force between the two side arms to squeeze the HWC arms on the sides of the user's head, this solution tends to cause comfort problems. The squeeze on the user's head has to be relatively high, as compared to non-computer glasses, to maintain enough pressure to overcome the additional weight in the front of the glasses and this high pressure tends to cause comfort issues. In embodiments of the present invention, a substantially stiff ear horn is provided and the back end of the ear horn wraps around the user's head and touches the user's head. The touch point is towards the back of the user's head such that it provides a point or area of counteracting force for the HWC 102 if it tries to pull forward or down the user's nose due to the front weight of the HWC 102. In embodiments, the end of the ear horn, or a section near the end, has a touch pad. The touch pad may be made of soft material so it is comfortable on the back of the user's head. In embodiments, the touch pad may be mounted such that it has angular flexibility. The angular flexibility allows the touch pad to better align with the touch point on the user's head so it can provide the counteractive force but spread the force over an area for greater comfort.

[00051] In embodiments, a head-worn computer is provided and has a see-through computer display configured to be mounted on the head of a user; a side arm configured to secure the see-through computer display to the user's head, the side arm further configured to be positioned to lay against the user's head proximate an ear of the user; and the side arm including a stiff member extending behind the ear of the user, contoured to substantially follow a curvature of the user's head behind the ear of the user, and to touch a portion of the user's head towards the rear of the user's head such that the see-through computer display remains substantially secure in a position in front of an eye of the user.

[00052] In embodiments, the stiff member is removeably secured to a temple portion of the side arm (as described herein elsewhere). The stiff member may be telescopically adjustable to fit the user's head. The stiff member

may be provided with a ratchet style securing mechanism for adjusting the telescopic adjustment. The stiff member may be provided with a rotatable style securing mechanism for adjusting the telescopic adjustment, or another style securing mechanism may be provided. The stiff member may touch a portion of the user's head at a rear end of the stiff member. The rear end of the stiff member may include a touch pad. The touch pad may be made of a soft material to increase the comfort and surface area of the touch area. The touch pad may be attached such that it has angular flexibility such that the touch pad changes position to increase a touch surface in contact with the rear of the user's head.

[00053] Figure 9 illustrates a HWC 102 mounted on the head of a user. The HWC 102 has a see-through optics module 204, a temple portion 304, a stiff ear horn 904 and a head-touch pad 902. As described herein elsewhere, the stiff ear horn 904 may be removable and replaceable. This can be useful when the exchange of ear horns from one type to another or one size to another is desired, for example. The stiff ear horn 904 may be made of aluminum, aluminum tubing, carbon fiber, or other material that is relatively stiff. The stiffness should be of a level that provides for lateral inflexibility such that the touch pad 902 can exert counteracting force with a high rear facing vector. Too much flexibility in the stiff ear horn 904 can detract from the rear-facing vector of force when the weight of the HWC 102 is pulling forward/down the nose. In embodiments, several different lengths, shapes, stiffnesses, etc. of stiff ear horn 904 may be provided so the user can select the set that best serves his purpose. The head-touch pad 902 may be made of a soft material, malleable material, etc. to provide comfort to the user and to increase the head touch surface. The head-touch pad 902 may also be mounted in such a way that the head-touch pad 902 can flex and/or change angle as it is pressed upon. The head-touch pad 902 may, for example, be mounted on the stiff ear horn 904 with a hinge or pivot mechanism such that the head-touch pad 902 self aligns with the user's head when the HWC 102 is put on the user's head. This configuration may increase the touch surface area between the head-touch pad 902 and the user's head and generate a larger counteracting force to prevent the slipping or moving of the HWC 102.

[00054] In embodiments, the side arms of the HWC 102 are designed to exert inward lateral pressure on the user's head, but the lateral pressure is reduced so it is not uncomfortable, along with having stiff side arms 904 and head-touch pads 902. In these embodiments, the ear horns 904 and head touch pads 902 cause significant counteracting forces in addition to the counteracting forces applied through the inward lateral forces applied by the side arms.

[00055] Another aspect of the present invention relates to the thermal management of the head-worn computer. In embodiments, the head-worn computer is a high functioning self-contained computer with wireless connectivity where the electronics are compacted to fit into a glasses style form factor. In embodiments, the main heat producing electronics are in an upper portion of a bridge section over the top of the lenses of the head-worn computer (e.g. as described in connection with figure 3B). The thermal management technologies described herein manage the heat such that the system can operate in high temperature environments (e.g. 55 degrees C ambient) and maintain a comfortable temperature for the user (e.g. below 70 degrees C along the forehead section).

[00056] Figure 3B illustrates an embodiment of a head-worn computer wherein the electronics are housed in an upper bridge section above the lenses of the glasses form factor. This has been referred to as the top mount 312. The top mount 312 may include the majority of the electronics that are used to form the fully functional computer. This may include the processor, memory, sensors, cameras, optical drive system, etc. In this embodiment, the batteries are housed in the temple portions of the side arms. The top mount 312 may include a cavity where the circuit board(s) are housed and secured. The top mount may also include a top plate 1000 designed to be mounted on the top of the cavity such that it forms a portion of the enclosure. In embodiments, the top plate 1000 is designed to receive heat from the circuit board and/or components mounted on the circuit board and then dissipate the heat into the environment surrounding the head-worn computer.

[00057] Figure 10 illustrates several perspective views of an embodiment top plate 1000. The top plate outside view 1002 illustrates the heat

dissipating fins on the top of the top plate 1002. The heat dissipating fins are on the outside of the completed head-worn computer assembly and dissipate the heat into the surrounding environment. The top plate front view 1004 illustrates a front perspective of the top plate. The top plate inside view 1008 illustrates a bottom view of the top plate. The bottom is the portion that is on the inside of the circuit board cavity in the fully assembled head-worn computer. The bottom of the top plate 1000 may have features to facilitate the mechanical and thermal connection with the circuit board and/or components on the circuit board. For example, in the embodiment illustrated in figure 10 the top plate 1000 includes an internal component thermal connection pad 1010. The thermal connection pad 1010 may be adapted to mechanically and thermally connect with the internal circuit board and/or a component on the circuit board (e.g. the processor, memory, or other heat producing component). The assembly may have intervening material between the top plate 1000 and the circuit board and/or circuit board component (e.g. a heat spreader plate designed to receive heat from a component or set of components and then spread the heat over an area, thermally conductive paste, glue, pad, or other facilitating material). In embodiments, a thermally conductive material is placed between the circuit board and/or circuit board component(s) and the thermal connection pad 1010 of the top plate 1000 to eliminate any air gap that might otherwise develop as a result of the mechanical mismatch of the components in the assembly. This can further facilitate the transfer of heat from the heat producing component(s) (e.g. the processor) to the thermal connection pad 1010 and out to the surrounding environment through the heat dissipating fins. The inventors used a thermally conductive material from Fujupoly in the thermally tested devices. This material has an advertised thermal conductivity of 11 Watt/m-k. Watt/m-k is a unit of measurement of thermal efficiency for thermal interface material.

[00058] Figure 11 illustrates some test results relating to a head-worn computer with a top plate 1000 assembly as described herein. The head-worn computer was placed in an environmental chamber at 55 degrees Celsius. The head-worn computer was then turned on and the top plate 1000 temperature was observed. Operation of the processor was also observed. As can be seen, the maximum temperature of the top plate 1000 remained below 70

degrees Celsius. While 70 degrees Celsius is still a fairly hot maximum temperature, the heat dissipating fins caused the assembly to be comfortable to the human touch. In addition to maintaining an acceptable outside assembly temperature, the processor continued to operate throughout the testing, which is a significant advantage over the state of the art.

[00059] Although embodiments of HWC have been described in language specific to features, systems, computer processes and/or methods, the appended claims are not necessarily limited to the specific features, systems, computer processes and/or methods described. Rather, the specific features, systems, computer processes and/or and methods are disclosed as non-limited example implementations of HWC. All documents referenced herein are hereby incorporated by reference.

Illustrative Methods, Systems, User Interfaces, Displays, Computers, Optics, and Modules

[00060] In some implementations, configurations of a head-worn computer may be described in the following clauses or otherwise described herein and as illustrated in Figs. 3A, 3B, 3C, 4, 5A, 5B, 5C, 5D, 5E, and 5F.

1. A head-worn computer, comprising:
    a. A first side arm, including a temple section and an ear horn section;
    b. The temple section, including a securing attachment system; and
    c. The ear horn section, including a pin adapted to mate with the securing attachment system, wherein, when pressure is exerted to pull the ear horn section away from the temple section, the ear horn section securely separates from the temple section and the ear horn section is adapted to be rotated about the pin causing the ear horn to be positioned in a folding position; wherein the folding position includes clearance for a second side arm to fully fold on top of the first side arm.
2. The head-worn computer of clause 1, wherein the temple section further includes a battery compartment.

3. The head-worn computer of clause 1, wherein the first side arm is rotatably attached to a bridge section, wherein the bridge section holds a see-through optic.
4. The head-worn computer of clause 3 wherein see-through optic is positioned such that it is held in front of an eye of a person wearing the head-worn computer.
5. The head-worn computer of clause 1 wherein the securing attachment system is further adapted to release the pin when the securing attachment system is rotated.

[00061] In some implementations, configurations of a head-worn computer may be described in the following clauses or otherwise described herein and as illustrated in Fig. 8.

1. A head-worn computer, comprising:
    a. A temple portion mechanically secured to a computer display and adapted to position the computer display in front of an eye of a user; and
    b. The temple portion including a speaker attachment, wherein the speaker attachment is adapted to:
        i. securely position a speaker assembly and electrically associate the speaker assembly with electronics internal to the head-worn computer; and
        ii. facilitate the user's release and re-securing of the speaker assembly with the temple portion.
2. The head-worn computer of clause 1, wherein the speaker attachment includes a magnetic element.
3. The head-worn computer of clause 1, wherein the speaker attachment includes a movable mechanical element that secures and un-secures the speaker assembly.
4. The head-worn computer of clause 1, wherein the speaker assembly has a form factor adapted to be inserted into an outer ear of the user.

5. The head-worn computer of clause 1, wherein the speaker assembly has a form factor adapted to cover at least a portion of an outer ear of the user.
6. The head-worn computer of clause 1, wherein the speaker assembly has a form factor adapted to cover an outer ear of the user.
7. The head-worn computer of clause 1, wherein the speaker assembly has a form factor adapted to position a speaker under the temple assembly and above an ear of the user.
8. The head-worn computer of clause 1, wherein the speaker assembly has a form factor adapted to position a speaker under the temple assembly and in front of an ear of the user.
9. The head-worn computer of clause 7, wherein the speaker assembly produces an ultrasonic wave of a frequency that is converted to an audio frequency when the ultrasonic wave passes into air.
10. The head-worn computer of clause 1, wherein the speaker assembly includes a vibration system adapted to be controlled by the head-worn computer.
11. The head-worn computer of clause 10, wherein the vibration system includes a piezo circuit.
12. The head-worn computer of clause 11, wherein the vibration system is adapted to provide haptic feedback to the user.
13. The head-worn computer of clause 11, wherein the haptic feedback is associated with a game being presented in the computer display.
14. The head-worn computer of clause 11, wherein the haptic feedback is associated with an application executing on the head-worn computer.
15. The head-worn computer of clause 11, wherein a second vibration system is provided proximate a second ear of the user.

[00062] In some implementations, configurations of a head-worn computer may be described in the following clauses or otherwise described herein and as illustrated in Fig. 9.

1. A head-worn computer, comprising:

a. A see-through computer display configured to be mounted on the head of a user;

b. A side arm configured to secure the see-through computer display to the user's head, the side arm further configured to be positioned to lay against the user's head proximate an ear of the user; and

c. The side arm including a stiff member extending behind the ear of the user, contoured to substantially follow a curvature of the user's head behind the ear of the user, and to touch a portion of the user's head towards the rear of the user's head such that the see-through computer display remains substantially secure in a position in front of an eye of the user.

2. The head-worn computer of clause 1, wherein the stiff member is removeably secured to a temple portion of the side arm.

3. The head-worn computer of clause 1, wherein the stiff member is telescopically adjustable to fit the user's head.

4. The head-worn computer of clause 3 wherein the stiff member is provided with a ratchet style securing mechanism for adjusting the telescopic adjustment.

5. The head-worn computer of clause 3, wherein the stiff member is provided with a rotatable style securing mechanism for adjusting the telescopic adjustment.

6. The head-worn computer of clause 1, wherein the stiff member touches the portion of the user's head at a rear end of the stiff member.

7. The head-worn computer of clause 6, wherein the rear end of the stiff member includes a touch pad.

8. The head-worn computer of clause 7, wherein the touch pad is soft.

9. The head-worn computer of clause 7, wherein the touch pad has angular flexibility such that the touch pad changes position to increase a touch surface in contact with the rear of the user's head.

[00063] In some implementations, configurations of a head-worn computer may be described in the following clauses or otherwise described herein and as illustrated in Figs. 10 and 11.

1. A head-worn computer, comprising:
    a. An upper compartment adapted to contain a processor, memory, and a sensor system, the upper compartment positioned above a lens assembly and including a top plate;
    b. The top plate including a processor connection pad mechanically adapted to facilitate the connection between the processor and the top plate;
    c. A thermally conductive material positioned between the processor connection pad and the processor to reduce an air gap and to further facilitate the thermal connection between the processor and the top plate; and
    d. The top plate further having heat dissipation fins adapted to dissipate heat received from the processor.

[00064] While only a few embodiments of the present invention have been shown and described, it will be obvious to those skilled in the art that many changes and modifications may be made thereunto without departing from the spirit and scope of the present invention as described in the following claims. All patent applications and patents, both foreign and domestic, and all other publications referenced herein are incorporated herein in their entireties to the full extent permitted by law.

[00065] The methods and systems described herein may be deployed in part or in whole through a machine that executes computer software, program codes, and/or instructions on a processor. The present invention may be implemented as a method on the machine, as a system or apparatus as part of or in relation to the machine, or as a computer program product embodied in a computer readable medium executing on one or more of the machines. In embodiments, the processor may be part of a server, cloud server, client, network infrastructure, mobile computing platform, stationary computing platform, or other computing platform. A processor may be any kind of computational or processing device capable of executing program instructions, codes, binary instructions and the like. The processor may be or may include a

signal processor, digital processor, embedded processor, microprocessor or any variant such as a co-processor (math co-processor, graphic co-processor, communication co-processor and the like) and the like that may directly or indirectly facilitate execution of program code or program instructions stored thereon. In addition, the processor may enable execution of multiple programs, threads, and codes. The threads may be executed simultaneously to enhance the performance of the processor and to facilitate simultaneous operations of the application. By way of implementation, methods, program codes, program instructions and the like described herein may be implemented in one or more thread. The thread may spawn other threads that may have assigned priorities associated with them; the processor may execute these threads based on priority or any other order based on instructions provided in the program code. The processor, or any machine utilizing one, may include memory that stores methods, codes, instructions and programs as described herein and elsewhere. The processor may access a storage medium through an interface that may store methods, codes, and instructions as described herein and elsewhere. The storage medium associated with the processor for storing methods, programs, codes, program instructions or other type of instructions capable of being executed by the computing or processing device may include but may not be limited to one or more of a CD-ROM, DVD, memory, hard disk, flash drive, RAM, ROM, cache and the like.

[00066] A processor may include one or more cores that may enhance speed and performance of a multiprocessor. In embodiments, the process may be a dual core processor, quad core processors, other chip-level multiprocessor and the like that combine two or more independent cores (called a die).

[00067] The methods and systems described herein may be deployed in part or in whole through a machine that executes computer software on a server, client, firewall, gateway, hub, router, or other such computer and/or networking hardware. The software program may be associated with a server that may include a file server, print server, domain server, internet server, intranet server, cloud server, and other variants such as secondary server, host server, distributed server and the like. The server may include one or more of

memories, processors, computer readable media, storage media, ports (physical and virtual), communication devices, and interfaces capable of accessing other servers, clients, machines, and devices through a wired or a wireless medium, and the like. The methods, programs, or codes as described herein and elsewhere may be executed by the server. In addition, other devices required for execution of methods as described in this application may be considered as a part of the infrastructure associated with the server.

[00068] The server may provide an interface to other devices including, without limitation, clients, other servers, printers, database servers, print servers, file servers, communication servers, distributed servers, social networks, and the like. Additionally, this coupling and/or connection may facilitate remote execution of program across the network. The networking of some or all of these devices may facilitate parallel processing of a program or method at one or more location without deviating from the scope of the disclosure. In addition, any of the devices attached to the server through an interface may include at least one storage medium capable of storing methods, programs, code and/or instructions. A central repository may provide program instructions to be executed on different devices. In this implementation, the remote repository may act as a storage medium for program code, instructions, and programs.

[00069] The software program may be associated with a client that may include a file client, print client, domain client, internet client, intranet client and other variants such as secondary client, host client, distributed client and the like. The client may include one or more of memories, processors, computer readable media, storage media, ports (physical and virtual), communication devices, and interfaces capable of accessing other clients, servers, machines, and devices through a wired or a wireless medium, and the like. The methods, programs, or codes as described herein and elsewhere may be executed by the client. In addition, other devices required for execution of methods as described in this application may be considered as a part of the infrastructure associated with the client.

[00070] The client may provide an interface to other devices including, without limitation, servers, other clients, printers, database servers,

print servers, file servers, communication servers, distributed servers and the like. Additionally, this coupling and/or connection may facilitate remote execution of program across the network. The networking of some or all of these devices may facilitate parallel processing of a program or method at one or more location without deviating from the scope of the disclosure. In addition, any of the devices attached to the client through an interface may include at least one storage medium capable of storing methods, programs, applications, code and/or instructions. A central repository may provide program instructions to be executed on different devices. In this implementation, the remote repository may act as a storage medium for program code, instructions, and programs.

[00071] The methods and systems described herein may be deployed in part or in whole through network infrastructures. The network infrastructure may include elements such as computing devices, servers, routers, hubs, firewalls, clients, personal computers, communication devices, routing devices and other active and passive devices, modules and/or components as known in the art. The computing and/or non-computing device(s) associated with the network infrastructure may include, apart from other components, a storage medium such as flash memory, buffer, stack, RAM, ROM and the like. The processes, methods, program codes, instructions described herein and elsewhere may be executed by one or more of the network infrastructural elements. The methods and systems described herein may be adapted for use with any kind of private, community, or hybrid cloud computing network or cloud computing environment, including those which involve features of software as a service (SaaS), platform as a service (PaaS), and/or infrastructure as a service (IaaS).

[00072] The methods, program codes, and instructions described herein and elsewhere may be implemented on a cellular network having multiple cells. The cellular network may either be frequency division multiple access (FDMA) network or code division multiple access (CDMA) network. The cellular network may include mobile devices, cell sites, base stations, repeaters, antennas, towers, and the like. The cell network may be a GSM, GPRS, 3G, EVDO, mesh, or other networks types.

[00073] The methods, program codes, and instructions described herein and elsewhere may be implemented on or through mobile devices. The

mobile devices may include navigation devices, cell phones, mobile phones, mobile personal digital assistants, laptops, palmtops, netbooks, pagers, electronic books readers, music players and the like. These devices may include, apart from other components, a storage medium such as a flash memory, buffer, RAM, ROM and one or more computing devices. The computing devices associated with mobile devices may be enabled to execute program codes, methods, and instructions stored thereon. Alternatively, the mobile devices may be configured to execute instructions in collaboration with other devices. The mobile devices may communicate with base stations interfaced with servers and configured to execute program codes. The mobile devices may communicate on a peer-to-peer network, mesh network, or other communications network. The program code may be stored on the storage medium associated with the server and executed by a computing device embedded within the server. The base station may include a computing device and a storage medium. The storage device may store program codes and instructions executed by the computing devices associated with the base station.

[00074] The computer software, program codes, and/or instructions may be stored and/or accessed on machine readable media that may include: computer components, devices, and recording media that retain digital data used for computing for some interval of time; semiconductor storage known as random access memory (RAM); mass storage typically for more permanent storage, such as optical discs, forms of magnetic storage like hard disks, tapes, drums, cards and other types; processor registers, cache memory, volatile memory, non-volatile memory; optical storage such as CD, DVD; removable media such as flash memory (e.g. USB sticks or keys), floppy disks, magnetic tape, paper tape, punch cards, standalone RAM disks, Zip drives, removable mass storage, off-line, and the like; other computer memory such as dynamic memory, static memory, read/write storage, mutable storage, read only, random access, sequential access, location addressable, file addressable, content addressable, network attached storage, storage area network, bar codes, magnetic ink, and the like.

[00075] The methods and systems described herein may transform physical and/or or intangible items from one state to another. The methods and

systems described herein may also transform data representing physical and/or intangible items from one state to another.

[00076] The elements described and depicted herein, including in flow charts and block diagrams throughout the figures, imply logical boundaries between the elements. However, according to software or hardware engineering practices, the depicted elements and the functions thereof may be implemented on machines through computer executable media having a processor capable of executing program instructions stored thereon as a monolithic software structure, as standalone software modules, or as modules that employ external routines, code, services, and so forth, or any combination of these, and all such implementations may be within the scope of the present disclosure. Examples of such machines may include, but may not be limited to, personal digital assistants, laptops, personal computers, mobile phones, other handheld computing devices, medical equipment, wired or wireless communication devices, transducers, chips, calculators, satellites, tablet PCs, electronic books, gadgets, electronic devices, devices having artificial intelligence, computing devices, networking equipment, servers, routers and the like. Furthermore, the elements depicted in the flow chart and block diagrams or any other logical component may be implemented on a machine capable of executing program instructions. Thus, while the foregoing drawings and descriptions set forth functional aspects of the disclosed systems, no particular arrangement of software for implementing these functional aspects should be inferred from these descriptions unless explicitly stated or otherwise clear from the context. Similarly, it will be appreciated that the various steps identified and described above may be varied, and that the order of steps may be adapted to particular applications of the techniques disclosed herein. All such variations and modifications are intended to fall within the scope of this disclosure. As such, the depiction and/or description of an order for various steps should not be understood to require a particular order of execution for those steps, unless required by a particular application, or explicitly stated or otherwise clear from the context.

[00077] The methods and/or processes described above, and steps associated therewith, may be realized in hardware, software or any combination of hardware and software suitable for a particular application. The hardware

may include a general- purpose computer and/or dedicated computing device or specific computing device or particular aspect or component of a specific computing device. The processes may be realized in one or more microprocessors, microcontrollers, embedded microcontrollers, programmable digital signal processors or other programmable device, along with internal and/or external memory. The processes may also, or instead, be embodied in an application specific integrated circuit, a programmable gate array, programmable array logic, or any other device or combination of devices that may be configured to process electronic signals. It will further be appreciated that one or more of the processes may be realized as a computer executable code capable of being executed on a machine-readable medium.

[00078] The computer executable code may be created using a structured programming language such as C, an object oriented programming language such as C++, or any other high-level or low-level programming language (including assembly languages, hardware description languages, and database programming languages and technologies) that may be stored, compiled or interpreted to run on one of the above devices, as well as heterogeneous combinations of processors, processor architectures, or combinations of different hardware and software, or any other machine capable of executing program instructions.

[00079] Thus, in one aspect, methods described above and combinations thereof may be embodied in computer executable code that, when executing on one or more computing devices, performs the steps thereof. In another aspect, the methods may be embodied in systems that perform the steps thereof, and may be distributed across devices in a number of ways, or all of the functionality may be integrated into a dedicated, standalone device or other hardware. In another aspect, the means for performing the steps associated with the processes described above may include any of the hardware and/or software described above. All such permutations and combinations are intended to fall within the scope of the present disclosure.

[00080] While the disclosure has been disclosed in connection with the preferred embodiments shown and described in detail, various modifications and improvements thereon will become readily apparent to those skilled in the

art. Accordingly, the spirit and scope of the present disclosure is not to be limited by the foregoing examples, but is to be understood in the broadest sense allowable by law.

[00081] The use of the terms "a" and "an" and "the" and similar referents in the context of describing the disclosure (especially in the context of the following claims) is to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. The terms "comprising," "having," "including," and "containing" are to be construed as open-ended terms (i.e., meaning "including, but not limited to,") unless otherwise noted. Recitation of ranges of values herein are merely intended to serve as a shorthand method of referring individually to each separate value falling within the range, unless otherwise indicated herein, and each separate value is incorporated into the specification as if it were individually recited herein. All methods described herein can be performed in any suitable order unless otherwise indicated herein or otherwise clearly contradicted by context. The use of any and all examples, or exemplary language (e.g., "such as") provided herein, is intended merely to better illuminate the disclosure and does not pose a limitation on the scope of the disclosure unless otherwise claimed. No language in the specification should be construed as indicating any non-claimed element as essential to the practice of the disclosure.

[00082] While the foregoing written description enables one of ordinary skill to make and use what is considered presently to be the best mode thereof, those of ordinary skill will understand and appreciate the existence of variations, combinations, and equivalents of the specific embodiment, method, and examples herein. The disclosure should therefore not be limited by the above described embodiment, method, and examples, but by all embodiments and methods within the scope and spirit of the disclosure.

[00083] All documents referenced herein are hereby incorporated by reference.

Claims

We claim:

1. A language translation system, comprising:
    a. A head-worn computer including a microphone and an audio communication system, wherein the head-worn computer is adapted to record a spoken utterance of a person wearing the head-worn computer, convert the spoken utterance into a language other than a first spoken language represented by the spoken utterance, forming translated language;
    b. A speaker of sufficient size to produce sound intensity such that a person at a conversational distance can hear the sound at a conversational level, the speaker in communication with the head-worn computer through the audio communication system; and
    c. The head-worn computer further adapted to communicate the translated language to the speaker and displaying, in a see-through head-worn display mechanically supported by the head-worn computer, a visual representation of the first spoken language.

2. The language system of claim 1, wherein the audio communication system is a wired system providing audio signals to the speaker.

3. The language system of claim 1, wherein the audio communication system is a wireless system providing audio signals to the speaker.

4. The language system of claim 1, wherein the speaker size produces sound in a range of approximately 30 to 40 db at a distance of 5 feet of the speaker.

5. The language system of claim 1, wherein the speaker size produces sound in a range of approximately 40 to 60 db at a distance of 5 feet of the speaker.

6. The language system of claim 1, wherein the speaker size produces sound in a range of approximately 60 to 80 db at a distance of 5 feet of the speaker.

7. The language system of claim 1, wherein the head-worn computer is further adapted to convert the spoken utterances into the translated language, wherein the translated language has a audible spectrum based on the user's spoken utterances.

8. The language system of claim 7, wherein the audible spectrum is determined through an analysis of the spoken utterances spectrum, wherein the analysis results in one of a plurality of tones to be used when communicating the translated language to the speaker.

9. The language system of claim 8, wherein the one tone is at least one of a high male tone, mid-tone male, low male tone, high female tone, mid-tone female, low female tone.

10. The language system of claim 1, wherein the speaker is mechanically adapted to fit into a shirt pocket of the user.

11. The language system of claim 1, wherein the speaker is mechanically adapted to clip onto a shirt of the user.

12. The language system of claim 1, wherein the head-worn computer is further adapted with a user interface that turns off the displaying of the visual representation of the first spoken language.

13. A head-worn computer, comprising:

a. A first side arm, including a temple section and an ear horn section;

b. The temple section, including a securing attachment system; and

c. The ear horn section, including a pin adapted to mate with the securing attachment system, wherein, when pressure is exerted to pull the ear horn section away from the temple section, the ear horn section securely separates

from the temple section and the ear horn section is adapted to be rotated about the pin causing the ear horn to be positioned in a folding position; wherein the folding position includes clearance for a second side arm to fully fold on top of the first side arm.

14. A head-worn computer, comprising:

a. A temple portion mechanically secured to a computer display and adapted to position the computer display in front of an eye of a user; and

b. The temple portion including a speaker attachment, wherein the speaker attachment is adapted to:

1. securely position a speaker assembly and electrically associate the speaker assembly with electronics internal to the head-worn computer; and

2. facilitate the user's release and re-securing of the speaker assembly with the temple portion.

15. A head-worn computer, comprising:

a. An upper compartment adapted to contain a processor, memory, and a sensor system, the upper compartment positioned above a lens assembly and including a top plate;

b. The top plate including a processor connection pad mechanically adapted to facilitate the connection between the processor and the top plate;

c. A thermally conductive material positioned between the processor connection pad and the processor to reduce an air gap and to further facilitate the thermal connection between the processor and the top plate; and

d. The top plate further having heat dissipation fins adapted to dissipate heat received from the processor.

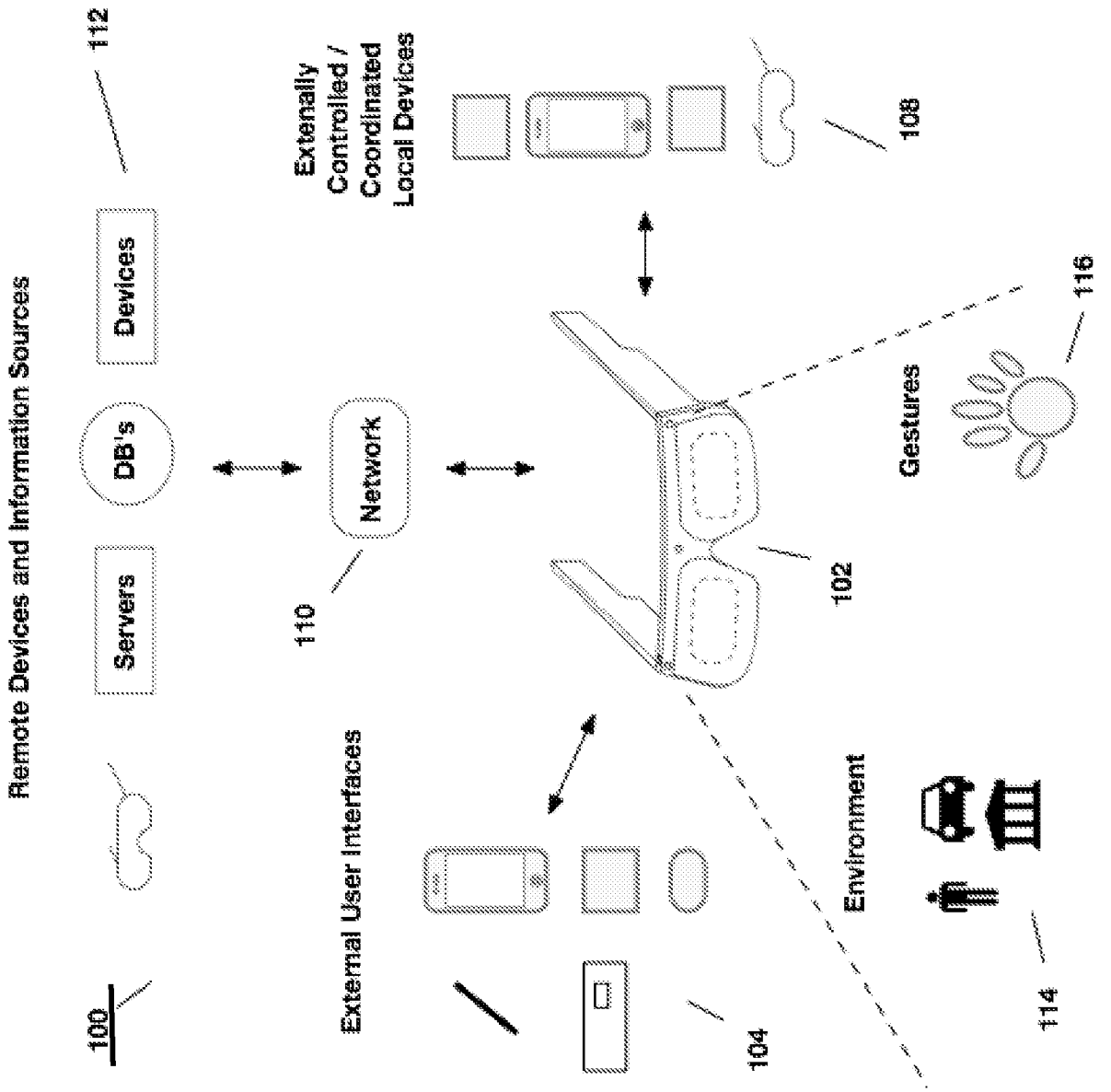
Remote Devices and Information Sources
100
Servers
DB's
Devices
112
110
Network
Externally Controlled / Coordinated Local Devices
108
External User Interfaces
104
102
Gestures
116
Environment
114

Figure 1

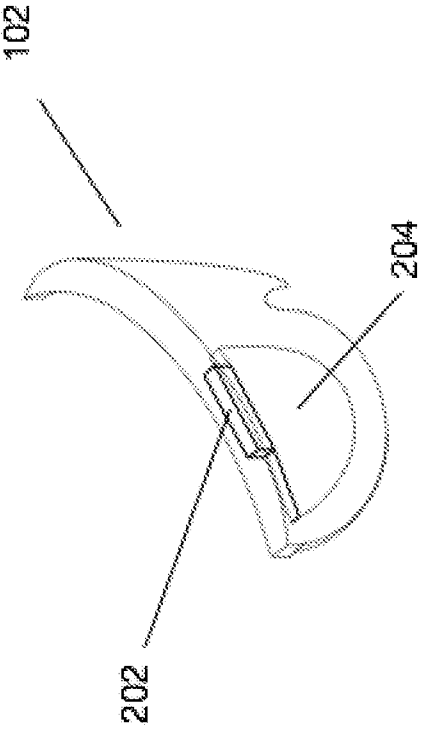

Figure 2

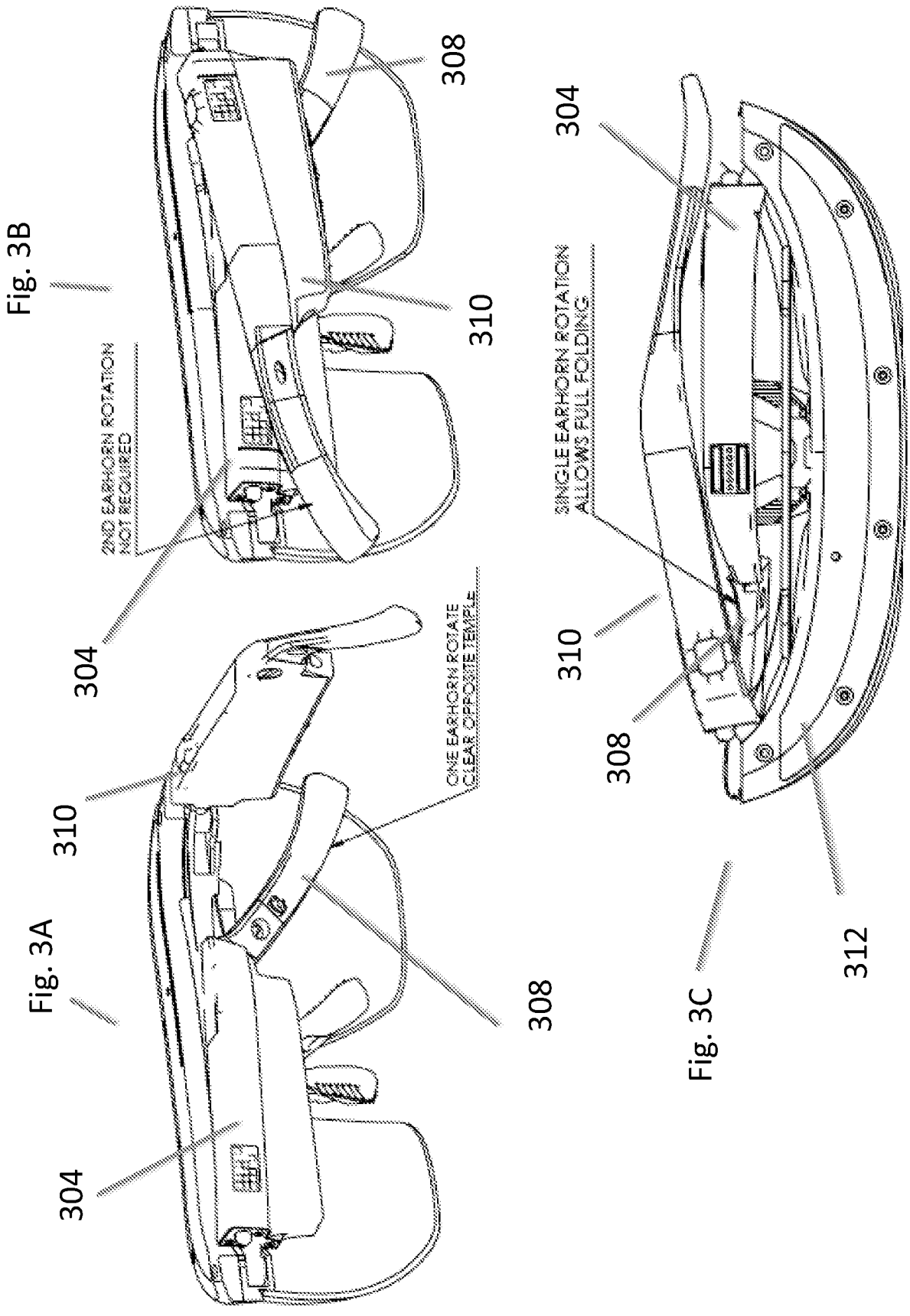
Fig. 3A
304
310
ONE EARHORN ROTATE
CLEAR OPROXITE TEMPLE
308
Fig. 3B
304
2ND EARHORN ROTATION
NOT REQUIRED
310
308
Fig. 3C
304
SINGLE EARHORN ROTATION
ALLOWS FULL FOLDING
310
308
312

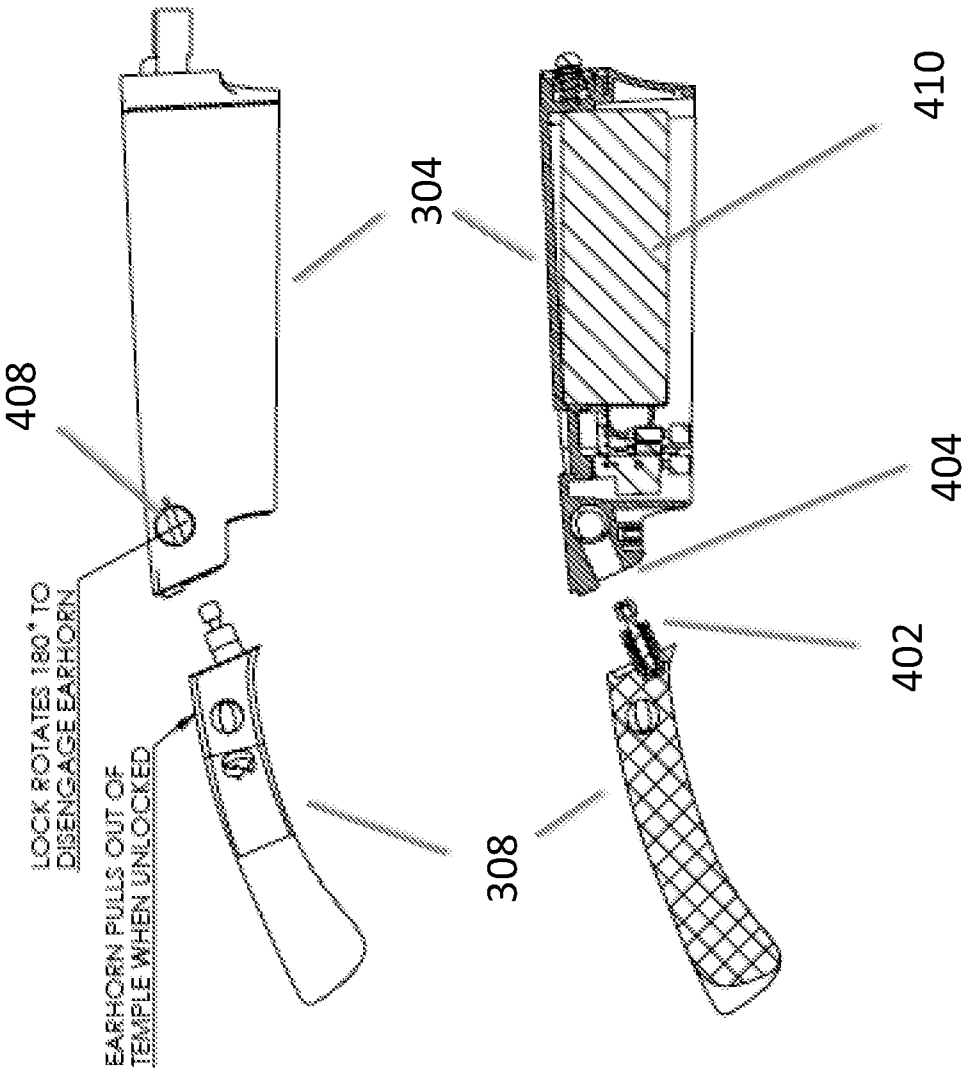
408
LOCK ROTATES 180° TO DISENGAGE EARHORN
EARHORN PULLS OUT OF TEMPLE WHEN UNLOCKED
304
308
410
404
402

Figure 4

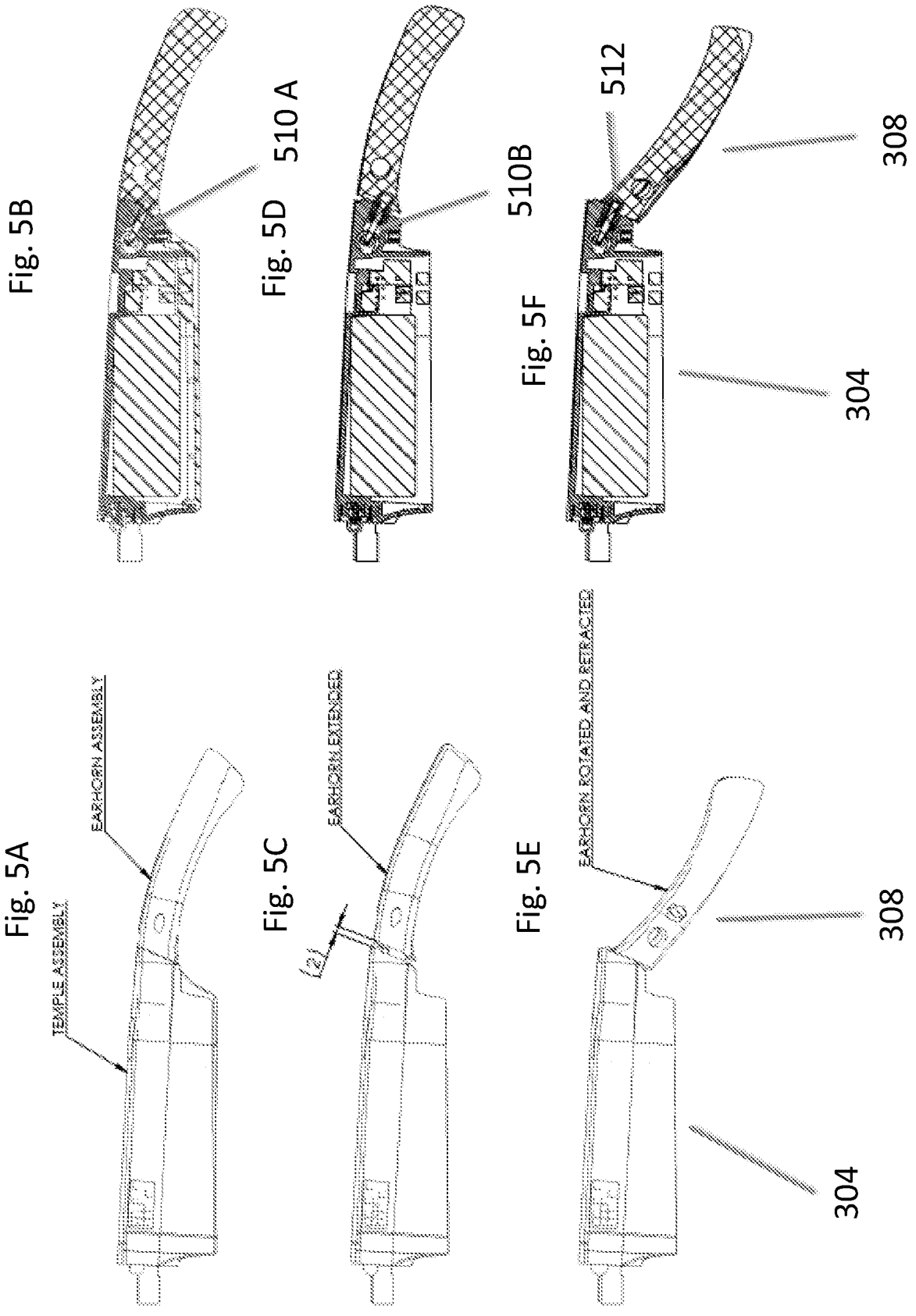
Fig. 5A
EARHORN ASSEMBLY
TEMPLE ASSEMBLY
Fig. 5B
510 A
Fig. 5C
EARHORN EXTENDED
(z)
Fig. 5D
510B
Fig. 5E
EARHORN ROTATED AND RETRACTED
308
304
Fig. 5F
512
308
304

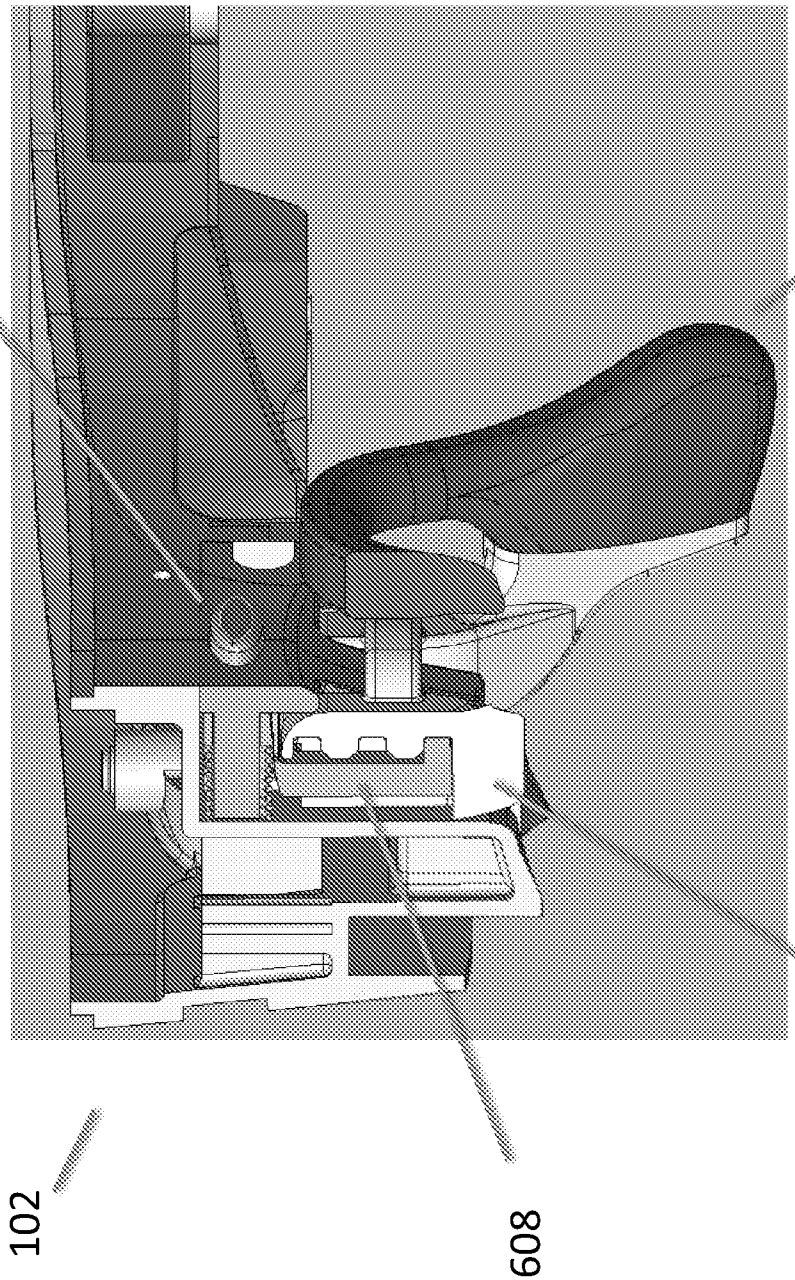

Figure 6

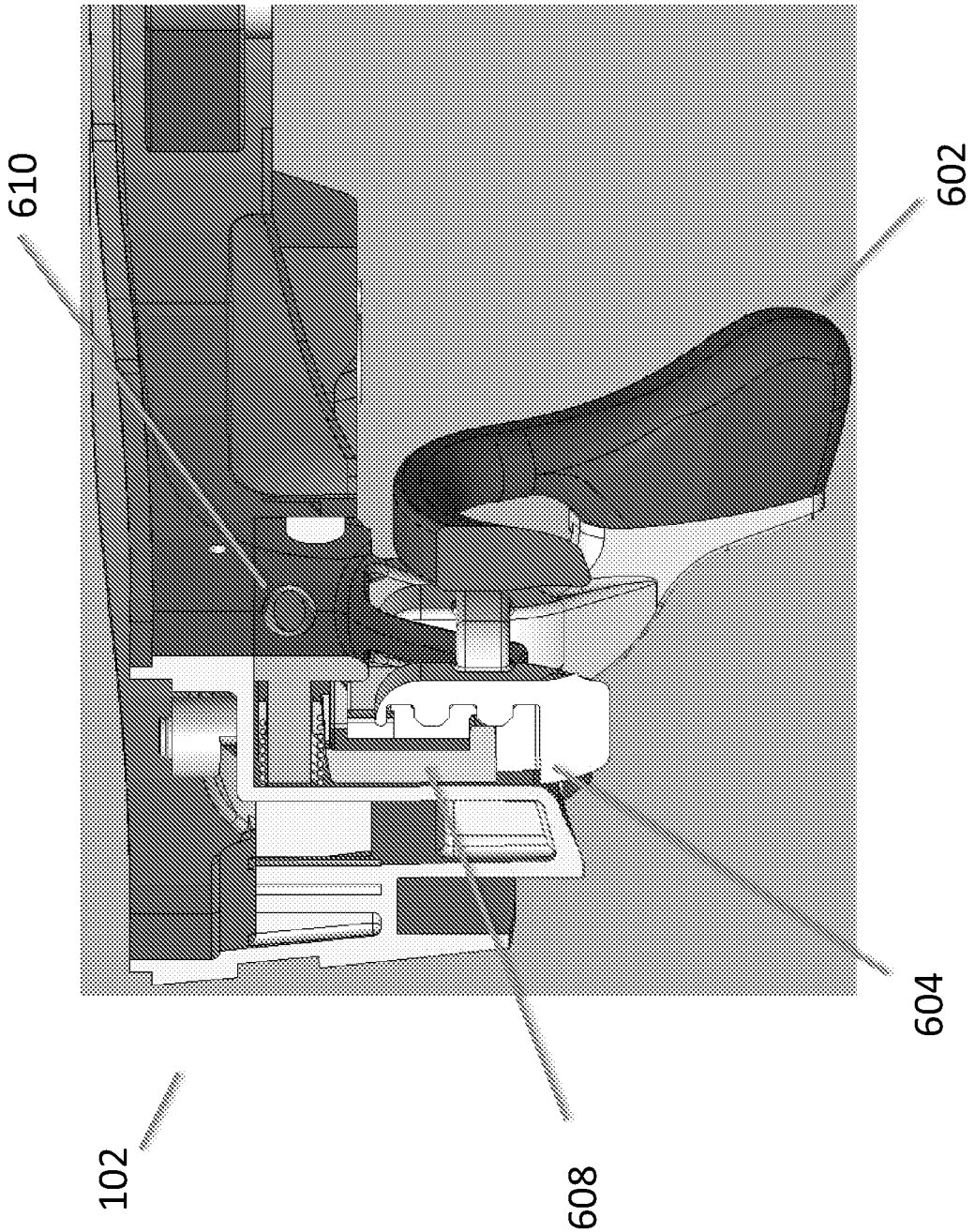

Figure 7

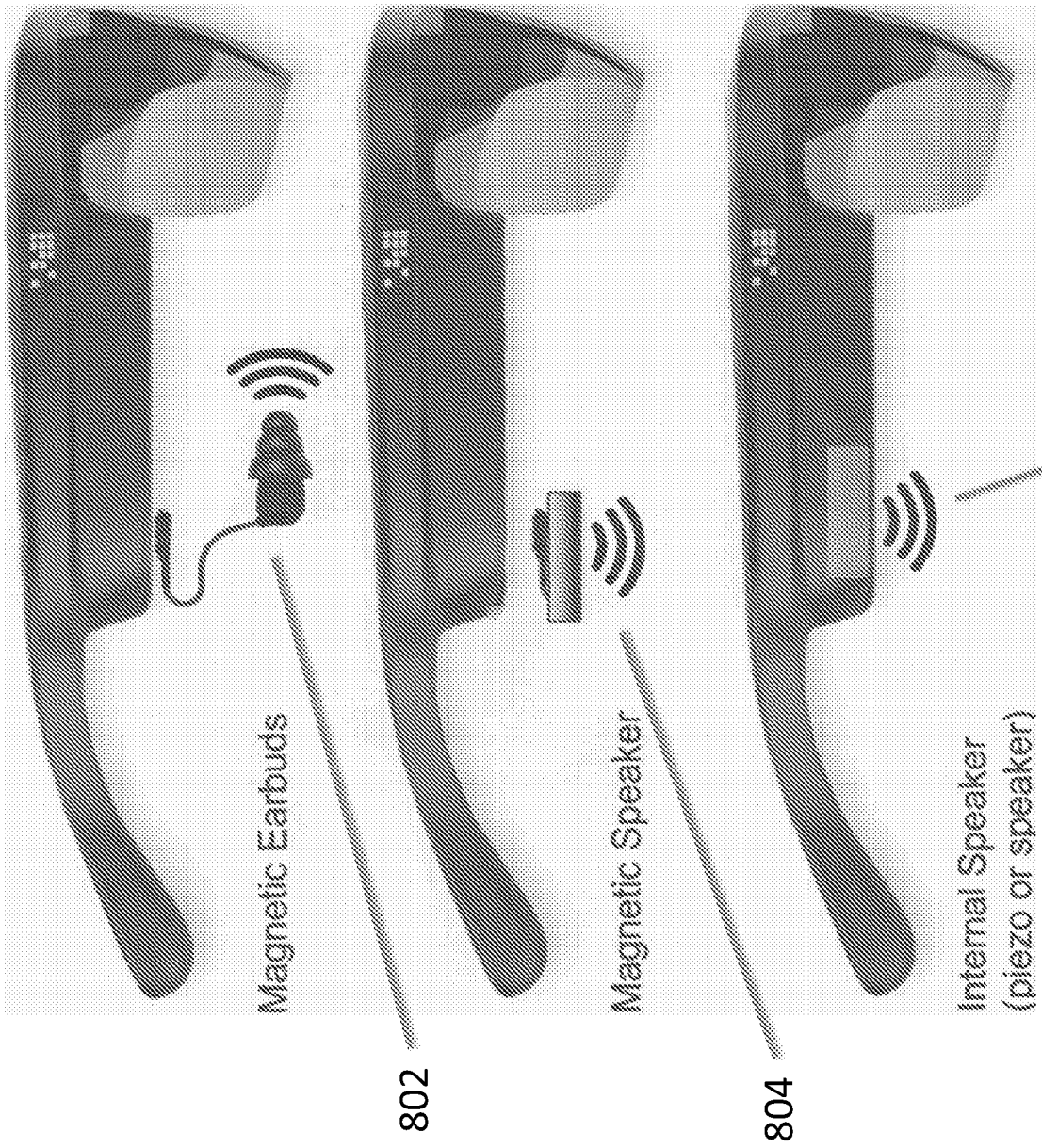
102
102
102
Magnetic Earbuds
Magnetic Speaker
Internal Speaker
(piezo or speaker)
802
804
808

Figure 8

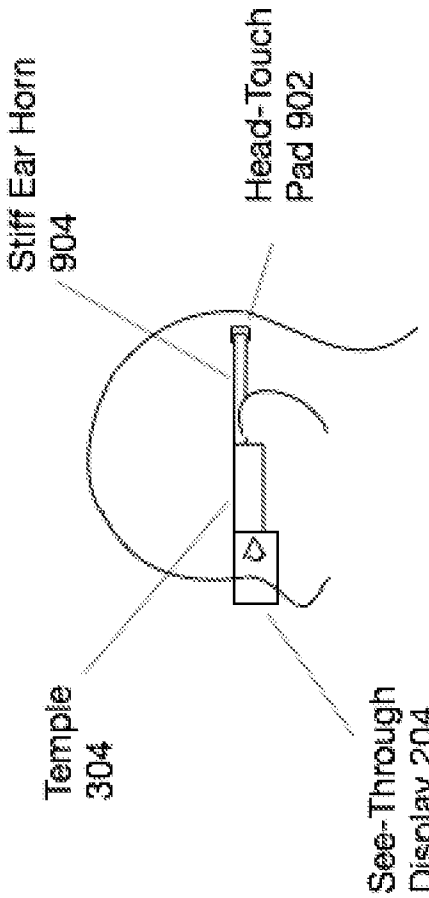
Stiff Ear Horn
904
Head-Touch
Pad 902
Temple
304
See-Through
Display 204

Figure 9

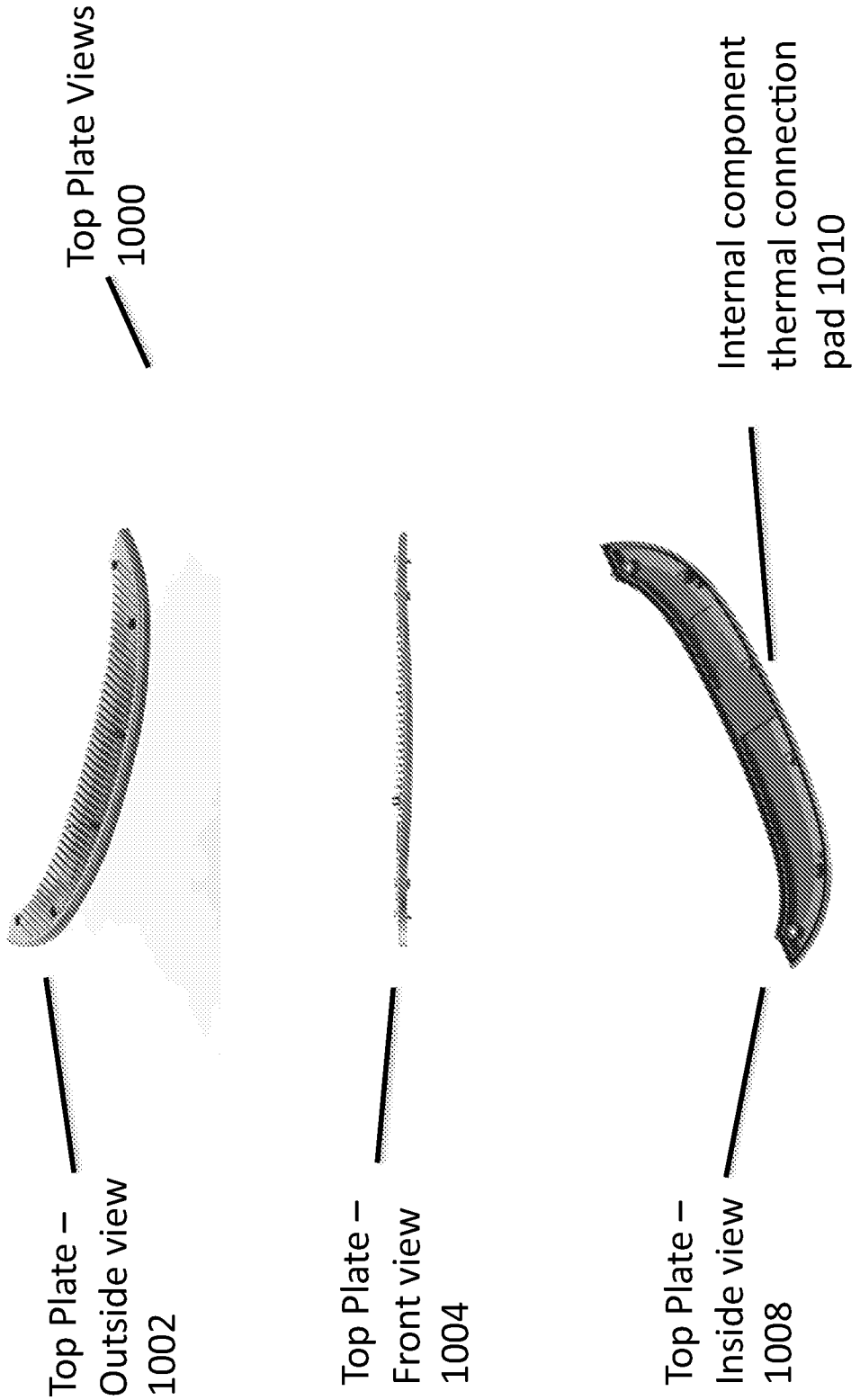
Top Plate Views
1000
Top Plate –
Outside view
1002
Top Plate –
Front view
1004
Top Plate –
Inside view
1008
Internal component
thermal connection
pad 1010

Figure 10

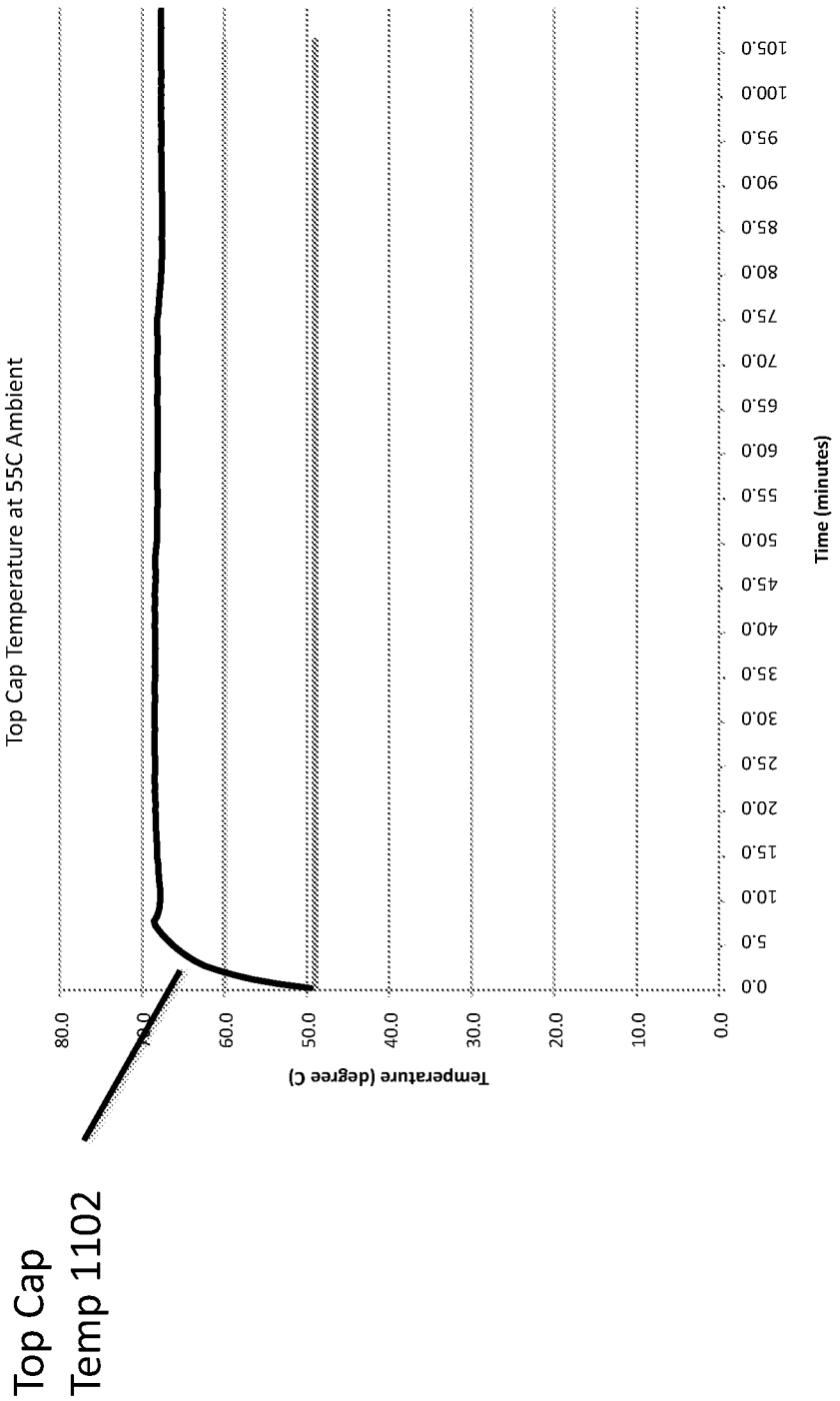
Top Cap Temperature at 55C Ambient
Temperature (degree C)
80.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Time (minutes)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
85.0
90.0
95.0
100.0
105.0
Top Cap Temp 1102

Figure 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/026704

A. CLASSIFICATION OF SUBJECT MATTER

G06F 17/28(2006.01)i, G06F 3/16(2006.01)i, G06F 3/01(2006.01)i, G06F 1/16(2006.01)i

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)
G06F 17/28; G10L 11/00; G10L 13/04; H04M 1/00; G10L 15/26; G09G 5/00; G06F 3/16; G06F 3/01; G06F 1/16

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: head-worn, wearable computing device, translation, language, spoken, and similar terms.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 2207164 A2 (KOPIN CORPORATION) 14 July 2010 See paragraphs [0058], [0104], [0106], [0109], [0111]-[0112], [0120], and [0124]; and figures 4 and 13-16.	1-12
Y	US 2007-0100637 A1 (TIMOTHY S. MCCUNE) 03 May 2007 See paragraphs [0012], [0028], and [0033]; claims 1-2; and figures 1 and 4.	1-12
Y	US 2002-0183101 A1 (SANG HOON OH et al.) 05 December 2002 See paragraphs [0030]-[0031] and [0043]; claims 1-3; and figure 3.	4-6,10-11
A	US 2012-0078628 A1 (MAHMOUD M. GHULMAN) 29 March 2012 See paragraphs [0018]-[0023] and figure 3.	1-12
A	US 2013-0185052 A1 (MICROSOFT CORPORATION) 18 July 2013 See paragraphs [0028]-[0034] and figure 3.	1-12

☐ Further documents are listed in the continuation of Box C.

☒ 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
21 August 2015 (21.08.2015)	**21 August 2015 (21.08.2015)**

Name and mailing address of the ISA/KR
International Application Division
Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 35208, Republic of Korea
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Telephone No. +82-42-481-8528

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/026704

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. ☐ Claims Nos.:
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:

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:

Group Ⅰ: Claims 1-12 are directed to a language translation system.
Group Ⅱ: Claim 13 is directed to a head-worn computer comprising a temple section including a securing attachment system and an ear horn section including a pin adapted to mate with the securing attachment system.
Group Ⅲ: Claim 14 is directed to a head-worn computer comprising a temple portion including a speaker attachment for securely positioning a speaker assembly and facilitating a user`s release and re-securing of the speaker assembly with the temple portion.
Group Ⅳ: Claim 15 is directed to a head-worn computer comprising: an upper compartment including a top plate which has heat dissipation fins; and a thermally conductive material.

1. ☐ As all required addtional 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 an additional fees, this Authority did not invite payment of any 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.:
1-12

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/US2015/026704

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2207164 A2	14/07/2010	CA 2685947 A1	27/11/2008
		CN 101632033 A	20/01/2010
		CN 101632033 B	31/07/2013
		CN 101755299 A	23/06/2010
		CN 101809651 A	18/08/2010
		CN 101809651 B	07/11/2012
		EP 2150950 A1	10/02/2010
		EP 2183742 A2	12/05/2010
		EP 2207164 A3	08/12/2010
		GB 2459220 A	21/10/2009
		JP 2010-516186 A	13/05/2010
		JP 2010-527557 A	12/08/2010
		JP 5190070 B2	24/04/2013
		KR 10-1441873 B1	04/11/2014
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		US 2009-0209205 A1	20/08/2009
		US 2009-0251409 A1	08/10/2009
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		WO 2008-088691 A3	02/10/2008
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		WO 2008-143870 A1	27/11/2008
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		WO 2009-017797 A3	26/03/2009
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		AU 2002-344307 A8	09/12/2002
		CN 1513233 A	14/07/2004
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		KR 10-2004-0019297 A	05/03/2004
		US 6957089 B2	18/10/2005
		WO 02-098111 A2	05/12/2002
		WO 02-098111 A3	10/04/2003
US 2012-0078628 A1	29/03/2012	WO 2012-050897 A1	19/04/2012
US 2013-0185052 A1	18/07/2013	US 2008-243473 A1	02/10/2008
		US 2013-338997 A1	19/12/2013
		US 8515728 B2	20/08/2013
		US 8645121 B2	04/02/2014