SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE

RELATED APPLICATIONS

This application is a continuation of U.S. Patent Application No. 17/553,716, filed December 16, 2021, which is a continuation of PCT Application No. PCT/US2020/041956, filed July 14, 2020, which claims priority to U.S. Provisional Application No. 62/876,454, filed July 19, 2019, and U.S. Provisional Application No. 62/943,375, filed December 4, 2019, the content of which are hereby incorporated by reference in their entireties.

TECHNICAL FIELD

This application relates generally to ear-worn electronic devices, including hearing devices, hearing aids, personal amplification devices, and other hearables.

BACKGROUND

Hearing devices provide sound for the wearer. Some examples of hearing devices are headsets, hearing aids, speakers, cochlear implants, bone conduction devices, and personal listening devices. For example, hearing aids provide amplification to compensate for hearing loss by transmitting amplified sounds to a wearer's ear canals. Hearing devices may be capable of performing wireless communication with other devices, such as receiving streaming audio from a streaming device via a wireless link. Wireless communication may also be performed for programming the hearing device and transmitting information from the hearing device. For performing such wireless communication, hearing devices such as hearing aids can include a wireless transceiver and an antenna. In order to provide power to electronic circuitry of a hearing device, a rechargeable battery is often housed within the hearing device, which requires routine charging to ensure proper operation of the hearing device.

SUMMARY

Embodiments are directed to a system comprising at least one hearing device configured to be worn at, in or on an ear of a wearer. The hearing device comprises a

rechargeable power source, power management circuitry, and a first charging interface comprising a first cathode contact and a first anode contact spaced apart from the first cathode contact. A charging module comprises a second charging interface configured to detachably couple with the first charging interface of the hearing device. The second charging interface comprises a second anode contact having a contact surface and a displaceable second cathode contact. An arrangement is configured to displace at least a portion of the second cathode contact above the contact surface to facilitate electrical contact between the first and second cathode contacts prior to electrical contact between the first and second anode contacts. Charging circuitry is coupled to the second charging interface and configured to charge the rechargeable power source of the hearing device.

Embodiments are directed to a system, comprising at least one hearing device configured to be worn at, in or on an ear of a wearer. The hearing device comprises a rechargeable power source, power management circuitry, and a first charging interface comprising a first cathode contact and a first anode contact spaced apart from the first cathode contact. The first anode contact can comprise a plurality of electrode elements each having a non-polygonal shape such a curvilinear, round, elliptical, oval or other closed curved shape comprising only or predominately curved lines. The first anode contact can comprise a plurality of electrode elements each having a polygonal shape such as a square, rectangular, triangular or any other closed plane shape formed with three or more straight lines (e.g., polygonal shapes having from three to twelve sides). The first anode contact can comprises a plurality of electrode elements having a combination of non-polygonal and polygonal shapes. A charging module comprises a second charging interface configured to detachably couple with the first charging interface of the hearing device. The second charging interface comprises a second anode contact having a contact surface and a displaceable second cathode contact. An arrangement is configured to displace at least a portion of the second cathode contact above the contact surface to facilitate electrical contact between the first and second cathode contacts prior to electrical contact between the first and second anode contacts. Charging circuitry of the charging module is coupled to the second charging interface and configured to charge the rechargeable power source of the hearing device.

Embodiments are directed to a system comprising at least one hearing device configured to be worn at, in or on an ear of a wearer. The hearing device comprises a rechargeable power source, power management circuitry, and a first charging interface comprising a first cathode contact surrounded by a first anode contact. The first anode contact can comprise a plurality of electrode elements each having a non-polygonal shape such a curvilinear, round, elliptical, oval or other closed curved shape comprising only or predominately curved lines. The first anode contact can comprise a plurality of electrode elements each having a polygonal shape such as a square, rectangular, triangular or any other closed plane shape formed with three or more straight lines (e.g., polygonal shapes having from three to twelve sides). The first anode contact can comprises a plurality of electrode elements having a combination of non-polygonal and polygonal shapes. A charging module comprises a second charging interface configured to detachably couple with the first charging interface of the hearing device. The second charging interface comprises a second anode contact having a contact surface, a through-hole, and a second cathode contact displaceable within the through-hole. A biasing arrangement is configured to bias at least a portion of the second cathode contact above the contact surface to facilitate electrical contact between the first and second cathode contacts prior to electrical contact between the first and second anode contacts. Charging circuitry of the charging module is coupled to the second charging interface and configured to charge the rechargeable power source of the hearing device. A retention arrangement is disposed on one or both of the hearing device and the charging module. The retention arrangement is configured to maintain engagement between the first and second charging interfaces during charging of the rechargeable power source of the hearing device.

Embodiments are directed to a system comprising at least one hearing device configured to be worn at, in or on an ear of a wearer. The hearing device comprises a rechargeable power source and a first charging interface comprising a first cathode contact and a first anode contact spaced apart from the first cathode contact. The first anode contact can comprise a plurality of electrode elements each having a non-polygonal shape such as a curvilinear, round, elliptical, oval or other closed curved shape comprising only or predominately curved lines. The first anode contact can comprise a plurality of electrode

elements each having a polygonal shape such as a square, rectangular, triangular or any other closed plane shape formed with three or more straight lines (e.g., polygonal shapes having from three to twelve sides). The first anode contact can comprises a plurality of electrode elements having a combination of non-polygonal and polygonal shapes. The first anode contact comprises a plurality of first electrode elements configured to communicate power and one or more disparate information signals. A charging module comprises a second charging interface configured to detachably couple with the first charging interface of the hearing device and comprises a second cathode contact and a second anode contact. The second anode contact comprises a plurality of second electrode elements configured to communicate power and the one or more disparate information signals. Charging circuitry of the charging module is coupled to the second charging interface and configured to charge the rechargeable power source of the hearing device. The first and second electrode elements are configured to communicate power and the one or more information signals between the charging module and the hearing device.

Embodiments are directed to a system comprising at least one hearing device configured to be worn at, in or on an ear of a wearer. The hearing device comprises a rechargeable power source and a first charging interface comprising a plurality of first electrode elements. The plurality of first electrode elements comprises first cathode and anode contacts configured to communicate power and a first data contact configured to communicate one or more disparate information signals. The first anode contact can comprise a plurality of electrode elements each having a non-polygonal shape such as a curvilinear, round, elliptical, oval or other closed curved shape comprising only or predominately curved lines. The first anode contact can comprise a plurality of electrode elements each having a polygonal shape such as a square, rectangular, triangular or any other closed plane shape formed with three or more straight lines (e.g., polygonal shapes having from three to twelve sides). The first anode contact can comprise a plurality of electrode elements having a combination of non-polygonal and polygonal shapes. A charging module comprises a second charging interface configured to detachably couple with the first charging interface of the hearing device and comprises a plurality of second electrode elements. The plurality of second electrode elements comprises second cathode and anode contacts

configured to communicate power and a second data contact configured to communicate one or more disparate information signals. Charging circuitry of the charging module is coupled to the second charging interface and configured to charge the rechargeable power source of the hearing device.

The above summary is not intended to describe each disclosed embodiment or every implementation of the present disclosure. The figures and the detailed description below more particularly exemplify illustrative embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

Throughout the specification reference is made to the appended drawings wherein:

Figures 1A and 1B illustrate an ear-worn electronic device arrangement incorporating charging circuitry and functionality in accordance with any of the embodiments disclosed herein;

Figures 2A and 2B illustrate a custom hearing aid system which incorporates charging circuitry and functionality in accordance with any of the embodiments disclosed herein;

Figure 3 illustrates an ear-worn electronic device and a charging module respectively incorporating charging circuitry and functionality in accordance with any of the embodiments disclosed herein;

Figure 4 illustrates an ear-worn electronic device and a charging module respectively incorporating charging circuitry and functionality in accordance with any of the embodiments disclosed herein;

Figure 5 illustrates a charging interface of one or both of an ear-worn electronic device and a charging module in accordance with any of the embodiments disclosed herein;

Figure 6 illustrates a charging interface of one or both of an ear-worn electronic device and a charging module in accordance with any of the embodiments disclosed herein;

Figure 7 illustrates a charging interface of one or both of an ear-worn electronic device and a charging module in accordance with any of the embodiments disclosed herein;

Figure 8A illustrates a charging interface of one or both of an ear-worn electronic device and a charging module in accordance with any of the embodiments disclosed herein;

Figure 8B illustrates a charging interface of one or both of an ear-worn electronic device and a charging module in accordance with any of the embodiments disclosed herein;

Figure 8C illustrates a charging interface of one or both of an ear-worn electronic device and a charging module in accordance with any of the embodiments disclosed herein;

Figure 8D illustrates a charging interface of one or both of an ear-worn electronic device and a charging module in accordance with any of the embodiments disclosed herein;

Figure 8E illustrates a charging interface of one or both of an ear-worn electronic device and a charging module in accordance with any of the embodiments disclosed herein;

Figures 8F-8I illustrate a charging interface of an ear-worn electronic device in accordance with any of the embodiments disclosed herein;

Figure 8J illustrates a charging interface of a hearing device comprising a central data contact surrounded by a triangular arrangement of curvilinear-shaped peripheral contacts coupled to a multi-phase rectifier in accordance with any of the embodiments disclosed herein;

Figure 8K illustrates a charging interface of a charging module comprising a central data pin surrounded by a pair of arcuate contacts in accordance with any of the embodiments disclosed herein;

Figure 9 is a cross-sectional view of a portion of a hearing device comprising charging circuitry in accordance with any of the embodiments disclosed herein;

Figure 10 is a cross-sectional view of a portion of a charging module comprising charging circuitry in accordance with any of the embodiments disclosed herein;

Figures 11 and 12 illustrate a system comprising an ear-worn electronic device and a charging module respectively incorporating charging circuitry and functionality in accordance with any of the embodiments disclosed herein;

Figure 13 is a schematic showing electrical components of a system comprising an ear-worn electronic device and a charging module respectively incorporating charging circuitry and functionality in accordance with any of the embodiments disclosed herein;

Figure 14A is a schematic showing electrical components of a system comprising an ear-worn electronic device and a charging module respectively incorporating charging circuitry and functionality in accordance with any of the embodiments disclosed herein;

Figure 14B illustrates a charging interface of a hearing device comprising a central cathode pin surrounded by split-ring pin connectors in accordance with any of the embodiments disclosed herein;

Figure 14C illustrates a charging interface of a hearing device comprising a central data pin surrounded by split-ring pin connectors coupled to a multi-phase rectifier in accordance with any of the embodiments disclosed herein;

Figure 14D illustrates a charging interface of a charging module comprising a central data pin surrounded by split-ring pin connectors in accordance with any of the embodiments disclosed herein;

Figure 15 illustrates a method of implementing accelerated charging of one or more hearing devices using a charging module in accordance with any of the embodiments disclosed herein; and

Figure 16 is a graph that characterizes accelerated charging of a lithium-ion battery of a hearing device in accordance with any of the embodiments disclosed herein.

The figures are not necessarily to scale. Like numbers used in the figures refer to like components. However, it will be understood that the use of a number to refer to a component in a given figure is not intended to limit the component in another figure labeled with the same number.

DETAILED DESCRIPTION

It is understood that the embodiments described herein may be used with any ear-worn or ear-level electronic device without departing from the scope of this disclosure. The devices depicted in the figures are intended to demonstrate the subject matter, but not in a limited, exhaustive, or exclusive sense. Ear-worn electronic devices (also referred to herein as "hearing devices"), such as hearables (e.g., wearable earphones, ear monitors, and earbuds), hearing aids, hearing instruments, and hearing assistance devices, typically include an enclosure, such as a housing or shell, within which internal components are disposed. Typical components of a hearing device can include a processor (e.g., a digital signal processor or DSP), memory circuitry, power management circuitry, one or more communication devices (e.g., a radio, a near-field magnetic induction (NFMI) device), one or

more antennas, one or more microphones, and a receiver/speaker, for example. Hearing devices can incorporate a long-range communication device, such as a Bluetooth® transceiver or other type of radio frequency (RF) transceiver. A communication device (e.g., a radio or NFMI device) of a hearing device can be configured to facilitate communication between a left ear device and a right ear device of the hearing device.

Hearing devices of the present disclosure can incorporate an antenna coupled to a high-frequency transceiver, such as a 2.4 GHz radio. The RF transceiver can conform to an IEEE 802.11 (e.g., WiFi®) or Bluetooth® (e.g., BLE, Bluetooth® 4. 2 or 5.0) specification, for example. It is understood that hearing devices of the present disclosure can employ other transceivers or radios, such as a 900 MHz radio. Hearing devices of the present disclosure can be configured to receive streaming audio (e.g., digital audio data or files) from an electronic or digital source. Representative electronic/digital sources (e.g., accessory devices) include an assistive listening system, a TV streamer, a radio, a smartphone, a laptop, a cell phone/entertainment device (CPED) or other electronic device that serves as a source of digital audio data or other types of data files. Hearing devices of the present disclosure can be configured to effect bi-directional communication (e.g., wireless communication) of data with an external source, such as a remote server via the Internet or other communication infrastructure. Hearing devices that include a left ear device and a right ear device can be configured to effect bi-directional communication (e.g., wireless communication) therebetween, so as to implement ear-to-ear communication between the left and right ear devices.

The term hearing device of the present disclosure refers to a wide variety of ear-level electronic devices that can aid a person with impaired hearing. The term hearing device also refers to a wide variety of devices that can produce processed sound for persons with normal hearing. Hearing devices of the present disclosure include hearables (e.g., wearable earphones, headphones, earbuds, virtual reality headsets), hearing aids (e.g., hearing instruments), cochlear implants, and bone-conduction devices, for example. Hearing devices include, but are not limited to, behind-the-ear (BTE), in-the-ear (ITE), in-the-canal (ITC), invisible-in-canal (IIC), receiver-in-canal (RIC), receiver-in-the-ear (RITE) or completely-in-the-canal (CIC) type hearing devices or some combination of the above. Throughout this

disclosure, reference is made to a “hearing device,” which is understood to refer to a system comprising a single left ear device, a single right ear device, or a combination of a left ear device and a right ear device.

Figures 1A and 1B illustrate various components of a representative hearing device arrangement in accordance with various embodiments. Figures 1A and 1B illustrate first and second hearing devices 100A and 100B configured to be supported at, by, in or on left and right ears of a wearer. In some embodiments, a single hearing device 100A or 100B can be supported at, by, in or on the left or right ear of a wearer. As illustrated, the first and second hearing devices 100A and 100B include the same functional components. It is understood that the first and second hearing devices 100A and 100B can include different functional components. The first and second hearing devices 100A and 100B can be representative of any of the hearing devices disclosed herein.

The first and second hearing devices 100A and 100B include an enclosure 101a, 101b configured for placement, for example, over or on the ear, entirely or partially within the external ear canal (e.g., between the pinna and ear drum) or behind the ear. Disposed within the enclosure 101a, 101b is a processor 102a, 102b which incorporates or is coupled to memory 103a, 103b. The processor 102a, 102b can include or be implemented as a multi-core processor, a digital signal processor (DSP), an audio processor or a combination of these processors. For example, the processor 102a, 102b may be implemented in a variety of different ways, such as with a mixture of discrete analog and digital components that include a processor configured to execute programmed instructions contained in a processor-readable storage medium (e.g., solid-state memory, e.g., Flash).

The processor 102a, 102b is coupled to a wireless transceiver 104a, 104b (also referred to herein as a radio), such as a BLE transceiver or other IEEE 802.11 compliant transceiver. The wireless transceiver 104a, 104b is operably coupled to an antenna 106a, 106b configured for transmitting and receiving radio signals. Impedance matching circuitry 105a, 105b can be operably coupled to the wireless transceiver 104a, 104b and the antenna 106a, 106b. The antenna 106a, 106b is disposed in, on, or extends from the enclosure 101a, 101b. The wireless transceiver 104a, 104b and the antenna 106a, 106b can be configured to operate in the 2.4 GHz ISM frequency band or other applicable communication band

(referred to as the "Bluetooth® band" herein). The wireless transceiver 104a, 104b and antenna 106a, 106b can be configured to enable ear-to-ear communication between the two hearing devices 100A and 100B, as well as communications with an external device (e.g., a smartphone or a digital music player).

A battery 110a, 110b or other power source (rechargeable or conventional) is provided within the enclosure 101a, 101b and is configured to provide power to the various components of the hearing devices 100A and 100B. The battery 110a, 110b is coupled to power management circuitry 111a, 111b, such as a power management integrated circuit (PMIC). The power management circuitry 111a, 111b is coupled to a charging interface 113a, 113b, which is configured to physically and electrically couple to a corresponding charging interface of a charging module. A speaker or receiver 108a, 108b is coupled to an amplifier (not shown) and the processor 102a, 102b. The speaker or receiver 108a, 108b is configured to generate sound which is communicated to the wearer's ear.

In some embodiments, the hearing devices 100A and 100B include a microphone 112a, 112b mounted on or inside the enclosure 101a, 101b. The microphone 112a, 112b may be a single microphone or multiple microphones, such as a microphone array. The microphone 112a, 112b can be coupled to a preamplifier (not shown), the output of which is coupled to the processor 102a, 102b. The microphone 112a, 112b receives sound waves from the environment and converts the sound into an input signal. The input signal is amplified by the preamplifier and sampled and digitized by an analog-to-digital converter of the processor 102a, 102b, resulting in a digitized input signal. In some embodiments (e.g., hearing aids), the processor 102a, 102b (e.g., DSP circuitry) is configured to process the digitized input signal into an output signal in a manner that compensates for the wearer's hearing loss. When receiving an audio signal from an external source, the wireless transceiver 104a, 104b may produce a second input signal for the DSP circuitry of the processor 102a, 102b that may be combined with the input signal produced by the microphone 112a, 112b or used in place thereof. In other embodiments, (e.g., hearables), the processor 102a, 102b can be configured to process the digitized input signal into an output signal in a manner that is tailored or optimized for the wearer (e.g., based on wearer

preferences). The output signal is then passed to an audio output stage that drives the speaker or receiver 108a, 108b, which converts the output signal into an audio output.

Some embodiments are directed to a custom hearing aid, such as an ITC, CIC, or IIC hearing aid, for example. For example, some embodiments are directed to a custom hearing aid which includes a wireless transceiver and an antenna arrangement configured to operate in the 2.4 GHz ISM frequency band (referred to as the "Bluetooth® band" herein). Figures 2A and 2B illustrate a custom hearing aid system which includes two hearing devices, e.g., left 201a and right 201b side hearing devices, configured to wirelessly communicate with each other and external devices and systems. Figure 2A conceptually illustrates functional blocks of the hearing devices 201a, 201b. The position of the functional blocks in Figure 2A does not necessarily indicate actual locations of components that implement these functional blocks within the hearing devices 201a, 201b. Figure 2B is a block diagram of components that may be disposed at least partially within the enclosure 205a, 205b of the hearing device 201a, 201b.

Each hearing device 201a, 201b includes a physical enclosure 205a, 205b that encloses an internal volume. The enclosure 205a, 205b is configured for at least partial insertion within the wearer's ear canal. The enclosure 205a, 205b includes an external side 202a, 202b that faces away from the wearer and an internal side 203a, 203b that is inserted in the ear canal. The enclosure 205a, 205b comprises a shell 206a, 206b and a faceplate 207a, 207b. The faceplate 207a, 207b may include a battery door 208a, 208b or drawer disposed near the external side 202a, 202b of the enclosure 205a, 205b and configured to allow the battery 240a, 240b to be inserted and removed from the enclosure 205a, 205b. An antenna 220a, 220b can be mounted to the faceplate 207a, 207b or elsewhere in the enclosure 205a, 205b. The antenna arrangement 220a, 220b can include a matching circuit that compensates for a smaller size antenna which allows the antenna arrangement 220a, 220b to fit within a customized device, such as a device that fits partially or fully within the ear canal of the wearer. The matching circuit can be designed so that the power transfer from the transceiver of the electronics 230a, 230b to the antenna arrangement 220a, 220b, provides a specified antenna efficiency, e.g., an optimal antenna efficiency for the customized environment.

The battery 240a, 240b powers electronic circuitry 230a, 230b which is also disposed within the shell 206a, 206b. As illustrated in Figures 2A and 2B, the hearing device 201a, 201b may include one or more microphones 251a, 251b configured to pick up acoustic signals and to transduce the acoustic signals into microphone electrical signals. The electrical signals generated by the microphones 251a, 251b may be conditioned by an analog front end 231 (see Figure 2B) by filtering, amplifying and/or converting the microphone electrical signals from analog to digital signals so that the digital signals can be further processed and/or analyzed by the processor 260. The processor 260 may perform signal processing and/or control various tasks of the hearing device 201a, 201b. In some implementations, the processor 260 comprises a DSP that may include additional computational processing units operating in a multi-core architecture.

The processor 260 is configured to control wireless communication between the hearing devices 201a, 201b and/or an external accessory device (e.g., a smartphone, a digital music player) via the antenna 220a, 220b. The wireless communication may include, for example, audio streaming data and/or control signals. The electronic circuitry 230a, 230b of the hearing device 201a, 201b includes a transceiver 232. The transceiver 232 has a receiver portion that receives communication signals from the antenna arrangement 220a, 220b, demodulates the communication signals, and transfers the signals to the processor 260 for further processing. The transceiver 232 also includes a transmitter portion that modulates output signals from the processor 260 for transmission via the antenna arrangement 220a, 220b. Electrical signals from the microphone 251a, 251b and/or wireless communication received via the antenna 220a, 220b may be processed by the processor 260 and converted to acoustic signals played to the wearer's ear 299 via a speaker 252a, 252b.

The battery 240a, 240b is of a rechargeable type, such as a lithium-ion battery for example. Power management circuitry 241a, 241b (e.g., a PMIC) is operatively coupled to the battery 240a, 240b and to a charging interface 243a, 243b. The charging interface 243a, 243b is configured to physically and electrically couple to a corresponding charging interface of a charging module.

The use of rechargeable batteries in hearing devices (e.g., hearing aids) has been well-received in the marketplace. Self-contained batteries require electrical contacts for

recharging. One complication of contact charging is the difficulty of placing a relatively small hearing device in a charger. Traditional approaches for charging hearing devices often require the wearer to fiddle with the hearing device to achieve the proper connection for charging. There is a need to provide a connection arrangement that allows the wearer to properly attach the hearing device to the charging fixture of the charger with relative ease.

Contact charging requires two electrical connections, namely, an anode (positive) connection and a cathode (negative) connection. When placing a hearing device into a charging fixture, it can be advantageous to connect the cathodes prior to connecting the anodes. For example, connecting the cathodes of the hearing devices and the charging fixture prior to connecting the anodes can serve to provide a consistent inrush current waveform when coupling the hearing devices and charger fixture together. Provision of a consistent inrush current waveform from the charger to the hearing devices informs the charging circuitry of the charger that the hearing devices are properly attached to the proper charging fixture and that a charging procedure can be initiated. If the hearing devices are properly connected to the charging fixture, full charging power can be supplied by the charging fixture to the hearing devices. If one or both of the hearing devices are not properly connected to the charging fixture, charging through the improper connection can be disabled. This can protect against the presence of foreign objects (e.g., keys, coins, other hearing devices) that can be intentionally or unintentionally introduced into the charging fixture. In some implementations, connecting the cathodes of the hearing devices and charger fixture prior to connecting the anodes can serve to establish a ground, which can reduce or minimize spurious electrical spikes in the circuitry.

A system comprising a charging module and at least one hearing device in accordance with any of the embodiments disclosed herein provides a number of technical advantages over conventional charging arrangements. As discussed above, a charging system according to any of the embodiments disclosed herein facilitates connection between charger and hearing device cathodes prior to connection between anodes, which provides for a consistent inrush current waveform when coupling the hearing devices and charger fixture together. A charging system according to any of the embodiments disclosed herein provides enhanced detection of incorrect placement of hearing devices and/or presence of foreign

conductive objects at the charging interface, which results in disabling of charging through the improper connection. A charging system according to any of the embodiments disclosed herein significantly reduces or minimizes spurious electrical spikes in the circuitry, by ensuring that the cathodes of the hearing devices and charger fixture are connected prior to connecting the anodes.

Embodiments of the disclosure are defined in the claims. However, below there is provided a non-exhaustive listing of non-limiting examples. Any one or more of the features of these examples may be combined with any one or more features of another example, embodiment, or aspect described herein.

Example Ex1. A system comprising at least one hearing device configured to be worn at, in or on an ear of a wearer, the hearing device comprising a rechargeable power source, power management circuitry, and a first charging interface comprising a first cathode contact and a first anode contact spaced apart from the first cathode contact. A charging module comprises a second charging interface configured to detachably couple with the first charging interface of the hearing device, the second charging interface comprising a second anode contact having a contact surface and a displaceable second cathode contact; an arrangement configured to displace at least a portion of the second cathode contact above the contact surface to facilitate electrical contact between the first and second cathode contacts prior to electrical contact between the first and second anode contacts; and charging circuitry coupled to the second charging interface and configured to charge the rechargeable power source of the hearing device.

Example Ex2. The system according to Ex1, wherein the second charging interface comprises a through-hole, and the second cathode contact is displaceable within the through-hole; and the displacement arrangement comprises a biasing arrangement configured to bias at least a portion of the second cathode contact above the contact surface.

Example Ex3. The system according to Ex2, wherein the second cathode contact comprises an elongated electrode; and the biasing arrangement comprises a spring.

Example Ex4. The system according to Ex2 or Ex3, wherein the second cathode contact and the biasing arrangement define a spring-loaded pogo pin assembly.

Example Ex5. The system according to one or more of Ex1 to Ex4 comprising a retention arrangement disposed on one or both of the hearing device and the charging module, the retention arrangement configured to maintain engagement between the first and second charging interfaces during charging of the rechargeable power source of the hearing device.

Example Ex6. The system according to Ex5, wherein the retention arrangement comprises one or more magnets or a mechanical retention arrangement.

Example Ex7. The system according to one or more of Ex1 to Ex6, wherein the first anode contact is configured to communicate power and one or more disparate information signals, the second anode contact is configured to communicate power and the one or more disparate information signals, and the first and second anode contacts are configured to communicate power and the one or more disparate information signals between the charging module and the hearing device.

Example Ex8. The system according to Ex7, wherein the one or more disparate information signals comprise one or more of data signals generated by one or both of the charging module and the hearing device, audio signals generated by one or both of the charging module and the hearing device, and signals received from one or more accessory devices configured to communicatively couple to one or both of the charging module and the hearing device.

Example Ex9. The system according to one or more of Ex1 to Ex8, wherein the first and second anode contacts comprise electrodes having a curvilinear, annular, oval, elliptical or polygonal shape.

Example Ex10. The system according to one or more of Ex1 to Ex9, wherein the first anode contact comprises a plurality of electrode elements, and the first cathode contact is surrounded by the plurality of electrode elements of the first anode contact.

Example Ex11. The system according to Ex10, wherein the second anode contact comprises a plurality of electrode elements, and the second cathode contact is surrounded by the plurality of electrode elements of the second anode contact.

Example Ex12. The system according to Ex10 or Ex11, wherein one of both of the plurality of electrodes of the first anode contact are substantially equidistant from the first

cathode contact, and the plurality of electrodes of the second anode contact are substantially equidistant from the second cathode contact.

Example Ex13. The system according to Ex 10 or Ex 11, wherein one of both of the plurality of electrodes of the first anode contact are arranged in a substantially triangular pattern relative to the first cathode contact, and the plurality of electrodes of the second anode contact are arranged in a substantially triangular pattern relative to the second cathode contact.

Example Ex14. The system according to one or more of Ex1 to Ex13, wherein the hearing device comprises an in-the-ear (ITE), in-the-canal (ITC), invisible-in-canal (IIC) or completely-in-the-canal (CIC) device comprising a housing having a preformed or formable shape that conforms to a shape of the wearer's ear canal.

Example Ex15. The system according to one or more of Ex1 to Ex14, wherein the charging circuitry is configured to charge the rechargeable power source of the hearing device at an accelerated charge rate above 1.0C when a state of charge (SoC) of the rechargeable power sources is within a predetermined SoC range.

Figure 3 illustrates a system in accordance with any of the embodiments disclosed herein. Figure 3 shows a cross-sectional view of a portion of an ear-worn electronic hearing device 302 and a portion of a charging module 322. The components of the hearing device 302 shown in Figure 3 are disposed in or on a housing configured to be worn at, in or on an ear of a wearer. The hearing device 302 includes a rechargeable power source 304 (e.g., a lithium-ion battery) coupled to power management circuitry 306 (e.g., a PMIC). The power management circuitry 306 is coupled to a first charging interface 310 comprising a first cathode contact 312 and a first anode contact 314 spaced apart from the first cathode contact 312. In the embodiment shown in Figure 3, the power management circuitry 306 is coupled to the first cathode contact 312 via a first connection 307 and to the first anode contact 314 via a second connection 309. The first anode contact 314 can comprise a single contact or a multiplicity of contacts coupled to the second connection 309.

The charging module 322 includes a second charging interface 330 configured to detachably couple (e.g., mechanically and electrically) with the first charging interface 310 of the hearing device 302. The second charging interface 330 includes a second anode

contact 334 having a contact surface 335 and a displaceable second cathode contact 332. The charging module 322 includes charging circuitry 326 coupled to the second charging interface 330 and a power source 324. The power source 324 can be configured to receive power from a standard wall outlet and/or can include a rechargeable or a conventional battery. In some embodiments, the power source 324 can be configured to receive wireless power from an external power source (e.g., inductive, radiofrequency, optical). For example, the power source 324 can be configured to implement inductive charging in accordance with the Qi open interface standard developed by the Wireless Power Consortium. In the embodiment shown in Figure 3, the charging circuitry 326 is coupled to the second cathode contact 332 via a connection 337 and to the second anode contact 334 via a second connection 339. The second anode contact 334 can comprise a single contact or a multiplicity of contacts coupled to the second connection 339.

The second cathode contact 332 is configured for displacement between a first position 331a above the contact surface 335 of the second anode contact 334 and a second position 331b at or below the contact surface 335 of the second anode contact 334. In some configurations, the second cathode contact 332 can be configured for displacement between the first position 331a above the contact surface 335 and a second position 331b above the contact surface 335 but below the first position 331a.

When the hearing device 302 and the charging module 322 are in a non-contacting relationship, such as shown in Figure 3, the second cathode contact 332 is positioned at the first position 331a above the contact surface 335 of the second anode contact 334. When the hearing device 302 and the charging module 322 are in a contacting relationship, the second cathode contact 332 is movable from the first position 331a to the second position 331b and establishes electrical contact with the first cathode contact 312 prior to electrical contact being established between the second anode contact 334 and the first anode contact 314.

More particularly, when the hearing device 302 and the charging module 322 are brought into contact with one another, the second cathode contact 332 positioned at the first position 331a establishes electrical contact with the first cathode contact 312 of the hearing device 302 prior to electrical contact being established between the first and second anode contacts 314, 334. After first establishing electrical contact between the first and second

cathode contacts 312, 332, the second cathode contact 332 is displaced into the body of the charging module 322 as the hearing device 302 is forcibly advanced onto the charging module 322. After displacing the second cathode into the body of the charging module 322 partially or entirely, electrical contact is then established between the first and second anode contacts 314, 334.

The charging module 322 includes an arrangement (shown in other figures) configured to displace at least a portion of the second cathode contact 332 above the contact surface 335 to facilitate electrical contact between the first and second cathode contacts 312, 332 prior to electrical contact between the first and second anode contacts 314, 334. The charging module 322 can also include a retention arrangement (shown in other figures) configured to maintain engagement between the first and second charging interfaces 310, 330 during charging of the rechargeable power source 304 of the hearing device 302. In some embodiments, the retention arrangement can comprise one or more magnets disposed at or near one or both of the first and second charging interfaces 310, 330. In other embodiments, the retention arrangement can comprise a mechanical retention arrangement configured to mechanically maintain engagement between the first and second charging interfaces 310, 330.

Figure 4 illustrates a system in accordance with any of the embodiments disclosed herein. Figure 4 shows a cross-sectional view of a portion of an ear-worn electronic hearing device 402 and a portion of a charging module 422. The components of the hearing device 402 shown in Figure 4 are disposed in or on a housing configured to be worn at, in or on an ear of a wearer. The hearing device 402 includes a rechargeable power source 404 (e.g., a lithium-ion battery) coupled to power management circuitry 406 (e.g., a PMIC). The power management circuitry 406 is coupled to a first charging interface 410. In the embodiment shown in Figure 4, the first charging interface 410 comprises a first cathode contact 412 and a multiplicity of anode contacts, 414, 416. In the illustrative example shown in Figure 4, the first charging interface 410 includes two anode contacts 414, 416, it being understood that the first charging interface 410 can include more than two spaced-apart anode contacts (e.g., 3, 4, 5 or 6 anode contacts).

In the embodiment shown in Figure 4, the power management circuitry 406 is coupled to the first cathode contact 412 via a first connection 407 and to the first and second anode contacts 414, 416 via separate connections. As shown, the power management circuitry 406 is coupled to the first anode contact 414 via a connection 409 and to the second anode contact 416 via a connection 411. It is understood that each physically separate anode contact of the first charging interface 410 can be coupled to the power management circuitry 406 via a separate electrical conductor. It is also understood that, in some configurations, the first charging interface 410 can include anode contacts coupled to the power management circuitry 406 via separate connections in combination with two or more anode contacts coupled to the power management circuitry 406 via a common connection.

The charging module 422 includes a second charging interface 430 configured to detachably couple (e.g., mechanically and electrically) with the first charging interface 410 of the hearing device 402. The charging module 422 includes charging circuitry 426 coupled to the second charging interface 430 and a power source 424. The power source 424 can be configured to receive power from a standard wall outlet and/or can include a rechargeable or a conventional battery. In some embodiments, the power source 424 can be configured to receive wireless power from an external power source (e.g., inductive, radiofrequency, optical). For example, the power source 424 can be configured to implement inductive charging in accordance with the Qi open interface standard developed by the Wireless Power Consortium. The second charging interface 430 includes a second cathode contact 432 and a multiplicity of anode contacts 434, 436. In the embodiment shown in Figure 4, the second cathode contact 432 is fixed in terms of its position on the charging module 422. In this regard, the second cathode contact 432 shown in Figure 4 it is not a displaceable cathode contact. However, it is understood that, in a variant embodiment of Figure 4, the second cathode contact 432 can be implemented as a displaceable cathode contact in the manner illustrated and described with reference to Figure 3.

In the illustrative example shown in Figure 4, the second charging interface 430 includes two anode contacts 434, 436, it being understood that the second charging interface 430 can include more than two spaced-apart anode contacts (e.g., 3, 4, 5 or 6 anode contacts). The number of anode contacts of the second charging interface 430 may or may not be equal

to the number of anode contacts of the first charging interface 410. In the embodiment shown in Figure 4, the charging circuitry 426 is coupled to the second cathode contact 432 via a connection 437 and to the first and second anode contacts 434, 436 via separate connections. More particularly, the first anode contact 434 is coupled to the charging circuitry 426 via connection 439, and the second anode contact 436 is coupled to the charging circuitry 426 via connection 441.

The charging module 422 can include a retention arrangement (shown in other figures) configured to maintain engagement between the first and second charging interfaces 410, 430 during charging of the rechargeable power source 404 of the hearing device 402. In some embodiments, the retention arrangement can comprise one or more magnets disposed at or near one or both of the first and second charging interfaces 410, 430. In other embodiments, the retention arrangement can comprise a mechanical retention arrangement configured to mechanically maintain engagement between the first and second charging interfaces 410, 430.

Provision of electrically separate anode contacts at the first and second charging interfaces 410, 430 provides for the communication of power and one or more disparate information signals between the charging module 422 and the hearing device 402. For example, charging of the rechargeable power supply 404 can be accomplished via first and second cathode contacts 412, 432 and anode contacts 414, 434. Data signals generated by one or both of the charging module 422 and the hearing device 402 can be communicated via anode contacts 416, 436. Although referred to as anode contacts generally, it is understood that the contacts of the first and second charging interfaces 410, 430 that are used for communicating information signals can be any form of electrical contact. Various types of disparate information signals can be communicated between respective pairs of anode contacts of the first and second charging interfaces 410, 430. The disparate forms of information signals can include state of charge and charging status data, control or command signals, audio signals, video signals, and signals from one or more accessory devices (e.g., smartphone, tablet, wearable sensor) configured to communicatively couple to one or both of the hearing device 402 and charging module 422.

Figure 5 illustrates a charging interface in accordance with any of the embodiments disclosed herein. The charging interface 500 shown in Figure 5 includes a cathode contact 502, which is typically coupled to a negative contact charging connection 506. The charging interface 500 also includes an anode contact 504, which is typically coupled to a positive contact charging connection 508. In the embodiment shown in Figure 5, the cathode contact 502 is surrounded by the anode contact 504, which has a continuous annular configuration.

In some embodiments, the hearing device and the charging module can have a charging interface that generally corresponds to the charging interface 500 shown in Figure 5. When implemented on a hearing device, for example, a region of the cathode contact 502 (e.g., central region) can be recessed relative to a contact surface of the anode contact 504 (see, e.g., Figures 9 and 12). When implemented on a charging module, and according to some embodiments, the cathode contact 502 can be displaceable (see, e.g., Figures 3, 10, and 11) and proud relative to a contact surface of the anode contact 504. In other embodiments, the cathode contact 502 is a fixed electrical element (non-displaceable) and need not be proud relative to a contact surface of the anode contact 504. Although shown as having a generally circular shape, the cathode and anode contacts 502, 504 can have any curvilinear or polygonal shape.

Figure 6 illustrates a charging interface in accordance with any of the embodiments disclosed herein. The charging interface 600 shown in Figure 6 includes a cathode contact 602, which is typically coupled to a negative contact charging connection 606. The charging interface 600 also includes an anode contact 604, which is typically coupled to a positive contact charging connection 608. In the embodiment shown in Figure 6, the anode contact 604 comprises a multiplicity of electrode elements 604a, 604b, 604c, each of which is coupled to connection 608. The anode contact 604 has a concentric tri-trace anode configuration. As shown, the cathode contact 602 is surrounded by the concentric tri-trace anode 604 comprising arcuate electrode elements 604a, 604b, 604c. The arcuate electrode elements 604a, 604b, 604c are situated at substantially the same radius (e.g., ~4-5 mm) relative to the cathode contact 602 (e.g., ~2-3 mm diameter). Although three arcuate electrode elements are shown in Figure 6, the concentric anode 604 can comprise two, four, five or more electrode elements, for example.

In some embodiments, the hearing device and the charging module can have a charging interface that generally corresponds to the charging interface 600 shown in Figure 6. When implemented on a hearing device, and in accordance with some embodiments, a region of the cathode contact 602 (e.g., central region) can be recessed relative to a contact surface of the anode contact 604 (see, e.g., Figures 9 and 12). When implemented on a charging module, for example, the cathode contact 602 can be displaceable (see, e.g., Figures 10 and 11) and proud relative to a contact surface of the anode contact 604. Although shown as having a generally circular or arcuate shape, the cathode and anode contacts 602, 604 can have any curvilinear or polygonal shape.

It is understood that the charging interface of the hearing device and that of the charging module can be substantially the same or different in configuration. For example, and in accordance with some embodiments, the charging module can have a charging interface corresponding to the charging interface 500 shown in Figure 5 (cathode contact surrounded by an annular anode contact). In such embodiments, the hearing device can have a charging interface corresponding to the charging interface 600 shown in Figure 6 (cathode contact surrounded by tri-trace anode contact).

Figure 7 illustrates a charging interface in accordance with any of the embodiments disclosed herein. The charging interface 700 shown in Figure 7 includes a cathode contact 702 surrounded by a multiplicity of anode elements 704a, 704b, 704c. In the embodiment shown in Figure 7, the cathode contact 702 and anode elements 704a, 704b, 704c have a polygonal shape. For example, the cathode contact 702 has a generally square shape, and each of the anode elements 704a, 704b, 704c has a generally rectangular shape. It is understood that a charging interface can include cathode and anode contact elements having the same or different curvilinear or polygonal shape.

Figure 8A illustrates a charging interface in accordance with any of the embodiments disclosed herein. The charging interface 800 shown in Figure 8A includes a cathode contact 802, which is typically coupled to a negative contact charging connection 806. The charging interface 800 also includes an anode contact 804, which comprising a contact element typically coupled to a positive contact charging connection 808. In the embodiment shown in Figure 8A, the anode contact 804 has a concentric tri-trace anode configuration comprising

a multiplicity of electrode elements 804a, 804b, 804c. As shown, the cathode contact 802 is surrounded by the concentric tri-trace anode 804 comprising individual arcuate electrode elements 804a, 804b, 804c. The arcuate electrode elements 804a, 804b, 804c are situated at substantially the same radius relative to the cathode contact 802. Although three arcuate electrode elements are shown in Figure 8A, the concentric anode 804 can comprise two, four, five or more electrode elements, for example.

According to various embodiments, a hearing device and a charging module incorporate the charging interface 800 shown in Figure 8A. Each of the electrode elements of the anode contact 804 is coupled to a separate electrical connection. More particularly, electrode element 804a is coupled to connection 810, electrode element 804b is coupled to connection 808, and electrode element 804c is coupled to connection 812. Electrode element 804b represents an anode contact of the charging interface 800. The electrode element 804b and the cathode contact 802 are configured to communicate power produced by the charging module when charging the rechargeable power source of the hearing device. Disparate information signals (e.g., signals S_1 and S_2) can be communicated between the hearing device and the charging module via electrode elements 804a, 804c and connections 810, 812. For example, signals S_1 can constitute data signals (e.g., state of charge and charging status data signals) and signals S_2 can constitute control signals generated by the charging module and/or the hearing device.

When implemented on a hearing device, and in accordance with some embodiments, a region of the cathode contact 802 (e.g., central region) can be recessed relative to a contact surface of the anode contact 804 (see, e.g., Figures 9 and 12). Alternatively, the cathode contact 802 and the anode contact 804 can be substantially coplanar. When implemented on a charging module, and in accordance with some embodiments, the cathode contact 802 is a fixed electrical element (non-displaceable) and need not be proud relative to a contact surface of the anode contact 804. In accordance with other embodiments, the cathode contact 802 can be displaceable (see, e.g., Figures 10 and 11) and proud relative to a contact surface of the anode contact 804. Although shown as having a generally circular or arcuate shape, the cathode and anode contacts 802, 804 can have any curvilinear or polygonal shape.

Figure 8B illustrates a charging interface in accordance with any of the embodiments disclosed herein. The charging interface 820 shown in Figure 8B includes an arrangement of electrodes 824 comprising at least one cathode contact 824a and at least one anode contact 824b. The electrode arrangement 824 can include additional electrodes, such as electrode 824c, which can be a cathode contact or an anode contact. It is understood that the electrodes of the arrangement 824 can be configured as cathode or anode contacts, as long as the arrangement of electrodes 824 includes at least one cathode contact and at least one anode contact. A data contact 822 is shown surrounded by electrodes of the electrode arrangement 824. In the representative embodiment shown in Figure 8B, the electrode arrangement 824 has a concentric tri-trace electrode configuration comprising contacts 824a, 824b, 824c, which surround data contact 822. In some embodiments, the electrode arrangement 824 includes two arcuate electrodes, such as cathode contact 824a and anode contact 824b, which can be spaced apart from one another in the manner shown in Figure 14D, for example. The arcuate electrode elements 824a, 824b, 824c are situated at substantially the same radius relative to the data contact 822. Although three arcuate electrode elements are shown in Figure 8B, the electrode arrangement 824 can comprise two, four, five or more electrode elements, for example.

According to various embodiments, a hearing device and a charging module incorporate the charging interface 820 shown in Figure 8B. Cathode contact 824a is typically coupled to a negative contact charging connection 830, and anode contact 824b is typically coupled to a positive contact charging connection 828. Electrical contact 824c can be coupled to either a negative or a positive charging connection 832. The electrode arrangement 824 is configured to communicate power produced by the charging module when charging the rechargeable power source of the hearing device. One or more information signals can be communicated between the hearing device and the charging module via data contact 822 via signal connection 826. For example, these information signals can constitute data signals (e.g., state of charge and charging status data signals) and control signals generated by the charging module and/or the hearing device.

Figure 8C illustrates a charging interface in accordance with any of the embodiments disclosed herein. The charging interface 840a shown in Figure 8C includes a cathode contact

842, which is typically coupled to a negative contact charging connection 846. The charging interface 840a also includes an anode contact 844, which is typically coupled to a positive contact charging connection 848. In the embodiment shown in Figure 8C, the anode contact 844 comprises a multiplicity of electrode elements 844a, 844b, 844c, each of which is coupled to connection 848. The anode contact 844 has a triangular configuration, and is arranged to surround the cathode contact 842. The triangular anode contact 844 includes three electrode elements 844a, 844b, 844c each having a generally curvilinear shape. In some embodiments, the electrode elements 844a, 844b, 844c have a closed curved shape comprising only curved lines (e.g., no line segments). For example, the electrode elements 844a, 844b, 844c can have a non-polygonal shape (e.g., a geometric shape that does not conform to the definition of a polygon). Representative examples of electrode elements 844a, 844b, 844c having a generally curvilinear shape include those having a generally round (e.g., circular) shape, an elliptical shape, and an oval shape. It is understood that the electrode elements 844a, 844b, 844c can also have an arbitrary closed curvilinear shape (e.g., a meandering shape) and/or a closed curvilinear shape comprising predominately curved lines (e.g., a minor percentage (≤ 10-20%) of line segments).

The electrode elements 844a, 844b, 844c can be situated at substantially the same distance (e.g., ~2-6 mm, ~4-5 mm, ~3-5 mm) relative to the cathode contact 842. The cathode contact 842 can have a diameter of about 1.5 mm to about 3 mm, and the electrode elements 844a, 844b, 844c can have the same or smaller diameter (e.g., about 1 mm to about 2.5 mm). Although three electrode elements 844a, 844b, 844c are shown in Figure 8C, the anode contact 844 can comprise one, two, four, five or more electrode elements, for example, arranged in a substantially triangular shape. Also, although the electrode elements 842, 844a, 844b, 844c are shown having the same general shape in Figure 8C (and other figures), it is understood that the electrode elements 842, 844a, 844b, 844c can have different shapes. For example, the electrode elements 842, 844a, 844b, 844c can have different curvilinear shapes or any combination of generally curvilinear shapes and generally rectilinear shapes.

When implemented on a hearing device, and in accordance with some embodiments, a region of the cathode contact 842 (e.g., central region) can be recessed relative to a contact surface of the anode contact 844 (see, e.g., Figures 9 and 12). Alternatively, the cathode

contact 842 and the anode contact 844 can be substantially coplanar. When implemented on a charging module, and in accordance with some embodiments, the cathode contact 842 is a fixed electrical element (non-displaceable) and need not be proud relative to a contact surface of the anode contact 844. In accordance with other embodiments, the cathode contact 842 can be displaceable (see, e.g., Figures 10 and 11) and proud relative to a contact surface of the anode contact 844.

Figure 8D illustrates a charging interface in accordance with any of the embodiments disclosed herein. The charging interface 840b shown in Figure 8D includes a cathode contact 842, which is typically coupled to a negative contact charging connection 846. The charging interface 840b also includes an anode contact 844, which is typically coupled to a positive contact charging connection 848. In the embodiment shown in Figure 8D, the anode contact 844 has a triangular anode configuration comprising a multiplicity of electrode elements 844a, 844b, 844c. As shown, the cathode contact 842 is surrounded by the triangular anode 844 comprising individual electrode elements 844a, 844b, 844c. The electrode elements 844a, 844b, 844c are situated at substantially the same distance relative to the cathode contact 842. Although three electrode elements 844a, 844b, 844c are shown in Figure 8D, the anode contact 844 can comprise one, two, four, five or more electrode elements, for example, arranged in a generally triangular shape. The electrode elements 842, 844a, 844b, 844c can have a generally curvilinear shape or other shapes and/or combination of shapes discussed above with reference to Figure 8C.

According to various embodiments, a hearing device and a charging module can incorporate the charging interface 840b shown in Figure 8D. Each of the electrode elements of the anode contact 844 is coupled to a separate electrical connection. More particularly, electrode element 844a is coupled to connection 850, electrode element 844b is coupled to connection 848, and electrode element 844c is coupled to connection 852. Electrode element 844b represents an anode contact of the charging interface 840b. The electrode element 844b and the cathode contact 842 are configured to communicate power produced by the charging module when charging the rechargeable power source of the hearing device. Disparate information signals (e.g., signals S_1 and S_2) can be communicated between the hearing device and the charging module via electrode elements 844a, 844c and connections 850, 852. For

example, signals S_1 can constitute data signals (e.g., state of charge and charging status data signals) and signals S_2 can constitute control signals generated by the charging module and/or the hearing device.

Figure 8E illustrates a charging interface in accordance with any of the embodiments disclosed herein. The charging interface 840c shown in Figure 8E includes an arrangement of electrodes 844 comprising at least one cathode contact 844a and at least one anode contact 844b. The electrode arrangement 844 can include additional electrodes, such as electrode 844c, which can be a cathode contact or an anode contact. It is understood that any of the electrodes of the arrangement 844 can be configured as cathode or anode contacts, as long as the arrangement of electrodes 844 includes at least one cathode contact and at least one anode contact. A data contact 842 is shown surrounded by electrodes of the electrode arrangement 844. The electrode elements 842, 844a, 844b, 844c can have a generally curvilinear shape or other shapes and/or combination of shapes discussed above with reference to Figure 8C.

In the representative embodiment shown in Figure 8E, the electrode arrangement 844 has a generally triangular configuration comprising contacts 844a, 844b, 844c, which surround data contact 842. In some embodiments, the electrode arrangement 844 can include two electrodes, such as cathode contact 844a and anode contact 844b, which are shaped to generally form a triangular pattern and can be spaced apart (e.g., equidistantly) from the data contact 842. The electrode elements 844a, 844b, 844c can be situated at substantially the same distance relative to the data contact 842. Although three curvilinear shaped electrode elements 844a, 844b, 844c are shown surrounding the central data contact 842 in Figure 8E, the electrode arrangement 844 can comprise one, two, four, five or more curvilinear shaped electrode elements that having a generally triangular pattern and surround the data contact 842.

According to various embodiments, a hearing device and a charging module can incorporate the charging interface 840c shown in Figure 8E. Cathode contact 844a is typically coupled to a negative contact charging connection 850, and anode contact 844b is typically coupled to a positive contact charging connection 848. Electrical contact 844c can be coupled to either a negative or a positive charging connection 852. The electrode

arrangement 844 is configured to communicate power produced by the charging module when charging the rechargeable power source of the hearing device. One or more information signals can be communicated between the hearing device and the charging module via data contact 842 and signal connection 846. For example, these information signals can constitute data signals (e.g., state of charge and charging status data signals) and control signals generated by the charging module and/or the hearing device.

When implemented on a hearing device, and in accordance with either of the embodiments shown in Figures 8D and 8E, a region of the central contact 842 (e.g., central region) can be recessed relative to a contact surface of the peripheral contacts 844a, 844b, 844c (see, e.g., Figures 9 and 12). Alternatively, the central contact 842 and the peripheral contacts 844a, 844b, 844c can be substantially coplanar. In accordance with either of the embodiments shown in Figures 8D and 8E (and other embodiments shown in other figures), when implemented on a hearing device, a region of the central contact 842 (e.g., central region) can be elevated relative to a contact surface of the peripheral contacts 844a, 844b, 844c.

Figures 8F-8I illustrate a custom hearing device (e.g., a custom hearing aid) in accordance with any of the embodiments disclosed herein. The hearing device 860 shown in Figures 8F-8I is configured to be worn at least partially within the ear canal of a wearer's ear. The hearing device 860 is representative of any type of ITE hearing aid, such as an ITC, IIC or CIC hearing aid, for example. The hearing device 860 includes a faceplate 862 and a shell 864 connected to the shell 864. The shell 864 houses the electronic and electrical components of the hearing device 860, such as those previously described. The shell 864 is typically shaped to conform to a particular wearer's ear canal using a mold taken from the wearer's ear. In some configurations, the shell 864 can be constructed from semi-soft material (e.g., polymeric material) which can conform to the shape of the wearer's ear canal when the shell 864 is inserted therein. The faceplate 862 includes a charging interface 840d and other components/structures of the hearing device 860, such as one or two microphones 866.

The charging interface 840d disposed on the faceplate 862 comprises a central contact 842 surrounded by three peripheral contacts 844a, 844b, 844c arranged in a substantially

triangular pattern. The peripheral contacts 844a, 844b, 844c can be situated at substantially the same distance (e.g., ~2-5 mm, ~4-5 mm, ~3-4 mm) relative to the central contact 842. The central contact 842 can have a diameter of about 2 mm to about 3 mm, and the peripheral contacts 844a, 844b, 844c can have the same or smaller diameter (e.g., about 1 mm to about 2.5 mm, ~1.5-2 mm).

The charging interface 840d can be representative of any of the charging interfaces discussed herein. For example, charging interface 840d can be configured and wired in the manner of charging interface 840a shown in Figure 8C. In this representative configuration, the charging interface 840d includes a central cathode contact 842, coupled to a negative charging connection, and three anode contacts 844a, 844b, 844c, each coupled to a positive charging connection. The anode contacts 844a, 844b, 844c are arranged in a substantially triangular pattern and surround the cathode contact 842. The contacts 842, 844a, 844b, 844c can have a generally curvilinear shape or other shapes and/or combination of shapes discussed above with reference to Figure 8C.

According to another example embodiment, the charging interface 840d can be configured and wired in the manner of charging interface 840b shown in Figure 8D. In this representative configuration, central contact 842 is configured as a cathode contact and peripheral contact 844b is an anode contact of the charging interface 840d. Central cathode contact 842 and peripheral anode contact 844b are configured to communicate power produced by a charging module when charging the rechargeable power source of the hearing device 860. Disparate information signals (e.g., signals S_1 and S_2) can be communicated between the hearing device 860 and the charging module via peripheral contacts 844a, 844c. For example, signals S_1 can constitute data signals (e.g., state of charge and charging status data signals) and signals S_2 can constitute control signals generated by the charging module and/or the hearing device 860.

According to another example embodiment, the charging interface 840d can be configured and wired in the manner of charging interface 840c shown in Figure 8E. In this representative configuration, the charging interface 840d includes at least one cathode contact 844a and at least one anode contact 844b. Electrode 844c can be configured as a cathode contact or an anode contact (or a separate signal communicating contact). A central

data contact 842 can be surrounded by contacts 844a, 844b, 844c arranged in a substantially triangular pattern. The contacts 842, 844a, 844b, 844c can have a generally curvilinear shape or other shapes and/or combination of shapes discussed above with reference to Figure 8C.

In accordance with any of the embodiments shown in Figures 8F-8I, a region of the charging interface 840d which includes the central contact 842 (e.g., central region) can be recessed relative to a contact surface of the peripheral contacts 844a, 844b, 844c (see, e.g., Figures 9 and 12). Alternatively, the central contact 842 and the peripheral contacts 844a, 844b, 844c can be substantially coplanar. In accordance with alternative embodiments, the central region of the charging interface 840d which includes the central contact 842 can be elevated relative to a contact surface of the peripheral contacts 844a, 844b, 844c. In accordance with any of the embodiments disclosed herein, the peripheral contacts 844a, 844b, 844c can be surrounded by a peripheral wall having a height greater than that of an exposed surface of peripheral contacts 844a, 844b, 844c.

Figure 8J illustrates a charging interface of a hearing device in accordance with any of the embodiments disclosed herein. The charging interface 870 shown in Figure 8J includes an arrangement of peripheral electrodes 874 comprising at least one cathode contact 874a and at least one anode contact 874b. The peripheral electrode arrangement 874 can include additional electrodes, such as electrode 874c, which can be an anode contact or a cathode contact. A data contact 872 is shown surrounded by electrodes of the electrode arrangement 874. In the representative embodiment shown in Figure 8J, each of the peripheral electrodes 874a, 874b, 874c and the data contact 872 has a generally curvilinear shape (e.g., rounded, circular, elliptical, oval).

The charging interface 870 is coupled to poly-phase rectification circuitry disposed in the housing of the hearing device, which is illustrated as a 3-phase rectifier 890 in Figure 8J. Contacts 874a, 874b, and 874c are coupled to the 3-phase rectifier 890 via charging connections 880, 878, and 882, respectively. The electrode arrangement 874 is configured to communicate power produced by the charging module when charging the rechargeable power source of the hearing device. In the embodiment shown in Figure 8J, power is contained within the concentric electrode arrangement 874. Using this electrode configuration, if at least one contact of the electrode arrangement 874 is connected to ground

(GND) and at least one other contact of the electrode arrangement 874 is connected to power (PWR), then the 3-phase rectifier 890 will supply the correct polarity with the correct voltage.

The charging interface 870 of the hearing device is configured to establish electrical connection with a charging interface 891 of a charging module, an example of which is shown in Figure 8K. The charging interface 870 of the hearing device includes at least two contacts 874a, 874b which serve as cathode and anode contacts. The two contacts 896, 898 of the charging module's charging interface 891 are configured and arranged so that each contact 896, 898 electrically connects with only one of the three contacts 874a, 874b, 874c of the hearing device's charging interface 870. This arrangement ensures that anode and cathode contacts of the hearing device electrically connect with respective anode and cathode contacts of the charging module. In Figure 8K, the contacts 896, 898 of the charging module's charging interface 891 are shown as having an arcuate shape. The contacts 896, 898 may alternatively have a curvilinear shape, a rectilinear shape, or other shape.

One or more information signals can be communicated between the hearing device and the charging module via data contact 872 and signal connection 876. For example, these information signals can constitute data signals (e.g., state of charge and charging status data signals) and control signals generated by the charging module and/or the hearing device. One or more disparate signals can be communicated over data contact 872 using a sequential or multiplexing data transmission technique (e.g., time-division multiplexing, frequency-division multiplexing, code-division multiplexing).

Figure 9 is a cross-sectional view of a portion of a hearing device in accordance with any of the embodiments disclosed herein. The portion of the hearing device 900 shown in Figure 9 includes a charging interface 902 incorporated on the shell or housing 904 of the hearing device 900. The charging interface 902 is situated at or near an exterior surface of the housing 904. For example, the charging interface 902 can be situated on a faceplate of an in-the-ear type hearing device (e.g., ITE, ITC, IIC, CIC device). In the case of an on-the-ear type hearing device (e.g., BTE, RIC, RITE device), for example, the charging interface 902 can be situated at or near a bottom or top end surface of the housing 902. The charging

interface 902 is configured to physically and electrically coupled to a corresponding charging interface of a charging module (see, e.g., Figures 3, 4, 10, and 11).

The charging interface 902 includes a cathode contact 906 partially or entirely surrounded by an anode contact 908. The anode contact 908 can be a single electrical contact or comprise a multiplicity of electrical contacts (see, e.g., Figures 3-8). For example, the anode contact 908 can comprise a single annular electrical contact or two or more arcuate electrical contacts (e.g., a concentric tri-trace anode configuration). The cathode contact 906 is shown extending slightly beyond the exterior surface of the housing 904 relative to the anode contact 908, which is shown as substantially coplanar with the exterior surface of the housing 904. In some implementations, the cathode contact 906 can be substantially coplanar with exterior surface of the housing 904. The cathode contact 906 can include a recessed region 907, which is typically situated within a central region of the cathode contact 906. The recessed region 907 serves to guide a corresponding cathode contact of a charging module into proper contact with the cathode contact 906.

In the embodiment shown in Figure 9, the hearing device 900 includes a retention arrangement 910. The retention arrangement 910 is configured to maintain engagement between the charging interface 902 and a corresponding charging interface of a charging module during charging of a rechargeable power source of the hearing device 900. The retention arrangement 910 includes a magnet 911 or magnetizable structure which can interact with a corresponding magnet or magnetizable structure of the charging module. In some embodiments, the anode contact 908 partially or entirely comprises magnetic material, in which case the separate magnet 911 or magnetizable structure need not be included in the retention arrangement 910.

Figure 10 is a cross-sectional view of a portion of a charging module in accordance with any of the embodiments disclosed herein. The portion of the charging module 1000 shown in Figure 10 includes a charging interface 1002 disposed on a charging surface 1004 of the charging module 1000. The charging interface 1002 is configured to physically and electrically coupled to a corresponding charging interface of a hearing device (see, e.g., Figures 3, 4, 9, and 12). The charging interface 1002 includes a cathode contact 1006 partially or entirely surrounded by an anode contact 1008. The anode contact 1008 can be a

single electrical contact or comprise a multiplicity of electrical contacts (see, e.g., Figures 3-8). For example, the anode contact 1008 can comprise a single annular electrical contact or two or more arcuate electrical contacts (e.g., a concentric tri-trace anode configuration).

The charging interface 1002 includes a through-hole 1012 within which the cathode contact 1006 is disposed. The cathode contact 1006 is displaceable within the through-hole 1012. A biasing arrangement 1014 is configured to bias at least a portion 1006a of the cathode contact 1006 above a contact surface 1009 of the anode contact 1008. As such, the cathode contact 1006 is proud relative to the anode contact 1008 prior to engagement with a corresponding charging interface of a hearing device. The biasing arrangement 1014 is configured to bias at least the portion 1006a of the cathode contact 1006 above the contact surface 1009 to facilitate electrical contact between the cathode contact 1006 and a corresponding cathode contact of a hearing device prior to electrical contact between the anode contact 1008 and corresponding anode contact of the hearing device.

According to some embodiments, the cathode contact 1006 comprises an elongated electrode, and the biasing arrangement 1014 comprises a spring 1016. In some embodiments, the cathode contact 1006 and biasing arrangement 1014 define a spring-loaded pogo pin assembly. The pogo pin assembly 1014 includes a center post pogo pin 1006 which is seated into the housing of the charging module 1000 via pogo housing 1018. The pogo housing 1018 contains a pogo spring 1016 and a pogo endstop 1019.

The charging module 1000 also includes a retention arrangement 1020 configured to maintain engagement between the charging interface 1002 and a corresponding charging interface of a hearing device during charging of a rechargeable power source of the hearing device. The retention arrangement 1020 includes a magnet 1022 or magnetizable structure which can interact with a corresponding magnet or magnetizable structure of the hearing device. In some embodiments, the anode contact 1008 partially or entirely comprises magnetic material, in which case the separate magnet 1022 or magnetizable structure need not be included in the retention arrangement 1020. In some embodiments, the anode contact 1008 can be implemented as a ring magnet plated with electrically conductive material. The ring magnet provides attraction to a different magnet or magnetizable structure in the hearing device in order to align the electrical contacts. The plating provides corrosion resistance.

Figures 11 and 12 illustrate a system in accordance with any of the embodiments disclosed herein. The system includes a hearing aid 1202 (Figure 12) configured to be worn at least partially within the ear canal of a wearer's ear. The hearing aid 1202 is representative of any type of ITE hearing aid, such as an ITC, IIC or CIC hearing aid, for example. The hearing aid 1202 includes a charging interface 1204 comprising a cathode contact 1206 surrounded by an anode contact 1208. Although shown as a concentric tri-trace anode in Figure 12, the anode contact 1208 can be configured as a single electrode element or a multiplicity of electrode elements. The charging interface 1204 is disposed on a faceplate 1203 of the hearing aid 1202.

Figure 11 shows a charging module 1122 which can be installed in, or be integral to, a charging fixture. The charging module 1122 includes a charging interface 1124 which includes a displaceable central cathode contact 1126 surrounded by a concentric anode contact 1128. The displaceable central cathode contact 1126 can be implemented as a spring-loaded elongated electrode, such as that shown in Figure 10 (e.g., a spring-loaded pogo pin assembly). It is understood that a charging fixture will typically include two of the charging modules 1122 configured to charge two of the hearing aids 1202.

Figure 13 is a schematic showing electrical components of a system in accordance with any of the embodiments disclosed herein. The schematic of system 1300 includes electrical components of a hearing device 1302 and electrical components of a charging module 1320. The hearing device 1302 includes a rechargeable power source 1304, such as a lithium-ion battery. The rechargeable power source 1304 is coupled to power management circuitry 1306, such as a PMIC. The power management circuitry 1306 is coupled to an anode contact R3 and a cathode contact R6. The anode contact R3 and cathode contact R6 of the hearing device 1302 can have a configuration and functionality described previously.

The charging module 1320 includes a power source V, which is represented as a battery in Figure 13. The power source V can include a rechargeable battery, a conventional battery, and/or an AC/DC converter configured to receive power from a standard wall outlet. In some embodiments, the power source V can be configured to receive wireless power from an external power source (e.g., Qi, inductive, radiofrequency, optical). The charging module impedance is represented by R1, which is shown coupled to an anode contact R2 via anode

switch S1. Resistor R4 represents a pulldown resistor for current sensing. Resistor R4 is coupled to a cathode contact R5 via cathode switch S2. The anode contact R2 and cathode contact R5 of the charging module 1320 can have a configuration and functionality described previously. In some embodiments, the charging module 1320 is not configured to control anode switch S1 and cathode switch S2 independently, so mechanically ensuring a ground (GND) contact first provides for a more accurate and consistent inrush current profile as previously discussed.

Figure 14A is a schematic showing electrical components of a system in accordance with any of the embodiments disclosed herein. The schematic of system 1400 includes electrical components of a hearing device 1402 and electrical components of a charging module 1420. The hearing device 1402 includes a rechargeable power source 1404, such as a lithium-ion battery. The rechargeable power source 1404 is coupled to power management circuitry 1406, such as a PMIC. The power management circuitry 1406 is coupled to a rectifier 1408. The rectifier 1408 is coupled to a contact arrangement 1410 comprising a cathode contact, at least one anode contact, and one or more electrical contacts configured to communicate information signals between the hearing device 1402 and the charging module 1420. The rectifier 1408 can be implemented as an N-phase rectifier, where N is equal to the number of electrical contacts of the contact arrangement 1410.

Any of contacts R3, R6, and R7 of the hearing device 1402 can be configured as an anode contact or a cathode contact. Any of contacts R3, R6, and R7 can be configured as an electrical contact configured to communicate information signals. In some embodiments, contacts R3, R6, and R7 can be configured as split-ring pin connectors, with the center pin connector being used for data signal transmission and the other two connectors being used as cathode and anode contacts for charging. Other electrical contact configurations are contemplated. For example, and with reference to the embodiment shown in Figure 14B, the hearing device 1402 can include a charging interface 1403 comprising a central cathode pin R7 surrounded by split-ring pin connectors R3 and R6. One of connectors R3 and R6 is configured as an anode contact for charging, and the other of connectors R3 and R6 is configured as an electrical contact configured for data signal transmission. The contact

arrangement 1410 of the hearing device 1402 can have a configuration and functionality described previously.

The charging module 1420 includes a power source V, which is represented as a battery in Figure 14. The power source V can include a rechargeable battery, a conventional battery, and/or an AC/DC converter configured to receive power from a standard wall outlet. In some embodiments, the power source V can be configured to receive wireless power from an external power source (e.g., Qi, inductive, radiofrequency, optical). The charging module impedance is represented by R1, which is shown coupled to an anode contact R2 via anode switch S1. Resistor R4 represents a pulldown resistor for current sensing. Resistor R4 is coupled to a cathode contact R5 via cathode switch S2. The anode contact R2 and cathode contact R5 of the charging module 1420 can have a configuration and functionality described previously. In some embodiments, the charging module 1420 is not configured to control anode switch S1 and cathode switch S2 independently, so mechanically ensuring a ground (GND) contact first provides for a more accurate inrush current profile as previously discussed.

In addition to providing anode and cathode contacts for charging, the hearing device 1402 and charging module 1420 include one or more additional electrical contacts for communicating information signals between the hearing device 1402 and charging module 1420. For example, data can be communicated via one or more contacts, which can be split into multiple contacts each providing a separate connection for disparate signal transmission. The type of signal transmitted over each contact can be detected automatically by the charging module 1420, which can reconfigure the charger connections in real time. For example, the charging module 1420 can include circuitry for detecting whether a particular contact is being used to transmit power and/or data, such as by detecting the pull-up strength of the contacts. In some embodiments, the charging module 1420 can include circuitry configured to detect the connections by cycling through known protocol possibilities and using the one that works through a handshaking procedure.

Figure 14C illustrates a charging interface of a hearing device in accordance with any of the embodiments disclosed herein. The charging interface 1430 shown in Figure 14C includes an arrangement of electrodes 1434 comprising at least one cathode contact 1434a

and at least one anode contact 1434b. The electrode arrangement 1434 can include additional electrodes, such as electrode 1434c, which can be an anode contact or a cathode contact. A data contact 1432 is shown surrounded by electrodes of the electrode arrangement 1434. In the representative embodiment shown in Figure 14C, the electrode arrangement 1434 has a concentric tri-trace electrode configuration comprising contacts 1434a, 1434b, 1434c, which surround data contact 1432. In some embodiments, the electrode arrangement 1434 includes two arcuate electrodes, such as cathode contact 1434a and anode contact 1434b, which can be spaced apart from one another (e.g., see Figure 14D). The arcuate electrode elements 1434a, 1434b, 1434c are situated at substantially the same radius relative to the data contact 1432. Although three arcuate electrode elements are shown in Figure 14C, the electrode arrangement 1434 can comprise two, four, five or more electrode elements, for example.

The charging interface 1430 is coupled to poly-phase rectification circuitry, which is illustrated as a 3-phase rectifier 1450 in Figure 14C. Contacts 1434a, 1434b, and 1434c are coupled to the 3-phase rectifier 1450 via charging connections 1440, 1438, and 1442, respectively. The electrode arrangement 1434 is configured to communicate power produced by the charging module when charging the rechargeable power source of the hearing device. In the embodiments shown in Figure 14C, power is contained within the concentric electrode arrangement 1434. Using this electrode configuration, if at least one contact of the electrode arrangement 1434 is connected to ground (GND) and at least one other contact of the electrode arrangement 1434 is connected to power (PWR), then the 3-phase rectifier 1450 will supply the correct polarity with the correct voltage.

The charging interface 1430 is configured to establish electrical connection with a charging interface of a charging module, an example of which is shown in Figure 14D. The charging interface 1450 includes at least two contacts 1454, 1456 which serve as anode and cathode contacts. The two contacts 1454, 1456 of the charging module's charging interface 1450 are configured and arranged so that each contact 1454, 1456 electrically connects with only one of the three contacts 1434a, 1434b, 1434c of the hearing device's charging interface 1430. This arrangement ensures that anode and cathode contacts of the hearing device 1430 electrically connect with respective anode and cathode contacts of the charging module.

One or more information signals can be communicated between the hearing device and the charging module via data contact 1432 and signal connection 1436. For example, these information signals can constitute data signals (e.g., state of charge and charging status data signals) and control signals generated by the charging module and/or the hearing device. One or more disparate signals can be communicated over data contact 1432 using a sequential or multiplexing data transmission technique (e.g., time-division multiplexing, frequency-division multiplexing, code-division multiplexing).

Figure 15 illustrates a method of implementing accelerated charging of one or more hearing devices using a charging module in accordance with any of the embodiments disclosed herein. In the illustrative method shown in Figure 15, two ear-worn electronic devices are subject to accelerated charging via two charging modules provided on the charging fixture. The method shown in Figure 15 involves establishing connection 1502 between first and second ear-worn electronic devices and first and second charging modules of the charging fixture. The method involves determining 1504 the state of charge (SoC) of the rechargeable power sources of the ear-worn electronic devices. A check 1506 is made to determine if the SoC of the rechargeable power sources is within a predetermined SoC range (e.g., 5-35%). If the SoC of the rechargeable power sources fall within the predetermined SoC range, the method involves charging 1508 the rechargeable power sources at an accelerated charge rate above 1.0C (e.g., 1.5C – 3.0C). Accelerated charging continues while the SoC of the rechargeable power sources remain within the predetermined SoC range. Accelerated charging is discontinued when the SoC of the rechargeable power sources is beyond the predetermined SoC range. In some embodiments, accelerated charging is discontinued in response to expiration of a predetermined time limit (e.g., 15 minutes), reaching a predetermined voltage limit (e.g., 4.1V), or reaching a predetermined energy limit (e.g., 7.5 mAh).

At the termination of accelerated charging, the ear-worn electronic devices may be removed from the charging modules of the charging fixture for immediate use. In some embodiments, five minutes of accelerated charging allows the ear worn electronic devices to be used for between 2 and 6 hours of normal operation. Rather than using the ear worn electronic devices after termination of accelerated charging, the method can involve charging

1510 the rechargeable power sources at a normal charge rate at or below 1.0 C. A check 1512 is made to determine if rechargeable power sources are fully charged. If not, charging at the normal charge rate continues. When the rechargeable power sources are fully charged, the charging procedure is terminated 1514. Accelerated charging can be implemented in accordance with the teachings disclosed in commonly-owned U.S. Patent Application Serial No. 16/012,399 (Higgins et al.), filed on June 19, 2018 and entitled PORTABLE CHARGING UNIT WITH ACCELERATED CHARGING FOR HEARING ASSISTANCE DEVICES, which is incorporated herein by reference.

Figure 16 is a graph that characterizes accelerated charging of a lithium-ion battery of an ear-worn electronic device in accordance with any of the embodiments disclosed herein. The graph of Figure 16 characterizes battery voltage 1602 and charge current 1604 as a function of time during different phases of a charging procedure. As is indicated below the time axis, the different phases of the charging procedure include a pre-charge phase (A), an accelerated constant current charge phase (B), a constant voltage charge phase (D), and a charge complete phase (E). During the pre-charge phase (A), the charge current 1604 is low (e.g., 0.1C) and the battery voltage 1602 slowly increases. It is noted that a well-designed system should stay out of this regime. The pre-charge phase (A) continues until the battery voltage 1602 reaches 3.0 V, at which time the accelerated constant current charge phase (B) is initiated.

During the accelerated charging phase (B), the charge current 1604 rapidly increases to a charge rate above 1.0C, such as 1.5C. During the accelerated charging phase (B), high current is supplied to the battery which results in a rapid increase in battery voltage 1602. For example, a charge current of 5 mA can be supplied to the battery during the latter part of the pre-charge phase (A) (e.g., at 0.3C). The charge current can be increased to between 17 and 24 mA during the accelerated charging phase (B). The accelerated charging phase (B) continues until a predetermined time limit (e.g., 5-15 min) has been reached. In some embodiments, the accelerated charging phase (B) continues until a predetermined battery voltage 1602 (e.g., 4.1 V) or predetermined energy level (e.g., 7.5 mAh) has been reached.

At the conclusion of the accelerated charging phase (B), the charge current 1604 rapidly decreases to a normal charge current level (e.g., 5 mA at a charge rate of 0.3C) at the

initiation of the constant current charge phase (C). During the constant current charge phase (C), a normal charge current (e.g., 5mA) is supplied to the battery resulting in a continued increase in the battery voltage 1602. When the battery voltage 1602 reaches a predetermined level (e.g., 4.2 V), the charging procedure transitions from the constant current charge phase (C) to the constant voltage charge phase (D). During the constant voltage charge phase (D), the charge current 1604 decreases until a cutoff 1606 is reached, at which time the charging procedure is terminated. It is noted that at the charging complete phase (E), the battery voltage 1602 slightly drops over time (e.g., from 4.1 V to 3.9 V). In the embodiment shown in the Figure 16, the charge current 1604 supplied during the accelerated charging phase (B) changes in a step-wise fashion. It is understood that, in some embodiments, the charge current 1604 can decrease gradually as the accelerated charging phase (B) transitions to the constant current charge phase (C).

Although reference is made herein to the accompanying set of drawings that form part of this disclosure, one of at least ordinary skill in the art will appreciate that various adaptations and modifications of the embodiments described herein are within, or do not depart from, the scope of this disclosure. For example, aspects of the embodiments described herein may be combined in a variety of ways with each other. Therefore, it is to be understood that, within the scope of the appended claims, the claimed invention may be practiced other than as explicitly described herein.

All references and publications cited herein are expressly incorporated herein by reference in their entirety into this disclosure, except to the extent they may directly contradict this disclosure. Unless otherwise indicated, all numbers expressing feature sizes, amounts, and physical properties used in the specification and claims may be understood as being modified either by the term “exactly” or “about.” Accordingly, unless indicated to the contrary, the numerical parameters set forth in the foregoing specification and attached claims are approximations that can vary depending upon the desired properties sought to be obtained by those skilled in the art utilizing the teachings disclosed herein or, for example, within typical ranges of experimental error.

The recitation of numerical ranges by endpoints includes all numbers subsumed within that range (e.g. 1 to 5 includes 1, 1.5, 2, 2.75, 3, 3.80, 4, and 5) and any range within

that range. Herein, the terms "up to" or "no greater than" a number (e.g., up to 50) includes the number (e.g., 50), and the term "no less than" a number (e.g., no less than 5) includes the number (e.g., 5).

The terms "coupled" or "connected" refer to elements being attached to each other either directly (in direct contact with each other) or indirectly (having one or more elements between and attaching the two elements). Either term may be modified by "operatively" and "operably," which may be used interchangeably, to describe that the coupling or connection is configured to allow the components to interact to carry out at least some functionality (for example, a radio chip may be operably coupled to an antenna element to provide a radio frequency electromagnetic signal for wireless communication).

Terms related to orientation, such as "top," "bottom," "side," and "end," are used to describe relative positions of components and are not meant to limit the orientation of the embodiments contemplated. For example, an embodiment described as having a "top" and "bottom" also encompasses embodiments thereof rotated in various directions unless the content clearly dictates otherwise.

Reference to "one embodiment," "an embodiment," "certain embodiments," or "some embodiments," etc., means that a particular feature, configuration, composition, or characteristic described in connection with the embodiment is included in at least one embodiment of the disclosure. Thus, the appearances of such phrases in various places throughout are not necessarily referring to the same embodiment of the disclosure. Furthermore, the particular features, configurations, compositions, or characteristics may be combined in any suitable manner in one or more embodiments.

The words "preferred" and "preferably" refer to embodiments of the disclosure that may afford certain benefits, under certain circumstances. However, other embodiments may also be preferred, under the same or other circumstances. Furthermore, the recitation of one or more preferred embodiments does not imply that other embodiments are not useful and is not intended to exclude other embodiments from the scope of the disclosure.

As used in this specification and the appended claims, the singular forms "a," "an," and "the" encompass embodiments having plural referents, unless the content clearly dictates

otherwise. As used in this specification and the appended claims, the term "or" is generally employed in its sense including "and/or" unless the content clearly dictates otherwise.

As used herein, "have," "having," "include," "including," "comprise," "comprising" or the like are used in their open-ended sense, and generally mean "including, but not limited to." It will be understood that "consisting essentially of," "consisting of," and the like are subsumed in "comprising," and the like. The term "and/or" means one or all of the listed elements or a combination of at least two of the listed elements.

The phrases "at least one of," "comprises at least one of," and "one or more of" followed by a list refers to any one of the items in the list and any combination of two or more items in the list.

CLAIMS

What is claimed is:

1. A system, comprising:

at least one hearing device configured to be worn at, in or on an ear of a wearer, the hearing device comprising a rechargeable power source, power management circuitry, and a first charging interface comprising a first cathode contact and a first anode contact spaced apart from the first cathode contact; and

a charging module comprising:

a second charging interface configured to detachably couple with the first charging interface of the hearing device, the second charging interface comprising a second anode contact having a contact surface and a displaceable second cathode contact;

an arrangement configured to displace at least a portion of the second cathode contact above the contact surface to facilitate electrical contact between the first and second cathode contacts prior to electrical contact between the first and second anode contacts; and

charging circuitry coupled to the second charging interface and configured to charge the rechargeable power source of the hearing device.

ABSTRACT

A system includes a hearing device comprising a rechargeable power source, power management circuitry, and a first charging interface comprising a first cathode contact and a first anode contact spaced apart from the first cathode contact. A charging module comprises a second charging interface configured to detachably couple with the first charging interface of the hearing device. The second charging interface comprises a second anode contact having a contact surface and a displaceable second cathode contact. An arrangement is configured to displace at least a portion of the second cathode contact above the contact surface to facilitate electrical contact between the first and second cathode contacts prior to electrical contact between the first and second anode contacts. Charging circuitry of the charging module is coupled to the second charging interface and configured to charge the rechargeable power source of the hearing device.

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Title of Invention

SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	7322	FILED BY	Mark Hollingsworth
PATENT CENTER #	66857628	FILING DATE	-
CUSTOMER #	142537	FIRST NAMED INVENTOR	Erik Carlson
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Mark Hollingsworth

Documents

TOTAL DOCUMENTS: 7

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
2024-08-20-ADS.pdf	9	Application Data Sheet	1227 KB
2024-08-20-Application-APP.TEXT.docx	44	Application body structured text document	104 KB
Warning: Bookmarks were found and have been removed.			
2024-08-20-Drawings.pdf	15	Drawings-only black and white line drawings	497 KB
ST0806US1 - Declarations.pdf	4	Oath or Declaration filed	496 KB
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2024-08-20-IDS 1449 and LETTER.pdf	4	Information Disclosure Statement (IDS) Form (SB08)	131 KB

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2024-08-20-Application.pdf	44	Auxiliary PDF of Application	198 KB

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2024-08-20-IDS 1449 and LETTER.pdf	1C7D946DC4DE8487EBE4718C2BD0B5C5A9A20E6233E05527 19351084D897FDE27CF552711DB3CCF8ED3A74E32513C8D5 B6752FA9CE6E13DBE0036E5FD8F2D050
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2024-08-20-Application.pdf	2679FEAC6B5C2CEB753F08660522B48B36060B8F2B9A0CF21 260E6ADEDDEE04A51BB09B232F452A958C57F5C07B1274A8 B21AB76D3819E237EC42DB4FA88AB20

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National Stage of an International Application under 35 U.S.C. 371

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New International Application Filed with the USPTO as a Receiving Office

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SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE

RELATED APPLICATIONS

This application is a continuation of U.S. Patent Application No. 17/553,716, filed December 16, 2021, which is a continuation of PCT Application No. PCT/US2020/041956, filed July 14, 2020, which claims priority to U.S. Provisional Application No. 62/876,454, filed July 19, 2019, and U.S. Provisional Application No. 62/943,375, filed December 4, 2019, the content of which are hereby incorporated by reference in their entireties.

TECHNICAL FIELD

This application relates generally to ear-worn electronic devices, including hearing devices, hearing aids, personal amplification devices, and other hearables.

BACKGROUND

Hearing devices provide sound for the wearer. Some examples of hearing devices are headsets, hearing aids, speakers, cochlear implants, bone conduction devices, and personal listening devices. For example, hearing aids provide amplification to compensate for hearing loss by transmitting amplified sounds to a wearer's ear canals. Hearing devices may be capable of performing wireless communication with other devices, such as receiving streaming audio from a streaming device via a wireless link. Wireless communication may also be performed for programming the hearing device and transmitting information from the hearing device. For performing such wireless communication, hearing devices such as hearing aids can include a wireless transceiver and an antenna. In order to provide power to electronic circuitry of a hearing device, a rechargeable battery is often housed within the hearing device, which requires routine charging to ensure proper operation of the hearing device.

SUMMARY

Embodiments are directed to a system comprising at least one hearing device configured to be worn at, in or on an ear of a wearer. The hearing device comprises a

rechargeable power source, power management circuitry, and a first charging interface comprising a first cathode contact and a first anode contact spaced apart from the first cathode contact. A charging module comprises a second charging interface configured to detachably couple with the first charging interface of the hearing device. The second charging interface comprises a second anode contact having a contact surface and a displaceable second cathode contact. An arrangement is configured to displace at least a portion of the second cathode contact above the contact surface to facilitate electrical contact between the first and second cathode contacts prior to electrical contact between the first and second anode contacts. Charging circuitry is coupled to the second charging interface and configured to charge the rechargeable power source of the hearing device.

Embodiments are directed to a system, comprising at least one hearing device configured to be worn at, in or on an ear of a wearer. The hearing device comprises a rechargeable power source, power management circuitry, and a first charging interface comprising a first cathode contact and a first anode contact spaced apart from the first cathode contact. The first anode contact can comprise a plurality of electrode elements each having a non-polygonal shape such a curvilinear, round, elliptical, oval or other closed curved shape comprising only or predominately curved lines. The first anode contact can comprise a plurality of electrode elements each having a polygonal shape such as a square, rectangular, triangular or any other closed plane shape formed with three or more straight lines (e.g., polygonal shapes having from three to twelve sides). The first anode contact can comprises a plurality of electrode elements having a combination of non-polygonal and polygonal shapes. A charging module comprises a second charging interface configured to detachably couple with the first charging interface of the hearing device. The second charging interface comprises a second anode contact having a contact surface and a displaceable second cathode contact. An arrangement is configured to displace at least a portion of the second cathode contact above the contact surface to facilitate electrical contact between the first and second cathode contacts prior to electrical contact between the first and second anode contacts. Charging circuitry of the charging module is coupled to the second charging interface and configured to charge the rechargeable power source of the hearing device.

Embodiments are directed to a system comprising at least one hearing device configured to be worn at, in or on an ear of a wearer. The hearing device comprises a rechargeable power source, power management circuitry, and a first charging interface comprising a first cathode contact surrounded by a first anode contact. The first anode contact can comprise a plurality of electrode elements each having a non-polygonal shape such a curvilinear, round, elliptical, oval or other closed curved shape comprising only or predominately curved lines. The first anode contact can comprise a plurality of electrode elements each having a polygonal shape such as a square, rectangular, triangular or any other closed plane shape formed with three or more straight lines (e.g., polygonal shapes having from three to twelve sides). The first anode contact can comprises a plurality of electrode elements having a combination of non-polygonal and polygonal shapes. A charging module comprises a second charging interface configured to detachably couple with the first charging interface of the hearing device. The second charging interface comprises a second anode contact having a contact surface, a through-hole, and a second cathode contact displaceable within the through-hole. A biasing arrangement is configured to bias at least a portion of the second cathode contact above the contact surface to facilitate electrical contact between the first and second cathode contacts prior to electrical contact between the first and second anode contacts. Charging circuitry of the charging module is coupled to the second charging interface and configured to charge the rechargeable power source of the hearing device. A retention arrangement is disposed on one or both of the hearing device and the charging module. The retention arrangement is configured to maintain engagement between the first and second charging interfaces during charging of the rechargeable power source of the hearing device.

Embodiments are directed to a system comprising at least one hearing device configured to be worn at, in or on an ear of a wearer. The hearing device comprises a rechargeable power source and a first charging interface comprising a first cathode contact and a first anode contact spaced apart from the first cathode contact. The first anode contact can comprise a plurality of electrode elements each having a non-polygonal shape such as a curvilinear, round, elliptical, oval or other closed curved shape comprising only or predominately curved lines. The first anode contact can comprise a plurality of electrode

elements each having a polygonal shape such as a square, rectangular, triangular or any other closed plane shape formed with three or more straight lines (e.g., polygonal shapes having from three to twelve sides). The first anode contact can comprises a plurality of electrode elements having a combination of non-polygonal and polygonal shapes. The first anode contact comprises a plurality of first electrode elements configured to communicate power and one or more disparate information signals. A charging module comprises a second charging interface configured to detachably couple with the first charging interface of the hearing device and comprises a second cathode contact and a second anode contact. The second anode contact comprises a plurality of second electrode elements configured to communicate power and the one or more disparate information signals. Charging circuitry of the charging module is coupled to the second charging interface and configured to charge the rechargeable power source of the hearing device. The first and second electrode elements are configured to communicate power and the one or more information signals between the charging module and the hearing device.

Embodiments are directed to a system comprising at least one hearing device configured to be worn at, in or on an ear of a wearer. The hearing device comprises a rechargeable power source and a first charging interface comprising a plurality of first electrode elements. The plurality of first electrode elements comprises first cathode and anode contacts configured to communicate power and a first data contact configured to communicate one or more disparate information signals. The first anode contact can comprise a plurality of electrode elements each having a non-polygonal shape such as a curvilinear, round, elliptical, oval or other closed curved shape comprising only or predominately curved lines. The first anode contact can comprise a plurality of electrode elements each having a polygonal shape such as a square, rectangular, triangular or any other closed plane shape formed with three or more straight lines (e.g., polygonal shapes having from three to twelve sides). The first anode contact can comprise a plurality of electrode elements having a combination of non-polygonal and polygonal shapes. A charging module comprises a second charging interface configured to detachably couple with the first charging interface of the hearing device and comprises a plurality of second electrode elements. The plurality of second electrode elements comprises second cathode and anode contacts

configured to communicate power and a second data contact configured to communicate one or more disparate information signals. Charging circuitry of the charging module is coupled to the second charging interface and configured to charge the rechargeable power source of the hearing device.

The above summary is not intended to describe each disclosed embodiment or every implementation of the present disclosure. The figures and the detailed description below more particularly exemplify illustrative embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

Throughout the specification reference is made to the appended drawings wherein:

Figures 1A and 1B illustrate an ear-worn electronic device arrangement incorporating charging circuitry and functionality in accordance with any of the embodiments disclosed herein;

Figures 2A and 2B illustrate a custom hearing aid system which incorporates charging circuitry and functionality in accordance with any of the embodiments disclosed herein;

Figure 3 illustrates an ear-worn electronic device and a charging module respectively incorporating charging circuitry and functionality in accordance with any of the embodiments disclosed herein;

Figure 4 illustrates an ear-worn electronic device and a charging module respectively incorporating charging circuitry and functionality in accordance with any of the embodiments disclosed herein;

Figure 5 illustrates a charging interface of one or both of an ear-worn electronic device and a charging module in accordance with any of the embodiments disclosed herein;

Figure 6 illustrates a charging interface of one or both of an ear-worn electronic device and a charging module in accordance with any of the embodiments disclosed herein;

Figure 7 illustrates a charging interface of one or both of an ear-worn electronic device and a charging module in accordance with any of the embodiments disclosed herein;

Figure 8A illustrates a charging interface of one or both of an ear-worn electronic device and a charging module in accordance with any of the embodiments disclosed herein;

Figure 8B illustrates a charging interface of one or both of an ear-worn electronic device and a charging module in accordance with any of the embodiments disclosed herein;

Figure 8C illustrates a charging interface of one or both of an ear-worn electronic device and a charging module in accordance with any of the embodiments disclosed herein;

Figure 8D illustrates a charging interface of one or both of an ear-worn electronic device and a charging module in accordance with any of the embodiments disclosed herein;

Figure 8E illustrates a charging interface of one or both of an ear-worn electronic device and a charging module in accordance with any of the embodiments disclosed herein;

Figures 8F-8I illustrate a charging interface of an ear-worn electronic device in accordance with any of the embodiments disclosed herein;

Figure 8J illustrates a charging interface of a hearing device comprising a central data contact surrounded by a triangular arrangement of curvilinear-shaped peripheral contacts coupled to a multi-phase rectifier in accordance with any of the embodiments disclosed herein;

Figure 8K illustrates a charging interface of a charging module comprising a central data pin surrounded by a pair of arcuate contacts in accordance with any of the embodiments disclosed herein;

Figure 9 is a cross-sectional view of a portion of a hearing device comprising charging circuitry in accordance with any of the embodiments disclosed herein;

Figure 10 is a cross-sectional view of a portion of a charging module comprising charging circuitry in accordance with any of the embodiments disclosed herein;

Figures 11 and 12 illustrate a system comprising an ear-worn electronic device and a charging module respectively incorporating charging circuitry and functionality in accordance with any of the embodiments disclosed herein;

Figure 13 is a schematic showing electrical components of a system comprising an ear-worn electronic device and a charging module respectively incorporating charging circuitry and functionality in accordance with any of the embodiments disclosed herein;

Figure 14A is a schematic showing electrical components of a system comprising an ear-worn electronic device and a charging module respectively incorporating charging circuitry and functionality in accordance with any of the embodiments disclosed herein;

Figure 14B illustrates a charging interface of a hearing device comprising a central cathode pin surrounded by split-ring pin connectors in accordance with any of the embodiments disclosed herein;

Figure 14C illustrates a charging interface of a hearing device comprising a central data pin surrounded by split-ring pin connectors coupled to a multi-phase rectifier in accordance with any of the embodiments disclosed herein;

Figure 14D illustrates a charging interface of a charging module comprising a central data pin surrounded by split-ring pin connectors in accordance with any of the embodiments disclosed herein;

Figure 15 illustrates a method of implementing accelerated charging of one or more hearing devices using a charging module in accordance with any of the embodiments disclosed herein; and

Figure 16 is a graph that characterizes accelerated charging of a lithium-ion battery of a hearing device in accordance with any of the embodiments disclosed herein.

The figures are not necessarily to scale. Like numbers used in the figures refer to like components. However, it will be understood that the use of a number to refer to a component in a given figure is not intended to limit the component in another figure labeled with the same number.

DETAILED DESCRIPTION

It is understood that the embodiments described herein may be used with any ear-worn or ear-level electronic device without departing from the scope of this disclosure. The devices depicted in the figures are intended to demonstrate the subject matter, but not in a limited, exhaustive, or exclusive sense. Ear-worn electronic devices (also referred to herein as "hearing devices"), such as hearables (e.g., wearable earphones, ear monitors, and earbuds), hearing aids, hearing instruments, and hearing assistance devices, typically include an enclosure, such as a housing or shell, within which internal components are disposed. Typical components of a hearing device can include a processor (e.g., a digital signal processor or DSP), memory circuitry, power management circuitry, one or more communication devices (e.g., a radio, a near-field magnetic induction (NFMI) device), one or

more antennas, one or more microphones, and a receiver/speaker, for example. Hearing devices can incorporate a long-range communication device, such as a Bluetooth® transceiver or other type of radio frequency (RF) transceiver. A communication device (e.g., a radio or NFMI device) of a hearing device can be configured to facilitate communication between a left ear device and a right ear device of the hearing device.

Hearing devices of the present disclosure can incorporate an antenna coupled to a high-frequency transceiver, such as a 2.4 GHz radio. The RF transceiver can conform to an IEEE 802.11 (e.g., WiFi®) or Bluetooth® (e.g., BLE, Bluetooth® 4. 2 or 5.0) specification, for example. It is understood that hearing devices of the present disclosure can employ other transceivers or radios, such as a 900 MHz radio. Hearing devices of the present disclosure can be configured to receive streaming audio (e.g., digital audio data or files) from an electronic or digital source. Representative electronic/digital sources (e.g., accessory devices) include an assistive listening system, a TV streamer, a radio, a smartphone, a laptop, a cell phone/entertainment device (CPED) or other electronic device that serves as a source of digital audio data or other types of data files. Hearing devices of the present disclosure can be configured to effect bi-directional communication (e.g., wireless communication) of data with an external source, such as a remote server via the Internet or other communication infrastructure. Hearing devices that include a left ear device and a right ear device can be configured to effect bi-directional communication (e.g., wireless communication) therebetween, so as to implement ear-to-ear communication between the left and right ear devices.

The term hearing device of the present disclosure refers to a wide variety of ear-level electronic devices that can aid a person with impaired hearing. The term hearing device also refers to a wide variety of devices that can produce processed sound for persons with normal hearing. Hearing devices of the present disclosure include hearables (e.g., wearable earphones, headphones, earbuds, virtual reality headsets), hearing aids (e.g., hearing instruments), cochlear implants, and bone-conduction devices, for example. Hearing devices include, but are not limited to, behind-the-ear (BTE), in-the-ear (ITE), in-the-canal (ITC), invisible-in-canal (IIC), receiver-in-canal (RIC), receiver-in-the-ear (RITE) or completely-in-the-canal (CIC) type hearing devices or some combination of the above. Throughout this

disclosure, reference is made to a "hearing device," which is understood to refer to a system comprising a single left ear device, a single right ear device, or a combination of a left ear device and a right ear device.

Figures 1A and 1B illustrate various components of a representative hearing device arrangement in accordance with various embodiments. Figures 1A and 1B illustrate first and second hearing devices 100A and 100B configured to be supported at, by, in or on left and right ears of a wearer. In some embodiments, a single hearing device 100A or 100B can be supported at, by, in or on the left or right ear of a wearer. As illustrated, the first and second hearing devices 100A and 100B include the same functional components. It is understood that the first and second hearing devices 100A and 100B can include different functional components. The first and second hearing devices 100A and 100B can be representative of any of the hearing devices disclosed herein.

The first and second hearing devices 100A and 100B include an enclosure 101a, 101b configured for placement, for example, over or on the ear, entirely or partially within the external ear canal (e.g., between the pinna and ear drum) or behind the ear. Disposed within the enclosure 101a, 101b is a processor 102a, 102b which incorporates or is coupled to memory 103a, 103b. The processor 102a, 102b can include or be implemented as a multi-core processor, a digital signal processor (DSP), an audio processor or a combination of these processors. For example, the processor 102a, 102b may be implemented in a variety of different ways, such as with a mixture of discrete analog and digital components that include a processor configured to execute programmed instructions contained in a processor-readable storage medium (e.g., solid-state memory, e.g., Flash).

The processor 102a, 102b is coupled to a wireless transceiver 104a, 104b (also referred to herein as a radio), such as a BLE transceiver or other IEEE 802.11 compliant transceiver. The wireless transceiver 104a, 104b is operably coupled to an antenna 106a, 106b configured for transmitting and receiving radio signals. Impedance matching circuitry 105a, 105b can be operably coupled to the wireless transceiver 104a, 104b and the antenna 106a, 106b. The antenna 106a, 106b is disposed in, on, or extends from the enclosure 101a, 101b. The wireless transceiver 104a, 104b and the antenna 106a, 106b can be configured to operate in the 2.4 GHz ISM frequency band or other applicable communication band

(referred to as the "Bluetooth® band" herein). The wireless transceiver 104a, 104b and antenna 106a, 106b can be configured to enable ear-to-ear communication between the two hearing devices 100A and 100B, as well as communications with an external device (e.g., a smartphone or a digital music player).

A battery 110a, 110b or other power source (rechargeable or conventional) is provided within the enclosure 101a, 101b and is configured to provide power to the various components of the hearing devices 100A and 100B. The battery 110a, 110b is coupled to power management circuitry 111a, 111b, such as a power management integrated circuit (PMIC). The power management circuitry 111a, 111b is coupled to a charging interface 113a, 113b, which is configured to physically and electrically couple to a corresponding charging interface of a charging module. A speaker or receiver 108a, 108b is coupled to an amplifier (not shown) and the processor 102a, 102b. The speaker or receiver 108a, 108b is configured to generate sound which is communicated to the wearer's ear.

In some embodiments, the hearing devices 100A and 100B include a microphone 112a, 112b mounted on or inside the enclosure 101a, 101b. The microphone 112a, 112b may be a single microphone or multiple microphones, such as a microphone array. The microphone 112a, 112b can be coupled to a preamplifier (not shown), the output of which is coupled to the processor 102a, 102b. The microphone 112a, 112b receives sound waves from the environment and converts the sound into an input signal. The input signal is amplified by the preamplifier and sampled and digitized by an analog-to-digital converter of the processor 102a, 102b, resulting in a digitized input signal. In some embodiments (e.g., hearing aids), the processor 102a, 102b (e.g., DSP circuitry) is configured to process the digitized input signal into an output signal in a manner that compensates for the wearer's hearing loss. When receiving an audio signal from an external source, the wireless transceiver 104a, 104b may produce a second input signal for the DSP circuitry of the processor 102a, 102b that may be combined with the input signal produced by the microphone 112a, 112b or used in place thereof. In other embodiments, (e.g., hearables), the processor 102a, 102b can be configured to process the digitized input signal into an output signal in a manner that is tailored or optimized for the wearer (e.g., based on wearer

preferences). The output signal is then passed to an audio output stage that drives the speaker or receiver 108a, 108b, which converts the output signal into an audio output.

Some embodiments are directed to a custom hearing aid, such as an ITC, CIC, or IIC hearing aid, for example. For example, some embodiments are directed to a custom hearing aid which includes a wireless transceiver and an antenna arrangement configured to operate in the 2.4 GHz ISM frequency band (referred to as the "Bluetooth® band" herein). Figures 2A and 2B illustrate a custom hearing aid system which includes two hearing devices, e.g., left 201a and right 201b side hearing devices, configured to wirelessly communicate with each other and external devices and systems. Figure 2A conceptually illustrates functional blocks of the hearing devices 201a, 201b. The position of the functional blocks in Figure 2A does not necessarily indicate actual locations of components that implement these functional blocks within the hearing devices 201a, 201b. Figure 2B is a block diagram of components that may be disposed at least partially within the enclosure 205a, 205b of the hearing device 201a, 201b.

Each hearing device 201a, 201b includes a physical enclosure 205a, 205b that encloses an internal volume. The enclosure 205a, 205b is configured for at least partial insertion within the wearer's ear canal. The enclosure 205a, 205b includes an external side 202a, 202b that faces away from the wearer and an internal side 203a, 203b that is inserted in the ear canal. The enclosure 205a, 205b comprises a shell 206a, 206b and a faceplate 207a, 207b. The faceplate 207a, 207b may include a battery door 208a, 208b or drawer disposed near the external side 202a, 202b of the enclosure 205a, 205b and configured to allow the battery 240a, 240b to be inserted and removed from the enclosure 205a, 205b. An antenna 220a, 220b can be mounted to the faceplate 207a, 207b or elsewhere in the enclosure 205a, 205b. The antenna arrangement 220a, 220b can include a matching circuit that compensates for a smaller size antenna which allows the antenna arrangement 220a, 220b to fit within a customized device, such as a device that fits partially or fully within the ear canal of the wearer. The matching circuit can be designed so that the power transfer from the transceiver of the electronics 230a, 230b to the antenna arrangement 220a, 220b, provides a specified antenna efficiency, e.g., an optimal antenna efficiency for the customized environment.

The battery 240a, 240b powers electronic circuitry 230a, 230b which is also disposed within the shell 206a, 206b. As illustrated in Figures 2A and 2B, the hearing device 201a, 201b may include one or more microphones 251a, 251b configured to pick up acoustic signals and to transduce the acoustic signals into microphone electrical signals. The electrical signals generated by the microphones 251a, 251b may be conditioned by an analog front end 231 (see Figure 2B) by filtering, amplifying and/or converting the microphone electrical signals from analog to digital signals so that the digital signals can be further processed and/or analyzed by the processor 260. The processor 260 may perform signal processing and/or control various tasks of the hearing device 201a, 201b. In some implementations, the processor 260 comprises a DSP that may include additional computational processing units operating in a multi-core architecture.

The processor 260 is configured to control wireless communication between the hearing devices 201a, 201b and/or an external accessory device (e.g., a smartphone, a digital music player) via the antenna 220a, 220b. The wireless communication may include, for example, audio streaming data and/or control signals. The electronic circuitry 230a, 230b of the hearing device 201a, 201b includes a transceiver 232. The transceiver 232 has a receiver portion that receives communication signals from the antenna arrangement 220a, 220b, demodulates the communication signals, and transfers the signals to the processor 260 for further processing. The transceiver 232 also includes a transmitter portion that modulates output signals from the processor 260 for transmission via the antenna arrangement 220a, 220b. Electrical signals from the microphone 251a, 251b and/or wireless communication received via the antenna 220a, 220b may be processed by the processor 260 and converted to acoustic signals played to the wearer's ear 299 via a speaker 252a, 252b.

The battery 240a, 240b is of a rechargeable type, such as a lithium-ion battery for example. Power management circuitry 241a, 241b (e.g., a PMIC) is operatively coupled to the battery 240a, 240b and to a charging interface 243a, 243b. The charging interface 243a, 243b is configured to physically and electrically couple to a corresponding charging interface of a charging module.

The use of rechargeable batteries in hearing devices (e.g., hearing aids) has been well-received in the marketplace. Self-contained batteries require electrical contacts for

recharging. One complication of contact charging is the difficulty of placing a relatively small hearing device in a charger. Traditional approaches for charging hearing devices often require the wearer to fiddle with the hearing device to achieve the proper connection for charging. There is a need to provide a connection arrangement that allows the wearer to properly attach the hearing device to the charging fixture of the charger with relative ease.

Contact charging requires two electrical connections, namely, an anode (positive) connection and a cathode (negative) connection. When placing a hearing device into a charging fixture, it can be advantageous to connect the cathodes prior to connecting the anodes. For example, connecting the cathodes of the hearing devices and the charging fixture prior to connecting the anodes can serve to provide a consistent inrush current waveform when coupling the hearing devices and charger fixture together. Provision of a consistent inrush current waveform from the charger to the hearing devices informs the charging circuitry of the charger that the hearing devices are properly attached to the proper charging fixture and that a charging procedure can be initiated. If the hearing devices are properly connected to the charging fixture, full charging power can be supplied by the charging fixture to the hearing devices. If one or both of the hearing devices are not properly connected to the charging fixture, charging through the improper connection can be disabled. This can protect against the presence of foreign objects (e.g., keys, coins, other hearing devices) that can be intentionally or unintentionally introduced into the charging fixture. In some implementations, connecting the cathodes of the hearing devices and charger fixture prior to connecting the anodes can serve to establish a ground, which can reduce or minimize spurious electrical spikes in the circuitry.

A system comprising a charging module and at least one hearing device in accordance with any of the embodiments disclosed herein provides a number of technical advantages over conventional charging arrangements. As discussed above, a charging system according to any of the embodiments disclosed herein facilitates connection between charger and hearing device cathodes prior to connection between anodes, which provides for a consistent inrush current waveform when coupling the hearing devices and charger fixture together. A charging system according to any of the embodiments disclosed herein provides enhanced detection of incorrect placement of hearing devices and/or presence of foreign

conductive objects at the charging interface, which results in disabling of charging through the improper connection. A charging system according to any of the embodiments disclosed herein significantly reduces or minimizes spurious electrical spikes in the circuitry, by ensuring that the cathodes of the hearing devices and charger fixture are connected prior to connecting the anodes.

Embodiments of the disclosure are defined in the claims. However, below there is provided a non-exhaustive listing of non-limiting examples. Any one or more of the features of these examples may be combined with any one or more features of another example, embodiment, or aspect described herein.

Example Ex1. A system comprising at least one hearing device configured to be worn at, in or on an ear of a wearer, the hearing device comprising a rechargeable power source, power management circuitry, and a first charging interface comprising a first cathode contact and a first anode contact spaced apart from the first cathode contact. A charging module comprises a second charging interface configured to detachably couple with the first charging interface of the hearing device, the second charging interface comprising a second anode contact having a contact surface and a displaceable second cathode contact; an arrangement configured to displace at least a portion of the second cathode contact above the contact surface to facilitate electrical contact between the first and second cathode contacts prior to electrical contact between the first and second anode contacts; and charging circuitry coupled to the second charging interface and configured to charge the rechargeable power source of the hearing device.

Example Ex2. The system according to Ex1, wherein the second charging interface comprises a through-hole, and the second cathode contact is displaceable within the through-hole; and the displacement arrangement comprises a biasing arrangement configured to bias at least a portion of the second cathode contact above the contact surface.

Example Ex3. The system according to Ex2, wherein the second cathode contact comprises an elongated electrode; and the biasing arrangement comprises a spring.

Example Ex4. The system according to Ex2 or Ex3, wherein the second cathode contact and the biasing arrangement define a spring-loaded pogo pin assembly.

Example Ex5. The system according to one or more of Ex1 to Ex4 comprising a retention arrangement disposed on one or both of the hearing device and the charging module, the retention arrangement configured to maintain engagement between the first and second charging interfaces during charging of the rechargeable power source of the hearing device.

Example Ex6. The system according to Ex5, wherein the retention arrangement comprises one or more magnets or a mechanical retention arrangement.

Example Ex7. The system according to one or more of Ex1 to Ex6, wherein the first anode contact is configured to communicate power and one or more disparate information signals, the second anode contact is configured to communicate power and the one or more disparate information signals, and the first and second anode contacts are configured to communicate power and the one or more disparate information signals between the charging module and the hearing device.

Example Ex8. The system according to Ex7, wherein the one or more disparate information signals comprise one or more of data signals generated by one or both of the charging module and the hearing device, audio signals generated by one or both of the charging module and the hearing device, and signals received from one or more accessory devices configured to communicatively couple to one or both of the charging module and the hearing device.

Example Ex9. The system according to one or more of Ex1 to Ex8, wherein the first and second anode contacts comprise electrodes having a curvilinear, annular, oval, elliptical or polygonal shape.

Example Ex10. The system according to one or more of Ex1 to Ex9, wherein the first anode contact comprises a plurality of electrode elements, and the first cathode contact is surrounded by the plurality of electrode elements of the first anode contact.

Example Ex11. The system according to Ex10, wherein the second anode contact comprises a plurality of electrode elements, and the second cathode contact is surrounded by the plurality of electrode elements of the second anode contact.

Example Ex12. The system according to Ex10 or Ex11, wherein one of both of the plurality of electrodes of the first anode contact are substantially equidistant from the first

cathode contact, and the plurality of electrodes of the second anode contact are substantially equidistant from the second cathode contact.

Example Ex13. The system according to Ex 10 or Ex 11, wherein one of both of the plurality of electrodes of the first anode contact are arranged in a substantially triangular pattern relative to the first cathode contact, and the plurality of electrodes of the second anode contact are arranged in a substantially triangular pattern relative to the second cathode contact.

Example Ex14. The system according to one or more of Ex1 to Ex13, wherein the hearing device comprises an in-the-ear (ITE), in-the-canal (ITC), invisible-in-canal (IIC) or completely-in-the-canal (CIC) device comprising a housing having a preformed or formable shape that conforms to a shape of the wearer's ear canal.

Example Ex15. The system according to one or more of Ex1 to Ex14, wherein the charging circuitry is configured to charge the rechargeable power source of the hearing device at an accelerated charge rate above 1.0C when a state of charge (SoC) of the rechargeable power sources is within a predetermined SoC range.

Figure 3 illustrates a system in accordance with any of the embodiments disclosed herein. Figure 3 shows a cross-sectional view of a portion of an ear-worn electronic hearing device 302 and a portion of a charging module 322. The components of the hearing device 302 shown in Figure 3 are disposed in or on a housing configured to be worn at, in or on an ear of a wearer. The hearing device 302 includes a rechargeable power source 304 (e.g., a lithium-ion battery) coupled to power management circuitry 306 (e.g., a PMIC). The power management circuitry 306 is coupled to a first charging interface 310 comprising a first cathode contact 312 and a first anode contact 314 spaced apart from the first cathode contact 312. In the embodiment shown in Figure 3, the power management circuitry 306 is coupled to the first cathode contact 312 via a first connection 307 and to the first anode contact 314 via a second connection 309. The first anode contact 314 can comprise a single contact or a multiplicity of contacts coupled to the second connection 309.

The charging module 322 includes a second charging interface 330 configured to detachably couple (e.g., mechanically and electrically) with the first charging interface 310 of the hearing device 302. The second charging interface 330 includes a second anode

contact 334 having a contact surface 335 and a displaceable second cathode contact 332. The charging module 322 includes charging circuitry 326 coupled to the second charging interface 330 and a power source 324. The power source 324 can be configured to receive power from a standard wall outlet and/or can include a rechargeable or a conventional battery. In some embodiments, the power source 324 can be configured to receive wireless power from an external power source (e.g., inductive, radiofrequency, optical). For example, the power source 324 can be configured to implement inductive charging in accordance with the Qi open interface standard developed by the Wireless Power Consortium. In the embodiment shown in Figure 3, the charging circuitry 326 is coupled to the second cathode contact 332 via a connection 337 and to the second anode contact 334 via a second connection 339. The second anode contact 334 can comprise a single contact or a multiplicity of contacts coupled to the second connection 339.

The second cathode contact 332 is configured for displacement between a first position 331a above the contact surface 335 of the second anode contact 334 and a second position 331b at or below the contact surface 335 of the second anode contact 334. In some configurations, the second cathode contact 332 can be configured for displacement between the first position 331a above the contact surface 335 and a second position 331b above the contact surface 335 but below the first position 331a.

When the hearing device 302 and the charging module 322 are in a non-contacting relationship, such as shown in Figure 3, the second cathode contact 332 is positioned at the first position 331a above the contact surface 335 of the second anode contact 334. When the hearing device 302 and the charging module 322 are in a contacting relationship, the second cathode contact 332 is movable from the first position 331a to the second position 331b and establishes electrical contact with the first cathode contact 312 prior to electrical contact being established between the second anode contact 334 and the first anode contact 314.

More particularly, when the hearing device 302 and the charging module 322 are brought into contact with one another, the second cathode contact 332 positioned at the first position 331a establishes electrical contact with the first cathode contact 312 of the hearing device 302 prior to electrical contact being established between the first and second anode contacts 314, 334. After first establishing electrical contact between the first and second

cathode contacts 312, 332, the second cathode contact 332 is displaced into the body of the charging module 322 as the hearing device 302 is forcibly advanced onto the charging module 322. After displacing the second cathode into the body of the charging module 322 partially or entirely, electrical contact is then established between the first and second anode contacts 314, 334.

The charging module 322 includes an arrangement (shown in other figures) configured to displace at least a portion of the second cathode contact 332 above the contact surface 335 to facilitate electrical contact between the first and second cathode contacts 312, 332 prior to electrical contact between the first and second anode contacts 314, 334. The charging module 322 can also include a retention arrangement (shown in other figures) configured to maintain engagement between the first and second charging interfaces 310, 330 during charging of the rechargeable power source 304 of the hearing device 302. In some embodiments, the retention arrangement can comprise one or more magnets disposed at or near one or both of the first and second charging interfaces 310, 330. In other embodiments, the retention arrangement can comprise a mechanical retention arrangement configured to mechanically maintain engagement between the first and second charging interfaces 310, 330.

Figure 4 illustrates a system in accordance with any of the embodiments disclosed herein. Figure 4 shows a cross-sectional view of a portion of an ear-worn electronic hearing device 402 and a portion of a charging module 422. The components of the hearing device 402 shown in Figure 4 are disposed in or on a housing configured to be worn at, in or on an ear of a wearer. The hearing device 402 includes a rechargeable power source 404 (e.g., a lithium-ion battery) coupled to power management circuitry 406 (e.g., a PMIC). The power management circuitry 406 is coupled to a first charging interface 410. In the embodiment shown in Figure 4, the first charging interface 410 comprises a first cathode contact 412 and a multiplicity of anode contacts, 414, 416. In the illustrative example shown in Figure 4, the first charging interface 410 includes two anode contacts 414, 416, it being understood that the first charging interface 410 can include more than two spaced-apart anode contacts (e.g., 3, 4, 5 or 6 anode contacts).

In the embodiment shown in Figure 4, the power management circuitry 406 is coupled to the first cathode contact 412 via a first connection 407 and to the first and second anode contacts 414, 416 via separate connections. As shown, the power management circuitry 406 is coupled to the first anode contact 414 via a connection 409 and to the second anode contact 416 via a connection 411. It is understood that each physically separate anode contact of the first charging interface 410 can be coupled to the power management circuitry 406 via a separate electrical conductor. It is also understood that, in some configurations, the first charging interface 410 can include anode contacts coupled to the power management circuitry 406 via separate connections in combination with two or more anode contacts coupled to the power management circuitry 406 via a common connection.

The charging module 422 includes a second charging interface 430 configured to detachably couple (e.g., mechanically and electrically) with the first charging interface 410 of the hearing device 402. The charging module 422 includes charging circuitry 426 coupled to the second charging interface 430 and a power source 424. The power source 424 can be configured to receive power from a standard wall outlet and/or can include a rechargeable or a conventional battery. In some embodiments, the power source 424 can be configured to receive wireless power from an external power source (e.g., inductive, radiofrequency, optical). For example, the power source 424 can be configured to implement inductive charging in accordance with the Qi open interface standard developed by the Wireless Power Consortium. The second charging interface 430 includes a second cathode contact 432 and a multiplicity of anode contacts 434, 436. In the embodiment shown in Figure 4, the second cathode contact 432 is fixed in terms of its position on the charging module 422. In this regard, the second cathode contact 432 shown in Figure 4 it is not a displaceable cathode contact. However, it is understood that, in a variant embodiment of Figure 4, the second cathode contact 432 can be implemented as a displaceable cathode contact in the manner illustrated and described with reference to Figure 3.

In the illustrative example shown in Figure 4, the second charging interface 430 includes two anode contacts 434, 436, it being understood that the second charging interface 430 can include more than two spaced-apart anode contacts (e.g., 3, 4, 5 or 6 anode contacts). The number of anode contacts of the second charging interface 430 may or may not be equal

to the number of anode contacts of the first charging interface 410. In the embodiment shown in Figure 4, the charging circuitry 426 is coupled to the second cathode contact 432 via a connection 437 and to the first and second anode contacts 434, 436 via separate connections. More particularly, the first anode contact 434 is coupled to the charging circuitry 426 via connection 439, and the second anode contact 436 is coupled to the charging circuitry 426 via connection 441.

The charging module 422 can include a retention arrangement (shown in other figures) configured to maintain engagement between the first and second charging interfaces 410, 430 during charging of the rechargeable power source 404 of the hearing device 402. In some embodiments, the retention arrangement can comprise one or more magnets disposed at or near one or both of the first and second charging interfaces 410, 430. In other embodiments, the retention arrangement can comprise a mechanical retention arrangement configured to mechanically maintain engagement between the first and second charging interfaces 410, 430.

Provision of electrically separate anode contacts at the first and second charging interfaces 410, 430 provides for the communication of power and one or more disparate information signals between the charging module 422 and the hearing device 402. For example, charging of the rechargeable power supply 404 can be accomplished via first and second cathode contacts 412, 432 and anode contacts 414, 434. Data signals generated by one or both of the charging module 422 and the hearing device 402 can be communicated via anode contacts 416, 436. Although referred to as anode contacts generally, it is understood that the contacts of the first and second charging interfaces 410, 430 that are used for communicating information signals can be any form of electrical contact. Various types of disparate information signals can be communicated between respective pairs of anode contacts of the first and second charging interfaces 410, 430. The disparate forms of information signals can include state of charge and charging status data, control or command signals, audio signals, video signals, and signals from one or more accessory devices (e.g., smartphone, tablet, wearable sensor) configured to communicatively couple to one or both of the hearing device 402 and charging module 422.

Figure 5 illustrates a charging interface in accordance with any of the embodiments disclosed herein. The charging interface 500 shown in Figure 5 includes a cathode contact 502, which is typically coupled to a negative contact charging connection 506. The charging interface 500 also includes an anode contact 504, which is typically coupled to a positive contact charging connection 508. In the embodiment shown in Figure 5, the cathode contact 502 is surrounded by the anode contact 504, which has a continuous annular configuration.

In some embodiments, the hearing device and the charging module can have a charging interface that generally corresponds to the charging interface 500 shown in Figure 5. When implemented on a hearing device, for example, a region of the cathode contact 502 (e.g., central region) can be recessed relative to a contact surface of the anode contact 504 (see, e.g., Figures 9 and 12). When implemented on a charging module, and according to some embodiments, the cathode contact 502 can be displaceable (see, e.g., Figures 3, 10, and 11) and proud relative to a contact surface of the anode contact 504. In other embodiments, the cathode contact 502 is a fixed electrical element (non-displaceable) and need not be proud relative to a contact surface of the anode contact 504. Although shown as having a generally circular shape, the cathode and anode contacts 502, 504 can have any curvilinear or polygonal shape.

Figure 6 illustrates a charging interface in accordance with any of the embodiments disclosed herein. The charging interface 600 shown in Figure 6 includes a cathode contact 602, which is typically coupled to a negative contact charging connection 606. The charging interface 600 also includes an anode contact 604, which is typically coupled to a positive contact charging connection 608. In the embodiment shown in Figure 6, the anode contact 604 comprises a multiplicity of electrode elements 604a, 604b, 604c, each of which is coupled to connection 608. The anode contact 604 has a concentric tri-trace anode configuration. As shown, the cathode contact 602 is surrounded by the concentric tri-trace anode 604 comprising arcuate electrode elements 604a, 604b, 604c. The arcuate electrode elements 604a, 604b, 604c are situated at substantially the same radius (e.g., ~4-5 mm) relative to the cathode contact 602 (e.g., ~2-3 mm diameter). Although three arcuate electrode elements are shown in Figure 6, the concentric anode 604 can comprise two, four, five or more electrode elements, for example.

In some embodiments, the hearing device and the charging module can have a charging interface that generally corresponds to the charging interface 600 shown in Figure 6. When implemented on a hearing device, and in accordance with some embodiments, a region of the cathode contact 602 (e.g., central region) can be recessed relative to a contact surface of the anode contact 604 (see, e.g., Figures 9 and 12). When implemented on a charging module, for example, the cathode contact 602 can be displaceable (see, e.g., Figures 10 and 11) and proud relative to a contact surface of the anode contact 604. Although shown as having a generally circular or arcuate shape, the cathode and anode contacts 602, 604 can have any curvilinear or polygonal shape.

It is understood that the charging interface of the hearing device and that of the charging module can be substantially the same or different in configuration. For example, and in accordance with some embodiments, the charging module can have a charging interface corresponding to the charging interface 500 shown in Figure 5 (cathode contact surrounded by an annular anode contact). In such embodiments, the hearing device can have a charging interface corresponding to the charging interface 600 shown in Figure 6 (cathode contact surrounded by tri-trace anode contact).

Figure 7 illustrates a charging interface in accordance with any of the embodiments disclosed herein. The charging interface 700 shown in Figure 7 includes a cathode contact 702 surrounded by a multiplicity of anode elements 704a, 704b, 704c. In the embodiment shown in Figure 7, the cathode contact 702 and anode elements 704a, 704b, 704c have a polygonal shape. For example, the cathode contact 702 has a generally square shape, and each of the anode elements 704a, 704b, 704c has a generally rectangular shape. It is understood that a charging interface can include cathode and anode contact elements having the same or different curvilinear or polygonal shape.

Figure 8A illustrates a charging interface in accordance with any of the embodiments disclosed herein. The charging interface 800 shown in Figure 8A includes a cathode contact 802, which is typically coupled to a negative contact charging connection 806. The charging interface 800 also includes an anode contact 804, which comprising a contact element typically coupled to a positive contact charging connection 808. In the embodiment shown in Figure 8A, the anode contact 804 has a concentric tri-trace anode configuration comprising

a multiplicity of electrode elements 804a, 804b, 804c. As shown, the cathode contact 802 is surrounded by the concentric tri-trace anode 804 comprising individual arcuate electrode elements 804a, 804b, 804c. The arcuate electrode elements 804a, 804b, 804c are situated at substantially the same radius relative to the cathode contact 802. Although three arcuate electrode elements are shown in Figure 8A, the concentric anode 804 can comprise two, four, five or more electrode elements, for example.

According to various embodiments, a hearing device and a charging module incorporate the charging interface 800 shown in Figure 8A. Each of the electrode elements of the anode contact 804 is coupled to a separate electrical connection. More particularly, electrode element 804a is coupled to connection 810, electrode element 804b is coupled to connection 808, and electrode element 804c is coupled to connection 812. Electrode element 804b represents an anode contact of the charging interface 800. The electrode element 804b and the cathode contact 802 are configured to communicate power produced by the charging module when charging the rechargeable power source of the hearing device. Disparate information signals (e.g., signals S_1 and S_2) can be communicated between the hearing device and the charging module via electrode elements 804a, 804c and connections 810, 812. For example, signals S_1 can constitute data signals (e.g., state of charge and charging status data signals) and signals S_2 can constitute control signals generated by the charging module and/or the hearing device.

When implemented on a hearing device, and in accordance with some embodiments, a region of the cathode contact 802 (e.g., central region) can be recessed relative to a contact surface of the anode contact 804 (see, e.g., Figures 9 and 12). Alternatively, the cathode contact 802 and the anode contact 804 can be substantially coplanar. When implemented on a charging module, and in accordance with some embodiments, the cathode contact 802 is a fixed electrical element (non-displaceable) and need not be proud relative to a contact surface of the anode contact 804. In accordance with other embodiments, the cathode contact 802 can be displaceable (see, e.g., Figures 10 and 11) and proud relative to a contact surface of the anode contact 804. Although shown as having a generally circular or arcuate shape, the cathode and anode contacts 802, 804 can have any curvilinear or polygonal shape.

Figure 8B illustrates a charging interface in accordance with any of the embodiments disclosed herein. The charging interface 820 shown in Figure 8B includes an arrangement of electrodes 824 comprising at least one cathode contact 824a and at least one anode contact 824b. The electrode arrangement 824 can include additional electrodes, such as electrode 824c, which can be a cathode contact or an anode contact. It is understood that the electrodes of the arrangement 824 can be configured as cathode or anode contacts, as long as the arrangement of electrodes 824 includes at least one cathode contact and at least one anode contact. A data contact 822 is shown surrounded by electrodes of the electrode arrangement 824. In the representative embodiment shown in Figure 8B, the electrode arrangement 824 has a concentric tri-trace electrode configuration comprising contacts 824a, 824b, 824c, which surround data contact 822. In some embodiments, the electrode arrangement 824 includes two arcuate electrodes, such as cathode contact 824a and anode contact 824b, which can be spaced apart from one another in the manner shown in Figure 14D, for example. The arcuate electrode elements 824a, 824b, 824c are situated at substantially the same radius relative to the data contact 822. Although three arcuate electrode elements are shown in Figure 8B, the electrode arrangement 824 can comprise two, four, five or more electrode elements, for example.

According to various embodiments, a hearing device and a charging module incorporate the charging interface 820 shown in Figure 8B. Cathode contact 824a is typically coupled to a negative contact charging connection 830, and anode contact 824b is typically coupled to a positive contact charging connection 828. Electrical contact 824c can be coupled to either a negative or a positive charging connection 832. The electrode arrangement 824 is configured to communicate power produced by the charging module when charging the rechargeable power source of the hearing device. One or more information signals can be communicated between the hearing device and the charging module via data contact 822 via signal connection 826. For example, these information signals can constitute data signals (e.g., state of charge and charging status data signals) and control signals generated by the charging module and/or the hearing device.

Figure 8C illustrates a charging interface in accordance with any of the embodiments disclosed herein. The charging interface 840a shown in Figure 8C includes a cathode contact

842, which is typically coupled to a negative contact charging connection 846. The charging interface 840a also includes an anode contact 844, which is typically coupled to a positive contact charging connection 848. In the embodiment shown in Figure 8C, the anode contact 844 comprises a multiplicity of electrode elements 844a, 844b, 844c, each of which is coupled to connection 848. The anode contact 844 has a triangular configuration, and is arranged to surround the cathode contact 842. The triangular anode contact 844 includes three electrode elements 844a, 844b, 844c each having a generally curvilinear shape. In some embodiments, the electrode elements 844a, 844b, 844c have a closed curved shape comprising only curved lines (e.g., no line segments). For example, the electrode elements 844a, 844b, 844c can have a non-polygonal shape (e.g., a geometric shape that does not conform to the definition of a polygon). Representative examples of electrode elements 844a, 844b, 844c having a generally curvilinear shape include those having a generally round (e.g., circular) shape, an elliptical shape, and an oval shape. It is understood that the electrode elements 844a, 844b, 844c can also have an arbitrary closed curvilinear shape (e.g., a meandering shape) and/or a closed curvilinear shape comprising predominately curved lines (e.g., a minor percentage ($\leq$ 10-20%) of line segments).

The electrode elements 844a, 844b, 844c can be situated at substantially the same distance (e.g., ~2-6 mm, ~4-5 mm, ~3-5 mm) relative to the cathode contact 842. The cathode contact 842 can have a diameter of about 1.5 mm to about 3 mm, and the electrode elements 844a, 844b, 844c can have the same or smaller diameter (e.g., about 1 mm to about 2.5 mm). Although three electrode elements 844a, 844b, 844c are shown in Figure 8C, the anode contact 844 can comprise one, two, four, five or more electrode elements, for example, arranged in a substantially triangular shape. Also, although the electrode elements 842, 844a, 844b, 844c are shown having the same general shape in Figure 8C (and other figures), it is understood that the electrode elements 842, 844a, 844b, 844c can have different shapes. For example, the electrode elements 842, 844a, 844b, 844c can have different curvilinear shapes or any combination of generally curvilinear shapes and generally rectilinear shapes.

When implemented on a hearing device, and in accordance with some embodiments, a region of the cathode contact 842 (e.g., central region) can be recessed relative to a contact surface of the anode contact 844 (see, e.g., Figures 9 and 12). Alternatively, the cathode

contact 842 and the anode contact 844 can be substantially coplanar. When implemented on a charging module, and in accordance with some embodiments, the cathode contact 842 is a fixed electrical element (non-displaceable) and need not be proud relative to a contact surface of the anode contact 844. In accordance with other embodiments, the cathode contact 842 can be displaceable (see, e.g., Figures 10 and 11) and proud relative to a contact surface of the anode contact 844.

Figure 8D illustrates a charging interface in accordance with any of the embodiments disclosed herein. The charging interface 840b shown in Figure 8D includes a cathode contact 842, which is typically coupled to a negative contact charging connection 846. The charging interface 840b also includes an anode contact 844, which is typically coupled to a positive contact charging connection 848. In the embodiment shown in Figure 8D, the anode contact 844 has a triangular anode configuration comprising a multiplicity of electrode elements 844a, 844b, 844c. As shown, the cathode contact 842 is surrounded by the triangular anode 844 comprising individual electrode elements 844a, 844b, 844c. The electrode elements 844a, 844b, 844c are situated at substantially the same distance relative to the cathode contact 842. Although three electrode elements 844a, 844b, 844c are shown in Figure 8D, the anode contact 844 can comprise one, two, four, five or more electrode elements, for example, arranged in a generally triangular shape. The electrode elements 842, 844a, 844b, 844c can have a generally curvilinear shape or other shapes and/or combination of shapes discussed above with reference to Figure 8C.

According to various embodiments, a hearing device and a charging module can incorporate the charging interface 840b shown in Figure 8D. Each of the electrode elements of the anode contact 844 is coupled to a separate electrical connection. More particularly, electrode element 844a is coupled to connection 850, electrode element 844b is coupled to connection 848, and electrode element 844c is coupled to connection 852. Electrode element 844b represents an anode contact of the charging interface 840b. The electrode element 844b and the cathode contact 842 are configured to communicate power produced by the charging module when charging the rechargeable power source of the hearing device. Disparate information signals (e.g., signals S_1 and S_2) can be communicated between the hearing device and the charging module via electrode elements 844a, 844c and connections 850, 852. For

example, signals S_1 can constitute data signals (e.g., state of charge and charging status data signals) and signals S_2 can constitute control signals generated by the charging module and/or the hearing device.

Figure 8E illustrates a charging interface in accordance with any of the embodiments disclosed herein. The charging interface 840c shown in Figure 8E includes an arrangement of electrodes 844 comprising at least one cathode contact 844a and at least one anode contact 844b. The electrode arrangement 844 can include additional electrodes, such as electrode 844c, which can be a cathode contact or an anode contact. It is understood that any of the electrodes of the arrangement 844 can be configured as cathode or anode contacts, as long as the arrangement of electrodes 844 includes at least one cathode contact and at least one anode contact. A data contact 842 is shown surrounded by electrodes of the electrode arrangement 844. The electrode elements 842, 844a, 844b, 844c can have a generally curvilinear shape or other shapes and/or combination of shapes discussed above with reference to Figure 8C.

In the representative embodiment shown in Figure 8E, the electrode arrangement 844 has a generally triangular configuration comprising contacts 844a, 844b, 844c, which surround data contact 842. In some embodiments, the electrode arrangement 844 can include two electrodes, such as cathode contact 844a and anode contact 844b, which are shaped to generally form a triangular pattern and can be spaced apart (e.g., equidistantly) from the data contact 842. The electrode elements 844a, 844b, 844c can be situated at substantially the same distance relative to the data contact 842. Although three curvilinear shaped electrode elements 844a, 844b, 844c are shown surrounding the central data contact 842 in Figure 8E, the electrode arrangement 844 can comprise one, two, four, five or more curvilinear shaped electrode elements that having a generally triangular pattern and surround the data contact 842.

According to various embodiments, a hearing device and a charging module can incorporate the charging interface 840c shown in Figure 8E. Cathode contact 844a is typically coupled to a negative contact charging connection 850, and anode contact 844b is typically coupled to a positive contact charging connection 848. Electrical contact 844c can be coupled to either a negative or a positive charging connection 852. The electrode

arrangement 844 is configured to communicate power produced by the charging module when charging the rechargeable power source of the hearing device. One or more information signals can be communicated between the hearing device and the charging module via data contact 842 and signal connection 846. For example, these information signals can constitute data signals (e.g., state of charge and charging status data signals) and control signals generated by the charging module and/or the hearing device.

When implemented on a hearing device, and in accordance with either of the embodiments shown in Figures 8D and 8E, a region of the central contact 842 (e.g., central region) can be recessed relative to a contact surface of the peripheral contacts 844a, 844b, 844c (see, e.g., Figures 9 and 12). Alternatively, the central contact 842 and the peripheral contacts 844a, 844b, 844c can be substantially coplanar. In accordance with either of the embodiments shown in Figures 8D and 8E (and other embodiments shown in other figures), when implemented on a hearing device, a region of the central contact 842 (e.g., central region) can be elevated relative to a contact surface of the peripheral contacts 844a, 844b, 844c.

Figures 8F-8I illustrate a custom hearing device (e.g., a custom hearing aid) in accordance with any of the embodiments disclosed herein. The hearing device 860 shown in Figures 8F-8I is configured to be worn at least partially within the ear canal of a wearer's ear. The hearing device 860 is representative of any type of ITE hearing aid, such as an ITC, IIC or CIC hearing aid, for example. The hearing device 860 includes a faceplate 862 and a shell 864 connected to the shell 864. The shell 864 houses the electronic and electrical components of the hearing device 860, such as those previously described. The shell 864 is typically shaped to conform to a particular wearer's ear canal using a mold taken from the wearer's ear. In some configurations, the shell 864 can be constructed from semi-soft material (e.g., polymeric material) which can conform to the shape of the wearer's ear canal when the shell 864 is inserted therein. The faceplate 862 includes a charging interface 840d and other components/structures of the hearing device 860, such as one or two microphones 866.

The charging interface 840d disposed on the faceplate 862 comprises a central contact 842 surrounded by three peripheral contacts 844a, 844b, 844c arranged in a substantially

triangular pattern. The peripheral contacts 844a, 844b, 844c can be situated at substantially the same distance (e.g., ~2-5 mm, ~4-5 mm, ~3-4 mm) relative to the central contact 842. The central contact 842 can have a diameter of about 2 mm to about 3 mm, and the peripheral contacts 844a, 844b, 844c can have the same or smaller diameter (e.g., about 1 mm to about 2.5 mm, ~1.5-2 mm).

The charging interface 840d can be representative of any of the charging interfaces discussed herein. For example, charging interface 840d can be configured and wired in the manner of charging interface 840a shown in Figure 8C. In this representative configuration, the charging interface 840d includes a central cathode contact 842, coupled to a negative charging connection, and three anode contacts 844a, 844b, 844c, each coupled to a positive charging connection. The anode contacts 844a, 844b, 844c are arranged in a substantially triangular pattern and surround the cathode contact 842. The contacts 842, 844a, 844b, 844c can have a generally curvilinear shape or other shapes and/or combination of shapes discussed above with reference to Figure 8C.

According to another example embodiment, the charging interface 840d can be configured and wired in the manner of charging interface 840b shown in Figure 8D. In this representative configuration, central contact 842 is configured as a cathode contact and peripheral contact 844b is an anode contact of the charging interface 840d. Central cathode contact 842 and peripheral anode contact 844b are configured to communicate power produced by a charging module when charging the rechargeable power source of the hearing device 860. Disparate information signals (e.g., signals S_1 and S_2) can be communicated between the hearing device 860 and the charging module via peripheral contacts 844a, 844c. For example, signals S_1 can constitute data signals (e.g., state of charge and charging status data signals) and signals S_2 can constitute control signals generated by the charging module and/or the hearing device 860.

According to another example embodiment, the charging interface 840d can be configured and wired in the manner of charging interface 840c shown in Figure 8E. In this representative configuration, the charging interface 840d includes at least one cathode contact 844a and at least one anode contact 844b. Electrode 844c can be configured as a cathode contact or an anode contact (or a separate signal communicating contact). A central

data contact 842 can be surrounded by contacts 844a, 844b, 844c arranged in a substantially triangular pattern. The contacts 842, 844a, 844b, 844c can have a generally curvilinear shape or other shapes and/or combination of shapes discussed above with reference to Figure 8C.

In accordance with any of the embodiments shown in Figures 8F-8I, a region of the charging interface 840d which includes the central contact 842 (e.g., central region) can be recessed relative to a contact surface of the peripheral contacts 844a, 844b, 844c (see, e.g., Figures 9 and 12). Alternatively, the central contact 842 and the peripheral contacts 844a, 844b, 844c can be substantially coplanar. In accordance with alternative embodiments, the central region of the charging interface 840d which includes the central contact 842 can be elevated relative to a contact surface of the peripheral contacts 844a, 844b, 844c. In accordance with any of the embodiments disclosed herein, the peripheral contacts 844a, 844b, 844c can be surrounded by a peripheral wall having a height greater than that of an exposed surface of peripheral contacts 844a, 844b, 844c.

Figure 8J illustrates a charging interface of a hearing device in accordance with any of the embodiments disclosed herein. The charging interface 870 shown in Figure 8J includes an arrangement of peripheral electrodes 874 comprising at least one cathode contact 874a and at least one anode contact 874b. The peripheral electrode arrangement 874 can include additional electrodes, such as electrode 874c, which can be an anode contact or a cathode contact. A data contact 872 is shown surrounded by electrodes of the electrode arrangement 874. In the representative embodiment shown in Figure 8J, each of the peripheral electrodes 874a, 874b, 874c and the data contact 872 has a generally curvilinear shape (e.g., rounded, circular, elliptical, oval).

The charging interface 870 is coupled to poly-phase rectification circuitry disposed in the housing of the hearing device, which is illustrated as a 3-phase rectifier 890 in Figure 8J. Contacts 874a, 874b, and 874c are coupled to the 3-phase rectifier 890 via charging connections 880, 878, and 882, respectively. The electrode arrangement 874 is configured to communicate power produced by the charging module when charging the rechargeable power source of the hearing device. In the embodiment shown in Figure 8J, power is contained within the concentric electrode arrangement 874. Using this electrode configuration, if at least one contact of the electrode arrangement 874 is connected to ground

(GND) and at least one other contact of the electrode arrangement 874 is connected to power (PWR), then the 3-phase rectifier 890 will supply the correct polarity with the correct voltage.

The charging interface 870 of the hearing device is configured to establish electrical connection with a charging interface 891 of a charging module, an example of which is shown in Figure 8K. The charging interface 870 of the hearing device includes at least two contacts 874a, 874b which serve as cathode and anode contacts. The two contacts 896, 898 of the charging module's charging interface 891 are configured and arranged so that each contact 896, 898 electrically connects with only one of the three contacts 874a, 874b, 874c of the hearing device's charging interface 870. This arrangement ensures that anode and cathode contacts of the hearing device electrically connect with respective anode and cathode contacts of the charging module. In Figure 8K, the contacts 896, 898 of the charging module's charging interface 891 are shown as having an arcuate shape. The contacts 896, 898 may alternatively have a curvilinear shape, a rectilinear shape, or other shape.

One or more information signals can be communicated between the hearing device and the charging module via data contact 872 and signal connection 876. For example, these information signals can constitute data signals (e.g., state of charge and charging status data signals) and control signals generated by the charging module and/or the hearing device. One or more disparate signals can be communicated over data contact 872 using a sequential or multiplexing data transmission technique (e.g., time-division multiplexing, frequency-division multiplexing, code-division multiplexing).

Figure 9 is a cross-sectional view of a portion of a hearing device in accordance with any of the embodiments disclosed herein. The portion of the hearing device 900 shown in Figure 9 includes a charging interface 902 incorporated on the shell or housing 904 of the hearing device 900. The charging interface 902 is situated at or near an exterior surface of the housing 904. For example, the charging interface 902 can be situated on a faceplate of an in-the-ear type hearing device (e.g., ITE, ITC, IIC, CIC device). In the case of an on-the-ear type hearing device (e.g., BTE, RIC, RITE device), for example, the charging interface 902 can be situated at or near a bottom or top end surface of the housing 902. The charging

interface 902 is configured to physically and electrically coupled to a corresponding charging interface of a charging module (see, e.g., Figures 3, 4, 10, and 11).

The charging interface 902 includes a cathode contact 906 partially or entirely surrounded by an anode contact 908. The anode contact 908 can be a single electrical contact or comprise a multiplicity of electrical contacts (see, e.g., Figures 3-8). For example, the anode contact 908 can comprise a single annular electrical contact or two or more arcuate electrical contacts (e.g., a concentric tri-trace anode configuration). The cathode contact 906 is shown extending slightly beyond the exterior surface of the housing 904 relative to the anode contact 908, which is shown as substantially coplanar with the exterior surface of the housing 904. In some implementations, the cathode contact 906 can be substantially coplanar with exterior surface of the housing 904. The cathode contact 906 can include a recessed region 907, which is typically situated within a central region of the cathode contact 906. The recessed region 907 serves to guide a corresponding cathode contact of a charging module into proper contact with the cathode contact 906.

In the embodiment shown in Figure 9, the hearing device 900 includes a retention arrangement 910. The retention arrangement 910 is configured to maintain engagement between the charging interface 902 and a corresponding charging interface of a charging module during charging of a rechargeable power source of the hearing device 900. The retention arrangement 910 includes a magnet 911 or magnetizable structure which can interact with a corresponding magnet or magnetizable structure of the charging module. In some embodiments, the anode contact 908 partially or entirely comprises magnetic material, in which case the separate magnet 911 or magnetizable structure need not be included in the retention arrangement 910.

Figure 10 is a cross-sectional view of a portion of a charging module in accordance with any of the embodiments disclosed herein. The portion of the charging module 1000 shown in Figure 10 includes a charging interface 1002 disposed on a charging surface 1004 of the charging module 1000. The charging interface 1002 is configured to physically and electrically coupled to a corresponding charging interface of a hearing device (see, e.g., Figures 3, 4, 9, and 12). The charging interface 1002 includes a cathode contact 1006 partially or entirely surrounded by an anode contact 1008. The anode contact 1008 can be a

single electrical contact or comprise a multiplicity of electrical contacts (see, e.g., Figures 3-8). For example, the anode contact 1008 can comprise a single annular electrical contact or two or more arcuate electrical contacts (e.g., a concentric tri-trace anode configuration).

The charging interface 1002 includes a through-hole 1012 within which the cathode contact 1006 is disposed. The cathode contact 1006 is displaceable within the through-hole 1012. A biasing arrangement 1014 is configured to bias at least a portion 1006a of the cathode contact 1006 above a contact surface 1009 of the anode contact 1008. As such, the cathode contact 1006 is proud relative to the anode contact 1008 prior to engagement with a corresponding charging interface of a hearing device. The biasing arrangement 1014 is configured to bias at least the portion 1006a of the cathode contact 1006 above the contact surface 1009 to facilitate electrical contact between the cathode contact 1006 and a corresponding cathode contact of a hearing device prior to electrical contact between the anode contact 1008 and corresponding anode contact of the hearing device.

According to some embodiments, the cathode contact 1006 comprises an elongated electrode, and the biasing arrangement 1014 comprises a spring 1016. In some embodiments, the cathode contact 1006 and biasing arrangement 1014 define a spring-loaded pogo pin assembly. The pogo pin assembly 1014 includes a center post pogo pin 1006 which is seated into the housing of the charging module 1000 via pogo housing 1018. The pogo housing 1018 contains a pogo spring 1016 and a pogo endstop 1019.

The charging module 1000 also includes a retention arrangement 1020 configured to maintain engagement between the charging interface 1002 and a corresponding charging interface of a hearing device during charging of a rechargeable power source of the hearing device. The retention arrangement 1020 includes a magnet 1022 or magnetizable structure which can interact with a corresponding magnet or magnetizable structure of the hearing device. In some embodiments, the anode contact 1008 partially or entirely comprises magnetic material, in which case the separate magnet 1022 or magnetizable structure need not be included in the retention arrangement 1020. In some embodiments, the anode contact 1008 can be implemented as a ring magnet plated with electrically conductive material. The ring magnet provides attraction to a different magnet or magnetizable structure in the hearing device in order to align the electrical contacts. The plating provides corrosion resistance.

Figures 11 and 12 illustrate a system in accordance with any of the embodiments disclosed herein. The system includes a hearing aid 1202 (Figure 12) configured to be worn at least partially within the ear canal of a wearer's ear. The hearing aid 1202 is representative of any type of ITE hearing aid, such as an ITC, IIC or CIC hearing aid, for example. The hearing aid 1202 includes a charging interface 1204 comprising a cathode contact 1206 surrounded by an anode contact 1208. Although shown as a concentric tri-trace anode in Figure 12, the anode contact 1208 can be configured as a single electrode element or a multiplicity of electrode elements. The charging interface 1204 is disposed on a faceplate 1203 of the hearing aid 1202.

Figure 11 shows a charging module 1122 which can be installed in, or be integral to, a charging fixture. The charging module 1122 includes a charging interface 1124 which includes a displaceable central cathode contact 1126 surrounded by a concentric anode contact 1128. The displaceable central cathode contact 1126 can be implemented as a spring-loaded elongated electrode, such as that shown in Figure 10 (e.g., a spring-loaded pogo pin assembly). It is understood that a charging fixture will typically include two of the charging modules 1122 configured to charge two of the hearing aids 1202.

Figure 13 is a schematic showing electrical components of a system in accordance with any of the embodiments disclosed herein. The schematic of system 1300 includes electrical components of a hearing device 1302 and electrical components of a charging module 1320. The hearing device 1302 includes a rechargeable power source 1304, such as a lithium-ion battery. The rechargeable power source 1304 is coupled to power management circuitry 1306, such as a PMIC. The power management circuitry 1306 is coupled to an anode contact R3 and a cathode contact R6. The anode contact R3 and cathode contact R6 of the hearing device 1302 can have a configuration and functionality described previously.

The charging module 1320 includes a power source V, which is represented as a battery in Figure 13. The power source V can include a rechargeable battery, a conventional battery, and/or an AC/DC converter configured to receive power from a standard wall outlet. In some embodiments, the power source V can be configured to receive wireless power from an external power source (e.g., Qi, inductive, radiofrequency, optical). The charging module impedance is represented by R1, which is shown coupled to an anode contact R2 via anode

switch S1. Resistor R4 represents a pulldown resistor for current sensing. Resistor R4 is coupled to a cathode contact R5 via cathode switch S2. The anode contact R2 and cathode contact R5 of the charging module 1320 can have a configuration and functionality described previously. In some embodiments, the charging module 1320 is not configured to control anode switch S1 and cathode switch S2 independently, so mechanically ensuring a ground (GND) contact first provides for a more accurate and consistent inrush current profile as previously discussed.

Figure 14A is a schematic showing electrical components of a system in accordance with any of the embodiments disclosed herein. The schematic of system 1400 includes electrical components of a hearing device 1402 and electrical components of a charging module 1420. The hearing device 1402 includes a rechargeable power source 1404, such as a lithium-ion battery. The rechargeable power source 1404 is coupled to power management circuitry 1406, such as a PMIC. The power management circuitry 1406 is coupled to a rectifier 1408. The rectifier 1408 is coupled to a contact arrangement 1410 comprising a cathode contact, at least one anode contact, and one or more electrical contacts configured to communicate information signals between the hearing device 1402 and the charging module 1420. The rectifier 1408 can be implemented as an N-phase rectifier, where N is equal to the number of electrical contacts of the contact arrangement 1410.

Any of contacts R3, R6, and R7 of the hearing device 1402 can be configured as an anode contact or a cathode contact. Any of contacts R3, R6, and R7 can be configured as an electrical contact configured to communicate information signals. In some embodiments, contacts R3, R6, and R7 can be configured as split-ring pin connectors, with the center pin connector being used for data signal transmission and the other two connectors being used as cathode and anode contacts for charging. Other electrical contact configurations are contemplated. For example, and with reference to the embodiment shown in Figure 14B, the hearing device 1402 can include a charging interface 1403 comprising a central cathode pin R7 surrounded by split-ring pin connectors R3 and R6. One of connectors R3 and R6 is configured as an anode contact for charging, and the other of connectors R3 and R6 is configured as an electrical contact configured for data signal transmission. The contact

arrangement 1410 of the hearing device 1402 can have a configuration and functionality described previously.

The charging module 1420 includes a power source V, which is represented as a battery in Figure 14. The power source V can include a rechargeable battery, a conventional battery, and/or an AC/DC converter configured to receive power from a standard wall outlet. In some embodiments, the power source V can be configured to receive wireless power from an external power source (e.g., Qi, inductive, radiofrequency, optical). The charging module impedance is represented by R1, which is shown coupled to an anode contact R2 via anode switch S1. Resistor R4 represents a pulldown resistor for current sensing. Resistor R4 is coupled to a cathode contact R5 via cathode switch S2. The anode contact R2 and cathode contact R5 of the charging module 1420 can have a configuration and functionality described previously. In some embodiments, the charging module 1420 is not configured to control anode switch S1 and cathode switch S2 independently, so mechanically ensuring a ground (GND) contact first provides for a more accurate inrush current profile as previously discussed.

In addition to providing anode and cathode contacts for charging, the hearing device 1402 and charging module 1420 include one or more additional electrical contacts for communicating information signals between the hearing device 1402 and charging module 1420. For example, data can be communicated via one or more contacts, which can be split into multiple contacts each providing a separate connection for disparate signal transmission. The type of signal transmitted over each contact can be detected automatically by the charging module 1420, which can reconfigure the charger connections in real time. For example, the charging module 1420 can include circuitry for detecting whether a particular contact is being used to transmit power and/or data, such as by detecting the pull-up strength of the contacts. In some embodiments, the charging module 1420 can include circuitry configured to detect the connections by cycling through known protocol possibilities and using the one that works through a handshaking procedure.

Figure 14C illustrates a charging interface of a hearing device in accordance with any of the embodiments disclosed herein. The charging interface 1430 shown in Figure 14C includes an arrangement of electrodes 1434 comprising at least one cathode contact 1434a

and at least one anode contact 1434b. The electrode arrangement 1434 can include additional electrodes, such as electrode 1434c, which can be an anode contact or a cathode contact. A data contact 1432 is shown surrounded by electrodes of the electrode arrangement 1434. In the representative embodiment shown in Figure 14C, the electrode arrangement 1434 has a concentric tri-trace electrode configuration comprising contacts 1434a, 1434b, 1434c, which surround data contact 1432. In some embodiments, the electrode arrangement 1434 includes two arcuate electrodes, such as cathode contact 1434a and anode contact 1434b, which can be spaced apart from one another (e.g., see Figure 14D). The arcuate electrode elements 1434a, 1434b, 1434c are situated at substantially the same radius relative to the data contact 1432. Although three arcuate electrode elements are shown in Figure 14C, the electrode arrangement 1434 can comprise two, four, five or more electrode elements, for example.

The charging interface 1430 is coupled to poly-phase rectification circuitry, which is illustrated as a 3-phase rectifier 1450 in Figure 14C. Contacts 1434a, 1434b, and 1434c are coupled to the 3-phase rectifier 1450 via charging connections 1440, 1438, and 1442, respectively. The electrode arrangement 1434 is configured to communicate power produced by the charging module when charging the rechargeable power source of the hearing device. In the embodiments shown in Figure 14C, power is contained within the concentric electrode arrangement 1434. Using this electrode configuration, if at least one contact of the electrode arrangement 1434 is connected to ground (GND) and at least one other contact of the electrode arrangement 1434 is connected to power (PWR), then the 3-phase rectifier 1450 will supply the correct polarity with the correct voltage.

The charging interface 1430 is configured to establish electrical connection with a charging interface of a charging module, an example of which is shown in Figure 14D. The charging interface 1450 includes at least two contacts 1454, 1456 which serve as anode and cathode contacts. The two contacts 1454, 1456 of the charging module's charging interface 1450 are configured and arranged so that each contact 1454, 1456 electrically connects with only one of the three contacts 1434a, 1434b, 1434c of the hearing device's charging interface 1430. This arrangement ensures that anode and cathode contacts of the hearing device 1430 electrically connect with respective anode and cathode contacts of the charging module.

One or more information signals can be communicated between the hearing device and the charging module via data contact 1432 and signal connection 1436. For example, these information signals can constitute data signals (e.g., state of charge and charging status data signals) and control signals generated by the charging module and/or the hearing device. One or more disparate signals can be communicated over data contact 1432 using a sequential or multiplexing data transmission technique (e.g., time-division multiplexing, frequency-division multiplexing, code-division multiplexing).

Figure 15 illustrates a method of implementing accelerated charging of one or more hearing devices using a charging module in accordance with any of the embodiments disclosed herein. In the illustrative method shown in Figure 15, two ear-worn electronic devices are subject to accelerated charging via two charging modules provided on the charging fixture. The method shown in Figure 15 involves establishing connection 1502 between first and second ear-worn electronic devices and first and second charging modules of the charging fixture. The method involves determining 1504 the state of charge (SoC) of the rechargeable power sources of the ear-worn electronic devices. A check 1506 is made to determine if the SoC of the rechargeable power sources is within a predetermined SoC range (e.g., 5-35%). If the SoC of the rechargeable power sources fall within the predetermined SoC range, the method involves charging 1508 the rechargeable power sources at an accelerated charge rate above 1.0C (e.g., 1.5C – 3.0C). Accelerated charging continues while the SoC of the rechargeable power sources remain within the predetermined SoC range. Accelerated charging is discontinued when the SoC of the rechargeable power sources is beyond the predetermined SoC range. In some embodiments, accelerated charging is discontinued in response to expiration of a predetermined time limit (e.g., 15 minutes), reaching a predetermined voltage limit (e.g., 4.1V), or reaching a predetermined energy limit (e.g., 7.5 mAh).

At the termination of accelerated charging, the ear-worn electronic devices may be removed from the charging modules of the charging fixture for immediate use. In some embodiments, five minutes of accelerated charging allows the ear worn electronic devices to be used for between 2 and 6 hours of normal operation. Rather than using the ear worn electronic devices after termination of accelerated charging, the method can involve charging

1510 the rechargeable power sources at a normal charge rate at or below 1.0 C. A check 1512 is made to determine if rechargeable power sources are fully charged. If not, charging at the normal charge rate continues. When the rechargeable power sources are fully charged, the charging procedure is terminated 1514. Accelerated charging can be implemented in accordance with the teachings disclosed in commonly-owned U.S. Patent Application Serial No. 16/012,399 (Higgins et al.), filed on June 19, 2018 and entitled PORTABLE CHARGING UNIT WITH ACCELERATED CHARGING FOR HEARING ASSISTANCE DEVICES, which is incorporated herein by reference.

Figure 16 is a graph that characterizes accelerated charging of a lithium-ion battery of an ear-worn electronic device in accordance with any of the embodiments disclosed herein. The graph of Figure 16 characterizes battery voltage 1602 and charge current 1604 as a function of time during different phases of a charging procedure. As is indicated below the time axis, the different phases of the charging procedure include a pre-charge phase (A), an accelerated constant current charge phase (B), a constant voltage charge phase (D), and a charge complete phase (E). During the pre-charge phase (A), the charge current 1604 is low (e.g., 0.1C) and the battery voltage 1602 slowly increases. It is noted that a well-designed system should stay out of this regime. The pre-charge phase (A) continues until the battery voltage 1602 reaches 3.0 V, at which time the accelerated constant current charge phase (B) is initiated.

During the accelerated charging phase (B), the charge current 1604 rapidly increases to a charge rate above 1.0C, such as 1.5C. During the accelerated charging phase (B), high current is supplied to the battery which results in a rapid increase in battery voltage 1602. For example, a charge current of 5 mA can be supplied to the battery during the latter part of the pre-charge phase (A) (e.g., at 0.3C). The charge current can be increased to between 17 and 24 mA during the accelerated charging phase (B). The accelerated charging phase (B) continues until a predetermined time limit (e.g., 5-15 min) has been reached. In some embodiments, the accelerated charging phase (B) continues until a predetermined battery voltage 1602 (e.g., 4.1 V) or predetermined energy level (e.g., 7.5 mAh) has been reached.

At the conclusion of the accelerated charging phase (B), the charge current 1604 rapidly decreases to a normal charge current level (e.g., 5 mA at a charge rate of 0.3C) at the

initiation of the constant current charge phase (C). During the constant current charge phase (C), a normal charge current (e.g., 5mA) is supplied to the battery resulting in a continued increase in the battery voltage 1602. When the battery voltage 1602 reaches a predetermined level (e.g., 4.2 V), the charging procedure transitions from the constant current charge phase (C) to the constant voltage charge phase (D). During the constant voltage charge phase (D), the charge current 1604 decreases until a cutoff 1606 is reached, at which time the charging procedure is terminated. It is noted that at the charging complete phase (E), the battery voltage 1602 slightly drops over time (e.g., from 4.1 V to 3.9 V). In the embodiment shown in the Figure 16, the charge current 1604 supplied during the accelerated charging phase (B) changes in a step-wise fashion. It is understood that, in some embodiments, the charge current 1604 can decrease gradually as the accelerated charging phase (B) transitions to the constant current charge phase (C).

Although reference is made herein to the accompanying set of drawings that form part of this disclosure, one of at least ordinary skill in the art will appreciate that various adaptations and modifications of the embodiments described herein are within, or do not depart from, the scope of this disclosure. For example, aspects of the embodiments described herein may be combined in a variety of ways with each other. Therefore, it is to be understood that, within the scope of the appended claims, the claimed invention may be practiced other than as explicitly described herein.

All references and publications cited herein are expressly incorporated herein by reference in their entirety into this disclosure, except to the extent they may directly contradict this disclosure. Unless otherwise indicated, all numbers expressing feature sizes, amounts, and physical properties used in the specification and claims may be understood as being modified either by the term "exactly" or "about." Accordingly, unless indicated to the contrary, the numerical parameters set forth in the foregoing specification and attached claims are approximations that can vary depending upon the desired properties sought to be obtained by those skilled in the art utilizing the teachings disclosed herein or, for example, within typical ranges of experimental error.

The recitation of numerical ranges by endpoints includes all numbers subsumed within that range (e.g. 1 to 5 includes 1, 1.5, 2, 2.75, 3, 3.80, 4, and 5) and any range within

that range. Herein, the terms "up to" or "no greater than" a number (e.g., up to 50) includes the number (e.g., 50), and the term "no less than" a number (e.g., no less than 5) includes the number (e.g., 5).

The terms "coupled" or "connected" refer to elements being attached to each other either directly (in direct contact with each other) or indirectly (having one or more elements between and attaching the two elements). Either term may be modified by "operatively" and "operably," which may be used interchangeably, to describe that the coupling or connection is configured to allow the components to interact to carry out at least some functionality (for example, a radio chip may be operably coupled to an antenna element to provide a radio frequency electromagnetic signal for wireless communication).

Terms related to orientation, such as "top," "bottom," "side," and "end," are used to describe relative positions of components and are not meant to limit the orientation of the embodiments contemplated. For example, an embodiment described as having a "top" and "bottom" also encompasses embodiments thereof rotated in various directions unless the content clearly dictates otherwise.

Reference to "one embodiment," "an embodiment," "certain embodiments," or "some embodiments," etc., means that a particular feature, configuration, composition, or characteristic described in connection with the embodiment is included in at least one embodiment of the disclosure. Thus, the appearances of such phrases in various places throughout are not necessarily referring to the same embodiment of the disclosure. Furthermore, the particular features, configurations, compositions, or characteristics may be combined in any suitable manner in one or more embodiments.

The words "preferred" and "preferably" refer to embodiments of the disclosure that may afford certain benefits, under certain circumstances. However, other embodiments may also be preferred, under the same or other circumstances. Furthermore, the recitation of one or more preferred embodiments does not imply that other embodiments are not useful and is not intended to exclude other embodiments from the scope of the disclosure.

As used in this specification and the appended claims, the singular forms "a," "an," and "the" encompass embodiments having plural referents, unless the content clearly dictates

otherwise. As used in this specification and the appended claims, the term "or" is generally employed in its sense including "and/or" unless the content clearly dictates otherwise.

As used herein, "have," "having," "include," "including," "comprise," "comprising" or the like are used in their open-ended sense, and generally mean "including, but not limited to." It will be understood that "consisting essentially of," "consisting of," and the like are subsumed in "comprising," and the like. The term "and/or" means one or all of the listed elements or a combination of at least two of the listed elements.

The phrases "at least one of," "comprises at least one of," and "one or more of" followed by a list refers to any one of the items in the list and any combination of two or more items in the list.

CLAIMS

What is claimed is:

1. A system, comprising:

at least one hearing device configured to be worn at, in or on an ear of a wearer, the hearing device comprising a rechargeable power source, power management circuitry, and a first charging interface comprising a first cathode contact and a first anode contact spaced apart from the first cathode contact; and

a charging module comprising:

a second charging interface configured to detachably couple with the first charging interface of the hearing device, the second charging interface comprising a second anode contact having a contact surface and a displaceable second cathode contact;

an arrangement configured to displace at least a portion of the second cathode contact above the contact surface to facilitate electrical contact between the first and second cathode contacts prior to electrical contact between the first and second anode contacts; and

charging circuitry coupled to the second charging interface and configured to charge the rechargeable power source of the hearing device.

ABSTRACT

A system includes a hearing device comprising a rechargeable power source, power management circuitry, and a first charging interface comprising a first cathode contact and a first anode contact spaced apart from the first cathode contact. A charging module comprises a second charging interface configured to detachably couple with the first charging interface of the hearing device. The second charging interface comprises a second anode contact having a contact surface and a displaceable second cathode contact. An arrangement is configured to displace at least a portion of the second cathode contact above the contact surface to facilitate electrical contact between the first and second cathode contacts prior to electrical contact between the first and second anode contacts. Charging circuitry of the charging module is coupled to the second charging interface and configured to charge the rechargeable power source of the hearing device.

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE

As the below named inventor, I hereby declare that:

This declaration is directed to:

- ☐ The attached application, or
- ☒ United States application or PCT international application number 17/553,716 filed on December 16, 2021.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

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LEGAL NAME OF INVENTOR

Inventor: Erik Carlson Date (Optional): 8/3/2023

Signature: / Erik Carlson /

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LEGAL NAME OF INVENTOR

Inventor: Thomas Burns Date (Optional): 8/3/2023

Signature: /Thomas Burns/

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LEGAL NAME OF INVENTOR

Inventor: Kyle Olson Date (Optional): 8/2/2023

Signature: / Kyle Olson /

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE

As the below named inventor, I hereby declare that:

This declaration is directed to:

- ☐ The attached application, or
- ☒ United States application or PCT international application number 17/553,716 filed on December 16, 2021.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Kent Giswold Date (Optional): 10/13/2023

Signature: /Kent Giswold/

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82A (07-13)
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TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	Unassigned
Filing Date	Herewith
First Named Inventor	Erik Carlson
Title	SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE
Art Unit	Unassigned
Examiner Name	Unassigned
Attorney Docket Number	ST0806US4/0532.000806US04

SIGNATURE of Applicant or Patent Practitioner

Signature	/Mark A. Hollingsworth/	Date (Optional)	
Name	Mark A. Hollingsworth	Registration Number	38,491
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☑ *Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/AIA/96 (08-12)
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STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: Starkey Laboratories, Inc.

Application No./Patent No.: Unassigned Filed/Issue Date: herewith

Titled: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE

Starkey Laboratories, Inc., a corporation

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☑ The assignee of the entire right, title, and interest.

2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):

   ☐ The extent (by percentage) of its ownership interest is _____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.

   ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (*e.g.*, bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

A. ☑ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel 051918, Frame 0191, or for which a copy thereof is attached.

B. ☐ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

   1. From: _____ To: _____

      The document was recorded in the United States Patent and Trademark Office at

      Reel _____, Frame _____, or for which a copy thereof is attached.

   2. From: _____ To: _____

      The document was recorded in the United States Patent and Trademark Office at

      Reel _____, Frame _____, or for which a copy thereof is attached.

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450**.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/AIA/96 (08-12)
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STATEMENT UNDER 37 CFR 3.73(c)

3. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

4. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

5. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

6. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☐ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Mark A. Hollingsworth/	August 20, 2024
Signature	Date
Mark A. Hollingsworth	38,491
Printed or Typed Name	Title or Registration Number

PTO/AIA/80 (07-12)
Approved for use through 11/30/2014, OMB 0651-0035
U.S. Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(c).

I hereby appoint:

☒ Practitioners associated with Customer Number: 142537

OR

☐ Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number	Name	Registration Number

As attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignments documents attached to this form in accordance with 37 CFR 3.73(c).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(c) to:

☒ The address associated with Customer Number: 142537

OR

☐	Firm or Individual Name		
	Address		
	City	State	Zip
	Country		
	Telephone	Email	

Assignee Name and Address: Starkey Laboratories, Inc.
6600 Washington Ave. S.
Eden Prairie, MN 55344

A copy of this form, together with a statement under 37 CFR 3.73(c) (Form PTO/AIA/96 or equivalent) is required to be Filed in each application in which this form is used. The statement under 37 CFR 3.73(c) may be completed by one of The practitioners appointed in this form, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record
The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature		Date	10/4/16
Name	Thomas Ting	Telephone	952-947-4609
Title	General Counsel, Starkey Laboratories, Inc.		

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/AIA/14 (02-18)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	ST0806US4/532.000806US04
	Application Number	
Title of Invention	SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Erik		Carlson	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Stillwater	State/Province	MN	Country of Residence	US

Mailing Address of Inventor:

Address 1	6700 Washington Avenue South		
Address 2			
City	Eden Prairie	State/Province	MN
Postal Code	55344	Country	US

Inventor 2 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Thomas		Burns	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Minneapolis	State/Province	MN	Country of Residence	US

Mailing Address of Inventor:

Address 1	6700 Washington Avenue South		
Address 2			
City	Eden Prairie	State/Province	MN
Postal Code	55344	Country	US

Inventor 3 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Kyle		Olson	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

PTO/AIA/14 (02-18)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	ST0806US4/532.000806US04
	Application Number	
Title of Invention	SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE	

City	St. Louis Park	State/Province	MN	Country of Residence	US

Mailing Address of Inventor:

Address 1	6700 Washington Avenue South		
Address 2			
City	Eden Prairie	State/Province	MN
Postal Code	55344	Country	US

Inventor 4 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Kent		Giswold	

Residence Information (Select One) (•) US Residency ( ) Non US Residency ( ) Active US Military Service

City	Minnetonka	State/Province	MN	Country of Residence	US

Mailing Address of Inventor:

Address 1	6700 Washington Avenue South		
Address 2			
City	Eden Prairie	State/Province	MN
Postal Code	55344	Country	US

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	142537		
Email Address		Add Email	Remove Email

Application Information:

Title of the Invention	SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		
Attorney Docket Number	ST0806US4/532.000806US04	Small Entity Status Claimed	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	15	Suggested Figure for Publication (if any)	

PTO/AIA/14 (02-18)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	ST0806US4/532.000806US04
	Application Number	
Title of Invention	SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	142537		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	17553716	2021-12-16

PTO/AIA/14 (02-18)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	ST0806US4/532.000806US04
	Application Number	
Title of Invention	SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE	

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
17553716	Continuation of	PCT/US2020/041956	2020-07-14
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2020/041956	Claims benefit of provisional	62876454	2019-07-19
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/US2020/041956	Claims benefit of provisional	62943375	2019-12-04
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.			Add

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

			Remove
Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)
Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.			Add

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

PTO/AIA/14 (02-18)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	ST0806US4/532.000806US04
	Application Number	
Title of Invention	SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

PTO/AIA/14 (02-18)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	ST0806US4/532.000806US04
	Application Number	
Title of Invention	SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1 Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

◉ Assignee	○ Legal Representative under 35 U.S.C. 117	○ Joint Inventor
○ Person to whom the inventor is obligated to assign.	○ Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name	Starkey Laboratories, Inc.		
Mailing Address Information For Applicant:			
Address 1	6700 Washington Avenue South		
Address 2			
City	Eden Prairie	**State/Province**	MN
Country	US	Postal Code	55344
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button. Add

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	ST0806US4/532.000806US04
	Application Number	
Title of Invention	SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE	

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

Remove

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add

Signature:

Remove

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Mark A. Hollingsworth/			Date (YYYY-MM-DD)	2024-08-20
First Name	Mark	Last Name	Hollingsworth	Registration Number	38491

Additional Signature may be generated within this form by selecting the Add button. Add

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	ST0806US4/532.000806US04
	Application Number	
Title of Invention	SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE	

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1 The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3 A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent CooperationTreaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Figure 1A

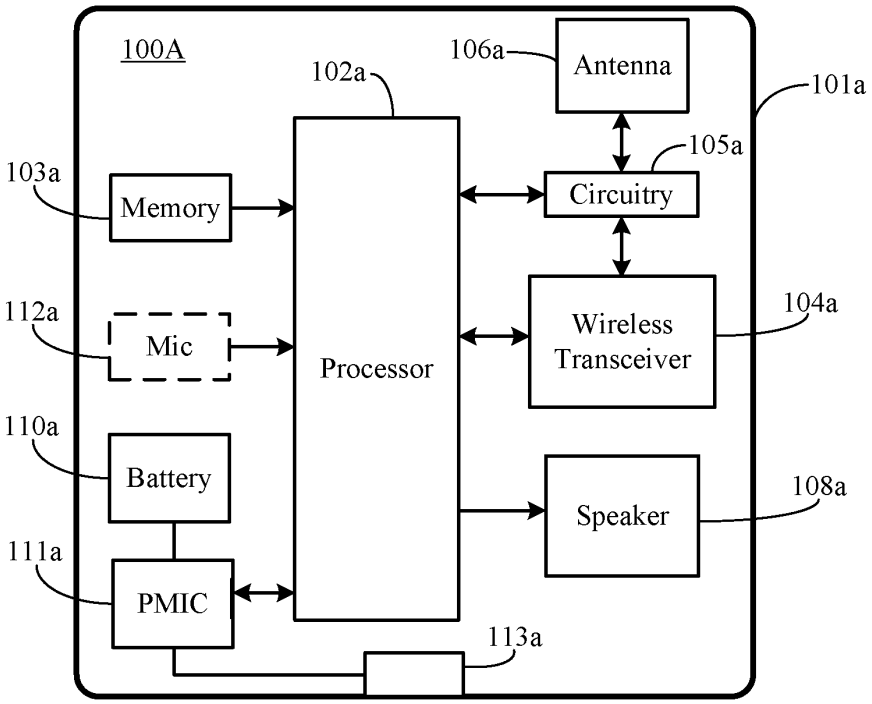
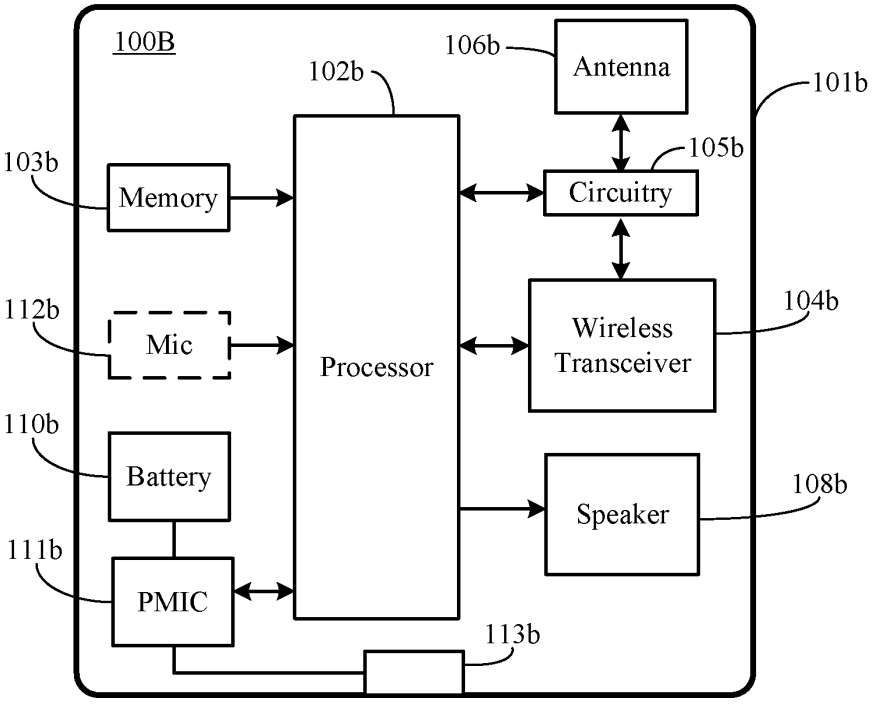


Figure 1B



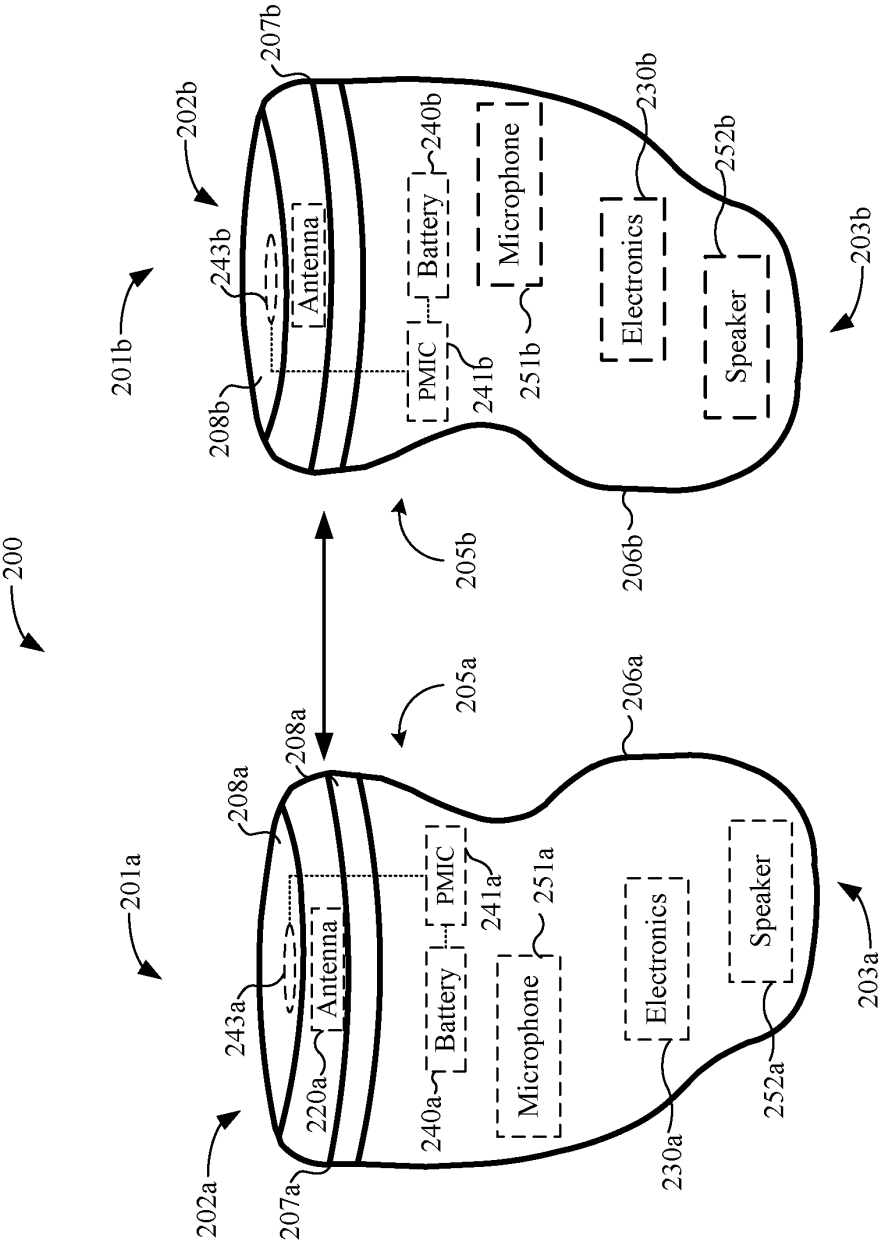

200
201a
201b
202a
202b
203a
203b
205a
205b
206a
206b
207a
207b
208a
208a
208b
220a
230a
230b
240a
240b
241a
241b
243a
243b
251a
251b
252a
252b
Antenna
Antenna
Battery
Battery
Electronics
Electronics
Microphone
Microphone
PMIC
PMIC
Speaker
Speaker

Figure 2A

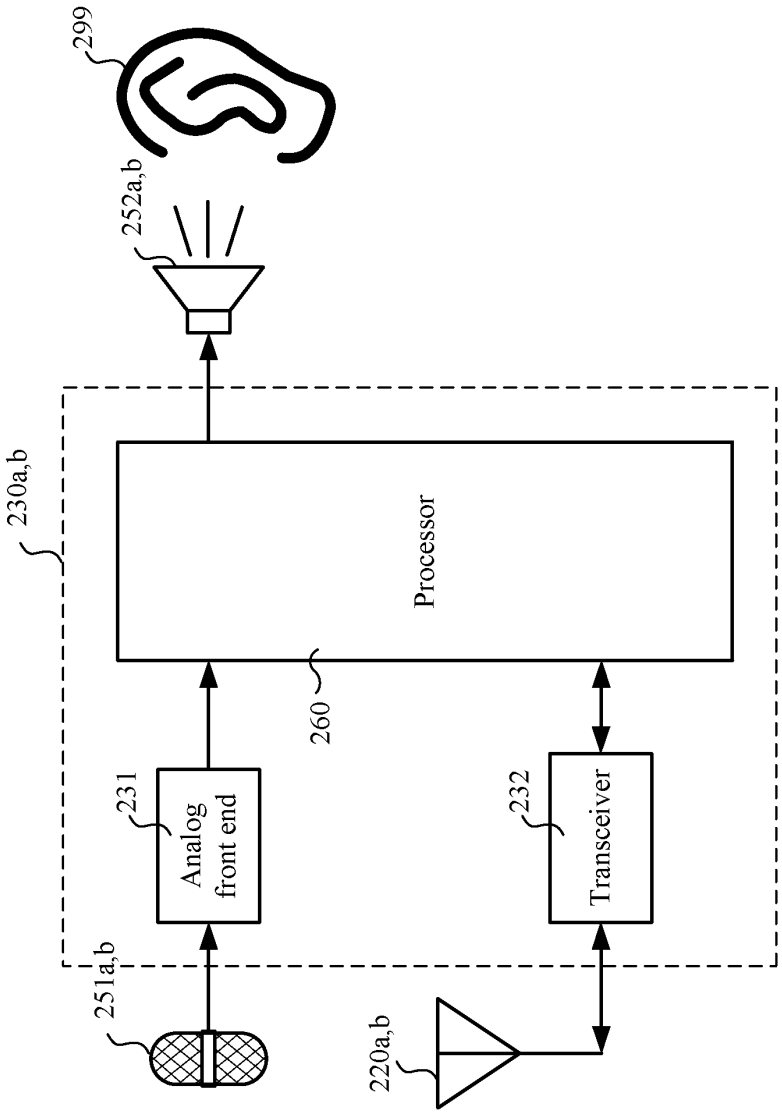

299
252a,b
230a,b
Processor
260
231
Analog front end
232
Transceiver
251a,b
220a,b

Figure 2B

Figure 3

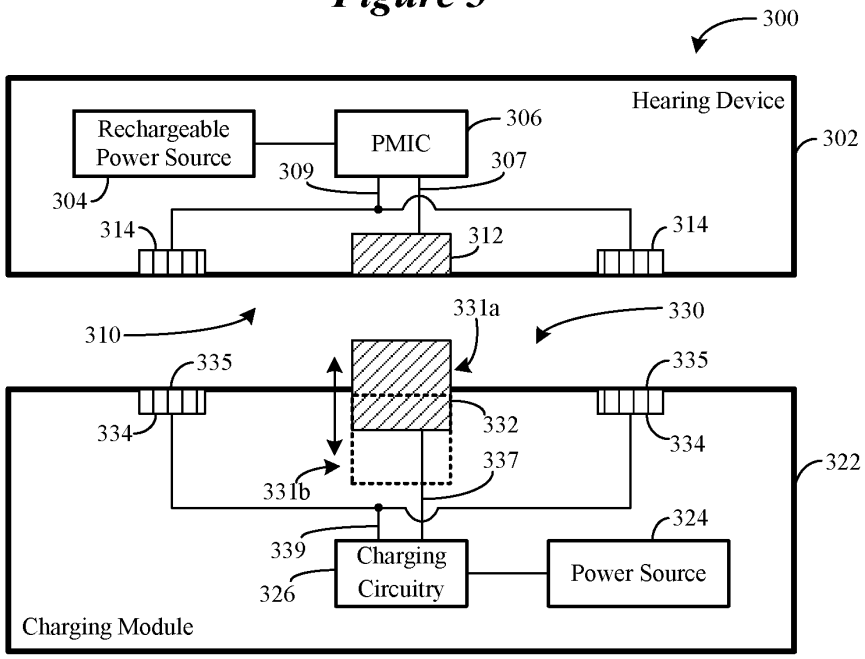
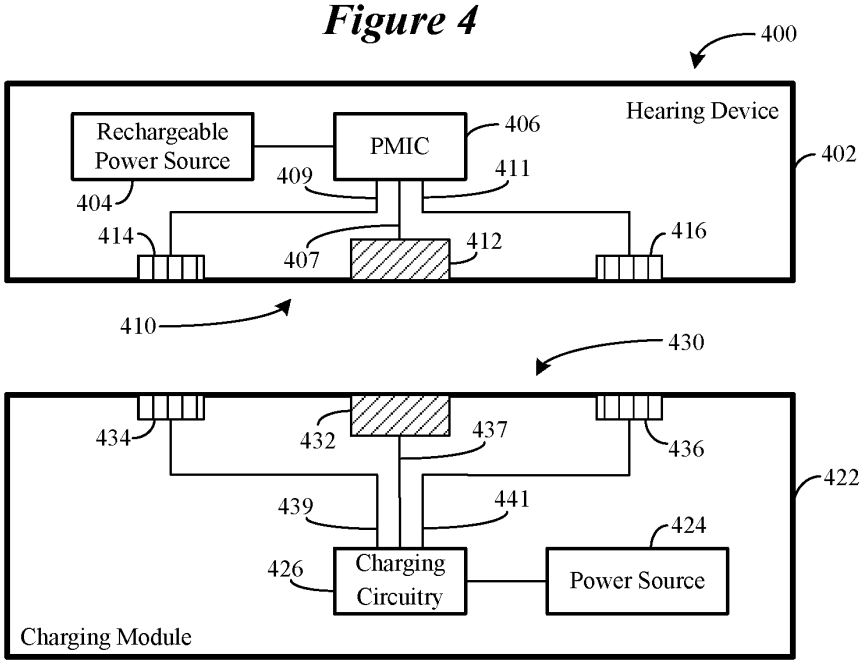


Figure 4



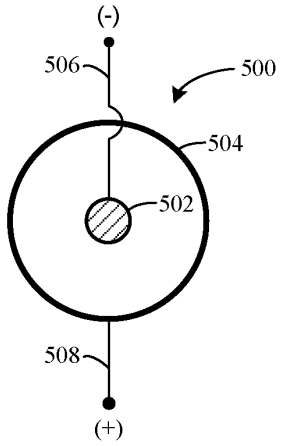


Figure 5

Figure 6

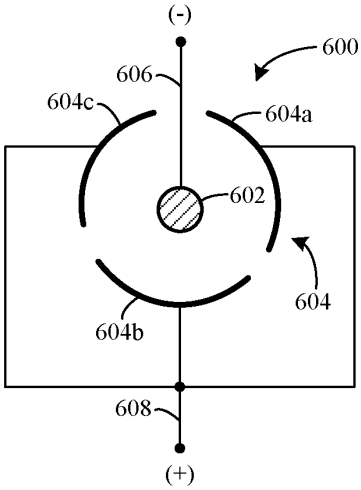


Figure 7

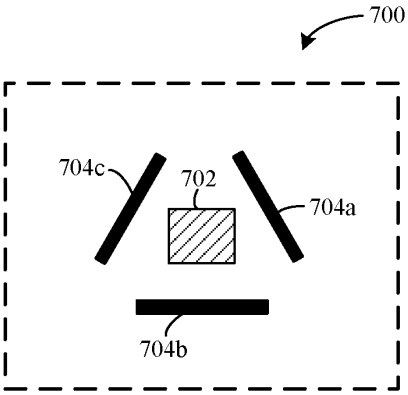


Figure 8A

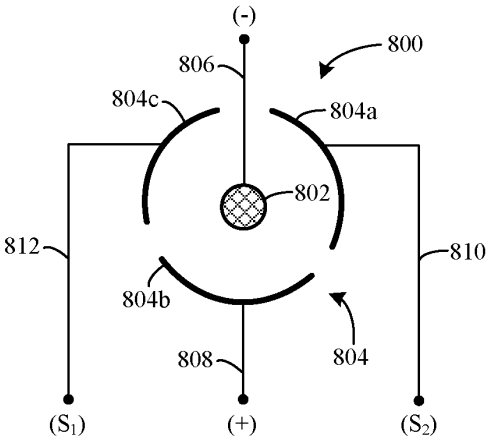


Figure 8B

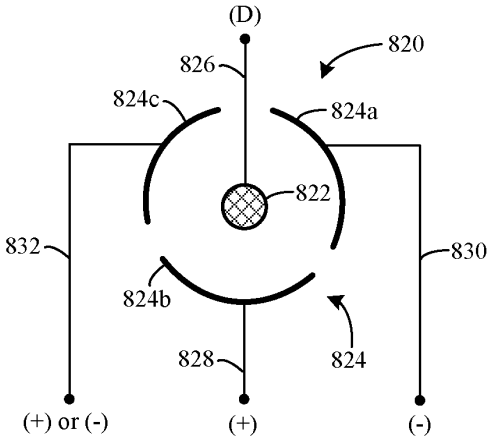


Figure 8C

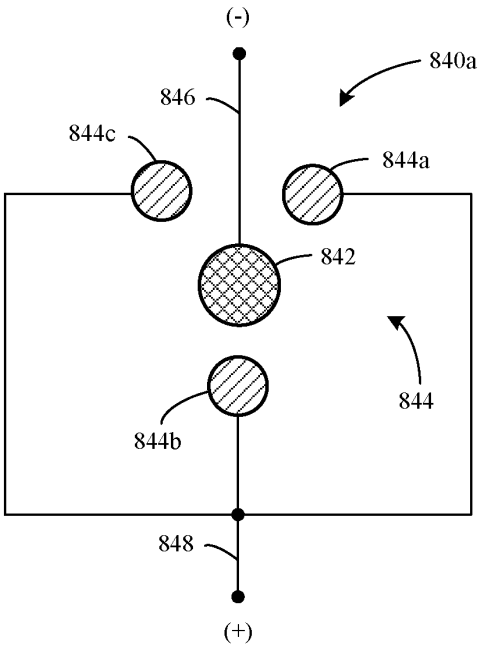


Figure 8D

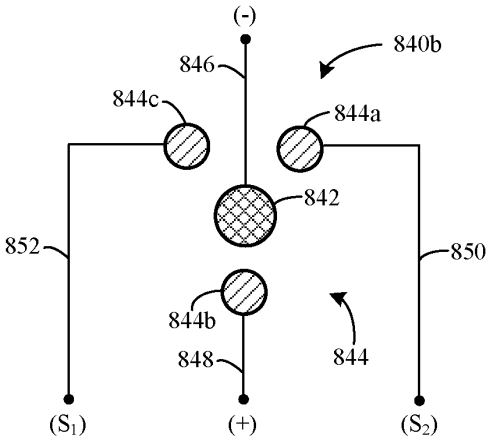
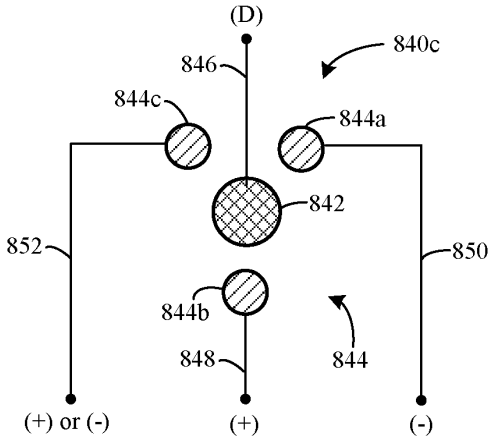


Figure 8E



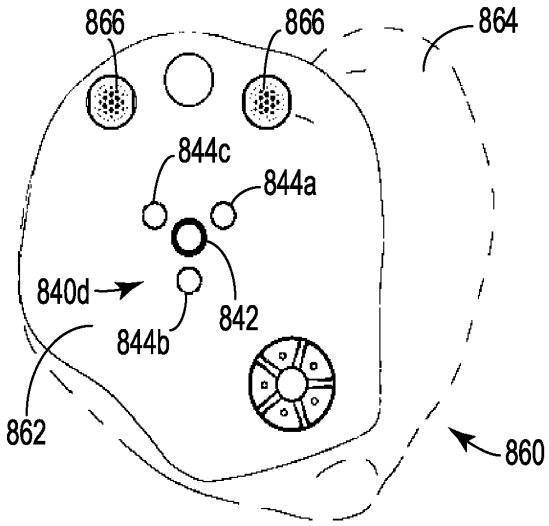


Figure 8F

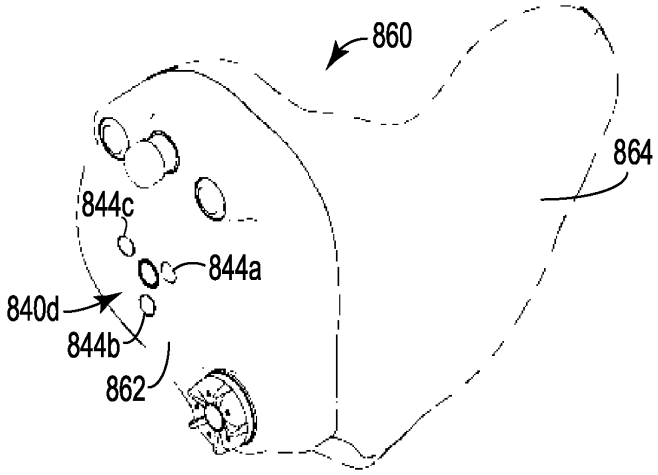


Figure 8G

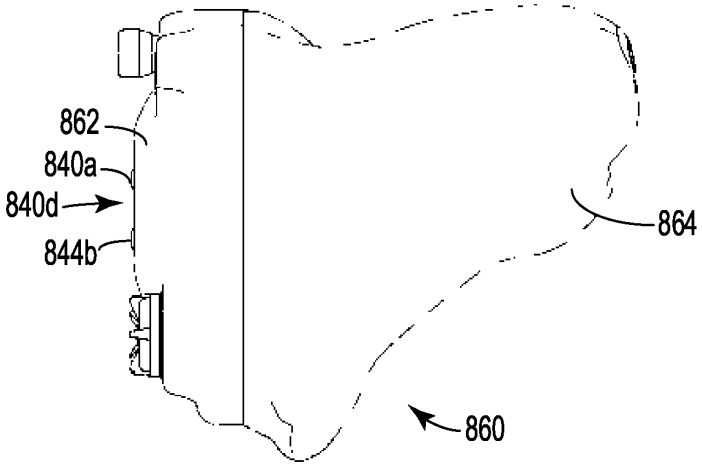


Figure 8H

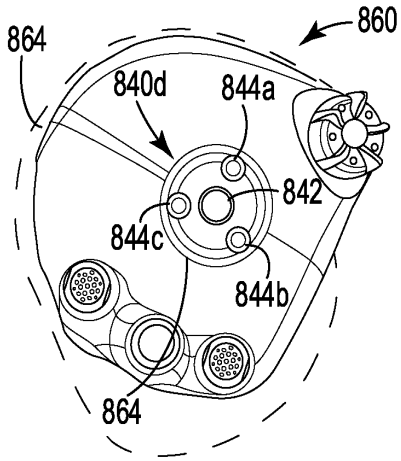


Figure 8I

SONOVA EX1004
Page 115

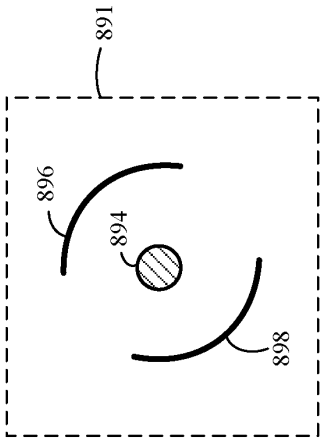


Figure 8K

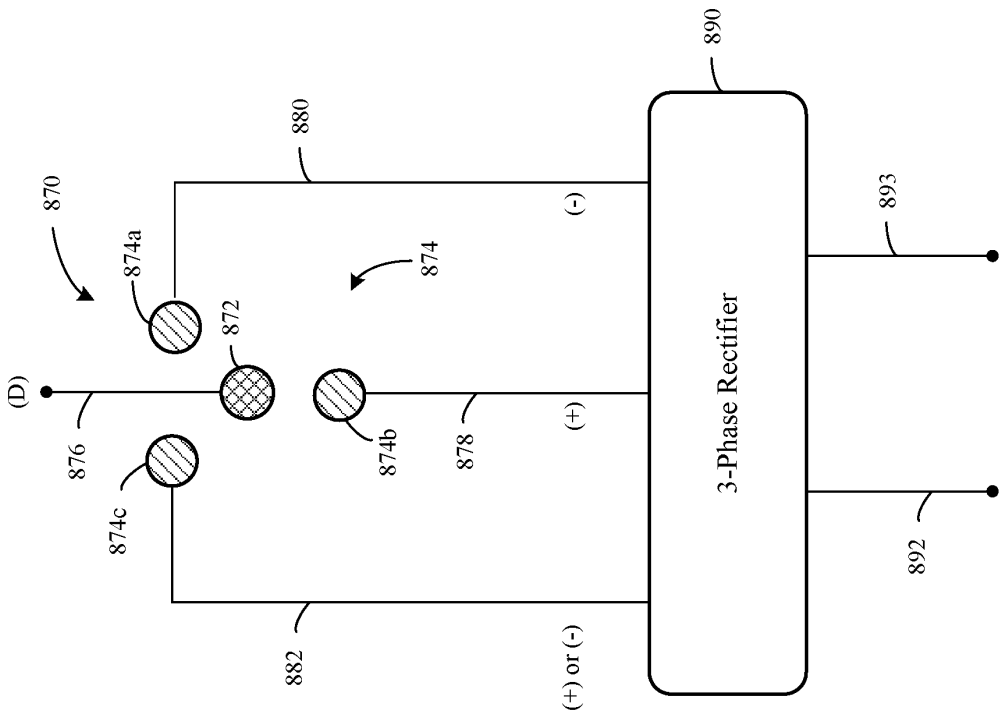


Figure 8J

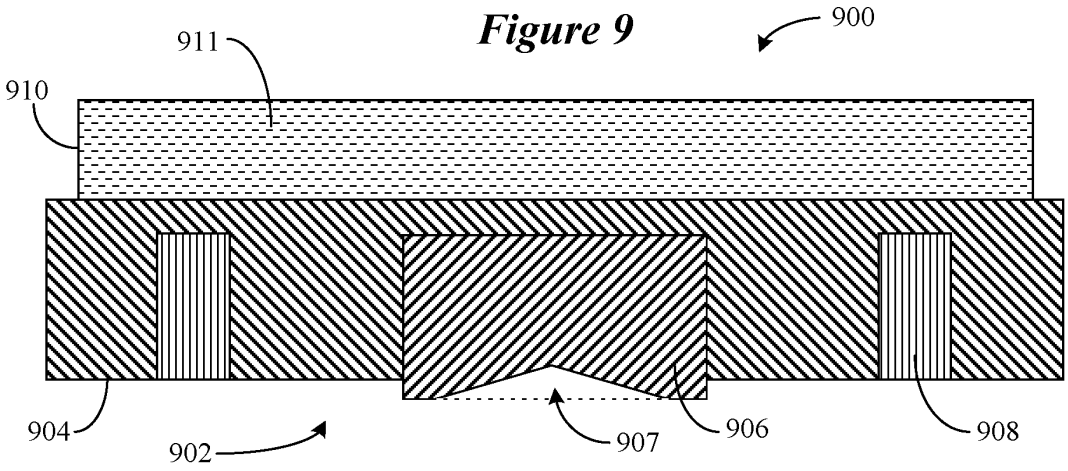


Figure 9

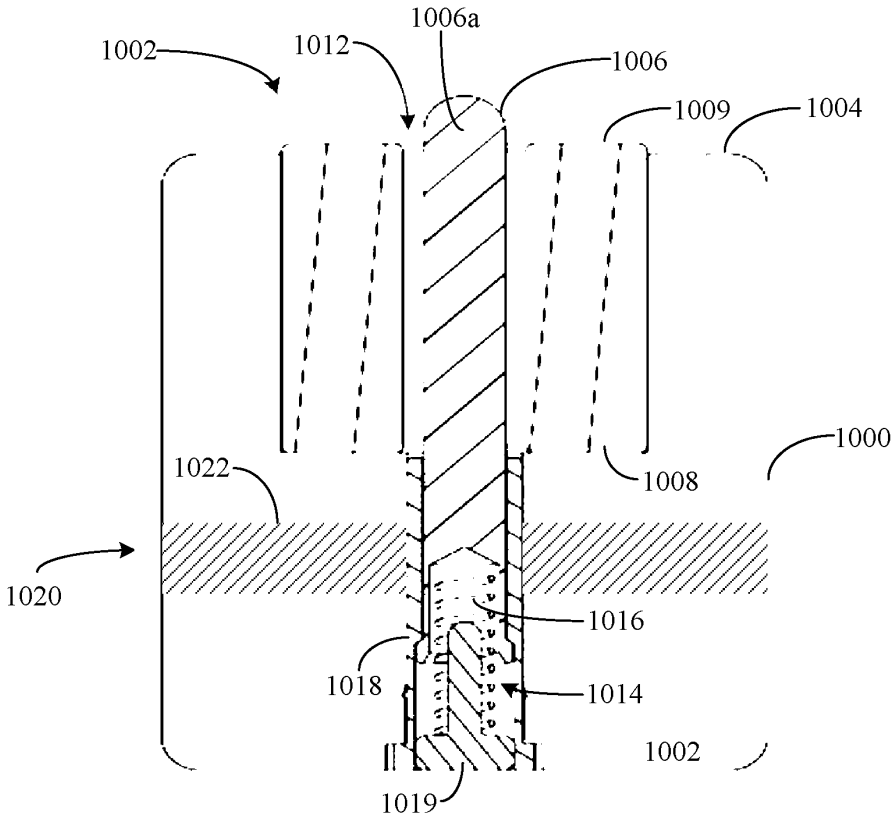


Figure 10



Figure 12

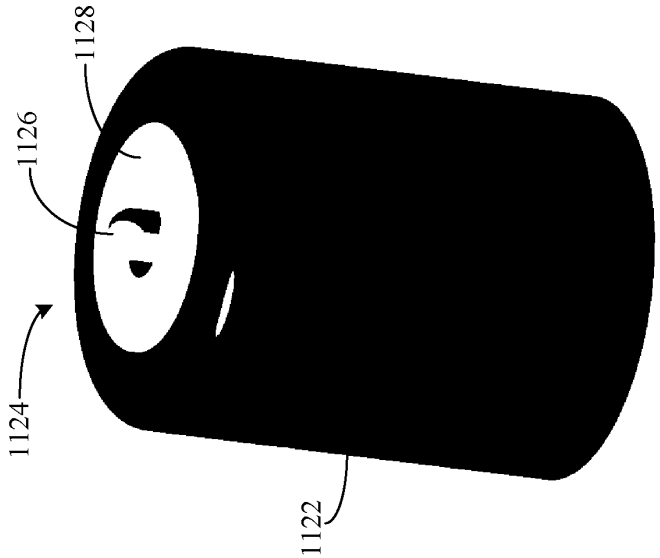


Figure 11

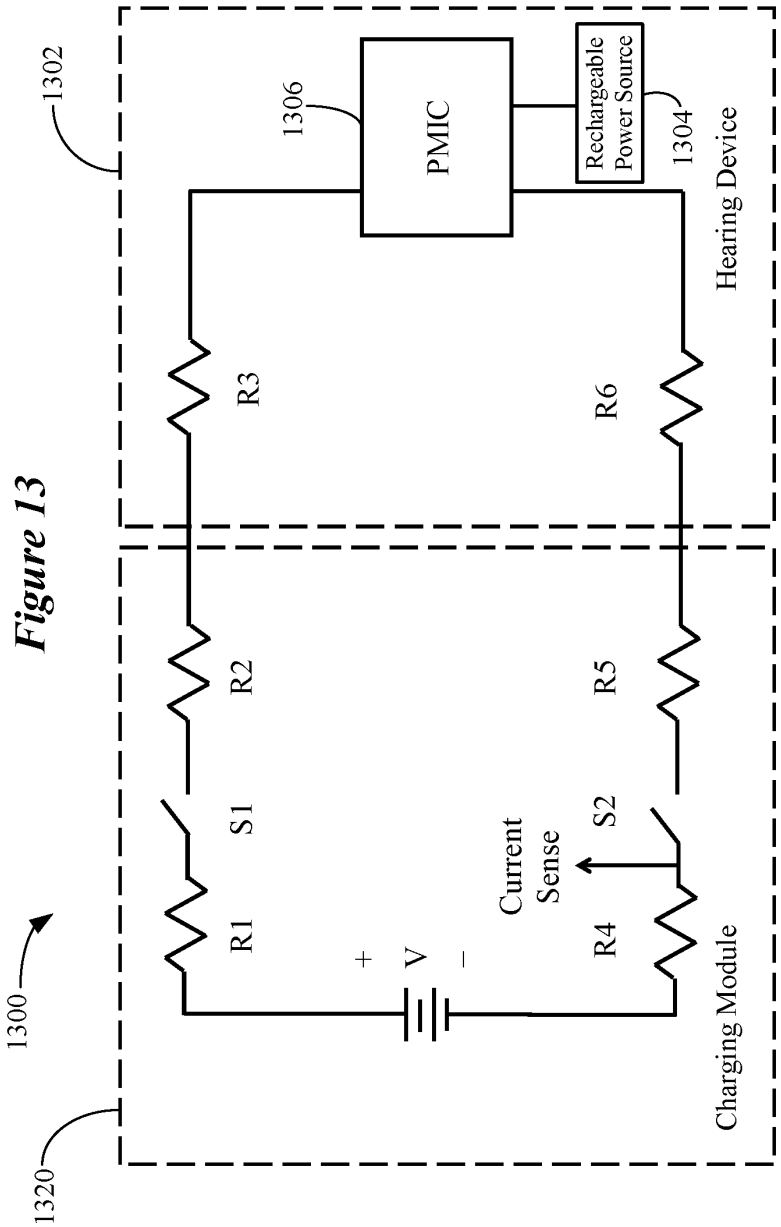

1302
1306
PMIC
Rechargeable Power Source
1304
Hearing Device
R3
R6
R2
R5
S1
S2
R1
R4
+
V
–
Current Sense
1300
1320
Charging Module

Figure 13

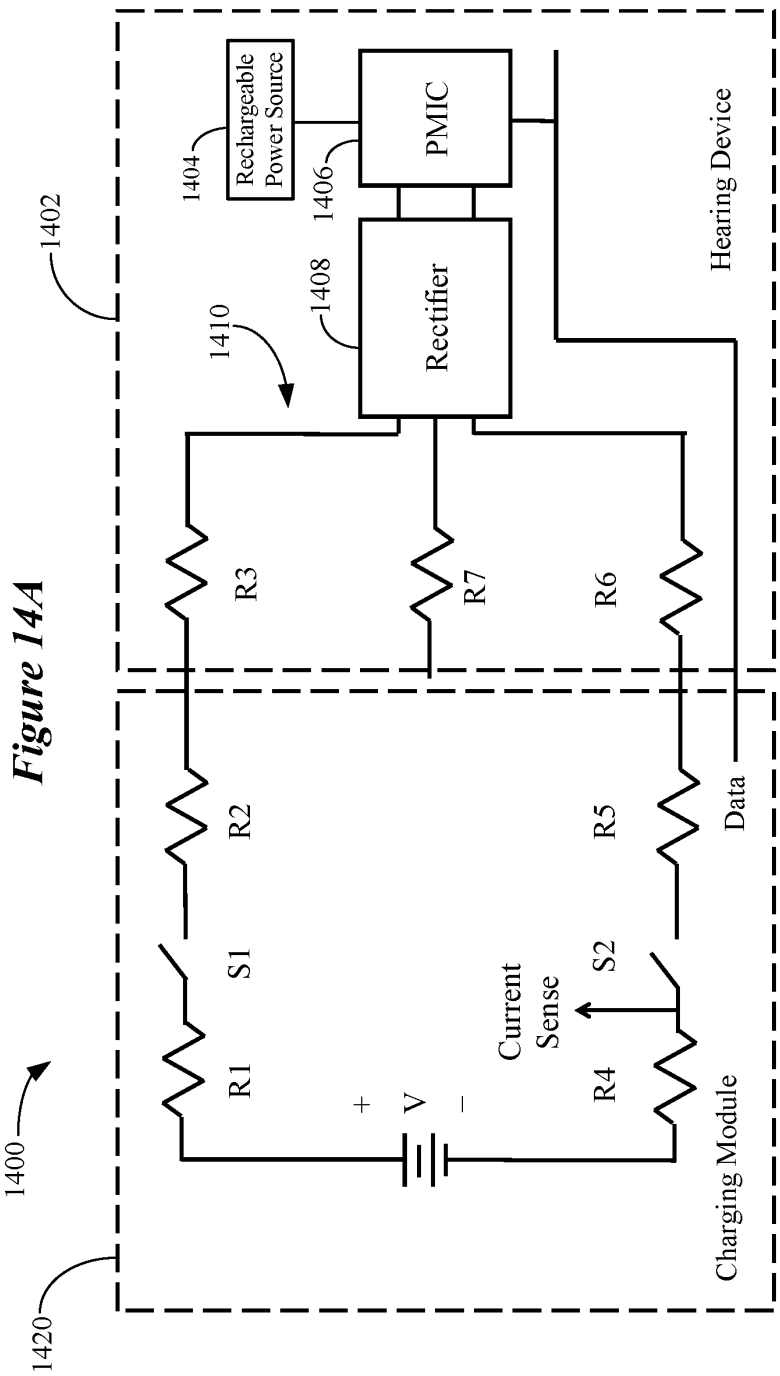


Figure 14A

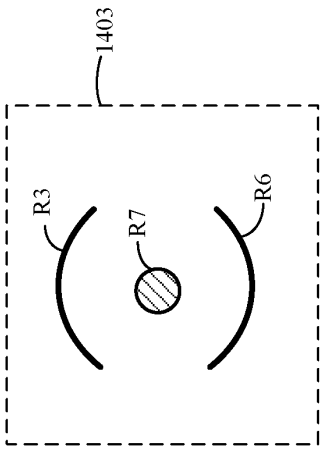


Figure 14B

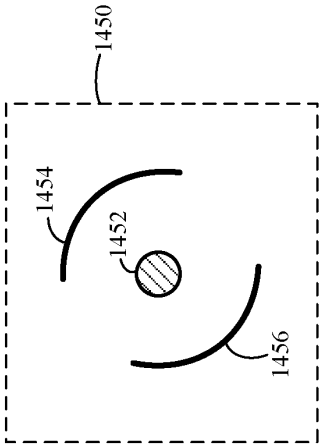


Figure 14D

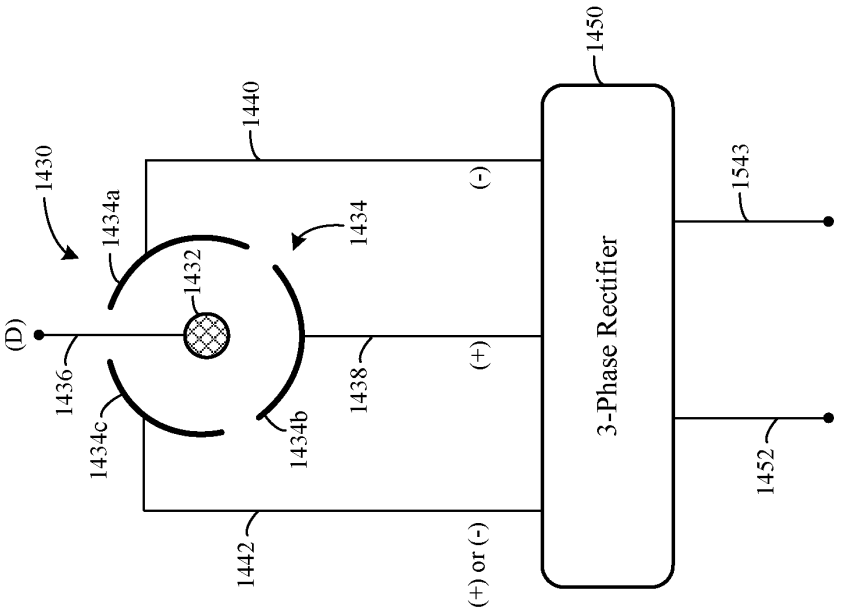


Figure 14C

Figure 15

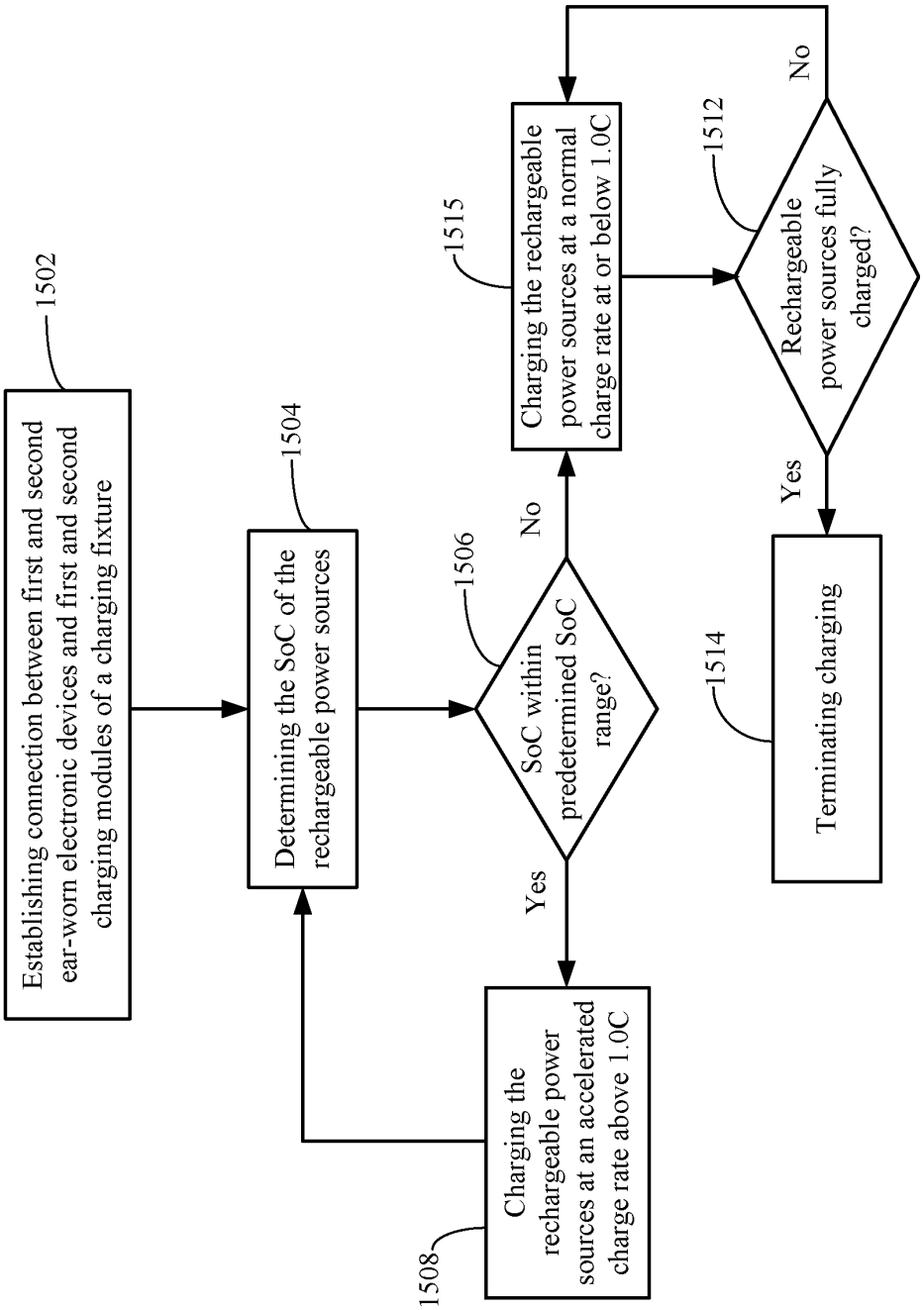
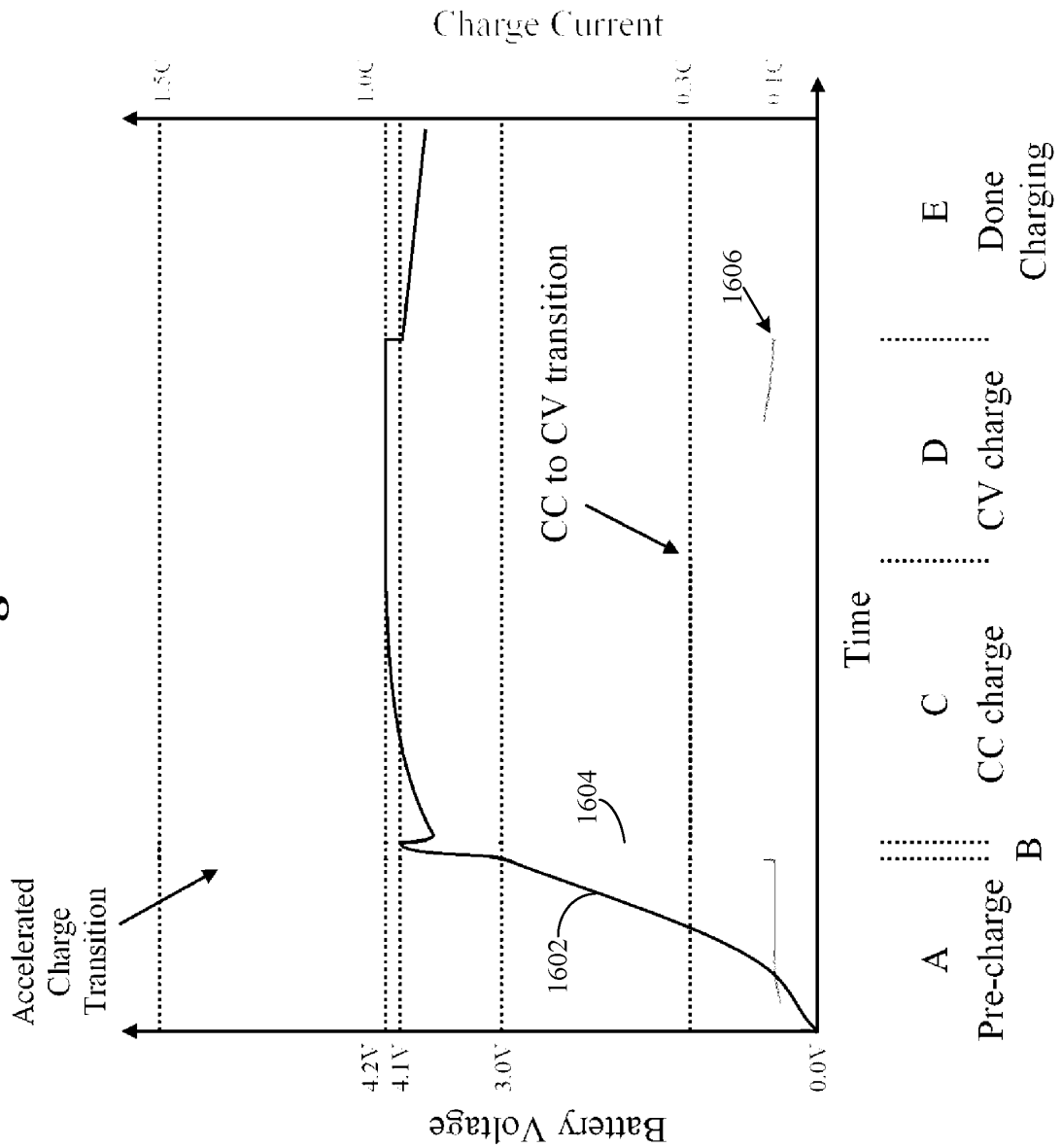

1502
Establishing connection between first and second ear-worn electronic devices and first and second charging modules of a charging fixture
1504
Determining the SoC of the rechargeable power sources
1506
SoC within predetermined SoC range?
Yes
No
1508
Charging the rechargeable power sources at an accelerated charge rate above 1.0C
1515
Charging the rechargeable power sources at a normal charge rate at or below 1.0C
1512
Rechargeable power sources fully charged?
Yes
No
1514
Terminating charging

Figure 16


Charge Current
1.5C
1.0C
0.3C
0.1C
Accelerated Charge Transition
CC to CV transition
1602
1604
1606
4.2V
4.1V
3.0V
0.0V
Battery Voltage
Time
A
Pre-charge
B
Accelerated CC charge
C
CC charge
D
CV charge
E
Done Charging

UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
www.uspto.gov

ELECTRONIC PAYMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/810,014	**08/20/2024 04:08:40 PM Z ET**	**ST0806US4/532.000806US04**

Title of Invention

SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	7322	FILED BY	Mark Hollingsworth
PATENT CENTER #	66857628	AUTHORIZED BY	Mark Hollingsworth
CUSTOMER #	142537	FILING DATE	-
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Erik Carlson

Payment Information

PAYMENT METHOD	PAYMENT TRANSACTION ID	PAYMENT AUTHORIZED BY
CARD / 7647	**E20248JG10195610**	**Mark Hollingsworth**

FEE CODE	DESCRIPTION	ITEM PRICE($)	QUANTITY	ITEM TOTAL($)
1111	UTILITY PATENT APPL. SEARCH FEE	700.00	1	700.00
1011	BASIC FILING FEE - UTILITY (PAPER FILING ALSO REQUIRES NON-ELECTRONIC FILING FEE UNDER 1.16(T))	320.00	1	320.00
1311	PATENT APPL. EXAMINATION FEE	800.00	1	800.00
			TOTAL AMOUNT:	**$1,820.00**

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application Number:	Unassigned
	Confirmation No:	Unassigned
	Filing Date:	Herewith
	First Named Inventor:	Erik Carlson
	Attorney Docket No.:	ST0806US4/532.000806US04
	Examiner Name:	Unassigned
	Art Unit:	Unassigned
Sheet 1 of 4	IDS filed on: August 20, 2024	
Title: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

INFORMATION DISCLOSURE STATEMENT

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

In compliance with the duty imposed by 37 C.F.R. § 1.56, and in accordance with 37 C.F.R. §§ 1.97(b) – (d) and 1.98, Applicant brings the materials enclosed herewith to the attention of the Examiner as possibly being of interest in connection with the above-identified patent application. Pursuant to M.P.E.P. § 609 and 37 C.F.R. § 1.97(h), the information cited in the present Information Disclosure Statement shall not be construed to be an admission that the information is, or is considered to be, material to patentability. Applicant requests that the Examiner consider each of the documents listed on the attached list of documents. Pursuant to the provisions of M.P.E.P. § 609, Applicant further requests that a copy of the list of documents marked as being considered and initialed by the Examiner, be returned along with the next official communication.

This application is a continuation of U.S. Patent Application No. **17/553,716**, filed **December 16, 2021**. In accordance with 37 C.F.R. § 1.98(d), copies of documents previously cited by or submitted to the U.S. Patent and Trademark Office in connection with Applicant's prior application(s) listed above, are not included herewith.

Applicant believes that no fee is due, as this Information Disclosure Statement is filed within three months of the filing date of the application. However, in the event a fee is due, please charge any fee or credit any overpayment to Deposit Account No. 13-4895.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	**Application Number:**	Unassigned
	Confirmation No:	Unassigned
	Filing Date:	Herewith
	First Named Inventor:	Erik Carlson
	Attorney Docket No.:	ST0806US4/532.000806US04
	Examiner Name:	Unassigned
	Art Unit:	Unassigned
Sheet 2 of 4	**IDS filed on: August 20, 2024**	
Title: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

Applicant invites the Examiner to contact the undersigned Applicant's Representative at the telephone number listed below if doing so may advance prosecution of this application.

Respectfully submitted by

Mueting Raasch Group
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Minneapolis, MN 55401
Phone: (612) 305-1220
Facsimile: (612) 305-1228

August 20, 2024
Date

/Mark A. Hollingsworth/
Mark A. Hollingsworth
Reg. No. 38,491
Direct Dial: (612) 767-5000

INFORMATION DISCLOSURE STATEMENT BY APPLICANT		
	Application Number:	Unassigned
	Confirmation No:	Unassigned
	Filing Date:	Herewith
	First Named Inventor:	Erik Carlson
	Attorney Docket No.:	ST0806US4/532.000806US04
	Examiner Name:	Unassigned
	Art Unit:	Unassigned
Sheet 3 of 4	**IDS filed on: August 20, 2024**	
Title: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

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Patent Number (Number - Kind Code)	Issue Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
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D857650 S	08-27-2019	Hardi	
D895806 S1	09-08-2020	Zheng	
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D924207 S1	07-06-2021	Li	
D941475 S1	01-18-2022	Burns	

U.S. PATENT APPLICATION PUBLICATIONS

Publication Number (Number - Kind Code)	Publication Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
2008/0118093	09-27-2011	Klemenz	
20160353216 A1	12-01-2016	Ruzicka	
2018/0370522	12-27-2018	Collins	

U.S. PATENT APPLICATIONS BY SERIAL NUMBER

Copy Enclosed	Document Number (Number - Kind Code)	Filing Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
	None			

FOREIGN PATENT DOCUMENTS

Copy Enclosed	Cite #	Country Code	Foreign Document Number	Kind Code	Publication Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments	translation	
								yes	no
	1	EP	2640170	A1	09-18-2013	Sanford			
	2	WO	2016/036309	A1	03-10-2016	Lindén			
	3	WO	2016/126476	A1	08-11-2016	Fletcher			
	4	WO	2019/037854	A1	02-28-2019	Baltensperger			

Examiner Signature		Date Considered	

***EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.**

INFORMATION DISCLOSURE STATEMENT BY APPLICANT		
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	Art Unit:	Unassigned
Sheet 4 of 4	**IDS filed on: August 20, 2024**	
Title: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

NON-PATENT LITERATURE DOCUMENTS

Copy Enclosed	Cite #	Document Description
	1	European Patent Application No. 20 750 976.1 (Attorney Docket No. 0532.000806WO01), filed July 14, 2020; European Office Action issued October 27, 2023, 8 pages.
	2	International Search Report and Written Opinion from PCT Application No. PCT/US2020/041956 dated November 2, 2020, 10 pages.

Examiner Signature		Date Considered	
***EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.**			

Figure 1A

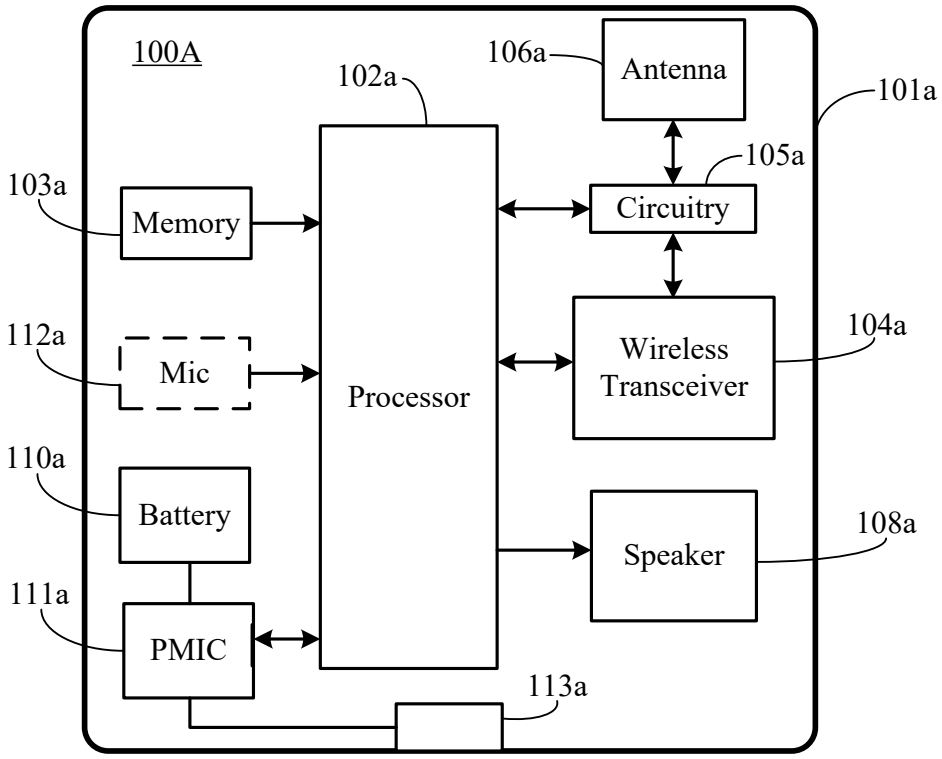
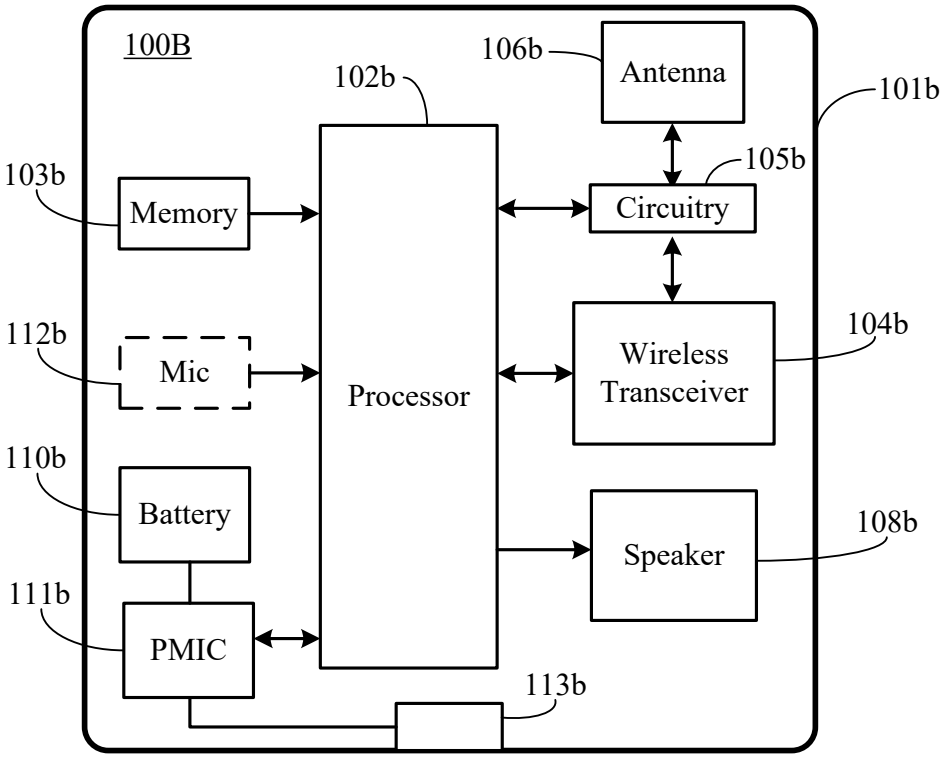


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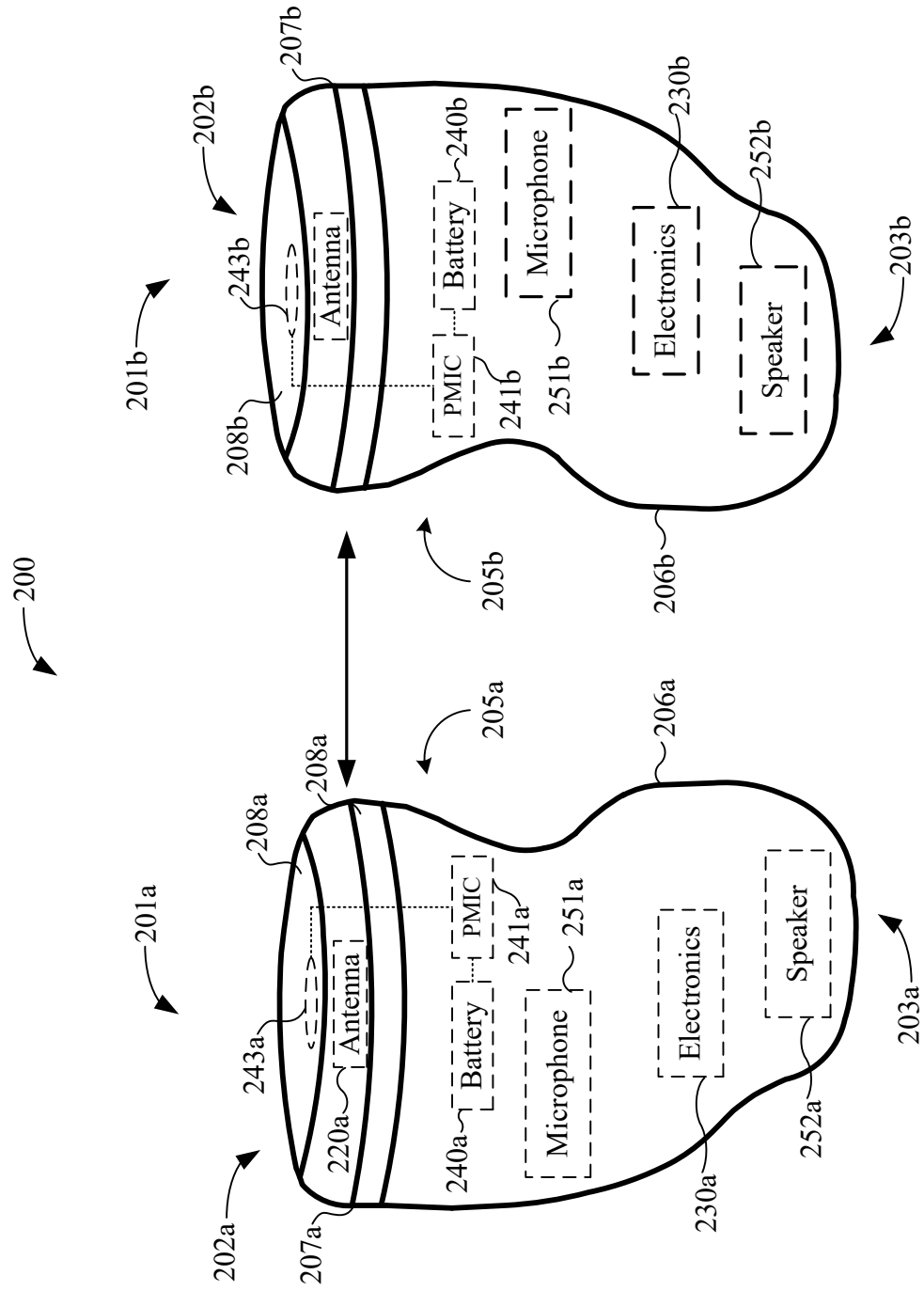

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252a
252b
Antenna
Battery
PMIC
Microphone
Electronics
Speaker

Figure 2A

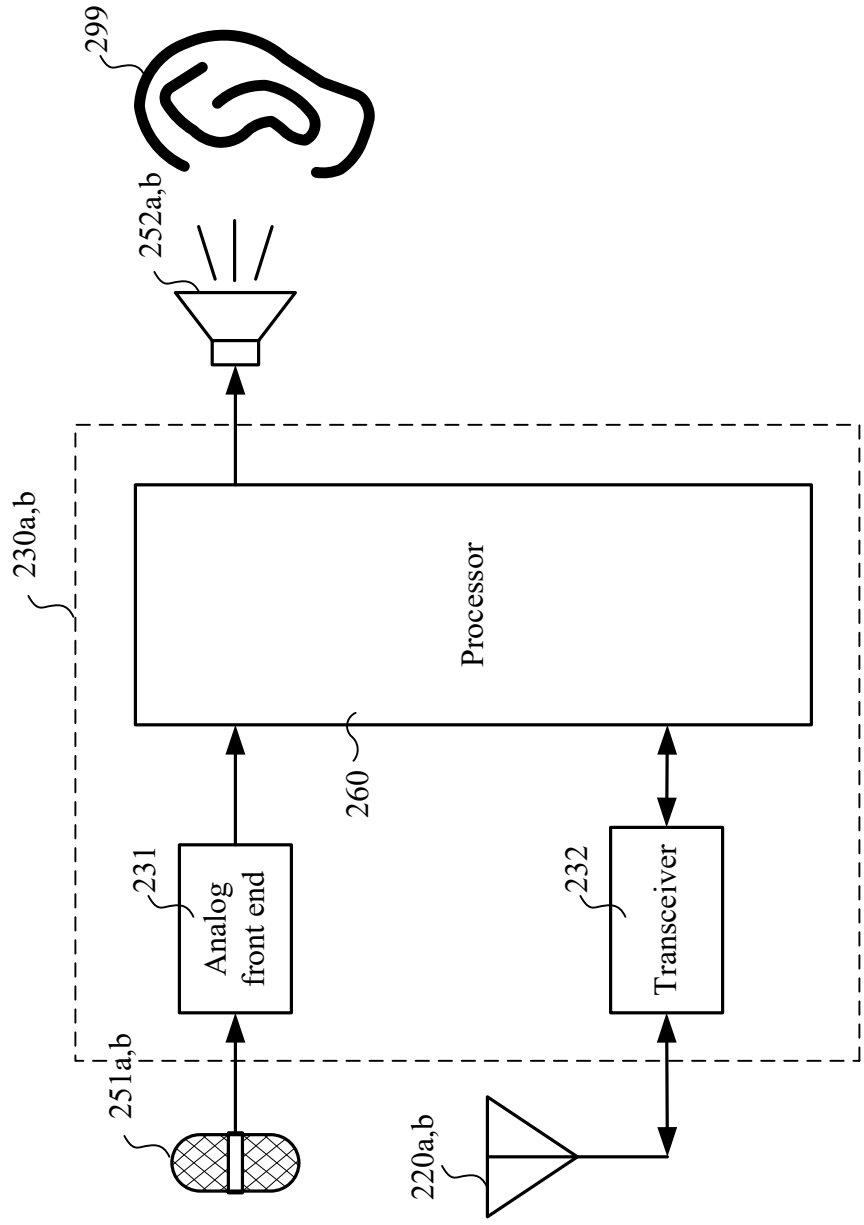

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Analog
front end
232
Transceiver
251a,b
220a,b

Figure 2B

Figure 3

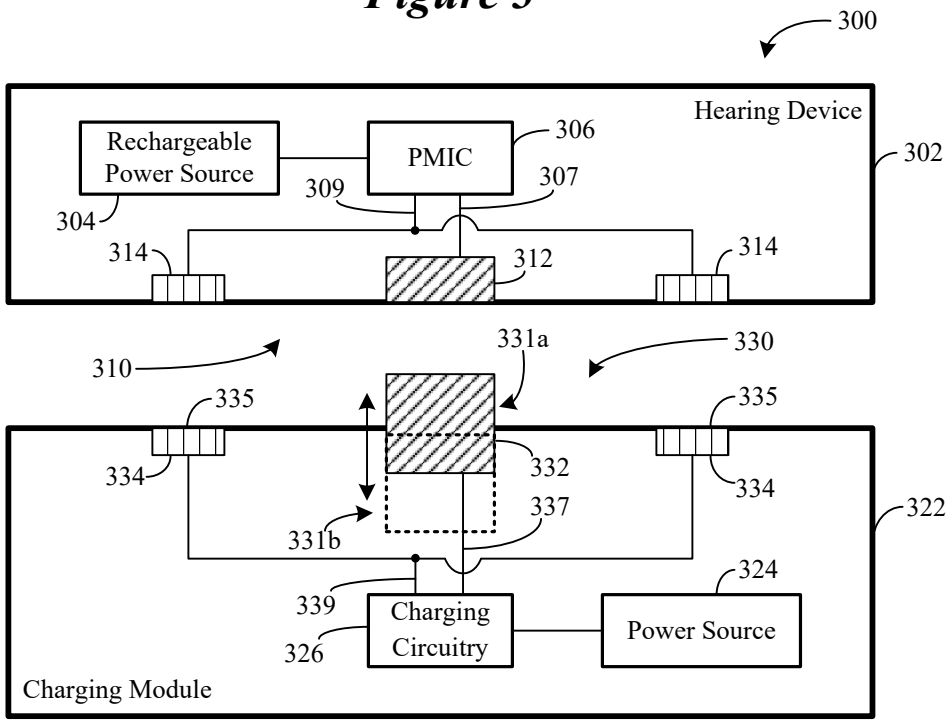
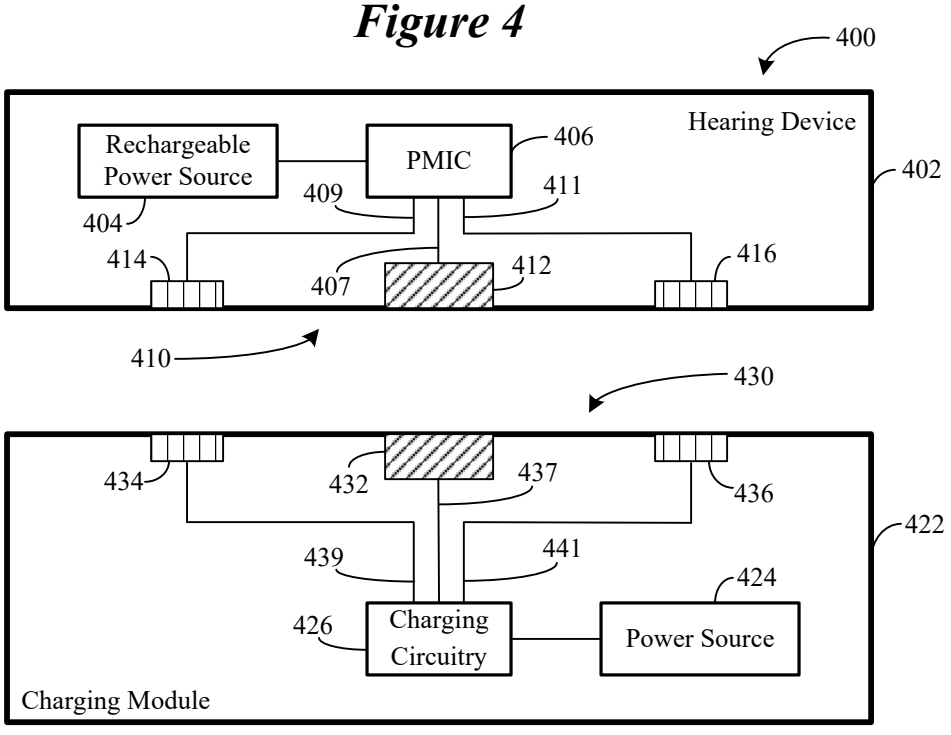


Figure 4



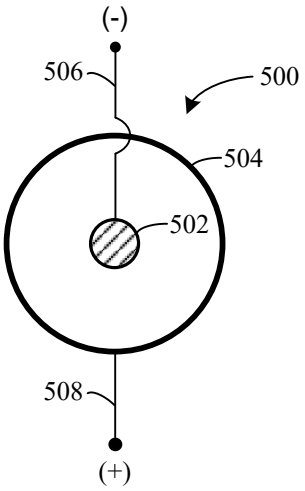


Figure 5

Figure 6

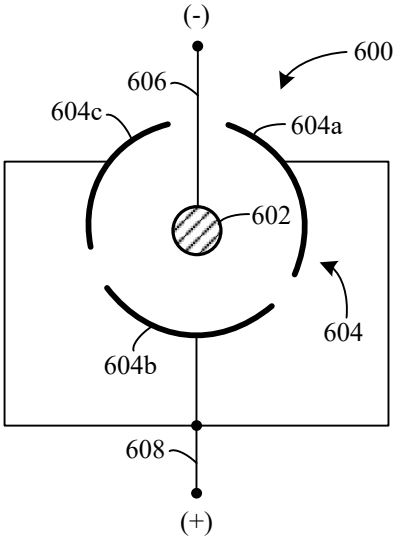


Figure 7

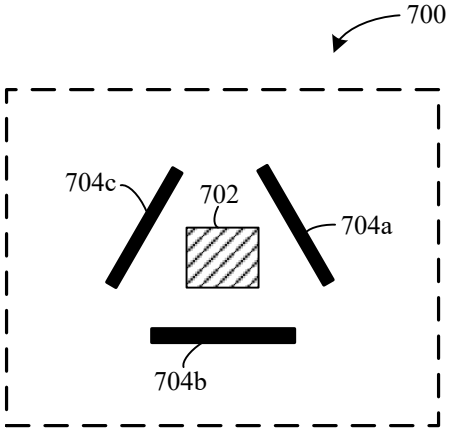


Figure 8A

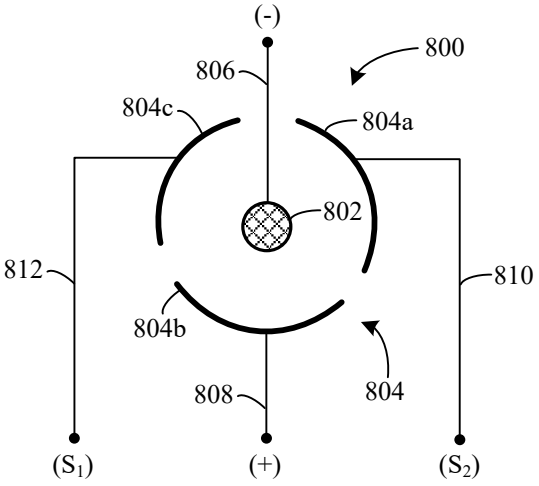


Figure 8B

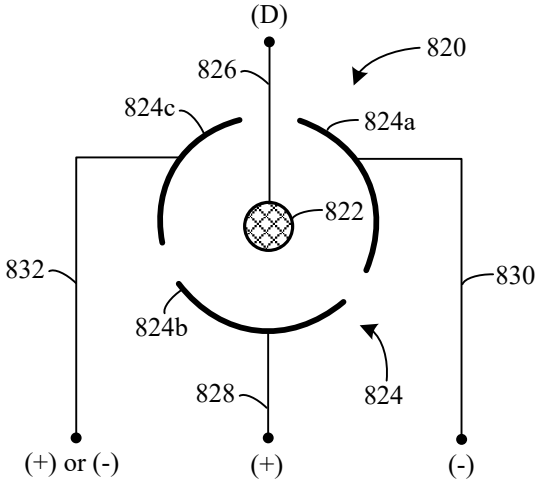


Figure 8C

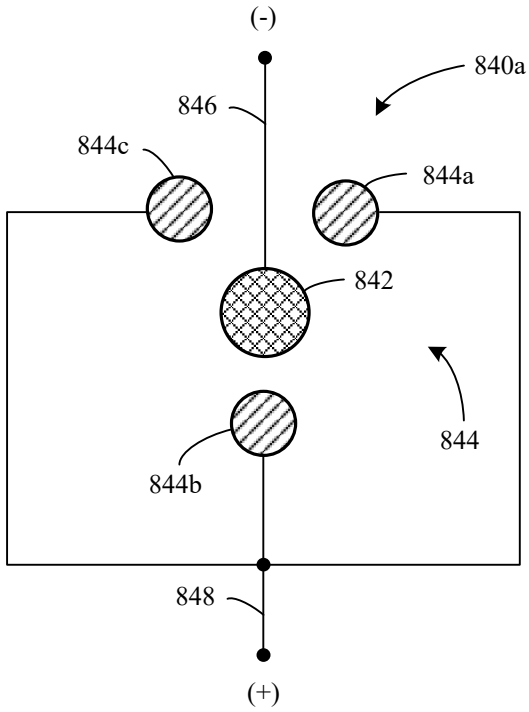


Figure 8D

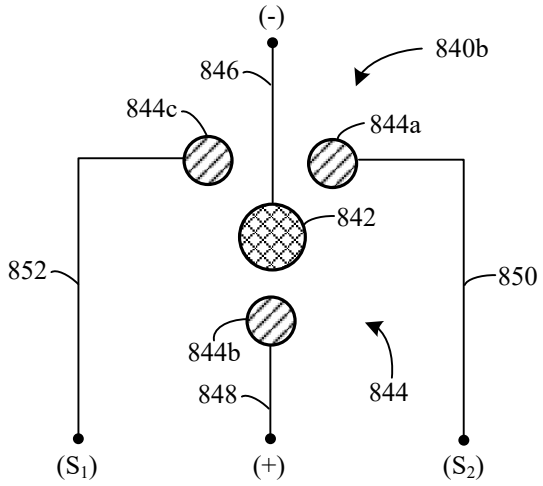
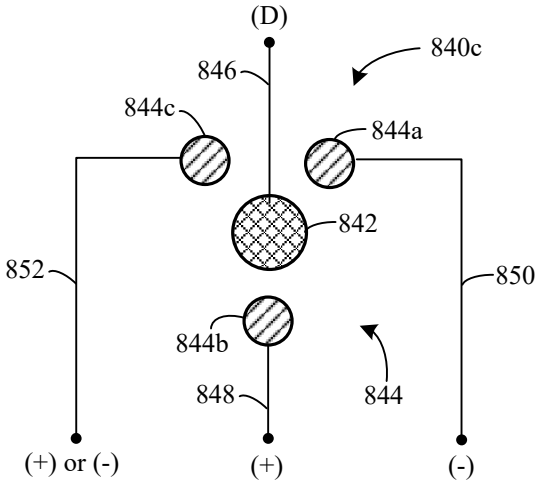


Figure 8E



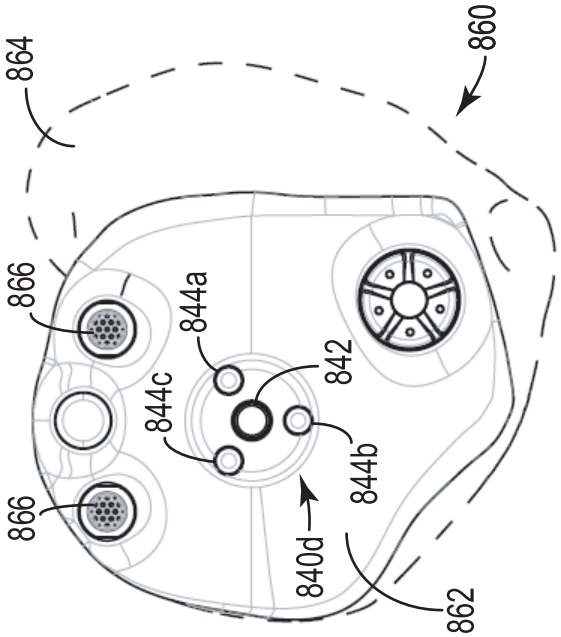


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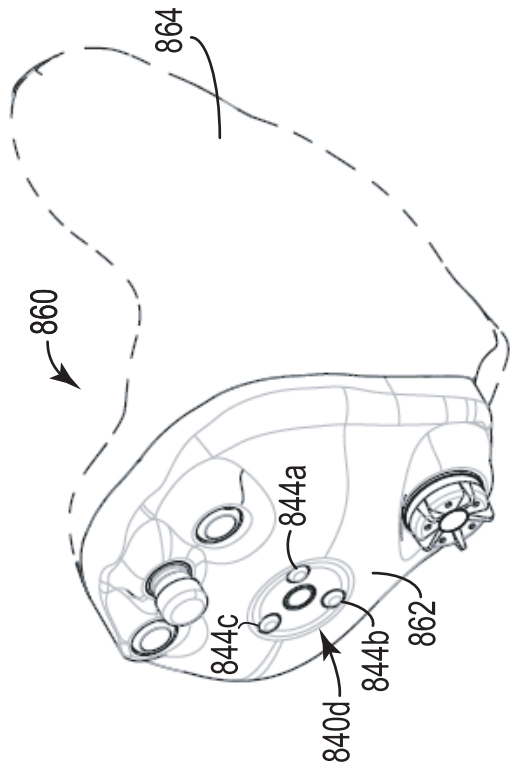


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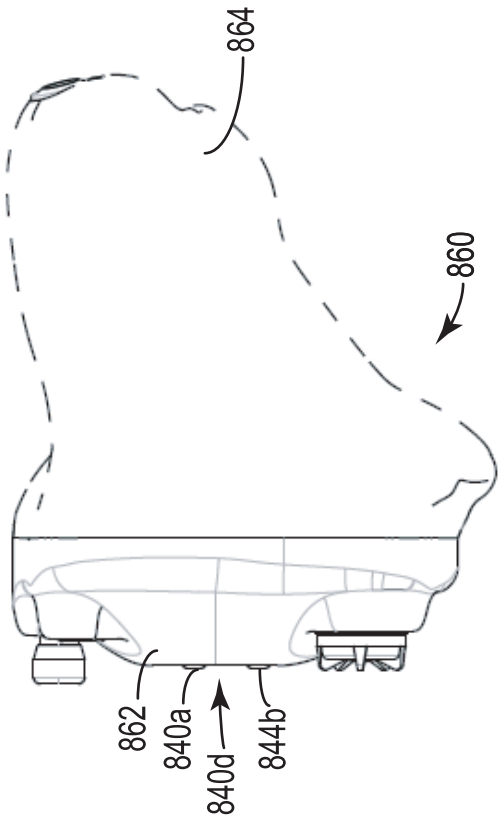


Figure 8I

Figure 8H

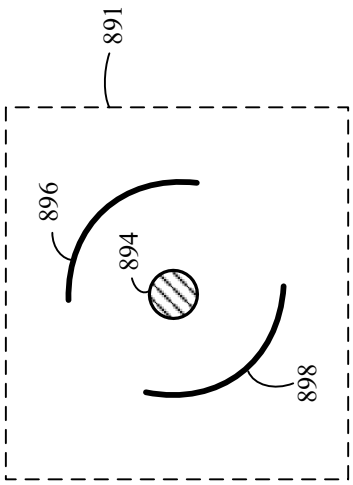


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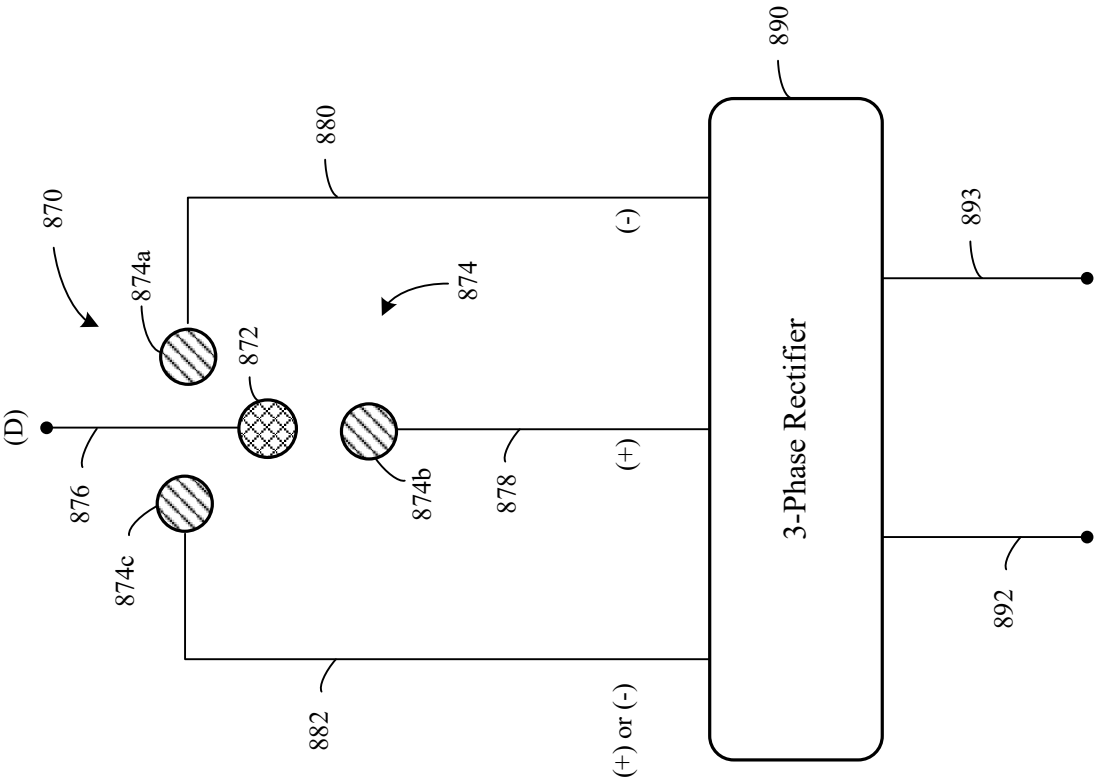


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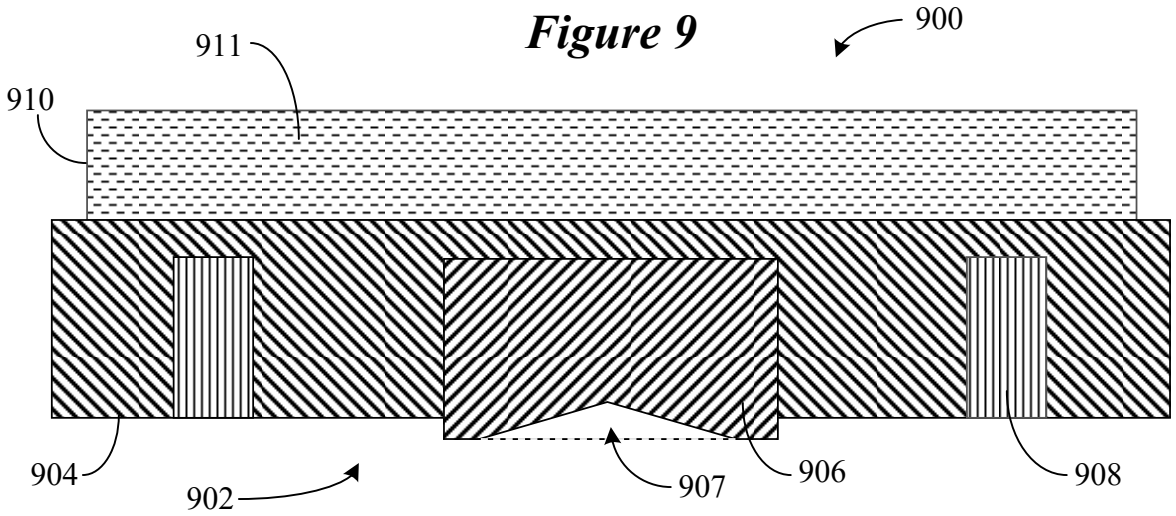


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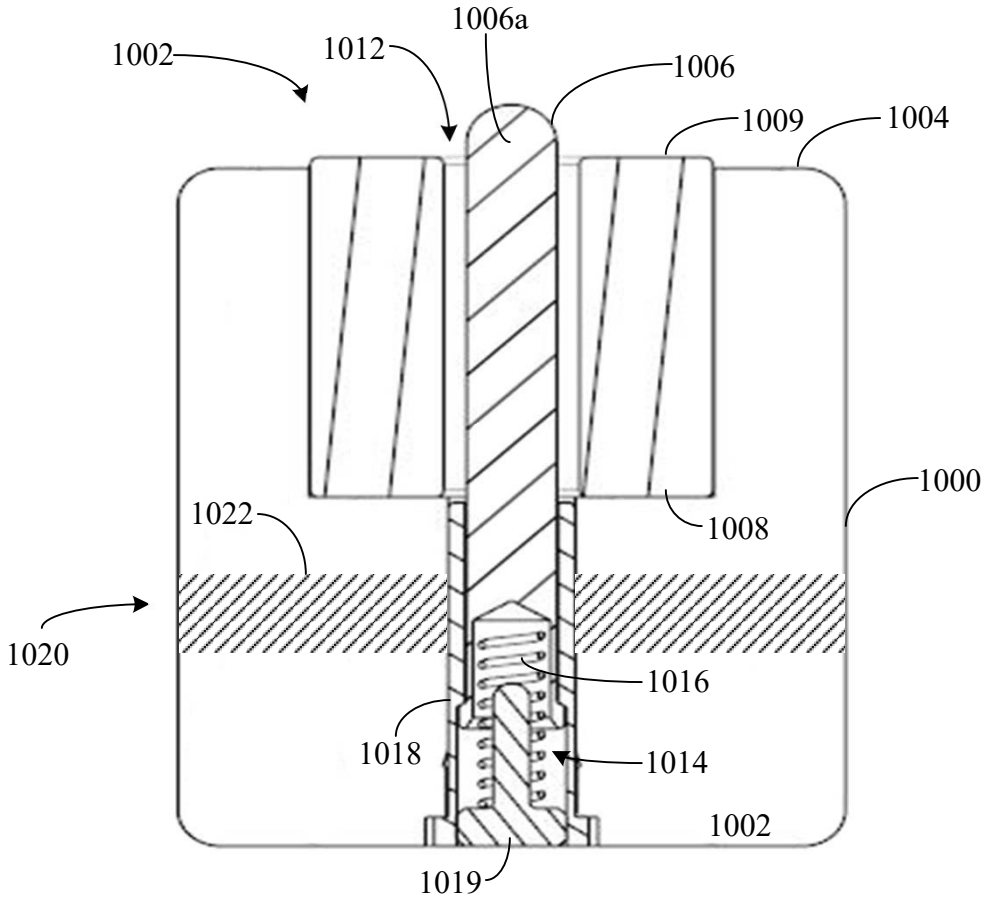


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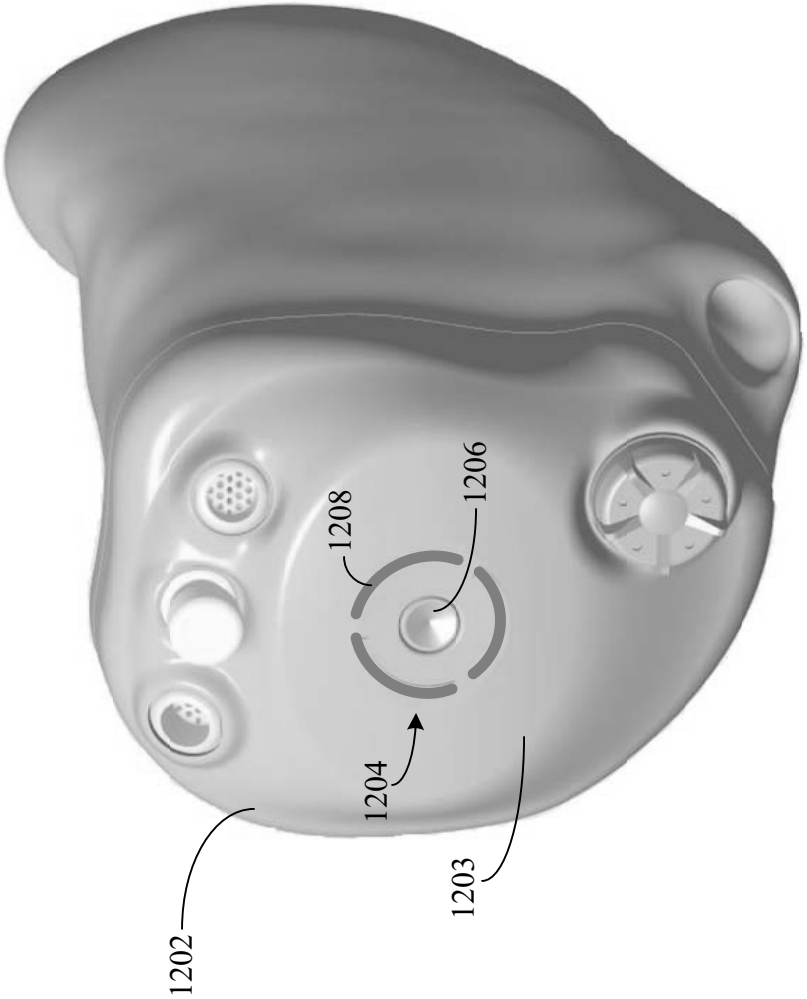


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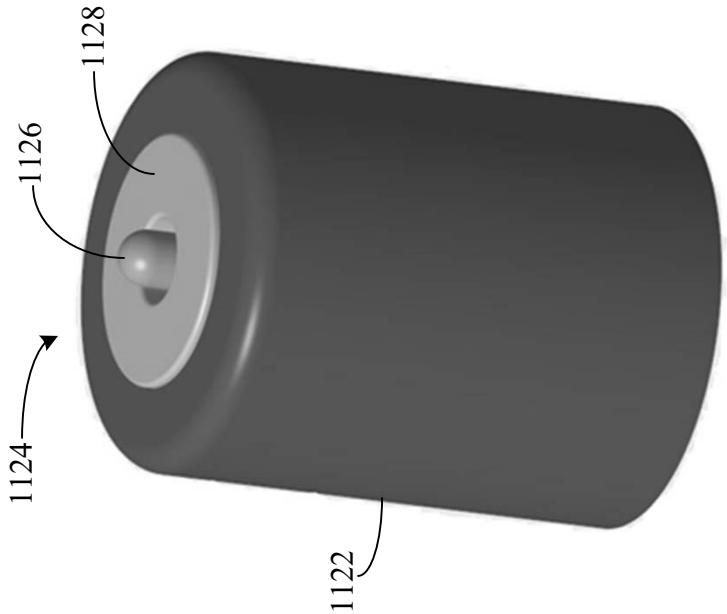


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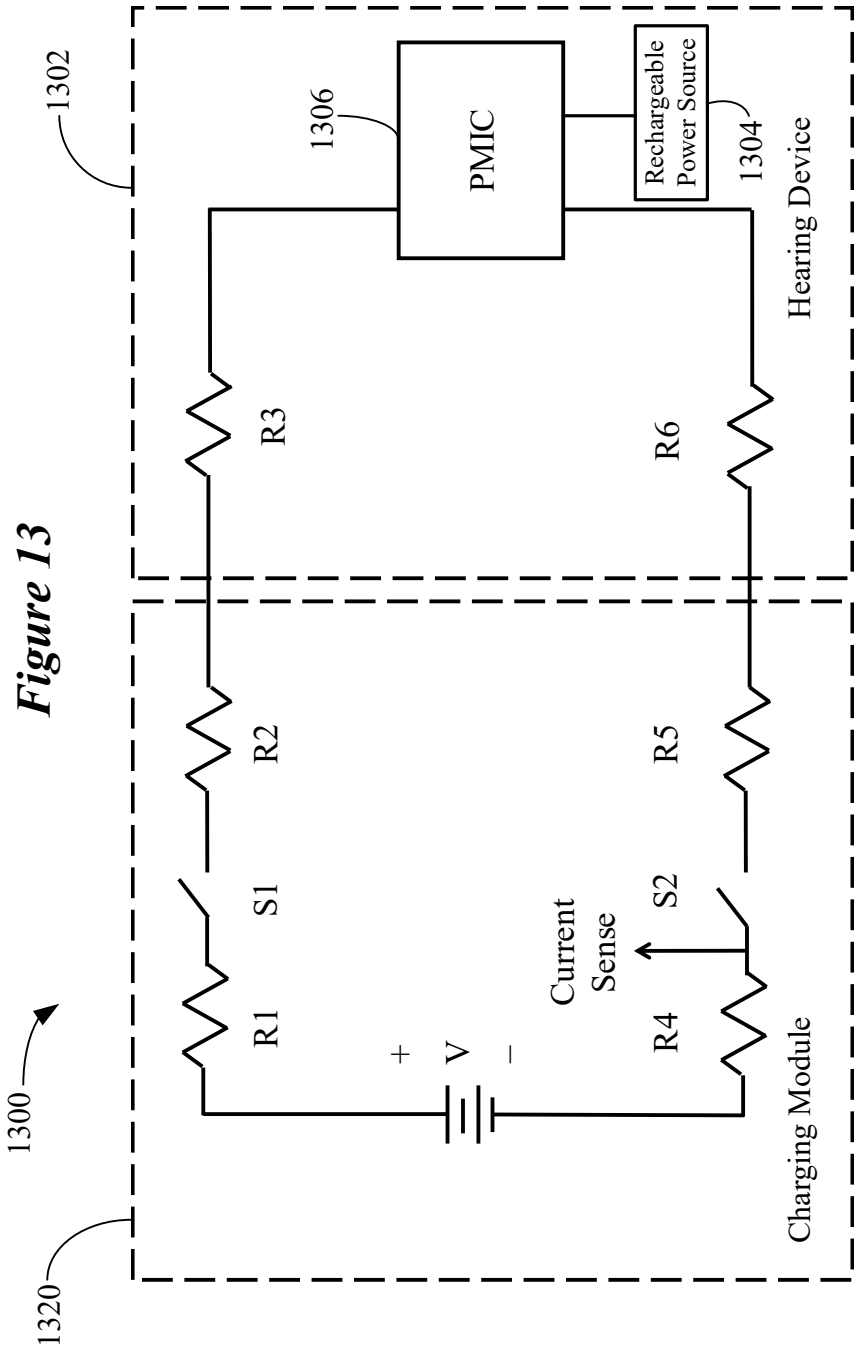

1320
1300
1302
1306
PMIC
Rechargeable Power Source
1304
Hearing Device
Charging Module
R1
S1
R2
R3
R4
S2
R5
R6
+
V
–
Current Sense

Figure 13

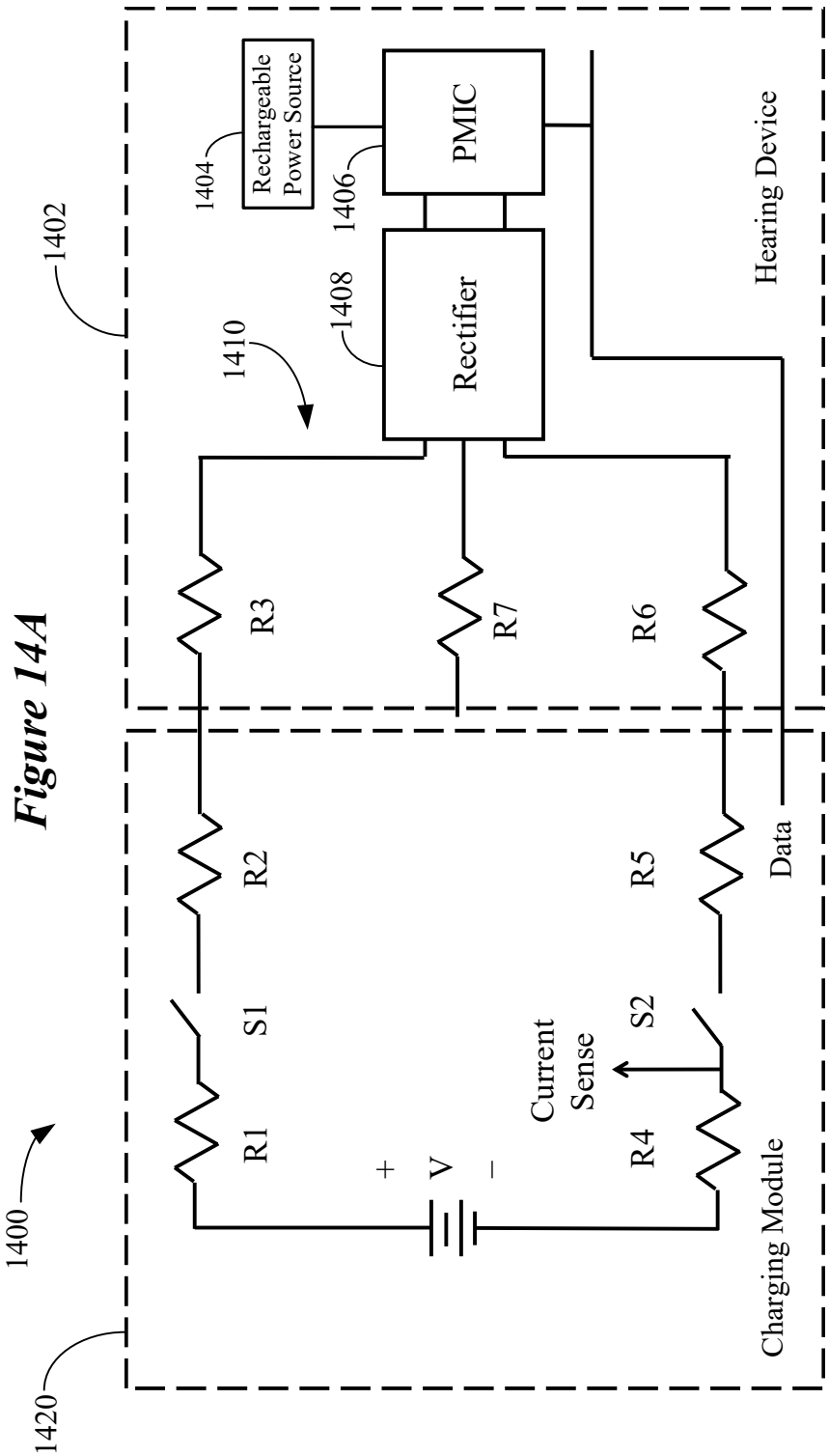


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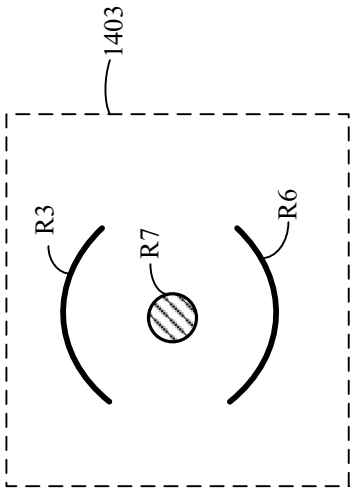


Figure 14B

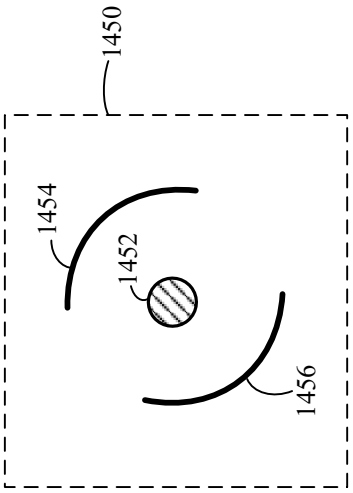


Figure 14D

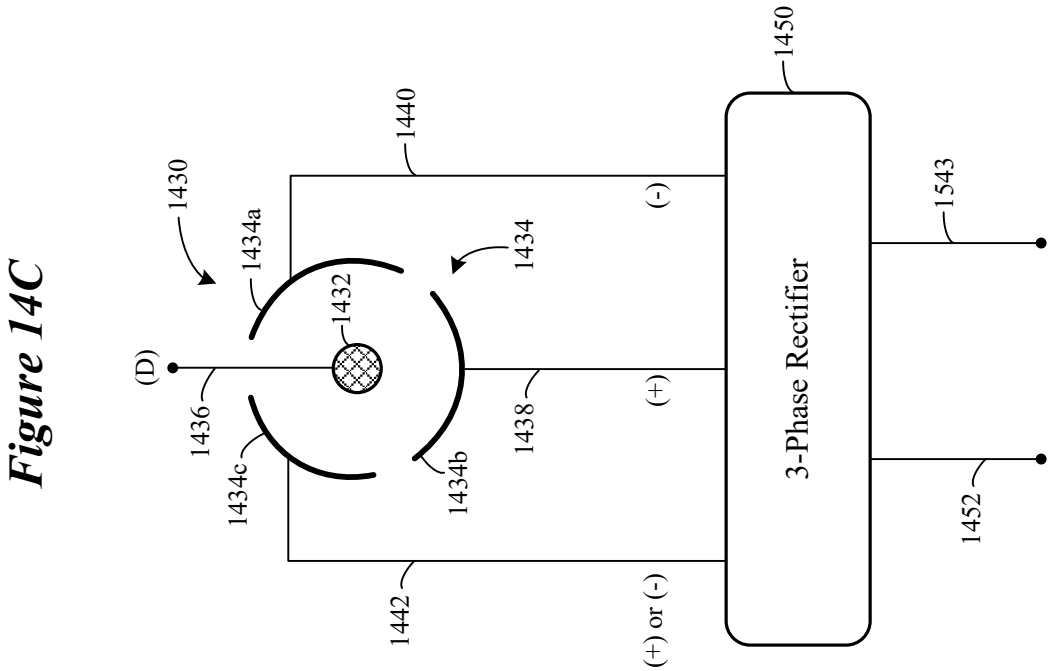


Figure 14C

Figure 15

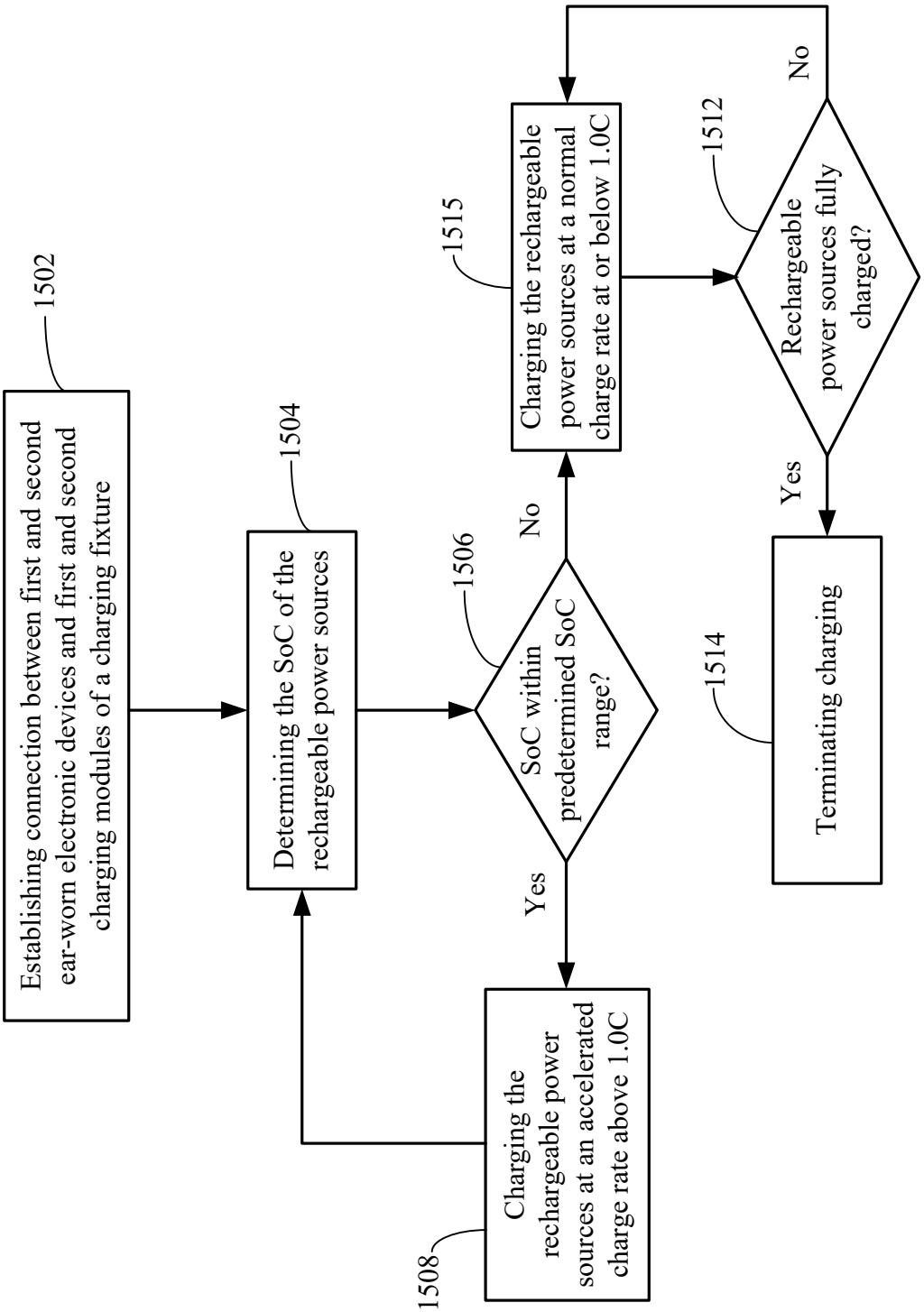

1502
Establishing connection between first and second ear-worn electronic devices and first and second charging modules of a charging fixture
1504
Determining the SoC of the rechargeable power sources
1506
SoC within predetermined SoC range?
Yes
No
1508
Charging the rechargeable power sources at an accelerated charge rate above 1.0C
1515
Charging the rechargeable power sources at a normal charge rate at or below 1.0C
1512
Rechargeable power sources fully charged?
Yes
No
1514
Terminating charging

Figure 16

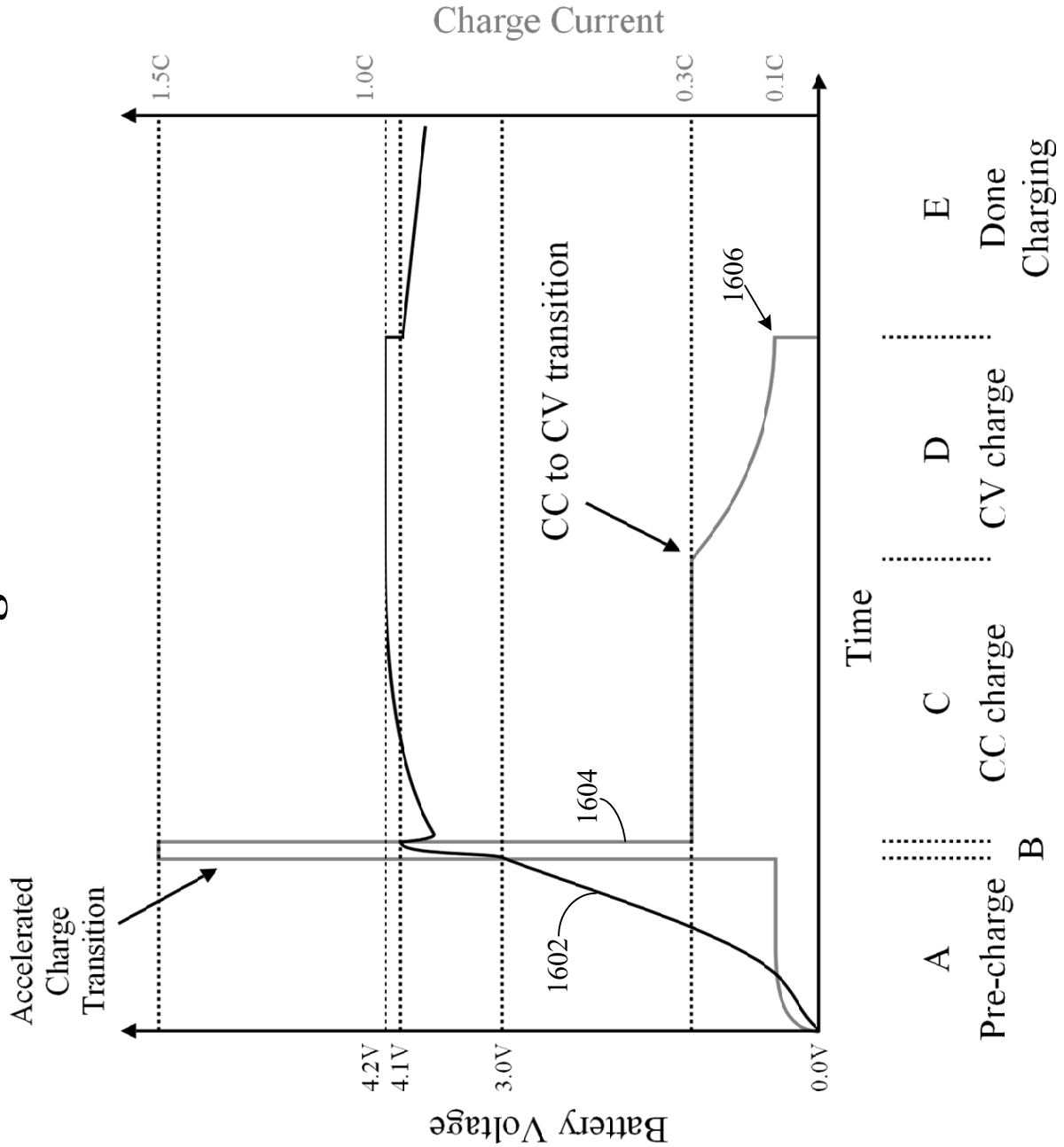

Charge Current
1.5C
1.0C
0.3C
0.1C
Accelerated Charge Transition
CC to CV transition
1602
1604
1606
4.2V
4.1V
3.0V
0.0V
Battery Voltage
Time
A
Pre-charge
B
Accelerated CC charge
C
CC charge
D
CV charge
E
Done Charging

Figure 1A

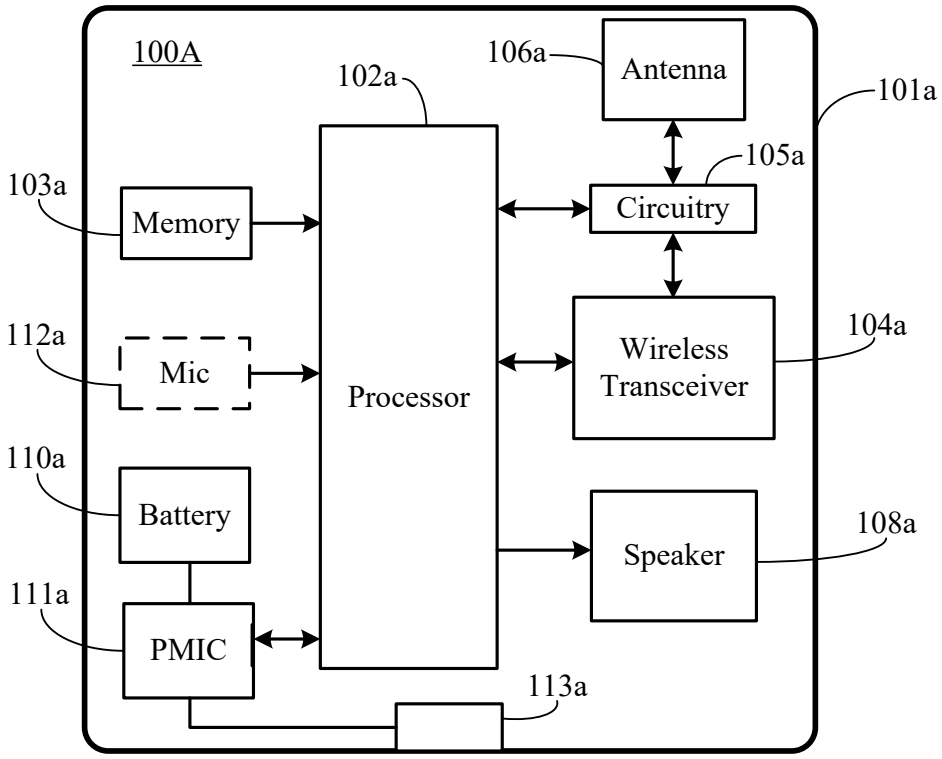
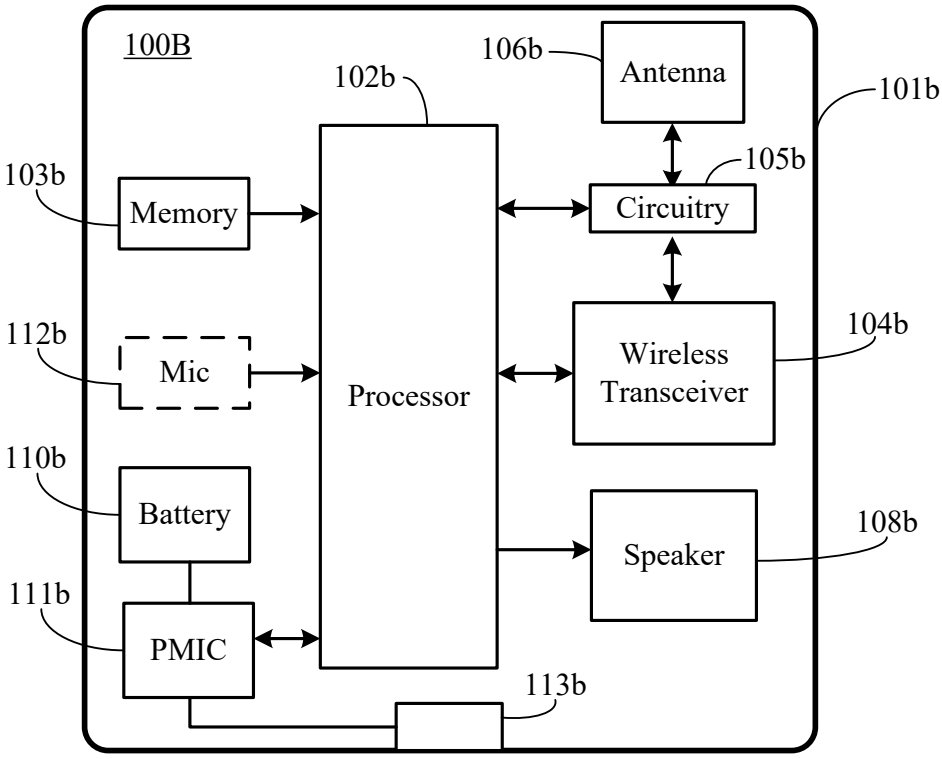


Figure 1B



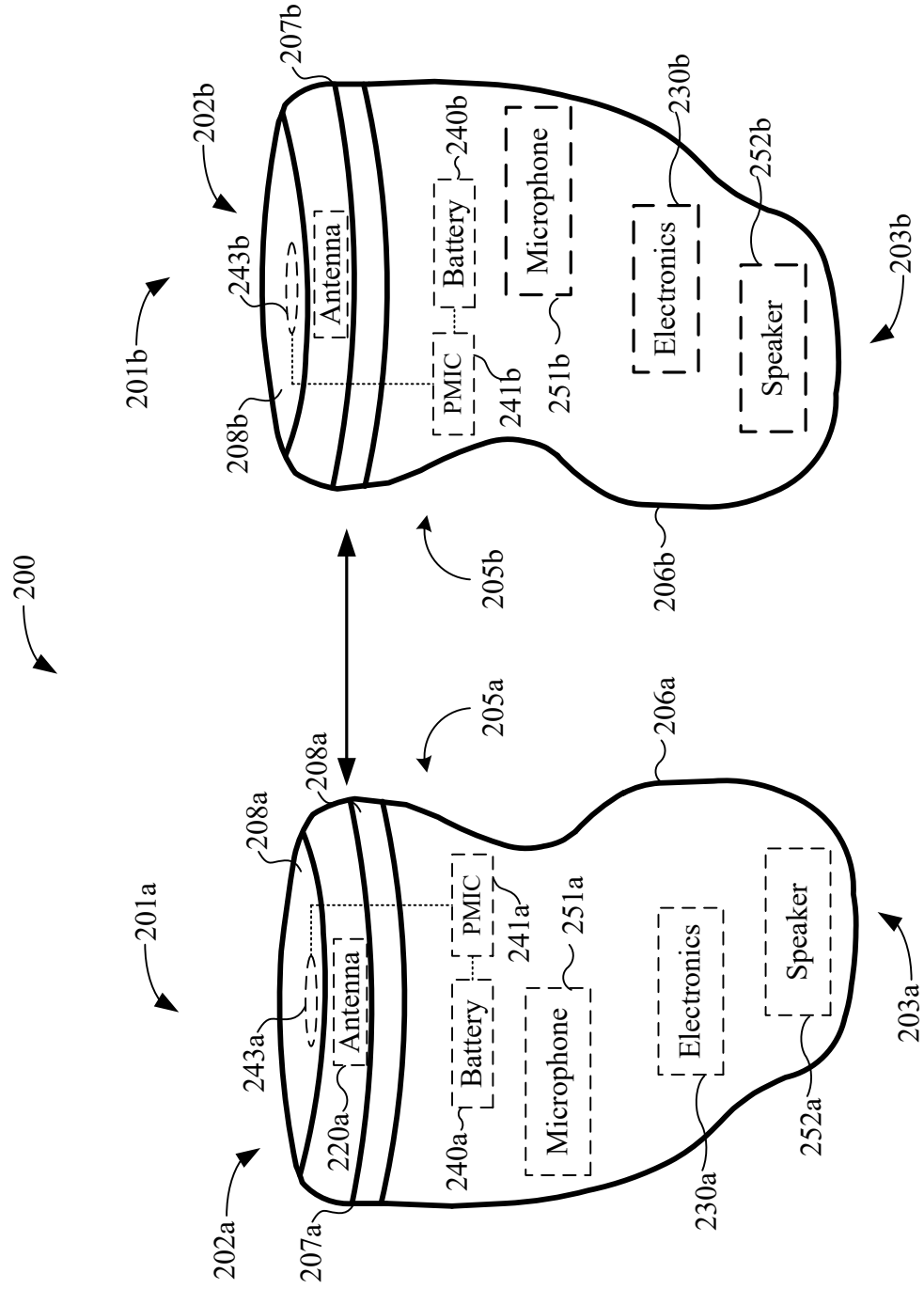

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252b
Antenna
Battery
PMIC
Microphone
Electronics
Speaker

Figure 2A

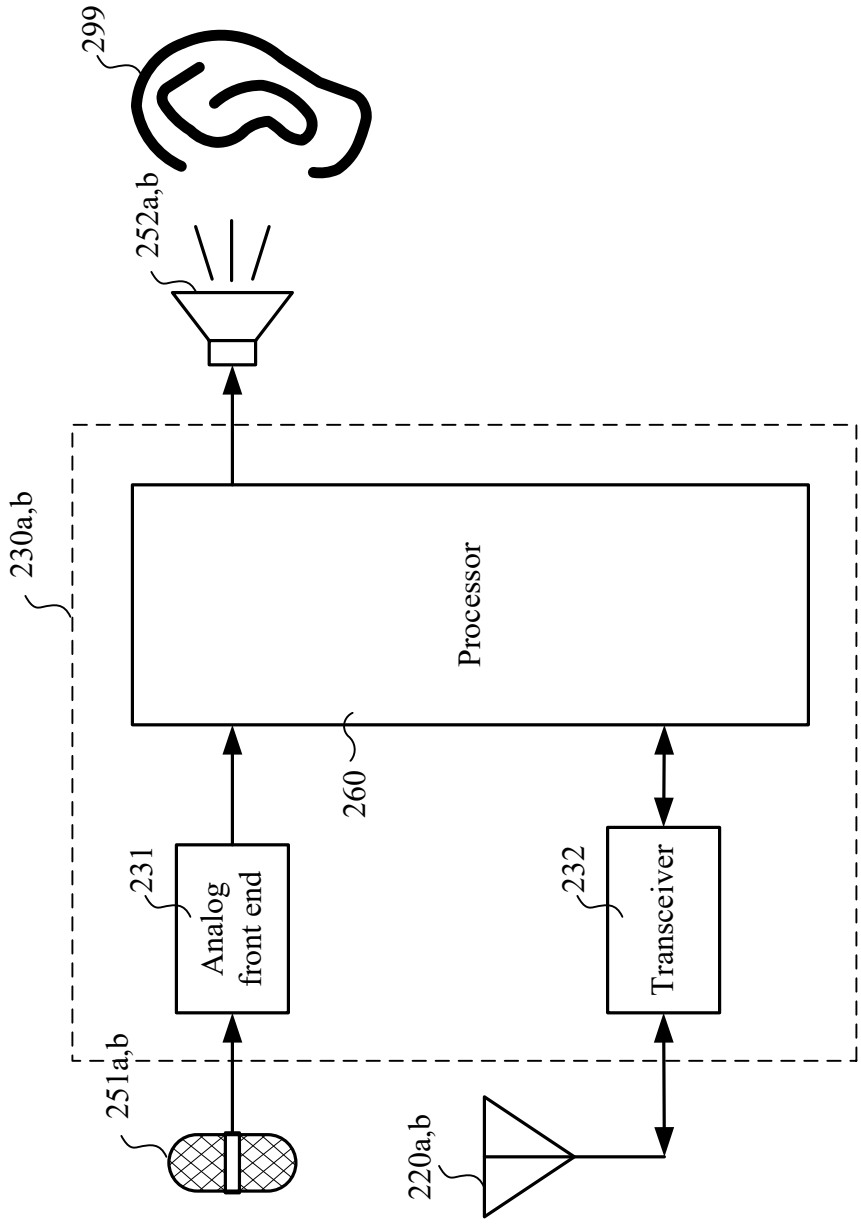

299
252a,b
230a,b
Processor
260
231
Analog
front end
232
Transceiver
251a,b
220a,b

Figure 2B

Figure 3

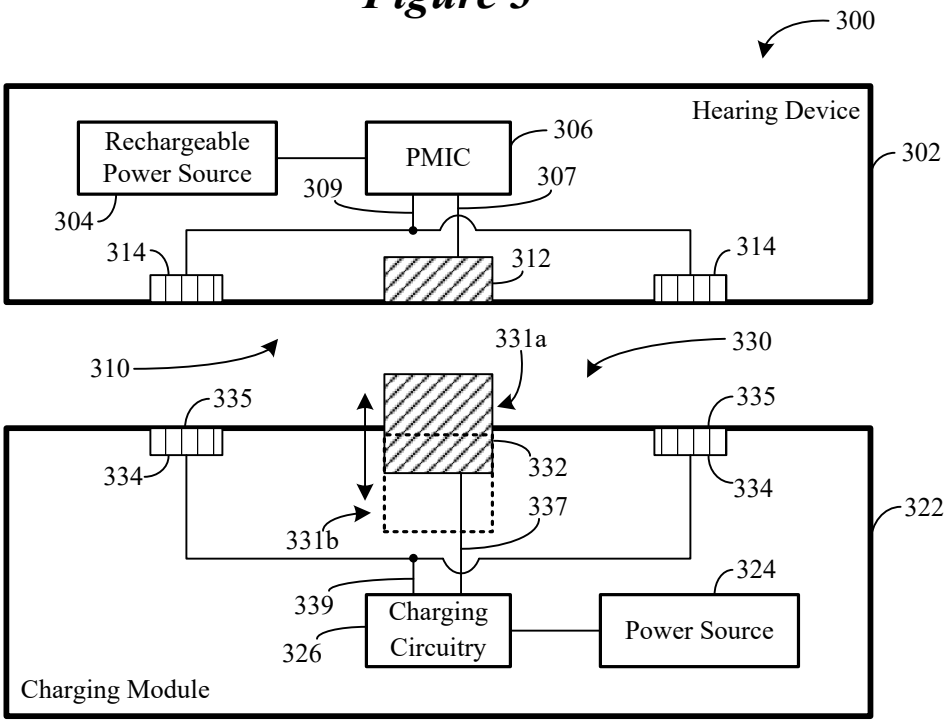


Figure 4

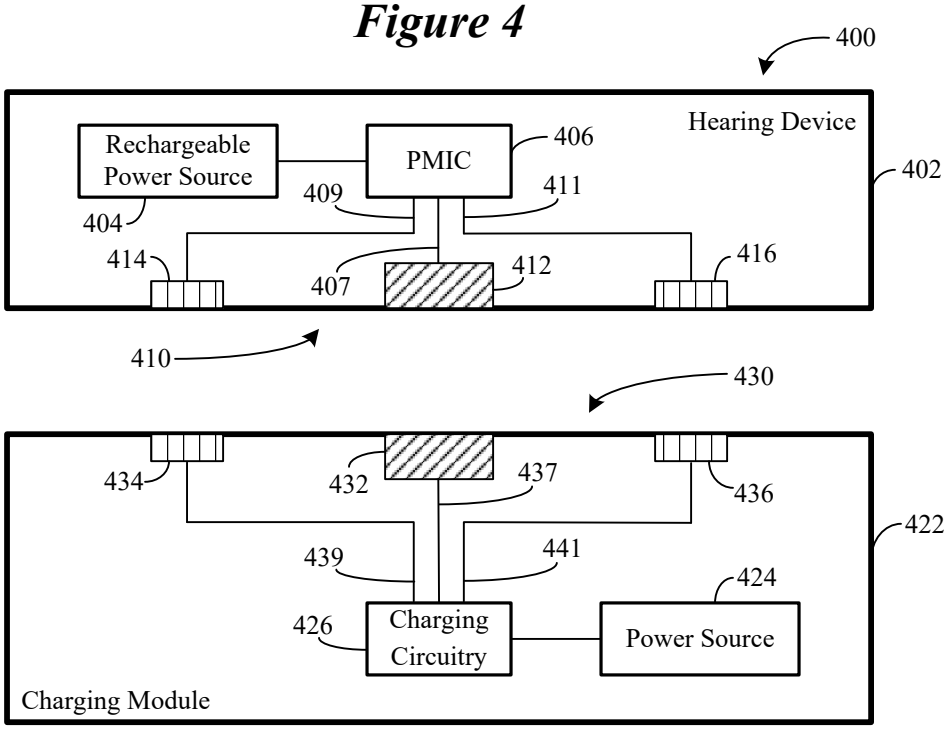


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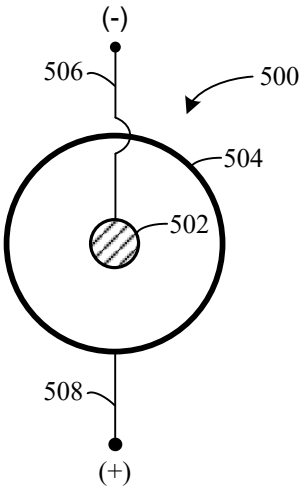


Figure 6

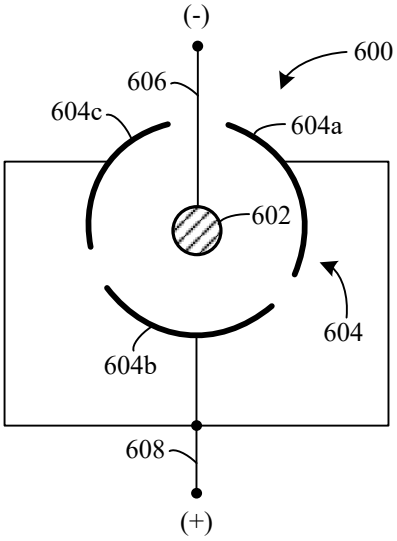


Figure 7

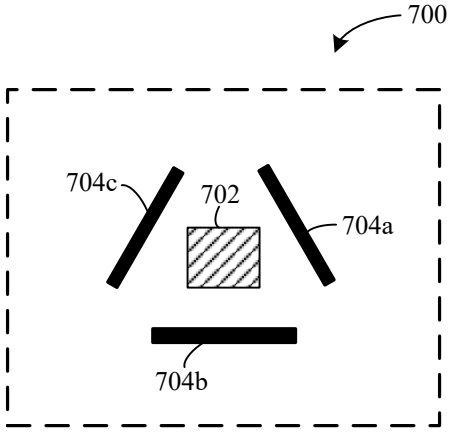


Figure 8A

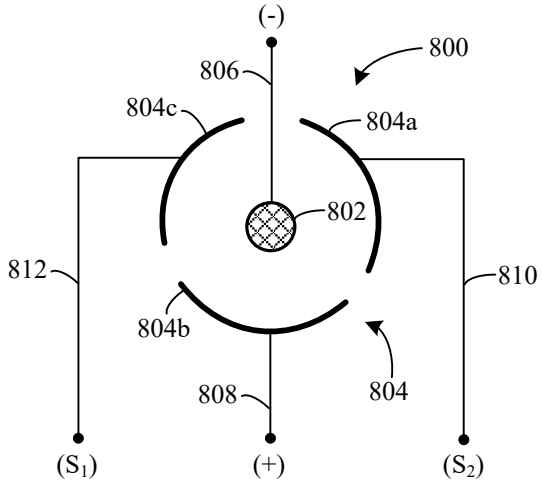


Figure 8B

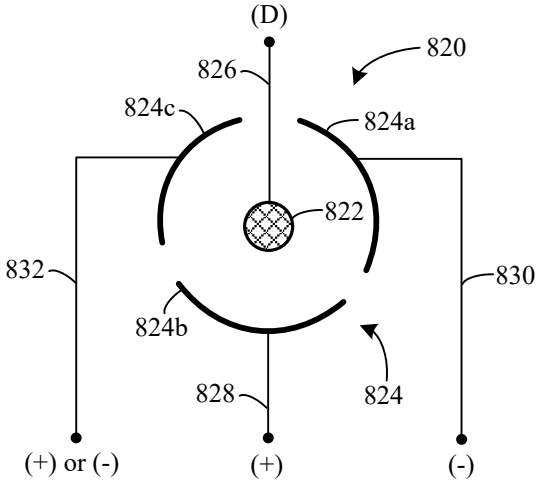


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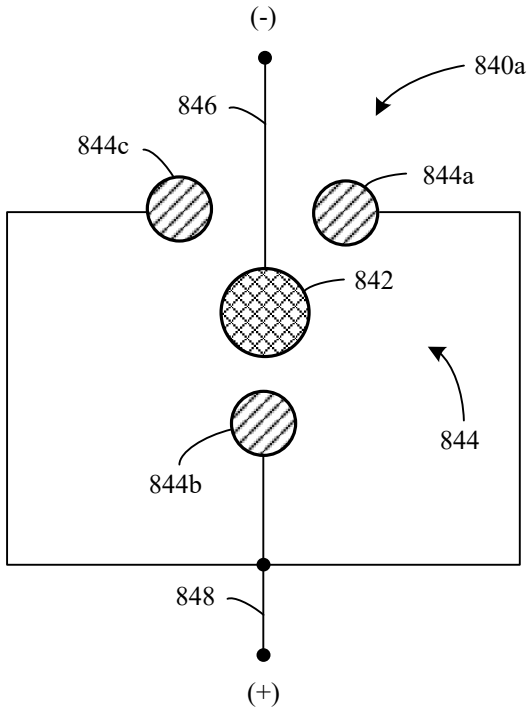


Figure 8D

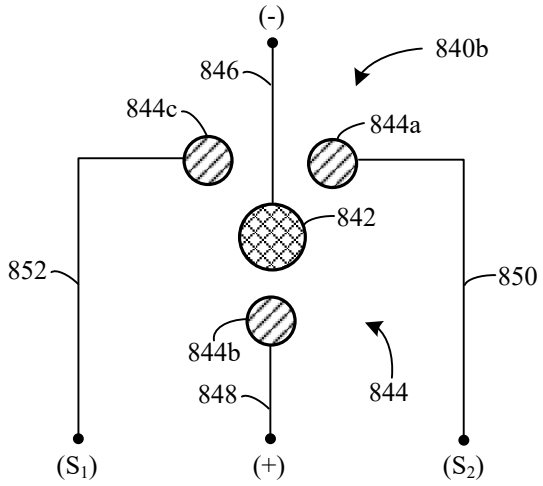
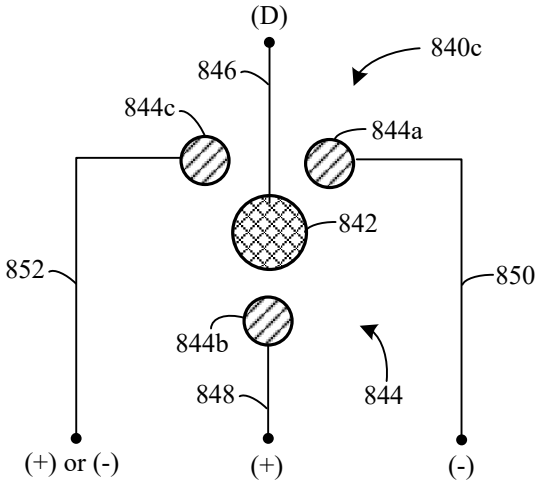


Figure 8E



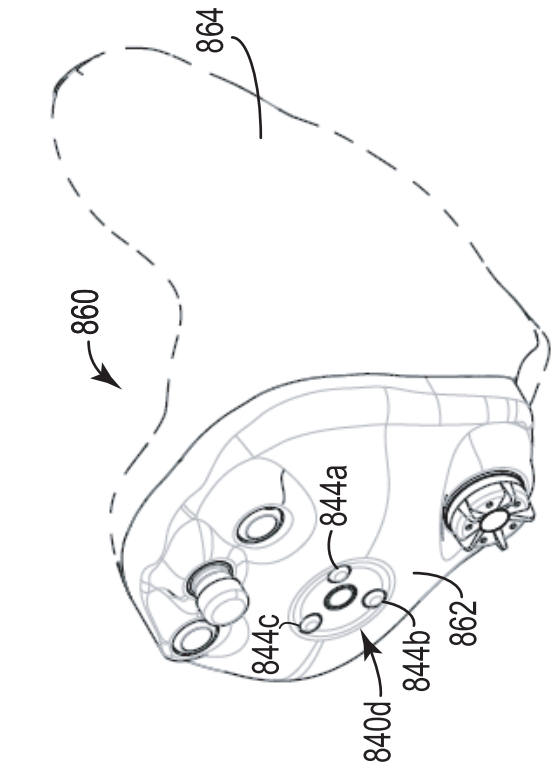


Figure 8G

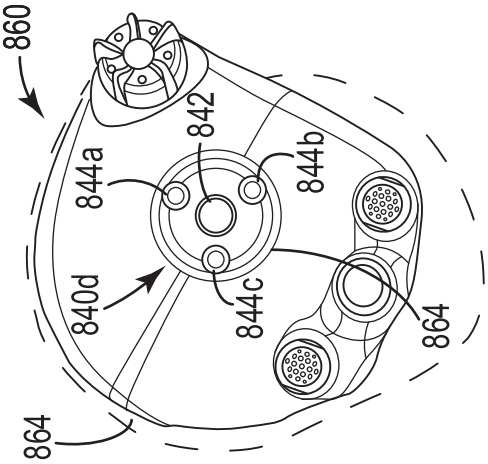


Figure 8I

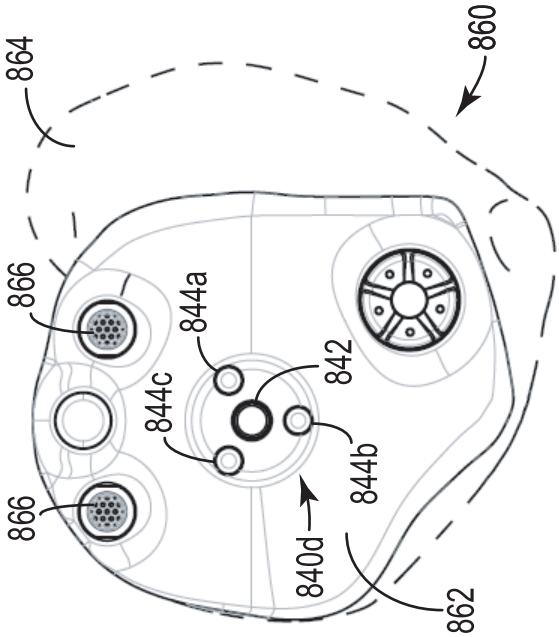


Figure 8F

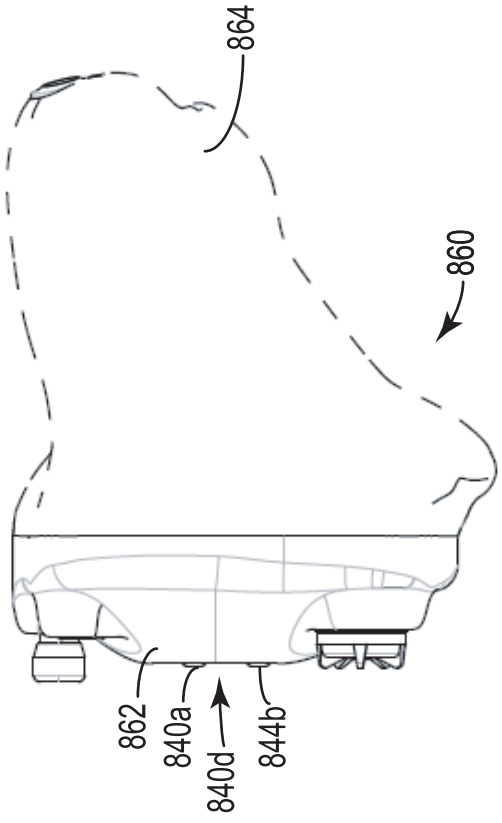


Figure 8H

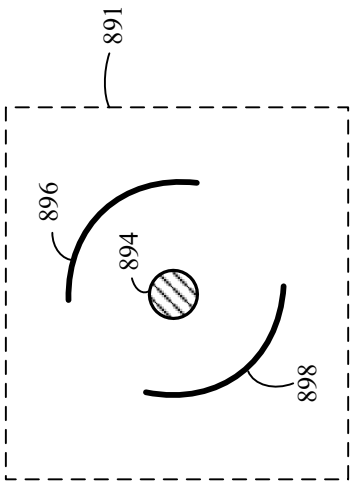


Figure 8K

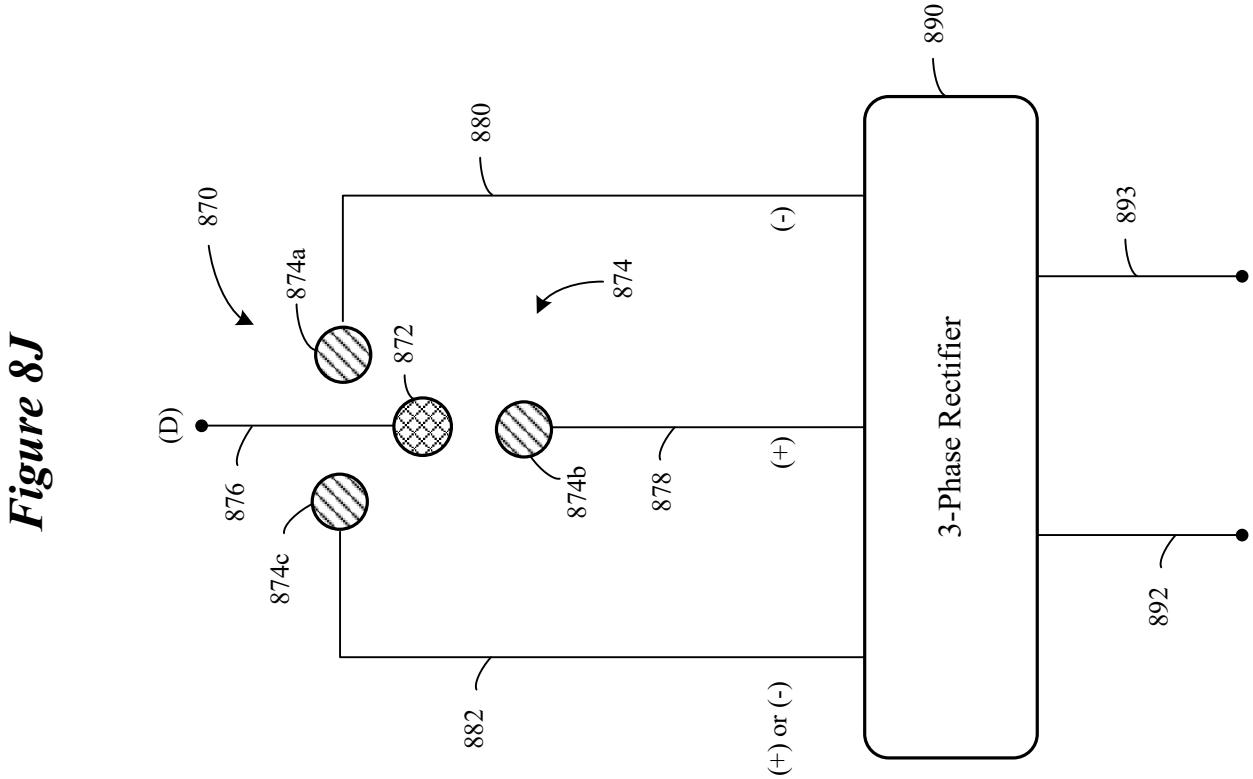


Figure 8J

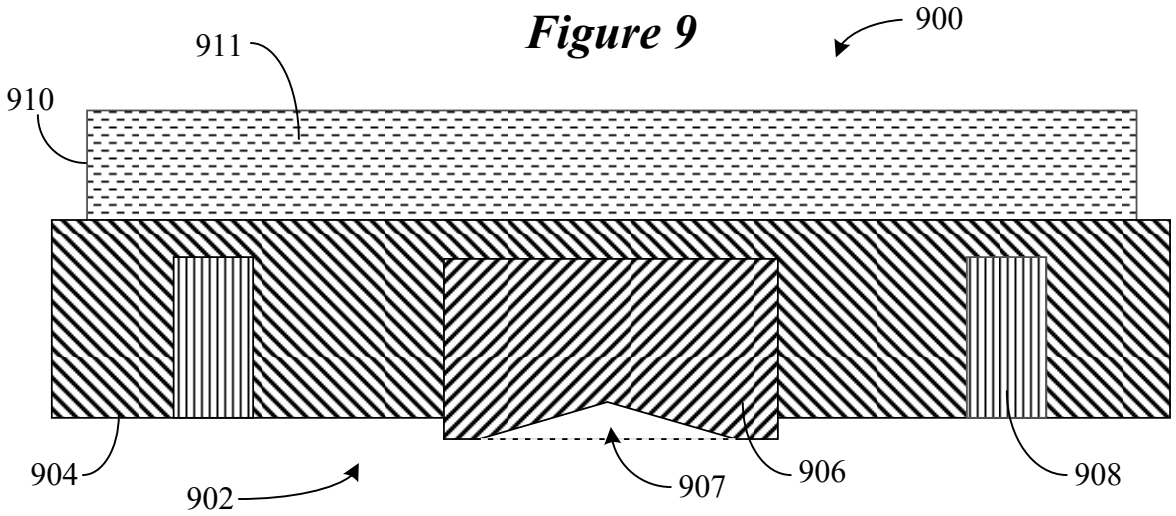


Figure 9

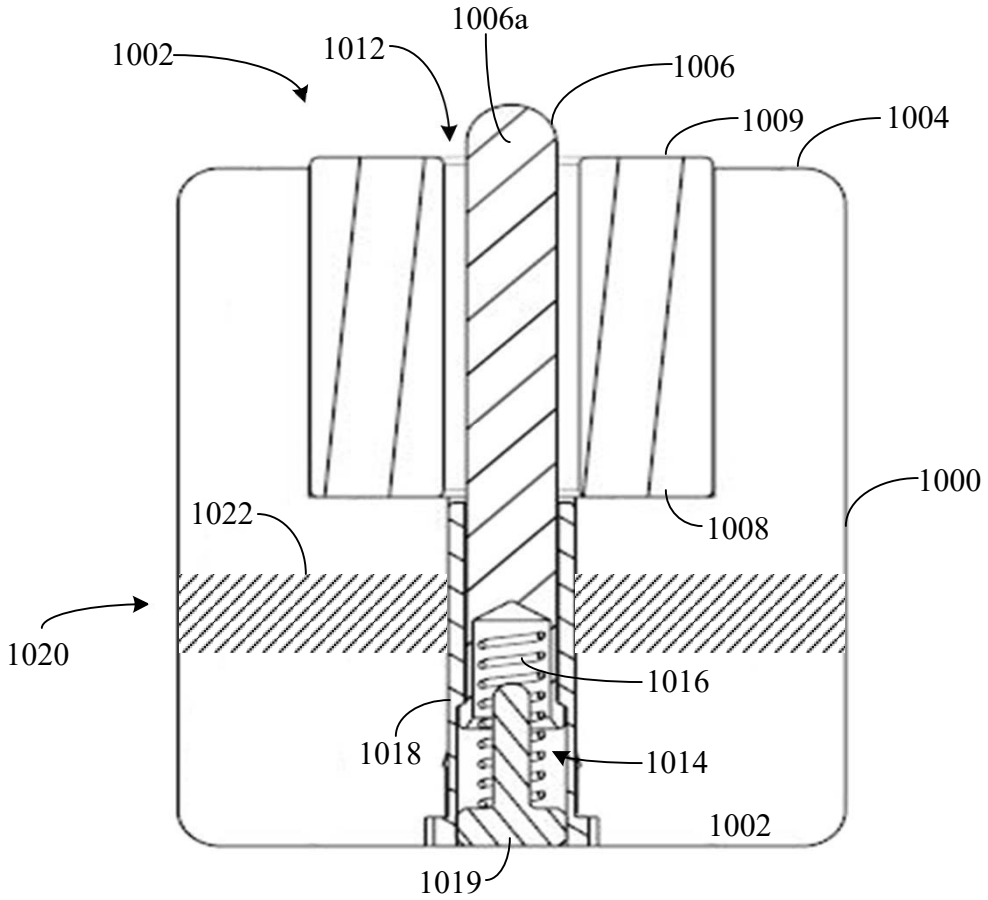


Figure 10

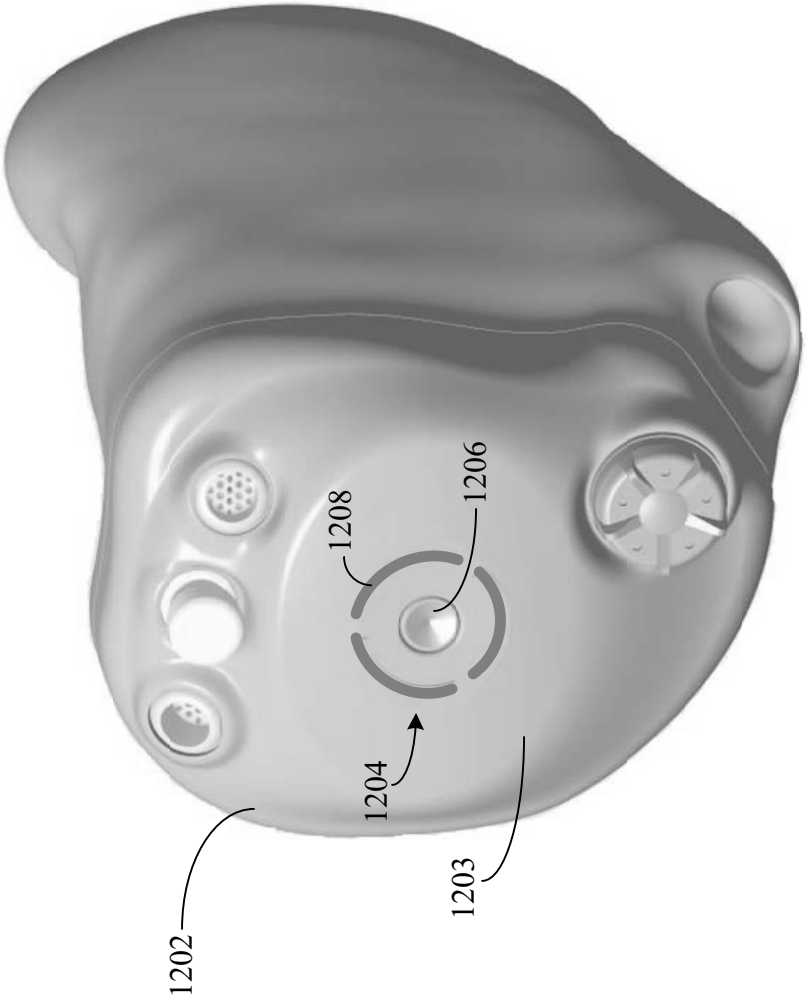


Figure 12

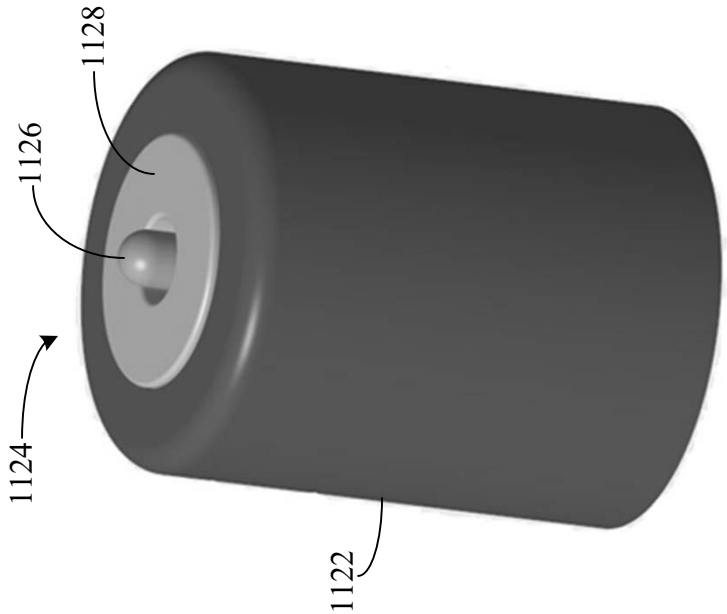


Figure 11

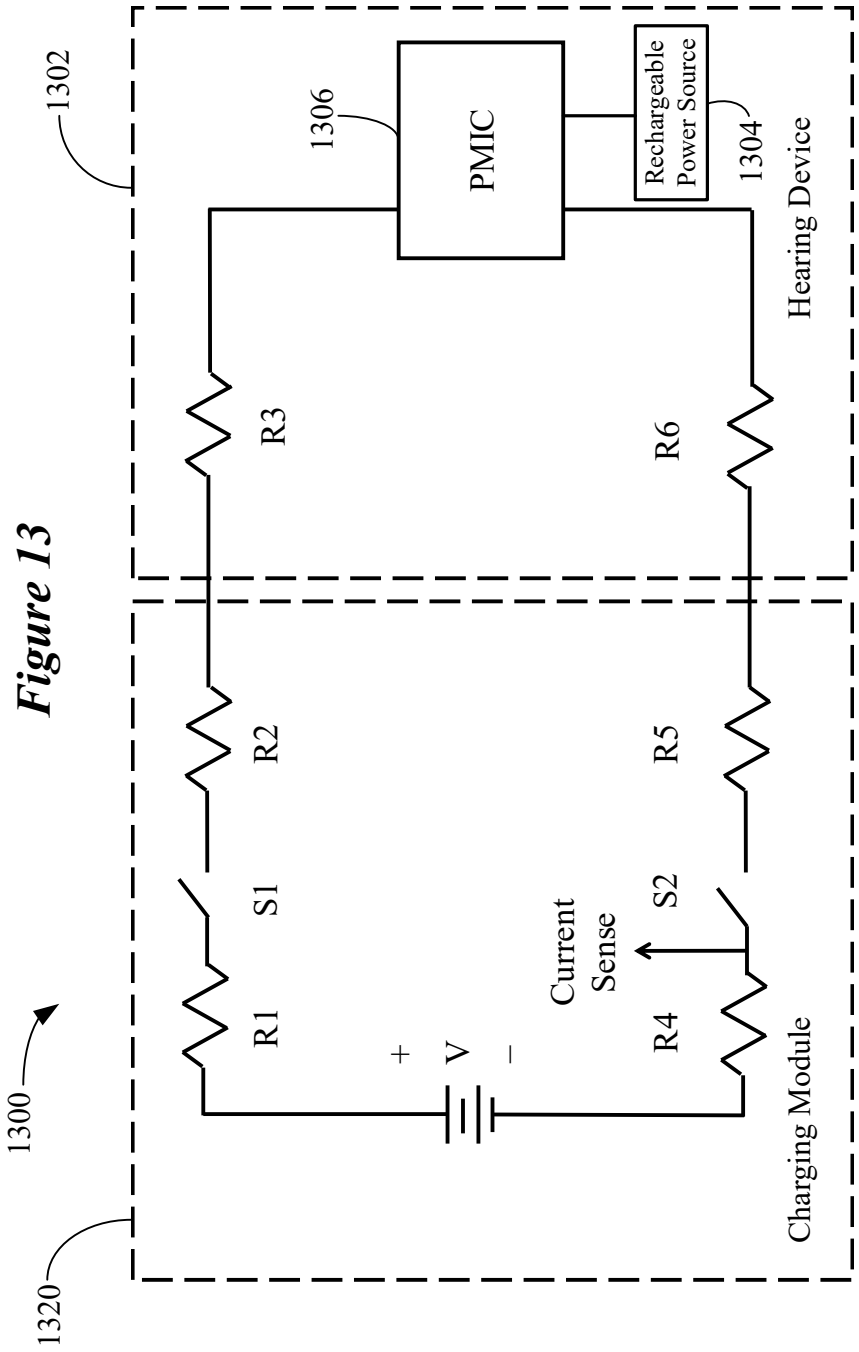

1320
1300
1302
Charging Module
Hearing Device
R1
S1
R2
R3
R4
S2
R5
R6
+
V
–
Current
Sense
1306
PMIC
Rechargeable
Power Source
1304

Figure 13

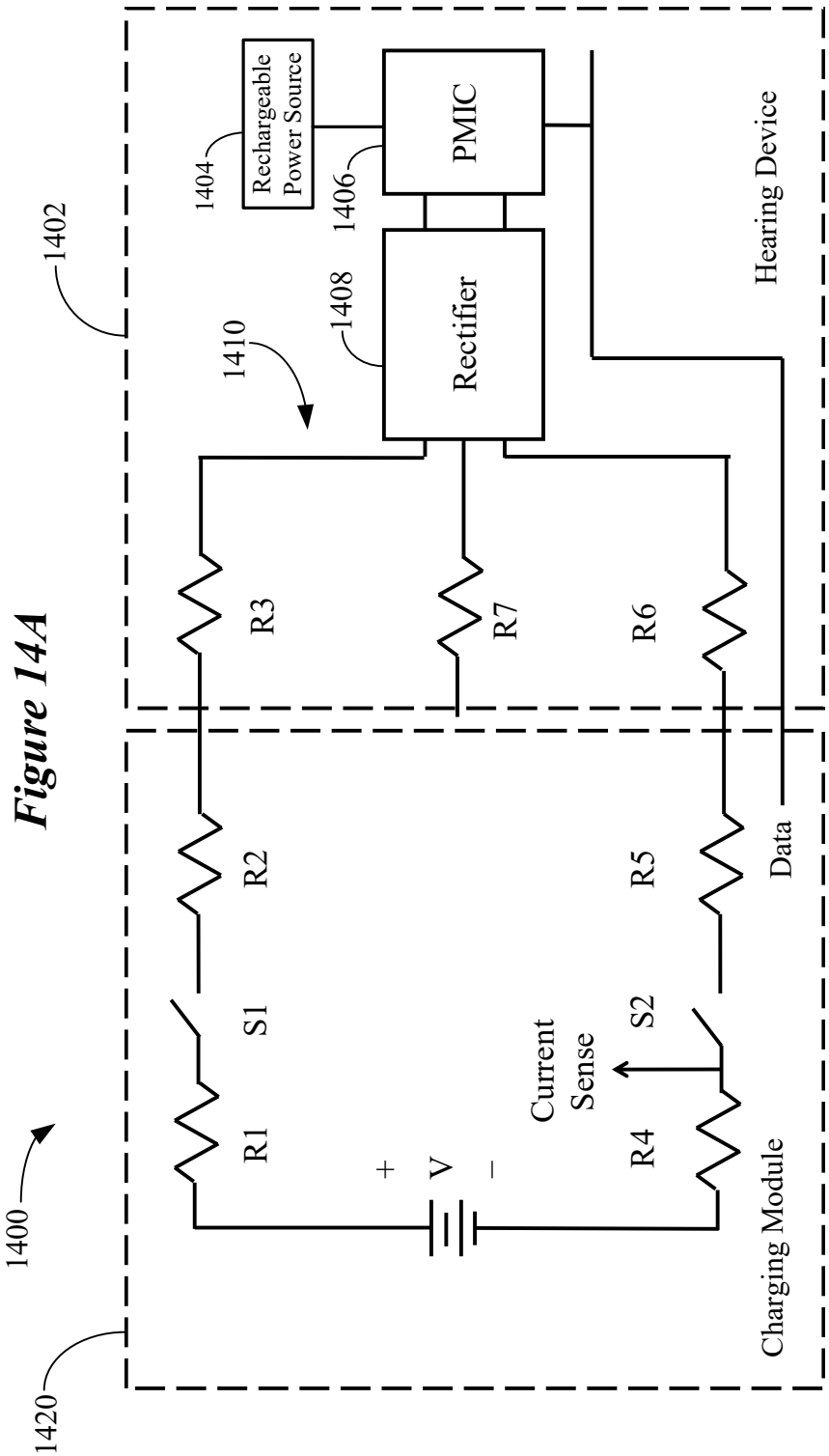


Figure 14A

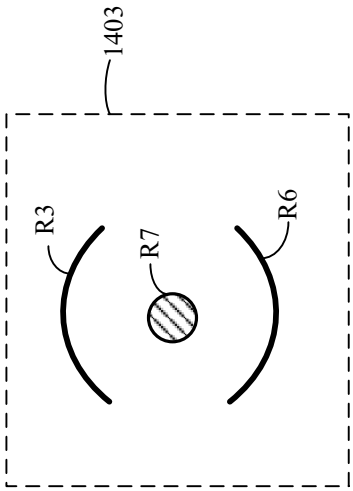


Figure 14B

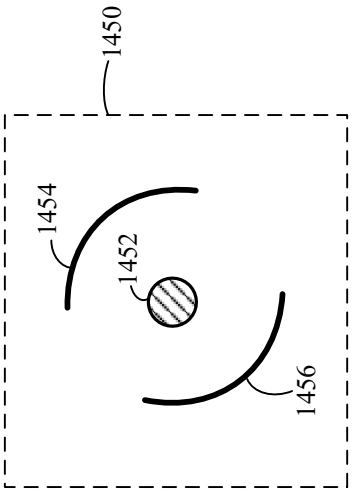


Figure 14D

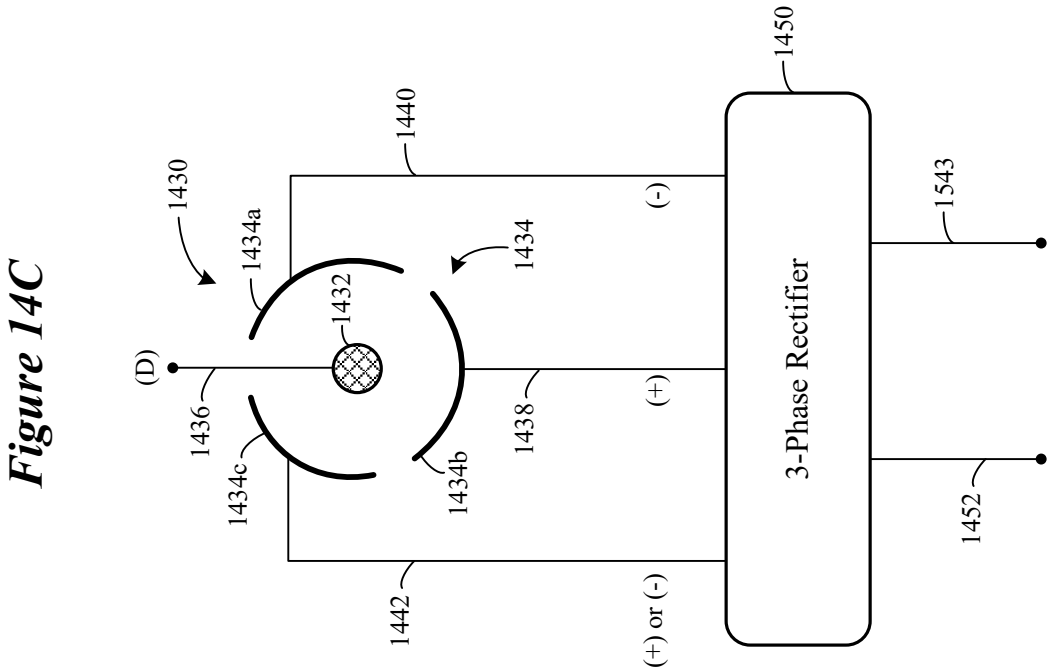


Figure 14C

Figure 15

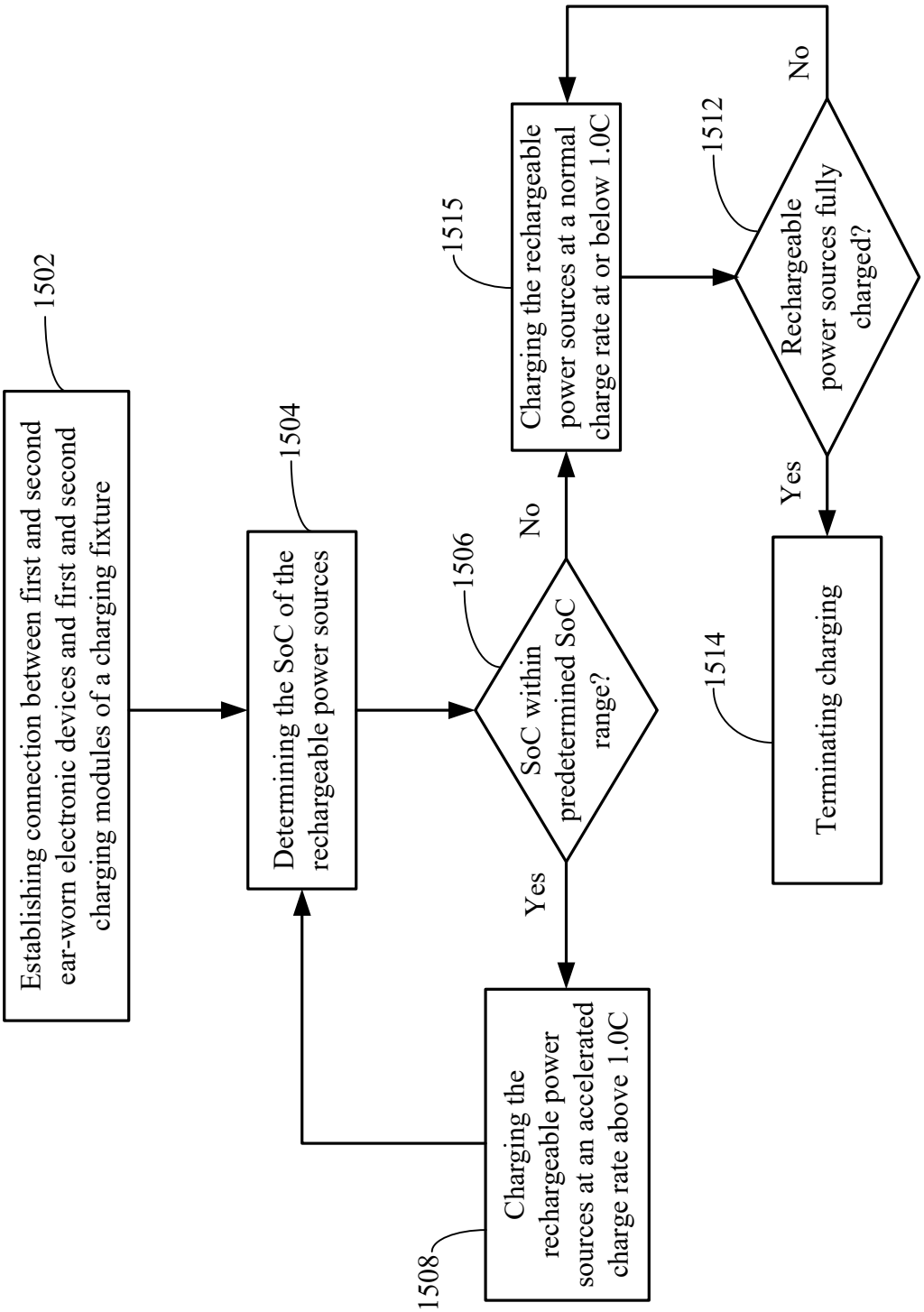
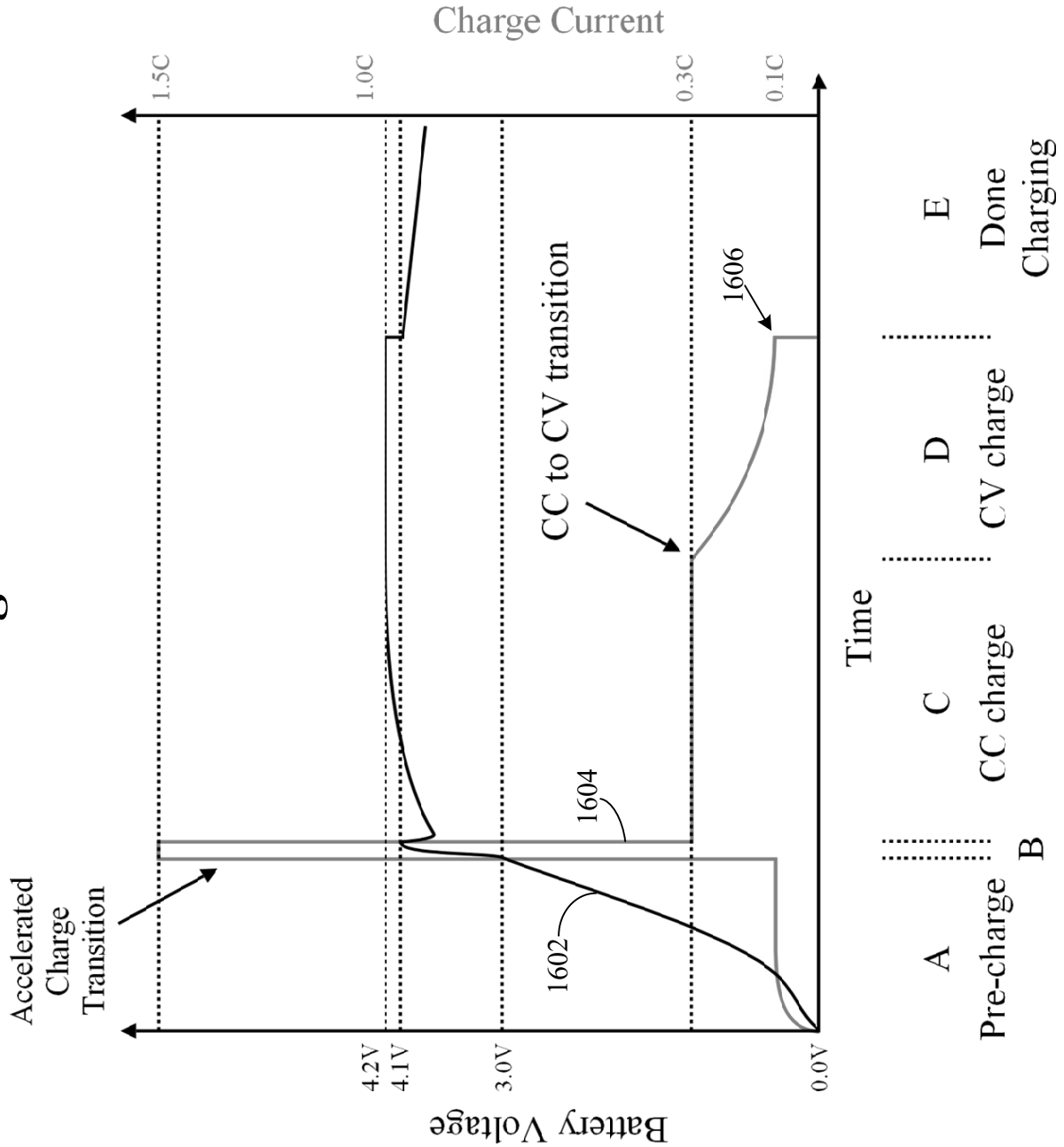

1502
Establishing connection between first and second ear-worn electronic devices and first and second charging modules of a charging fixture
1504
Determining the SoC of the rechargeable power sources
1506
SoC within predetermined SoC range?
Yes
No
1508
Charging the rechargeable power sources at an accelerated charge rate above 1.0C
1515
Charging the rechargeable power sources at a normal charge rate at or below 1.0C
1512
Rechargeable power sources fully charged?
Yes
No
1514
Terminating charging

Figure 16


Charge Current
1.5C
1.0C
0.3C
0.1C
Accelerated Charge Transition
CC to CV transition
1602
1604
1606
4.2V
4.1V
3.0V
0.0V
Battery Voltage
Time
A
Pre-charge
B
Accelerated CC charge
C
CC charge
D
CV charge
E
Done Charging

DocCode - SCORE

Placeholder Sheet for Supplemental Content

Application Number: 18810014 Document Date: 08/20/2024

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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 18/810,014

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	320
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	700
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	800
TOTAL CLAIMS (37 CFR 1.16(i))	1 minus 20 =	* 0			OR	x =	0
INDEPENDENT CLAIMS (37 CFR 1.16(h))	1 minus 3 =	*				x =	0
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1820

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
18/810,014	08/20/2024		1820	ST0806US4/532.000806US04	1	1

CONFIRMATION NO. 7322

142537
MRG/HD - Starkey
c/o Mueting Raasch Group
111 Washington Ave. S., Suite 700
Minneapolis, MN 55401

FILING RECEIPT

OC000000077222417

Date Mailed: 09/04/2024

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

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Inventor(s)

Erik Carlson, Stillwater, MN;
Thomas Burns, Minneapolis, MN;
Kyle Olson, St. Louis Park, MN;
Kent Giswold, Minnetonka, MN;

Applicant(s)

Starkey Laboratories, Inc., Eden Prairie, MN;

Power of Attorney: The patent practitioners associated with Customer Number 142537

Domestic Priority data as claimed by applicant

This application is a CON of 17/553,716 12/16/2021
which is a CON of PCT/US2020/041956 07/14/2020
which claims benefit of 62/876,454 07/19/2019
and claims benefit of 62/943,375 12/04/2019

Foreign Applications for which priority is claimed (You may be eligible to benefit from the Patent Prosecution Highway program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

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Permission to Access Search Results: Yes

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The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 18/810,014**

Projected Publication Date: 12/12/2024

Non-Publication Request: No

Early Publication Request: No

Title

SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE

Preliminary Class

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
18/810,014	08/20/2024	Erik Carlson	ST0806US3/532.000806US04

CONFIRMATION NO. 7322

142537
MRG/HD - Starkey
c/o Mueting Raasch Group
111 Washington Ave. S., Suite 700
Minneapolis, MN 55401

PUBLICATION NOTICE

OC000000081858448

Date Mailed: 12/13/2024

Title:SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE

Publication No.US-2024-0414465-A1
Publication Date:12/12/2024

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In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through Patent Center, the USPTO's electronic patent application filing and management system. The direct link to access this status information is currently https://patentcenter.uspto.gov/. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of Patent Center.

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Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.:	18/810,014	Attorney Docket No.:	ST0806US4 / 532.000806US04
Confirmation No.:	7322	Customer No.:	142537
Filing Date:	August 20, 2024	Examiner Name:	Unassigned
First Named Inventor:	Erik Carlson	Group Art Unit:	Unassigned
Title:	SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

PRELIMINARY AMENDMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

Prior to taking up the above-identified application for examination, please amend the application as follows:

Amendments to the Claims begin on the page entitled “Amendments to the Claims.”

Remarks begin on the page entitled “Remarks.”

Amendments to the Claims

This listing of claims replaces all prior versions, and listings, of claims in the above-identified application:

Listing of Claims

1. (Canceled)

2. (New) A hearing device comprising:

a housing that encloses an internal volume and extends from an internal side to an external side, the housing comprising:

a shell arranged at the internal side, the internal side configured to be inserted in a wearer's ear canal; and

a faceplate arranged at the external side, the external side configured to face away from the wearer;

an electrode arrangement disposed in an outer surface of the faceplate, the electrode arrangement comprising:

a central contact; and

an annular ring contact surrounding the central contact or a plurality of contacts surrounding the central contact; and

circuitry disposed in the internal volume and coupled to the electrode arrangement.

3. (New) The hearing device of claim 2, further comprising one or more microphone ports disposed in the outer surface of the faceplate.

4. (New) The hearing device of claim 2, further comprising a receiver outlet disposed in the shell**.**

5. (New) The hearing device of claim 2, wherein the electrode arrangement comprises the plurality of contacts.

6. (New) The hearing device of claim 5, wherein each of the plurality of contacts is arranged the same distance from the central contact as each other contact of the plurality of contacts.

7. (New) The hearing device of claim 5, wherein the plurality of contacts defines a circle.

8. (New) The hearing device of claim 5, wherein each of the plurality of contacts comprises a curvilinear, annular, oval, elliptical, or polygonal shape.

9. (New) The hearing device of claim 5, wherein the plurality of contacts comprises three arcuate contacts each arranged at substantially the same distance from the central contact.

10. (New) The hearing device of claim 5, wherein the central contact defines a cathode contact and at least one contact of the plurality of contacts defines an anode contact.

11. (New) The hearing device of claim 2, wherein the electrode arrangement comprises the annular ring contact surrounding the central contact.

12. (New) The hearing device of claim 2, wherein the circuitry comprises charging circuitry, and wherein the electrode arrangement is coupled to the charging circuitry.

13. (New) The hearing device of claim 2, wherein the electrode arrangement is configured to communicate power and one or more information signals.

14. (New) A system comprising:

a hearing device comprising:

a housing that encloses an internal volume and extends from an internal side to an external side, the housing comprising:

a shell arranged at the internal side, the internal side configured to be inserted in a wearer's ear canal; and

a faceplate arranged at the external side, the external side configured to face away from the wearer;

an electrode arrangement disposed in an outer surface of the faceplate, the electrode arrangement comprising:

a central contact; and

an annular ring contact surrounding the central contact or a plurality of contacts surrounding the central contact; and

circuitry disposed in the internal volume and coupled to the electrode arrangement; and

a charging module comprising a charging interface that comprises:

a central charging contact; and

an annular ring charging contact or a plurality of charging contacts surrounding the central contact.

15. (New) The system of claim 14, wherein the hearing device further comprises:

one or more microphone ports disposed in the outer surface of the faceplate; and

a receiver outlet disposed in the shell.

16. (New) The system of claim 14, wherein the electrode arrangement of the hearing device comprises the plurality of contacts.

17. (New) The system of claim 16, wherein each of the plurality of contacts is arranged the same distance from the central contact as each other contact of the plurality of contacts.

18. (New) The system of claim 16, wherein the plurality of contacts defines a circle.

19. (New) The system of claim 16, wherein the plurality of contacts comprises three arcuate contacts each arranged at substantially the same distance from the central contact.

20. (New) The system of claim 14, wherein the electrode arrangement of the hearing device comprises the annular ring contact surrounding the central contact.

21. (New) The system of claim 14, wherein the hearing device comprises a first charging interface comprising the electrode arrangement, wherein the circuitry of the hearing device comprises charging circuitry coupled to the electrode arrangement, wherein the charging interface of the charging module defines a second charging interface configured to detachably couple with the first charging interface of the hearing device;

wherein the charging module further comprises charging circuitry coupled to the second charging interface and configured to charge a rechargeable power source of the hearing device that is coupled to the first charging interface.

Remarks

Please enter and consider new claims 2–21 as set forth above. Further, please cancel claim 1. The pending claims are, therefore, claims 2–21.

Conclusion

Applicant invites the Examiner to contact the undersigned Applicant's Representative at the telephone number listed below if there are any questions regarding this Preliminary Amendment or if doing so may advance prosecution of this application.

Respectfully submitted by

Mueting Raasch Group
111 Washington Ave. S., Suite 700
Minneapolis, MN 55401
Phone: (612) 305-1220
Facsimile: (612) 305-1228

August 19, 2025
Date

/Jay R. Pralle/
Jay R. Pralle
Reg. No. 52131
Direct Dial: (612) 305-0083

UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
www.uspto.gov

ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/810,014	**08/19/2025 11:02:48 AM Z ET**	**ST0806US3/532.000806US04**

Title of Invention

SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	7322	FILED BY	Candace Berling
PATENT CENTER #	71916716	FILING DATE	08/20/2024
CUSTOMER #	142537	FIRST NAMED INVENTOR	Erik Carlson
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Jay Pralle

Documents

TOTAL DOCUMENTS: 3

DOCUMENT		PAGES	DESCRIPTION	SIZE (KB)
2025-08-19-Preliminary Amendment.pdf		6	-	106 KB
2025-08-19-Preliminary Amendment-A.PE.pdf	(1-1)	1	Preliminary Amendment	76 KB
2025-08-19-Preliminary Amendment-CLM.pdf	(2-5)	4	Claims	99 KB
2025-08-19-Preliminary Amendment-REM.pdf	(6-6)	1	Applicant Arguments/Remarks Made in an Amendment	94 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)

2025-08-19-Preliminary Amendment.pdf	A69F55B89195F75AAB327BED1D9630992AEBB8FF15FB83A73 6747E4F1256C0C8857A5936EAED915B19E3434F3F8AC42B07 54CF8E09C35761721284637FCB1C4D
2025-08-19-Preliminary Amendment-A.PE.pdf	6E5780C2F96E4518E307BB42805FDF1C5B998280C133131E64 93FCA6217570C2C1A9DCB517C6B343C0FD4DB671D9FF22C9 32B9BAB1FBC6AE5D02ACE24AD50FF4
2025-08-19-Preliminary Amendment-CLM.pdf	3F222A18E87FD94EBA0429A21ED4CF1827E1FB4D81AE4580 D74A2EDD2505134D92C358FAA98DC8BA009E4E805E17C356 E8B68967FDAE74D494EDD18E0229DD45
2025-08-19-Preliminary Amendment-REM.pdf	63CC3E74AFBF2ABE61FF9E0D727AB53B67B277A7E9BD73ED 52E3173454DA896E500889AEF480578CF30AB81EB15194D36 D4E2D9D5073F068129E96D685AECBF2

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New International Application Filed with the USPTO as a Receiving Office

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.:	18/810,014	Attorney Docket No.:	ST0806US4 / 532.000806US04
Confirmation No.:	7322	Customer No.:	142537
Filing Date:	August 20, 2024	Examiner Name:	Unassigned
First Named Inventor:	Erik Carlson	Group Art Unit:	Unassigned
Title:	SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

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a shell arranged at the internal side, the internal side configured to be inserted in a wearer's ear canal; and

a faceplate arranged at the external side, the external side configured to face away from the wearer;

an electrode arrangement disposed in an outer surface of the faceplate, the electrode arrangement comprising:

a central contact; and

an annular ring contact surrounding the central contact or a plurality of contacts surrounding the central contact; and

circuitry disposed in the internal volume and coupled to the electrode arrangement.

3. (New) The hearing device of claim 2, further comprising one or more microphone ports disposed in the outer surface of the faceplate.

4. (New) The hearing device of claim 2, further comprising a receiver outlet disposed in the shell.

5. (New) The hearing device of claim 2, wherein the electrode arrangement comprises the plurality of contacts.

6. (New) The hearing device of claim 5, wherein each of the plurality of contacts is arranged the same distance from the central contact as each other contact of the plurality of contacts.

7. (New) The hearing device of claim 5, wherein the plurality of contacts defines a circle.

8. (New) The hearing device of claim 5, wherein each of the plurality of contacts comprises a curvilinear, annular, oval, elliptical, or polygonal shape.

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12. (New) The hearing device of claim 2, wherein the circuitry comprises charging circuitry, and wherein the electrode arrangement is coupled to the charging circuitry.

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a hearing device comprising:

a housing that encloses an internal volume and extends from an internal side to an external side, the housing comprising:

a shell arranged at the internal side, the internal side configured to be inserted in a wearer's ear canal; and

a faceplate arranged at the external side, the external side configured to face away from the wearer;

an electrode arrangement disposed in an outer surface of the faceplate, the electrode arrangement comprising:

a central contact; and

an annular ring contact surrounding the central contact or a plurality of contacts surrounding the central contact; and

circuitry disposed in the internal volume and coupled to the electrode arrangement; and

a charging module comprising a charging interface that comprises:

a central charging contact; and

an annular ring charging contact or a plurality of charging contacts surrounding the central contact.

15. (New) The system of claim 14, wherein the hearing device further comprises:

one or more microphone ports disposed in the outer surface of the faceplate; and

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wherein the charging module further comprises charging circuitry coupled to the second charging interface and configured to charge a rechargeable power source of the hearing device that is coupled to the first charging interface.

Remarks

Please enter and consider new claims 2–21 as set forth above. Further, please cancel claim 1. The pending claims are, therefore, claims 2–21.

Conclusion

Applicant invites the Examiner to contact the undersigned Applicant's Representative at the telephone number listed below if there are any questions regarding this Preliminary Amendment or if doing so may advance prosecution of this application.

Respectfully submitted by

Mueting Raasch Group
111 Washington Ave. S., Suite 700
Minneapolis, MN 55401
Phone: (612) 305-1220
Facsimile: (612) 305-1228

August 19, 2025
Date

/Jay R. Pralle/
Jay R. Pralle
Reg. No. 52131
Direct Dial: (612) 305-0083

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application Number:	18/810,014
	Confirmation No:	7322
	Filing Date:	August 20, 2024
	First Named Inventor:	Erik Carlson
	Attorney Docket No.:	ST0806US4/0532.000806US04
	Examiner Name:	NA
	Art Unit:	NA
Sheet 1 of 3	IDS filed on: February 13, 2026	
Title: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

INFORMATION DISCLOSURE STATEMENT

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

In compliance with the duty imposed by 37 C.F.R. § 1.56, and in accordance with 37 C.F.R. §§ 1.97(b) – (d) and 1.98, Applicant brings the materials enclosed herewith to the attention of the Examiner as possibly being of interest in connection with the above-identified patent application. Pursuant to M.P.E.P. § 609 and 37 C.F.R. § 1.97(h), the information cited in the present Information Disclosure Statement shall not be construed to be an admission that the information is, or is considered to be, material to patentability. Applicant requests that the Examiner consider each of the documents listed on the attached list of documents. Pursuant to the provisions of M.P.E.P. § 609, Applicant further requests that a copy of the list of documents marked as being considered and initialed by the Examiner, be returned along with the next official communication.

Applicant wishes to bring to the Examiner's attention that the materials indicated on the attached list of documents include documents cited in a foreign search report. A copy of this search

Filing of IDS under 37 C.F.R. § 1.97

Applicant believes that no fee is due, as this Information Disclosure Statement is filed prior to the receipt of any Action on the merits. However, in the event a fee is due, please charge any fee or credit any overpayment to Deposit Account No. 13-4895.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT		
	Application Number:	18/810,014
	Confirmation No:	7322
	Filing Date:	August 20, 2024
	First Named Inventor:	Erik Carlson
	Attorney Docket No.:	ST0806US4/0532.000806US04
	Examiner Name:	NA
	Art Unit:	NA
Sheet 2 of 3	**IDS filed on: February 13, 2026**	
Title: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

Size Fee Assertion

Applicant certifies that no Information Disclosure Statement size fee is required for the Information Disclosure Statement submitted herewith.

Applicant invites the Examiner to contact the undersigned Applicant's Representative at the telephone number listed below if doing so may advance prosecution of this application.

Respectfully submitted by

Mueting Raasch Group
111 Washington Ave. S., Suite 700
Minneapolis, MN 55401
Phone: (612) 305-1220
Facsimile: (612) 305-1228

February 13, 2026
Date

/Jay R. Pralle/
Jay R. Pralle
Reg. No. 52131
Direct Dial: (612) 305-0083

INFORMATION DISCLOSURE STATEMENT BY APPLICANT		
	Application Number:	18/810,014
	Confirmation No:	7322
	Filing Date:	August 20, 2024
	First Named Inventor:	Erik Carlson
	Attorney Docket No.:	ST0806US4/0532.000806US04
	Examiner Name:	NA
	Art Unit:	NA
Sheet 3 of 3	**IDS filed on: February 13, 2026**	
Title: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

U.S. PATENTS

Cite #	Patent Number (Number - Kind Code)	Issue Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
1	*None*			
2				
3				
4				
5				
6				

U.S. PATENT APPLICATION PUBLICATIONS

Cite #	Publication Number (Number - Kind Code)	Publication Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
1	2009/0067652	03/12/2009	Schmidt	
2	2017/0195466	07/06/2017	Chen	
3				
4				
5				
6				

U.S. PATENT APPLICATIONS BY SERIAL NUMBER

Copy Enclosed	Cite #	Document Number (Number - Kind Code)	Filing Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
	1	*None*			
	2				

FOREIGN PATENT DOCUMENTS

Copy Enclosed	Cite #	Country Code	Foreign Document Number	Kind Code	Publication Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments	translation	
								yes	no
	1		*None*						
	2								

NON-PATENT LITERATURE DOCUMENTS

Copy Enclosed	Cite #	Document Description
X	1	Extended European Search Report for Application No. 25212122.3 dated February 4, 2026 (8 pages).

Examiner Signature		Date Considered	
***EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.**			

UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
www.uspto.gov

ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/810,014	**02/13/2026 12:21:17 PM Z ET**	**ST0806US3/532.000806US04**

Title of Invention

SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	7322	FILED BY	Denise Lagro
PATENT CENTER #	74469673	FILING DATE	08/20/2024
CUSTOMER #	142537	FIRST NAMED INVENTOR	Erik Carlson
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Jay Pralle

Documents

TOTAL DOCUMENTS: 2

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
2026-02-13-IDS-SB08.pdf	3	Information Disclosure Statement (IDS) Form (SB08)	127 KB
Warning: This is not a USPTO supplied IDS fillable form. Data in the form cannot be automatically loaded to other USPTO systems.			
2026-02-04-EP-SR-npl.pdf	8	Non Patent Literature	155 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
2026-02-13-IDS-SB08.pdf	28082EBCCBF94961ADF98790135EBD70AF19AD2C1C3E227F ED463C72EFC771DCD74B8F36E118A4492D1E38CC1AFEBFB 436094CAF6E1813A7E6C9AF66EEA1BE40

2026-02-04-EP-SR-npl.pdf

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74402A5192D70BBC7D80E4A1C8E0810

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

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UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
www.uspto.gov

ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/810,014	**02/25/2026 03:53:30 PM Z ET**	**ST0806US3/532.000806US04**

Title of Invention

SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	7322	FILED BY	Denise Lagro
PATENT CENTER #	74617238	FILING DATE	08/20/2024
CUSTOMER #	142537	FIRST NAMED INVENTOR	Erik Carlson
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Jay Pralle

Documents

TOTAL DOCUMENTS: 1

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
2026-02-25-IDS-SB08.pdf	3	Information Disclosure Statement (IDS) Form (SB08)	127 KB

Warning: This is not a USPTO supplied IDS fillable form. Data in the form cannot be automatically loaded to other USPTO systems.

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
2026-02-25-IDS-SB08.pdf	A8C6A4B78CF85C47830198B1E78974D436D8415D916C94E985742D9ABBE1E800FC1F3BE6D1738FD19BD1FCB3213675BB4B85C2DE46AFE550A4FF601F3877B117

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application Number:	18/810,014
	Confirmation No:	7322
	Filing Date:	August 20, 2024
	First Named Inventor:	Erik Carlson
	Attorney Docket No.:	ST0806US4/0532.000806US04
	Examiner Name:	NA
	Art Unit:	NA
Sheet 1 of 3	IDS filed on: February 25, 2026	
Title: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

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Sheet 2 of 3	IDS filed on: February 25, 2026	
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February 25, 2026
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT		
	Application Number:	18/810,014
	Confirmation No:	7322
	Filing Date:	August 20, 2024
	First Named Inventor:	Erik Carlson
	Attorney Docket No.:	ST0806US4/0532.000806US04
	Examiner Name:	NA
	Art Unit:	NA
Sheet 3 of 3	**IDS filed on: February 25, 2026**	
Title: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

U.S. PATENTS

Cite #	Patent Number (Number - Kind Code)	Issue Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
1	5,253,300	10/12/1993	Knapp	
2				
3				
4				
5				
6				

U.S. PATENT APPLICATION PUBLICATIONS

Cite #	Publication Number (Number - Kind Code)	Publication Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
1	2008/0240480	10/02/2008	Pinnell	
2				
3				
4				
5				
6				

U.S. PATENT APPLICATIONS BY SERIAL NUMBER

Copy Enclosed	Cite #	Document Number (Number - Kind Code)	Filing Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
	1	*None*			
	2				

FOREIGN PATENT DOCUMENTS

Copy Enclosed	Cite #	Country Code	Foreign Document Number	Kind Code	Publication Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments	translation	
								yes	no
	1		*None*						
	2								

NON-PATENT LITERATURE DOCUMENTS

Copy Enclosed	Cite #	Document Description
	1	*None*

Examiner Signature		Date Considered	

***EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.**

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
18/810,014	08/20/2024	Erik Carlson	ST0806US3/532.000806US04	7322

142537 7590 02/26/2026

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EXAMINER
MONIKANG, GEORGE C

ART UNIT	PAPER NUMBER
2692	

NOTIFICATION DATE	DELIVERY MODE
02/26/2026	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

eofficeaction@appcoll.com
patents@starkey.com
ptodocketing@mrgs.com

Office Action Summary	Application No. 18/810,014	Applicant(s) Carlson et al.	
	Examiner GEORGE C MONIKANG	Art Unit 2692	AIA (First Inventor to File) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 8/19/2025.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 2-21 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 2-21 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Information Disclosure Statement

The information disclosure statement (IDS)s submitted on 8/20/2024 & 2/13/2026 have been considered and entered by the examiner.

Double Patenting

The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on nonstatutory

double patenting provided the reference application or patent either is shown to be commonly owned with the examined application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement. See MPEP § 717.02 for applications subject to examination under the first inventor to file provisions of the AIA as explained in MPEP § 2159. See MPEP § 2146 *et seq.* for applications not subject to examination under the first inventor to file provisions of the AIA. A terminal disclaimer must be signed in compliance with 37 CFR 1.321(b).

The filing of a terminal disclaimer by itself is not a complete reply to a nonstatutory double patenting (NSDP) rejection. A complete reply requires that the terminal disclaimer be accompanied by a reply requesting reconsideration of the prior Office action. Even where the NSDP rejection is provisional the reply must be complete. See MPEP § 804, subsection I.B.1. For a reply to a non-final Office action, see 37 CFR 1.111(a). For a reply to final Office action, see 37 CFR 1.113(c). A request for reconsideration while not provided for in 37 CFR 1.113(c) may be filed after final for consideration. See MPEP §§ 706.07(e) and 714.13.

The USPTO Internet website contains terminal disclaimer forms which may be used. Please visit www.uspto.gov/patent/patents-forms. The actual filing date of the application in which the form is filed determines what form (e.g., PTO/SB/25, PTO/SB/26, PTO/AIA/25, or PTO/AIA/26) should be used. A web-based eTerminal Disclaimer may be filled out completely online using web-screens. An eTerminal Disclaimer that meets all requirements is auto-processed and approved immediately upon submission. For more information about eTerminal Disclaimers, refer to www.uspto.gov/patents/apply/applying-online/eterminal-disclaimer.

Claim 1 of 18/810,014	Claim 1 of 18/924,062
A hearing device comprising: a housing that encloses an internal volume and extends from an internal side to an external side, the housing comprising: a shell arranged at the internal side, the internal side configured to be inserted in a wearer’s ear canal; and a faceplate arranged at the external side, the external side configured to face away from the wearer, an electrode arrangement disposed in an outer surface of the faceplate, the electrode arrangement comprising: a central contract; and an annular ring contact surrounding the central contact or a plurality of contacts surrounding the central contact; and circuitry disposed in the internal volume and coupled to the electrode arrangement. Claim 3 of 18/810,014	A hearing device comprising: a housing that encloses an internal volume and extending from an internal side to an external side, the housing comprising: a shell arranged at the internal side, the internal side configured to be inserted in a wearer's ear canal; and a faceplate arranged at the external side, the external side configured to face away from the wearer; an electrode arrangement disposed in an outer surface of the faceplate, the electrode arrangement comprising: a central contact; and a plurality of contacts surrounding the central contact; one or more microphone ports disposed in an outer surface of the faceplate; circuitry disposed in the internal volume and coupled to the electrode arrangement; and a receiver outlet disposed in the shell.

The hearing device of claim 2, further comprising one or more microphone ports disposed in the outer surface of the faceplate. Claim 4 of 18/810,014 The hearing device of claim 2, further comprising a receiver outlet disposed in the shell.	
Claim 14 of 18/810,014 A system comprising: a hearing device comprising: a housing that encloses an internal volume and extends from an internal side to an external side, the housing comprising: a shell arranged at the internal side, the internal side configured to be inserted in a wearer's ear canal; and a faceplate arranged at the external side, the external side configured to face away from the wearer; an electrode arrangement disposed in an outer surface of the faceplate, the electrode arrangement comprising: a	Claim 15 of 18/924,062 A hearing device comprising: a housing that encloses an internal volume and extending from an internal side to an external side, the housing comprising: a shell arranged at the internal side, the internal side configured to be inserted in a wearer's ear canal; and a faceplate arranged at the external side, the external side configured to face away from the wearer; an electrode arrangement disposed in an outer surface of the faceplate, the electrode arrangement comprising: a central contact having an

central contact; and an annular ring contact surrounding the central contact or a plurality of contacts surrounding the central contact; and circuitry disposed in the internal volume and coupled to the electrode arrangement; and a charging module comprising a charging interface that comprises: a central charging contact; and an annular ring charging contact or a plurality of charging contacts surrounding the central contact. Claim 15 of 18/810,014 The system of claim 14, wherein the hearing device further comprises: one or more microphone ports disposed in the outer surface of the faceplate; and a receiver outlet disposed in the shell.	annular shape; and a plurality of contacts surrounding the central contact, each of the plurality of contacts having an arcuate shape; one or more microphone ports disposed in an outer surface of the faceplate; circuitry disposed in the internal volume and coupled to the electrode arrangement, the circuitry comprising charging circuitry coupled to the electrode arrangement; and a receiver outlet disposed in the shell.

Claims 1, 3-4 & 14-15 of application number 18/810,014 (hereinafter referred to as ‘014) are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1 & 15 of U.S. Patent No. 18/924,062 (hereinafter referred to as ‘062).

Although the claims at issue are not identical, they are not patentably distinct from each other because ‘014 claims 1, 3-4 & 14-15 are obvious various wordings of ‘062 claims 1 & 15.

Claim 1 of 18/810,014	Claim 1 of 19/303,720
A hearing device comprising: a housing that encloses an internal volume and extends from an internal side to an external side, the housing comprising: a shell arranged at the internal side, the internal side configured to be inserted in a wearer’s ear canal; and a faceplate arranged at the external side, the external side configured to face away from the wearer, an electrode arrangement disposed in an outer surface of the faceplate, the electrode arrangement comprising: a central contract; and an annular ring contact surrounding the central contact or a plurality of contacts surrounding the central contact; and circuitry disposed in the internal volume	A hearing device comprising: a housing that encloses an internal volume and extends from an internal side to an external side, the housing comprising: a shell arranged at the internal side, the internal side configured to be inserted in a wearer's ear canal; and a faceplate arranged at the external side, the external side configured to face away from the wearer; an electrode arrangement disposed in an outer surface of the faceplate, the electrode arrangement comprising: electrode arrangement comprising: a central contact and at least one arcuate contact that extends around at least a portion of the central contact; and circuitry disposed in the internal

and coupled to the electrode arrangement. Claim 3 of 18/810,014 The hearing device of claim 2, further comprising one or more microphone ports disposed in the outer surface of the faceplate. Claim 4 of 18/810,014 The hearing device of claim 2, further comprising a receiver outlet disposed in the shell.	volume and coupled to the electrode arrangement. Claim 7 of 19/303,720 The hearing device of claim 1, further comprising: one or more microphone ports disposed in the outer surface of the faceplate; and a receiver outlet disposed in the shell.
Claim 14 of 18/810,014 A system comprising: a hearing device comprising: a housing that encloses an internal volume and extends from an internal side to an external side, the housing comprising: a shell arranged at the internal side, the internal side configured to be inserted in a wearer's ear canal; and a faceplate arranged at the	Claim 14 of 19/303,720 A system comprising: a hearing device comprising: a housing that encloses an internal volume and extends from an internal side to an external side, the housing comprising: a shell arranged at the internal side, the internal side configured to be inserted in a wearer's ear canal; and a faceplate arranged at the

external side, the external side configured to face away from the wearer; an electrode arrangement disposed in an outer surface of the faceplate, the electrode arrangement comprising: a central contact; and an annular ring contact surrounding the central contact or a plurality of contacts surrounding the central contact; and circuitry disposed in the internal volume and coupled to the electrode arrangement; and a charging module comprising a charging interface that comprises: a central charging contact; and an annular ring charging contact or a plurality of charging contacts surrounding the central contact.	external side, the external side configured to face away from the wearer; an electrode arrangement disposed in an outer surface of the faceplate, the electrode arrangement comprising: a central contact; and at least one arcuate contact that extends around at least a portion of the central contact; and circuitry disposed in the internal volume and coupled to the electrode arrangement; and a charging module comprising a charging interface that comprises: a central charging contact; and an annular ring charging contact or a plurality of charging contacts surrounding the central contact.
Claim 15 of 18/810,014 The system of claim 14, wherein the hearing device further comprises: one or more microphone ports disposed in the outer surface of the faceplate; and a receiver outlet disposed in the shell.	Claim 21 of 19/303,720 The system of claim 14, wherein the hearing device further comprises: one or more microphone ports disposed in the outer surface of the faceplate; and a receiver outlet disposed in the shell.

Claims 1, 3-4 & 14-15 of application number 18/810,014 (hereinafter referred to as '014) are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1, 7, 14 & 21 of U.S. Patent No. 19/303,720 (hereinafter referred to as '720).

Although the claims at issue are not identical, they are not patentably distinct from each other because '014 claims 1, 3-4 & 14-15 are obvious various wordings of '720 claims 1, 7, 14 & 21.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

The factual inquiries for establishing a background for determining obviousness under 35 U.S.C. 103 are summarized as follows:

1. Determining the scope and contents of the prior art.

2. Ascertaining the differences between the prior art and the claims at issue.

3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claims 2, 4-14, 16-21 are rejected under 35 U.S.C. 103 as being unpatentable over Pinnell et al, US Patent Pub. 20080240480 A1, in view of Linden, WO 2016036309 A1. (The Linden reference is cited in IDS filed 8/20/2024)

Re Claim 2, Pinnell et al discloses a hearing device (*abstract: hearing aid with batteries*) comprising: a housing that encloses an internal volume and extends from an internal side to an external side (*figs. 2-2A: hearing device with an ear canal insertable internal portion that extends and ends at an external faceplate facing away from the user's ear is illustrated*), the housing comprising: a shell arranged at the internal side, the internal side configured to be inserted in a wearer's ear canal (*figs. 2-2A: hearing device with an ear canal insertable internal portion that extends and ends at an external faceplate facing away from the user's ear is illustrated*); and a faceplate arranged at the external side, the external side configured to face away from the wearer (*figs. 2-2A: hearing device with an ear canal insertable internal portion that extends and ends at an external faceplate facing away from the user's ear is illustrated*), an electrode arrangement disposed in an outer surface of the faceplate (*figs. 2-2A: 110; para 0034: electrical contact/electrode are placed within the plurality of portions 110 of the hearing device illustratively located at the edge of the circular/arcuate/curve faceplate; wherein the charge contact will naturally be installed within the inner volume of the hearing device close to the charging contacts/electrodes on the faceplate*), and an annular ring contact surrounding center of the faceplate and circuitry disposed in the internal volume and coupled to the electrode arrangement (*figs. 2-2A: 110; para 0034: electrical contact/electrode are placed within the plurality of portions 110 of the hearing device illustratively located at the edge of the circular/arcuate/curve faceplate; wherein the*

charge contact will naturally be installed within the inner volume of the hearing device close to the charging contacts/electrodes on the faceplate); but fails to disclose the electrode arrangement comprising: a central contract. However, Linden teaches the concept of using a three pong/electrode configuration, including a middle/central pong/electrode, to enable connection charging of a hearing device (*Linden, pg. 6, lines 10-25*). It would have been obvious to a person having ordinary skills in the art before the effective filing date of the application to modify the Pinnell et al device such that it includes a middle/central contact/pong/electrode as taught in Linden for the purpose of including a third middle/central contact to enable ground connection within the charging.

Re Claim 4, the combined teachings of Pinnell et al and Linden disclose the hearing device of claim 2, further comprising a receiver outlet disposed in the shell (*Pinnell et al, abstract; figs. 2-2A: hearing device inherently includes a receiver within its housing*).

Re Claim 5, the combined teachings of Pinnell et al and Linden disclose the hearing device of claim 2, wherein the electrode arrangement comprises the plurality of contacts (*Pinnell et al, figs. 2-2A: 110; para 0034: electrical contact/electrode are placed within the plurality of portions 110 of the hearing device illustratively located at the edge of the circular/arcuate/curve faceplate; wherein the charge contact will naturally be installed within the inner volume of the hearing device close to the charging contacts/electrodes on the faceplate*).

Re Claim 6, the combined teachings of Pinnell et al and Linden disclose the hearing device of claim 5, wherein each of the plurality of contacts is arranged the same distance from the central contact as each other contact of the plurality of contacts

(*Pinnell et al, figs. 2-2A: 110; para 0034: electrical contact/electrode are placed within the plurality of portions 110 of the hearing device illustratively located at the edge of the circular/arcuate/curve faceplate; wherein the charge contact will naturally be installed within the inner volume of the hearing device close to the charging contacts/electrodes on the faceplate; wherein the modification of adding the third middle/central pong/electrode of Linden results with a tri-trace configuration with the middle/central pong naturally being equal distance to the other two prongs of Pinnell located at the arcs of it's circular faceplate*).

Re Claim 7, the combined teachings of Pinnell et al and Linden disclose the hearing device of claim 5, wherein the plurality of contacts defines a circle (*Pinnell et al, figs. 2-2A: 110; para 0034: electrical contact/electrode are placed within the plurality of portions 110 of the hearing device illustratively located at the edge of the circular/arcuate/curve faceplate; wherein the charge contact will naturally be installed within the inner volume of the hearing device close to the charging contacts/electrodes on the faceplate; wherein the modification of adding the third middle/central pong/electrode of Linden results with a tri-trace configuration with the middle/central pong naturally being equal distance to the other two prongs of Pinnell located at the arcs of it's circular faceplate*).

Re Claim 8, the combined teachings of Pinnell et al and Linden disclose the hearing device of claim 5, wherein each of the plurality of contacts comprises a curvilinear, annular, oval, elliptical, or polygonal shape (*Pinnell et al, figs. 2-2A: 110; para 0034: electrical contact/electrode are placed within the plurality of portions 110 of the hearing device illustratively located at the edge of the circular/arcuate/curve*

faceplate; wherein the charge contact will naturally be installed within the inner volume of the hearing device close to the charging contacts/electrodes on the faceplate; wherein the modification of adding the third middle/central pong/electrode of Linden results with a tri-trace configuration with the middle/central pong naturally being equal distance to the other two prongs of Pinnell located at the arcs of it's circular faceplate; wherein annular/ring/circular is selected from the Markush language).

Re Claim 9, the combined teachings of Pinnell et al and Linden disclose the hearing device of claim 5, wherein the plurality of contacts comprises three arcuate contacts each arranged at substantially the same distance from the central contact (*Pinnell et al, para 0017: cathode includes a plurality of arcuate portions along with the anode portion implies three or more arcuate contacts*).

Re Claim 10, the combined teachings of Pinnell et al and Linden disclose the hearing device of claim 5, but fail to explicitly disclose wherein the central contact defines a cathode contact and at least one contact of the plurality of contacts defines an anode contact. The additional contact/pong by the Linden modification located at the center can be ground/anode/cathode as deem by the user, thus making the other contacts either ground/anode/cathode for the purpose of setting up the connection in whatever configuration deem the most ideal by the user for optimum connection with the charging base.

Re Claim 11, the combined teachings of Pinnell et al and Linden disclose the hearing device of claim 2, wherein the electrode arrangement comprises the annular ring contact surrounding the central contact (*Pinnell et al, figs. 2-2A: 110; para 0034: electrical contact/electrode are placed within the plurality of portions 110 of the hearing*

device illustratively located at the edge of the circular/arcuate/curve faceplate; wherein the charge contact will naturally be installed within the inner volume of the hearing device close to the charging contacts/electrodes on the faceplate).

Re Claim 12, the combined teachings of Pinnell et al and Linden disclose the hearing device of claim 2, wherein the circuitry comprises charging circuitry (*Pinnell et al, figs. 2-2A: 110; para 0034: electrical contact/electrode are placed within the plurality of portions 110 of the hearing device illustratively located at the edge of the circular/arcuate/curve faceplate; wherein the charge contact will naturally be installed within the inner volume of the hearing device close to the charging contacts/electrodes on the faceplate; wherein the modification of adding the third middle/central pong/electrode of Linden results with a tri-trace configuration with the middle/central pong naturally being equal distance to the other two prongs of Pinnell located at the arcs of it's circular faceplate*), and wherein the electrode arrangement is coupled to the charging circuitry (*Pinnell et al, figs. 2-2A: 110; para 0034: electrical contact/electrode are placed within the plurality of portions 110 of the hearing device illustratively located at the edge of the circular/arcuate/curve faceplate; wherein the charge contact will naturally be installed within the inner volume of the hearing device close to the charging contacts/electrodes on the faceplate; wherein the modification of adding the third middle/central pong/electrode of Linden results with a tri-trace configuration with the middle/central pong naturally being equal distance to the other two prongs of Pinnell located at the arcs of it's circular faceplate*).

Re Claim 13, the combined teachings of Pinnell et al and Linden disclose the hearing device of claim 2, wherein the electrode arrangement is configured to

communicate power (*Linden, pg. 6, lines 10-25*) and one or more information signals (*Linden, pg. 13, line 31 through pg. 14, line 3: audio information*).

Claim 14 has been analyzed and rejected according to claims 2 & 11-12.

Claim 16 has been analyzed and rejected according to claims 2, 5 & 11-12.

Claim 17 has been analyzed and rejected according to claims 2, 5-6 & 11-12.

Claim 18 has been analyzed and rejected according to claims 2, 5, 7 & 11-12.

Claim 19 has been analyzed and rejected according to claims 2, 5-6 & 11-12.

Claim 20 has been analyzed and rejected according to claims 2 & 11-12.

Re Claim 14 & 21, the combined teachings of Pinnell et al and Linden disclose the system of claim 14, wherein the hearing device comprises a first charging interface comprising the electrode arrangement, wherein the circuitry of the hearing device comprises charging circuitry coupled to the electrode arrangement, wherein the charging interface of the charging module defines a second charging interface configured to detachably couple with the first charging interface of the hearing device (*Pinnell et al, figs. 2-2A: 110; para 0034: electrical contact/electrode are placed within the plurality of portions 110 of the hearing device illustratively located at the edge of the circular/arcuate/curve faceplate; wherein the charge contact will naturally be installed within the inner volume of the hearing device close to the charging contacts/electrodes on the faceplate; wherein the modification of adding the third middle/central pong/electrode of Linden results with a tri-trace configuration with the middle/central pong naturally being equal distance to the other two prongs of Pinnell located at the arcs of it's circular faceplate; wherein the hearing the charging electrodes of the hearing device are charged by connecting said charging electrodes into the external*

rechargeable ports/(second charging interface) of figs. 3-3B (para 0034)); wherein the charging module further comprises charging circuitry coupled to the second charging interface and configured to charge a rechargeable power source of the hearing device that is coupled to the first charging interface (*Pinnell et al, figs. 2-2A: 110; para 0034: electrical contact/electrode are placed within the plurality of portions 110 of the hearing device illustratively located at the edge of the circular/arcuate/curve faceplate; wherein the charge contact will naturally be installed within the inner volume of the hearing device close to the charging contacts/electrodes on the faceplate; wherein the modification of adding the third middle/central pong/electrode of Linden results with a tri-trace configuration with the middle/central pong naturally being equal distance to the other two prongs of Pinnell located at the arcs of it's circular faceplate; wherein the hearing the charging electrodes of the hearing device are charged by connecting said charging electrodes into the external rechargeable ports/(second charging interface) of figs. 3-3B (para 0034)*).

Claims 3 & 15 are rejected under 35 U.S.C. 103 as being unpatentable over Pinnell et al, US Patent Pub. 20080240480 A1 and Linden, WO 2016036309 A1, as applied to claim 2, and further in view of Knapp, US Patent 5253300.

Re Claim 3, the combined teachings of Pinnell et al and Linden disclose the hearing device of claim 2, but fail to disclose further comprising one or more microphone ports disposed in the outer surface of the faceplate. Knapp teaches the concept of a hearing device with a microphone port on the outer surface of its faceplate (*Knapp, fig. 7: microphone aperture 23; col. 5, lines 62-68*). It would have been obvious

to a person having ordinary skills in the art before the effective filing date of the application to modify the Pinnell et al and Linden device such that it includes a microphone aperture at the outer surface of its faceplate as taught in Knapp for the purpose of enabling picking up of environment sounds.

Claim 15 has been analyzed and rejected according to claims 2-4 & 11-12.

Contact

Any inquiry concerning this communication or earlier communications from the examiner should be directed to GEORGE C MONIKANG whose telephone number is (571)270-1190. The examiner can normally be reached Mon. - Fri., 9AM-5PM, ALT. Fridays off.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carolyn R Edwards can be reached at 571-270-7136. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of published or unpublished applications may be obtained from Patent Center. Unpublished application information in Patent Center is available to registered users. To file and manage patent submissions in Patent Center, visit: https://patentcenter.uspto.gov. Visit https://www.uspto.gov/patents/apply/patent-

center for more information about Patent Center and

https://www.uspto.gov/patents/docx for information about filing in DOCX format. For

additional questions, contact the Electronic Business Center (EBC) at 866-217-9197

(toll-free). If you would like assistance from a USPTO Customer Service

Representative, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/GEORGE C MONIKANG/
Primary Examiner, Art Unit 2692 02/19/2026

/CAROLYN R EDWARDS/
Supervisory Patent Examiner, Art Unit 2692

Notice of References Cited	Application/Control No. 18/810,014	Applicant(s)/Patent Under Reexamination Carlson et al.	
	Examiner GEORGE C MONIKANG	Art Unit 2692	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date YYYY-MM-DD	Name	CPC Classification	US Classification
*	A	US-20080240480-A1	2008-10-02	Pinnell; Leslie J.	H04R25/602	381/323
*	B	US-5253300-A	1993-10-12	Knapp; Herbert C.	H04R25/602	381/328
	C					
	D					
	E					
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	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date YYYY-MM-DD	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title, Date, Publisher, Edition or Volume, Pertinent Pages
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in YYYY-MM-DD format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	18/810,014	Carlson et al.
	Examiner	Art Unit
	GEORGE C MONIKANG	2692

CPC - Searched*		
Symbol	Date	Examiner
H04R1/1025; H04R25/602; H04R2225/31; H04R2225/57	02/19/2026	GM

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner
381	312, 314, 322, 324, 328	02/19/2026	GM

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Double patenting rejection made. Inventor/Assignee search completed in PE2E.	02/19/2026	GM
Similarity search completed in PE2E.	02/19/2026	GM

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

/GEORGE C MONIKANG/ Primary Examiner, Art Unit 2692	/CAROLYN R EDWARDS/ Supervisory Patent Examiner, Art Unit 2692

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	18/810,014	Carlson et al.
	Examiner	**Art Unit**
	GEORGE C MONIKANG	2692

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS										
☐ Claims renumbered in the same order as presented by applicant					☐ CPA		☐ T.D.		☐ R.1.47	
CLAIM		DATE								
Final	Original	02/19/2026								
	1	-								
	2	✓								
	3	✓								
	4	✓								
	5	✓								
	6	✓								
	7	✓								
	8	✓								
	9	✓								
	10	✓								
	11	✓								
	12	✓								
	13	✓								
	14	✓								
	15	✓								
	16	✓								
	17	✓								
	18	✓								
	19	✓								
	20	✓								
	21	✓								

PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L1	1	"17553716"	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/19 03:50 PM
L2	1	(hearing SAME aid SAME charg$8 SAME displac$8 SAME anode SAME cathode)	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/19 04:43 PM
L3	576	(charg$8 SAME displac$8 SAME anode SAME cathode)	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/19 04:43 PM
L4	1	(charg$8 SAME displac$8 SAME anode SAME cathode) AND 381/$.ccls.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/19 04:43 PM
L5	0	(charg$8 SAME pogo SAME anode SAME cathode) AND 381/$.ccls.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/20 06:13 PM
L6	0	(charg$8 SAME pogo SAME positive SAME negative) AND 381/$.ccls.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/20 06:13 PM
L7	6	(charg$8 SAME pogo SAME anode SAME cathode)	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/20 06:14 PM
L8	69	(charg$8 SAME pogo SAME positive SAME negative)	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/20 06:19 PM
L9	1	(charg$8 SAME pogo SAME positive SAME negative SAME hearing)	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/20 06:20 PM
L10	0	(charg$8 SAME pogo SAME pin$1 SAME triang$6)	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 04:20 PM
L11	75	(pogo SAME pin$1 SAME triang$6)	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 04:21 PM
L12	0	(pogo SAME pin$1 SAME triang$6) AND 381/$.ccls.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 04:21 PM
L13	623	(state WITH charge WITH rate WITH recharg$6)	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 05:28 PM
L14	0	(state WITH charge WITH rate WITH recharg$6) AND 381/$.ccls.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 05:29 PM
L15	2	(state WITH charge WITH rate WITH	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 05:30 PM

		recharg$6 WITH accelerate)					
L16	11	(state SAME charge SAME rate SAME recharg$6 SAME accelerate)	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 05:33 PM
L17	133	carlson-erik$.in.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 06:42 PM
L18	0	carlson-erik$.in. AND (battery).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 06:42 PM
L19	3	carlson-erik$.in. AND (charg$6).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 06:42 PM
L20	5	burns-thomas$.in. AND (charg$6).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 06:43 PM
L21	14	olson-kyle$.in. AND (charg$6).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 06:44 PM
L22	1	giswold-kent$.in. AND (charg$6).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 06:47 PM
L23	0	(state WITH charge WITH rate WITH recharg$6) AND (381/312,322,323).ccls.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 07:02 PM
L24	0	(charg$8 SAME displac$8 SAME anode SAME cathode) AND (381/312,322,323).ccls.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 07:02 PM
L25	0	(charg$8 SAME displac$8 SAME anode SAME cathode) AND 381/323	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 07:03 PM
L26	1	(charg$8 SAME displac$8 SAME anode SAME cathode) AND h04r1/1025	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 07:04 PM
L27	4	(charg$8 SAME displac$8 SAME anode SAME cathode) AND h01m10/46	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 07:04 PM
L28	1	(charg$8 SAME displac$8 SAME anode SAME cathode) AND h04r25/602	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 07:05 PM
L29	1	(charg$8 SAME displac$8 SAME anode SAME cathode) AND h04r2225/31	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 07:05 PM
L30	20	(charg$8 SAME anode SAME cathode) AND h04r2225/31	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 07:05 PM
L31	21	(charg$8 SAME anode SAME cathode) AND h04r1/1025	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 07:08 PM

L32	3	"20160353216"	(US-PGPUB; USPAT)	OR	ON	ON	2024/01/19 09:21 PM
L33	1	(cathode SAME anode SAME power SAME source SAME charg$5 SAME interface SAME prior).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2024/01/19 09:46 PM
L34	1	"17553716"	(US-PGPUB; USPAT)	OR	ON	ON	2024/01/19 10:06 PM
L35	4	"8213651"	(US-PGPUB; USPAT)	OR	ON	ON	2024/05/03 06:18 PM
L36	3	"20080118093"	(US-PGPUB; USPAT)	OR	ON	ON	2024/05/03 06:18 PM
L37	37	(charg$8 SAME anode SAME cathode SAME electrode) AND h04r2225/31	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2026/02/07 01:09 PM
L38	9	(charg$8 SAME anode SAME cathode SAME electrode) AND h04r2225/57	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2026/02/07 01:12 PM
L39	21	(charg$8 SAME anode SAME cathode SAME electrode) AND h04r25/602	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2026/02/07 01:12 PM

L40	8	"2016036309"	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2026/02/07 01:18 PM
L41	9	(charg$8 SAME anode SAME cathode SAME electrode SAME hearing SAME faceplate)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 01:20 PM
L42	198	(charg$8 SAME anode SAME cathode SAME electrode SAME faceplate)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 01:21 PM
L43	7	(charg$8 SAME anode SAME cathode SAME electrode SAME faceplate) AND h04r2225/57	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 01:21 PM

L44	7	(charg$8 SAME anode SAME cathode SAME electrode SAME faceplate) AND h04r2225/31	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 01:21 PM
L45	7	(charg$8 SAME anode SAME cathode SAME electrode SAME faceplate) AND h04r25/602	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 01:22 PM
L46	7	(charg$8 SAME anode SAME cathode SAME electrode SAME faceplate) AND h04r1/1025	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 01:22 PM
L47	0	(charg$8 SAME anode SAME cathode SAME electrode SAME faceplate) AND 381/$.ccls.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 01:22 PM

L48	198	(charg$8 SAME anode SAME cathode SAME electrode SAME faceplate)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 01:22 PM
L49	10	(charg$8 SAME anode SAME cathode SAME electrode SAME faceplate SAME ear)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 01:22 PM
L50	35	(Artificial Intelligence) More like doc: US-20080240480-A1 Text: (US-345124-A OR US-3493695-A OR SE-7502352-L OR US-4279972-A OR US-4401735-A OR US-4526846-A OR US-5176968-A OR US-5253300-A OR WO-9528817-A1 OR JP-H08265405-A OR JP-3539448-B2 OR ZA-963605-B OR US-5879832-A OR US-5691073-A OR US-5750277-A OR US-6037071-A OR US-6514640-B1 OR US-5910382-A OR WO-9802933-A1 OR EP-0986118-B1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2026/02/07 01:24 PM
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			JPO; DERWENT; IBM_TDB)				
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L57	32	"2016126476"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2026/02/07 02:03 PM
L58	23	"2019037854"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB,	OR	ON	ON	2026/02/07 02:04 PM

			HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L59	71	"2640170"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2026/02/07 02:05 PM
L60	10	(charg$8 SAME anode SAME cathode SAME faceplate SAME ear)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:12 PM
L61	9	(charg$8 SAME anode SAME cathode SAME faceplate SAME hearing)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:12 PM
L62	591	(charg$8 SAME anode SAME cathode SAME	(US-PGPUB; USPAT; USOCR; FIT (AP, AT,	OR	ON	ON	2026/02/07 02:13 PM

		hearing)	AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))				
L63	74	(charg$8 WITH anode WITH cathode WITH hearing)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:13 PM
L64	9	(charg$8 SAME electrodes SAME faceplate SAME hearing)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:15 PM
L65	9	(charg$8 SAME electrode$1 SAME faceplate SAME hearing)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:15 PM
L66	2781	(charg$8 SAME electrode$1 SAME	(US-PGPUB; USPAT; USOCR; FIT (AP, AT,	OR	ON	ON	2026/02/07 02:15 PM

		hearing)	AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))				
L67	9	(charg$8 SAME electrode$1 SAME hearing SAME faceplate)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:16 PM
L68	1145	(charg$8 SAME electrode$1 SAME faceplate)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:16 PM
L69	7	(charg$8 SAME electrode$1 SAME faceplate) AND h04r2225/31	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:16 PM
L70	11	(charg$8 SAME electrode$1 SAME	(US-PGPUB; USPAT; USOCR; FIT (AP, AT,	OR	ON	ON	2026/02/07 02:16 PM

		faceplate) AND h04r2225/57	AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))				
L71	1	(charg$8 SAME electrode$1 SAME faceplate) AND 381/$.ccls.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:17 PM
L72	11	(charg$8 SAME electrode$1 SAME faceplate) AND h04r1/1025	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:17 PM
L73	239	(charg$8 WITH electrode$1 WITH faceplate)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:17 PM
L74	0	(charg$8 WITH electrode$1 WITH	(US-PGPUB; USPAT; USOCR; FIT (AP, AT,	OR	ON	ON	2026/02/07 02:17 PM

		faceplate WITH hearing)	AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))				
L75	1	(charg$8 WITH electrode$1 WITH faceplate WITH ear)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:17 PM
L76	181	(charg$8 WITH contacts WITH faceplate)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:41 PM
L77	39	(charg$8 WITH contacts WITH faceplate) AND h04r2225/31	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:41 PM
L78	46	(Artificial Intelligence) More like doc:	(US-PGPUB; USPAT; USOCR; FIT (AU, AP,	OR	ON	ON	2026/02/07 02:43 PM

		EP-4543046-A1 Text: (DE-4233813-C1 OR AT-E541414-T1 OR CN-215420765-U OR CN-114554345-A OR US-20250133357-A1 OR EP-4543046-A1 OR AU-2025202980-A1 OR EP-3836564-B1 OR DE-1847045-U OR US-20230345191-A1 OR DE-102019201784-B3 OR CN-218160944-U OR WO-2004057909-A2 OR US-20210204075-A1 OR CN-116648930-A OR CN-113170267-A OR CN-114650479-A OR WO-2011083425-A2 OR US-20230292030-A1 OR DE-102006018631-A1).did.	AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L79	45	(Artificial Intelligence) More like doc: CN-114554345-A Text: (WO-2006104981-A2 OR CN-207505089-U OR CN-207802267-U OR CN-107635173-A OR US-10728645-B2 OR CN-110049398-A OR US-11245989-B2 OR CN-211128130-U OR CN-212751847-U OR CN-212752596-U OR CN-212936166-U OR CN-215420765-U OR CN-114554345-A OR EP-4236355-A1 OR US-20230269511-A1 OR US-12457439-B2 OR CN-114554345-B OR EP-4236355-B1 OR JP-2023123403-A OR JP-7663971-B2).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2026/02/07 02:46 PM
L80	40	(Artificial Intelligence) More like doc: EP-4262239-A1 Text: (DK-42197-A OR KR-100795306-B1 OR US-8737658-B2 OR DK-2285136-T3 OR EP-3086572-A1 OR EP-	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO,	OR	ON	ON	2026/02/07 02:48 PM

		3629599-B1 OR US-10827249-B1 OR US-20230336928-A1 OR EP-4262239-A1 OR EP-4668782-A1 OR US-20250386155-A1 OR EP-4492824-A1 OR CN-217216897-U OR DE-19502994-A1 OR US-20250016924-A1 OR US-20220102797-A1 OR CN-119316784-A OR US-20050221167-A1 OR US-20240313319-A1 OR US-20240313320-A1).did.	MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L81	37	(Artificial Intelligence) More like doc: US-20210185453-A1 Text: (US-7010137-B1 OR US-7142682-B2 OR EP-2285138-B1 OR US-8494197-B2 OR NL-2003672-C2 OR CN-102413410-A OR CN-207075092-U OR CN-112954564-A OR EP-3836564-B1 OR US-20220150646-A1 OR US-11638101-B2 OR EP-3836564-A1 OR US-11245989-B2 OR US-20210185453-A1 OR EP-3836558-A1 OR EP-3836558-B1 OR US-20220240025-A1 OR US-20210185452-A1 OR US-6700983-B1 OR DE-102011083523-B4).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2026/02/07 02:50 PM
L82	26	(charg$8 WITH contacts WITH faceplate) AND h04r1/1025	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:52 PM
L83	7	(charg$8 WITH central	(US-PGPUB; USPAT;	OR	ON	ON	2026/02/07

		WITH faceplate) AND h04r1/1025	USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))				02:54 PM
L84	7	(charg$8 WITH central WITH faceplate) AND h04r2225/31	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:54 PM
L85	7	(charg$8 WITH central WITH faceplate) AND h04r2225/57	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:54 PM
L86	7	(charg$8 WITH central WITH faceplate) AND h04r25/602	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:54 PM
L87	7	(charg$8 SAME central	(US-PGPUB; USPAT;	OR	ON	ON	2026/02/07

		SAME faceplate) AND h04r2225/31	USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))				02:55 PM
L88	40	(charg$8 WITH central WITH faceplate)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:55 PM
L89	359	(charg$8 SAME central SAME faceplate)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:56 PM
L90	11	(charg$8 SAME central SAME faceplate SAME (ear OR hearing))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:56 PM
L91	2	"19303720"	(US-PGPUB; USPAT;	OR	ON	ON	2026/02/07

			USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))				03:39 PM
L92	269	carlson-erik$.in.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 06:34 PM
L93	9	carlson-erik$.in. AND (hearing).clm.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 06:34 PM
L94	110	burns-thomas$.in. AND (hearing).clm.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 06:53 PM
L95	10	burns-thomas$.in. AND	(US-PGPUB; USPAT;	OR	ON	ON	2026/02/07

		(electrode$1 OR (anode SAME cathode)).clm.	USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))				06:53 PM
L96	10	olson-kyle$.in. AND (electrode$1 OR (anode SAME cathode)).clm.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 06:54 PM
L97	7	giswold-kent$.in. AND (electrode$1 OR (anode SAME cathode)).clm.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 06:54 PM
L98	0	starkey-laboratories$.in. AND (electrode$1 OR (anode SAME cathode)).clm.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 06:55 PM
L99	22	starkey-	(US-PGPUB; USPAT;	OR	ON	ON	2026/02/07

		laboratories$.as. AND (electrode$1 OR (anode SAME cathode)).clm.	USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))				06:55 PM
L100	5	"20080240480"	(US-PGPUB; USPAT)	OR	ON	ON	2026/02/19 07:22 PM
L101	8	"2016036309"	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2026/02/19 07:22 PM
L102	5	"18810014"	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2026/02/19 07:24 PM
L103	50	(Artificial Intelligence) Similar to: 18/810,014 with 0 CPC Selections and 0 Text Selections Text: (US-20250048012-A1 OR EP-4664932-A2 OR US-12101588-B2 OR US-20220109924-A1 OR WO-2021015998-A1 OR EP-4000277-B1 OR US-20240414465-	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA,	OR	ON	ON	2026/02/19 09:10 PM

		A1 OR US-20250234141-A1 OR EP-4195703-A1 OR US-20230179931-A1 OR US-20250039617-A1 OR US-12238485-B2 OR CH-721509-A2 OR DE-102021213958-B4 OR US-20240214752-A1 OR US-20090202093-A1 OR WO-2021173841-A1 OR US-20210211815-A1 OR KR-20210013603-A OR US-20240305933-A1 OR EP-2026602-B1 OR US-20220408199-A1 OR CN-116095580-A OR EP-2026602-A1 OR US-12108213-B2 OR US-20200260176-A1 OR US-8126178-B2 OR DE-102008008670-A1 OR US-20250254457-A1 OR US-20090208046-A1 OR CN-219536310-U OR WO-2015039707-A1 OR EP-4604352-A1 OR EP-2091124-A2 OR EP-4178222-A1 OR US-20250350893-A1 OR US-20230148224-A1 OR US-9060234-B2 OR US-12401955-B2 OR US-20240298111-A1 OR US-12279093-B2 OR DE-102007013420-A1 OR WO-2022146627-A1 OR US-20240323622-A1 OR CN-120474126-A OR CN-110024416-A OR US-20180376264-A1 OR US-10623875-B2 OR DE-102006029197-B4 OR CH-720428-A2).did.	VN))				

PE2E SEARCH - Search History (Interference)

There are no Interference searches to show.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application Number:	Unassigned 18/810,014
	Confirmation No:	Unassigned 08/20/2024
	Filing Date:	Herewith
	First Named Inventor:	Erik Carlson
	Attorney Docket No.:	ST0806US4/532.000806US04
	Examiner Name:	Unassigned
	Art Unit:	Unassigned
Sheet 1 of 4	IDS filed on: August 20, 2024	
Title: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

INFORMATION DISCLOSURE STATEMENT

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

In compliance with the duty imposed by 37 C.F.R. § 1.56, and in accordance with 37 C.F.R. §§ 1.97(b) – (d) and 1.98, Applicant brings the materials enclosed herewith to the attention of the Examiner as possibly being of interest in connection with the above-identified patent application. Pursuant to M.P.E.P. § 609 and 37 C.F.R. § 1.97(h), the information cited in the present Information Disclosure Statement shall not be construed to be an admission that the information is, or is considered to be, material to patentability. Applicant requests that the Examiner consider each of the documents listed on the attached list of documents. Pursuant to the provisions of M.P.E.P. § 609, Applicant further requests that a copy of the list of documents marked as being considered and initialed by the Examiner, be returned along with the next official communication.

This application is a continuation of U.S. Patent Application No. **17/553,716**, filed **December 16, 2021**. In accordance with 37 C.F.R. § 1.98(d), copies of documents previously cited by or submitted to the U.S. Patent and Trademark Office in connection with Applicant's prior application(s) listed above, are not included herewith.

Applicant believes that no fee is due, as this Information Disclosure Statement is filed within three months of the filing date of the application. However, in the event a fee is due, please charge any fee or credit any overpayment to Deposit Account No. 13-4895.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application Number:	Unassigned 18/810,014
	Confirmation No:	Unassigned 08/20/2024
	Filing Date:	Herewith
	First Named Inventor:	Erik Carlson
	Attorney Docket No.:	ST0806US4/532.000806US04
	Examiner Name:	Unassigned
	Art Unit:	Unassigned
Sheet 2 of 4	IDS filed on: August 20, 2024	
Title: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

Applicant invites the Examiner to contact the undersigned Applicant's Representative at the telephone number listed below if doing so may advance prosecution of this application.

Respectfully submitted by

Mueting Raasch Group
111 Washington Ave. S., Suite 700
Minneapolis, MN 55401
Phone: (612) 305-1220
Facsimile: (612) 305-1228

August 20, 2024
Date

/Mark A. Hollingsworth/
Mark A. Hollingsworth
Reg. No. 38,491
Direct Dial: (612) 767-5000

INFORMATION DISCLOSURE STATEMENT BY APPLICANT		
	Application Number:	Unassigned 18/810,014
	Confirmation No:	Unassigned 08/20/2024
	Filing Date:	Herewith
	First Named Inventor:	Erik Carlson
	Attorney Docket No.:	ST0806US4/532.000806US04
	Examiner Name:	Unassigned
	Art Unit:	Unassigned
Sheet 3 of 4	**IDS filed on: August 20, 2024**	
Title: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

U.S. PATENTS

Patent Number (Number - Kind Code)	Issue Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
/G.C.M/ 8,213,651	07-03-2012	Schmidt	
/G.C.M/ 10,798,500	10-06-2020	Shi	
/G.C.M/D397796 S	09-01-1998	Yabe	
/G.C.M/D554756 S1	11-06-2007	Sjursen	
/G.C.M/ D611606 S1	03-09-2010	Vaterlaus	
/G.C.M/D728107 S1	04-28-2015	Torres Martin	
/G.C.M/ D857650 S	08-27-2019	Hardi	
/G.C.M/D895806 S1	09-08-2020	Zheng	
/G.C.M/ D896969 S1	09-22-2020	Yu	
/G.C.M/D924207 S1	07-06-2021	Li	
/G.C.M/D941475 S1	01-18-2022	Burns	

U.S. PATENT APPLICATION PUBLICATIONS

Publication Number (Number - Kind Code)	Publication Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
/G.C.M/2008/0118093	09-27-2011	Klemenz	
/G.C.M/ 20160353216 A1	12-01-2016	Ruzicka	
/G.C.M/2018/0370522	12-27-2018	Collins	

U.S. PATENT APPLICATIONS BY SERIAL NUMBER

Copy Enclosed	Document Number (Number - Kind Code)	Filing Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
	None			

FOREIGN PATENT DOCUMENTS

Copy Enclosed	Cite #	Country Code	Foreign Document Number	Kind Code	Publication Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments	translation yes	translation no
/G.C.M/	1	EP	2640170	A1	09-18-2013	Sanford			
/G.C.M/	2	WO	2016/036309	A1	03-10-2016	Lindén			
/G.C.M/	3	WO	2016/126476	A1	08-11-2016	Fletcher			
/G.C.M/	4	WO	2019/037854	A1	02-28-2019	Baltensperger			

Examiner Signature	/GEORGE C MONIKANG/	Date Considered	02/19/2026

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT		
	Application Number:	Unassigned 18/810,014
	Confirmation No:	Unassigned 08/20/2024
	Filing Date:	Herewith
	First Named Inventor:	Erik Carlson
	Attorney Docket No.:	ST0806US4/532.000806US04
	Examiner Name:	Unassigned
	Art Unit:	Unassigned
Sheet 4 of 4	**IDS filed on: August 20, 2024**	
Title: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

NON-PATENT LITERATURE DOCUMENTS

Copy Enclosed	Cite #	Document Description
/G.C.M/	1	European Patent Application No. 20 750 976.1 (Attorney Docket No. 0532.000806WO01), filed July 14, 2020; European Office Action issued October 27, 2023, 8 pages.
/G.C.M/	2	International Search Report and Written Opinion from PCT Application No. PCT/US2020/041956 dated November 2, 2020, 10 pages.

Examiner Signature	/GEORGE C MONIKANG/	Date Considered	02/19/2026

***EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.**

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application Number:	18/810,014
	Confirmation No:	7322
	Filing Date:	August 20, 2024
	First Named Inventor:	Erik Carlson
	Attorney Docket No.:	ST0806US4/0532.000806US04
	Examiner Name:	NA
	Art Unit:	NA
Sheet 1 of 3	IDS filed on: February 13, 2026	
Title: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

INFORMATION DISCLOSURE STATEMENT

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

In compliance with the duty imposed by 37 C.F.R. § 1.56, and in accordance with 37 C.F.R. §§ 1.97(b) – (d) and 1.98, Applicant brings the materials enclosed herewith to the attention of the Examiner as possibly being of interest in connection with the above-identified patent application. Pursuant to M.P.E.P. § 609 and 37 C.F.R. § 1.97(h), the information cited in the present Information Disclosure Statement shall not be construed to be an admission that the information is, or is considered to be, material to patentability. Applicant requests that the Examiner consider each of the documents listed on the attached list of documents. Pursuant to the provisions of M.P.E.P. § 609, Applicant further requests that a copy of the list of documents marked as being considered and initialed by the Examiner, be returned along with the next official communication.

Applicant wishes to bring to the Examiner's attention that the materials indicated on the attached list of documents include documents cited in a foreign search report. A copy of this search

Filing of IDS under 37 C.F.R. § 1.97

Applicant believes that no fee is due, as this Information Disclosure Statement is filed prior to the receipt of any Action on the merits. However, in the event a fee is due, please charge any fee or credit any overpayment to Deposit Account No. 13-4895.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT		
	Application Number:	18/810,014
	Confirmation No:	7322
	Filing Date:	August 20, 2024
	First Named Inventor:	Erik Carlson
	Attorney Docket No.:	ST0806US4/0532.000806US04
	Examiner Name:	NA
	Art Unit:	NA
Sheet 2 of 3	**IDS filed on: February 13, 2026**	
Title: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

Size Fee Assertion

Applicant certifies that no Information Disclosure Statement size fee is required for the Information Disclosure Statement submitted herewith.

Applicant invites the Examiner to contact the undersigned Applicant's Representative at the telephone number listed below if doing so may advance prosecution of this application.

Respectfully submitted by

Mueting Raasch Group
111 Washington Ave. S., Suite 700
Minneapolis, MN 55401
Phone: (612) 305-1220
Facsimile: (612) 305-1228

February 13, 2026
Date

/Jay R. Pralle/
Jay R. Pralle
Reg. No. 52131
Direct Dial: (612) 305-0083

INFORMATION DISCLOSURE STATEMENT BY APPLICANT		
	Application Number:	18/810,014
	Confirmation No:	7322
	Filing Date:	August 20, 2024
	First Named Inventor:	Erik Carlson
	Attorney Docket No.:	ST0806US4/0532.000806US04
	Examiner Name:	NA
	Art Unit:	NA
Sheet 3 of 3	**IDS filed on: February 13, 2026**	
Title: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

U.S. PATENTS

Cite #	Patent Number (Number - Kind Code)	Issue Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
1	*None*			
2				
3				
4				
5				
6				

U.S. PATENT APPLICATION PUBLICATIONS

Cite #	Publication Number (Number - Kind Code)	Publication Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
1	2009/0067652	03/12/2009	Schmidt	
2	2017/0195466	07/06/2017	Chen	
3				
4				
5				
6				

U.S. PATENT APPLICATIONS BY SERIAL NUMBER

Copy Enclosed	Cite #	Document Number (Number - Kind Code)	Filing Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
	1	*None*			
	2				

FOREIGN PATENT DOCUMENTS

Copy Enclosed	Cite #	Country Code	Foreign Document Number	Kind Code	Publication Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments	translation	
								yes	no
	1		*None*						
	2								

NON-PATENT LITERATURE DOCUMENTS

Copy Enclosed	Cite #	Document Description
X	1	Extended European Search Report for Application No. 25212122.3 dated February 4, 2026 (8 pages).

Examiner Signature	/GEORGE C MONIKANG/	Date Considered	02/19/2026

***EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.**

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /G.C.M/

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.:	18/810,014	Attorney Docket No.:	ST0806US4/0532.000806US04
Confirmation No.:	7322	Customer No.:	142537
Filing Date:	August 20, 2024	Examiner Name:	Monikang, George C.
First Named Inventor:	Erik Carlson	Group Art Unit:	2692
Title:	SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

AMENDMENT AND RESPONSE

Commissioner for Patents
Mail Stop Amendment
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

In response to the non-final Office Action of February 26, 2026, please consider the following.

Amendments to the Claims begin on the page entitled “Amendments to the Claims.”

Remarks begin on the page entitled “Remarks.”

Authorization is given to charge Deposit Account No. 13-4895 any necessary fees for this filing and all required extension of time fees.

Amendments to the Claims

This listing of claims replaces all prior versions, and listings, of claims in the above-identified application:

Listing of Claims

1. (Canceled)

2. (Currently Amended) A hearing device comprising:

a housing that encloses an internal volume and extends from an internal side to an external side, the housing comprising:

a shell arranged at the internal side, the internal side configured to be inserted in a wearer's ear canal; and

a faceplate arranged at the external side, the external side configured to face away from the wearer;

an electrode arrangement disposed in an outer surface of the faceplate, the electrode arrangement comprising:

a central contact; and

an annular ring contact surrounding the central contact or a plurality of contacts surrounding the central contact, wherein the central contact and the annular ring contact or the plurality of contacts form at least a portion of an exterior surface of the hearing device; and

circuitry disposed in the internal volume and coupled to the electrode arrangement.

3. (Previously Presented) The hearing device of claim 2, further comprising one or more microphone ports disposed in the outer surface of the faceplate.

4. (Previously Presented) The hearing device of claim 2, further comprising a receiver outlet disposed in the shell.

5. (Previously Presented) The hearing device of claim 2, wherein the electrode arrangement comprises the plurality of contacts.

6. (Previously Presented) The hearing device of claim 5, wherein each of the plurality of contacts is arranged the same distance from the central contact as each other contact of the plurality of contacts.

7. (Previously Presented) The hearing device of claim 5, wherein the plurality of contacts defines a circle.

8. (Previously Presented) The hearing device of claim 5, wherein each of the plurality of contacts comprises a curvilinear, annular, oval, elliptical, or polygonal shape.

9. (Previously Presented) The hearing device of claim 5, wherein the plurality of contacts comprises three arcuate contacts each arranged at substantially the same distance from the central contact.

10. (Previously Presented) The hearing device of claim 5, wherein the central contact defines a cathode contact and at least one contact of the plurality of contacts defines an anode contact.

11. (Previously Presented) The hearing device of claim 2, wherein the electrode arrangement comprises the annular ring contact surrounding the central contact.

12. (Previously Presented) The hearing device of claim 2, wherein the circuitry comprises charging circuitry, and wherein the electrode arrangement is coupled to the charging circuitry.

13. (Previously Presented) The hearing device of claim 2, wherein the electrode arrangement is configured to communicate power and one or more information signals.

14. (Currently Amended) A system comprising:

a hearing device comprising:

a housing that encloses an internal volume and extends from an internal side to an external side, the housing comprising:

a shell arranged at the internal side, the internal side configured to be inserted in a wearer's ear canal; and

a faceplate arranged at the external side, the external side configured to face away from the wearer;

an electrode arrangement disposed in an outer surface of the faceplate, the electrode arrangement comprising:

a central contact; and

an annular ring contact surrounding the central contact or a plurality of contacts surrounding the central contact, wherein the central contact and the annular ring contact or the plurality of contacts form at least a portion of an exterior surface of the hearing device; and

circuitry disposed in the internal volume and coupled to the electrode arrangement; and

a charging module comprising a charging interface that comprises:

a central charging contact; and

an annular ring charging contact or a plurality of charging contacts surrounding the central contact.

15. (Previously Presented) The system of claim 14, wherein the hearing device further comprises:

one or more microphone ports disposed in the outer surface of the faceplate; and

a receiver outlet disposed in the shell.

16. (Previously Presented) The system of claim 14, wherein the electrode arrangement of the hearing device comprises the plurality of contacts.

17. (Previously Presented) The system of claim 16, wherein each of the plurality of contacts is arranged the same distance from the central contact as each other contact of the plurality of contacts.

18. (Previously Presented) The system of claim 16, wherein the plurality of contacts defines a circle.

19. (Previously Presented) The system of claim 16, wherein the plurality of contacts comprises three arcuate contacts each arranged at substantially the same distance from the central contact.

20. (Previously Presented) The system of claim 14, wherein the electrode arrangement of the hearing device comprises the annular ring contact surrounding the central contact.

21. (Previously Presented) The system of claim 14, wherein the hearing device comprises a first charging interface comprising the electrode arrangement, wherein the circuitry of the hearing device comprises charging circuitry coupled to the electrode arrangement, wherein the charging interface of the charging module defines a second charging interface configured to detachably couple with the first charging interface of the hearing device;

wherein the charging module further comprises charging circuitry coupled to the second charging interface and configured to charge a rechargeable power source of the hearing device that is coupled to the first charging interface.

22. (New) The hearing device of claim 2, wherein the central contact comprises a central contact surface and the annular ring contact or the plurality of contacts comprises a contact

surface, wherein one of the central contact surface and the contact surface of the annular ring contact or the plurality of contacts is recessed relative to the other.

Remarks

The non-final Office Action of February 26, 2026, has been received and reviewed. In this Response, claims 2 and 14 have been amended, and claim 22 has been added. As a result, the pending claims are claims 2–22. Reconsideration and withdrawal of the pending rejections are respectfully requested.

New Claim

Support for new claim 22 can be found, e.g., in the specification at p. 21, lines 9–11, p. 22, lines 3–5, p. 31, lines 25–26, and p. 32, lines 7–10; and in FIGS. 8F–I, 10, and 12.

Claim Amendments

Support for the amendments to independent claims 2 and 14 can be found, e.g., in the specification at p. 31, lines 25–26, and p. 32, lines 7–11; and FIGS. 3–4, 8F–I, 10, and 12.

Double Patenting Rejection

Claims 1, 3–4, and 14–15[1] were provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1 and 15 of co-pending U.S. Patent Application No. 18/924,062.

Claims 1, 3–4, and 14–15 were provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1, 7, 14, and 21 of co-pending U.S. Patent Application No. 19/303,720.

Submitted herewith is a Terminal Disclaimer that, Applicant submits, complies with 37 C.F.R. § 1.321(c) and thereby obviates the double patenting rejections of pending claims 2–4 and 14–15.

[1] Applicant presumes that the Examiner intended these rejections to be of claims 2, 3–4, and 14–15 as independent claim 1 had been canceled in the Preliminary Amendment dated August 19, 2025, and the restatement of independent claim 1 on pp. 4 and 7 of the Office Action is instead of independent claim 2.

The 35 U.S.C. § 103 Rejection

Claims 2, 4–14, and 16–21 were rejected under 35 U.S.C. § 103 as being obvious over Pinnell et al. (U.S. Patent Publication No. 2008/0240480) (Pinnell) in view of Linden et al. (WO 2016/036309) (Linden). Applicant traverses this rejection; however, to further move this application towards allowance, Applicant has amended independent claims 2 and 14 as described above. Applicant submits that amended claims 2, 4–14, and 16–21 are not *prima facie* obvious because the combination of Pinnell and Linden as alleged does not teach or suggest all of the elements of these claims. To establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. *See In re Royka*, 490 F.2d 981 (C.C.P.A. 1974). Further, under the obviousness theory alleged (e.g., a combination of references), the Examiner must "make findings, supported by evidence and explanation" that "all of the elements" of the claims are found in the cited references. *See Personal Web Technologies, LLC v. Apple, Inc.*, 848 F.3d 987, 992 (Fed. Cir. 2017).

For example, Applicant submits that the combination of Pinnell and Linden as alleged does not teach or suggest that the alleged central contact and the alleged annular ring contact or the plurality of contacts form at least a portion of an exterior surface of the alleged hearing device as is recited in independent claims 2 and 14.

Amended claims 2 and 14 in part recite that the central contact and the annular ring contact or the plurality of contacts form at least a portion of an exterior surface of the hearing device. For example, as shown, e.g., in FIG. 8F of the present application, which is an exemplary embodiment of hearing device of the present application, central contact 842 and plurality of contacts 844a–c form at least a portion of an exterior surface of the hearing device.

In contrast to claims 2 and 14, Pinnell as alleged describes secondary batteries for hearing aids. *See* Pinnell, Abstract. In particular, the reference discloses a hearing aid that includes a hearing aid body, hearing aid components disposed within the body, and a secondary battery in the form of a button cell configured to be recharged without removal from the hearing aid body. *See id.* ¶ [0013]. As shown in FIGS. 2 and 2A, Pinnell as alleged further discloses a hearing aid 100 having a body 102 with a portion 104 configured to be placed in a user's ear, a base 108, and

a battery compartment door 106. *See id*. ¶ [0033]. Pinnell further discloses that "[a]djacent the battery compartment door are a pair of sliding contact doors 110, which cover and protect a pair of electrical contacts (not shown)," and that "[t]he sliding contact doors 110 are designed to be deflected by a cooperating portion of a battery charger, exposing the electrical contacts for connection with corresponding contacts of the charger." *Id.* As shown in FIGS. 2–2A, the sliding contact doors 110 are positioned adjacent the battery compartment door 106 at the base 108 of the body 102.

The Examiner identified Figs. 2–2A, the sliding contact doors 110, and ¶ [0034] of Pinnell as disclosing the claimed electrode arrangement except for a central contact. *See* Non-Final Act. 11–12. The Examiner also asserted, in the rejection of claim 9, that ¶ [0017] of Pinnell discloses arcuate contacts. *See id.* 11 and 14. While admitting that Pinnell fails to teach or suggest that the alleged electrode arrangement includes a central contact, the Examiner alleges that it would have been obvious for one of skill in the art to modify the Pinnell device to include the alleged central contact 44b of Linden "for the purpose of including a third middle/central contact to enable ground connection within the charging [sic]." Non-Final Act. 12.

Applicant strongly disagrees at least because (1) Pinnell's alleged central contact and the annular ring contact or the plurality of contacts of the disclosed hearing device as modified by Linden do not form at least a portion of an exterior surface of the hearing device as recited in independent claims 2 and 14, (2) nothing identified by the Examiner in Linden remedies the deficiencies of Pinnell, (3) the alleged motivation to combine Pinnell and Linden is a mere conclusory statement, and (4) modifying Pinnell such that the electrical contacts form at least a portion of the exterior surface of the alleged hearing device would render Pinnell's sliding contact door design unsatisfactory for its intended purpose.

1. Pinnell's alleged central contact and the annular ring contact or the plurality of contacts do not form at least a portion of an exterior surface of the alleged hearing device.

Pinnell as alleged describes "sliding contact doors 110, which cover and protect a pair of electrical contacts (not shown)." Pinnell ¶ [0033]. The electrical contacts in Pinnell are explicitly "not shown" in the figures and are hidden behind protective sliding doors 110. *See id.* The reference numbers 110 refer to the doors that cover the contacts, not the contacts themselves. As shown in FIGS. 2 and 2A, the reference describes that the sliding contact doors 110, and not the alleged electrical contacts that form at least a portion of an exterior surface of the alleged hearing device.

Further, Pinnell confirms that the contacts are "underlying" by describing that the charger's contacts are "configured to push the sliding contact doors 110 of the hearing aid out of the way **exposing the underlying contacts of the hearing aid**…." *Id.* ¶ [0034] (emphasis added). Because Pinnell's electrical contacts are concealed behind sliding doors and are "underlying," they cannot form at least a portion of an exterior surface of the alleged hearing device as recited in independent claims 2 and 14.

Therefore, Pinnell as alleged fails to teach or suggest that the alleged central contact and the annular ring contact or the plurality of contacts form at least a portion of an exterior surface of the hearing device as recited in independent claims 2 and 14.

2. Nothing identified by the Examiner in Linden remedies the deficiencies of Pinnell.

As relied upon by the Examiner, Linden discloses a wireless earbud 10 that includes an earbud housing 12, 16, a loudspeaker element 13, a rechargeable battery 14, a main printed circuit board 15, and a charging interface member 17. *See* Linden, Abstract. Linden further discloses a storage and charging capsule 20 for charging the earbud 10, where the capsule includes a power transmission arrangement having a first charging connector disc 42 with charging connector elements 44a, 44b, 44c in the form of pogo pins, including center pogo pin

44b (i.e., the alleged central contact) that provides a first power supply potential such as ground. *See id*. 6:10–25; FIG. 4.

Linden as alleged does not, however, teach or suggest electrical contacts that form at least a portion of an exterior surface of the hearing device as recited in independent claims 2 and 14. For at least these reasons, Pennell and Linden fail to teach or suggest the recited electrode arrangement as recited in independent claims 2 and 14 as required for a *prima facie* case of obviousness.

3. The alleged motivation to combine Pinnell and Linden is a mere conclusory statement.

Absent any articulated reasoning with some rational underpinning as to why one of ordinary skill in the art would add a contact to the device of Pinnell in the location asserted by the Examiner, the current rejection amounts to a mere conclusory statement of obviousness. *See* M.P.E.P. § 2143.

The Examiner asserted that "[i]t would have been obvious to a person having ordinary skills in the art before the effective filing date of the application to modify the Pinnell et al [sic] device such that it includes a middle/central/contact/pong/electrode as taught in Linden for the purpose of including a third middle/central contact to enable ground connection within the charging [sic]." Non-Final Act. 12. However, this conclusory statement fails to articulate why one of ordinary skill in the art would add a third contact to enable a ground connection or a third contact specifically at a middle/central location.

It is unclear why one of ordinary skill in the art would be motivated, based on the contacts 44 of the storage and charge capsule 20, to modify the Pinnell device to include a third contact to be a middle/central contact that would arrive at the claimed electrode arrangement. The device of Pinnell can charge without a ground connection, and the Examiner has declined to articulate what purpose such ground connection would serve. Furthermore, the Examiner has failed to provide any articulated reasoning with some rational underpinning why one of ordinary skill in the art would add a third contact specifically at a middle/central location.

Absent any articulated reasoning with some rational underpinning as to why one of ordinary skill in the art would add a contact to the device of Pinnell in the location asserted by the Examiner, the current rejection amounts to a mere conclusory statement of obviousness. In other words, it appears that the Examiner has merely alleged the claimed electrode arrangement is obvious by arbitrarily rearranging elements of Pinnell and Linden using the claims of the present application as a guide in an act of impermissible hindsight reasoning.

Therefore, Pinnell in view of Linden as alleged fails to teach or suggest an electrode arrangement that includes a central contact and an annular ring contact or a plurality of contacts that form at least a portion of an exterior surface of the hearing device as recited in independent claims 2 and 14.

4. Modifying Pinnell such that the central contact and the annular ring contact or the plurality of contacts form at least a portion of an exterior surface of the hearing device would render Pinnell's sliding contact door design unsatisfactory for its intended purpose.

Moreover, modifying Pinnell to dispose the alleged electrical contacts such that they form at least a portion of an exterior surface of the hearing device as the Examiner suggests, would render Pinnell's sliding contact door design unsatisfactory for its intended purpose. *See* M.P.E.P. § 2143.01(V). Pinnell's sliding contact doors 110 are specifically designed to "cover and protect" the electrical contacts. Pinnell ¶ [0033]. Disposing the contacts such that they form at least a portion of an exterior surface of the hearing device as recited in independent claims 2 and 14 would eliminate the very protection that Pinnell's sliding doors 110 are designed to provide. A person of ordinary skill in the art following Pinnell's teachings would be led to conceal the contacts behind protective doors 110, not form a portion of the exterior surface.

Therefore, there is no teaching, suggestion, or motivation to modify the device of Pinnell to arrive at the electrode arrangement as recited in independent claims 2 and 14.

As a result, the combination of Pinnell and Linden as alleged does not teach or suggest all of the elements of claims 2 and 14; therefore, such claims are patentable over this combination.

Further, claims 4–13 and 16–21, which depend from either independent claim 2 or independent claim 14, are patentable over the combination of Pinnell and Linden as alleged for at least the same reasons as presented above for claims 2 and 14. In addition, each of claims 4–13 and 16–21 recites additional elements that further support patentability when combined with either claim 1 or claim 14.

For example, in the rejection of dependent claims 9 and 19, the Examiner cites Pinnell ¶ [0017] for allegedly describing "three arcuate contacts each arranged at substantially the same distance from the central contact…." Non-Final Act. 14 and 16.

As set forth above, Figs. 2–2A of Pinnell do not show the electrical contacts and, therefore, cannot be relied on as a disclosure of three arcuate contacts. Pinnell describes "sliding contact doors 110, which cover and protect a pair of electrical contacts (not shown)." Pinnell ¶ [0033]. Notably, the electrical contacts are explicitly stated to be "not shown" in the figures, and they are covered by sliding doors 110. The reference numbers 110 refer to the doors that cover the contacts, not the contacts themselves. As shown in FIGS. 2–2A, the reference describes that the sliding contact doors 110, and not the alleged electrode arrangement, are disposed in an outer surface of the faceplate.

Further, the Examiner has failed to provide any teaching or suggestion in Pinnell that describes that the alleged arcuate contacts, which are hidden behind door 110 and, therefore, "not shown" in FIGS. 2–2A, are arcuate. Under the broadest reasonable interpretation, the words of a claim must be given their plain meaning. *See* M.P.E.P. § 2111.01. The plain meaning of a term means the ordinary and customary meaning given to the term by those of ordinary skill in the art. *See id.* The term "arcuate" recited in claim 1 is commonly defined as "[c]urved like a bow, arc-shaped, arched." Oxford English Dictionary [retrieved on 2026-04-19]. Retrieved from the Internet: <URL: https://www.oed.com/search/dictionary/?scope=Entries&q=arcuate>. Thus, "three arcuate contacts" as recited in dependent claims 9 and 19 require contacts each having a curved or bow-shaped form that extends around at least a portion of the central contact. Pinnell as alleged does not, however, teach or suggest such arcuate contacts. As a result, Pinnell as

alleged does not teach or suggest all of the elements of dependent claims 9 and 19. And the addition of Linden as alleged does nothing to cure the deficiencies already present in Pinnell.

Further, for example, the Examiner cites Linden 13:31 through 14:3 for allegedly describing that the electrode arrangement of the hearing device is configured to communicate power and one or more information signals as recited in claim 13. *See* Non-Final Act. 15–16. However, the cited portions of Linden relate to wireless radio communication circuitry (Bluetooth) on the main printed circuit board, not communication of information signals through the electrode/charging interface. *See* Linden 10:31–33 (describing that the device includes a main circuit board 115 that includes "circuitry for wireless radio communication 110, audio codec 112 and earbud operation control 114"). Claim 13 requires the electrode arrangement itself to be "configured to communicate power and one or more information signals." The electrode arrangement in Linden as alleged is solely for charging, not for communicating information signals through the physical electrode contacts. As a result, Pinnell as alleged does not teach or suggest all of the elements of dependent claims 13. And the addition of Linden as alleged does nothing to cure the deficiencies already present in Pinnell.

For at least the above reasons, Applicant submits that claims 2, 4–14, and 16–21 are patentable over the combination of Pinnell and Linden as alleged. Reconsideration and withdrawal of this rejection are, therefore, respectfully requested.

Claims 3 and 15 were rejected under 35 U.S.C. § 103 as being obvious over Pinnell and Linden as applied to claim 2, and further in view of Knapp (U.S. Patent No. 5,253,300). Applicant traverses this rejection and submits that claims 3 and 15 are not *prima facie* obvious because the combination of Pinnell, Linden, and Knapp as alleged does not teach or suggest all of the elements of these claims.

Claims 3 and 15 depend from independent claims 2 and 14, respectively, and, therefore, include all of the elements of their respective independent claims. As stated above, the combination of Pinnell and Linden as alleged does not teach or suggest all of the elements of claims 2 and 14. And the addition of Knapp as alleged does nothing to cure the deficiencies

already present in Pinnell and Linden. As a result, the combination of these references as alleged does not teach or suggest all of the elements of independent claims 2 and 14; therefore, such combination does not teach or suggest all of the elements of claims 3 and 15. In addition, each of claims 3 and 15 recites additional elements that further support patentability when combined with either independent claim 2 or independent claim 14.

For at least the above reasons, Applicant submits that claims 3 and 15 are patentable over the combination of Pinnell, Linden, and Knapp as alleged. Reconsideration and withdrawal of this rejection are, therefore, respectfully requested.

Summary

Applicant submits that the claims are in condition for allowance and requests notification to that effect. Applicant invites the Examiner to contact the undersigned Applicant's Representative at the telephone number listed below if doing so may advance prosecution of this application.

Respectfully submitted by

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.:	18/810,014	Attorney Docket No.:	ST0806US4/0532.000806US04
Confirmation No.:	7322	Customer No.:	142537
Filing Date:	August 20, 2024	Examiner Name:	Monikang, George C.
First Named Inventor:	Erik Carlson	Group Art Unit:	2692
Title:	SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

AMENDMENT AND RESPONSE

Commissioner for Patents
Mail Stop Amendment
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

In response to the non-final Office Action of February 26, 2026, please consider the following.

Amendments to the Claims begin on the page entitled "Amendments to the Claims."

Remarks begin on the page entitled "Remarks."

Authorization is given to charge Deposit Account No. 13-4895 any necessary fees for this filing and all required extension of time fees.

Amendments to the Claims

This listing of claims replaces all prior versions, and listings, of claims in the above-identified application:

Listing of Claims

1. (Canceled)

2. (Currently Amended) A hearing device comprising:

a housing that encloses an internal volume and extends from an internal side to an external side, the housing comprising:

a shell arranged at the internal side, the internal side configured to be inserted in a wearer's ear canal; and

a faceplate arranged at the external side, the external side configured to face away from the wearer;

an electrode arrangement disposed in an outer surface of the faceplate, the electrode arrangement comprising:

a central contact; and

an annular ring contact surrounding the central contact or a plurality of contacts surrounding the central contact, wherein the central contact and the annular ring contact or the plurality of contacts form at least a portion of an exterior surface of the hearing device; and

circuitry disposed in the internal volume and coupled to the electrode arrangement.

3. (Previously Presented) The hearing device of claim 2, further comprising one or more microphone ports disposed in the outer surface of the faceplate.

4. (Previously Presented) The hearing device of claim 2, further comprising a receiver outlet disposed in the shell.

5. (Previously Presented) The hearing device of claim 2, wherein the electrode arrangement comprises the plurality of contacts.

6. (Previously Presented) The hearing device of claim 5, wherein each of the plurality of contacts is arranged the same distance from the central contact as each other contact of the plurality of contacts.

7. (Previously Presented) The hearing device of claim 5, wherein the plurality of contacts defines a circle.

8. (Previously Presented) The hearing device of claim 5, wherein each of the plurality of contacts comprises a curvilinear, annular, oval, elliptical, or polygonal shape.

9. (Previously Presented) The hearing device of claim 5, wherein the plurality of contacts comprises three arcuate contacts each arranged at substantially the same distance from the central contact.

10. (Previously Presented) The hearing device of claim 5, wherein the central contact defines a cathode contact and at least one contact of the plurality of contacts defines an anode contact.

11. (Previously Presented) The hearing device of claim 2, wherein the electrode arrangement comprises the annular ring contact surrounding the central contact.

12. (Previously Presented) The hearing device of claim 2, wherein the circuitry comprises charging circuitry, and wherein the electrode arrangement is coupled to the charging circuitry.

13. (Previously Presented) The hearing device of claim 2, wherein the electrode arrangement is configured to communicate power and one or more information signals.

14. (Currently Amended) A system comprising:

a hearing device comprising:

a housing that encloses an internal volume and extends from an internal side to an external side, the housing comprising:

a shell arranged at the internal side, the internal side configured to be inserted in a wearer's ear canal; and

a faceplate arranged at the external side, the external side configured to face away from the wearer;

an electrode arrangement disposed in an outer surface of the faceplate, the electrode arrangement comprising:

a central contact; and

an annular ring contact surrounding the central contact or a plurality of contacts surrounding the central contact, wherein the central contact and the annular ring contact or the plurality of contacts form at least a portion of an exterior surface of the hearing device; and

circuitry disposed in the internal volume and coupled to the electrode arrangement; and

a charging module comprising a charging interface that comprises:

a central charging contact; and

an annular ring charging contact or a plurality of charging contacts surrounding the central contact.

15. (Previously Presented) The system of claim 14, wherein the hearing device further comprises:

one or more microphone ports disposed in the outer surface of the faceplate; and

a receiver outlet disposed in the shell.

16. (Previously Presented) The system of claim 14, wherein the electrode arrangement of the hearing device comprises the plurality of contacts.

17. (Previously Presented) The system of claim 16, wherein each of the plurality of contacts is arranged the same distance from the central contact as each other contact of the plurality of contacts.

18. (Previously Presented) The system of claim 16, wherein the plurality of contacts defines a circle.

19. (Previously Presented) The system of claim 16, wherein the plurality of contacts comprises three arcuate contacts each arranged at substantially the same distance from the central contact.

20. (Previously Presented) The system of claim 14, wherein the electrode arrangement of the hearing device comprises the annular ring contact surrounding the central contact.

21. (Previously Presented) The system of claim 14, wherein the hearing device comprises a first charging interface comprising the electrode arrangement, wherein the circuitry of the hearing device comprises charging circuitry coupled to the electrode arrangement, wherein the charging interface of the charging module defines a second charging interface configured to detachably couple with the first charging interface of the hearing device;

wherein the charging module further comprises charging circuitry coupled to the second charging interface and configured to charge a rechargeable power source of the hearing device that is coupled to the first charging interface.

22. (New) The hearing device of claim 2, wherein the central contact comprises a central contact surface and the annular ring contact or the plurality of contacts comprises a contact

surface, wherein one of the central contact surface and the contact surface of the annular ring contact or the plurality of contacts is recessed relative to the other.

Remarks

The non-final Office Action of February 26, 2026, has been received and reviewed. In this Response, claims 2 and 14 have been amended, and claim 22 has been added. As a result, the pending claims are claims 2–22. Reconsideration and withdrawal of the pending rejections are respectfully requested.

New Claim

Support for new claim 22 can be found, e.g., in the specification at p. 21, lines 9–11, p. 22, lines 3–5, p. 31, lines 25–26, and p. 32, lines 7–10; and in FIGS. 8F–I, 10, and 12.

Claim Amendments

Support for the amendments to independent claims 2 and 14 can be found, e.g., in the specification at p. 31, lines 25–26, and p. 32, lines 7–11; and FIGS. 3–4, 8F–I, 10, and 12.

Double Patenting Rejection

Claims 1, 3–4, and 14–15[1] were provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1 and 15 of co-pending U.S. Patent Application No. 18/924,062.

Claims 1, 3–4, and 14–15 were provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1, 7, 14, and 21 of co-pending U.S. Patent Application No. 19/303,720.

Submitted herewith is a Terminal Disclaimer that, Applicant submits, complies with 37 C.F.R. § 1.321(c) and thereby obviates the double patenting rejections of pending claims 2–4 and 14–15.

[1] Applicant presumes that the Examiner intended these rejections to be of claims 2, 3–4, and 14–15 as independent claim 1 had been canceled in the Preliminary Amendment dated August 19, 2025, and the restatement of independent claim 1 on pp. 4 and 7 of the Office Action is instead of independent claim 2.

The 35 U.S.C. § 103 Rejection

Claims 2, 4–14, and 16–21 were rejected under 35 U.S.C. § 103 as being obvious over Pinnell et al. (U.S. Patent Publication No. 2008/0240480) (Pinnell) in view of Linden et al. (WO 2016/036309) (Linden). Applicant traverses this rejection; however, to further move this application towards allowance, Applicant has amended independent claims 2 and 14 as described above. Applicant submits that amended claims 2, 4–14, and 16–21 are not *prima facie* obvious because the combination of Pinnell and Linden as alleged does not teach or suggest all of the elements of these claims. To establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. *See In re Royka*, 490 F.2d 981 (C.C.P.A. 1974). Further, under the obviousness theory alleged (e.g., a combination of references), the Examiner must "make findings, supported by evidence and explanation" that "all of the elements" of the claims are found in the cited references. *See Personal Web Technologies, LLC v. Apple, Inc.*, 848 F.3d 987, 992 (Fed. Cir. 2017).

For example, Applicant submits that the combination of Pinnell and Linden as alleged does not teach or suggest that the alleged central contact and the alleged annular ring contact or the plurality of contacts form at least a portion of an exterior surface of the alleged hearing device as is recited in independent claims 2 and 14.

Amended claims 2 and 14 in part recite that the central contact and the annular ring contact or the plurality of contacts form at least a portion of an exterior surface of the hearing device. For example, as shown, e.g., in FIG. 8F of the present application, which is an exemplary embodiment of hearing device of the present application, central contact 842 and plurality of contacts 844a–c form at least a portion of an exterior surface of the hearing device.

In contrast to claims 2 and 14, Pinnell as alleged describes secondary batteries for hearing aids. *See* Pinnell, Abstract. In particular, the reference discloses a hearing aid that includes a hearing aid body, hearing aid components disposed within the body, and a secondary battery in the form of a button cell configured to be recharged without removal from the hearing aid body. *See id.* ¶ [0013]. As shown in FIGS. 2 and 2A, Pinnell as alleged further discloses a hearing aid 100 having a body 102 with a portion 104 configured to be placed in a user's ear, a base 108, and

a battery compartment door 106. *See id.* ¶ [0033]. Pinnell further discloses that "[a]djacent the battery compartment door are a pair of sliding contact doors 110, which cover and protect a pair of electrical contacts (not shown)," and that "[t]he sliding contact doors 110 are designed to be deflected by a cooperating portion of a battery charger, exposing the electrical contacts for connection with corresponding contacts of the charger." *Id.* As shown in FIGS. 2–2A, the sliding contact doors 110 are positioned adjacent the battery compartment door 106 at the base 108 of the body 102.

The Examiner identified Figs. 2–2A, the sliding contact doors 110, and ¶ [0034] of Pinnell as disclosing the claimed electrode arrangement except for a central contact. *See* Non-Final Act. 11–12. The Examiner also asserted, in the rejection of claim 9, that ¶ [0017] of Pinnell discloses arcuate contacts. *See id.* 11 and 14. While admitting that Pinnell fails to teach or suggest that the alleged electrode arrangement includes a central contact, the Examiner alleges that it would have been obvious for one of skill in the art to modify the Pinnell device to include the alleged central contact 44b of Linden "for the purpose of including a third middle/central contact to enable ground connection within the charging [sic]." Non-Final Act. 12.

Applicant strongly disagrees at least because (1) Pinnell's alleged central contact and the annular ring contact or the plurality of contacts of the disclosed hearing device as modified by Linden do not form at least a portion of an exterior surface of the hearing device as recited in independent claims 2 and 14, (2) nothing identified by the Examiner in Linden remedies the deficiencies of Pinnell, (3) the alleged motivation to combine Pinnell and Linden is a mere conclusory statement, and (4) modifying Pinnell such that the electrical contacts form at least a portion of the exterior surface of the alleged hearing device would render Pinnell's sliding contact door design unsatisfactory for its intended purpose.

1. Pinnell's alleged central contact and the annular ring contact or the plurality of contacts do not form at least a portion of an exterior surface of the alleged hearing device.

Pinnell as alleged describes "sliding contact doors 110, which cover and protect a pair of electrical contacts (not shown)." Pinnell ¶ [0033]. The electrical contacts in Pinnell are explicitly "not shown" in the figures and are hidden behind protective sliding doors 110. *See id.* The reference numbers 110 refer to the doors that cover the contacts, not the contacts themselves. As shown in FIGS. 2 and 2A, the reference describes that the sliding contact doors 110, and not the alleged electrical contacts that form at least a portion of an exterior surface of the alleged hearing device.

Further, Pinnell confirms that the contacts are "underlying" by describing that the charger's contacts are "configured to push the sliding contact doors 110 of the hearing aid out of the way **exposing the underlying contacts of the hearing aid**…." *Id.* ¶ [0034] (emphasis added). Because Pinnell's electrical contacts are concealed behind sliding doors and are "underlying," they cannot form at least a portion of an exterior surface of the alleged hearing device as recited in independent claims 2 and 14.

Therefore, Pinnell as alleged fails to teach or suggest that the alleged central contact and the annular ring contact or the plurality of contacts form at least a portion of an exterior surface of the hearing device as recited in independent claims 2 and 14.

2. Nothing identified by the Examiner in Linden remedies the deficiencies of Pinnell.

As relied upon by the Examiner, Linden discloses a wireless earbud 10 that includes an earbud housing 12, 16, a loudspeaker element 13, a rechargeable battery 14, a main printed circuit board 15, and a charging interface member 17. *See* Linden, Abstract. Linden further discloses a storage and charging capsule 20 for charging the earbud 10, where the capsule includes a power transmission arrangement having a first charging connector disc 42 with charging connector elements 44a, 44b, 44c in the form of pogo pins, including center pogo pin

44b (i.e., the alleged central contact) that provides a first power supply potential such as ground. *See id.* 6:10–25; FIG. 4.

Linden as alleged does not, however, teach or suggest electrical contacts that form at least a portion of an exterior surface of the hearing device as recited in independent claims 2 and 14. For at least these reasons, Pennell and Linden fail to teach or suggest the recited electrode arrangement as recited in independent claims 2 and 14 as required for a *prima facie* case of obviousness.

3. The alleged motivation to combine Pinnell and Linden is a mere conclusory statement.

Absent any articulated reasoning with some rational underpinning as to why one of ordinary skill in the art would add a contact to the device of Pinnell in the location asserted by the Examiner, the current rejection amounts to a mere conclusory statement of obviousness. *See* M.P.E.P. § 2143.

The Examiner asserted that "[i]t would have been obvious to a person having ordinary skills in the art before the effective filing date of the application to modify the Pinnell et al [sic] device such that it includes a middle/central/contact/pong/electrode as taught in Linden for the purpose of including a third middle/central contact to enable ground connection within the charging [sic]." Non-Final Act. 12. However, this conclusory statement fails to articulate why one of ordinary skill in the art would add a third contact to enable a ground connection or a third contact specifically at a middle/central location.

It is unclear why one of ordinary skill in the art would be motivated, based on the contacts 44 of the storage and charge capsule 20, to modify the Pinnell device to include a third contact to be a middle/central contact that would arrive at the claimed electrode arrangement. The device of Pinnell can charge without a ground connection, and the Examiner has declined to articulate what purpose such ground connection would serve. Furthermore, the Examiner has failed to provide any articulated reasoning with some rational underpinning why one of ordinary skill in the art would add a third contact specifically at a middle/central location.

Absent any articulated reasoning with some rational underpinning as to why one of ordinary skill in the art would add a contact to the device of Pinnell in the location asserted by the Examiner, the current rejection amounts to a mere conclusory statement of obviousness. In other words, it appears that the Examiner has merely alleged the claimed electrode arrangement is obvious by arbitrarily rearranging elements of Pinnell and Linden using the claims of the present application as a guide in an act of impermissible hindsight reasoning.

Therefore, Pinnell in view of Linden as alleged fails to teach or suggest an electrode arrangement that includes a central contact and an annular ring contact or a plurality of contacts that form at least a portion of an exterior surface of the hearing device as recited in independent claims 2 and 14.

4. Modifying Pinnell such that the central contact and the annular ring contact or the plurality of contacts form at least a portion of an exterior surface of the hearing device would render Pinnell's sliding contact door design unsatisfactory for its intended purpose.

Moreover, modifying Pinnell to dispose the alleged electrical contacts such that they form at least a portion of an exterior surface of the hearing device as the Examiner suggests, would render Pinnell's sliding contact door design unsatisfactory for its intended purpose. *See* M.P.E.P. § 2143.01(V). Pinnell's sliding contact doors 110 are specifically designed to "cover and protect" the electrical contacts. Pinnell ¶ [0033]. Disposing the contacts such that they form at least a portion of an exterior surface of the hearing device as recited in independent claims 2 and 14 would eliminate the very protection that Pinnell's sliding doors 110 are designed to provide. A person of ordinary skill in the art following Pinnell's teachings would be led to conceal the contacts behind protective doors 110, not form a portion of the exterior surface.

Therefore, there is no teaching, suggestion, or motivation to modify the device of Pinnell to arrive at the electrode arrangement as recited in independent claims 2 and 14.

As a result, the combination of Pinnell and Linden as alleged does not teach or suggest all of the elements of claims 2 and 14; therefore, such claims are patentable over this combination.

Further, claims 4–13 and 16–21, which depend from either independent claim 2 or independent claim 14, are patentable over the combination of Pinnell and Linden as alleged for at least the same reasons as presented above for claims 2 and 14. In addition, each of claims 4–13 and 16–21 recites additional elements that further support patentability when combined with either claim 1 or claim 14.

For example, in the rejection of dependent claims 9 and 19, the Examiner cites Pinnell ¶ [0017] for allegedly describing "three arcuate contacts each arranged at substantially the same distance from the central contact…." Non-Final Act. 14 and 16.

As set forth above, Figs. 2–2A of Pinnell do not show the electrical contacts and, therefore, cannot be relied on as a disclosure of three arcuate contacts. Pinnell describes "sliding contact doors 110, which cover and protect a pair of electrical contacts (not shown)." Pinnell ¶ [0033]. Notably, the electrical contacts are explicitly stated to be "not shown" in the figures, and they are covered by sliding doors 110. The reference numbers 110 refer to the doors that cover the contacts, not the contacts themselves. As shown in FIGS. 2–2A, the reference describes that the sliding contact doors 110, and not the alleged electrode arrangement, are disposed in an outer surface of the faceplate.

Further, the Examiner has failed to provide any teaching or suggestion in Pinnell that describes that the alleged arcuate contacts, which are hidden behind door 110 and, therefore, "not shown" in FIGS. 2–2A, are arcuate. Under the broadest reasonable interpretation, the words of a claim must be given their plain meaning. *See* M.P.E.P. § 2111.01. The plain meaning of a term means the ordinary and customary meaning given to the term by those of ordinary skill in the art. *See id.* The term "arcuate" recited in claim 1 is commonly defined as "[c]urved like a bow, arc-shaped, arched." Oxford English Dictionary [retrieved on 2026-04-19]. Retrieved from the Internet: <URL: https://www.oed.com/search/dictionary/?scope=Entries&q=arcuate>. Thus, "three arcuate contacts" as recited in dependent claims 9 and 19 require contacts each having a curved or bow-shaped form that extends around at least a portion of the central contact. Pinnell as alleged does not, however, teach or suggest such arcuate contacts. As a result, Pinnell as

alleged does not teach or suggest all of the elements of dependent claims 9 and 19. And the addition of Linden as alleged does nothing to cure the deficiencies already present in Pinnell.

Further, for example, the Examiner cites Linden 13:31 through 14:3 for allegedly describing that the electrode arrangement of the hearing device is configured to communicate power and one or more information signals as recited in claim 13. *See* Non-Final Act. 15–16. However, the cited portions of Linden relate to wireless radio communication circuitry (Bluetooth) on the main printed circuit board, not communication of information signals through the electrode/charging interface. *See* Linden 10:31–33 (describing that the device includes a main circuit board 115 that includes "circuitry for wireless radio communication 110, audio codec 112 and earbud operation control 114"). Claim 13 requires the electrode arrangement itself to be "configured to communicate power and one or more information signals." The electrode arrangement in Linden as alleged is solely for charging, not for communicating information signals through the physical electrode contacts. As a result, Pinnell as alleged does not teach or suggest all of the elements of dependent claims 13. And the addition of Linden as alleged does nothing to cure the deficiencies already present in Pinnell.

For at least the above reasons, Applicant submits that claims 2, 4–14, and 16–21 are patentable over the combination of Pinnell and Linden as alleged. Reconsideration and withdrawal of this rejection are, therefore, respectfully requested.

Claims 3 and 15 were rejected under 35 U.S.C. § 103 as being obvious over Pinnell and Linden as applied to claim 2, and further in view of Knapp (U.S. Patent No. 5,253,300). Applicant traverses this rejection and submits that claims 3 and 15 are not *prima facie* obvious because the combination of Pinnell, Linden, and Knapp as alleged does not teach or suggest all of the elements of these claims.

Claims 3 and 15 depend from independent claims 2 and 14, respectively, and, therefore, include all of the elements of their respective independent claims. As stated above, the combination of Pinnell and Linden as alleged does not teach or suggest all of the elements of claims 2 and 14. And the addition of Knapp as alleged does nothing to cure the deficiencies

already present in Pinnell and Linden. As a result, the combination of these references as alleged does not teach or suggest all of the elements of independent claims 2 and 14; therefore, such combination does not teach or suggest all of the elements of claims 3 and 15. In addition, each of claims 3 and 15 recites additional elements that further support patentability when combined with either independent claim 2 or independent claim 14.

For at least the above reasons, Applicant submits that claims 3 and 15 are patentable over the combination of Pinnell, Linden, and Knapp as alleged. Reconsideration and withdrawal of this rejection are, therefore, respectfully requested.

Summary

Applicant submits that the claims are in condition for allowance and requests notification to that effect. Applicant invites the Examiner to contact the undersigned Applicant's Representative at the telephone number listed below if doing so may advance prosecution of this application.

Respectfully submitted by

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April 24, 2026
Date

/Jay R. Pralle/
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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/810,014	**04/24/2026 02:10:06 PM Z ET**	**ST0806US2/0532.000806US04**

Title of Invention

SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	7322	FILED BY	Denise Lagro
PATENT CENTER #	75483706	FILING DATE	08/20/2024
CUSTOMER #	142537	FIRST NAMED INVENTOR	Erik Carlson
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Jay Pralle

Documents

TOTAL DOCUMENTS: 3

DOCUMENT		PAGES	DESCRIPTION	SIZE (KB)
2026-04-24-Amend-Response.pdf		15	-	164 KB
2026-04-24-Amend-Response-A....pdf	(1-1)	1	Amendment/Request for Reconsideration-After Non-Final Rejection	87 KB
2026-04-24-Amend-Response-CLM.pdf	(2-6)	5	Claims	109 KB
2026-04-24-Amend-Response-REM.pdf	(7-15)	9	Applicant Arguments/Remarks Made in an Amendment	150 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
2026-04-24-Amend-Response.pdf	3A0AB8B8FEBBFC36ABB83A17405AB1CBD383E7B351AA878D63F683C67E1BA4F41CDF5441B42254E26BFAEB306D3FC408EE6AB34B513BC24D7AD4421EA0A2D36B
2026-04-24-Amend-Response-A....pdf	C90D698508C6C8C4802C08FF0085526AD8434DAFD9D1B31A7D2C10FED2E7367E972710ACDCDBBA8FB6867912C2D436538344A7AE95E5578AAC35C583467074D3
2026-04-24-Amend-Response-CLM.pdf	571E089EB55C9D52C0706A5927899656BCE16F1A8F986BC4D8EF455D34D7C3FC01C973E4A68C9B86A6121D3C1BD0D89E5F6B4EFEBB1C49E4707B8ED22BE7A60A
2026-04-24-Amend-Response-REM.pdf	FBDE21EF00A3CD2828E7AE35CBCB61029B29320757FBCB5531C5DF7B19545C12606B5CB1FDCA6B935F70B1377B92330EAFE7D8F46C797B543EAFE82DAEE16D88

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

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If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

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ELECTRONIC PAYMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/810,014	**04/24/2026 02:10:06 PM Z ET**	**ST0806US2/0532.000806US04**

Title of Invention

SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE

Application Information

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PATENT CENTER #	75483706	AUTHORIZED BY	Jay Pralle
CUSTOMER #	142537	FILING DATE	08/20/2024
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Erik Carlson

Payment Information

PAYMENT METHOD	PAYMENT TRANSACTION ID	PAYMENT AUTHORIZED BY
CARD / 7647	**E20264NE10275215**	**Denise Lagro**

FEE CODE	DESCRIPTION	ITEM PRICE($)	QUANTITY	ITEM TOTAL($)
1202	EACH CLAIM IN EXCESS OF 20	200.00	1	200.00
			TOTAL AMOUNT:	**$200.00**

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submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

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PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 18/810,014	Filing Date 08/20/2024	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $100 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $480 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	04/24/2026	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 21	Minus	** 20	= 1		x $200 =	200
	Independent (37 CFR 1.16(h))	* 3	Minus	*** 3	= 0		x $600 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	200

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	LIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/KIMBERLY N PANNELL/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A PRIOR PATENT

APPLICATION #	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET #
18810014	**08/20/2024**	**Erik Carlson**	**ST0806US2/0532.000806US04**

Title of Invention

SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE

☑ Filing of terminal disclaimer does not obviate requirement for response under 37 CFR 1.111 to outstanding Office Action

☑ This electronic Terminal Disclaimer is not being used for a Joint Research Agreement.

Owner	Percent interest
Starkey Laboratories, Inc.	100%

The owner(s) of percent interest listed above in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of any patent granted on pending reference Application Number(s)

Application #	Filing Date
18924062	10/23/2024
19303720	08/19/2025

as the term of any patent granted on said reference application may be shortened by any terminal disclaimer filed prior to the grant of any patent on the pending reference application. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and any patent granted on the reference application are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.
In making the above disclaimer, the owner does not disclaim the terminal part of any patent granted on the instant application that would extend to the expiration date of the full statutory term of any patent granted on said reference application, "as the term of any patent granted on said reference application may be shortened by any terminal disclaimer filed prior to the grant of any patent on the pending reference application," in the event that any such patent granted on the pending reference application: expires for failure to pay a maintenance fee, is held unenforceable, is found invalid by a court of competent jurisdiction, is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321, has all claims canceled by a reexamination certificate, is reissued, or is in any manner terminated prior to the expiration of its full statutory term as shortened by any terminal disclaimer filed prior to its grant.

The owner(s) of percent interest listed above in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of prior patent number(s)

Patent #

as the term of said prior patent is presently shortened by any terminal disclaimer. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the prior patent are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.
In making the above disclaimer, the owner does not disclaim the terminal part of the term of any patent granted on the instant application that would extend to the expiration date of the full statutory term of the prior patent, "as the term of said prior patent is presently shortened by any terminal disclaimer," in the event that said prior patent later:
- expires for failure to pay a maintenance fee;
- is held unenforceable;
- is found invalid by a court of competent jurisdiction;
- is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321;
- has all claims canceled by a reexamination certificate;
- is reissued; or
- is in any manner terminated prior to the expiration of its full statutory term as presently shortened by any terminal disclaimer.

 Terminal disclaimer fee under 37 CFR 1.20(d) included with Electronic Terminal Disclaimer request.

Applicant claims the following entity status:
Regular Undiscounted

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

I certify, in accordance with 37 CFR 1.4(d)(4) that I am: An attorney or agent registered to practice before the Patent and Trademark Office who is of record in this application

Signature	Name	Registration #
/Jay R. Pralle/	Jay Pralle	52131

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APPROVAL LETTER

APPLICATION #	FILING DATE	APPLICANT/PATENT UNDER REEXAMINATION
18/810,014	**08/20/2024**	**Erik Carlson**

Title of Invention

SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE

Electronic terminal disclaimer filed on 05/07/2026

Approved

This patent is subject to a Terminal Disclaimer

Approved / Disapproved by: Electronic Terminal Disclaimer automatically approved

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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/810,014	**05/07/2026 09:16:07 AM Z ET**	**ST0806US2/0532.000806US04**

Title of Invention

SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	7322	FILED BY	Jay Pralle
PATENT CENTER #	75962374	FILING DATE	08/20/2024
CUSTOMER #	142537	FIRST NAMED INVENTOR	Erik Carlson
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Jay Pralle

Documents

TOTAL DOCUMENTS: 2

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
petition-request.pdf	3	Terminal Disclaimer-Filed (Electronic)	44 KB
grantLetter.pdf	1	Terminal Disclaimer-Electronic-Approved	18 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
petition-request.pdf	ED9612A287D55870E59A0199A33E4689D9C5A569ABE7D64B7CB4AE6C603E7035A2D17142A37CAB55BC5CBC5CCD9AA96F6D5CA7B5D2975B716767BB884AEBF171

grantLetter.pdf

76DFD7F0ADE74854979CBD6DB772305878B9CBEE0E131E63
DEEA2F3264ECF144A6840B0AC027961AB629680D9AA77D85
DBF098EAA2A48A96F1DEA9B415426639

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New Applications Under 35 U.S.C. 111

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ELECTRONIC PAYMENT RECEIPT

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18/810,014	**05/07/2026 09:16:07 AM Z ET**	**ST0806US2/0532.000806US04**

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CUSTOMER #	142537	FILING DATE	08/20/2024
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Erik Carlson

Payment Information

PAYMENT METHOD	PAYMENT TRANSACTION ID	PAYMENT AUTHORIZED BY
CARD / 7647	**E202657016316806**	**Jay Pralle**

PRE-AUTHORIZED ACCOUNT	PRE-AUTHORIZED CATEGORY
134895	**37 CFR 1.16 (National application filing, search, and examination fees); 37 CFR 1.17 (Patent application and reexamination processing fees); 37 CFR 1.19 (Document supply fees); 37 CFR 1.20 (Post Issuance fees); 37 CFR 1.21 (Miscellaneous fees and charges)**

FEE CODE	DESCRIPTION	ITEM PRICE($)	QUANTITY	ITEM TOTAL($)
1814	STATUTORY DISCLAIMER, INCLUDING TERMINAL DISCLAIMER	183.00	1	183.00
			TOTAL AMOUNT:	**$183.00**

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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
6 April 2017 (06.04.2017)

WIPO | PCT

(10) International Publication Number
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(51) International Patent Classification:
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(22) International Filing Date:
23 September 2016 (23.09.2016)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

62/235,213	30 September 2015 (30.09.2015)	US
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62/235,219	30 September 2015 (30.09.2015)	US
62/235,226	30 September 2015 (30.09.2015)	US
62/384,114	6 September 2016 (06.09.2016)	US

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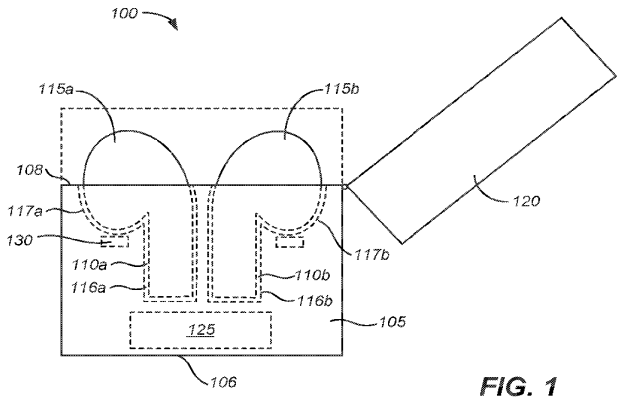


FIG. 1

(57) **Abstract**: A case for a pair of earbuds includes a housing having cavities to receive the pair of earbuds and charging circuitry that is configured to initiate charging of the pair of earbuds when an earbud detector detects that the earbuds are inserted within the cavities.

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CASE FOR CHARGING AND RETAINING PORTABLE LISTENING DEVICES

BACKGROUND

[0001] The described embodiments relate generally to portable listening devices such as earbuds and other types of headphones, and to cases for storing and charging such devices.

[0002] Portable listening devices can be used with a wide variety of electronic devices such as portable media players, smart phones, tablet computers, laptop computers, stereo systems and other types of devices. Portable listening devices have historically included one or more small speakers configured to be place on, in, or near a user's ear, structural components that hold the speakers in place, and a cable that electrically connects the portable listening device to an audio source. Other portable listening devices can be wireless devices that do not include a cable and instead, wirelessly receive a stream of audio data from a wireless audio source.

[0003] While wireless portable listening devices have many advantages over wired devices, they also have some potential drawbacks. For example, wireless portable listening devices, typically require one or more batteries, such as a rechargeable battery, that provides power to the wireless communication circuitry and other components of the device. Single use batteries need to be replaced when their charge is depleted while rechargeable batteries need to be periodically recharged. Also, if the portable wireless listening device is a pair of wireless earbuds, the earbuds can be relatively small and easy to lose when not in use. Further, achieving high-end acoustic performance from the relatively small earbuds can challenge manufacturers due to the reduced amount of space available within each earbud.

SUMMARY

[0004] Some embodiments of the present disclosure relate to a case that can store and charge a portable listening device, such as a pair of wireless earbuds or other types of headphones. In various embodiments the case can include one or more features that can improve the user experience associated with using the case and the portable listening device. For example, some embodiments of the disclosure pertain to a case for wireless earbuds that includes a detector that detects if the earbuds are stored in the case along with a detector that detects if a lid of the case is opened or closed. Circuitry within the case can use information from the detectors to improve the user experience associated with charging the earbuds, pairing the earbuds to a host device, such as a portable media player or other source of an audio signal, and/or turning one or more features of the earbuds off to extend the life of any battery used to power the earbuds.

[0005] In other embodiments, a case for a portable listening device can include a lid that, when closed, encloses the listening device within the case and when open exposes the stored listening device so that a user can remove the listening device from the case. The lid can be pivotably coupled to a housing of the case with a bi-stable hinge with an over center configuration where the lid is in a stable position when it is either closed or fully open and is unstable at positions in between such that the lid tends to move to the open or closed position. The bi-stable operation of the lid can provide a positive user experience in opening and closing the lid as the lid moves easily, and with minimal effort, between closed and fully open positions. In other embodiments a case for a portable listening device can be configured to magnetically attract and retain the listening device within the case. Still other embodiments facilitate the pairing of a wireless portable listening device with a host device and/or automatically turn OFF the wireless radio of a wireless portable listening device when the device is stored and fully enclosed within the case and automatically turn ON the wireless radio upon opening the case lid. Various embodiments of the disclosure can include all of the above features together or just some of the features.

EARBUD CASE WITH CHARGING SYSTEM:

[0006] In some embodiments a case for transporting and charging a portable listening device that includes a rechargeable battery and a power contact is provided. The portable listening device case can include a housing configured to receive the portable listening device; a lid

attached to the housing and operable between a closed position where the lid conceals the listening device within the case and an open position where the lid is displaced from the housing such that a user can remove the listening device from the case; a detector configured to generate a detect signal when the listening device is placed in the housing; and charging circuitry configured to initiate charging of the rechargeable battery in response to receiving the detect signal.

CASE WITH MAGNETIC OVER-CENTER MECHANISM:

[0007] Some embodiments of the disclosure pertain to a case that can be used to store a portable listening device or another type of electronic device. The case can include: a housing having a cavity to receive the electronic device and a receiving opening that communicates with the receiving opening; a lid secured to housing with a pivotable joint, the lid being operable between an open position in which the receiving opening is exposed and a closed position in which the lid covers the receiving opening; and a plurality of magnetic elements disposed within the housing and the lid, the plurality of magnetic elements configured to create an over center position for the lid such that the lid resists rotating from the open position to the closed position until the lid is moved past the over center position when the lid is then attracted to the closed position.

EARBUD CASE WITH WIRELESS RADIO SHUTDOWN FEATURE:

[0008] Some embodiments pertain to a case for a portable listening device having a wireless radio where the case includes: a housing having a cavity configured to receive the portable listening device; a lid attached to the housing and operable between a closed position where the lid conceals the portable listening device within the case and an open position where the lid is displaced from the housing such that a user can remove the portable listening device from the case; a lid sensor to detect if the lid is in the closed position or the open position; and circuitry configured to turn ON the wireless radio when the lid sensor detects that the lid is moved from the closed position to the open position. The lid sensor can generate an open signal when the lid moves from a closed position to an open position, and the circuitry can be configured to turn ON the wireless radio in response to the open signal. In some instances the case can further include an electrical connector having a first contact positioned within the cavity to electrically connect

to a second contact on the portable listening device when the portable listening device is received within the cavity, and the case the circuitry can turn ON the wireless radio in the portable listening device by sending an instruction to the portable listening device over the first contact.

EARBUDS WITH ACOUSTIC INSERT:

[0009] Some embodiments of the disclosure pertain to an earbud that includes: a housing having a non-occluding ear portion; a directional sound port disposed in the non-occluding ear portion; a driver assembly positioned within the housing having a front volume disposed in front of the driver assembly and a back volume disposed behind the driver assembly; and an acoustic insert positioned within the housing behind the driver assembly and attached to an interior surface of the housing such that the acoustic insert and the housing form a bass channel that is routed from the back volume to a multiport vent within the housing. The acoustic insert can include a recess defined by raised weld regions that are acoustically bonded to the interior surface of the housing. In some instances the recess within the acoustic insert forms three walls of the bass channel and the housing forms a fourth wall of the bass channel. The acoustic insert can further include an aperture that couples the front volume to the multiport vent, and the bass channel and the aperture can be coupled to a multiport chamber that is vented through the multiport vent. In some examples the acoustic insert is formed from a carbon doped plastic that absorbs laser energy.

[0010] In some embodiments a method of forming an earbud is provided. The method can include: forming a housing having an interior surface and an exterior surface; forming an acoustic insert such that it has a recess defined by raised weld regions; inserting the acoustic insert within the housing such that the raised weld regions are disposed against the interior surface of the housing; and directing a laser through the housing such that it impinges the raised weld regions of the acoustic insert and welds the raised weld regions to the interior surface of the housing. The housing can be formed from a plastic that is substantially transparent to a wavelength of the laser, and the acoustic insert can be formed from a plastic that absorbs laser energy.

WIRELESS PAIRING OF EARBUDS AND CASE:

[0011] In some embodiments a case for a portable listening device that includes a wireless radio can include: a housing having a receiving area for the portable listening device; a lid attached to the housing and operable between a closed position where the lid conceals the portable listening device within the case and an open position that allows a user to remove the portable listening device from the receiving area; an electrical connector positioned within the receiving area, the electrical connector having one or more case electrical contacts that electrically connect to the one or more device electrical contacts when the portable listening device is received in the receiving area; an input device configured to generate a signal in response to a user-generated action; and a processor coupled to the input device and the electrical connector. The processor can be configured to receive the signal from the input device and, in response, send an instruction to the portable listening device through the electrical connector to initiate wireless pairing of the portable listening device to a host electronic device. In some instances the processor can be further configured to receive send an instruction to the portable listening device through the electrical connector to turn ON its wireless radio in response to receiving the signal from the input device prior to sending an instruction to the portable listening device to initiate wireless pairing of the portable listening device to the host electronic device.

[0012] In some embodiments a method of wirelessly pairing a first electronic device to a second electronic device is provided. The method can include: receiving an input from a user at a third electronic device, different than the first and second devices. In response to receiving the input, the third electronic device can communicate a user input signal to the first electronic device through a wired connection between the third and the first electronic devices. In response to the first electronic device receiving the user input signal, the first electronic device can broadcast a wireless pairing request, and in response to receiving the wireless pairing request, the second electronic device can wirelessly pair with the first device. In some instances, the first electronic device can be a wireless headphone set, the second electronic device can be a mobile electronic device and the third electronic device can be a case for the portable listening device. Also, in some embodiments where the third electronic device is a case for a portable listening device, the input from the user can be opening a lid of a case.

EARBUD CASE WITH RECEPTACLE CONNECTOR FOR EARBUDS:

[0013] In some embodiments a case for a pair of earbuds is provided where each earbud has an ear portion and a stem portion with an electrical connector disposed at a distal end of the stem portion. The case can include: a housing; an insert positioned within the housing, the insert having first and second cavities sized and shaped to accommodate first and second earbuds, respectively, each of the first and second cavities having a receiving opening to receive an earbud into the cavity and a contact opening opposite the receiving opening; and a contact assembly attached to the insert, the contact assembly comprising a first pair of electrical contacts extending into the first cavity and a second pair of electrical contacts extending into the second cavity, the first and second pairs of electrical contacts configured to make electrical contact with the electrical connector disposed at the distal end of the first and second earbuds, respectively, through the contact opening.

WIRELESS EARBUDS WITH ELECTRONIC CONTACTS:

[0014] In some embodiments a wireless earbud is provided that includes: a housing having a stem portion aligned with a longitudinal axis, the stem portion including first and second ends; a speaker assembly having a driver unit and a directional sound port proximate the first end and offset from the longitudinal axis, wherein the driver unit is aligned to emit sound from the directional sound port and comprises a magnet, a voice coil, and a diaphragm; a rechargeable battery disposed in the housing; and first and second external contacts exposed at an external surface at the second end of the stem portion and electrically coupled to provide power to the rechargeable battery. The first and second external contacts can each have a partial annular shape and can be spaced in an oppositional and symmetrical relationship with each other. In some instances an outer perimeter of the first and second external contacts is flush with an exterior surface of the stem portion.

[0015] In some embodiments a wireless earbud includes: a housing; a rechargeable battery disposed in the housing; a speaker assembly including a driver unit and a directional sound port, wherein the driver unit is aligned to emit sound from the directional sound port and comprises a magnet, a voice coil, and a diaphragm; and a plurality of contacts exposed at an external surface of the housing, each contact in the plurality of contacts including a conductive base having a

binary metal alloy plated layer at an outer surface of each contact, the binary metal alloy plated layer comprising rhodium and ruthenium. In some instances, the weight percentage of rhodium is at least 85 percent, with the remainder in ruthenium.

MAGNETIC RETENTION OF EARBUD WITHIN CAVITY:

[0016] Some embodiments of the disclosure pertain to a case for an earbud having one or more earbud magnetic components. The case can include: a receiving cavity sized and shaped to accept the earbud; one or more housing magnetic components disposed within the case and positioned and configured to magnetically attract and magnetically secure the earbud into the receiving cavity and the second earbud into the second receiving cavity; and a lid operable between an open position in which the receiving cavity is exposed and a closed position in which the lid covers the receiving cavity. The case can be configured to store a pair of earbuds and the receiving cavity includes a first receiving cavity sized and shaped to accept a first earbud in the pair of earbuds, and a second receiving cavity sized and shaped to accept a second earbud in the pair of earbuds. In some embodiments the one or more housing magnetic components can include a first plurality of magnetic components disposed around the first receiving cavity and configured to magnetically attract and magnetically retain the first earbud within the first receiving cavity, and a second plurality of magnetic components disposed around the second receiving cavity and configured to magnetically attract and magnetically retain the second earbud within the second receiving cavity.

[0017] In some embodiments an earbud includes: a housing formed to fit at least partially within a user's ear; a directional sound port formed within the housing; a speaker assembly disposed within the housing and including a driver unit comprising a first magnet, the driver unit aligned to emit sound from the directional sound port; a magnetic retention component, separate from the speaker assembly, and positioned in the housing. The housing can have an ear portion and a stem portion, and the magnetic retention component can be disposed within the ear portion. The driver unit can include a diaphragm and a voice coil, and the first magnet can be operatively coupled to the voice coil to move the diaphragm in response to electrical signals and the magnetic retention component is not operatively coupled to the voice coil.

[0018] In some embodiments a wireless listening system is provided that includes the above described case and pair of earbuds.

CASE WITH INDUCTIVE CHARGING TRANSMITTER TO CHARGE A PORTABLE DEVICE:

[0019] In some embodiments a case for a portable listening device includes: a housing having one or more cavities configured to receive the portable listening device and an exterior charging surface; a lid attached to the housing and operable between a closed position where the lid is aligned over the one or more cavities and an open position where the lid is displaced from the one or more cavities; a battery; a first charging system configured to charge the portable listening device when positioned in the one or more cavities; and a second charging system including a transmitting coil positioned within the housing adjacent to the exterior charging surface, the transmitting coil configured to wirelessly transmit power to a power receiving coil of an electronic device positioned outside the housing adjacent to the exterior charging surface. In some embodiments the portable listening device can be a case for a pair of earbuds; the housing can include first and second cavities configured to receive first and second earbuds, respectively; and the first charging system can be configured to charge the first and second earbuds when the earbuds are positioned within the first and second cavities.

WATERPROOF RECEPTACLE CONNECTOR:

[0020] In some embodiments an electrical receptacle connector is disclosed that includes: a housing comprised of an electrically insulative polymer that extends between a receiving face and a rear face, the housing defining a cavity that communicates with an opening in the receiving face to receive a plug portion of a mating plug connector; a contact spacer positioned adjacent to the rear face; a gasket disposed between the rear face of the housing and the contact assembly; a plurality of contacts, each of the plurality of contacts having a tip positioned within the cavity, an anchor portion that anchors each contact to the contact spacer and a beam portion that connects the tip to the anchor portion; and a metallic bracket disposed around an outside surface of the housing.

EARBUDS WITH CAPACITIVE TOUCH SENSOR:

[0021] Some embodiments pertain to an earbud including: a housing defining a cavity in which one or more electrical components of the earbud are housed, the housing having a touch sensitive region at an exterior surface of the housing and an interior surface within the cavity opposite the exterior surface; a capacitive sensor insert having a first surface with metallized circuitry formed thereon and positioned within the housing such that the first surface is adjacent the interior surface of the housing; an earbud processor disposed within the housing; and at least one conductor that electrically couples the capacitive sensor insert to the earbud processor. The capacitive sensor insert can be formed to closely match a shape of the housing. In some instances the metallized circuitry forms at least one self-capacitance sensor in which, when touched by a user, loads self-capacitance circuitry that can be detected. In other instances the metallized circuitry includes row and column electrodes that form at least one mutual-capacitance sensor in which, when touched by a user, mutual coupling between row and column electrodes is altered and detected. The capacitive sensor insert is formed from a plastic that includes metallic particulates.

CASE WITH TORSION SPRING OVER-CENTER MECHANISM:

[0022] In some embodiments a case for a listening device incudes: a housing having a cavity to receive the listening device; a lid attached to the housing with a pivotable joint allowing the lid to rotate between a closed position where the lid is aligned over the cavity and an open position where the lid is angularly displaced allowing the listening device to be removed from the cavity; and an over center mechanism for the lid including an extension attached to the lid and disposed on an opposite side of the pivotable joint from the lid, wherein the extension is in contact with an arm that resists the lid rotating from the open position to the closed position until the lid is moved past an over center position when the lid is then impelled to the closed position.

[0023] To better understand the nature and advantages of the present disclosure, reference should be made to the following description and the accompanying figures. It is to be understood, however, that each of the figures is provided for the purpose of illustration only and is not intended as a definition of the limits of the scope of the present disclosure. Also, as a general rule, and unless it is evident to the contrary from the description, where elements in

different figures use identical reference numbers, the elements are generally either identical or at least similar in function or purpose.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] FIG. 1 is a side view of a case having a lid and configured to hold a pair of earbuds according to embodiments of the disclosure;

[0025] FIG. 2 is a system level diagram of a case with a charging system coupled to a pair of earbuds according to some embodiments of the disclosure;

[0026] FIG. 3 is a simplified cross-sectional view of the case shown in FIG. 1;

[0027] FIG. 4A is a partial cross-sectional view of an earbud connector according to an embodiment of the disclosure;

[0028] FIG. 4B is a plan view of the earbud connector illustrated in FIG. 4A;

[0029] FIG. 5A is a partial cross-sectional view of another embodiment of an earbud connector according to the disclosure;

[0030] FIG. 5B is a plan view of the earbud connector illustrated in FIG. 5A;

[0031] FIG. 6A is a partial cross-sectional view of another embodiment of an earbud connector according to the disclosure;

[0032] FIG. 6B is a plan view of the earbud connector illustrated in FIG. 6A;

[0033] FIG. 6C is an isometric exploded view of a connector assembly for the earbud connector illustrated in FIG. 6A;

[0034] FIG. 6D is an isometric view of the assembled earbud connector illustrated in FIG. 6A;

[0035] FIG. 7A is an isometric exploded view of another embodiment of an earbud connector according to the disclosure;

[0036] FIG. 7B is an isometric view of the assembled earbud connector illustrated in FIG. 7A;

[0037] FIG. 8A is a partial cross-sectional view of another embodiment of an earbud connector according to the disclosure;

[0038] FIG. 8B is a plan view of the connector on the earbud illustrated in FIG. 8A;

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[0039] FIG. 8C is an isometric exploded view of the earbud connector illustrated in FIG. 8A;

[0040] FIGS. 9A and 9B are front and rear isometric views of one of the earbuds shown in FIG. 1, respectively;

[0041] FIG. 10 is a top view of the case shown in FIG. 1 with the case lid removed;

[0042] FIG. 11 is a partial cross-sectional view of an earbud retained in a cavity within the case illustrated in FIG. 10 along section A-A;

[0043] FIG. 12 is a partial cross-sectional view of an earbud retained in a cavity within the case illustrated in FIG. 10 along section B-B;

[0044] FIG. 13 is an isometric view of a case having an over center lid according to some embodiments of the disclosure;

[0045] FIG. 14 is an isometric view of the case shown in FIG. 13 with the over center lid in an open position;

[0046] FIG. 15 is a graph showing attraction and repulsion forces associated with an over center lid according to some embodiments of the disclosure;

[0047] FIG. 16 is a side view of a case that includes one pair of magnets with misaligned poles and one pair with a high permeable material surrounding them according to some embodiments of the disclosure;

[0048] FIG. 17 is a side view of a case that includes two pairs of magnets attached to springs according to some embodiments of the disclosure;

[0049] FIG. 18 is an isometric view of a magnet that may be used in a case according to some embodiments of the disclosure;

[0050] FIG. 19 is an isometric view of a magnet that may be used in a case according to some embodiments of the disclosure;

[0051] FIG. 20 is an isometric view of a magnet that may be used in a case according to some embodiments of the disclosure;

[0052] FIG. 21 is an isometric view of a magnet that may be used in a case according to some embodiments of the disclosure;

[0053] FIG. 22A is a side view of a case with a torsion spring over center mechanism according to some embodiments of the disclosure with its lid closed;

[0054] FIG. 22B is an isometric view of the torsion spring over center mechanism illustrated in FIG. 22A;

[0055] FIG. 22C is a side view of the case illustrated in FIG. 22A with its lid partially open;

[0056] FIG. 22D is a side view of the case illustrated in FIG. 22A with its lid open further;

[0057] FIG. 23 is a simplified perspective view of a wireless charging system according to embodiments of the disclosure;

[0058] FIG. 24 is a block diagram of an inductive power receiving system that can be part of the charging system illustrated in FIG. 23 according to some embodiments;

[0059] FIG. 25 is a simplified plan view of the earbud case illustrated in FIG. 23;

[0060] FIG. 26 is a block diagram of an embodiment of the inductive power transmitting system illustrated in FIG. 23;

[0061] FIG. 27 is a simplified isometric view of an inductively charged case on an inductive charging system according to some embodiments of the disclosure;

[0062] FIG. 28 is an isometric view of an electrical connector that can be included in the case illustrated in FIG. 1 according to some embodiments of the disclosure;

[0063] FIG. 29 is an isometric exploded view of the electrical connector illustrated in FIG. 28;

[0064] FIG. 30 illustrates isometric front and rear views of a left earbud according to some embodiments of the disclosure;

[0065] FIG. 31 illustrates isometric front and rear views of a right earbud according to some embodiments of the disclosure;

[0066] FIG. 32 is a cross-sectional view of one of the earbuds illustrated in FIGS. 30 and 31;

[0067] FIG. 33 is a cross-sectional view of one of the earbuds illustrated in FIGS. 30 and 31 with some components removed;

[0068] FIG. 34 is a plan view of a flexible circuit board that can be used in earbuds according to some embodiments of the disclosure;

[0069] FIG. 35 is an isometric view of the flexible circuit board illustrated in FIG. 34;

[0070] FIG. 36 is an isometric view of a connector structure that can be included in the earbuds illustrated in FIGS. 30 and 31;

[0071] FIG. 37 is an isometric view of contacts for the connector structure illustrated in FIG. 36 according to some embodiments of the disclosure;

[0072] FIG. 38 is an isometric view of the contact structure illustrated in FIG. 36;

[0073] FIG. 39 is an isometric view of an earbud connector contact according to an embodiment of the disclosure;

[0074] FIG. 40 is an isometric view of an insert molded connector contact that was illustrated in FIG. 39;

[0075] FIG. 41 is an isometric view of an earbud with a capacitive sensor insert according to some embodiments of the disclosure;

[0076] FIG. 42 is a cross-section of the earbud and the capacitive sensor insert illustrated in FIG. 41;

[0077] FIG. 43 is a plan view of a capacitive sensor insert illustrated according to an embodiment of the disclosure;

[0078] FIG. 44 is a plan view of a capacitive sensor insert illustrated according to an embodiment of the disclosure;

[0079] FIG. 45A is an illustration of an earbud with an acoustic insert according to an embodiment of the disclosure;

[0080] FIG. 45B is an illustration of the earbud with the acoustic insert illustrated in FIG. 45A;

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[0081] FIG. 46 is a flowchart illustrating steps associated with manufacturing an earbud according to some embodiments of the disclosure;

[0082] FIG. 47 illustrates a system 47 according to some embodiments of the disclosure;

[0083] FIG. 48 is a simplified block diagram of a system 4800 according to some embodiments of the disclosure;

[0084] FIG. 49 is a flowchart illustrating steps associated with pairing wireless headphones with a host device according to some embodiments of the disclosure;

[0085] FIG. 50 is a flowchart illustrating steps associated with activating a wireless radio in earbuds according to some embodiments of the disclosure; and

[0086] FIG. 51 is a flowchart illustrating steps associated with deactivating a wireless radio in earbuds according to some embodiments of the disclosure.

DETAILED DESCRIPTION

[0087] Some embodiments of the present disclosure relate to portable listening devices and cases for containing and/or charging such devices that have improved features that can improve the user experience associated with using the case and/or the portable listening device. While the present disclosure can be useful for a wide variety of portable listening devices, some embodiments of the disclosure are particularly useful for wireless earbuds and cases for wireless earbuds as described in more detail below.

[0088] For example, in some embodiments a pair of wireless earbuds are sized and shaped to fit within a case that can also include a rechargeable battery and charging circuitry. The pair of earbuds can be charged when an earbud detector within the case detects that the earbuds are placed within the case. Further the case can include sensors to detect if the lid is open such that the wireless radio within each earbud can be activated so they are ready for use by the user. Similarly, when the lid is closed the wireless radio can be shut off so the charge in the earbud batteries is conserved.

[0089] In another example the case can have a pairing button on it that is operable to place the earbuds in a pairing mode. In a further example the case can also have one or more charge indicator lights to inform the user of the charge level in the case battery as well as the charge level in each earbud.

[0090] In another example the case can have a lid with an over center configuration such that the lid is in a first stable position when in a closed position and is in a second stable position when in the open position, but is in an unstable position in-between the closed position and the open position. In some embodiments the over center configuration can be achieved by using two pairs of magnets while in other embodiments it can be achieved with a torsion spring. In further examples the case can have one or more magnets within it to attract the earbuds into cavities formed within the case and to retain them until a user removes them.

[0091] In another example the case can be liquid-tight to prevent liquid from damaging the internal circuitry. The electrical connections for both the earbud recharging and for recharging the case can be resistant to penetration by a liquid.

[0092] In another example the earbuds can have an acoustic insert that forms one or more acoustic ports such as a bass port vent and a rear vent that enable the internal speaker to provide audio performance in the confined space within the earbud housing.

[0093] In another example the earbud case can be used to initiate Bluetooth® pairing of the earbuds with a host device. In one embodiment a lid position sensor detects when the lid is open and initiates pairing of the earbuds.

[0094] In order to better appreciate the features and aspects of portable listening devices and their cases according to the present disclosure, further context for the disclosure is provided in the following section by discussing several particular implementations for earbuds and a case for earbuds according to embodiments of the present disclosure. The specific embodiments discussed are for example purposes only and other embodiments can be employed in other portable listening devices and cases that can be used for other portable listening devices as well as other devices.

[0095] As used herein, the term "portable listening device" includes any portable device designed to play sound that can be heard by a user. Headphones are one type of portable listening device, portable speakers are another. The term "headphones" represents a pair of small, portable listening devices that are designed to be worn on or around a user's head. They convert an electrical signal to a corresponding sound that can be heard by the user. Headphones include traditional headphones that are worn over a user's head and include left and right listening devices connected to each other by a headband, headsets (a combination of a headphone and a microphone); and earbuds (very small headphones that are designed to be fitted directly in a user's ear). Traditional headphones include both over-ear headphones (sometimes referred to as either circumaural or full-size headphones) that have earpads that fully encompass a user's ears, and on-ear headphones (sometimes referred to as supra-aural headphones) that have earpads that press against a user's ear instead of surrounding the ear. As used herein, the term "earbuds", which can also be referred to as earphones or ear-fitting headphones, includes both small headphones that fit within a user's outer ear facing the ear canal without being inserted into the ear canal, and in-ear headphones, sometimes referred to as canalphones, that are inserted in the ear canal itself.

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EARBUD CASE

[0096] FIG. 1 depicts a simplified plan view of a case 100 for a pair of wireless earbuds according to some embodiments of the disclosure. As shown in FIG. 1, case 100 includes a housing 105, also called a body, having one or more cavities 110a, 110b configured to receive a pair of earbuds 115a, 115b. In some embodiments, cavities 110a, 110b can be positioned adjacent to each other on opposite sides of a center plane of case 100. Each cavity 110a, 110b can be sized and shaped to match that of its respective earbud 115a, 115b. Each cavity can include a stem section 116a, 116b and a bud section 117a, 117b. Each stem section 116a, 116b can be an elongated generally cylindrical cavity that extends from its respective bud section 117a,117b towards a bottom 106 of case 100. Each bud section 117a, 117b can be offset from its respective stem section 116a, 116b and open at an upper surface 108 of housing 105. Embodiments of the disclosure are not limited to any particular shape, configuration or number of cavities 110a, 110b and in other embodiments cavities 110a, 110b can have different shapes to accommodate different types of earbuds, different configurations and/or can be a single cavity or more than two cavities.

[0097] Case 100 further includes a lid 120 attached to housing 105. Lid 120 is operable between a closed position where lid 120 is aligned over one or more cavities 110a, 110b fully enclosing pair of earbuds 115a, 115b within the housing, and an open position where the lid is displaced from the housing and cavities 110a, 110b such that a user can remove the earbuds from the cavities or replace the earbuds within the cavities. Lid 120 can be pivotably attached to housing 105 and can include a magnetic or mechanical system (not shown in FIG. 1) that provides lid 120 with a bi-stable operation, as described more fully below. In some embodiments case 100 can also include a charging system 125 configured to charge pair of earbuds 115a, 115b; one or more magnets 130 configured to orient and retain the pair of earbuds within one or more cavities 110a, 110b; and other features that are further described below.

[0098] FIG. 2 is a simplified block diagram of system 200 according to an embodiment of the present disclosure. System 200 can include pair of earbuds 202a, 202b, a case 204 for the pair of earbuds, and a power source 205 for charging the case. Earbuds 202a, 202b can be positioned within case 204 (e.g., within an interior space or cavity of the case defined by a housing or an insert within the housing) where they can be conveniently stored and charged. Case 204 can be

representative of case 100 and earbuds 202a, 202b can be representative of earbuds 115a, 115b discussed above with respect to FIG. 1.

[0099] Each earbud 202a, 202b can each have one or more inputs 255, internal components 260 and one or more outputs 265. In some embodiments one or more inputs 255 can be a microphone input and one or more buttons or sensors that register a user's touch. In various embodiments an accelerometer or a capacitive sensor can be used as an input 255 and can be activated, for example, by a user to answer a call or command earbuds 202a, 202b to enter a pairing mode that can be indicated by a light on either or both earbuds. In various embodiments one or more internal components 260 can include a speaker, a microphone, a rechargeable battery, a processor, and/or other circuitry and components. In various embodiments one or more outputs 265 can be audio from a speaker, a light or other indicator. In some embodiments the indicator light can indicate an incoming call, a battery charge level, a pairing mode or other function.

[0100] In some embodiments each of earbuds 202a, 202b can include a wireless radio that can be both an input 255 and an output 265 device. The wireless radio can enable the earbuds to receive an audio signal from an audio player, such as a smart phone. In some embodiments one or more of earbuds 202a, 202b include a radio that can also transmit an audio signal such as a microphone signal from one or more of the earbuds. In yet further embodiments, one or more of earbuds 202a, 202b can include a radio that can transmit communication signals that can command the receiving device (e.g., a host device such as a smartphone) to perform one or more functions such as, but not limited to, connect a phone call, disconnect a phone call, pause audio playback, fast forward or rewind audio playback or mute a microphone signal. The wireless radio can employ any short range, low power communication protocol such as Bluetooth®, low power Bluetooth®, or Zigbee among protocols.

[0101] Case 204 can include a case processor 210, an earbud detector 215, radio 217, a lid sensor 220, case charging circuitry 225, a battery 227 and earbud charging circuitry 230. Case 204 can also include an earbud interface 245 that enables circuitry within case 204 to communicate with and/or charge earbuds 202a, 202b and power source interface 250 that couples the case to wired or wireless power source 205, such as an AC or DC power source or an inductive charging pad. In some embodiments, case charging circuitry 225, battery 227, earbud

charging circuitry 230 and interfaces 245 and 250 are all representative components of charging system 125 shown in Fig. 1.

[0102] Power source interface 250 can be part of a receptacle connector for a micro USB connector, a Lightening connector or other connector that can provide power to earbud case 204. Alternatively, or in addition to a receptacle connector, power interface 250 can include a wireless power receiver, such as one or more wireless power receiving coils, that can receive inductive power from power source 205. Earbud interface 245 can transfer power and/or data between case 204 and the earbuds via case transfer interface 270 in each earbud. Earbud interface 245 can include an electrical connector, such as one of the connectors described herein with respect to FIGS. 4A-8C, a different type of electrical connector, or a wireless power transmitter, such as a wireless power transmitting coil that can transmit inductive power to an inductive power receiver within the earbuds.

[0103] Case processor 210 can be configured to control various functions of case 204 as described in more detail below. In some embodiments, earbud detector 215 includes one or more sensors that detect when one or both of earbuds 202a, 202b are placed within case 204. In one embodiment earbud detector 215 can be a circuit that periodically "pings" the earbud contacts within case 204 to determine if either earbud 202a, 202b is present. In other embodiments earbud detector 215 can be any type of mechanical or electrical sensor, such as, but not limited to, a magnetic sensor, an optical sensor, a switch, a hall effect sensor, a flux sensor, a capacitive sensor, a photodetector, a proximity detector, a momentary switch or any other type of sensor.

[0104] In embodiments where earbud detector 215 is a flux sensor, the flux sensor can be beneficial to minimizing power consumption of case 204. As an example, a flux sensor can be formed in case 204 for each earbud from a coil of wire and one or more magnets within earbuds 202a, 202b. Each flux sensor can be configured to generate a current in the coil of wire when an earbud is inserted or withdrawn from case 204 and the magnet within the earbud passes through the coil of wire. In a further example, a flux sensor can function as a completely passive sensor that requires no power to operate, and generates its own energy to notify processor 210 of the removal or replacement of either earbud 202a, 202b within case 204. In some embodiments a hall effect sensor can also be beneficial to minimize power consumption. In various

embodiments, one or more sensors can be beneficial so that a voltage bias (e.g., a ping) need not be applied to the earbud connectors, thus mitigating contact corrosion and/or oxidation in moist environments.

[0105] In one example case 204 can include separate earbud receiving cavities within the case, such as cavities 110a, 110b described above, and earbud detector 215 can include first and second earbud detectors – one detector for each cavity. The first earbud detector can be operatively coupled to detect when an earbud (e.g., a left earbud) is inserted within a first of the cavities and the second earbud detector can be operatively coupled to detect when an earbud (e.g., a right earbud) is inserted within the other cavity. In other embodiments a single detector can detect when either earbud 202a, 202b is placed within case 204.

[0106] In response to detecting the insertion of an earbud within the case, earbud detector 215 can generate a detect signal that can be sent to and processed by other circuitry within case 204 to initiate charging of the buds. When earbud detector 215 includes first and second detectors that can detect the insertion of the left and right earbuds (or first and second earbuds that are interchangeable between the left and right ears), respectively, each earbud detector can generate a separate detect signal that can initiate charging of the detected earbud only.

[0107] Similar to initiating charging, earbud detector 215 can also be used to stop charging. For example, earbud detector 215 can detect when either or both of the earbuds are removed from the case and generate a removal signal that stops the charging of the removed earbud or earbuds.

[0108] In some embodiments earbud detector 215 can initiate the charging process of each earbud 202a, 202b when the earbud detector detects that electrical contact is made between the earbuds and corresponding charging contacts within the housing (e.g., within each cavity 110a, 110b). More specifically, in various embodiments earbud detector 215 can periodically "ping" the charging contacts to see if either or both earbuds 202a, 202b are present within each cavity 110a, 110b. Even if either or both earbuds 202a, 202b have zero battery charge they can still have a characteristic impedance or other electrical characteristic that enables earbud detector 215 to detect that they are connected to the charging contacts and initiate charging with earbud charging circuitry 230. The charging contacts and electrical connection between earbuds 202a, 202b and case 204 will be discussed in detail below. In some embodiments earbud detector 215

is part of processor 210 and the processor does the sensing. In other embodiments, earbud detector 215 is separate active/passive components. In various embodiments, case 204 does not include a case processor 210 and instead, circuitry comprising various active and/or passive components is configured to perform the functions described herein and attributed to the processor.

[0109] In some embodiments case processor 210 can communicate with pair of earbuds 202a, 202b by sending and receiving data through earbud interface 245 (and through case interface of either or both earbuds) and can communicate with power source 205 by sending and receiving data through power source interface 250. That is, in various embodiments earbud interface 245 and power source interface 250 can be capable of carrying both power and data signals for single or bidirectional communication. In some embodiments separate power and data contacts can be used while in various embodiments one set of contacts is used for both power and data. For example, in some embodiments power source 205 can be a computing device that communicates with power source interface 250 through an interface (not shown), such as a USB interconnect or a Lightning interconnect developed by Apple Inc. The interconnect can provide DC current to case battery 227 for charging and can provide bidirectional communication between case processor 210 and the computing device. In another example power source 205 can transmit firmware updates to both case processor 210 and pair of earbuds 202a, 202b through the same contacts that are used to charge the devices. Data communication between earbud interface 245 and pair of earbuds 202a, 202b can use a similar communication protocol as discussed above or any other protocol such as, for example, serial communications.

[0110] In some embodiments case 204 can include a wireless radio 217 that enables the case to transmit and receive data communications with earbuds 202a, 202b and a host device (e.g., a smartphone, a tablet computer, a laptop computer or the like) in addition to, or instead of, relying on data exchange through interfaces 245 and 250. For example, wireless radio 217 can be used to initiate a pairing sequence between earbuds 202a, 202b and a host device. In another example radio 217 can be used to receive a music download from a host device to be stored in case 204.

[0111] Lid sensor 220 can detect when a lid to the case (e.g., lid 120 shown in FIG. 1) is in the open position and when the lid is in the closed position. In some embodiments case processor 210 is coupled to lid sensor 220 and receives signals from the lid sensor indicating when the lid

is opened and closed. More specifically, in some embodiments lid sensor 220 can generate and send an "open" signal to processor 210 upon detecting when the lid is opened, and lid sensor 220 can generate and send a "closed" signal to processor 210 upon detecting the closure of the lid. Processor 210 can be configured to communicate with pair of earbuds 202a, 202b to turn ON their wireless radios when the lid is in the open position (e.g., in response to receiving the "open" signal) so they are ready for use by a user and turn OFF their wireless radios when the lid is in the closed position (e.g., in response to receiving the "closed" signal) to conserve their power. In various embodiments lid sensor 220 can also trigger case processor 210 to enter a pairing mode when the case lid is opened, as explained in more detail below. In some embodiments case processor 210 can communicate with pair of earbuds 202a, 202b through earbud interface 245 and case interface 270 using a wired connection as discussed above, while in other embodiments case processor 210 can communicate with earbuds 202a, 202b through interfaces 245 and 270 wirelessly in addition to, or instead of, using a wired connection. In some embodiments lid sensor 220 can be any type of mechanical or electrical switch including, but not limited to, a momentary switch, a capacitive sensor, a magnetic sensor (e.g., hall effect) or an optical sensor.

[0112] Case battery 227 provides power for the circuitry associated with case 204 and can be a rechargeable battery that can be charged by power source 205 and enclosure charging circuitry 225 through power source interface 250. Case battery 227 is also coupled to earbud interface 245 and can charge pair of earbuds 202a, 202b in conjunction with earbud charging circuitry 230. In some embodiments earbud charging circuitry 230 can charge pair of earbuds 202a, 202b anytime they are properly stored within cavities 110a, 110b even though case 204 is not coupled to power source 205. Thus, case 204 can be capable of charging pair of earbuds 202a, 202b while the case is, for example, in a user's pocket as long as case battery 227 has sufficient charge. In various embodiments case battery 227 can be sealed within case 204, while in some embodiments the case battery can be removable for servicing and/or replacement with another charged battery. Case processor 210 can additionally be coupled to case charging circuitry 225 that can control the charging of case battery 227 (e.g., control the voltage and current supplied to the battery to optimize the speed of charging and the life of the battery). In some embodiments case charging circuitry 225 can include a DC/DC converter, an AC/DC converter, battery voltage level monitoring circuitry and/or safety features to properly charge case battery 227.

[0113] Similarly, in some embodiments case processor 210 can be coupled to earbud charging circuitry 230 that can control the charging of batteries within pair of earbuds 202a, 202b (e.g., control the voltage and current supplied to the batteries to optimize the speed of charging and the life of the batteries) through earbud interface 245. In various embodiments earbud charging circuitry 230 can include a DC/DC converter, battery voltage level monitoring circuitry and/or safety features to properly charge earbud batteries.

[0114] In various embodiments case 204 can include one or more charge indicators 235 that can indicate a charge level of case battery 227 and/or the pair of earbud batteries such that a user can see the indicators on an outer surface of case 100 (see FIG. 1). In some embodiments charge indicators 235 can include three LEDs, one indicating the status for case battery 227 and one for indicating the status of the battery in each of pair of earbuds 202a, 202b. In various embodiments charge indicators 235 can be a first color (e.g., green) if the respective battery is near full charge, a second color (e.g., amber) if the respective battery is less than 75 percent charged and a third color (e.g., red) if there is no charge or limited charge. In some embodiments, charge indicators 235 can include multiple LEDs for each of battery 227, earbud 115a and earbud 115b, where the number of LEDs lit indicate the strength of the battery for each component. For example, in one particular instance three sets of three LEDs can be included on case 204.

[0115] In some embodiments case 204 can also include one or more user input devices 240. Each included input device 240 can be a button or other type of input that, in response to being activated by or otherwise receiving input from a user, generates a signal that can be communicated to processor 210 or other circuitry within case 204. Processor 210, or the other circuitry, can then act upon the signal. For example, in various embodiments the wireless radios used by pair of earbuds 202a, 202b can be a Bluetooth® or other radio system that requires a pairing sequence to establish communication between the pair of earbuds and a wireless transmitter in an electronic device. In such embodiments, if input device 240 is a wireless pairing button, processor 210 can send a signal to the earbuds via earbud interface 245 to place the wireless radios within pair of earbuds 202a, 202b into a pairing mode. More specifically, in some embodiments the user can depress a pairing button located on case 204 that notifies case processor 210 to instruct pair of earbuds 202a, 202b via interface 245 to enter a pairing mode. In

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some embodiments pair of earbuds 202a, 202b can be required to be within the case (e.g., within cavities 110a, 110b as shown in FIG. 1) while entering the pairing mode while in other embodiments the earbuds may not need to be within case 204 and only need to be within wireless communication range of the case. Further details with regard to wireless pairing will be discussed later in the application.

[0116] Now referring to FIG. 3, a simplified cross-sectional perspective view of case 100 is illustrated. As shown in FIG. 3, case 100 includes housing 105 having cavities 110a, 110b for holding pair of earbuds 115a, 115b and various electronic circuitry. Case 100 further includes lid 120 attached to housing 105 and operable between a closed position where lid 120 is aligned over one or more cavities 110a, 110b fully enclosing pair of earbuds 115a, 115b within housing and an open position where the cavities 110a, 110b are exposed such that a user can remove or replace the earbuds within the cavities.

[0117] As discussed above, lid 120 can be pivotably attached to housing 105 with joint 305 enabling the lid to be operable between a closed position and an open position. In some embodiments lid 120 can have a bi-stable position where it is stable in the closed and open positions, but unstable between those positions such that it tends to be attracted to either the closed or the open position. In various embodiments the bi-stable operation can be enabled by employing a first pair of magnetic elements 310a, 310b and a second pair of magnetic elements 315a, 315b, as discussed in more detail below. In some embodiments a lid sensor 220 can be disposed in housing 105 and configured to detect when lid 120 is in the closed position (e.g., when a detectable medium 320 is adjacent the lid sensor) and when the lid is in the open position (e.g., when the detectable medium is not adjacent the lid sensor). In some embodiments the detectable medium can be a magnetic material.

[0118] Pair of earbuds 115a, 115b can fit within cavities 110a, 110b each of which is sized and shaped to accept one of the earbuds. In some embodiments, when each earbud is fully inserted within its respective cavity 110a, 110b, a portion of each earbud extends out of the cavity enabling a user to easily grab and remove the earbud from the case. Lid 120 can include a cavity (or pair of cavities 360a, 360b as shown in FIG. 3) into which the portion of each earbud that extends out of its respective cavity 110a, 110b, extents into. While not shown in FIG. 3, each

cavity 360a, 360b can be sized and shaped to match the size and shape of the portion of each earbud the cavity surrounds to more securely store the earbuds within case 100.

[0119] Each earbud can include a speaker assembly (not shown in FIG. 3) disposed within a housing of the earbud. The speaker assembly can include a driver unit aligned to emit sound from the directional sound port. The driver unit can include an electromagnetic voice coil, a speaker diaphragm and a driver magnet (shown in FIG. 3 as magnet 325) operatively coupled to the voice coil to move the diaphragm in response to electrical signals and produce sound. In addition to the driver magnet, earbuds according to some embodiments of the disclosure can include an additional magnetic plate 330 that is not operatively coupled to the voice coil. Either or both of magnet 325 and magnetic plate 330 can be attracted to at least one housing magnetic component 130 disposed within case 100. The attraction can be strong enough to magnetically secure first earbud 115a into first cavity 110a and second earbud 115b into second cavity 110b, as discussed in more detail below. In some embodiments magnetic plate 330 can be made from a magnetic material and in various embodiments it can be made with a metal injection molding process. In some embodiments magnetic plate 330 is magnetized while in other embodiments it is not magnetized but is magnetically attractable.

[0120] To increase the magnetic attraction between magnetic component 130 and magnetic plate 330, the magnetic plate 330 in each earbud can be positioned direction adjacent to the earbud housing. Additionally, the magnetic plate be contoured to match the curvature of the housing thereby ensuring a minimum distance between the magnetic plate and the housing across the surface are of the magnetic plate. Similarly, at least some or the housing magnetic components 130 can be disposed as close as possible to the surface of the receiving cavity at a location that is spaced directly apart from where the magnetic plate 330 will be when an earbud is received within the cavity. In some embodiments the housing components 130 can be contoured to match the curvature of the receiving area (which matches the curvature of its respective earbud) to minimize the distance between the housing magnetic component 130 and the magnetic plate 330.

[0121] In some embodiments housing 105 and lid 120 can be made from the same material while in various embodiments they can be made from different materials. In some embodiments

both housing 105 and/or lid 120 can be made from a plastic material, stainless steel, aluminum or any other material.

[0122] Charging system 125 can include a circuit board 335 or other electrical routing structure, a rechargeable case battery 227, electrical interconnects 340 to pair of earbuds 115a, 115b, one or more electronic components, such as case processor 210, and an electrical connector 345 for connecting to power source 205 (see FIG. 2). In some embodiments connector 345 can, for example, be a non-proprietary interface such as a USB connector or can be a proprietary interface such as the Lightning connector developed by Apple Inc. In various embodiments connector 345 can be liquid-tight, as discussed in more detail below. One or more charge indicators 235 can be visible on an exterior surface 350 of case 100. In some embodiments each earbud in pair of earbuds 115a, 115b can be electrically coupled to charging system 125 by a connector 347 disposed at an end of a stem portion of each earbuds 115a, 115b, as discussed in more detail below.

EARBUD CONNECTORS

[0123] FIGS. 4A-8C illustrate several examples of electrical connectors that can be used between each individual earbud in pair of earbuds 115a, 115b and case 100 (see FIG. 3), similar to connector 347 in FIG. 3. While each of FIGS. 4A-8C illustrate an earbud connector for a first earbud 115a, it is to be understood that second earbud 115b can be configured identical to first earbud 115a and thus include a similar electrical connector. Additionally, while the embodiments illustrated in FIGS. 4A-8C include external contacts that are disposed at the end of a stem of the earbud, the contacts can be at different locations in other embodiments.

[0124] FIGS. 4A and 4B are simplified cross-sectional views of an electrical connector 400 that can be incorporated into earbud case 100 and an electrical connector 405 at the end of a stem portion of an earbud 115a according to an embodiment of the disclosure. Electrical connector 405 can be used to conduct power and/or data according to some embodiments of the disclosure. Connector 405 can be part of an earbud interface and can include first and second earbud contacts 410, 415, respectively. A bottom view of electrical connector 405 is illustrated in FIG. 4B. In some embodiments, earbud contacts 410, 415 can be annular and separated by an insulator 420. Receptacle connector 400 can be used in a case such as case 100 illustrated above and can have a first earbud case contact 425 and a second earbud case contact 430. First annular

contact 410 can interface with first earbud contact 425 and second annular contact 415 can interface with second earbud contact 430. First and second annular contacts 410, 415 can be any type of conductive material including gold, silver or palladium plated copper.

[0125] In some embodiments first and second earbud contacts 410, 415, respectively are power and ground contacts. That is, either of first and second earbud contacts 410, 415, respectively can be used for power while the other can be used for ground. As examples, in some embodiments first contact 410 is used for power and second contact 415 is ground while in other embodiments first contact 410 is used for ground and second contact 415 is used for power. In various embodiments other connector configurations can be used that have more than two contacts.

[0126] First and second earbud case contacts 425, 430 can be coupled to charging system 125 (see FIG. 3) with electrical interconnects 340 in case 100 to facilitate charging and communication of each earbud 115a, 115b. In various embodiments a circular microphone aperture 435 can be located in the center of second annular contact 415 of each earbud 115a, 115b to facilitate two way telephonic communication and/or noise cancellation. Microphone aperture 435 can be covered by an aesthetic acoustic mesh to protect the microphone from debris and damage.

[0127] FIGS. 5A and 5B illustrate another example receptacle connector 500 that can be incorporated into earbud case 100 and an electrical connector 505 at the end of a stem portion of an earbud 115a according to an embodiment of the disclosure. Connector 500 has one annular contact and one center contact, however, as described in more detail below. Connector 505 can be part of an earbud interface and can include first and second earbud contacts 510, 515, respectively. A bottom view of electrical connector 505 is illustrated in FIG. 5B. In some embodiments, ring contact 510 can be ring shaped and circular contact 515 can be circular with the contacts separated by an insulator 520 (e.g., insulator 520 can be an air gap). Ring contact 510 can interface with first earbud contact 525 and circular contact 515 can interface with second earbud contact 530. In various embodiments a circular microphone aperture 535 can be located between ring contact 510 and circular contact 515 so one or more of pair of earbuds 115a, 115b can be used for two way telephonic communication.

[0128] FIGS. 6A and 6B illustrate another example receptacle connector 600 that can be incorporated into earbud case 100 and an electrical earbud connector 605 disposed at the end of a stem portion of an earbud 115a according to an embodiment of the disclosure. Receptacle connector 600 can make electrical contact with electrical earbud connector 605 as described in more detail below. Earbud connector 605 can be part of an earbud interface and can include first and second earbud contacts 610, 615, respectively. A bottom view of electrical earbud connector 605 is illustrated in FIG. 6B. As shown in FIG. 6B, contacts 610, 615 can be spaced from each other in an oppositional and symmetrical relationship. In some embodiments, each of earbud contacts 610 and 615 can have a partial annular shape (i.e., a partial ring) with the open portions of each contact facing the other. For example, contact 610 can include ends 610a, 610b and contact 615 can include ends 615a, 615b where end 610a is spaced apart from end 615a and end 610b is spaced apart from end 615b. While FIG. 6B illustrates each of contacts 610, 615 as half rings, in other embodiments the contacts can include shorter length arcs and/or have different opposing shapes altogether.

[0129] Earbud contacts 610, 615 can be separated from each other by an insulator 620 (e.g., insulator 620 can be a dielectric material as discussed in more detail below). Earbud contact 610 can interface with first earbud case contact 625 and earbud contact 615 can interface with second earbud case contact 630. In various embodiments a circular microphone aperture 635 can be located between earbud contacts 610 and 615 enabling pair of earbuds 115a, 115b to be used for two way telephonic communication. Receptacle connector 600 can include a contact carrier 640 that retains earbud case contacts 625, 630 as described in more detail below. In some embodiments, contact carrier 640 can make earbud receptacle cavity 645 liquid-tight.

[0130] In some embodiments, each of the first and second earbud contacts 610, 615, respectively, can include a contact portion that extends into an earbud receiving cavity of the earbud case when the earbud is positioned within the cavity. Receptacle connector 600 can include a pair of earbud case contacts 625, 630 that are positioned on opposite sides of and extend into the earbud receiving cavity. Earbud case contacts 625, 630 can be held within receiving slots 628, 633 of a contact carrier 640 as discussed further below. The contact portion of each earbud contact 610, 615 can have an arcuate cross-section that makes contact with arcuate contact portions 626, 631 of contacts 625, 630 respectively, during a mating event when

the earbud is inserted into the earbud receiving cavity. The combination of arcuate surfaces on the earbud contact and earbud case contact enable a contact wiping motion each time the earbuds are inserted within and drawn out of the receptacle connector, creating a reliable interconnect. In FIG. 6A, contacts 625, 630 are illustrated in a deflected state that illustrates their approximate position when earbud 115a is fully inserted into its receiving cavity such that the earbud contact is engaged with the earbud case connector.

[0131] The same contacts 625, 630 are also illustrated in FIG. 6A in a non-deflected state 627, 632 showing the contacts extending into the earbud receiving cavity prior to being mated with the earbud contacts of earbud 115a. During a mating event, as earbud 115a is inserted deeper into the earbud receiving cavity, the earbud case contacts 625, 630 come in contact with the earbud contacts and deflect outward. The exterior contacting surfaces of the earbud contacts and earbud case contacts rub against each other during both the mating event and during a de-mating event when the earbud 115a is withdrawn from the earbud receiving cavity. In various embodiments the deflecting arcuate portions 626, 631 of contacts 625, 630 respectively, are deflected by arcuate portions of first and second earbud contacts 610, 615, respectively during insertion and withdrawal of the first and second earbuds. Since the arcuate portions are in direct contact and contacts 625, 630 are in a deflected (e.g., spring loaded state), pair of earbuds 115a, 115b has a vertical (e.g., ejecting) force applied to them when fully mated with the case. In some embodiments, as discussed in more detail herein, one or more magnets can be used to overcome the vertical force and hold the earbuds within their respective cavities.

[0132] In some embodiments one of contacts 625, 630 can be arranged to make contact with the earbud contacts 610, 615, first by preloading one of contacts 625, 630 at a different height than the other (e.g., sequential contacts). This can be useful in some embodiments to make a ground connection to the earbud first before making an active electrical connection with it. The wiping contacts and the sequentially contacting contacts can be used in any of the connector embodiments disclosed herein.

[0133] In various embodiments contact carrier 640 can include a debris recess 609 disposed below the contact interface region. Debris recess 609 can have a cup-like shape defined by sidewalls 609a and can be useful for providing a location for debris that falls into either earbud cavity. Debris recess 609 can be disposed between earbud case contact receiving slots 628, 633

and spaced apart from the contact area so the debris does not interfere with the earbuds making electrical contact with receptacle connector 600. Debris recess 609 can further be open to the earbud receiving cavity so that debris can be periodically cleaned out as needed. In some embodiments a separate debris recess 609 is disposed under each earbud contact area while in other embodiments a single debris recess can be sufficiently wide to capture debris from both contact areas.

[0134] Debris recess 609, or a similar debris capture structure, can be included in any of the connector embodiments disclosed herein. In one embodiment debris recess 609 has a depth below arcuate portions 626, 631 of contacts 625, 630 that is 50 percent or more than a diameter of debris recess 609. In another embodiment debris recess 609 has a depth that is 75 percent or more than the diameter of debris recess 609 while in another embodiment its depth is 100 percent (e.g., having a depth to diameter ratio of 1:1) or more of the diameter.

[0135] In some embodiments contacts 625, can be made out of a copper, nickel and silver alloy while in other embodiments they can be made out of a phosphor and bronze alloy, and in other embodiments a different alloy can be used.

[0136] Now referring to FIG. 6C an exploded view of receptacle connector 600 is shown. As shown in FIG. 6C, connector 600 includes first and second shells 650, 655 that define receiving cavities for a pair of earbuds retaining and guiding a stem portion of each earbud into case 100 (see FIG. 1). While not shown in FIG. 6C, the receiving cavity in each shell can include an elongated tube portion that opens to a larger earbud receiving opening. The elongated tube portion can be sized and shaped to accommodate the stem section of an earbud and the larger earbud receiving opening can be sized and shaped to partially or fully accommodate the ear interface portion (i.e., the portion of the earbud that fits within a user's ear).

[0137] In some embodiments shells 650, 655 can be separate components joined together by the contact carrier while in other embodiments shells 650, 655 can be a single component that can be formed, for example, in a molding process, a 3D printing process or with a milling process. Contact carrier 640 holds first and second earbud contacts 625, 630, respectively, that can interface with a first earbud, and also holds third and fourth earbud contacts 660, 665, respectively, that can interface with a second earbud. A collar 670 can be bonded to a top surface 675 of contact carrier 640. In some embodiments collar 670 can have a removable tie

bar (not shown in FIG. 6C) that holds the three pieces of the collar together during assembly and that can then be removed after assembly such that the tie bar is not included within a finished earbud case.

[0138] Distal ends 680, 685 of first and second shells 650, 655, respectively, can be narrower than the elongated tube portion of shell 650, 655, and each distal end 680, 685 can be fit within and bonded to collar 670 forming a completed shell and receptacle connector assembly 690, illustrated in FIG. 6D. In the completed assembly, each earbud case contact 625, 630 fits within a respective contact opening of shell 650 and each earbud case contact 625, 630 fits within a respective contact opening (e.g., opening 687 visible in FIG. 6C) of shell 655. Each contact opening (e.g., opening 687) enables its respective contact to extend into the earbud receiving cavity within its respective shell 650, 655 to make electrical contact with an earbud contact during a mating event. When assembled, shell and contact assembly 690 can create a liquid-tight seal as defined herein. Shell and contact assembly 690 can subsequently be assembled into a case, such as case 100 illustrated in FIG. 1. In some embodiments first and second shells 650, 655 can be a single shell having two cavities, one cavity for each earbud.

[0139] As defined herein, a liquid-tight seal shall mean a seal that conforms to one or more of the following ratings as defined by the International Protection Rating and International Electrochemical Commission (IEC) 60529 that can also be known as the I.P.68 rating. In some embodiments the liquid-tight seal will protect the connector assembly against the harmful ingress of water and have a "liquid ingress" rating between 1 (dripping water) and 8 (immersion beyond 1 meter). In various embodiments the liquid-tight seal shall be rated between 1 (dripping water) and 4 (splashing water) while in some embodiments the liquid-tight seal shall be rated between 2 (dripping water with device tilted at 15 degrees) and 5 (water jet). In various embodiments the liquid-tight seal shall be rated between 3 (spraying water) and 6 (powerful water jets) while in some embodiments the liquid-tight seal shall be rated between 4 (splashing water) and 7 (immersion up to 1 meter). In various embodiments the liquid-tight seal shall be rated between 5 (water jets) and 8 (immersion beyond 1 meter) while in some embodiments liquid-tight shall mean the seal will protect the electronic device against liquid ingress up to 100 feet for 30 minutes.

[0140] Now referring to FIGS. 7A and 7B another example of a receptacle connector 700 is illustrated that is similar to connector 600 illustrated in FIGS. 6A and 6B. Receptacle connector 700 has a different configuration for the contacts and the contact carrier, however, as described in more detail below. This embodiment can use the same earbud connector shown in FIGS. 6A and 6B, where the earbud contacts are semicircular and separated by an insulator.

[0141] A contact carrier 740 holds first and second earbud contacts 725, 730, respectively, that can interface with a first earbud, and also holds third and fourth earbud contacts 760, 765, respectively, that can interface with a second earbud. A cap 770 can be bonded to a bottom surface 775 of contact carrier 740 with a layer of adhesive 773. As illustrated in FIG. 7B, distal ends of first and second shells 750, 755, respectively, can be fit within and bonded to contact carrier 740 forming a completed shell and receptacle connector assembly 790. Shell and contact assembly 790 can be liquid-tight, meeting one or more of the ranges as defined herein. Shell and contact assembly 790 can subsequently be assembled into a case, such as case 100 illustrated in FIG. 1.

[0142] Similar to contact carrier 640, first and second earbud contacts can have an arcuate cross-section and can make contact with arcuate portions of receptacle connector contacts 725, 730. The combination of arcuate surfaces can enable a wiping motion each time the earbuds are inserted within and drawn out of the receptacle connector, creating a reliable interconnect. Further, in some embodiments one contact can be arranged to make contact with the earbud first. In one example the contacts can be preloaded at different heights. This can be useful in some embodiments to ground the earbud first before making an active electrical connection with it.

[0143] Now referring to FIGS. 8A and 8B another example of a receptacle connector 800 is illustrated that is similar to connector 400 illustrated in FIGS. 4A and 4B. Receptacle connector 800 has a different configuration for the inner and outer contacts, however, as described in more detail below.

[0144] In some embodiments, earbud contacts 810, 815 can be annular and separated by an electrical insulator 820. First annular contact 810 can interface with first earbud contact 825 and second annular contact 815 can interface with second earbud contact 830. First and second annular contacts 810, 815 can be formed from any type of conductive material including copper and copper alloys and can be plated with any metal. In various embodiments a circular

microphone aperture 835 can be located in the center of second annular contact 815 so one or more of pair of earbuds 115a, 115b (see FIG. 1) can be used for two way telephonic communication. Microphone aperture 835 can be covered by an aesthetic acoustic mesh to protect the microphone from debris and damage.

[0145] Similar to contact carrier 640, first and second earbud contacts can have an arcuate cross-section and can make contact with arcuate portions of contacts 825, 830 respectively in receptacle connector 800. The combination of arcuate surfaces can enable a wiping motion each time the earbuds are inserted within and drawn out of the receptacle connector, creating a reliable interconnect. Additionally, as shown in FIG. 8A, in some embodiments an exterior surface 821 of the earbud stem can be flush with an exterior side surface of the earbud contacts. Further, in some embodiments one contact can be arranged to make contact with the earbud first. In one example the contacts can be preloaded at different heights. This can be useful in some embodiments to ground the earbud first before making an active electrical connection with it.

[0146] Now referring to FIG. 8C an exploded view of receptacle connector 800 is shown illustrating how it can be coupled to first and second shells 850, 855 that retain and guide a stem portion of each earbud into case 100 (see FIG. 1). Contact carrier 840 holds first and second earbud contacts 825, 830, respectively, that can be used with a first earbud, and also holds third and fourth earbud contacts that can be used with a second earbud. Contact carrier 840 can be bonded to distal ends 880, 885 of first and second shells 850, 855, respectively, forming a completed shell and receptacle connector assembly. Shell and contact assembly can create a liquid-tight seal as defined herein. Shell and contact assembly 690 can subsequently be assembled into a case, such as case 100 illustrated in FIG. 1. In some embodiments first and second shells 850, 855 can be a single shell having two cavities, one cavity for each earbud.

[0147] In some embodiments the electrical connector (for example connector 405 in FIG. 4A) on pair of earbuds 115a, 115b may not be an annular (e.g., ring shaped) external contact-type connector and can be any other type of electrical connector, such as, but not limited to a pin and socket, a pin and contact pad or a wiping arm and contact pad. In various embodiments one or more contact pads can be located on a vertical portion of the stem portion of the pair of earbuds and a wiping arm can interface with them. In another example an interface connector can be disposed on the ear portion of the earbud housing. A mating connector can be disposed within

the case and can interface with the connector when the earbud is placed in its respective cavity. In some embodiments such a connector can be gold plated to minimize corrosion that can occur as a result of being in contact with a user's ear for extended periods of time. In yet further examples wireless inductive charging of the earbuds can be used.

MAGNETIC RETENTION OF EARBUDS

[0148] FIGS. 9A and 9B illustrate front and rear perspective views, respectively, of one of wireless earbuds 115a, 115b. As shown in FIGS. 9A and 9B, earbuds 115a, 115b include an external housing having an ear interface portion 903 and a stem portion 910. Ear interface portion 903 can be formed to fit at least partially within a user's ear and can be non-occluding, as discussed in more detail herein. An aesthetic acoustic mesh 915 can fit on ear interface portion 903 and allow sound to travel from an internal speaker to a user's ear. Some embodiments can have one or more user inputs 955 that can be used to answer a call, pause or mute playback, or perform other functions. The outer housing for pair of earbuds 115a, 115b can be made from a plastic material including, but not limited to, ABS or a polycarbonate.

[0149] Now referring to FIG. 10, a top view of housing 105 (see FIG. 1) of case 100 for pair of earbuds 115a, 115b is illustrated. As shown in FIG. 10, housing 105 can include multiple retention magnets 905a-905h for the earbuds and one or more sensors. Earbuds 115a, 115b can be inserted in cavities 110a, 110b and retained in the cavities by the retention magnets 905a-905h. Each cavity 110a, 110b can include a stem section 116a, 116b and a bud section 117a, 117b. Earbud retention magnets 905a-905d are used to retain first earbud 115a and retention magnets 905e-905h are used to retain second earbud 115b. However, in other embodiments fewer or additional retention magnets 905a-905h can be used and the magnets can vary in geometry, size and placement from those depicted.

[0150] Lid sensor 220 can be used to detect whether lid 120 (see FIG. 1) is closed or open. In the embodiments illustrated in FIG. 10, lid sensor 220 is disposed between cavities 110a, 110b, but the lid sensor can be located differently in other embodiments. Lid magnets 910a, 910b can be used for operating the lid (not shown in FIG. 10), as discussed in more detail below, and in some cases can increase the strength of retention magnets 905a-h, as also discussed in more detail below. Cross-sectional view A-A is shown in FIG. 11 and illustrates a side view of how earbud 115a can be oriented relative to the magnets discussed above.

[0151] FIG. 11 illustrates a cross-sectional view of earbud 115a in case 100. As shown in FIG. 11, earbud 115a is secured within cavity 110a in housing 105. In some embodiments earbud 115a can have a speaker magnet 325 and/or a magnetic plate 330 positioned to align with earbud retention magnets 905f and 905h. Speaker magnet 325 and/or magnetic plate 330 can be attracted to one or more earbud retention magnets 905f and 905h and one or both can include a magnetic material.

[0152] As defined herein, a magnetic material is any material that is capable of being attracted by or acquiring the properties of a magnet to attract magnetic materials. This includes ferromagnets (i.e., magnets including iron) as well as non-ferrous magnets. Some example magnetic materials are, but are not limited to: neodymium, steel, nickel, cobalt, and alnico, an aluminum-nickel-cobalt alloy, some alloys of rare earth metals, and some naturally occurring minerals such as lodestone. In comparison, a magnet is a magnetic material that is magnetized so it attracts a magnetic material.

[0153] In one embodiment magnetic plate 330 can include a magnetic material and magnets 905f and 905h can be oriented and positioned to be within a distance to attract the magnetic plate with sufficient force to retain earbud 115a in housing 105 even if the housing is inverted or shaken. However, the strength of retention magnets 905f, 905h can be selected to allow a user to grasp earbud 115a with their fingers and remove it from housing 105 by applying a force greater than the force of magnetic retention. In further embodiments one or more of retention magnets 905f, 905h can be positioned and oriented to attract speaker magnet 325 which can assist with attracting earbud 115a into housing 105 and retaining it. In other embodiments, an earbud ejection mechanism can be included in the case. For example, a mechanical ejector that pushes the earbuds out when the lid is opened (or when an ejection button is pushed).

[0154] In some embodiments additional magnets such as those depicted in FIG. 10 can be used to augment the attraction and retention forces imparted on magnetic plate 330 and/or speaker magnet 325. More specifically, lid magnet 910b can be used to attract lid 120 (or a magnetic material 1105 disposed within the lid) and can also be used as a part of a Halbach array to augment the magnetic field of earbud retention magnets 905 to attract earbud 115a from a greater distance and to retain it more securely. A Halbach array is a special arrangement of permanent magnets that augments the magnetic field on one side of the magnetic array while cancelling the

field to near zero on the other side. Retention magnets 905e, 905f and 905g (see FIG. 10) can also be used as a part of the Halbach array.

[0155] Now referring to FIG. 12, a cross-sectional view B-B of housing 105 is shown from FIG. 10. As shown in FIG. 12 three earbud retention magnets 905e, 905f and 905g are disposed within housing 105 to secure earbud 115a within its cavity. In some embodiments, magnets 905g and 905e can have an angled upper surface to partially conform to the circular shape of ear interface portion 805 of earbud 115a. Any configuration or arrangement of magnets can be used to attract speaker magnet 325 and/or magnetic plate 330. In some embodiments a carrier 920 can be formed to retain and position one or more of retention magnets 905a-905h.

[0156] Also, as described above with respect to FIG. 3, the magnetic plate 330 in each earbud can be positioned direction adjacent to the earbud housing and be contoured to match the curvature of the housing (as shown in FIGS. 11 and 12) to ensure a minimum distance between the magnetic plate and the housing across the surface are of the magnetic plate and increase the magnetic attraction between the housing magnetic components and magnetic plate 330 using minimal magnetic material. Similarly, some or all of the housing magnetic components 905a-905h can be disposed as close as possible to an appropriate surface of the earbud case and contoured in shape to match the surface.

MAGNETICALLY ACTUATED CASE

[0157] FIGS. 13-21 illustrate case 1300 having a lid with a magnetically actuated over center position and several example magnet geometries. As shown in FIG. 13, case 1300 can be similar to case 100 illustrated in FIG. 1 and used to retain a pair of earbuds, however case 1300 can be used for myriad other purposes such as, for example, but not limited to, a container for storing medicine, a container for storing cigars or a recharging container for a miniature portable media player.

[0158] Now referring simultaneously to FIGS. 13 and 14, in some embodiments case 1300 can include a housing 1305 having a receiving opening 1301, a bottom face 1302 disposed opposite of the receiving opening. Similar to the cases discussed above, case 1300 can have a closed position, illustrated in FIG. 13 where a housing 1305 is covered by a lid 1310 that is pivotally coupled to the housing. Case 1300 can also have an open position, illustrated in FIG. 14 where

lid 1310 is pivotally displaced from housing 1305 by an angle theta. Case 1300 can further include an upper wall 1303 opposite a lower wall 1304 and a first sidewall 1306 opposite a second sidewall 1307 where the walls extend between receiving opening 1301 and bottom face 1302 defining a cavity 1308 that communicates with receiving opening 1301. Receiving opening 1301 can be further defined by four wall ends 1309a, 1309b, 1309c and 1309d including ends of upper wall 1303, lower wall 1304, first sidewall 1306 and second sidewall 1307, respectively.

[0159] A first pair of magnetic elements 1315a, 1315b can be oriented such that they repel one another and are disposed proximate pivotable joint 1317 with first magnetic element 1315a of the first pair disposed within housing 1305 and a second magnetic element 1315b of the first pair disposed within lid 1310. In some embodiments first pair of magnetic elements 1315a, 1315b can both be magnets. A second pair of magnetic elements 1320a, 1320b are oriented such that they attract one another and are disposed proximate to a wall end 1309a opposite pivotable joint 1317 with a first magnetic element 1320a of the second pair of magnetic elements disposed within housing 1305 and a second magnetic element 1320b of the second pair of magnetic elements disposed within lid 1310. In some embodiments both magnetic elements 1320a, 1320b can be magnets while in another embodiment one of the magnetic elements can be a magnet while the other element is a magnetic material.

[0160] In some embodiments case 1300 can be configured to create an over center configuration for lid 1310 where the lid is in a first stable position when in the closed position (illustrated in FIG. 13) and is in a second stable position when in the open position (illustrated in FIG. 14), but is in an unstable position in-between the closed position and the open position. In some embodiments this can be achieved by the attractive forces between second pair of magnetic elements 1320a, 1320b over powering the repulsive forces of first pair of magnetic elements 1315a, 1315b when lid 1310 is transitioned from the open position to the closed position. This condition can be explained graphically as illustrated in FIG. 15.

[0161] In some embodiments any of the magnetic arrangements disclosed herein can be arranged in a multipole configuration to concentrate the magnetic field within and between the magnets. In some embodiments a multipole can be used for magnetic elements 1320a and 1320b where 1320a has a north end adjacent a south end and 1320b has a south end that attracts to 1320a's north end, and has a north end that attracts to 1320a's south end. In other embodiments

any other arrangement can be used. A multipole arrangement can be beneficial to attenuate magnetic fields outside of the case so they don't negatively interact with other magnetic objects such as cards with magnetic strips on them.

[0162] FIG. 15 illustrates a graph of the magnetic forces on lid 1310. As shown in FIG. 13, lid 1310 has an over center position due to forces imparted on it from two pairs of magnetic elements. As discussed above, first pair of magnetic elements 1315a, 1315b (see FIGS. 13 and 14) are oriented to have repulsive forces which are shown as the line on the graph labeled $F_{Repulsion}$. Similarly, second pair of magnetic elements 1320a, 1320b are oriented to have attractive forces which are shown as the line on the graph labeled $F_{Attraction}$. From examination of FIG. 14 it can be seen than an angle of theta = 0° is when lid 1310 is closed and an angle of theta = 180° is when the lid is fully open (e.g., pivotally displaced from housing 1305 to its maximum extent). At some angle labeled X° is an over center position for lid 1310 where it is unstable and it will "automatically" (i.e., through magnetic attraction) move either towards the closed position or the open position.

[0163] Continuing to refer to FIG. 15, at an angle of 0° lid 1310 is closed and the attractive forces ($F_{Attraction}$) of second pair of magnetic elements 1320a, 1320b are greater than the repulsive forces ($F_{Repulsion}$) of first pair of magnetic elements 1315a, 1315b so the lid is secured in the closed position. In some embodiments, even if first pair of magnetic elements 1315a, 1315b and second pair of magnetic elements 1320a, 1320b have the same strength, the over center design will work since the leverage the first pair of magnetic elements has on the pivotable joint is less than the leverage the second pair of magnetic elements has on the pivotable joint. More specifically, since first pair of magnetic elements 1315a, 1315b are closer to the pivotable joint it will apply less torque to lid 1310 than second pair of magnetic elements 1320a, 1320b.

[0164] However, as lid 1310 transitions to greater angles of theta (i.e., when transitioning to an open position), second pair of magnetic elements 1320a, 1320b moves apart from one another faster than first pair of magnetic elements 1315a, 1315b. Since magnetic forces vary exponentially with distance, the $F_{Attraction}$ falls much faster than $F_{Repulsion}$, therefore at some angle of X° the $F_{Repulsion}$ overcomes the $F_{Attraction}$ and the lid will be attracted to the open position. When transitioning from the open position to the closed position the reverse happens and after the over center point is reached the lid will be attracted to the closed position.

[0165] In some embodiments first pair of magnetic elements 1315a, 1315b can be configured to stop lid 1310 from fully opening (i.e., where theta is 180°). In some embodiments first pair of magnets 1315a, 1315b can be configured to be repulsive, therefore in such embodiments the magnetic elements could be elongated such that when lid 1310 rotates close to the 180° open position first pair of magnetic elements 1315a, 1315b repel each other such that the weight of the lid is supported by their repulsive force and the lid is essentially suspended in a semi-open position. Some shapes of magnets such as an "L" can be used to enhance the forces to support lid 1310 in a semi-open position. In various embodiments the force vector of first pair of magnetic elements 1315a, 1315b can be adjusted to increase or decrease this effect, as discussed in more detail below.

[0166] In some embodiments case 1300 can be designed to have a particular feel for a user. For example, in one embodiment case 1300 can be designed so a user can hold case 1300 in their hand in the closed position and by snapping their wrist lid 1310 will snap open and remain in the open position without resting against 1305. In further embodiments lid 1310 can be in the open position and the user can snap their wrist and close the lid. In further embodiments a user can use their hand to try to open lid 1310 and once the lid has been moved a certain distance the lid will snap or spring open. In further embodiments a user can grasp lid 1310 and move it towards the closed position and at a certain distance the lid will snap or spring closed.

[0167] Now referring to FIG. 16 another embodiment of a case 1600 with a magnetically actuated lid 1604 is illustrated. As shown in FIG. 16, case 1600 has one pair of magnetic elements having misaligned poles (i.e., force vectors) and another pair of magnetic elements having a high permeability material used to increase magnetic forces. Similar to previous embodiments, lid 1604 is pivotally attached to housing 1603. However, in this case first pair of magnetic elements 1605a, 1605b are oriented so the force vectors are not directly aligned as illustrated by the arrows. In this scenario, lid 1604 can still have an over center position, however the $F_{Repulsion}$ from first pair of magnetic elements 1605a, 1605b will be less than the scenario illustrated in FIG. 13. However, one feature of such a misalignment of force vectors can be used to resist lid 1604 from transitioning to a 180° fully open position. More specifically, magnetic forces from first pair of magnetic elements 1605a, 1605b can resist lid 1604 from going to the closed position, but can also resist lid from going to the 180° open position. Other

variations of misaligned magnetic force vectors can be used and are within the scope of this disclosure.

[0168] Continuing to refer to FIG. 16, second pair of magnetic elements 1610a, 1610b can have a high permeability material 1615a, 1615b at least partially surrounding them to increase the forces of attraction between the second pair of magnetic elements. A high permeability material as discussed herein can be any material with a relatively high permeability. The permeability of a material is the measure of the material's ability to support the formation of a magnetic field within itself. More specifically, it is the degree of magnetization that a material obtains in response to an applied magnetic field. Thus, the more "magnetically conductive", or the less resistant a material is to magnetic fields, the higher its permeability. Following this behavior, high permeability material 1615a, 1615b as discussed herein can essentially re-direct the magnetic fields from second pair of magnetic elements 1610a, 1610b so the attractive forces are increased. High permeability materials can also be used on repulsive magnets, lid magnets or magnets used to attract and secure earbuds within the case.

[0169] FIG. 17 illustrates another embodiment of a case 1700. As shown in FIG. 17, case 1700 has springs attached to the first and second pairs of magnetic elements to change the over center behavior of the lid. Case 1700 can have a first pair of magnetic elements 1705a, 1705b configured to be repulsive and a second pair of magnetic elements 1710a, 1710b configured to attract. However, in this embodiment springs 1707a, 1707b can be attached to first pair of magnetic elements 1705a, 1705b and springs 1717a, 1717b can be attached to second pair of magnetic elements 1710a, 1710b. Springs 1707a, 1707b, 1717a, 1717b can be used to change the over center position and behavior of lid 1704. For example, when in the closed position, first and second magnetic elements 1705a, 1705b can repel each other and compress springs 1707a, 1707b, relieving some of the repulsive forces. Conversely, while in the closed position second pair of magnetic elements 1710a, 1710b can be attracted closer together resulting in higher attractive forces since springs 1717a, 1717b allow the magnetic elements to move closer together. Other configurations of springs can be used with magnetic elements without departing from this disclosure.

[0170] Now referring to FIGS. 18-21, various magnet geometries can be used in the cases discussed above. These are only examples, and other geometries can be used without departing

from the disclosure. FIG. 18 shows a square bar 1800, while FIG. 19 shows a rectangular bar 1900. FIG. 20 shows an "L" shaped bar 2000 while FIG. 21 shows a cylindrical bar 2100.

SPRING ACTUATED CASE

[0171] Now referring to FIGS. 22A-22D a case and a spring actuated hinges are illustrated. As shown in FIG. 22A, case 2200 has a lid 2210 with a spring actuated over center mechanism 2220. Case 2200 can be similar to case 100 illustrated in FIG. 1 and case 1300 illustrated in FIG. 13 and in some embodiments can used to store and charge a pair of earbuds or other type of portable listening device. In other embodiments, however case 2200 can be used to store a variety of other objects different than portable listening devices.

[0172] Similar to the cases discussed above, case 2200 can have a closed position, illustrated in FIG. 22A where a housing 2205 is covered by a lid 2210 that is pivotally coupled to the housing. Case 2200 can also have an open position, illustrated in FIG. 22D where lid 2210 is pivotally displaced from housing 2205. A spring actuated over center mechanism 2220 is shown in more detail in the expanded view in FIG. 22A. Lid 2210 includes an extension 2225 attached to the lid and disposed on an opposite side of pivotable joint 2230 from the lid. That is, when lid 2210 rotates about pivotable joint 2230, extension 2225 also rotates about the pivotable joint. Extension 2225 has a rounded distal end 2226 that is in contact with a spring loaded arm 2235 such that the lid resists rotating from the open position to the closed position until the lid is moved past an over center position (illustrated in FIG. 22C) when the lid is then impelled to the closed position (illustrated in FIG. 22D).

[0173] Spring loaded arm 2235 is attached to a second pivotable joint 2240 at a first end and extends to a distal tip 2245. Spring loaded arm 2235 can have a rounded distal tip 2245 with a first and second surface 2246, 2247, respectively arranged opposite each other and extending between the distal tip and the first end. In the illustration in FIG. 22A, spring loaded arm 2235 has a rotational force from a torsion spring applying a clock-wise torque. As lid 2210 is moved towards the open position, extension 2225 rotates in a clock-wise direction about pivotable joint 2230, slides along a first portion 2248 of first surface 2246, and forces arm 2235 in a counter-clock-wise direction increasing the clock-wise torque on the arm. Thus, spring loaded mechanism 2220 resists lid 2210 transitioning from the closed position (illustrated in FIG. 22A) towards the open position (illustrated in FIG. 22D.)

[0174] FIG. 22B illustrates an isometric view of spring loaded mechanism 2220. As shown in FIG. 22B, spring loaded mechanism 2220 includes a spring loaded arm 2235, extension 2225, torsion spring 2250 and spring stop 2255. Torsion spring 2250 is formed around a pin of second pivotable joint 2240, however in other embodiments a different configuration for the mechanism can be used including, but not limited to, cantilevered springs and coil springs.

[0175] FIG. 22C illustrates case 2200 with a partially open lid 2210. As shown in FIG. 22C, lid 2210 is shown in an over center position where the lid is in a first stable position when in the closed position (illustrated in FIG. 22A) and is in a second stable position when in the open position (illustrated in FIG. 22D), but is in an unstable position in-between the closed position and the open position. In some embodiments the over-center performance of lid 2210 can be achieved by extension 2225 having a rounded distal end 2226 that is in contact with arm 2235 that has a clockwise torque applied to it. In various embodiments extension 2225 is oriented perpendicular to first surface 2246 when in the unstable position in-between the closed position and the open position. In some embodiments arm 2235 and or distal end 2226 can have a lubricant and/or one or more lubricant channels on it to maintain a low coefficient of friction between the parts and to provide smooth actuation.

[0176] FIG. 22D illustrates case 2200 with a fully open lid 2210. As shown in FIG. 22D, lid 2210 is past the over-center position and is in a stable open position. In some embodiments the stable position can be achieved by extension 2225 being past the over center location on arm 2235, with extension 2225 sliding along a second portion 2249 of first surface 2246, and the arm holding the lid open due to the clock-wise torque applied to the arm by torsion spring 2250 (see FIG. 22B).

EARBUD CASE WITH WIRELESS CHARGING TRANSMITTER

[0177] Reference is now made to FIG. 23, which illustrates an earbud case 2300 that includes a wireless power transmitting component 2330 that enables the case to wirelessly charge an accessory electronic device outside of the case instead of within the case. For example, as shown in FIG. 23, case 2300 is depicted as wireless charging a watch 2301 that is placed over and aligned with wireless power transmitting component 2330. While FIG. 23 illustrates a watch as the accessory device being charged, embodiments of the disclosure can be used to wirelessly charge other appropriate electronic devices as well. In some instances, embodiments of the

disclosure are particularly well suited for use with portable electronic media devices because of their potentially small form factor. As used herein, an electronic media device includes any device with at least one electronic component that can be used to present human-perceivable media. Such devices can include, for example, portable music players (e.g., MP3 devices and Apple's iPod™ devices), portable video players (e.g., portable DVD players), cellular telephones (e.g., smart telephones such as Apple's iPhone devices), video cameras, digital still cameras, projection systems (e.g., holographic projection systems), gaming systems, PDAs, as well as tablet (e.g., Apple's iPad devices), laptop or other mobile computers. Some of these devices can be configured to provide audio, video or other data or sensory output.

[0178] In the embodiment illustrated in FIG. 23, case 2300 can include all or some of the features of case 204 discussed above with respect to FIG. 2 along with a second charging system in which a wireless power transmitting component 2330 is positioned within housing 2335 adjacent to an exterior charging surface 2340. In some embodiments exterior charging surface 2340 can be any exterior surface of case 2300. Wireless power transmitting component 2330 can be configured to wirelessly transmit power across housing 2335 to a power receiving coil (not shown in FIG. 23) of watch 2301 when the watch is positioned outside housing 2335 adjacent to exterior charging surface 2340, as discussed in more detail below.

[0179] As further shown in FIG. 23, watch 2301 includes a casing 2302 that houses a display 2304 and various input devices including a dial 2306 and a button 2308. Watch 2301 can be worn on a user's wrist and secured thereto by a band 2310. Casing 2302 also houses electronic circuitry (not shown in FIG. 23), including a processor and communication circuitry. A battery (not shown in FIG. 23) internal to casing 2302 powers watch 2301. The battery can be recharged by a wireless power transfer system and watch 2301 can include circuitry configured to operate as a receiver in the wireless power transfer system while wireless power transmitter component 2330 is a transmitter in the system. One example of a wireless power transfer system is an inductive power transfer system. In an inductive power transfer system, a power-receiving electronic device includes or otherwise incorporates an inductive power-receiving element configured to wirelessly receive power and/or charge one or more internal batteries. Similarly, a charging device (i.e., power transmitting component) includes or otherwise incorporates an

inductive power-transmitting element configured to wirelessly transmit power to the power-receiving electronic device.

[0180] FIG. 24 is a block diagram of inductive power receiving system 2400 according to an embodiment of the present disclosure. As shown in FIG. 24, system 2400 is an inductive power receiving system that can be located within casing 2302 of watch 2301 (see FIG. 23) or within a different type of electronic accessory that can be charged by wireless power transmitting component 2330. When power receiving system 2400 is operatively coupled with an appropriate inductive power transmitting component, such as wireless power transmitting component 2330, battery 2402 within the device can be wirelessly charged. Battery 2402 is operably connected to a receive coil 2404 via power conditioning circuitry 2406. Receive coil 2404 can be inductively coupled to a transmit coil of a charging device to receive power wirelessly from the charging device and pass the received power to battery 2402 within the electronic device via power conditioning circuitry 2406. Power conditioning circuitry 2406 can be configured to convert the alternating current received by the receive coil 2404 into direct current power for use by other components of the device. A processing unit 2410 can direct the power, via one or more routing circuits and under the execution of an appropriate program residing in a memory 2412, to perform or coordinate one or more functions of the electronic device typically powered by battery 2402.

[0181] Now referring to FIG. 25, case 2300 is illustrated with a pair of earbuds 115a, 115b stored within a housing 2505 of the case and covered by a lid 2520. Case 2300 can charge earbuds 115a, 115b in the same manner as case 100 discussed above (i.e., either with a wired connection or with a wireless power transfer system). Case 2300 can also, however, include an inductive charging system 2525 positioned and configured to charge a different portable electronic device positioned outside of case 2300 instead of within the case. Inductive charging system 2525 can include a wireless power transmitting component to wirelessly charge an auxiliary device such as watch 2301 (see FIG. 23). In some embodiments case 2500 can be different from case 100 (see FIG. 1) and can be of any other configuration having one or more cavities and a lid that covers the one or more cavities. In one example lid 2520 can be separable from the case. Inductive charging system 2525 can include wireless charging circuitry within

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housing 2505 that enables case 2300 to wirelessly recharge a battery, for example, battery 2402 (see FIG. 24) of watch 2301.

[0182] FIG. 26 is a block diagram of a wireless charging system 2600 according to an embodiment of the disclosure. As shown in FIG. 26, wireless charging system 2600 includes an inductive power transmitting component 2602. Inductive power transmitting component 2602 includes a power source 2604, which can be case battery 227 (see FIG. 2), operatively coupled to a transmit coil 2606 to transmit power to a wearable device via electromagnetic induction or magnetic resonance.

[0183] Transmit coil 2606 can be an electromagnetic coil that produces a time-varying electromagnetic flux to induce a current within an electromagnetic coil within an electronic device (e.g., coil 2404 in FIG. 24). Transmit coil 2606 can transmit power at a selected frequency or band of frequencies. In one example the transmit frequency is substantially fixed, although this is not required. In another example, the transmit frequency can be adjusted to improve power transfer efficiency for particular operational conditions. More particularly, a high transmit frequency can be selected if more power is required by the accessory and a low transmit frequency can be selected if less power is required by the accessory. In other examples, transmit coil 2606 can produce a static electromagnetic field and can physically move, shift, or otherwise change its position to produce a spatially-varying electromagnetic flux to induce a current within the receive coil.

[0184] When watch 2301 (see FIG. 23) is operatively coupled (e.g., disposed on or adjacent to) case 2300, the wearable electronic device can receive charge to replenish the charge of its rechargeable battery or to provide power to operating components associated with the electronic device. To facilitate the transfer of electromagnetic energy, transmit coil 2606 can be positioned within the housing of case 2300 (see FIG. 23) such that it aligns with receive coil 2404 (see FIG. 24) in watch 2301 along a mutual axis. If misaligned, the power transfer efficiency between transmit coil 2606 and receive coil 2404 (see FIG. 24) can decrease as misalignment increases. In some embodiments, one or more alignment features can be used to aid the alignment along a mutual axis, including mechanical alignment features (e.g., recesses, ledges, detents) and magnetic features (e.g., alignment magnet 2630), as discussed in more detail below.

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[0185] As one example, alignment magnet 2630 can be included in case 2300 that magnetically mates with an alignment magnet (not shown) of watch 2301 to facilitate proper alignment of the case and the wearable electronic device. More specifically, alignment magnet 2630 attracts the mating alignment magnet in watch 2301 such that the wearable device is laterally moved into a particular location and held firmly against an outer surface of the case. Additionally, the top and bottom surfaces of case 2300 and watch 2301, respectively, can cooperate to further facilitate alignment. For example, in one embodiment a bottom surface of watch 2301 is convex and a top surface of case 2300 is concave, following the same curvature as the bottom surface of the wearable device.

[0186] In some embodiments, case 2300 (see FIG. 23) can also include one or more sensors to determine whether watch 2301 is present and ready to receive transmitted power from the charger. For example, watch 2301 can include an optical sensor, such as an infrared proximity sensor. When watch 2301 is attached to case 2300, the infrared proximity sensor can produce a signal used to determine the presence of the wearable device. Other methods or structures to verify the presence of watch 2301 can include a mass sensor, a mechanical interlock, switch, button or the like, a Hall-effect sensor, or other electronic sensor.

[0187] Some embodiments can include a prioritized charging algorithm to preferentially use the stored charge in case battery 227 (see FIG. 2) depending on what chargeable devices are coupled to case 2300. For example charging system 2525 (see FIG. 25) can be programmed to first recharge earbuds 115a, 115b, then charge watch 2301. In another example a user is able to program the charging priority while in another example case 2300 can simply charge any device that is coupled to it. In further examples case 2300 can be coupled to a power source through connector 345 (see FIG. 3) and can charge one device, preferentially charge multiple devices or simultaneously charge multiple devices.

[0188] Some embodiments can have a wired interface for case 2300 charging battery 2402 (see FIG. 24) and/or for exchanging data with watch 2301. The wired interface can be in addition to or instead of a wireless interface. For example, in one embodiment case 2300 can include contacts that are sized and positioned to physically and electrically couple to one or more contacts on watch 2301. The contacts can include one or more power contacts as well as one or

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more data contacts, such as a pair of differential data contacts. In another embodiment connector 345 (see FIG. 3) of case can be used to charge watch 2301.

WIRELESSLY CHARGED CASE

[0189] Now referring to FIG. 27, a simplified perspective view of case 2700 on a charging station 2705 is illustrated. As shown in FIG. 27, case 2700 can be similar to other cases in this disclosure, such as case 100 in FIG.1, and can be inductively charged by a charging station 2705. Case 2700 can have a rechargeable battery that can be inductively recharged with a wireless charging system similar to that illustrated and described above with reference to FIGS. 23 through 26. More specifically, all of the features described above with regard to inductively charged watch 2301 can be employed in inductively charged case 2700.

[0190] Wireless charging station 2705 can include wireless charging circuitry within housing 2710 that enables case 2700 to wirelessly recharge an internal battery. Wireless charging station 2705 can include an inductive power transmitting coil 2715, that is similar to wireless power transmitting component 2602 described above in FIG. 26. Inductive power transmitting coil 2715 is capable of transmitting power to case 2700 via electromagnetic induction or magnetic resonance. When case 2700 is operatively coupled (e.g., disposed on or adjacent to) charging station 2705, the case can receive charge to replenish the charge of its rechargeable battery or to provide power to operating components associated with the case.

[0191] To facilitate the transfer of electromagnetic energy, transmit coil 2715 can be positioned within the housing of charging station 2705 such that it aligns with one or more receive coils 2720 in case 2700 along a mutual axis. If misaligned, the power transfer efficiency between transmit coil 2715 and receive coil 2720 can decrease as misalignment increases. In some embodiments, one or more alignment features can be used to aid the alignment along a mutual axis, including mechanical alignment features (e.g., recesses, ledges, detents) and magnetic features (e.g., alignment magnet), as discussed herein. In further embodiments case 2700 can include more than one receive coil and can detect which receive coil is better aligned and selectively only receive charge from that particular coil. In various embodiments case 2700 can use one or more planar receive coils 2720, however in other embodiments other receive coil designs can be used.

WATERPROOF RECEPTACLE CONNECTOR

[0192] FIGS. 28 and 29 illustrate a liquid-tight electrical connector 2800. As shown in FIG. 28, electrical connector 2800 can have mounting flanges and sealed features to make it resistant or impervious to liquid penetration. Electrical connector 2800 can be used to couple power and data to a case, similar to connector 345 in FIG. 3 . In some embodiments connector 2800 can, for example, be any non-proprietary interface such as a USB connector or can be any proprietary interface such as the Lightning connector used by Apple Incorporated of Cupertino, CA. In various embodiments connector 2800 can be liquid-tight, as discussed in more detail below.

[0193] Metallic bracket 2805 is formed around an exterior portion of connector 2800 and has one or more mounting holes 2810 for securing the connector to a circuit board or a chassis. Connector 2800 has a receiving face 2815 that has a front opening (not shown in FIG. 28, but shown in FIG. 3 for connector 345) for receiving a plug portion of a mating connector. An interconnection face 2820 contains a plurality of metallic pins 2825 that each connect to an internal electrical contact as described in more detail below. One or more ground pins 2826 can also extend out of interconnection face 2820. Metallic pins 2825 and ground pins 2826 can be sealed by an overmolded portion 2830 so they are liquid-tight. Metallic bracket 2805 can be two pieces and welded together as described below. Metallic bracket 2805 can also have one or more deformable fingers 2835 that can be used to secure the components of connector 2800 together.

[0194] As shown in FIG. 29 connector 2800 includes a contact plate 2980 coupled to a housing 2905 with a gasket to make the connector liquid-tight. Housing 2905 is made from an electrically insulative polymer that extends between receiving face 2815 and a rear face 2910. Housing 2905 defines a cavity 2915 that communicates with a front opening in receiving face 2815 to receive a plug portion of a mating plug connector. A spacer 2920 is formed from a plastic material and has a plurality of retention features 2925 that are each configured to each receive an electrical contact from a set of electrical contacts 2930 that can be stitched into it. Each electrical contact in the set of electrical contacts 2930, can include an elongated beam portion 2935 positioned between a contact tip 2940 and an anchor portion 2945. Each contact tip 2940 is positioned within cavity 2915 so that it can be electrically coupled to a corresponding plug connector contact during a mating event.

[0195] Beam portion 2935 allows tip 2940 of each contact to flex slightly downward during a mating event and biases the tip to keep physical and electrical contact with a contact in the plug connector that aligns with the particular receptacle contact. Anchor portion 2945 can be a substantially flat plate with one or more cutouts that fits within a slot 2950 of housing 2905 to secure or anchor the contacts in place. Set of electrical contacts 2930 can further include electrical leads 2955 that extend out of interconnection face 2820 (see FIG. 28) of connector assembly 2800 that can couple the receptacle connector to a printed circuit board or similar substrate. Each contact in the set of contacts 2930 can also have an alignment portion 2960 adjacent anchor portion 2945 to align the contact structures within slots 2950 of housing 2905. In some particular embodiments, set of electrical contacts 2930 includes eight contacts spaced apart from each other along a single row.

[0196] A ground latch 2965 can be formed from a conductive metal and inserted through ground slots 2970 in spacer 2920. The ground latch can include first and second spring arms extending along opposing sides of the set of contacts 2930. The first and second spring arms can latch to retention features of a corresponding plug connector to assist in retaining the plug connector within the receptacle connector 2800 after a mating event. In other embodiments ground latch 2965 can be insert mold within spacer 2920. Spacer 2920, with set of contacts 2930 and ground latch 2965, can then be overmolded with dielectric overmold portion 2975. Overmold portion 2975 covers a portion of spacer 2920 and the anchor portion of each contact in the set of contacts 2930 forming a liquid-tight seal to leads 2955 and ground latch 2965 and creating an integrated contact plate 2980. A gasket 2985 can be disposed against rear face 2910 of housing 2905 and contact plate 2980 can then be pressed against the gasket to form a liquid-tight assembly. Metallic bracket 2805 can include a top bracket 2990a laser welded to a bottom bracket 2990b. Bracket fingers 2835 can be formed to hold contact plate 2980 against housing 2905 such that connector 2800 is liquid-tight. That is, if liquid were to enter receiving opening of connector (see connector 345 in FIG. 3) the liquid would not be able to pass through the connector and enter case 100.

WIRELESS EARBUDS

[0197] Now referring to FIGS. 30-46, non-occluding earbuds 3000a, 3000b and methods for making the same are described and illustrated. As shown in FIGS. 30 and 31 earbuds 3000a,

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3000b can be similar to earbuds 115a, 115b illustrated in FIG. 1, however earbuds 3000a, 3000b can include various other features including in ear sensing and acoustic features as described in more detail below.

[0198] FIGS. 30 and 31 show front and rear perspective views, respectively, of a non-occluding left earbud 3000a (FIG. 30) and a non-occluding right earbud 3000b (FIG. 31). Generally, non-occluding earbuds are designed not to form an airtight seal between the ear (or ear canal) and the outer surface of the earbud. By way of contrast, occluding earbuds are generally designed to fit inside of the user's ear canal and form a substantially airtight seal. Each earbud 3000a, 3000b can include an external housing 3005 having an ear portion 3010 coupled to a stem portion 3015. Housing 3005 can have an asymmetric shape amenable to in-the-ear retention, but does not form an airtight seal with the user's ear or ear canal. The absence of an airtight seal can benefit from volumes within the earbud being specifically tuned (e.g., by specifically shaping the volumes and/or adding material to the volumes) to achieve a desired frequency response. Ear portion 3010 can include a directional sound port 3020 offset with respect to a center axis of the ear bud. Directional sound port 3020 can be designed to direct sound waves from an internal driver (e.g., part of an earbud speaker, not shown in FIGS. 30 and 31) directly into a user's ear canal.

[0199] In addition, secondary apertures in the earbud can be employed in housing 3005 to achieve desired sound performance. For example, one or more secondary apertures can serve as a controlled leak port to expose an acoustic pressure within the earbud to the external, surrounding environment. In this aspect, the secondary apertures can be calibrated to modify an acoustic response of the earbud. In this embodiment earbuds 3000a, 3000b each include a front leak port 3025 and a multiport 3030 formed in ear portion 3010. Multiport 3030 can include both a rear vent 3035 and a bass port 3040, that will be described in more detail below. In addition, earbuds according to embodiments of this disclosure can be constructed to have a seamless finish even though two or more parts are joined together to form part of the earbud.

[0200] Ear portion 3010 of earbuds 3000a, 3000b can also include one or more "in the ear" sensors to assist each earbud 3000a, 3000b in determining whether or not the earbud is in a user's ear. In one embodiment an optical tragus sensor 3045 is configured to sense the presence or absence of a user's tragus, and an optical concha sensor 3050 is configured to sense the

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presence or absence of a user's concha. Tragus and concha sensors 3045, 3050, respectively, can use any type of optical sensor including, but not limited to an LED or vertical cavity surface emitting laser (VCSEL) device. Further embodiments can include one or more capacitive sensors and/or accelerometers to detect the presence of a user's ear and/or earbud orientation, as described in more detail below. In the ear detection can be useful for features such as, but not limited to, determining which earbud 3000a, 3000b to use as a microphone when a user desires to accept a call and when a user stops using one earbud and starts using the other earbud.

[0201] A distal end 3055 of stem portion 3015 of each earbud 3000a, 3000b can include an electrical connector 3060 that is formed to make contact with a corresponding connector (e.g., a receptacle connector) of a charging station and/or earbud charging case, such as one of the connector structures described in FIGS. 4A-8C. In one particular embodiment, each connector 3060 can include first and second contacts spaced apart from each other in an oppositional and symmetrical relationship, such as partially annular earbud contacts 610 and 615 shown in FIG. 6B. Each of the first and second contacts can include an outer perimeter that is flush with an exterior surface of the stem portion and include an arcuate or other curved surface that creates a strong wiping action during a contact mating event. Electrical connector 3060 can be used to recharge an internal battery within each earbud 3000a, 3000b and in some cases can also be used to transfer data to and from each earbud. Distal end 3055 can also include a bottom microphone port 3065 (e.g., microphone aperture 635 illustrated in FIG. 6B) that works in conjunction with a top microphone port 3070 to receive a user's voice and/or perform noise cancellation.

[0202] FIGS. 32 and 33 illustrate partial cross sections of earbuds 3000a, 3000b. As shown in FIG. 32, earbuds 3000a, 3000b include a driver 3205, an acoustic insert 3220, a flexible circuit 3225, an antenna 3330, a rechargeable battery 3335 and an electrical connector 3060. Driver 3205 is located within ear portion 3010 and defines a front acoustic volume 3210 in front of the driver and a rear acoustic volume 3215 behind the driver. Driver 3205 can include an electromagnetic voice coil, a driver magnet and a speaker diaphragm (not shown in FIG. 32). Acoustic insert 3220 is positioned behind driver 3205 and adhered to housing 3005, as described in more detail below. Ear portion 3010 further includes a folded up portion of a flexible circuit 3225 that can contain one or more sensors, controllers and myriad other circuits for operating earbud 3000a,b. Flexible circuit 3225 can include portions that are flexible as well as portions

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that are not flexible, such as multilayer epoxy and glass composite circuit boards and can further couple the myriad electronic systems of earbud 3000a, 3000b together, as described in more detail below.

[0203] Stem portion 3015 of earbud 3000a, 3000b can include an antenna 3330, a rechargeable battery 3335 and electrical connector 3060. A portion of flexible circuit 3225 can extend down and electrically connect to electrical connector 3060.

[0204] As shown in FIG. 33, earbuds 3000a, 3000b include several internal sensors. In FIG. 33 some internal components of earbud 3000a, 3000b have been removed for clarity. Ear portion 3010 can contain a tragus sensor 3045, a concha optical sensor 3050 and an accelerometer 3315 that can work together to determine whether earbud 3000a, 3000b is in a user's ear. Flexible circuit 3225 (see FIG. 32) can be used to electrically couple all these devices together.

FOLDABLE, FLEXIBLE CIRCUIT

[0205] FIGS. 34 and 35 illustrate simplified views of flexible circuit 3225. As shown in FIG. 34, flexible circuit 3225 is shown in a flat pattern. FIG. 35 shows flexible circuit 3225 folded up as it is installed in earbud 3000a, 3000b as shown in FIG. 32. Now referring simultaneously to FIGS. 34 and 35 the various portions of flexible circuit 3225 are described. A concha portion 3405 can be used to attach to and communicate with optical concha sensor 3050 (see FIG. 33). Towards this purpose, concha portion 3405 can include one or more electrical terminals that can be bonded to contacts of optical concha sensor 3050.

[0206] Processor portion 3410 can include one or more central processing units, controllers and passives. Processor portion 3410 can be a rigid portion of flexible circuit 3225 and can include multiple stacked routing layers. In one embodiment processor portion can have 4, 6, 8 or 10 routing layers.

[0207] An accelerometer portion 3415 can include one or more accelerometers to assist in detecting a position and/or orientation of the earbud, to assist in acting as a microphone that may be used to mitigate wind noise and to function as a user input device recognizing a tap or touching sequence on the earbud housing. A top microphone portion 3420 can be used to attach to and communicate with a top microphone through one or more electrical terminals. A tragus

sensor portion 3430 can be used to attach to and communicate with optical tragus sensor 3045 (see FIG. 33) through one or more 3430 formed within portion , and a bottom microphone portion 3435 can be used to attach to and communicate with a bottom microphone through one or more terminals formed within portion 3435.

[0208] Each of the flexible portions 3440 can be sufficiently flexible to fold up flexible circuit 3225 as illustrated in FIG. 35. Further, each of the flexible portions 3440 can include one or more electrical traces that route electrical signals between different components of flexible circuit 3225. For example, flexible portion 3440 between concha portion 3405 and processor portion 3410 can include one or more electrical traces that run between the concha portion terminals and the processor. Similarly, flexible portion 3440 between bottom microphone portion 3435 can include one or more electrical traces that run between the bottom microphone terminals and the processor.

EARBUD CONNECTORS

[0209] FIGS. 36-41 illustrate several embodiments of earbud connectors that can be used in the distal end of a stem portion of each earbud such as connector 3060 in FIG. 30. As shown in FIG. 36, connector 3600 can be affixed to a distal end 3055 of an earbud 3000a, 3000b and be used to couple charging and data signals to the earbuds. Connector 3600 can be mated with receptacle connectors that can be disposed in a case or docking station such as the receptacle connectors disclosed in FIGS. 4A-8C.

[0210] Connector 3600 is illustrated in FIG. 36 in a partially assembled state before it is attached to a distal end 3055 of a stem portion 3015 of earbud 3000a, 3000b. In this embodiment connector 3600 includes an inner circular metallic contact 3610 and an outer circular metallic contact 3615 with a dielectric ring 3620 separating the two contacts. In various embodiments inner circular contact 3610 can have an aperture 3613 within it that can be used for both a receptacle connector contact surface and an aperture for a microphone. In some embodiments inner and outer circular contacts 3610, 3615, can be separately manufactured components and can be made from a metal or alloy that can have one or more layers of plating, as described in more detail below. In various embodiments inner and outer circular contacts 3610, 3615, can be made from a copper or copper-based alloy such as, but not limited to C5212 phosphor bronze. In some embodiments inner and outer circular contacts 3610, 3615, can be individually machined,

cast or metal injection molded. In further embodiments they can be made from an electrically conductive plastic or made from an insulative plastic that is plated with one or more metals or alloys.

[0211] As shown in FIG. 37, connector 3600 includes inner and outer circular contacts 3610, 3615, respectively that can be manufactured as separate components. In one example inner and outer circular contacts 3610, 3615, include one or more ridges 3625 to enable increased retention force to dielectric ring 3620. To electrically couple inner and outer circular contacts 3610, 3615, to earbuds 3000a, 3000b the contacts can each include coupling tabs. More specifically inner circular contact 3610 can have a first coupling tab 3630 for attaching to a portion of flexible circuit 3225 (see FIGS. 34-36). In some embodiments first coupling tab 3630 is soldered to a metallized pad 3635 (see FIG. 36) on flexible circuit 3225, however in other embodiments it can be attached with a conductive epoxy or other method. Outer circular contact 3615 can have a second coupling tab 3640 for attaching to a portion of flexible circuit 3225 similar to the aforementioned process.

[0212] As described above, outer circular contact 3615 can have an arcuate cross-section to facilitate wiping of a mating contact to provide a reliable interconnect with a receptacle connector. Inner circular contact 3610 can also have an arcuate or sloped cross-section to promote contact wiping with a receptacle connector. In some embodiments inner and outer circular contacts 3610, 3615, can be plated with one or more metals that can prevent oxidation of the contact surface for reduced interconnect resistance and in further embodiments the plating can be used to provide an aesthetically appealing appearance, as described in more detail below.

[0213] In various embodiments inner and outer circular contacts 3610, 3615, can be plated first with a layer of nickel followed by a final layer of gold. In some embodiments inner and outer circular contacts 3610, 3615, can be plated with a first layer of copper between 3 and 5 microns thick, followed by a layer of gold between 0.5 and 0.7 microns thick, followed by a layer of gold between 0.1 and 0.2 microns thick, followed by a layer of palladium between 0.5 and 0.8 microns thick, followed by a layer of gold between 0.1 and 0.2 microns thick, followed by a binary alloy layer including a first element and a second element, between 0.7 and 1.0 microns thick.

[0214] In some embodiments inner and outer circular contacts 3610, 3615, can be plated with a first layer of copper between 3 and 4.5 microns thick, followed by a layer of gold between 0.5 and 0.9 microns thick, followed by a layer of palladium between 0.5 and 0.8 microns thick, followed by a layer of gold between 0.1 and 0.2 microns thick, followed by a binary alloy layer including a first element and a second element, between 0.65 and 1.0 microns thick.

[0215] In these and other embodiments of the present invention, the first element of the binary alloy layer may be an element in a first group consisting of platinum, palladium, iridium, osmium and rhodium. In these and other embodiments of the present invention, the first element may be rhodium.

[0216] In these and other embodiments of the present invention, the second element of the binary alloy layer may be an element in a second group consisting of platinum, palladium, iridium, osmium, and ruthenium. In these and other embodiments of the present invention, the second element may be ruthenium.

[0217] In these and other embodiments of the present invention, the first element may comprise approximately 85 weight percent of the binary alloy while the second element may comprise approximately 15 weight percent of the binary alloy. In these and other embodiments of the present invention, the first element may comprise approximately 90 weight percent of the binary alloy while the second element may comprise approximately 10 weight percent of the binary alloy. In these and other embodiments of the present invention, the first element may comprise approximately 95 weight percent of the binary alloy while the second element may comprise approximately 5 weight percent of the binary alloy. In these and other embodiments of the present invention, the first element may comprise approximately 99 weight percent of the binary alloy while the second element may comprise approximately 1 weight percent of the binary alloy. In these and other embodiments of the present invention, the first element may comprise more than or approximately 99.5 weight percent of the binary alloy while the second element may comprise less than or approximately 0.5 weight percent of the binary alloy.

[0218] In some embodiments a combination of rhodium and ruthenium for the binary alloy can be used to prevent oxidation of the contact surface while providing an aesthetically appealing gray or silver appearance. Other combinations and compositions of plating are within the scope of this disclosure. In yet further embodiments first and second coupling tabs 3630, 3640 can be

masked before the final layer of the binary alloy, leaving them with a gold surface for improved solderability.

[0219] After inner and outer circular contacts 3610, 3615 are plated they can be insert molded to form a connector 3600 as shown in FIG. 38. A dielectric ring 3620 can be molded in-between and around portions of inner and outer circular contacts 3610, 3615, and can be used to form one or more attachment tabs 3655 that assist connector 3600 being attached to earbud 3000a, 3000b as illustrated in FIG. 36.

[0220] Now referring to FIGS. 39 and 40 perspective views of connector 3900 are illustrated. As shown in FIGS. 39 and 40, connector 3900 is similar to connector 3600 illustrated in FIG. 36, however connector 3900 includes two semicircular contacts instead of circular inner and an outer contacts. An end view of connector 3900 is similar to the end view of connector 605 illustrated in FIG. 6B. Connector 3900 includes a first semicircular contact 3910 and a second semicircular contact 3915 with a dielectric layer 3920 separating the two contacts. First and second semicircular contacts 3910, 3915, respectively, can be spaced in an oppositional and symmetrical relationship with each other. In various embodiments first and second semicircular contacts 3910, 3915, respectively, can form an aperture 3913 between them that can be used for both a receptacle connector contact surface and an aperture for a microphone. First and second semicircular contacts 3910, 3915, respectively, can be manufactured and plated using the same processes described above with regard to connector 3600.

[0221] To electrically couple first and second semicircular contacts 3910, 3915, respectively, to earbud 3000a, 3000b they can each include coupling tabs similar to connector 3600. More specifically first semicircular contact 3910 can have a first coupling tab 3930 for attaching to a portion of flexible circuit 3225 (see FIGS. 34-36). Second semicircular contact 3915 can have a second coupling tab 3940 for attaching to a portion of flexible circuit 3225 similar to the aforementioned process.

[0222] After first and second semicircular contacts 3910, 3915, respectively, are plated they can be insert molded to form a connector 3900 as shown in FIG. 40. A dielectric layer 3920 can be molded in-between and around portions of first and second semicircular contacts 3910, 3915, respectively, and can be used to form one or more attachment tabs 3955 that assist connector 3900 being attached to earbud 3000a,b as illustrated in FIG. 36.

CAPACITIVE SENSOR INSERT

[0223] FIG. 41 illustrates a simplified perspective view of earbud 4100. As shown in FIG. 41, earbud 4100 includes a housing 4105 and a capacitive sensor insert 4110 that can sense a user's touch on exterior surface 4115 of the housing. Capacitive sensor insert 4110 has sensor circuitry 4120 that can create one or more capacitive sensors, as explained in more detail below. For example, sensor circuitry 4120 can create a first capacitive sensor in region 4125 on exterior surface 4115 of housing 4105 that can be used to detect the touch of a user's ear for in the ear sensing and can create a second capacitive sensor in region 4130 that can be used to detect the touch of a user's finger to answer a call or to perform any other function.

[0224] FIG. 42 illustrates a simplified cross-section of earbud housing 4104. As shown in FIG. 42, housing 4105 includes a capacitive sensor insert 4110 positioned within a cavity 4205 defined by the housing. Cavity can also house one or more other components of the earbuds 3000a,b. Earbud housing 4105 has at least one touch sensitive region 4125, 4130 at exterior surface 4115 of the housing that is formed by capacitive sensor insert 4110. Housing 4105 has an interior surface 4210 within cavity 4205, opposite exterior surface 4115. Capacitive sensor insert 4110 has a first surface 4215 with metalized sensor circuitry 4120 (see FIG. 41) that is positioned adjacent interior surface 4210 of housing 4105. Capacitive sensor insert 4110 has a second surface 4220 that is opposite first surface 4215.

[0225] FIGS. 43 and 44 illustrate simplified plan views of capacitive sensor inserts 4300, 4400, respectively. As shown in FIGS. 43 and 44, different types of circuitry can be used to form the capacitive sensors, for example in FIG. 43 self-capacitance circuitry can be used and in FIG. 44 mutual-capacitance sensor circuitry can be used.

[0226] Now referring to FIG. 43, a plan view of sensor insert 4300 is illustrated. As shown in FIG. 43, sensor insert 4300 has self-capacitance sensor circuitry 4305 that senses the touch of a user (e.g., the user's ear and/or finger) on exterior surface 4115 (see FIG. 42) of housing 4105. The user's touch loads the self-capacitance circuitry and/or increases the parasitic capacitance to ground which is interpreted by the sensor insert 4300 and communicated to the earbud processor. Sensor circuitry 4305 can have one or more interconnect regions 4310, for example solder pads or plated through holes, that allow it to be coupled to an earbud processor with one or more conductors.

[0227] In one embodiment sensor insert 4300 can be formed from a plastic that includes metallic particulates. A laser can then be used to laser activate regions 4315 on first surface 4320 of sensor insert 4300, that correspond to the desired location of sensor circuity 4305. The laser activated regions can then be metallized in a plating bath. In one example metal circuitry can be plated on to the activated regions forming sensor circuitry 4305. This process may be known in the art as laser direct structuring. Other methods can be used for form sensor insert 4300 without departing from this disclosure. For example in another embodiment a flexible circuit can be adhered to first surface 4320 of sensor insert and used as the sensor circuitry. In another example first surface 4320 can be entirely plated and can be etched using a photo-imageable ink.

[0228] In further embodiments sensor insert 4300 can have one or more acoustic apertures 4325 that allow sound to pass through and can be aligned with a sound port of the earbuds. In some embodiments insert 4300 can be formed in a hemispherical or other shape to closely match a shape of the external earbud housing. Additionally, in some embodiments, sensor circuitry 4305 can fully surround or partially surround the acoustic apertures.

[0229] Now referring to FIG. 44, a plan view of sensor insert 4400 is illustrated. As shown in FIG. 44, sensor insert 4400 has mutual-capacitance sensor circuitry 4405 that senses the touch of a user (e.g., the user's ear and/or finger) on exterior surface 4115 (see FIG. 42) of housing 4105. The user's touch alters the mutual coupling between row and column electrodes 4410, which are scanned sequentially and communicated to the earbud processor. Sensor circuitry 4405 is formed on first surface 4407 of sensor insert 4400 and can have one or more interconnect regions 4415, for example solder pads or plated through holes, that allow it to be coupled to earbud processor with one or more conductors.

[0230] As described above with regard to sensor insert 4300 in FIG. 43, sensor insert 4400 can be manufactured in the same way and can have similar features and functions. Additionally, in some embodiments sensor insert 4400 can include one or more acoustic apertures 4425 that allow sound to pass through sensor circuitry 4305 and at least some of sensor circuitry 4405 can fully surround or partially surround the acoustic apertures. Additionally, in some embodiments sensor insert 4400 can be formed in a hemispherical or other shape to closely match a shape of the external earbud housing.

ACOUSTIC INSERT

[0231] FIG. 45A illustrates a simplified rear perspective view of earbud 3000a. As shown in FIG. 45A, earbud 3000a includes an acoustic insert 4505 (shown in dashed lines within housing 3005 and in solid lines outside of the housing) that can be used to provide venting for driver (e.g., speaker) in earbud 3000a. More specifically, acoustic insert 4505 can be used to assist in forming a bass port 3040 and a rear vent 3035, that combine into a multiport 3030. In some embodiments, certain features of acoustic insert 4505 can be useful for forming acoustic vents in a relatively small and confined area such as an earbud housing.

[0232] Earbud 3000a can have multiple acoustic apertures, some of which are shown in FIG. 30. In addition to bass port 3040, rear vent 3035 and multiport 3030, each earbud can also have a directional sound port 3020 and a front leak port 3025. These apertures can provide venting for the driver, sound for the user, and can help tune the frequency response of earbud 3000a. More specifically, each aperture is not just a random opening, but instead can be intentionally formed for a particular purpose, namely to change the frequency response of ear bud 3000a in a way that helps to tune the frequency response and/or provide a consistent bass response amongst the same user and across users. The acoustic apertures can each also include various meshes (e.g., a directional sound port mesh, front leak mesh, back vent mesh, bass port mesh, and a multiport mesh) that cover or fit into a corresponding acoustic aperture of earbud 3000a.

[0233] FIG. 45B illustrates a simplified side view of earbud 3000a with acoustic insert 4505. As shown in FIG. 45B, acoustic insert 4505 and driver 4570 are disposed within housing 3005 (illustrated in dashed lines). Now referring simultaneously to FIGS. 45A and 45B the function of acoustic insert 4505 is described in more detail. Driver 4570 can be positioned within cavity 4510 of housing 3005, forming a front volume 4515 in front of the driver and a back volume 4520 behind the driver. Driver 4570 can be positioned such that front volume 4515 is acoustically isolated from a back volume 4520. Front and back volumes 4515, 4520, respectively can be formed within cavity 4510 at least partially by housing 3005 and sized and shaped to achieve a desired frequency response of the earbud.

[0234] In some embodiments, portions of acoustic insert 4505 are formed to closely match the contours of an interior surface 4525 of housing 3005. More specifically, raised regions 4530 of acoustic insert 4505 can be formed to fit securely against interior surface 4525 such that they can

be bonded to interior surface 4525 forming a bass port channel 4527 and a multiport chamber 4507 that are acoustically sealed. That is, bass port channel 4527 can be formed by first, second and third walls 4535, 4540, 4545, respectively of bass port recess 4550 and a fourth wall formed by interior surface 4525 of housing 3005. Similarly, raised regions 4530 can be sealed to interior surface 4525 forming multiport chamber 4507 that is acoustically sealed.

[0235] Bass port channel 4527 can have an entrance aperture 4555 that communicates with back volume 4520. Bass port channel 4527 can be routed from entrance aperture 4555 to an exit aperture 4560 that is formed within multiport chamber 4507 that can be vented to the ambient. Rear vent 3035 can also be routed to multiport chamber 4507, providing a vent from back volume 4520 through rear vent aperture 4565 in acoustic insert 4505 to multiport chamber 4507. The size and shape of bass port channel 4527 and rear vent aperture 4565 can be formed for a particular purpose, namely to change the frequency response of ear bud 3000a in a way that helps to tune the frequency response and/or provide a consistent bass response amongst the same user and across users.

[0236] Housing 3005 can serve as a housing for the remaining components of the earbud assembly and can be formed in any suitable manner and can be made from any suitable material. For example, in one embodiment housing 3005 is made from a molded plastic. Similarly, acoustic insert 4505 can be made from any suitable material including a molded plastic.

[0237] Myriad methods can be used to bond raised regions 4530 of acoustic insert to interior surface 4525 of housing 3005. In one embodiment housing 3005 can be made from an ABS plastic that is substantially transparent, or at least semitransparent to the wavelength of a laser (FIG. 46, step 4605). Acoustic insert 4505 can be made from a plastic that is opaque or at least mostly opaque to the same laser (FIG. 46, step 4610). Acoustic insert 4505 can be placed within cavity 4510 of housing 3005 such that raised regions 4530 are firmly against interior surface 4525 (FIG. 46, step 4615). A laser beam from the laser can then be directed through housing 3005 such that it impinges raised regions 4530, melting at least a portion of the raised regions and bonding them to interior surface 4525 of housing 3005 (FIG. 46, step 4620).

[0238] In some embodiments, to enable the laser to be directed through housing 3005, housing 3005 can use a relatively low amount of pigment, a pigment that is transparent to the laser, or other features to allow the laser to be transmitted through the housing with enough energy to

melt at least a portion of raised regions 4530. Acoustic insert 4505 can be made from a plastic that contains an absorptive dopant, such as carbon, so it absorbs the laser energy. In one embodiment a laser system that is similar to a laser direct structuring laser can be used to perform the laser bonding operation. In other embodiments raised regions 4530 can be bonded to interior surface 4525 with other methods such as, but not limited to, a pressure sensitive adhesive, a heat activated film or a laser activated adhesive.

WIRELESS PAIRING

[0239] FIGS. 47-49 illustrate a wireless pairing system 4700 that includes a pair of wireless headphones 4710 (e.g., a pair of wireless earbuds) that can be wirelessly paired to a host device 4715 (e.g., a computer, a smartphone, a tablet computer, a smart watch, or the like), with the pairing initiated by an intermediate device 4705 (e.g., a case for the headphones). Intermediate device 4705 can instruct wireless headphones 4710 to enter a pairing sequence with host device 4715 in response to a user input. The user input can be a user-initiated event, such as opening earbud case lid 4720 or depressing an input button 4725. In some embodiments headphones 4710 can receive the pairing instruction via a wired connection between intermediate device 4705 and wireless headphones 4710 (e.g., through mated electrical contacts in a case for a pair of wireless earbuds and the earbuds as described above). In other embodiments, intermediate device 4705 can include a wireless radio that communicates the instruction to the wireless radio within wireless headphones 4710. Upon receiving the pairing instruction, headphones 4710 can initiate a pairing sequence to host device 4715 via a wireless communication protocol (e.g., via Bluetooth®) that supports bidirectional data transfer.

[0240] In some cases, headphones 4710 are a pair of wireless earbuds and only one earbud in the pair (i.e., a primary earbud) is paired with the companion host device 4715. In such cases, the primary earbud communicatively couples with the other earbud (a secondary earbud) so that audio data received from host device 4715 by the primary wireless earbud can be shared with the communicatively coupled secondary wireless earbud.

[0241] In some embodiments, headphones 4710 do not include a user input mechanism, such as a button that can be pressed for a user to initiate pairing between the headphones and host device 4715, and wireless pairing between intermediate device 4705 and host device 4715 can only be initiated via intermediate device 4705 (e.g., in response to user-input by either opening

the case lid or pressing an input button on the case or other suitable means) or by host device 4715.

[0242] FIG. 48 illustrates a wireless pairing system 4800 according to an embodiment of the present disclosure that includes intermediate device 4705, headphones 4710 and host device 4715 shown in FIG. 47. While FIG. 48 illustrates simplified block diagrams of each of intermediate device 4705, wireless headphones 4710 and host device 4715, it is understood each of the illustrated devices can include functions and features in addition to those illustrated in FIG. 48. For example, while not shown in FIG. 48, each of intermediate device 4705, wireless headphones 4710 and host device 4715 can include a battery, such as a rechargeable battery, that provides power to the various components of each device.

[0243] In some embodiments, host device 4715 can be an electronic device or portable media player, such as an iPod ™ media player manufactured and sold by Apple Inc., assignee of the present application. In general, a media player can be any device capable of storing and playing media assets including, but not limited to, audio, video, and/or still images. Alternatively, host device 4715 can be a mobile phone (e. g., using conventional cellular communication technology), a personal digital assistant (PDA), or a multifunctional device that incorporates a combination of media player, mobile phone, and/ or PDA capabilities, such as an iPhone ™ mobile device produced and sold by Apple, Inc. Host device 4715 can also be a general-purpose computer, such as a handheld computer, laptop computer, desktop computer, or the like.

[0244] Host device 4715 includes a processor 4820, a memory 4825, a user interface 4830, a first wireless transceiver 4835 (e.g., a Bluetooth transceiver), a second wireless transceiver 4840 (e.g., a cellular transceiver) and a wired input/output 4845. Processor 4820, which can be implemented as one or more integrated circuits, can control the operation of host device 4715. For example, in response to user input signals provided by a user through user interface 4830, processor 4820 can initiate programs to search, list or play media assets stored in memory 4825. In communication with cellular transceiver 4840, processor 4820 can control placing and receiving of telephone calls. Second transceiver 4840 can also be used to communicate data with a network, including network storage 4815. First transceiver 4835 can be used to support short range wireless communication (e.g., Bluetooth communication) between host device 4715 and various accessory devices, including headphones 4710. Memory 4825 can store any

information, including Bluetooth pairing information as described in more detail below. Wired input/output 4845 can be any wired connection, such as a USB protocol or a proprietary protocol, such as that used by the Apple Lightning™ connector.

[0245] Wireless headphones 4710 can be traditional headphones that are worn over a user's head, headsets (a combination of a headphone and a microphone), earbuds (very small headphones that are designed to be fitted directly in a user's ear) or any other portable listening device. In some embodiments wireless headphones 4710 include a processor 4850, a wired input/output 4855, a memory 4860 and a wireless transceiver 4865 (e.g., a Bluetooth transceiver).

[0246] Processor 4850, which can be implemented as one or more integrated circuits, can control the operation of headphones 4710. Wired input/output 4855 can be any wired connection between intermediate device 4705 and wireless headphones 4710 including a proprietary interconnection. In one example wired input/output 4855 is an electrical connector, such as connector 347 (see FIG. 3) or any of the connectors illustrated in FIGS. 4A-8C, that provides a direct electrical connection between wireless headphones 4710 and intermediate device 4705 when the headphones are mated with the intermediate device (e.g., stored in a case). Wired input/output 4855 can be used for charging wireless headphones 4710 and/or communicating data with intermediate device 4705. In one example, wired input/output 4855 of headphones 4710 can be used to receive a signal from wired input/output 4875 of intermediate device 4705 to initiate a pairing sequence of the headphones, as described in more detail below.

[0247] Wireless transceiver 4865 can be used to support short range wireless communication (e.g., Bluetooth communication) between headphones 4710 and various host devices, including host device 4715. In one embodiment, intermediate device 4705 may also be equipped with a wireless transceiver (not shown; e.g., a Bluetooth transceiver) that can wirelessly communicate with wireless transceiver 4865. Wireless transceiver 4865 enables headphones 4710 to communicate wirelessly with host device 4715 once a channel for wireless communication has been established between the two. For example, headphones 4710 and host device 4715 may each be provided with Bluetooth® technology, including appropriate short-range transceiver units. In some embodiments, it may be possible to establish a Bluetooth® pairing between host device 4715 and headphones 4710 using conventional techniques, such as manual entry of a

passcode (or PIN code) associated with headphones 4710 into host device 4715. In other embodiments, Bluetooth® pairings can be established automatically as described below.

[0248] Memory 4860 can store firmware for operating headphones 4710 as well as data for coupling with other wireless ear buds and for pairing headphones 4710 with companion host devices. For example, memory 4860 can store a connection history for companion host devices such as host device 4715, with which headphones 4710 have previously paired. The connection history can include data for automatically pairing headphones 4710 with the companion host device without having to configure a connection between the headphones and the companion host device (e.g., enter a password, exchange shared secrets, etc.). For example, the connection history can include one or more link keys for connecting to a wireless network (e.g., Bluetooth link keys). Memory 4860 can also store a MAC address that uniquely identifies headphones 4710 as well as store a paired partner MAC address of another headphone that has previously coupled with the wireless ear bud 165. For example, in one embodiment headphones 4710 are wireless earbuds and memory 4860 can store the MAC address of a paired partner earbud.

[0249] In another example once headphones 4710 are paired with host device 4715, the host device can save related pairing information from headphones 4710 to a network storage system 4815 such as cloud storage. In one embodiment the related pairing information stored in network storage 4815 can then be used by other host devices to be pre-paired with wireless headphones 4710. As an illustrative example, in one embodiment wireless headphones are initially paired with an iPhone. The iPhone communicates the pairing information to the user's iTunes or iCloud account that is saved on a remote network separate from host device 4715 (e.g., in the iCloud). The wireless headphones will then be listed on the user's iTunes or iCloud account as an authorized wireless device for the account. For example, the user's iCloud account may include a first list of host devices (one or more smart phones, one or more tablet computers and one or more laptop computers) including host device 4715 that are automatically authorized, for example based on the previous authorization and/or authentication of the devices to the iCloud account, to be paired with one or more wireless headphones that have been added to the account (including wireless headphones 4710). The user can then go to their iPad which can be automatically paired to the headphones without having to initiate a separate pairing sequence

between headphones 4710 and the iPad based on the list of approved pairing in the user's iCloud account. Multiple host devices can be pre-authorized and automatically paired using this feature.

[0250] In some embodiments, intermediate device 4705 can be a case for headphones 4710, a docking station, or another type of accessory or electronic device. In some embodiments intermediate device 4705 includes a processor 4870, a wired input/output 4875, and a user input device 4880 and a memory 4885.

[0251] Processor 4870, which can be implemented as one or more integrated circuits, can control the operation of intermediate device 4705 by executing computer instructions stored in a computer-readable memory or medium, such as memory 4885. For example, instructions stored within memory 4885 can cause processor 4870 to, in response to user input signals provided by user input device 4880, send an instruction to headphones 4710 (e.g., via wired I/O interface 4875 or by a wireless channel between intermediate device 4705 and wireless headphones 4710) to enter a pairing sequence with a host device. Wired input/output 4875 can be any wired connection between intermediate device 4705 and wireless headphones 4710 including a proprietary interconnection. In one example wired input/output 4855 is a portion of an electrical connector 347 (see FIG. 3) between pair of earbuds 115a, 115b and case 100 and can be any connector illustrated in FIGS. 4A-8C. Wired input/output 4855 can be used for charging and/or data. In various embodiments wired input/output 4855 can be used to transmit a signal to headphones 4710 to initiate a pairing sequence, as described in more detail below.

[0252] User input device 4880 can be any device operable by a user. In one embodiment user input device 4880 is a lid sensor such as lid sensor 220 (see FIG. 2) that detects an opening or a closing of a lid of intermediate device 4705. In one example an opening event is detected and processor 4870 sends a signal through wired input/output 4875 of intermediate device to wired input/output 4855 of headphones to processor 4850 of headphones 4710 to initiate a pairing sequence and/or to turn on Bluetooth transceiver 4865. In another example, wireless headphones 4710 have never been paired before and headphones 4710 enter a pairing sequence. In a further example headphones 4710 have been paired before and headphones 4710 activate Bluetooth transceiver 4865 but do not initiate a pairing sequence. In one embodiment intermediate device 4705 may include one or more indicator lights to notify a user that it has sent a pairing signal to headphones 4710.

[0253] FIG. 49 describes a method 4900 in which an intermediate device (e.g., intermediate device 4705) initiates wireless pairing between a host device (e.g., host device 4715) and a pair of wireless headphones (e.g., wireless headphones 4710). The method set forth in FIG. 49 can be carried out by, for example, a processor within the intermediate device executing computer instructions stored within a computer-readable memory (e.g., processor 4870 executing instructions stored in computer-readable memory 4885). In step 4905 the intermediate device receives a user input. In some embodiments the intermediate device is a case for a pair of headphones or a pair of earbuds. In various embodiments the user input can be opening a lid of the case, depressing a button on the case or doing anything else to the case that the case registers as a user input indicative of a desire to initiate the pairing sequence. In one particular example, when a user opens a lid of the case, a lid sensor sends a signal to processor 4870 notifying the processor that the lid has been opened.

[0254] In step 4910, in response to receiving the user input, the intermediate device determines if the headphones are connected to the intermediate device. For example, in some embodiments the intermediate device is an earbud case and the pair of wireless headphones is a pair of wireless earbuds that fit within earbud receiving cavities of the case. The earbud case can include one or more earbud detectors as described above that can generate a signal indicating whether and can determine whether the earbuds are stored within the case as described above and provide a signal to the processor indicating whether the earbuds are stored within the case. As one particular example, an earbud case can determine if earbuds are stored within the case based on whether one or more electrical contacts on the earbuds are electrically connected to one or more electrical contacts within the case. In another embodiment the intermediate device is a docking station that couples to the headphones with a mating connector. If some embodiments, if the headphones are not connected to intermediate device there is no action taken by the intermediate device (step 4912), while if the headphones are connected to the intermediate device the method proceeds to step 4915. In other embodiments, step 4910 is optional and the intermediate device proceeds with step 4915 regardless. In such embodiments, however, if the headphones are not communicatively coupled to the intermediate device, the headphones will not receive the instruction generated in step 4915 and thus the end result of method 4900 in such cases will be "no action taken" (step 4912).

[0255] In step 4915, in response to the intermediate device determining that the headphones are connected to the intermediate device, the intermediate device transmits an "initiate pairing" instruction or signal to the headphones. In one embodiment the intermediate device transmits the "initiate pairing" signal through a charging connection between the headphones and the intermediate device. In another embodiment the intermediate device can send the signal wirelessly to the headphones. In one example different user inputs result in the intermediate device transmitting different "initiate pairing" signals to the headphones that are distinguishable by the headphones. As one example where the intermediate device is a case for a pair of earbuds, the case can transmit an instruction to the earbuds to automatically pair with a known and previously paired host when the lid opened. If, the input button is depressed, either before or after the lid is opened, the case can transmit an instruction to the earbuds to enter a discovery mode instead of the automatic pairing mode. The discovery mode then enables the earbuds to be selectively paired by a user to a different host device using a standard pairing sequence. In some embodiments, as described above, step 4910 is optional and intermediate device transmits an "initiate pairing" request signal to the headphones without attempting to determine if the headphones are connected, but if the headphones are not connected, the signal will not be received.

[0256] In step 4920 the headphones receive the "initiate pairing" signal from the intermediate device through an electrical connector, or through a wireless connection.

[0257] In step 4925, in response to receiving the "initiate pairing" signal, the headphones determine if a pairing sequence should be initiated. In one embodiment the headphones examine a pairing memory within the headphones and determine if this is a first pairing or a subsequent pairing of the headphones. If it is a first pairing the headphone processor can determine what type of user input was received to determine if pairing should be initiated. For example, for a first pairing (e.g., the pairing memory of the headphones is empty) if a user opened the lid, pairing can be initiated, but if a user pushed a button pairing is not initiated. However, if this is a subsequent pairing (e.g., the pairing memory of the headphones has at least one registry), if a user opens the lid pairing is not initiated but if a user pushed a button then pairing is initiated. These are only examples and other logic sequences are within the scope of this disclosure.

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[0258] In a further example the headphones will only pair to a host device within a predetermined proximity of the headphones. In one example the headphones will only pair to a host electronic device within 10 meters, while in another embodiment it must be within 5 meters and in a further embodiment within 3 meters and in yet another embodiment within 1 meter. The maximum proximity pairing distance between the headphones and host device can be set at either the headphones or at the host device.

[0259] In some embodiments, the distance can be controlled by the headphones by the strength of the wireless signal sent from the headphones to the host device. For example, the headphones can broadcast a pairing signal that is at a predetermined reduced power level to insure that the electronic device is within a desired proximity. In one embodiment the headphones may broadcast a pairing signal that is 80% or less of its normal broadcasting power (i.e., its normal signal strength). In another embodiment the pairing signal may be 50% or less of the normal signal strength and in a further embodiment it may be 25% or less of the normal signal strength.

[0260] In some embodiments, the distance can be controlled by the host electronic device based on the strength of the signal received from the headphones. For example, in some embodiments the host electronic device will only accept the wireless pairing request from the first device if the strength of the wireless signal transmitting the pairing request is above a predetermined threshold that is higher than a minimum signal strength required for normal wireless communication between the first and second devices. In one embodiment the predetermined threshold is 200% higher than the normal minimum signal strength required for wireless communication between the headphones and host device. In another embodiment the predetermined threshold is 150% higher than the normal minimum signal strength and in still further embodiments it can be 100% or 50% higher than the normal minimum signal strength.

[0261] Regardless of the approach taken, if the host electronic device is not sufficiently proximate the headphones, the headphones will not accept (or will not receive) the pairing request and no further action to consummate the pairing is taken (step 4927). However if the required conditions are met, the method proceeds to step 4930.

[0262] In step 4930, in response to the headphones determining that a pairing sequence should be initiated (or should continue), the headphones transmit a wireless pairing signal using a wireless protocol common between the headphones and host device. In some embodiments this

may be a standardized recurring Bluetooth signal that can stop after a predetermined period of time if there is no answer. In other embodiments, other known wireless protocols can be used.

[0263] In step 4935, in response to receiving the pairing signal, the host device authenticates and pairs the headphones. In one example the host device provides the user a prompt asking if pairing should be performed before pairing the headphones. If the user accepts, the host device sends data to the headphones and authentication of the headphones is performed.

[0264] In some instances, prior to initiating a wireless pairing sequence between a pair of wireless headphones and a host device, a case for a pair of wireless earbuds according to the present disclosure can automatically turn ON the wireless radio of the earbuds when a user opens the lid that encloses the earbuds within the case. FIG. 50 illustrates a method 5000 in which an earbud case (e.g., intermediate device 4705) turns ON the wireless radio of a pair of earbuds (e.g., wireless headphones 4710) stored within the case according to some embodiments of the disclosure. As shown in FIG. 50, method 5000 can start when intermediate device 4705 detects that lid 4720 is moved from a closed position to an open position (step 5005).

[0265] If the earbuds are not in the case, then no action is taken (step 5020). If wireless headphones 4710 are within the case (step 5010), the case can generate and send an instruction to the pair of earbuds that causes the earbuds to turn their wireless radio on. In some embodiments the instruction can be sent over one or more electrical contacts positioned within the receiving cavity as described above. Once the earbuds turn their wireless radio on, the buds can be further instructed to initiate a pairing sequence with a host device. In some embodiments, a single user interaction with the case (e.g., opening lid 4720 or depressing button 4725) can generate instructions that are sent to the earbuds to both turn on the earbud wireless radio and initiate a pairing sequence as described with respect to FIG. 49. In some embodiments a single instruction from intermediate device 4705 can initiate both actions and in other embodiments the case can send multiple instructions in response to the single event.

[0266] In other embodiments, the closure of lid 4720 can automatically turn OFF the wireless radio in the earbuds as described with respect to FIG. 51, which illustrates a method 5100 according to some embodiments of the disclosure. As shown in FIG. 51, method 5100 can start when intermediate device 4705 detects that lid 4720 is moved from an open position to a closed position (step 5105). If the earbuds are not in the case, then no action is taken (step 5120). If

wireless headphones 4710 are within the case (step 5110), the case can generate and send an instruction to the pair of earbuds that causes the earbuds to turn OFF their wireless radio thus saving charge of the batteries within the earbuds.

[0267] While the various embodiments and examples described above were primarily focused on earbuds and a case for storing such earbuds, embodiments of the disclosure are not limited to such and the techniques of the disclosure described above are equally applicable to headphones and other listening devices and cases for such. For example, in one embodiment, case 100 described in FIG. 1 can be a case for a pair of headphones instead of a pair of earbuds. In such an embodiment, cavities 110a, 110b can be sized and shaped to hold left and right earpads of the headphones along with portions of a band connecting the two earpads. In other embodiments, a single cavity can be included in the case to hold the earpads and some or all of the connecting headband. Similarly, in other embodiments, case 100 can be sized and shaped to hold a portable speaker or other type of listening device.

[0268] For simplicity, various internal components, such as circuitry, bus, memory, storage devices and other components of pair of earbuds 115a, 115b, case 100 (see FIG. 1) and wearable electronic device 2301(see FIG. 23) are sometimes not shown in the figures. Also, it is noted that some embodiments have been described as a process that is depicted as a flow diagram or block diagram. Although each diagram may describe the process as a sequential series of operations, many of the operations can be performed in parallel or concurrently. In addition, the order of the operations may be rearranged. A process may have additional steps not included in the figures.

[0269] In the foregoing specification, embodiments of the disclosure have been described with reference to numerous specific details that may vary from implementation to implementation. The specification and drawings are, accordingly, to be regarded in an illustrative rather than a restrictive sense. The sole and exclusive indicator of the scope of the disclosure, and what is intended by the applicants to be the scope of the disclosure, is the literal and equivalent scope of the set of claims that issue from this application, in the specific form in which such claims issue, including any subsequent correction. The specific details of particular embodiments may be combined in any suitable manner without departing from the spirit and scope of embodiments of the disclosure. Additionally, spatially relative terms, such as "bottom" or "top" and the like may

be used to describe an element and/or feature's relationship to another element(s) and/or feature(s) as, for example, illustrated in the figures. It will be understood that the spatially relative terms are intended to encompass different orientations of the device in use and/or operation in addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, elements described as a "bottom" surface may then be oriented "above" other elements or features. The device may be otherwise oriented (e.g., rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein interpreted accordingly.

[0270] The following list of embodiments and examples are set forth to provide additional support and details indicative of the scope and breadth of various embodiments of the present invention. For convenience and ease of reference, the embodiments and examples are listed under different headings. It is to be understood that various features listed under one particular heading can be included in or used with embodiments listed under a different heading.

EARBUD CASE WITH CHARGING SYSTEM

[0271] In some embodiments a case for transporting and charging a portable listening device that includes a rechargeable battery and a power contact is provided. The portable listening device case can include a housing configured to receive the listening device; a lid attached to the housing and operable between a closed position where the lid conceals the listening device within the case and an open position where the lid is displaced from the housing such that a user can remove the listening device from the case; a detector configured to generate a detect signal when the listening device is placed in the housing; and charging circuitry configured to initiate charging of the rechargeable battery in response to receiving the detect signal.

[0272] In some embodiments a case for a pair of earbuds includes a housing having one or more cavities configured to receive the pair of earbuds; a lid attached to the housing and operable between a closed position where the lid is aligned over the one or more cavities and an open position where the lid is displaced from the one or more cavities; and a charging system. The charging system can include a case battery; an earbud detector configured to detect when an earbud is placed in the one or more cavities; and charging circuitry configured to initiate charging of the earbud when the earbud detector detects that the earbud is inserted into the one or more cavities. The one or more cavities can include a first cavity configured to receive a first

earbud in the pair of earbuds and a second cavity sized and shaped to receive a second earbud in the pair of earbuds. The earbud detector can include a first earbud sensor configured to detect when the first earbud is placed in first cavity and a second earbud sensor configured to detect when the second earbud is placed in the second cavity. In some instances, each of the first and second earbud sensors can detect insertion of their respective earbud by detecting a magnetic field generated by the earbud and the charging circuitry can be configured to initiate charging of the first earbud when the first earbud sensor detects the first earbud within the first cavity and initiate charging of the second earbud when the second earbud sensor detects the second earbud within the second cavity. In some embodiments the housing can include a first cavity configured to receive a first earbud in the pair of earbuds and a second cavity sized and shaped to receive a second earbud in the pair of earbuds, and the case can further include a first charging contact positioned within the first cavity to deliver power to the first earbud and a second charging contact positioned within the second cavity to deliver power to the second earbud, and the earbud detector can include detection circuitry operatively coupled to the first and the second charging contacts that detects one or more electrical characteristics of the first and the second earbuds, respectively, when the first and the second earbuds are placed in their respective cavities. In some instance, the earbud detector periodically applies a voltage to the first charging contact to detect the first earbud and periodically applies a voltage to the second charging contact to detect the second earbud. In some embodiments, the charging circuitry initiates charging of the earbud by turning on earbud charging circuitry. Also, the case can include a first plurality of charge level indicators that visually indicate a charge level of the case battery disposed within the case and a second plurality of charge level indicators that visually indicate a charge level of one or more rechargeable batteries within the pair of earbuds. The case further include: a pairing input mechanism disposed on the case and operatively coupled to circuitry within the case that sends a signal to at least one earbud in the pair of earbuds to place the earbud into a pairing mode, and/or a connector configured to interface with a power source that supplies power to the case to charge the case battery. The connector can also be configured to provide a communication path between the power source and a case processor within the case such that data can be transferred from the power source to the case processor.

[0273] In some embodiments a case for a pair of earbuds, each earbud having an ear interface portion, a stem, an earbud battery and a wireless radio is provided. The case can include: a

housing having a first cavity configured to receive a first earbud in the pair of earbuds and a second cavity configured to receive a second earbud in the pair of earbuds; a lid attached to the housing and operable between a closed position where the lid conceals the earbuds within the case and an open position that allows a user to remove the earbuds from the case; and a charging system. The charging system can include a case battery; a first connector configured to interface to a power source for charging the case battery; a second connector configured to couple to each of the first and second earbuds, the second connector having at least one contact positioned in the first cavity and at least one contact positioned in the second cavity; an earbud detector configured to detect when an earbud is placed in either of the first or second cavities; and charging circuitry configured to initiate charging of an earbud battery when the earbud detector detects insertion of an earbud within either the first cavity or the second cavity and configured to cease charging the earbud when the earbud detector detects an earbud is removed from the cavity. Each of the first and second earbuds can include a connector at a distal end of the stem having a power contact and a ground contact. The second connector can couple power and ground connections of the charging circuitry to each earbud when the first and the second earbuds are placed within the first and the second cavities, respectively. The charging system can include a first charging contact positioned within the first cavity and a second charging contact positioned within the second cavity, and the earbud detector can detect insertion of the first earbud within the first cavity by detecting an electrical characteristic of the first earbud through the first charging contact and detect insertion of the second earbud within the second cavity by detecting an electrical characteristic of the second earbud through the second charging contact. The case can further include a user input device disposed at an exterior surface of the case, the user input device operable by a user to place a wireless radio of one of the earbuds into a pairing mode.

CASE WITH MAGNETIC OVER-CENTER MECHANISM

[0274] Some embodiments of the disclosure pertain to a case that can be used to store a portable listening device or another type of electronic device. The case can include: a housing having a cavity to receive the electronic device and a receiving opening that communicates with the receiving opening; a lid secured to housing with a pivotable joint, the lid being operable between an open position in which the receiving opening is exposed and a closed position in

which the lid covers the receiving opening; and a plurality of magnetic elements disposed within the housing and the lid, the plurality of magnetic elements configured to create an over center position for the lid such that the lid resists rotating from the open position to the closed position until the lid is moved past the over center position when the lid is then attracted to the closed position. The housing cam include first and second opposing sidewalls and third and fourth opposing sidewalls that extend between the first and second sidewalls, a bottom wall that extends between the first, second, third and fourth sidewalls, and an insert positioned within an interior space defined by the sidewalls and the bottom wall where the insert defines a shape of the cavity, and a receiving opening opposite the bottom wall that communicates with the receiving cavity. The receiving cavity can be configured to receive one or more listening devices. The plurality of magnetic elements can be configured to create an over center configuration for the lid where the lid is in a first stable position when in the closed position and is in a second stable position when in the open position, but is in an unstable position in-between the closed position and the open position. When the lid is in the closed position attractive forces between the second pair of magnetic elements can over power repulsive forces of the first pair of magnetic elements; when the lid is in the open position repulsive forces between the first pair of magnetic elements can over power attractive forces of the second pair of magnetic elements. In some instances one or more of the plurality of magnetic elements can be partially surrounded by a high magnetic permeability material. In some instances the one or more of the plurality of magnetic elements are oriented such that its pole is not aligned with its mating magnetic element when the lid is in the closed position, and in some instances the one or more of the plurality of magnetic elements can be secured to a spring that allows unilateral movement.

[0275] In some embodiments a case for a portable listening device is provided. The case can include: a housing having a cavity to receive the listening device; a lid attached to the housing with a pivotable joint allowing the lid to rotate between a closed position where the lid is aligned over the cavity and an open position where the lid is angularly displaced allowing the listening device to be removed from the cavity; and a plurality of magnetic elements disposed within the housing and the lid, the plurality of magnetic elements configured to secure the lid in the closed position and to resist the lid moving from the open position to the closed position. The plurality of magnetic elements can include a first pair of magnetic elements configured to repel each other and a second pair of magnetic elements configured to attract each other. The first pair of

magnetic elements can include a first magnet positioned in the lid adjacent to the pivotable joint and a second magnet positioned in the housing adjacent to the pivotable joint and oriented to repel the first magnet. The the second pair of magnetic elements can include a first magnetic element positioned in the lid opposite the pivotable joint and a second magnetic element positioned in a housing wall opposite the pivotable joint and oriented to attract the first magnetic element. In some instances both of the magnetic elements of the second pair of magnetic elements are magnets. In some instances one of the magnetic elements of the second pair of magnetic elements is a magnet and the other magnetic element is a magnetic material. The over center position can be created by combination of repulsive forces between the first and the second magnetic elements, attractive forces between the second and third magnetic elements and a distance of the first, the second, the third and the fourth magnetic elements from the pivotable joint.

[0276] In some embodiments, a case for a portable listening device includes: a housing having a cavity to receive the listening device and a receiving opening that communicates with the cavity; a lid secured to housing with a pivotable joint, the lid being operable between an open position in which the receiving opening is exposed and a closed position in which the lid covers the receiving opening; a first magnetic element located in the lid proximate the pivotable joint and oriented to repel a second magnetic element located in the housing proximate the pivotable joint; and a third magnetic element located in the lid at a distal end of the lid opposite the pivotable joint and oriented to attract a fourth magnetic element located in the housing at a distal end of the housing opposite the pivotable joint; wherein the first, second, third and fourth magnetic elements cooperate to define an over center position for the lid disposed between the open position and the closed position such that that the lid resists rotating from the open position to the closed position until the lid is moved past the over center position where the lid is impelled to the closed position. In some examples the plurality of magnetic elements can include a first pair of magnetic elements oriented such that they repel each other and are located proximate a pivotable joint connecting the housing to the lid, with a first magnetic element of the first pair disposed within the case and a second magnetic element of the first pair disposed within the lid. In some examples the plurality of magnetic elements can include a second pair of magnetic elements oriented such that they attract each other and are located opposite the pivotable joint, with a first magnetic element disposed within the case and a second magnetic element disposed

within the lid. In some embodiments the over center position is created by a combination of repulsive forces between the first pair of magnetic elements, attractive forces between the second pair of magnetic elements, a distance of the first pair of magnetic elements from the pivotable joint and a distance of the pair of magnetic elements from the pivotable joint.

EARBUD CASE WITH WIRELESS RADIO SHUTDOWN FEATURE

[0277] In some embodiments a case for a portable listening device having a wireless radio is provided. The case includes: a housing having a cavity configured to receive the portable listening device; a lid attached to the housing and operable between a closed position where the lid conceals the portable listening device within the case and an open position where the lid is displaced from the housing such that a user can remove the portable listening device from the case; a lid sensor to detect if the lid is in the closed position or the open position; and circuitry configured to turn ON the wireless radio when the lid sensor detects that the lid is moved from the closed position to the open position. The lid sensor can generate an open signal when the lid moves from a closed position to an open position, and the circuitry can be configured to turn ON the wireless radio in response to the open signal. In some instances the case can further include an electrical connector having a first contact positioned within the cavity to electrically connect to a second contact on the portable listening device when the portable listening device is received within the cavity, and the case the circuitry can turn ON the wireless radio in the portable listening device by sending an instruction to the portable listening device over the first contact. The device detector can be configured to detect when the portable listening device is received within the cavity, and the circuitry can be configured to not send the instruction to the portable listening device unless the device detector detects the portable listening device is received within the cavity. In various instances the lid sensor can be a Hall-effect sensor, the electrical connector can also provide an electrical connection that enables the case to charge a rechargeable battery within the listening device, and/or the portable listening device can be a pair of headphones.

[0278] In some embodiments a case for a portable listening device having a wireless radio includes: a housing having a cavity configured to receive the portable listening device; a lid attached to the housing and operable between a closed position where the lid conceals the portable listening device within the case and an open position where the lid is displaced from the housing such that a user can remove the portable listening device from the case; a device detector

configured to detect when the portable listening device is placed in the cavity; a lid sensor to detect if the lid is in the closed position or the open position; and circuitry configured to turn OFF the wireless radio when the lid sensor detects that the lid is moved from the open position to the closed position. The lid sensor can generate a close signal when the lid moves from an open position to a closed position, and the circuitry can be configured to turn OFF the wireless radio in response to the close signal. In some instances the case can further include an electrical connector having a first contact positioned within the cavity to electrically connect to a second contact on the portable listening device when the portable listening device is received within the cavity, and the case the circuitry can turn OFF the wireless radio in the portable listening device by sending an instruction to the portable listening device over the first contact.

[0279] In some embodiments a case for a pair of earbuds can include: a housing having a first cavity configured to receive a first earbud in the pair of earbuds and a second cavity configured to receive a second earbud in the pair of earbuds; a lid attached to the housing and operable between a closed position where the lid conceals the earbuds within the case and an open position that allows a user to remove the earbuds from the case; a lid sensor to detect if the lid is in the closed position or the open position; a case battery; circuitry configured charge an earbud battery within each earbud; and circuitry configured to turn ON a wireless radio in an earbud when the lid sensor detects that the lid is moved from the closed position to the open position and to turn OFF the wireless radio in an earbud when the lid sensor detects that the lid is moved from the open position to the closed position. In some embodiments, the lid sensor can generate an open signal when the lid moves from a closed position to an open position and generate an close signal when the lid moves from an open to a closed position, and the circuitry included within the case can be configured to turn ON the wireless radio in response to the open signal and to turn OFF the wireless radio in response to the close signal. In various embodiments the case can further include a device detector that detects when a portable listening device is received within the cavity, and circuitry within the case can be configured to only send instructions to the portable listening device to turn the wireless radio ON or OFF if the device detector detects that the portable listening device is received within the cavity. In various examples, the lid sensor can be a Hall-effect sensor. The case can also include one or more earbud detectors configured to detect when an earbud is placed in either of the first or second cavities, and the circuitry can be configured to turn OFF the wireless radio in the first earbud when the one or more earbud

detectors detects that the first earbud is received within the first cavity and the lid sensor detects the lid in a closed position and configured to turn OFF the wireless radio in the second earbud when the one or more earbud detectors detects that the second earbud is received within the second cavity and the lid sensor detects the lid in a closed position.

EARBUDS WITH ACOUSTIC INSERT

[0280] Some embodiments of the disclosure pertain to an earbud that includes: a housing having a non-occluding ear portion; a directional sound port disposed in the non-occluding ear portion; a driver assembly positioned within the housing having a front volume disposed in front of the driver assembly and a back volume disposed behind the driver assembly; and an acoustic insert positioned within the housing behind the driver assembly and attached to an interior surface of the housing such that the acoustic insert and the housing form a bass channel that is routed from the back volume to a multiport vent within the housing where the bass port channel can change a frequency response of the earbud. The acoustic insert can include a recess defined by raised weld regions that are acoustically bonded to the interior surface of the housing. In some instances the recess within the acoustic insert forms three walls of the bass channel and the housing forms a fourth wall of the bass channel. The acoustic insert can further include an aperture that couples the front volume to the multiport vent, and the bass channel and the aperture can be coupled to a multiport chamber that is vented through the multiport vent. In some examples the acoustic insert is formed from a carbon doped plastic that absorbs laser energy. In some examples, the earbud housing can be made from Acrylonitrile butadiene styrene (ABS) with a titanium dioxide pigment. The acoustic insert can be attached to an interior surface of the housing earbud housing with a laser bonded interface or with an adhesive. .

[0281] In some embodiments a method of forming an earbud is provided. The method can include: forming a housing having an interior surface and an exterior surface; forming an acoustic insert such that it has a recess defined by raised weld regions; inserting the acoustic insert within the housing such that the raised weld regions are disposed against the interior surface of the housing; and directing a laser through the housing such that it impinges the raised weld regions of the acoustic insert and welds the raised weld regions to the interior surface of the housing. In some instances the housing can be formed from a plastic that is substantially

transparent to a wavelength of the laser, and the acoustic insert can be formed from a carbon doped plastic that absorbs laser energy.

[0282] An earbud according to some embodiments can include: a housing having an ear portion coupled to a stem; a cavity formed within the ear portion; a driver assembly positioned within the cavity and defining a front volume disposed in front of the driver assembly and a back volume disposed behind the driver assembly; an acoustic insert positioned within the cavity behind the driver assembly and attached to an interior surface of the housing; and a bass channel formed by the acoustic insert and the housing that is routed from the back volume to an external environment via a vent. The acoustic insert can include a recess defined by raised weld regions that are bonded to the interior surface of the housing. The acoustic insert can further include an aperture that couples the front volume to the external environment.

WIRELESS PAIRING OF EARBUDS AND CASE

[0283] In some embodiments a case for a pair of wireless earbuds having a wireless radio can include: a housing having a first cavity configured to receive a first earbud in the pair of earbuds and a second cavity configured to receive a second earbud in the pair of earbuds; a lid attached to the housing and operable between a closed position where the lid conceals the earbuds within the case and an open position that allows a user to remove the earbuds from the case; a connector configured to couple to each of the first and second earbuds, the connector having a first contact positioned in the first cavity and a second contact positioned in the second cavity; a lid sensor configured to generate a detect signal when the lid is moved from a closed position to an open position; and circuitry coupled to the first or second contacts and configured to, in response to the detect signal, send one or more signals to the pair of wireless earbuds to turn ON the wireless radio and to initiate pairing of the pair of wireless earbuds to an electronic device. The circuitry can include a processor operatively coupled to a computer-readable memory that stores instructions that can be executed by the processor to send the one or more signals. The connector can include a first power contact for the first earbud of the pair of wireless earbuds and a second power contact for the second earbud of the pair of wireless earbuds, and each of the first and second power contacts can be configured to transmit both power and data to the first earbud and the second earbud, respectively.

[0284] In some embodiments a case for a portable listening device that includes a wireless radio can include: a housing having a receiving area for the portable listening device; a lid attached to the housing and operable between a closed position where the lid conceals the portable listening device within the case and an open position that allows a user to remove the portable listening device from the receiving area; an electrical connector positioned within the receiving area, the electrical connector having one or more case electrical contacts that electrically connect to the one or more device electrical contacts when the portable listening device is received in the receiving area; an input device configured to generate a signal in response to a user-generated action; and a processor coupled to the input device and the electrical connector. The processor can be configured to receive the signal from the input device and, in response, send an instruction to the portable listening device through the electrical connector to initiate wireless pairing of the portable listening device to a host electronic device. In some instances the processor can be further configured to receive send an instruction to the portable listening device through the electrical connector to turn ON its wireless radio in response to receiving the signal from the input device prior to sending an instruction to the portable listening device to initiate wireless pairing of the portable listening device to the host electronic device.

[0285] In various embodiments the portable listening device can be a pair of wireless earbuds (the pair including first and second earbuds), and the electrical connector can include a first contact for transmitting power to the first wireless earbud and a second contact for transmitting power to the second wireless earbud. Circuitry positioned within the housing can be configured to transmit data signals between the case and the first and second wireless earbuds over the first and second contacts, respectively, that are also used to charge the earbuds. The input device can include one or both of a lid sensor that is activated by a user moving the lid from the closed position to the open position and a depressible button on the case. In some instances where two or more different input devices are included, such as a lid sensor and a depressible button, the different input devices can generate different signals that are distinguishable by the processor and can be used by the processor to initiate different pairing procedures. The case can also include a rechargeable battery that is coupled to one or more case electrical contacts within the case that are configured to provide electrical charge to the first and second wireless earbuds to recharge a batteries within the earbuds.

[0286] In some embodiments a method of wirelessly pairing a first electronic device to a second electronic device is provided. The method can include: receiving an input from a user at a third electronic device, different than the first and second devices. In response to receiving the input, the third electronic device can communicate a user input signal to the first electronic device through a wired connection between the third and the first electronic devices. In response to the first electronic device receiving the user input signal, the first electronic device can broadcast a wireless pairing request, and in response to receiving the wireless pairing request, the second electronic device can wirelessly pair with the first device. In some instances, the first electronic device can be a wireless headphone set, the second electronic device can be a mobile electronic device and the third electronic device can be a case for the portable listening device. Also, in some embodiments where the third electronic device is a case for a portable listening device, the input from the user can be opening a lid of a case. In the method, the wired connection between the third electronic device and the first electronic device can include a connector that is used to charge the first electronic device. Also, in response to receiving the signal by the first electronic device, the first electronic device can broadcast a wireless pairing request with a pre-determined signal strength that is less than a strength of its normal broadcasting power and the second device will only accept the wireless pairing request from the first electronic device if a signal strength of a wireless signal transmitting the request is above a predetermined threshold that is higher than a minimum signal strength required for normal wireless communication between the first and second electronic devices. In some embodiments, before the first electronic device broadcasts the wireless pairing request, it checks a memory to determine if it has previously wirelessly paired with another device. In some embodiments, if the first electronic device has previously paired with another electronic device, the first electronic device does not broadcast the wireless pairing request. Additionally, in some embodiments, the third device can transmit a first user input signal if a lid of the third device is opened and transmit a second user input signal, different than the first signal, if a button on the third device is depressed.

EARBUD CASE WITH RECEPTACLE CONNECTOR FOR EARBUDS

[0287] In some embodiments a case for a pair of earbuds is provided where each earbud has an ear portion and a stem portion with an electrical connector disposed at a distal end of the stem

portion. The case can include: a housing; an insert positioned within the housing, the insert having first and second cavities sized and shaped to accommodate first and second earbuds, respectively, each of the first and second cavities having a receiving opening to receive an earbud into the cavity and a contact opening opposite the receiving opening; and a contact assembly attached to the insert, the contact assembly comprising a first pair of electrical contacts extending into the first cavity and a second pair of electrical contacts extending into the second cavity, the first and second pairs of electrical contacts configured to make electrical contact with the electrical connector disposed at the distal end of the first and second earbuds, respectively, through the contact opening. The insert can include first and second shells joined together, the first shell including the first cavity and the second shell including the second cavity. The case can further include a collar adhered to a top of the contact assembly and to a periphery of a distal end of each of the first and the second shells. The first and second pairs of electrical contacts can each have arcuate portions that are positioned by a contact carrier to couple to the electrical connector disposed at the distal end of the first and second earbuds. The contact assembly can include a cavity formed below the arcuate portions where the cavity has a depth that extends below the arcuate portions. The depth of the cavity can be greater than one half of a diameter of the cavity enabling the cavity to capture debris, such as lint. The arcuate portions of the contacts can deflect outwardly when the pair of earbuds are received within the first and second cavities. In some embodiments the contact assembly is formed from a dielectric material and a liquid-tight seal can be formed between the contact assembly and the insert.

[0288] In some embodiments an electrical connector assembly for an earbud charging system is provided. The electrical connector assembly can be configured to receive an earbud having an ear portion and a stem portion with an earbud connector disposed at a distal end of the stem portion. The electrical connector assembly can include: a shell having a receiving opening to receive the earbud in a stem-first orientation, a distal end opposite the receiving opening, and a contact opening proximate the distal end that opens to the receiving opening; a contact carrier formed from a dielectric material and coupled to the distal end of the shell, the contact carrier having a cavity sized to receive the distal end of the shell and a pair of contact receiving slots; and a pair of deflectable electrical contacts disposed within the pair of contact receiving slots, each deflectable electrical contact having a contact portion that extends through the contact opening of the shell. The distal end of the shell can be disposed within the cavity and adhered to

the contact carrier. In some embodiments the shell can include a pair of clearance slots disposed in the distal end such that when the distal end of the shell is disposed within the cavity the contact portions of the pair of deflectable electrical contacts protrude through the slots. The electrical connector assembly can further include a collar adhered to a top of the contact carrier and to a periphery of the shell, and the contact portions of the deflectable electrical contacts can be positioned to interfere with the earbud connector when the earbud is received by the electrical connector assembly. In some embodiments the electrical connector assembly can further include a second shell, a second contact carrier and a second pair of deflectable electrical contacts such that the connector assembly can receive a pair of earbuds.

[0289] In some embodiments a case for a pair of earbuds is provided where each earbud has an ear interface portion and a stem portion with an electrical connector disposed at a distal end of the stem portion. The case can include: a housing; an insert positioned within the housing, the insert having first and second earbud receiving cavities sized and shaped to accommodate first and second earbuds, respectively, each of the first and second receiving cavities having a receiving opening to receive an earbud into the receiving cavity in a stem-first orientation, a contact opening at an opposite end of the receiving opening; a contact carrier formed from a dielectric material and coupled to the insert, the contact carrier having first and second pairs of contact receiving slots disposed at a contact interface region and a debris recess configured to capture debris positioned between the first pair of contact receiving slots and a second debris recess disposed below the contact interface region and sized and shaped to capture debris; a first pair of deflectable electrical contacts disposed within first pair of contact receiving slots, each of the first pair of deflectable electrical contacts having a contact portion that extends into the first receiving cavity in the contact interface region; and a second pair of deflectable electrical contacts disposed within second pair of contact receiving slots, each of the second pair of deflectable electrical contacts having a contact portion that extends into the second receiving cavity in the contact interface region. In some instance the debris recess can include a first debris recess positioned between the first pair of contact receiving slots and a second debris recess positioned between the second pair of contact receiving slots. Each of the first and second earbud receiving cavities can include an elongated tube portion sized and shaped to accommodate the stem portion of an earbud and a larger earbud receiving opening sized and

shaped to at least partially accommodate the ear interface portion. The contact portion of each of the deflectable electrical contacts can have a curved profile.

WIRELESS EARBUDS WITH ELECTRONIC CONTACTS

[0290] In some embodiments a wireless earbud is provided that includes: a housing having a stem portion aligned with a longitudinal axis, the stem portion including first and second ends; a speaker assembly having a driver unit and a directional sound port proximate the first end and offset from the longitudinal axis, wherein the driver unit is aligned to emit sound from the directional sound port and comprises a magnet, a voice coil, and a diaphragm; a rechargeable battery disposed in the housing; and first and second external contacts exposed at an external surface at the second end of the stem portion and electrically coupled to provide power to the rechargeable battery. The second contact can be electrically coupled to a ground.

[0291] In some embodiments the wireless earbud further includes data communication circuitry operatively coupled to the first contact and configured to transmit data to and from the wireless earbud over the first contact. The first and second external contacts can each have a partial annular shape and can be spaced in an oppositional and symmetrical relationship with each other with dielectric material disposed between them. In some instances an outer perimeter of the first and second external contacts is flush with an exterior surface of the stem portion. In some examples, the first and second external contacts each include an arcuate peripheral contact surface. In some embodiments the first and second electrical contacts form a circular shape having an acoustic aperture in a center for a microphone positioned at the second end of the stem portion of the earbud. In some embodiments the first and second electrical contacts are each circularly shaped with the second electrical contact being concentrically positioned within the first electrical contact. In some instance the first and the second contacts are terminated in a binary metal alloy plated layer at an outer surface of each contact, the binary metal alloy plated layer comprising rhodium and ruthenium.

[0292] In some embodiments a wireless earbud includes: a housing having a stem portion aligned with a longitudinal axis, the stem portion including first and second ends; a speaker assembly having a driver unit and a directional sound port proximate the first end and offset from the longitudinal axis, wherein the driver unit is aligned to emit sound from the directional sound

port and comprises a magnet, a voice coil, and a diaphragm; a rechargeable battery disposed in the housing; a first semicircular contact disposed at an external surface at the second end of the stem portion and electrically coupled to the rechargeable battery; and a second semicircular contact disposed at an external surface at the second end of the stem portion, the first and second partial annular contacts spaced in an oppositional and symmetrical relationship with each other.

[0293] In some embodiments a wireless earbud includes: a housing; a rechargeable battery disposed in the housing; a speaker assembly including a driver unit and a directional sound port, wherein the driver unit is aligned to emit sound from the directional sound port and comprises a magnet, a voice coil, and a diaphragm; and a plurality of contacts exposed at an external surface of the housing, each contact in the plurality of contacts including a conductive base having a binary metal alloy plated layer at an outer surface of each contact, the binary metal alloy plated layer comprising rhodium and ruthenium. In some instances, the weight percentage of rhodium is at least 85 percent, with the remainder in ruthenium. The plurality of contacts can be external contacts disposed at an exterior surface of the housing. In some instances the binary metal alloy plated layer is between 0.65-1.0 microns thick, and the plurality of contacts can include at least one intermediate layer disposed between the conductive base and the binary metal alloy plated layer.

MAGNETIC RETENTION OF EARBUD WITHIN CAVITY

[0294] Some embodiments of the disclosure pertain to a case for an earbud having one or more earbud magnetic components. The case can include: a receiving cavity sized and shaped to accept the earbud; one or more housing magnetic components disposed within the case and positioned and configured to magnetically attract and magnetically secure the earbud into the receiving cavity and the second earbud into the second receiving cavity; and a lid operable between an open position in which the receiving cavity is exposed and a closed position in which the lid covers the receiving cavity. The case can be configured to store a pair of earbuds and the receiving cavity includes a first receiving cavity sized and shaped to accept a first earbud in the pair of earbuds, and a second receiving cavity sized and shaped to accept a second earbud in the pair of earbuds. In some embodiments the one or more housing magnetic components can include a first plurality of magnetic components disposed around the first receiving cavity and configured to magnetically attract and magnetically retain the first earbud within the first

receiving cavity, and a second plurality of magnetic components disposed around the second receiving cavity and configured to magnetically attract and magnetically retain the second earbud within the second receiving cavity.

[0295] In some examples the first plurality of magnetic components can include a first magnetic component positioned and configured to magnetically attract a speaker magnet in the first earbud and the second plurality of magnetic components can include a second magnetic component positioned and configured to magnetically attract a speaker magnet in the second earbud. In other examples the first plurality of magnetic components can include a first magnetic component positioned and configured to magnetically attract a magnetic plate disposed in an ear portion of the first earbud and the second plurality of magnetic components can include a second magnetic component positioned and configured to magnetically attract a magnetic plate disposed in an ear portion of the second earbud.

[0296] In some instances the first plurality of magnetic components can includes one or more magnetic components disposed around a portion of the first receiving cavity that accepts an ear interface portion of the first earbud and the second plurality of magnetic components can include one or more magnetic components disposed around a portion of the second receiving cavity that accepts an ear interface portion of the second earbud. In some instances the first plurality of magnetic components can include a first housing magnetic component arranged to attract a speaker magnet in the first earbud, and a second housing magnetic component arranged to attract a magnetic plate disposed within an ear portion of the first earbud; and the second plurality of magnetic components can include a third housing magnetic component arranged to attract a speaker magnet in the second earbud, and a fourth housing magnetic component arranged to attract a magnetic plate disposed within an ear portion of the second earbud. In some instances the first plurality of magnetic components includes a first set of magnetic components that form a first Halbach array to increase attractive forces for the first earbud and the second plurality of magnetic components includes a second set of magnetic components that form a second Halbach array to increase attractive forces for the second earbud. The first and second Halbach arrays can be configured to attract the first and the second earbuds into respective cavities and magnetically retain them within the cavities until they are removed by a user.

[0297] In some embodiments an earbud includes: a housing formed to fit at least partially within a user's ear; a directional sound port formed within the housing; a speaker assembly disposed within the housing and including a driver unit comprising a first magnet, the driver unit aligned to emit sound from the directional sound port; a magnetic retention component, separate from the speaker assembly, and positioned in the housing. The housing can have an ear portion and a stem portion, and the magnetic retention component can be disposed within the ear portion. The driver unit can include a diaphragm and a voice coil, and the first magnet can be operatively coupled to the voice coil to move the diaphragm in response to electrical signals and the magnetic retention component is not operatively coupled to the voice coil.

[0298] In some embodiments a wireless listening system is provided that includes a pair of wireless earbuds and a storage case for the pair of earbuds. Each wireless earbud can include: a housing formed to fit at least partially within a user's ear; a directional sound port formed within the housing; a speaker assembly disposed within the housing and including a driver unit comprising a first magnet, a diaphragm and a voice coil, and wherein the first magnet is operatively coupled to the voice coil to move the diaphragm in response to electrical signals, the driver unit aligned to emit sound from the directional sound port; and a magnetic retention component, separate from the speaker assembly, and positioned in the housing. In some instances the magnetic retention component is positioned within an ear portion of the housing, and in some instances it includes a plate of magnetic material contoured in shape to match the housing. The storage case can include: a first receiving cavity sized and shaped to accept a first earbud of the pair of earbuds; a second receiving cavity sized and shaped to accept a second earbud of the pair of earbuds; a plurality of housing magnetic components disposed within the case and positioned and configured to magnetically attract and magnetically secure the first earbud into the first receiving cavity and the second earbud into the second receiving cavity; and a lid operable between an open position in which the first and second receiving cavities are exposed and a closed position in which the lid covers the first and second receiving cavities. The plurality of housing magnetic components can include a first magnetic component positioned and configured to magnetically attract a speaker magnet in the first earbud and a second magnetic component positioned and configured to magnetically attract a speaker magnet in the second earbud. The plurality of housing magnetic components can further includes a third magnetic component positioned and configured to magnetically attract a magnetic plate disposed in an ear

portion of the first earbud and a fourth magnetic component positioned and configured to magnetically attract a magnetic plate disposed in an ear portion of the second earbud. The plurality of housing magnetic components can include a plurality of magnets arranged to form a Halbach array positioned to attract and retain each wireless earbud.

CASE WITH INDUCTIVE CHARGING TRANSMITTER TO CHARGE A PORTABLE DEVICE

[0299] In some embodiments a case for a portable listening device includes: a housing having one or more cavities configured to receive the portable listening device and an exterior charging surface; a lid attached to the housing and operable between a closed position where the lid is aligned over the one or more cavities and an open position where the lid is displaced from the one or more cavities; a battery; a first charging system configured to charge the portable listening device when positioned in the one or more cavities; and a second charging system including a transmitting coil positioned within the housing adjacent to the exterior charging surface, the transmitting coil configured to wirelessly transmit power to a power receiving coil of an electronic device positioned outside the housing adjacent to the exterior charging surface. The case can further include an alignment feature that aligns the transmitting coil on a mutual axis with the receiving coil. In various embodiments the alignment feature can be an alignment magnet in the case that magnetically mates with a mating alignment magnet in the wearable electronic device; can be centered within the transmitting coil; and/or can be a concave feature within the exterior charging surface that mates with a convex feature formed on a bottom surface of the wearable electronic device. Circuitry within the case can detect whether the portable listening device is within the one or more cavities and whether the electronic device is positioned adjacent the exterior charging surface. The circuitry can preferentially charge the portable listening device before the electronic device if the portable listening device is within the one or more cavities while the electronic device is positioned adjacent the exterior charging surface. In some embodiments the first and the second charging systems can receive power from a case battery and can also receive power from a case connector. The case can further include a plurality of magnetic elements disposed within the housing and the lid that are configured to secure the lid in the closed position and to resist the lid moving from the open position to the closed position. The plurality of magnetic elements can include a first pair of magnetic

elements configured to repel each other and a second pair of magnetic elements configured to attract each other.

[0300] In some embodiments the portable listening device can be a case for a pair of earbuds; the housing can include first and second cavities configured to receive first and second earbuds, respectively; and the first charging system can be configured to charge the first and second earbuds when the earbuds are positioned within the first and second cavities.

[0301] In some embodiments a case for a pair of earbuds includes: a housing having an exterior charging surface and first and second cavities configured to receive first and second earbuds, respectively, in the pair of earbuds; a lid operable between a closed position where the lid is aligned over the first and second cavities and an open position where the lid is displaced from the first and second cavities; a battery; a first charging system configured to charge the first and second earbuds when the earbuds are positioned within the first and second cavities; and a second charging system including a transmitting coil positioned within the housing adjacent to the exterior charging surface, the transmitting coil configured to wirelessly transmit power to a power receiving coil of an electronic device positioned outside the housing adjacent to the exterior charging surface. The case can further include an alignment magnet configured to align the transmitting coil with the receiving coil. The transmitting coil can be an electromagnetic coil that produces a time-varying electromagnetic flux to induce a current within the receiving coil. In various embodiments the lid is attached to the housing with a hinge, and/or the lid can be separable from the housing.

[0302] In some embodiments a case for a pair of earbuds is provided. Each earbud can include an ear interface portion, a stem, an earbud battery and a wireless radio. The case include: a housing having a first cavity configured to receive a first earbud in the pair of earbuds and a second cavity configured to receive a second earbud in the pair of earbuds; a lid operable between a closed position where the lid conceals the pair of earbuds within the case and an open position where the lid is displaced from the case such that a user can remove the earbuds from the case and first and second charging systems. The first charging system can include: a case battery; a wireless power receiving coil positioned within the housing, the wireless power receiving coil configured to wirelessly receive power from a wireless power source; a connector configured to couple to each of the first and second earbuds, the second connector having at least

one contact positioned in the first cavity and at least one contact positioned in the second cavity; and charging circuitry operatively coupled to charge the case battery and provide power to the connector to charge the first and second earbuds from wireless power received over the wireless power receiving coil. The second charging system can include a transmitting coil positioned within the housing and configured to wirelessly transmit power to a power receiving coil of an auxiliary electronic device positioned adjacent the case. The case can further include an earbud detector configured to detect when an earbud is placed in either of the first or second cavities. The transmitting coil can be positioned adjacent an exterior charging surface that is a portion of an exterior housing of the case, and the case can further include an alignment magnet configured to align the transmitting coil with the receiving coil. In some embodiments the auxiliary electronic device is a wearable electronic device.

WATERPROOF RECEPTACLE CONNECTOR

[0303] In some embodiments an electrical receptacle connector is disclosed that includes: a housing comprised of an electrically insulative polymer that extends between a receiving face and a rear face, the housing defining a cavity that communicates with an opening in the receiving face to receive a plug portion of a mating plug connector; a contact spacer positioned adjacent to the rear face; a gasket disposed between the rear face of the housing and the contact assembly; a plurality of contacts, each of the plurality of contacts having a tip positioned within the cavity, an anchor portion that anchors each contact to the contact spacer and a beam portion that connects the tip to the anchor portion; and a metallic bracket disposed around an outside surface of the housing. The cavity includes slots that align with each of the plurality of contacts; the metallic bracket can include a top bracket attached to a bottom bracket; the gasket can form a liquid-tight seal between the contact assembly and the housing; and each of the plurality of contacts include an electrical lead that extends out of the contact assembly. In some embodiments the electrical receptacle connector further includes a dielectric overmolded component formed around a portion of the contact spacer and the anchor portion of each of the plurality of contacts that can form a liquid-tight seal to each of the plurality of contacts. In some embodiments a ground latch is included and coupled to the dielectric overmold. The ground latch can include first and second spring arms on opposing sides of the plurality of contacts. In some embodiments the plurality of contacts consists of eight contacts spaced apart from each other along a single row.

[0304] In some other embodiments an electrical receptacle connector includes: a housing comprised of an electrically insulative polymer that extends between a receiving face and a rear face, the housing defining a cavity that communicates with a front opening in the receiving face to receive a plug portion of a mating plug connector and wherein the housing has a plurality of slots that form a portion of the cavity; a contact assembly including: (i) a contact spacer positioned adjacent to the rear face; (ii) a plurality of contacts, each of the plurality of contacts having a tip that extents into the cavity through one of the plurality of slots, an anchor portion coupled to the contact spacer, and a beam portion that connects the tip to the anchor portion; and (iii) a ground latch having first and second spring arms on opposing sides of the plurality of contacts; a gasket disposed between the rear face of the housing and the contact assembly; and a metallic bracket disposed around an outside surface of the housing and formed to secure the contact assembly to the housing. In some embodiments the electrical receptacle connector further includes an overmolded dielectric component and wherein the contact assembly includes a spacer and the overmolded dielectric component is formed around a portion of the spacer and around the anchor portion of each contact in the plurality of contacts. The overmolded dielectric component forms a liquid-tight seal to each of the plurality of contacts. In some embodiments the contact assembly further includes a ground latch having first and second retention features on opposing sides of the plurality of contacts and the overmolded dielectric component secures the ground latch to the contact assembly. In some instances the metallic bracket includes a top bracket attached to a bottom bracket, and the plurality of contacts includes an electrical lead that extends out of the contact assembly. In some embodiments the gasket forms a liquid-tight seal between the contact assembly and the housing.

[0305] In some embodiments an electrical receptacle connector includes: a housing comprised of an electrically insulative polymer that extends between a receiving face and a rear face, the housing defining a cavity that communicates with a front opening in the receiving face to receive a plug portion of a mating plug connector and wherein the housing has a plurality of slots that form a portion of the cavity; a contact assembly including: (i) a contact spacer positioned adjacent to the rear face; (ii) a plurality of contacts, each of the plurality of contacts having a tip that extents into the cavity through one of the plurality of slots, an anchor portion coupled to the contact spacer, and a beam portion that connects the tip to the anchor portion; and (iii) a ground latch having first and second spring arms on opposing sides of the plurality of contacts; a gasket

disposed between the rear face of the housing and the contact assembly; and a metallic bracket disposed around an outside surface of the housing and formed to secure the contact assembly to the housing.

EARBUDS WITH CAPACITIVE TOUCH SENSOR

[0306] Some embodiments pertain to an earbud including: a housing defining a cavity in which one or more electrical components of the earbud are housed, the housing having a touch sensitive region at an exterior surface of the housing and an interior surface within the cavity opposite the exterior surface; a capacitive sensor insert having a first surface with metallized circuitry formed thereon and positioned within the housing such that the first surface is adjacent the interior surface of the housing; an earbud processor disposed within the housing; and at least one conductor that electrically couples the capacitive sensor insert to the earbud processor. The capacitive sensor insert can be formed to closely match a shape of the housing. In some instances the metallized circuitry forms at least one self-capacitance sensor in which, when touched by a user, loads self-capacitance circuitry that can be detected. In other instances the metallized circuitry includes row and column electrodes that form at least one mutual-capacitance sensor in which, when touched by a user, mutual coupling between row and column electrodes is altered and detected. The capacitive sensor insert is formed from a plastic that includes metallic particulates. In various embodiments the capacitive sensor insert can include one or more acoustic apertures that allow sound to pass through it; the metallized circuitry can at least partially surround the one or more acoustic apertures; and/or the capacitive sensor insert can be configured to detect when the earbud is within a user's ear, and/or to detect a user's touch against the exterior surface of the earbud housing.

[0307] In some embodiments an earbud includes: a housing that defines an enclosed cavity in which one or more electrical components of the earbud are housed, the earbud housing having a touch sensitive region at an exterior curved surface of the housing and an interior curved surface within the enclosed cavity opposite the exterior curved surface; a directional sound port formed within the housing; a speaker assembly disposed within the enclosed cavity and including a driver unit comprising a magnet, the driver unit aligned to emit sound from the directional sound port; a capacitive sensor configured to sense a user's touch on the touch sensitive region, the capacitive sensor including a sensor insert positioned within the enclosed cavity and one or more

acoustic apertures aligned with the directional sound port, the sensor insert having a first surface adjacent to and contoured to match the interior curved surface, the first surface including metallized circuitry formed thereon and at least partially surrounding the acoustic aperture; and a processor coupled to the capacitive sensor and disposed within the enclosed cavity. In some embodiments the first surface is contoured to closely match a contour of the housing. In various embodiments the metallized circuitry can form at least one self-capacitance sensor and/or the metallized circuitry can form at least one mutual-capacitance sensor. In some instances, the metallized circuitry can include a plurality of row and column electrodes and the capacitive sensor can be configured to scan the row and column electrodes sequentially to whether mutual coupling between row and column electrodes has been altered.

[0308] According to some embodiments an earbud includes: a housing that defines a cavity in which one or more electrical components of the earbud are housed, the earbud housing having a touch sensitive region at an exterior surface of the housing and an interior surface within the cavity opposite the exterior surface; a directional sound port formed within the housing; a speaker assembly disposed within the housing and including a driver unit comprising a magnet, the driver unit aligned to emit sound from the directional sound port; a capacitive sensor that can sense a user's touch on the touch sensitive region, the capacitive sensor comprising a sensor insert having a first surface with metallized circuitry formed thereon and positioned within the housing such that the first surface is adjacent the interior surface of the housing; and a processor coupled to the capacitive sensor and disposed within the cavity.

CASE WITH TORSION SPRING OVER-CENTER MECHANISM

[0309] In some embodiments a case for a listening device incudes: a housing having a cavity to receive the listening device; a lid attached to the housing with a pivotable joint allowing the lid to rotate between a closed position where the lid is aligned over the cavity and an open position where the lid is angularly displaced allowing the listening device to be removed from the cavity; and an over center mechanism for the lid including an extension attached to the lid and disposed on an opposite side of the pivotable joint from the lid, wherein the extension is in contact with an arm that resists the lid rotating from the open position to the closed position until the lid is moved past an over center position when the lid is then impelled to the closed position. The arm can have a force applied to it by a spring that forces it in contact with the extension.

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The spring can be a torsion spring. The arm can includes a first end attached to an arm pivot and a second end opposite the first end. The arm can include first and a second surfaces arranged opposite each other and extending between the first and second ends where the extension is positioned to be in sliding contact with first surface as the lid is transitioned between the open position to the closed positions. The extension can further be oriented perpendicular to the first surface when the lid is at the over center position, and the extension can include a rounded contact end that is in sliding contact with the first surface of the arm when the lid is transitioned between the opened and closed positions.

[0310] In some embodiments a case for an electronic device includes: a housing having a cavity to receive the electronic device and a receiving opening that communicates with the receiving opening; a lid secured to housing with a first pivotable joint, the lid being operable between an open position in which the receiving opening is exposed and a closed position in which the lid covers the receiving opening; and a spring loaded over center mechanism for the lid. The spring-loaded over-center mechanism can include: an extension coupled to the lid and having a rounded contact portion at a distal end; an arm coupled to the housing by a second pivotable joint, the arm extending between a first end attached to the second pivotable joint and a second end, opposite the first end, the arm having first and second surfaces extending between the first and second ends; and a torsion spring formed around the second pivotable joint such that it applies a torque to the arm forcing the arm against the rounded portion of the extension. The spring loaded over center mechanism can resist the lid rotating from the open position to the closed position until the lid is moved past an over center position when the lid is then impelled to the closed position. The extension and arm can be configured such that the extension is in sliding contact with a first portion of the first surface proximate the first end when the lid is between the open position and the over-center position; the distal end of the extension is oriented perpendicular to the first surface when the lid is at the over-center position; and the extension is in sliding contact with a second portion of the first surface proximate the second end when the lid is between the closed position and the over-center position. The extension can have a rounded portion at the distal end that is in sliding contact with the arm when the lid is transitioned between the opened and closed positions. The torsion spring can be preloaded against a spring stop that is attached to the housing. The cavity can be formed to receive a pair

of earbuds and the can further include charging circuitry configured to charge the pair of earbuds and a sensor configured to detect if the lid is in the open position or the closed position.

[0311] In some embodiments a case for a pair of earbuds includes: a housing having a first receiving cavity sized and shaped to receive a first earbud in the pair of earbuds and a second cavity sized and shaped to receive a second earbud in the pair of earbuds; a lid secured to housing with a first pivotable joint, the lid being operable between an open position in which the first and second cavities are exposed and a closed position in which the lid covers the first and second cavities; a spring-loaded over-center mechanism coupled to the lid and configured to resists the lid rotating from the open position to the closed position until the lid is moved past an over center position when the lid is then impelled to the closed position; and charging circuitry configured to charge the first earbud when the first earbud is received within the first cavity and charge the second earbud when the second earbud is received within the second cavity. The the spring-loaded over-center mechanism can include: (i) an extension coupled to the lid and having a rounded contact portion at a distal end; (ii) an arm coupled to the housing by a second pivotable joint, the arm extending between a first end attached to the second pivotable joint and a second end, opposite the first end, the arm having first and second surfaces extending between the first and second ends; and (iii) a torsion spring formed around the second pivotable joint such that it applies a torque to the arm forcing the arm against the rounded portion of the extension. The torsion spring can be preloaded against a spring stop that is attached to the housing.

[0147] The embodiments and examples disclosed herein were chosen and described in order to best explain the principles of the invention and its practical applications to thereby enable others skilled in the art to best utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. Thus, it will be appreciated that the disclosure is intended to cover all modifications and equivalents within the scope of the embodiments and examples listed above as well as all modifications and equivalents within the scope of following claims.

WHAT IS CLAIMED IS:

1. A case for a pair of earbuds, the case comprising:

a housing having one or more cavities configured to receive the pair of earbuds;

a lid attached to the housing and operable between a closed position where the lid is aligned over the one or more cavities and an open position where the lid is displaced from the one or more cavities; and

a charging system including:

a case battery;

an earbud detector configured to detect when an earbud is placed in the one or more cavities; and

charging circuitry configured to initiate charging of the earbud when the earbud detector detects that the earbud is inserted into the one or more cavities.

2. The case of claim 1 wherein the housing includes a first cavity configured to receive a first earbud in the pair of earbuds and a second cavity sized and shaped to receive a second earbud in the pair of earbuds; and the earbud detector includes a first earbud sensor configured to detect when the first earbud is placed in first cavity and a second earbud sensor configured to detect when the second earbud is placed in the second cavity.

3. The case of claim 2 wherein each of the first and second earbud sensors detect insertion of their respective earbud by detecting a magnetic field generated by the earbud.

4. The case of claim 3 wherein the charging circuitry is configured initiate charging of the first earbud when the first earbud sensor detects the first earbud within the first cavity and initiate charging of the second earbud when the second earbud sensor detects the second earbud within the second cavity.

5. The case of claim 1 wherein the housing includes a first cavity configured to receive a first earbud in the pair of earbuds and a second cavity sized and shaped to receive a second earbud in the pair of earbuds, wherein the case includes a first charging contact positioned within the first cavity to deliver power to the first earbud and a second charging

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contact positioned within the second cavity to deliver power to the second earbud, and wherein the earbud detector comprises detection circuitry operatively coupled to the first and the second charging contacts that detects one or more electrical characteristics of the first and the second earbuds, respectively, when the first and the second earbuds are placed in their respective cavities.

6. The case of claim 5 wherein the earbud detector periodically applies a voltage to the first charging contact to detect the first earbud and periodically applies a voltage to the second charging contact to detect the second earbud.

7. The case of any of claims 1-6 further comprising a pairing input mechanism disposed on the case and operatively coupled to circuitry within the case that sends a signal to at least one earbud in the pair of earbuds to place the earbud into a pairing mode.

8. The case of any of claims 1-6 further comprising a connector configured to interface with a power source that supplies power to the case to charge the case battery.

9. A case for transporting and charging a portable listening device that includes a rechargeable battery and a power contact, the case comprising:

a housing configured to receive the portable listening device;

a lid attached to the housing and operable between a closed position where the lid conceals the listening device within the case and an open position where the lid is displaced from the housing such that a user can remove the listening device from the case;

a detector configured to generate a detect signal when the listening device is placed in the housing; and

charging circuitry configured to initiate charging of the rechargeable battery in response to receiving the detect signal.

10. The case of claim 9 wherein the portable listening device comprises a pair of earbuds, each of the earbuds having an ear interface portion formed to fit at least partially within a user's ear.

11. A case for a portable listening device that includes a wireless radio and one or more device electrical contacts, the case comprising:

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a housing having a receiving area for the portable listening device;

a lid attached to the housing and operable between a closed position where the lid conceals the portable listening device within the case and an open position that allows a user to remove the portable listening device from the receiving area;

an electrical connector positioned within the receiving area, the electrical connector having one or more case electrical contacts that electrically connect to the one or more device electrical contacts when the portable listening device is received in the receiving area;

an input device configured to generate a signal in response to a user-generated action; and

a processor coupled to the input device and the electrical connector, the processor configured to receive the signal from the input device and, in response, send an instruction to the portable listening device through the electrical connector to initiate wireless pairing of the portable listening device to a host electronic device.

12. The case of claim 11 wherein the input device comprises a lid sensor that is activated by a user moving the lid from the closed position to the open position.

13. The case of claim 11 wherein the input device comprises a depressible button on the case.

14. The case of claim 11 wherein the input device is a first input device comprising a lid sensor, and wherein the case further comprises a second input device comprising a depressible button on the case, the first and second input devices generating different signals that are distinguishable by the processor.

15. The case of claim 14 wherein the portable listening device comprises first and second wireless earbuds and the electrical connector includes a first contact for transmitting power to the first wireless earbud and a second contact for transmitting power to the second wireless earbud.

16. The case of any of claims 11-15 further comprising a rechargeable battery that is coupled to the one or more case electrical contacts and configured to provide recharging energy to the first and second wireless earbuds.

17. The case of any of claims 11-15 wherein the processor is further configured to receive send an instruction to the portable listening device through the electrical connector to turn ON its wireless radio in response to receiving the signal from the input device prior to sending an instruction to the portable listening device to initiate wireless pairing of the portable listening device to the host electronic device.

18. A method of wirelessly pairing a first electronic device to a second electronic device, the method comprising:

receiving an input from a user at a third electronic device;

in response to receiving the input, the third electronic device communicates a user input signal to the first electronic device through a wired connection between the third and the first electronic devices;

in response to receiving the user input signal by the first electronic device, the first electronic device broadcasts a wireless pairing request; and

in response to receiving the wireless pairing request, the second electronic device wirelessly pairs with the first device.

19. The method of claim 18 wherein the first electronic device is a wireless headphone set, the second electronic device is a mobile electronic device and the third electronic device is a case for the wireless headphone set.

20. The method of claim 19 wherein the input from the user is opening a lid of the case for the wireless headphone set.

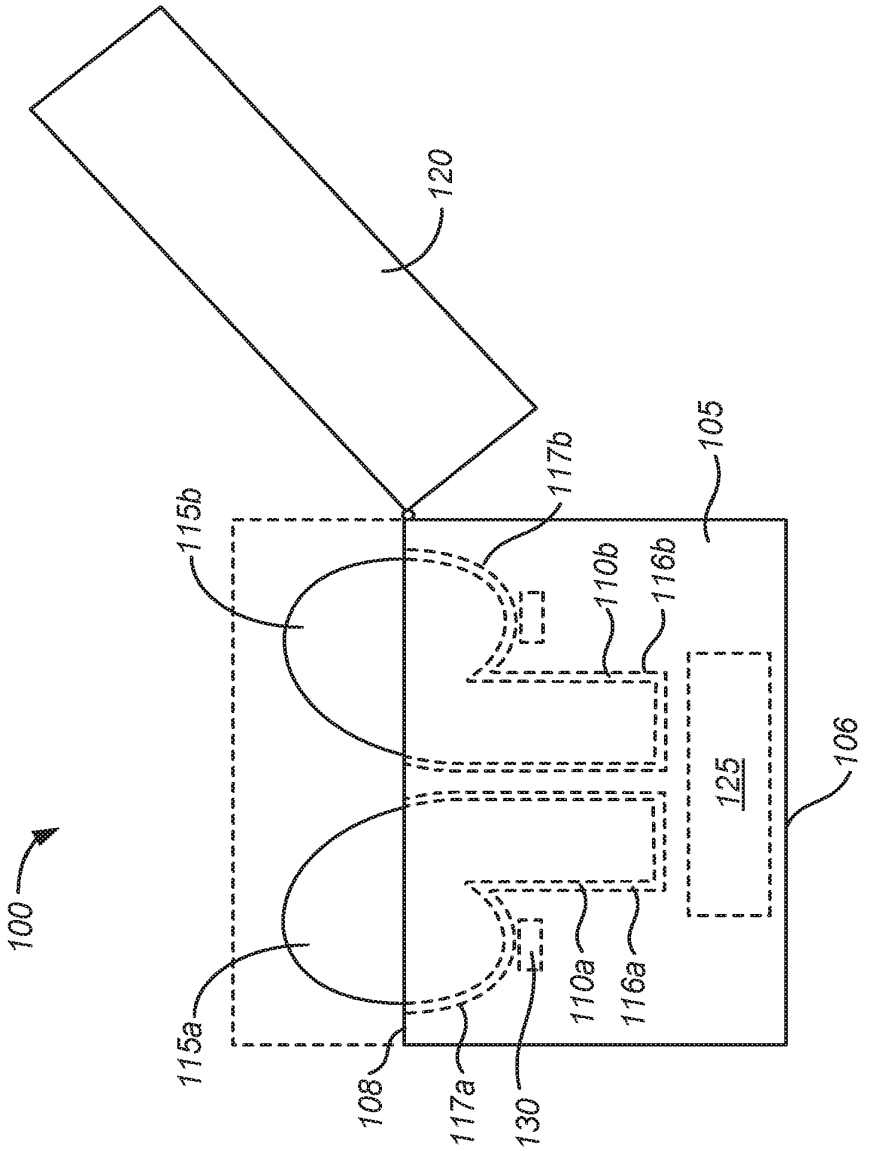

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FIG. 1

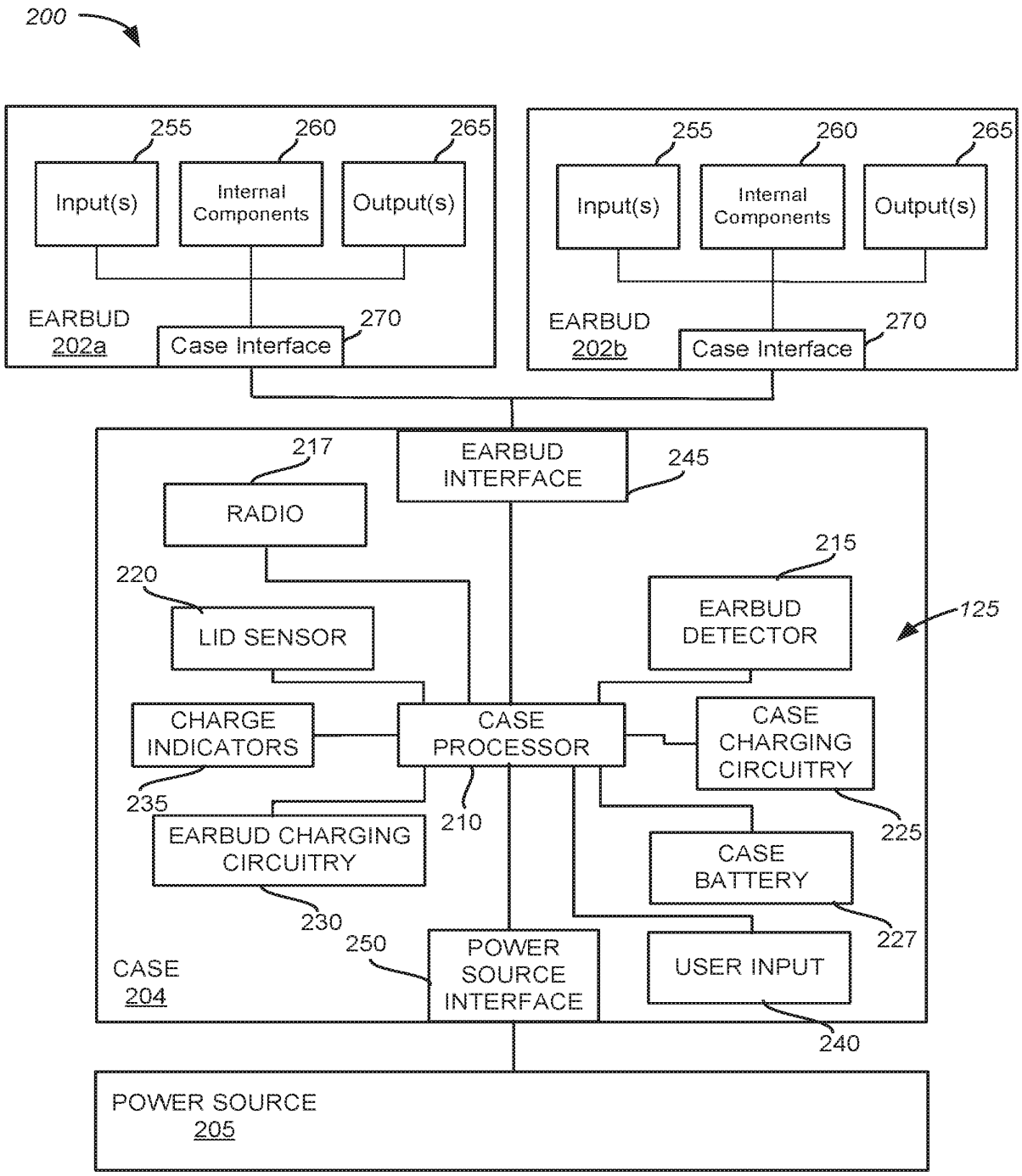

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Output(s)
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Case Interface
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EARBUD 202b
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RADIO
EARBUD INTERFACE
245
215
220
LID SENSOR
EARBUD DETECTOR
125
CHARGE INDICATORS
CASE PROCESSOR
CASE CHARGING CIRCUITRY
235
210
225
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USER INPUT
CASE 204
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POWER SOURCE 205

FIG. 2

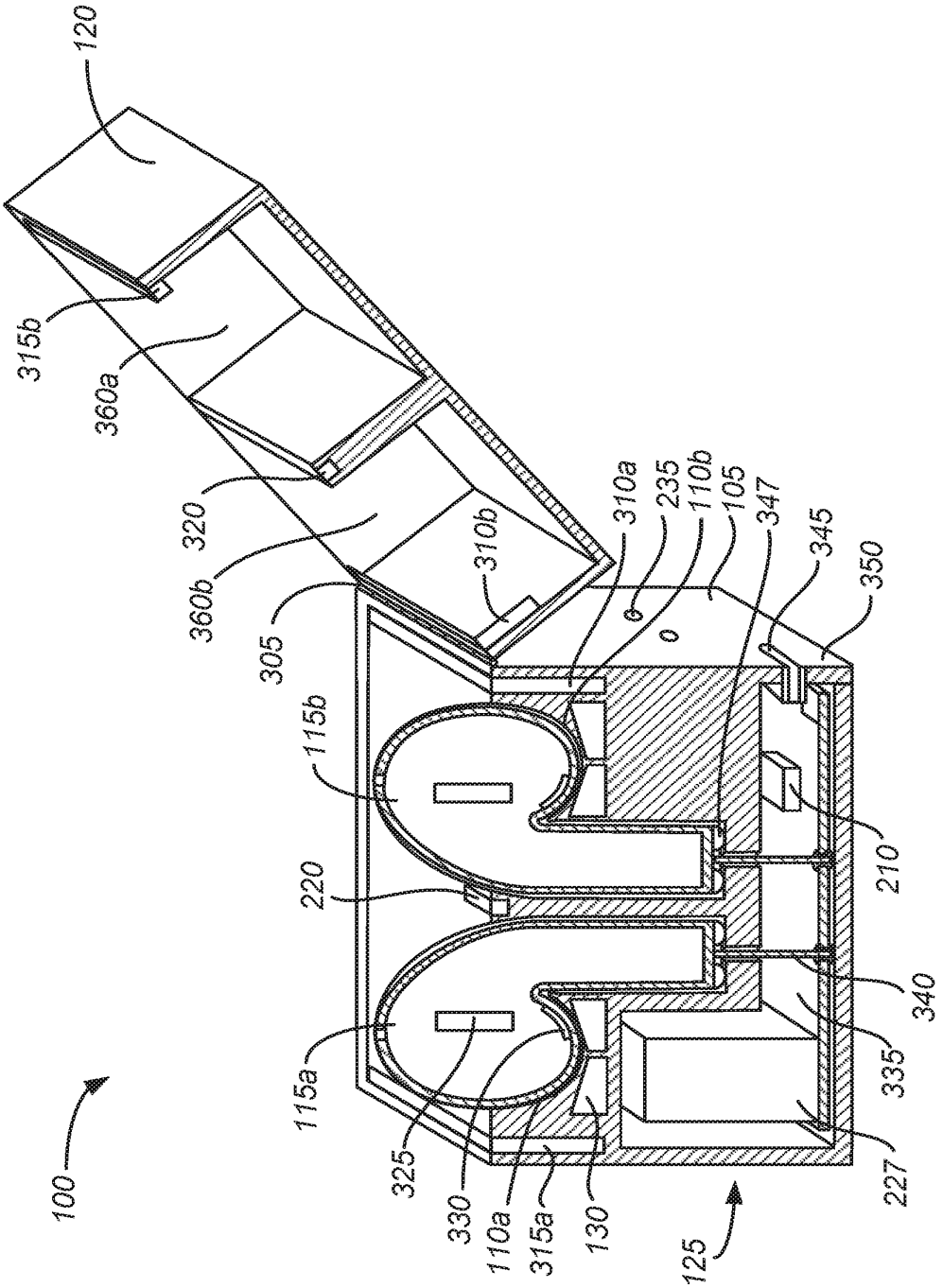

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100

FIG. 3

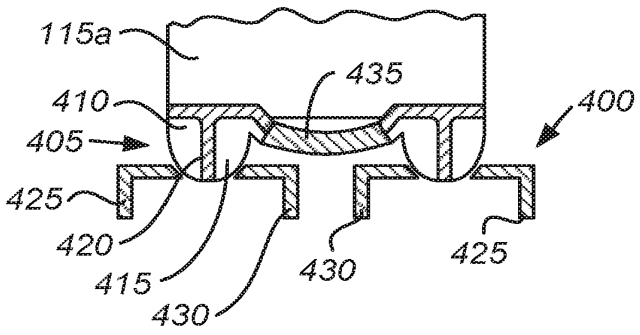


FIG. 4A

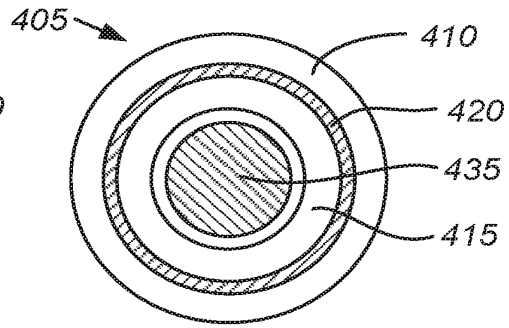


FIG. 4B

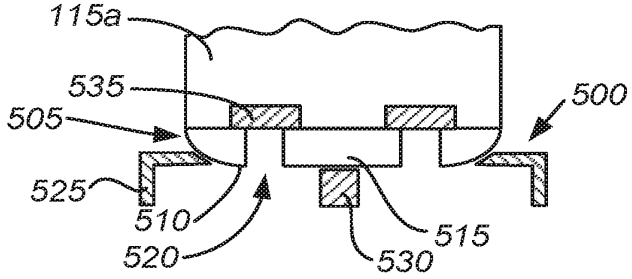


FIG. 5A

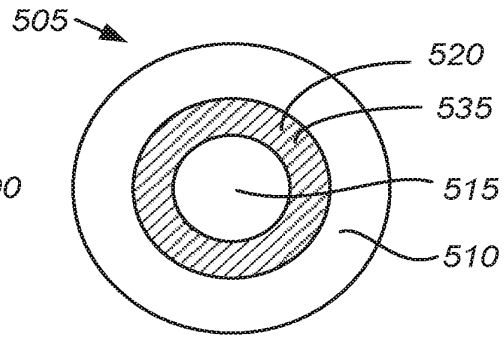


FIG. 5B

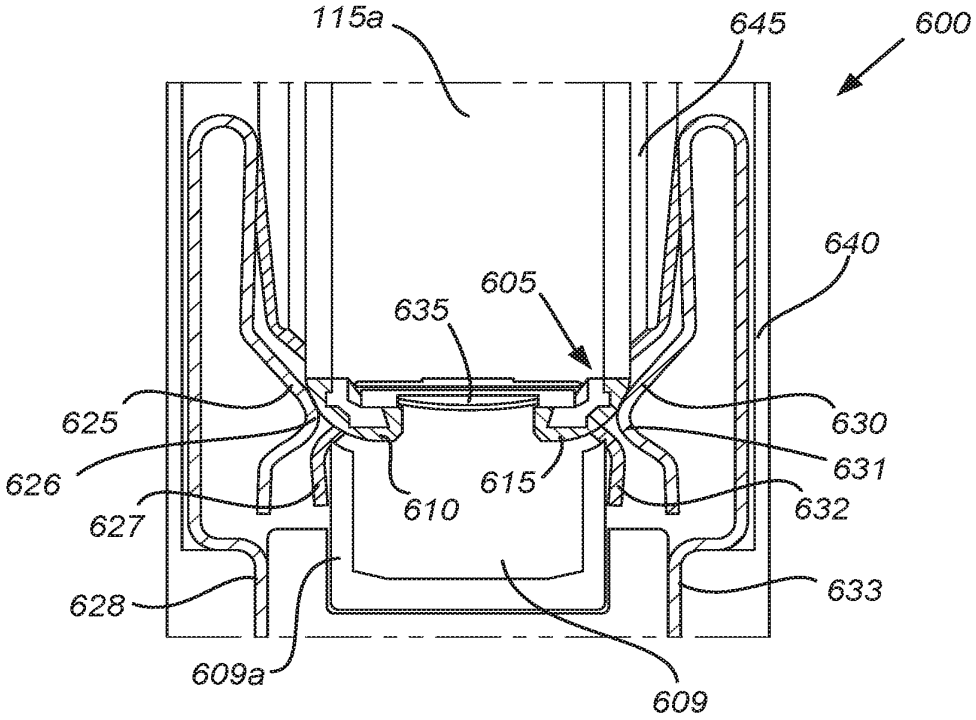

115a
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609a
609

FIG. 6A

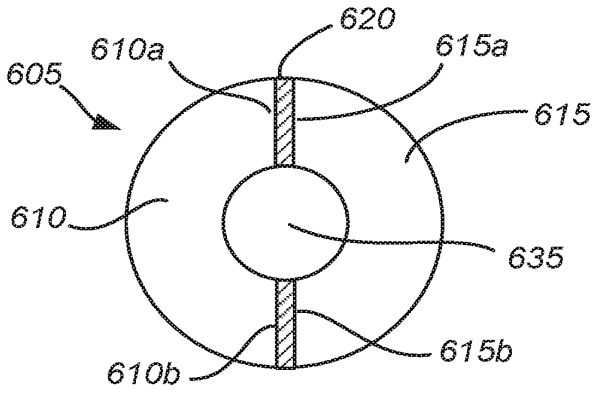

620
610a
615a
605
615
610
635
615b
610b

FIG. 6B

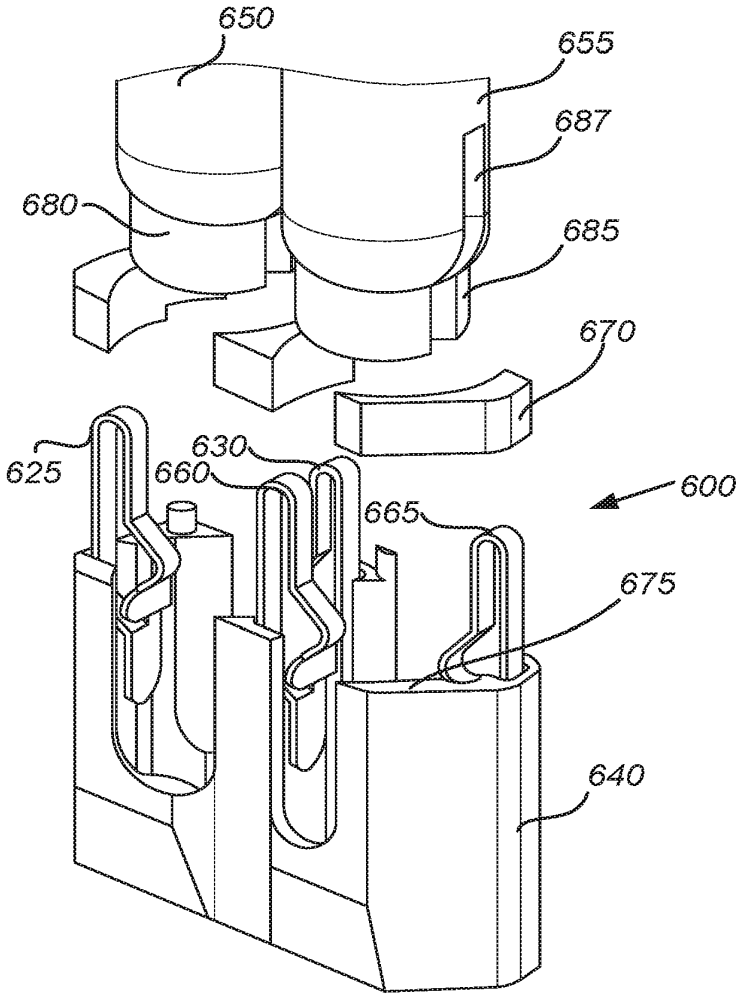


FIG. 6C

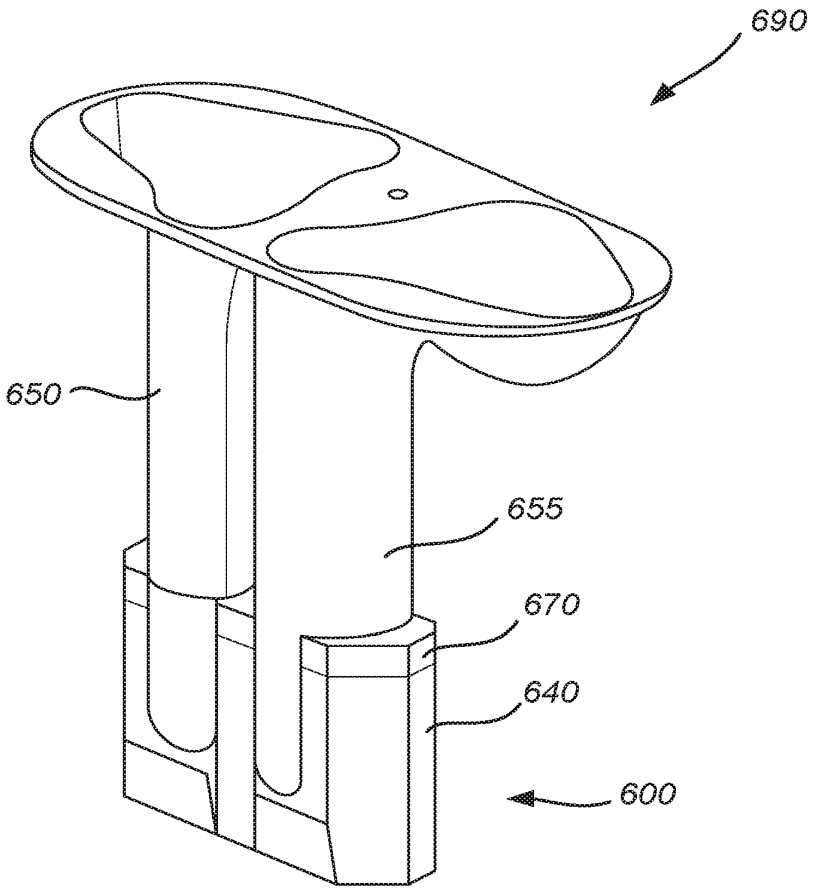


FIG. 6D

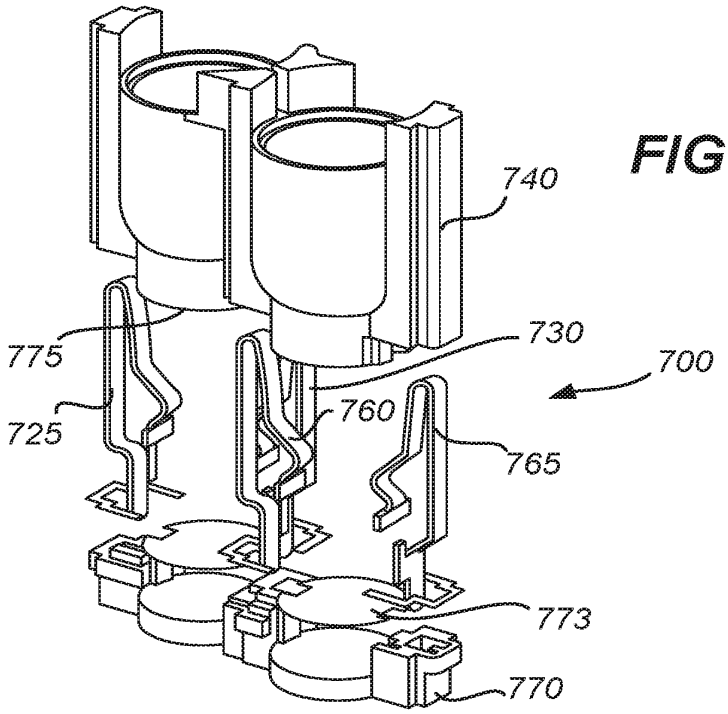


FIG. 7A

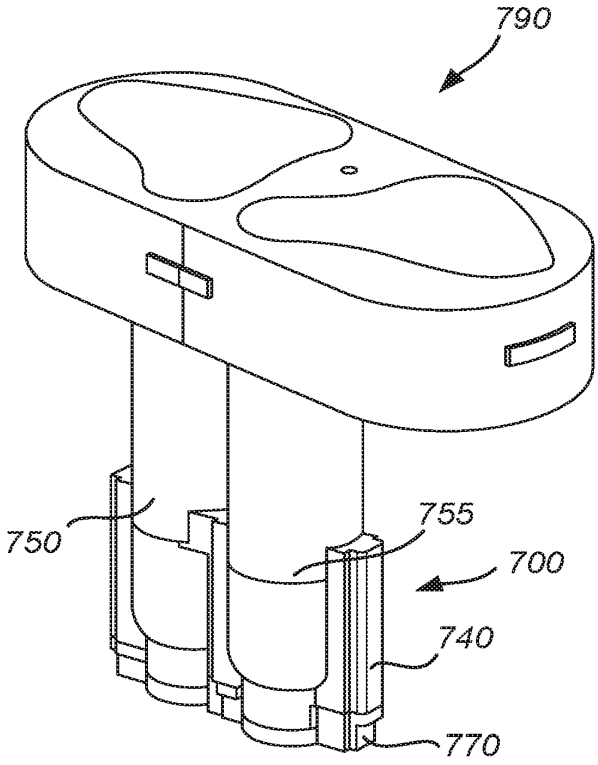


FIG. 7B

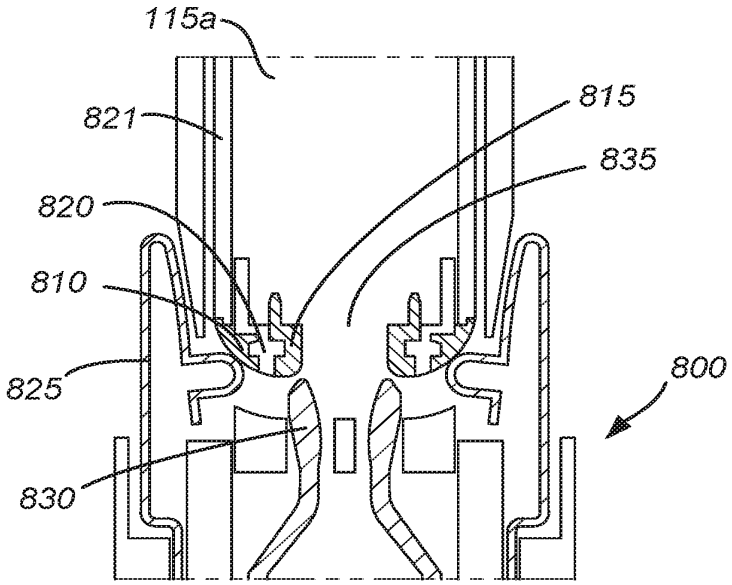


FIG. 8A

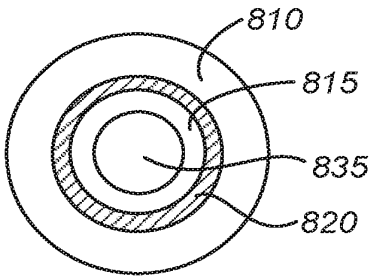


FIG. 8B

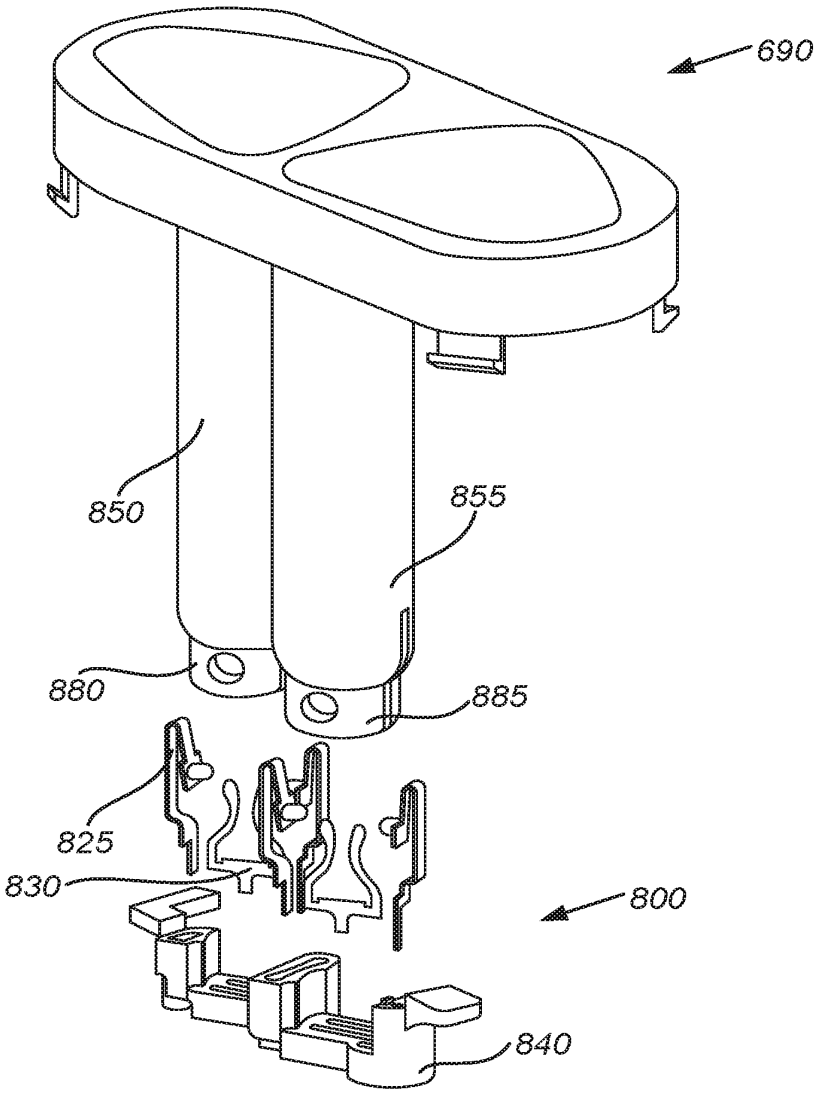
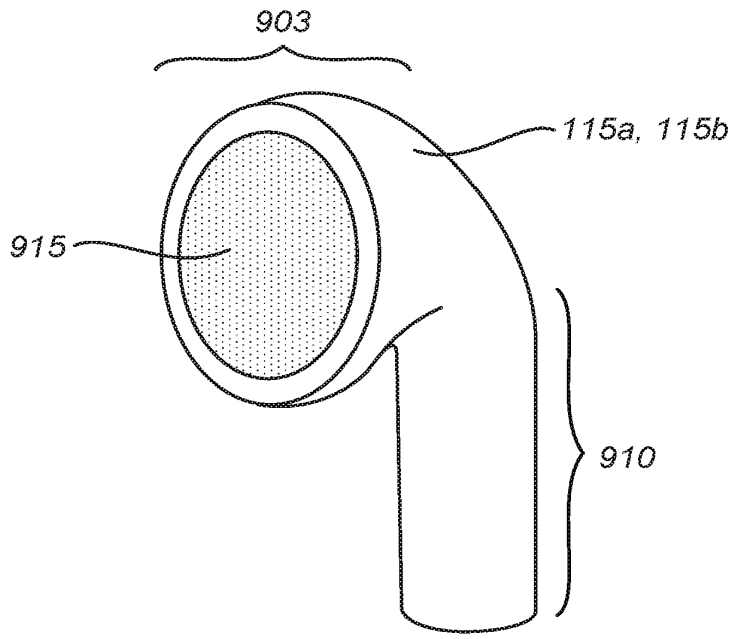


FIG. 8C

FIG. 9A



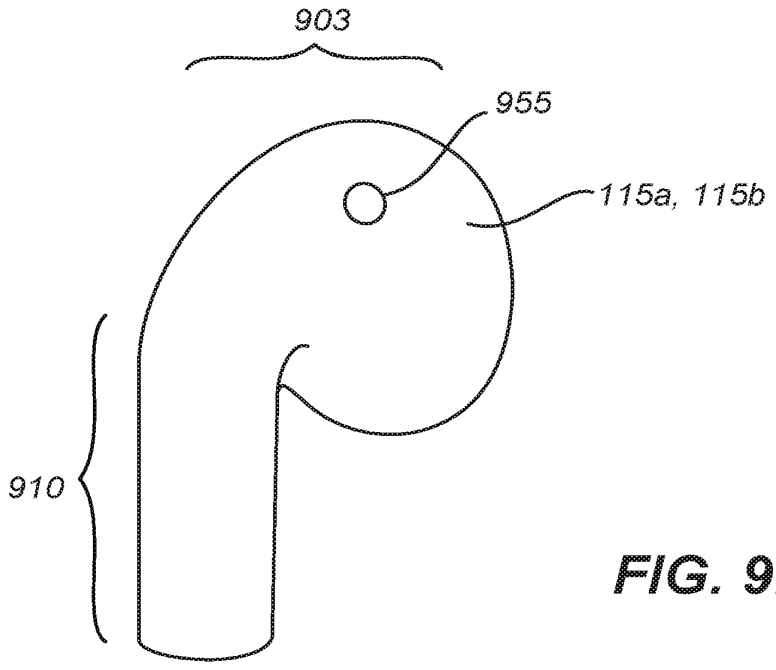


FIG. 9B

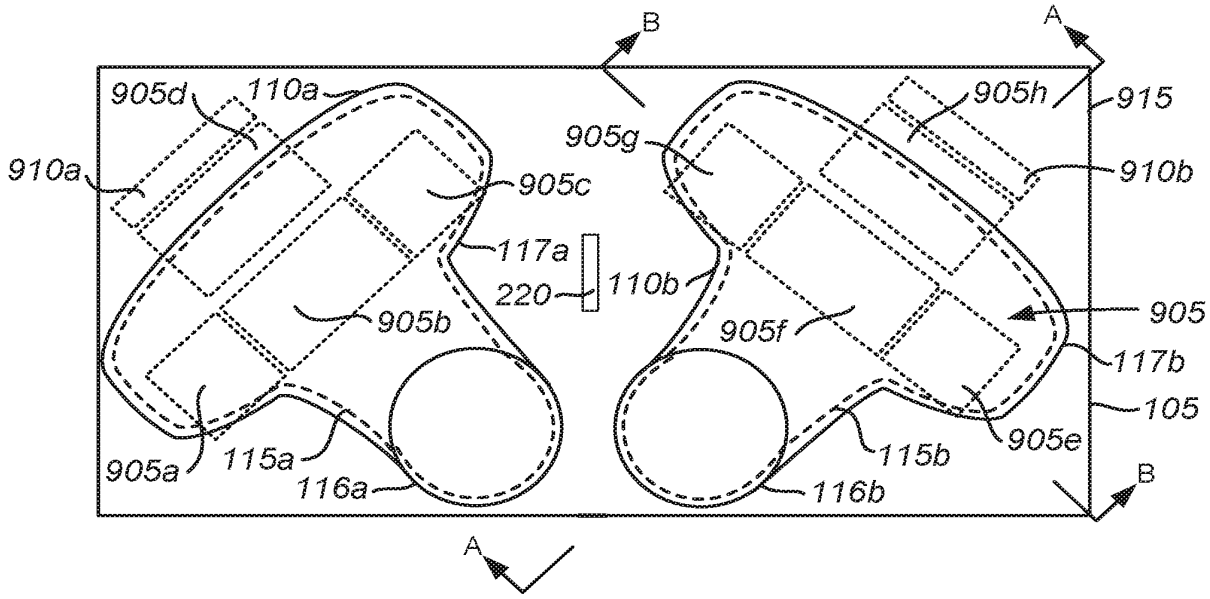
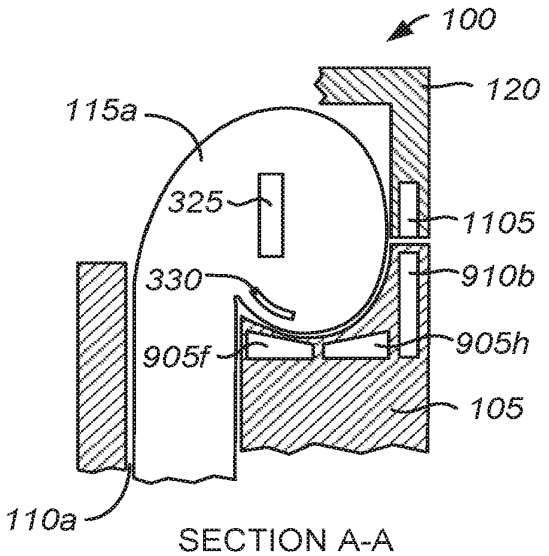
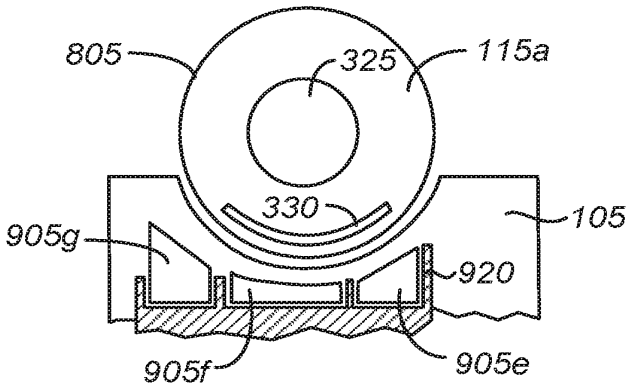


FIG. 10



SECTION A-A

FIG. 11



SECTION B-B

FIG. 12

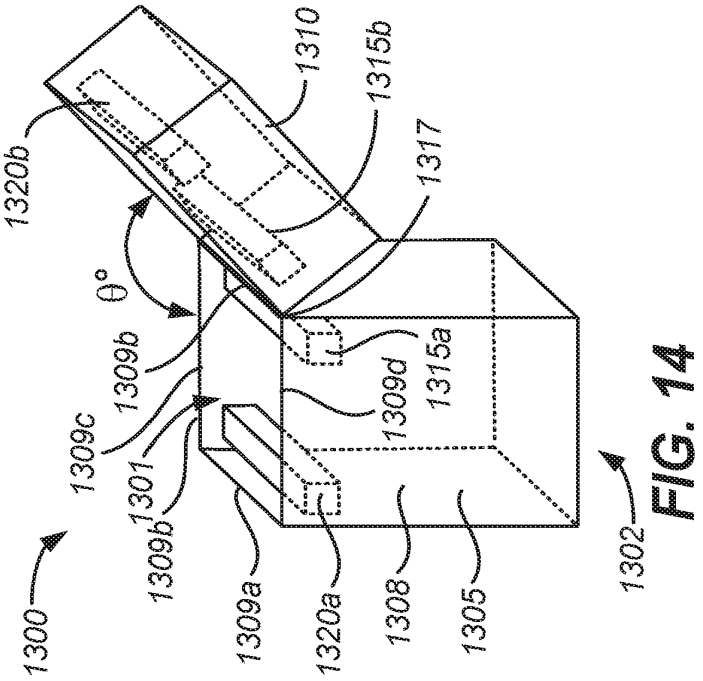


FIG. 14

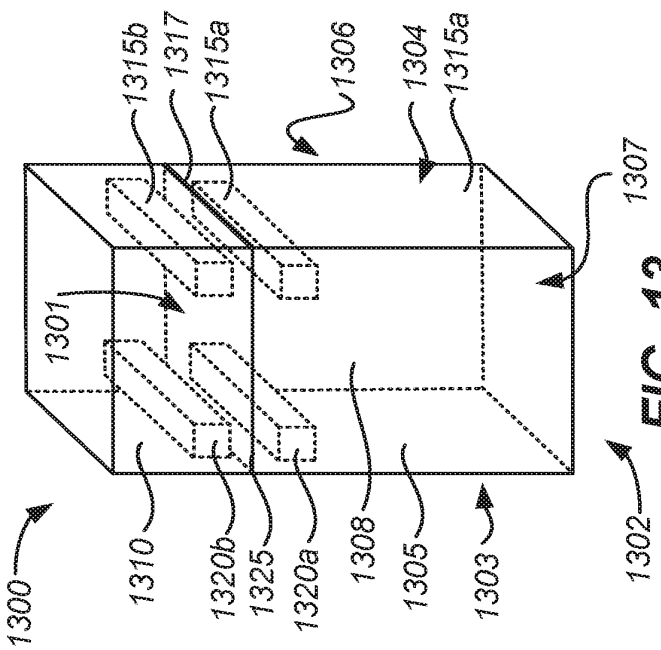


FIG. 13

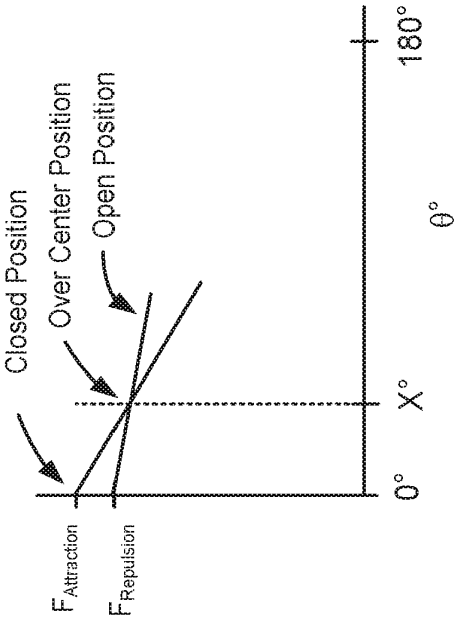


FIG. 15

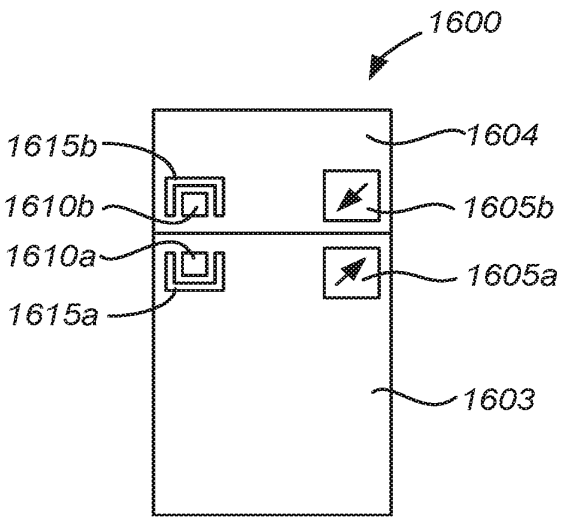


FIG. 16

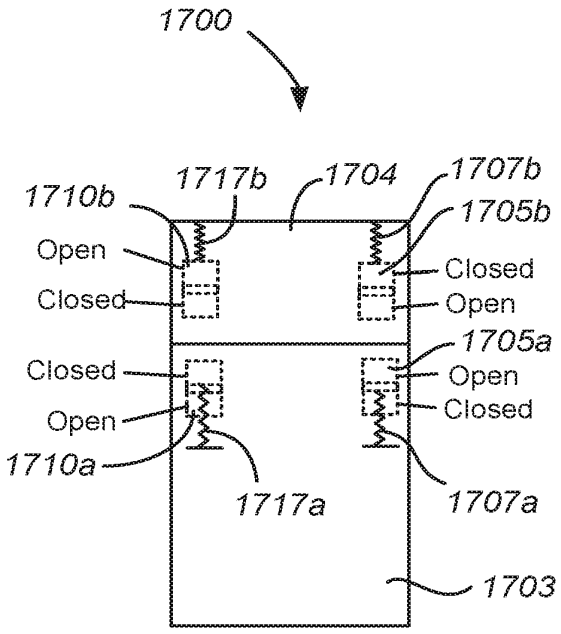


FIG. 17

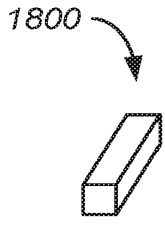


FIG. 18

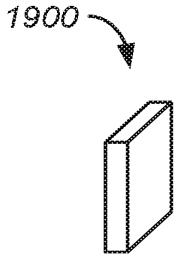


FIG. 19

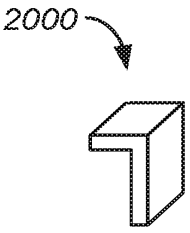


FIG. 20

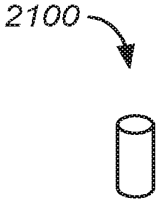


FIG. 21

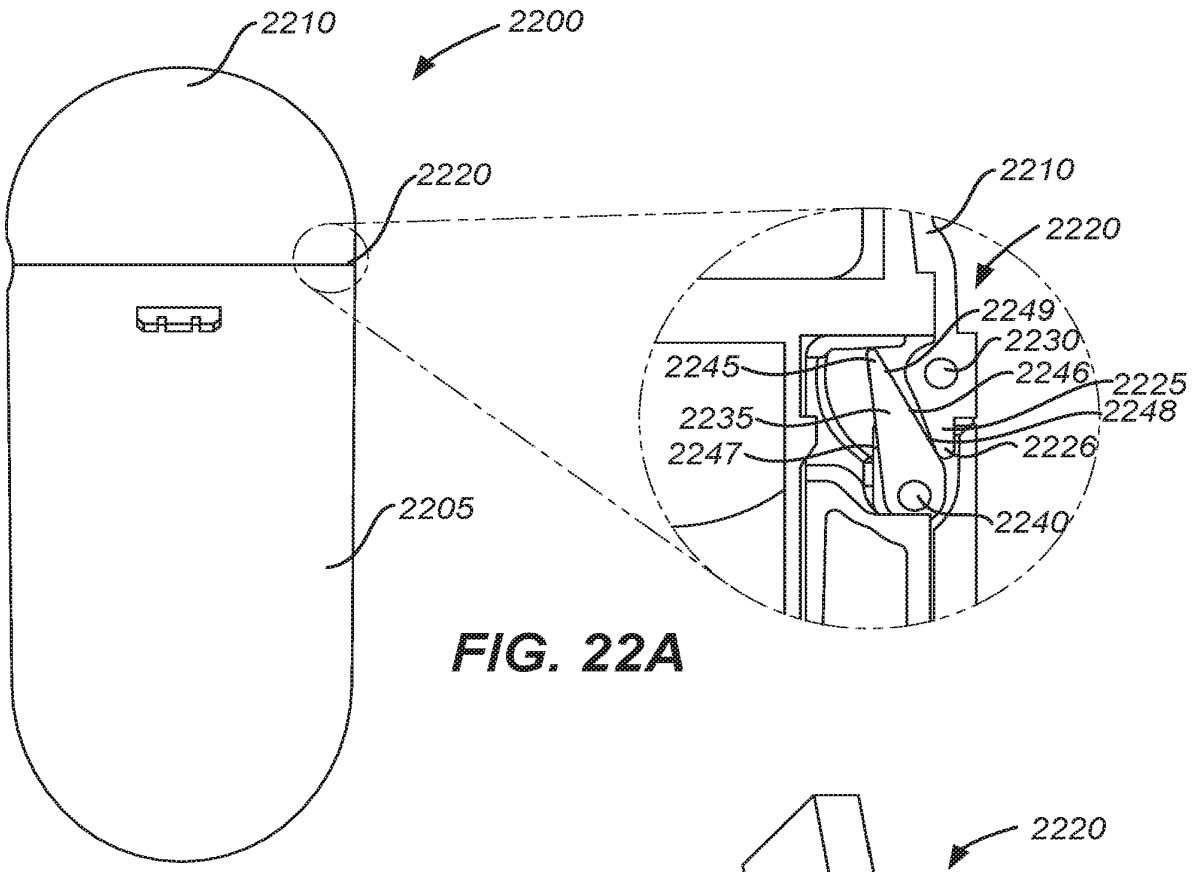


FIG. 22A

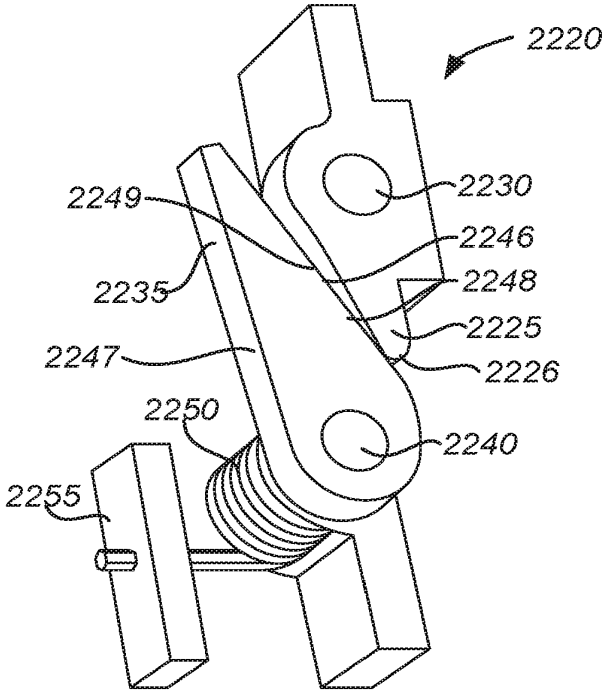


FIG. 22B

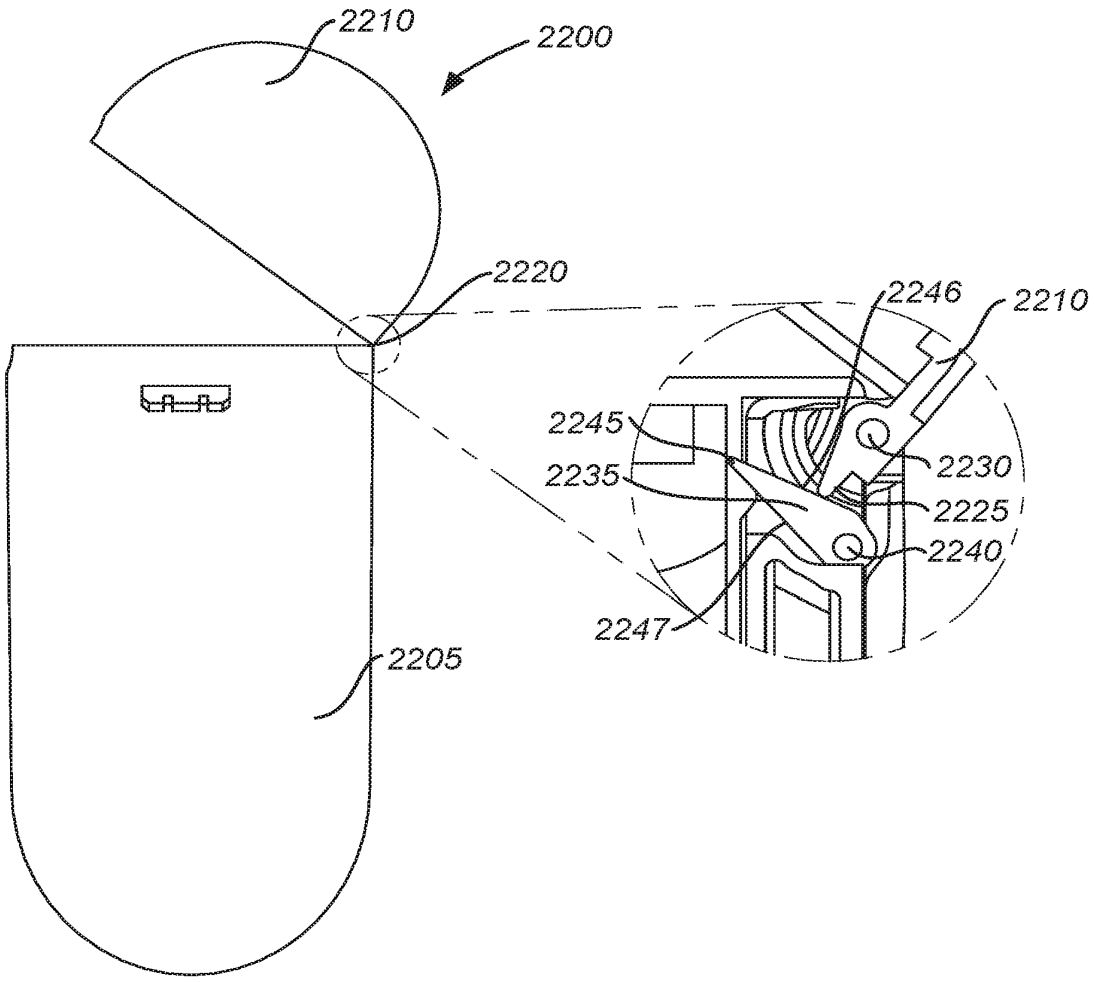


FIG. 22C

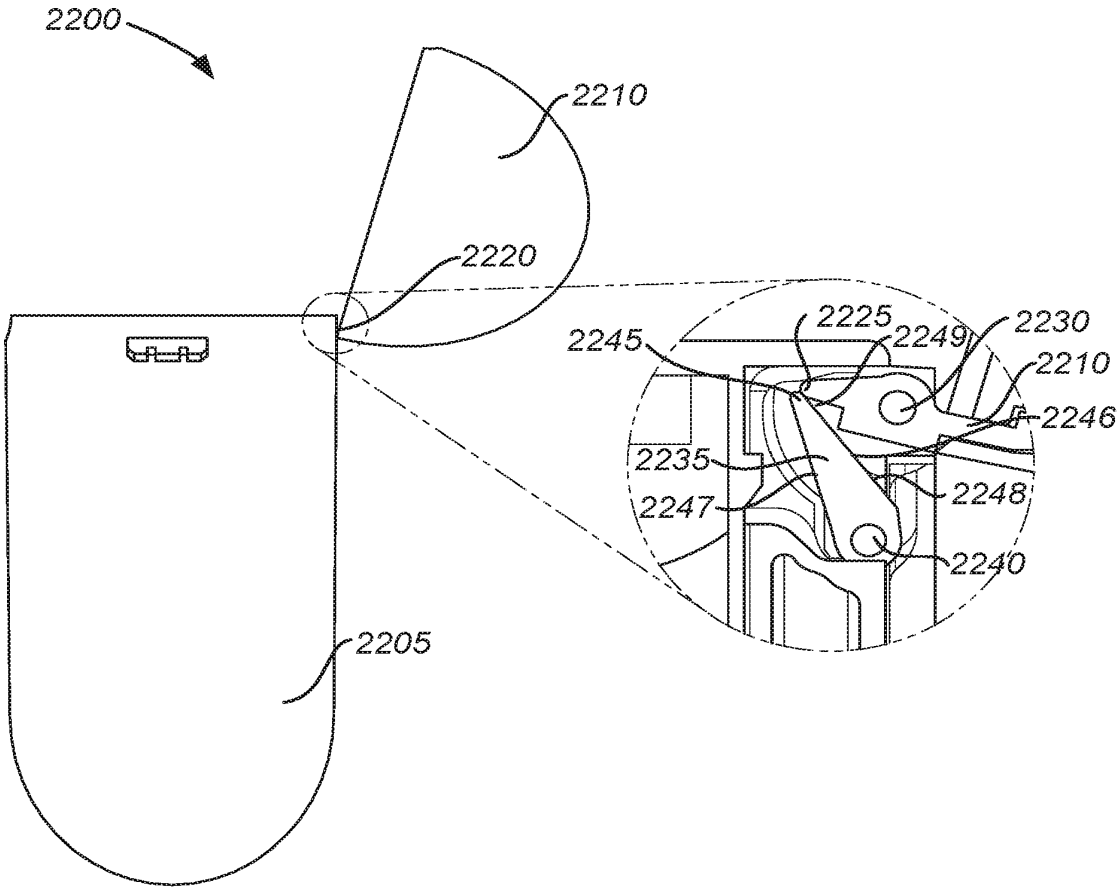

2200
2210
2220
2245
2225
2249
2230
2210
2246
2235
2247
2248
2240
2205

FIG. 22D

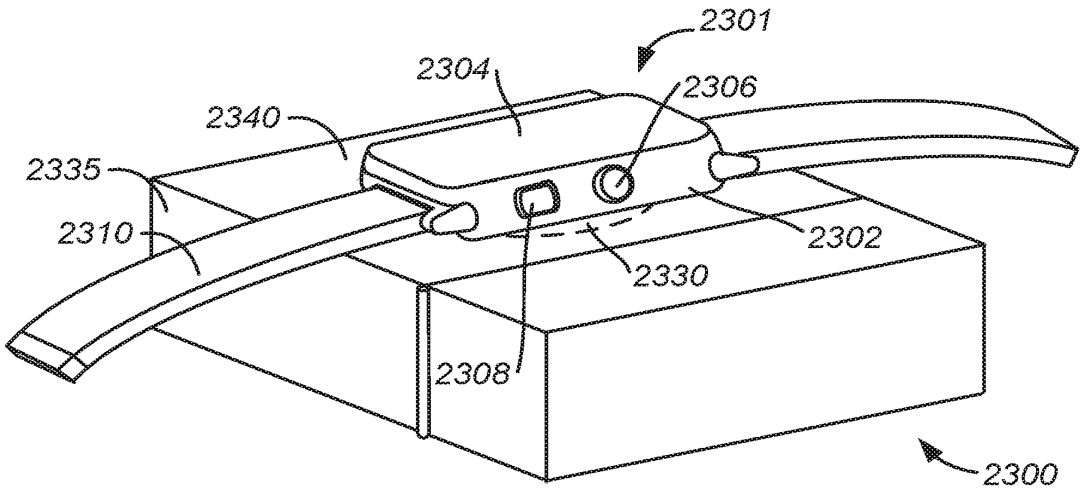

2301
2304
2306
2340
2335
2310
2302
2330
2308
2300

FIG. 23

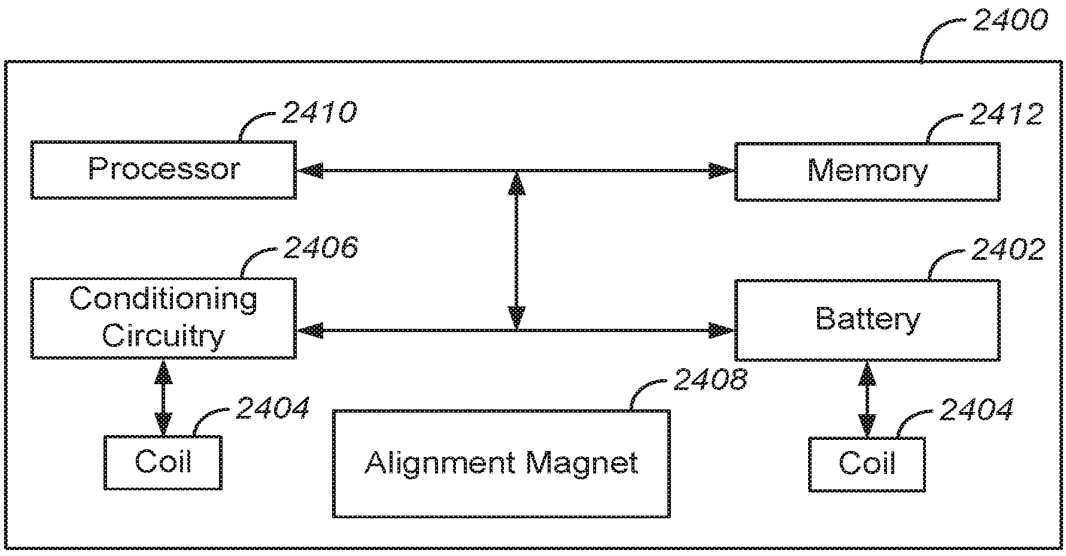

2400
2410
Processor
2412
Memory
2406
Conditioning Circuitry
2402
Battery
2408
2404
Coil
Alignment Magnet
2404
Coil

FIG. 24

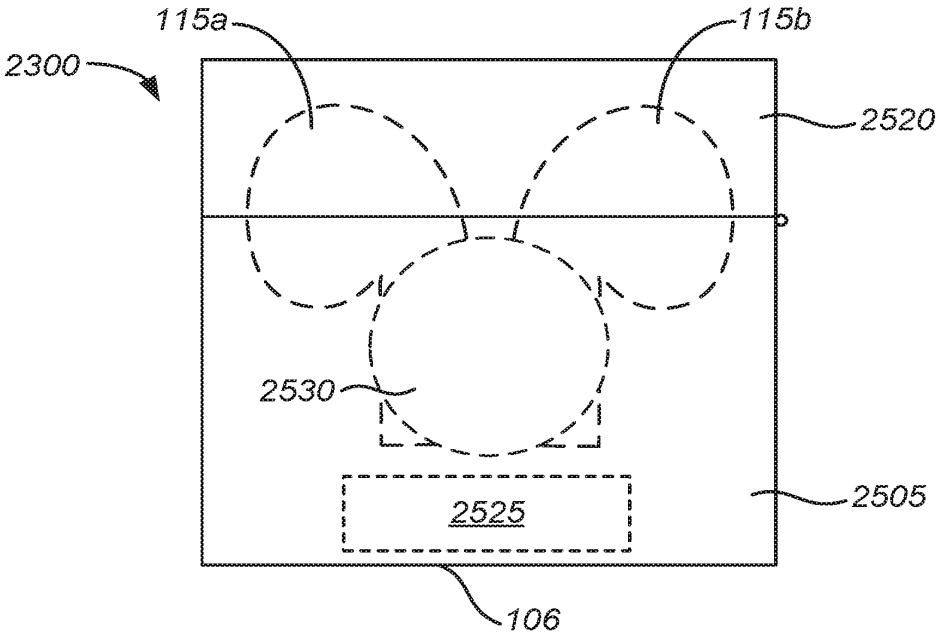

115a
115b
2300
2520
2530
2525
2505
106

FIG. 25

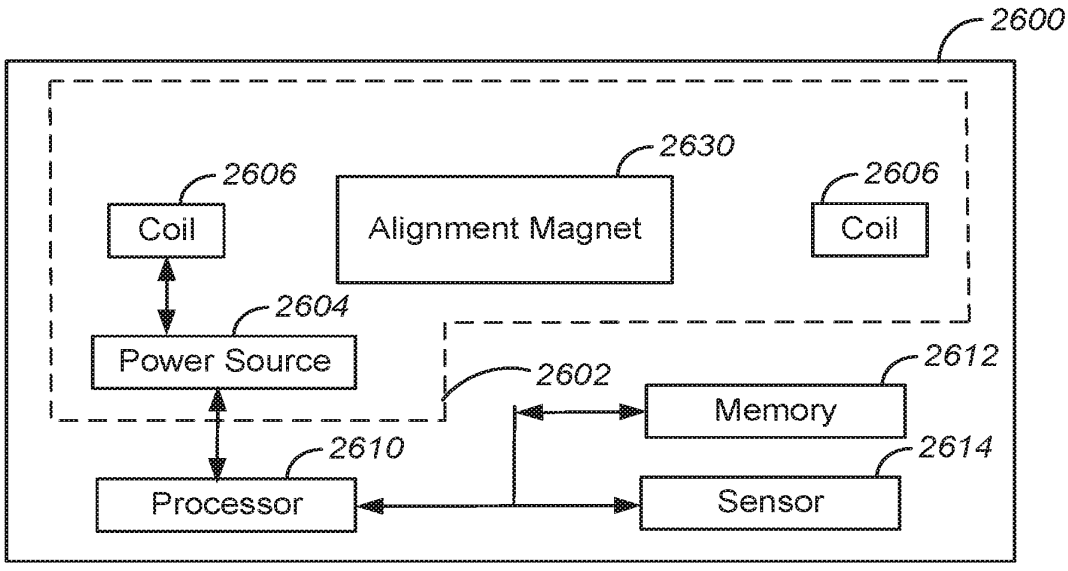

2600
2606
Coil
2630
Alignment Magnet
2606
Coil
2604
Power Source
2602
2612
Memory
2610
Processor
2614
Sensor

FIG. 26

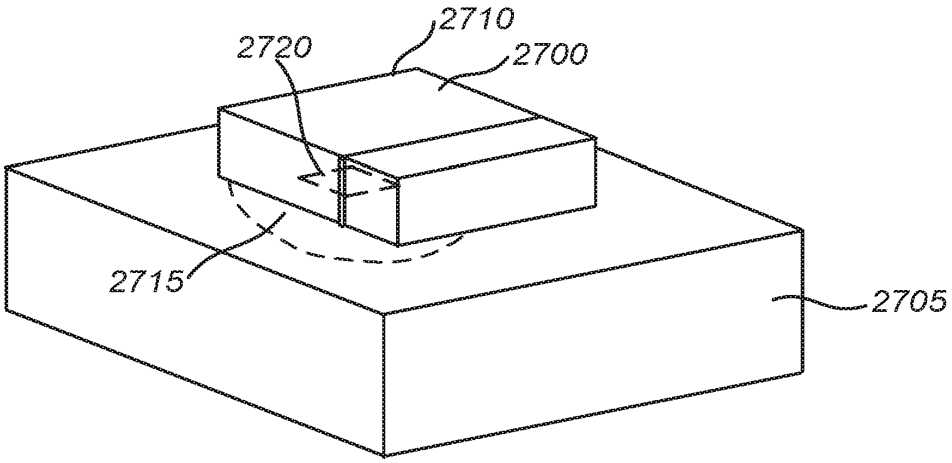

2710
2720
2700
2715
2705

FIG. 27

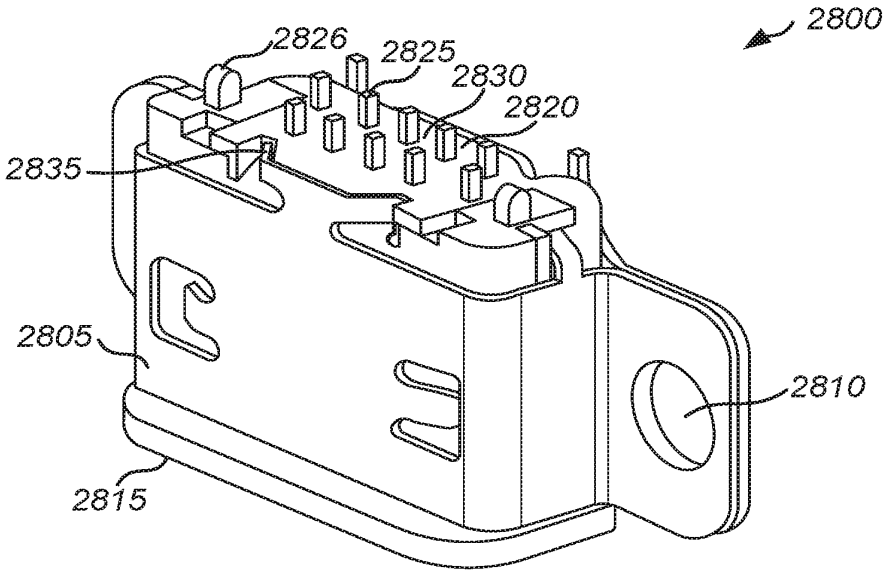

2800
2826
2825
2830
2820
2835
2805
2810
2815

FIG. 28

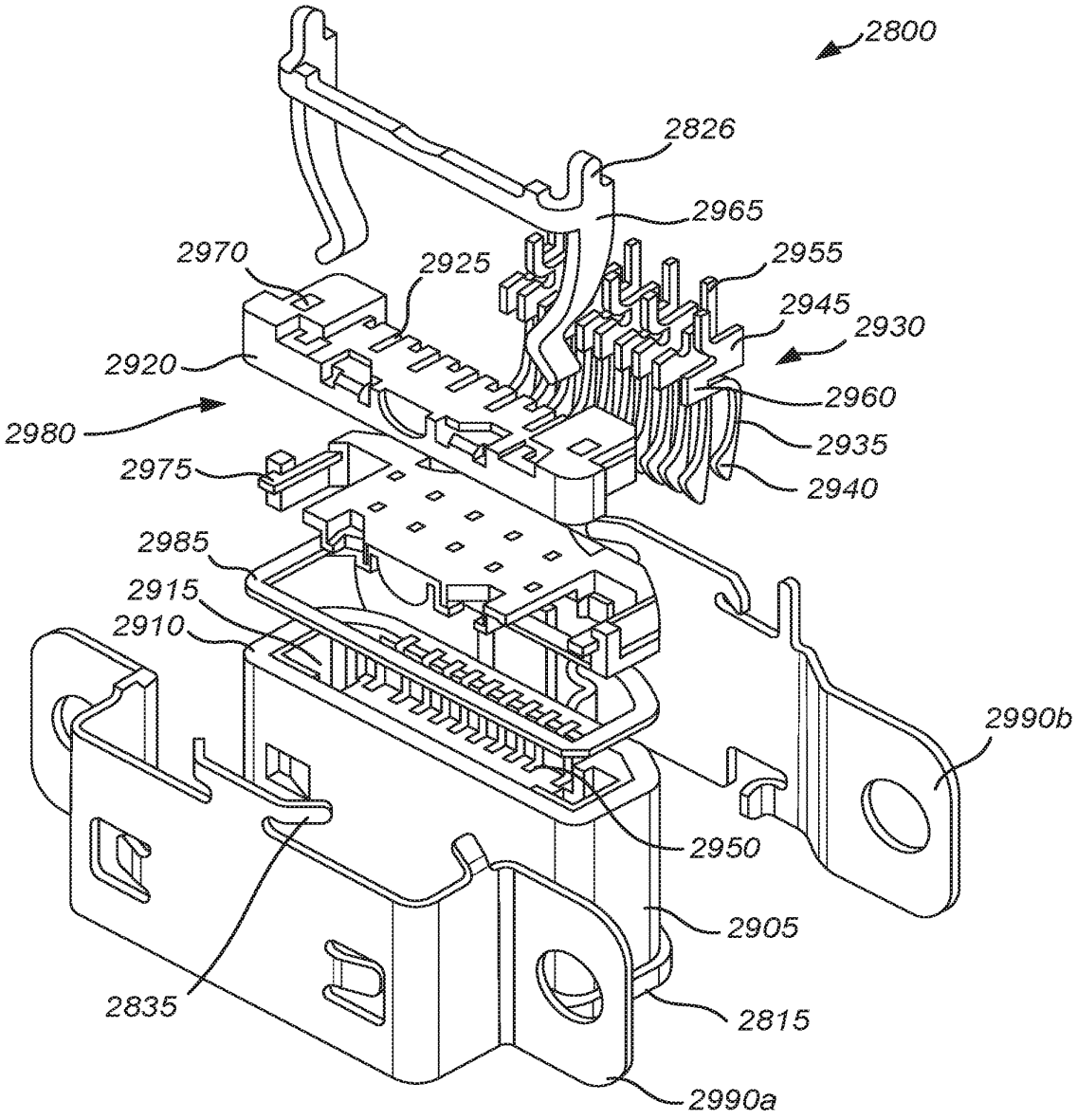

2800
2826
2965
2970
2925
2955
2945
2930
2920
2960
2980
2935
2975
2940
2985
2915
2910
2990b
2950
2905
2835
2815
2990a

FIG. 29

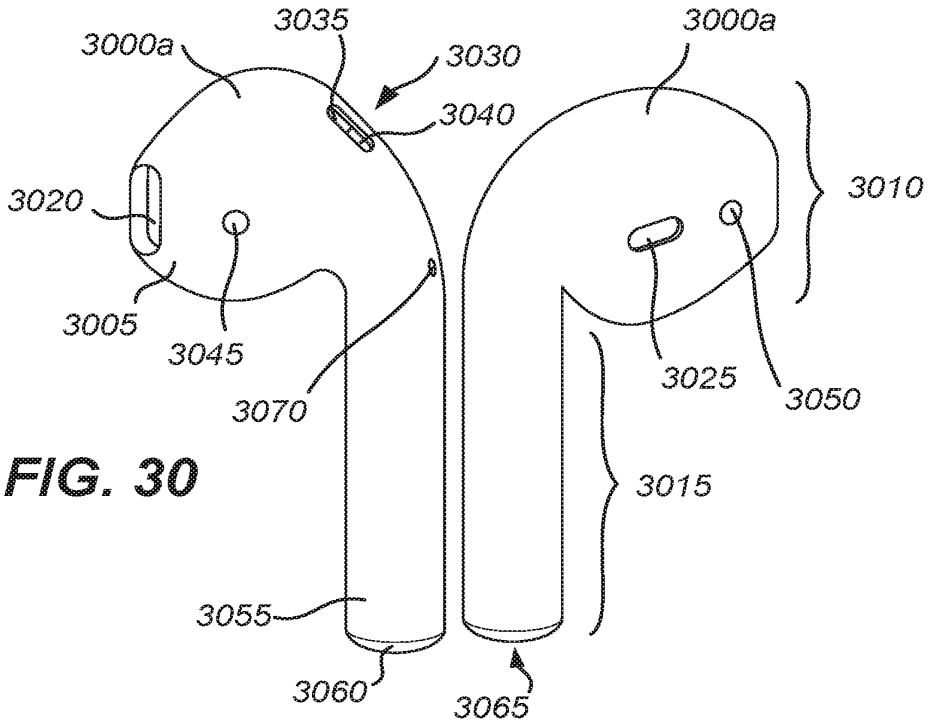

3035
3000a
3030
3000a
3040
3020
3010
3005
3045
3025
3050
3070
3015
3055
3060
3065

FIG. 30

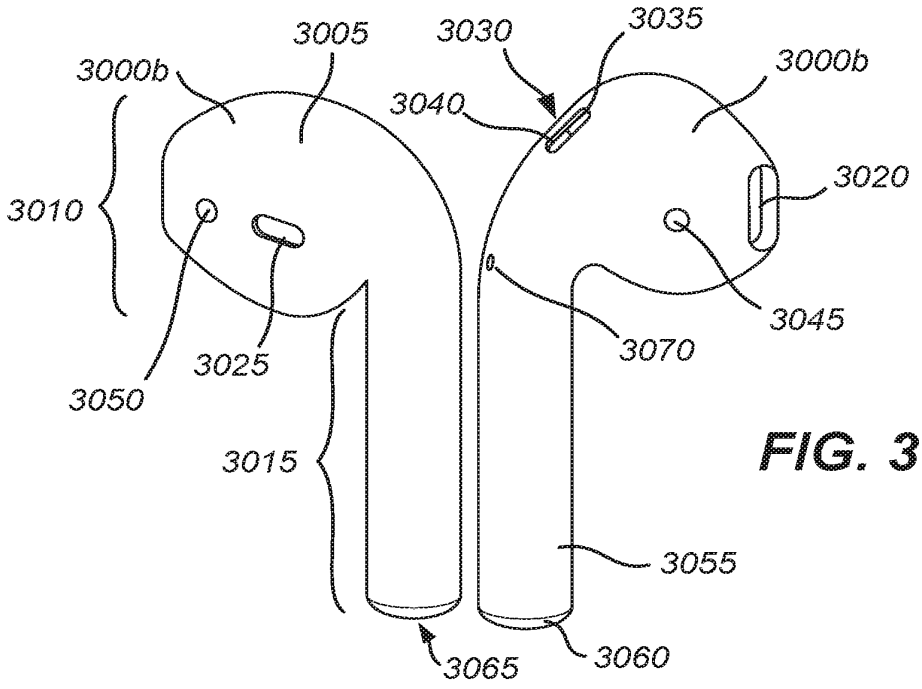
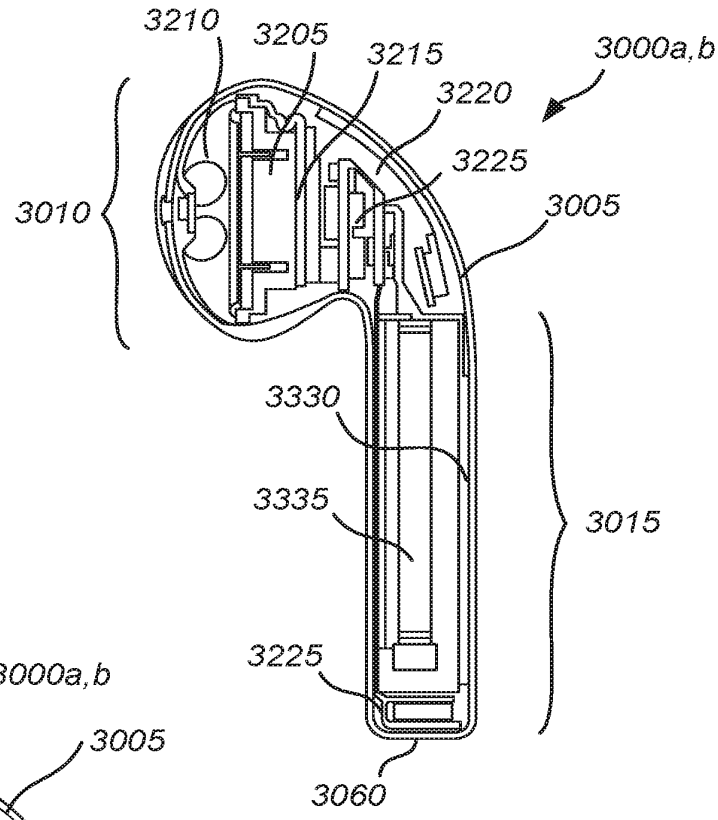

3005
3030
3035
3000b
3000b
3040
3020
3010
3045
3070
3025
3050
3015
3055
3065
3060

FIG. 31

FIG. 32


3210
3205
3215
3000a,b
3220
3225
3010
3005
3330
3335
3015
3225
3060

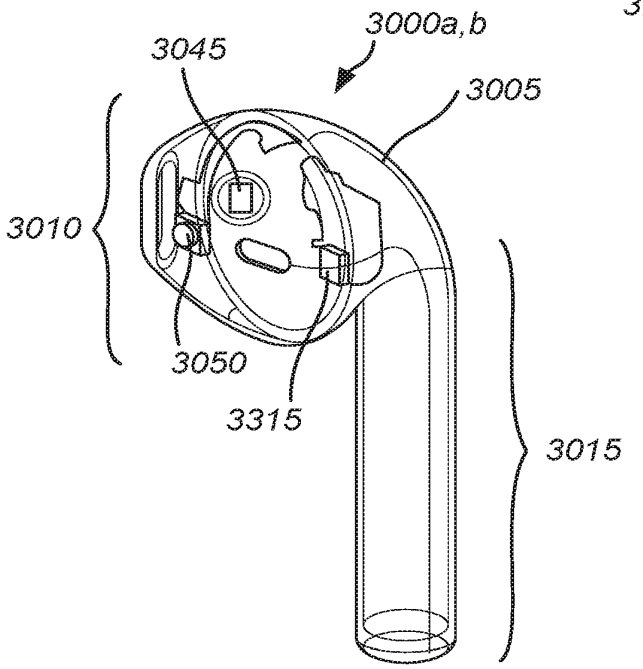

3000a,b
3045
3005
3010
3050
3315
3015

FIG. 33

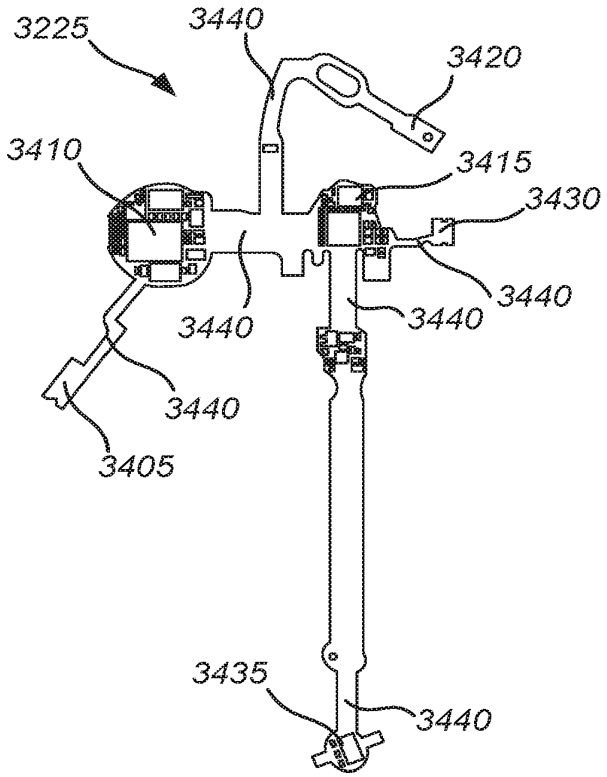

3225
3440
3420
3410
3415
3430
3440
3440
3440
3440
3405
3435
3440

FIG. 34

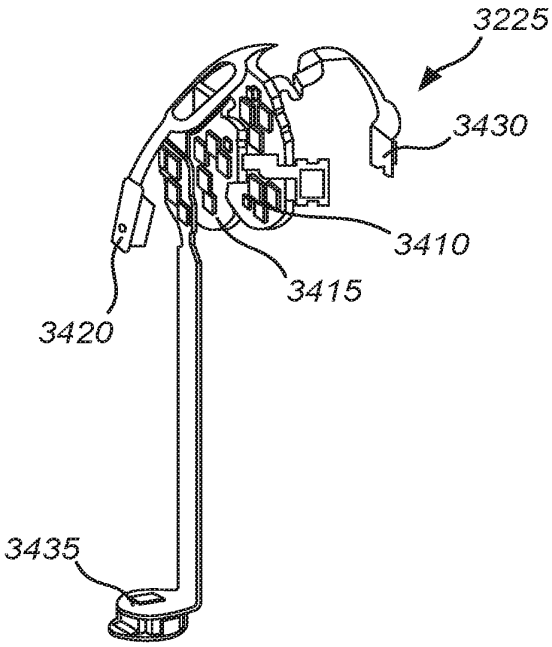

3225
3430
3410
3415
3420
3435

FIG. 35

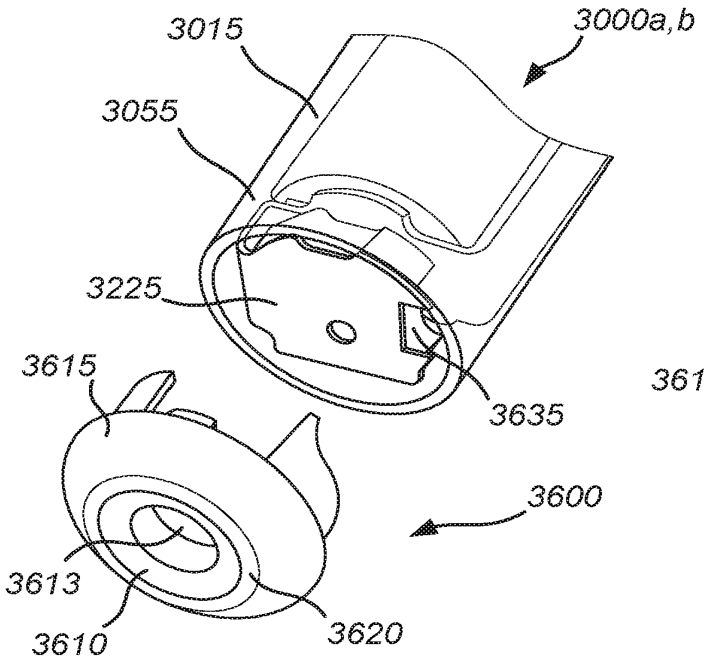


FIG. 36

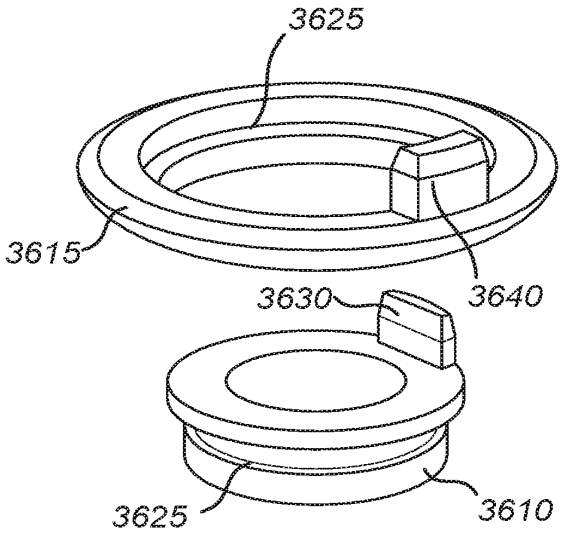


FIG. 37

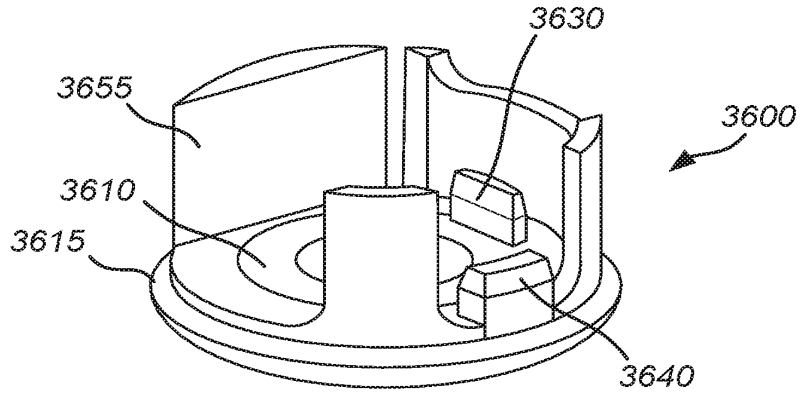


FIG. 38

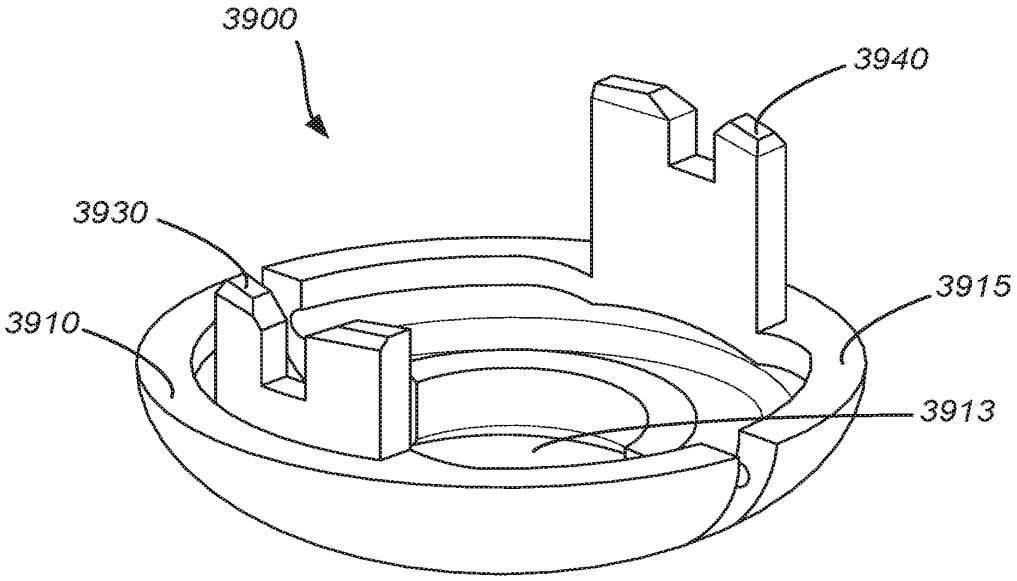

3900
3940
3930
3915
3910
3913

FIG. 39

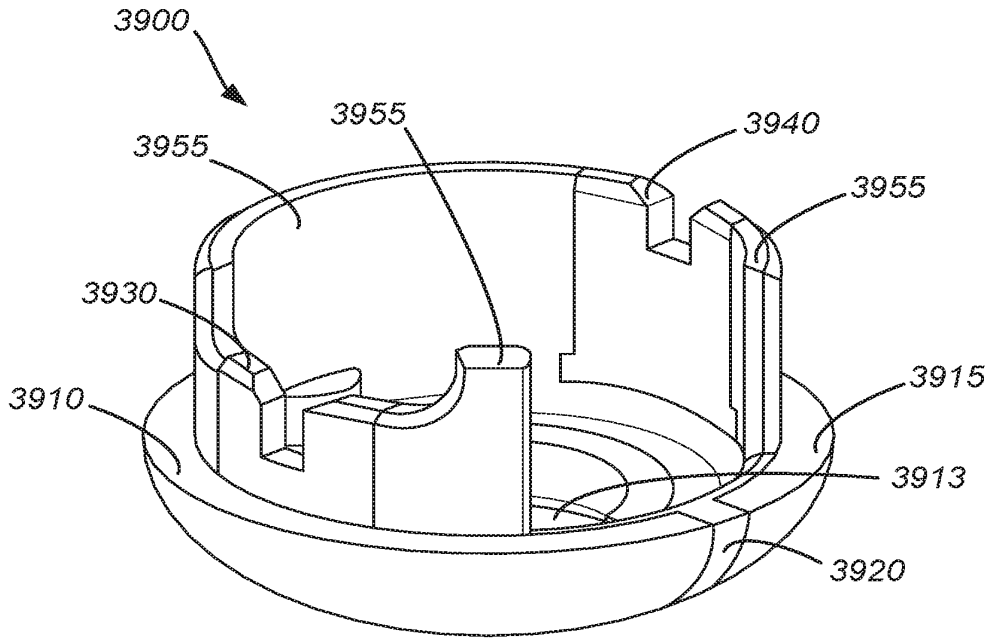

3900
3955
3940
3955
3955
3930
3915
3910
3913
3920

FIG. 40

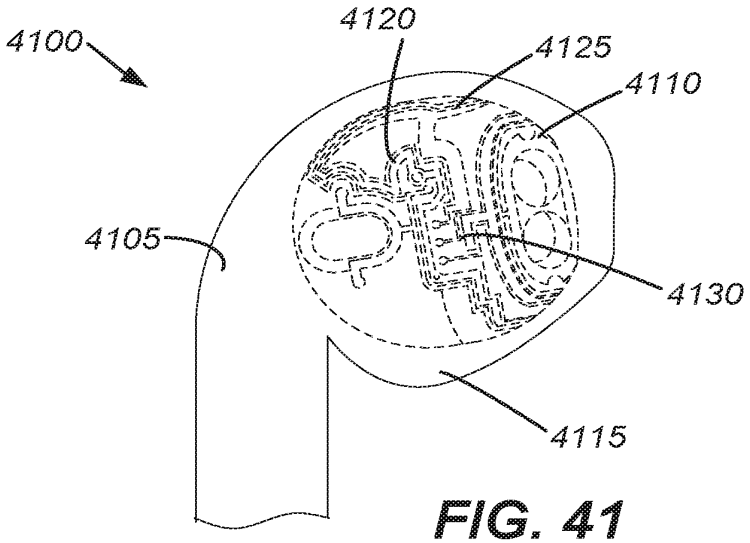

4100
4120
4125
4110
4105
4130
4115

FIG. 41

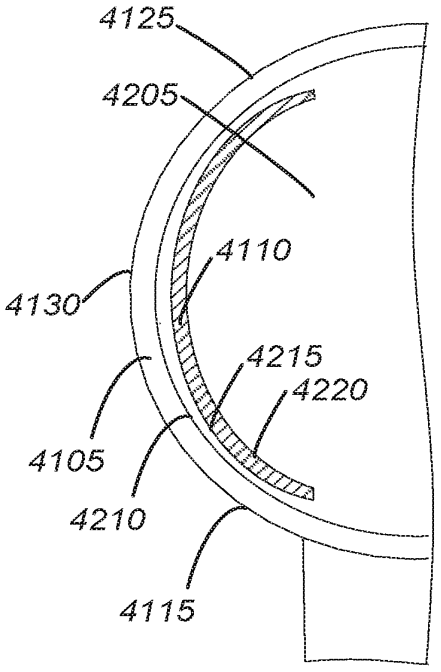

4125
4205
4110
4130
4215
4220
4105
4210
4115

FIG. 42

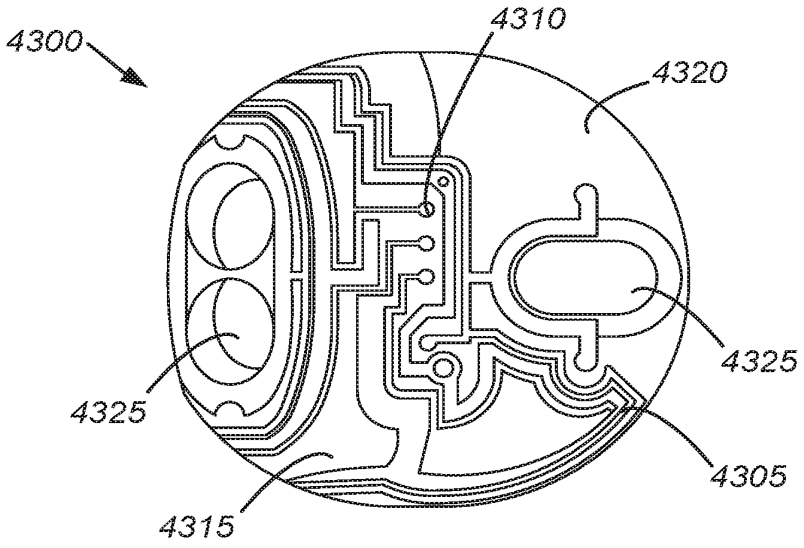

4300
4310
4320
4325
4325
4305
4315

FIG. 43

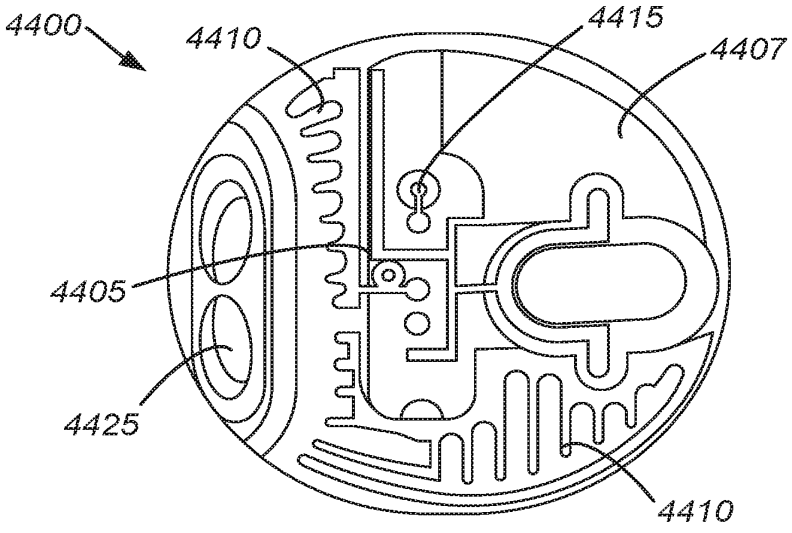

4400
4410
4415
4407
4405
4425
4410

FIG. 44

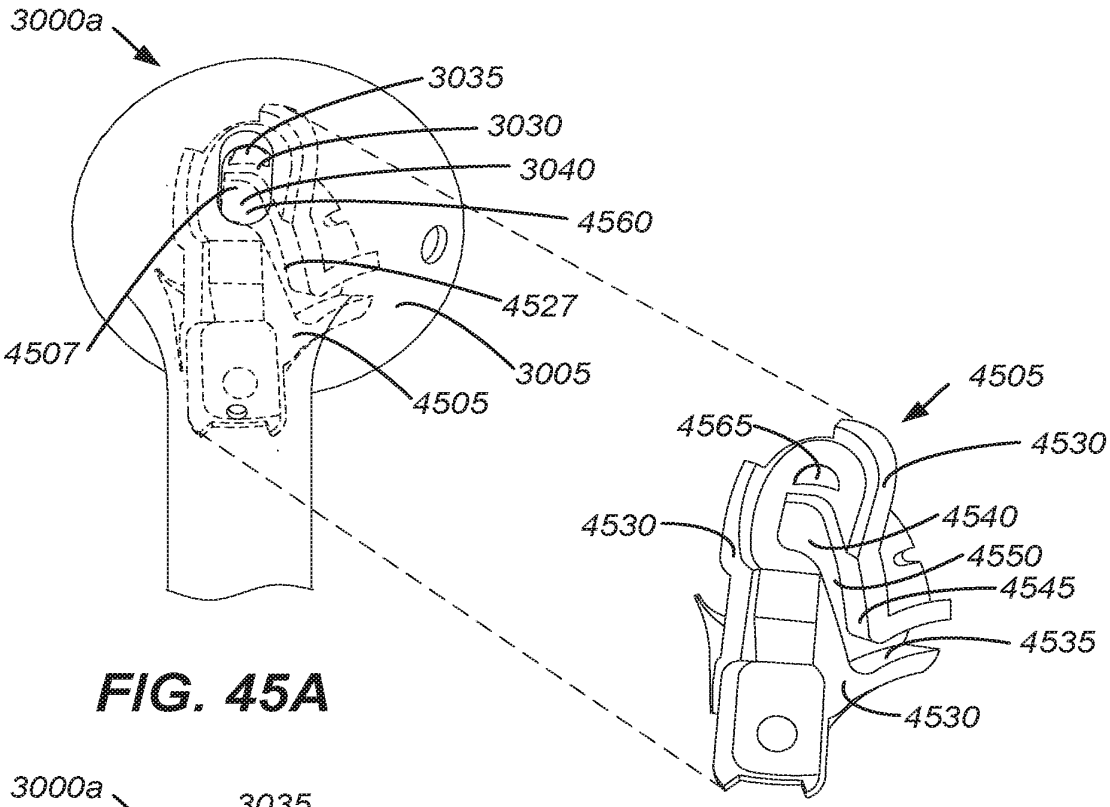


FIG. 45A

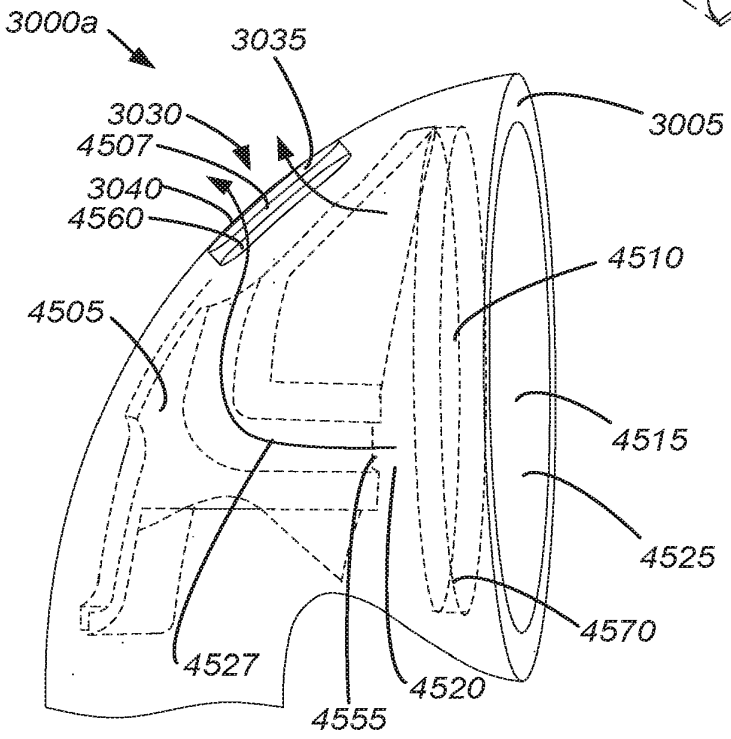


FIG. 45B

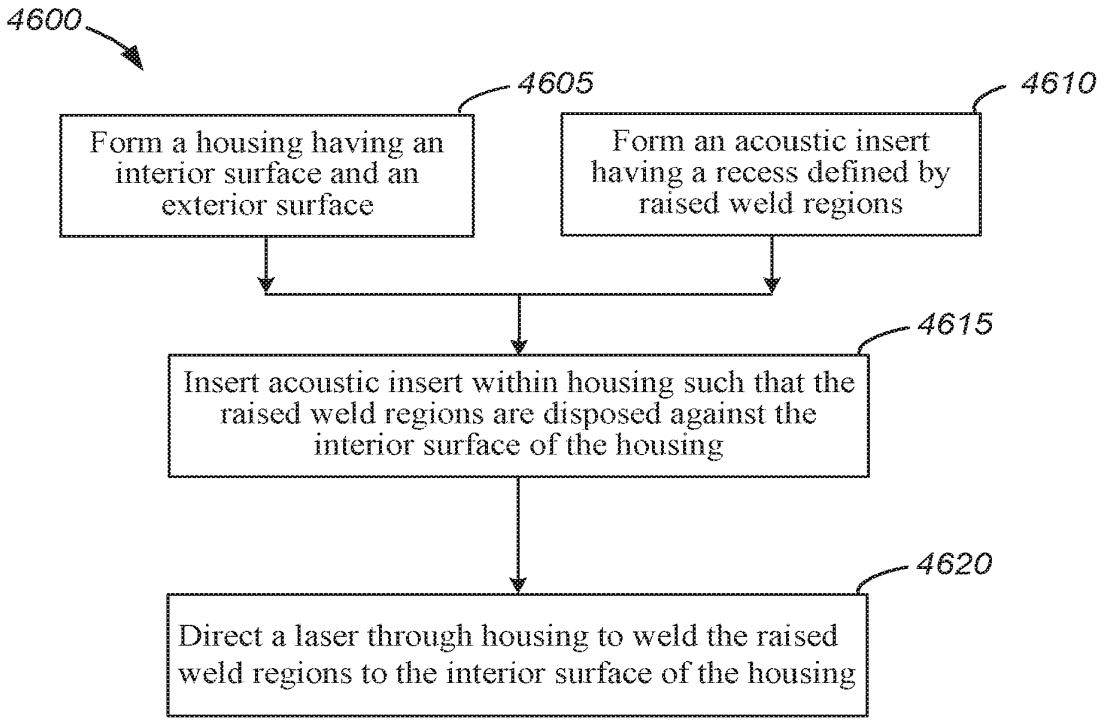

4600
4605
Form a housing having an interior surface and an exterior surface
4610
Form an acoustic insert having a recess defined by raised weld regions
4615
Insert acoustic insert within housing such that the raised weld regions are disposed against the interior surface of the housing
4620
Direct a laser through housing to weld the raised weld regions to the interior surface of the housing

FIG. 46

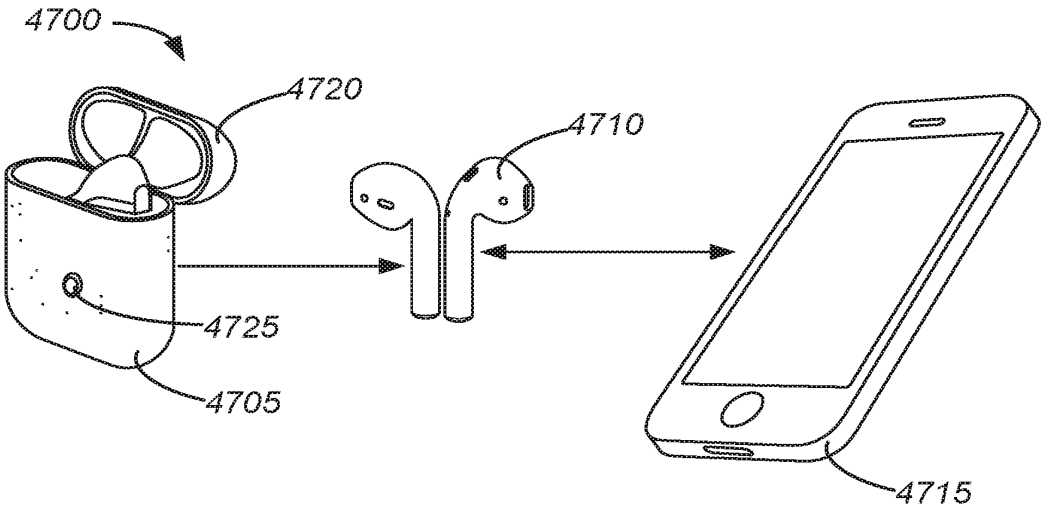

4700
4720
4710
4725
4705
4715

FIG. 47

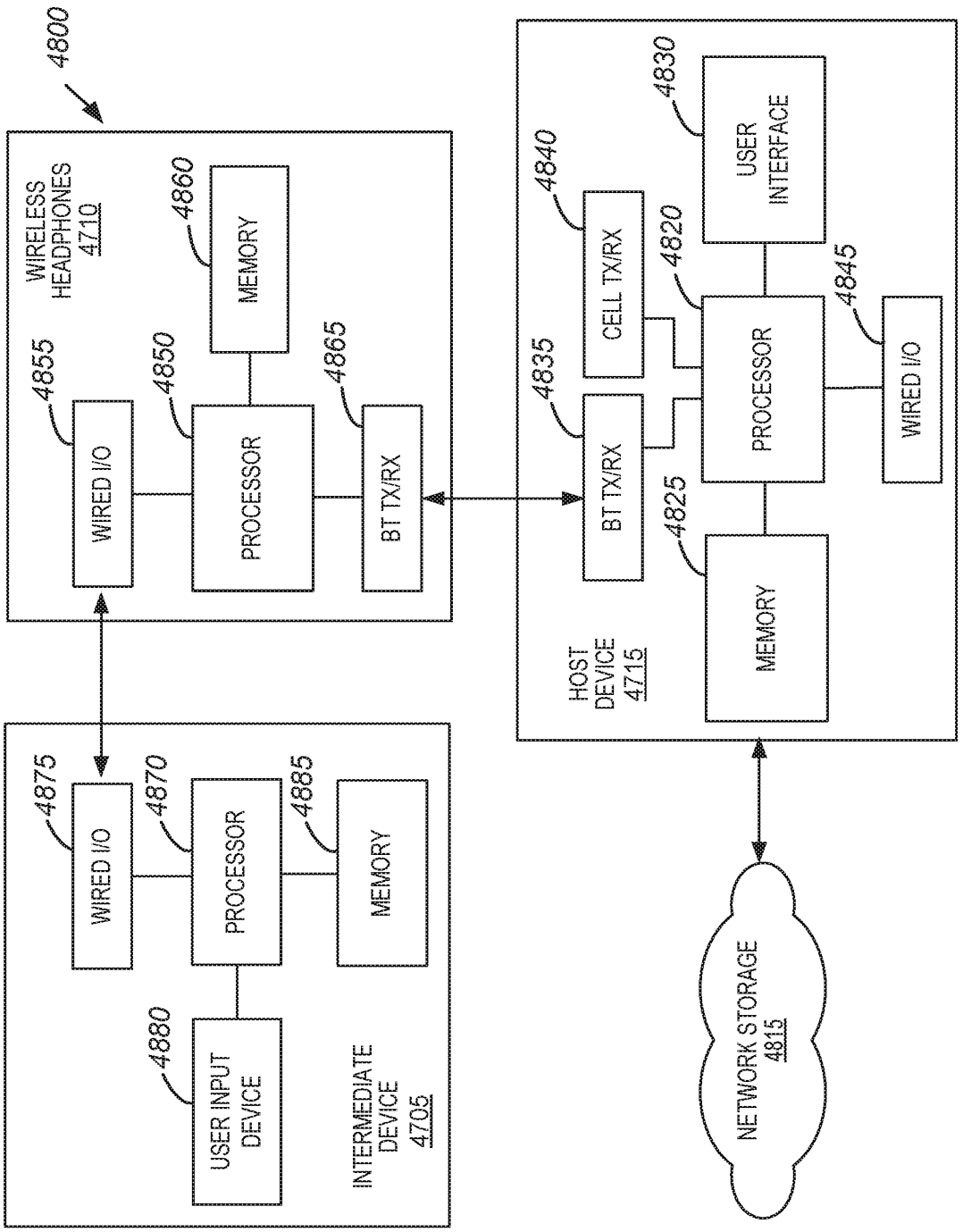

4800
WIRELESS HEADPHONES 4710
4855
WIRED I/O
4850
PROCESSOR
4860
MEMORY
4865
BT TX/RX
4835
BT TX/RX
4840
CELL TX/RX
4820
PROCESSOR
4830
USER INTERFACE
4845
WIRED I/O
4825
MEMORY
HOST DEVICE 4715
4875
WIRED I/O
4870
PROCESSOR
4885
MEMORY
4880
USER INPUT DEVICE
INTERMEDIATE DEVICE 4705
NETWORK STORAGE 4815

FIG. 48

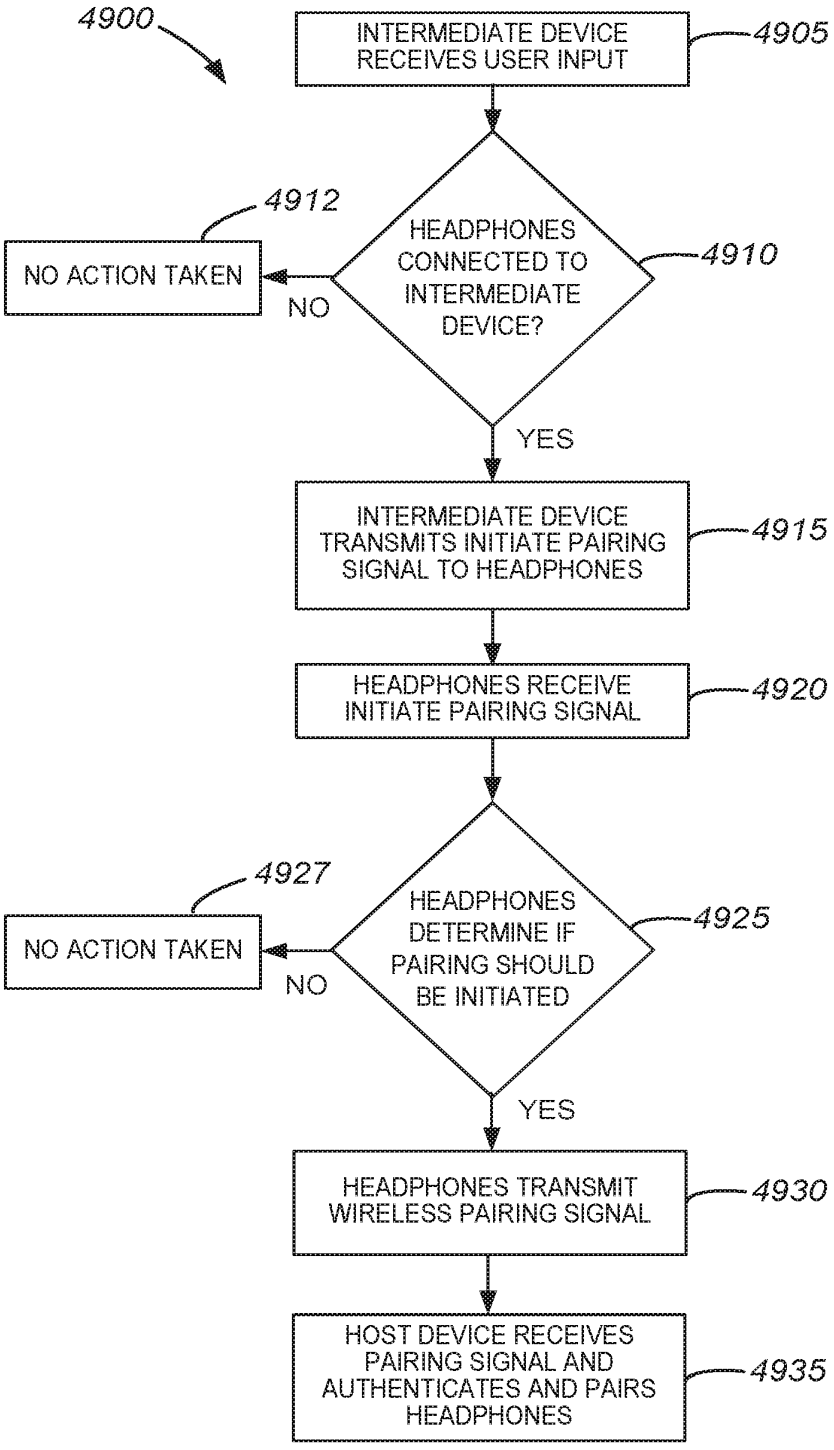

4900
INTERMEDIATE DEVICE RECEIVES USER INPUT
4905
HEADPHONES CONNECTED TO INTERMEDIATE DEVICE?
4910
NO
4912
NO ACTION TAKEN
YES
INTERMEDIATE DEVICE TRANSMITS INITIATE PAIRING SIGNAL TO HEADPHONES
4915
HEADPHONES RECEIVE INITIATE PAIRING SIGNAL
4920
HEADPHONES DETERMINE IF PAIRING SHOULD BE INITIATED
4925
NO
4927
NO ACTION TAKEN
YES
HEADPHONES TRANSMIT WIRELESS PAIRING SIGNAL
4930
HOST DEVICE RECEIVES PAIRING SIGNAL AND AUTHENTICATES AND PAIRS HEADPHONES
4935

FIG. 49

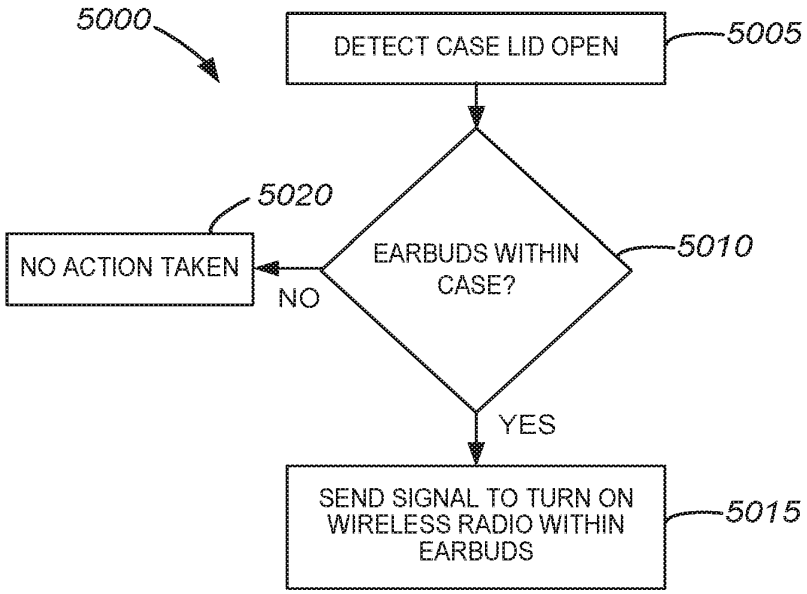

5000
DETECT CASE LID OPEN
5005
EARBUDS WITHIN CASE?
5010
NO
5020
NO ACTION TAKEN
YES
SEND SIGNAL TO TURN ON WIRELESS RADIO WITHIN EARBUDS
5015

FIG. 50

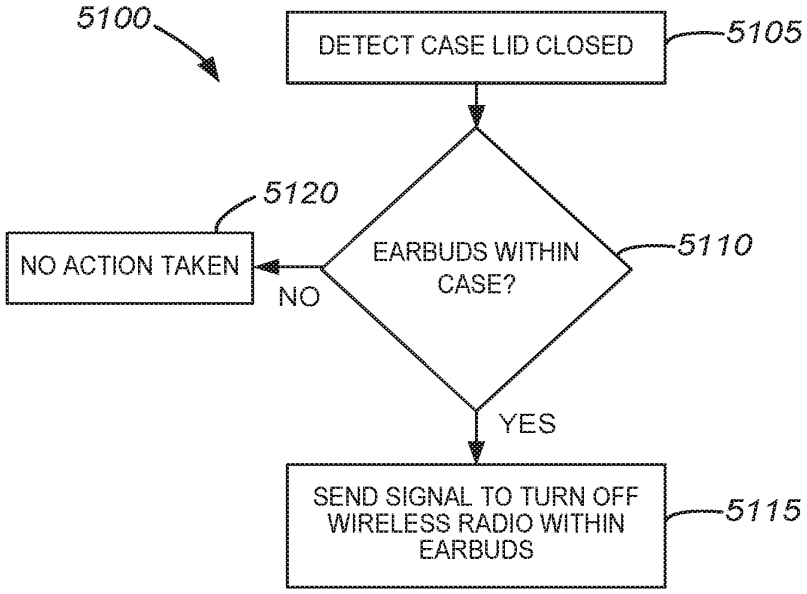

5100
DETECT CASE LID CLOSED
5105
EARBUDS WITHIN CASE?
5110
NO
5120
NO ACTION TAKEN
YES
SEND SIGNAL TO TURN OFF WIRELESS RADIO WITHIN EARBUDS
5115

FIG. 51

INFORMATION DISCLOSURE STATEMENT BY APPLICANT		
	Application Number:	18/810,014
	Confirmation No:	7322
	Filing Date:	August 20, 2024
	First Named Inventor:	Erik Carlson
	Attorney Docket No.:	ST0806US2/0532.000806US04
	Examiner Name:	NA
	Art Unit:	NA
Sheet 1 of 3	**IDS filed on: June 15, 2026**	
Title: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

INFORMATION DISCLOSURE STATEMENT

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

In compliance with the duty imposed by 37 C.F.R. § 1.56, and in accordance with 37 C.F.R. §§ 1.97(b) – (d) and 1.98, Applicant brings the materials enclosed herewith to the attention of the Examiner as possibly being of interest in connection with the above-identified patent application. Pursuant to M.P.E.P. § 609 and 37 C.F.R. § 1.97(h), the information cited in the present Information Disclosure Statement shall not be construed to be an admission that the information is, or is considered to be, material to patentability. Applicant requests that the Examiner consider each of the documents listed on the attached list of documents. Pursuant to the provisions of M.P.E.P. § 609, Applicant further requests that a copy of the list of documents marked as being considered and initialed by the Examiner, be returned along with the next official communication.

Filing of IDS under 37 C.F.R. § 1.97

Since this Information Disclosure Statement is being submitted after the receipt of a Non-Final Office Action in the above-identified patent application, Applicant hereby authorizes a charge of $280.00 to Deposit Account No. 13-4895 to cover the fee required under 37 C.F.R. §§ 1.97(c)(2) and 1.17(p). Please charge any additional fees or credit any overpayment to Deposit Account No. 13-4895.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application Number:	18/810,014
	Confirmation No:	7322
	Filing Date:	August 20, 2024
	First Named Inventor:	Erik Carlson
	Attorney Docket No.:	ST0806US2/0532.000806US04
	Examiner Name:	NA
	Art Unit:	NA
Sheet 2 of 3	IDS filed on: June 15, 2026	
Title: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

Size Fee Assertion

Applicant certifies that no Information Disclosure Statement size fee is required for the Information Disclosure Statement submitted herewith.

Applicant invites the Examiner to contact the undersigned Applicant's Representative at the telephone number listed below if doing so may advance prosecution of this application.

Respectfully submitted by

Mueting Raasch Group
111 Washington Ave. S., Suite 700
Minneapolis, MN 55401
Phone: (612) 305-1220
Facsimile: (612) 305-1228

June 15, 2026
Date

/Jay R. Pralle/
Jay R. Pralle
Reg. No. 52131
Direct Dial: (612) 305-0083

INFORMATION DISCLOSURE STATEMENT BY APPLICANT		
	Application Number:	18/810,014
	Confirmation No:	7322
	Filing Date:	August 20, 2024
	First Named Inventor:	Erik Carlson
	Attorney Docket No.:	ST0806US2/0532.000806US04
	Examiner Name:	NA
	Art Unit:	NA
Sheet 3 of 3	**IDS filed on: June 15, 2026**	
Title: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

U.S. PATENTS

Cite #	Patent Number (Number - Kind Code)	Issue Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
1	*None*			
2				
3				
4				
5				
6				

U.S. PATENT APPLICATION PUBLICATIONS

Cite #	Publication Number (Number - Kind Code)	Publication Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
1	*None*			
2				
3				
4				
5				
6				

U.S. PATENT APPLICATIONS BY SERIAL NUMBER

Copy Enclosed	Cite #	Document Number (Number - Kind Code)	Filing Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
	1	*None*			
	2				

FOREIGN PATENT DOCUMENTS

Copy Enclosed	Cite #	Country Code	Foreign Document Number	Kind Code	Publication Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments	translation	
								yes	no
X	1	WO	2017/058675		04/06/2017	Apple Inc.			
	2								

NON-PATENT LITERATURE DOCUMENTS

Copy Enclosed	Cite #	Document Description
	1	*None*

Examiner Signature		Date Considered	

***EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.**

UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
www.uspto.gov

ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/810,014	**06/15/2026 02:50:36 PM Z ET**	**ST0806US2/0532.000806US04**

Title of Invention

SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	7322	FILED BY	Denise Lagro
PATENT CENTER #	77452081	FILING DATE	08/20/2024
CUSTOMER #	142537	FIRST NAMED INVENTOR	Erik Carlson
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Jay Pralle

Documents

TOTAL DOCUMENTS: 2

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
2026-06-15-IDS-SB08.pdf	3	Information Disclosure Statement (IDS) Form (SB08)	129 KB
Warning: This is not a USPTO supplied IDS fillable form. Data in the form cannot be automatically loaded to other USPTO systems.			
WO_2017058675-for.pdf	134	Foreign Reference	11768 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
2026-06-15-IDS-SB08.pdf	2FD612E3CBC06FF60242278267735ECEE4CD2B4A26B2649B3C9E9685781246EEA17820FB5C3442922F1B496AF18F8E066AA

46123D0EFDC26A1732BAA9C0C937A

WO_2017058675-for.pdf

A7924A6DC72E9951D5562567B5DE630390761359FE26E00E57
FF81333D7A79F2AEDAC8B1149BF19531A614C0D4AA10BE17
ADC12101BADE36060409996A72B76A

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
www.uspto.gov

ELECTRONIC PAYMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/810,014	**06/15/2026 02:50:36 PM Z ET**	**ST0806US2/0532.000806US04**

Title of Invention

SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	7322	FILED BY	Denise Lagro
PATENT CENTER #	77452081	AUTHORIZED BY	Jay Pralle
CUSTOMER #	142537	FILING DATE	08/20/2024
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Erik Carlson

Payment Information

PAYMENT METHOD	PAYMENT TRANSACTION ID	PAYMENT AUTHORIZED BY
CARD / 7647	**E20266EE51059165**	**Denise Lagro**

FEE CODE	DESCRIPTION	ITEM PRICE($)	QUANTITY	ITEM TOTAL($)
1806	SUBMISSION OF AN INFORMATION DISCLOSURE STATEMENT	280.00	1	280.00
			TOTAL AMOUNT:	**$280.00**

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

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371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

142537 7590 07/16/2026

MRG/HD - Starkey
c/o Mueting Raasch Group
111 Washington Ave. S., Suite 700
Minneapolis, MN 55401

EXAMINER	
MONIKANG, GEORGE C	
ART UNIT	PAPER NUMBER
2692	

DATE MAILED: 07/16/2026

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
18/810,014	08/20/2024	Erik Carlson	ST0806US2/0532.000806US04	7322

TITLE OF INVENTION: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1290	$0.00	$0.00	$1290	10/16/2026

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 40% the amount of undiscounted fees, and micro entity fees are 20% the amount of undiscounted fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PTOL-85 (Rev. 11/23)

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via the USPTO patent electronic filing system.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 6 should be completed where appropriate. All further correspondence will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications. **Because electronic patent issuance may occur shortly after issue fee payment, any desired continuing application should preferably be filed prior to payment of this issue fee in order not to jeopardize copendency.**

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

142537 7590 07/16/2026
MRG/HD - Starkey
c/o Mueting Raasch Group
111 Washington Ave. S., Suite 700
Minneapolis, MN 55401

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via the USPTO patent electronic filing system or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
18/810,014	08/20/2024	Erik Carlson	ST0806US2/0532.000806US04	7322

TITLE OF INVENTION: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1290	$0.00	$0.00	$1290	10/16/2026

EXAMINER	ART UNIT	CLASS-SUBCLASS
MONIKANG, GEORGE C	2692	381-323000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/AIA/122 or PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑Issue Fee ❑Publication Fee (if required)

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via the USPTO patent electronic filing system ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29
NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

❑ Applicant asserting small entity status. See 37 CFR 1.27
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

❑ Applicant changing to regular undiscounted fee status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

6. **Courtesy Ceremonial Copy**

❑ Applicant requests a courtesy ceremonial copy of the electronic patent grant. Applicant understands that the electronic patent grant is the official statutory patent grant.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

SONOVA EX1004
Page 429

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
18/810,014	08/20/2024	Erik Carlson	ST0806US2/0532.000806US04	7322

142537 7590 07/16/2026

MRG/HD - Starkey
c/o Mueting Raasch Group
111 Washington Ave. S., Suite 700
Minneapolis, MN 55401

EXAMINER	
MONIKANG, GEORGE C	
ART UNIT	PAPER NUMBER
2692	

DATE MAILED: 07/16/2026

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

PTOL-85 (Rev. 11/23)

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. The United States Patent and Trademark Office (USPTO) collects the information in this record under authority of 35 U.S.C. 2. The USPTO's system of records is used to manage all applicant and owner information including name, citizenship, residence, post office address, and other information with respect to inventors and their legal representatives pertaining to the applicant's/ owner's activities in connection with the invention for which a patent is sought or has been granted. The applicable Privacy Act System of Records Notice for the information collected in this form is COMMERCE/PAT-TM-7 Patent Application Files, available in the Federal Register at 78 FR 19243 (March 29, 2013).
https://www.govinfo.gov/content/pkg/FR-2013-03-29/pdf/2013-07341.pdf

Routine uses of the information in this record may include disclosure to:

1) law enforcement, in the event that the system of records indicates a violation or potential violation of law;
2) a federal, state, local, or international agency, in response to its request;
3) a contractor of the USPTO having need for the information in order to perform a contract;
4) the Department of Justice for determination of whether the Freedom of Information Act (FOIA) requires disclosure of the record;
5) a Member of Congress submitting a request involving an individual to whom the record pertains, when the individual has requested the Member's assistance with respect to the subject matter of the record;
6) a court, magistrate, or administrative tribunal, in the course of presenting evidence, including disclosures to opposing counsel in the course of settlement negotiations;
7) the Administrator, General Services Administration (GSA), or their designee, during an inspection of records conducted by GSA under authority of 44 U.S.C. 2904 and 2906, in accordance with the GSA regulations and any other relevant (i.e., GSA or Commerce) directive, where such disclosure shall not be used to make determinations about individuals;
8) another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c));
9) the Office of Personnel Management (OPM) for personnel research purposes; and
10) the Office of Management and Budget (OMB) for legislative coordination and clearance.

If you do not furnish the information requested on this form, the USPTO may not be able to process and/or examine your submission, which may result in termination of proceedings, abandonment of the application, and/or expiration of the patent.

Notice of Allowability	Application No. 18/810,014	Applicant(s) Carlson et al.	
	Examiner GEORGE C MONIKANG	Art Unit 2692	AIA (First Inventor to File) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to 04/24/2026.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are 2-22 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some* c) ☐ None of the:

   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☑ Notice of References Cited (PTO-892)
2. ☑ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☐ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/GEORGE C MONIKANG/
Primary Examiner, Art Unit 2692

DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Allowable Subject Matter

Claims 2-22 are allowed.

The following is an examiner's statement of reasons for allowance:

Claims 2 & 14 are allowed for the reasons set forth in applicants arguments filed 04/24/2026 pages 8-14.

Claims 3-13, 22 depend on claim 2. Claims 15-21 depend on claim 14.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Contact

Any inquiry concerning this communication or earlier communications from the examiner should be directed to GEORGE C MONIKANG whose telephone number is (571)270-1190. The examiner can normally be reached Mon. - Fri., 9AM-5PM, ALT. Fridays off.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carolyn R Edwards can be reached at 571-270-7136. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of published or unpublished applications may be obtained from Patent Center. Unpublished application information in Patent Center is available to registered users. To file and manage patent submissions in Patent Center, visit: https://patentcenter.uspto.gov. Visit https://www.uspto.gov/patents/apply/patent-center for more information about Patent Center and https://www.uspto.gov/patents/docx for information about filing in DOCX format. For additional questions, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/GEORGE C MONIKANG/
Primary Examiner, Art Unit 2692 07/11/2026

Notice of References Cited	Application/Control No. 18/810,014	Applicant(s)/Patent Under Reexamination Carlson et al.	
	Examiner GEORGE C MONIKANG	Art Unit 2692	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date YYYY-MM-DD	Name	CPC Classification	US Classification
*	A	US-20080240480-A1	2008-10-02	Pinnell; Leslie J.	H04R25/602	381/323
*	B	US-5253300-A	1993-10-12	Knapp; Herbert C.	H04R25/602	381/328
	C					
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date YYYY-MM-DD	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title, Date, Publisher, Edition or Volume, Pertinent Pages
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in YYYY-MM-DD format are publication dates. Classifications may be US or foreign.

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	18/810,014	Carlson et al.
	Examiner	**Art Unit**
	GEORGE C MONIKANG	2692

CPC						
Symbol					**Type**	**Version**
H04R	/	1	/	1025	F	2013-01-01
H01M	/	10	/	46	I	2013-01-01
H04R	/	25	/	602	I	2013-01-01
H04R	/	2225	/	57	A	2019-04-30
H04R	/	2225	/	31	A	2013-01-01

CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
	/		/					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	21	
/GEORGE C MONIKANG/ Primary Examiner, Art Unit 2692	11 July 2026	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1, 14	fig. 1A

U.S. Patent and Trademark Office — Part of Paper No.: 20260711

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	18/810,014	Carlson et al.
	Examiner	Art Unit
	GEORGE C MONIKANG	2692

INTERNATIONAL CLASSIFICATION				
CLAIMED				
H04R	/	1	/	1025
H04R	/	2225	/	31
H04R	/	2225	/	57
H04R	/	25	/	602

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	SUBCLASS
381	322

CROSS REFERENCES(S)						
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)					
381	324	312	314			

NONE (Assistant Examiner)	(Date)	Total Claims Allowed: 21	
/GEORGE C MONIKANG/ Primary Examiner, Art Unit 2692 (Primary Examiner)	11 July 2026 (Date)	O.G. Print Claim(s) 1, 14	O.G. Print Figure fig. 1A

U.S. Patent and Trademark Office — Part of Paper No.: 20260711

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	18/810,014	Carlson et al.
	Examiner	Art Unit
	GEORGE C MONIKANG	2692

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1	9	10	19	19										
1	2	10	11	20	20										
2	3	11	12	21	21										
3	4	12	13	13	22										
4	5	14	14												
5	6	15	15												
6	7	16	16												
7	8	17	17												
8	9	18	18												

NONE (Assistant Examiner)	(Date)	Total Claims Allowed: 21	
/GEORGE C MONIKANG/ Primary Examiner, Art Unit 2692 (Primary Examiner)	11 July 2026 (Date)	O.G. Print Claim(s) 1, 14	O.G. Print Figure fig. 1A

U.S. Patent and Trademark Office Part of Paper No.: 20260711

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	18/810,014	Carlson et al.
	Examiner	Art Unit
	GEORGE C MONIKANG	2692

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS										
☐ Claims renumbered in the same order as presented by applicant				☐ CPA		☐ T.D.		☐ R.1.47		
CLAIM		DATE								
Final	Original	02/19/2026	07/11/2026							
	1	-	-							
1	2	✓	=							
2	3	✓	=							
3	4	✓	=							
4	5	✓	=							
5	6	✓	=							
6	7	✓	=							
7	8	✓	=							
8	9	✓	=							
9	10	✓	=							
10	11	✓	=							
11	12	✓	=							
12	13	✓	=							
14	14	✓	=							
15	15	✓	=							
16	16	✓	=							
17	17	✓	=							
18	18	✓	=							
19	19	✓	=							
20	20	✓	=							
21	21	✓	=							
13	22		=							

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	18/810,014	Carlson et al.
	Examiner	Art Unit
	GEORGE C MONIKANG	2692

CPC - Searched*		
Symbol	**Date**	**Examiner**
H04R1/1025; H04R25/602; H04R2225/31; H04R2225/57	02/19/2026	GM
H04R1/1025; H04R25/602; H04R2225/31; H04R2225/57	07/11/2026	GM

CPC Combination Sets - Searched*		
Symbol	**Date**	**Examiner**

US Classification - Searched*			
Class	**Subclass**	**Date**	**Examiner**
381	312, 314, 322, 324, 328	02/19/2026	GM
381	312, 314, 322, 324, 328	07/11/2026	GM

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	**Date**	**Examiner**
Double patenting rejection made. Inventor/Assignee search completed in PE2E.	02/19/2026	GM
Similarity search completed in PE2E.	02/19/2026	GM
Double patenting rejection overcome by terminal disclaimer approved on 05/07/2026.	07/11/2026	GM

/GEORGE C MONIKANG/ Primary Examiner, Art Unit 2692	07/11/2026

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	18/810,014	Carlson et al.
	Examiner	Art Unit
	GEORGE C MONIKANG	2692

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
	Interference search completed in PE2E.	07/11/2026	GM
	Same class/subclass as above.	07/11/2026	GM

/GEORGE C MONIKANG/ Primary Examiner, Art Unit 2692	07/11/2026

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application Number:	18/810,014
	Confirmation No:	7322
	Filing Date:	August 20, 2024
	First Named Inventor:	Erik Carlson
	Attorney Docket No.:	ST0806US4/0532.000806US04
	Examiner Name:	NA
	Art Unit:	NA
Sheet 1 of 3	IDS filed on: February 25, 2026	
Title: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

INFORMATION DISCLOSURE STATEMENT

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

In compliance with the duty imposed by 37 C.F.R. § 1.56, and in accordance with 37 C.F.R. §§ 1.97(b) – (d) and 1.98, Applicant brings the materials enclosed herewith to the attention of the Examiner as possibly being of interest in connection with the above-identified patent application. Pursuant to M.P.E.P. § 609 and 37 C.F.R. § 1.97(h), the information cited in the present Information Disclosure Statement shall not be construed to be an admission that the information is, or is considered to be, material to patentability. Applicant requests that the Examiner consider each of the documents listed on the attached list of documents. Pursuant to the provisions of M.P.E.P. § 609, Applicant further requests that a copy of the list of documents marked as being considered and initialed by the Examiner, be returned along with the next official communication.

Filing of IDS under 37 C.F.R. § 1.97

Applicant believes that no fee is due, as this Information Disclosure Statement is filed prior to the receipt of any Action on the merits. However, in the event a fee is due, please charge any fee or credit any overpayment to Deposit Account No. 13-4895.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT		
	Application Number:	18/810,014
	Confirmation No:	7322
	Filing Date:	August 20, 2024
	First Named Inventor:	Erik Carlson
	Attorney Docket No.:	ST0806US4/0532.000806US04
	Examiner Name:	NA
	Art Unit:	NA
Sheet 2 of 3	**IDS filed on: February 25, 2026**	
Title: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

Size Fee Assertion

Applicant certifies that no Information Disclosure Statement size fee is required for the Information Disclosure Statement submitted herewith.

Applicant invites the Examiner to contact the undersigned Applicant's Representative at the telephone number listed below if doing so may advance prosecution of this application.

Respectfully submitted by

Mueting Raasch Group
111 Washington Ave. S., Suite 700
Minneapolis, MN 55401
Phone: (612) 305-1220
Facsimile: (612) 305-1228

February 25, 2026
Date

/Jay R. Pralle/
Jay R. Pralle
Reg. No. 52131
Direct Dial: (612) 305-0083

INFORMATION DISCLOSURE STATEMENT BY APPLICANT		
	Application Number:	18/810,014
	Confirmation No:	7322
	Filing Date:	August 20, 2024
	First Named Inventor:	Erik Carlson
	Attorney Docket No.:	ST0806US4/0532.000806US04
	Examiner Name:	NA
	Art Unit:	NA
Sheet 3 of 3	**IDS filed on: February 25, 2026**	
Title: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

U.S. PATENTS

Cite #	Patent Number (Number - Kind Code)	Issue Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
/G.C.M/ 1	5,253,300	10/12/1993	Knapp	
2				
3				
4				
5				
6				

U.S. PATENT APPLICATION PUBLICATIONS

Cite #	Publication Number (Number - Kind Code)	Publication Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
/G.C.M/ 1	2008/0240480	10/02/2008	Pinnell	
2				
3				
4				
5				
6				

U.S. PATENT APPLICATIONS BY SERIAL NUMBER

Copy Enclosed	Cite #	Document Number (Number - Kind Code)	Filing Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
	1	*None*			
	2				

FOREIGN PATENT DOCUMENTS

Copy Enclosed	Cite #	Country Code	Foreign Document Number	Kind Code	Publication Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments	translation yes	translation no
	1		*None*						
	2								

NON-PATENT LITERATURE DOCUMENTS

Copy Enclosed	Cite #	Document Description
	1	*None*

Examiner Signature	/GEORGE C MONIKANG/	Date Considered	07/11/2026

***EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.**

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

BIB DATA SHEET

CONFIRMATION NO. 7322

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
18/810,014	08/20/2024 RULE	381	2692	ST0806US2/0532.000806US04

APPLICANTS
Starkey Laboratories, Inc., Eden Prairie, MN;

INVENTORS
Erik Carlson, Stillwater, MN;
Thomas Burns, Minneapolis, MN;
Kyle Olson, St. Louis Park, MN;
Kent Giswold, Minnetonka, MN;

**** CONTINUING DATA ***************************
This application is a CON of 17/553,716 12/16/2021 PAT 12101588
which is a CON of PCT/US2020/041956 07/14/2020
which claims benefit of 62/876,454 07/19/2019
and claims benefit of 62/943,375 12/04/2019

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****
08/29/2024

			STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
Foreign Priority claimed	❑ Yes ☑ No					
35 USC 119(a-d) conditions met	❑ Yes ☑ No	❑ Met after Allowance	MN	15	1	1
Verified and Acknowledged	/GEORGE C MONIKANG/ Examiner's Signature	GM Initials				

ADDRESS
MRG/HD - Starkey
c/o Mueting Raasch Group
111 Washington Ave. S., Suite 700
Minneapolis, MN 55401
UNITED STATES

TITLE
SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE

FILING FEE RECEIVED		
0.00	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	❑ All Fees ❑ 1.16 Fees (Filing) ❑ 1.17 Fees (Processing Ext. of time) ❑ 1.18 Fees (Issue) ❑ Other _____ ❑ Credit

INFORMATION DISCLOSURE STATEMENT BY APPLICANT		
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	Confirmation No:	7322
	Filing Date:	August 20, 2024
	First Named Inventor:	Erik Carlson
	Attorney Docket No.:	ST0806US2/0532.000806US04
	Examiner Name:	NA
	Art Unit:	NA
Sheet 1 of 3	**IDS filed on: June 15, 2026**	
Title: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

INFORMATION DISCLOSURE STATEMENT

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

In compliance with the duty imposed by 37 C.F.R. § 1.56, and in accordance with 37 C.F.R. §§ 1.97(b) – (d) and 1.98, Applicant brings the materials enclosed herewith to the attention of the Examiner as possibly being of interest in connection with the above-identified patent application. Pursuant to M.P.E.P. § 609 and 37 C.F.R. § 1.97(h), the information cited in the present Information Disclosure Statement shall not be construed to be an admission that the information is, or is considered to be, material to patentability. Applicant requests that the Examiner consider each of the documents listed on the attached list of documents. Pursuant to the provisions of M.P.E.P. § 609, Applicant further requests that a copy of the list of documents marked as being considered and initialed by the Examiner, be returned along with the next official communication.

Filing of IDS under 37 C.F.R. § 1.97

Since this Information Disclosure Statement is being submitted after the receipt of a Non-Final Office Action in the above-identified patent application, Applicant hereby authorizes a charge of $280.00 to Deposit Account No. 13-4895 to cover the fee required under 37 C.F.R. §§ 1.97(c)(2) and 1.17(p). Please charge any additional fees or credit any overpayment to Deposit Account No. 13-4895.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application Number:	18/810,014
	Confirmation No:	7322
	Filing Date:	August 20, 2024
	First Named Inventor:	Erik Carlson
	Attorney Docket No.:	ST0806US2/0532.000806US04
	Examiner Name:	NA
	Art Unit:	NA
Sheet 2 of 3	IDS filed on: June 15, 2026	
Title: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

Size Fee Assertion

Applicant certifies that no Information Disclosure Statement size fee is required for the Information Disclosure Statement submitted herewith.

Applicant invites the Examiner to contact the undersigned Applicant's Representative at the telephone number listed below if doing so may advance prosecution of this application.

Respectfully submitted by

Mueting Raasch Group
111 Washington Ave. S., Suite 700
Minneapolis, MN 55401
Phone: (612) 305-1220
Facsimile: (612) 305-1228

June 15, 2026
Date

/Jay R. Pralle/
Jay R. Pralle
Reg. No. 52131
Direct Dial: (612) 305-0083

INFORMATION DISCLOSURE STATEMENT BY APPLICANT		
	Application Number:	18/810,014
	Confirmation No:	7322
	Filing Date:	August 20, 2024
	First Named Inventor:	Erik Carlson
	Attorney Docket No.:	ST0806US2/0532.000806US04
	Examiner Name:	NA
	Art Unit:	NA
Sheet 3 of 3	**IDS filed on: June 15, 2026**	
Title: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

U.S. PATENTS

Cite #	Patent Number (Number - Kind Code)	Issue Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
1	*None*			
2				
3				
4				
5				
6				

U.S. PATENT APPLICATION PUBLICATIONS

Cite #	Publication Number (Number - Kind Code)	Publication Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
1	*None*			
2				
3				
4				
5				
6				

U.S. PATENT APPLICATIONS BY SERIAL NUMBER

Copy Enclosed	Cite #	Document Number (Number - Kind Code)	Filing Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
	1	*None*			
	2				

FOREIGN PATENT DOCUMENTS

Copy Enclosed	Cite #	Country Code	Foreign Document Number	Kind Code	Publication Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments	translation yes	translation no
/G.C.M/ X	1	WO	2017/058675		04/06/2017	Apple Inc.			
	2								

NON-PATENT LITERATURE DOCUMENTS

Copy Enclosed	Cite #	Document Description
	1	*None*

Examiner Signature	/GEORGE C MONIKANG/	Date Considered	07/11/2026

***EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.**

PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L1	1	"17553716"	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/19 03:50 PM
L2	1	(hearing SAME aid SAME charg$8 SAME displac$8 SAME anode SAME cathode)	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/19 04:43 PM
L3	576	(charg$8 SAME displac$8 SAME anode SAME cathode)	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/19 04:43 PM
L4	1	(charg$8 SAME displac$8 SAME anode SAME cathode) AND 381/$.ccls.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/19 04:43 PM
L5	0	(charg$8 SAME pogo SAME anode SAME cathode) AND 381/$.ccls.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/20 06:13 PM
L6	0	(charg$8 SAME pogo SAME positive SAME negative) AND 381/$.ccls.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/20 06:13 PM
L7	6	(charg$8 SAME pogo SAME anode SAME cathode)	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/20 06:14 PM
L8	69	(charg$8 SAME pogo SAME positive SAME negative)	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/20 06:19 PM
L9	1	(charg$8 SAME pogo SAME positive SAME negative SAME hearing)	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/20 06:20 PM
L10	0	(charg$8 SAME pogo SAME pin$1 SAME triang$6)	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 04:20 PM
L11	75	(pogo SAME pin$1 SAME triang$6)	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 04:21 PM
L12	0	(pogo SAME pin$1 SAME triang$6) AND 381/$.ccls.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 04:21 PM
L13	623	(state WITH charge WITH rate WITH recharg$6)	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 05:28 PM
L14	0	(state WITH charge WITH rate WITH recharg$6) AND 381/$.ccls.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 05:29 PM
L15	2	(state WITH charge WITH rate WITH	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 05:30 PM

		recharg$6 WITH accelerate)					
L16	11	(state SAME charge SAME rate SAME recharg$6 SAME accelerate)	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 05:33 PM
L17	133	carlson-erik$.in.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 06:42 PM
L18	0	carlson-erik$.in. AND (battery).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 06:42 PM
L19	3	carlson-erik$.in. AND (charg$6).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 06:42 PM
L20	5	burns-thomas$.in. AND (charg$6).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 06:43 PM
L21	14	olson-kyle$.in. AND (charg$6).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 06:44 PM
L22	1	giswold-kent$.in. AND (charg$6).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 06:47 PM
L23	0	(state WITH charge WITH rate WITH recharg$6) AND (381/312,322,323).ccls.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 07:02 PM
L24	0	(charg$8 SAME displac$8 SAME anode SAME cathode) AND (381/312,322,323).ccls.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 07:02 PM
L25	0	(charg$8 SAME displac$8 SAME anode SAME cathode) AND 381/323	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 07:03 PM
L26	1	(charg$8 SAME displac$8 SAME anode SAME cathode) AND h04r1/1025	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 07:04 PM
L27	4	(charg$8 SAME displac$8 SAME anode SAME cathode) AND h01m10/46	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 07:04 PM
L28	1	(charg$8 SAME displac$8 SAME anode SAME cathode) AND h04r25/602	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 07:05 PM
L29	1	(charg$8 SAME displac$8 SAME anode SAME cathode) AND h04r2225/31	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 07:05 PM
L30	20	(charg$8 SAME anode SAME cathode) AND h04r2225/31	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 07:05 PM
L31	21	(charg$8 SAME anode SAME cathode) AND h04r1/1025	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/21 07:08 PM

L32	3	"20160353216"	(US-PGPUB; USPAT)	OR	ON	ON	2024/01/19 09:21 PM
L33	1	(cathode SAME anode SAME power SAME source SAME charg$5 SAME interface SAME prior).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2024/01/19 09:46 PM
L34	1	"17553716"	(US-PGPUB; USPAT)	OR	ON	ON	2024/01/19 10:06 PM
L35	4	"8213651"	(US-PGPUB; USPAT)	OR	ON	ON	2024/05/03 06:18 PM
L36	3	"20080118093"	(US-PGPUB; USPAT)	OR	ON	ON	2024/05/03 06:18 PM
L37	37	(charg$8 SAME anode SAME cathode SAME electrode) AND h04r2225/31	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2026/02/07 01:09 PM
L38	9	(charg$8 SAME anode SAME cathode SAME electrode) AND h04r2225/57	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2026/02/07 01:12 PM
L39	21	(charg$8 SAME anode SAME cathode SAME electrode) AND h04r25/602	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2026/02/07 01:12 PM

L40	8	"2016036309"	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2026/02/07 01:18 PM
L41	9	(charg$8 SAME anode SAME cathode SAME electrode SAME hearing SAME faceplate)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 01:20 PM
L42	198	(charg$8 SAME anode SAME cathode SAME electrode SAME faceplate)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 01:21 PM
L43	7	(charg$8 SAME anode SAME cathode SAME electrode SAME faceplate) AND h04r2225/57	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 01:21 PM

L44	7	(charg$8 SAME anode SAME cathode SAME electrode SAME faceplate) AND h04r2225/31	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 01:21 PM
L45	7	(charg$8 SAME anode SAME cathode SAME electrode SAME faceplate) AND h04r25/602	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 01:22 PM
L46	7	(charg$8 SAME anode SAME cathode SAME electrode SAME faceplate) AND h04r1/1025	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 01:22 PM
L47	0	(charg$8 SAME anode SAME cathode SAME electrode SAME faceplate) AND 381/$.ccls.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 01:22 PM

L48	198	(charg$8 SAME anode SAME cathode SAME electrode SAME faceplate)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 01:22 PM
L49	10	(charg$8 SAME anode SAME cathode SAME electrode SAME faceplate SAME ear)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 01:22 PM
L50	35	(Artificial Intelligence) More like doc: US-20080240480-A1 Text: (US-345124-A OR US-3493695-A OR SE-7502352-L OR US-4279972-A OR US-4401735-A OR US-4526846-A OR US-5176968-A OR US-5253300-A OR WO-9528817-A1 OR JP-H08265405-A OR JP-3539448-B2 OR ZA-963605-B OR US-5879832-A OR US-5691073-A OR US-5750277-A OR US-6037071-A OR US-6514640-B1 OR US-5910382-A OR WO-9802933-A1 OR EP-0986118-B1).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2026/02/07 01:24 PM
L51	12	"20080118093"	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA,	OR	ON	ON	2026/02/07 01:54 PM

			EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L52	0	"200800118093"	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2026/02/07 01:54 PM
L53	7	"20160353216"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2026/02/07 01:56 PM
L54	5	"20180370522"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO;	OR	ON	ON	2026/02/07 01:56 PM

			JPO; DERWENT; IBM_TDB)				
L55	31	"8213651"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2026/02/07 01:57 PM
L56	23	"10798500"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2026/02/07 02:02 PM
L57	32	"2016126476"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2026/02/07 02:03 PM
L58	23	"2019037854"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB,	OR	ON	ON	2026/02/07 02:04 PM

			HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L59	71	"2640170"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2026/02/07 02:05 PM
L60	10	(charg$8 SAME anode SAME cathode SAME faceplate SAME ear)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:12 PM
L61	9	(charg$8 SAME anode SAME cathode SAME faceplate SAME hearing)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:12 PM
L62	591	(charg$8 SAME anode SAME cathode SAME	(US-PGPUB; USPAT; USOCR; FIT (AP, AT,	OR	ON	ON	2026/02/07 02:13 PM

		hearing)	AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))				
L63	74	(charg$8 WITH anode WITH cathode WITH hearing)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:13 PM
L64	9	(charg$8 SAME electrodes SAME faceplate SAME hearing)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:15 PM
L65	9	(charg$8 SAME electrode$1 SAME faceplate SAME hearing)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:15 PM
L66	2781	(charg$8 SAME electrode$1 SAME	(US-PGPUB; USPAT; USOCR; FIT (AP, AT,	OR	ON	ON	2026/02/07 02:15 PM

		hearing)	AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))				
L67	9	(charg$8 SAME electrode$1 SAME hearing SAME faceplate)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:16 PM
L68	1145	(charg$8 SAME electrode$1 SAME faceplate)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:16 PM
L69	7	(charg$8 SAME electrode$1 SAME faceplate) AND h04r2225/31	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:16 PM
L70	11	(charg$8 SAME electrode$1 SAME	(US-PGPUB; USPAT; USOCR; FIT (AP, AT,	OR	ON	ON	2026/02/07 02:16 PM

		faceplate) AND h04r2225/57	AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))				
L71	1	(charg$8 SAME electrode$1 SAME faceplate) AND 381/$.ccls.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:17 PM
L72	11	(charg$8 SAME electrode$1 SAME faceplate) AND h04r1/1025	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:17 PM
L73	239	(charg$8 WITH electrode$1 WITH faceplate)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:17 PM
L74	0	(charg$8 WITH electrode$1 WITH	(US-PGPUB; USPAT; USOCR; FIT (AP, AT,	OR	ON	ON	2026/02/07 02:17 PM

		faceplate WITH hearing)	AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))				
L75	1	(charg$8 WITH electrode$1 WITH faceplate WITH ear)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:17 PM
L76	181	(charg$8 WITH contacts WITH faceplate)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:41 PM
L77	39	(charg$8 WITH contacts WITH faceplate) AND h04r2225/31	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:41 PM
L78	46	(Artificial Intelligence) More like doc:	(US-PGPUB; USPAT; USOCR; FIT (AU, AP,	OR	ON	ON	2026/02/07 02:43 PM

		EP-4543046-A1 Text: (DE-4233813-C1 OR AT-E541414-T1 OR CN-215420765-U OR CN-114554345-A OR US-20250133357-A1 OR EP-4543046-A1 OR AU-2025202980-A1 OR EP-3836564-B1 OR DE-1847045-U OR US-20230345191-A1 OR DE-102019201784-B3 OR CN-218160944-U OR WO-2004057909-A2 OR US-20210204075-A1 OR CN-116648930-A OR CN-113170267-A OR CN-114650479-A OR WO-2011083425-A2 OR US-20230292030-A1 OR DE-102006018631-A1).did.	AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L79	45	(Artificial Intelligence) More like doc: CN-114554345-A Text: (WO-2006104981-A2 OR CN-207505089-U OR CN-207802267-U OR CN-107635173-A OR US-10728645-B2 OR CN-110049398-A OR US-11245989-B2 OR CN-211128130-U OR CN-212751847-U OR CN-212752596-U OR CN-212936166-U OR CN-215420765-U OR CN-114554345-A OR EP-4236355-A1 OR US-20230269511-A1 OR US-12457439-B2 OR CN-114554345-B OR EP-4236355-B1 OR JP-2023123403-A OR JP-7663971-B2).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2026/02/07 02:46 PM
L80	40	(Artificial Intelligence) More like doc: EP-4262239-A1 Text: (DK-42197-A OR KR-100795306-B1 OR US-8737658-B2 OR DK-2285136-T3 OR EP-3086572-A1 OR EP-	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO,	OR	ON	ON	2026/02/07 02:48 PM

		3629599-B1 OR US-10827249-B1 OR US-20230336928-A1 OR EP-4262239-A1 OR EP-4668782-A1 OR US-20250386155-A1 OR EP-4492824-A1 OR CN-217216897-U OR DE-19502994-A1 OR US-20250016924-A1 OR US-20220102797-A1 OR CN-119316784-A OR US-20050221167-A1 OR US-20240313319-A1 OR US-20240313320-A1).did.	MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L81	37	(Artificial Intelligence) More like doc: US-20210185453-A1 Text: (US-7010137-B1 OR US-7142682-B2 OR EP-2285138-B1 OR US-8494197-B2 OR NL-2003672-C2 OR CN-102413410-A OR CN-207075092-U OR CN-112954564-A OR EP-3836564-B1 OR US-20220150646-A1 OR US-11638101-B2 OR EP-3836564-A1 OR US-11245989-B2 OR US-20210185453-A1 OR EP-3836558-A1 OR EP-3836558-B1 OR US-20220240025-A1 OR US-20210185452-A1 OR US-6700983-B1 OR DE-102011083523-B4).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2026/02/07 02:50 PM
L82	26	(charg$8 WITH contacts WITH faceplate) AND h04r1/1025	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:52 PM
L83	7	(charg$8 WITH central	(US-PGPUB; USPAT;	OR	ON	ON	2026/02/07

		WITH faceplate) AND h04r1/1025	USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))				02:54 PM
L84	7	(charg$8 WITH central WITH faceplate) AND h04r2225/31	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:54 PM
L85	7	(charg$8 WITH central WITH faceplate) AND h04r2225/57	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:54 PM
L86	7	(charg$8 WITH central WITH faceplate) AND h04r25/602	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:54 PM
L87	7	(charg$8 SAME central	(US-PGPUB; USPAT;	OR	ON	ON	2026/02/07

		SAME faceplate) AND h04r2225/31	USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))				02:55 PM
L88	40	(charg$8 WITH central WITH faceplate)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:55 PM
L89	359	(charg$8 SAME central SAME faceplate)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:56 PM
L90	11	(charg$8 SAME central SAME faceplate SAME (ear OR hearing))	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 02:56 PM
L91	2	"19303720"	(US-PGPUB; USPAT;	OR	ON	ON	2026/02/07

			USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))				03:39 PM
L92	269	carlson-erik$.in.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 06:34 PM
L93	9	carlson-erik$.in. AND (hearing).clm.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 06:34 PM
L94	110	burns-thomas$.in. AND (hearing).clm.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 06:53 PM
L95	10	burns-thomas$.in. AND	(US-PGPUB; USPAT;	OR	ON	ON	2026/02/07

		(electrode$1 OR (anode SAME cathode)).clm.	USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))				06:53 PM
L96	10	olson-kyle$.in. AND (electrode$1 OR (anode SAME cathode)).clm.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 06:54 PM
L97	7	giswold-kent$.in. AND (electrode$1 OR (anode SAME cathode)).clm.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 06:54 PM
L98	0	starkey-laboratories$.in. AND (electrode$1 OR (anode SAME cathode)).clm.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/02/07 06:55 PM
L99	22	starkey-	(US-PGPUB; USPAT;	OR	ON	ON	2026/02/07

		laboratories$.as. AND (electrode$1 OR (anode SAME cathode)).clm.	USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))				06:55 PM
L100	5	"20080240480"	(US-PGPUB; USPAT)	OR	ON	ON	2026/02/19 07:22 PM
L101	8	"2016036309"	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2026/02/19 07:22 PM
L102	5	"18810014"	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2026/02/19 07:24 PM
L103	50	(Artificial Intelligence) Similar to: 18/810,014 with 0 CPC Selections and 0 Text Selections Text: (US-20250048012-A1 OR EP-4664932-A2 OR US-12101588-B2 OR US-20220109924-A1 OR WO-2021015998-A1 OR EP-4000277-B1 OR US-20240414465-	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA,	OR	ON	ON	2026/02/19 09:10 PM

		A1 OR US-20250234141-A1 OR EP-4195703-A1 OR US-20230179931-A1 OR US-20250039617-A1 OR US-12238485-B2 OR CH-721509-A2 OR DE-102021213958-B4 OR US-20240214752-A1 OR US-20090202093-A1 OR WO-2021173841-A1 OR US-20210211815-A1 OR KR-20210013603-A OR US-20240305933-A1 OR EP-2026602-B1 OR US-20220408199-A1 OR CN-116095580-A OR EP-2026602-A1 OR US-12108213-B2 OR US-20200260176-A1 OR US-8126178-B2 OR DE-102008008670-A1 OR US-20250254457-A1 OR US-20090208046-A1 OR CN-219536310-U OR WO-2015039707-A1 OR EP-4604352-A1 OR EP-2091124-A2 OR EP-4178222-A1 OR US-20250350893-A1 OR US-20230148224-A1 OR US-9060234-B2 OR US-12401955-B2 OR US-20240298111-A1 OR US-12279093-B2 OR DE-102007013420-A1 OR WO-2022146627-A1 OR US-20240323622-A1 OR CN-120474126-A OR CN-110024416-A OR US-20180376264-A1 OR US-10623875-B2 OR DE-102006029197-B4 OR CH-720428-A2).did.	VN))				
L104	5	"20080240480"	(US-PGPUB; USPAT)	OR	ON	ON	2026/04/14 02:03 PM
L105	3	"2016036309"	(US-PGPUB; USPAT)	OR	ON	ON	2026/04/14 02:03 PM
L106	8	"2016036309"	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU,	OR	ON	ON	2026/04/14 02:03 PM

			CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))				
L107	5	"20080240480"	(US-PGPUB; USPAT)	OR	ON	ON	2026/04/24 06:05 PM
L108	3	"2016036309"	(US-PGPUB; USPAT)	OR	ON	ON	2026/04/24 06:05 PM
L109	8	"20090067652"	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2026/04/26 10:00 AM
L110	4	"18924062"	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2026/04/26 10:31 AM
L111	716916	(hearing SAME device contact$1 SAME arcuate)	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2026/04/26 11:26 AM

L112	9807	(hearing SAME device contact$1 SAME arcuate) AND 381/$.ccls.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2026/04/26 11:26 AM
L113	0	((hearing NEAR device) SAME (contact$1 NEAR arcuate)) AND 381/$.ccls.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2026/04/26 11:27 AM
L114	4	((hearing NEAR device) SAME (contact$1 NEAR arcuate))	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2026/04/26 11:27 AM
L115	1	(hearing WITH device WITH contact$1 WITH arcuate) AND 381/$.ccls.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/04/26 11:32 AM

L116	11	(hearing WITH device WITH contact$1 WITH arcuate)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/04/26 11:33 AM
L117	137	(hearing SAME device SAME contact$1 SAME arcuate)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/04/26 11:39 AM
L118	3	(hearing SAME device SAME contact$1 SAME arcuate) AND 381/$.ccls.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/04/26 11:39 AM
L119	14	(hearing SAME device SAME contact$1 SAME arcuate) AND h04r1/1025	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/04/26 11:40 AM

L120	11	(hearing SAME device SAME contact$1 SAME arcuate) AND h04r25/556	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/04/26 11:41 AM
L121	8	(hearing SAME device SAME contact$1 SAME arcuate) AND h04r2225/57	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/04/26 11:42 AM
L122	9	(hearing SAME device SAME contact$1 SAME arcuate) AND h04r25/603	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/04/26 12:10 PM
L123	22	(hearing WITH aid WITH contact$1 WITH arcuate)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/04/26 12:11 PM

L124	83	(hearing SAME aid SAME contact$1 SAME arcuate)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/04/26 12:32 PM
L125	3	(hearing SAME aid SAME contact$1 SAME arcuate SAME charg$6)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/04/26 12:33 PM
L126	22	(hearing WITH aid WITH contact$1 WITH arcuate)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/04/26 12:54 PM
L127	138	(device WITH contact$1 WITH arcuate WITH charg$6)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/04/26 12:55 PM

L128	5	(device WITH contact$1 WITH arcuate WITH charg$6) AND h04r1/1025	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/04/26 12:55 PM
L129	2	(device WITH contact$1 WITH arcuate WITH charg$6) AND h01m10/46	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/04/26 12:57 PM
L130	3	(device WITH contact$1 WITH arcuate WITH charg$6) AND h04r2225/31	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/04/26 12:58 PM
L131	3	(device WITH contact$1 WITH arcuate WITH charg$6) AND h04r2225/57	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/04/26 12:58 PM

L132	3	(device WITH contact$1 WITH arcuate WITH charg$6) AND h04r25/556	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/04/26 12:58 PM
L133	2	(device WITH contact$1 WITH arcuate WITH charg$6) AND h04r25/603	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/04/26 12:58 PM
L134	8	(device SAME contact$1 SAME arcuate SAME charg$6) AND h04r25/603	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/04/26 12:59 PM
L135	31	(device SAME contact$1 SAME arcuate SAME charg$6) AND h04r1/1025	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/04/26 01:00 PM

L136	50	(Artificial Intelligence) Similar to: 18/924,062 with 0 CPC Selections and 0 Text Selections Text: (US-20250048012-A1 OR EP-4664932-A2 OR US-20220109924-A1 OR US-12101588-B2 OR WO-2021015998-A1 OR EP-4000277-B1 OR US-20260089424-A1 OR US-11902748-B2 OR US-20210127219-A1 OR US-20250234141-A1 OR EP-4195703-A1 OR DE-102021213958-A1 OR US-20240305933-A1 OR KR-20210013603-A OR US-20230095933-A1 OR CH-721509-A2 OR US-20210211815-A1 OR US-20250039617-A1 OR US-20230179931-A1 OR US-12238485-B2 OR DE-102021213958-B4 OR US-10587965-B2 OR US-20220408199-A1 OR US-12108213-B2 OR US-12563340-B2 OR US-20240258830-A1 OR CN-120474126-A OR CN-116095580-A OR US-20250350893-A1 OR EP-4178222-A1 OR US-20240298111-A1 OR WO-2015039707-A1 OR US-20230148224-A1 OR US-12401955-B2 OR US-8126178-B2 OR WO-2022146627-A1 OR US-20090208046-A1 OR US-20200260176-A1 OR US-20250254457-A1 OR CN-114448019-A OR US-20090202093-A1 OR EP-4604352-A1 OR EP-2026602-B1 OR WO-2019037854-A1 OR CN-116032028-A OR EP-2026602-A1 OR	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/04/26 04:28 PM

		CN-219536310-U OR CN-120433355-A OR DE-102007013420-A1 OR DE-102008008670-A1).did.					
L137	9	136 AND arcuate	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/06/30 03:43 PM
L138	4	"18924062"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/06/30 04:57 PM
L139	5	(hearing SAME central SAME volume SAME contact SAME internal SAME volume SAME electrode).clm.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/06/30 09:52 PM
L140	5	(hearing SAME central SAME volume SAME contact SAME internal SAME volume SAME electrode SAME faceplate).clm.	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL,	OR	ON	ON	2026/06/30 09:53 PM

			NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))				
L141	50	(Artificial Intelligence) Similar to: 19/303,720 with 0 CPC Selections and 0 Text Selections Text: (EP-4664932-A2 OR US-20250048012-A1 OR US-20220109924-A1 OR US-20260089424-A1 OR WO-2021015998-A1 OR EP-4000277-B1 OR US-20240414465-A1 OR US-20250234141-A1 OR CH-721509-A2 OR CH-721509-B1 OR EP-4195703-A1 OR DE-102021213958-A1 OR DE-102021213958-B4 OR US-20230179931-A1 OR US-20250039617-A1 OR US-12238485-B2 OR US-20240305933-A1 OR US-10587965-B2 OR US-12022258-B2 OR US-20220408199-A1 OR US-20210211815-A1 OR KR-20210013603-A OR US-12108213-B2 OR CN-120474126-A OR CN-115515062-A OR US-12563340-B2 OR CN-116095580-A OR WO-2015039707-A1 OR US-8126178-B2 OR EP-4178222-A1 OR US-20090208046-A1 OR US-20250350893-A1 OR US-12401955-B2 OR DE-102008008670-A1 OR US-20230148224-A1 OR US-20090202093-A1 OR EP-2026602-B1 OR US-20240298111-A1 OR EP-2026602-A1 OR DE-102007013420-A1 OR WO-2022146627-A1 OR	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/06/30 09:58 PM

		CN-114448019-A OR US-20250254457-A1 OR EP-2091124-A2 OR CN-120433355-A OR EP-4604352-A1 OR CN-219536310-U OR EP-3833050-A1 OR US-20180376264-A1 OR US-10623875-B2).did.					
L142	8	"20090067652"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/06/30 10:10 PM
L143	7	"20170195466"	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2026/06/30 10:10 PM
L144	2	(canal SAME hearing SAME device SAME central SAME ring SAME annular SAME electrode SAME internal).clm.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2026/07/11 02:24 PM
L145	2	(canal SAME hearing SAME device SAME central SAME ring SAME annular SAME	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU,	OR	ON	ON	2026/07/11 02:24 PM

		electrode SAME internal SAME annular).clm.	CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))				
L146	91	"5253300"	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2026/07/11 02:24 PM
L147	5	"20080240480"	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2026/07/11 02:25 PM
L148	35	"2017058675"	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2026/07/11 02:26 PM
L149	0	(central SAME ring SAME hearing SAME exterior SAME contact$1 SAME	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU,	OR	ON	ON	2026/07/11 03:05 PM

		wear$4 SAME internal SAME annular).clm.	CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))				

PE2E SEARCH - Search History (Interference)

There are no Interference searches to show.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via the USPTO patent electronic filing system.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 6 should be completed where appropriate. All further correspondence will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications. **Because electronic patent issuance may occur shortly after issue fee payment, any desired continuing application should preferably be filed prior to payment of this issue fee in order not to jeopardize copendency.**

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

142537 7590 07/16/2026
MRG/HD - Starkey
c/o Mueting Raasch Group
111 Washington Ave. S., Suite 700
Minneapolis, MN 55401

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via the USPTO patent electronic filing system or by facsimile to (571) 273-2885, on the date below.

Denise M. Lagro	(Typed or printed name)
/Denise M. Lagro/	(Signature)
July 17, 2026	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
18/810,014	08/20/2024	Erik Carlson	ST0806US2/0532.000806US04	7322

TITLE OF INVENTION: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1290	$0.00	$0.00	$1290	10/16/2026

EXAMINER	ART UNIT	CLASS-SUBCLASS
MONIKANG, GEORGE C	2692	381-323000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/AIA/122 or PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Mueting Raasch Group
2
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: Starkey Laboratories, Inc.
(B) RESIDENCE: (CITY and STATE OR COUNTRY): Eden Prairie, MN

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. Fees submitted: ☒ Issue Fee ☐ Publication Fee (if required)

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

☒ Electronic Payment via the USPTO patent electronic filing system ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)

☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. 134895

5. **Change in Entity Status** (from status indicated above)

☐ Applicant certifying micro entity status. See 37 CFR 1.29
NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

☐ Applicant asserting small entity status. See 37 CFR 1.27
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

☐ Applicant changing to regular undiscounted fee status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

6. **Courtesy Ceremonial Copy**

☐ Applicant requests a courtesy ceremonial copy of the electronic patent grant. Applicant understands that the electronic patent grant is the official statutory patent grant.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /Jay R. Pralle/ Date July 17, 2026

Typed or printed name Jay R. Pralle Registration No. 52131

PTOL-85 Part B (11/23) Approved for use through 03/31/2026 OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
www.uspto.gov

ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/810,014	**07/17/2026 02:14:59 PM Z ET**	**ST0806US2/0532.000806US04**

Title of Invention

SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	7322	FILED BY	Denise Lagro
PATENT CENTER #	78918414	FILING DATE	08/20/2024
CUSTOMER #	142537	FIRST NAMED INVENTOR	Erik Carlson
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Jay Pralle

Documents

TOTAL DOCUMENTS: 1

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
2026-07-17-Issue Fee Payment.pdf	1	Issue Fee Payment (PTO-85B)	114 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
2026-07-17-Issue Fee Payment.pdf	DE5AD17F9FF64CF1C7BC6C724F63654BBD20DC8EE710C9D765D15F158043978EBEB983573D015DB84EEE281BD3C01F5BA2512F73EBE7CACED42E18F44FC0808B

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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PATENT AND TRADEMARK OFFICE

P.O. Box 1450
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ELECTRONIC PAYMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/810,014	**07/17/2026 02:14:59 PM Z ET**	**ST0806US2/0532.000806US04**

Title of Invention

SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	7322	FILED BY	Denise Lagro
PATENT CENTER #	78918414	AUTHORIZED BY	Jay Pralle
CUSTOMER #	142537	FILING DATE	08/20/2024
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Erik Carlson

Payment Information

PAYMENT METHOD	PAYMENT TRANSACTION ID	PAYMENT AUTHORIZED BY
CARD / 7647	**E20267GE15177049**	**Denise Lagro**

FEE CODE	DESCRIPTION	ITEM PRICE($)	QUANTITY	ITEM TOTAL($)
1501	UTILITY ISSUE FEE	1290.00	1	1290.00
			TOTAL AMOUNT:	**$1,290.00**

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

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New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT		
	Application Number:	Unassigned
	Confirmation No:	Unassigned
	Filing Date:	Herewith
	First Named Inventor:	Erik Carlson
	Attorney Docket No.:	ST0806US4/532.000806US04
	Examiner Name:	Unassigned
	Art Unit:	Unassigned
Sheet 3 of 4	**IDS filed on: August 20, 2024**	
Title: SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE		

U.S. PATENTS

Patent Number (Number - Kind Code)	Issue Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
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U.S. PATENT APPLICATION PUBLICATIONS

Publication Number (Number - Kind Code)	Publication Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
2008/0118093	~~09-27-2011~~	Klemenz	05/2008
20160353216 A1	12-01-2016	Ruzicka	
2018/0370522	12-27-2018	Collins	

Change(s) ~~applied~~ to document,
/J.E./
7/22/2026

U.S. PATENT APPLICATIONS BY SERIAL NUMBER

Copy Enclosed	Document Number (Number - Kind Code)	Filing Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments
	None			

FOREIGN PATENT DOCUMENTS

Copy Enclosed	Cite #	Country Code	Foreign Document Number	Kind Code	Publication Date (MM-DD-YYYY)	Name of Patentee or Applicant	Comments	translation yes	translation no
	1	EP	2640170	A1	09-18-2013	Sanford			
	2	WO	2016/036309	A1	03-10-2016	Lindén			
	3	WO	2016/126476	A1	08-11-2016	Fletcher			
	4	WO	2019/037854	A1	02-28-2019	Baltensperger			

Examiner Signature		Date Considered	
***EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.**			

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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
18/810,014	09/22/2026	12745031	ST0806US2/0532.000806US04	7322

142537 7590 09/09/2026

MRG/HD - Starkey
c/o Mueting Raasch Group
111 Washington Ave. S., Suite 700
Minneapolis, MN 55401

ISSUE NOTIFICATION

The projected patent number and issue date are specified above. The patent will issue electronically. The electronically issued patent is the official patent grant pursuant to 35 U.S.C. § 153. The patent may be accessed on or after the issue date through Patent Center at https://patentcenter.uspto.gov/. The patent will be available in both the public and the private sides of Patent Center. Further assistance in electronically accessing the patent, or about Patent Center, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

The USPTO will automatically mail a courtesy ceremonial copy of the electronic patent grant to the correspondence address of record if the issue fee was paid before March 9, 2026. If the issue fee was paid on or after March 9, 2026, a courtesy ceremonial copy will be mailed if the applicant opted-in to receiving it. Additional copies of the patent (i.e., certified and presentation copies) may be ordered for a fee from the USPTO's Certified Copy Center at https://certifiedcopycenter.uspto.gov/index.html. The Certified Copy Center may be reached at (800)972-6382.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 77 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Center (https://patentcenter.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Patents Stakeholder Experience (OPSE), Stakeholder Support Division (SSD) at (571)-272-4200.

INVENTOR(s) (Please see PATENT CENTER site https://patentcenter.uspto.gov for additional inventors):

Erik Carlson, Stillwater, MN;
Thomas Burns, Minneapolis, MN;
Kyle Olson, St. Louis Park, MN;
Kent Giswold, Minnetonka, MN;

APPLICANT(s) (Please see PATENT CENTER site https://patentcenter.uspto.gov for additional applicants):

Starkey Laboratories, Inc., Eden Prairie, MN;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

1776 – 2026

United States of America

To Promote the Progress of Science and Useful Arts

The Director

of the United States Patent and Trademark Office has received an application for a patent for a new and useful invention. The title and description of the invention are enclosed. The requirements of law have been complied with, and it has been determined that a patent on the invention shall be granted under the law.

Therefore, this United States

Patent

grants to the person(s) having title to this patent the right to exclude others from making, using, offering for sale, or selling the invention throughout the United States of America or importing the invention into the United States of America, and if the invention is a process, of the right to exclude others from using, offering for sale or selling throughout the United States of America, products made by that process, for the term set forth in 35 U.S.C. 154(a)(2) or (c)(1), subject to the payment of maintenance fees as provided by 35 U.S.C. 41(b). See the Maintenance Fee Notice on the inside of the cover.

John A. Squires

Director of the United States Patent and Trademark Office

1776-2026

UNITED STATES PATENT AND TRADEMARK OFFICE

Celebrating 250 years of life, liberty, and the pursuit of innovation

Maintenance Fee Notice

If the application for this patent was filed on or after December 12, 1980, maintenance fees are due three years and six months, seven years and six months, and eleven years and six months after the date of this grant, or within a grace period of six months thereafter upon payment of a surcharge as provided by law. The amount, number and timing of the maintenance fees required may be changed by law or regulation. Unless payment of the applicable maintenance fee is received in the United States Patent and Trademark Office on or before the date the fee is due or within a grace period of six months thereafter, the patent will expire as of the end of such grace period.

Patent Term Notice

If the application for this patent was filed on or after June 8, 1995, the term of this patent begins on the date on which this patent issues and ends twenty years from the filing date of the application or, if the application contains a specific reference to an earlier filed application or applications under 35 U.S.C. 120, 121, 365(c), or 386(c), twenty years from the filing date of the earliest such application ("the twenty-year term"), subject to the payment of maintenance fees as provided by 35 U.S.C. 41(b), and any extension as provided by 35 U.S.C. 154(b) or 156 or any disclaimer under 35 U.S.C. 253.

If this application was filed prior to June 8, 1995, the term of this patent begins on the date on which this patent issues and ends on the later of seventeen years from the date of the grant of this patent or the twenty-year term set forth above for patents resulting from applications filed on or after June 8, 1995, subject to the payment of maintenance fees as provided by 35 U.S.C. 41(b) and any extension as provided by 35 U.S.C. 156 or any disclaimer under 35 U.S.C. 253.

US012745031B2

(12) **United States Patent**
Carlson et al.

(10) **Patent No.: US 12,745,031 B2**
(45) **Date of Patent: *Sep. 22, 2026**

(54) **SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE**

(71) Applicant: **Starkey Laboratories, Inc.**, Eden Prairie, MN (US)

(72) Inventors: **Erik Carlson**, Stillwater, MN (US); **Thomas Burns**, Minneapolis, MN (US); **Kyle Olson**, St. Louis Park, MN (US); **Kent Giswold**, Minnetonka, MN (US)

(73) Assignee: **Starkey Laboratories, Inc.**, Eden Prairie, MN (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 77 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **18/810,014**

(22) Filed: **Aug. 20, 2024**

(65) **Prior Publication Data**

US 2024/0414465 A1 Dec. 12, 2024

Related U.S. Application Data

(63) Continuation of application No. 17/553,716, filed on Dec. 16, 2021, now Pat. No. 12,101,588, which is a (Continued)

(51) **Int. Cl.**
H04R 1/1025 (2026.01)
H01M 10/46 (2006.01)
H04R 25/00 (2006.01)

(52) **U.S. Cl.**
CPC ***H04R 1/1025*** (2013.01); ***H01M 10/46*** (2013.01); ***H04R 25/602*** (2013.01); *H04R 2225/31* (2013.01); *H04R 2225/57* (2019.05)

(58) **Field of Classification Search**
CPC H04R 1/1025; H04R 25/602; H04R 2225/31; H04R 2225/57
(Continued)

(56) **References Cited**

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(Continued)

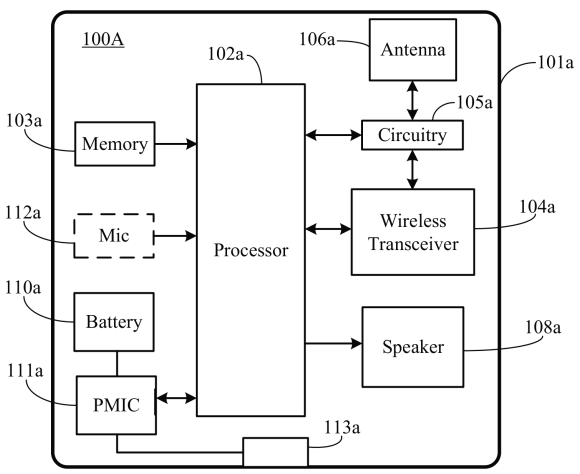
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(Continued)

Primary Examiner — George C Monikang
(74) *Attorney, Agent, or Firm* — Mueting Raasch Group

(57) **ABSTRACT**

A system includes a hearing device comprising a rechargeable power source, power management circuitry, and a first charging interface comprising a first cathode contact and a first anode contact spaced apart from the first cathode contact. A charging module comprises a second charging interface configured to detachably couple with the first charging interface of the hearing device. The second charging interface comprises a second anode contact having a contact surface and a displaceable second cathode contact. An arrangement is configured to displace at least a portion of the second cathode contact above the contact surface to facilitate electrical contact between the first and second cathode contacts prior to electrical contact between the first and second anode contacts. Charging circuitry of the charg-
(Continued)



ing module is coupled to the second charging interface and configured to charge the rechargeable power source of the hearing device.

21 Claims, 15 Drawing Sheets

Related U.S. Application Data

continuation of application No. PCT/US2020/041956, filed on Jul. 14, 2020.

(60) Provisional application No. 62/876,454, filed on Jul. 19, 2019, provisional application No. 62/943,375, filed on Dec. 4, 2019.

(58) **Field of Classification Search**
USPC 381/312, 314, 322, 324, 328
See application file for complete search history.

(56) **References Cited**

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Extended European Search Report for Application No. 252121223 dated Feb. 4, 2026 (8 pages).

* cited by examiner

Figure 1A

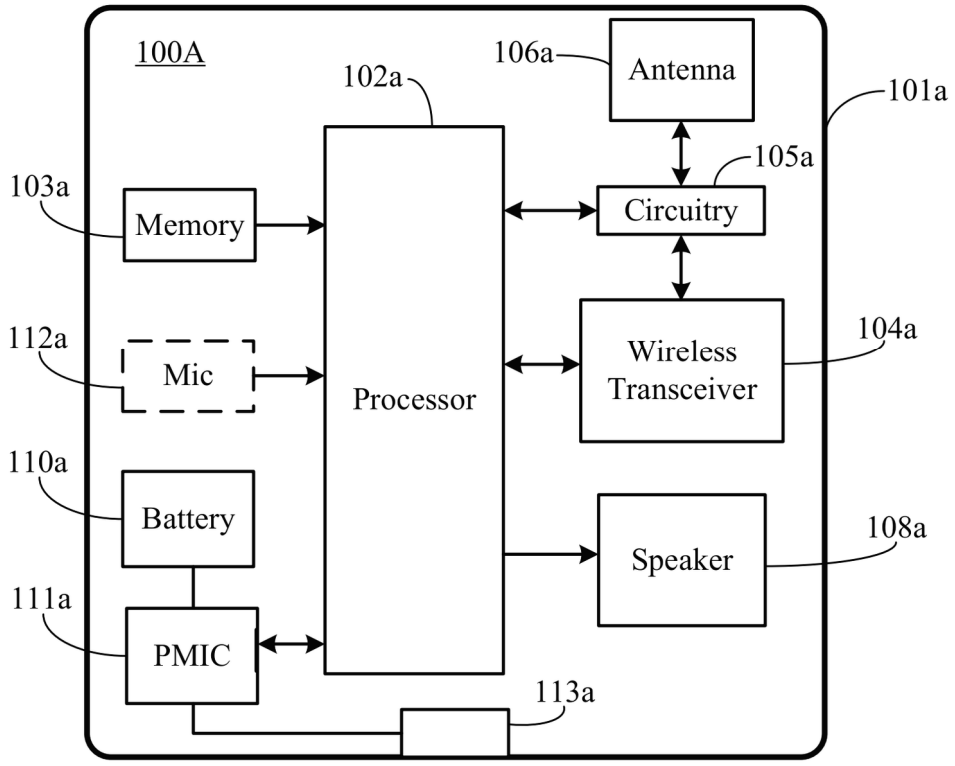
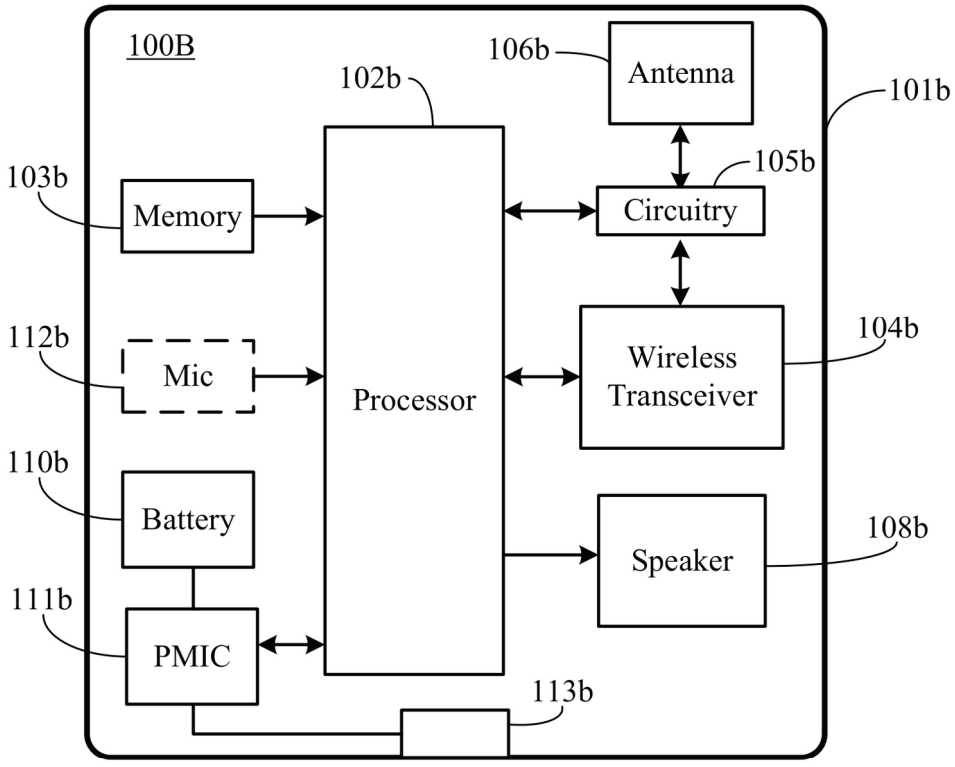


Figure 1B



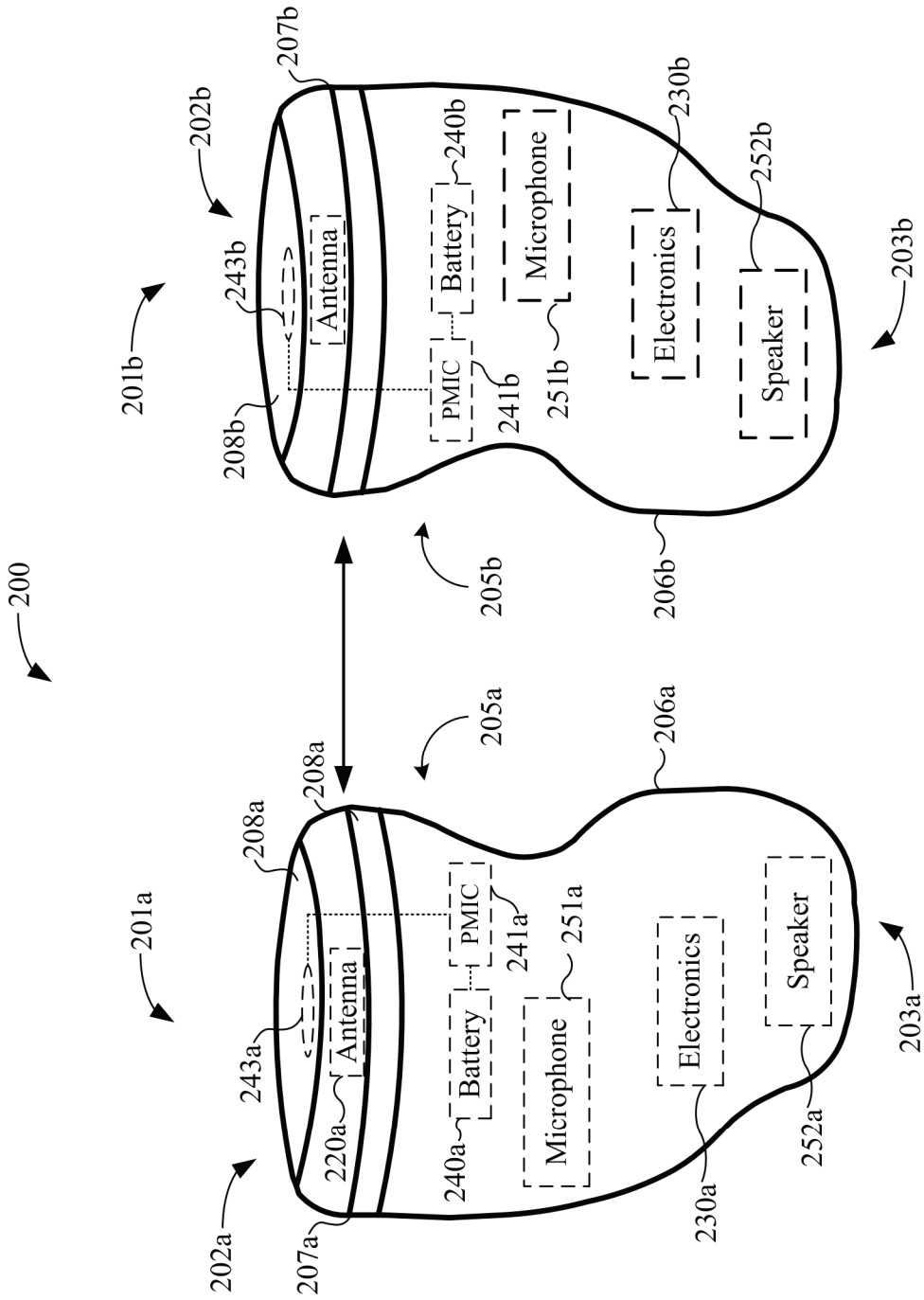

200
201a
201b
202a
202b
203a
203b
205a
205b
206a
206b
207a
207b
208a
208b
220a
230a
230b
240a
240b
241a
241b
243a
243b
251a
251b
252a
252b
Antenna
Battery
PMIC
Microphone
Electronics
Speaker

Figure 2A

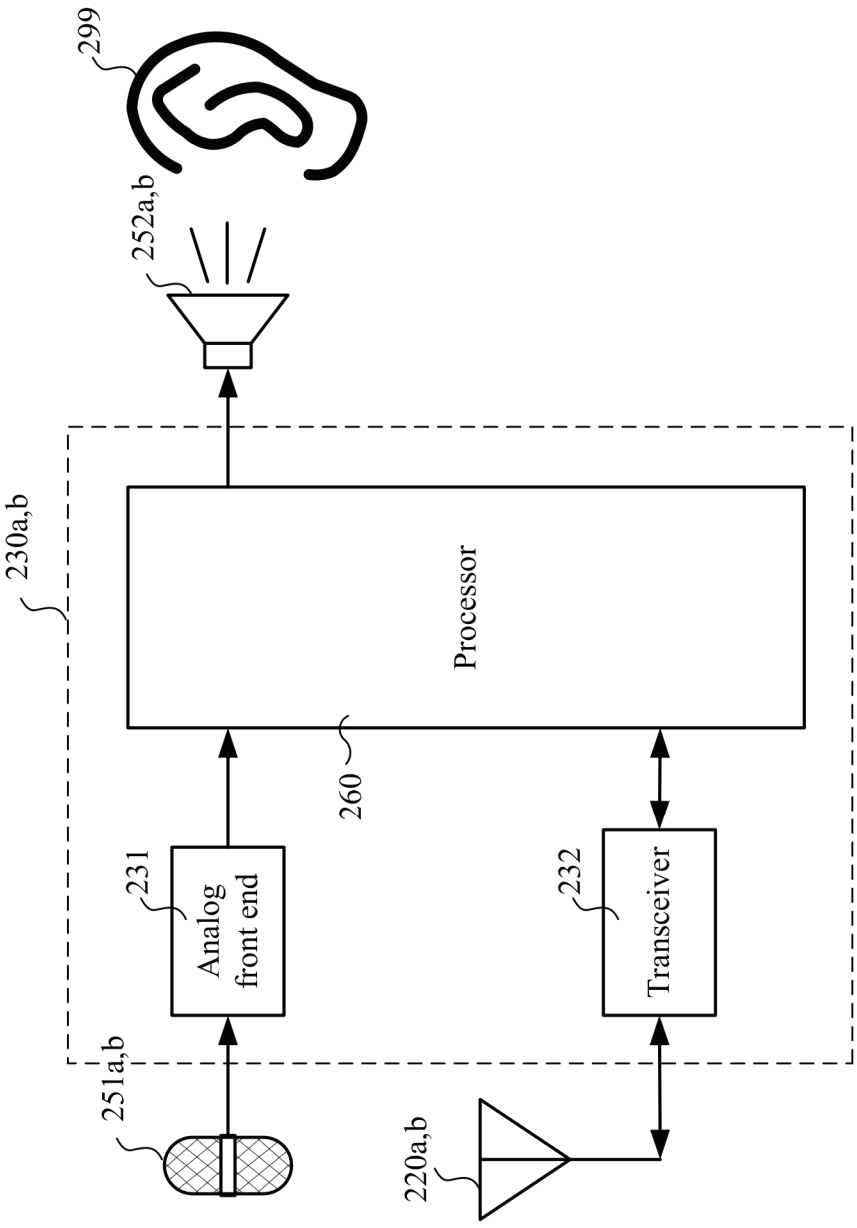

299
252a,b
230a,b
Processor
260
231
Analog front end
232
Transceiver
251a,b
220a,b

Figure 2B

Figure 3

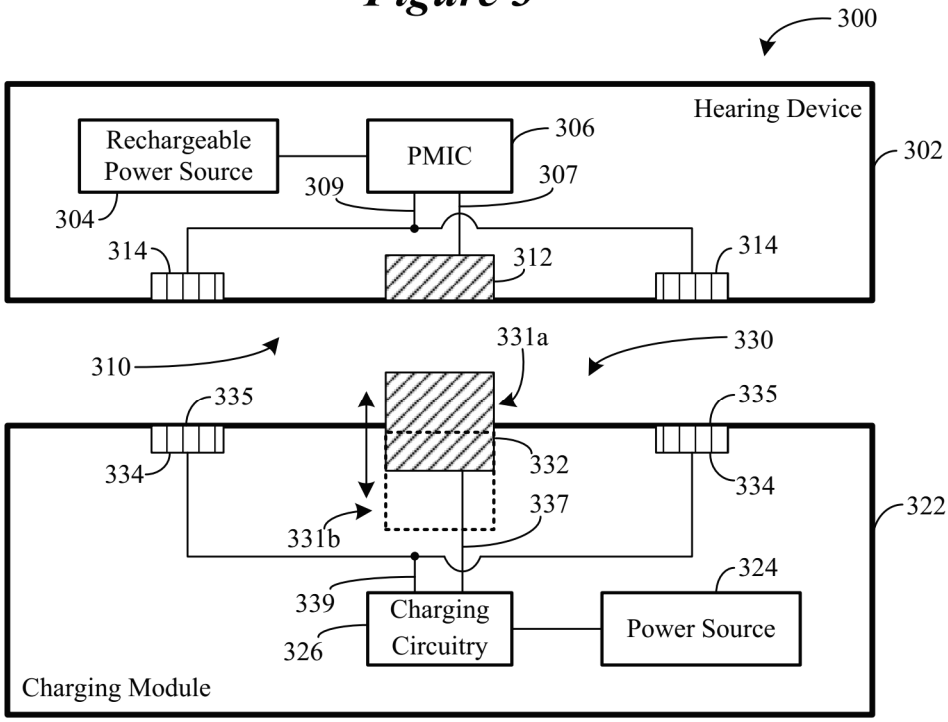
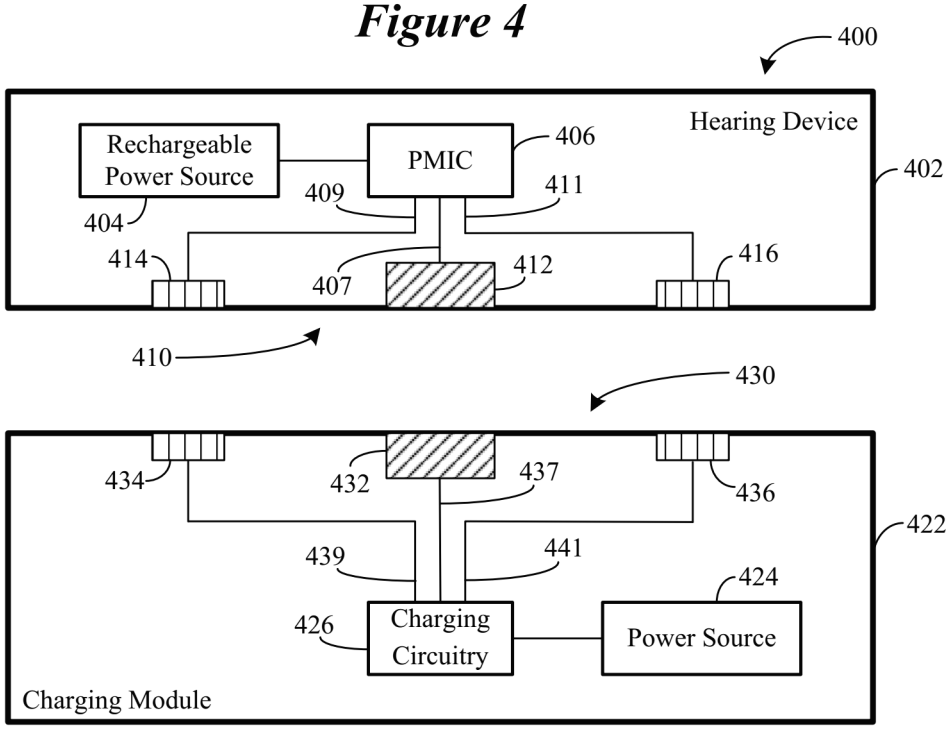


Figure 4



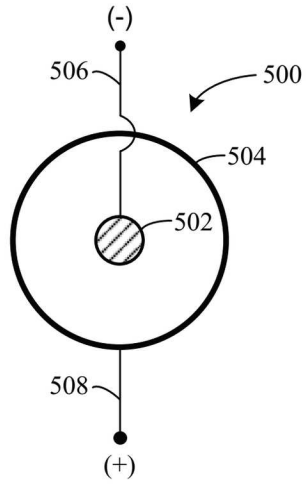


Figure 5

Figure 6

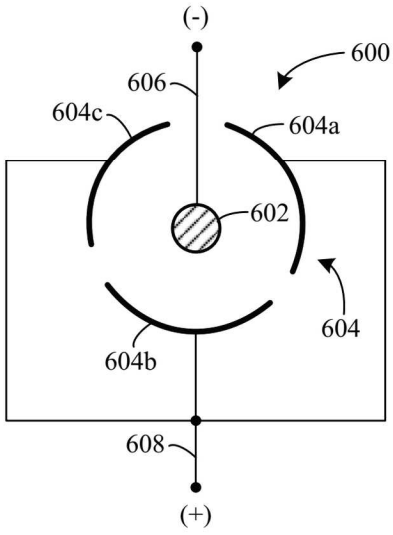


Figure 7

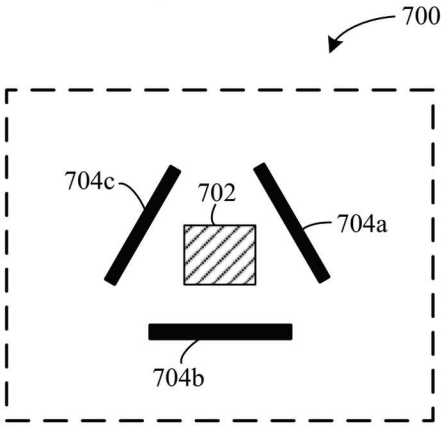


Figure 8A

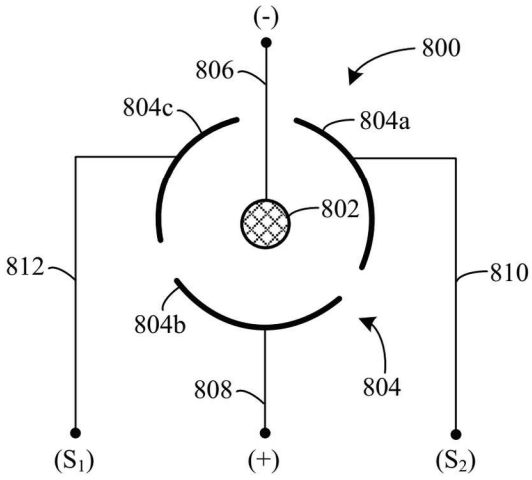


Figure 8B

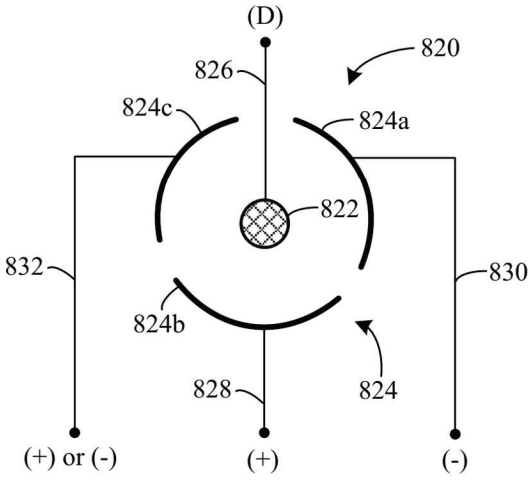


Figure 8C

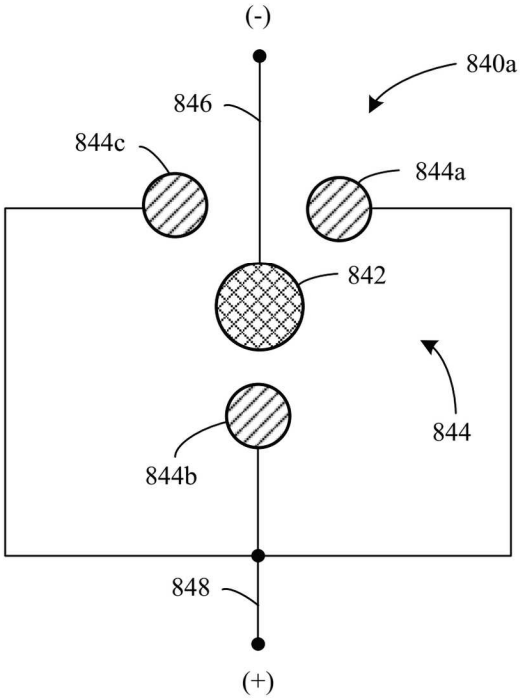


Figure 8D

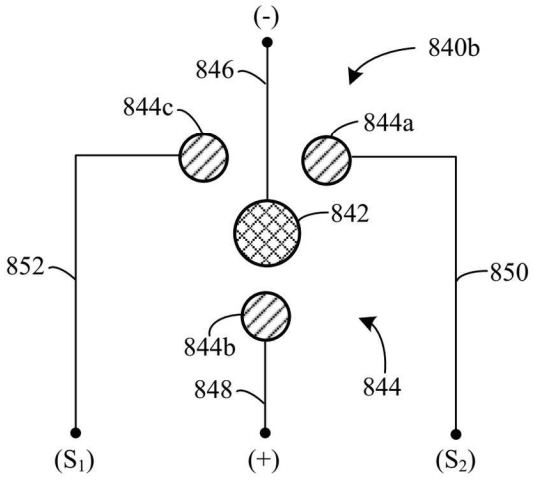
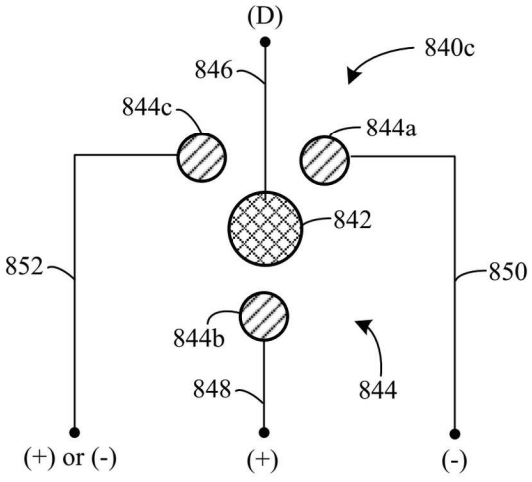


Figure 8E



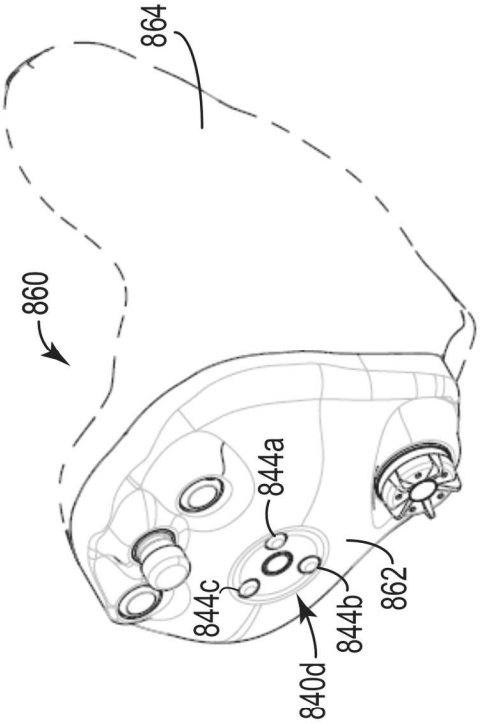


Figure 8G

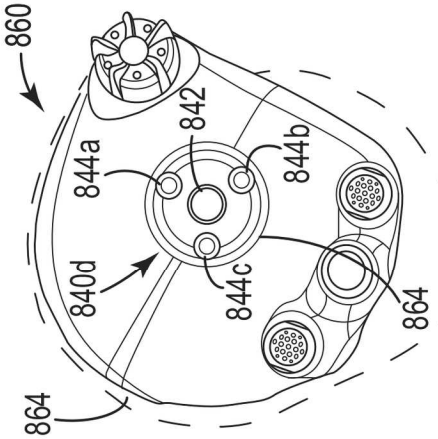


Figure 8I

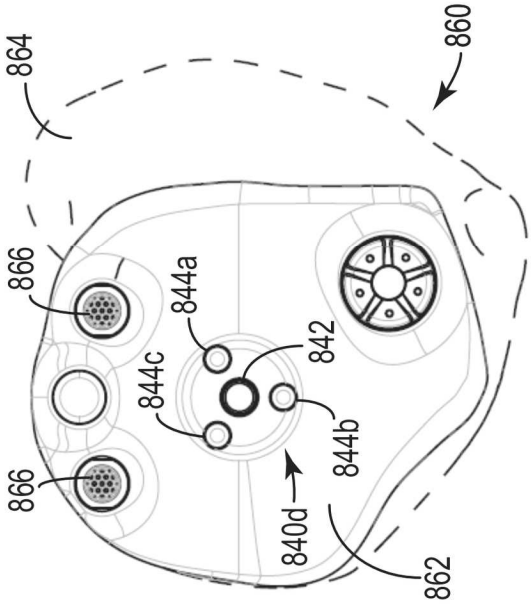


Figure 8F

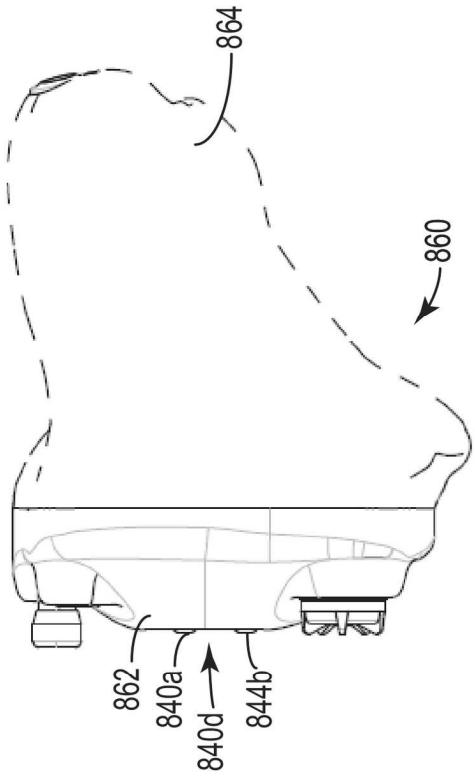


Figure 8H

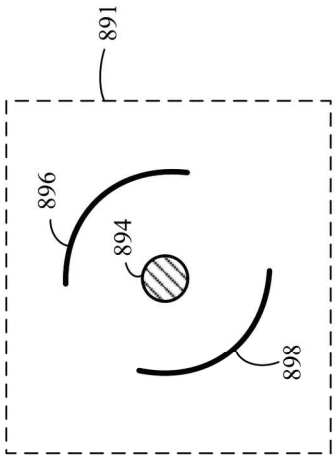


Figure 8K

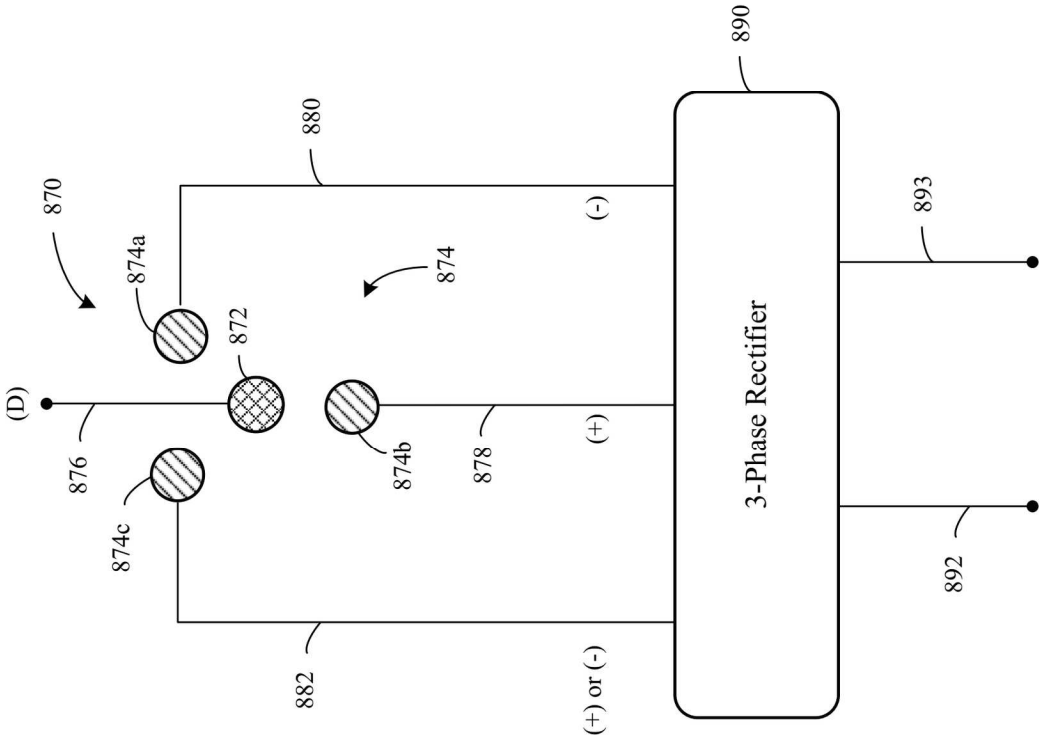
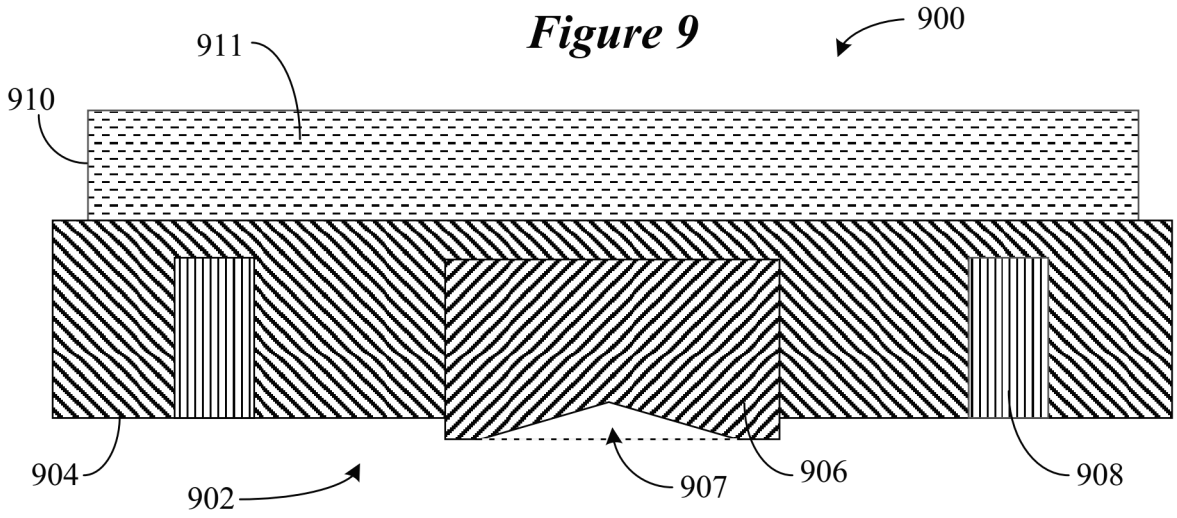


Figure 8J

Figure 9



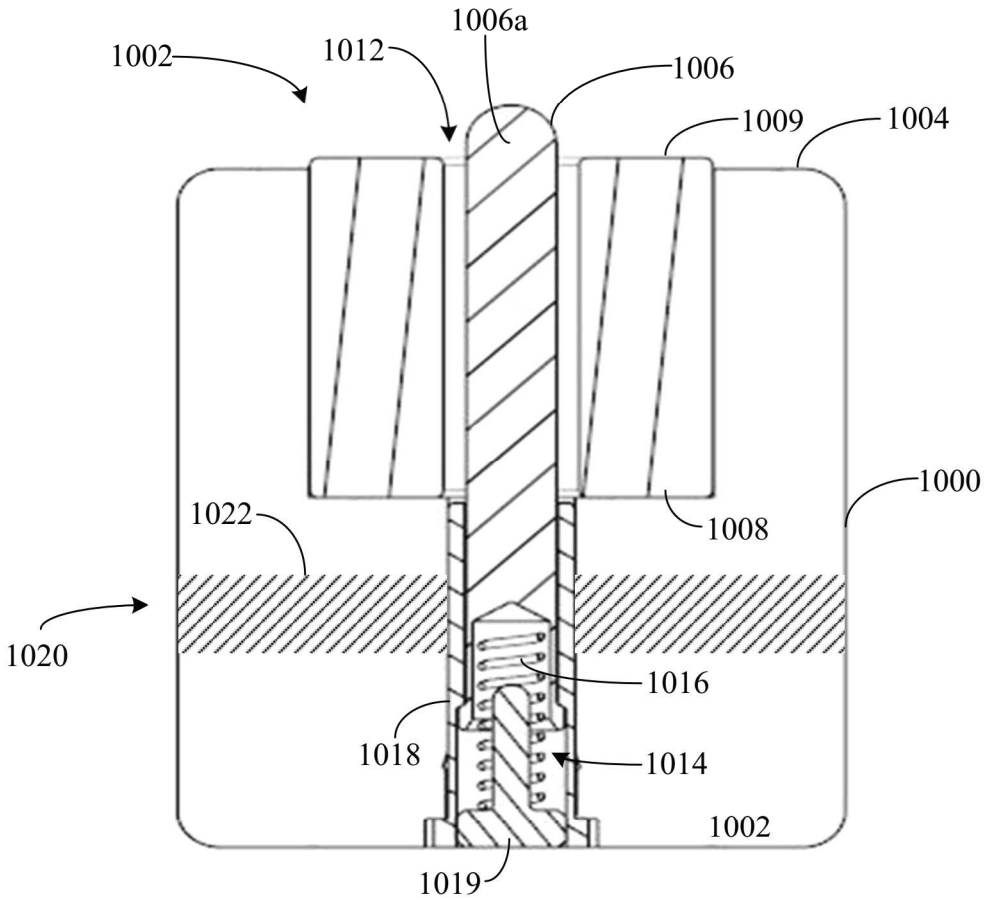


Figure 10

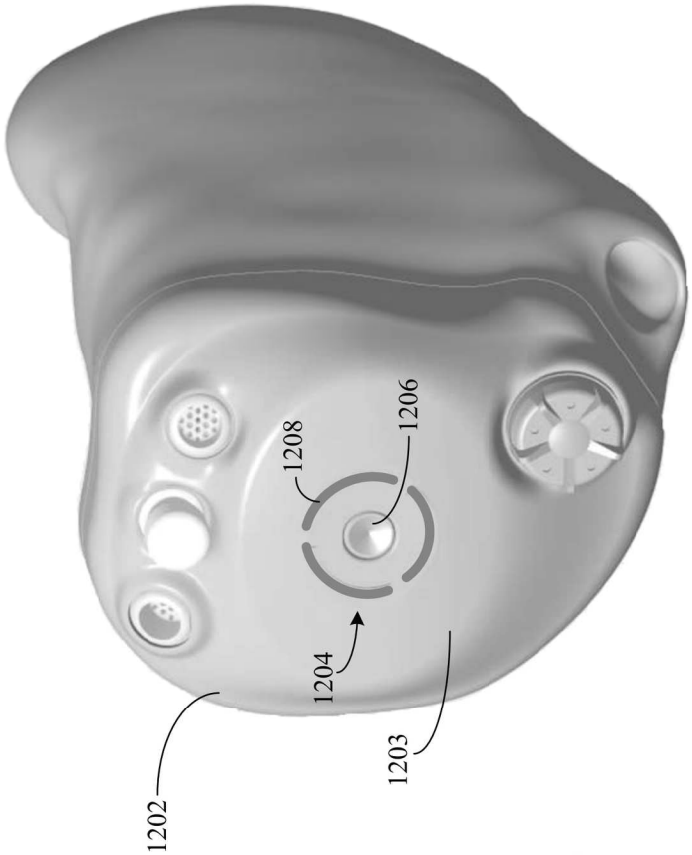


Figure 12

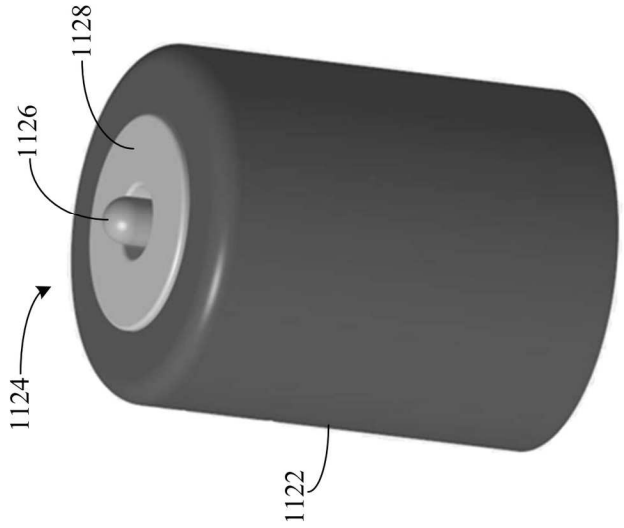


Figure 11

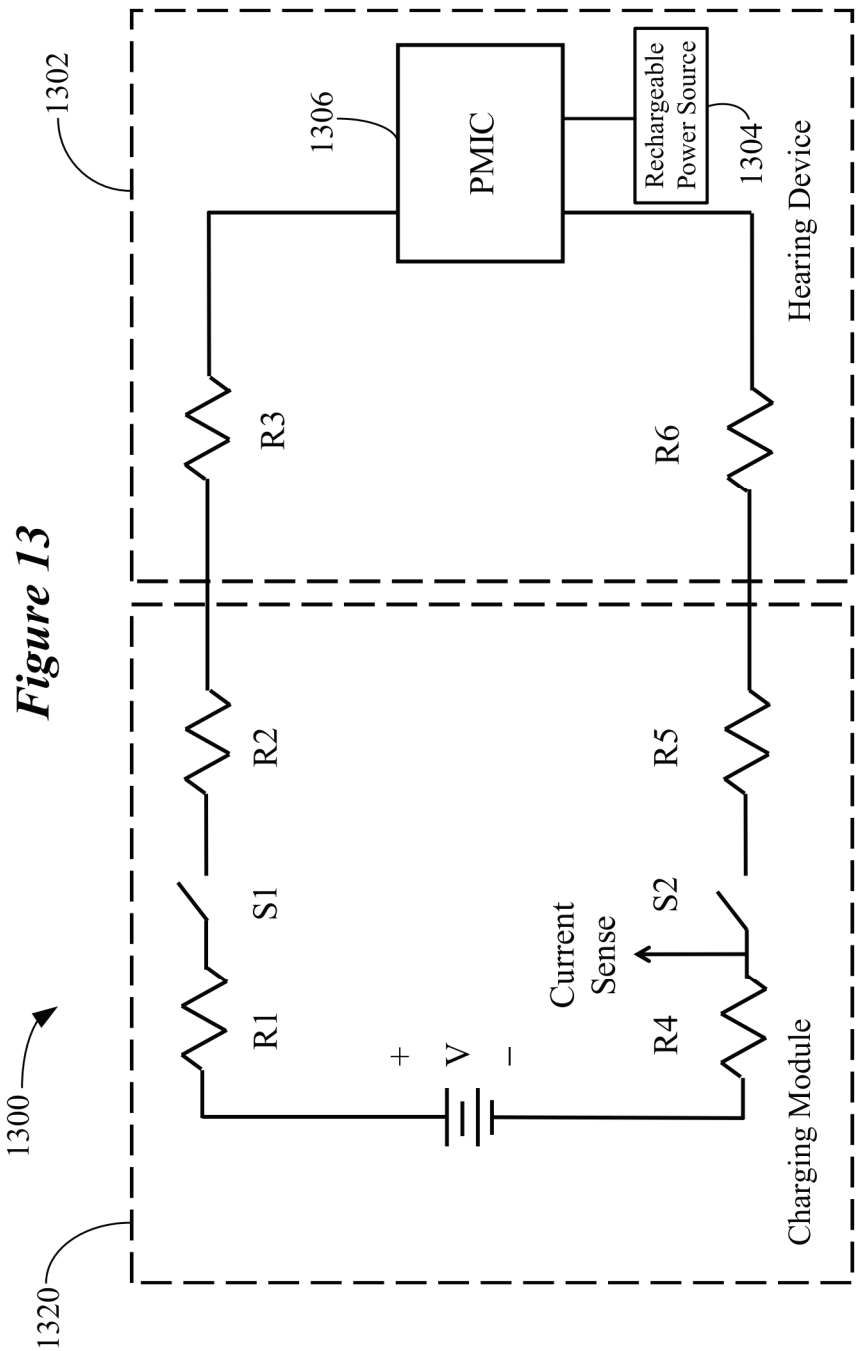

1302
1306
PMIC
Rechargeable Power Source
1304
Hearing Device
R3
R6
R2
R5
S1
S2
Current Sense
R1
R4
+
V
–
1300
1320
Charging Module

Figure 13

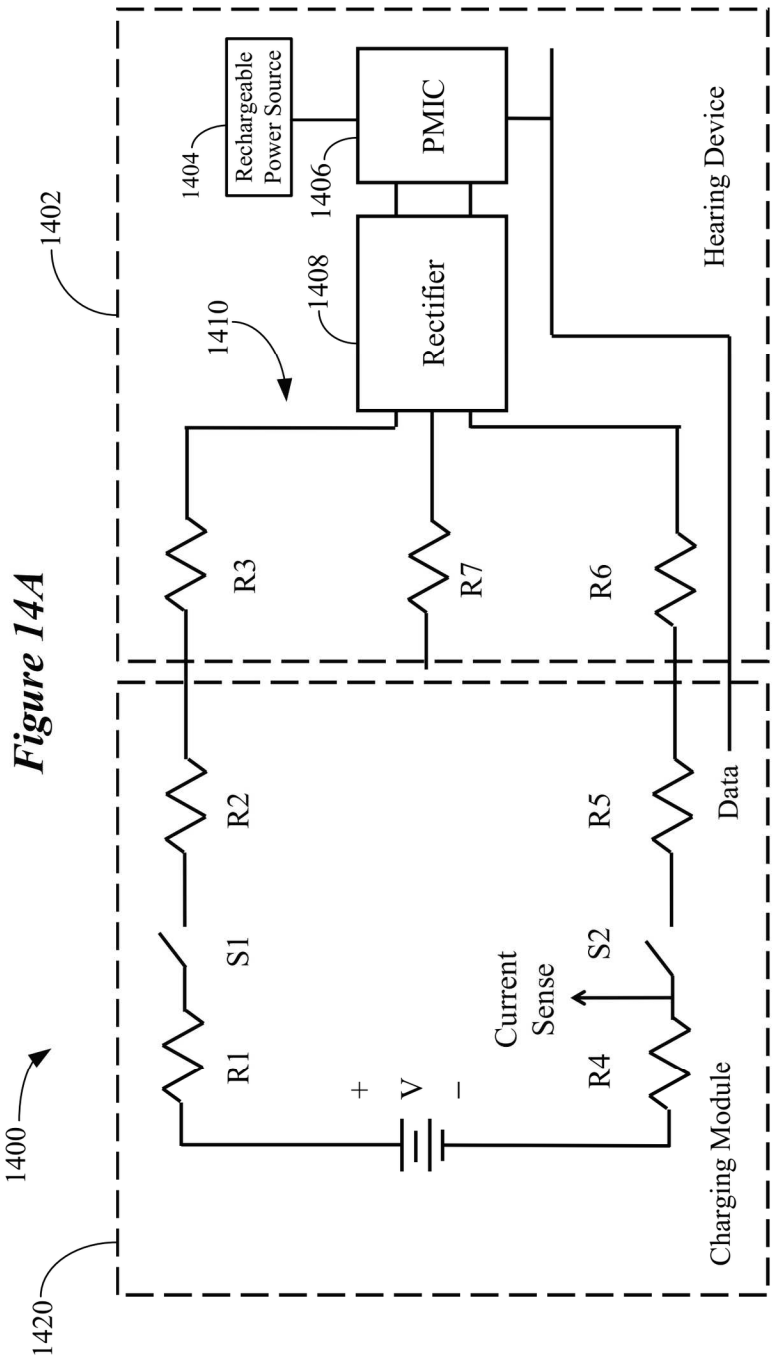


Figure 14A

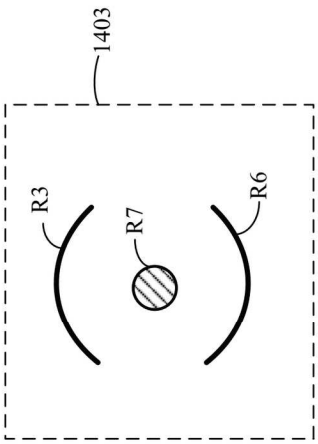


Figure 14B

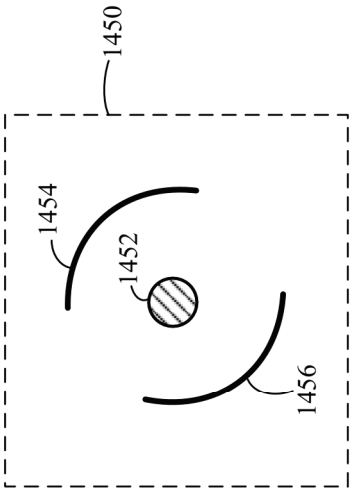


Figure 14D

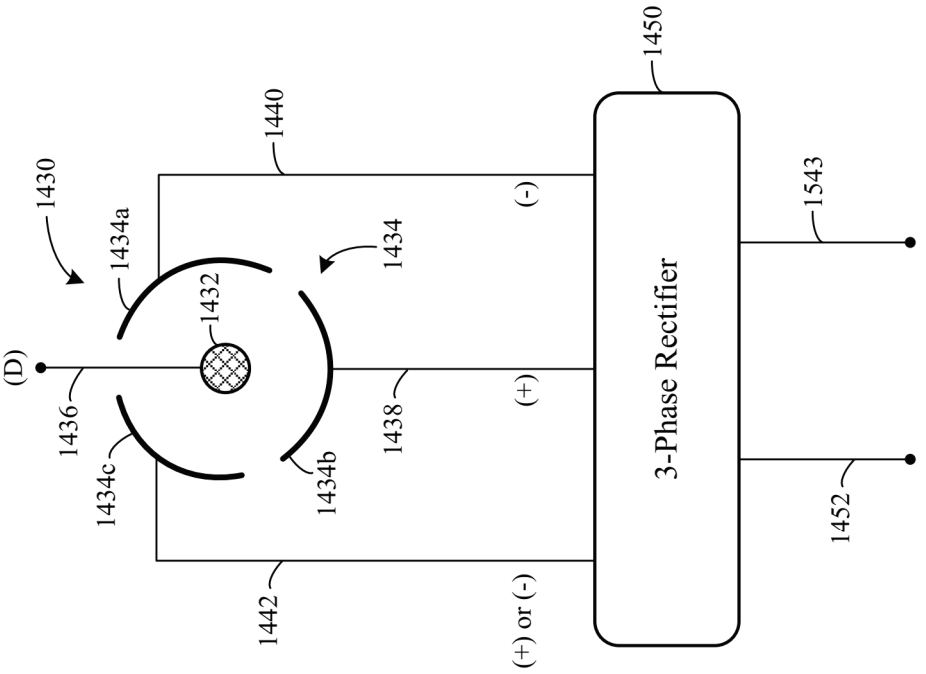


Figure 14C

Figure 15

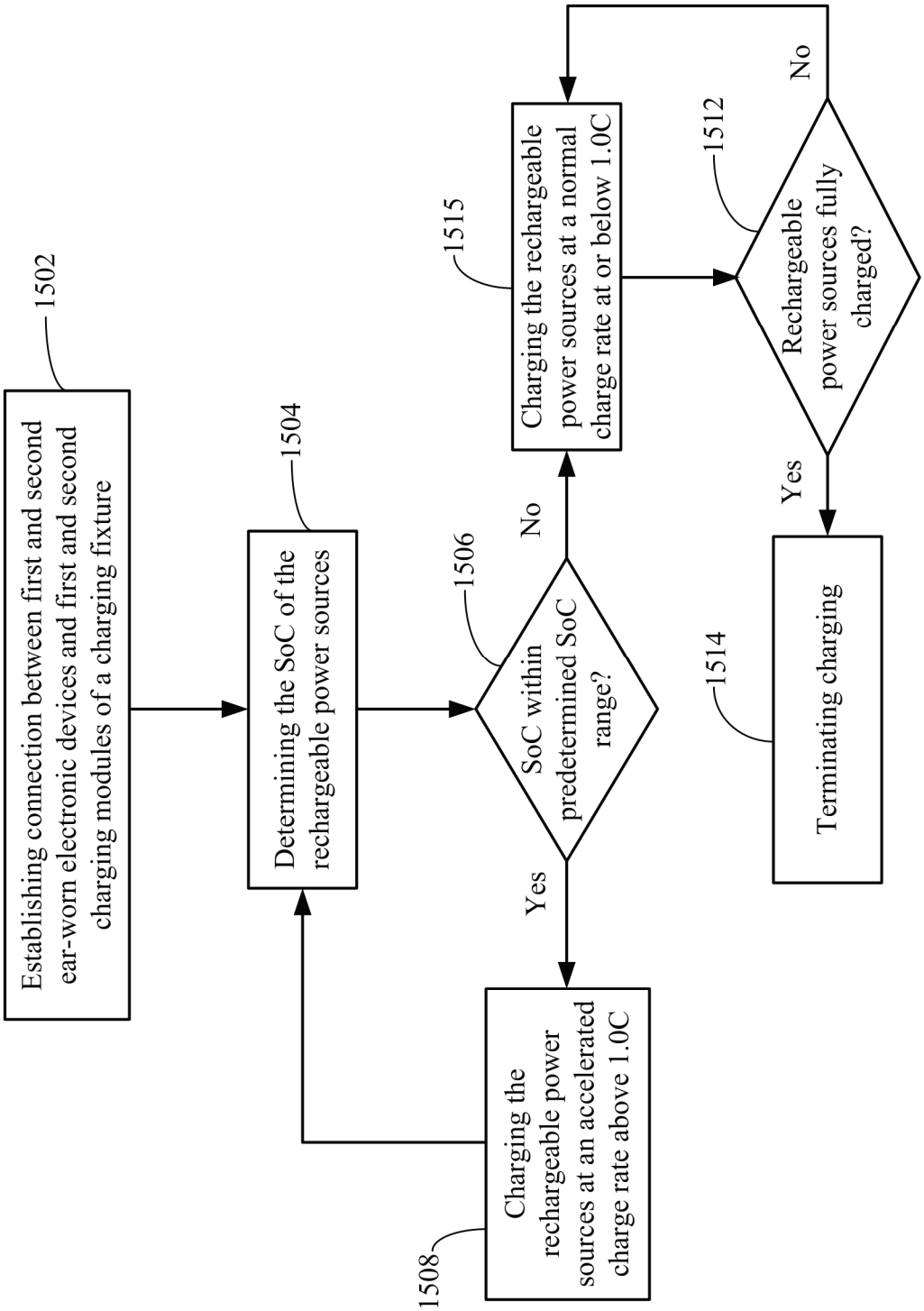
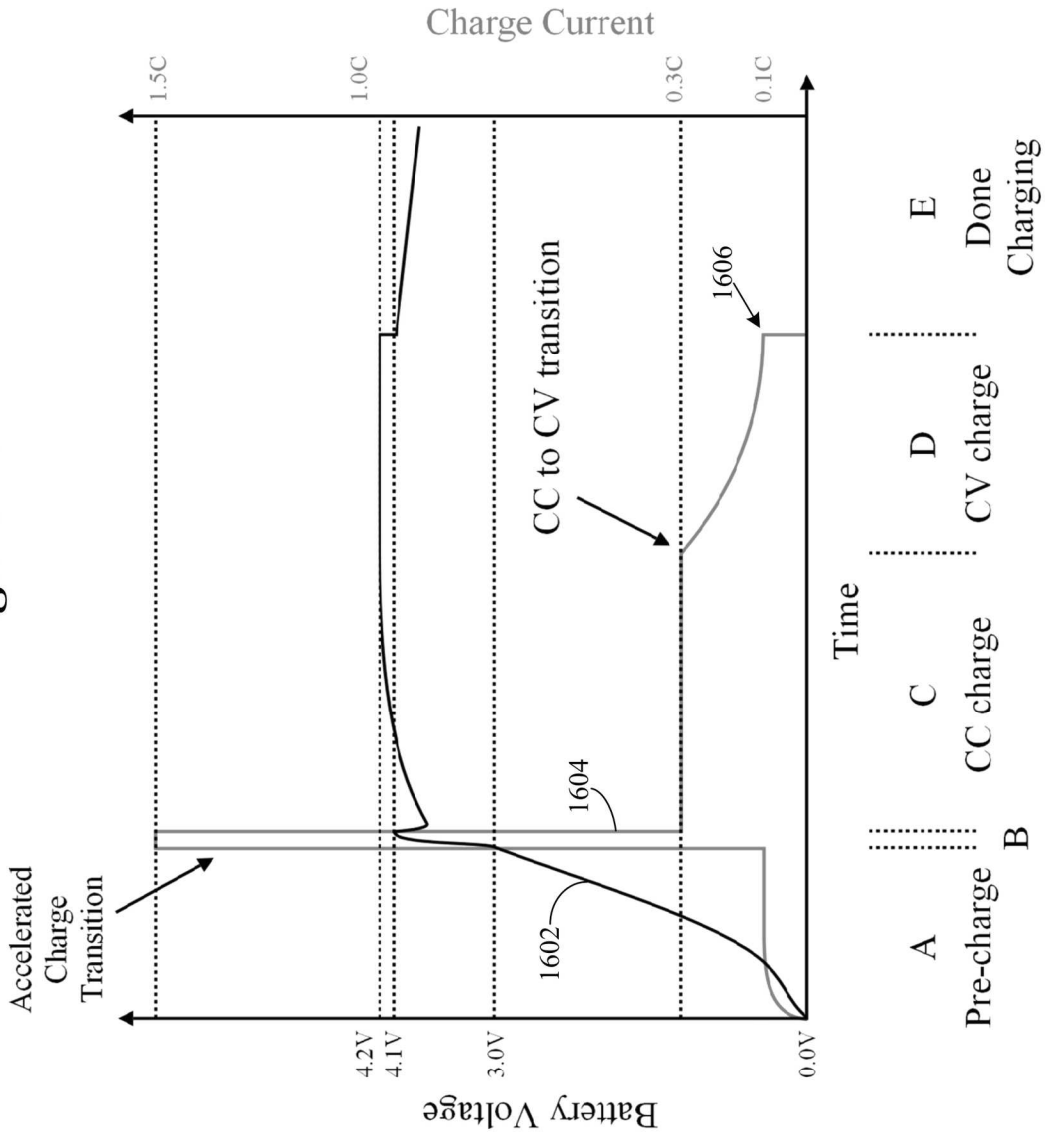

1502
Establishing connection between first and second ear-worn electronic devices and first and second charging modules of a charging fixture
1504
Determining the SoC of the rechargeable power sources
1506
SoC within predetermined SoC range?
No
Yes
1508
Charging the rechargeable power sources at an accelerated charge rate above 1.0C
1515
Charging the rechargeable power sources at a normal charge rate at or below 1.0C
1512
Rechargeable power sources fully charged?
No
Yes
1514
Terminating charging

Figure 16


Charge Current
1.5C
1.0C
0.3C
0.1C
Accelerated Charge Transition
CC to CV transition
1606
1604
1602
4.2V
4.1V
3.0V
0.0V
Battery Voltage
Time
A
Pre-charge
B
C
CC charge
D
CV charge
E
Done Charging
Accelerated CC charge

SYSTEM FOR CHARGING AN EAR-WORN ELECTRONIC DEVICE

RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 17/553,716, filed Dec. 16, 2021, which is a continuation of PCT Application No. PCT/US2020/041956, filed Jul. 14, 2020, which claims priority to U.S. Provisional Application No. 62/876,454, filed Jul. 19, 2019, and U.S. Provisional Application No. 62/943,375, filed Dec. 4, 2019, the content of which are hereby incorporated by reference in their entireties.

TECHNICAL FIELD

This application relates generally to ear-worn electronic devices, including hearing devices, hearing aids, personal amplification devices, and other hearables.

BACKGROUND

Hearing devices provide sound for the wearer. Some examples of hearing devices are headsets, hearing aids, speakers, cochlear implants, bone conduction devices, and personal listening devices. For example, hearing aids provide amplification to compensate for hearing loss by transmitting amplified sounds to a wearer's ear canals. Hearing devices may be capable of performing wireless communication with other devices, such as receiving streaming audio from a streaming device via a wireless link. Wireless communication may also be performed for programming the hearing device and transmitting information from the hearing device. For performing such wireless communication, hearing devices such as hearing aids can include a wireless transceiver and an antenna. In order to provide power to electronic circuitry of a hearing device, a rechargeable battery is often housed within the hearing device, which requires routine charging to ensure proper operation of the hearing device.

SUMMARY

Embodiments are directed to a system comprising at least one hearing device configured to be worn at, in or on an ear of a wearer. The hearing device comprises a rechargeable power source, power management circuitry, and a first charging interface comprising a first cathode contact and a first anode contact spaced apart from the first cathode contact. A charging module comprises a second charging interface configured to detachably couple with the first charging interface of the hearing device. The second charging interface comprises a second anode contact having a contact surface and a displaceable second cathode contact. An arrangement is configured to displace at least a portion of the second cathode contact above the contact surface to facilitate electrical contact between the first and second cathode contacts prior to electrical contact between the first and second anode contacts. Charging circuitry is coupled to the second charging interface and configured to charge the rechargeable power source of the hearing device.

Embodiments are directed to a system, comprising at least one hearing device configured to be worn at, in or on an ear of a wearer. The hearing device comprises a rechargeable power source, power management circuitry, and a first charging interface comprising a first cathode contact and a first anode contact spaced apart from the first cathode contact. The first anode contact can comprise a plurality of electrode elements each having a non-polygonal shape such a curvilinear, round, elliptical, oval or other closed curved shape comprising only or predominately curved lines. The first anode contact can comprise a plurality of electrode elements each having a polygonal shape such as a square, rectangular, triangular or any other closed plane shape formed with three or more straight lines (e.g., polygonal shapes having from three to twelve sides). The first anode contact can comprises a plurality of electrode elements having a combination of non-polygonal and polygonal shapes. A charging module comprises a second charging interface configured to detachably couple with the first charging interface of the hearing device. The second charging interface comprises a second anode contact having a contact surface and a displaceable second cathode contact. An arrangement is configured to displace at least a portion of the second cathode contact above the contact surface to facilitate electrical contact between the first and second cathode contacts prior to electrical contact between the first and second anode contacts. Charging circuitry of the charging module is coupled to the second charging interface and configured to charge the rechargeable power source of the hearing device.

Embodiments are directed to a system comprising at least one hearing device configured to be worn at, in or on an ear of a wearer. The hearing device comprises a rechargeable power source, power management circuitry, and a first charging interface comprising a first cathode contact surrounded by a first anode contact. The first anode contact can comprise a plurality of electrode elements each having a non-polygonal shape such a curvilinear, round, elliptical, oval or other closed curved shape comprising only or predominately curved lines. The first anode contact can comprise a plurality of electrode elements each having a polygonal shape such as a square, rectangular, triangular or any other closed plane shape formed with three or more straight lines (e.g., polygonal shapes having from three to twelve sides). The first anode contact can comprises a plurality of electrode elements having a combination of non-polygonal and polygonal shapes. A charging module comprises a second charging interface configured to detachably couple with the first charging interface of the hearing device. The second charging interface comprises a second anode contact having a contact surface, a through-hole, and a second cathode contact displaceable within the through-hole. A biasing arrangement is configured to bias at least a portion of the second cathode contact above the contact surface to facilitate electrical contact between the first and second cathode contacts prior to electrical contact between the first and second anode contacts. Charging circuitry of the charging module is coupled to the second charging interface and configured to charge the rechargeable power source of the hearing device. A retention arrangement is disposed on one or both of the hearing device and the charging module. The retention arrangement is configured to maintain engagement between the first and second charging interfaces during charging of the rechargeable power source of the hearing device.

Embodiments are directed to a system comprising at least one hearing device configured to be worn at, in or on an car of a wearer. The hearing device comprises a rechargeable power source and a first charging interface comprising a first cathode contact and a first anode contact spaced apart from the first cathode contact. The first anode contact can comprise a plurality of electrode elements each having a non-polygonal shape such as a curvilinear, round, elliptical, oval

or other closed curved shape comprising only or predominately curved lines. The first anode contact can comprise a plurality of electrode elements each having a polygonal shape such as a square, rectangular, triangular or any other closed plane shape formed with three or more straight lines (e.g., polygonal shapes having from three to twelve sides). The first anode contact can comprises a plurality of electrode elements having a combination of non-polygonal and polygonal shapes. The first anode contact comprises a plurality of first electrode elements configured to communicate power and one or more disparate information signals. A charging module comprises a second charging interface configured to detachably couple with the first charging interface of the hearing device and comprises a second cathode contact and a second anode contact. The second anode contact comprises a plurality of second electrode elements configured to communicate power and the one or more disparate information signals. Charging circuitry of the charging module is coupled to the second charging interface and configured to charge the rechargeable power source of the hearing device. The first and second electrode elements are configured to communicate power and the one or more information signals between the charging module and the hearing device.

Embodiments are directed to a system comprising at least one hearing device configured to be worn at, in or on an car of a wearer. The hearing device comprises a rechargeable power source and a first charging interface comprising a plurality of first electrode elements. The plurality of first electrode elements comprises first cathode and anode contacts configured to communicate power and a first data contact configured to communicate one or more disparate information signals. The first anode contact can comprise a plurality of electrode elements each having a non-polygonal shape such as a curvilinear, round, elliptical, oval or other closed curved shape comprising only or predominately curved lines. The first anode contact can comprise a plurality of electrode elements each having a polygonal shape such as a square, rectangular, triangular or any other closed plane shape formed with three or more straight lines (e.g., polygonal shapes having from three to twelve sides). The first anode contact can comprise a plurality of electrode elements having a combination of non-polygonal and polygonal shapes. A charging module comprises a second charging interface configured to detachably couple with the first charging interface of the hearing device and comprises a plurality of second electrode elements. The plurality of second electrode elements comprises second cathode and anode contacts configured to communicate power and a second data contact configured to communicate one or more disparate information signals. Charging circuitry of the charging module is coupled to the second charging interface and configured to charge the rechargeable power source of the hearing device.

The above summary is not intended to describe each disclosed embodiment or every implementation of the present disclosure. The figures and the detailed description below more particularly exemplify illustrative embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

Throughout the specification reference is made to the appended drawings wherein:

FIGS. **1**A and **1**B illustrate an ear-worn electronic device arrangement incorporating charging circuitry and functionality in accordance with any of the embodiments disclosed herein;

FIGS. **2**A and **2**B illustrate a custom hearing aid system which incorporates charging circuitry and functionality in accordance with any of the embodiments disclosed herein;

FIG. **3** illustrates an ear-worn electronic device and a charging module respectively incorporating charging circuitry and functionality in accordance with any of the embodiments disclosed herein;

FIG. **4** illustrates an ear-worn electronic device and a charging module respectively incorporating charging circuitry and functionality in accordance with any of the embodiments disclosed herein;

FIG. **5** illustrates a charging interface of one or both of an ear-worn electronic device and a charging module in accordance with any of the embodiments disclosed herein;

FIG. **6** illustrates a charging interface of one or both of an ear-worn electronic device and a charging module in accordance with any of the embodiments disclosed herein;

FIG. **7** illustrates a charging interface of one or both of an ear-worn electronic device and a charging module in accordance with any of the embodiments disclosed herein;

FIG. **8**A illustrates a charging interface of one or both of an ear-worn electronic device and a charging module in accordance with any of the embodiments disclosed herein;

FIG. **8**B illustrates a charging interface of one or both of an ear-worn electronic device and a charging module in accordance with any of the embodiments disclosed herein;

FIG. **8**C illustrates a charging interface of one or both of an ear-worn electronic device and a charging module in accordance with any of the embodiments disclosed herein;

FIG. **8**D illustrates a charging interface of one or both of an ear-worn electronic device and a charging module in accordance with any of the embodiments disclosed herein;

FIG. **8**E illustrates a charging interface of one or both of an ear-worn electronic device and a charging module in accordance with any of the embodiments disclosed herein;

FIGS. **8**F-**8**I illustrate a charging interface of an ear-worn electronic device in accordance with any of the embodiments disclosed herein;

FIG. **8**J illustrates a charging interface of a hearing device comprising a central data contact surrounded by a triangular arrangement of curvilinear-shaped peripheral contacts coupled to a multi-phase rectifier in accordance with any of the embodiments disclosed herein;

FIG. **8**K illustrates a charging interface of a charging module comprising a central data pin surrounded by a pair of arcuate contacts in accordance with any of the embodiments disclosed herein;

FIG. **9** is a cross-sectional view of a portion of a hearing device comprising charging circuitry in accordance with any of the embodiments disclosed herein;

FIG. **10** is a cross-sectional view of a portion of a charging module comprising charging circuitry in accordance with any of the embodiments disclosed herein;

FIGS. **11** and **12** illustrate a system comprising an ear-worn electronic device and a charging module respectively incorporating charging circuitry and functionality in accordance with any of the embodiments disclosed herein;

FIG. **13** is a schematic showing electrical components of a system comprising an ear-worn electronic device and a charging module respectively incorporating charging circuitry and functionality in accordance with any of the embodiments disclosed herein;

FIG. **14**A is a schematic showing electrical components of a system comprising an ear-worn electronic device and a charging module respectively incorporating charging circuitry and functionality in accordance with any of the embodiments disclosed herein;

FIG. **14**B illustrates a charging interface of a hearing device comprising a central cathode pin surrounded by split-ring pin connectors in accordance with any of the embodiments disclosed herein;

FIG. **14**C illustrates a charging interface of a hearing device comprising a central data pin surrounded by split-ring pin connectors coupled to a multi-phase rectifier in accordance with any of the embodiments disclosed herein;

FIG. **14**D illustrates a charging interface of a charging module comprising a central data pin surrounded by split-ring pin connectors in accordance with any of the embodiments disclosed herein;

FIG. **15** illustrates a method of implementing accelerated charging of one or more hearing devices using a charging module in accordance with any of the embodiments disclosed herein; and

FIG. **16** is a graph that characterizes accelerated charging of a lithium-ion battery of a hearing device in accordance with any of the embodiments disclosed herein.

The figures are not necessarily to scale. Like numbers used in the figures refer to like components. However, it will be understood that the use of a number to refer to a component in a given figure is not intended to limit the component in another figure labeled with the same number.

DETAILED DESCRIPTION

It is understood that the embodiments described herein may be used with any ear-worn or ear-level electronic device without departing from the scope of this disclosure. The devices depicted in the figures are intended to demonstrate the subject matter, but not in a limited, exhaustive, or exclusive sense. Ear-worn electronic devices (also referred to herein as "hearing devices"), such as hearables (e.g., wearable earphones, ear monitors, and earbuds), hearing aids, hearing instruments, and hearing assistance devices, typically include an enclosure, such as a housing or shell, within which internal components are disposed. Typical components of a hearing device can include a processor (e.g., a digital signal processor or DSP), memory circuitry, power management circuitry, one or more communication devices (e.g., a radio, a near-field magnetic induction (NFMI) device), one or more antennas, one or more microphones, and a receiver/speaker, for example. Hearing devices can incorporate a long-range communication device, such as a Bluetooth® transceiver or other type of radio frequency (RF) transceiver. A communication device (e.g., a radio or NFMI device) of a hearing device can be configured to facilitate communication between a left ear device and a right ear device of the hearing device.

Hearing devices of the present disclosure can incorporate an antenna coupled to a high-frequency transceiver, such as a 2.4 GHz radio. The RF transceiver can conform to an IEEE 802.11 (e.g., WiFi®) or Bluetooth® (e.g., BLE, Bluetooth® 4. 2 or 5.0) specification, for example. It is understood that hearing devices of the present disclosure can employ other transceivers or radios, such as a 900 MHz radio. Hearing devices of the present disclosure can be configured to receive streaming audio (e.g., digital audio data or files) from an electronic or digital source. Representative electronic/digital sources (e.g., accessory devices) include an assistive listening system, a TV streamer, a radio, a smartphone, a laptop, a cell phone/entertainment device (CPED) or other electronic device that serves as a source of digital audio data or other types of data files. Hearing devices of the present disclosure can be configured to effect bi-directional communication (e.g., wireless communication) of data with an external source, such as a remote server via the Internet or other communication infrastructure. Hearing devices that include a left ear device and a right ear device can be configured to effect bi-directional communication (e.g., wireless communication) therebetween, so as to implement car-to-car communication between the left and right car devices.

The term hearing device of the present disclosure refers to a wide variety of car-level electronic devices that can aid a person with impaired hearing. The term hearing device also refers to a wide variety of devices that can produce processed sound for persons with normal hearing. Hearing devices of the present disclosure include hearables (e.g., wearable earphones, headphones, earbuds, virtual reality headsets), hearing aids (e.g., hearing instruments), cochlear implants, and bone-conduction devices, for example. Hearing devices include, but are not limited to, behind-the-car (BTE), in-the-car (ITE), in-the-canal (ITC), invisible-in-canal (IIC), receiver-in-canal (RIC), receiver-in-the-car (RITE) or completely-in-the-canal (CIC) type hearing devices or some combination of the above. Throughout this disclosure, reference is made to a "hearing device," which is understood to refer to a system comprising a single left ear device, a single right ear device, or a combination of a left ear device and a right car device.

FIGS. **1**A and **1**B illustrate various components of a representative hearing device arrangement in accordance with various embodiments. FIGS. **1**A and **1**B illustrate first and second hearing devices **100**A and **100**B configured to be supported at, by, in or on left and right ears of a wearer. In some embodiments, a single hearing device **100**A or **100**B can be supported at, by, in or on the left or right ear of a wearer. As illustrated, the first and second hearing devices **100**A and **100**B include the same functional components. It is understood that the first and second hearing devices **100**A and **100**B can include different functional components. The first and second hearing devices **100**A and **100**B can be representative of any of the hearing devices disclosed herein.

The first and second hearing devices **100**A and **100**B include an enclosure **101***a*, **101***b* configured for placement, for example, over or on the car, entirely or partially within the external ear canal (e.g., between the pinna and ear drum) or behind the car. Disposed within the enclosure **101***a*, **101***b* is a processor **102***a*, **102***b* which incorporates or is coupled to memory **103***a*, **103***b*. The processor **102***a*, **102***b* can include or be implemented as a multi-core processor, a digital signal processor (DSP), an audio processor or a combination of these processors. For example, the processor **102***a*, **102***b* may be implemented in a variety of different ways, such as with a mixture of discrete analog and digital components that include a processor configured to execute programmed instructions contained in a processor-readable storage medium (e.g., solid-state memory, e.g., Flash).

The processor **102***a*, **102***b* is coupled to a wireless transceiver **104***a*, **104***b* (also referred to herein as a radio), such as a BLE transceiver or other IEEE 802.11 compliant transceiver. The wireless transceiver **104***a*, **104***b* is operably coupled to an antenna **106***a*, **106***b* configured for transmitting and receiving radio signals. Impedance matching circuitry **105***a*, **105***b* can be operably coupled to the wireless transceiver **104***a*, **104***b* and the antenna **106***a*, **106***b*. The antenna **106***a*, **106***b* is disposed in, on, or extends from the

enclosure **101***a*, **101***b*. The wireless transceiver **104***a*, **104***b* and the antenna **106***a*, **106***b* can be configured to operate in the 2.4 GHz ISM frequency band or other applicable communication band (referred to as the "Bluetooth® band" herein). The wireless transceiver **104***a*, **104***b* and antenna **106***a*, **106***b* can be configured to enable car-to-car communication between the two hearing devices **100**A and **100**B, as well as communications with an external device (e.g., a smartphone or a digital music player).

A battery **110***a*, **110***b* or other power source (rechargeable or conventional) is provided within the enclosure **101***a*, **101***b* and is configured to provide power to the various components of the hearing devices **100**A and **100**B. The battery **110***a*, **110***b* is coupled to power management circuitry **111***a*, **111***b*, such as a power management integrated circuit (PMIC). The power management circuitry **111***a*, **111***b* is coupled to a charging interface **113***a*, **113***b*, which is configured to physically and electrically couple to a corresponding charging interface of a charging module. A speaker or receiver **108***a*, **108***b* is coupled to an amplifier (not shown) and the processor **102***a*, **102***b*. The speaker or receiver **108***a*, **108***b* is configured to generate sound which is communicated to the wearer's ear.

In some embodiments, the hearing devices **100**A and **100**B include a microphone **112***a*, **112***b* mounted on or inside the enclosure **101***a*, **101***b*. The microphone **112***a*, **112***b* may be a single microphone or multiple microphones, such as a microphone array. The microphone **112***a*, **112***b* can be coupled to a preamplifier (not shown), the output of which is coupled to the processor **102***a*, **102***b*. The microphone **112***a*, **112***b* receives sound waves from the environment and converts the sound into an input signal. The input signal is amplified by the preamplifier and sampled and digitized by an analog-to-digital converter of the processor **102***a*, **102***b*, resulting in a digitized input signal. In some embodiments (e.g., hearing aids), the processor **102***a*, **102***b* (e.g., DSP circuitry) is configured to process the digitized input signal into an output signal in a manner that compensates for the wearer's hearing loss. When receiving an audio signal from an external source, the wireless transceiver **104***a*, **104***b* may produce a second input signal for the DSP circuitry of the processor **102***a*, **102***b* that may be combined with the input signal produced by the microphone **112***a*, **112***b* or used in place thereof. In other embodiments, (e.g., hearables), the processor **102***a*, **102***b* can be configured to process the digitized input signal into an output signal in a manner that is tailored or optimized for the wearer (e.g., based on wearer preferences). The output signal is then passed to an audio output stage that drives the speaker or receiver **108***a*, **108***b*, which converts the output signal into an audio output.

Some embodiments are directed to a custom hearing aid, such as an ITC, CIC, or IIC hearing aid, for example. For example, some embodiments are directed to a custom hearing aid which includes a wireless transceiver and an antenna arrangement configured to operate in the 2.4 GHz ISM frequency band (referred to as the "Bluetooth® band" herein). FIGS. **2**A and **2**B illustrate a custom hearing aid system which includes two hearing devices, e.g., left **201***a* and right **201***b* side hearing devices, configured to wirelessly communicate with each other and external devices and systems. FIG. **2**A conceptually illustrates functional blocks of the hearing devices **201***a*, **201***b*. The position of the functional blocks in FIG. **2**A does not necessarily indicate actual locations of components that implement these functional blocks within the hearing devices **201***a*, **201***b*. FIG. **2**B is a block diagram of components that may be disposed at least partially within the enclosure **205***a*, **205***b* of the hearing device **201***a*, **201***b*.

Each hearing device **201***a*, **201***b* includes a physical enclosure **205***a*, **205***b* that encloses an internal volume. The enclosure **205***a*, **205***b* is configured for at least partial insertion within the wearer's ear canal. The enclosure **205***a*, **205***b* includes an external side **202***a*, **202***b* that faces away from the wearer and an internal side **203***a*, **203***b* that is inserted in the car canal. The enclosure **205***a*, **205***b* comprises a shell **206***a*, **206***b* and a faceplate **207***a*, **207***b*. The faceplate **207***a*, **207***b* may include a battery door **208***a*, **208***b* or drawer disposed near the external side **202***a*, **202***b* of the enclosure **205***a*, **205***b* and configured to allow the battery **240***a*, **240***b* to be inserted and removed from the enclosure **205***a*, **205***b*. An antenna **220***a*, **220***b* can be mounted to the faceplate **207***a*, **207***b* or elsewhere in the enclosure **205***a*, **205***b*. The antenna arrangement **220***a*, **220***b* can include a matching circuit that compensates for a smaller size antenna which allows the antenna arrangement **220***a*, **220***b* to fit within a customized device, such as a device that fits partially or fully within the car canal of the wearer. The matching circuit can be designed so that the power transfer from the transceiver of the electronics **230***a*, **230***b* to the antenna arrangement **220***a*, **220***b*, provides a specified antenna efficiency, e.g., an optimal antenna efficiency for the customized environment.

The battery **240***a*, **240***b* powers electronic circuitry **230***a*, **230***b* which is also disposed within the shell **206***a*, **206***b*. As illustrated in FIGS. **2**A and **2**B, the hearing device **201***a*, **201***b* may include one or more microphones **251***a*, **251***b* configured to pick up acoustic signals and to transduce the acoustic signals into microphone electrical signals. The electrical signals generated by the microphones **251***a*, **251***b* may be conditioned by an analog front end **231** (see FIG. **2**B) by filtering, amplifying and/or converting the microphone electrical signals from analog to digital signals so that the digital signals can be further processed and/or analyzed by the processor **260**. The processor **260** may perform signal processing and/or control various tasks of the hearing device **201***a*, **201***b*. In some implementations, the processor **260** comprises a DSP that may include additional computational processing units operating in a multi-core architecture.

The processor **260** is configured to control wireless communication between the hearing devices **201***a*, **201***b* and/or an external accessory device (e.g., a smartphone, a digital music player) via the antenna **220***a*, **220***b*. The wireless communication may include, for example, audio streaming data and/or control signals. The electronic circuitry **230***a*, **230***b* of the hearing device **201***a*, **201***b* includes a transceiver **232**. The transceiver **232** has a receiver portion that receives communication signals from the antenna arrangement **220***a*, **220***b*, demodulates the communication signals, and transfers the signals to the processor **260** for further processing. The transceiver **232** also includes a transmitter portion that modulates output signals from the processor **260** for transmission via the antenna arrangement **220***a*, **220***b*. Electrical signals from the microphone **251***a*, **251***b* and/or wireless communication received via the antenna **220***a*, **220***b* may be processed by the processor **260** and converted to acoustic signals played to the wearer's ear **299** via a speaker **252***a*, **252***b*.

The battery **240***a*, **240***b* is of a rechargeable type, such as a lithium-ion battery for example. Power management circuitry **241***a*, **241***b* (e.g., a PMIC) is operatively coupled to the battery **240***a*, **240***b* and to a charging interface **243***a*, **243***b*. The charging interface **243***a*, **243***b* is configured to

physically and electrically couple to a corresponding charging interface of a charging module.

The use of rechargeable batteries in hearing devices (e.g., hearing aids) has been well-received in the marketplace. Self-contained batteries require electrical contacts for recharging. One complication of contact charging is the difficulty of placing a relatively small hearing device in a charger. Traditional approaches for charging hearing devices often require the wearer to fiddle with the hearing device to achieve the proper connection for charging. There is a need to provide a connection arrangement that allows the wearer to properly attach the hearing device to the charging fixture of the charger with relative case.

Contact charging requires two electrical connections, namely, an anode (positive) connection and a cathode (negative) connection. When placing a hearing device into a charging fixture, it can be advantageous to connect the cathodes prior to connecting the anodes. For example, connecting the cathodes of the hearing devices and the charging fixture prior to connecting the anodes can serve to provide a consistent inrush current waveform when coupling the hearing devices and charger fixture together. Provision of a consistent inrush current waveform from the charger to the hearing devices informs the charging circuitry of the charger that the hearing devices are properly attached to the proper charging fixture and that a charging procedure can be initiated. If the hearing devices are properly connected to the charging fixture, full charging power can be supplied by the charging fixture to the hearing devices. If one or both of the hearing devices are not properly connected to the charging fixture, charging through the improper connection can be disabled. This can protect against the presence of foreign objects (e.g., keys, coins, other hearing devices) that can be intentionally or unintentionally introduced into the charging fixture. In some implementations, connecting the cathodes of the hearing devices and charger fixture prior to connecting the anodes can serve to establish a ground, which can reduce or minimize spurious electrical spikes in the circuitry.

A system comprising a charging module and at least one hearing device in accordance with any of the embodiments disclosed herein provides a number of technical advantages over conventional charging arrangements. As discussed above, a charging system according to any of the embodiments disclosed herein facilitates connection between charger and hearing device cathodes prior to connection between anodes, which provides for a consistent inrush current waveform when coupling the hearing devices and charger fixture together. A charging system according to any of the embodiments disclosed herein provides enhanced detection of incorrect placement of hearing devices and/or presence of foreign conductive objects at the charging interface, which results in disabling of charging through the improper connection. A charging system according to any of the embodiments disclosed herein significantly reduces or minimizes spurious electrical spikes in the circuitry, by ensuring that the cathodes of the hearing devices and charger fixture are connected prior to connecting the anodes.

Embodiments of the disclosure are defined in the claims. However, below there is provided a non-exhaustive listing of non-limiting examples. Any one or more of the features of these examples may be combined with any one or more features of another example, embodiment, or aspect described herein.

Example Ex1. A system comprising at least one hearing device configured to be worn at, in or on an ear of a wearer, the hearing device comprising a rechargeable power source, power management circuitry, and a first charging interface comprising a first cathode contact and a first anode contact spaced apart from the first cathode contact. A charging module comprises a second charging interface configured to detachably couple with the first charging interface of the hearing device, the second charging interface comprising a second anode contact having a contact surface and a displaceable second cathode contact; an arrangement configured to displace at least a portion of the second cathode contact above the contact surface to facilitate electrical contact between the first and second cathode contacts prior to electrical contact between the first and second anode contacts; and charging circuitry coupled to the second charging interface and configured to charge the rechargeable power source of the hearing device.

Example Ex2. The system according to Ex1, wherein the second charging interface comprises a through-hole, and the second cathode contact is displaceable within the through-hole; and the displacement arrangement comprises a biasing arrangement configured to bias at least a portion of the second cathode contact above the contact surface.

Example Ex3. The system according to Ex2, wherein the second cathode contact comprises an elongated electrode; and the biasing arrangement comprises a spring.

Example Ex4. The system according to Ex2 or Ex3, wherein the second cathode contact and the biasing arrangement define a spring-loaded pogo pin assembly.

Example Ex5. The system according to one or more of Ex1 to Ex4 comprising a retention arrangement disposed on one or both of the hearing device and the charging module, the retention arrangement configured to maintain engagement between the first and second charging interfaces during charging of the rechargeable power source of the hearing device.

Example Ex6. The system according to Ex5, wherein the retention arrangement comprises one or more magnets or a mechanical retention arrangement.

Example Ex7. The system according to one or more of Ex1 to Ex6, wherein the first anode contact is configured to communicate power and one or more disparate information signals, the second anode contact is configured to communicate power and the one or more disparate information signals, and the first and second anode contacts are configured to communicate power and the one or more disparate information signals between the charging module and the hearing device.

Example Ex8. The system according to Ex7, wherein the one or more disparate information signals comprise one or more of data signals generated by one or both of the charging module and the hearing device, audio signals generated by one or both of the charging module and the hearing device, and signals received from one or more accessory devices configured to communicatively couple to one or both of the charging module and the hearing device.

Example Ex9. The system according to one or more of Ex1 to Ex8, wherein the first and second anode contacts comprise electrodes having a curvilinear, annular, oval, elliptical or polygonal shape.

Example Ex10. The system according to one or more of Ex1 to Ex9, wherein the first anode contact comprises a plurality of electrode elements, and the first cathode contact is surrounded by the plurality of electrode elements of the first anode contact.

Example Ex11. The system according to Ex10, wherein the second anode contact comprises a plurality of electrode elements, and the second cathode contact is surrounded by the plurality of electrode elements of the second anode contact.

Example Ex12. The system according to Ex10 or Ex11, wherein one of both of the plurality of electrodes of the first anode contact are substantially equidistant from the first cathode contact, and the plurality of electrodes of the second anode contact are substantially equidistant from the second cathode contact.

Example Ex13. The system according to Ex 10 or Ex 11, wherein one of both of the plurality of electrodes of the first anode contact are arranged in a substantially triangular pattern relative to the first cathode contact, and the plurality of electrodes of the second anode contact are arranged in a substantially triangular pattern relative to the second cathode contact.

Example Ex14. The system according to one or more of Ex1 to Ex13, wherein the hearing device comprises an in-the-ear (ITE), in-the-canal (ITC), invisible-in-canal (IIC) or completely-in-the-canal (CIC) device comprising a housing having a preformed or formable shape that conforms to a shape of the wearer's ear canal.

Example Ex15. The system according to one or more of Ex1 to Ex14, wherein the charging circuitry is configured to charge the rechargeable power source of the hearing device at an accelerated charge rate above 1.0 C when a state of charge (SoC) of the rechargeable power sources is within a predetermined SoC range.

FIG. **3** illustrates a system in accordance with any of the embodiments disclosed herein. FIG. **3** shows a cross-sectional view of a portion of an ear-worn electronic hearing device **302** and a portion of a charging module **322**. The components of the hearing device **302** shown in FIG. **3** are disposed in or on a housing configured to be worn at, in or on an ear of a wearer. The hearing device **302** includes a rechargeable power source **304** (e.g., a lithium-ion battery) coupled to power management circuitry **306** (e.g., a PMIC). The power management circuitry **306** is coupled to a first charging interface **310** comprising a first cathode contact **312** and a first anode contact **314** spaced apart from the first cathode contact **312**. In the embodiment shown in FIG. **3**, the power management circuitry **306** is coupled to the first cathode contact **312** via a first connection **307** and to the first anode contact **314** via a second connection **309**. The first anode contact **314** can comprise a single contact or a multiplicity of contacts coupled to the second connection **309**.

The charging module **322** includes a second charging interface **330** configured to detachably couple (e.g., mechanically and electrically) with the first charging interface **310** of the hearing device **302**. The second charging interface **330** includes a second anode contact **334** having a contact surface **335** and a displaceable second cathode contact **332**. The charging module **322** includes charging circuitry **326** coupled to the second charging interface **330** and a power source **324**. The power source **324** can be configured to receive power from a standard wall outlet and/or can include a rechargeable or a conventional battery. In some embodiments, the power source **324** can be configured to receive wireless power from an external power source (e.g., inductive, radiofrequency, optical). For example, the power source **324** can be configured to implement inductive charging in accordance with the Qi open interface standard developed by the Wireless Power Consortium. In the embodiment shown in FIG. **3**, the charging circuitry **326** is coupled to the second cathode contact **332** via a connection **337** and to the second anode contact **334** via a second connection **339**. The second anode contact **334** can comprise a single contact or a multiplicity of contacts coupled to the second connection **339**.

The second cathode contact **332** is configured for displacement between a first position **331***a* above the contact surface **335** of the second anode contact **334** and a second position **331***b* at or below the contact surface **335** of the second anode contact **334**. In some configurations, the second cathode contact **332** can be configured for displacement between the first position **331***a* above the contact surface **335** and a second position **331***b* above the contact surface **335** but below the first position **331***a*.

When the hearing device **302** and the charging module **322** are in a non-contacting relationship, such as shown in FIG. **3**, the second cathode contact **332** is positioned at the first position **331***a* above the contact surface **335** of the second anode contact **334**. When the hearing device **302** and the charging module **322** are in a contacting relationship, the second cathode contact **332** is movable from the first position **331***a* to the second position **331***b* and establishes electrical contact with the first cathode contact **312** prior to electrical contact being established between the second anode contact **334** and the first anode contact **314**.

More particularly, when the hearing device **302** and the charging module **322** are brought into contact with one another, the second cathode contact **332** positioned at the first position **331***a* establishes electrical contact with the first cathode contact **312** of the hearing device **302** prior to electrical contact being established between the first and second anode contacts **314**, **334**. After first establishing electrical contact between the first and second cathode contacts **312**, **332**, the second cathode contact **332** is displaced into the body of the charging module **322** as the hearing device **302** is forcibly advanced onto the charging module **322**. After displacing the second cathode into the body of the charging module **322** partially or entirely, electrical contact is then established between the first and second anode contacts **314**, **334**.

The charging module **322** includes an arrangement (shown in other figures) configured to displace at least a portion of the second cathode contact **332** above the contact surface **335** to facilitate electrical contact between the first and second cathode contacts **312**, **332** prior to electrical contact between the first and second anode contacts **314**, **334**. The charging module **322** can also include a retention arrangement (shown in other figures) configured to maintain engagement between the first and second charging interfaces **310**, **330** during charging of the rechargeable power source **304** of the hearing device **302**. In some embodiments, the retention arrangement can comprise one or more magnets disposed at or near one or both of the first and second charging interfaces **310**, **330**. In other embodiments, the retention arrangement can comprise a mechanical retention arrangement configured to mechanically maintain engagement between the first and second charging interfaces **310**, **330**.

FIG. **4** illustrates a system in accordance with any of the embodiments disclosed herein. FIG. **4** shows a cross-sectional view of a portion of an ear-worn electronic hearing device **402** and a portion of a charging module **422**. The components of the hearing device **402** shown in FIG. **4** are disposed in or on a housing configured to be worn at, in or on an ear of a wearer. The hearing device **402** includes a rechargeable power source **404** (e.g., a lithium-ion battery) coupled to power management circuitry **406** (e.g., a PMIC). The power management circuitry **406** is coupled to a first charging interface **410**. In the embodiment shown in FIG. **4**, the first charging interface **410** comprises a first cathode contact **412** and a multiplicity of anode contacts, **414**, **416**. In the illustrative example shown in FIG. **4**, the first charging

interface **410** includes two anode contacts **414**, **416**, it being understood that the first charging interface **410** can include more than two spaced-apart anode contacts (e.g., 3, 4, 5 or 6 anode contacts).

In the embodiment shown in FIG. **4**, the power management circuitry **406** is coupled to the first cathode contact **412** via a first connection **407** and to the first and second anode contacts **414**, **416** via separate connections. As shown, the power management circuitry **406** is coupled to the first anode contact **414** via a connection **409** and to the second anode contact **416** via a connection **411**. It is understood that each physically separate anode contact of the first charging interface **410** can be coupled to the power management circuitry **406** via a separate electrical conductor. It is also understood that, in some configurations, the first charging interface **410** can include anode contacts coupled to the power management circuitry **406** via separate connections in combination with two or more anode contacts coupled to the power management circuitry **406** via a common connection.

The charging module **422** includes a second charging interface **430** configured to detachably couple (e.g., mechanically and electrically) with the first charging interface **410** of the hearing device **402**. The charging module **422** includes charging circuitry **426** coupled to the second charging interface **430** and a power source **424**. The power source **424** can be configured to receive power from a standard wall outlet and/or can include a rechargeable or a conventional battery. In some embodiments, the power source **424** can be configured to receive wireless power from an external power source (e.g., inductive, radiofrequency, optical). For example, the power source **424** can be configured to implement inductive charging in accordance with the Qi open interface standard developed by the Wireless Power Consortium. The second charging interface **430** includes a second cathode contact **432** and a multiplicity of anode contacts **434**, **436**. In the embodiment shown in FIG. **4**, the second cathode contact **432** is fixed in terms of its position on the charging module **422**. In this regard, the second cathode contact **432** shown in FIG. **4** it is not a displaceable cathode contact. However, it is understood that, in a variant embodiment of FIG. **4**, the second cathode contact **432** can be implemented as a displaceable cathode contact in the manner illustrated and described with reference to FIG. **3**.

In the illustrative example shown in FIG. **4**, the second charging interface **430** includes two anode contacts **434**, **436**, it being understood that the second charging interface **430** can include more than two spaced-apart anode contacts (e.g., 3, 4, 5 or 6 anode contacts). The number of anode contacts of the second charging interface **430** may or may not be equal to the number of anode contacts of the first charging interface **410**. In the embodiment shown in FIG. **4**, the charging circuitry **426** is coupled to the second cathode contact **432** via a connection **437** and to the first and second anode contacts **434**, **436** via separate connections. More particularly, the first anode contact **434** is coupled to the charging circuitry **426** via connection **439**, and the second anode contact **436** is coupled to the charging circuitry **426** via connection **441**.

The charging module **422** can include a retention arrangement (shown in other figures) configured to maintain engagement between the first and second charging interfaces **410**, **430** during charging of the rechargeable power source **404** of the hearing device **402**. In some embodiments, the retention arrangement can comprise one or more magnets disposed at or near one or both of the first and second charging interfaces **410**, **430**. In other embodiments, the retention arrangement can comprise a mechanical retention arrangement configured to mechanically maintain engagement between the first and second charging interfaces **410**, **430**.

Provision of electrically separate anode contacts at the first and second charging interfaces **410**, **430** provides for the communication of power and one or more disparate information signals between the charging module **422** and the hearing device **402**. For example, charging of the rechargeable power supply **404** can be accomplished via first and second cathode contacts **412**, **432** and anode contacts **414**, **434**. Data signals generated by one or both of the charging module **422** and the hearing device **402** can be communicated via anode contacts **416**, **436**. Although referred to as anode contacts generally, it is understood that the contacts of the first and second charging interfaces **410**, **430** that are used for communicating information signals can be any form of electrical contact. Various types of disparate information signals can be communicated between respective pairs of anode contacts of the first and second charging interfaces **410**, **430**. The disparate forms of information signals can include state of charge and charging status data, control or command signals, audio signals, video signals, and signals from one or more accessory devices (e.g., smartphone, tablet, wearable sensor) configured to communicatively couple to one or both of the hearing device **402** and charging module **422**.

FIG. **5** illustrates a charging interface in accordance with any of the embodiments disclosed herein. The charging interface **500** shown in FIG. **5** includes a cathode contact **502**, which is typically coupled to a negative contact charging connection **506**. The charging interface **500** also includes an anode contact **504**, which is typically coupled to a positive contact charging connection **508**. In the embodiment shown in FIG. **5**, the cathode contact **502** is surrounded by the anode contact **504**, which has a continuous annular configuration.

In some embodiments, the hearing device and the charging module can have a charging interface that generally corresponds to the charging interface **500** shown in FIG. **5**. When implemented on a hearing device, for example, a region of the cathode contact **502** (e.g., central region) can be recessed relative to a contact surface of the anode contact **504** (see, e.g., FIGS. **9** and **12**). When implemented on a charging module, and according to some embodiments, the cathode contact **502** can be displaceable (see, e.g., FIGS. **3**, **10**, and **11**) and proud relative to a contact surface of the anode contact **504**. In other embodiments, the cathode contact **502** is a fixed electrical element (non-displaceable) and need not be proud relative to a contact surface of the anode contact **504**. Although shown as having a generally circular shape, the cathode and anode contacts **502**, **504** can have any curvilinear or polygonal shape.

FIG. **6** illustrates a charging interface in accordance with any of the embodiments disclosed herein. The charging interface **600** shown in FIG. **6** includes a cathode contact **602**, which is typically coupled to a negative contact charging connection **606**. The charging interface **600** also includes an anode contact **604**, which is typically coupled to a positive contact charging connection **608**. In the embodiment shown in FIG. **6**, the anode contact **604** comprises a multiplicity of electrode elements **604***a*, **604***b*, **604***c*, each of which is coupled to connection **608**. The anode contact **604** has a concentric tri-trace anode configuration. As shown, the cathode contact **602** is surrounded by the concentric tri-trace anode **604** comprising arcuate electrode elements **604***a*, **604***b*, **604***c*. The arcuate electrode elements **604***a*, **604***b*, **604***c* are situated at substantially the same radius (e.g., ~4-5

mm) relative to the cathode contact **602** (e.g., ~2-3 mm diameter). Although three arcuate electrode elements are shown in FIG. **6**, the concentric anode **604** can comprise two, four, five or more electrode elements, for example.

In some embodiments, the hearing device and the charging module can have a charging interface that generally corresponds to the charging interface **600** shown in FIG. **6**. When implemented on a hearing device, and in accordance with some embodiments, a region of the cathode contact **602** (e.g., central region) can be recessed relative to a contact surface of the anode contact **604** (see, e.g., FIGS. **9** and **12**). When implemented on a charging module, for example, the cathode contact **602** can be displaceable (see, e.g., FIGS. **10** and **11**) and proud relative to a contact surface of the anode contact **604**. Although shown as having a generally circular or arcuate shape, the cathode and anode contacts **602**, **604** can have any curvilinear or polygonal shape.

It is understood that the charging interface of the hearing device and that of the charging module can be substantially the same or different in configuration. For example, and in accordance with some embodiments, the charging module can have a charging interface corresponding to the charging interface **500** shown in FIG. **5** (cathode contact surrounded by an annular anode contact). In such embodiments, the hearing device can have a charging interface corresponding to the charging interface **600** shown in FIG. **6** (cathode contact surrounded by tri-trace anode contact).

FIG. **7** illustrates a charging interface in accordance with any of the embodiments disclosed herein. The charging interface **700** shown in FIG. **7** includes a cathode contact **702** surrounded by a multiplicity of anode elements **704***a*, **704***b*, **704***c*. In the embodiment shown in FIG. **7**, the cathode contact **702** and anode elements **704***a*, **704***b*, **704***c* have a polygonal shape. For example, the cathode contact **702** has a generally square shape, and each of the anode elements **704***a*, **704***b*, **704***c* has a generally rectangular shape. It is understood that a charging interface can include cathode and anode contact elements having the same or different curvilinear or polygonal shape.

FIG. **8**A illustrates a charging interface in accordance with any of the embodiments disclosed herein. The charging interface **800** shown in FIG. **8**A includes a cathode contact **802**, which is typically coupled to a negative contact charging connection **806**. The charging interface **800** also includes an anode contact **804**, which comprising a contact element typically coupled to a positive contact charging connection **808**. In the embodiment shown in FIG. **8**A, the anode contact **804** has a concentric tri-trace anode configuration comprising a multiplicity of electrode elements **804***a*, **804***b*, **804***c*. As shown, the cathode contact **802** is surrounded by the concentric tri-trace anode **804** comprising individual arcuate electrode elements **804***a*, **804***b*, **804***c*. The arcuate electrode elements **804***a*, **804***b*, **804***c* are situated at substantially the same radius relative to the cathode contact **802**. Although three arcuate electrode elements are shown in FIG. **8**A, the concentric anode **804** can comprise two, four, five or more electrode elements, for example.

According to various embodiments, a hearing device and a charging module incorporate the charging interface **800** shown in FIG. **8**A. Each of the electrode elements of the anode contact **804** is coupled to a separate electrical connection. More particularly, electrode element **804***a* is coupled to connection **810**, electrode element **804***b* is coupled to connection **808**, and electrode element **804***c* is coupled to connection **812**. Electrode element **804***b* represents an anode contact of the charging interface **800**. The electrode element **804***b* and the cathode contact **802** are configured to communicate power produced by the charging module when charging the rechargeable power source of the hearing device. Disparate information signals (e.g., signals S_1 and S_2) can be communicated between the hearing device and the charging module via electrode elements **804***a*, **804***c* and connections **810**, **812**. For example, signals S_1 can constitute data signals (e.g., state of charge and charging status data signals) and signals S_2 can constitute control signals generated by the charging module and/or the hearing device.

When implemented on a hearing device, and in accordance with some embodiments, a region of the cathode contact **802** (e.g., central region) can be recessed relative to a contact surface of the anode contact **804** (see, e.g., FIGS. **9** and **12**). Alternatively, the cathode contact **802** and the anode contact **804** can be substantially coplanar. When implemented on a charging module, and in accordance with some embodiments, the cathode contact **802** is a fixed electrical element (non-displaceable) and need not be proud relative to a contact surface of the anode contact **804**. In accordance with other embodiments, the cathode contact **802** can be displaceable (see, e.g., FIGS. **10** and **11**) and proud relative to a contact surface of the anode contact **804**. Although shown as having a generally circular or arcuate shape, the cathode and anode contacts **802**, **804** can have any curvilinear or polygonal shape.

FIG. **8**B illustrates a charging interface in accordance with any of the embodiments disclosed herein. The charging interface **820** shown in FIG. **8**B includes an arrangement of electrodes **824** comprising at least one cathode contact **824***a* and at least one anode contact **824***b*. The electrode arrangement **824** can include additional electrodes, such as electrode **824***c*, which can be a cathode contact or an anode contact. It is understood that the electrodes of the arrangement **824** can be configured as cathode or anode contacts, as long as the arrangement of electrodes **824** includes at least one cathode contact and at least one anode contact. A data contact **822** is shown surrounded by electrodes of the electrode arrangement **824**. In the representative embodiment shown in FIG. **8**B, the electrode arrangement **824** has a concentric tri-trace electrode configuration comprising contacts **824***a*, **824***b*, **824***c*, which surround data contact **822**. In some embodiments, the electrode arrangement **824** includes two arcuate electrodes, such as cathode contact **824***a* and anode contact **824***b*, which can be spaced apart from one another in the manner shown in FIG. **14**D, for example. The arcuate electrode elements **824***a*, **824***b*, **824***c* are situated at substantially the same radius relative to the data contact **822**. Although three arcuate electrode elements are shown in FIG. **8**B, the electrode arrangement **824** can comprise two, four, five or more electrode elements, for example.

According to various embodiments, a hearing device and a charging module incorporate the charging interface **820** shown in FIG. **8**B. Cathode contact **824***a* is typically coupled to a negative contact charging connection **830**, and anode contact **824***b* is typically coupled to a positive contact charging connection **828**. Electrical contact **824***c* can be coupled to either a negative or a positive charging connection **832**. The electrode arrangement **824** is configured to communicate power produced by the charging module when charging the rechargeable power source of the hearing device. One or more information signals can be communicated between the hearing device and the charging module via data contact **822** via signal connection **826**. For example, these information signals can constitute data signals (e.g.,

state of charge and charging status data signals) and control signals generated by the charging module and/or the hearing device.

FIG. **8**C illustrates a charging interface in accordance with any of the embodiments disclosed herein. The charging interface **840***a* shown in FIG. **8**C includes a cathode contact **842**, which is typically coupled to a negative contact charging connection **846**. The charging interface **840***a* also includes an anode contact **844**, which is typically coupled to a positive contact charging connection **848**. In the embodiment shown in FIG. **8**C, the anode contact **844** comprises a multiplicity of electrode elements **844***a*, **844***b*, **844***c*, each of which is coupled to connection **848**. The anode contact **844** has a triangular configuration, and is arranged to surround the cathode contact **842**. The triangular anode contact **844** includes three electrode elements **844***a*, **844***b*, **844***c* each having a generally curvilinear shape. In some embodiments, the electrode elements **844***a*, **844***b*, **844***c* have a closed curved shape comprising only curved lines (e.g., no line segments). For example, the electrode elements **844***a*, **844***b*, **844***c* can have a non-polygonal shape (e.g., a geometric shape that does not conform to the definition of a polygon). Representative examples of electrode elements **844***a*, **844***b*, **844***c* having a generally curvilinear shape include those having a generally round (e.g., circular) shape, an elliptical shape, and an oval shape. It is understood that the electrode elements **844***a*, **844***b*, **844***c* can also have an arbitrary closed curvilinear shape (e.g., a meandering shape) and/or a closed curvilinear shape comprising predominately curved lines (e.g., a minor percentage (≤10-20%) of line segments).

The electrode elements **844***a*, **844***b*, **844***c* can be situated at substantially the same distance (e.g., ~2-6 mm, ~4-5 mm, ~3-5 mm) relative to the cathode contact **842**. The cathode contact **842** can have a diameter of about 1.5 mm to about 3 mm, and the electrode elements **844***a*, **844***b*, **844***c* can have the same or smaller diameter (e.g., about 1 mm to about 2.5 mm). Although three electrode elements **844***a*, **844***b*, **844***c* are shown in FIG. **8**C, the anode contact **844** can comprise one, two, four, five or more electrode elements, for example, arranged in a substantially triangular shape. Also, although the electrode elements **842**, **844***a*, **844***b*, **844***c* are shown having the same general shape in FIG. **8**C (and other figures), it is understood that the electrode elements **842**, **844***a*, **844***b*, **844***c* can have different shapes. For example, the electrode elements **842**, **844***a*, **844***b*, **844***c* can have different curvilinear shapes or any combination of generally curvilinear shapes and generally rectilinear shapes.

When implemented on a hearing device, and in accordance with some embodiments, a region of the cathode contact **842** (e.g., central region) can be recessed relative to a contact surface of the anode contact **844** (see, e.g., FIGS. **9** and **12**). Alternatively, the cathode contact **842** and the anode contact **844** can be substantially coplanar. When implemented on a charging module, and in accordance with some embodiments, the cathode contact **842** is a fixed electrical element (non-displaceable) and need not be proud relative to a contact surface of the anode contact **844**. In accordance with other embodiments, the cathode contact **842** can be displaceable (see, e.g., FIGS. **10** and **11**) and proud relative to a contact surface of the anode contact **844**.

FIG. **8**D illustrates a charging interface in accordance with any of the embodiments disclosed herein. The charging interface **840***b* shown in FIG. **8**D includes a cathode contact **842**, which is typically coupled to a negative contact charging connection **846**. The charging interface **840***b* also includes an anode contact **844**, which is typically coupled to a positive contact charging connection **848**. In the embodiment shown in FIG. **8**D, the anode contact **844** has a triangular anode configuration comprising a multiplicity of electrode elements **844***a*, **844***b*, **844***c*. As shown, the cathode contact **842** is surrounded by the triangular anode **844** comprising individual electrode elements **844***a*, **844***b*, **844***c*. The electrode elements **844***a*, **844***b*, **844***c* are situated at substantially the same distance relative to the cathode contact **842**. Although three electrode elements **844***a*, **844***b*, **844***c* are shown in FIG. **8**D, the anode contact **844** can comprise one, two, four, five or more electrode elements, for example, arranged in a generally triangular shape. The electrode elements **842**, **844***a*, **844***b*, **844***c* can have a generally curvilinear shape or other shapes and/or combination of shapes discussed above with reference to FIG. **8**C.

According to various embodiments, a hearing device and a charging module can incorporate the charging interface **840***b* shown in FIG. **8**D. Each of the electrode elements of the anode contact **844** is coupled to a separate electrical connection. More particularly, electrode element **844***a* is coupled to connection **850**, electrode element **844***b* is coupled to connection **848**, and electrode element **844***c* is coupled to connection **852**. Electrode element **844***b* represents an anode contact of the charging interface **840***b*. The electrode element **844***b* and the cathode contact **842** are configured to communicate power produced by the charging module when charging the rechargeable power source of the hearing device. Disparate information signals (e.g., signals S_1 and S_2) can be communicated between the hearing device and the charging module via electrode elements **844***a*, **844***c* and connections **850**, **852**. For example, signals S_1 can constitute data signals (e.g., state of charge and charging status data signals) and signals S_2 can constitute control signals generated by the charging module and/or the hearing device.

FIG. **8**E illustrates a charging interface in accordance with any of the embodiments disclosed herein. The charging interface **840***c* shown in FIG. **8**E includes an arrangement of electrodes **844** comprising at least one cathode contact **844***a* and at least one anode contact **844***b*. The electrode arrangement **844** can include additional electrodes, such as electrode **844***c*, which can be a cathode contact or an anode contact. It is understood that any of the electrodes of the arrangement **844** can be configured as cathode or anode contacts, as long as the arrangement of electrodes **844** includes at least one cathode contact and at least one anode contact. A data contact **842** is shown surrounded by electrodes of the electrode arrangement **844**. The electrode elements **842**, **844***a*, **844***b*, **844***c* can have a generally curvilinear shape or other shapes and/or combination of shapes discussed above with reference to FIG. **8**C.

In the representative embodiment shown in FIG. **8**E, the electrode arrangement **844** has a generally triangular configuration comprising contacts **844***a*, **844***b*, **844***c*, which surround data contact **842**. In some embodiments, the electrode arrangement **844** can include two electrodes, such as cathode contact **844***a* and anode contact **844***b*, which are shaped to generally form a triangular pattern and can be spaced apart (e.g., equidistantly) from the data contact **842**. The electrode elements **844***a*, **844***b*, **844***c* can be situated at substantially the same distance relative to the data contact **842**. Although three curvilinear shaped electrode elements **844***a*, **844***b*, **844***c* are shown surrounding the central data contact **842** in FIG. **8**E, the electrode arrangement **844** can comprise one, two, four, five or more curvilinear shaped electrode elements that having a generally triangular pattern and surround the data contact **842**.

According to various embodiments, a hearing device and a charging module can incorporate the charging interface **840***c* shown in FIG. **8**E. Cathode contact **844***a* is typically coupled to a negative contact charging connection **850**, and anode contact **844***b* is typically coupled to a positive contact charging connection **848**. Electrical contact **844***c* can be coupled to either a negative or a positive charging connection **852**. The electrode arrangement **844** is configured to communicate power produced by the charging module when charging the rechargeable power source of the hearing device. One or more information signals can be communicated between the hearing device and the charging module via data contact **842** and signal connection **846**. For example, these information signals can constitute data signals (e.g., state of charge and charging status data signals) and control signals generated by the charging module and/or the hearing device.

When implemented on a hearing device, and in accordance with either of the embodiments shown in FIGS. **8**D and **8**E, a region of the central contact **842** (e.g., central region) can be recessed relative to a contact surface of the peripheral contacts **844***a*, **844***b*, **844***c* (see, e.g., FIGS. **9** and **12**). Alternatively, the central contact **842** and the peripheral contacts **844***a*, **844***b*, **844***c* can be substantially coplanar. In accordance with either of the embodiments shown in FIGS. **8**D and **8**E (and other embodiments shown in other figures), when implemented on a hearing device, a region of the central contact **842** (e.g., central region) can be elevated relative to a contact surface of the peripheral contacts **844***a*, **844***b*, **844***c*.

FIGS. **8**F-**8**I illustrate a custom hearing device (e.g., a custom hearing aid) in accordance with any of the embodiments disclosed herein. The hearing device **860** shown in FIGS. **8**F-**8**I is configured to be worn at least partially within the ear canal of a wearer's ear. The hearing device **860** is representative of any type of ITE hearing aid, such as an ITC, IIC or CIC hearing aid, for example. The hearing device **860** includes a faceplate **862** and a shell **864** connected to the shell **864**. The shell **864** houses the electronic and electrical components of the hearing device **860**, such as those previously described. The shell **864** is typically shaped to conform to a particular wearer's ear canal using a mold taken from the wearer's ear. In some configurations, the shell **864** can be constructed from semi-soft material (e.g., polymeric material) which can conform to the shape of the wearer's ear canal when the shell **864** is inserted therein. The faceplate **862** includes a charging interface **840***d* and other components/structures of the hearing device **860**, such as one or two microphones **866**.

The charging interface **840***d* disposed on the faceplate **862** comprises a central contact **842** surrounded by three peripheral contacts **844***a*, **844***b*, **844***c* arranged in a substantially triangular pattern. The peripheral contacts **844***a*, **844***b*, **844***c* can be situated at substantially the same distance (e.g., ~2-5 mm, ~4-5 mm, ~3-4 mm) relative to the central contact **842**. The central contact **842** can have a diameter of about 2 mm to about 3 mm, and the peripheral contacts **844***a*, **844***b*, **844***c* can have the same or smaller diameter (e.g., about 1 mm to about 2.5 mm, ~1.5-2 mm).

The charging interface **840***d* can be representative of any of the charging interfaces discussed herein. For example, charging interface **840***d* can be configured and wired in the manner of charging interface **840***a* shown in FIG. **8**C. In this representative configuration, the charging interface **840***d* includes a central cathode contact **842**, coupled to a negative charging connection, and three anode contacts **844***a*, **844***b*, **844***c*, each coupled to a positive charging connection. The anode contacts **844***a*, **844***b*, **844***c* are arranged in a substantially triangular pattern and surround the cathode contact **842**. The contacts **842**, **844***a*, **844***b*, **844***c* can have a generally curvilinear shape or other shapes and/or combination of shapes discussed above with reference to FIG. **8**C.

According to another example embodiment, the charging interface **840***d* can be configured and wired in the manner of charging interface **840***b* shown in FIG. **8**D. In this representative configuration, central contact **842** is configured as a cathode contact and peripheral contact **844***b* is an anode contact of the charging interface **840***d*. Central cathode contact **842** and peripheral anode contact **844***b* are configured to communicate power produced by a charging module when charging the rechargeable power source of the hearing device **860**. Disparate information signals (e.g., signals S_1 and S_2) can be communicated between the hearing device **860** and the charging module via peripheral contacts **844***a*, **844***c*. For example, signals S_1 can constitute data signals (e.g., state of charge and charging status data signals) and signals S_2 can constitute control signals generated by the charging module and/or the hearing device **860**.

According to another example embodiment, the charging interface **840***d* can be configured and wired in the manner of charging interface **840***c* shown in FIG. **8**E. In this representative configuration, the charging interface **840***d* includes at least one cathode contact **844***a* and at least one anode contact **844***b*. Electrode **844***c* can be configured as a cathode contact or an anode contact (or a separate signal communicating contact). A central data contact **842** can be surrounded by contacts **844***a*, **844***b*, **844***c* arranged in a substantially triangular pattern. The contacts **842**, **844***a*, **844***b*, **844***c* can have a generally curvilinear shape or other shapes and/or combination of shapes discussed above with reference to FIG. **8**C.

In accordance with any of the embodiments shown in FIGS. **8**F-**8**I, a region of the charging interface **840***d* which includes the central contact **842** (e.g., central region) can be recessed relative to a contact surface of the peripheral contacts **844***a*, **844***b*, **844***c* (see, e.g., FIGS. **9** and **12**). Alternatively, the central contact **842** and the peripheral contacts **844***a*, **844***b*, **844***c* can be substantially coplanar. In accordance with alternative embodiments, the central region of the charging interface **840***d* which includes the central contact **842** can be elevated relative to a contact surface of the peripheral contacts **844***a*, **844***b*, **844***c*. In accordance with any of the embodiments disclosed herein, the peripheral contacts **844***a*, **844***b*, **844***c* can be surrounded by a peripheral wall having a height greater than that of an exposed surface of peripheral contacts **844***a*, **844***b*, **844***c*.

FIG. **8**J illustrates a charging interface of a hearing device in accordance with any of the embodiments disclosed herein. The charging interface **870** shown in FIG. **8**J includes an arrangement of peripheral electrodes **874** comprising at least one cathode contact **874***a* and at least one anode contact **874***b*. The peripheral electrode arrangement **874** can include additional electrodes, such as electrode **874***c*, which can be an anode contact or a cathode contact. A data contact **872** is shown surrounded by electrodes of the electrode arrangement **874**. In the representative embodiment shown in FIG. **8**J, each of the peripheral electrodes **874***a*, **874***b*, **874***c* and the data contact **872** has a generally curvilinear shape (e.g., rounded, circular, elliptical, oval).

The charging interface **870** is coupled to poly-phase rectification circuitry disposed in the housing of the hearing device, which is illustrated as a 3-phase rectifier **890** in FIG. **8**J. Contacts **874***a*, **874***b*, and **874***c* are coupled to the 3-phase rectifier **890** via charging connections **880**, **878**, and **882**, respectively. The electrode arrangement **874** is config-

ured to communicate power produced by the charging module when charging the rechargeable power source of the hearing device. In the embodiment shown in FIG. **8**J, power is contained within the concentric electrode arrangement **874**. Using this electrode configuration, if at least one contact of the electrode arrangement **874** is connected to ground (GND) and at least one other contact of the electrode arrangement **874** is connected to power (PWR), then the 3-phase rectifier **890** will supply the correct polarity with the correct voltage.

The charging interface **870** of the hearing device is configured to establish electrical connection with a charging interface **891** of a charging module, an example of which is shown in FIG. **8**K. The charging interface **870** of the hearing device includes at least two contacts **874***a*, **874***b* which serve as cathode and anode contacts. The two contacts **896**, **898** of the charging module's charging interface **891** are configured and arranged so that each contact **896**, **898** electrically connects with only one of the three contacts **874***a*, **874***b*, **874***c* of the hearing device's charging interface **870**. This arrangement ensures that anode and cathode contacts of the hearing device electrically connect with respective anode and cathode contacts of the charging module. In FIG. **8**K, the contacts **896**, **898** of the charging module's charging interface **891** are shown as having an arcuate shape. The contacts **896**, **898** may alternatively have a curvilinear shape, a rectilinear shape, or other shape.

One or more information signals can be communicated between the hearing device and the charging module via data contact **872** and signal connection **876**. For example, these information signals can constitute data signals (e.g., state of charge and charging status data signals) and control signals generated by the charging module and/or the hearing device. One or more disparate signals can be communicated over data contact **872** using a sequential or multiplexing data transmission technique (e.g., time-division multiplexing, frequency-division multiplexing, code-division multiplexing).

FIG. **9** is a cross-sectional view of a portion of a hearing device in accordance with any of the embodiments disclosed herein. The portion of the hearing device **900** shown in FIG. **9** includes a charging interface **902** incorporated on the shell or housing **904** of the hearing device **900**. The charging interface **902** is situated at or near an exterior surface of the housing **904**. For example, the charging interface **902** can be situated on a faceplate of an in-the-car type hearing device (e.g., ITE, ITC, IIC, CIC device). In the case of an on-the-car type hearing device (e.g., BTE, RIC, RITE device), for example, the charging interface **902** can be situated at or near a bottom or top end surface of the housing **902**. The charging interface **902** is configured to physically and electrically coupled to a corresponding charging interface of a charging module (see, e.g., FIGS. **3**, **4**, **10**, and **11**).

The charging interface **902** includes a cathode contact **906** partially or entirely surrounded by an anode contact **908**. The anode contact **908** can be a single electrical contact or comprise a multiplicity of electrical contacts (see, e.g., FIGS. **3**-**8**). For example, the anode contact **908** can comprise a single annular electrical contact or two or more arcuate electrical contacts (e.g., a concentric tri-trace anode configuration). The cathode contact **906** is shown extending slightly beyond the exterior surface of the housing **904** relative to the anode contact **908**, which is shown as substantially coplanar with the exterior surface of the housing **904**. In some implementations, the cathode contact **906** can be substantially coplanar with exterior surface of the housing **904**. The cathode contact **906** can include a recessed region **907**, which is typically situated within a central region of the cathode contact **906**. The recessed region **907** serves to guide a corresponding cathode contact of a charging module into proper contact with the cathode contact **906**.

In the embodiment shown in FIG. **9**, the hearing device **900** includes a retention arrangement **910**. The retention arrangement **910** is configured to maintain engagement between the charging interface **902** and a corresponding charging interface of a charging module during charging of a rechargeable power source of the hearing device **900**. The retention arrangement **910** includes a magnet **911** or magnetizable structure which can interact with a corresponding magnet or magnetizable structure of the charging module. In some embodiments, the anode contact **908** partially or entirely comprises magnetic material, in which case the separate magnet **911** or magnetizable structure need not be included in the retention arrangement **910**.

FIG. **10** is a cross-sectional view of a portion of a charging module in accordance with any of the embodiments disclosed herein. The portion of the charging module **1000** shown in FIG. **10** includes a charging interface **1002** disposed on a charging surface **1004** of the charging module **1000**. The charging interface **1002** is configured to physically and electrically coupled to a corresponding charging interface of a hearing device (see, e.g., FIGS. **3**, **4**, **9**, and **12**). The charging interface **1002** includes a cathode contact **1006** partially or entirely surrounded by an anode contact **1008**. The anode contact **1008** can be a single electrical contact or comprise a multiplicity of electrical contacts (see, e.g., FIGS. **3**-**8**). For example, the anode contact **1008** can comprise a single annular electrical contact or two or more arcuate electrical contacts (e.g., a concentric tri-trace anode configuration).

The charging interface **1002** includes a through-hole **1012** within which the cathode contact **1006** is disposed. The cathode contact **1006** is displaceable within the through-hole **1012**. A biasing arrangement **1014** is configured to bias at least a portion **1006***a* of the cathode contact **1006** above a contact surface **1009** of the anode contact **1008**. As such, the cathode contact **1006** is proud relative to the anode contact **1008** prior to engagement with a corresponding charging interface of a hearing device. The biasing arrangement **1014** is configured to bias at least the portion **1006***a* of the cathode contact **1006** above the contact surface **1009** to facilitate electrical contact between the cathode contact **1006** and a corresponding cathode contact of a hearing device prior to electrical contact between the anode contact **1008** and corresponding anode contact of the hearing device.

According to some embodiments, the cathode contact **1006** comprises an elongated electrode, and the biasing arrangement **1014** comprises a spring **1016**. In some embodiments, the cathode contact **1006** and biasing arrangement **1014** define a spring-loaded pogo pin assembly. The pogo pin assembly **1014** includes a center post pogo pin **1006** which is seated into the housing of the charging module **1000** via pogo housing **1018**. The pogo housing **1018** contains a pogo spring **1016** and a pogo endstop **1019**.

The charging module **1000** also includes a retention arrangement **1020** configured to maintain engagement between the charging interface **1002** and a corresponding charging interface of a hearing device during charging of a rechargeable power source of the hearing device. The retention arrangement **1020** includes a magnet **1022** or magnetizable structure which can interact with a corresponding magnet or magnetizable structure of the hearing device. In some embodiments, the anode contact **1008** partially or entirely comprises magnetic material, in which case the

separate magnet **1022** or magnetizable structure need not be included in the retention arrangement **1020**. In some embodiments, the anode contact **1008** can be implemented as a ring magnet plated with electrically conductive material. The ring magnet provides attraction to a different magnet or magnetizable structure in the hearing device in order to align the electrical contacts. The plating provides corrosion resistance.

FIGS. **11** and **12** illustrate a system in accordance with any of the embodiments disclosed herein. The system includes a hearing aid **1202** (FIG. **12**) configured to be worn at least partially within the ear canal of a wearer's ear. The hearing aid **1202** is representative of any type of ITE hearing aid, such as an ITC, IIC or CIC hearing aid, for example. The hearing aid **1202** includes a charging interface **1204** comprising a cathode contact **1206** surrounded by an anode contact **1208**. Although shown as a concentric tri-trace anode in FIG. **12**, the anode contact **1208** can be configured as a single electrode element or a multiplicity of electrode elements. The charging interface **1204** is disposed on a faceplate **1203** of the hearing aid **1202**.

FIG. **11** shows a charging module **1122** which can be installed in, or be integral to, a charging fixture. The charging module **1122** includes a charging interface **1124** which includes a displaceable central cathode contact **1126** surrounded by a concentric anode contact **1128**. The displaceable central cathode contact **1126** can be implemented as a spring-loaded elongated electrode, such as that shown in FIG. **10** (e.g., a spring-loaded pogo pin assembly). It is understood that a charging fixture will typically include two of the charging modules **1122** configured to charge two of the hearing aids **1202**.

FIG. **13** is a schematic showing electrical components of a system in accordance with any of the embodiments disclosed herein. The schematic of system **1300** includes electrical components of a hearing device **1302** and electrical components of a charging module **1320**. The hearing device **1302** includes a rechargeable power source **1304**, such as a lithium-ion battery. The rechargeable power source **1304** is coupled to power management circuitry **1306**, such as a PMIC. The power management circuitry **1306** is coupled to an anode contact R**3** and a cathode contact R**6**. The anode contact R**3** and cathode contact R**6** of the hearing device **1302** can have a configuration and functionality described previously.

The charging module **1320** includes a power source V, which is represented as a battery in FIG. **13**. The power source V can include a rechargeable battery, a conventional battery, and/or an AC/DC converter configured to receive power from a standard wall outlet. In some embodiments, the power source V can be configured to receive wireless power from an external power source (e.g., Qi, inductive, radiofrequency, optical). The charging module impedance is represented by R**1**, which is shown coupled to an anode contact R**2** via anode switch S**1**. Resistor R**4** represents a pulldown resistor for current sensing. Resistor R**4** is coupled to a cathode contact R**5** via cathode switch S**2**. The anode contact R**2** and cathode contact R**5** of the charging module **1320** can have a configuration and functionality described previously. In some embodiments, the charging module **1320** is not configured to control anode switch S**1** and cathode switch S**2** independently, so mechanically ensuring a ground (GND) contact first provides for a more accurate and consistent inrush current profile as previously discussed.

FIG. **14**A is a schematic showing electrical components of a system in accordance with any of the embodiments disclosed herein. The schematic of system **1400** includes electrical components of a hearing device **1402** and electrical components of a charging module **1420**. The hearing device **1402** includes a rechargeable power source **1404**, such as a lithium-ion battery. The rechargeable power source **1404** is coupled to power management circuitry **1406**, such as a PMIC. The power management circuitry **1406** is coupled to a rectifier **1408**. The rectifier **1408** is coupled to a contact arrangement **1410** comprising a cathode contact, at least one anode contact, and one or more electrical contacts configured to communicate information signals between the hearing device **1402** and the charging module **1420**. The rectifier **1408** can be implemented as an N-phase rectifier, where N is equal to the number of electrical contacts of the contact arrangement **1410**.

Any of contacts R**3**, R**6**, and R**7** of the hearing device **1402** can be configured as an anode contact or a cathode contact. Any of contacts R**3**, R**6**, and R**7** can be configured as an electrical contact configured to communicate information signals. In some embodiments, contacts R**3**, R**6**, and R**7** can be configured as split-ring pin connectors, with the center pin connector being used for data signal transmission and the other two connectors being used as cathode and anode contacts for charging. Other electrical contact configurations are contemplated. For example, and with reference to the embodiment shown in FIG. **14**B, the hearing device **1402** can include a charging interface **1403** comprising a central cathode pin R**7** surrounded by split-ring pin connectors R**3** and R**6**. One of connectors R**3** and R**6** is configured as an anode contact for charging, and the other of connectors R**3** and R**6** is configured as an electrical contact configured for data signal transmission. The contact arrangement **1410** of the hearing device **1402** can have a configuration and functionality described previously.

The charging module **1420** includes a power source V, which is represented as a battery in FIG. **14**. The power source V can include a rechargeable battery, a conventional battery, and/or an AC/DC converter configured to receive power from a standard wall outlet. In some embodiments, the power source V can be configured to receive wireless power from an external power source (e.g., Qi, inductive, radiofrequency, optical). The charging module impedance is represented by R**1**, which is shown coupled to an anode contact R**2** via anode switch S**1**. Resistor R**4** represents a pulldown resistor for current sensing. Resistor R**4** is coupled to a cathode contact R**5** via cathode switch S**2**. The anode contact R**2** and cathode contact R**5** of the charging module **1420** can have a configuration and functionality described previously. In some embodiments, the charging module **1420** is not configured to control anode switch S**1** and cathode switch S**2** independently, so mechanically ensuring a ground (GND) contact first provides for a more accurate inrush current profile as previously discussed.

In addition to providing anode and cathode contacts for charging, the hearing device **1402** and charging module **1420** include one or more additional electrical contacts for communicating information signals between the hearing device **1402** and charging module **1420**. For example, data can be communicated via one or more contacts, which can be split into multiple contacts each providing a separate connection for disparate signal transmission. The type of signal transmitted over each contact can be detected automatically by the charging module **1420**, which can reconfigure the charger connections in real time. For example, the charging module **1420** can include circuitry for detecting whether a particular contact is being used to transmit power and/or data, such as by detecting the pull-up strength of the contacts. In some embodiments, the charging module **1420**

can include circuitry configured to detect the connections by cycling through known protocol possibilities and using the one that works through a handshaking procedure.

FIG. **14**C illustrates a charging interface of a hearing device in accordance with any of the embodiments disclosed herein. The charging interface **1430** shown in FIG. **14**C includes an arrangement of electrodes **1434** comprising at least one cathode contact **1434***a* and at least one anode contact **1434***b*. The electrode arrangement **1434** can include additional electrodes, such as electrode **1434***c*, which can be an anode contact or a cathode contact. A data contact **1432** is shown surrounded by electrodes of the electrode arrangement **1434**. In the representative embodiment shown in FIG. **14**C, the electrode arrangement **1434** has a concentric tri-trace electrode configuration comprising contacts **1434***a*, **1434***b*, **1434***c*, which surround data contact **1432**. In some embodiments, the electrode arrangement **1434** includes two arcuate electrodes, such as cathode contact **1434***a* and anode contact **1434***b*, which can be spaced apart from one another (e.g., see FIG. **14**D). The arcuate electrode elements **1434***a*, **1434***b*, **1434***c* are situated at substantially the same radius relative to the data contact **1432**. Although three arcuate electrode elements are shown in FIG. **14**C, the electrode arrangement **1434** can comprise two, four, five or more electrode elements, for example.

The charging interface **1430** is coupled to poly-phase rectification circuitry, which is illustrated as a 3-phase rectifier **1450** in FIG. **14**C. Contacts **1434***a*, **1434***b*, and **1434***c* are coupled to the 3-phase rectifier **1450** via charging connections **1440**, **1438**, and **1442**, respectively. The electrode arrangement **1434** is configured to communicate power produced by the charging module when charging the rechargeable power source of the hearing device. In the embodiments shown in FIG. **14**C, power is contained within the concentric electrode arrangement **1434**. Using this electrode configuration, if at least one contact of the electrode arrangement **1434** is connected to ground (GND) and at least one other contact of the electrode arrangement **1434** is connected to power (PWR), then the 3-phase rectifier **1450** will supply the correct polarity with the correct voltage.

The charging interface **1430** is configured to establish electrical connection with a charging interface of a charging module, an example of which is shown in FIG. **14**D. The charging interface **1450** includes at least two contacts **1454**, **1456** which serve as anode and cathode contacts. The two contacts **1454**, **1456** of the charging module's charging interface **1450** are configured and arranged so that each contact **1454**, **1456** electrically connects with only one of the three contacts **1434***a*, **1434***b*, **1434***c* of the hearing device's charging interface **1430**. This arrangement ensures that anode and cathode contacts of the hearing device **1430** electrically connect with respective anode and cathode contacts of the charging module.

One or more information signals can be communicated between the hearing device and the charging module via data contact **1432** and signal connection **1436**. For example, these information signals can constitute data signals (e.g., state of charge and charging status data signals) and control signals generated by the charging module and/or the hearing device. One or more disparate signals can be communicated over data contact **1432** using a sequential or multiplexing data transmission technique (e.g., time-division multiplexing, frequency-division multiplexing, code-division multiplexing).

FIG. **15** illustrates a method of implementing accelerated charging of one or more hearing devices using a charging module in accordance with any of the embodiments disclosed herein. In the illustrative method shown in FIG. **15**, two ear-worn electronic devices are subject to accelerated charging via two charging modules provided on the charging fixture. The method shown in FIG. **15** involves establishing connection **1502** between first and second car-worn electronic devices and first and second charging modules of the charging fixture. The method involves determining **1504** the state of charge (SoC) of the rechargeable power sources of the ear-worn electronic devices. A check **1506** is made to determine if the SoC of the rechargeable power sources is within a predetermined SoC range (e.g., 5-35%). If the SoC of the rechargeable power sources fall within the predetermined SoC range, the method involves charging **1508** the rechargeable power sources at an accelerated charge rate above 1.0 C (e.g., 1.5 C-3.0 C). Accelerated charging continues while the SoC of the rechargeable power sources remain within the predetermined SoC range. Accelerated charging is discontinued when the SoC of the rechargeable power sources is beyond the predetermined SoC range. In some embodiments, accelerated charging is discontinued in response to expiration of a predetermined time limit (e.g., 15 minutes), reaching a predetermined voltage limit (e.g., 4.1V), or reaching a predetermined energy limit (e.g., 7.5 mAh).

At the termination of accelerated charging, the car-worn electronic devices may be removed from the charging modules of the charging fixture for immediate use. In some embodiments, five minutes of accelerated charging allows the ear worn electronic devices to be used for between 2 and 6 hours of normal operation. Rather than using the car worn electronic devices after termination of accelerated charging, the method can involve charging **1510** the rechargeable power sources at a normal charge rate at or below 1.0 C. A check **1512** is made to determine if rechargeable power sources are fully charged. If not, charging at the normal charge rate continues. When the rechargeable power sources are fully charged, the charging procedure is terminated **1514**. Accelerated charging can be implemented in accordance with the teachings disclosed in commonly-owned U.S. patent application Ser. No. 16/012,399 (Higgins et al.), filed on Jun. 19, 2018 and entitled PORTABLE CHARGING UNIT WITH ACCELERATED CHARGING FOR HEARING ASSISTANCE DEVICES, which is incorporated herein by reference.

FIG. **16** is a graph that characterizes accelerated charging of a lithium-ion battery of an car-worn electronic device in accordance with any of the embodiments disclosed herein. The graph of FIG. **16** characterizes battery voltage **1602** and charge current **1604** as a function of time during different phases of a charging procedure. As is indicated below the time axis, the different phases of the charging procedure include a pre-charge phase (A), an accelerated constant current charge phase (B), a constant voltage charge phase (D), and a charge complete phase (E). During the pre-charge phase (A), the charge current **1604** is low (e.g., 0.1 C) and the battery voltage **1602** slowly increases. It is noted that a well-designed system should stay out of this regime. The pre-charge phase (A) continues until the battery voltage **1602** reaches 3.0 V, at which time the accelerated constant current charge phase (B) is initiated.

During the accelerated charging phase (B), the charge current **1604** rapidly increases to a charge rate above 1.0 C, such as 1.5 C. During the accelerated charging phase (B), high current is supplied to the battery which results in a rapid increase in battery voltage **1602**. For example, a charge current of 5 mA can be supplied to the battery during the latter part of the pre-charge phase (A) (e.g., at 0.3 C). The

charge current can be increased to between 17 and 24 mA during the accelerated charging phase (B). The accelerated charging phase (B) continues until a predetermined time limit (e.g., 5-15 min) has been reached. In some embodiments, the accelerated charging phase (B) continues until a predetermined battery voltage **1602** (e.g., 4.1 V) or predetermined energy level (e.g., 7.5 mAh) has been reached.

At the conclusion of the accelerated charging phase (B), the charge current **1604** rapidly decreases to a normal charge current level (e.g., 5 mA at a charge rate of 0.3 C) at the initiation of the constant current charge phase (C). During the constant current charge phase (C), a normal charge current (e.g., 5 mA) is supplied to the battery resulting in a continued increase in the battery voltage **1602**. When the battery voltage **1602** reaches a predetermined level (e.g., 4.2 V), the charging procedure transitions from the constant current charge phase (C) to the constant voltage charge phase (D). During the constant voltage charge phase (D), the charge current **1604** decreases until a cutoff **1606** is reached, at which time the charging procedure is terminated. It is noted that at the charging complete phase (E), the battery voltage **1602** slightly drops over time (e.g., from 4.1 V to 3.9 V). In the embodiment shown in the FIG. **16**, the charge current **1604** supplied during the accelerated charging phase (B) changes in a step-wise fashion. It is understood that, in some embodiments, the charge current **1604** can decrease gradually as the accelerated charging phase (B) transitions to the constant current charge phase (C).

Although reference is made herein to the accompanying set of drawings that form part of this disclosure, one of at least ordinary skill in the art will appreciate that various adaptations and modifications of the embodiments described herein are within, or do not depart from, the scope of this disclosure. For example, aspects of the embodiments described herein may be combined in a variety of ways with each other. Therefore, it is to be understood that, within the scope of the appended claims, the claimed invention may be practiced other than as explicitly described herein.

All references and publications cited herein are expressly incorporated herein by reference in their entirety into this disclosure, except to the extent they may directly contradict this disclosure. Unless otherwise indicated, all numbers expressing feature sizes, amounts, and physical properties used in the specification and claims may be understood as being modified either by the term "exactly" or "about." Accordingly, unless indicated to the contrary, the numerical parameters set forth in the foregoing specification and attached claims are approximations that can vary depending upon the desired properties sought to be obtained by those skilled in the art utilizing the teachings disclosed herein or, for example, within typical ranges of experimental error.

The recitation of numerical ranges by endpoints includes all numbers subsumed within that range (e.g. 1 to 5 includes 1, 1.5, 2, 2.75, 3, 3.80, 4, and 5) and any range within that range. Herein, the terms "up to" or "no greater than" a number (e.g., up to 50) includes the number (e.g., 50), and the term "no less than" a number (e.g., no less than 5) includes the number (e.g., 5).

The terms "coupled" or "connected" refer to elements being attached to each other either directly (in direct contact with each other) or indirectly (having one or more elements between and attaching the two elements). Either term may be modified by "operatively" and "operably," which may be used interchangeably, to describe that the coupling or connection is configured to allow the components to interact to carry out at least some functionality (for example, a radio chip may be operably coupled to an antenna element to provide a radio frequency electromagnetic signal for wireless communication).

Terms related to orientation, such as "top," "bottom," "side," and "end," are used to describe relative positions of components and are not meant to limit the orientation of the embodiments contemplated. For example, an embodiment described as having a "top" and "bottom" also encompasses embodiments thereof rotated in various directions unless the content clearly dictates otherwise.

Reference to "one embodiment," "an embodiment," "certain embodiments," or "some embodiments," etc., means that a particular feature, configuration, composition, or characteristic described in connection with the embodiment is included in at least one embodiment of the disclosure. Thus, the appearances of such phrases in various places throughout are not necessarily referring to the same embodiment of the disclosure. Furthermore, the particular features, configurations, compositions, or characteristics may be combined in any suitable manner in one or more embodiments.

The words "preferred" and "preferably" refer to embodiments of the disclosure that may afford certain benefits, under certain circumstances. However, other embodiments may also be preferred, under the same or other circumstances. Furthermore, the recitation of one or more preferred embodiments does not imply that other embodiments are not useful and is not intended to exclude other embodiments from the scope of the disclosure.

As used in this specification and the appended claims, the singular forms "a," "an," and "the" encompass embodiments having plural referents, unless the content clearly dictates otherwise. As used in this specification and the appended claims, the term "or" is generally employed in its sense including "and/or" unless the content clearly dictates otherwise.

As used herein, "have," "having," "include," "including," "comprise," "comprising" or the like are used in their open-ended sense, and generally mean "including, but not limited to." It will be understood that "consisting essentially of," "consisting of," and the like are subsumed in "comprising," and the like. The term "and/or" means one or all of the listed elements or a combination of at least two of the listed elements.

The phrases "at least one of," "comprises at least one of," and "one or more of" followed by a list refers to any one of the items in the list and any combination of two or more items in the list.

What is claimed is:

1. A hearing device comprising:

a housing that encloses an internal volume and extends from an internal side to an external side, the housing comprising:

a shell arranged at the internal side, the internal side configured to be inserted in a wearer's ear canal; and

a faceplate arranged at the external side, the external side configured to face away from the wearer;

an electrode arrangement disposed in an outer surface of the faceplate, the electrode arrangement comprising:

a central contact; and

an annular ring contact surrounding the central contact or a plurality of contacts surrounding the central contact, wherein the central contact and the annular ring contact or the plurality of contacts form at least a portion of an exterior surface of the hearing device; and

circuitry disposed in the internal volume and coupled to the electrode arrangement.

2. The hearing device of claim **1**, further comprising one or more microphone ports disposed in the outer surface of the faceplate.

3. The hearing device of claim **1**, further comprising a receiver outlet disposed in the shell.

4. The hearing device of claim **1**, wherein the electrode arrangement comprises the plurality of contacts.

5. The hearing device of claim **4**, wherein each of the plurality of contacts is arranged the same distance from the central contact as each other contact of the plurality of contacts.

6. The hearing device of claim **4**, wherein the plurality of contacts defines a circle.

7. The hearing device of claim **4**, wherein each of the plurality of contacts comprises a curvilinear, annular, oval, elliptical, or polygonal shape.

8. The hearing device of claim **4**, wherein the plurality of contacts comprises three arcuate contacts each arranged at substantially the same distance from the central contact.

9. The hearing device of claim **4**, wherein the central contact defines a cathode contact and at least one contact of the plurality of contacts defines an anode contact.

10. The hearing device of claim **1**, wherein the electrode arrangement comprises the annular ring contact surrounding the central contact.

11. The hearing device of claim **1**, wherein the circuitry comprises charging circuitry, and wherein the electrode arrangement is coupled to the charging circuitry.

12. The hearing device of claim **1**, wherein the electrode arrangement is configured to communicate power and one or more information signals.

13. The hearing device of claim **1**, wherein the central contact comprises a central contact surface and the annular ring contact or the plurality of contacts comprises a contact surface, wherein one of the central contact surface and the contact surface of the annular ring contact or the plurality of contacts is recessed relative to the other.

14. A system comprising:

a hearing device comprising:

a housing that encloses an internal volume and extends from an internal side to an external side, the housing comprising:

a shell arranged at the internal side, the internal side configured to be inserted in a wearer's ear canal; and

a faceplate arranged at the external side, the external side configured to face away from the wearer;

an electrode arrangement disposed in an outer surface of the faceplate, the electrode arrangement comprising:

a central contact; and

an annular ring contact surrounding the central contact or a plurality of contacts surrounding the central contact, wherein the central contact and the annular ring contact or the plurality of contacts form at least a portion of an exterior surface of the hearing device; and

circuitry disposed in the internal volume and coupled to the electrode arrangement; and

a charging module comprising a charging interface that comprises:

a central charging contact; and

an annular ring charging contact or a plurality of charging contacts surrounding the central contact.

15. The system of claim **14**, wherein the hearing device further comprises:

one or more microphone ports disposed in the outer surface of the faceplate; and

a receiver outlet disposed in the shell.

16. The system of claim **14**, wherein the electrode arrangement of the hearing device comprises the plurality of contacts.

17. The system of claim **16**, wherein each of the plurality of contacts is arranged the same distance from the central contact as each other contact of the plurality of contacts.

18. The system of claim **16**, wherein the plurality of contacts defines a circle.

19. The system of claim **16**, wherein the plurality of contacts comprises three arcuate contacts each arranged at substantially the same distance from the central contact.

20. The system of claim **14**, wherein the electrode arrangement of the hearing device comprises the annular ring contact surrounding the central contact.

21. The system of claim **14**, wherein the hearing device comprises a first charging interface comprising the electrode arrangement, wherein the circuitry of the hearing device comprises charging circuitry coupled to the electrode arrangement, wherein the charging interface of the charging module defines a second charging interface configured to detachably couple with the first charging interface of the hearing device;

wherein the charging module further comprises charging circuitry coupled to the second charging interface and configured to charge a rechargeable power source of the hearing device that is coupled to the first charging interface.

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