and may use that identity to identify the second profile. For example, the sighting message may include metadata that indicates the sighting message was transmitted by a device within a certain retail store that has registered a profile with the central server. The operations in block 2874 may be similar to those described above with reference to determining whether a received sighting message relates to a registered service (e.g., the operations in determination block 1604).

[0385] In block 2876, the central server may identify authorized, relevant first profile information to share based on the permissions of the first profile and the assigned categories of the first and second profiles. The operations in block 2876 may be similar to the operations in blocks 2612, 2614, and 2660 with reference to FIG. 26B as described above. For example, the central server may find profile information having assigned categories within the first profile that matches assigned categories within the second profile.

[0386] In an embodiment, the central server may identify relevant, authorized first profile information based on public profile information within the second profile. The central server may only be enabled to match categories of information within the first profile with categories of information set as "public" within the second profile. For example, the central server may use the public information of "favorite sports team" within a second profile to match with the first profile, but not the second profile's private information of "religious affiliation." In this way, both parties and profiles may be secured from divulging private information.

[0387] In an embodiment, the central server may determine relevant information based on various characteristics stored within a profile. For example, the central server may identify food preferences from the first profile as relevant when the second profile includes profile information that indicates the user of the second profile is a waitress and/or affiliated with a restaurant. The central server may also determine relevance of profile information based on location information

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provided by the received sighting message. For example, the central server may determine the proximity broadcast receiver that transmitted the sighting message is within a restaurant based on metadata, and thus may combine that location information with profile information that indicates a waitress occupation to conclude that the user of the proximity broadcast receiver is a waitress on-duty within the restaurant.

[0388] In determination block 2878, the central server may determine whether there is any first profile information to share. In other words, the central server may determine whether any authorized and relevant information from the first profile was identified in the operations in block 2876. If there is first profile information is to be shared (i.e., determination block 2878 = "Yes"), in block 2880 the central server may transmit a message including the authorized first profile information to a device associated with the second profile. Such a device associated with the second profile may be a local server, proximity broadcast receiver, or mobile device that is indicated in the second profile as being an appropriate recipient for the first profile information. In various embodiments, such a device may be the proximity broadcast receiver that transmitted the received sighting message.

[0389] If no first profile information is to be shared (i.e., determination block 2878 = "No"), or if the message is transmitted in block 2880, in block 2882 the central server may identify authorized, relevant second profile information to share based on the permissions of the second profile and the assigned categories of the first and second profiles. The operations in block 2882 may be similar to the operations described above related to identifying authorized, relevant first profile information. In other words, the central server may compare assigned categories of the two profiles to identify relevant information of the second profile and check the second profile's permissions to determine whether any relevant information is authorized to be shared from the second profile.

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[0390] In determination block 2884, the central server may determine whether there is any second profile information to share. In other words, the central server may determine whether any authorized and relevant information from the second profile was identified in the operations in block 2882. If there is second profile information is to be shared (i.e., determination block 2884 = "Yes"), in block 2886 the central server may transmit a message including the authorized second profile information to a device associated with the first profile. For example, the central server may transmit an email, SMS text message, or other message to a mobile device associated with the first profile as described above with reference to FIG. 28B. The central server may continue with the operations in determination block 1402.

[0391] In another illustration, when authorized by permissions, the central server may transmit medical information from the first profile to a device associated with the second profile (or vice versa) when the second profile corresponds to a user with a medical background (e.g., doctor, EMT, nurse, etc.). Due to the sensitive nature of medical information, the central server may utilize other determinations before transmitting such medical information, such as whether an emergency is indicated (e.g., sensor data within the received sighting message indicates the user of the first profile is sick/injured) and/or whether the user of the second profile is on active duty and/or within a medical care facility (e.g., the nurse is on-duty and within a hospital geofence, etc.).

[0392] In an embodiment, the method 2870 may be performed by the central server to enable speed dating. Based on received sighting messages from one or both identity transceivers carried by speed dating participants, the central server may identify related profiles, match the identified profiles, and transmit messages to the participants when there is matching profile information. For example, the central server may compare the occupations indicated in two profiles to identify if they are similar, within the same field, or other measures of commonality. Alternatively, the central server may simply analyze the two profiles and return any public profile information that may be of interest to the participants. For

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example, if a user sets permissions to allow her salary range to be a public or shared piece of information, the central server may transmit a message indicating the salary to another participant.

[0393] FIGS. 29A-29B illustrate a second device 2902 (referred to as "Device B") sharing authorized profile information in response to receiving short-range signals from a first device 2901 (referred to as "Device A") within proximity. The first device 2901 and the second device 2902 may be mobile computing devices (e.g., smartphones, tablets, etc.) that are configured to perform operations of wireless identity transceivers and that are associated with various users, such as a customer, or alternatively a merchant, vendor, or business (e.g., Starbucks, etc.). Alternatively, either of the devices 2901, 2902 may be proximity broadcast receivers stationed within a place. For example, the first device 2901 may be a stationary identity transceiver collocated with a cash register in a coffee shop and the second device 2902 may be a mobile identity transceiver carried by a customer. The communications described in FIGS. 29A-B and the method described below with reference to FIG. 29C may be important as they permit relevant, public profile information stored on devices to be transmitted by devices when within proximity. However, as a central server may not be included with reference to FIGS. 29A-B, the shared information may be less secure, as broadcasting messages with public information may be received by any proximate devices and as no authentication (or verification) of the information or parties may be provided via the central server. Accordingly, profile information transmitted in various embodiments may only be non-sensitive data authorized for sharing to the public by users.

[0394] FIG. 29A shows the first device 2901 broadcasting a message 2904 that includes information related to the first device 2901. The message 2904 may include public profile information that the user of the first device 2901 has authorized as open for anyone to receive. For example, the message 2904 may include indications of the categories, topics of interest, or the businesses or services relevant to the user of the first device 2901, such as a coffee shop.

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When within proximity of the first device 2901, the second device 2902 may receive the message 2904 via a short-range transceiver, such as a Bluetooth® LE radio.

[0395] FIG. 29B shows the second device 2902 transmitting a response message 2914 that includes profile information related to the second device 2902. The response message 2914 may include public profile information the user of the second device 2902 has authorized as open for anyone to receive and that is relevant to the received message from the first device 2901. For example, the response message 2914 may include public information the user of the second device 2902 does not mind transmitting in the clear (i.e., authorized via permissions as 'public') and that is relevant based on matching information received from the first device 2901 with the profile stored on the second device 2902.

[0396] In an embodiment, the profile information within the response message 2914 may be normally set as private by the user of the second device 2902 and may only be transmitted when the received message from the first device 2901 includes certain information. For example, the second device 2902 may only transmit the response message 2914 when it receives a message from the first device 2901 that indicates the first device 2901 is associated with an emergency service (e.g., an EMT).

[0397] FIG. 29C is a process flow diagram of an embodiment method for a computing device to share authorized profile information in response to receiving short-range signals from a device within proximity. In various embodiments, the method 2950 may be performed by a mobile device, such as those described above with reference to FIGS. 29A-B. For example, the computing device may be a smartphone or an identity transceiver (e.g., a smartphone configured to transmit short-range signals as well as process incoming broadcast messages from proximate devices). Additionally, the method 2950 may be similar to the method described above with reference to FIG. 28C, except that the method 2950

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may only include operations for transmitting profile information from a single profile that is stored locally on the computing device.

[0398] In optional block 2952, the computing device may receive profile information from user interaction, such as inputs on a smartphone graphical user interface. For example, a user input may provide text or selections that indicate personal information, categories of information relevant to the user of the computing device, as well as permissions for the profile information (e.g., indicators of the public/private nature of particular pieces of information, whether certain third-parties may receive certain data, etc.). In optional block 2954, the computing device may download profile information from a central server. For example, the computing device may be configured to periodically download profile information associated with the user of the computing device as is currently stored in the central server. In other words, users may download their current profiles from the central server for use with software and services executing on the computing device (e.g., an app executing on a smartphone).

[0399] In block 2956, the computing device may store profile information locally, such as in a database within the computing device. The profile information may also include permissions as described above, such as indicators whether various pieces of the profile may be shared with certain categories of third-parties (e.g., public, private, only for sharing with "Tom's BBQ Restaurant," etc.). In an embodiment, the computing device may store the profile information such that the information is connected to or otherwise accessible to software executing on the computing device that is in communication with the central server. In determination block 2957, the computing device may determine whether a short-range wireless message is received from a proximate device, such as a broadcast message from a proximate wireless identity transmitter. In various embodiments, the short-range wireless message may be transmitted by a wireless identity transceiver or alternatively any device configured to broadcast signals in a protocol and format recognized by the computing device. If a message is not received (i.e., determination block 2957 =

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"No"), the computing device may continue with the operations in determination block 2957.

[0400] If a message is received (i.e., determination block 2957 = "Yes"), in block 2958 the computing device may identify categories based on an evaluation of the received message. In particular, the computing device may parse the received message to detect whether any profile information and/or descriptive indicators are within the received message. The computing device may evaluate metadata, header information, or other information appended to or within the received message. In an embodiment, the computing device may generate categories for information included in the received message, such as by performing natural language evaluation routines to determine the content or meaning of any data within the message. In block 2960, the computing device may identity relevant, authorized profile information to share based on stored profile permissions and the identified categories. In other words, the computing device may match the identified categories related to the received message with the locally stored profile information to find relevant information, and may use stored permissions to identify any of such relevant information that may be shared. For example, in response to the computing device identifying that the received message includes information regarding a restaurant, the computing device may identify food-related profile information that has been authorized (or labeled) by the user to be public information. In determination block 2962, the computing device may determine whether there is profile information to share, such as profile information marked with a "public" permissions setting that also relates to the received message. If there is no profile information to share (i.e., determination block 2962 = "No"), the computing device may continue with the operations in determination block 702.

[0401] If there is profile information to share (i.e., determination block 2962 = "Yes"), in optional block 2964 the computing device may obscure authorized profile information based on instructions in the received message. In an embodiment, received messages may solicit response messages and may include

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instructions, such as encryption requests and transmissions scheduling, that the computing device may perform prior to transmitting the profile information. For example, the computing device may detect instructions which indicate a secret key that may be used to encrypt, encode, or otherwise obscure any authorized profile information such that only the device that transmitted the received message may access the profile information. In block 2966, the computing device may transmit a response message that includes the authorized profile information, and may continue with the operations in determination block 702.

[0402] FIGS. 30-32C describe the use of profile information to authenticate a payment. Payment authentication information may be information stored within a registered user's profile that may be used by other parties to facilitate and verify transactions. As described above, payment authentication information may include profile information stored within a central server that is associated with a user, such as photographic information (e.g., Facebook imagery, driver's license photo, previous security footage from store surveillance, etc.), audio samples of the user's voice, signature samples, customer account information, and purchase history information. Additionally, the payment authentication information may include financial and/or credit data to facilitate payment processes. For example, credit card numbers, social security data, addresses, email addresses, phone numbers, and other personal information may be included within the payment authentication information received at the point-of-sale device.

[0403] Once received from the central server, merchants, vendors, and other registered services may utilize payment authentication to expedite a purchase or customer service with a registered user. For example, a proximity broadcast receiver within a retail store may receive payment authentication for a proximate user and may display photographic information of the user for use by customer service agents. As another example, a point-of-sale device may receive and display a list of previous purchases by a user along with a message to a retail store's agent instructing him/her to go talk to the user.

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[0404] FIG. 30 illustrates an exemplary display 3090 of various payment authentication information on a local computing device within a retail store. As described below, the local computing device may be configured to receive return messages that include payment authentication information as stored within profiles and authorized by various permissions or other privacy settings corresponding to the profiles. The local computing device may be configured to operate as a point-of-sale device, such as a cash register or store kiosk. As described below, the local computing device configured to perform as a cash register may render payment authentication information on a display 3090, such as a computer screen viewed by store employees. For example, the local computing device may display information related to a restaurant or a food court area within the retail store.

[0405] For illustration purposes, the display 3090 may include a food items section 3096, a pricing section 3097, and a customer section 3091 that may include payment authentication information based on data within return messages received from the central server. In particular, the customer section 3091 of the display 3090 may include an in-line section 3092 that indicates customers (i.e., customers who are users registered with a central server) within proximity of the local computing device as well as an in-store section 3098 that indicates customers that are within the retail store but not within proximity of the local computing device. The display 3090 may indicate customer names 3093, customer photographs 3094, and even prior purchase information 3095, such as food items previously purchased by the various customers. Such displayed information may be used by store employees to identify and facilitate payments and customer interactions.

[0406] FIG. 31 describes an embodiment method 3100 for using wireless identity transmitters to improve experiences and services within a place (e.g., a retail store) by providing payment authentication information based on proximity of users to point-of-sale devices within the place. Additionally, the various methods may enable registered services (e.g., merchants) associated with the

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place to amass data based on broadcast messages that describes valuable foot traffic and other user information.

[0407] In general, as users walk around the retail store, they may pause to browse inventory, exit the retail store, and wait in particular areas of the retail store. For example, users may wait in line to pay for merchandise, return products, and/or receive user service assistance. In particular, users' wireless identity transmitters may transmit broadcast messages that are received by proximity broadcast receivers within the retail store. The central server may receive sighting messages from these proximity broadcast receivers and may determine whether a point-of-sale device is located near the users. If users are near point-of-sale devices, such as computing devices configured to perform as cash registers or user kiosks, the central server may transmit relevant, authorized payment authentication information for use in the retail store.

[0408] In block 3102, the central server may store profile information that may include permissions settings from a user. As described above, profile information, such as personal information (e.g., name, birth date, etc.) may be stored in databases or other data structures and may also include indicators of how, when, and/or to whom profile information may be shared. In determination block 1402, the central server may determine whether a sighting message is received. As described above, the sighting message may be transmitted by a proximity broadcast receiver located within the retail store. For example, as a user carrying a wireless identity transmitter walks within proximity of a point-of-sale device (e.g., a cash register device), a proximity broadcast receiver located within the point-of-sale device may receive broadcast messages from the wireless identity transmitter and transmit sighting messages to the central server based on the received broadcast messages. If the central server does not receive a sighting message (i.e., determination block 1402 = "No"), the central server may continue with the operations in determination block 1402.

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[0409] However, if the central server does receive a sighting message (i.e., determination block 1402 = "Yes"), in determination block 1602 the central server may determine whether a wireless identity transmitter identity is known based on the received sighting message. If the wireless identity transmitter identity is not known by the central server (i.e., determination block 1602 = "No"), in block 1603 the central server may ignore the sighting message and continue with the operations in determination block 1402. If the wireless identity transmitter identity is known by the central server (i.e., determination block 1602 = "Yes"), in determination block 1604 the central server may determine whether the sighting message is related to a registered service, such as the retail store. If the sighting message is not related to a registered service (i.e., determination block 1604 = "No"), the central server may continue with the operations in block 1603. If the sighting message is related to a registered service (i.e., determination block 1604 = "Yes"), in block 1414 the central server may store data based on the sighting message in relation to the wireless identity transmitter identity, such as by updating information within the user's profile. In another embodiment, the central server may also store data that may be used by the registered service (e.g., merchant, retail store, etc.) for generating foot traffic data. For example, the central server may use the received sighting message to update and/or modify information describing the number of unique users within the retail store at a given time, day, week, or month.

[0410] In determination block 3104, the central server may determine whether the wireless identity transmitter is near a point-of-sale device. For example, the central server may determine whether the wireless identity transmitter is within a few inches, feet, or meters of any computing device within the retail store that is used for performing sales transactions. In various embodiments, the retail store may include various proximity broadcast receivers that are placed throughout the retail store (e.g., around show floors, at the entrance, on shelves, etc.). The central server may store data that indicates the location of such stationary proximity broadcast receivers within the retail store and well as data that

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indicates the location of various known point-of-sale devices within the retail store. For example, the central server may maintain a database that describes the GPS coordinates and/or relative location information of all stationary proximity broadcast receivers and point-of-sale devices within the retail store. Since the wireless identity transmitter is within proximity of the proximity broadcast receiver associated with the received sighting message, the central server may compare a location (e.g., GPS coordinates) of the proximity broadcast receiver to stored location data of point-of-sale devices to determine whether the wireless identity transmitter is near a point-of-sale device. When the distance between the location of the proximity broadcast receiver and the location of a point-of-sale device is within a proximity threshold, the wireless identity transmitter may be considered near to (or within proximity of) the point-of-sale device.

[0411] In various embodiments, proximity broadcast receivers within the retail store may be positioned near (or collocated) and connected to point-of-sale devices. For example, a proximity broadcast receiver positioned on top of a point-of-sale device may transmit text and/or audio data received from the central server to the point-of-sale device for rendering. Alternatively, proximity broadcast receivers and point-of-sale devices may be within a common (or same) device. For example, a cash register point-of-sale device may include a short-range wireless transceiver configured to receive short-range broadcast messages from proximate wireless identity transmitters.

[0412] In various embodiments, the central server may utilize additional information when determining whether the wireless identity transmitter is near a point-of-sale device. In particular, the central server may estimate the position of the wireless identity transmitter as within a circular area of the proximity broadcast receiver that transmitted the sighting message. The circular area may have a radius equal to the wireless identity transmitter's average broadcast range. The central server may also evaluate signal strength information describing the broadcast message reported within the sighting message to determine more precise proximity information of the wireless identity transmitter. For example,

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based on known capabilities of the proximity broadcast receiver and the signal strength of the associated broadcast message, the central server may determine that the wireless identity transmitter was within a certain distance from the proximity broadcast receiver at the time of transmitting the broadcast message within the sighting message. In an embodiment, the central server may use received signal strength indication (or "RSSI") information from within the sighting message to determine approximate distance of the wireless identity transmitter to the proximity broadcast receiver. In another embodiment, the central server may also employ schematics or other floor plan or blueprint data of the retail store to determine more precise location information of the proximity broadcast receiver and thus the wireless identity transmitter. For example, the central server may determine that the wireless identity transmitter is located to the east or south side of the proximity broadcast receiver based on a floor plan that indicates the proximity broadcast receiver is surrounded by exterior walls to the north and west. In an embodiment, the central server may also perform the operations of the methods 1820 and/or 1860 described above to determine more precise proximity information for the wireless identity transmitter. For example, the central server may compare information within concurrent sighting messages to define a precise proximity of a wireless identity transmitter within the retail store.

[0413] If the central server determines the wireless identity transmitter is within proximity of server point-of-sale devices, such as a cluster or line of check-out terminals, the central server may identify a closest point-of-sale device based on signal strength information within the sighting message. For example, if the proximity broadcast receiver (and thus the wireless identity transmitter) is determined to be within the proximity threshold of more than one cash register devices within a store, the central server may determine the closest register device (or the device that is most likely to be the closest) as the device with the shortest distance to the proximity broadcast receiver's estimated location. When point-of-sale devices are proximity broadcast receivers, the central server may

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simply determine the closest point-of-sale device as the device related to a sighting message indicating the strongest signal strength. In another embodiment, the central server may utilize dead reckoning and other estimation routines or algorithms to determine whether the customer (and the wireless identity transmitter) may be near a point-of-sale device in the near future. For example, the central server may evaluate recent movement patterns of the customer to determine within a few seconds he/she may be in front of a product display.

[0414] Returning to FIG. 31A, if the wireless identity transmitter is not near a point-of-sale device (i.e., determination block 3104 = "No"), the central server may continue with the operations in determination block 1402. For example, the user may be located near an aisle that is within the retail store but not within proximity of a cash register, so payment authentication information is not likely needed yet. However, if the wireless identity transmitter is near a point-of-sale device (i.e., determination block 3104 = "Yes"), the wireless identity transmitter may be in a position indicating that the associated user is attempting to pay for an item (e.g., the user is waiting in a check-out line). Thus, in block 3105, the central server may identify payment authentication information from the user's profile that is relevant to the proximate point-of-sale device and that is authorized for sharing by the profile permissions. In general, the central server may perform operations as described above to match categories relevant to the retail store to profile information stored for the user associated with the wireless identity transmitter. In particular, the central server may identify the profile information that may be useful for purchases or other transactions relevant to the retail store. For example, when the retail store is a restaurant, the central server may identify food-related profile information, such as previous food products purchased at the retail store, as well as the payment methods used previously used by the user (e.g., a store rewards card, a credit card, cash, etc.). Further, the central server may only identify the payment authentication information that is authorized by the user based on the stored permissions defined within the user's profile. For

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example, when the user indicates the central server may not provide credit card information to any registered service, the central server may only be able to identify payment authentication information that includes the user's name and photo. In an embodiment, the identified payment authentication information may be based on the capabilities of the near point-of-sale device. For example, if the central server stores information indicating a cash register device is configured to only display text information, the identified payment authentication information may only include text information identifying the user and not visual or audible data (e.g., photo, sound file, etc.).

[0415] In block 3106, the central server may transmit a return message to the point-of-sale device that includes payment authentication information. For example, the point-of-sale device may be a computing device that is configured to receive return messages via Internet protocols from the central server. This return message may be used by the point-of-sale device to assist in a transaction between the retail store and the user. In an embodiment, the central server may generate a return message for transmission to a local computing device within the retail store which in turn may deliver payment authentication information to the point-of-sale device near the user. For example, the point-of-sale device may be a computing device that is configured to receive return messages routed from a retail store server. Once the payment authentication information is transmitted, the central server may continue with the operations in determination block 1402.

[0416] In another embodiment, the central server may perform the method 3100 in response to receiving a sighting message transmitted by a mobile proximity broadcast receiver carried by the user within the retail store. As described above, instead of deploying proximity broadcast receivers, a retail store may deploy wireless identity transmitters throughout the building, such as in departments or at check-out or payment lines. When a user's mobile proximity broadcast receiver (e.g., such as smartphone configured to execute software that can relay broadcast messages to the central server) is within proximity of one of the retail store's wireless identity transmitters, the mobile proximity broadcast receiver

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may receive a broadcast message and transmit a sighting message to the central server. In such a scenario, the central server may identify that the wireless identity transmitter is a store device and that the proximity broadcast receiver that transmitted the received sighting message belongs to the user (i.e., the user may be considered a "registered service" as referred to in FIG. 31). Further, the central server may determine whether the wireless identity transmitter is near a point-of-sale device by comparing stored locations of point-of-sale devices to either location information within the sighting message (e.g., via metadata indicating the GPS coordinates of the user's mobile proximity broadcast receiver) or a stored list of locations of the wireless identity transmitters within the retail store. For example, the central server may compare a known location within the retail store corresponding to the wireless identity transmitter indicated in the received sighting message to all stored locations of cash register devices within the retail store.

[0417] FIGS. 32A-32C illustrate embodiment methods 3200, 3250, and 3275 for a local computing device to utilize payment authentication information to facilitate transactions with a user within a retail store. As described above, the local computing device may be a retail store server, a point-of-sale device, proximity broadcast receiver, or other computing device within the retail store that is configured to utilize payment authentication information received from a central server. For example, the local computing device may be a point-of-sale device that is configured to be used by store agents when performing payment and other transaction operations with the user. In other embodiments, the local computing device may receive return messages from the central server and transmit payment authentication information to point-of-sale devices within the retail store. For example, the local computing device may be a local server that may transmit photographic information of a user to a cash register computing device at a payment area within the retail store.

[0418] FIG. 32A illustrates an embodiment method 3200 for a local computing device receiving payment authentication information from a central server. In

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determination block 1101, the local computing device may determine whether a return message is received from the central server. For example, the local computing device may monitor a buffer, message queue, communications port, etc. for incoming Internet protocol communications from the central server. If a return message is not received (i.e., determination block 1101 = "No"), the local computing device may continue with the operations in determination block 1101.

[0419] If a return message is received (i.e., determination block 1101 = "Yes"), in block 3202 the local computing device may parse the return message to detect data related to a user, such as identification and proximity (or location) information related to a user's wireless identity transmitter within the retail store. For example, the local computing device may evaluate the received return message and identify wireless identity transmitter identification information, a data segment that includes software instructions (e.g., firmware update instructions, etc.), and/or a data segment that contains payment authentication information associated with the user's profile stored on the central server. In an embodiment, the local computing device may also decode, decrypt, or otherwise access obscured data transmitted by the central server. For example, the local computing device and central server may share a secret code that may be used by the local computing device to decode contents of the return message.

[0420] In optional block 3203, the local computing device may store the data from the return message and/or sighting message in a local database. For example, payment authentication information for a particular user may be stored in the local computing device (e.g., a local store server) so that subsequent transactions may be more efficient without the need for the central server to retransmit the same data numerous times. In an embodiment, the local computing device may store data to generate statistical or historical information, as described above. For example, in addition to or in place of the central server accumulating data for foot traffic reports (e.g., the number of unique visitors to the retail store within a certain period, the duration of a particular user's dwelling within a certain area of the retail store, etc.), the local computing device may

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maintain similar statistical information. In an embodiment, the local computing device may be configured to only store data relevant to the particular store building, or alternatively, to interactions related to the local computing device itself. For example, when the local computing device is configured to operate as a proximity broadcast receiver and/or point-of-sale device, payment authentication information may be stored only when it relates to broadcast messages directly received by the local computing device.

[0421] In determination block 3204, the local computing device may determine whether the return message contains payment authentication data. For example, the local computing device may evaluate metadata associated with various data segments within the return message. In an embodiment, the return message may contain metadata and/or header information that indicates when payment authentication information is contained within the return message. For example, header information may include a code known by the local computing device to indicate the presence of payment authentication information. In an embodiment, the local computing device may determine whether imagery, credit card information, or other particular data types are contained within the return message and its data segments. For example, if the return message contains a photographic image of a face, or alternatively, facial characteristics data as generated by a facial recognition algorithm, the local computing device may determine that payment authentication information is contained within the return message. If the return message does not contain payment authentication information (i.e., determination block 3204 = "No"), the local computing device may continue with the operations in determination block 1101.

[0422] However, if the return message does contain payment authentication information (i.e., determination block 3204 = "Yes"), in block 3206 the local computing device may utilize the payment authentication information to assist in a transaction with the user. For example, the local computing device may display a picture of the user on a connected LCD screen so that a customer service agent using the local computing device may recognize the user waiting in line. In an

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embodiment, the local computing device may initiate software, applications, or routines based on receiving the payment authentication information. For example, upon receiving the return message, the local computing device may enter a transaction application and auto-fill data to represent the user's personal information. Additionally, the local computing device may transmit various messages to assist in the transaction based on the payment authentication information. For example, if the payment authentication information indicates the user is a preferred or rewards member, the local computing device may display a message for customer service representatives to make certain promotional offers and/or address the user in a particular manner (e.g., by name or by rewards zone experience or status indicators, etc.). As another example, the local computing device may instruct store agents by sending texts to employees, such as a manager or a particular sales rep, to come greet the user or try to conduct follow-up communications. After utilizing the payment authentication information, the local computing device may continue with the operations in determination block 1101.

[0423] FIG. 32B illustrates an embodiment method 3250 for a local computing device receiving sighting messages from a proximity broadcast receiver and receiving payment authentication information from a central server. The method 3250 is similar to method 3200 described above with reference to FIG. 32A, except that method 3250 includes operations for the local computing device to receive and transmit sighting messages from associated proximity broadcast receivers. For example, stationary proximity broadcast receivers within a retail store may receive broadcast messages from users' wireless identity transmitters and transmit sighting messages to the local computing device, which may serve as a router or communications path to the Internet and thus the central server.

[0424] In determination block 3252, the local computing device may determine whether a sighting message is received from a proximity broadcast receiver. If the local computing device does not receive a sighting message (i.e., determination block 3252 = "No"), the local computing device may continue

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with the operations in determination block 3252. However, if the local computing device receives a sighting message (i.e., determination block 3252 = "Yes"), in optional block 3254 the local computing device may append additional data to the sighting message. For example, the appended information may include data identifying the local computing device, such as a local server ID, relative location information within the store, a registered service code known by the central server, the store's name/address/ contact information, etc.). In block 3256, the local computing device may relay the sighting message (and any additional data) to the central server.

[0425] In determination block 1101, the local computing device may determine whether a return message has been received from the central server. If a return message is not received (i.e., determination block 1101 = "No"), the local computing device may continue to perform the operations in determination block 1101. In an alternative embodiment, if a return message is not received (i.e., determination block 1101 = "No"), the local computing device may continue to perform the operations in determination block 3252.

[0426] However, if a return message is received (i.e., determination block 1101 = "Yes"), in block 3202 the local computing device may parse the return message to detect data related to a user, and in optional block 3203, the local computing device may store the data from the return message and/or sighting message in a local database. In determination block 3204, the local computing device may determine whether the return message contains payment authentication data. If the return message does not contain payment authentication information (i.e., determination block 3204 = "No"), the local computing device may continue with the operations in determination block 3252. If the return message does contain payment authentication information (i.e., determination block 3204 = "Yes"), in block 3206 the local computing device may utilize the payment authentication information to assist in a transaction with the user, and may continue with the operations in determination block 3252.

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[0427] FIG. 32C illustrates an embodiment method 3275 for a local computing device associated with a retail store receiving payment authentication information from a central server. The method 3275 is similar to method 3200 described above with reference to FIG. 32A, except that method 3275 includes operations for the local computing device to determine whether the wireless identity transmitter is within proximity of a point-of-sale device. In other words, instead of the central server, the local computing device may perform operations to determine whether the wireless identity transmitter is near a point-of-sale device within the retail store. For example, the retail store may not provide location information of all point-of-sale devices within the store to the central server for storage, and thus may be required to determine to which cash registered computing device in the store a user's payment authentication information should be delivered.

[0428] In determination block 1101, the local computing device may determine whether a return message is received from the central server. If a return message is not received (i.e., determination block 1101 = "No"), the local computing device may continue with the operations in determination block 1101. If a return message is received (i.e., determination block 1101 = "Yes"), in block 3202 the local computing device may parse the return message to detect data related to a users, such as profile information related to the user's preferred payment methods and/or proximity information related to a user's wireless identity transmitter within the retail store. In optional block 3203, the local computing device may store the data from the return message. In determination block 3204, the local computing device may determine whether the return message contains payment authentication data. If the return message does not contain payment authentication information (i.e., determination block 3204 = "No"), the local computing device may continue with the operations in determination block 1101.

[0429] However, if the return message does contain payment authentication information (i.e., determination block 3204 = "Yes"), in block 3276 the local computing device may identify a proximity broadcast receiver within proximity

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of the user based on the return message. In other words, based on information within the return message (e.g., metadata, etc.) the local computing device may obtain the identifier (e.g., a unique code) of the proximity broadcast receiver that transmitted the sighting message reporting the user's wireless identity transmitter. For example, the return message may include data indicating that the return message was transmitted in response to receiving a sighting message from a particular proximity broadcast receiver within the retail store. In addition, the return message may include the identity of the wireless identity transmitter as well as the signal strength of the broadcast message related to the return message. In an embodiment, the return message may include the location information of the proximity broadcast receiver in addition to or instead of the proximity broadcast receiver identifier.

[0430] In determination block 3278, the local computing device may determine whether the proximity broadcast receiver is near a point-of-sale device. The operations in determination block 3278 may be similar to the operations in determination block 3104 described above with reference to FIG. 31. In particular, the local computing device may compare the location of the identified proximity broadcast receiver to locations of known point-of-sale devices within the retail store. For example, the local computing device may determine the distance between the identified proximity broadcast receiver's location information (as obtained from the return message or alternatively stored within a data table) to all known point-of-sale device locations within the retail store, and determine whether the shortest distance is within a proximity or distance threshold. In an embodiment, the local computing device may also use signal strength information (e.g., RSSI value) of broadcast messages indicated within the return message to determine an estimated distance from the proximity broadcast receiver (and the user's wireless identity transmitter) to the closest point-of-sale device.

[0431] In various embodiments, the proximity broadcast receivers of the retail store may be the same as the point-of-sale devices in the retail store. For

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example, the proximity broadcast receivers may all be cash register computing devices that are configured to receive and relay broadcast messages from users' wireless identity transmitters. In another embodiment, the proximity broadcast receiver related to the return message may be coincident with or the same as the local computing device. For example, the return message may correspond to a sighting message generated and transmitted by the local computing device.

[0432] If the proximity broadcast receiver is not near a point-of-sale device within the retail store (i.e., determination block 3278 = "No"), the local computing device may continue with the operations in determination block 1101. However, if the proximity broadcast receiver is near a point-of-sale device (i.e., determination block 3278 = "Yes"), in block 3206 the local computing device may utilize the payment authentication information to assist in a transaction with the user, as described above. In optional block 3280, the local computing device may transmit a message to a point-of-sale device with payment authentication. For example, based on the operations in blocks 3276-3278, the local computing device may identify a cash register computing device that is within proximity of the user and that is capable of presenting the user's payment authentication to customer service agents. The local computing device may then continue with the operations in determination block 1101.

[0433] FIG. 33A illustrates components of an exemplary wireless identity transmitter 110. The wireless identity transmitter 110 may include a microcontroller 3302, a short-range radio 3304 (e.g., a Bluetooth® radio or transceiver) coupled to an antenna 3306, a memory 3308, and a battery 3310. Although these components are shown linked by a common connection, they may be interconnected and configured in various ways. For example, a wireless identity transmitter 110 may be configured such that the microcontroller 3302 may determine when to transmit a message based on the contents of the memory 3308. In an embodiment, the microcontroller 3302 may be a Bluetooth® system-on-chip unit. The memory 3308 may also include one or more messages or message portions to be transmitted by the short-range radio 3304 via the antenna

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3306 based on commands from the microcontroller 3302. The battery 3310 may supply power as needed by the other components. Also, in some implementations the microcontroller 3302, the short-range radio 3304 and/or the memory 3308 may be integrated together as a single integrated circuit. Since these components may be microchips of standard or off-the-shelf configuration, they are represented in FIG. 33A as blocks consistent with the structure of an example embodiment.

[0434] The wireless identity transmitter 110 may be coupled with or built into various objects, such as a bracelet. For example, an exemplary wireless identity transmitter 110 may be in a form easily attached to a strap, such as a watchband or dog collar. Alternate embodiments may incorporate a wireless identity transmitter 110 into any other mobile objects that may need tracking.

[0435] The wireless identity transmitter 110 may conserve power by periodically entering a power saving mode or going to sleep, such as regularly alternating between sleeping and broadcasting of the packet with the wireless identity transmitter 110's identification code. Various embodiments may include different cycles of broadcasting and sleeping, such as some embodiments broadcasting more or less frequently, such as waking and broadcasting every few seconds or minutes between periods of sleep.

[0436] In an embodiment, the battery 3310 may be a replaceable coin cell battery. In another embodiment, the wireless identity transmitter 110 may utilize the antenna 3306 to receive update software, instructions, or other data for storage and use in configuration operations, such as configuring transmission intervals and/or transmissions power. The wireless identity transmitter 110 may also store and execute software, algorithms, instructions, code, or other routines for generating rolling codes or identifiers, as described above. In an embodiment, the wireless identity transmitter may not maintain time (e.g., UTC) information, but may instead use a 30 ppm 16 kHz crystal as a clock. Such use

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of a crystal as a clock may create a timing drift of approximately 40 seconds per year.

[0437] FIG. 33B illustrates components of an embodiment wireless identity transmitter 110. Similar to the embodiment described above with reference to FIG. 33A, the wireless identity transmitter 110 may include a microcontroller 3302, a short-range radio 3304 (e.g., Bluetooth®, BTLE, Zigbee®, Peanut®, etc.) connected to an antenna 3306 and coupled to the microcontroller 3302, memory 3308, and a battery unit 3310. Alternatively the memory 3308 may be contained within the microcontroller 3302, which may also include a separate processing unit. The short-range radio 3304 may be a transmitter capable of broadcasting messages or signals including a device ID or, alternatively, a transceiver configured to transmit and receive RF signals, enabling communications with other devices utilizing a communication protocol. For example, the wireless identity transmitter 110 may be configured to communicate with other short-range radio enabled devices, such as smartphones. In an embodiment, the short-range radio 3304 may be configured to communicate via various low-energy, wireless communication protocols, such as LTE-D, peer-to-peer LTE-D, and WiFi-Direct.

[0438] In an embodiment, the wireless identity transmitter 110 may include a speaker (not shown) configured to emit a sound capable of being received by a proximity broadcast receiver and/or being heard by a heard by a user. For example, the wireless identity transmitter 110 may emit audible communications that may indicate its presence to listening proximity broadcast receivers. In another embodiment, the wireless identity transmitter 110 may be configured to transmit signals at varying signal strengths, thereby varying the range at which broadcasts from the wireless identity transmitter 110 may be received by proximity broadcast receivers.

[0439] Additionally, the wireless identity transmitter 110 may include one or more sensors for measuring various conditions and variables. In an embodiment,

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the wireless identity transmitter 110 may include an accelerometer 3315 (or any other motion sensor such as a gyroscope or gravitometer), which may collect data indicative of motion of an asset associated with the wireless identity transmitter 110. For example, the accelerometer 3315 may generate motion data describing the movements of a child carrying the wireless identity transmitter 110. Other sensors that may be included within the wireless identity transmitter 110 include a temperature sensor 3316 (such as a thermistor), a radiation sensor 3317, a humidity sensor 3318, and a carbon dioxide (CO_2) sensor 3319. In the various embodiments, the wireless identity transmitter 110 may include any combination of these and other sensors. These potential sensors are only examples of the types of sensors that may be integrated into wireless identity transmitters 110 and other types of sensors may be included. For example, the wireless identity transmitter 110 may also include sensors not shown in the various diagrams, such as a microphone, a camera, a heat sensor, a pressure sensor, and a light sensor.

[0440] FIG. 34A illustrates primary components of an exemplary proximity broadcast receiver embodiment. The proximity broadcast receiver 142 may include a short-range radio 3404 (e.g., a Bluetooth radio or transceiver) capable of communicating with a short-range wireless radio (e.g., a Bluetooth® radio in the wireless identity transmitter) coupled to an antenna 3406, and a secondary network device 3408 capable of communicating directly or indirectly back to a central server via a network, such as the Internet. In some embodiments, the secondary network device 3408 may be a cellular or wireless radio or a modem or other wired network device. The proximity broadcast receiver 142 may also include a processor 3402, a memory 3412, and a battery 3410 either as the primary power supply or as a backup power supply in the case of proximity broadcast receiver 142 coupled to utility power. The proximity broadcast receiver 142 may include a GPS receiver 3414 or other type of location determining mechanism for determining a current location to associate with any message received from a wireless identity transmitter. If the proximity broadcast receiver is not mobile, it may not include a GPS receiver 3414 in some

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embodiments since the location may be known and constant. Although these components are shown linked by a common connection, they may interconnected and configured in various ways. Since these components may be microchips of standard or off-the-shelf configuration, they are represented in FIG. 34A as blocks consistent with the structure of an example embodiment.

[0441] FIG. 34B illustrates an embodiment proximity broadcast receiver 3475 that can be plugged into a power outlet. Similar to the embodiment described above with reference to FIG. 34A, the proximity broadcast receiver 3475 may include a processor 3402, a memory unit 3412, and a short-range radio 3404 (e.g., Bluetooth®, Bluetooth® LE, LTE-D, peer-to-peer LTE-D, Zigbee®, Peanut®, etc.) connected to an antenna 3406. The proximity broadcast receiver 3475 may also include a WiFi system-on-chip 3478 (referred to as "SOC" in FIG. 34C) coupled to a second antenna 3476. In another embodiment, the system-on-chip 3478 may be a Bluetooth® Low Energy system-on-chip. The proximity broadcast receiver 3475 may utilize the system-on-chip 3478 to exchange data over a wireless local area network, such as by communicating with a WiFi router. Additionally, the proximity broadcast receiver 3475 may include a plug 3482 for interfacing with a power supply or otherwise receiving power, such as alternating current power (or "AC"). In various embodiments, the plug 3482 may be configured to connect with different power outlets standards (e.g., British Standards, National Electrical Manufacturers Association, etc.), and may include a grounding element (not shown). The plug 3482 may be coupled to a USB Power supply 3480 that provides power to the various components of the proximity broadcast receiver 3475, such as the processor 3402. In an alternative embodiment, the proximity broadcast receiver 3475 may recharge an internal battery (not shown) using power received from the plug 3482 and/or USB power supply 3480.

[0442] In an embodiment, the proximity broadcast receiver 3475 may store software instructions, such as within the memory 3412 or other circuitry that may be utilized by the processor 3402 and/or the system-on-chip 3478 to perform

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operations to transmit and/or receive short-range and long-range signals, respectively. In an embodiment, the proximity broadcast receiver 3475 may utilize the antennas 3406, 3476 to receive update software, instructions, or other data for storage and use in updating firmware, modifying operating parameters, and other configuration modifications.

[0443] FIG. 35 is a system block diagram of a smartphone type mobile device suitable for use with various embodiments. A smartphone 3500 may include a processor 3501 coupled to internal memory 3502, a display 3503, and to a speaker 3554. Additionally, the smartphone 3500 may include an antenna 3504 for sending and receiving electromagnetic radiation that may be connected to a wireless data link and/or cell telephone transceiver 3505 coupled to the processor 3501 and capable of communicating over a wide area wireless communication network. Smartphones may include a separate short-range radio transceiver 3524 capable of communicating or pairing with wireless identity transmitters. Smartphones 3500 typically may also include menu selection buttons or rocker switches 3508 for receiving user inputs.

[0444] FIG. 36 is a system block diagram of a server 3600 suitable for implementing the various embodiments of this disclosure. The server 3600 may be a commercially available server device. Such a server 3600 typically includes a processor 3601 coupled to volatile memory 3602 and a large capacity nonvolatile memory, such as a disk drive 3603. The server 3600 may also include a floppy disc drive, compact disc (CD) or DVD disc drive 3606 coupled to the processor 3601. The server 3600 may also include network access ports 3604 coupled to the processor 3601 for establishing data connections with a network 3605, such as a local area network coupled to other broadcast system computers and servers.

[0445] The processors 3501, 3601 may be any programmable microprocessor, microcomputer or multiple processor chip or chips that can be configured by software instructions (applications) to perform a variety of functions, including

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the functions of the various embodiments described below. In some mobile proximity broadcast receivers, multiple processors 3501 may be provided, such as one processor dedicated to wireless communication functions and one processor dedicated to running other applications. Typically, software applications may be stored in the internal memory 3502, 3602 before they are accessed and loaded into the processor 3501, 3601. The processor 3501, 3601 may include internal memory sufficient to store the application software instructions.

[0446] The foregoing method descriptions and the process flow diagrams are provided merely as illustrative examples and are not intended to require or imply that the steps of the various embodiments must be performed in the order presented. As will be appreciated by one of skill in the art the order of steps in the foregoing embodiments may be performed in any order. Words such as "thereafter," "then," "next," etc. are not intended to limit the order of the steps; these words are simply used to guide the reader through the description of the methods. Further, any reference to claim elements in the singular, for example, using the articles "a," "an" or "the" is not to be construed as limiting the element to the singular.

[0447] The various illustrative logical blocks, modules, circuits, and algorithm steps described in connection with the embodiments disclosed herein may be implemented as electronic hardware, computer software, or combinations of both. To clearly illustrate this interchangeability of hardware and software, various illustrative components, blocks, modules, circuits, and steps have been described above generally in terms of their functionality. Whether such functionality is implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system. Skilled artisans may implement the described functionality in varying ways for each particular application, but such implementation decisions should not be interpreted as causing a departure from the scope of the present invention.

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[0448] The hardware used to implement the various illustrative logics, logical blocks, modules, and circuits described in connection with the aspects disclosed herein may be implemented or performed with a general purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general-purpose processor may be a microprocessor, but, in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration. Alternatively, some steps or methods may be performed by circuitry that is specific to a given function.

[0449] In one or more exemplary aspects, the functions described may be implemented in hardware, software, firmware, or any combination thereof. If implemented in software, the functions may be stored on or transmitted over as one or more instructions or code on a computer-readable medium. The steps of a method or algorithm disclosed herein may be embodied in a processor-executable software module, which may reside on a tangible, non-transitory computer-readable storage medium. Tangible, non-transitory processor-readable storage medium or non-transitory computer-readable storage media may be any available media that may be accessed by a computer. By way of example, and not limitation, such non-transitory processor-readable and computer-readable storage media may comprise RAM, ROM, EEPROM, CD-ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other medium that may be used to store desired program code in the form of instructions or data structures and that may be accessed by a computer. Disk and disc, as used herein, includes compact disc (CD), laser disc, optical disc, digital versatile disc (DVD), floppy disk, and blu-ray disc where disks usually reproduce

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data magnetically, while discs reproduce data optically with lasers. Combinations of the above should also be included within the scope of non-transitory processor-readable storage medium. Additionally, the operations of a method or algorithm may reside as one or any combination or set of codes and/or instructions on a tangible, non-transitory machine readable medium and/or computer-readable medium, which may be incorporated into a computer program product.

[0450] The preceding description of the disclosed embodiments is provided to enable any person skilled in the art to make or use the present invention. Various modifications to these embodiments will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other embodiments without departing from the spirit or scope of the invention. Thus, the present invention is not intended to be limited to the embodiments shown herein but is to be accorded the widest scope consistent with the following claims and the principles and novel features disclosed herein.

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CLAIMS

What is claimed is:

1. A method for providing profile information associated with a user based on proximity, comprising:

receiving in a server a sighting message that includes a rolling identifier of a wireless identity transmitter associated with an individual, wherein the rolling identifier is generated via an algorithm that uses a unique device identifier of the wireless identity transmitter, a secret key shared with the server, and a counter;

determining in the server whether the wireless identity transmitter is associated with the user based on the rolling identifier;

determining in the server whether the sighting message is related to a registered service based on information included within the sighting message regarding a proximity broadcast receiver;

identifying profile information within stored profile information associated with the user that is relevant to the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service; and

transmitting a message that includes the identified relevant profile information.

2. The method of claim 1, wherein the relevant profile information includes at least one of personal demographics, interests, birth date, residence, medical information, health conditions, customer preferences, and clothing and shoe size information.

3. The method of claim 1, wherein identifying relevant profile information within the stored profile information associated with the user that is relevant to the registered service comprises:

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identifying categories corresponding to the registered service, wherein categories describe at least one of services offered, products offered, a type of business, demographics, interests, and target audience of the registered service; and

matching the identified categories to the profile information associated with the user.

4. The method of claim 1, further comprising storing profile information received from the user during a registration process.

5. The method of claim 1, further comprising automatically obtaining the profile information related to the user from online sources, wherein the online sources include at least one of social networking accounts and shopping websites.

6. The method of claim 1, further comprising storing profile permissions from the user, wherein identifying profile information within stored profile information associated with the user that is relevant to the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service comprises identifying the relevant profile information associated with the user that is relevant to the registered service and authorized by the stored profile permissions from the user when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service.

7. The method of claim 1, wherein transmitting a message that includes the identified relevant profile information comprises transmitting the message to a local computing device associated with the registered service that includes the identified relevant profile information, wherein the local computing device is at least one of a point-of-sale device, a mobile device used by an employee of the registered service, and the proximity broadcast receiver associated with the registered service.

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8. The method of claim 1, further comprising:

determining whether the wireless identity transmitter is near a point-of-sale device associated with the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service,

wherein transmitting a message that includes the identified relevant profile information comprises transmitting the message to the point-of-sale device that is near the wireless identity transmitter, and

wherein the identified relevant profile information associated with the user includes payment authentication information for confirming an identity of the user.

9. The method of claim 8, wherein the payment authentication information includes at least one of address information, an email address, a photo, a signature sample, audio samples, credit card information, and preferred banking account information.

10. A method for sharing profile information of an individual based on proximity, comprising:

receiving in a server a sighting message that includes a rolling identifier of a wireless identity transmitter associated with the individual, wherein the rolling identifier is generated via an algorithm that uses a unique device identifier of the wireless identity transmitter, a secret key shared with the server, and a counter;

identifying a first profile based on the rolling identifier of the wireless identity transmitter;

identifying a second profile based on information related to a proximity broadcast receiver included within the sighting message;

identifying relevant profile information from the first profile that is authorized to be shared based on permissions of the first profile;

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identifying relevant profile information from the second profile that is authorized to be shared based on permissions of the second profile;

transmitting a first message to a first device associated with the second profile when there is relevant profile information from the first profile that is identified and authorized to be shared; and

transmitting a second message to a second device associated with the first profile when there is relevant profile information from the second profile that is identified and authorized to be shared.

11. A server configured to provide profile information associated with a user based on proximity, comprising:

a server processor configured with server-executable instructions to perform operations comprising:

receiving in the server a sighting message that includes a rolling identifier of a wireless identity transmitter associated with an individual, wherein the rolling identifier is generated via an algorithm that uses a unique device identifier of the wireless identity transmitter, a secret key shared with the server, and a counter;

determining in the server whether the wireless identity transmitter is associated with the user based on the rolling identifier;

determining in the server whether the sighting message is related to a registered service based on information included within the sighting message regarding a proximity broadcast receiver;

identifying profile information within stored profile information associated with the user that is relevant to the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service; and

transmitting a message that includes the identified relevant profile information.

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12. The server of claim 11, wherein the relevant profile information includes at least one of personal demographics, interests, birth date, residence, medical information, health conditions, customer preferences, and clothing and shoe size information.

13. The server of claim 11, wherein the server processor is configured with server executable instructions to perform operations such that identifying relevant profile information within the stored profile information associated with the user that is relevant to the registered service comprises:

identifying categories corresponding to the registered service, wherein categories describe at least one of services offered, products offered, a type of business, demographics, interests, and target audience of the registered service; and

matching the identified categories to the profile information associated with the user.

14. The server of claim 11, wherein the server processor is configured with server executable instructions to perform operations further comprising storing profile information received from the user during a registration process.

15. The server of claim 11, wherein the server processor is configured with server executable instructions to perform operations further comprising automatically obtaining the profile information related to the user from online sources, wherein the online sources include at least one of social networking accounts and shopping websites.

16. The server of claim 11, wherein the server processor is configured with server executable instructions to perform operations further comprising storing profile permissions from the user, wherein the server processor is configured with server executable instructions to perform operations such that identifying profile information within stored profile information associated with the user that

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is relevant to the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service comprises identifying the relevant profile information associated with the user that is relevant to the registered service and authorized by the stored profile permissions from the user when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service.

17. The server of claim 11, wherein the server processor is configured with server executable instructions to perform operations such that transmitting a message that includes the identified relevant profile information comprises transmitting the message to a local computing device associated with the registered service that includes the identified relevant profile information, wherein the local computing device is at least one of a point-of-sale device, a mobile device used by an employee of the registered service, and the proximity broadcast receiver associated with the registered service.

18. The server of claim 11, wherein the server processor is configured with server executable instructions to perform operations further comprising:

determining whether the wireless identity transmitter is near a point-of-sale device associated with the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service,

wherein the server processor is configured with server executable instructions to perform operations such that transmitting a message that includes the identified relevant profile information comprises transmitting the message to the point-of-sale device that is near the wireless identity transmitter, and

wherein the identified relevant profile information associated with the user includes payment authentication information for confirming an identity of the user.

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19. The server of claim 18, wherein the payment authentication information includes at least one of address information, an email address, a photo, a signature sample, audio samples, credit card information, and preferred banking account information.

20. A server configured to share profile information of an individual based on proximity, comprising:

a server processor configured with server-executable instructions to perform operations comprising:

receiving in the server a sighting message that includes a rolling identifier of a wireless identity transmitter associated with the individual, wherein the rolling identifier is generated via an algorithm that uses a unique device identifier of the wireless identity transmitter, a secret key shared with the server, and a counter;

identifying a first profile based on the rolling identifier of the wireless identity transmitter;

identifying a second profile based on information related to a proximity broadcast receiver included within the sighting message;

identifying relevant profile information from the first profile that is authorized to be shared based on permissions of the first profile;

identifying relevant profile information from the second profile that is authorized to be shared based on permissions of the second profile;

transmitting a first message to a first device associated with the second profile when there is relevant profile information from the first profile that is identified and authorized to be shared; and

transmitting a second message to a second device associated with the first profile when there is relevant profile information from the second profile that is identified and authorized to be shared.

21. A server configured to provide profile information associated with a user based on proximity, comprising:

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means for receiving in the server a sighting message that includes a rolling identifier of a wireless identity transmitter associated with an individual, wherein the rolling identifier is generated via an algorithm that uses a unique device identifier of the wireless identity transmitter, a secret key shared with the server, and a counter;

means for determining in the server whether the wireless identity transmitter is associated with the user based on the rolling identifier;

means for determining in the server whether the sighting message is related to a registered service based on information included within the sighting message regarding a proximity broadcast receiver;

means for identifying profile information within stored profile information associated with the user that is relevant to the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service; and

means for transmitting a message that includes the identified relevant profile information.

22. The server of claim 21, wherein the relevant profile information includes at least one of personal demographics, interests, birth date, residence, medical information, health conditions, customer preferences, and clothing and shoe size information.

23. The server of claim 21, wherein means for identifying relevant profile information within the stored profile information associated with the user that is relevant to the registered service comprises:

means for identifying categories corresponding to the registered service, wherein categories describe at least one of services offered, products offered, a type of business, demographics, interests, and target audience of the registered service; and

means for matching the identified categories to the profile information associated with the user.

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24. The server of claim 21, further comprising means for storing profile information received from the user during a registration process.

25. The server of claim 21, further comprising means for automatically obtaining the profile information related to the user from online sources, wherein the online sources include at least one of social networking accounts and shopping websites.

26. The server of claim 21, further comprising means for storing profile permissions from the user, wherein means for identifying profile information within stored profile information associated with the user that is relevant to the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service comprises means for identifying the relevant profile information associated with the user that is relevant to the registered service and authorized by the stored profile permissions from the user when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service.

27. The server of claim 21, wherein means for transmitting a message that includes the identified relevant profile information comprises means for transmitting the message to a local computing device associated with the registered service that includes the identified relevant profile information, wherein the local computing device is at least one of a point-of-sale device, a mobile device used by an employee of the registered service, and the proximity broadcast receiver associated with the registered service.

28. The server of claim 21, further comprising:

means for determining whether the wireless identity transmitter is near a point-of-sale device associated with the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service,

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wherein means for transmitting a message that includes the identified relevant profile information comprises means for transmitting the message to the point-of-sale device that is near the wireless identity transmitter, and

wherein the identified relevant profile information associated with the user includes payment authentication information for confirming an identity of the user.

29. The server of claim 28, wherein the payment authentication information includes at least one of address information, an email address, a photo, a signature sample, audio samples, credit card information, and preferred banking account information.

30. A server configured to share profile information of an individual based on proximity, comprising:

means for receiving in the server a sighting message that includes a rolling identifier of a wireless identity transmitter associated with the individual, wherein the rolling identifier is generated via an algorithm that uses a unique device identifier of the wireless identity transmitter, a secret key shared with the server, and a counter;

means for identifying a first profile based on the rolling identifier of the wireless identity transmitter;

means for identifying a second profile based on information related to a proximity broadcast receiver included within the sighting message;

means for identifying relevant profile information from the first profile that is authorized to be shared based on permissions of the first profile;

means for identifying relevant profile information from the second profile that is authorized to be shared based on permissions of the second profile;

means for transmitting a first message to a first device associated with the second profile when there is relevant profile information from the first profile that is identified and authorized to be shared; and

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means for transmitting a second message to a second device associated with the first profile when there is relevant profile information from the second profile that is identified and authorized to be shared.

31. A non-transitory server-readable storage medium having stored thereon server-executable instructions configured to cause a server to perform operations for providing profile information associated with a user based on proximity, the operations comprising:

receiving in the server a sighting message that includes a rolling identifier of a wireless identity transmitter associated with an individual, wherein the rolling identifier is generated via an algorithm that uses a unique device identifier of the wireless identity transmitter, a secret key shared with the server, and a counter;

determining in the server whether the wireless identity transmitter is associated with the user based on the rolling identifier;

determining in the server whether the sighting message is related to a registered service based on information included within the sighting message regarding a proximity broadcast receiver;

identifying profile information within stored profile information associated with the user that is relevant to the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service; and

transmitting a message that includes the identified relevant profile information.

32. The non-transitory server-readable storage medium of claim 31, wherein the relevant profile information includes at least one of personal demographics, interests, birth date, residence, medical information, health conditions, customer preferences, and clothing and shoe size information.

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33. The non-transitory server-readable storage medium of claim 31, wherein the stored server-executable instructions are configured to cause the server to perform operations such that identifying relevant profile information within the stored profile information associated with the user that is relevant to the registered service comprises:

identifying categories corresponding to the registered service, wherein categories describe at least one of services offered, products offered, a type of business, demographics, interests, and target audience of the registered service; and

matching the identified categories to the profile information associated with the user.

34. The non-transitory server-readable storage medium of claim 31, wherein the stored server-executable instructions are configured to cause the server to perform operations further comprising storing profile information received from the user during a registration process.

35. The non-transitory server-readable storage medium of claim 31, wherein the stored server-executable instructions are configured to cause the server to perform operations further comprising automatically obtaining the profile information related to the user from online sources, wherein the online sources include at least one of social networking accounts and shopping websites.

36. The non-transitory server-readable storage medium of claim 31, wherein the stored server-executable instructions are configured to cause the server to perform operations further comprising storing profile permissions from the user, and wherein the stored server-executable instructions are configured to cause the server to perform operations such that identifying profile information within stored profile information associated with the user that is relevant to the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service comprises

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identifying the relevant profile information associated with the user that is relevant to the registered service and authorized by the stored profile permissions from the user when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service.

37. The non-transitory server-readable storage medium of claim 31, wherein the stored server-executable instructions are configured to cause the server to perform operations such that transmitting a message that includes the identified relevant profile information comprises transmitting the message to a local computing device associated with the registered service that includes the identified relevant profile information, wherein the local computing device is at least one of a point-of-sale device, a mobile device used by an employee of the registered service, and the proximity broadcast receiver associated with the registered service.

38. The non-transitory server-readable storage medium of claim 31, wherein the stored server-executable instructions are configured to cause the server to perform operations further comprising:

determining whether the wireless identity transmitter is near a point-of-sale device associated with the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service,

wherein the stored server-executable instructions are configured to cause the server to perform operations such that transmitting a message that includes the identified relevant profile information comprises transmitting the message to the point-of-sale device that is near the wireless identity transmitter, and

wherein the identified relevant profile information associated with the user includes payment authentication information for confirming an identity of the user.

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39. The non-transitory server-readable storage medium of claim 38, wherein the payment authentication information includes at least one of address information, an email address, a photo, a signature sample, audio samples, credit card information, and preferred banking account information.

40. A non-transitory server-readable storage medium having stored thereon server-executable instructions configured to cause a server to perform operations for sharing profile information of an individual based on proximity, the operations comprising:

receiving in the server a sighting message that includes a rolling identifier of a wireless identity transmitter associated with the individual, wherein the rolling identifier is generated via an algorithm that uses a unique device identifier of the wireless identity transmitter, a secret key shared with the server, and a counter;

identifying a first profile based on the rolling identifier of the wireless identity transmitter;

identifying a second profile based on information related to a proximity broadcast receiver included within the sighting message;

identifying relevant profile information from the first profile that is authorized to be shared based on permissions of the first profile;

identifying relevant profile information from the second profile that is authorized to be shared based on permissions of the second profile;

transmitting a first message to a first device associated with the second profile when there is relevant profile information from the first profile that is identified and authorized to be shared; and

transmitting a second message to a second device associated with the first profile when there is relevant profile information from the second profile that is identified and authorized to be shared.

41. A system, comprising:

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a server;

a wireless identity transmitter; and

a proximity broadcast receiver,

wherein the wireless identity transmitter comprises:

a first memory;

a first transceiver configured to broadcast short-range wireless signals capable of being received by the proximity broadcast receiver; and

a first processor coupled to the first memory and the first transceiver, and configured with processor-executable instructions to perform operations comprising:

generating a rolling identifier periodically via an algorithm that uses a unique device identifier of the wireless identity transmitter that is associated with an individual, a secret key shared with the server, and a counter; and

periodically broadcasting via the first transceiver a short-range wireless signal including the rolling identifier of the wireless identity transmitter, and

wherein the proximity broadcast receiver comprises:

a second memory;

a second transceiver configured to exchange short-range wireless signals with the wireless identity transmitter;

a network device configured to exchange signals with the server;

a second processor coupled to the second memory, the second transceiver, and the network device and configured with processor-executable instructions to perform operations comprising:

receiving via the second transceiver the short-range wireless signal including the rolling identifier broadcast by the wireless identity transmitter within proximity;

generating a sighting message in response to the received signal, wherein the sighting message includes the rolling identifier and associated data; and

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transmitting the sighting message via long-range communications using the network device, and

wherein the server is configured with server-executable instructions to perform operations comprising:

storing the profile information associated with a user;

receiving in the server the sighting message that includes the rolling identifier;

determining in the server whether the wireless identity transmitter is associated with the user based on the rolling identifier;

determining in the server whether the sighting message is related to a registered service based on information included within the sighting message regarding the proximity broadcast receiver;

identifying relevant profile information within the stored profile information associated with the user that is relevant to the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service; and

transmitting a message that includes the identified relevant profile information.

42. The system of claim 41, wherein the relevant profile information includes at least one of personal demographics, interests, birth date, residence, medical information, health conditions, customer preferences, and clothing and shoe size information.

43. The system of claim 41, wherein the server is configured with server-executable instructions to perform operations such that identifying relevant profile information within the stored profile information associated with the user that is relevant to the registered service comprises:

identifying categories corresponding to the registered service, wherein categories describe at least one of services offered, products offered, a type of

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business, demographics, interests, and target audience of the registered service; and

matching the identified categories to the profile information associated with the user.

44. The system of claim 41, wherein the server is configured with server-executable instructions to perform operations such that storing the profile information associated with the user comprises storing data received from the user during a registration that includes the profile information.

45. The system of claim 41, wherein the server is configured with server-executable instructions to perform operations further comprising automatically obtaining the profile information related to the user from online sources, wherein the online sources include at least one of social networking accounts and shopping websites.

46. The system of claim 41, wherein:

the server is configured with server-executable instructions to perform operations further comprising storing profile permissions from the user; and

the server is configured with server-executable instructions to perform operations such that identifying relevant profile information within the stored profile information associated with the user that is relevant to the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service comprises identifying the relevant profile information within the stored profile information associated with the user that is relevant to the registered service and authorized by the stored profile permissions from the user when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service.

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47. The system of claim 41, wherein the server is configured with server-executable instructions to perform operations such that transmitting a message that includes the identified relevant profile information comprises transmitting the message to a local computing device associated with the registered service that includes the identified relevant profile information, wherein the local computing device is at least one of a point-of-sale device, a mobile device used by an employee of the registered service, and the proximity broadcast receiver associated with the registered service.

48. The system of claim 41, wherein the server is configured with server-executable instructions to perform operations further comprising:

determining whether the wireless identity transmitter is near a point-of-sale device associated with the registered service when the wireless identity transmitter is associated with the user and the sighting message is related to the registered service, and

wherein the server is configured with server-executable instructions to perform operations such that transmitting a message that includes the identified relevant profile information comprises transmitting the message to the point-of-sale device that is near the wireless identity transmitter, and

wherein the identified relevant profile information associated with the user includes payment authentication information for confirming an identity of the user.

49. The system of claim 48, wherein the payment authentication information includes at least one of address information, an email address, a photo, a signature sample, audio samples, credit card information, and preferred banking account information.

50. A system, comprising:

a server;

a wireless identity transmitter; and

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a proximity broadcast receiver,

wherein the wireless identity transmitter comprises:

a first memory;

a first transceiver configured to broadcast short-range wireless signals capable of being received by the proximity broadcast receiver; and

a first processor coupled to the first memory and the first transceiver, and configured with processor-executable instructions to perform operations comprising:

generating a rolling identifier periodically via an algorithm that uses a unique device identifier of the wireless identity transmitter that is associated with an individual, a secret key shared with the server, and a counter; and

periodically broadcasting via the first transceiver a short-range wireless signal including the rolling identifier of the wireless identity transmitter, and

wherein the proximity broadcast receiver comprises:

a second memory;

a second transceiver configured to exchange short-range wireless signals with the wireless identity transmitter;

a network device configured to exchange signals with the server;

a second processor coupled to the second memory, the second transceiver, and the network device and configured with processor-executable instructions to perform operations comprising:

receiving via the second transceiver the short-range wireless signal including the rolling identifier broadcast by the wireless identity transmitter within proximity;

generating a sighting message in response to the received signal, wherein the sighting message includes the rolling identifier and associated data; and

transmitting the sighting message via long-range communications using the network device, and

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wherein the server is configured with server-executable instructions to perform operations comprising:

receiving in the server the sighting message that includes the rolling identifier;

identifying a first profile based on the rolling identifier of the wireless identity transmitter;

identifying a second profile based on information related to the proximity broadcast receiver included within the sighting message;

identifying relevant profile information from the first profile that is authorized to be shared based on permissions of the first profile;

identifying relevant profile information from the second profile that is authorized to be shared based on permissions of the second profile;

transmitting a first message to a first device associated with the second profile when there is relevant profile information from the first profile that is identified and authorized to be shared; and

transmitting a second message to a second device associated with the first profile when there is relevant profile information from the second profile that is identified and authorized to be shared.

51. A method for a mobile device to provide profile information associated with a user based on proximity, comprising:

storing the profile information locally within the mobile device;

receiving a short-range wireless message from a proximate device;

identifying relevant profile information within the stored profile information that is authorized to be shared based on the received message; and

transmitting a response message including the identified relevant profile information that is authorized to be shared.

52. A mobile device configured to provide profile information associated with a user based on proximity, comprising:

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means for storing the profile information locally within the mobile device;

means for receiving a short-range wireless message from a proximate device;

means for identifying relevant profile information within the stored profile information that is authorized to be shared based on the received message; and

means for transmitting a response message including the identified relevant profile information that is authorized to be shared.

53. A mobile device configured to provide profile information associated with a user based on proximity, comprising:

a memory; and

a processor coupled to the memory, wherein the processor is configured with processor-executable instructions to perform operations comprising:

storing the profile information locally within the mobile device;

receiving a short-range wireless message from a proximate device;

identifying relevant profile information within the stored profile information that is authorized to be shared based on the received message; and

transmitting a response message including the identified relevant profile information that is authorized to be shared.

54. A non-transitory processor-readable storage medium having stored thereon processor executable instructions configured to cause a mobile device to perform operations to provide profile information associated with a user based on proximity, the operations comprising:

storing the profile information locally within the mobile device;

receiving a short-range wireless message from a proximate device;

identifying relevant profile information within the stored profile information that is authorized to be shared based on the received message; and

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transmitting a response message including the identified relevant profile information that is authorized to be shared.

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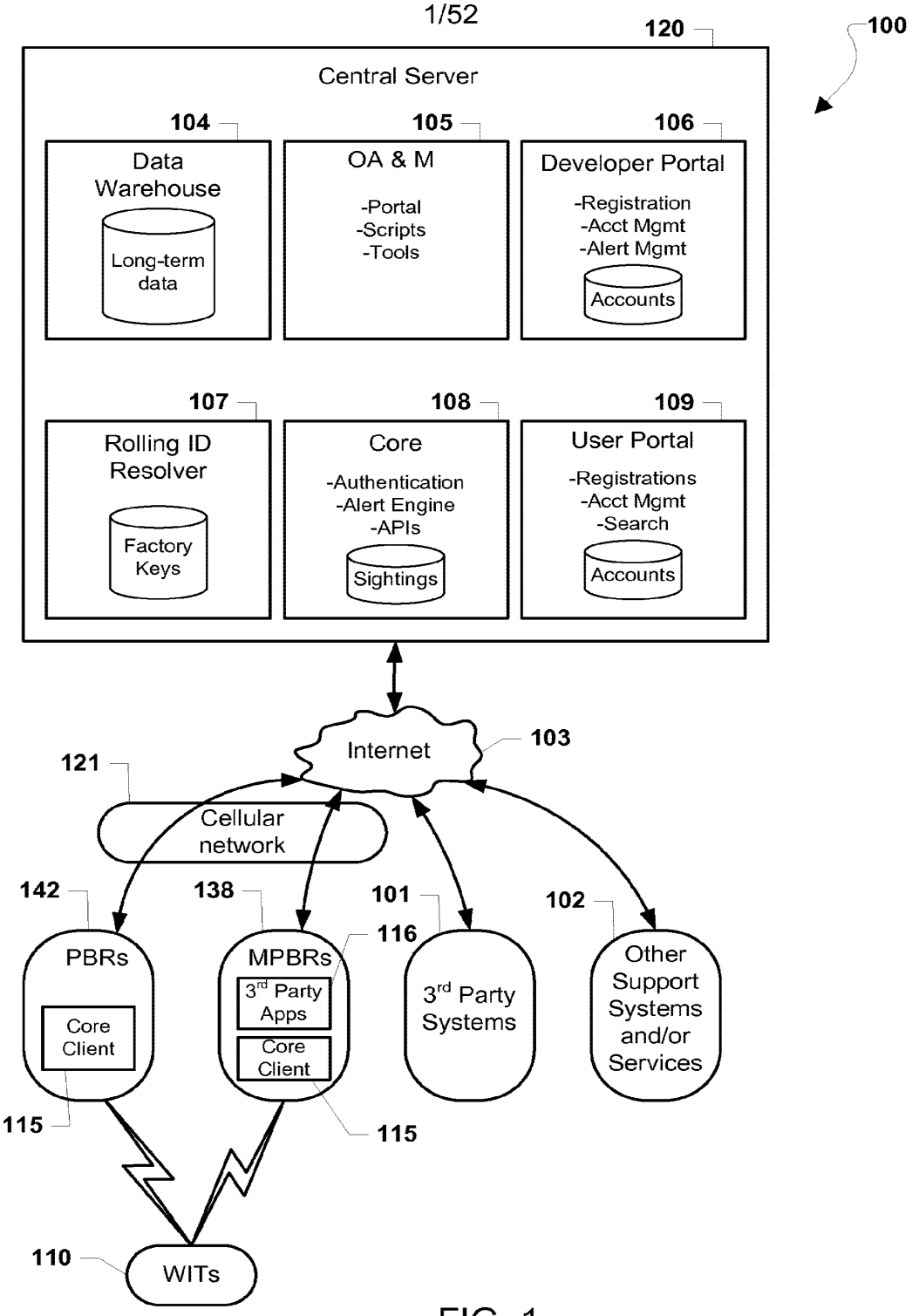

100
120
Central Server
104
Data Warehouse
Long-term data
105
OA & M
-Portal
-Scripts
-Tools
106
Developer Portal
-Registration
-Acct Mgmt
-Alert Mgmt
Accounts
107
Rolling ID Resolver
Factory Keys
108
Core
-Authentication
-Alert Engine
-APIs
Sightings
109
User Portal
-Registrations
-Acct Mgmt
-Search
Accounts
Internet
103
121
Cellular network
142
PBRs
Core Client
138
MPBRs
3rd Party Apps
Core Client
116
101
3rd Party Systems
102
Other Support Systems and/or Services
115
115
110
WITs

FIG. 1

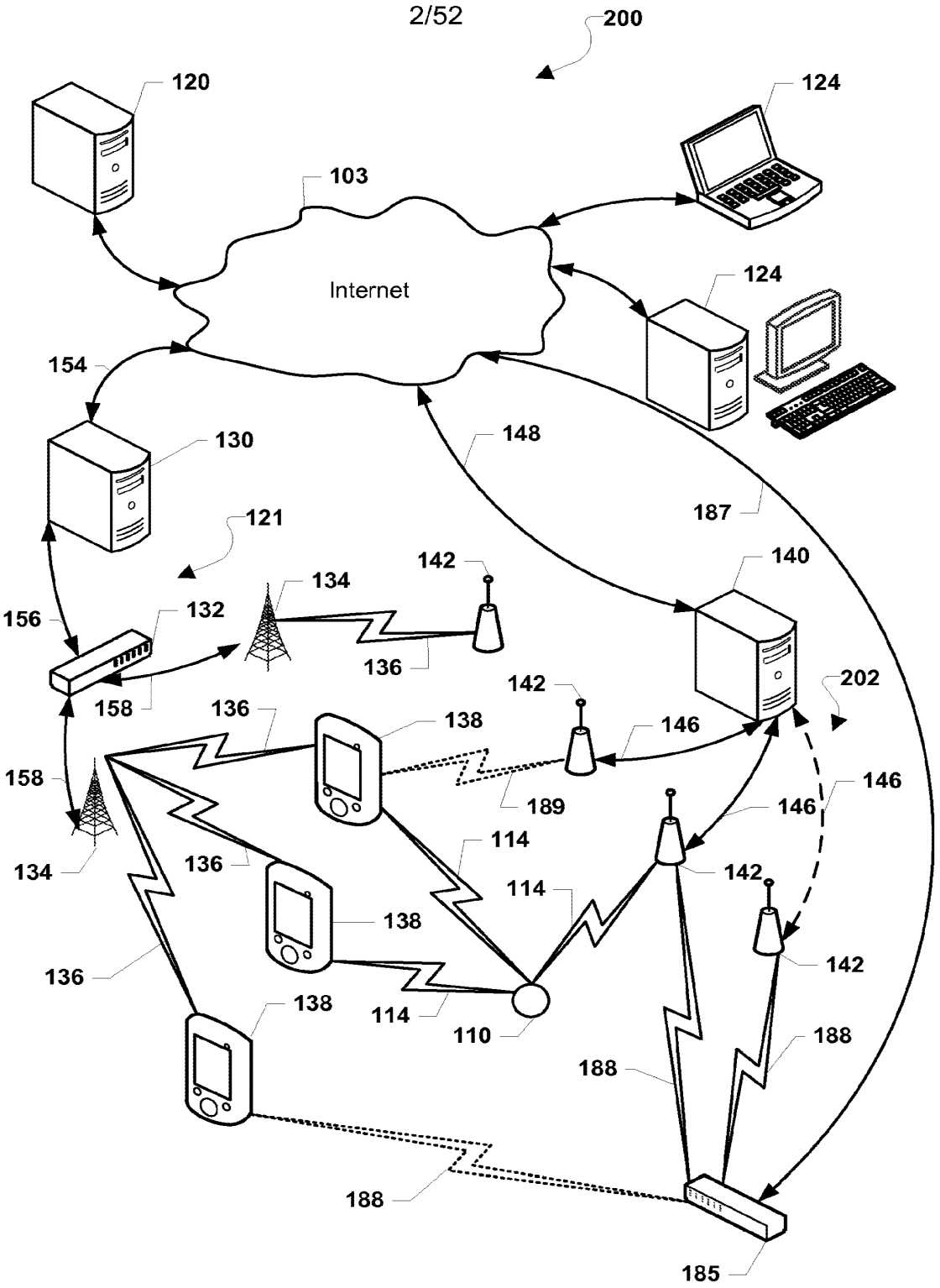


FIG. 2

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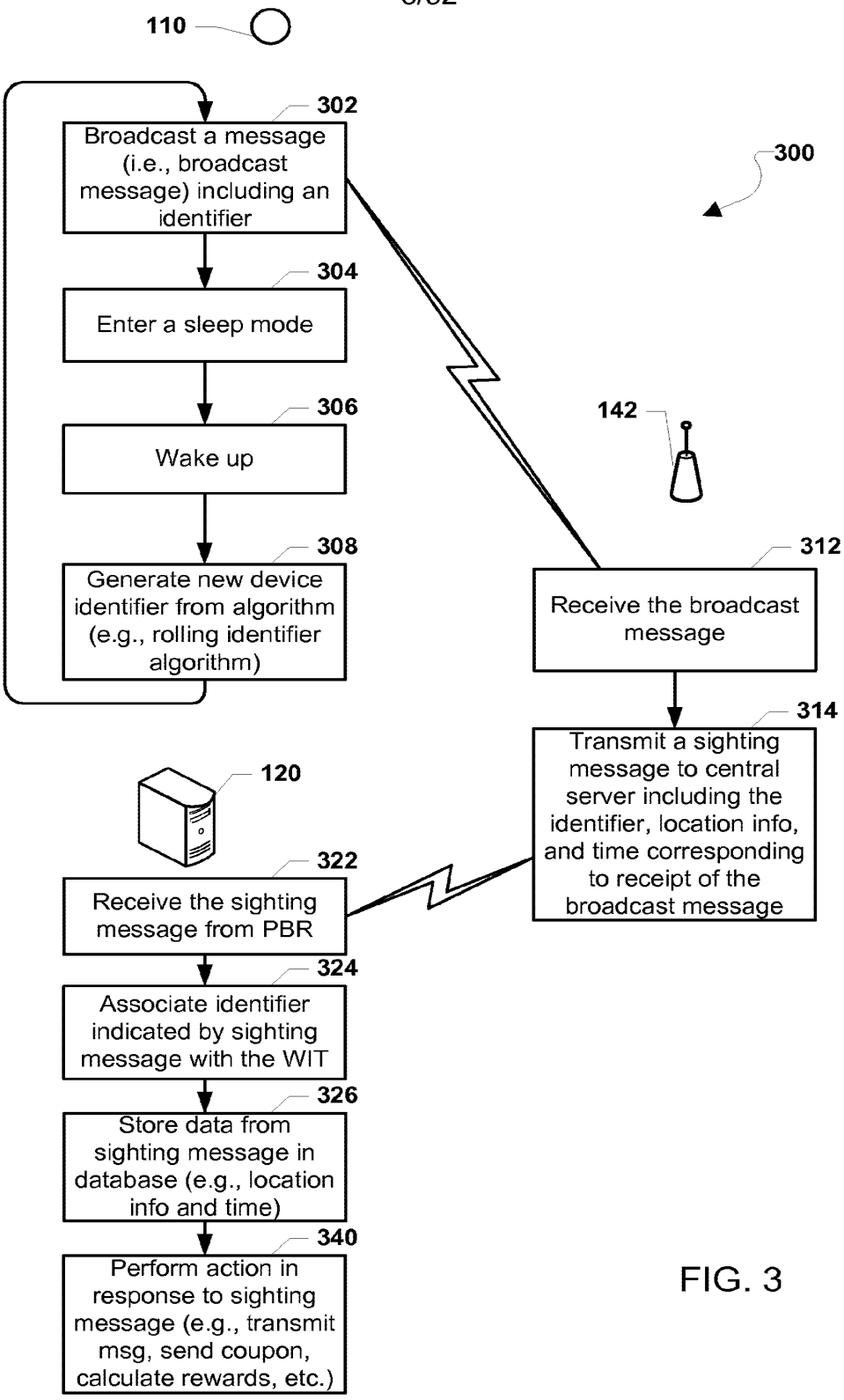

110
302
Broadcast a message (i.e., broadcast message) including an identifier
304
Enter a sleep mode
306
Wake up
308
Generate new device identifier from algorithm (e.g., rolling identifier algorithm)
300
142
312
Receive the broadcast message
314
Transmit a sighting message to central server including the identifier, location info, and time corresponding to receipt of the broadcast message
120
322
Receive the sighting message from PBR
324
Associate identifier indicated by sighting message with the WIT
326
Store data from sighting message in database (e.g., location info and time)
340
Perform action in response to sighting message (e.g., transmit msg, send coupon, calculate rewards, etc.)

FIG. 3

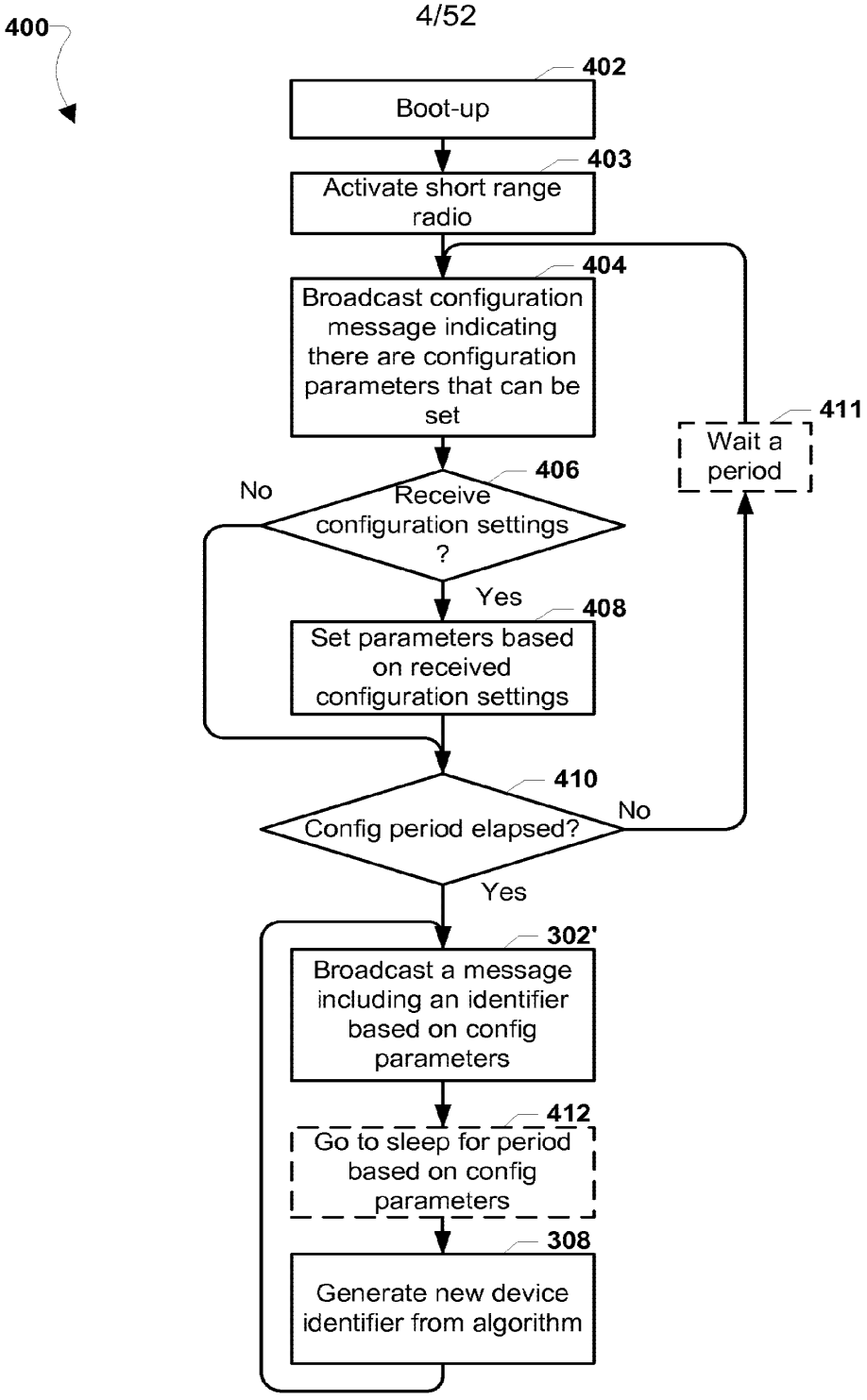

400
402
Boot-up
403
Activate short range radio
404
Broadcast configuration message indicating there are configuration parameters that can be set
406
Receive configuration settings ?
No
Yes
408
Set parameters based on received configuration settings
410
Config period elapsed?
No
Yes
411
Wait a period
302'
Broadcast a message including an identifier based on config parameters
412
Go to sleep for period based on config parameters
308
Generate new device identifier from algorithm

FIG. 4

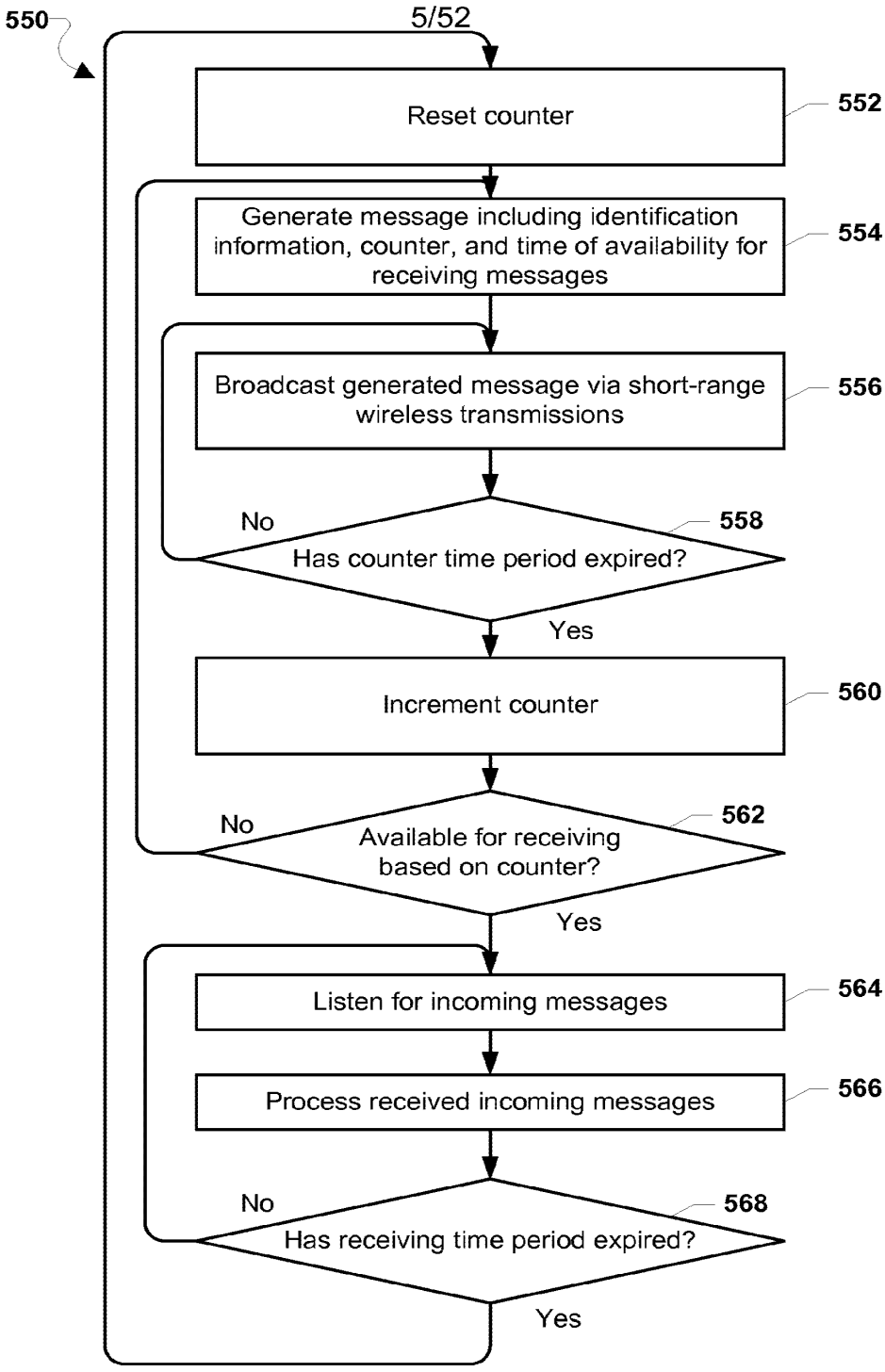

550
5/52
Reset counter
552
Generate message including identification information, counter, and time of availability for receiving messages
554
Broadcast generated message via short-range wireless transmissions
556
No
Has counter time period expired?
558
Yes
Increment counter
560
No
Available for receiving based on counter?
562
Yes
Listen for incoming messages
564
Process received incoming messages
566
No
Has receiving time period expired?
568
Yes

FIG. 5

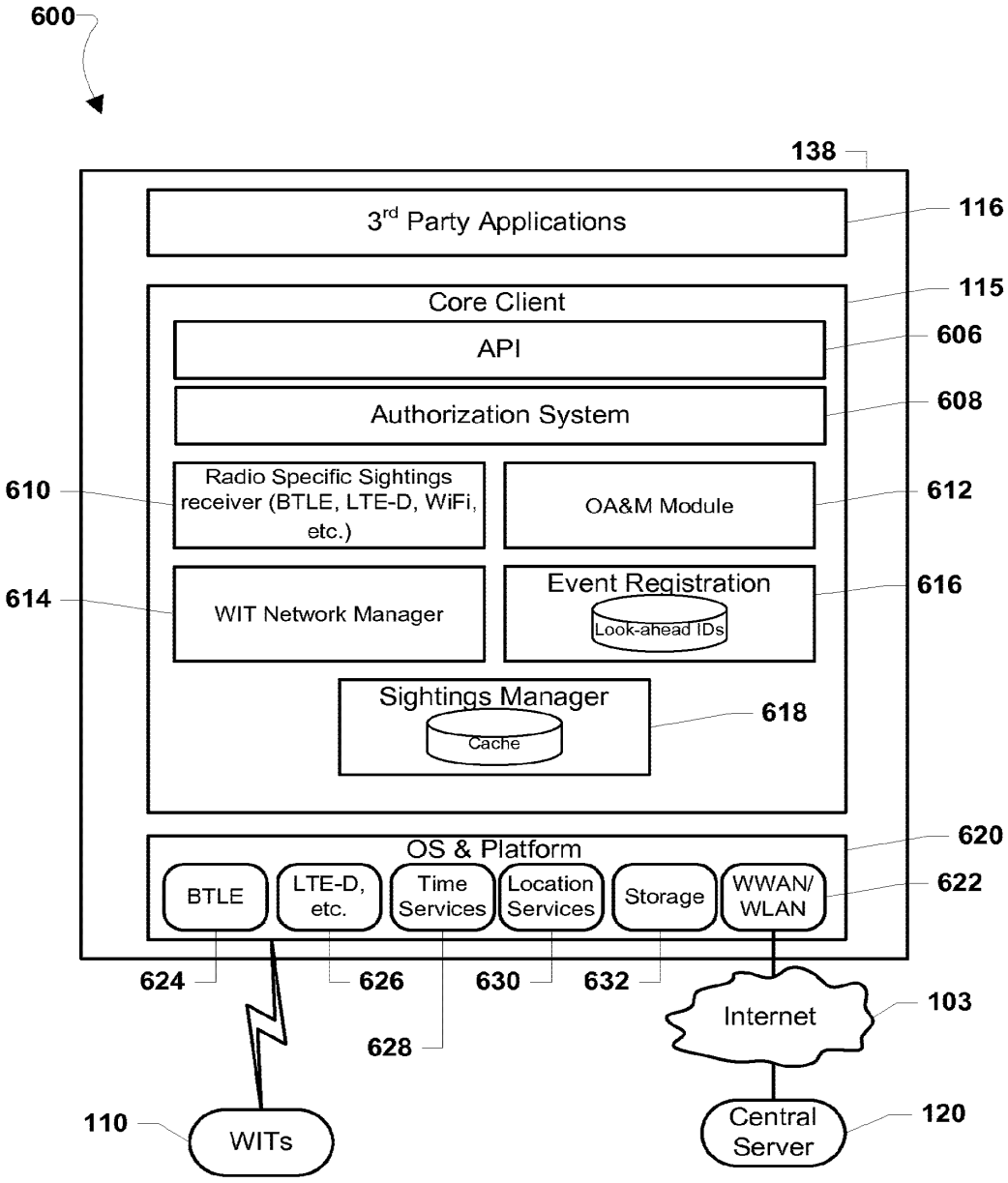

600
138
3rd Party Applications
116
Core Client
115
API
606
Authorization System
608
610
Radio Specific Sightings receiver (BTLE, LTE-D, WiFi, etc.)
OA&M Module
612
614
WIT Network Manager
Event Registration
Look-ahead IDs
616
Sightings Manager
Cache
618
OS & Platform
620
BTLE
LTE-D, etc.
Time Services
Location Services
Storage
WWAN/ WLAN
622
624
626
628
630
632
Internet
103
110
WITs
Central Server
120

FIG. 6

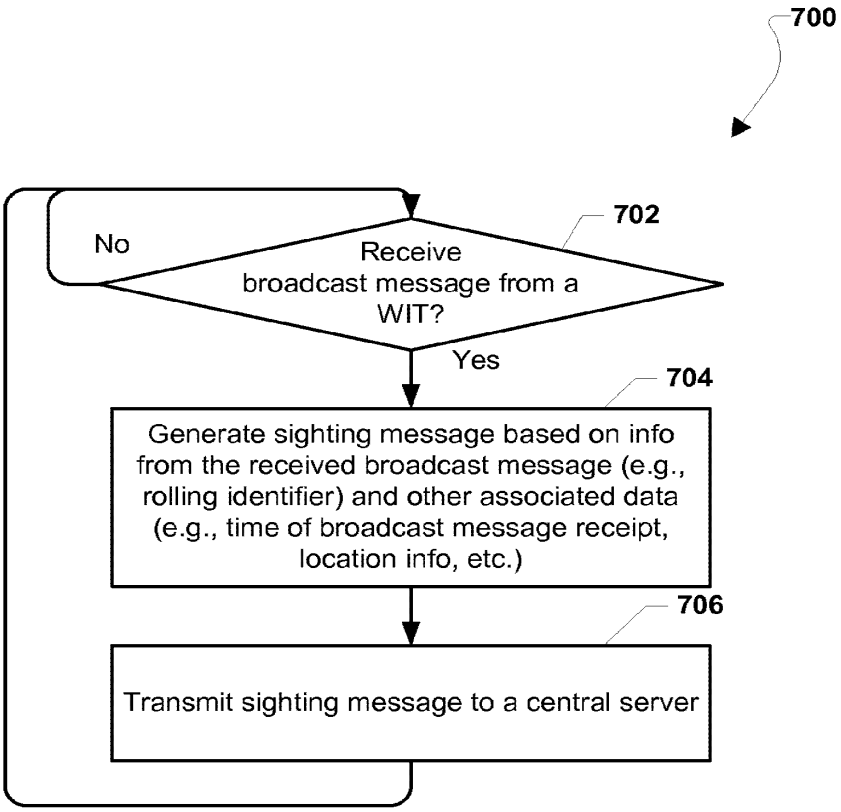

700
702
No
Receive broadcast message from a WIT?
Yes
704
Generate sighting message based on info from the received broadcast message (e.g., rolling identifier) and other associated data (e.g., time of broadcast message receipt, location info, etc.)
706
Transmit sighting message to a central server

FIG. 7

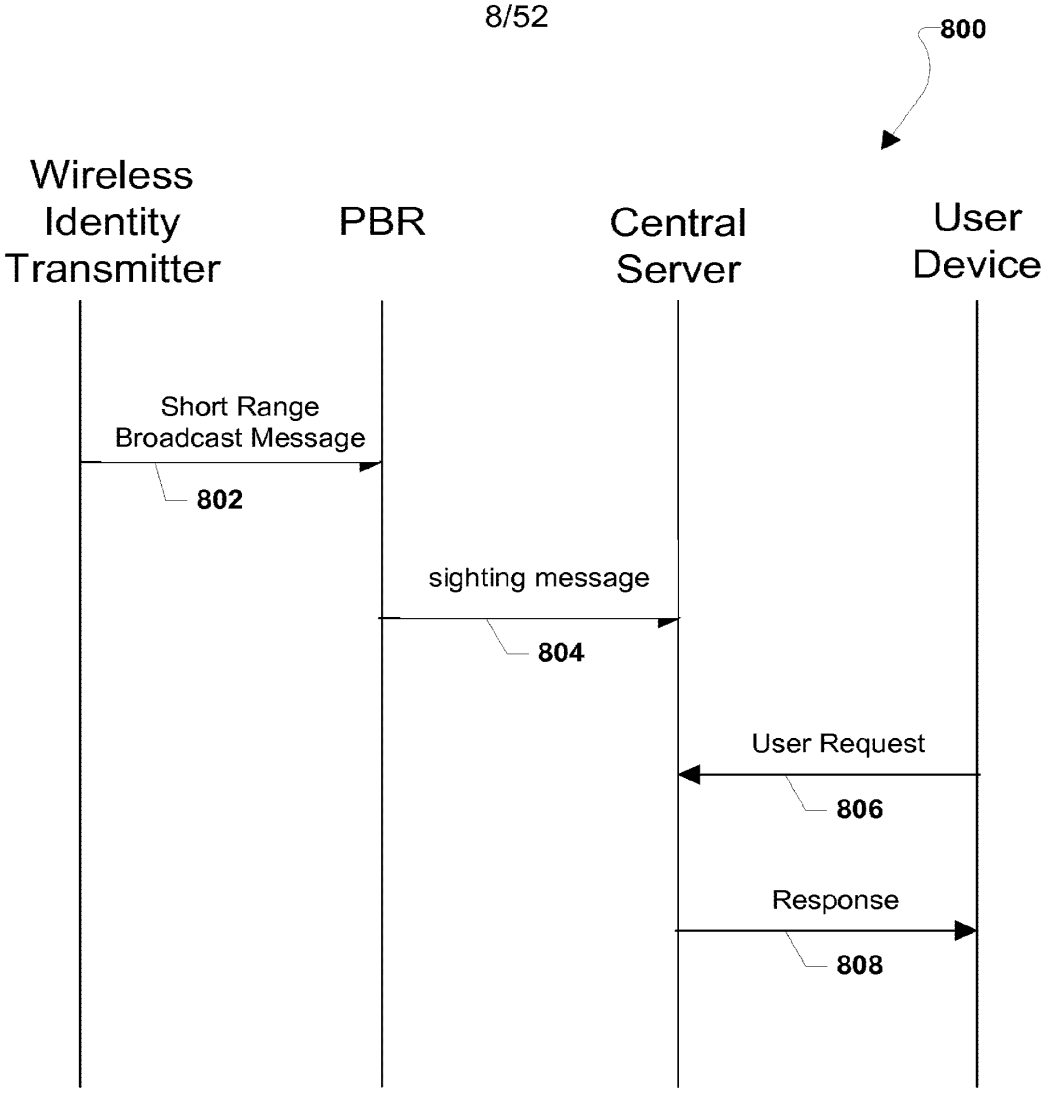

800
Wireless Identity Transmitter
PBR
Central Server
User Device
Short Range Broadcast Message
802
sighting message
804
User Request
806
Response
808

FIG. 8

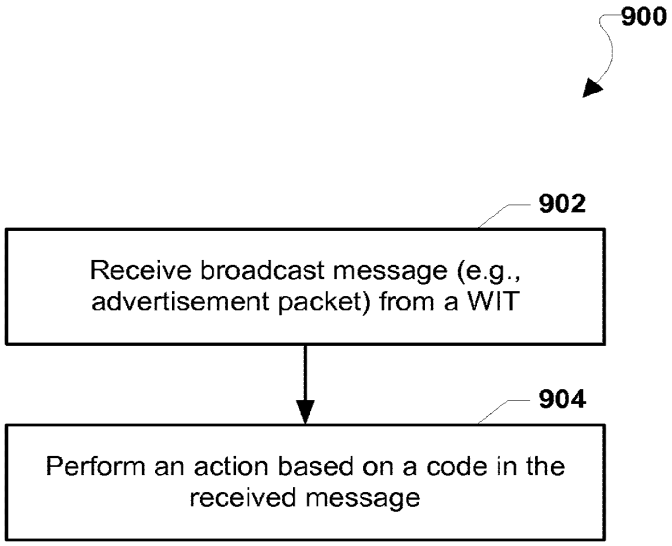

900
902
Receive broadcast message (e.g., advertisement packet) from a WIT
904
Perform an action based on a code in the received message

FIG. 9

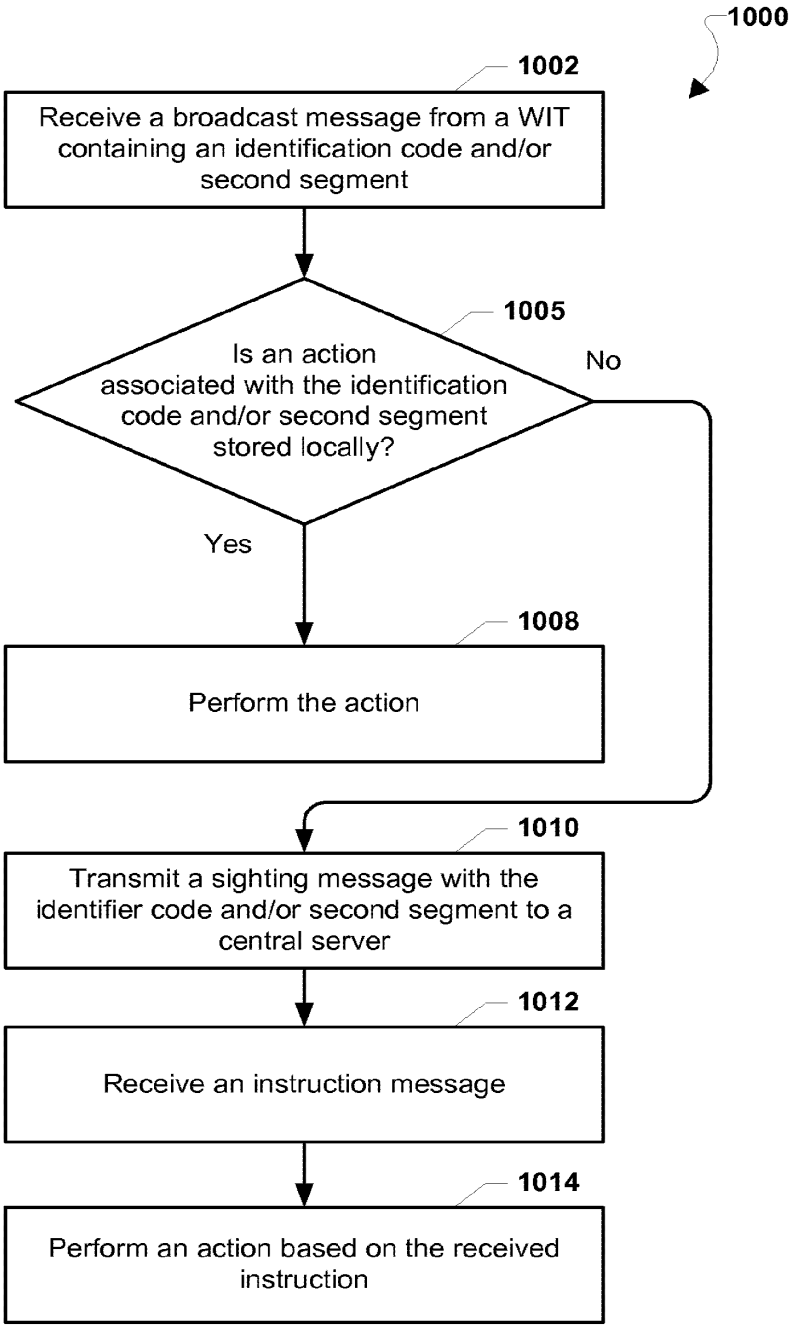

1000
1002
Receive a broadcast message from a WIT containing an identification code and/or second segment
1005
Is an action associated with the identification code and/or second segment stored locally?
No
Yes
1008
Perform the action
1010
Transmit a sighting message with the identifier code and/or second segment to a central server
1012
Receive an instruction message
1014
Perform an action based on the received instruction

FIG. 10

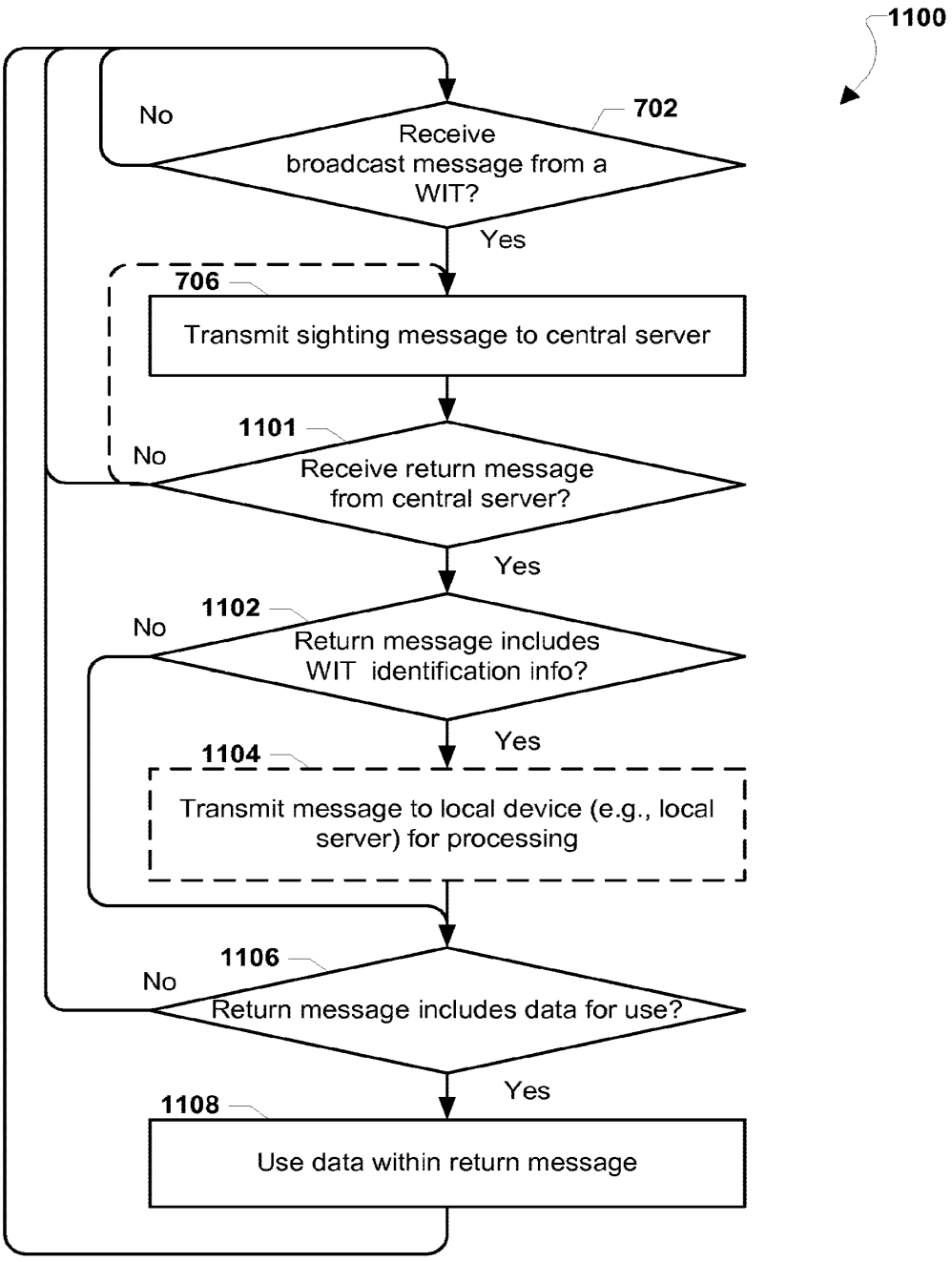

1100
No
Receive broadcast message from a WIT?
702
Yes
706
Transmit sighting message to central server
1101
No
Receive return message from central server?
Yes
1102
No
Return message includes WIT identification info?
Yes
1104
Transmit message to local device (e.g., local server) for processing
1106
No
Return message includes data for use?
Yes
1108
Use data within return message

FIG. 11

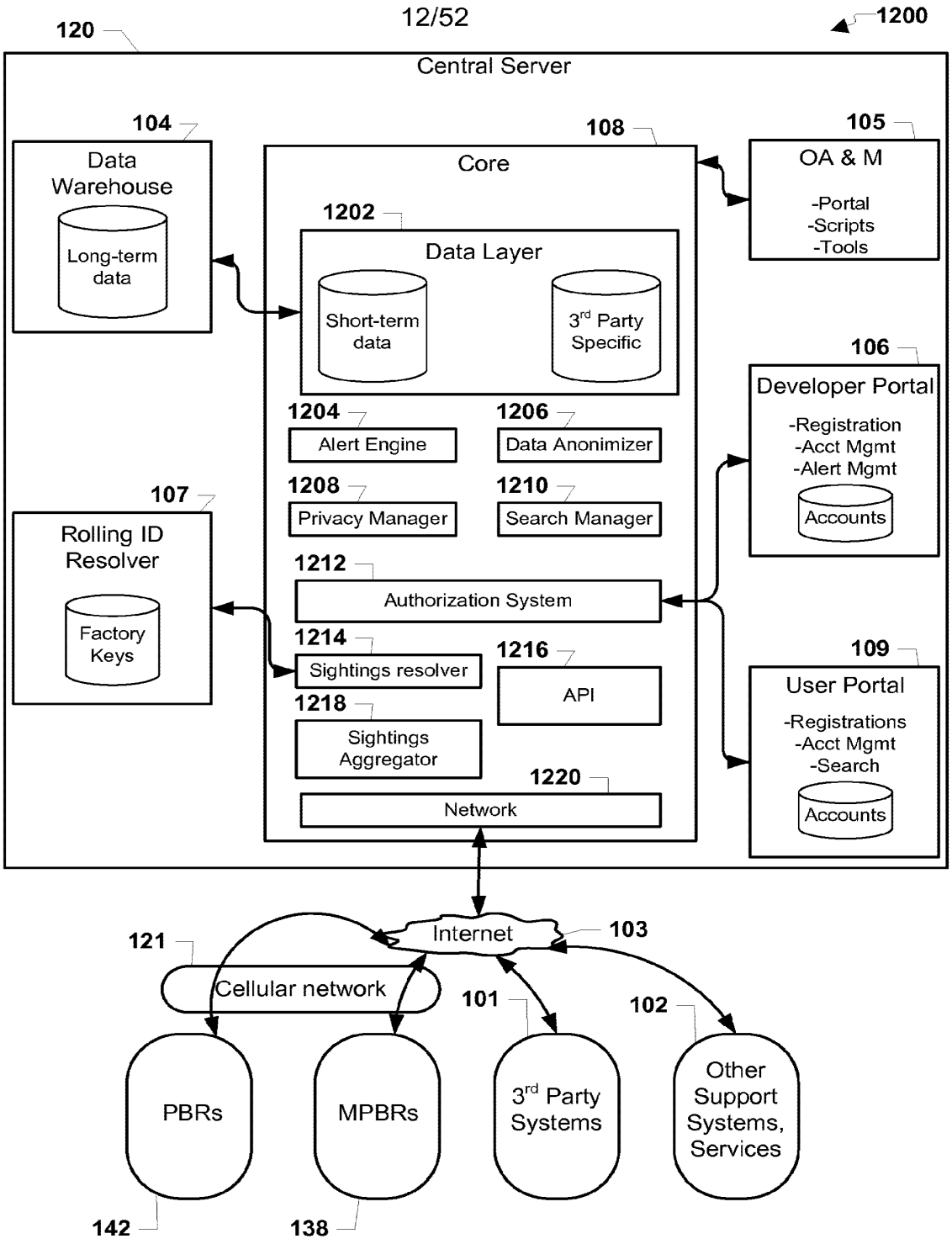

120
1200
Central Server
104
Data Warehouse
Long-term data
108
Core
1202
Data Layer
Short-term data
3rd Party Specific
105
OA & M
-Portal
-Scripts
-Tools
106
Developer Portal
-Registration
-Acct Mgmt
-Alert Mgmt
Accounts
1204
Alert Engine
1206
Data Anonimizer
1208
Privacy Manager
1210
Search Manager
107
Rolling ID Resolver
Factory Keys
1212
Authorization System
1214
Sightings resolver
1216
API
1218
Sightings Aggregator
1220
Network
109
User Portal
-Registrations
-Acct Mgmt
-Search
Accounts
121
Internet
103
Cellular network
101
102
PBRs
MPBRs
3rd Party Systems
Other Support Systems, Services
142
138

FIG. 12

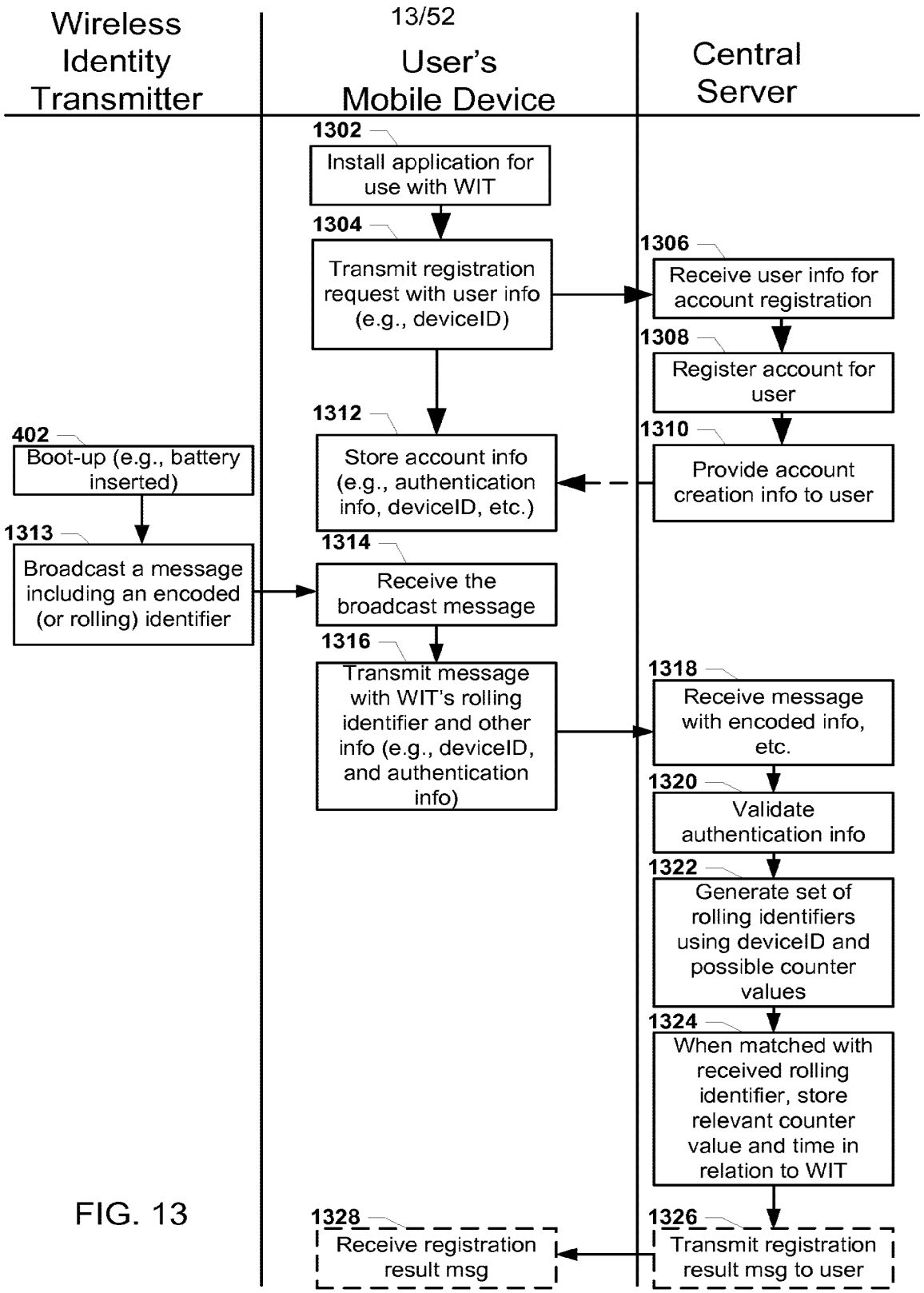


FIG. 13

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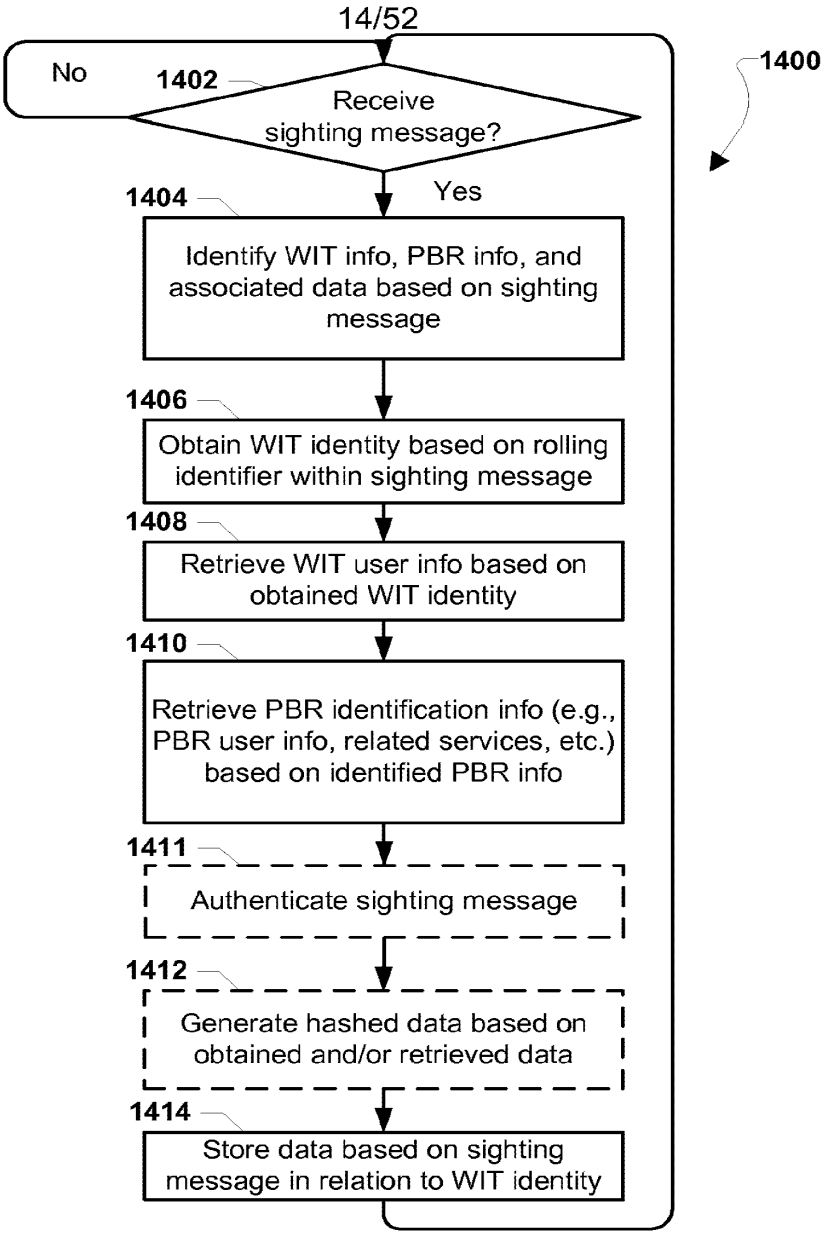

1400
No
1402
Receive sighting message?
Yes
1404
Identify WIT info, PBR info, and associated data based on sighting message
1406
Obtain WIT identity based on rolling identifier within sighting message
1408
Retrieve WIT user info based on obtained WIT identity
1410
Retrieve PBR identification info (e.g., PBR user info, related services, etc.) based on identified PBR info
1411
Authenticate sighting message
1412
Generate hashed data based on obtained and/or retrieved data
1414
Store data based on sighting message in relation to WIT identity

FIG. 14A

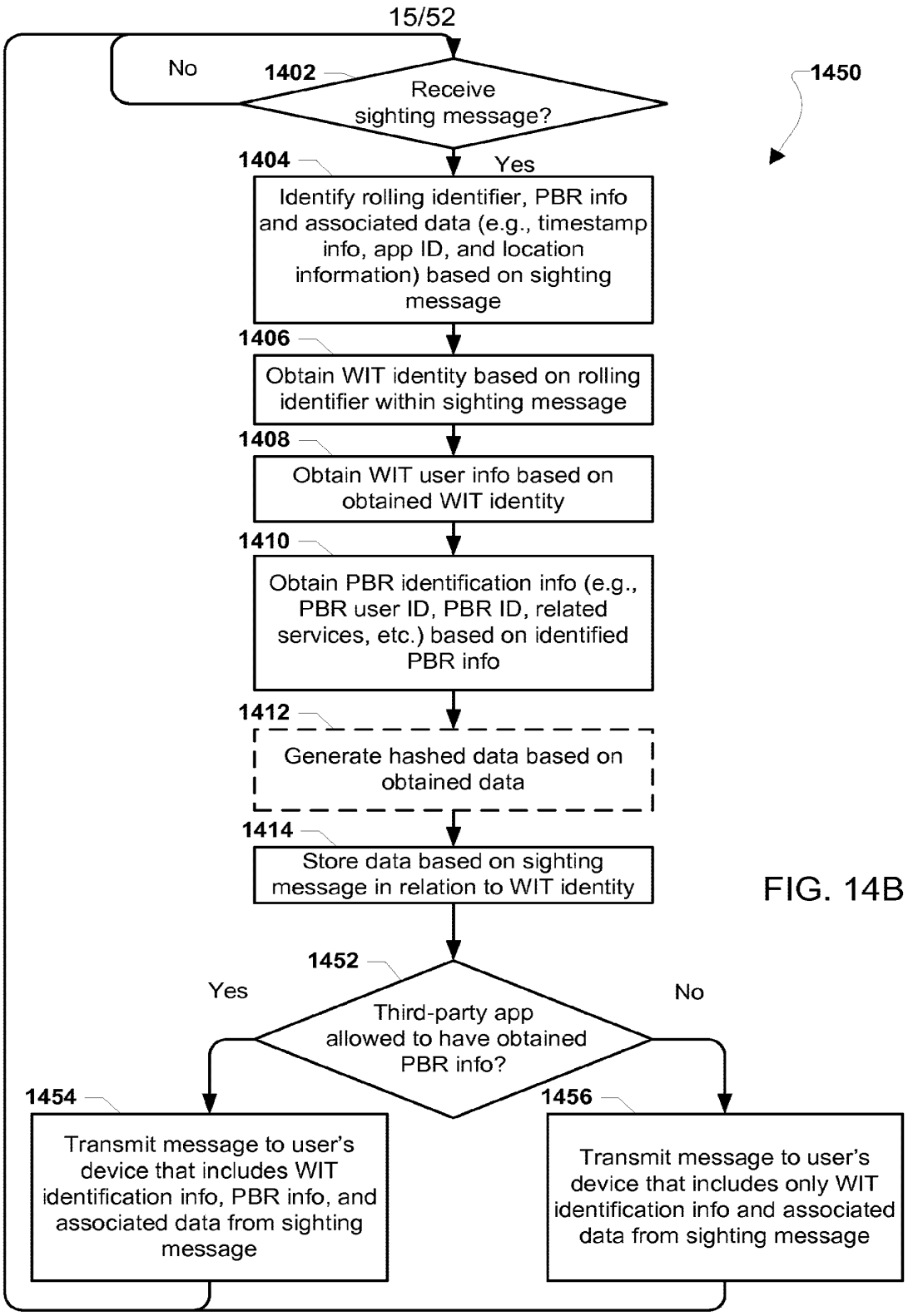

1450
1402
Receive sighting message?
No
Yes
1404
Identify rolling identifier, PBR info and associated data (e.g., timestamp info, app ID, and location information) based on sighting message
1406
Obtain WIT identity based on rolling identifier within sighting message
1408
Obtain WIT user info based on obtained WIT identity
1410
Obtain PBR identification info (e.g., PBR user ID, PBR ID, related services, etc.) based on identified PBR info
1412
Generate hashed data based on obtained data
1414
Store data based on sighting message in relation to WIT identity
1452
Third-party app allowed to have obtained PBR info?
Yes
No
1454
Transmit message to user's device that includes WIT identification info, PBR info, and associated data from sighting message
1456
Transmit message to user's device that includes only WIT identification info and associated data from sighting message

FIG. 14B

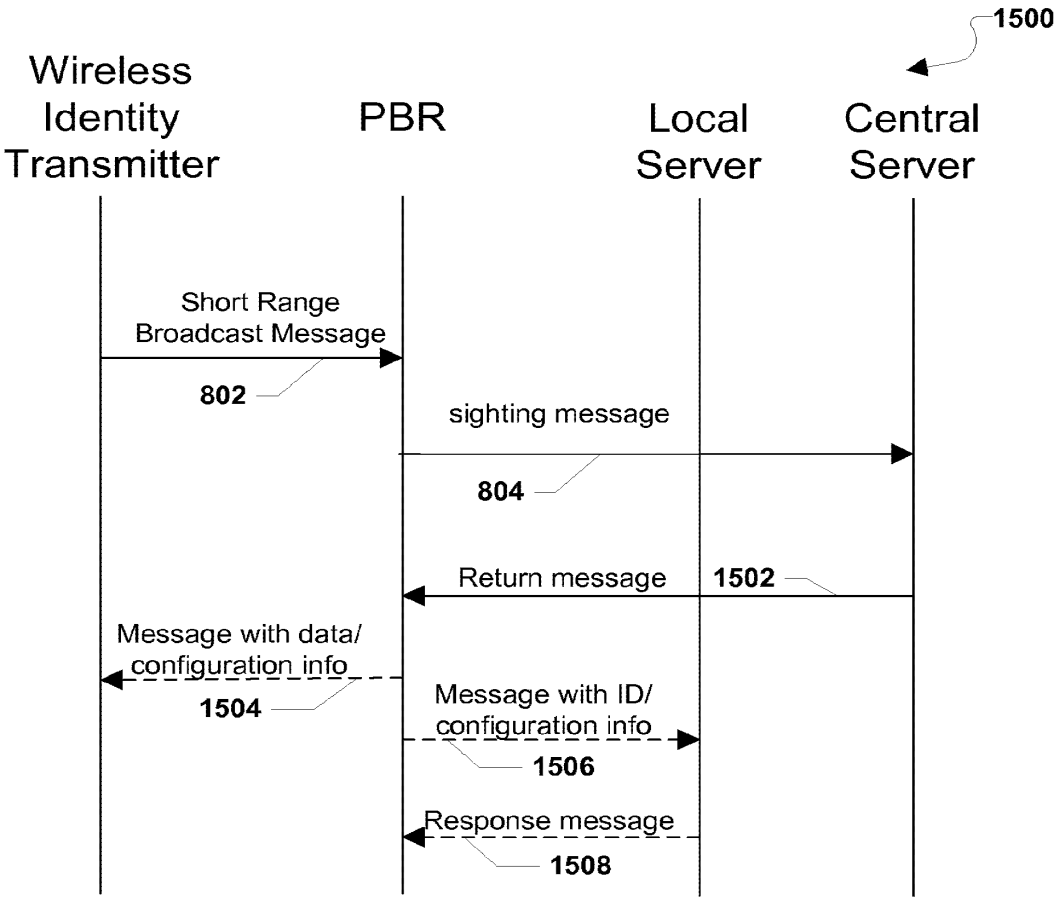

1500
Wireless Identity Transmitter
PBR
Local Server
Central Server
Short Range Broadcast Message
802
sighting message
804
Return message
1502
Message with data/ configuration info
1504
Message with ID/ configuration info
1506
Response message
1508

FIG. 15A

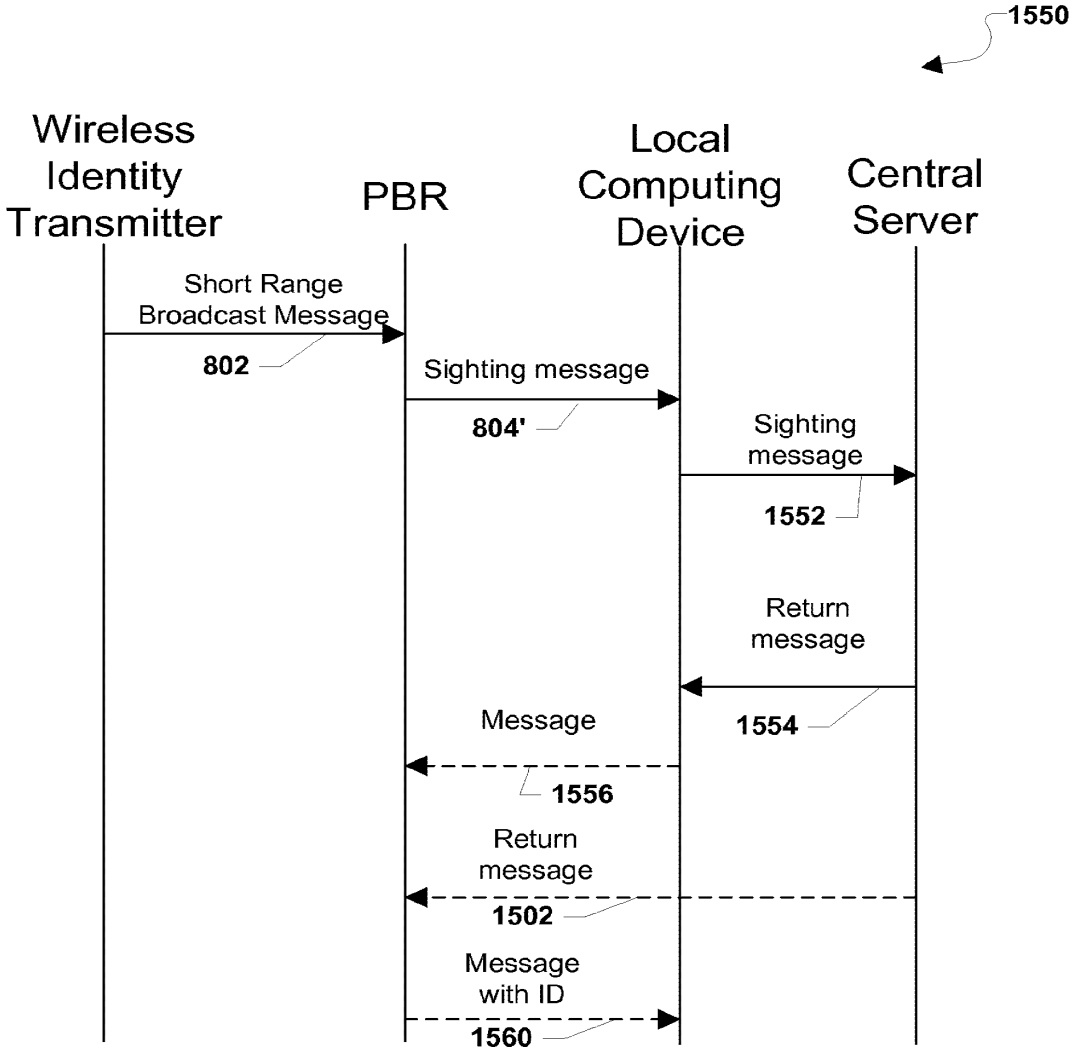

1550
Wireless Identity Transmitter
PBR
Local Computing Device
Central Server
Short Range Broadcast Message
802
Sighting message
804'
Sighting message
1552
Return message
1554
Message
1556
Return message
1502
Message with ID
1560

FIG. 15B

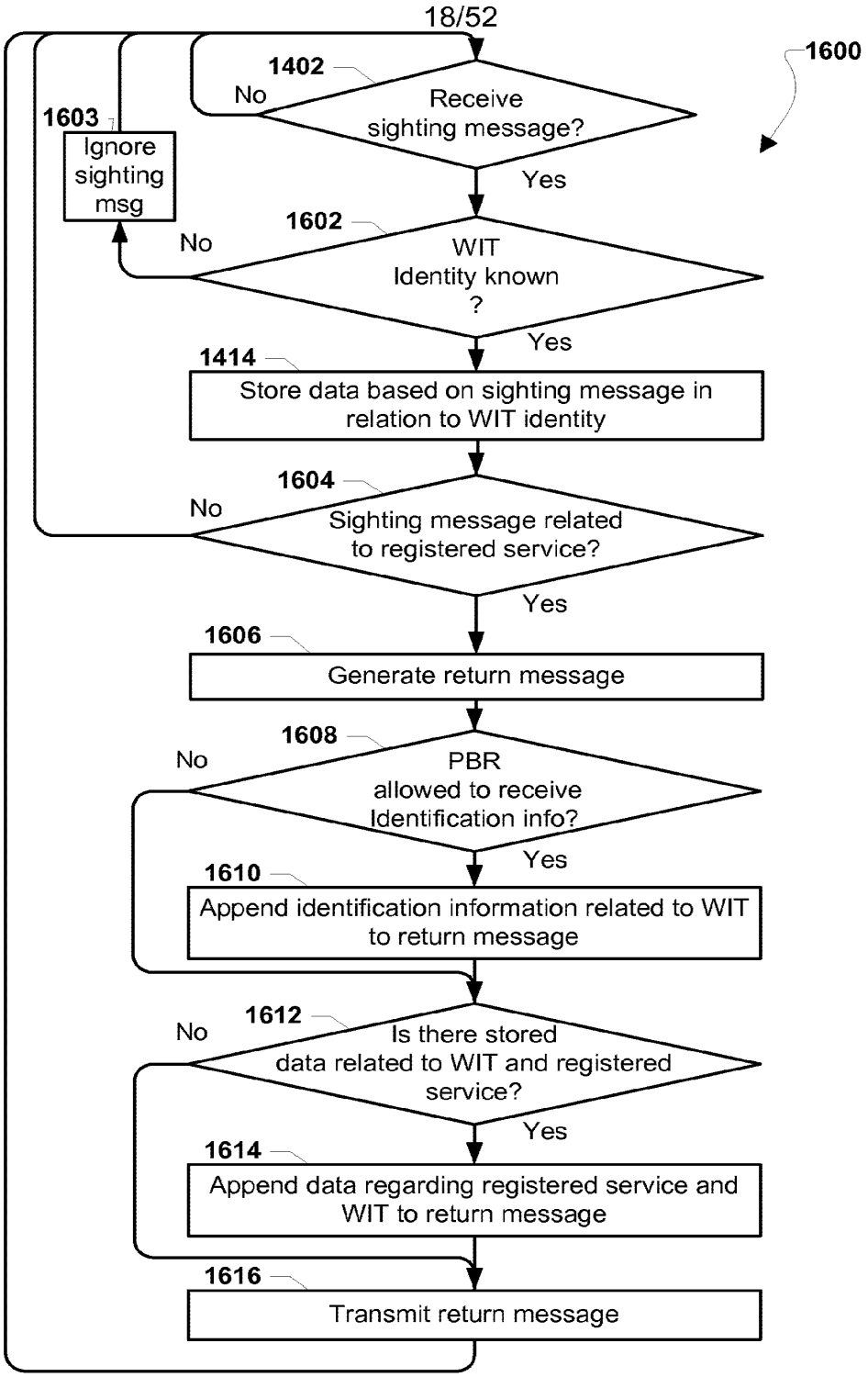

1600
1402
Receive sighting message?
No
Yes
1603
Ignore sighting msg
1602
WIT Identity known ?
No
Yes
1414
Store data based on sighting message in relation to WIT identity
1604
Sighting message related to registered service?
No
Yes
1606
Generate return message
1608
PBR allowed to receive Identification info?
No
Yes
1610
Append identification information related to WIT to return message
1612
Is there stored data related to WIT and registered service?
No
Yes
1614
Append data regarding registered service and WIT to return message
1616
Transmit return message

FIG. 16

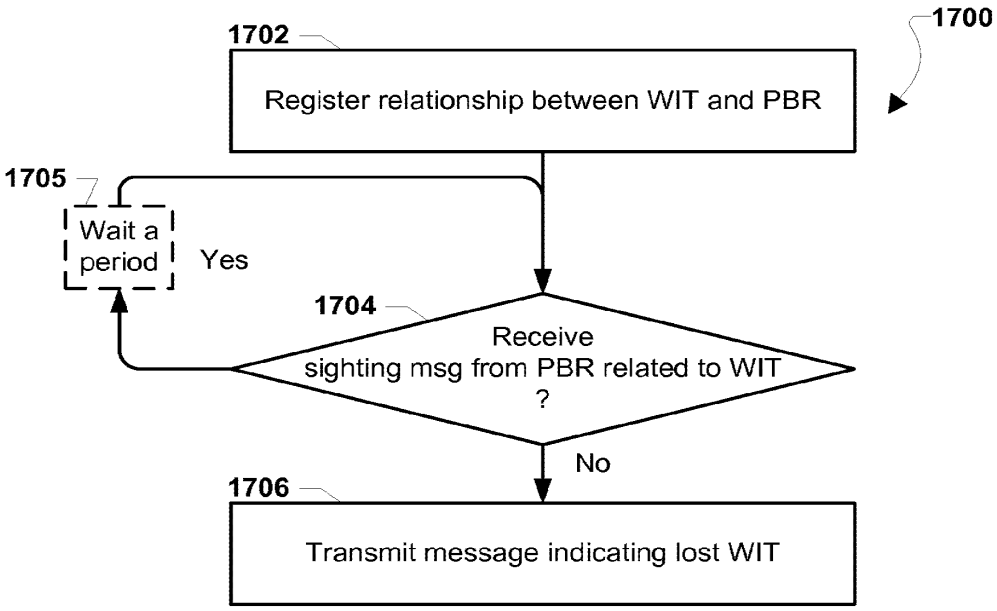

1700
1702
Register relationship between WIT and PBR
1705
Wait a period
Yes
1704
Receive sighting msg from PBR related to WIT ?
No
1706
Transmit message indicating lost WIT

FIG. 17

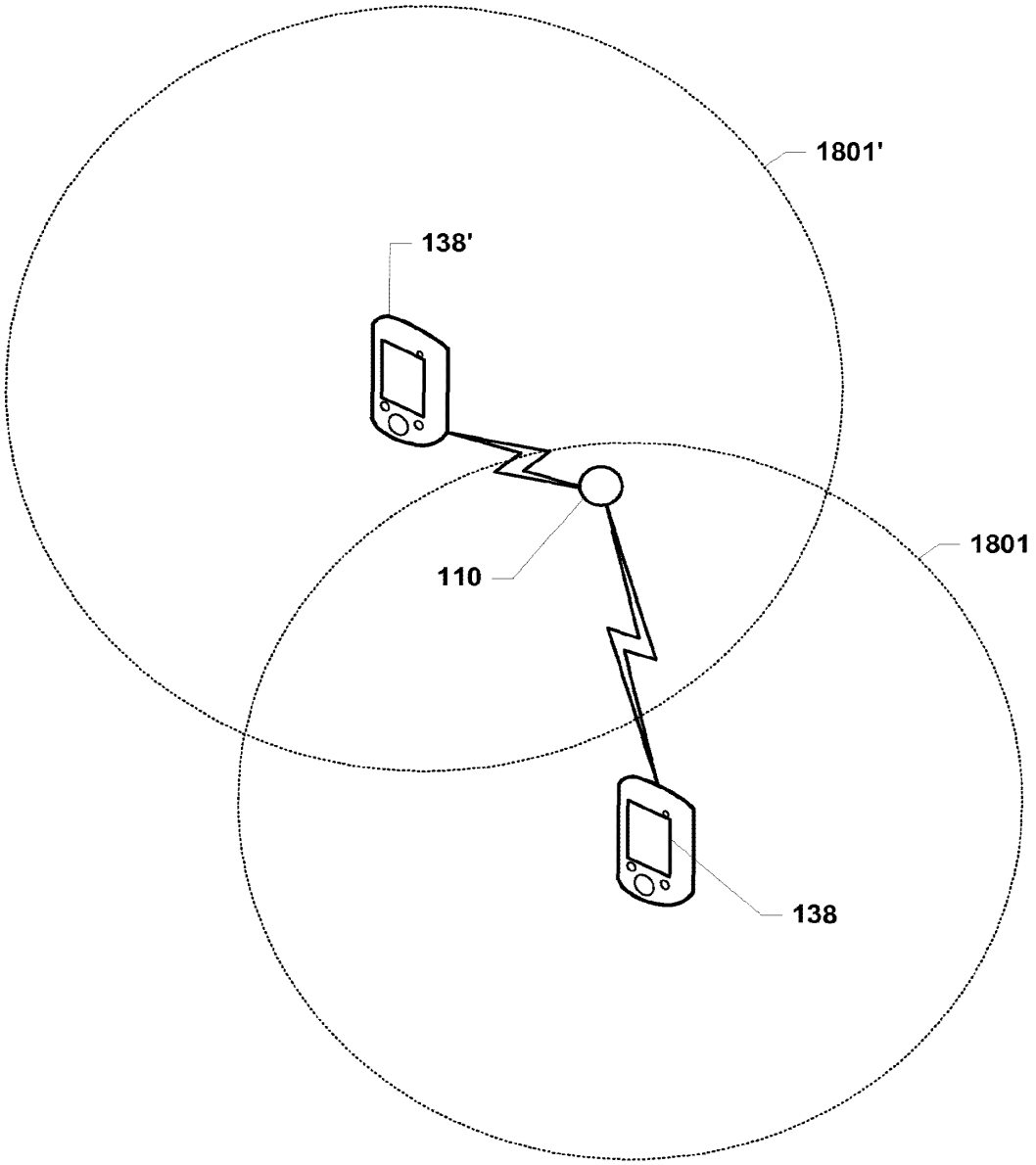


FIG. 18A

Petitioner Samsung Ex-1004, 0427

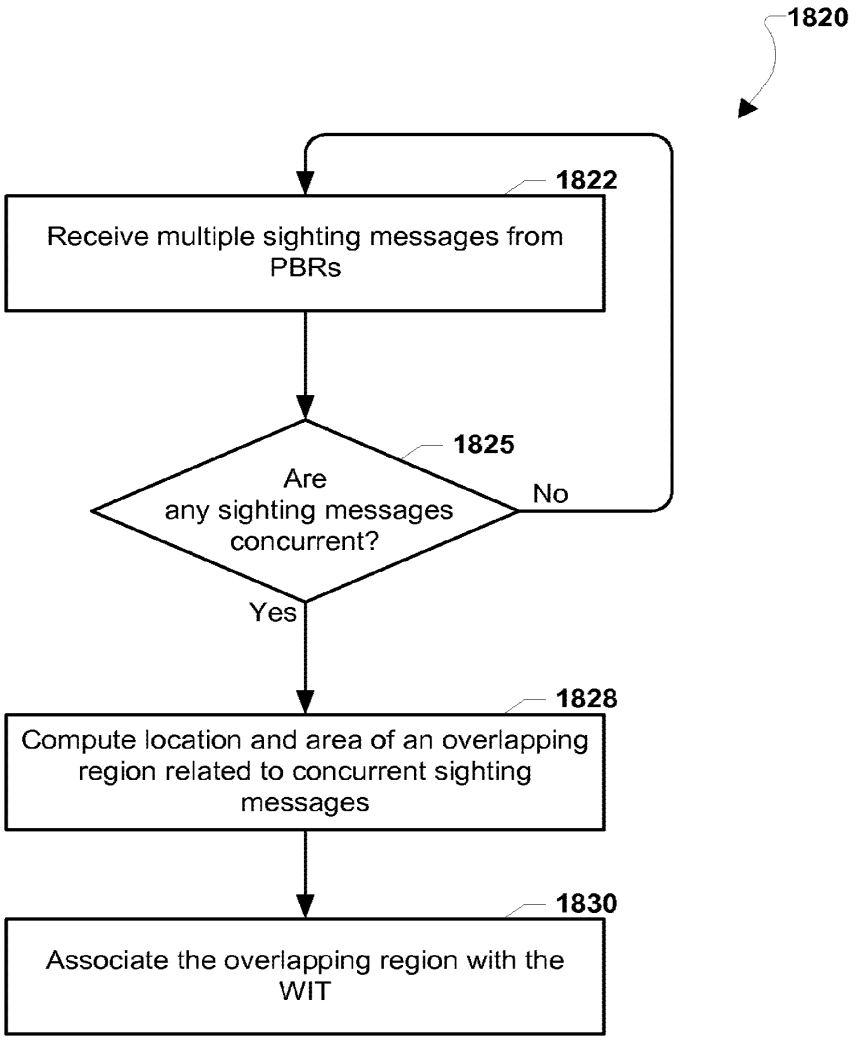

1820
1822
Receive multiple sighting messages from PBRs
1825
Are any sighting messages concurrent?
No
Yes
1828
Compute location and area of an overlapping region related to concurrent sighting messages
1830
Associate the overlapping region with the WIT

FIG. 18B

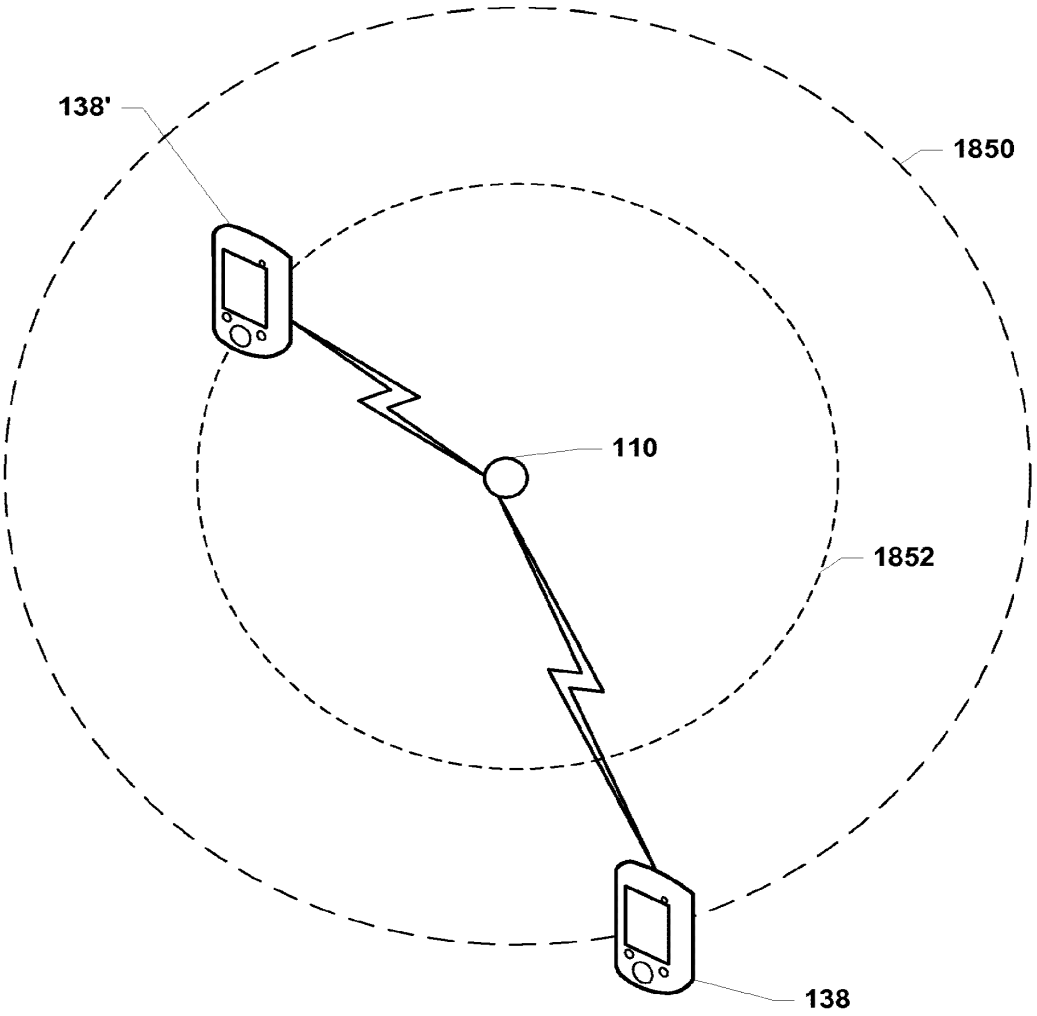


FIG. 18C

Petitioner Samsung Ex-1004, 0429

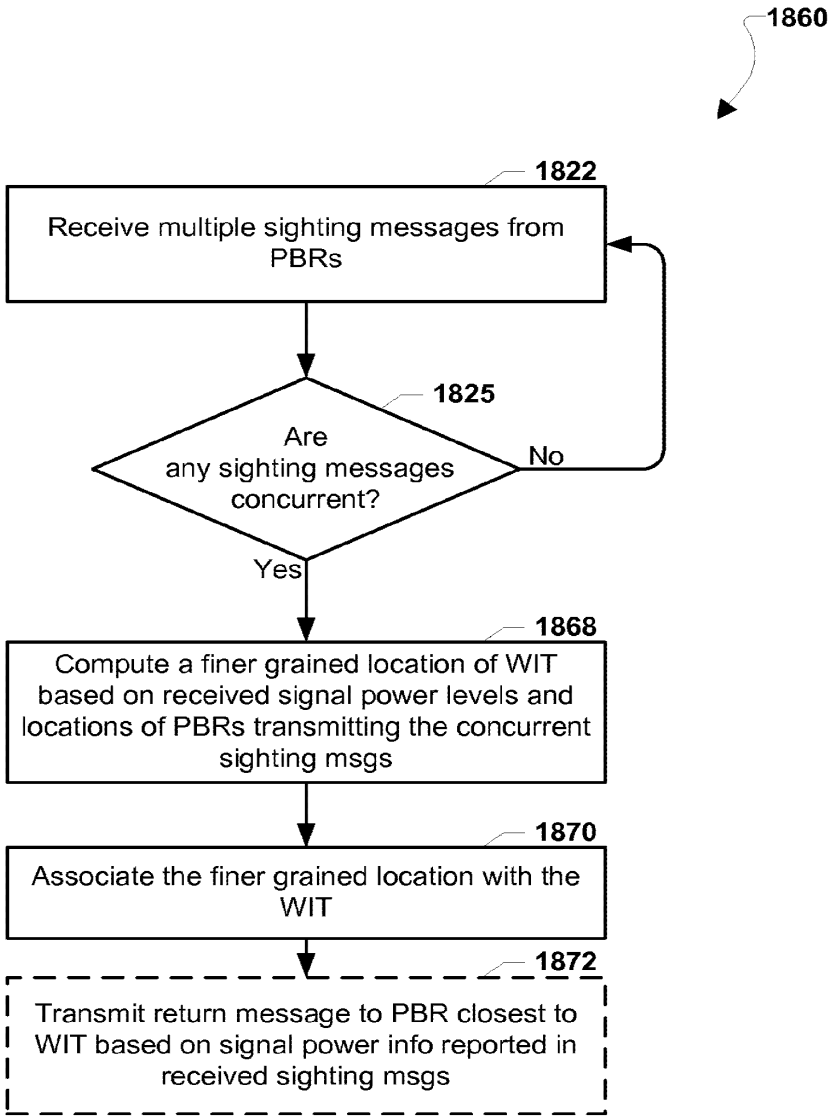

1860
1822
Receive multiple sighting messages from PBRs
1825
Are any sighting messages concurrent?
No
Yes
1868
Compute a finer grained location of WIT based on received signal power levels and locations of PBRs transmitting the concurrent sighting msgs
1870
Associate the finer grained location with the WIT
1872
Transmit return message to PBR closest to WIT based on signal power info reported in received sighting msgs

FIG. 18D

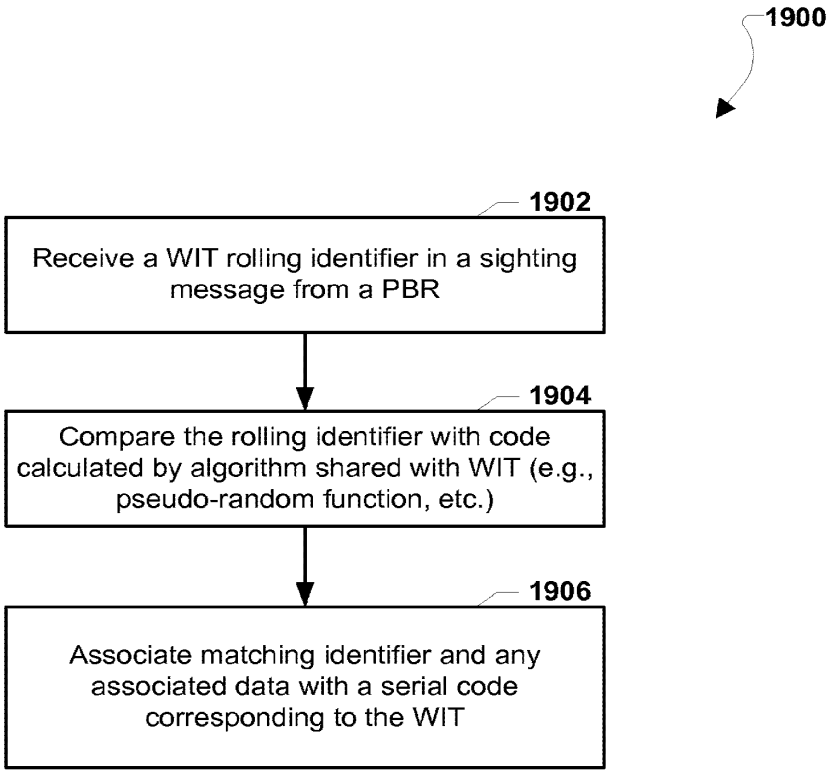

1900
1902
Receive a WIT rolling identifier in a sighting message from a PBR
1904
Compare the rolling identifier with code calculated by algorithm shared with WIT (e.g., pseudo-random function, etc.)
1906
Associate matching identifier and any associated data with a serial code corresponding to the WIT

FIG. 19

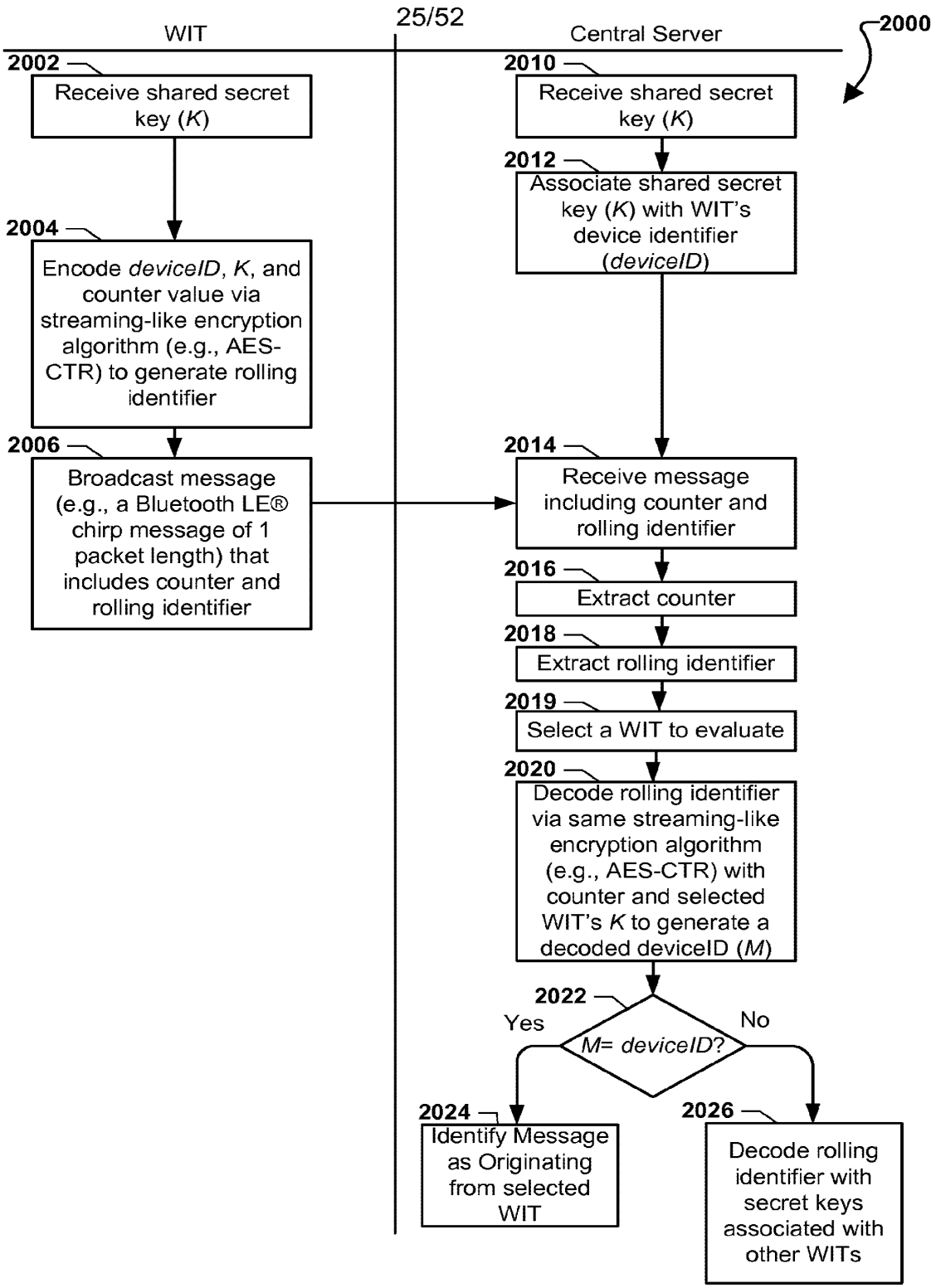

WIT
Central Server
2000
2002
Receive shared secret key (K)
2004
Encode deviceID, K, and counter value via streaming-like encryption algorithm (e.g., AES-CTR) to generate rolling identifier
2006
Broadcast message (e.g., a Bluetooth LE® chirp message of 1 packet length) that includes counter and rolling identifier
2010
Receive shared secret key (K)
2012
Associate shared secret key (K) with WIT's device identifier (deviceID)
2014
Receive message including counter and rolling identifier
2016
Extract counter
2018
Extract rolling identifier
2019
Select a WIT to evaluate
2020
Decode rolling identifier via same streaming-like encryption algorithm (e.g., AES-CTR) with counter and selected WIT's K to generate a decoded deviceID (M)
2022
M= deviceID?
Yes
No
2024
Identify Message as Originating from selected WIT
2026
Decode rolling identifier with secret keys associated with other WITs

FIG. 20

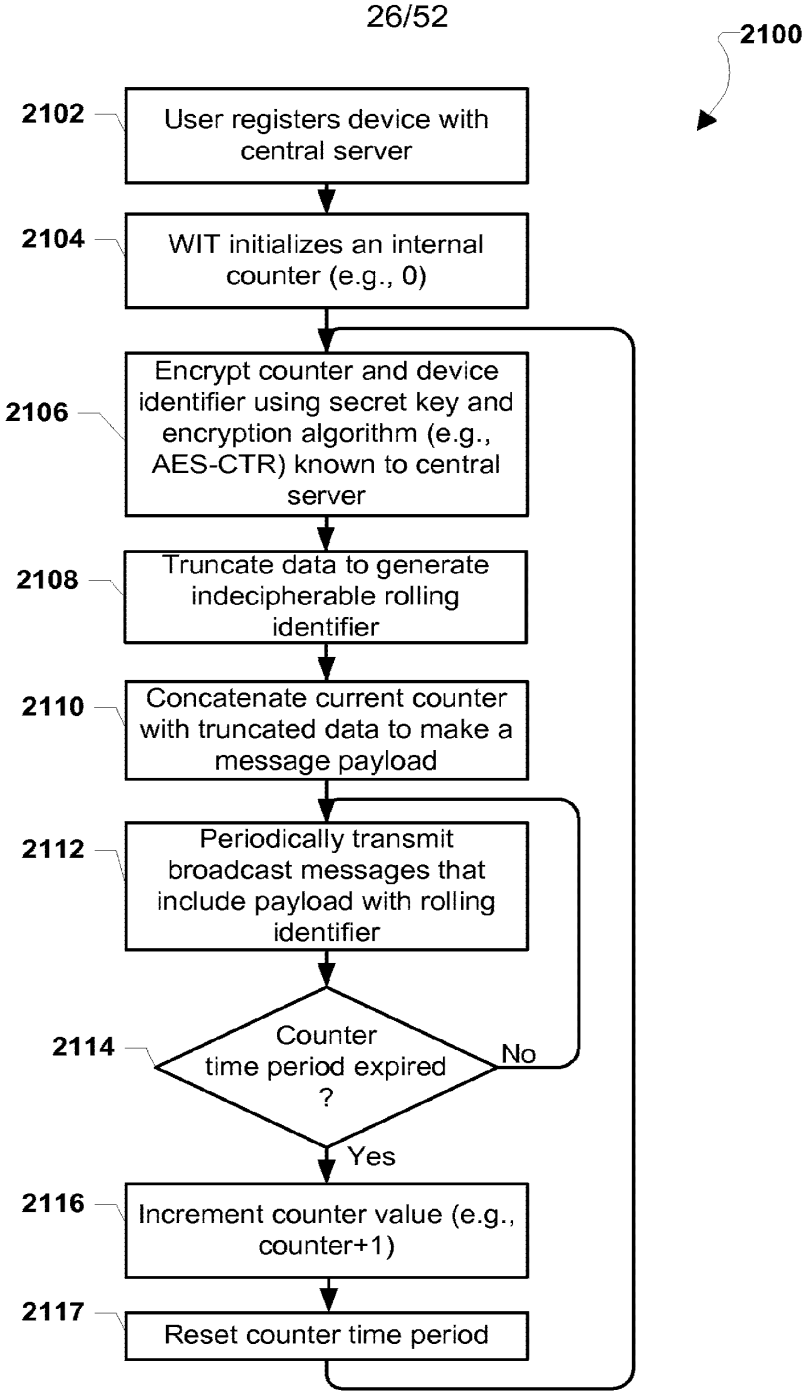

2100
2102
User registers device with central server
2104
WIT initializes an internal counter (e.g., 0)
2106
Encrypt counter and device identifier using secret key and encryption algorithm (e.g., AES-CTR) known to central server
2108
Truncate data to generate indecipherable rolling identifier
2110
Concatenate current counter with truncated data to make a message payload
2112
Periodically transmit broadcast messages that include payload with rolling identifier
2114
Counter time period expired ?
No
Yes
2116
Increment counter value (e.g., counter+1)
2117
Reset counter time period

FIG. 21A

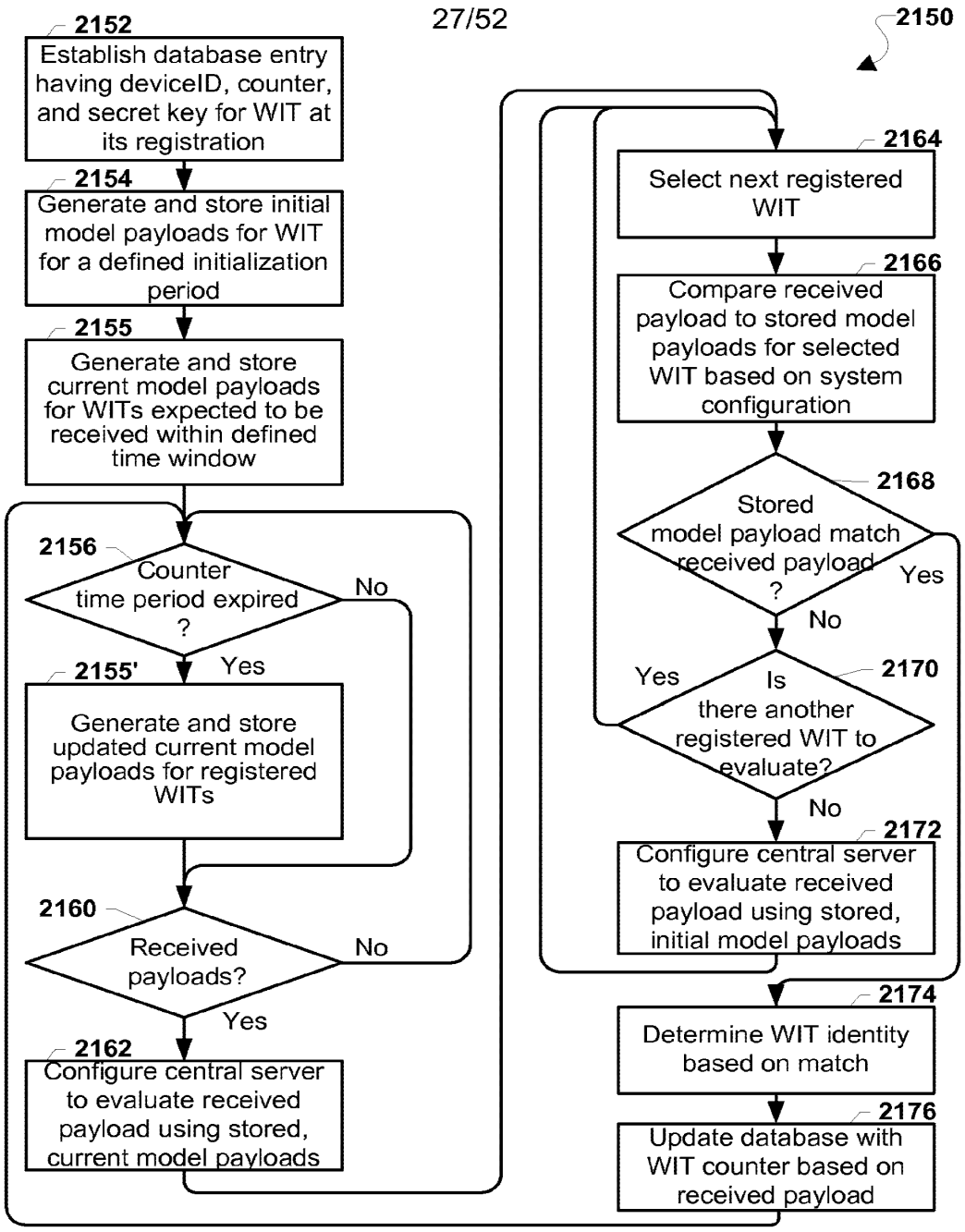

2150
2152
Establish database entry having deviceID, counter, and secret key for WIT at its registration
2154
Generate and store initial model payloads for WIT for a defined initialization period
2155
Generate and store current model payloads for WITs expected to be received within defined time window
2156
Counter time period expired ?
No
Yes
2155'
Generate and store updated current model payloads for registered WITs
2160
Received payloads?
No
Yes
2162
Configure central server to evaluate received payload using stored, current model payloads
2164
Select next registered WIT
2166
Compare received payload to stored model payloads for selected WIT based on system configuration
2168
Stored model payload match received payload ?
Yes
No
2170
Is there another registered WIT to evaluate?
Yes
No
2172
Configure central server to evaluate received payload using stored, initial model payloads
2174
Determine WIT identity based on match
2176
Update database with WIT counter based on received payload

FIG. 21B

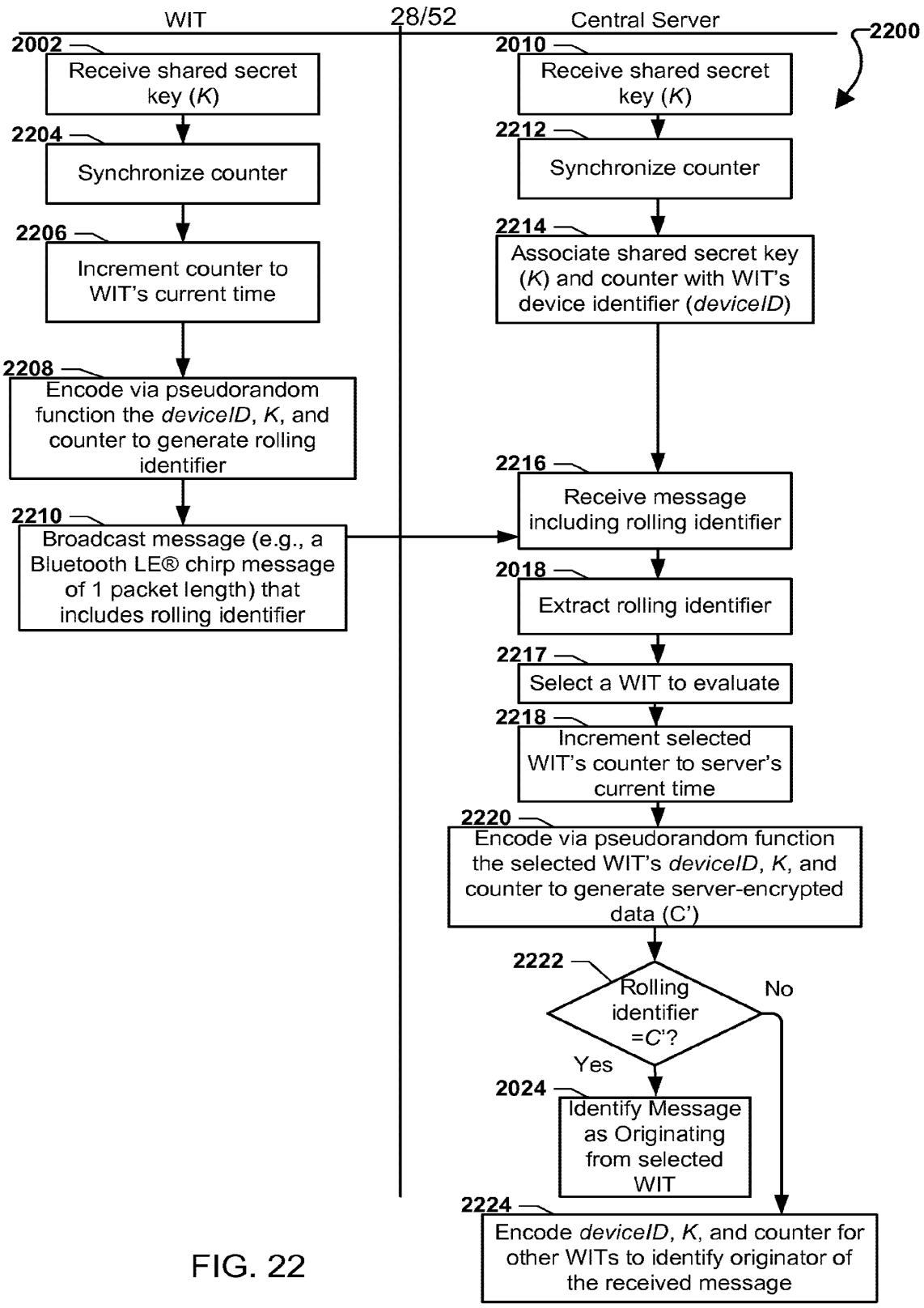

WIT
Central Server
2200
2002
Receive shared secret key (K)
2204
Synchronize counter
2206
Increment counter to WIT's current time
2208
Encode via pseudorandom function the deviceID, K, and counter to generate rolling identifier
2210
Broadcast message (e.g., a Bluetooth LE® chirp message of 1 packet length) that includes rolling identifier
2010
Receive shared secret key (K)
2212
Synchronize counter
2214
Associate shared secret key (K) and counter with WIT's device identifier (deviceID)
2216
Receive message including rolling identifier
2018
Extract rolling identifier
2217
Select a WIT to evaluate
2218
Increment selected WIT's counter to server's current time
2220
Encode via pseudorandom function the selected WIT's deviceID, K, and counter to generate server-encrypted data (C')
2222
Rolling identifier =C'?
No
Yes
2024
Identify Message as Originating from selected WIT
2224
Encode deviceID, K, and counter for other WITs to identify originator of the received message

FIG. 22

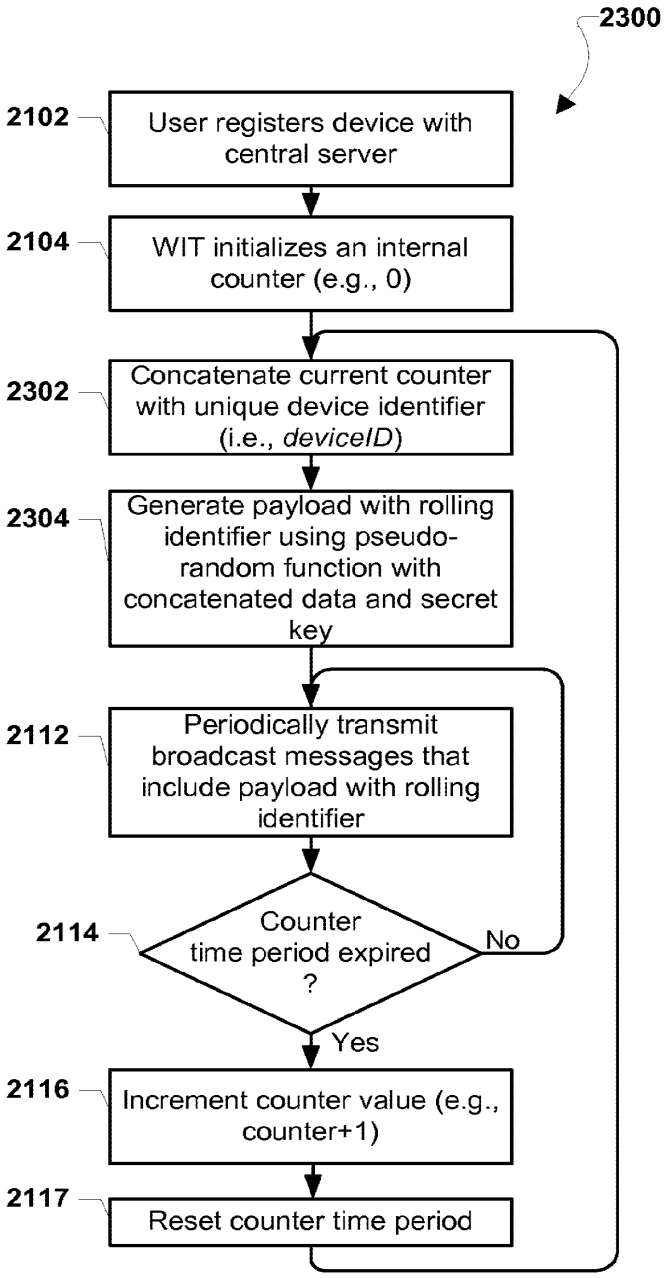


FIG. 23A

Petitioner Samsung Ex-1004, 0436

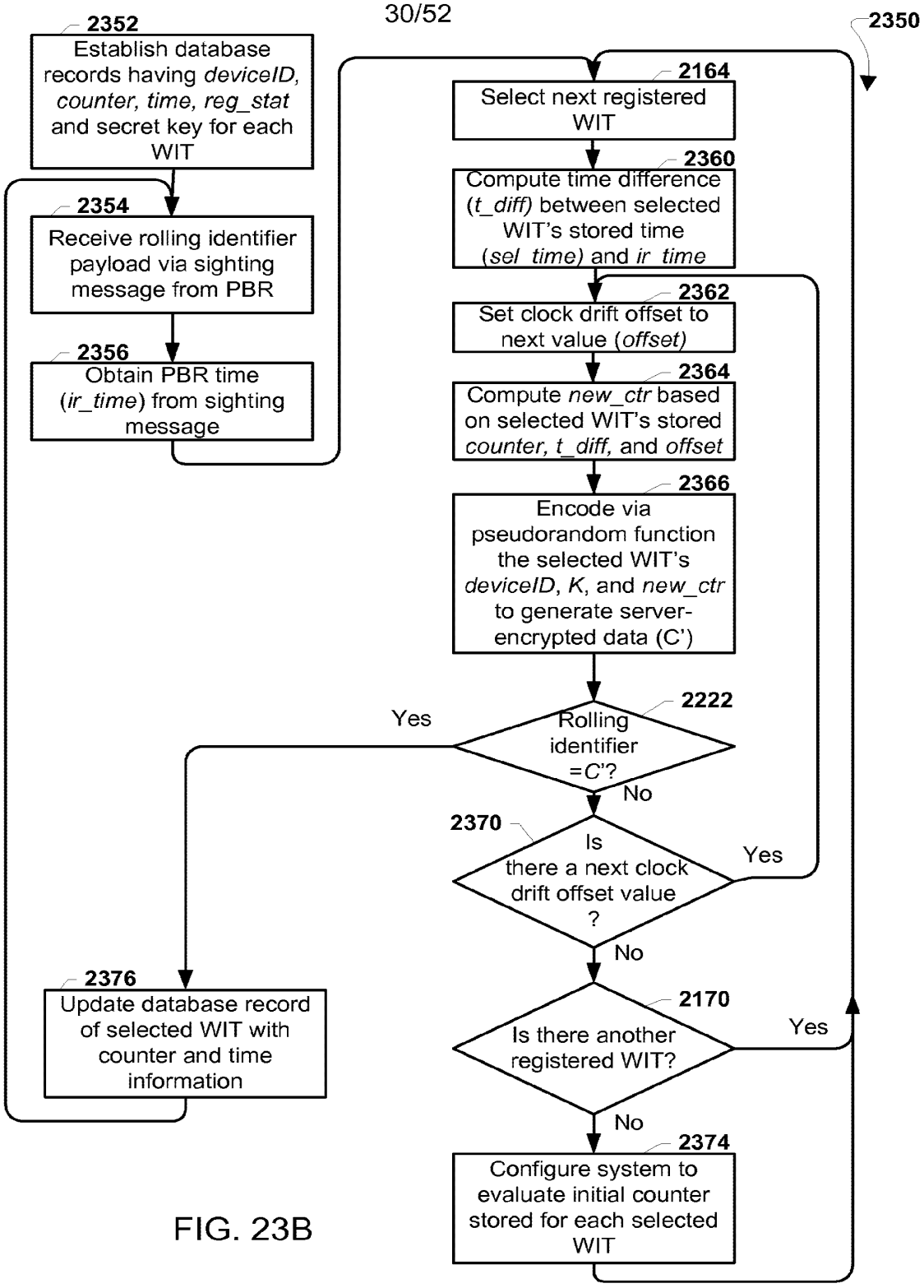


FIG. 23B

Petitioner Samsung Ex-1004, 0437

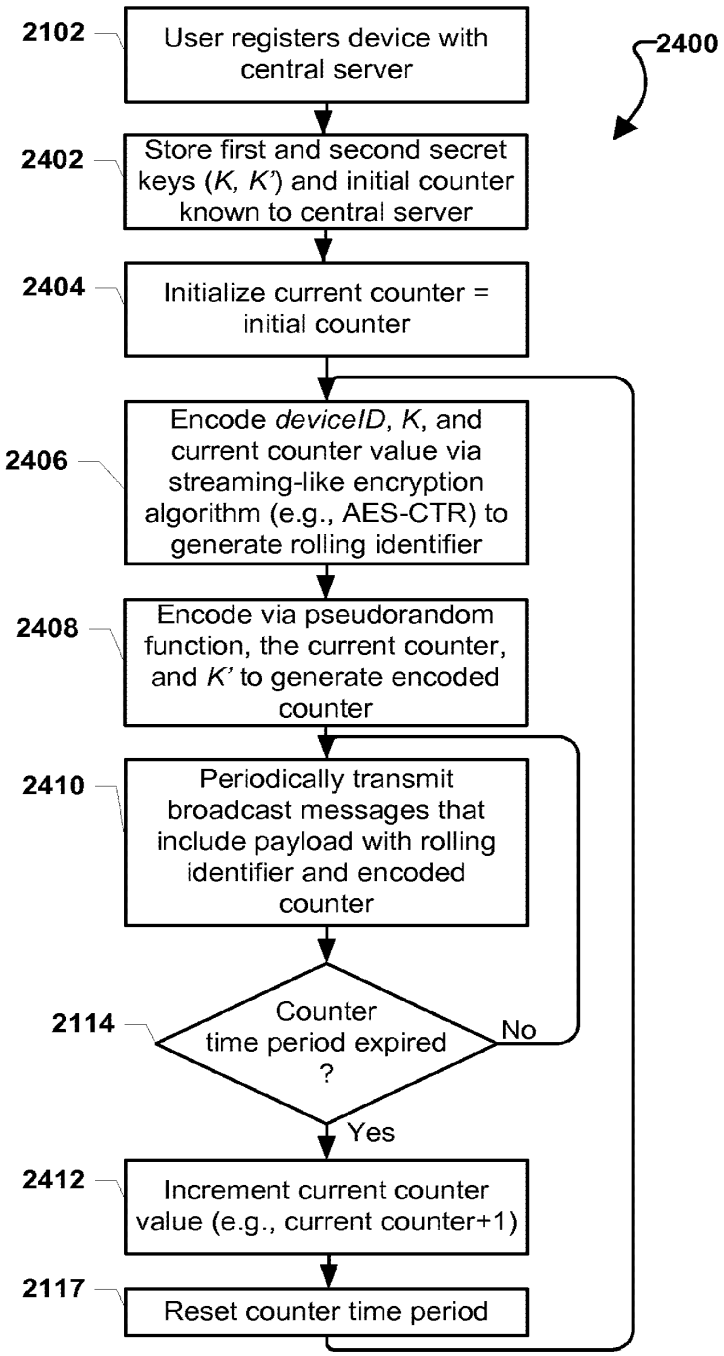

2102
User registers device with central server
2400
2402
Store first and second secret keys (K, K') and initial counter known to central server
2404
Initialize current counter = initial counter
2406
Encode deviceID, K, and current counter value via streaming-like encryption algorithm (e.g., AES-CTR) to generate rolling identifier
2408
Encode via pseudorandom function, the current counter, and K' to generate encoded counter
2410
Periodically transmit broadcast messages that include payload with rolling identifier and encoded counter
2114
Counter time period expired ?
No
Yes
2412
Increment current counter value (e.g., current counter+1)
2117
Reset counter time period

FIG. 24A

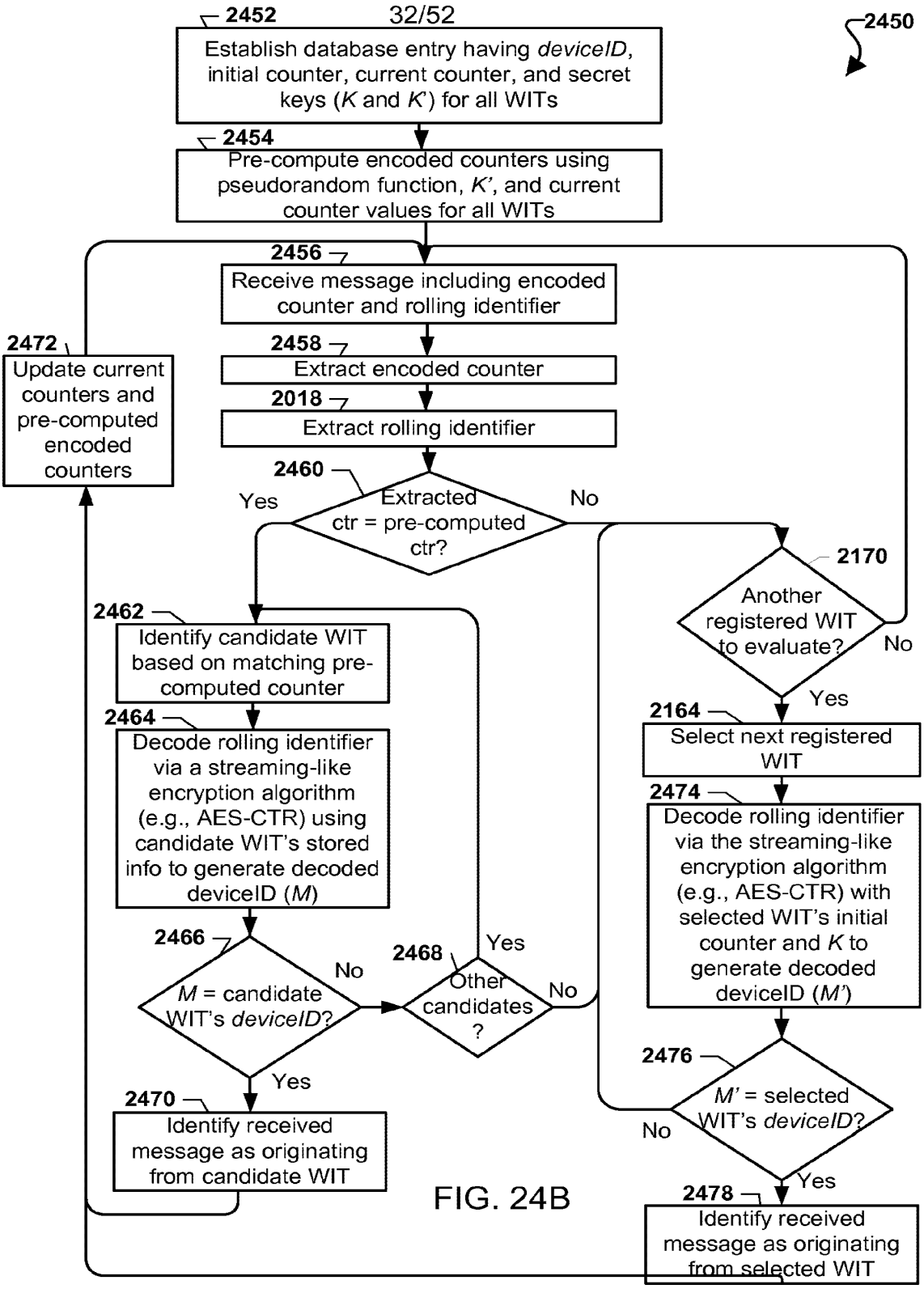

2450
2452
Establish database entry having deviceID, initial counter, current counter, and secret keys (K and K') for all WITs
2454
Pre-compute encoded counters using pseudorandom function, K', and current counter values for all WITs
2456
Receive message including encoded counter and rolling identifier
2458
Extract encoded counter
2018
Extract rolling identifier
2460
Extracted ctr = pre-computed ctr?
Yes
No
2472
Update current counters and pre-computed encoded counters
2462
Identify candidate WIT based on matching pre-computed counter
2464
Decode rolling identifier via a streaming-like encryption algorithm (e.g., AES-CTR) using candidate WIT's stored info to generate decoded deviceID (M)
2466
M = candidate WIT's deviceID?
No
Yes
2468
Other candidates ?
Yes
No
2470
Identify received message as originating from candidate WIT
2170
Another registered WIT to evaluate?
No
Yes
2164
Select next registered WIT
2474
Decode rolling identifier via the streaming-like encryption algorithm (e.g., AES-CTR) with selected WIT's initial counter and K to generate decoded deviceID (M')
2476
M' = selected WIT's deviceID?
No
Yes
2478
Identify received message as originating from selected WIT

FIG. 24B

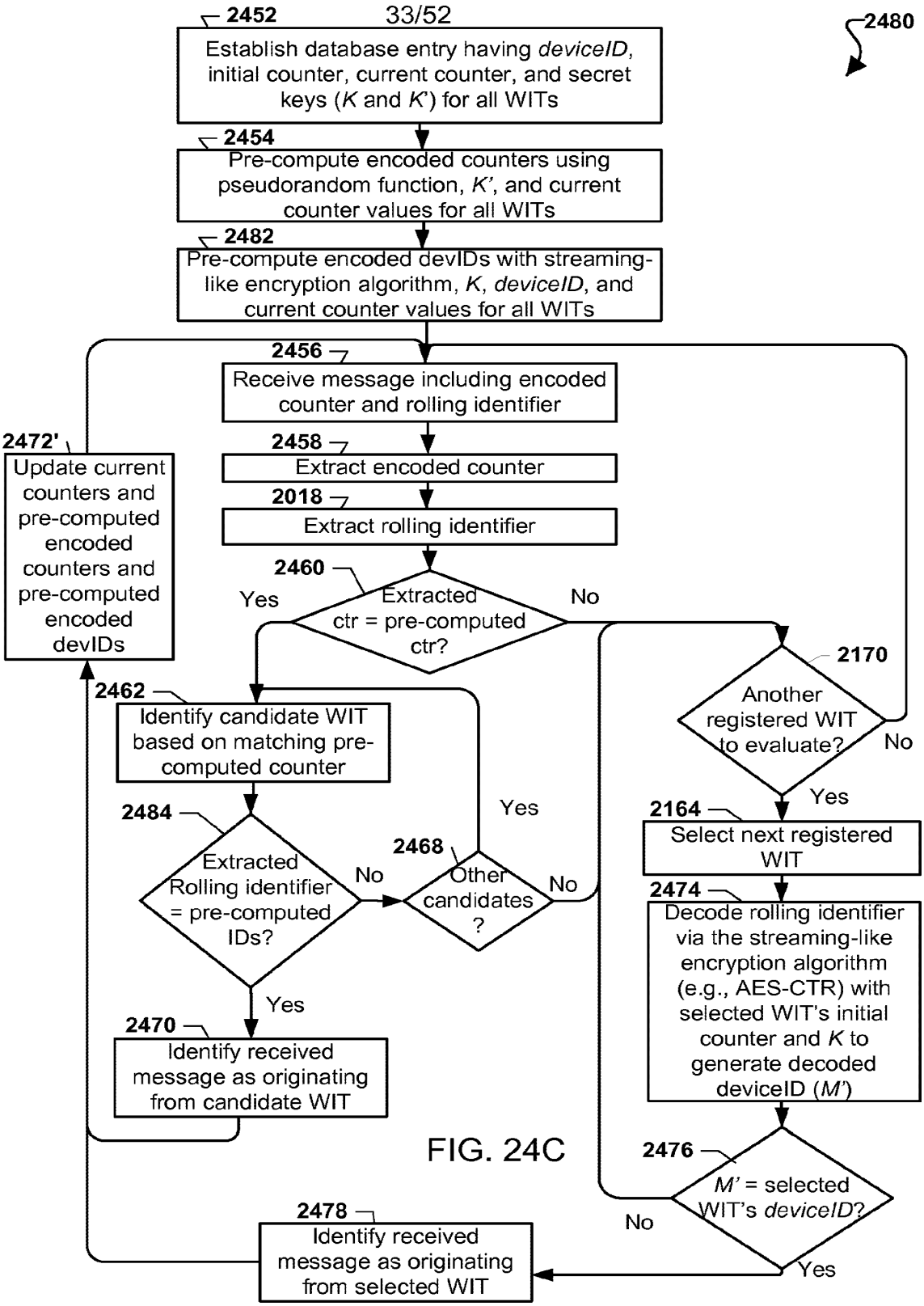

2480
2452
Establish database entry having deviceID, initial counter, current counter, and secret keys (K and K') for all WITs
2454
Pre-compute encoded counters using pseudorandom function, K', and current counter values for all WITs
2482
Pre-compute encoded devIDs with streaming-like encryption algorithm, K, deviceID, and current counter values for all WITs
2456
Receive message including encoded counter and rolling identifier
2458
Extract encoded counter
2018
Extract rolling identifier
2460
Extracted ctr = pre-computed ctr?
Yes
No
2472'
Update current counters and pre-computed encoded counters and pre-computed encoded devIDs
2462
Identify candidate WIT based on matching pre-computed counter
2484
Extracted Rolling identifier = pre-computed IDs?
No
2468
Other candidates ?
No
Yes
Yes
2470
Identify received message as originating from candidate WIT
2170
Another registered WIT to evaluate?
No
Yes
2164
Select next registered WIT
2474
Decode rolling identifier via the streaming-like encryption algorithm (e.g., AES-CTR) with selected WIT's initial counter and K to generate decoded deviceID (M')
2476
M' = selected WIT's deviceID?
No
Yes
2478
Identify received message as originating from selected WIT

FIG. 24C

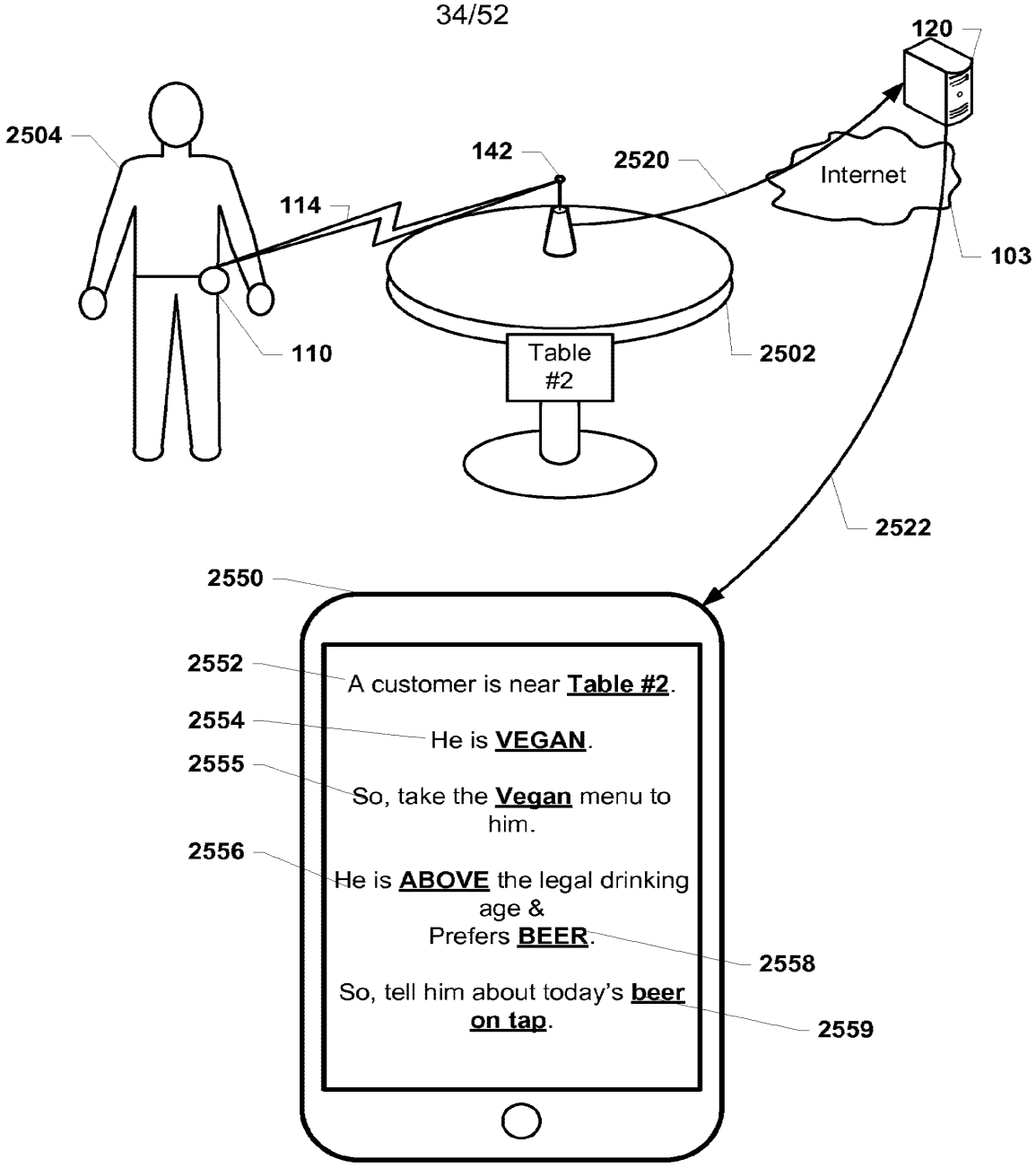

120
2504
142
2520
Internet
114
103
110
Table
#2
2502
2522
2550
2552
A customer is near Table #2.
2554
He is VEGAN.
2555
So, take the Vegan menu to
him.
2556
He is ABOVE the legal drinking
age &
Prefers BEER.
2558
So, tell him about today's beer
on tap.
2559

FIG. 25

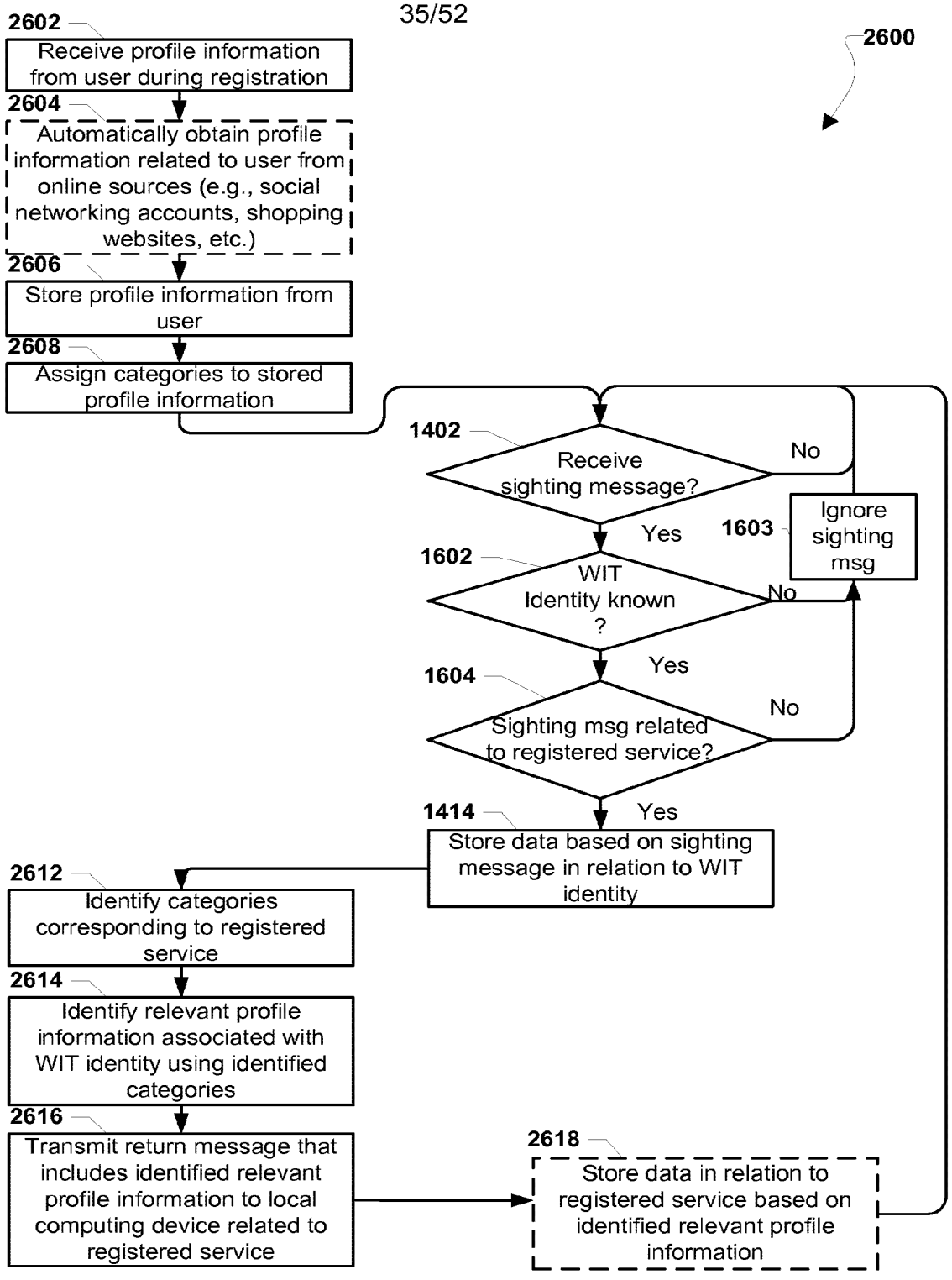

2600
2602
Receive profile information from user during registration
2604
Automatically obtain profile information related to user from online sources (e.g., social networking accounts, shopping websites, etc.)
2606
Store profile information from user
2608
Assign categories to stored profile information
1402
Receive sighting message?
No
Yes
1603
Ignore sighting msg
1602
WIT Identity known ?
No
Yes
1604
Sighting msg related to registered service?
No
Yes
1414
Store data based on sighting message in relation to WIT identity
2612
Identify categories corresponding to registered service
2614
Identify relevant profile information associated with WIT identity using identified categories
2616
Transmit return message that includes identified relevant profile information to local computing device related to registered service
2618
Store data in relation to registered service based on identified relevant profile information

FIG. 26A

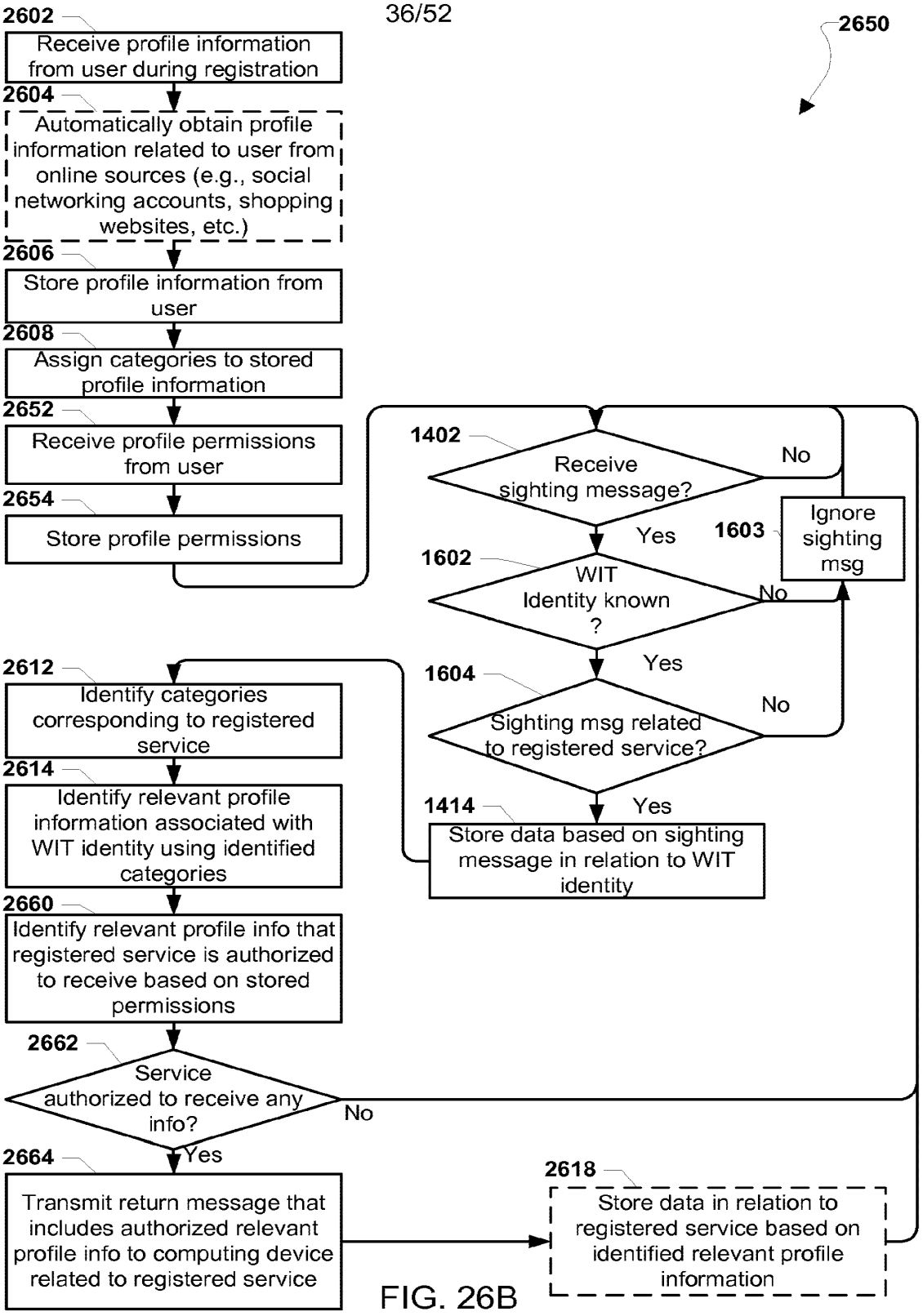


FIG. 26B

Petitioner Samsung Ex-1004, 0443

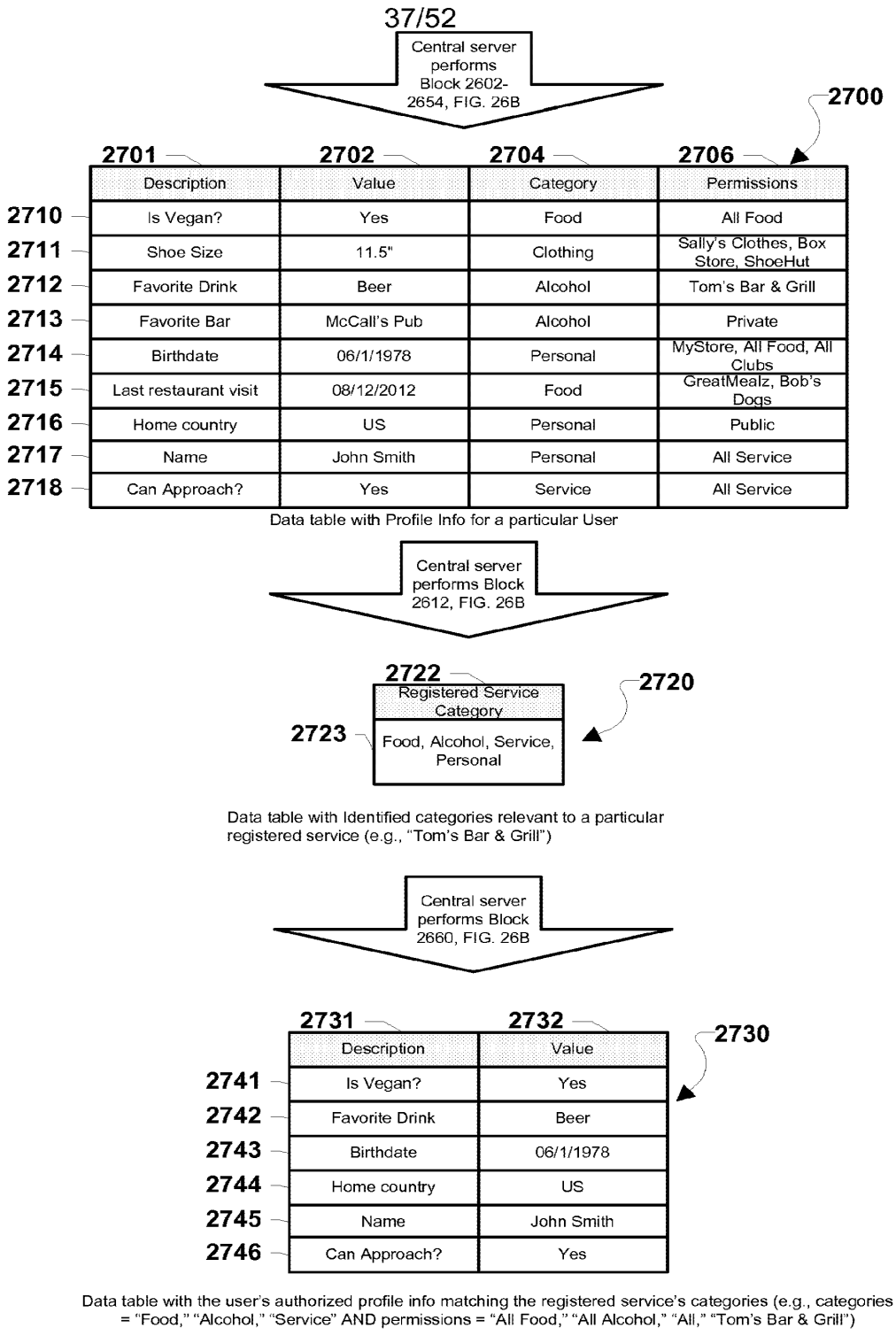

Central server performs Block 2602-2654, FIG. 26B
2700
2701
2702
2704
2706
Description
Value
Category
Permissions
2710
Is Vegan?
Yes
Food
All Food
2711
Shoe Size
11.5"
Clothing
Sally's Clothes, Box Store, ShoeHut
2712
Favorite Drink
Beer
Alcohol
Tom's Bar & Grill
2713
Favorite Bar
McCall's Pub
Alcohol
Private
2714
Birthdate
06/1/1978
Personal
MyStore, All Food, All Clubs
2715
Last restaurant visit
08/12/2012
Food
GreatMealz, Bob's Dogs
2716
Home country
US
Personal
Public
2717
Name
John Smith
Personal
All Service
2718
Can Approach?
Yes
Service
All Service
Data table with Profile Info for a particular User
Central server performs Block 2612, FIG. 26B
2722
Registered Service Category
2720
2723
Food, Alcohol, Service, Personal
Data table with Identified categories relevant to a particular registered service (e.g., "Tom's Bar & Grill")
Central server performs Block 2660, FIG. 26B
2731
2732
2730
Description
Value
2741
Is Vegan?
Yes
2742
Favorite Drink
Beer
2743
Birthdate
06/1/1978
2744
Home country
US
2745
Name
John Smith
2746
Can Approach?
Yes
Data table with the user's authorized profile info matching the registered service's categories (e.g., categories = "Food," "Alcohol," "Service" AND permissions = "All Food," "All Alcohol," "All," "Tom's Bar & Grill")

FIG. 27A

2750

Info	Value	Category	Permissions
Clothing Sizes: Shirt	XXL, 17.5, 34-35	Clothing	The Nice Shop, Dr. Mens
Clothing Sizes: Shoe	11.5"	Clothing, Shoes	Sally's Clothes, Box Store, ShoeHut
Clothing Sizes: Waist	34	Clothing	PRIVATE
Clothing Sizes: Inseam	32	Clothing	Dr. Mens
Food Preference: Meat	None	Food	All Food
Beverage Preference: Beer	IPA, BrandX, "TopShelf" Brewery	Food, Beverage, Alcohol	All Food, All Bars
Beverage Preference: Wine	Merlot, "Tbird" Wineries	Food, Beverage, Alcohol	MyStore, All Food, All Clubs
Beverage Preference: Hot Drinks	Chai Latte w/ soy	Food, Beverage	GreatMealz, Bob's Dogs
Food Alergies	Chocolate	Food	All Food, Medical
My Interests for matching purposes	Sports, anime, history	Interests	PUBLIC

FIG. 27B

FIG. 28A

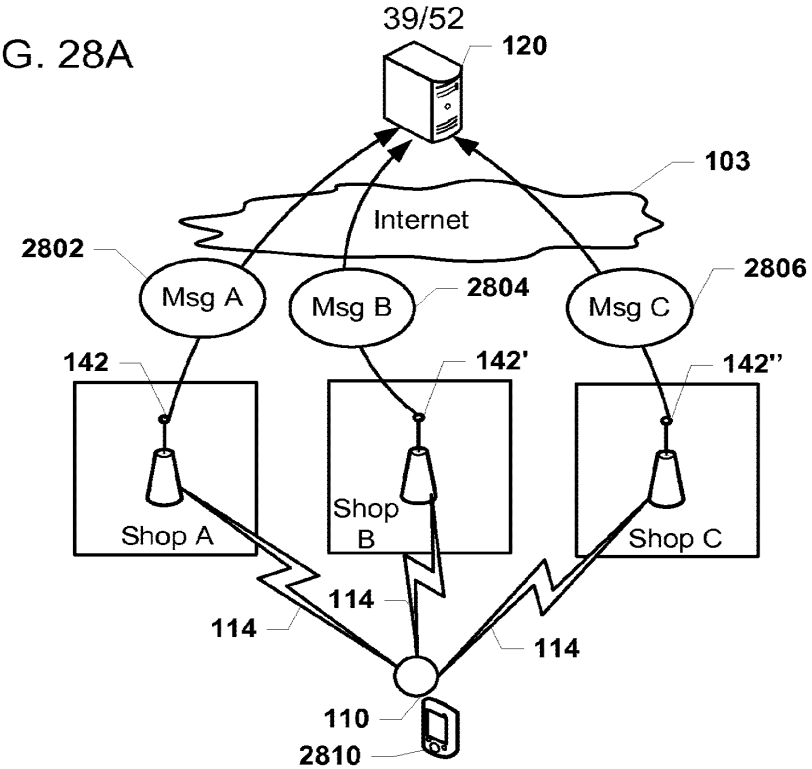
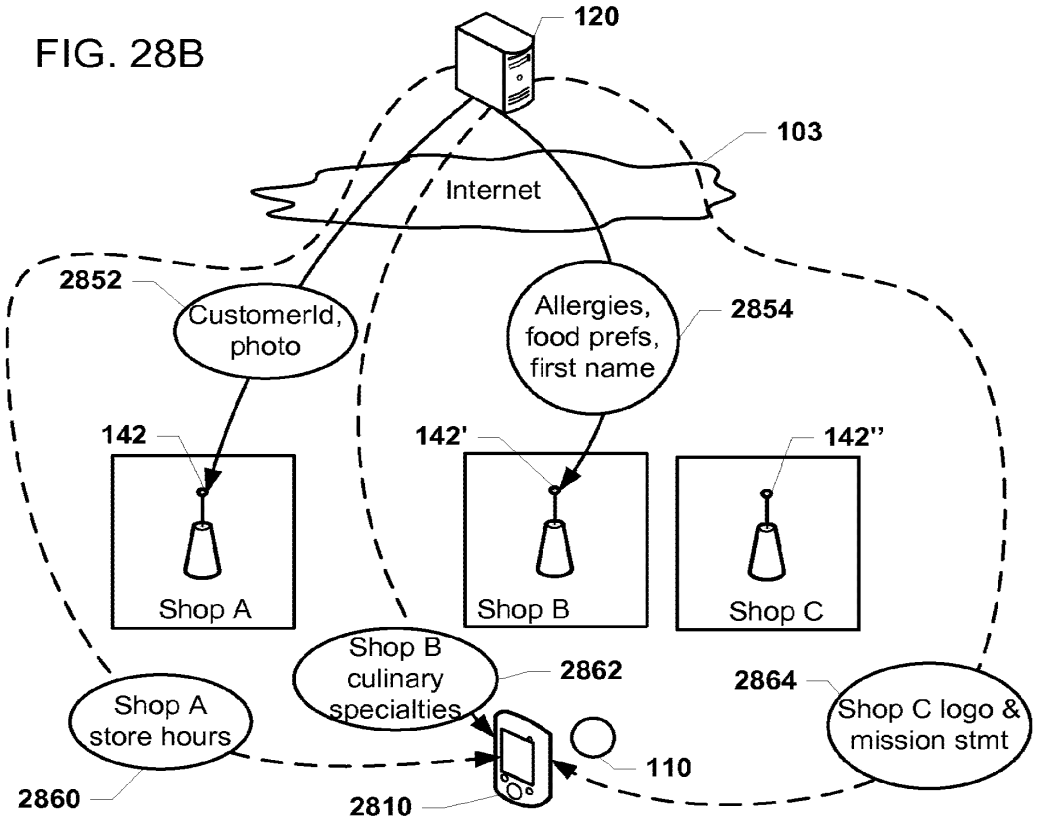


FIG. 28B



Petitioner Samsung Ex-1004, 0446

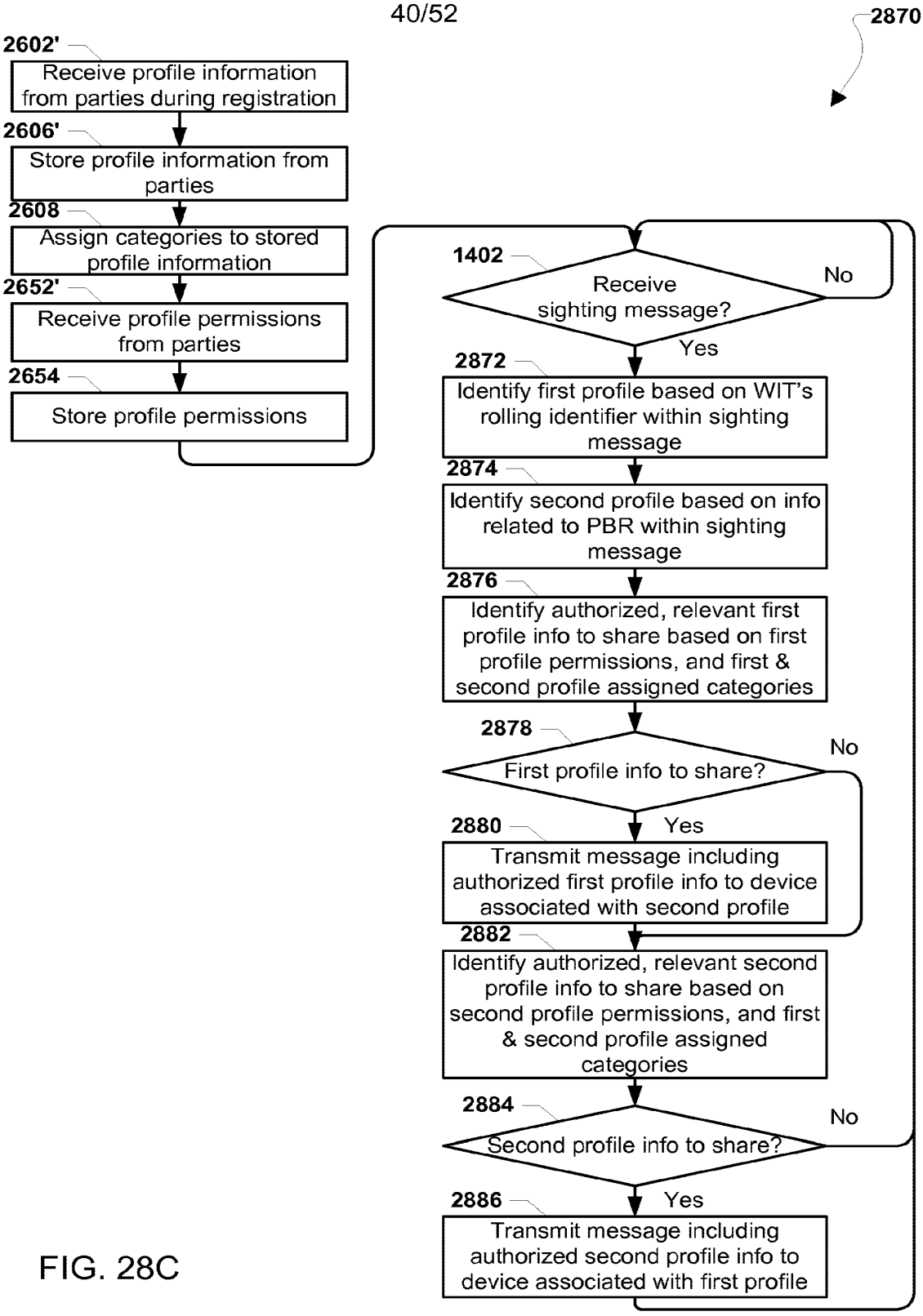

2870
2602'
Receive profile information from parties during registration
2606'
Store profile information from parties
2608
Assign categories to stored profile information
2652'
Receive profile permissions from parties
2654
Store profile permissions
1402
Receive sighting message?
No
Yes
2872
Identify first profile based on WIT's rolling identifier within sighting message
2874
Identify second profile based on info related to PBR within sighting message
2876
Identify authorized, relevant first profile info to share based on first profile permissions, and first & second profile assigned categories
2878
First profile info to share?
No
Yes
2880
Transmit message including authorized first profile info to device associated with second profile
2882
Identify authorized, relevant second profile info to share based on second profile permissions, and first & second profile assigned categories
2884
Second profile info to share?
No
Yes
2886
Transmit message including authorized second profile info to device associated with first profile

FIG. 28C

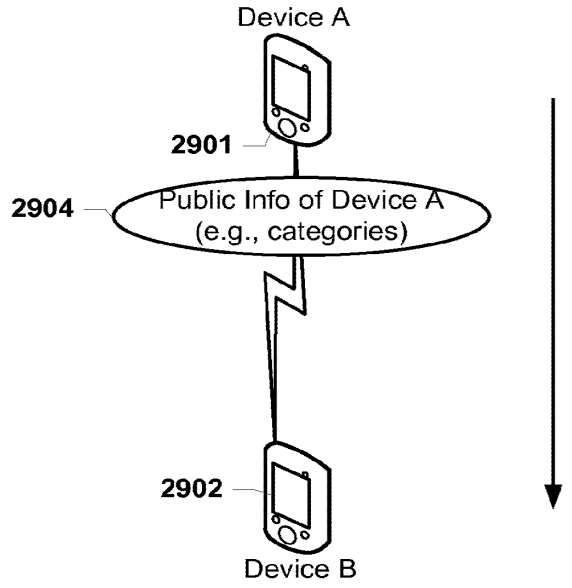


FIG. 29A

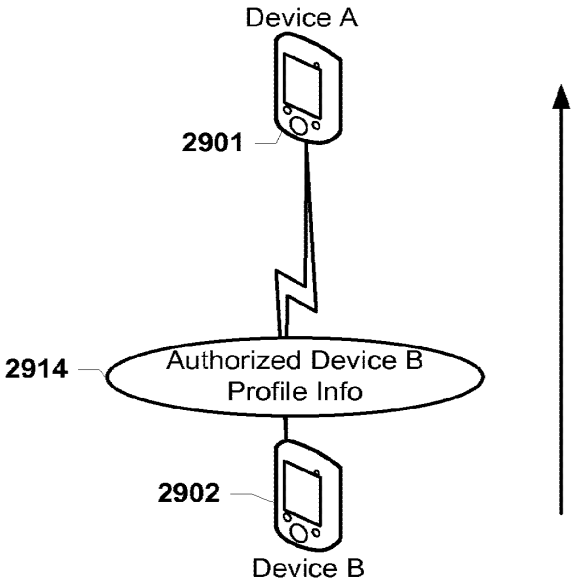


FIG. 29B

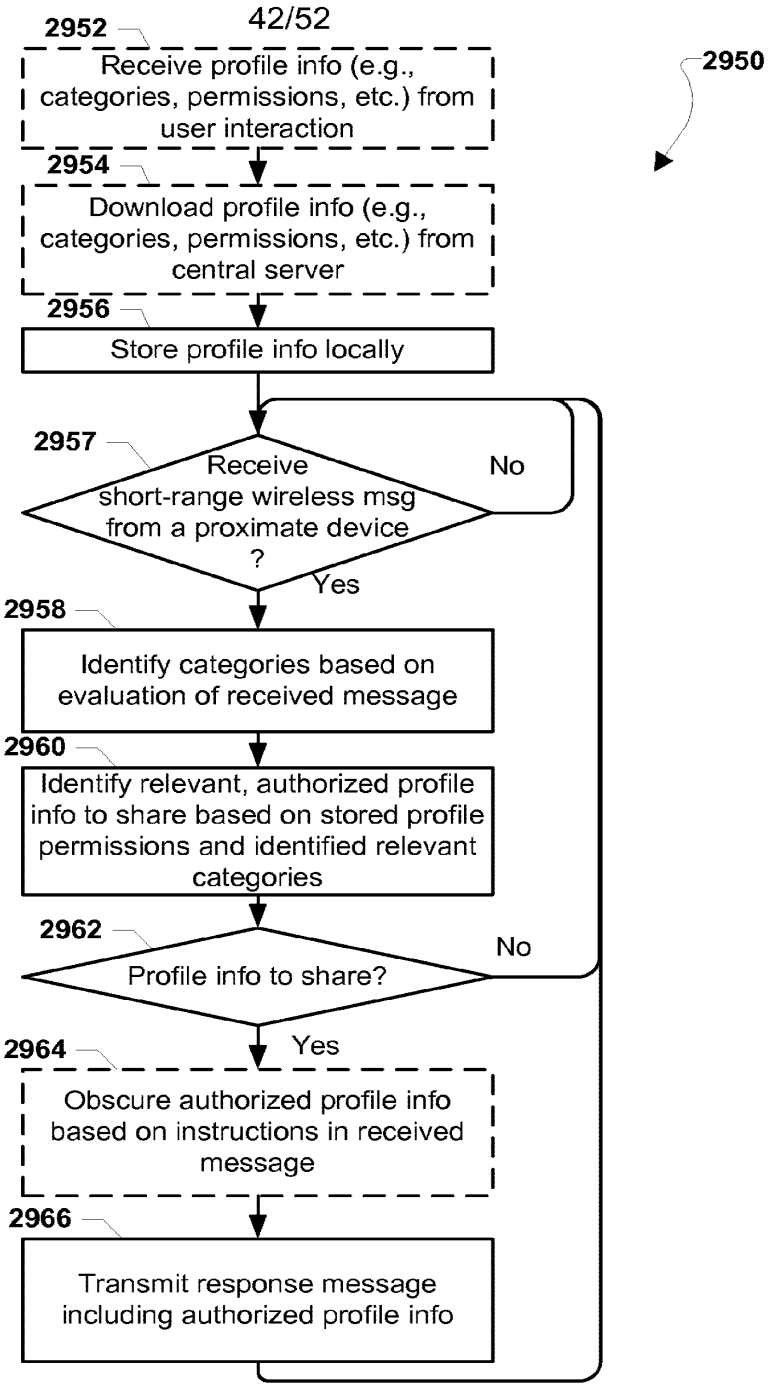

2950
2952
Receive profile info (e.g., categories, permissions, etc.) from user interaction
2954
Download profile info (e.g., categories, permissions, etc.) from central server
2956
Store profile info locally
2957
Receive short-range wireless msg from a proximate device ?
No
Yes
2958
Identify categories based on evaluation of received message
2960
Identify relevant, authorized profile info to share based on stored profile permissions and identified relevant categories
2962
Profile info to share?
No
Yes
2964
Obscure authorized profile info based on instructions in received message
2966
Transmit response message including authorized profile info

FIG. 29B

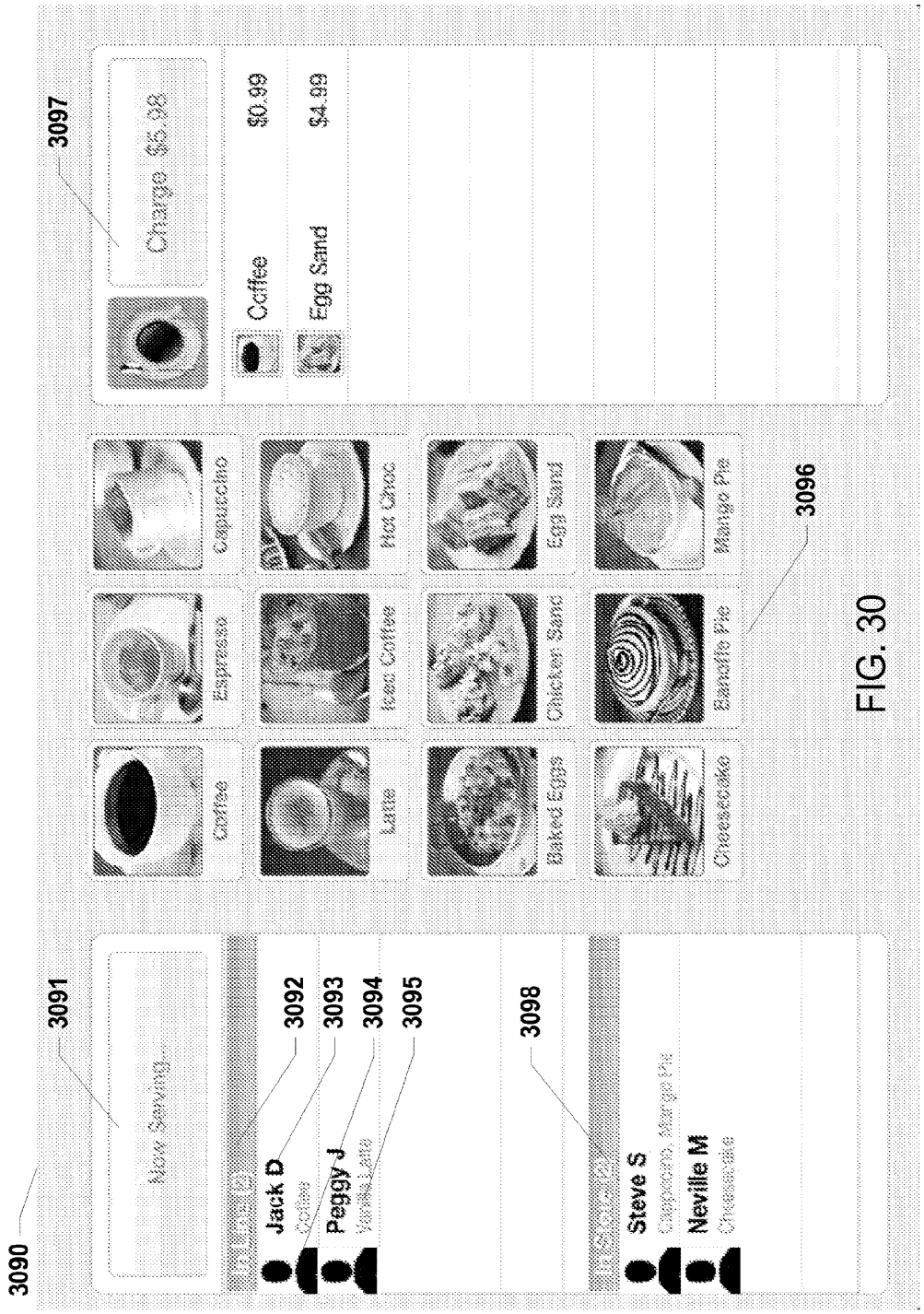

3090
3091
Now Serving...
Dining
Jack D
Coffee
Peggy J
Vanilla Latte
Steve S
Cappuccino, Mango Pie
Neville M
Cheesecake
3092
3093
3094
3095
3098
Coffee
Espresso
Cappuccino
Latte
Iced Coffee
Hot Choc
Baked Eggs
Chicken Sand
Egg Sand
Cheesecake
Banoffe Pie
Mango Pie
3096
3097
Charge $5.98
Coffee $0.99
Egg Sand $4.99

FIG. 30

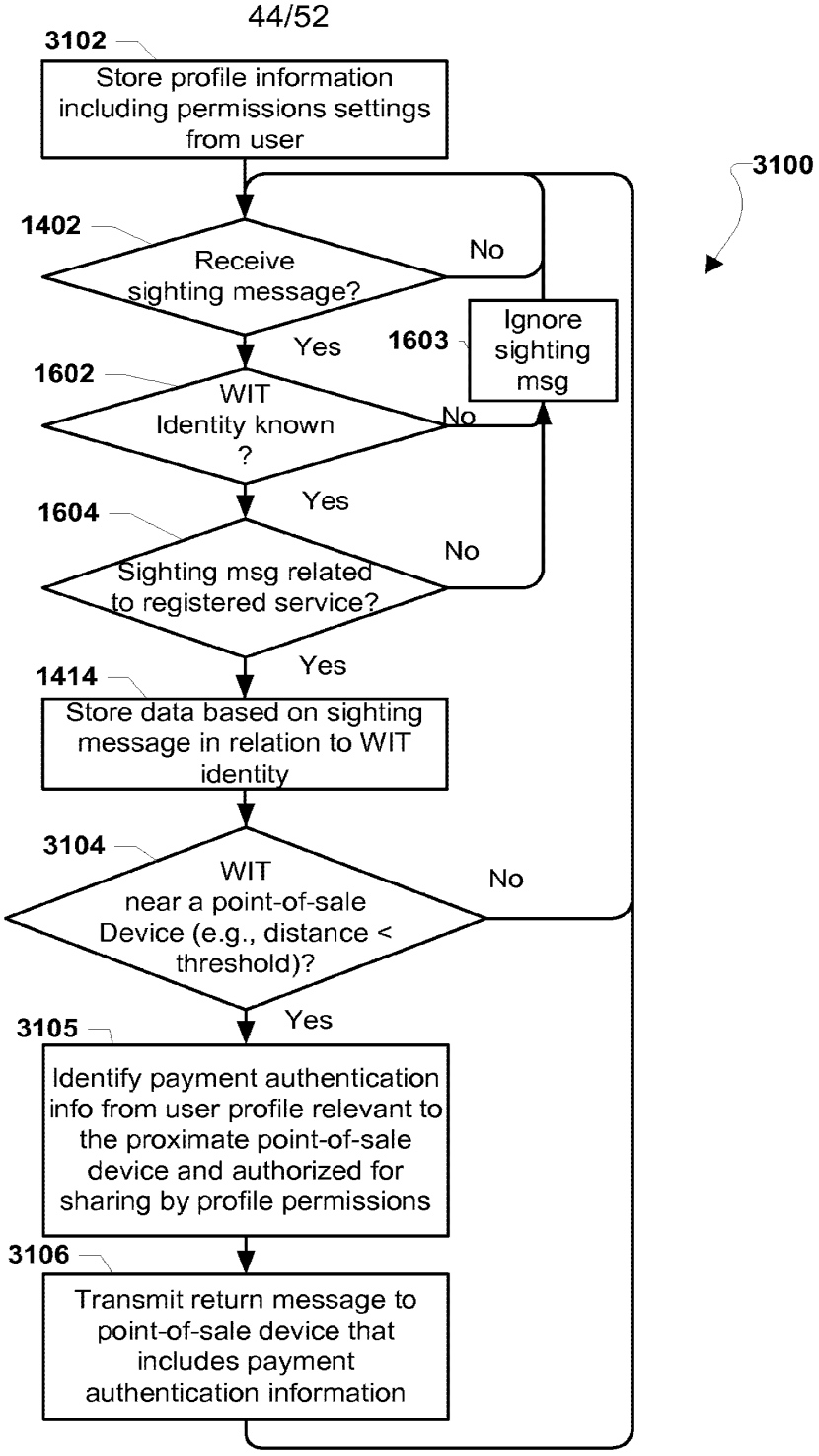

3102
Store profile information including permissions settings from user
3100
1402
Receive sighting message?
No
Yes
1603
Ignore sighting msg
1602
WIT Identity known ?
No
Yes
1604
Sighting msg related to registered service?
No
Yes
1414
Store data based on sighting message in relation to WIT identity
3104
WIT near a point-of-sale Device (e.g., distance < threshold)?
No
Yes
3105
Identify payment authentication info from user profile relevant to the proximate point-of-sale device and authorized for sharing by profile permissions
3106
Transmit return message to point-of-sale device that includes payment authentication information

FIG. 31

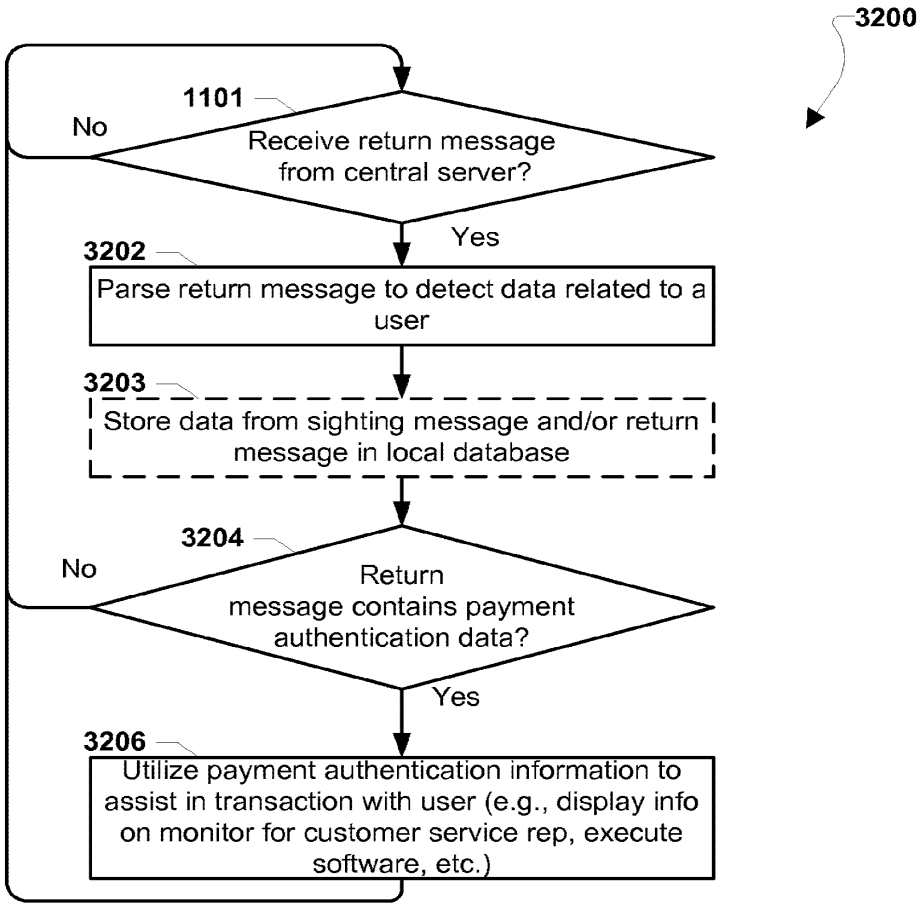

3200
1101
No
Receive return message from central server?
Yes
3202
Parse return message to detect data related to a user
3203
Store data from sighting message and/or return message in local database
3204
No
Return message contains payment authentication data?
Yes
3206
Utilize payment authentication information to assist in transaction with user (e.g., display info on monitor for customer service rep, execute software, etc.)

FIG. 32A

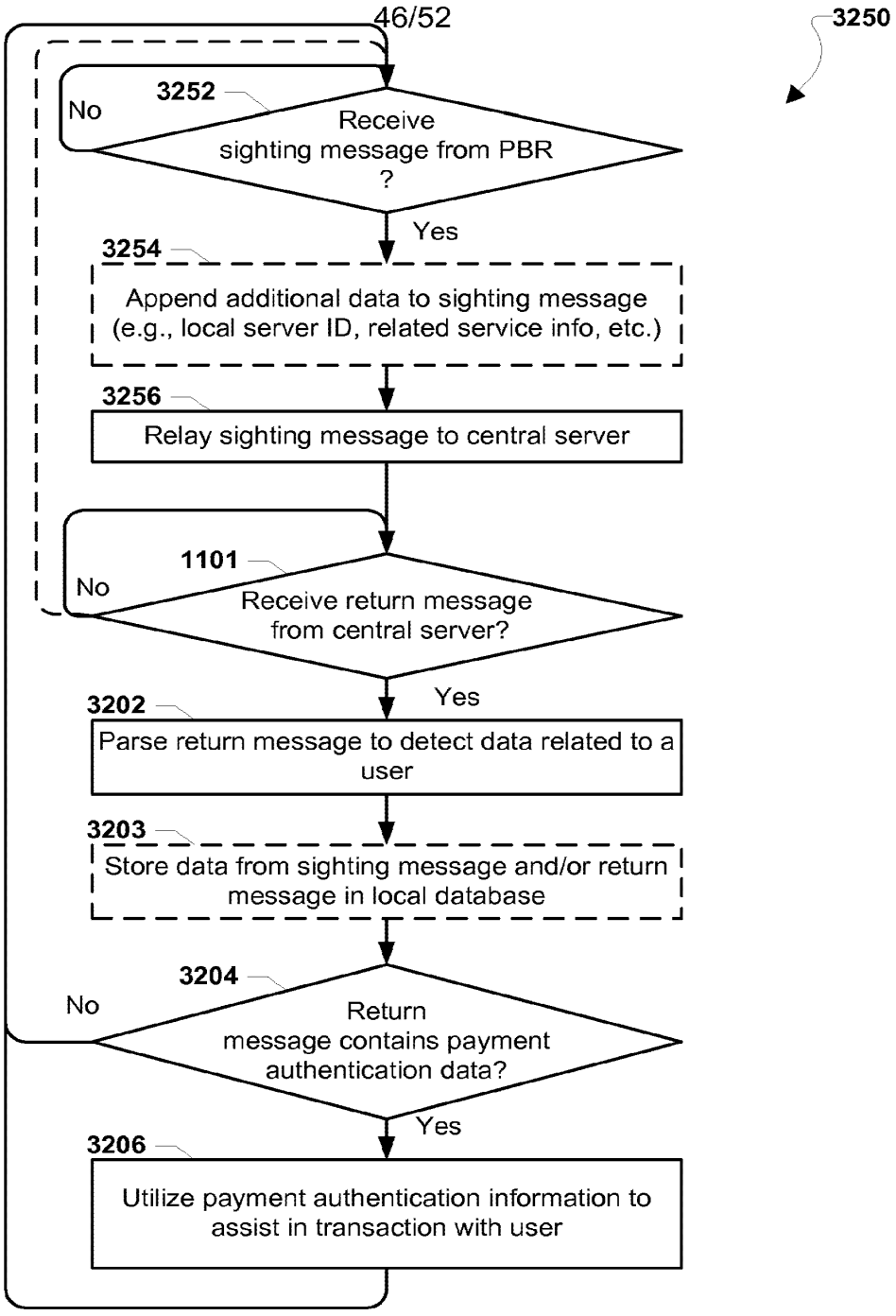

46/52
3250
3252
No
Receive sighting message from PBR ?
Yes
3254
Append additional data to sighting message (e.g., local server ID, related service info, etc.)
3256
Relay sighting message to central server
1101
No
Receive return message from central server?
Yes
3202
Parse return message to detect data related to a user
3203
Store data from sighting message and/or return message in local database
3204
No
Return message contains payment authentication data?
Yes
3206
Utilize payment authentication information to assist in transaction with user

FIG. 32B

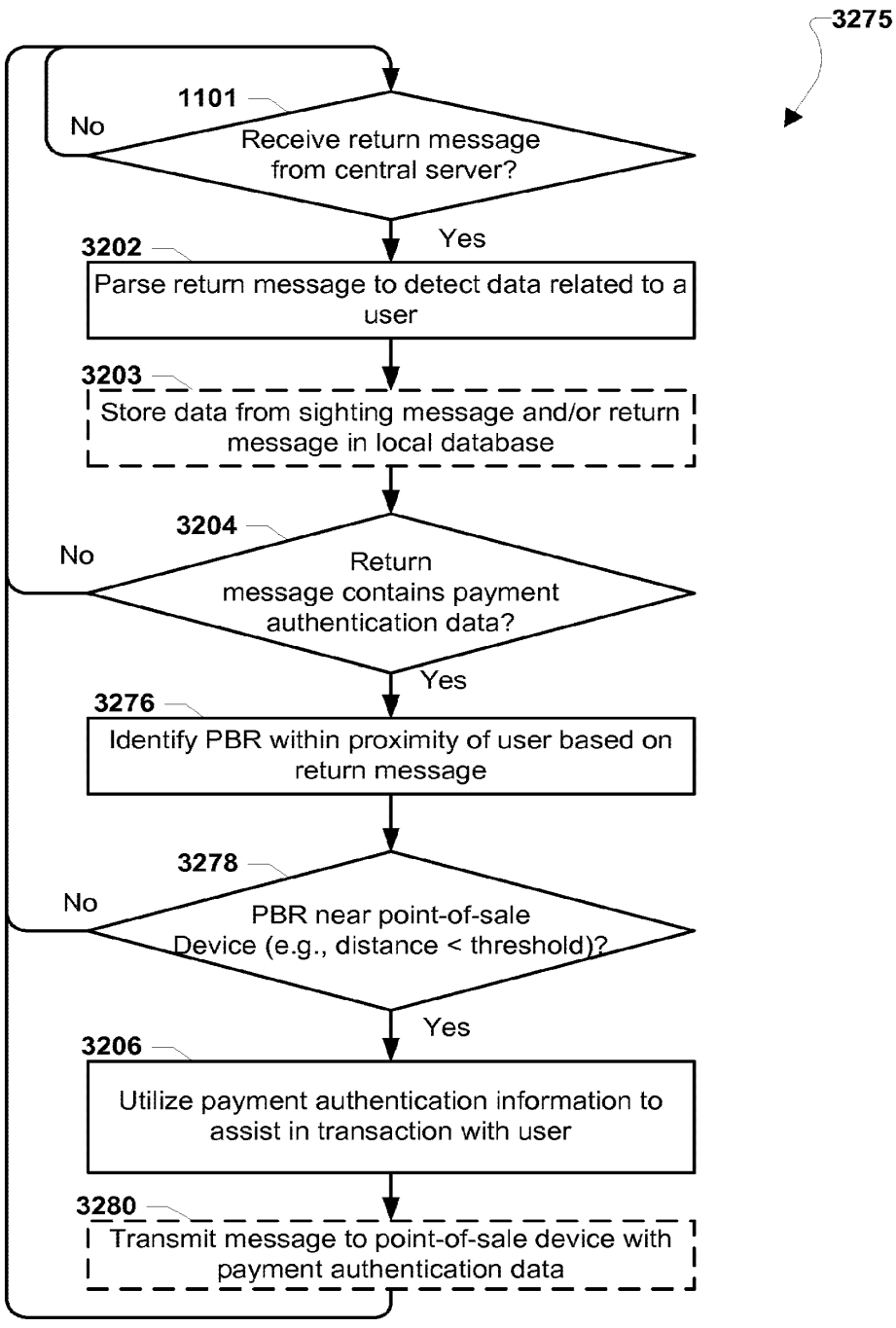

3275
1101
Receive return message from central server?
No
Yes
3202
Parse return message to detect data related to a user
3203
Store data from sighting message and/or return message in local database
3204
Return message contains payment authentication data?
No
Yes
3276
Identify PBR within proximity of user based on return message
3278
PBR near point-of-sale Device (e.g., distance < threshold)?
No
Yes
3206
Utilize payment authentication information to assist in transaction with user
3280
Transmit message to point-of-sale device with payment authentication data

FIG. 32C

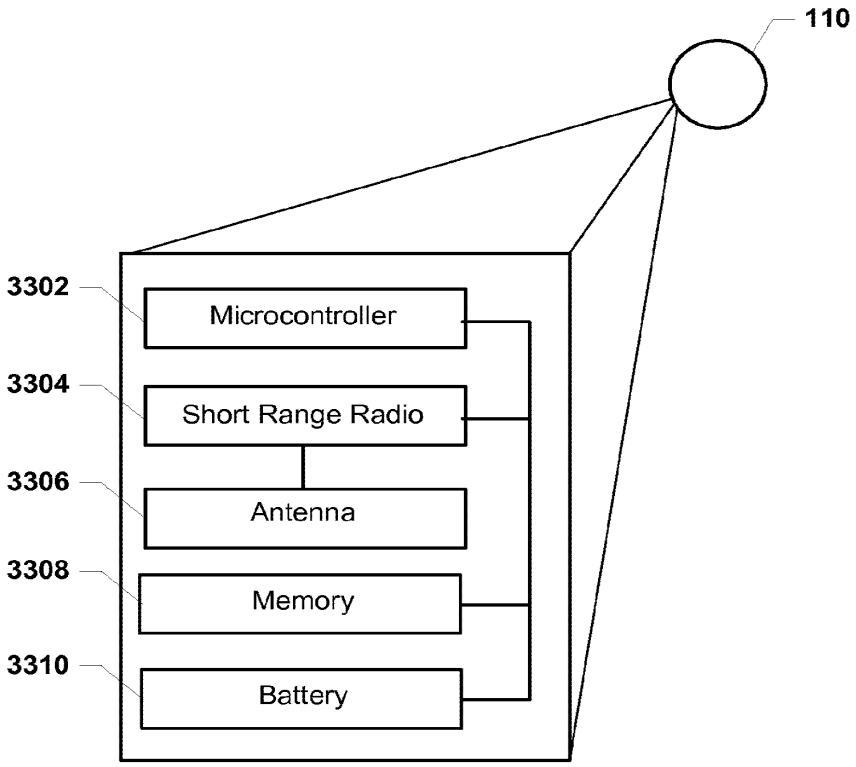

110
3302
Microcontroller
3304
Short Range Radio
3306
Antenna
3308
Memory
3310
Battery

FIG. 33A

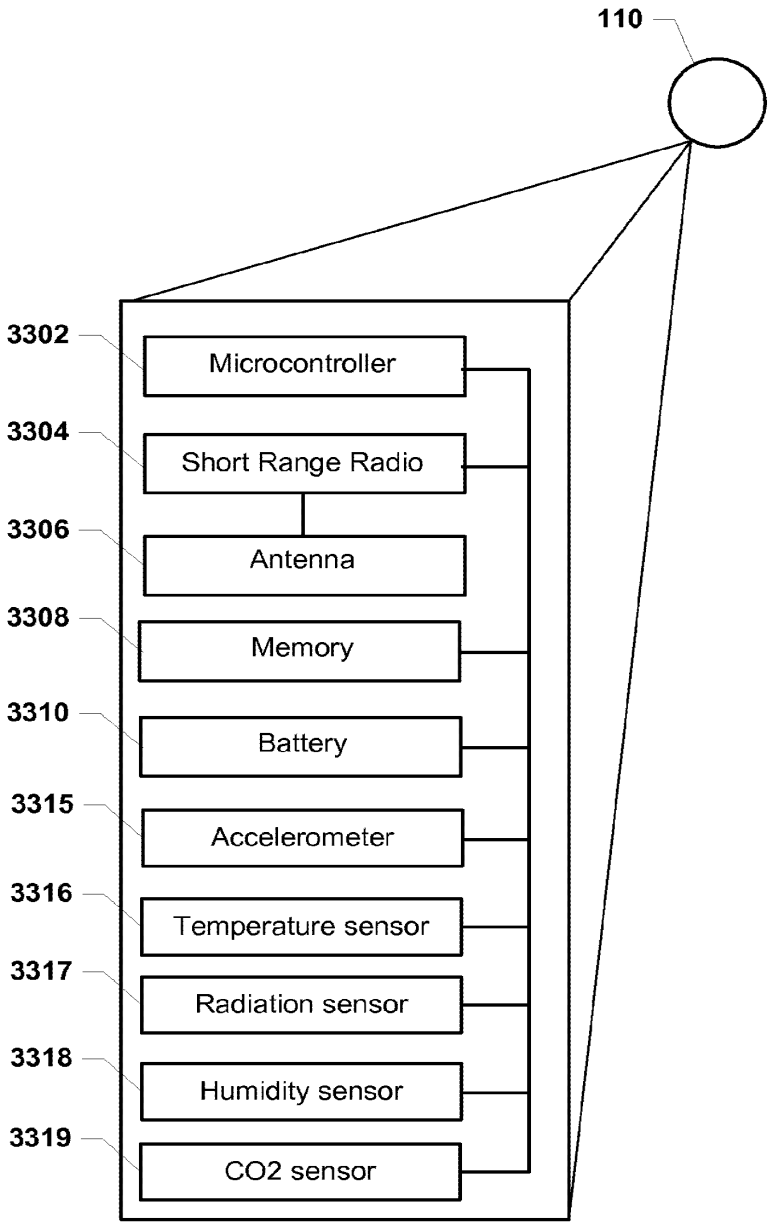

110
3302
Microcontroller
3304
Short Range Radio
3306
Antenna
3308
Memory
3310
Battery
3315
Accelerometer
3316
Temperature sensor
3317
Radiation sensor
3318
Humidity sensor
3319
CO2 sensor

FIG. 33B

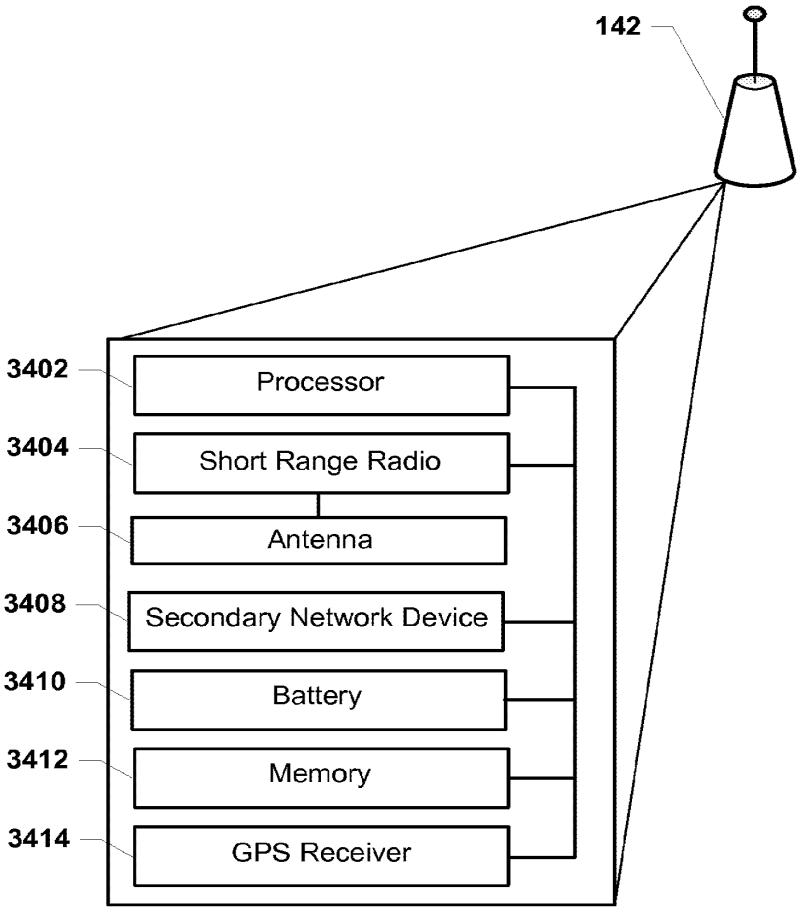

142
3402
Processor
3404
Short Range Radio
3406
Antenna
3408
Secondary Network Device
3410
Battery
3412
Memory
3414
GPS Receiver

FIG. 34A

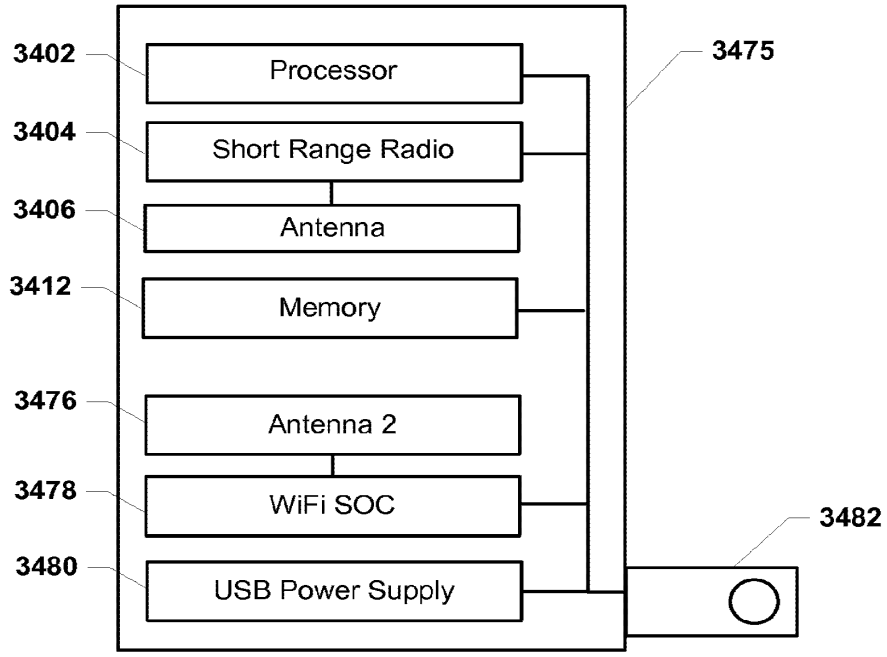

3402
Processor
3404
Short Range Radio
3406
Antenna
3412
Memory
3476
Antenna 2
3478
WiFi SOC
3480
USB Power Supply
3475
3482

FIG. 34B

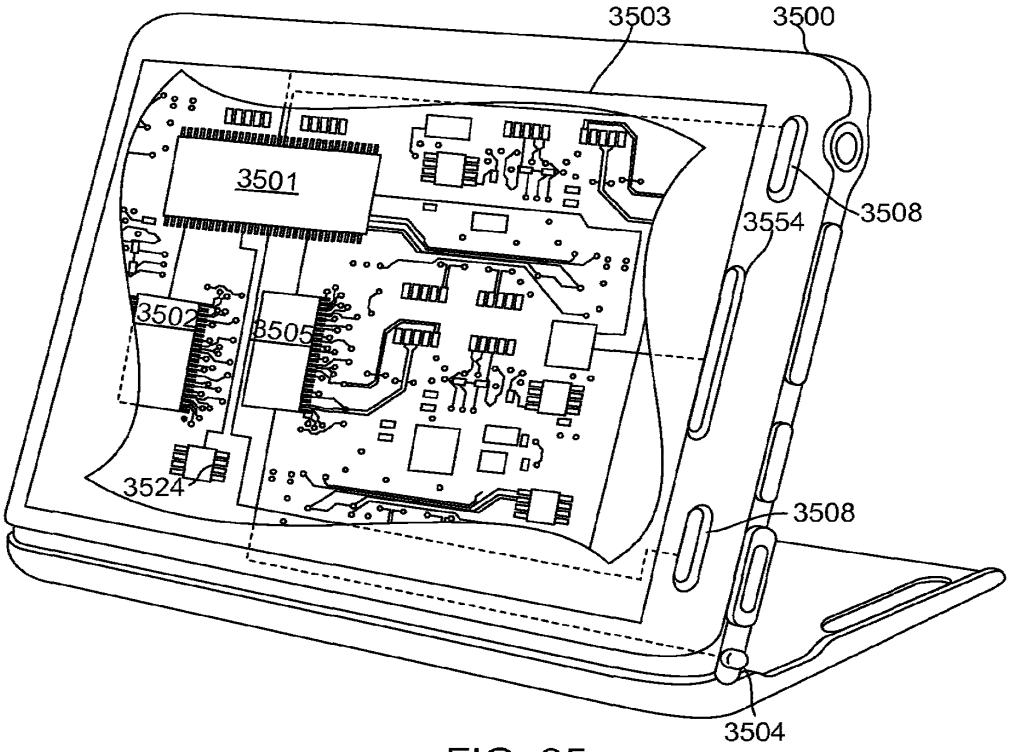

3503
3500
3501
3508
3554
3502
3505
3524
3508
3504

FIG. 35

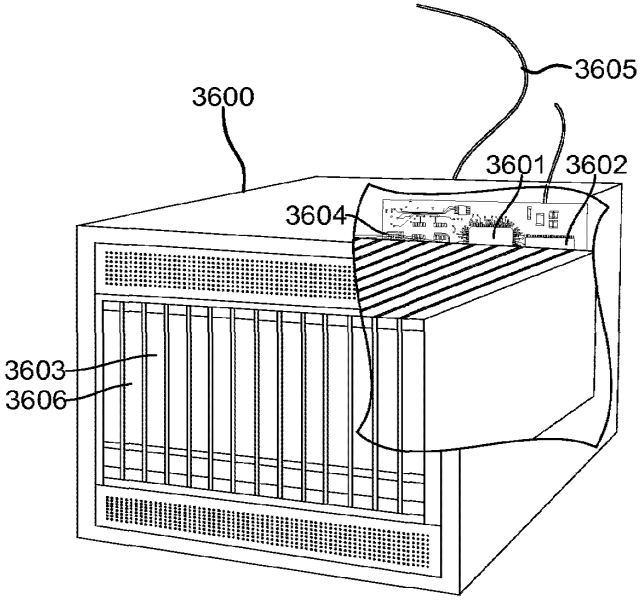

3605
3600
3601
3602
3604
3603
3606

FIG. 36

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/038038

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04L29/08 H04W4/00 G06Q30/00
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04L G06Q H04W

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2009/254416 A1 (NOMULA JAGADESHWAR R [US]) 8 October 2009 (2009-10-08) abstract page 1, paragraph 16 - page 2, paragraph 20 page 3, paragraphs 28,29	1-50
A	WO 2012/035149 A1 (CONNECTED ZINKING S L [ES]; PANE ARREGUI JUAN [ES]; SALVADOR GARCIA GU) 22 March 2012 (2012-03-22) page 1, lines 13-20 page 4, last paragraph - page 5, last paragraph page 9, last paragraph - page 11, paragraph 3	10, 20-30, 40,50

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
3 October 2013	10/10/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Blanco Cardona, P

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Form PCT/ISA/210 (second sheet) (April 2005)

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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/038038

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 02/073864 A2 (KARGO INC [US]) 19 September 2002 (2002-09-19) abstract page 1, last paragraph - page 2, last paragraph page 4, lines 17-29	1-50
A	SCHNEIDER M A ET AL: "Efficient commerce protocols based on one-time pads", COMPUTER SECURITY APPLICATIONS, 2000. ACSAC '00. 16TH ANNUAL CONFERENC E NEW ORLEANS, LA, USA 11-15 DEC. 2000, LOS ALAMITOS, CA, USA,IEEE COMPUT. SOC, US, 11 December 2000 (2000-12-11), pages 317-326, XP010529829, DOI: 10.1109/ACSAC.2000.898886 ISBN: 978-0-7695-0859-7 abstract page 319, right-hand column, paragraph 1 page 322, right-hand column, last paragraph - page 323, left-hand column, paragraph 1	1,10,11, 20,30, 31,40, 41,50
X	US 2008/123683 A1 (CHENG TSZ S [US] ET AL CHENG TSZ SIMON [US] ET AL) 29 May 2008 (2008-05-29) abstract page 2, paragraph 21 page 3, paragraphs 33,37	51-54
X	US 2011/179064 A1 (RUSSO ANTHONY PETER [US]) 21 July 2011 (2011-07-21) page 4, paragraphs 53,54 and 57 page 6, paragraphs 71,72	51-54

3

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

Petitioner Samsung Ex-1004, 0461

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/038038

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

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

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

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

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

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

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

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

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

Remark on Protest

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

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

☒ No protest accompanied the payment of additional search fees.

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FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-50

Method, server and system where a server provides profile information based on a received message including a rolling wireless transmitter identifier and information related to a proximity broadcast receiver

---

2. claims: 51-54

Method and mobile device providing profile information via a short-range wireless message

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2013/038038

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2009254416 A1	08-10-2009	NONE	
WO 2012035149 A1	22-03-2012	NONE	
WO 02073864 A2	19-09-2002	AU 2002250326 A1	24-09-2002
		CA 2441217 A1	19-09-2002
		CN 1552021 A	01-12-2004
		EP 1415228 A2	06-05-2004
		HK 1071453 A1	04-12-2009
		JP 2004530195 A	30-09-2004
		US 2002143961 A1	03-10-2002
		WO 02073864 A2	19-09-2002
US 2008123683 A1	29-05-2008	CN 101127684 A	20-02-2008
		US 2008123683 A1	29-05-2008
US 2011179064 A1	21-07-2011	NONE	

Petitioner Samsung Ex-1004, 0464

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

(19) World Intellectual Property Organization
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(43) International Publication Date
16 September 2004 (16.09.2004)

PCT

(10) International Publication Number
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PCT/US2004/006014

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(30) Priority Data:

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60/516,101	30 November 2003 (30.11.2003)	US

(71) Applicants and
(72) Inventors: **AVICOLA, Ken** [US/US]; 1252 Arlington RD, Livermore, CA 94551 (US). **MORTON, Richard, G.** [US/US]; 17786 Aguamiel Road, San Diego, CA 92127 (US). **ROSS, John, R.** [US/US]; Po Box 2138, Del Mar, CA 92014 (US).

(74) Common Representative: **ROSS, John, R.**; Po Box 2138, Del Mar, CA 92014 (US).

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

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

Published:
— *without international search report and to be republished upon receipt of that report*

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

(54) Title: FLASHING JEWELRY HEARTBEAT MONITOR WITH MULTIPLE LIGHTS

(57) Abstract: Jewelry, such as finger rings and earrings, which flash in synchronism with the wearer's heartbeat. A pulsed IR signal is directed into the wearer's tissue and a reflected or transmitted signal is monitored to determine when the wearer's heart beats at which time one or more light emitting sources in the jewelry flashes. The monitored signal is utilized to determine the wearer's heart rate. At least two light emitting sources are provided one of which flashes with each heart beat and the other flashes when the heart rate reaches or exceeds a predetermined range or increases faster than a predetermined rate. Preferred embodiments include three visible LED's (red, green and blue) and a micro-processor which calculates pulse rate and causes the red LED to blink on each pulse, the green LED to blink on each pulse when the wearer's pulse rate is greater a first threshold and the blue LED to blink on each pulse when the wearer's pulse rate is greater than a second threshold corresponding to extreme excitement. These threshold values may correspond to increased heart rates of typical persons engaged in exercise and love-making. The monitor may also be self calibrating to adjust the thresholds based on measurements of the wearer's heart rate over extended periods which would include periods of rest as well as periods of exertion or excitement. Other preferred embodiments vary the brightness of the LED's depending on the estimated blood pressure that also increases by about the same degree as pulse rate.

WO 2004/078028 A2

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FLASHING JEWELRY HEARTBEAT MONITOR WITH MULTIPLE LIGHTS

This application claims the benefit of Provisional Applications SN 60/516,101 filed 11/3/2003 and SN 60/451,009 filed 2/28/2003. The present invention relates to jewelry and heartbeat monitors.

BACKGROUND OF THE INVENTION

US Patent No. 6,277,079 issued to the present inventors discloses a flashing earring heartbeat monitor. The '079 patent is incorporated herein by reference. In the background section of that patent is disclosed a well-known technique for monitoring heartbeat. Infrared light is transmitted into tissue and the reflected light is monitored to determine heart beat. This works because changing quantities of blood in the tissue with each heartbeat will affect the amount of light reflected from the tissue. In that patent Applicants described an earring (see FIGS. 1and 2, which were FIGS. 2 and 3 in the '079 patent) which used that basic technique to make an earring which would flash with each heartbeat. Applicants summarized the invention as follows:

"The ... invention provides an earring that flashes in synchronism with the wearer's heartbeat. A pulsed IR LED/photocell combination is built into an earring along with a comparator and a visible light-emitting source. The comparator determines when the heart has beat from the variation in the signal from the photocell and transmits a signal to a solid state switch to turn on the visible light-emitting source. Thus, the light emitting source flashes once for each heart beat. In a preferred use of the ... invention a lover is able to determine when his or her partner is excited by observing the rate at which the partner's earring flashes. The invention may also be used for medical monitoring of patients."

Heart rates are known to vary substantially with age and activity. Resting heart rates are typically in the range of about 50 to 70 beats per minute. A rule of thumb is: Maximum Heart Rate = 220 – Age. The range of variation gets smaller with age. The maximum heart rate ranges from about 100 to 200 for 20 year old people and from about 75 to about

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150 for 70 year old people. Heart rates increase toward the maximum rates during strenuous exercise and during periods of excitement including sexual excitement. FIGS. 4A and 4B are graphs extracted from page 596 of Sexual Behavior in the Human Female by the Staff of the Institute for Sex Research, Indiana University, Alfred C. Kinsey et al Research Associates, Published by W. B. Sanders, Philadelphia. The subjects were a married couple. The graphs show heart rate ranges for the female from about 90 during the period preceding love making to 140 during lovemaking down to about 75 during sleep. For the male the corresponding ranges were about 90, 140 and 72. The female experienced four periods of extreme excitement. The male experienced only one.

Applicants have been informed that the potential market for these flashing earring heartbeat monitors may be in the many millions and that other jewelry monitoring heartbeat my also be very popular. What is needed are an improved versions of the earring described in the '079 patent and other jewelry applications of improved versions of that invention.

SUMMARY OF THE INVENTION

The present invention provides jewelry, such as finger rings and earrings, which flash in synchronism with the wearer's heartbeat. A pulsed IR signal is directed into the wearer's tissue and a reflected or transmitted signal is monitored to determine when the wearer's heart beats at which time one or more light emitting sources in the jewelry flashes. The monitored signal is utilized to determine the wearer's heart rate. At least two light emitting sources are provided one of which flashes with each heart beat and the other flashes when the heart rate reaches or exceeds a predetermined range or increases faster than a predetermined rate. Preferred embodiments utilize inexpensive off-the-shelf reflection sensors developed for card readers each of which includes both an IR emitter and a phototransistor IR detector. Preferred embodiments include a power-up-on-skin-contact feature to preserve battery power. Embodiments include a variety of color LED's and a variety of types of jewelry are proposed as heartbeat monitors. Disclosed are detailed instructions describing working prototype earrings built by Applicants and their licensees and descriptions for low cost fabrication of embodiments of the present

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invention using application specific integrated circuit (ASIC) technology and surface mount technology. Preferred embodiments include three visible LED's (red, green and blue) and a micro-processor which calculates pulse rate and causes the red LED to blink on each pulse, the green LED to blink on each pulse when the wearer's pulse rate is greater a first threshold and the blue LED to blink on each pulse when the wearer's pulse rate is greater than a second threshold corresponding to extreme excitement. These threshold values may correspond to increased heart rates of typical persons engaged in exercise and love making. The monitor may also be self calibrating to adjust the thresholds based on measurements of the wearer's heart rate over extended periods which would include periods of rest as well as periods of exertion or excitement. Other preferred embodiments vary the brightness of the LED's depending on the estimated blood pressure that also increases by about the same degree as pulse rate. Also described is a special technique for providing power to the heartbeat monitor that consists of a small diameter pin for providing an electrical connection between a battery and a circuit board comprising an IR transmitter and an IR receiver and one or more LED's. The battery unit is preferably on the inside of the earlobe and the circuit board is preferably on the outside of the earlobe. Also disclosed is a technique for charging the battery unit.

BRIEF DESCRIIPTION OF THE DRAWINGS

FIGS. 1 and 2 are drawings from the '079 patent referred to above showing feature disclosed in that prior art patent.

FIG. 3 is a circuit diagram showing features of a working prototype of the present invention.

FIG. 3A is a version of FIG.3 showing sections of the circuits shown enlarged in FIGS. 3A(1) through 3A(7)

FIGS. 3A(1) through 3A(7) each show a portion of the FIG. 3 circuit.

FIGS. 4A and 4B are prior art graphs that show heart rates of a female and male human engaged in love making.

FIGS. 5A and 5B show block diagrams of control circuits and logic for controlling a three-light embodiment of the present invention.

FIG. 6 is a drawing of an inexpensive IR transmitter and detector.

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FIGS. 7A and 7B discloses a battery unit for providing power for the IR transmitter and the IR receiver and for one or more LED's.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Prototype Embodiments

Applicants and their licensee have built and tested prototype-flashing earring that has demonstrated excellent performance of features of the present invention. A prototype earring was fabricated by modifying an earring having a magnetic clasp purchased from a Target department store and using inexpensive reflection IR emitter-sensors developed for card readers. Two magnets attract each other on both sides of a wearer's ear lobe. An IR transmitter, and IR receiver of the emitter-sensor and an on/off skin contact switch was mounted along with one of two magnets on one side of the ear lobe. The electronic parts for the earring are mounted on two small circuit boards contained in a heart shaped box hanging from the attaching magnetic clasps. The box has dimensions of about 1 inch X 1 inch X ¾ inch. The earring is fitted with a red Valentine shaped heart cover in which a visible light (red) emitting diode is mounted. Three hearing aid batteries also contained in the heart shaped box power this prototype earring. Only only a single battery powers other embodiments.

Circuit Diagram

An electric circuit diagram of the prototype embodiment of the present invention actually built and tested by Applicants is shown in FIG. 3. This circuit diagram is also broken into seven parts as shown in FIG. 3A and FIGS. 3A(1) through 3A(7).

As shown in FIG. 3A(1) timer integrated circuit U1 with its associated components shown at 20 produces a pulse train of 500 microseconds pulse width pulses at a 200 Hz rate. These pulses activate the switch in IC U2 (a dual analog switch) 22 which permits current to flow in IR LED 24.

As shown in FIG. 3A(2), the emitted IR pulses enter the earlobe tissue and the light scattered back into the phototransistor 26 and is detected production a pulse amplitude

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modulated signal across R3 28. The network of D1, D2, C2 and R4 form a "track and hold" amplitude insulator 30.

As shown in FIG. 3A(3), integrated circuit U3 is a quad, OP Amp 32. The first amplifier is used as a voltage follower with high input impedance and a low output impedance which isolates the track and hold circuit from the following amplifier. R5 and C3 form a low pass filter 34 to reduce the high frequency noise from the pulse signal.

In FIG. 3A(4) R6 and C4 form a high pass filter 36 and OP amp 38 provides a gain of about 500 at the frequency range centered at about 2.5 Hz which is the frequency of interest. C5 along with the feedback resistor R7 forms another low pass filter 40. All the filters together form a narrow pass band filter centered at 2.5 Hz. The pass band is wide enough to detect heart rates between 40 pulses per minute and about 250 pulses per minute. The signal at pin 8 of OP amp is now the recovered heartbeat waveform.

In FIG. 3A(5) the recovered heartbeat waveform is AC coupled into the last OP Amp 42 which acts as a threshold detector. The network 44 of R10, R11and R12 sets a threshold of about 0.2V. A signal above this amplitude causes the output (pin 14) 46 to go from 5 V to 0 V.

As shown in FIG. 3A(6) the second switch in U2 48 is closed upon detection of a beat, which causes current to flow in the visible LED 50. The decoupling network 52 comprising R14, C9 and R 16, C12 isolates the LED current transmits from the 08 Am PS.

In FIG. 3A(7) U4 is a DC-DC converter 54. A 1.4 V battery 56 is converted to a regulated 5V as shown at 60 to power the circuitry. It has a shutdown feature used to automatically turn on power upon skin contact as shown at 58.

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Components of Prototype Are Off-the-Shelf

All of the electronic components of the above described prototype are off-the-shelf components available from vendors such as Radio Shack and Target with many locations, Allied Electronics with offices in Fort Worth Texas and Digi-Key with offices in Thief River Falls, MN. The IR transmitter and detector in the above embodiment is a very inexpensive device used for card reading an sells for $1.37 in quantities of 100. The unit operates at a wavelength of 940 nm which scatters well in and easily penetrates tissue as thick as the earlobe. Applicants have adopted it for their monitor with excellent results. A drawing of the IR transmitter and detector is shown in FIG. 6. Other parts are also very inexpensive so that Applicants expect to be able to produce their monitor for about $20 or less in large quantities. Therefore, Applicants expect enormous markets for the products of the present invention for medical, exercise, sports of all types and many other uses. As suggested above Applicants expect that their biggest market will be lovers.

Testing

The prototype earring has been thoroughly tested by Applicants and its excellent performance has been confirmed. One of the Applicants has tested the earring at a wide range of heart rates comparing the blinking of the LED with his own pulse with perfect match throughout the range.

Types of Jewelry Other than Earrings

Experimentation by Applicants have proven that the principals of the invention claimed in the '079 patent can be extended to other types of jewelry. Applicants have determined that heartbeat rings worn at other locations of the body perform just as well or better as compared to the earlobe. Other potential locations include the fingers, belly button, nose, toes, breast, and parts of the breast. Applicants have also determined that the flashing heartbeat monitor can be attached to skin as a patch with excellent performance. For example a heart shaped patch containing the electronic components described above can be applied on a skin region corresponding to the region of a person's heart.

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Miniaturization

Although the prototype version of the invention actually built by Applicants is small enough to make a practical earring having substantial appeal, Applicants expect that much smaller earrings will have much greater appeal. Therefore, Applicants expect to have the electronics described converted to an application specific integrated circuit chip (an ASIC chip). These chips can be produced in volume production for less than $2 so that the cost of the heart monitoring jewelry could be as low a few dollars. Many ASIC manufacturers/designers are available which could convert the circuit shown in FIG. 3 into an ASIC chip mass producible for less than $2. These include Intrinsix Corp with offices in Westboro, MA; System to ASIC with offices in Bothell WA ASIC Northwest with offices in Portland, OR and Arizona Microtek, Inc with offices in Mesa, AZ. Another technique to miniaturize the jewelry of the present invention is by utilizing so called "surface mounting" techniques. These components are typically only about one-tenth to one fifth the size of conventional components. Thus, the prototype earring built and tested by applicants using off-the-shelf components, which is somewhat smaller than 1 inch cube, could be reduced in size to about one tenth or one fifth this volume using these surface mount techniques. Greater reductions are possible using the ASIC techniques but the surface mount approach generally requires a smaller front-end investment. Therefore, earrings of the present invention will be in sizes that are typical for earrings currently worn.

Three-Light Model

A preferred embodiment of the present includes an earring with three visible LED's, (red, green and blue) and a micro-processor which calculates pulse rate and causes the red LED to blink on each pulse, the green LED to blink on each pulse when the wearer's pulse rate is greater than a first threshold rate (such as 115% of normal) and the blue LED to blink on each pulse when the wearer's pulse rate reaches a second threshold corresponding to extreme excitement (such as 130% of normal). These ranges would correspond to increased heart rates of typical persons engaged in exercise and love-making. In preferred embodiments the example percentages may be adjusted to span a wider range for persons such as younger persons and athletes who have a much greater

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range of heart rate. The monitor may also be self calibrating based on measurements of the wearer's heart rate over extended periods which would include periods of rest as well as periods of extreme exertion or excitement. FIG. 5A is a block diagram showing additional circuitry for the green and blue lights at 50, and FIG. 5B shows a simplified block diagram of the logic 52 for turning on the green and blue lights. In another preferred embodiment the earring is programmed to turn on the blue light when the heart rate increases by at least 15 percent within a period of 3 minutes or less. The reason for this approach will be obvious to the reader from a review of FIGS 4A and 4B.

Blood Pressure Estimation and Indication

Blood pressure in humans varies in about the same degree as heart rate. Other preferred embodiments vary the brightness of the LED's (or other visible light) depending on the estimated blood pressure which also increases by about the same degree as pulse rate. In order to do this the detector monitors the intensity of measured light transmitted through tissue or reflected out of the tissue. The light transmitted or reflected is dependent on the amount of blood in the tissue which is in turn dependent on the blood pressure. In these preferred embodiment the LED will therefore not only blink with each heart beat but the intensity of the light will be roughly proportional to the blood pressure.

Battery Unit

FIGS. 7A and 7B describe a technique for providing power to an earring heartbeat monitor. A circuit board 60 comprises an IR transmitter Tx and an IR receiver Rx and one or more LED light sources 61 as described above. The board 60 includes cylindrical pin 62 comprised of cylindrical conductor 64 having a diameter small enough to fit through the pierced ear of typical persons with pierced ears. Conductor 64 is treated as ground. The pin includes central conductor 66 that is connected to the positive terminal 68 of battery unit 70 as shown in FIG. 7A. Preferably, the board unit 60 is positioned on the outside of the earlobe and the battery unit 70 is positioned on the inside of the earlobe (i.e., between the user's earlobe and her neck). The reader should note that an advantage of this design is that power is drawn from the battery unit only when the earring is being worn. When the earring is not being worn (assuming that the battery is a rechargeable

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battery) the battery unit may be recharged as shown in FIG. 7B. The reader should note that the pin element could be a part of the battery unit instead of the board unit. The pin 62 could be held in place by a pressure fit or threads could be provided so that the battery unit 70 is threaded on to pin 62. Battery 69 could be a re-chargeable battery in which case a battery charge unit could be provided with a fitting similar to pin 62 for charging battery 69 with wall power as shown in FIG. 7B. Also, techniques could be added to accommodate various thicknesses of earlobes.

Although the present invention has been described in terms of particular embodiments, persons skilled in the art will recognize that many other embodiments using the principals of the invention are possible. Such variations include IR transmitters and receivers operating at different wavelengths which penetrate tissue and are absorbed in blood to a lesser or greater extent than the 940 nm light. Visible light components other than LED's could be used so long as they are small and efficient. The earring could include a tiny transmitter to transmit a signal to a nearby receiver. In a preferred embodiment the signal energizing the blue light could be transmitted to a nearby receiver that would then activate an audio receiver that would produce sounds such as church bells. Applicants have learned through testing of prototype earrings that bright sunlight adversely affects performance of the heartbeat earrings. Placing an infrared absorber between the earlobe and the clamp on the inside of the earlobe minimizes these adverse effects. Another solution to the sunlight problem is to design the earring so that the optical components of the earring are shielded from direct or reflected rays from the sun. Therefore, the scope of the invention should be determined by the appended claims and their legal equivalents.

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We claim:

1. Flashing jewelry comprising:
   A) an infrared emitter positioned to emit infrared light into tissue of a wearer,
   B) an infrared detector positioned to detect infrared light emanating from said tissue,
   C) a power source for said emitter and said detector,
   D) an electrical circuit for analyzing electrical signals from said detector to detect each beat of a wearers heart,
   E) at least two visible light emitters,
   F) a first trigger circuit for initiating electrical pulses to cause one of said visible light emitters to flash once for each heart beat,
   G) a pulse rate calculation means for calculating the wearer's pulse rate, and
   H) a second trigger circuit for initiating pulses to cause a second of said visible light emitters to flash once for each heart beat when said pulse rate exceeds a first predetermined rate.
2. Jewelry as in Claim 1 and further comprising a third trigger circuit for initiating pulses to cause a third of said at least two visible light emitters to flash once for each heart beat when said pulse rate exceeds a second predetermined rate.
3. Jewelry as in Claim 2 wherein said at least two visible light emitters are three visible light emitters emitting respectively red, green and blue light.
4. Jewelry as in Claim 1 wherein said jewelry is an earring.
5. Jewelry as in Claim 1 wherein said jewelry is a finger ring.
6. Jewelry as in Claim 1 wherein said jewelry is attached to skin of said wearer by a patch.
7. Jewelry as in Claim 1 wherein said jewelry is a patch in the shape of a heart.
8. Jewelry as in Claim 1 wherein said at least one visible light emitter is three visible light emitters.

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9. Jewelry as in Claim 8 wherein said three visible light emitters are red green and blue emitters and said jewelry further comprises a means to determine heart rates of said wearer.
10. Jewelry as in Claim 9 wherein said red emitter is programmed to flash with each heart beat, said green emitter is programmed to flash with each heart beat when the heart rate of the wearer is in excess of a first threshold in excess of the wearer's rest heart rate and said blue emitter is programmed to flash with each heart beat when the heart rate of said wearer is in excess of a second threshold in excess of said first threshold.
11. Jewelry as in Claim 10 wherein said first threshold is at least 115 % of the wearer's resting heart rate and said second threshold is at least 130 % of wearer's resting heart rate.
12. Jewelry as in Claim 1 wherein said electric circuit comprises and ASIC circuit.
13. Jewelry as in Claim 1 wherein said electric circuit comprises surface mounted circuit.
14. Jewelry as in Claim 3 and further comprising a transmitter for transmitting a signal to an audio device to initiate a sound when one of said thresholds are exceeded.
15. Jewelry as in Claim 14 wherein said sound is church bells.
16. Jewelry as in Claim 1 wherein said power source is a battery unit positioned on the inside of an earlobe and connected through an earlobe to a circuit board comprising said infrared emitter, said infrared detector and said at least two visible light sources

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FIG. 1
PRIOR ART

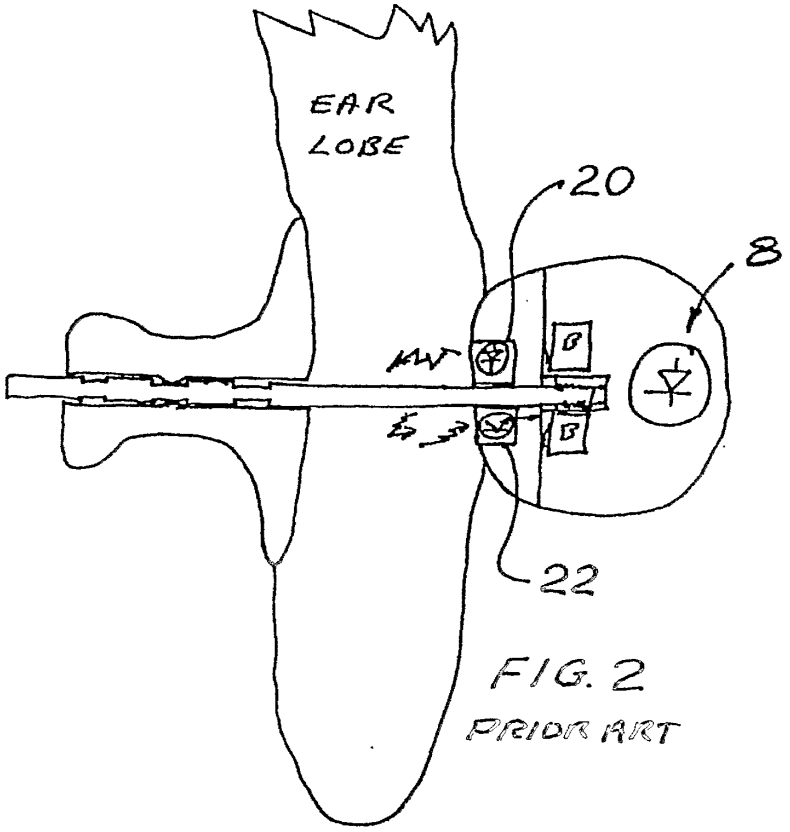


FIG. 2
PRIOR ART

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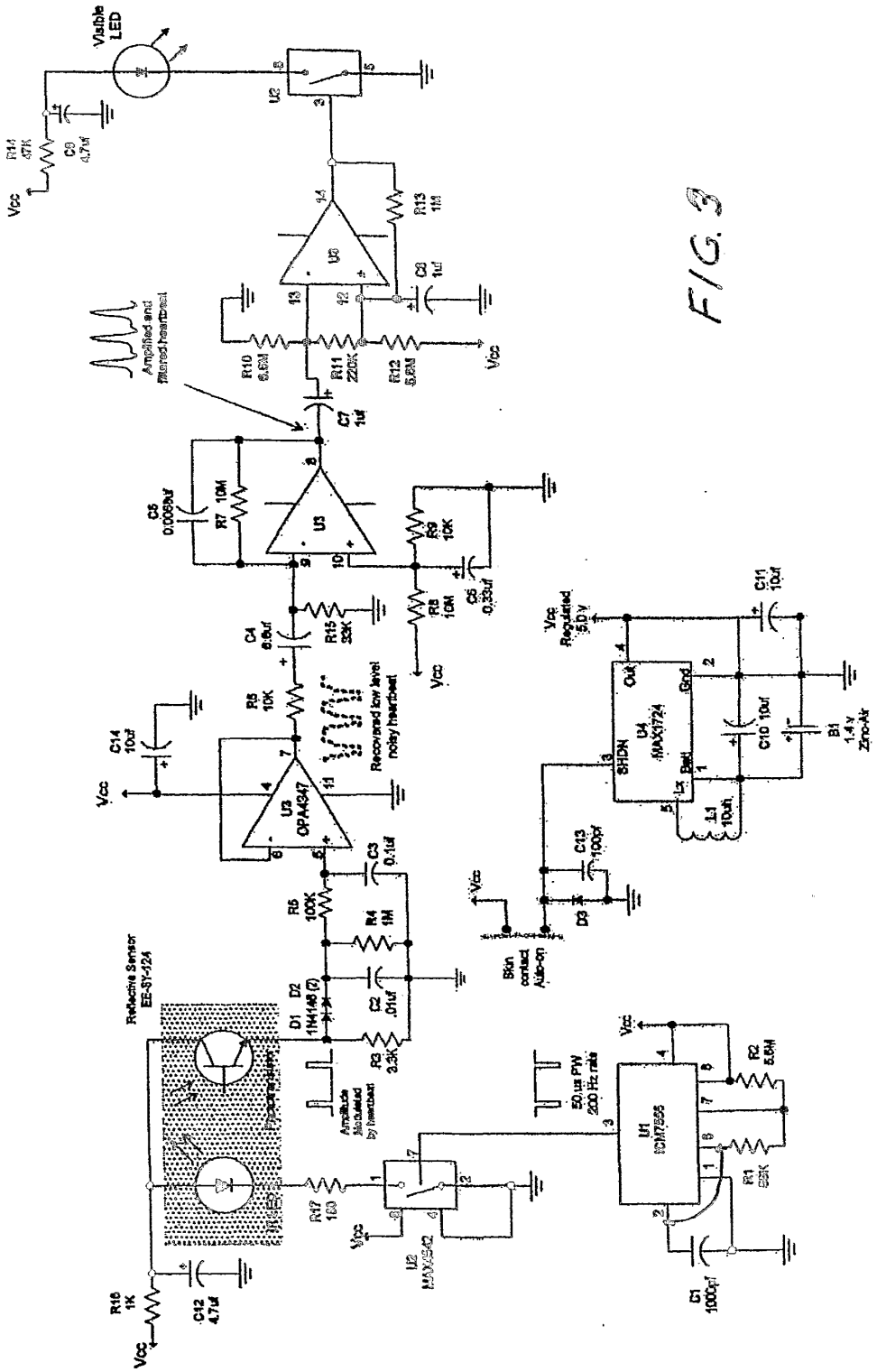


FIG. 3

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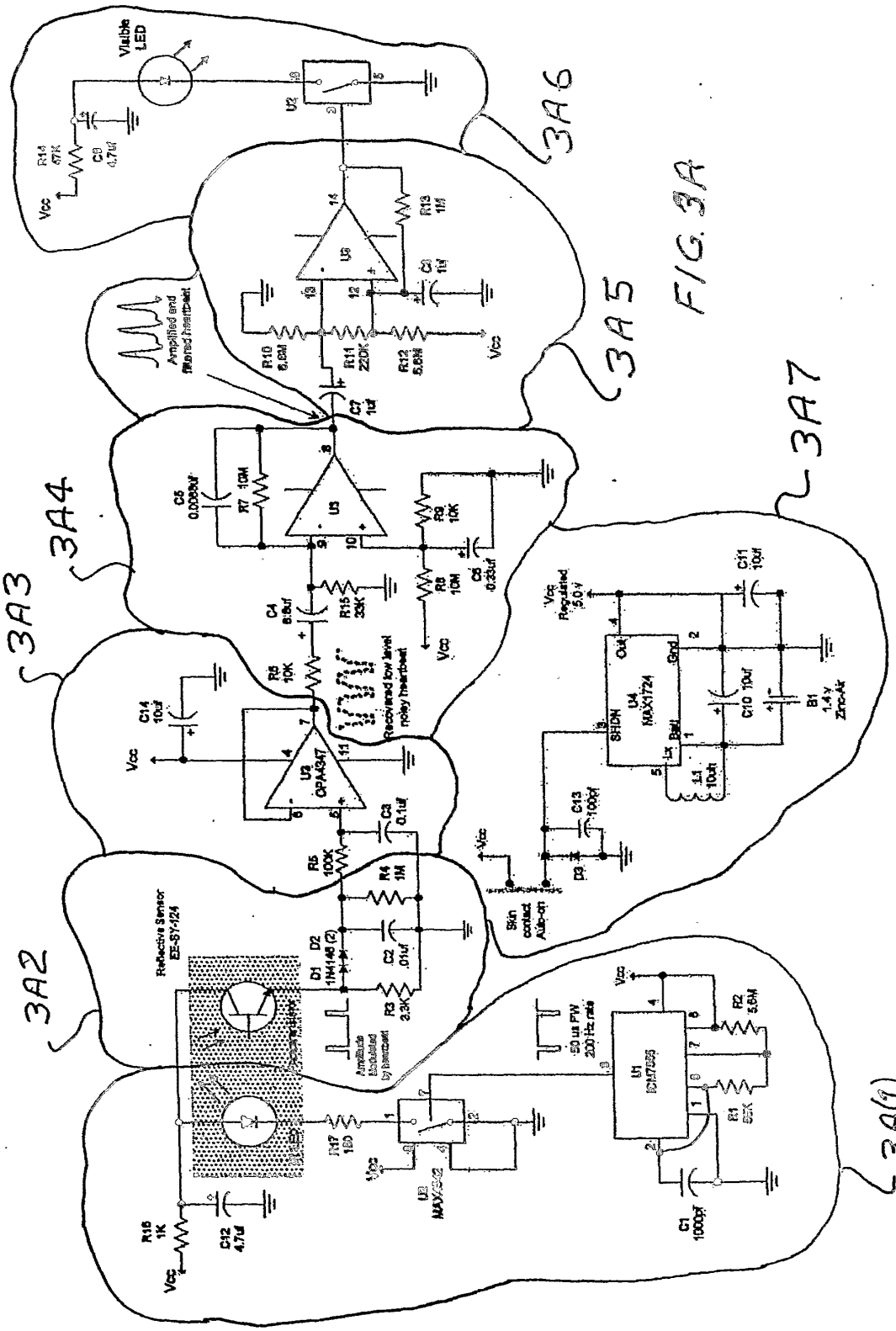
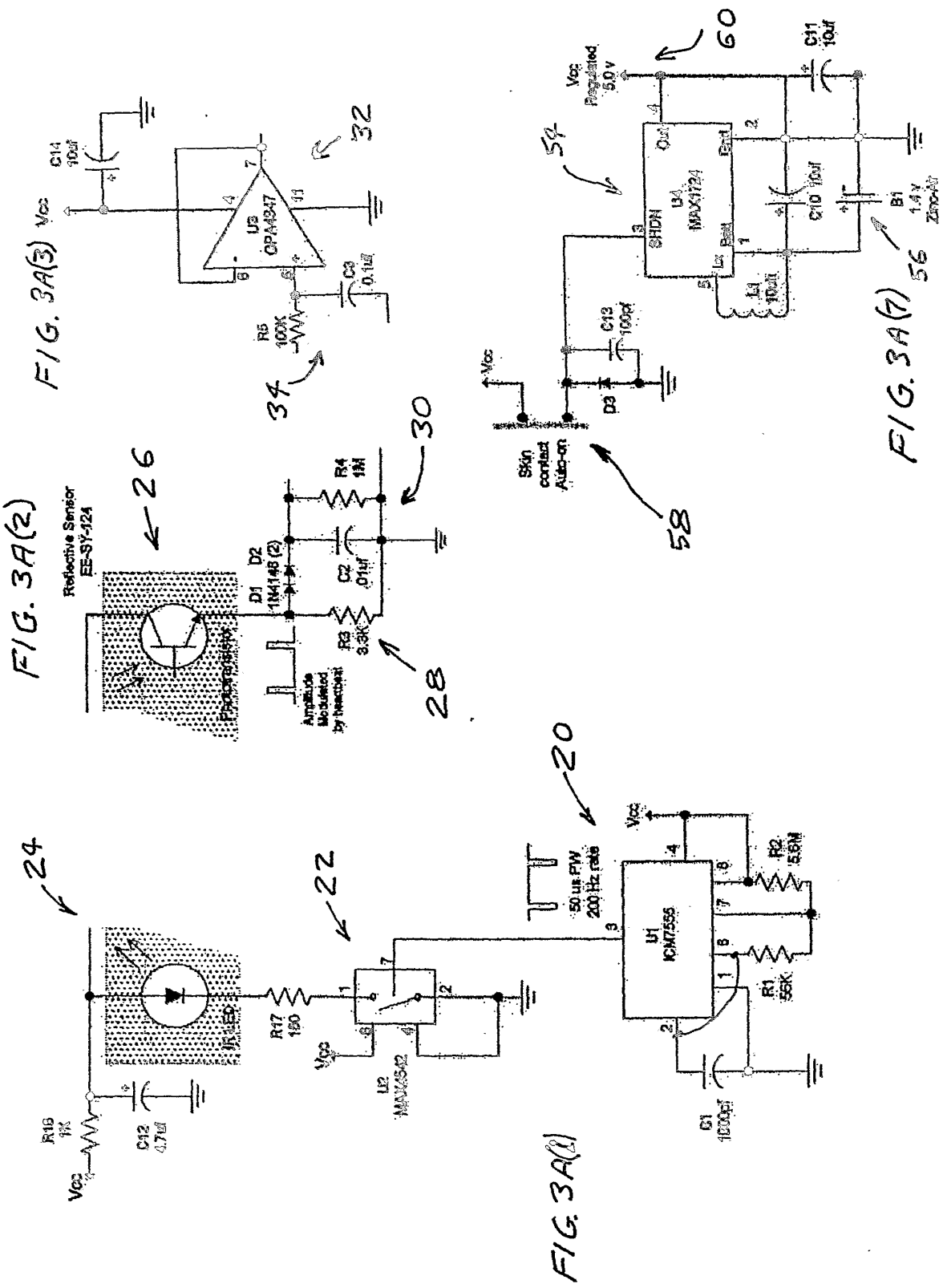


FIG. 3A

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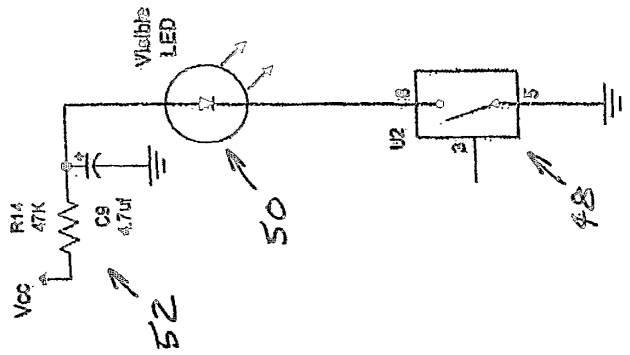


FIG. 3A(6)

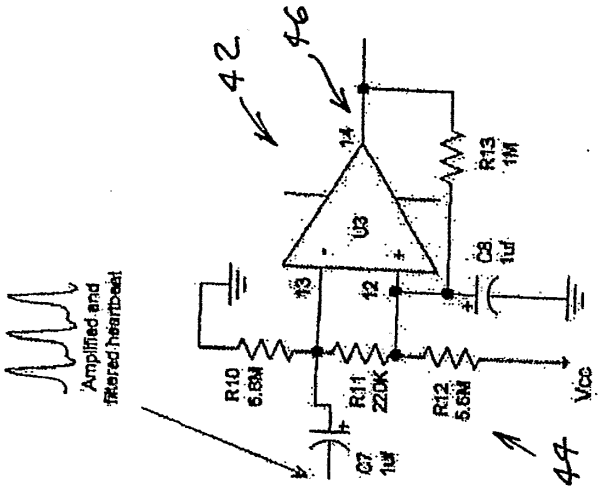


FIG. 3A(5)

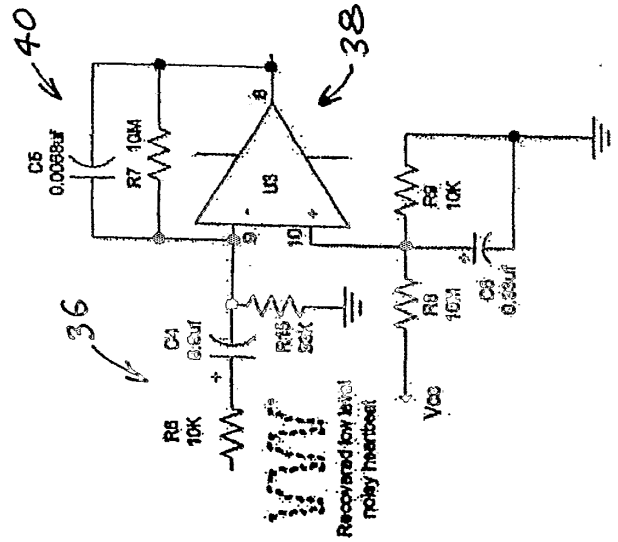
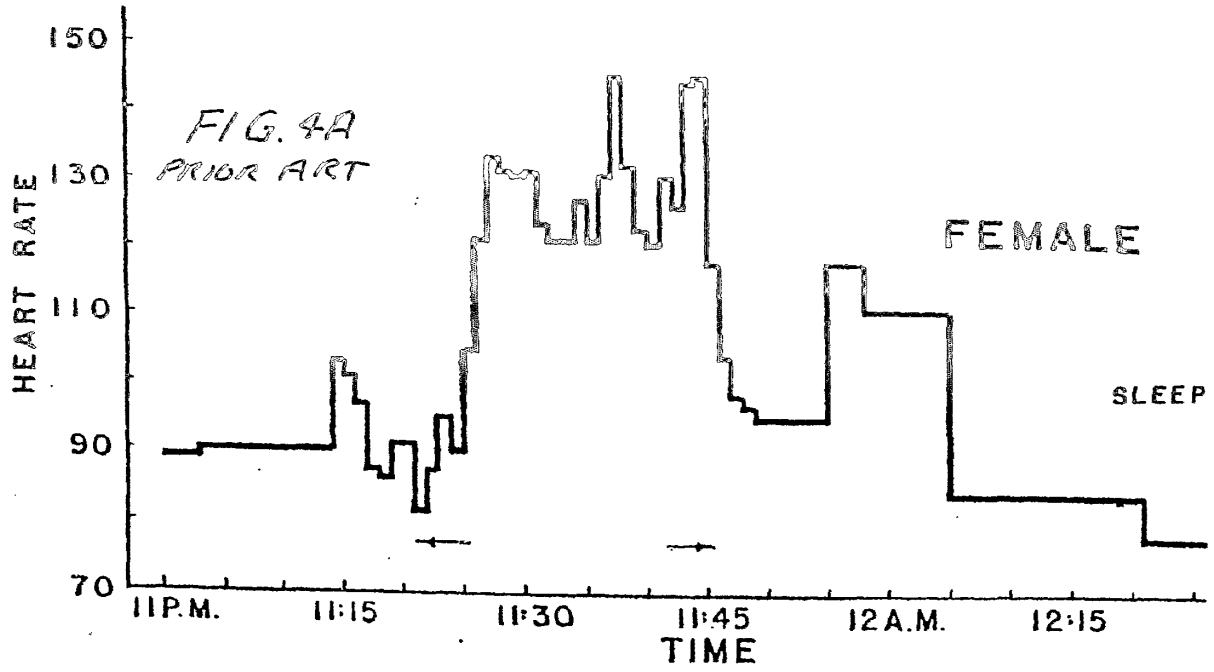
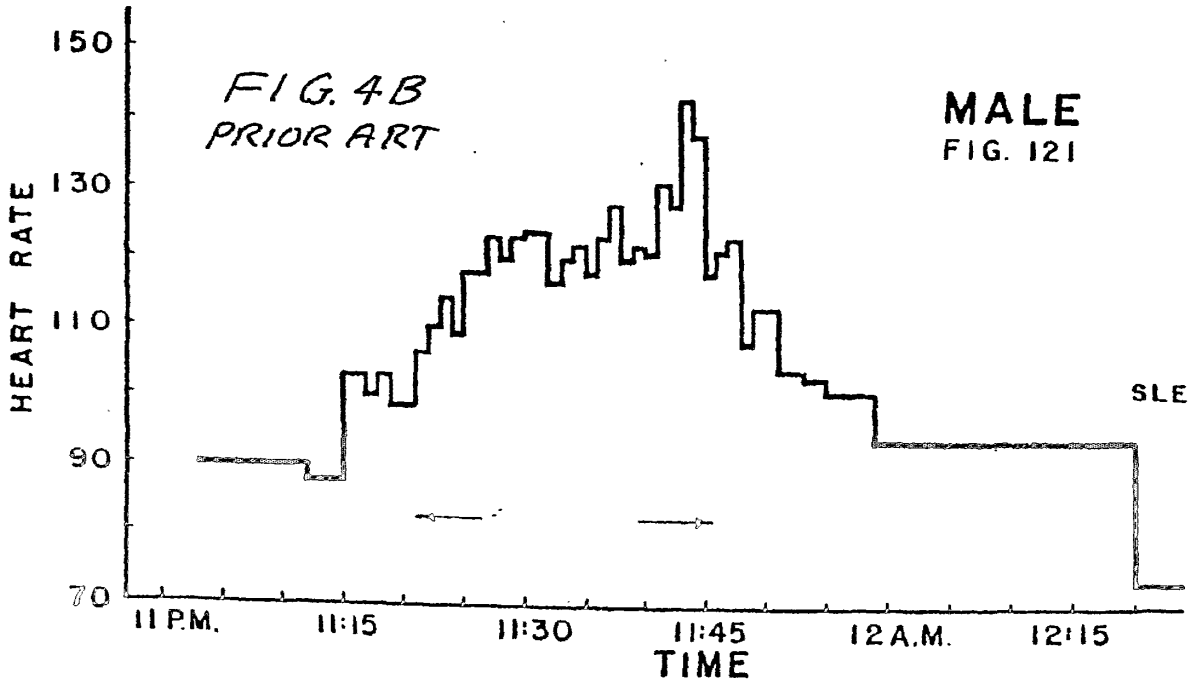


FIG. 3A(4)

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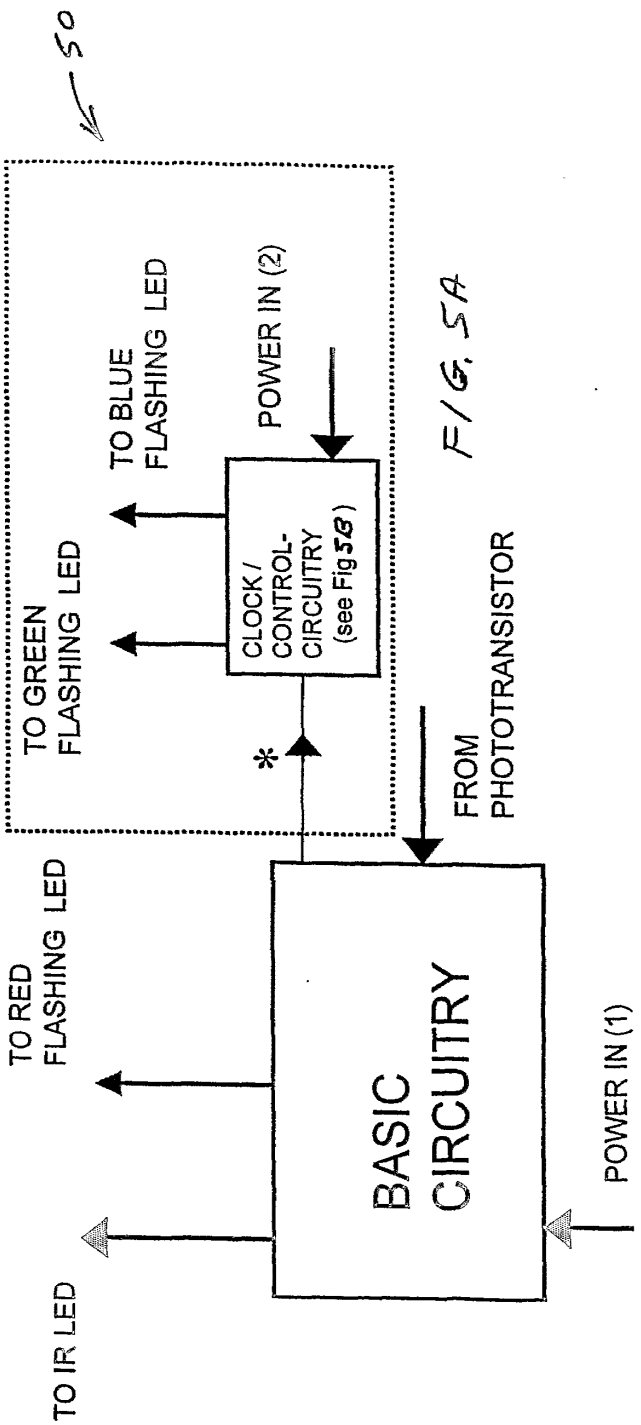


FIG. 5A

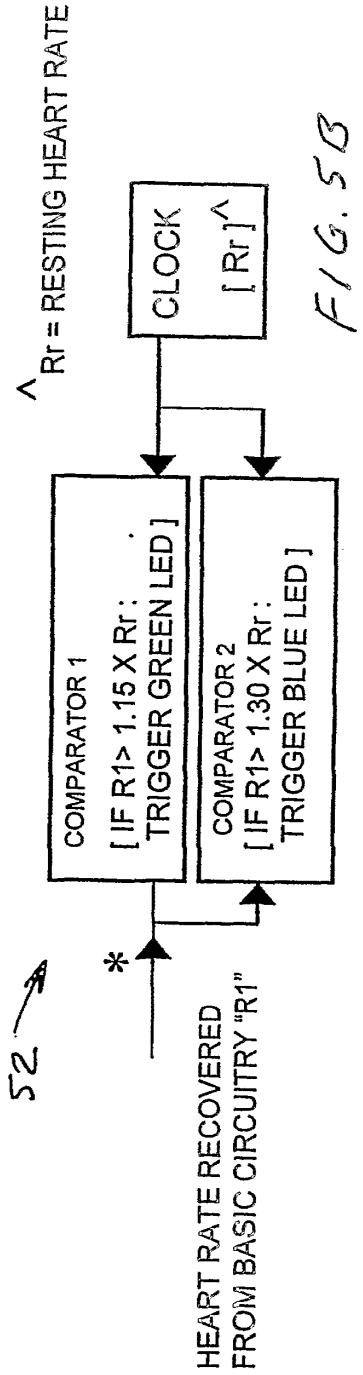


FIG. 5B

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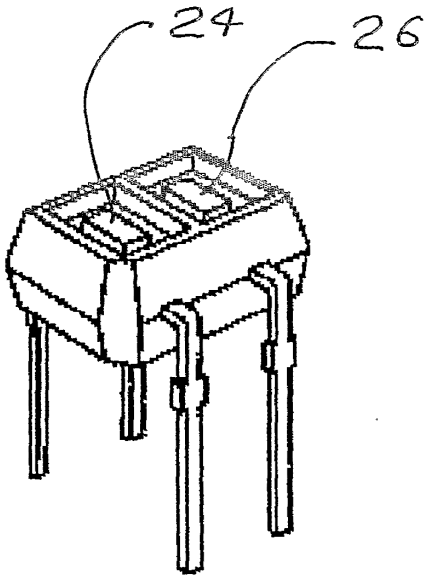


FIG. 6

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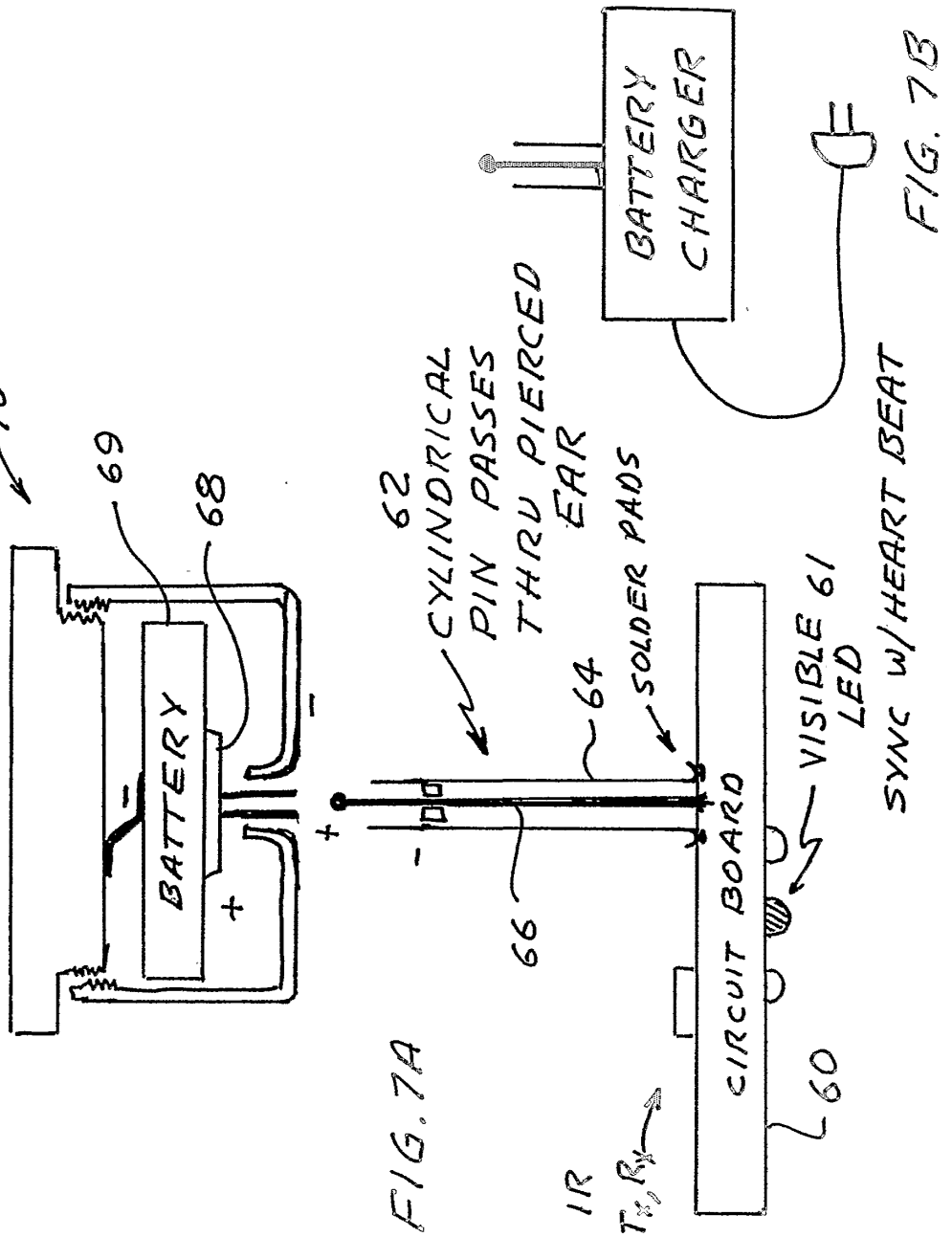


FIG. 7A

FIG. 7B

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(72) Inventors; and
(71) Applicants : **WISSMAR, Stanley** [SE/SE]; Nidarosslingan 1, SE-175 66 Järfälla (SE). **RADAMSON, Henry** [SE/SE]; Sätunavägen 11B, SE-195 46 Märsta (SE).

(74) Agent: **ALBIHNS.ZACCO AB**; P.O Box 5581, Valhallavägen 117, S-114 85 Stockholm (SE).

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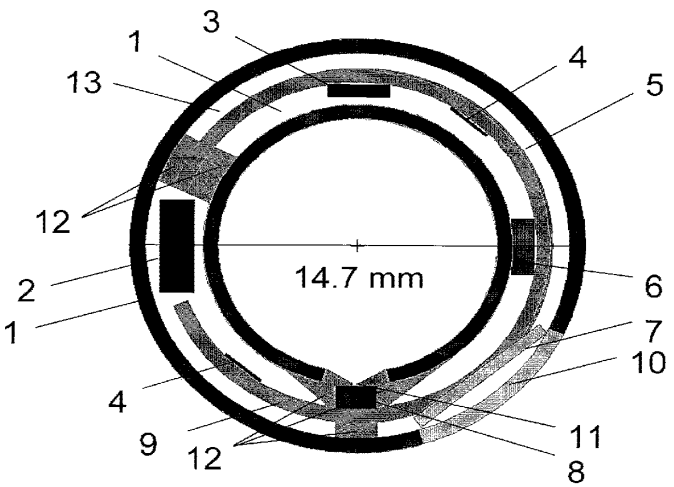


Fig. 1

(57) Abstract: The present invention provides an electronic finger ring (1) for wireless, 4-dimensional remote steering and/or monitoring. The electronic finger ring comprises electronic components packaged and integrated in different ways to obtain either omni- or unidirectional RF transmission dependent on its application, e.g. acting as a multiple steering device communicating with nearby electronic devices wirelessly or for wireless user medical diagnostics.

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ELECTRONIC FINGER RING AND THE FABRICATION THEREOF

Technical Field of the Invention

The present invention relates to a toroidal finger ring, in particular to such an accessory comprising several electrical- and micromechanical components acting as a multiple sensor device communicating with nearby electronic devices wirelessly with e.g. bluetooth technology.

Background of the Invention

A computer mouse (or equivalent touchpad or touchscreen) is used as a steering device to control the two dimensional (horizontal and vertical) motion of an icon on a computer screen (stationary pc, laptop, pda). It takes up large space which limits the user's freedom of movement. Through the years several types of models has been developed and manufactured; mechanical-, optical-, laser- and inertial- computer mouses. The last mentioned using accelerometers to steer the mouse pointer in x- and y- directions.

Another application uses micromechanical accelerometers on top of a finger ring to control sound effects to an electric guitar (see www.sourceaudio.net/index.php).

On yet another application a finger ring is used for mobile voice communication where it is integrated with a microphone and speakers in order to transfer sonar vibrations from the speakers (see " A finger-ring shaped wearable handset based on bone-conduction", Fukumoto, M; Wearable Computers; Proceedings, Ninth IEEE International Symposium on 18-21 Oct. 2005, pages 10-13).

U.S. Pat. No. 2003/0142065 A1 describes a ring-like device which encompasses several electronic components carried on a flexible printed circuit board (FPCB).

U.S. Pat. No. 2003/0227437 A1 describes a pointing device which is characterized by a band that is mountable on a computer user's thumb.

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U.S. Pat. No. 2004/0032346 A1 describes a distancing sensing unit to function primarily as a virtual keyboard.

U.S. Pat. No. 2005/0052412 A1 describes a human interface machine interface used exclusively as a computer mouse type device.

U.S. Pat. No. 2006/0001646 A1 describes an operating device which is "C" shaped.

German Pat. No. DE102005021527 A1 describes an operating device which has electronic components embodied in a structure mounted on top of the finger ring.

U.S. Pat. No. US005638092 describes a cursor control system exclusively used in connection to a keyboard.

Summary of the Invention

It is an object of the invention to solve or at least mitigate one or more problems associated with the above mentioned devices according to prior art.

In particular, it is an object of the invention to provide a user-friendly steering device for controlling an external electronic device, such as a computer.

This object is achieved by an electronic finger ring as defined by claim 1.

This electronic finger ring offers an effective and ergonomic way of steering/controlling an external electronic device in up to four dimensions.

Specific embodiments of the invention are defined in the dependent claims, the advantages of which are apparent from the detailed description following hereinafter.

The present invention is based on the understanding that an alternative steering device design, compared to an established computer mouse, can be achieved using an electronic finger ring based on a 4-dimensional steering device control integrated in the rings interior.

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According to a first aspect of the present invention, there is provided an accelerometer for motion sensing, to steer in a 3-dimensional space. There is further provided a micromechanical pressure sensor in order to steer in an additional 4th dimension, i.e. a steering device design which facilitates to additionally move/control a mouse cursor in a 4th dimension on a computer screen (or equivalent). This gives the user the ability to; for example, zoom in or out of a picture on a computer screen. Additionally custom pre-configure it to the users need in different situations dependent on application; like in a home environment: turn on or off home entertainment system in 1st dimension; change to tv- music- or movie mode in a 2nd dimension; change tv channel/music- or movie track in a 3rd dimension and start-, stop- or pause track in a 4th dimension. That the pressure sensor is adapted to allow steering in an additional 4th dimension means, at least in some embodiments of the invention, that the pressure sensor is adapted to control a function of the external electronic device not relating to steering in a 3-dimensional space.

Alternatively, the micromechanical pressure sensor may function as a finger plethysmograph providing a non-invasive measurement for changes in finger blood flow reflected by pulse wave amplitude (PWA).

The above mentioned active components are combined with mixed signal microcontrollers enabling control and signal processing of these aforementioned active components. To communicate with other, external electronic devices a radio frequency (RF) transceiver is electrically connected to the previous mentioned active components. All the aforementioned electronic components are mounted on a flexible printed circuit board (FPCB) where conductor lines electrically connect the individual components. The actual order and placement of the respective components are novel in order to obtain the desired functionality and packaging inside the toroidal shaped ring. To obtain matching currents and voltages for individual active components passive components are connected. These passive components could either be mounted on the FPCB as individual physical components or be integrated in the FPCB.

To supply power to the components, they may be connected to a battery integrated in the electronic finger ring. In one embodiment, these aforementioned components constitute the internal electronic circuit of the electronic finger ring.

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An alternative to provide a source of energy is integrating the conformal coating with piezoelectric nanofibers (for example, pzt – lead zirconate titanate – or zink oxide materials), which converts mechanical energy to electrical energy, which can be placed/located on both the outer- and/or inner circumference of the fpcb and connected electrically to the fpcb to provide electricity to the electrical components.

Yet an alternative power source for powering the electronic components of the finger ring is a coil for generating induced current to the components when the ring is subject to an alternating magnetic field. Such a coil may be integrated in the ring and be used instead of, or in addition to, a battery and/or piezoelectric nanofibres.

In an embodiment of the present invention, after the electrical components are mounted and electrically connected to the FPCB they are covered with nonconductive, conformal coating.

To further reduce the RF radiation on the electrical components as well as the user's finger, the conformal coating, coated on the inner circumference of the FPCB, is mixed with cenospheres, a material which functions as a RF shielding. In one embodiment, the above mentioned piezoelectric nanofibers are integrated in the conformal coating.

A great advantage of the electronic finger ring of the present invention is that the whole ring constitutes the complete electronic circuit. That is, the complete electronic circuit is integrated in the interior of the electronic finger ring. In one embodiment in which the ring is a toroidal shaped metal ring it functions as (i). an external antenna, to obtain coarse tuning to the operational frequency, connected to the internal antenna and RF transceiver located inside the ring or as an (ii) electric ground plane to the internal antenna.

In an embodiment of the present invention, constituting the top metal layer on the interfaces of the toroidal halves is a material which has two functions, (i). to enhance the welding between the joints by its chemical, adhesive properties and (ii). enhancing the hermetic encapsulation (i.e. lowering the pressure in the sealed ring cavity) by its getter properties.

In an embodiment of the present invention, the aforementioned pressure sensor is located in a cavity within the electronic finger ring where the inlet hole geometry is

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shaped as a horn cone to maximize the pressure compression ratio at the pressure sensor end.

In an embodiment of the present invention, the aforementioned cenospheres can further be deposited on the exterior of the inner circumference of the ring shell in order to reduce RF radiation on the user's finger.

In an embodiment of the present invention to adapt and optimize to different applications the antenna has different designs : (i). External, omnidirectional (ii). internal integrated unidirectional (iii). internal integrated unidirectional with extended, elevated housing (iv). Dielectric integrated with folded monopole.

An intermediate metal strip layer is designed to function as a microstrip feed (transmission) line, electrically connecting an RF transceiver with the internal antenna, preferably optimized to obtain 50 Ω matching impedance. This implies limitations in how the components, the internal antenna and RF transceiver, are placed within the toroidal shaped finger ring.

In an embodiment of the present invention, to complete the design of the aforementioned antennas they are respectively combined with a ground plane located in (i). intermediate layers in the FPCB (ii). or when a portion of the toroidal shaped ring has a dielectric part integrated with folded monopole antenna, the remaining toroidal shaped outer metallic shell functions as a ground plane.

In an embodiment of the present invention, a portion of an outer metal shell is opened to function as a window housing to allow unperturbed RF radiation either (i). having a shape which is identical to the toroidal ring or (ii). Constitute of a dielectric material in said portion of ring or (iii). have a locally extended, elevated sphere shape to minimize return losses of the RF radiation.

Another object of the invention is to provide an alternative use of a finger ring apart from being an aesthetical and/or cultural valued item.

Other objects of the invention are to address the following problems:
- how to integrate an antenna having either omnidirectional or unidirectional radiation properties in a finger ring,

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- how to design an electric circuit comprising various electrical- and/or micromechanical components which can be integrated in a normally sized finger ring,
- how to manufacture a finger ring comprising integrated electrical- and/or micromechanical components,
- how to manufacture such a ring in a way that increases the lifetime and/or the performance of the ring.

Yet another object of the invention is to provide an electronic finger ring design allowing the ring to be adapted for one or more of the following applications:
(i). Steer and control the functions of electronic devices which are in the users immediate vicinity
(ii). Identification – to use instead of an ordinary security pass card
(iii). Electronic payment – to use instead of an existing credit card
(iv). For continuous measurement and diagnosis of a user's health state – A person diagnosed with Parkinson disease needs his or hers finger or hand tremor movements to be continuously monitored in order to receive proper medication or treatment by medical staff
(v). For mute persons – to improve real-time communication with people who do not understand sign language
(iv). For communication – to inform the ring user about something
(vii). Assault larm – when suspecting assault the person carrying the electronic fingering can perform an immediate action with the ring and a signal is wirelessly transmitted to his or her's mobile phone which in turn automatically sends an emergency call for help
(viii). Finger Plethysmograph - to provide a non-invasive measurement for changes in finger blood flow reflected by pulse wave amplitude (PWA) for accurate data collection technique, used for example monitoring heart periods for use in heart rate variability (HRV) calculations.

All of the above objects may be achieved according to the invention by means of a toroidal shaped finger ring hermetically encapsulating electrical components allowing the ring to communicate wirelessly with electronic devices in its immediate vicinity while at the same time having the aesthetic properties of a conventional jewellery ring.

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Brief description of the drawings

The above, as well as additional objects, features and advantages of the present invention, will be better understood through the following illustrative and non-limiting detailed description of preferred embodiments of the present invention, with reference to the appended drawings, wherein the same reference numerals are used for similar elements, and in which:

Fig. 1 is a schematic profile view of the electronic finger ring where the electronic components are mounted on a flexible printed circuit board packaged inside the torus shaped finger ring with a pressure sensor facing the inner boundary of the torus in accordance with an embodiment of the present invention.

Fig. 2 is a schematic top view of the electronic components mounted on both sides of a flexible printed circuit board.

Fig. 3 is a schematic profile view zoomed on the inlet hole shaped as a horn cone to maximize the pressure compression ratio at the pressure sensor end.

Fig. 4 is a schematic profile view of the electronic components mounted on a flexible printed circuit board packaged inside a torus shaped finger ring with an alternative design having the pressure sensor being placed on the outer boundary of the torus.

Fig. 5 is a schematic profile view of the electronic components mounted on a flexible printed circuit board packaged inside a torus shaped finger ring with an alternative design having a folded monopole antenna.

Fig 6. is a schematic top view of the electronic components mounted on both sides of a flexible printed circuit board having an alternative design with a folded monopole antenna.

Fig 7 is a schematic three dimensional view of the torus shaped electronic finger ring where the outer and inner metal shells are constituted of two different metals to allow unidirectional, unperturbed RF radiation in accordance with another embodiment of the present invention.

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Fig. 8 is a schematic, three dimensional illustration of the cross section of the inner and outer toroidal shells showing how the different metal layers are deposited in accordance with another embodiment of the present invention.

Fig. 9 is a schematic illustration of the top and bottom halves of the ring toroidal shell where the interface (as well as inner surface) is a titanium compound in accordance with another embodiment of the present invention.

Fig. 10 is a schematic view of an external, coarse, omnidirectional design where the whole toroidal shaped metallic shell functions as an RF antenna in accordance with an embodiment of the present invention.

Fig. 11 is a schematic view of where the internal, unidirectional antenna is located where the outer shell is opened leaving the inner shell exposed (constituted of Titanium compound) to allow unperturbed RF radiation in accordance with an embodiment of the present invention.

Fig. 12 is a schematic view of an extended, unidirectional antenna housing constituted of an integrated sphere design which has no top shell material deposited leaving the inner shell exposed (constituted of Titanium compound) to allow unperturbed RF radiation transmission in accordance with an embodiment of the present invention.

Fig. 13 is a schematic illustration of a monopole antenna design integrated in a dielectric material in accordance with an embodiment of the present invention.

Fig. 14 is a schematic illustration of a monopole antenna design which is located where an outer shell is opened leaving the inner shell exposed to allow unperturbed RF radiation in accordance with an embodiment of the present invention.

Fig 15 is a schematic view of how the ground planes on the FPCB are designed. The ground plane facing the outer circumference of the ring acts as a ground plane for the RF antenna circuitry, the ground plane facing the inner circumference of the ring acts as a ground plane and optionally also a thermal heat sink for the electronic components; in accordance with an embodiment of the present invention.

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Fig 16 is a schematic view showing how the microstrip is connected to the RF transceiver with the adjacent groundplanes as intermediate layers in the FPCB. Additional conductor lines, Vcc etc. are not shown; in accordance with an embodiment of the present invention.

Fig 17 is a cross sectional view of the folded monopole antenna showing how it obtains its desired geometry after integrated in the ring in accordance with an embodiment of the present invention.

Fig 18 is a top view of the folded monopole antenna in accordance with an embodiment of the present invention.

Fig. 19 is a three-dimensional illustration view of the folded monopole antenna in accordance with an embodiment of the present invention.

Detailed description of Embodiments of the Invention

The following description is of the best mode presently contemplated for carrying out the invention. This description is not to be taken in a limiting sense, but is made merely for the purpose of describing the general principles of the invention. The scope of the invention should be determined with reference to the claims.

A toroidal shaped, electronic finger ring constitutes the complete electronic circuit. The toroidal shaped metal ring functions as either (i). an external antenna, to obtain coarse tuning to the operational frequency, which is connected to the internal antenna and RF transceiver located inside the ring or as an (ii) electric ground plane to an internal antenna.

The electronic finger ring functions as a 4-dimensional steering device where an accelerometer steers in 3-dimensional space and a pressure sensor steers in an additional 4th dimension, i.e. a novel steering device design.

With reference to Fig. 1 and 2, a first embodiment of the present invention is a toroidal shaped finger ring structure 1, constituted of two different metallic shells: (i). 1a, made of gold (Au) or silver (Ag), enclosing the major parts of the finger ring structure geometrically described as radially furthest away from the toroids centre, and (ii). 1b,

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made of a titanium compound (Ti, TiW), being the metal enclosing facing the inner parts of the finger ring structure. The toroidal shaped finger ring structure 1 is comprised of different electronic components: a battery 2, a RF transceiver 3 and a micro processor 4, a microstrip line 5, an accelerometer 6, an internal antenna 7, a pressure sensor 8; all mounted on a flexible printed circuit board 9. In this embodiment, there is also an outer metal shell opening 10 serving as an RF window letting through unperturbed RF radiation. In this embodiment, at the inner boundary of the toroidal shaped finger ring structure 1 located at the pressure sensor 8 there is an inlet hole shaped as a horn cone to maximize the pressure compression ratio at the pressure sensor end 11. To permanently place the pressure sensor and one end of the flexible printed circuit board in respective places, fixtures 12, are casted as part of the metallic shell. In this embodiment, there is a protective coating layer 13 located between the outer boundary of the toroidal shaped finger ring structure 1 and the flexible printed circuit board 9, and another form of protective coating (with cenospheres) 14 located between the inner boundary of the toroidal shaped finger ring structure 1 and the flexible printed circuit board 9, as explained above. The internal antenna 7 is connected to the RF transceiver 3 by a microstrip line 5, where the design of the microstrip is optimized to obtain 50 Ω matching impedance. In the case of an external antenna option, the outer shell of the toroidal shaped finger ring structure 1 serves as a coarse antenna. In the case of using exclusively an internal antenna option, the internal antenna is located at a position along the circumference of the toroidal shaped finger ring structure 1 where there is no outer metallic shell covering 10 allowing unperturbed, unidirectional radiation.

In this embodiment, the above mentioned active components are combined with micro processor 4 enabling control and signal processing of these aforementioned active components. To communicate with other, external electronic devices an RF transceiver is electrically connected to the previous mentioned active components. All the aforementioned electronic components are mounted on a flexible printed circuit board (FPCB) where conductor lines electrically connect the individual components. The actual order and placement of the respective components are optimized in order to obtain the desired functionality and packaging inside the toroidal shaped ring. To obtain matching currents and voltages for individual active components passive components are connected (not shown). These passive components could either be mounted on the FPCB as individual physical components or be integrated in the FPCB.

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To supply power to the components a battery 2 is connected. These aforementioned components comprise the internal electronic circuit of the electronic finger ring.

In this embodiment of the present invention, after the electrical components are mounted and electrically connected to the FPCB they are painted with a nonconductive and preferably conformal coating 13. Commonly used conformal coatings are silicone, epoxy, acrylic, urethane and paraxylene. The function of the coating is to (i). prevent damage from rough handling, (ii). reduction of mechanical and thermal stress as well as (iii). prolonging the lifetime of the components. Also to (iv). increase the dielectric strength between conductors lines on the FPCB enabling the design of the FPCB to be more compact and small.

As the electrical components are mounted on one side of the FPCB, the inside circumference of the FPCB, the conformal coating absorbs the stress released from forming the FPCB into a toroidal/circular shape, thus reducing the risk of the respective electrical component and FPCB losing mechanical or electrical connection to each other.

In fig. 15 and 16, to reduce RF radiation generated from the antenna circuitry the FPCB has one or several intermediate ground planes 17, which serves to (i). reflect any RF radiation directed inward (ii). function as a ground plane for the antenna circuitry reducing return losses of the RF radiation and (iii). function as a circuit ground plane for the electrical components and, optionally also as a (iv). thermal heat sink. The electrical components are placed on the inner circumference of the FPCB in such an order to minimize RF radiation generated from the aforementioned antenna. Due to the design limitations inherit in the antenna circuitry, constituted of the antenna, microstrip line, RF transceiver, the order and placement of the same in respect to the ground planes are critical in order to obtain a sufficient shielding minimizing the aforementioned RF radiation. Thus the ground planes located in the FPCB are designed to stretch at least in-between from where the internal antenna is located on the outer circumference side of the FPCB and the RF transceiver located in the inner circumference side of the FPCB.

To further reduce the RF radiation on the electrical components as well as the users finger, the conformal coating 14, coated on the inner circumference of the FPCB, can be made (mixed) with such material which functions as a RF shielding. This material can be made of cenospheres (constituted of a range of nanoparticle sized metal oxides) which reflects RF radiation.

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An intermediate metal strip layer 5 is designed to function as a microstrip feed (transmission) line, electrically connecting the RF transceiver with the internal antenna, preferably optimized to obtain 50 Ω matching impedance.

The range for the width and length of the microstrip feed line must be such that each dimension of the microstrip feed line radiates only the required frequency (2.4 GHz). For a toroidal shaped antenna of this invention thus requires a microstrip feed line length, $I_{transmission\_line}^{circumference}$, along the circumference of the ring described as $I_{transmission\_line}^{circumference}(max)$ = 0.30λ and $I_{transmission\_line}^{circumference}(min)$ = 0.20λ, where λ is the wavelength to the corresponding radiation frequency (λ = 125 mm @ 2.4 GHz). In analogy, the microstrip feed line width is required to be in the range of w(min) = 0.008λ and w(max) = 0.028λ.

In fig. 3, the aforementioned pressure sensor is located in a cavity within the electronic finger where the inlet hole geometry is shaped as a horn cone to maximize the pressure compression ratio at the pressure sensor end. To optimize sensitivity the inlet hole should have a minimum aspect ratio size difference of the diameter of the narrow end, x, of the horn cone to the outer end, y as 1:10; equivalently, the total height, m, of the horn cone should have an aspect ratio size to the height of the narrow end of the horn cone, n, as 6:1.

The pressure sensor can be located in two alternative positions as seen in fig. 1 and fig. 4 to steer in a 4th dimension, the former by vertical finger movement (i.e. bending) of the finger the electronic finger ring is mounted on; the later by, for example, a finger on the other hand of the user. In Fig. 1, the pressure sensor 8 and the inlet hole are located so that the cavity housing the sensor 8 faces the inner circumference of the toroidal shaped finger ring structure 1. This location makes the pressure on the pressure sensor increase when the finger carrying the ring is bended since the tissue of the lower part of the finger then becomes compressed and expanded in its radial direction. Thus, steering an external device to which the ring is connected in a 4th dimension is easily achieved by simply bending/vertically moving the finger carrying the ring. In Fig. 4, the pressure sensor 8 and the inlet hole are located so that the cavity housing the sensor 8 faces the outer circumference of the toroidal shaped finger ring structure 1. In this case, activation of the pressure sensor and hence steering of the external device in the 4th dimension may be achieved by pressing the pressure sensor 8 with either another finger of the

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hand carrying the ring, or a finger of the other hand. Preferably, in this scenario, the pressure sensor 8 is activated by using the thumb of the hand on which the ring is carried.

In fig. 8 constituting the top metal layer on the interfaces of the toroidal halves (including the intermediate metal strip layer), is a material which has two functions, (i). to enhance the welding between the joints by its chemical, adhesive properties and (ii). enhancing the hermetic encapsulation (i.e. lowering the pressure in the sealed ring cavity) by its getter properties. This material could be made of titanium (Ti) compositions. Material compositions containing Ti are well known to have a low thermal conductivity as well as good getter properties (for most commonly existing gases that are out-gassing: oxygen, water vapour and hydrocarbons). The activation of the metallic getter film is done during the welding procedure by heat transfer where the metal surface reacts with gas atoms in the newly created cavity, locking them into the getter. These trapped atoms diffuses into the getter, thereby renewing the metal surface, ready to adsorb more gas atoms and hereby reducing the pressure obtaining an hermetic seal.

In fig. 9 during fabrication of the electrical finger ring, welding the respective halves 1c, 1d of the toroidal ring, excessive heat is produced. Weld pool width is an important parameter dependent on the laser spot size. The weld absorption of the material, constituting the intermediate metal layer, is dependent on its energy transfer efficiency, During the welding procedure, melting the interfaces of the respective toroidal halves, to concurrently not damage the internal electrical components the laser pulse time must be <2.2 ms.

Concurrently, the aforementioned nonconductive, conformal coating acts as a thermal heat absorber to reduce the overall thermal stress on the electrical components during the welding procedure.

The aforementioned material used for the top metal layer on the interfaces of the toroidal halves and the nonconductive, conformal coating enables a greater freedom in design regarding the respective thicknesses and patterning chosen to optimize the hermetic encapsulation and thus increase the lifetime of the internal, electrical components.

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In an embodiment of the present invention, the aforementioned cenospheres can further be deposited on the exterior of the inner circumference of the ring shell in order to reduce RF radiation on the user's finger (not shown).

In an embodiment of the present invention to adapt and optimize to different applications the antenna has different designs: (i). external omnidirectional (ii). internal integrated unidirectional (iii). internal integrated unidirectional with extended, elevated housing (iv). dielectric integrated with folded monopole.

In fig. 10 the external, coarse antenna is omnidirectional and constituted of a toroidal shaped metal ring, to obtain coarse tuning to the operational frequency. The external antenna's electrical length should be one wavelength, one half wavelength (a dipole) or one quarter wavelength with a ground plane to minimize all but real antenna impedances. It is reminiscent of a circular disc monopole (CDM) antenna but without the monopole acting as a ground plane. To obtain a coarse tuning to match 2.4 – 2.5 GHz (Bluetooth frequency range) the external antenna's diameter of the toroidal ring is calculated to 12 – 15 mm. As a coarse tuning is needed, either the outer- or inner diameters of the toroidal finger ring is sufficient to obtain matching impedance. The external antenna is connected to the internal antenna by the toroidal shaped ring by a metallic wall vertical to its circumference (not shown).

In fig. 11 the second alternative is the internal integrated unidirectional antenna. The antenna could be an Inverted-F antenna (IFA), either (i). mounted on the flexible printed circuit board or (ii). integrated/printed in the flexible printed circuit board as part of its fabrication (not shown). Any other type of unidirectional antenna can also be used. The antenna is located under the portion of the ring which has no outer shell metal deposited on the toroidal shaped ring facing outwards, geometrically described as radially away from the toroids centre. The opening is a maximum of 12 mm along the circumference functioning as a window housing made of a titanium compound to allow unperturbed RF radiation. The electronic finger ring needs only to be provided with this type of opening, or RF window, when the outer shell is completely or almost completely made of a metal having substantial adverse effects on RF radiation, such as gold or silver. There is normally no need for an RF window when the outer shell or the complete ring is made of a non-RF shielding material, such as a plastic compound. The use of an RF window, however, allows the rest of the outer shell to be made of gold, silver or any other

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precious metal having adverse effects on RF radiation and thereby give the user the sensation of a conventional jewellery ring.

In fig. 12 the third alternative is a toroid shaped finger ring with a locally extended, elevated sphere shape 15 to function as a housing for the internal integrated unidirectional antenna constituted of 1b, minimizing return losses of the RF radiation. The radius of the integrated sphere shape is a maximum of 7 mm. The extended housing will make it possible to place the internal antenna further away, elevated, from the ground plane of the flexible printed circuit board; as opposed to being mounted directly on the flexible printed circuit board. This significantly reduces the return losses of the RF radiation. Concurrently, the aforementioned nonconductive, conformal coating acts in this case also as a dielectric cavity in the interspace between the antenna and the ground plane.

In fig. 13 and 19 the fourth alternative is a portion of the toroidal ring constituted of a dielectric 16 integrated with a folded monopole antenna 7a. The dielectric may for example be made of ceramic or epoxy material. The dielectric may also be the protective coating layer 13 described with reference to Fig. 1. The monopole antenna is made of a wire or a strip of conductive material which is placed in the outer boundary of the dielectric portion of the toroidal shaped ring. One end of the antenna is free inside the dielectric portion and the other is electrically connected to the RF transceiver via a feed line (not shown). Alternatively, the monopole antenna 7a is integrated on the top layer of the flexible printed circuit board (fig. 5 and 17), with one end of the antenna free inside the dielectric portion (fig. 6 and 18), the other electrically connected to the RF transceiver via a feed line. The length of the antenna is determined by a quarter wavelength of the self-resonating frequency of 2.4 GHz, which corresponds to a total length, L, of the folded wire as L = 31 mm.

In an embodiment of the present invention, to complete the design of the aforementioned antenna designs are combined with a ground plane located in either (i). in intermediate layers in the FPCB (fig. 15 and 16) or (ii). when a portion of the toroidal shaped ring has a dielectric part integrated with folded monopole antenna, the remaining toroidal shaped outer metallic shell functions as a ground plane (fig. 13).

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The ground plane is designed to minimize RF losses by having a length along the circumference which results in low impedance. This implies a length $l_{ground\_plane}^{circumference}$ = λ/2n, where n = 1,2,3….

The invention has mainly been described above with reference to a number of explicitly disclosed embodiments. However, as is readily appreciated by a person skilled in the art, other embodiments than the ones disclosed above are equally possible within the scope of the invention.

For example, in one embodiment of the invention the toroidal shaped finger ring structure, constituted of two torodial shaped shell halves, can alternatively encapsulate non-hermetically the electrical components by fixating their respective complementary interfaces with one or more screws in order to obtain a lower cost fabrication solution.

Another example, mounting fewer amount of components than described above (i.e. only microcontroller, bluetooth, microstrip and antenna) the components may be mounted on only one side of the fpcb along the circumference of the toroidal shaped fingering structure in order to obtain a lower cost fabrication solution. Note, in this embodiment, the electronic circuit may function passively (i.e. no battery needed) communicating with near field technology (RFID, proximity cards etc.) which transfers signal via magnetic field induction using the above described antenna design.

Another example, in one embodiment the torodial ring shell can be made of plastic instead of metal wherin the above mentioned conformal coating, coated either (or both) on the (i). inner circumference of the fpcb, or (ii). be deposited on the exterior of the inner circumference of the ring shell, mixed with cenospheres to function as a RF shielding on the users finger.

Concurrently, the plastic torodial ring shell could be made of light emitting polymers (LEP) electrically connected to the fpcb. In this embodiment the ring shell could communicate visually with its immediate vicinity by emitting electromagnetic radiation, for example a red colour, in order to communicate to other people that the user belongs to the “red” debate team just created at the college seminar course. In practice, the microcontroller may be configured to, in response to a signal received internally by the pressure- or accelerometer sensor of the ring, to send the correct current to the LEP ring

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shell to obtain the desired wavelength emitted. Alternatively, the microcontroller may be configured in response to a signal received from an external unit.

For example, in one embodiment, the electronic finger ring may be used as a means of communication in order to call for the attention of the ring carrier. In this embodiment, the ring may comprise a heat generating means configured to supply heat to the finger of the user in response to reception of a signal from an external unit by the RF antenna circuitry. To this end, the microcontroller may be configured to, in response to a signal received by the RF antenna circuitry, control the heat generating means to transfer heat to the inner circumference of the ring (i.e. the surface facing the finger of the user) so that the user is notified that the signal is received by the increased temperature of the ring. For example, the external unit may be a mobile phone, or a network node forwarding a signal from a mobile phone, and the signal may be any signal intended to call for the attention of the ring user. For example, the signal may be a signal indicating that the ring user has received a text message on his/her mobile phone, or a signal originating from a communication device of a friend who wants to signal to the ring user that he/she is thinking about the ring user. The heat generating means may for example be a resistive heating film in thermal contact with a metallic shell of the finger ring facing its inner circumference and contacting the finger of the user.

In one embodiment, the ring comprises a micromechanical component as part of the electronic circuit in the form of a vibration motor by means configured to supply mechanical vibrations to the finger of the user in response to reception of a signal from an external unit. To this end, the microcontroller may be configured to, in response to a signal received by an antenna of the ring, control the magnitude or time interval (frequency) generated so that the user is notified that the signal is received by the vibrations of the ring. For example, the external unit may be a mobile phone, or computer forwarding a signal adressed from an online game the ring user is connected to, which signal indicates that he or she has been hit or touched by a gaming participant at some instance during the game.

In one embodiment, the aforementioned pressure sensor is located in a cavity within the electronic finger having the inlet hole facing the inner circumference opening optimized, as above described geometry, to function as a finger plethysmograph providing a non-invasive measurement for changes in finger blood flow reflected by pulse wave

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amplitude (PWA). The end application used could either be, for example, for medical, health or dating purposes.

In one embodiment, the aforementioned pressure sensor, when located in the cavity within the electronic finger having the inlet hole facing the inner circumference opening, could be replaced by a temperature sensor sensing the temperature of the fingering user. The end application used could either be, for example, for medical, health or dating purposes.

The electronic finger ring has herein been described mainly in the context of an electronic finger ring functioning as a 4-dimensional steering device for controlling an external electronic device, such as a computer. However, it should be appreciated that many of the teachings disclosed herein are advantageous also when the electronic finger ring is adapted for other applications, such as identification, electronic payment, etc., mentioned in the summary of the invention, or for "heat- or vibration or light emitting communication" as described in the above passage.

It should also be understood that the set of electronic and/or electromechanical components integrated in the ring may be easily adapted to the intended use of the ring. For example, the electronic finger ring needs not to include an accelerometer or a pressure sensor when used for identification of the user wearing it. In this case, it may be sufficient to integrate the microcontroller (programmed with an identification number or the like) and the antenna circuitry in the electronic finger ring.

Consequently, it should be understood that the following aspects of the invention are also encompassed by this disclosure:

Aspect 1: An electronic finger ring comprising:

- a toroidal shaped finger ring structure having an outer metal shell, and
- a microcontroller and RF antenna circuitry integrated in said toroidal shaped finger ring structure for communicating with an external, electronic device,

wherein an internal antenna of the RF antenna circuitry is located under an opening in said outer metal shell serving as a window for RF radiation.

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Aspect 2: The electronic finger ring according to aspect 1, wherein the internal antenna is connected to the outer metal shell which is adapted to serve as an external antenna for coarse tuning to an operational frequency.

Aspect 3: The electronic finger ring according to aspect 1 or 2, further comprising an inner shell, and wherein the opening in the outer metal shell leaves the inner shell exposed, the inner shell preferably comprising a titanium compound.

Aspect 4: An electronic finger ring comprising:

- a toroidal shaped finger ring structure having an outer metal shell, and
- a microcontroller and RF antenna circuitry integrated in said toroidal shaped finger ring structure for communicating with an external, electronic device,

wherein an internal antenna of the RF antenna circuitry is connected to the outer metal shell which is adapted to serve as an external antenna for coarse tuning to an operational frequency.

Aspect 5: The electronic finger ring according to any of the preceding aspects, wherein the internal antenna is connected to an RF transceiver of the RF antenna circuitry through a metal strip layer serving as a microstrip feed line.

Aspect 6: The electronic finger ring according to any of the preceding aspects, wherein the ring further comprises at least one ground plane for reflecting RF radiation directed inwardly, the ground plane preferably stretching at least between the internal antenna and an RF transceiver of the RF antenna circuitry.

Aspect 7: The electronic finger ring according to any of the preceding aspects, further comprising an elevated sphere shape functioning as a housing for the internal integrated antenna.

Aspect 8: An electronic finger ring comprising:

- a toroidal shaped finger ring structure having an outer shell, and
- electronic components comprising at least a microcontroller and RF antenna circuitry integrated in said toroidal shaped finger ring structure for communicating with an external, electronic device,

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wherein the outer shell comprises a top and bottom half that are welded together along an interface comprising a material having getter properties to enchance the hermetic encapsulation of the printed circuit board and the electric components.

Aspect 9: The electronic finger ring according to aspect 8, wherein the material also has chemical, adhesive properties.

Aspect 10: The electronic finger ring according to aspect 8 or 9, wherein the material is a metallic getter film the getter properties of which are activated by heat transfer during the welding procedure.

Aspect 11: The electronic finger ring according to any of the aspects 8 to 10, wherein the material comprises a titanium compound.

Aspect 12: Method for manufacturing an electronic finger ring comprising the steps of:

- providing a top and bottom half of a shell of a toroidal shaped finger ring structure;
- mounting inside and along the circumference of a first of said halves a flexible printed circuit board comprising electronic components;
- integrating said flexible printed circuit board and the electronic components in a toroidal finger ring structure by welding the first and the second of said halves together along an interface between the two halves, and
- before welding the two halves together, forming said interface at least partially of a material having getter properties to enhance the hermetic encapsulation of the printed circuit board and the electric components.

Aspect 13: Method according to aspect 12, wherein said interface is at least partially formed of a material having both getter properties and chemical, adhesive properties enhancing the welding between the two halves.

Aspect 14: Method according to aspect 12 or 13, wherein the interface material is a titanium composition.

Aspect 15: Method for manufacturing an electronic finger ring comprising the steps of: fixating the respective complementary top and bottom half of the toroidal shaped shell interfaces with one or more screws in order to obtain a non-hermetic encapsulation of the electrical components.

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Aspect 16: An electronic finger ring comprising:

- a toroidal shaped finger ring structure having an outer shell, and
- electronic components comprising at least a microcontroller and RF antenna circuitry integrated in said toroidal shaped finger ring structure for communicating with an external, electronic device,

the electronic components being fabricated or mounted on a flexible printed circuit board which is packaged inside, along the circumference of the toroidal shaped finger ring structure, the RF antenna circuitry comprising an internal antenna being arranged either in the flexible printed circuit board or between the flexible printed circuit board and the outer boundary of the toroidal shaped finger ring structure,

wherein the electronic finger ring further comprises RF shielding coating between the inner boundary of the toroidal shaped finger ring structure and the flexible printed circuit board to shield the user's finger from RF radiation.

Aspect 17: An electronic finger ring comprising:

a torodial ring shell that is made of plastic instead of metal wherin the conformal coating, is either coated (or both) on the (i). inner circumference of the fpcb, or (ii). on the exterior of the inner circumference of the ring shell, and mixed with cenospheres to function as a RF shielding on the users finger.

Aspect 18: The electronic finger ring according to aspect 17 wherin the plastic torodial ring shell is made of a light emitting polymer (LEP) electrically connected to the fpcb to optically communicate (emitting) with others in the users immediate vicinity.

Aspect 19: The electronic finger ring according to aspect 16, wherein at least one of the electronic components is arranged between the flexible printed circuit board and the inner boundary of the toroidal shaped finger ring, and wherein the RF shielding coating is provided on the inner side of the flexible printed circuit board so that the RF shielding coating shields both the user's finger and the at least one electronic component from RF radiation.

Aspect 20: An electronic finger ring comprising:

- a toroidal shaped finger ring structure having a metal shell intended to contact a finger of a user wearing the ring, and

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- electronic components integrated in said toroidal shaped finger ring structure, comprising at least a microcontroller, an RF antenna circuitry for communicating with an external, electronic device, and a heat generating means,

wherein the heat generating means is adapted to supply heat to the metal shell of the toroidal shaped finger ring structure in response to a signal received by the RF antenna circuitry from the external device.

Aspect 21: Electronic finger ring according to aspect 20, wherein the microcontroller is adapted to analyse the received signal and control the heat generating means to supply heat to the metal shell if the signal indicates that the user's attention should be called for.

Aspect 22: Electronic finger ring according to aspect 20 or 21, wherein the heat generating means is a resistive heating film arranged in thermal contact with the metal shell of the toroidal shaped finger ring structure.

Aspect 23: An electronic finger ring comprising:

- a toroidal shaped finger ring structure having a metal shell intended to contact a finger of a user wearing the ring, and
- electronic components integrated in said toroidal shaped finger ring structure, comprising at least a microcontroller, an RF antenna circuitry for communicating with an external, electronic device, and a vibrating generating means,

wherein the vibrating generating means is adapted to supply vibrations to the whole finger ring and its user in response to a signal received by the RF antenna circuitry from the external device.

Aspect 24: Electronic finger ring according to aspect 23, wherein the microcontroller is adapted to analyse the received signal and control the vibrating generating means to supply vibrations to the whole finger ring and its user if the signal indicates that the user's attention should be called for.

Aspect 25: Electronic finger ring according to aspect 23 or 24, wherein the vibrating generating means is a micromechanical vibrational motor that is connected to the electronic circuit within the toroidal shaped finger ring structure.

Aspect 26: An electronic finger ring comprising:

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- a toroidal shaped finger ring structure having a metal shell intended to contact a finger of a user wearing the ring, and
- electronic components integrated in said toroidal shaped finger ring structure, comprising at least a microcontroller, an RF antenna circuitry for communicating with an external, electronic device, and a pressure sensing means located in a cavity within the electronic finger having the inlet hole facing the inner circumference opening optimized, as above described geometry, to function as a finger plethysmograph providing a non-invasive measurement

wherein the pressure sensing means is adapted to detect pressure differences from changes in finger blood flow of the user.

Aspect 27: The electronic finger ring according to any of the preceding aspects, wherein all electrical components of the electronic finger ring are fabricated or mounted on a flexible printed circuit board which is packaged inside, along the circumference of the toroidal shaped finger ring structure.

Aspect 28: The electronic finger ring according to any of the preceding aspects, wherein the electronic components of the electronic finger ring includes one or more of:

- a power source, such as a battery, an inductive coil, and/or piezoelectric nanofibers, for powering active electronic components of the finger ring;
- an accelerometer for steering the external device in a 3-dimensional space based on motions of the user's hand, and
- a pressure sensor for steering the external device in a 4th dimension.

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Claims

1. An electronic finger ring for steering an external electronic device in up to four dimensions, comprising:
   - a toroidal shaped finger ring structure (1) having an outer shell (1a), and
   - electronic components comprising a micro processor (4), RF antenna circuitry (3, 5, 7), an accelerometer (6), and a pressure sensor (8), all fabricated or mounted on a flexible printed circuit board, FPCB, (9) which is packaged inside, along the circumference of the toroidal shaped finger ring structure (1).

2. The electronic finger ring according to claim 1, wherein the accelerometer (6) is configured to steer in 3-dimensional space and the pressure sensor (8) is configured to steer in an additional 4th dimension.

3. The electronic finger ring according to claim 1 or 2, wherein the pressure sensor (8) is located in a cavity within the electronic finger ring having an inlet hole.

4. The electronic finger ring according to claim 3, wherein the inlet hole is shaped as a horn cone to maximize the pressure compression ratio at the pressure sensor end (11).

5. The electronic finger ring according to claim 4, wherein to optimize sensitivity of the pressure sensor (8) the inlet hole (11) has a minimum aspect ratio size difference of the diameter of the narrow end (x) of the horn cone to the outer end (y) of the horn cone as 1:10.

6. The electronic finger ring according to claim 4 or 5, wherein the total height of the horn cone (m) should have an aspect ratio size to the height of the narrow end of the horn cone (n) as 6:1.

7. The electronic finger ring according to any of the claims 3 to 6, wherein the pressure sensor (8) and the inlet hole are located so that the cavity faces the inner circumference of the toroidal shaped finger ring structure (1) to allow pressure to be applied to the pressure sensor (8) by bending the finger carrying the ring.

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8. The electronic finger ring according to any of the claims 3 to 6, wherein the pressure sensor (8) and the inlet hole are located so that the cavity faces the outer circumference of the toroidal shaped finger ring structure (1) to allow pressure to be applied to the pressure sensor (8) by using another finger not carrying the ring.

9. The electronic finger ring according to any of the preceding claims, wherein the outer shell (1a) is made of metal, and wherein the RF antenna circuitry (3, 5, 7) comprises an internal antenna (7) located under an opening (10) in the outer metal shell (1a) serving as a window for RF radiation.

10. The electronic finger ring according to claim 9, wherein the toroidal shaped finger ring structure (1) comprises a locally extended, elevated sphere shape (15) functioning as a housing for the internal antenna (7) and minimizing return losses of the RF radiation.

11. The electronic finger ring according to claim 9 or 10, further comprising an inner shell (1b), and wherein the opening in the outer metal shell (1a) leaves the inner shell (1b) exposed, the inner shell preferably comprising a titanium compound.

12. The electronic finger ring according to any of the claims 9 to 11, wherein the internal antenna (7) is connected to the outer metal shell (1a) which is adapted to serve as an external, omnidirectional antenna obtaining coarse tuning to an operational frequency.

13. The electronic finger ring according to any of the preceding claims, wherein the outer shell (1a) of the toroidal shaped finger ring structure (1) is constituted of two toroidal complementing halves (1c, 1d) which are welded together along an interface between the two halves.

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14. The electronic finger ring according to claim 13, wherein the interface comprises a material having getter properties to enhance the hermetic encapsulation of the printed circuit board and the electric components.

15. The electronic finger ring according to claim 14, wherein the material also has chemical, adhesive properties enhancing the welding between the two halves (1c, 1d).

16. The electronic finger ring according to any of the preceding claims, wherein the electronic components further comprises a battery (2).

17. The electronic finger ring according to any of the preceding claims, further comprising a protective coating (14) having RF shielding properties located between the inner boundary of the toroidal shaped finger ring structure (1) and the flexible printed circuit board (9).

18. The electronic finger ring according to claim 17, wherein the protective coating (14) comprises cenospheres.

19. The electronic finger ring according to any of the preceding claims, wherein the RF antenna circuitry (3, 5, 7) comprises a microstrip feed line (5), which has a shape designed to stretch along the circumference of the toroidal shaped finger ring structure (1) and which is electrically optimized to obtain 50 Ω matching impedance.

20. The electronic finger ring according to claim 19, wherein the width and length of the microstrip feed line (5) are selected such that each dimension of the microstrip feed line radiates at 2.4 GHz.

21. The electronic finger ring according to any of the preceding claims, further comprising at least one ground plane (17) designed to minimize RF losses and having a length along the circumference of the toroidal finger ring structure (1) of $I_{ground\_plane}^{circumference} = \lambda/2n$, where n = 1,2,3….

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22. The electronic finger ring according to claim 21, wherein the at least one ground plane (17) stretches at least in-between an internal antenna (7) of the RF antenna circuitry (3, 5, 7), located on the outer circumference side of the flexible printed circuit board (9) and an RF transceiver (3) of the RF antenna circuitry (3, 5, 7), located on the inner circumference side of the flexible printed circuit board (9).

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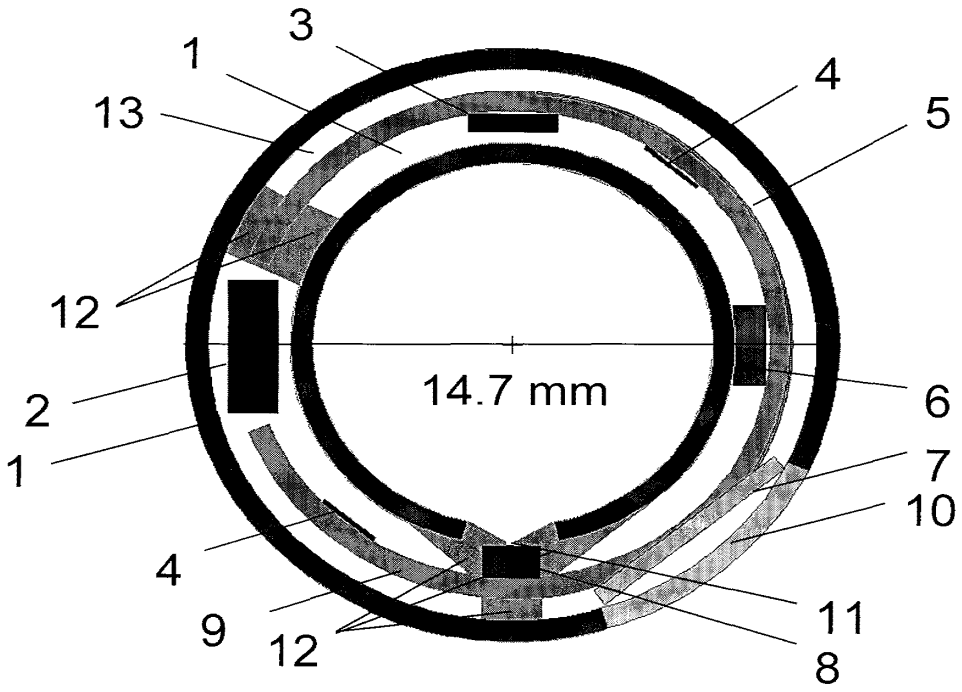


Fig. 1

Petitioner Samsung Ex-1004, 0514

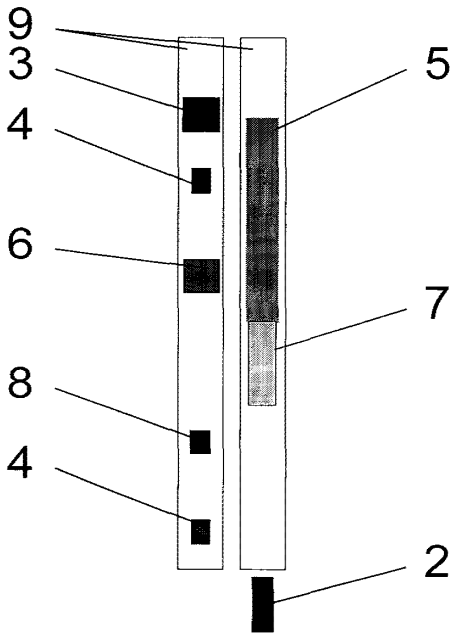


Fig. 2

Petitioner Samsung Ex-1004, 0515

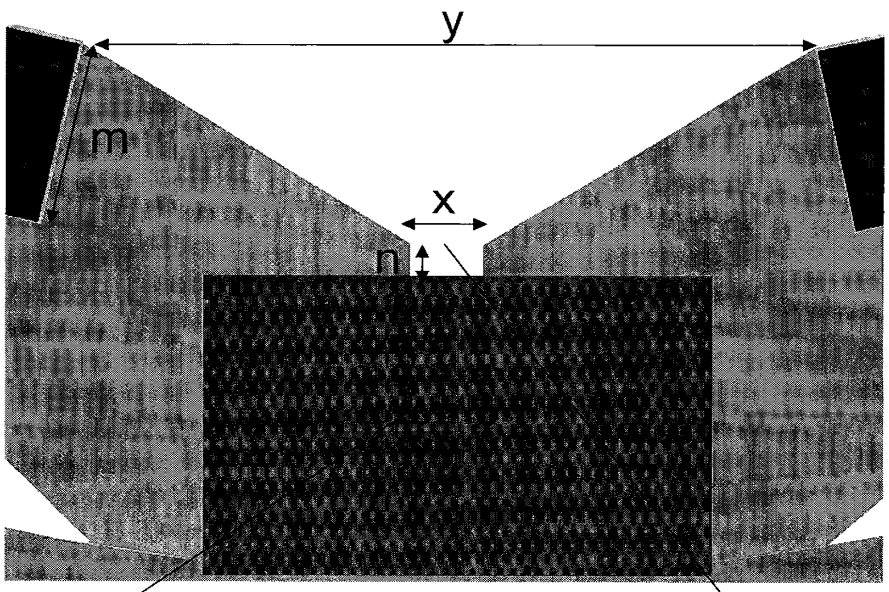


Fig. 3

Petitioner Samsung Ex-1004, 0516

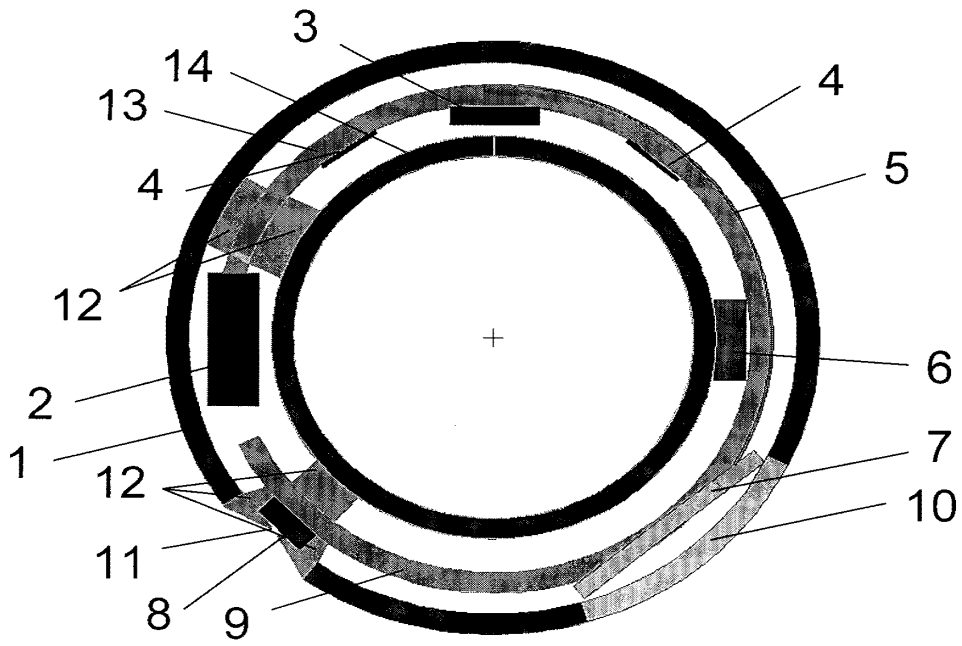


Fig. 4

Petitioner Samsung Ex-1004, 0517

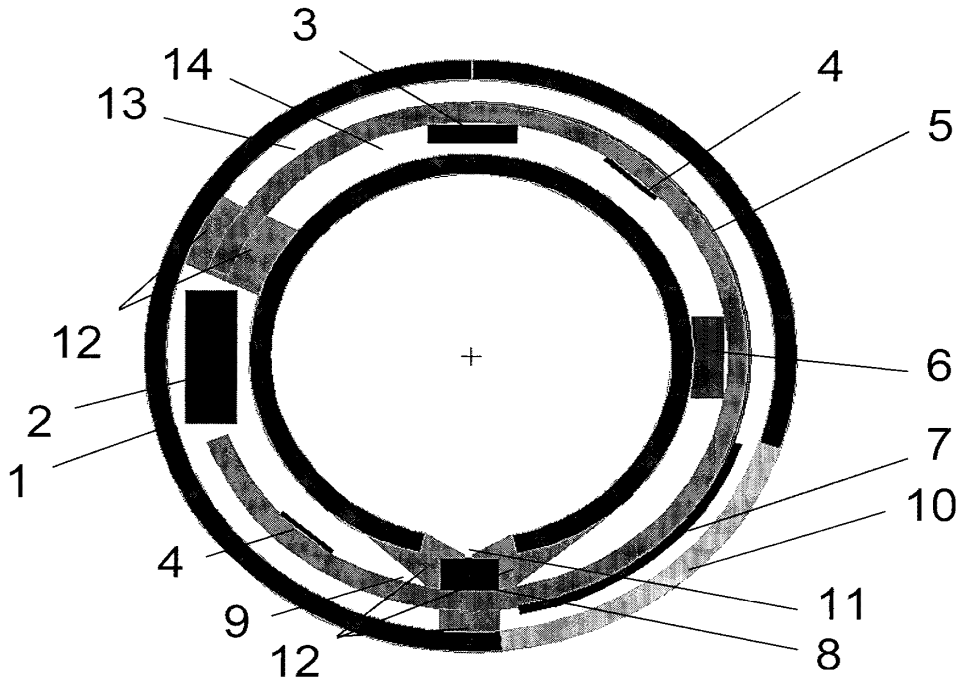


Fig. 5

Petitioner Samsung Ex-1004, 0518

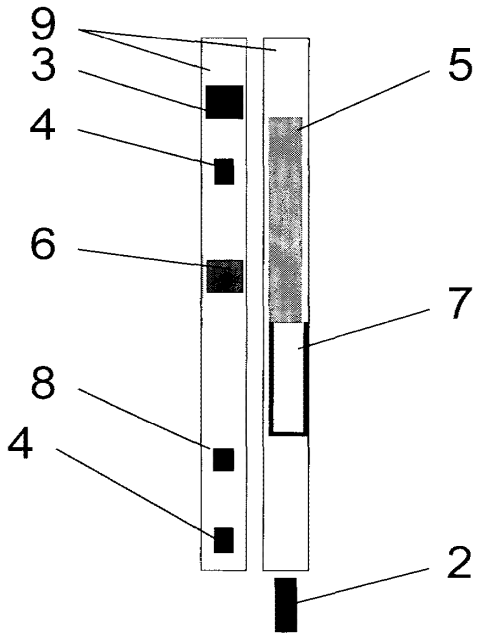


Fig. 6

Petitioner Samsung Ex-1004, 0519

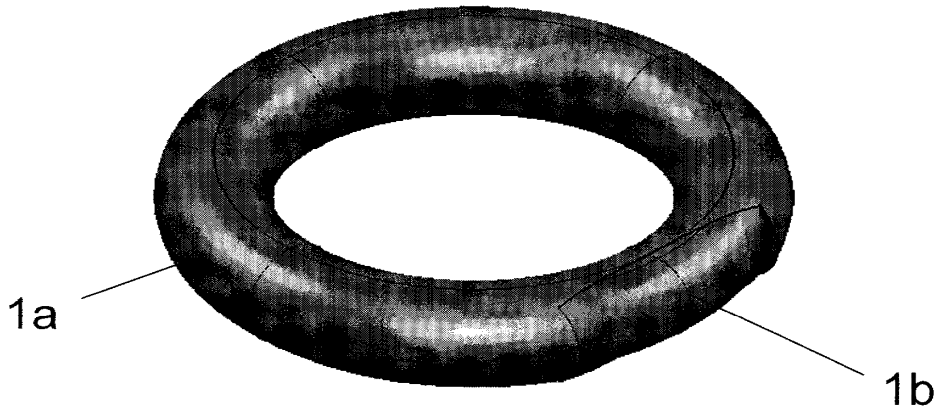


Fig. 7

Petitioner Samsung Ex-1004, 0520

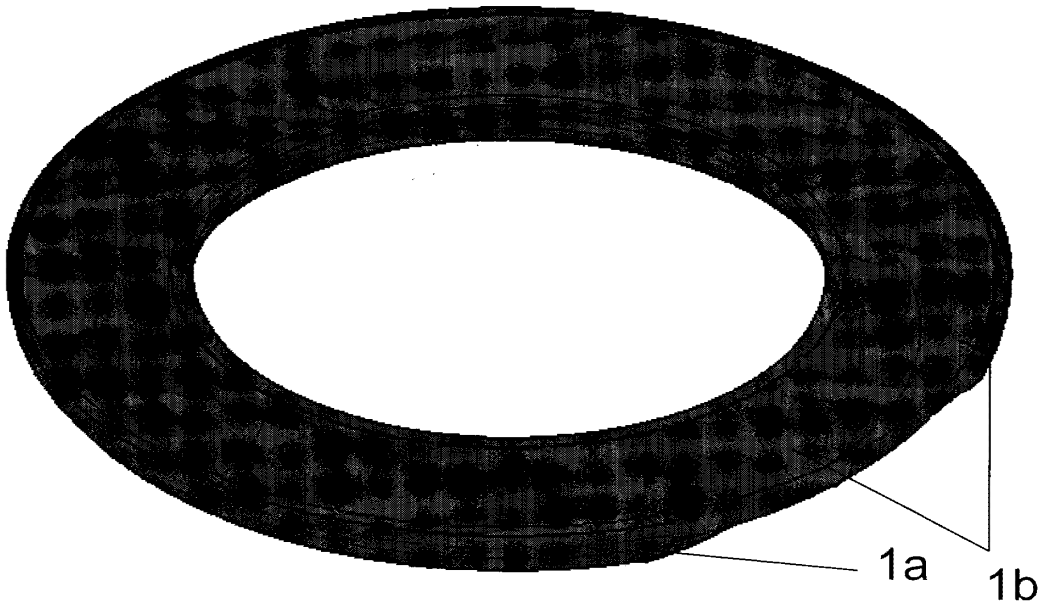


Fig. 8

Petitioner Samsung Ex-1004, 0521

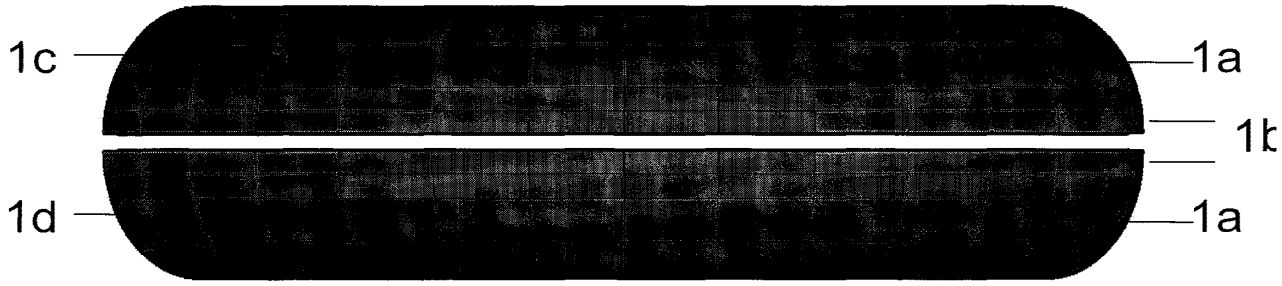


Fig. 9

Petitioner Samsung Ex-1004, 0522

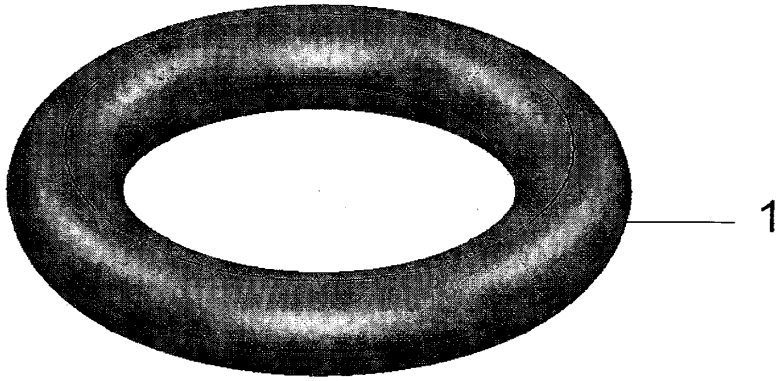


Fig. 10

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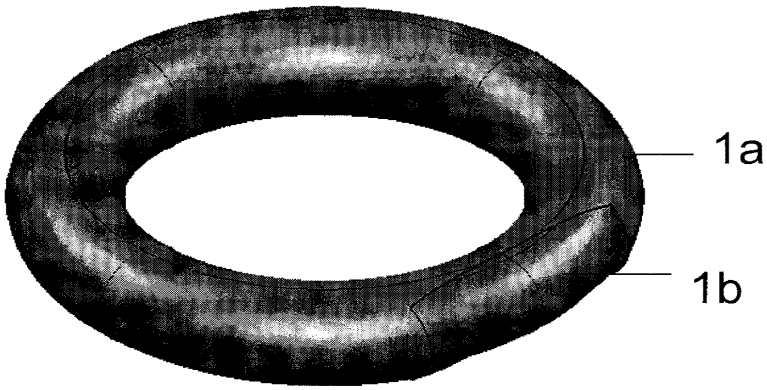


Fig. 11

Petitioner Samsung Ex-1004, 0524

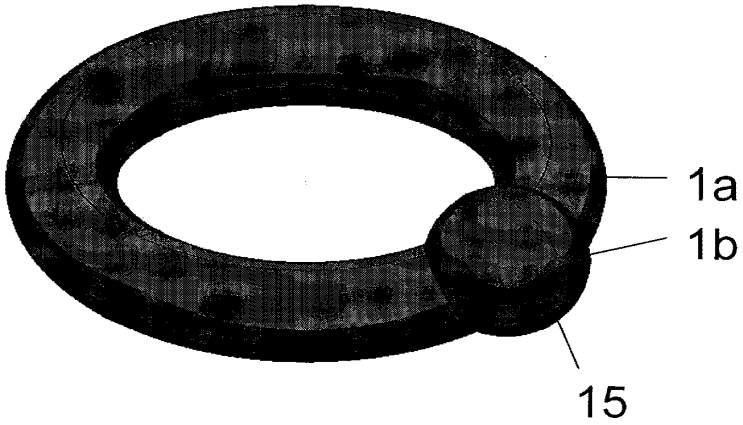


Fig. 12

Petitioner Samsung Ex-1004, 0525

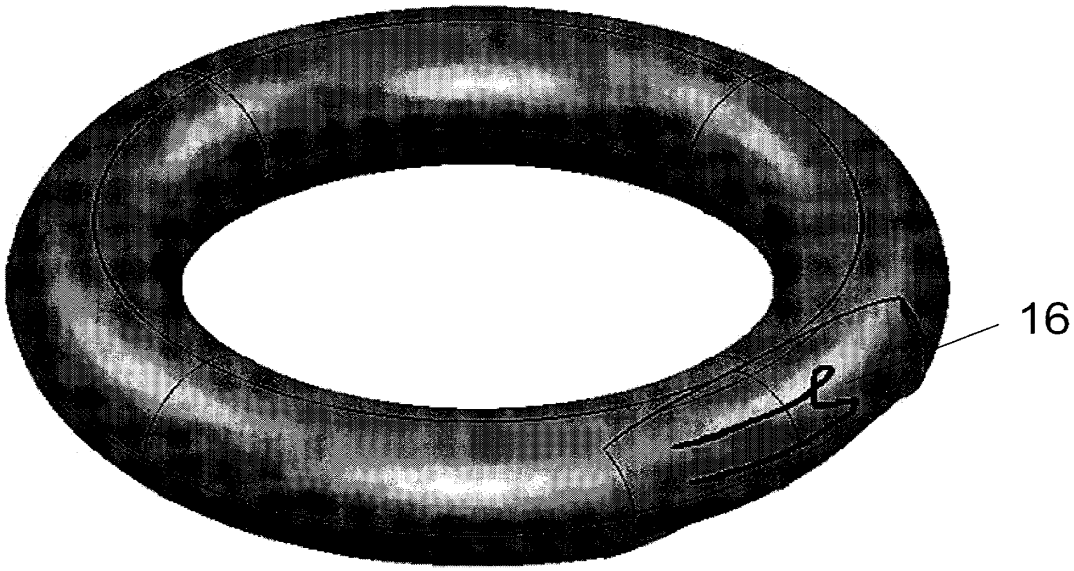


Fig. 13

Petitioner Samsung Ex-1004, 0526

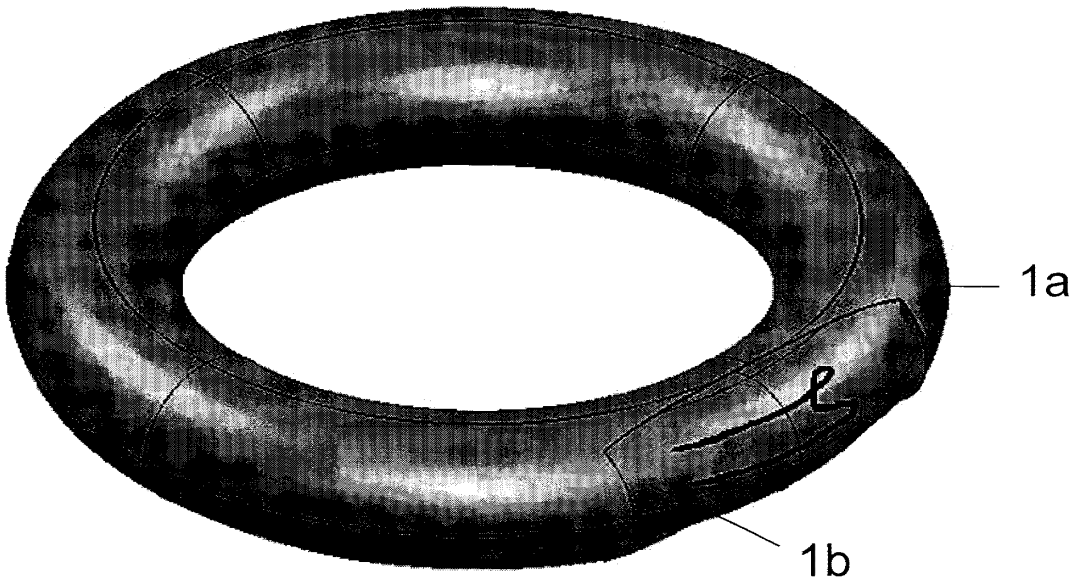


Fig. 14

Petitioner Samsung Ex-1004, 0527

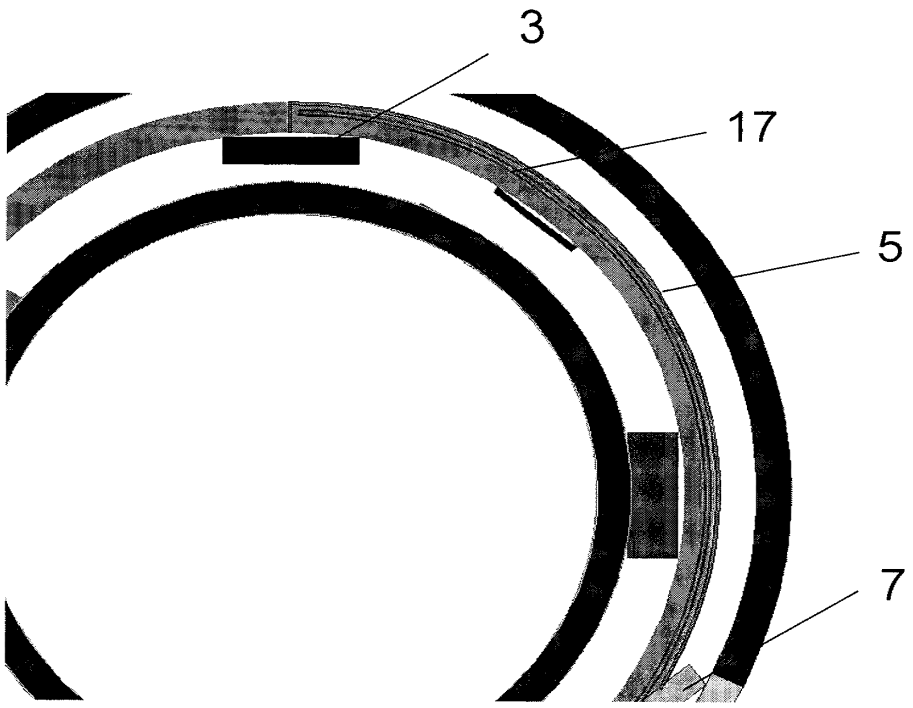


Fig. 15

Petitioner Samsung Ex-1004, 0528

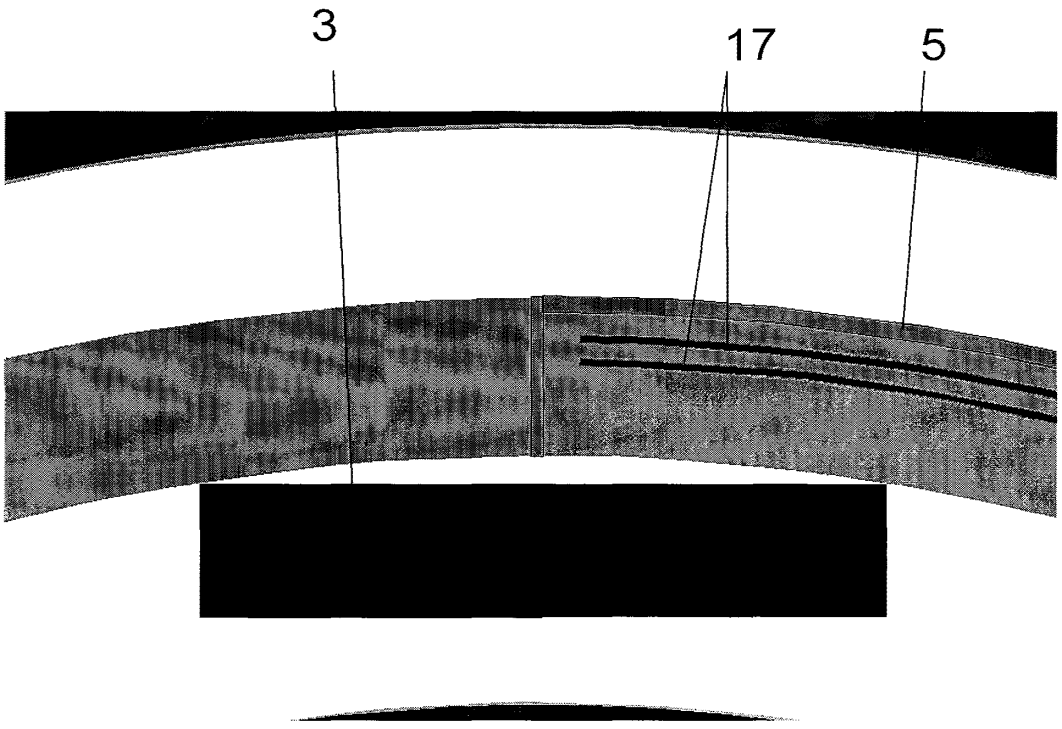


Fig. 16

Petitioner Samsung Ex-1004, 0529

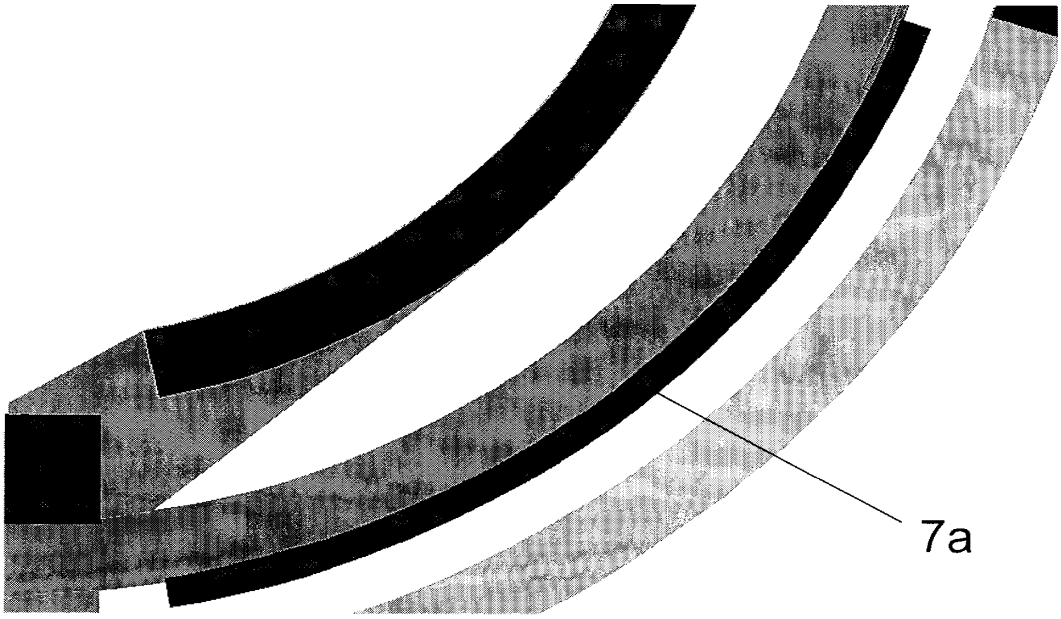


Fig. 17

Petitioner Samsung Ex-1004, 0530

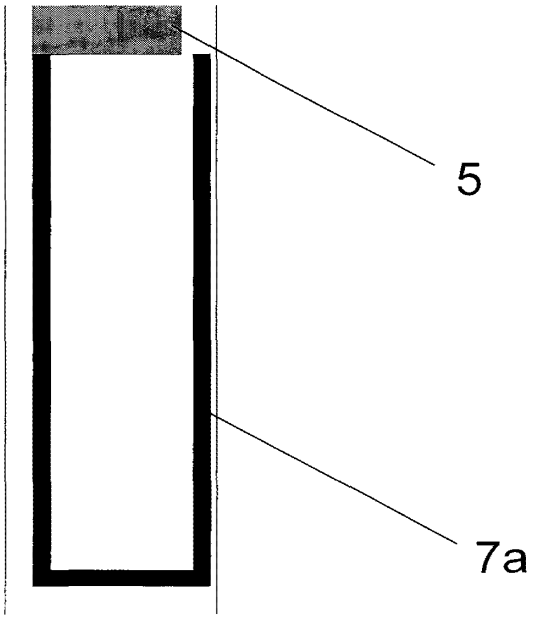


Fig. 18

Petitioner Samsung Ex-1004, 0531



Fig. 19

Petitioner Samsung Ex-1004, 0532

INTERNATIONAL SEARCH REPORT

International application No
PCT/SE2010/051167

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06F3/033
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G06F

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2003/142065 A1 (PAHLAVAN KOUROSH [US]) 31 July 2003 (2003-07-31) cited in the application the whole document	1-3,7-22
X	US 2008/088468 A1 (KIM YONG-DUCK [KR]) 17 April 2008 (2008-04-17) the whole document	1-3, 13-16
A	US 2003/214481 A1 (XIONG YONGMING [US]) 20 November 2003 (2003-11-20) the whole document	1,2,9-22
A	WO 96/34333 A1 (INTERVAL RESEARCH CORP [US]) 31 October 1996 (1996-10-31) the whole document	1-3,7-9, 12,16

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 February 2011	04/03/2011

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Bravo, Piero

1

Form PCT/ISA/210 (second sheet) (April 2005)

Petitioner Samsung Ex-1004, 0533

INTERNATIONAL SEARCH REPORT

International application No
PCT/SE2010/051167

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2001 109569 A (NEC CORP) 20 April 2001 (2001-04-20) * abstract figures 1, 4	1-3,7,8
A	WO 03/103486 A1 (MASSACHUSETTS INST TECHNOLOGY [US]) 18 December 2003 (2003-12-18) the whole document	1-3,16
A	WO 2007/092239 A2 (XPRESENSE LLC [US]; BAUM ROBERT THOMAS JR [US]; CURRY JAMES EDWARD [US) 16 August 2007 (2007-08-16) paragraph [0039] - paragraph [0111]; figures 1-5, 7a-9c	1,9-22

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

Petitioner Samsung Ex-1004, 0534

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/SE2010/051167

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2003142065 A1	31-07-2003	NONE	
US 2008088468 A1	17-04-2008	CN 101165642 A	23-04-2008
		KR 20080034291 A	21-04-2008
US 2003214481 A1	20-11-2003	NONE	
WO 9634333 A1	31-10-1996	AT 217986 T	15-06-2002
		AU 5027996 A	18-11-1996
		DE 69621330 D1	27-06-2002
		DE 69621330 T2	24-10-2002
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		JP 11508382 T	21-07-1999
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JP 2001109569 A	20-04-2001	NONE	
WO 03103486 A1	18-12-2003	AU 2003232450 A1	22-12-2003
WO 2007092239 A2	16-08-2007	WO 2007092238 A2	16-08-2007
		WO 2007092240 A2	16-08-2007

Petitioner Samsung Ex-1004, 0535

Electronic Acknowledgement Receipt

EFS ID:	21254568
Application Number:	14556062
International Application Number:	
Confirmation Number:	8229
Title of Invention:	WEARABLE COMPUTING DEVICE
First Named Inventor/Applicant Name:	Curt C. von Badinski
Customer Number:	77099
Filer:	William Alex Loginov/Katherine Draus
Filer Authorized By:	William Alex Loginov
Attorney Docket Number:	340/0002
Receipt Date:	22-JAN-2015
Filing Date:	28-NOV-2014
Time Stamp:	12:30:54
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	MechioIDS0002.pdf	613048 ea211de999c80f53eb1f18a0d7da7f93c3569a59	no	7

Warnings:	
Information:	

2	Foreign Reference	EP2660680A1.pdf	311115 f271fc44f77fc341addb5a343d09b9e3158f5f2a	no	11
Warnings:					
Information:					
3	Foreign Reference	WO2013093638A3.pdf	55346 ee6b1cb47a9d17690f700f93d6a589a9e2c0be45	no	5
Warnings:					
Information:					
4	Foreign Reference	WO2013163326A1.pdf	1913384 bea26f0083d7543c56c32a4d3f57017057d09c7e	no	278
Warnings:					
Information:					
5	Foreign Reference	WO2004078028A2.pdf	602105 05ccdf3654e3722a1e76ef1b23d46f05be9f1d67	no	21
Warnings:					
Information:					
6	Foreign Reference	WO2011053235A1.pdf	553660 322a33c8a59a3876ec800adf0b88cab28f60f134	no	50
Warnings:					
Information:					
		Total Files Size (in bytes):	4048658		

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<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a 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.

<u>National Stage of an International Application under 35 U.S.C. 371</u>
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.

<u>New International Application Filed with the USPTO as a Receiving Office</u>
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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s): von Badinski, et al. Application No.: 14/556,062 Filed: 11/28/2014 Title: WEARABLE COMPUTING DEVICE Attorney Docket No.: 340/0002	Art Unit: 2668

RESPONSE TO NOTICE TO FILE MISSING PARTS OF APPLICATION

Sir:

This is in response to a Notice to File Missing Parts of Application under 37 CFR 1.53(f) electronically filed via the United States Patent and Trademark Office EFS website. Enclosed is a copy of said Notice and the following documents and fees to complete the filing requirements of the above-identified application.

(X) Statutory basic filing fee (X) Utility $70.00

(X) Additional claim fees of $3,300.00

(X) Missing Parts Surcharge $70.00

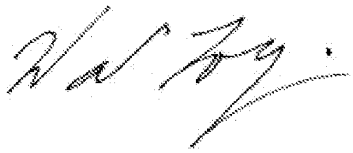
(X) Search Fee $300.00

(X) Examination Fee $360.00

(X) Other: Replacement Drawings, Figs. 1 to 49

(X) Other: Substitute specification, both a clean and marked set are included. No new matter is added.

Respectfully submitted,



By _____
William A. Loginov,

Reg. No. 34863
Date: February 17, 2015
Telephone No.: 603-336-3026

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/556,062	11/28/2014	Curt C. von Badinski	340/0002

CONFIRMATION NO. 8229

77099
LOGINOV & ASSOCIATES, PLLC
214 South Main Street
CONCORD, NH 03301

FORMALITIES LETTER

OC000000072356463

Date Mailed: 12/16/2014

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The statutory basic filing fee is missing.
- The application search fee must be submitted.
- The application examination fee must be submitted.

The application is informal since it does not comply with the regulations for the reason(s) indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:

- A substitute specification in compliance with 37 CFR 1.52, 1.121(b)(3), and 1.125, is required. The substitute specification must be submitted with markings and be accompanied by a clean version (without markings) as set forth in 37 CFR 1.125(c) and a statement that the substitute specification contains no new matter (see 37 CFR 1.125(b)). The specification, claims, and/or abstract page(s) submitted is not acceptable and cannot be scanned or properly stored because:
  - The application contains drawings, but the specification does not contain a brief description of the several views of the drawings as required by 37 CFR 1.74 and 37 CFR 1.77(b)(9).
- Replacement drawings in compliance with 37 CFR 1.84 and 37 CFR 1.121(d) are required. The drawings submitted are not acceptable because:
  - The drawings must be reasonably free from erasures and must be free from alterations, overwriting, interlineations, folds, and copy marks. See Figure(s) 14B, 14D, 27A.
  - The drawings contain excessive text. Suitable descriptive legends may be used, or may be required by the Examiner where necessary for understanding of the drawing but should contain as few words as possible (see 37 CFR 1.84(o)). See Figure(s) 23A, 28B.
  - The drawings submitted to the Office are not electronically reproducible because portions of figures 27B, 33D, 33E are missing and/or blurry.

The following item(s) appear to have been **omitted** from the application:

Petitioner Samsung Ex-1004, 0539

• Figure(s) **15C** described in the specification.

Applicant must reply to this notice within the time period set forth in this notice to avoid abandonment of this application. Applicant must select one of the three following options and the reply must comply with the requirements set forth in the selected option and any other requirements set forth in this notice. The reply should also indicate which option applicant has selected.

I. Petition for date of deposit: Should applicant contend that the above-noted omitted item(s) was in fact deposited in the U.S. Patent and Trademark Office (USPTO) with the nonprovisional application papers, a copy of this Notice and a petition (and the petition fee set forth in 37 CFR 1.17(f) with evidence of such deposit **must** be filed within **TWO MONTHS** of the date of this Notice. The petition fee will be refunded if it is determined that the item(s) was received by the USPTO. **THIS TWO MONTH PERIOD IS EXTENDABLE UNDER 37 CFR 1.136(a) or (b).**

II. Petition for later filing date: Should applicant desire to supply the omitted item(s) and accept the date that such omitted item(s) was filed in the USPTO as the filing date of the above-identified application, a copy of this Notice, the omitted item(s), and a petition under 37 CFR 1.182 with the petition fee set forth in 37 CFR 1.17(f) requesting the later filing date **must** be filed within **TWO MONTHS** of the date of this Notice. **THIS TWO MONTH PERIOD IS EXTENDABLE UNDER 37 CFR 1.136(a) or (b).**
Applicant is advised that generally the filing fee required for an application is the filing fee in effect on the filing date accorded the application and that payment of the requisite basic filing fee on a date later than the filing date of the application requires payment of a surcharge (37 CFR 1.16(f)). To avoid processing delays and payment of a surcharge, applicant should submit any balance due for the requisite filing fee based on the later filing date being requested when submitting the omitted item(s) and the petition (and petition fee) requesting the later filing date.

III. Acceptance of application as deposited: Applicant may accept the application as deposited in the USPTO by filing an appropriate amendment as set forth in either (A) or (B) below within **TWO MONTHS** of the date of this Notice. **THIS TWO MONTH PERIOD IS EXTENDABLE UNDER 37 CFR 1.136(a) or (b)** . The application will maintain a filing date as of the date of deposit of the application papers in the USPTO, and original application papers (i.e., the original disclosure of the invention) will include only those application papers present in the USPTO on the date of deposit. A petition is not required for this option.
(A) If applicant wants to accept the application as deposited without adding the subject matter that was in the omitted item (e.g., a missing page or figure), applicant is required to submit one or more of the following items without adding any new matter (see 35 U.S.C. 132(a)):

1. For a missing page of the specification,
   a) a substitute specification including claims that amends the specification to renumber the pages consecutively and cancels any incomplete sentences, and
   b) a statement that the substitute specification includes no new matter, in compliance with 37 CFR 1.121(b)(3) and 1.125;
2. For a missing figure of the drawings,
   a) replacement drawing sheets in compliance with 37 CFR 1.121(d) to renumber the drawing figures consecutively (if necessary),
   b) a substitute specification excluding claims that amends the specification to cancel any references to any omitted drawing(s) and corrects the references in the specification to the drawing figures to correspond with any relabeled drawing figures, and
   c) a statement that the substitute specification includes no new matter, in compliance with 37 CFR 1.121(b)(3) and 1.125;
3. For a missing page of the claim listing only, a replacement claim listing with the claims renumbered consecutively or, if amendment to the claims is also necessary, then a complete claim listing in compliance with 37 CFR 1.121(c);
4. For a missing or unreadable compact disc,

Petitioner Samsung Ex-1004, 0540

a) a substitute specification (excluding the claims) deleting the reference to the compact disc and the files contained on the compact disc, and
b) a statement that the substitute specification includes no new matter, in compliance with 37 CFR 1.121(b)(3) and 1.125; and

5. For a missing or unreadable file submitted on a compact disc,
   a) a substitute specification (excluding the claims) deleting the reference to the missing or unreadable file, and a statement that the substitute specification includes no new matter, in compliance with 37 CFR 1.121(b)(3) and 1.125; and
   b) a replacement transmittal letter listing all of the files except the missing or unreadable file in compliance with 37 CFR 1.52(e)(3)(ii).

(B) Alternatively, if applicant wants to accept the application as deposited but wishes to add the subject matter in the omitted item (e.g., a missing page or figure) by relying on an incorporation by reference under 37 CFR 1.57 or other portions of the original disclosure, applicant is required to submit one or more of the following items without adding any new matter (see 35 U.S.C. 132(a)):

1. To add the subject matter in a missing page of specification,
   a) a substitute specification excluding claims and
   b) a statement that the substitute specification includes no new matter, in compliance with 37 CFR 1.121(b)(3) and 1.125;
2. To add a missing figure of the drawings, new and replacement drawing sheets in compliance with 37 CFR 1.121(d);
3. To add the subject matter in a missing page of the claim listing, a complete claim listing in compliance with 37 CFR 1.121(c) (e.g., a claim in the missing page should be submitted as a new claim);
4. To add the subject matter in a missing or unreadable compact disc,
   a) a replacement compact disc and a duplicate copy of the compact disc, in compliance with 37 CFR 1.52(e); and
   b) a statement that the replacement compact disc contains no new matter in compliance with 37 CFR 1.52(e)(4); and,
5. To add the subject matter in a missing or unreadable file submitted on a compact disc,
   a) a replacement compact disc that contains all of the files listed in the specification including the missing or unreadable file and a duplicate copy of the compact disc, in compliance with 37 CFR 1.52(e); and
   b) a statement that the replacement compact disc contains no new matter in compliance with 37 CFR 1.52(e)(4).

If applicant is relying on an incorporation by reference under 37 CFR 1.57 to add the omitted subject matter, then applicant must also comply with the requirements of 37 CFR 1.57.

Applicant is cautioned that correction of the above items may cause the specification and drawings page count to exceed 100 pages. If the specification and drawings exceed 100 pages, applicant will need to submit the required application size fee.

- Additional claim fees of $ **3300** as a small entity, including any required multiple dependent claim fee, are required. Applicant must submit the additional claim fees or cancel the additional claims for which fees are due.
- Surcharge as set forth in 37 CFR 1.16(f) must be submitted.
  The surcharge is due for any one of:
  - late submission of the basic filing fee, search fee, or examination fee,
  - late submission of inventor's oath or declaration,
  - filing an application that does not contain at least one claim on filing, or
  - submission of an application filed by reference to a previously filed application.

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SUMMARY OF FEES DUE:

The fee(s) required within **TWO MONTHS** from the date of this Notice to avoid abandonment is/are itemized below. Small entity discount is in effect. If applicant is qualified for micro entity status, an acceptable Certification of Micro Entity Status must be submitted to establish micro entity status. (See 37 CFR 1.29 and forms PTO/SB/15A and 15B.)

- $ **70** basic filing fee.
- $ **70** surcharge.
- $ **300** search fee.
- $ **360** examination fee.
- $ **2100** for **10** independent claims over 3.
- $ **1200** for **30** total claims over 20.
- $(**0**) previous unapplied payment amount.
- $ **4100** TOTAL FEE BALANCE DUE.

Items Required To Avoid Processing Delays:

Applicant is notified that the above-identified application contains the deficiencies noted below. No period for reply is set forth in this notice for correction of these deficiencies. However, if a deficiency relates to the inventor's oath or declaration, the applicant must file an oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each actual inventor no later than the expiration of the time period set in the "Notice of Allowability" to avoid abandonment. See 37 CFR 1.53(f).

- A properly executed inventor's oath or declaration has not been received for the following inventor(s):
  Curt C. von Badinski
  Michael J. Strasser
  Peter Twiss

Replies must be received in the USPTO within the set time period or must include a proper Certificate of Mailing or Transmission under 37 CFR 1.8 with a mailing or transmission date within the set time period. For more information and a suggested format, see Form PTO/SB/92 and MPEP 512.

Replies should be mailed to:

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web, including a copy of this Notice and selecting the document description "Applicant response to Pre-Exam Formalities Notice". https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html

For more information about EFS-Web please call the USPTO Electronic Business Center at **1-866-217-9197** or visit our website at http://www.uspto.gov/ebc.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

/hhagos/

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

Petitioner Samsung Ex-1004, 0542

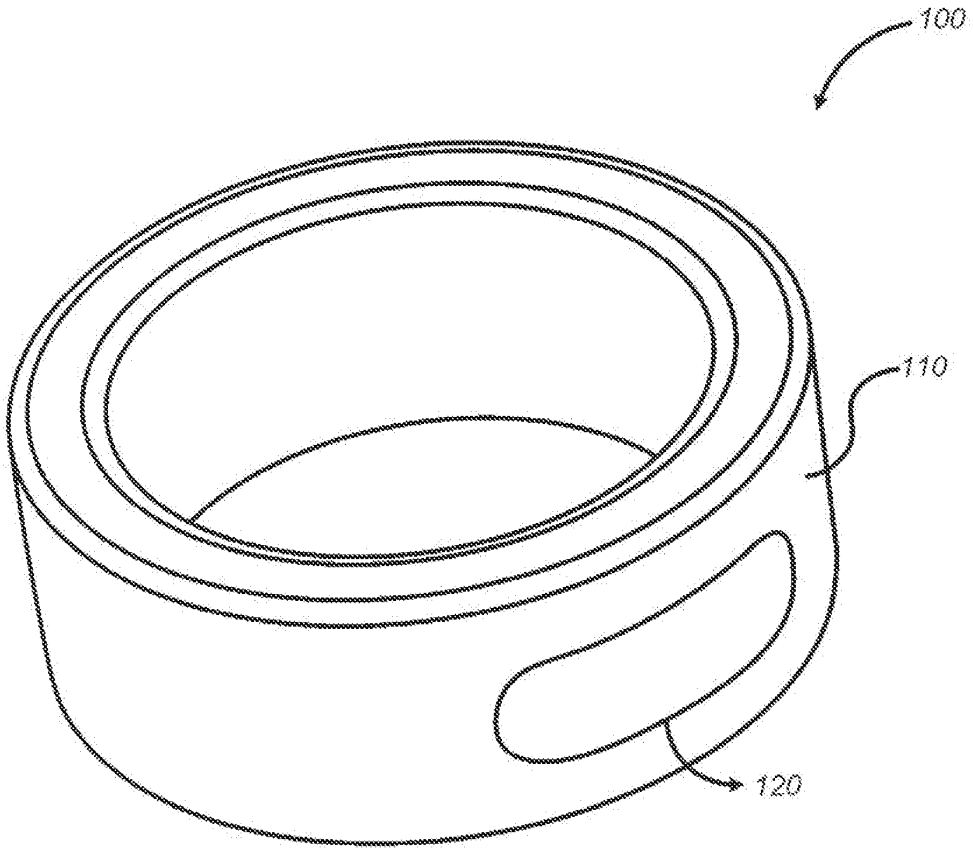


FIG. 1A

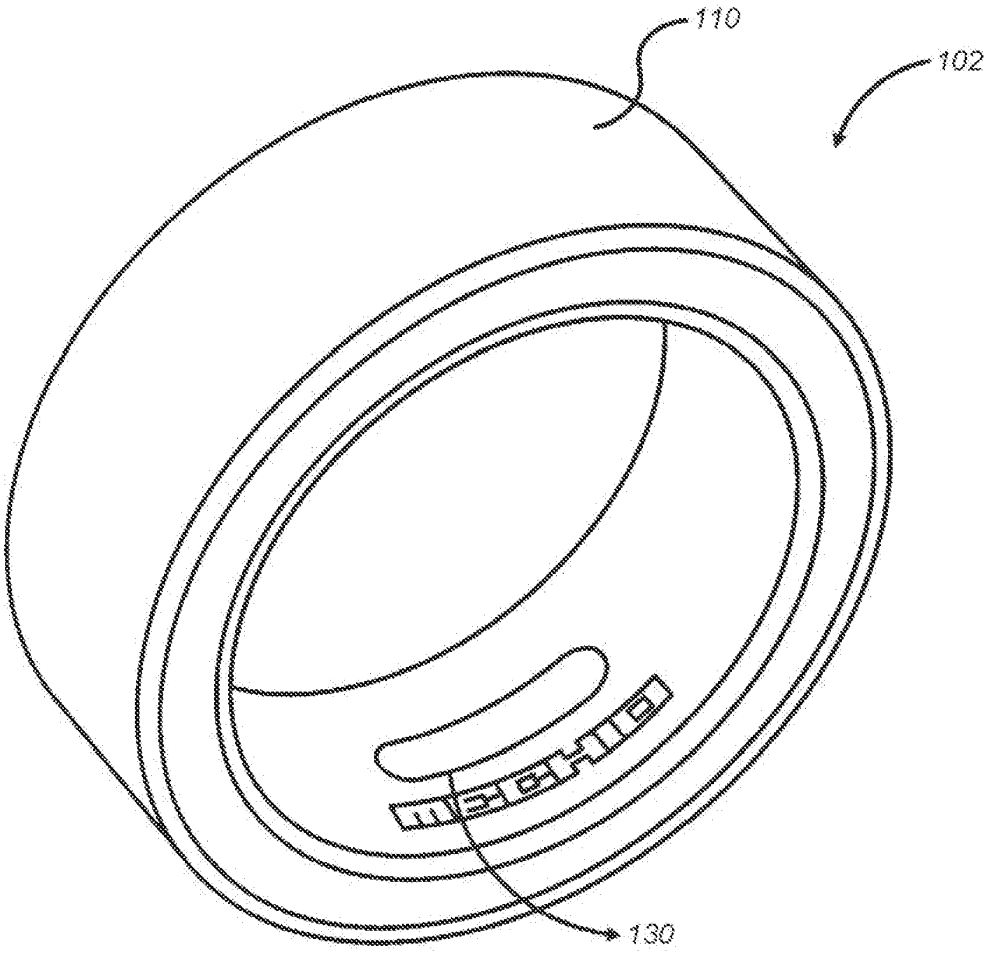


FIG. 1B

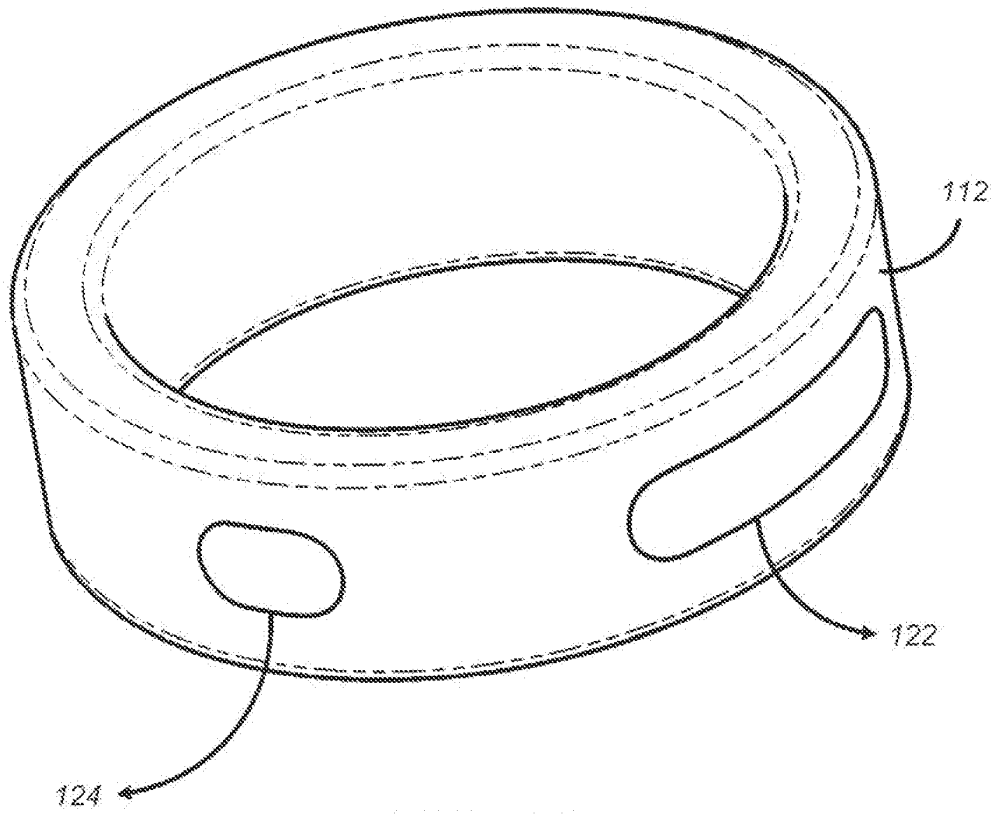


FIG. 1C

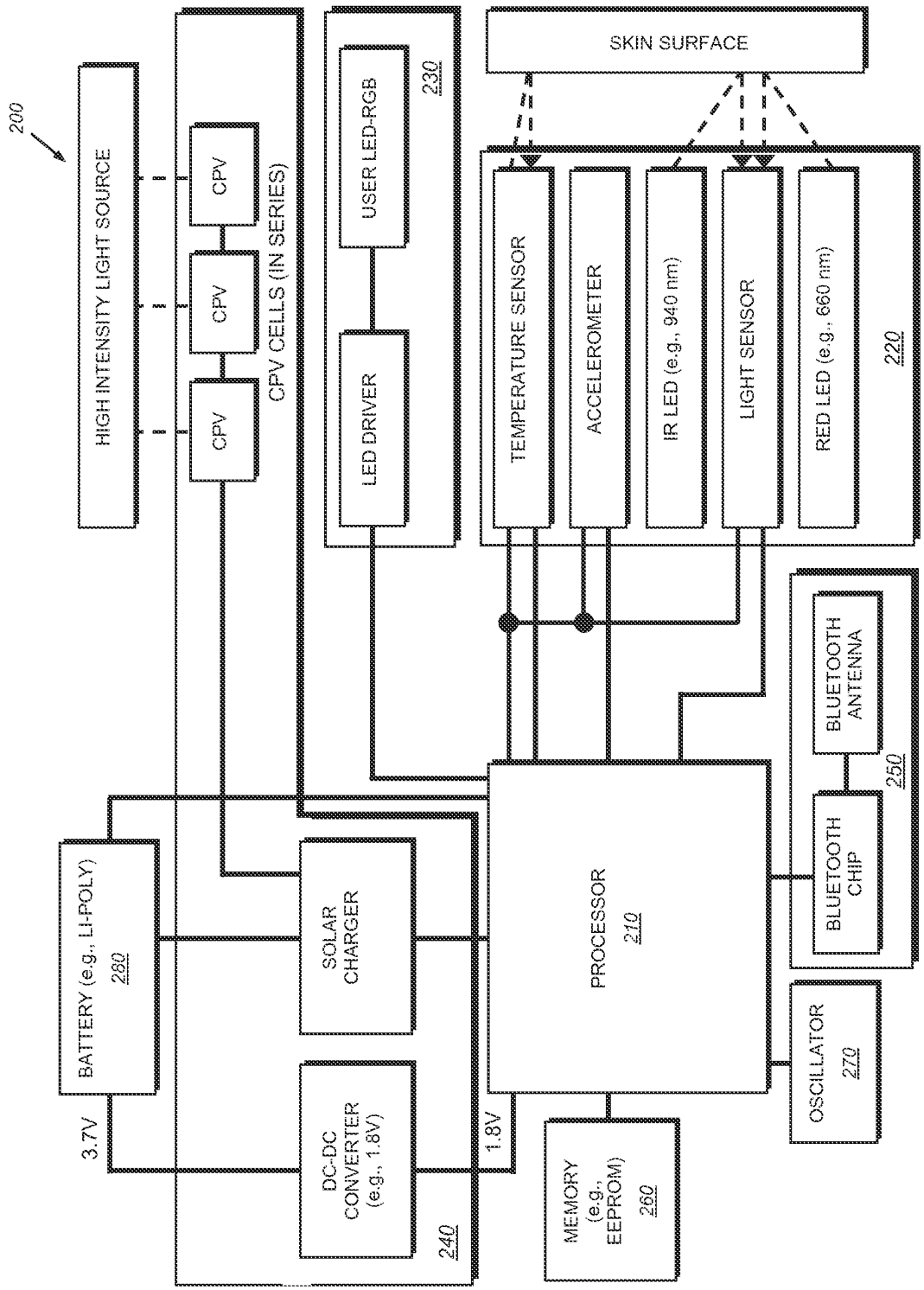

200
HIGH INTENSITY LIGHT SOURCE
CPV CELLS (IN SERIES)
CPV
CPV
CPV
USER LED-RGB
230
LED DRIVER
SKIN SURFACE
TEMPERATURE SENSOR
ACCELEROMETER
IR LED (e.g., 940 nm)
LIGHT SENSOR
RED LED (e.g., 660 nm)
220
BLUETOOTH ANTENNA
250
BLUETOOTH CHIP
PROCESSOR
210
BATTERY (e.g., LI-POLY)
260
SOLAR CHARGER
3.7V
DC-DC CONVERTER (e.g., 1.8V)
240
1.8V
MEMORY (e.g., EEPROM)
260
OSCILLATOR
270

FIG. 2

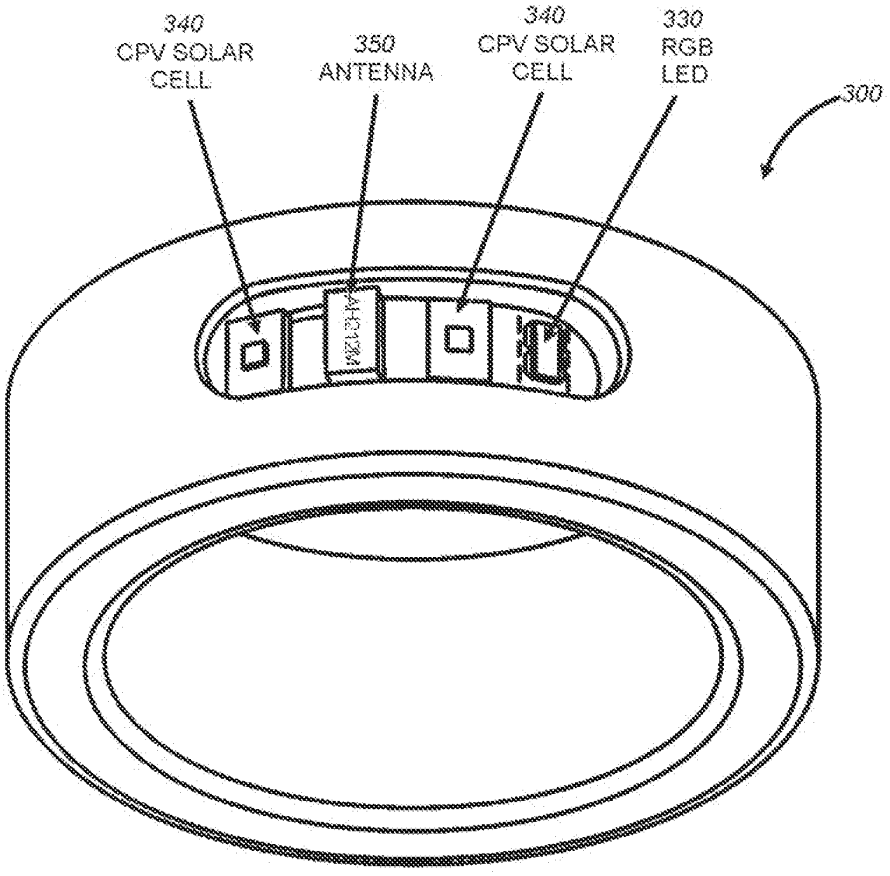

340
CPV SOLAR
CELL
350
ANTENNA
340
CPV SOLAR
CELL
330
RGB
LED
300

FIG. 3A

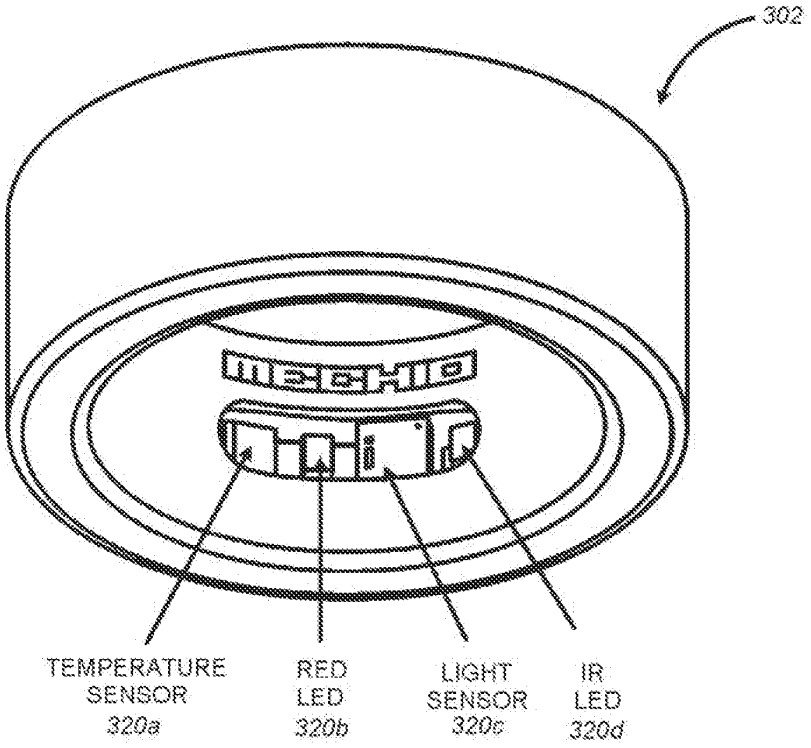

302
TEMPERATURE SENSOR 320a
RED LED 320b
LIGHT SENSOR 320c
IR LED 320d

FIG. 3B

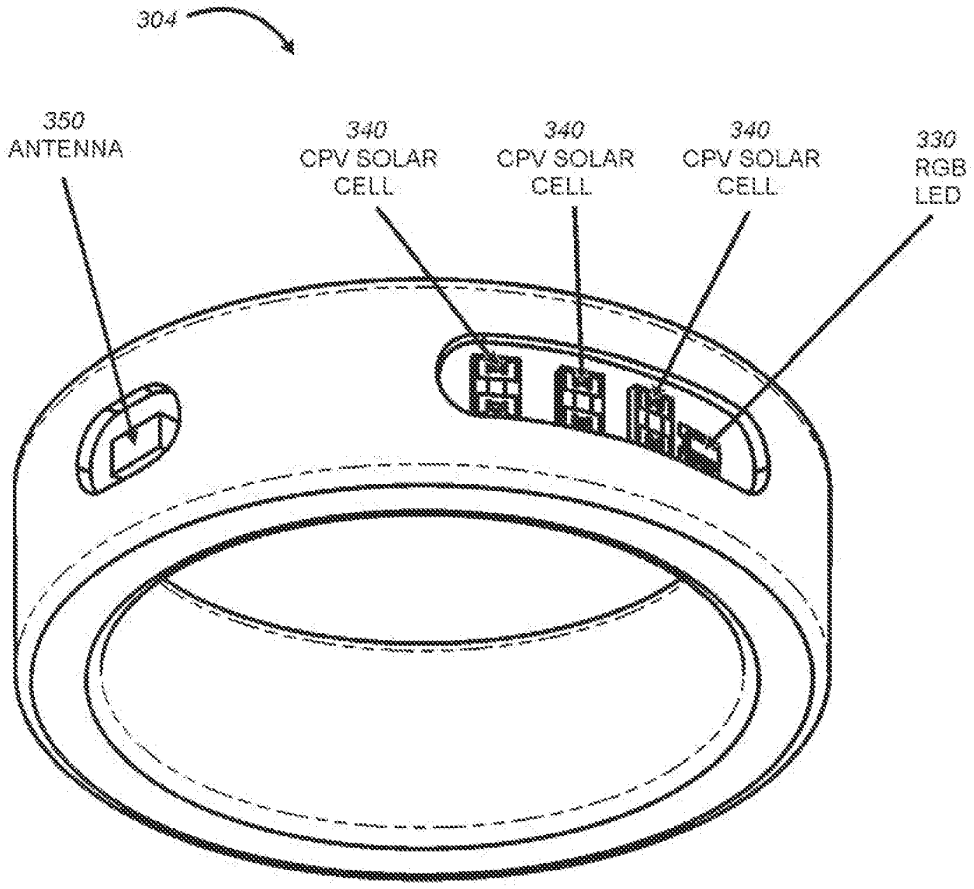

304
350
ANTENNA
340
CPV SOLAR
CELL
340
CPV SOLAR
CELL
340
CPV SOLAR
CELL
330
RGB
LED

FIG. 3C

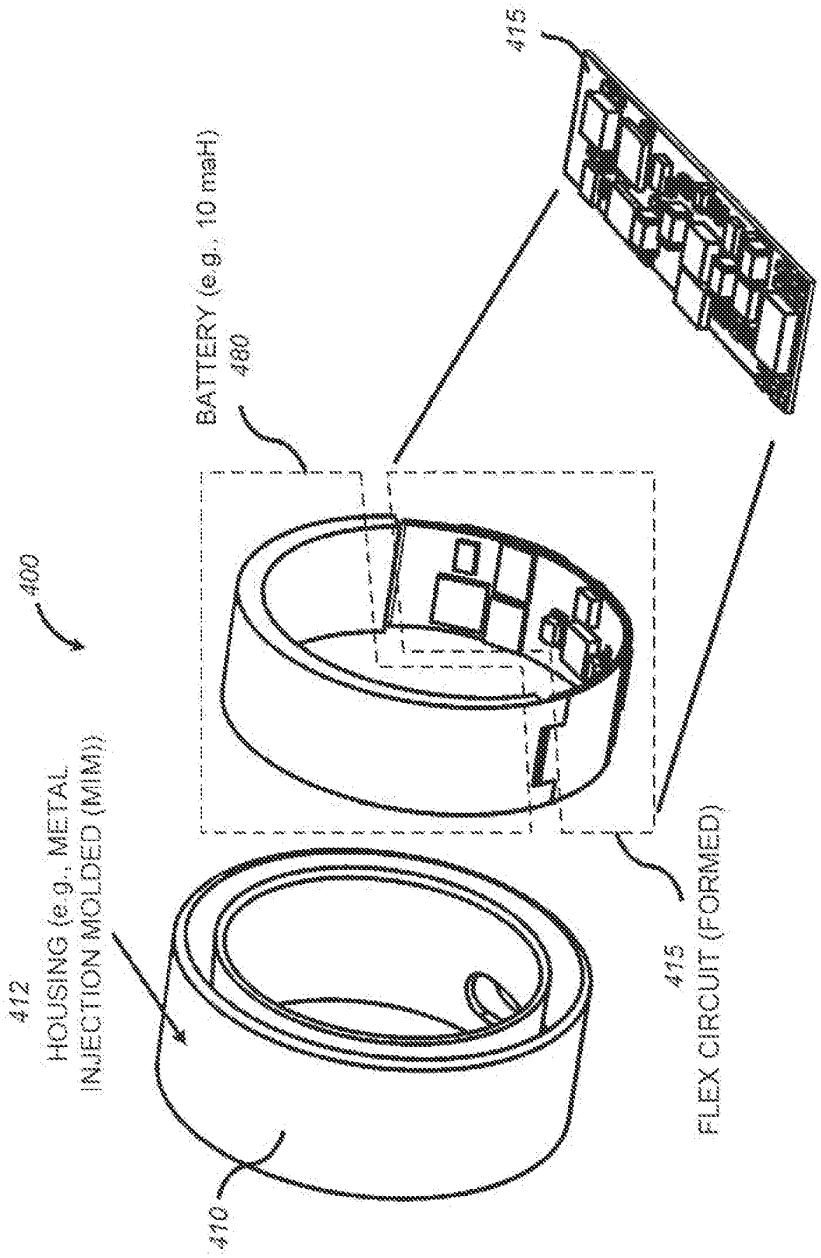

400
412
HOUSING (e.g., METAL INJECTION MOLDED (MIM))
410
BATTERY (e.g., 10 maH)
480
415
415
FLEX CIRCUIT (FORMED)

FIG. 4

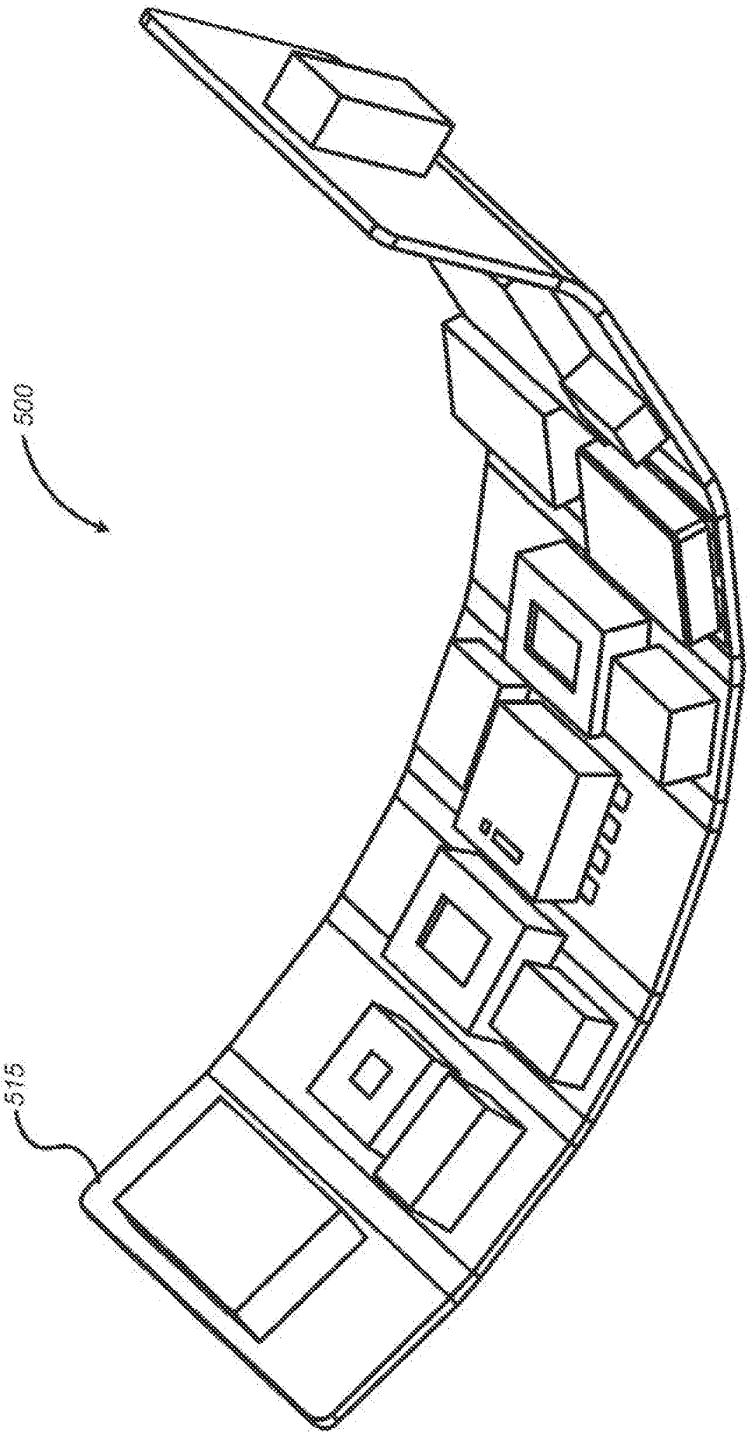


FIG. 5

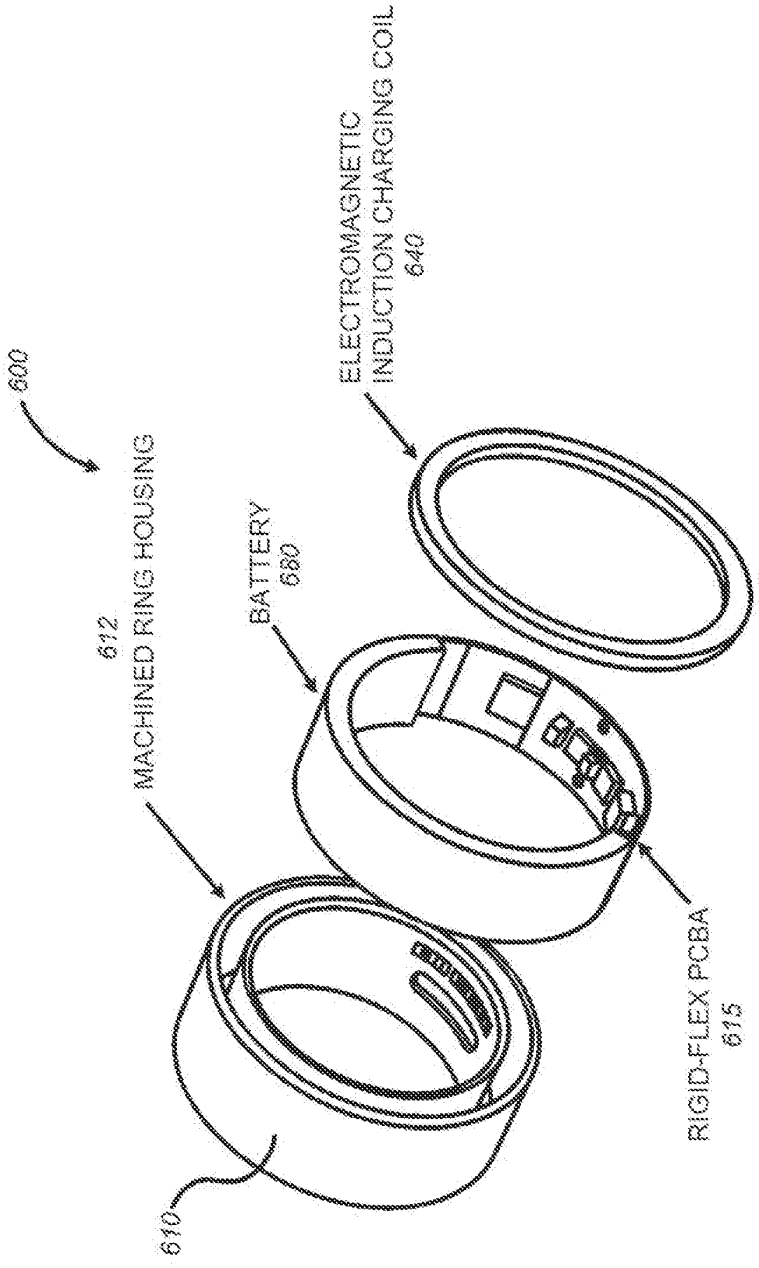

600
612
MACHINED RING HOUSING
ELECTROMAGNETIC
INDUCTION CHARGING COIL
640
BATTERY
680
RIGID-FLEX PCBA
615
610

FIG. 6

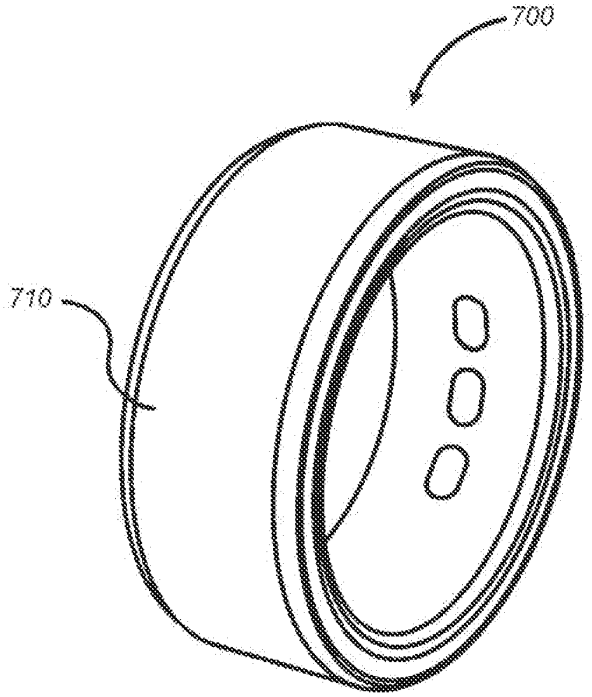


FIG. 7

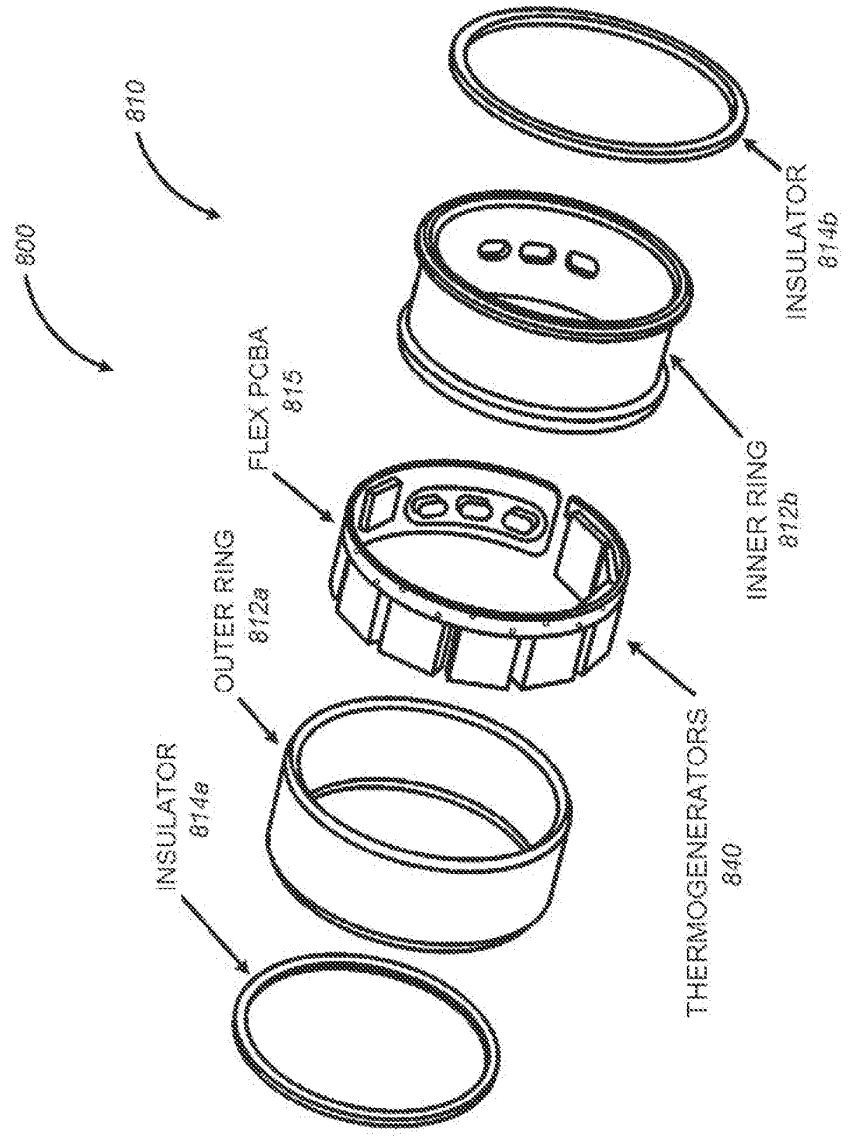

800
810
INSULATOR
814a
OUTER RING
812a
FLEX PCBA
815
THERMOGENERATORS
840
INNER RING
812b
INSULATOR
814b

FIG. 8

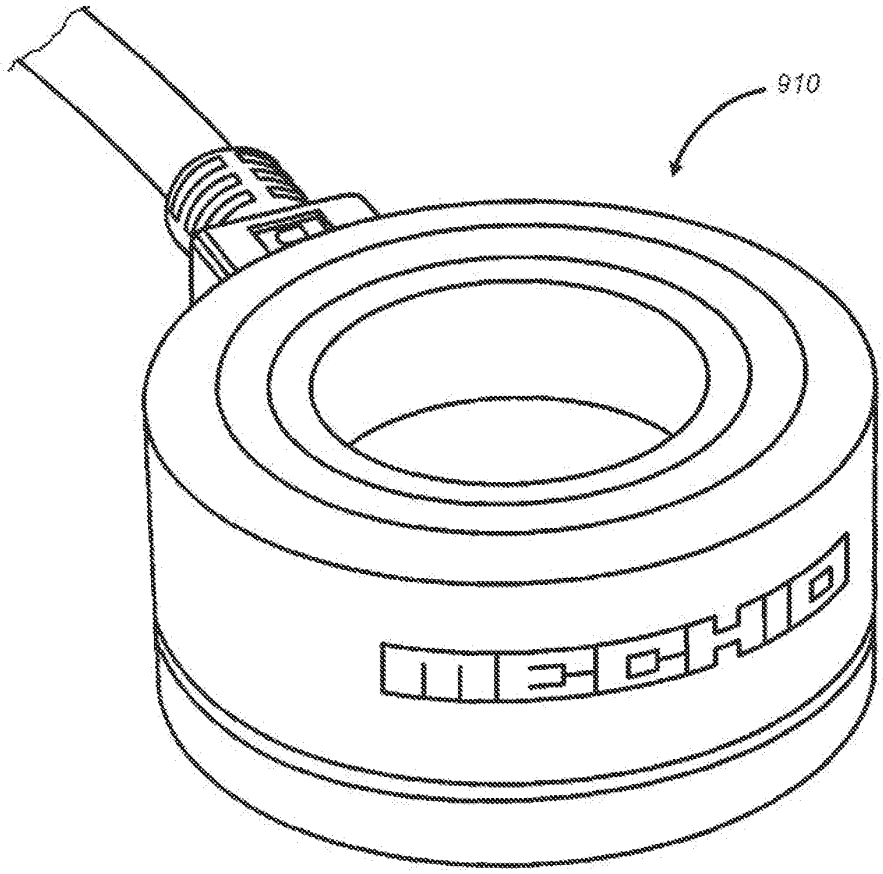


FIG. 9A

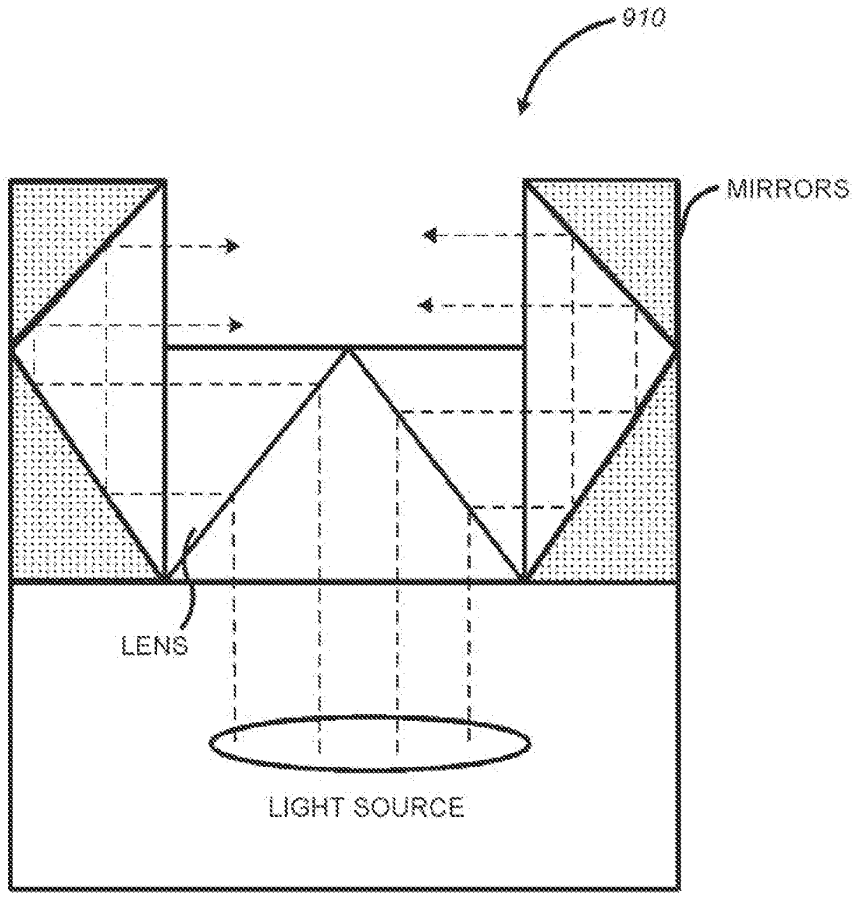


FIG. 9B

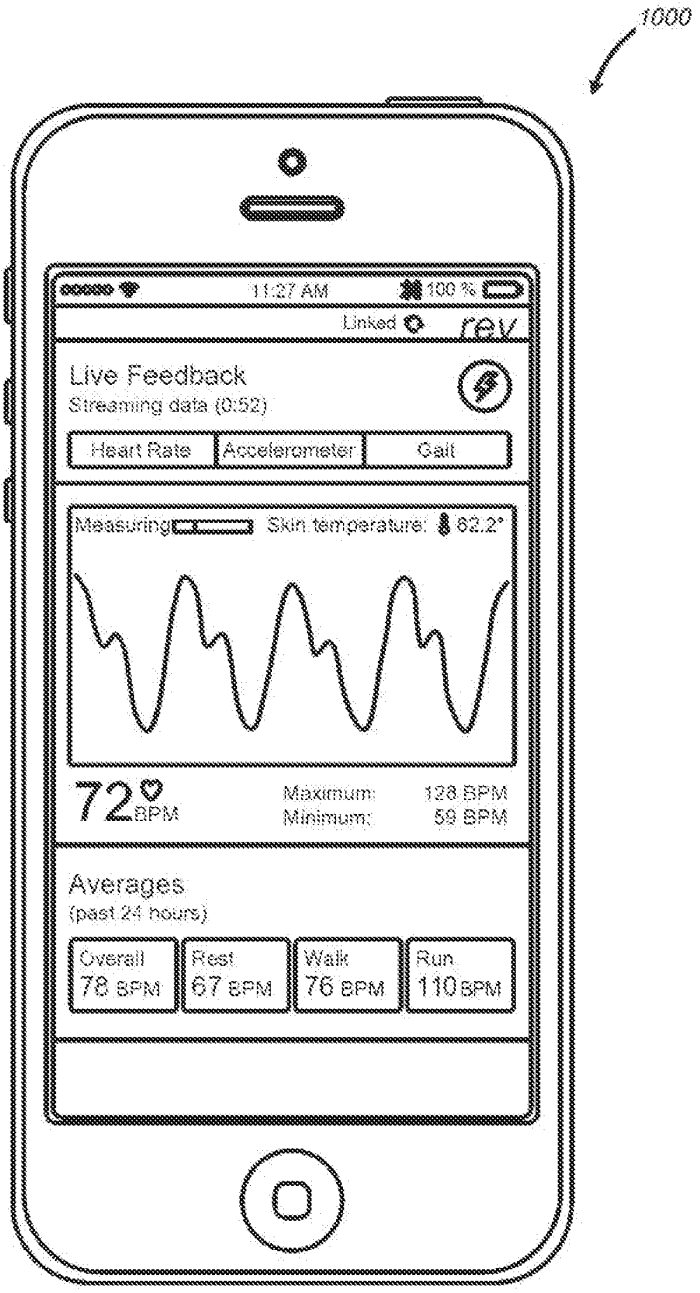

1000
11:27 AM
100 %
Linked
rev
Live Feedback
Streaming data (0:52)
Heart Rate
Accelerometer
Gait
Measuring
Skin temperature: 82.2°
72° BPM
Maximum: 128 BPM
Minimum: 59 BPM
Averages
(past 24 hours)
Overall 78 BPM
Rest 67 BPM
Walk 76 BPM
Run 110 BPM

FIG. 10

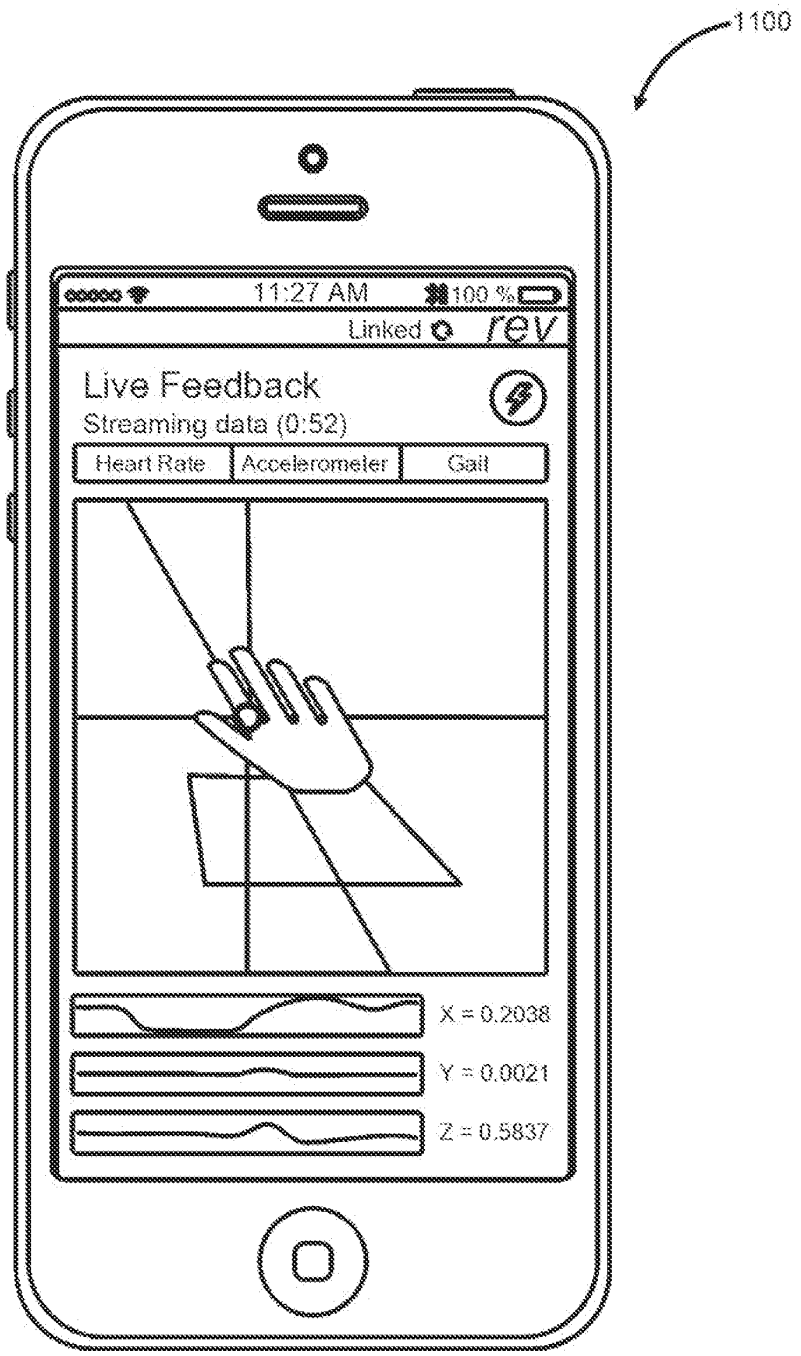

1100
11:27 AM
100 %
Linked
rev
Live Feedback
Streaming data (0:52)
Heart Rate
Accelerometer
Gait
X = 0.2038
Y = 0.0021
Z = 0.5837

FIG. 11

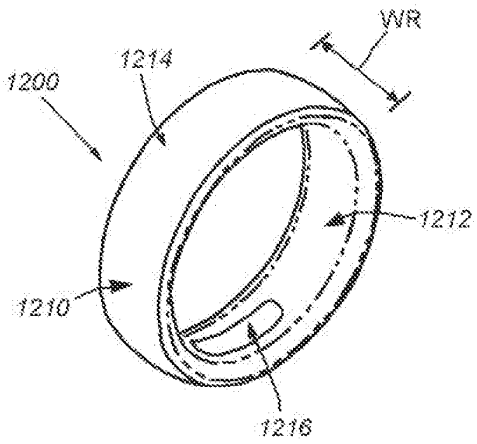


FIG. 12A

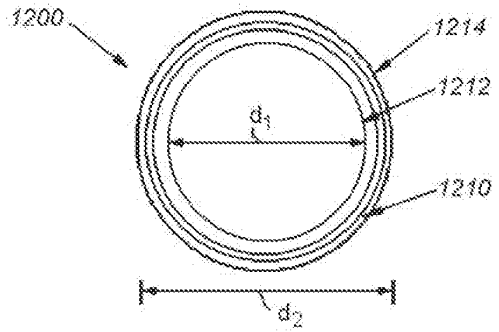


FIG. 12B

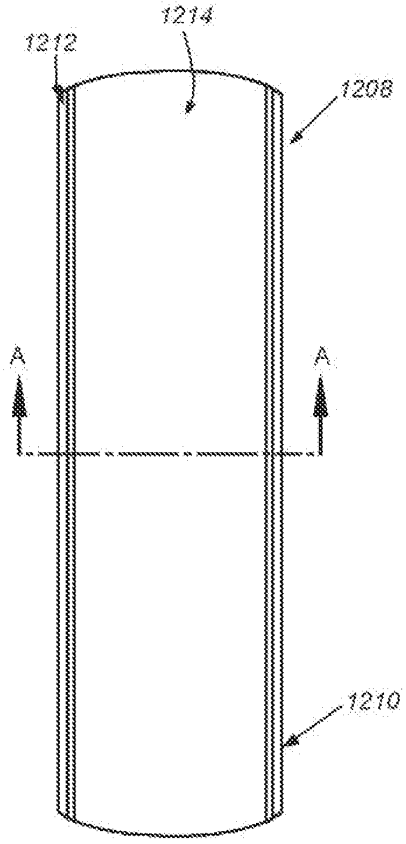


FIG. 12C

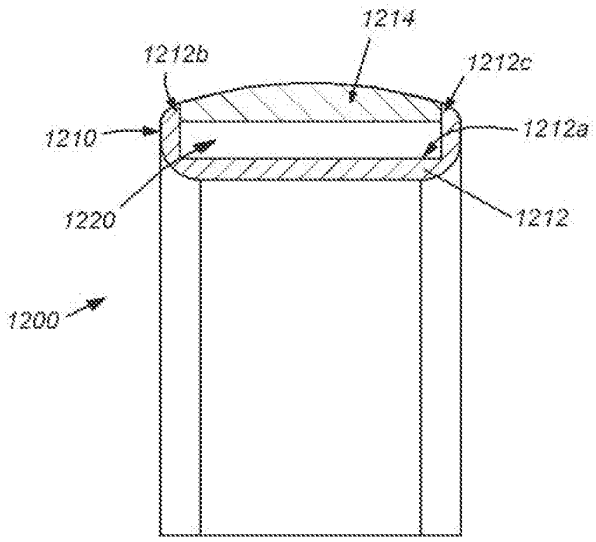


FIG. 12D

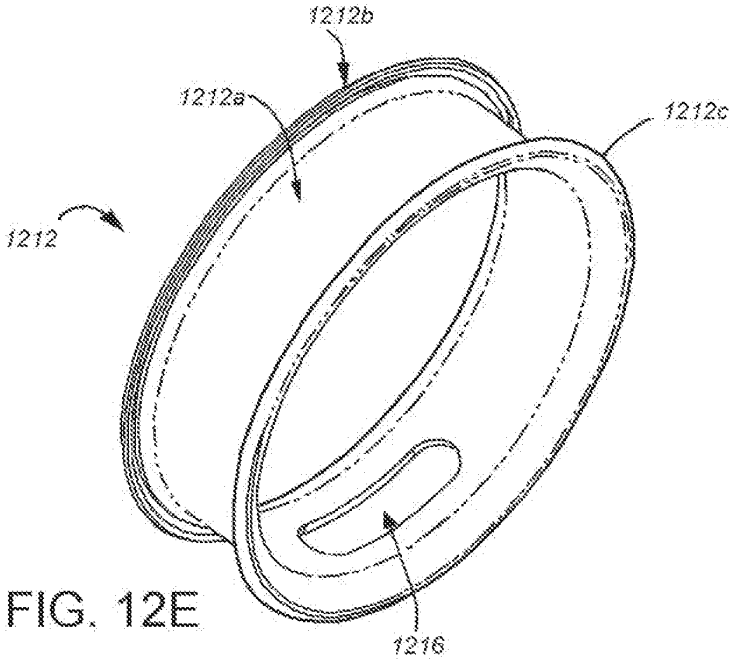


FIG. 12E

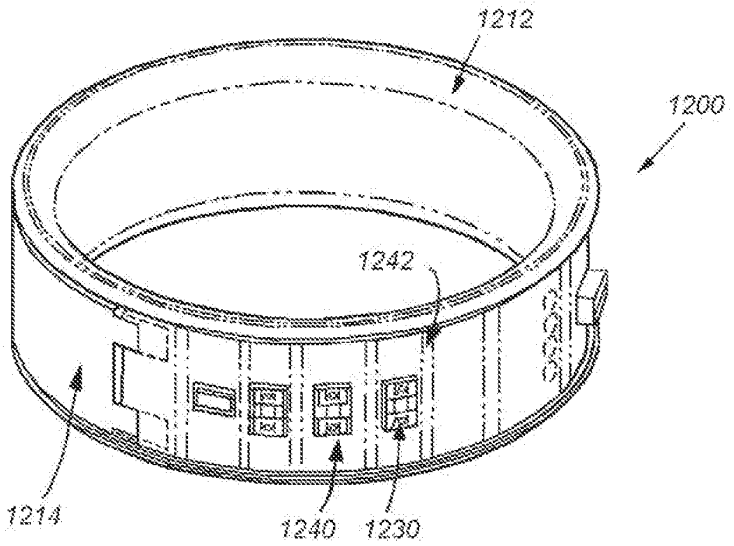


FIG. 12F

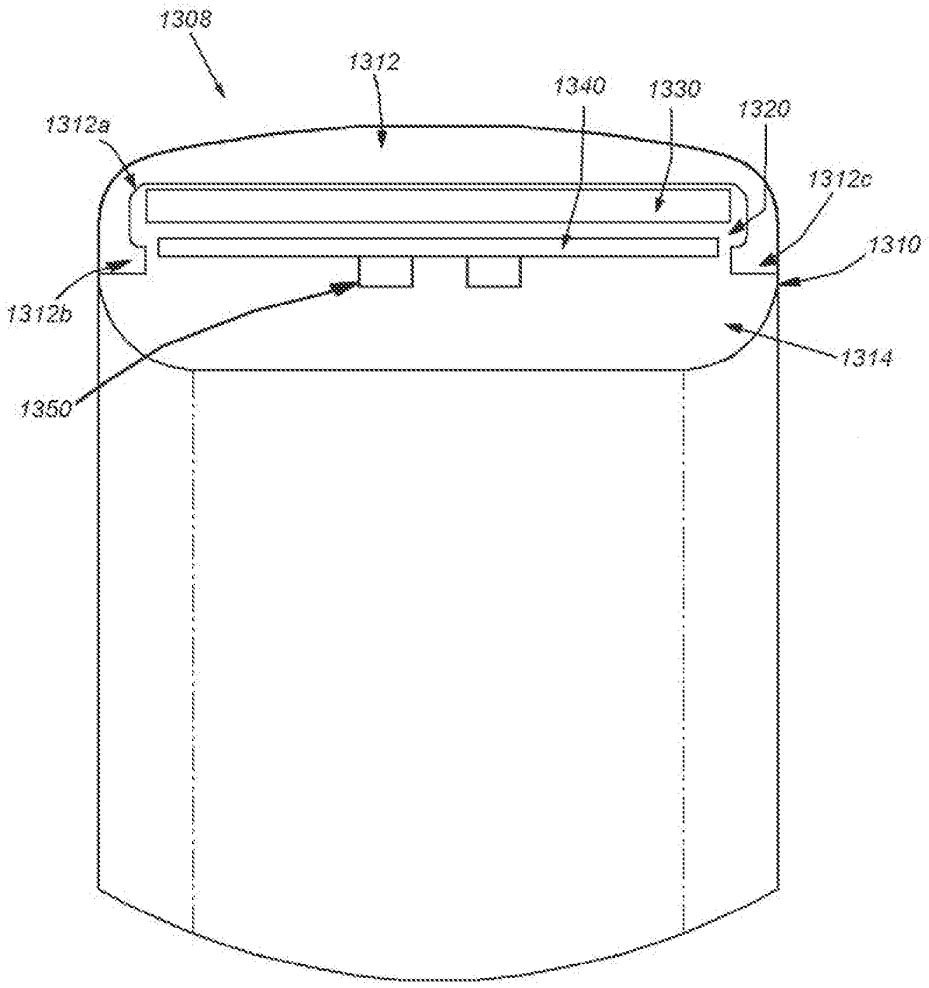


FIG. 13

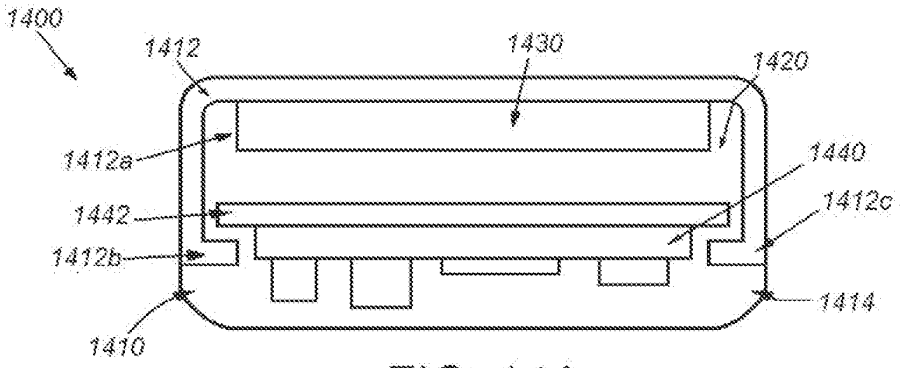


FIG. 14A

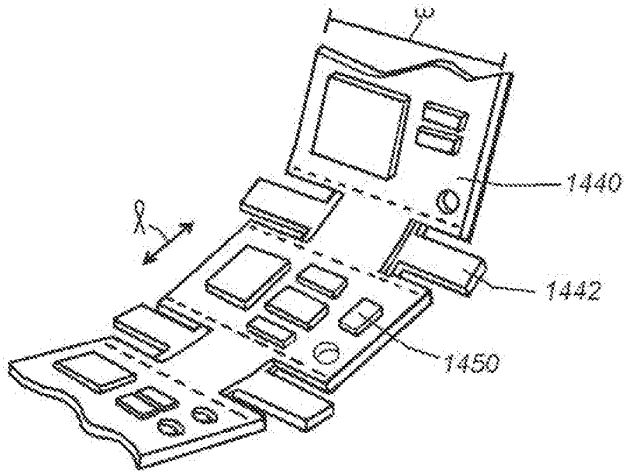


FIG. 14B

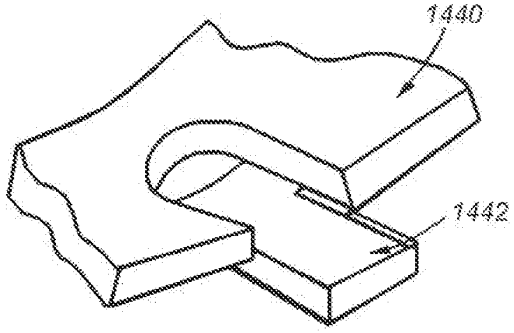


FIG. 14C

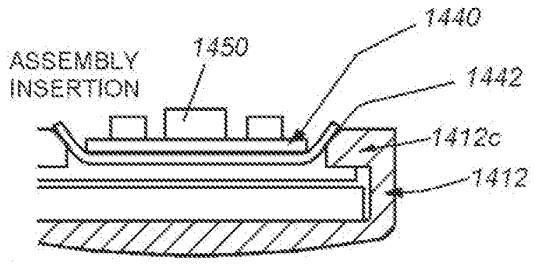


FIG. 14D

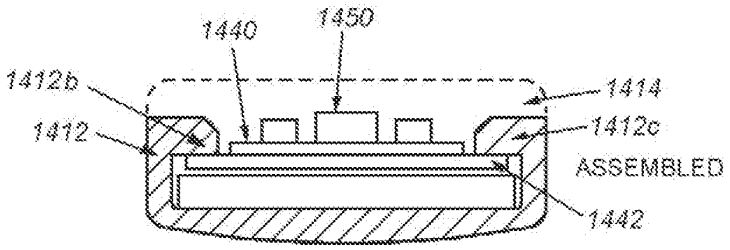


FIG. 14E

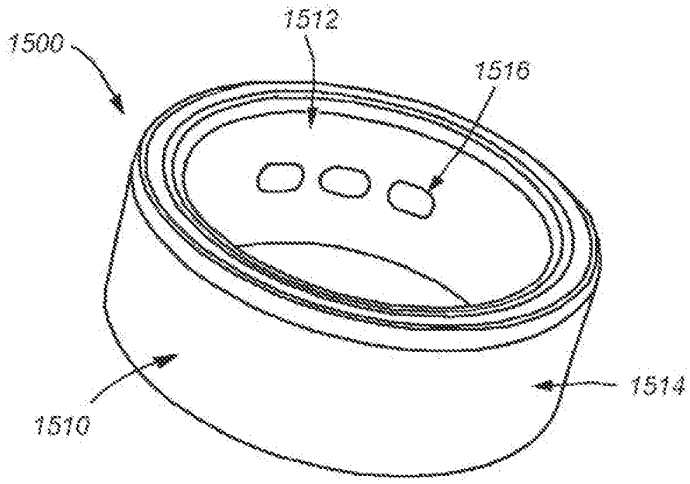


FIG. 15A

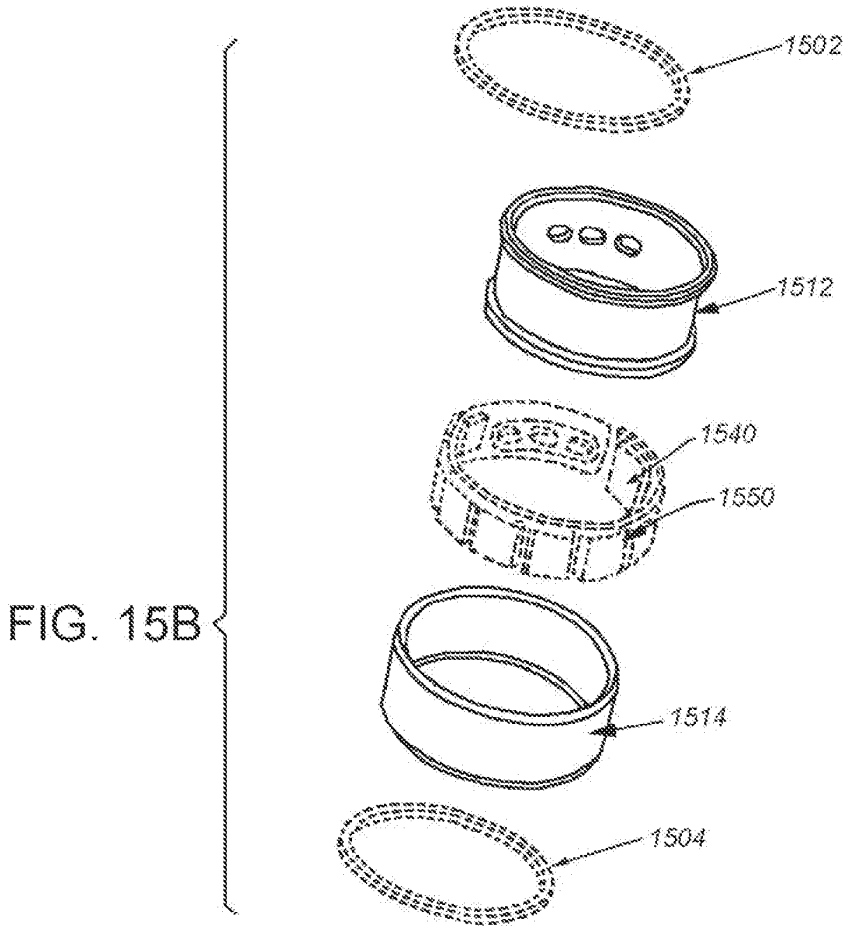
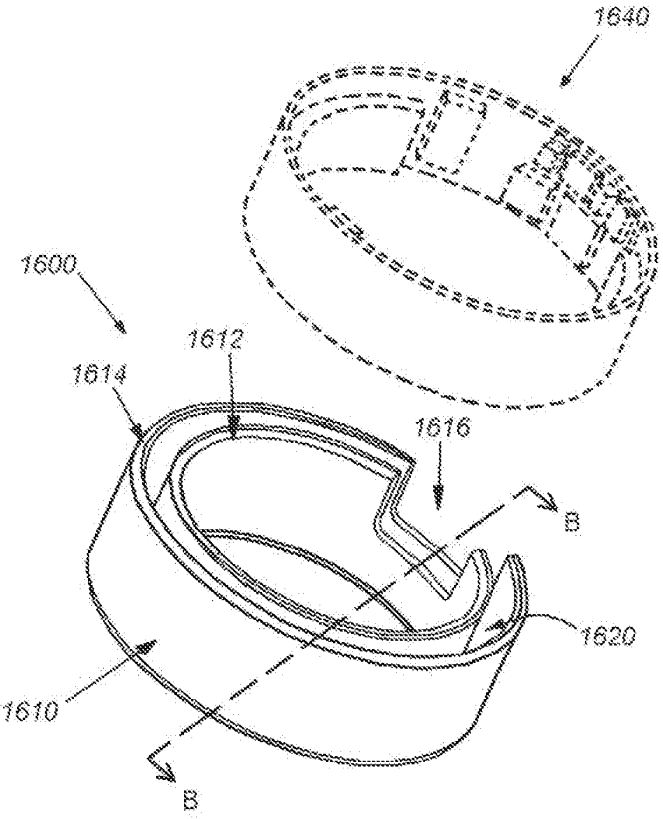


FIG. 15B

FIG. 16A



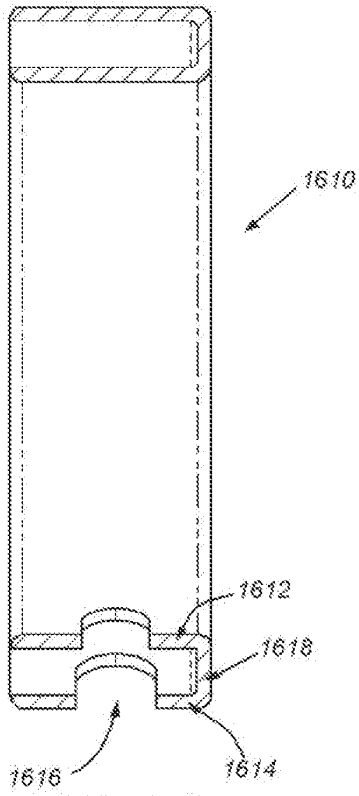


FIG. 16B

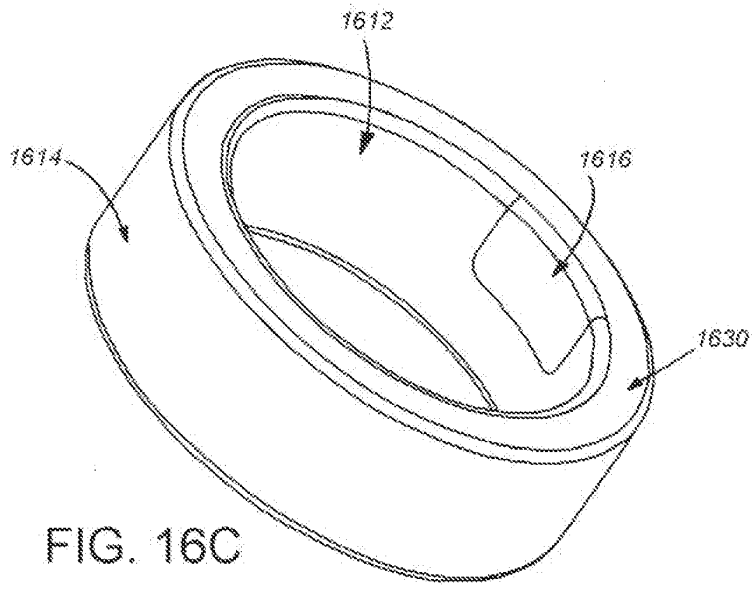


FIG. 16C

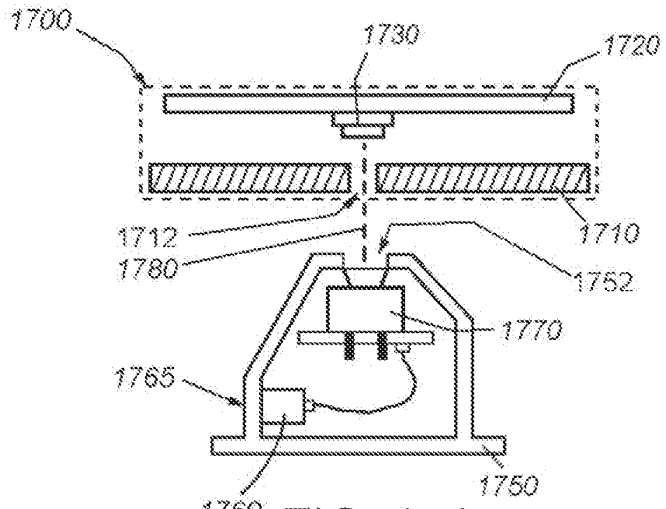


FIG. 17A

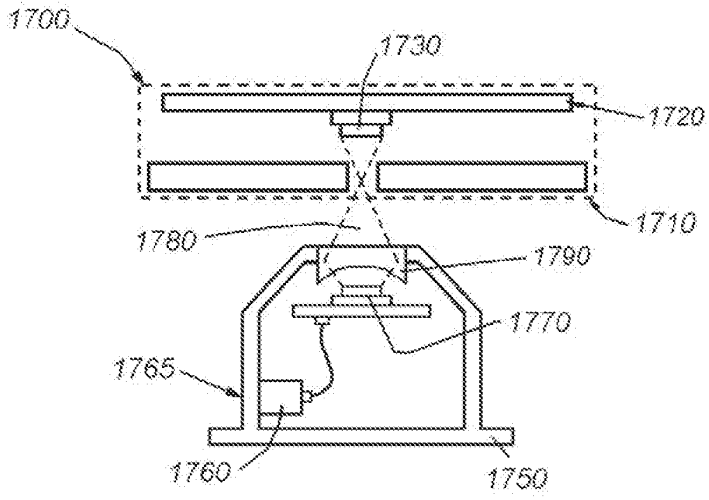


FIG. 17B

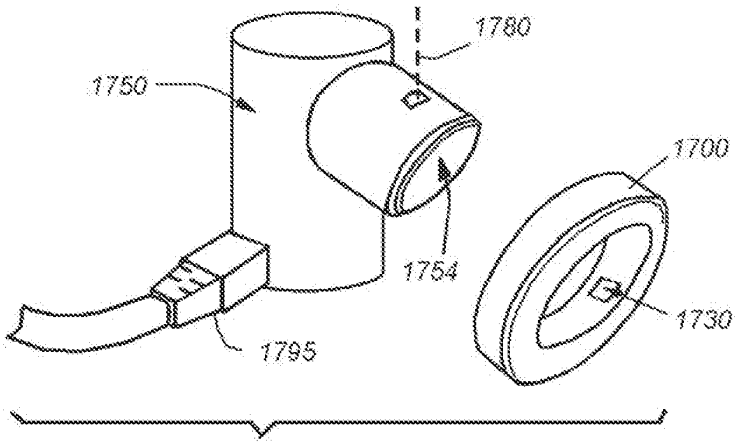


FIG. 17C

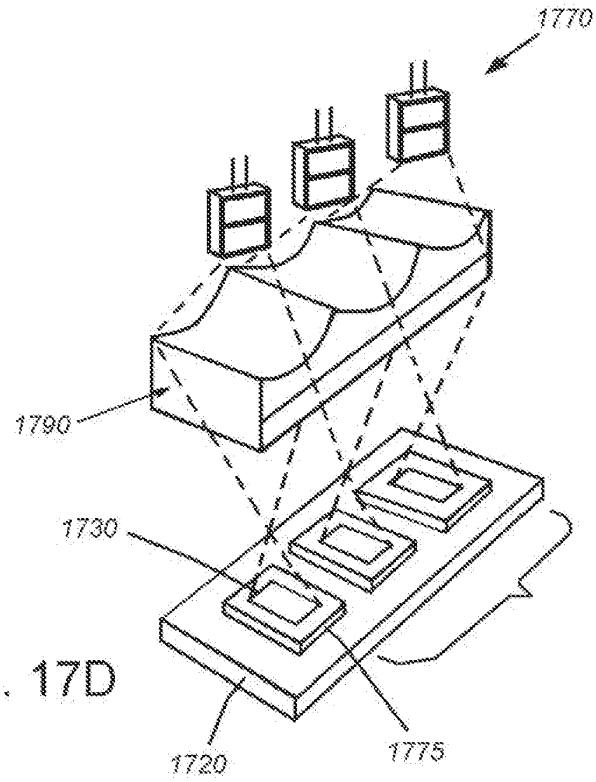


FIG. 17D

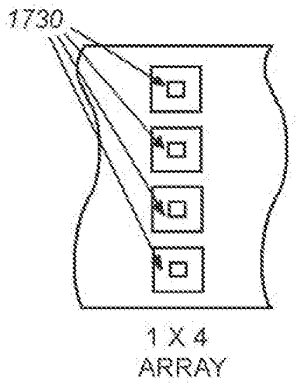


FIG. 17E

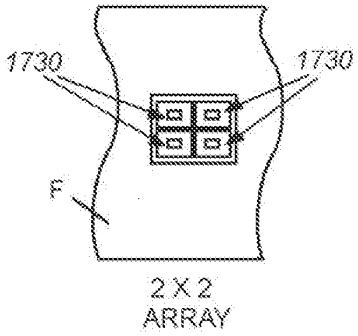


FIG. 17F

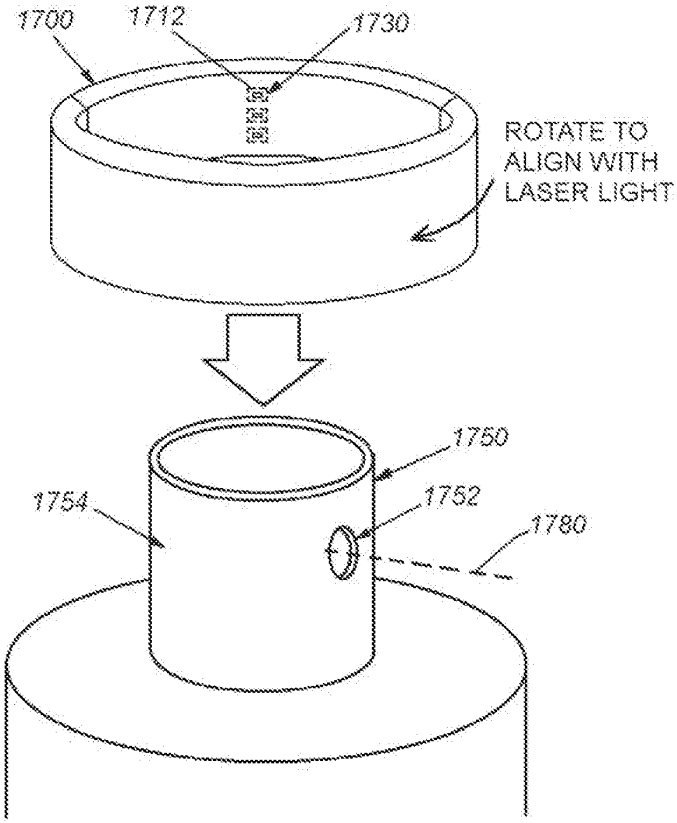


FIG. 17G

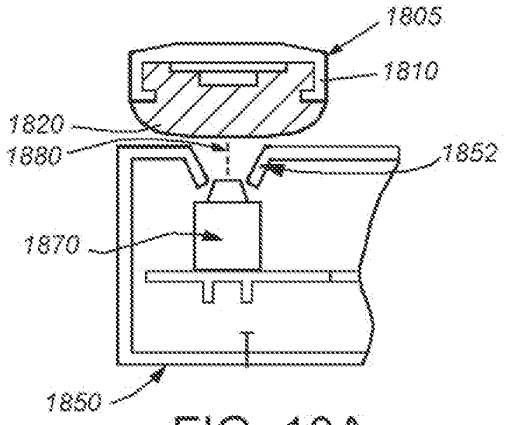


FIG. 18A

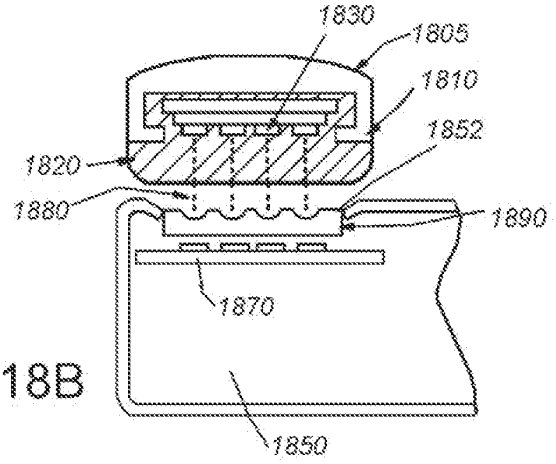


FIG. 18B

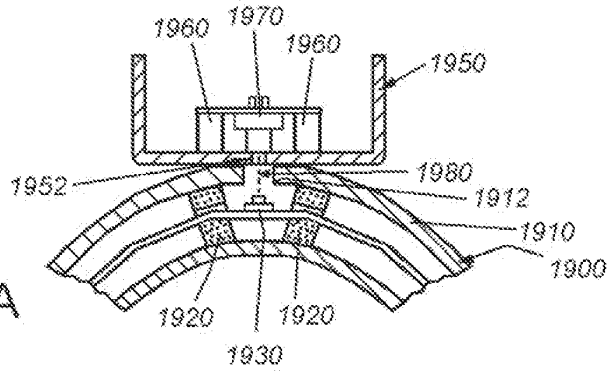


FIG. 19A

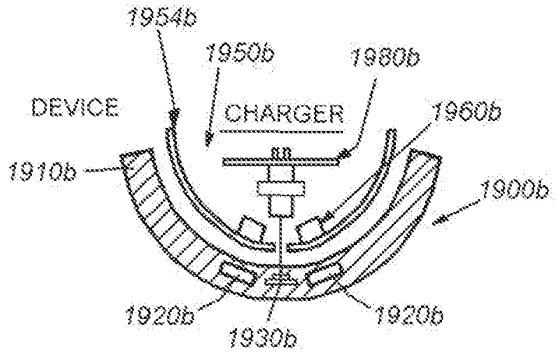


FIG. 19B

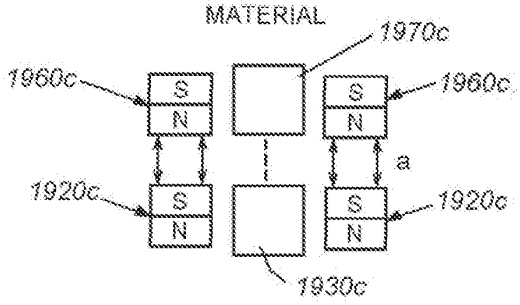


FIG. 19C

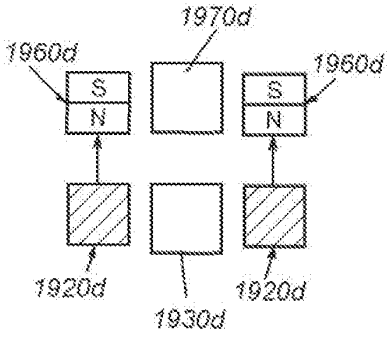


FIG. 19D

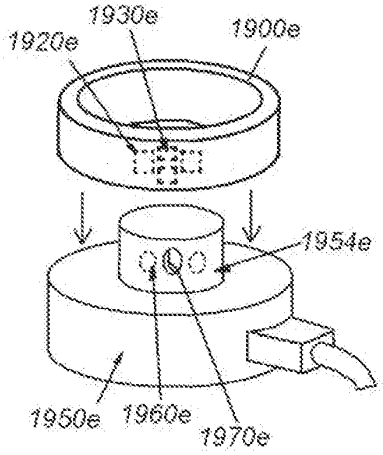


FIG. 19E

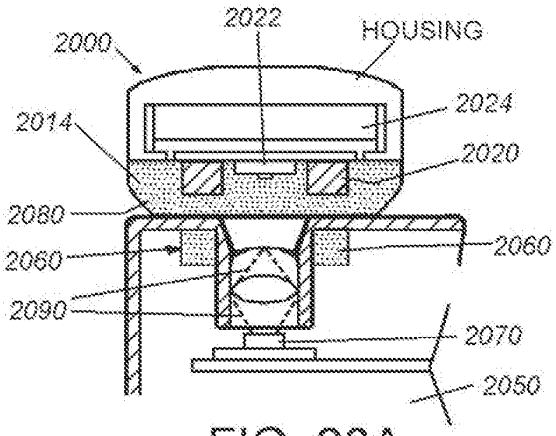


FIG. 20A

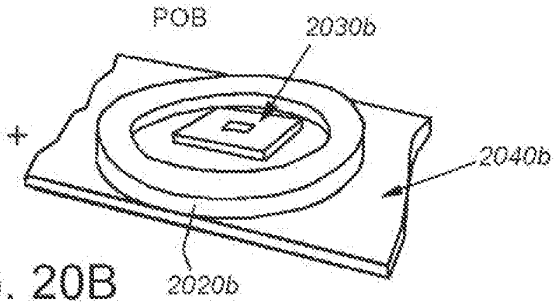


FIG. 20B

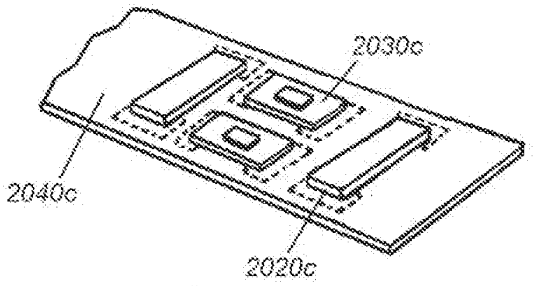


FIG. 20C

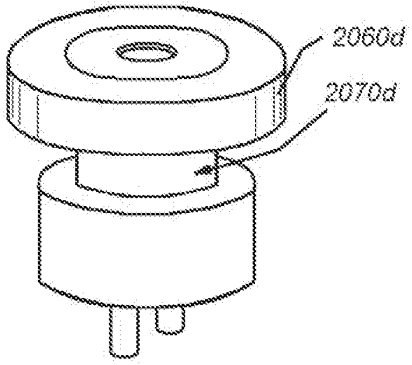


FIG. 20D

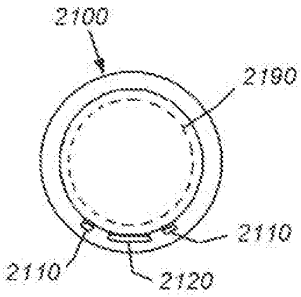


FIG. 21A

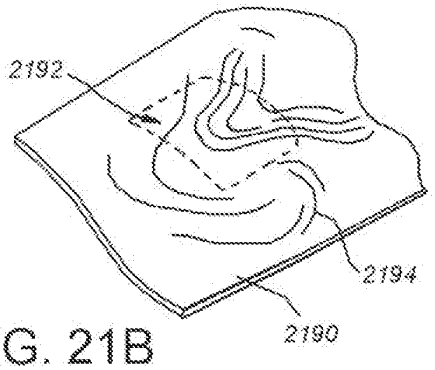


FIG. 21B

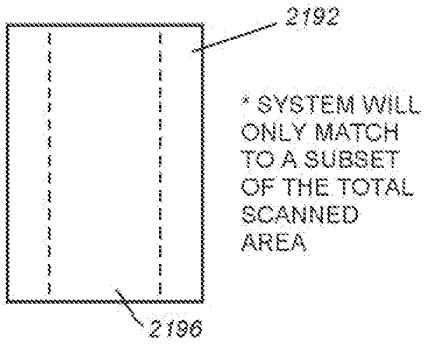


FIG. 21C

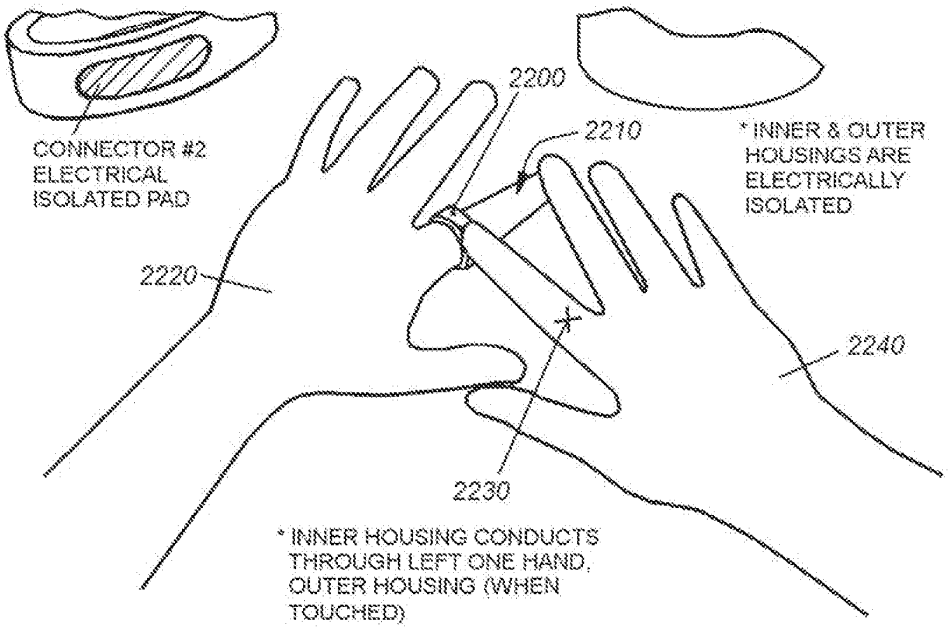


FIG. 22A

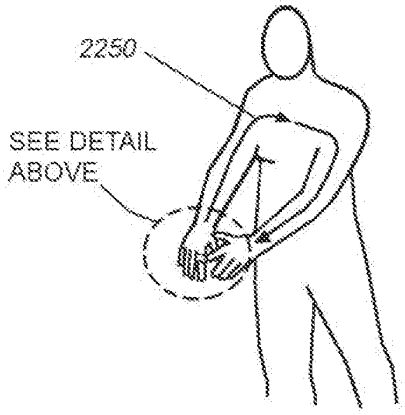


FIG. 22B

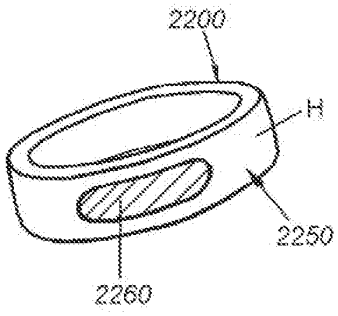


FIG. 22C

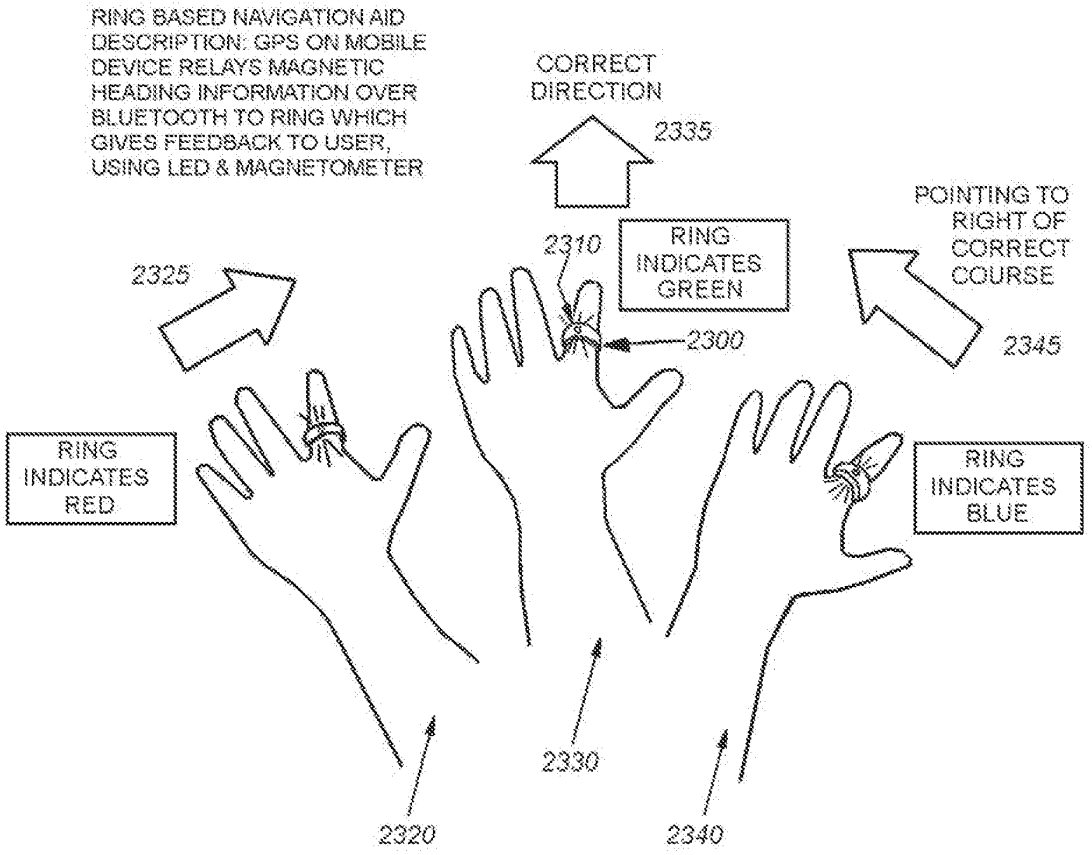

RING BASED NAVIGATION AID DESCRIPTION: GPS ON MOBILE DEVICE RELAYS MAGNETIC HEADING INFORMATION OVER BLUETOOTH TO RING WHICH GIVES FEEDBACK TO USER, USING LED & MAGNETOMETER
CORRECT DIRECTION
2335
POINTING TO RIGHT OF CORRECT COURSE
2345
2310
RING INDICATES GREEN
2325
2300
RING INDICATES RED
RING INDICATES BLUE
2330
2320
2340

FIG. 23A

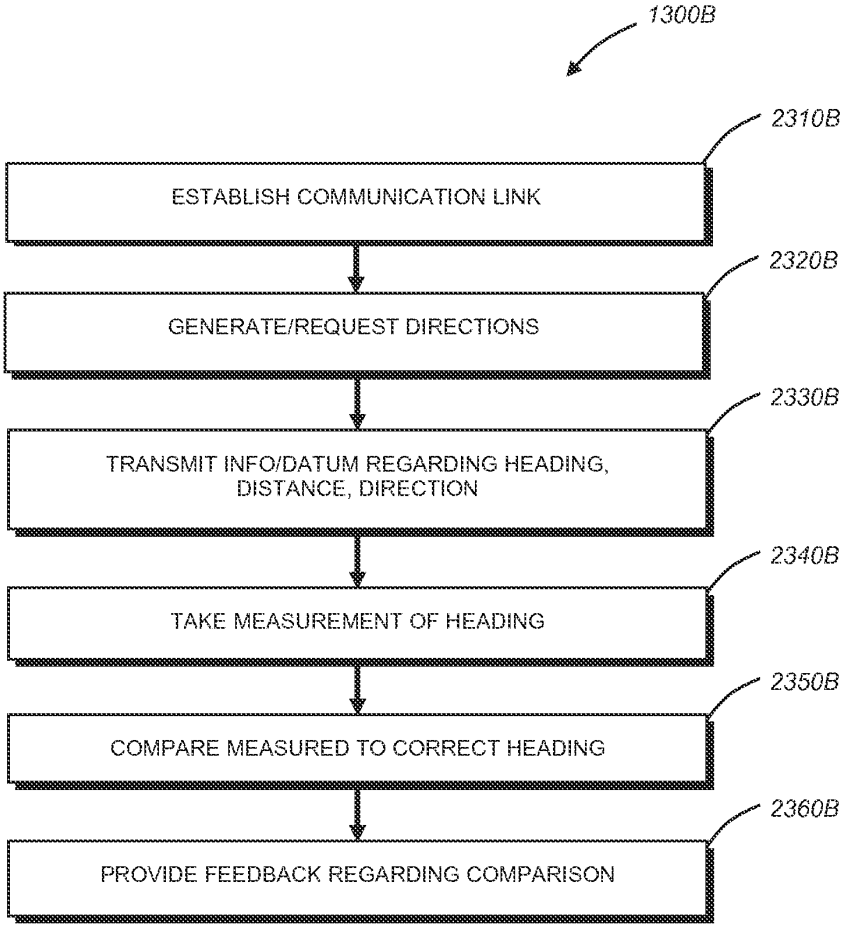

1300B
2310B
ESTABLISH COMMUNICATION LINK
2320B
GENERATE/REQUEST DIRECTIONS
2330B
TRANSMIT INFO/DATUM REGARDING HEADING, DISTANCE, DIRECTION
2340B
TAKE MEASUREMENT OF HEADING
2350B
COMPARE MEASURED TO CORRECT HEADING
2360B
PROVIDE FEEDBACK REGARDING COMPARISON

FIG. 23B

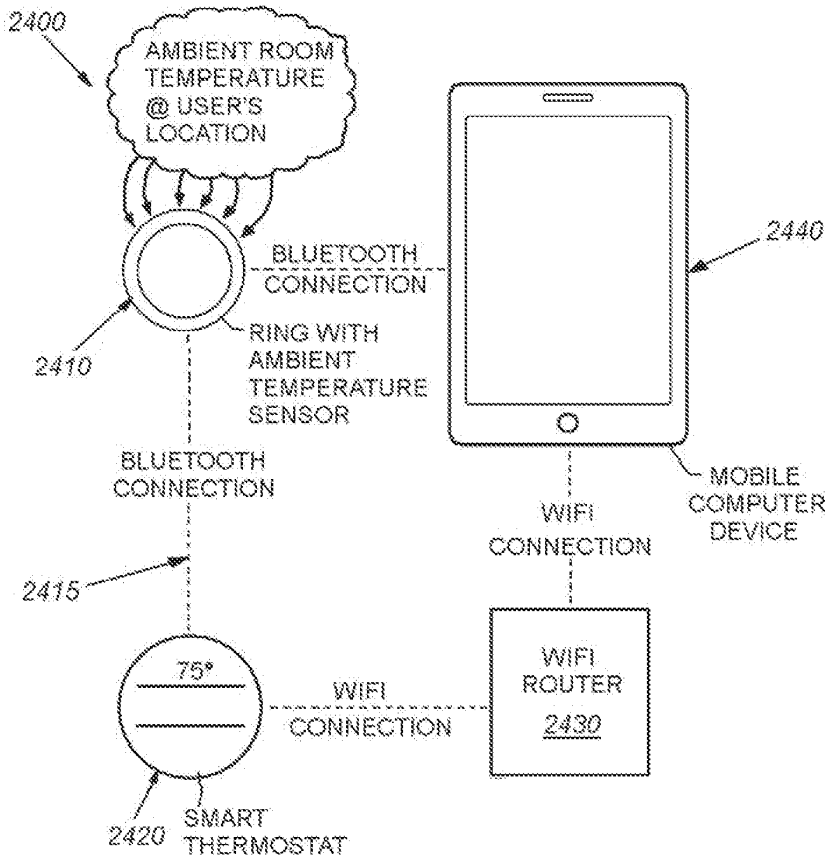


FIG. 24A

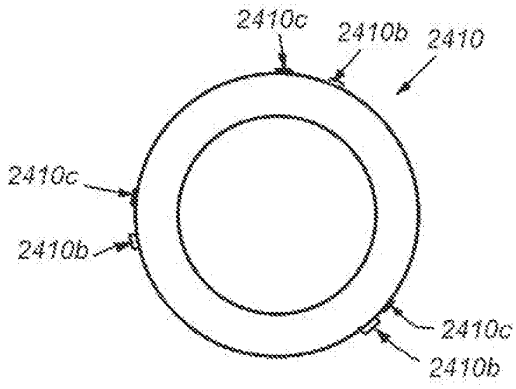


FIG. 24B

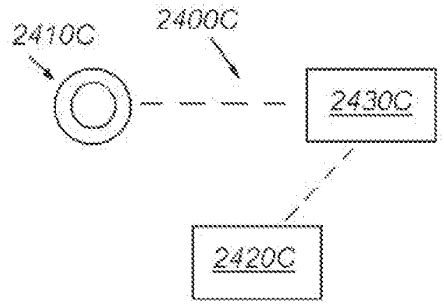


FIG. 24C

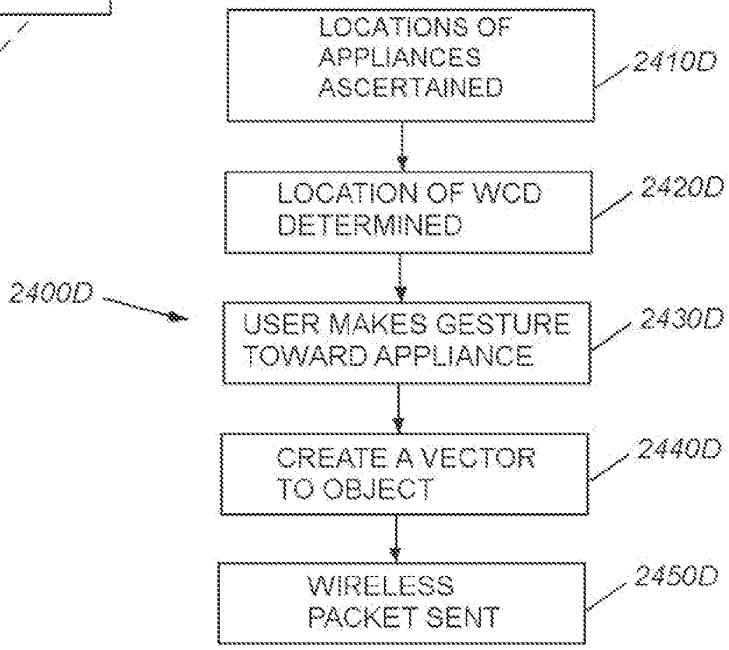


FIG. 24D

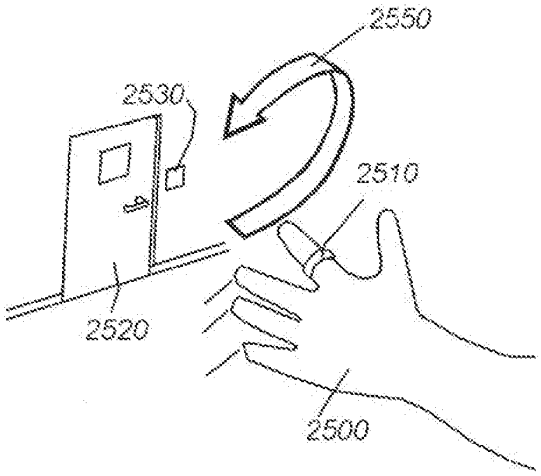


FIG. 25

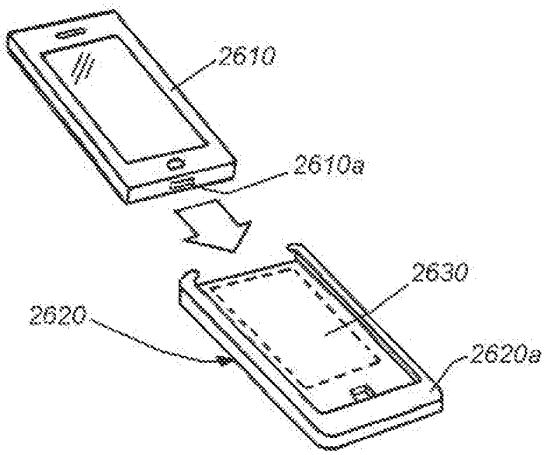


FIG. 26A

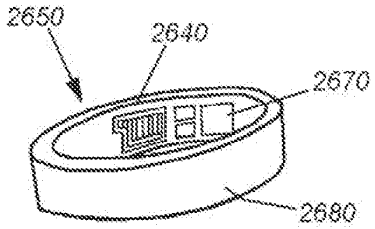


FIG. 26B

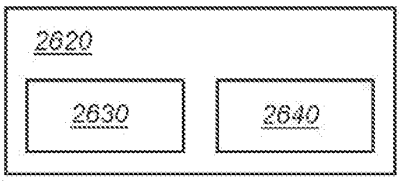


FIG. 26C

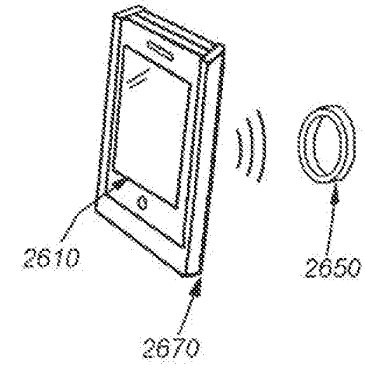


FIG. 26D

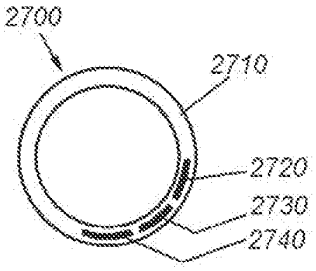


FIG. 27A

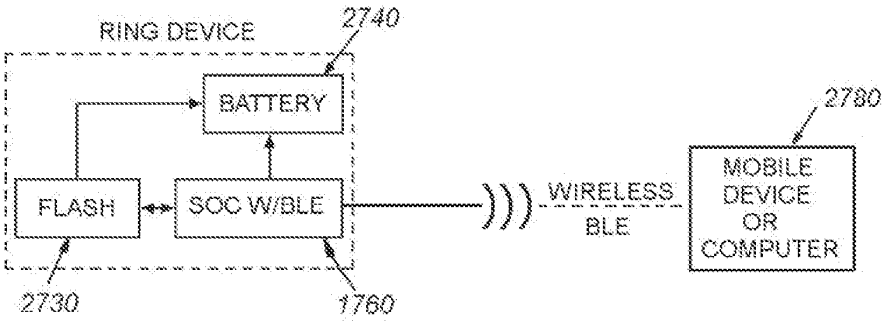


FIG. 27B

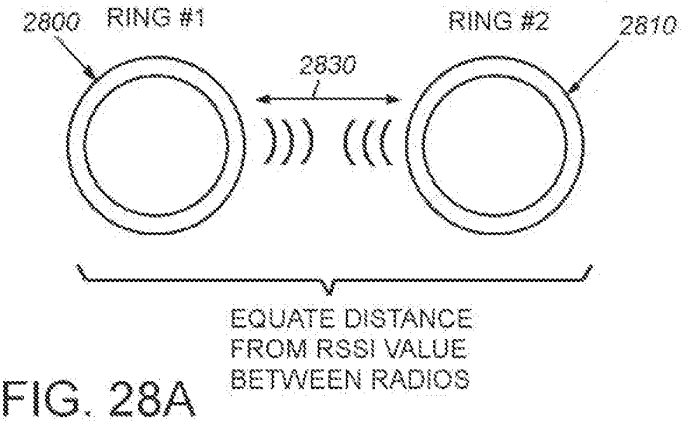


FIG. 28A

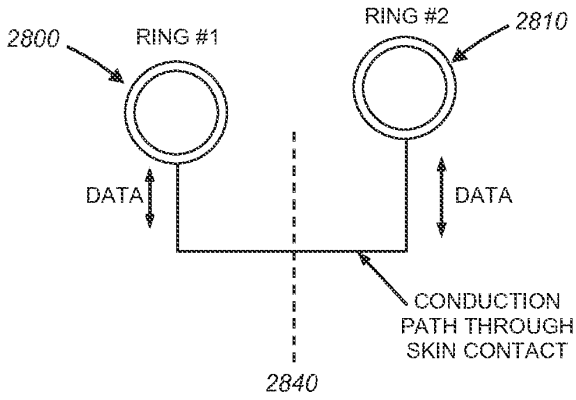


FIG. 28B

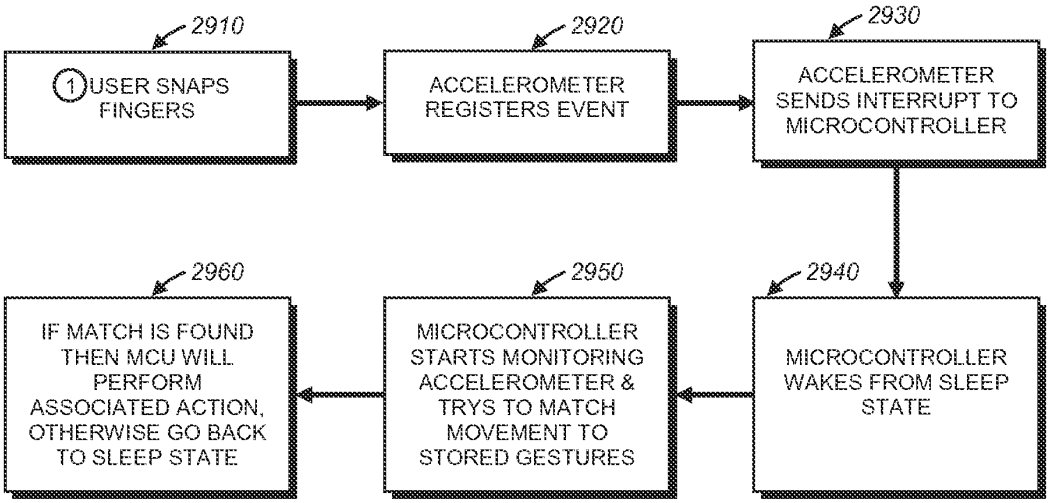


FIG. 29A

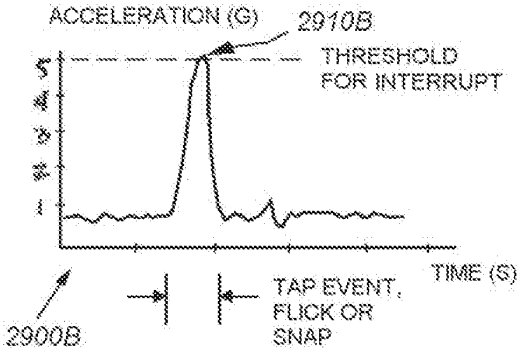


FIG. 29B

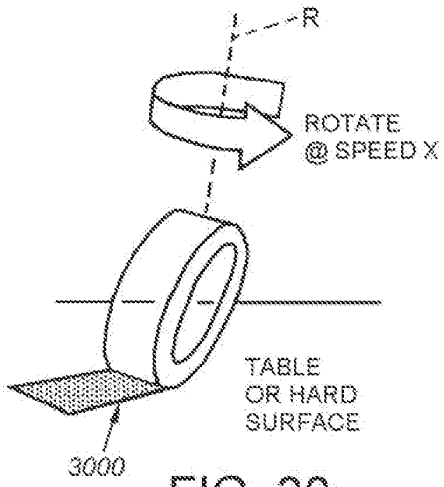


FIG. 30

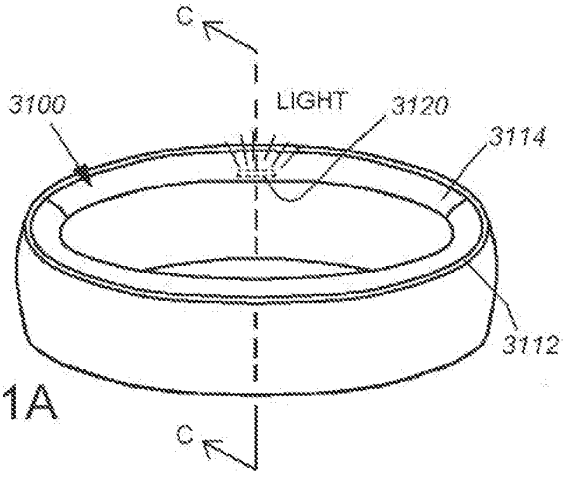


FIG. 31A

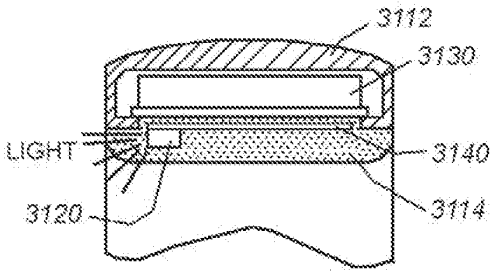


FIG. 31C

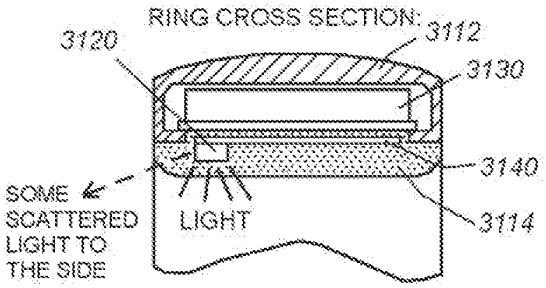


FIG. 31B

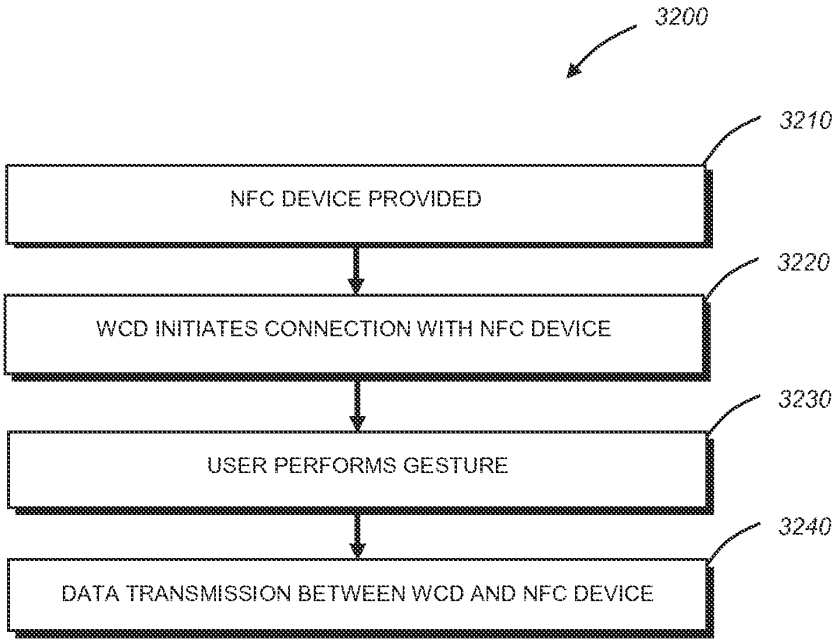

3200
3210
NFC DEVICE PROVIDED
3220
WCD INITIATES CONNECTION WITH NFC DEVICE
3230
USER PERFORMS GESTURE
3240
DATA TRANSMISSION BETWEEN WCD AND NFC DEVICE

FIG. 32

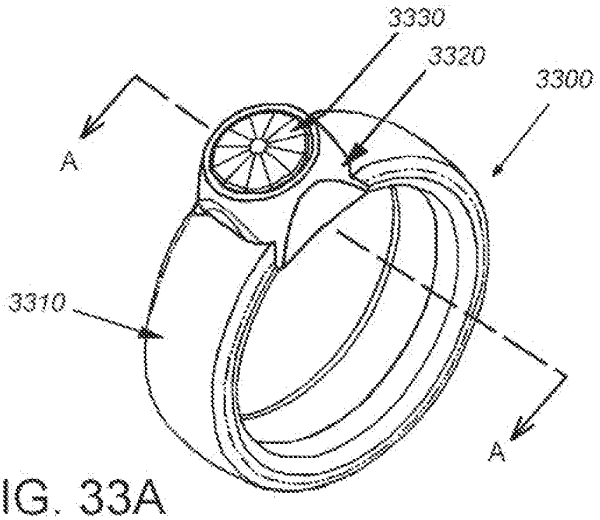


FIG. 33A

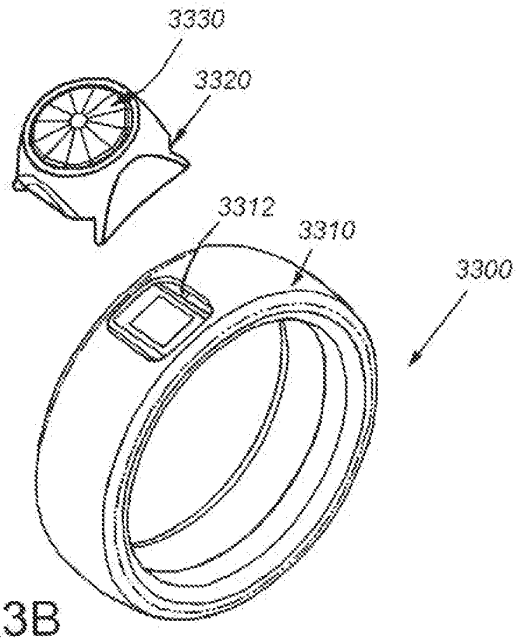


FIG. 33B

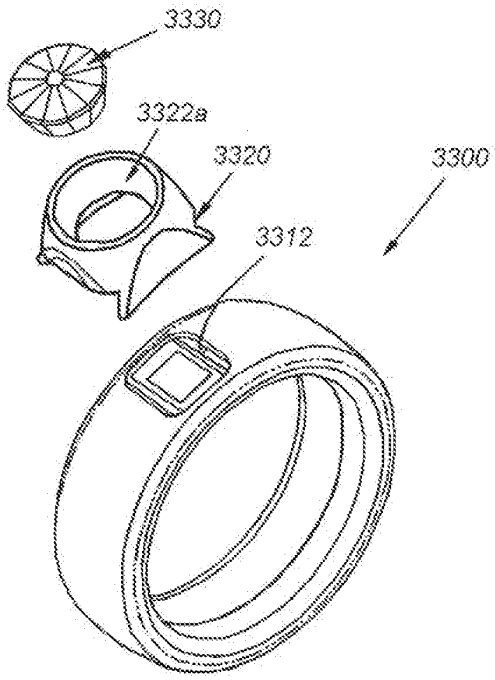


FIG. 33C

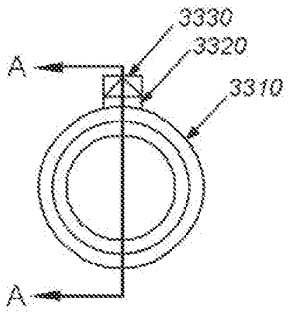


FIG. 33D

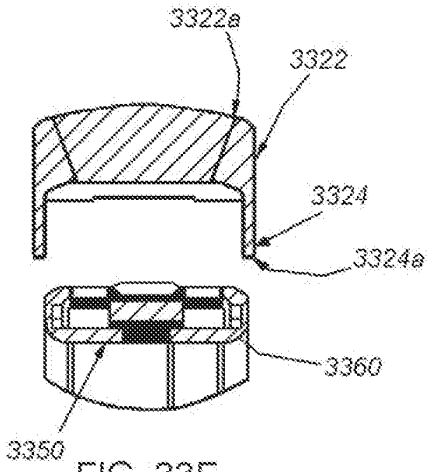


FIG. 33E

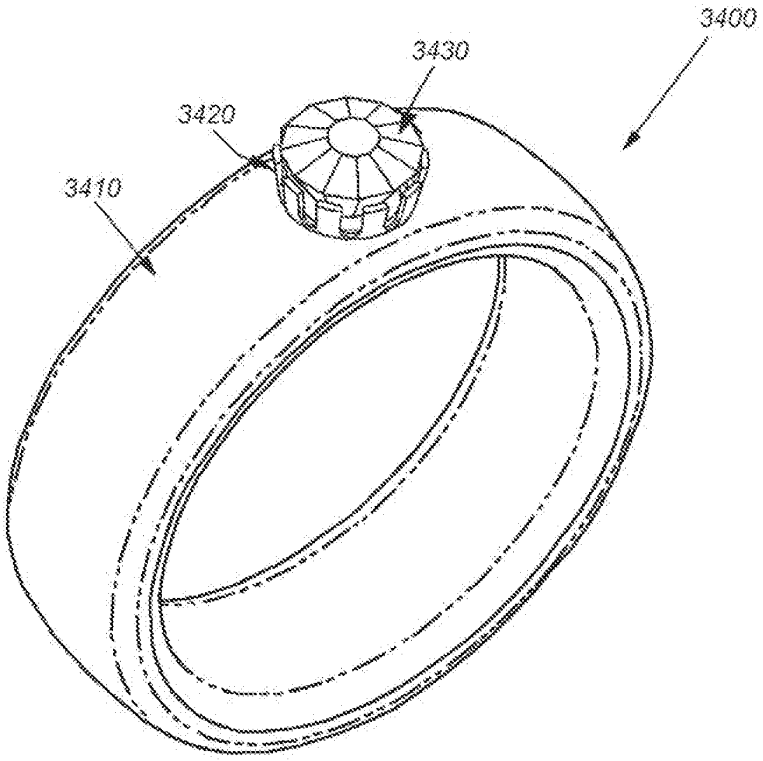


FIG. 34A

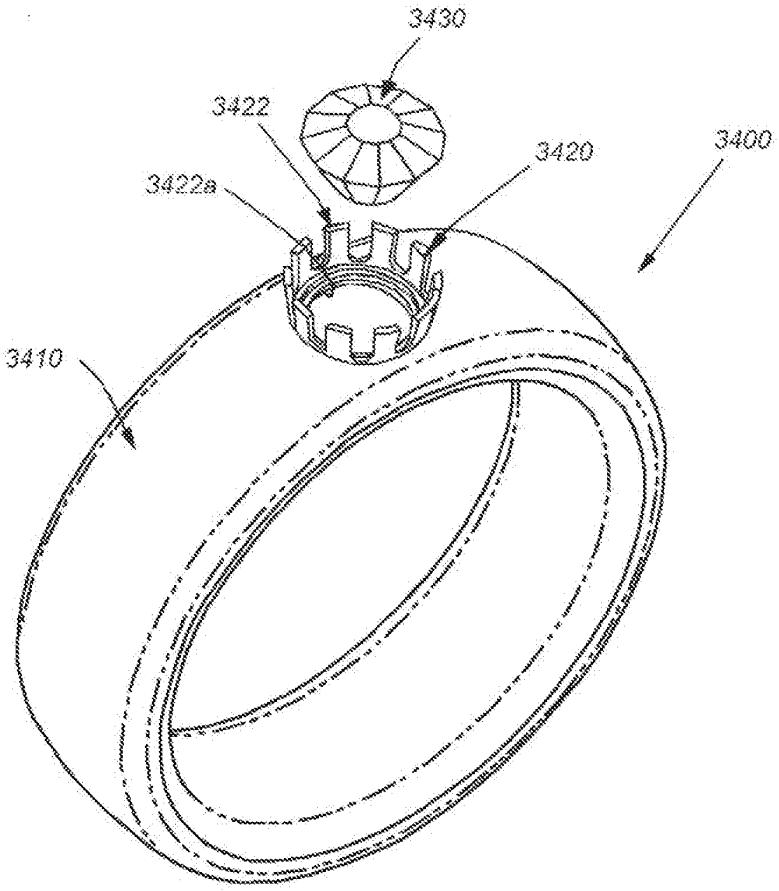


FIG. 34B

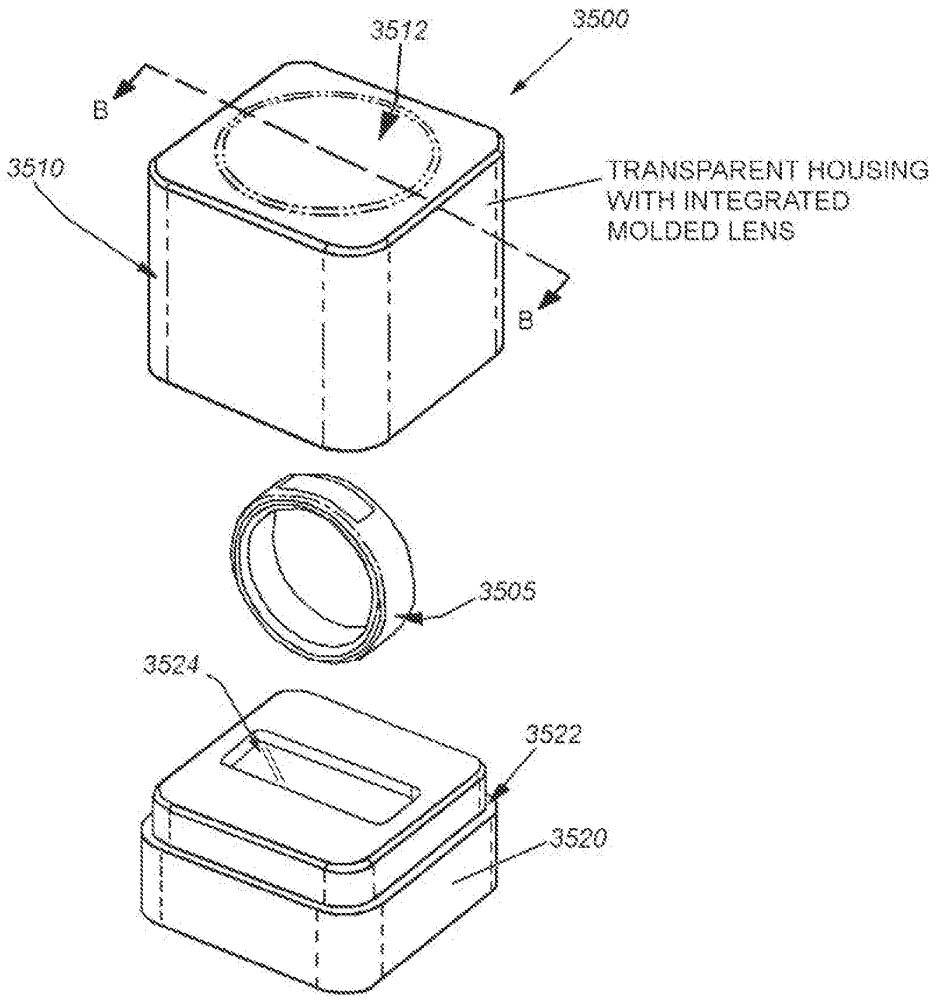

3512
3500
B
3510
TRANSPARENT HOUSING
WITH INTEGRATED
MOLDED LENS
B
3505
3524
3522
3520

FIG. 35A

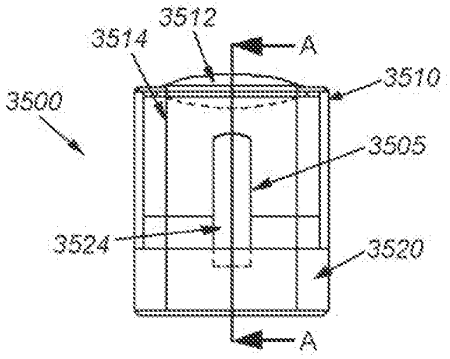


FIG. 35B

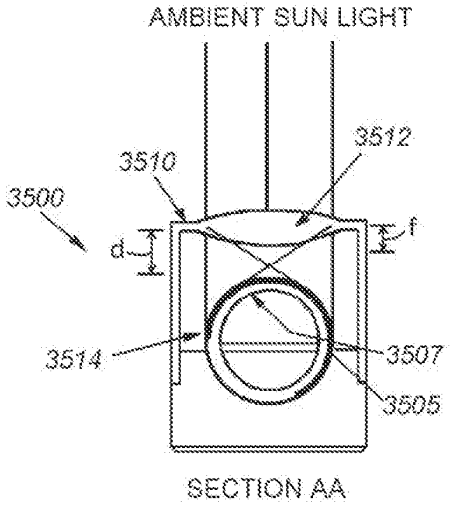


FIG. 35C

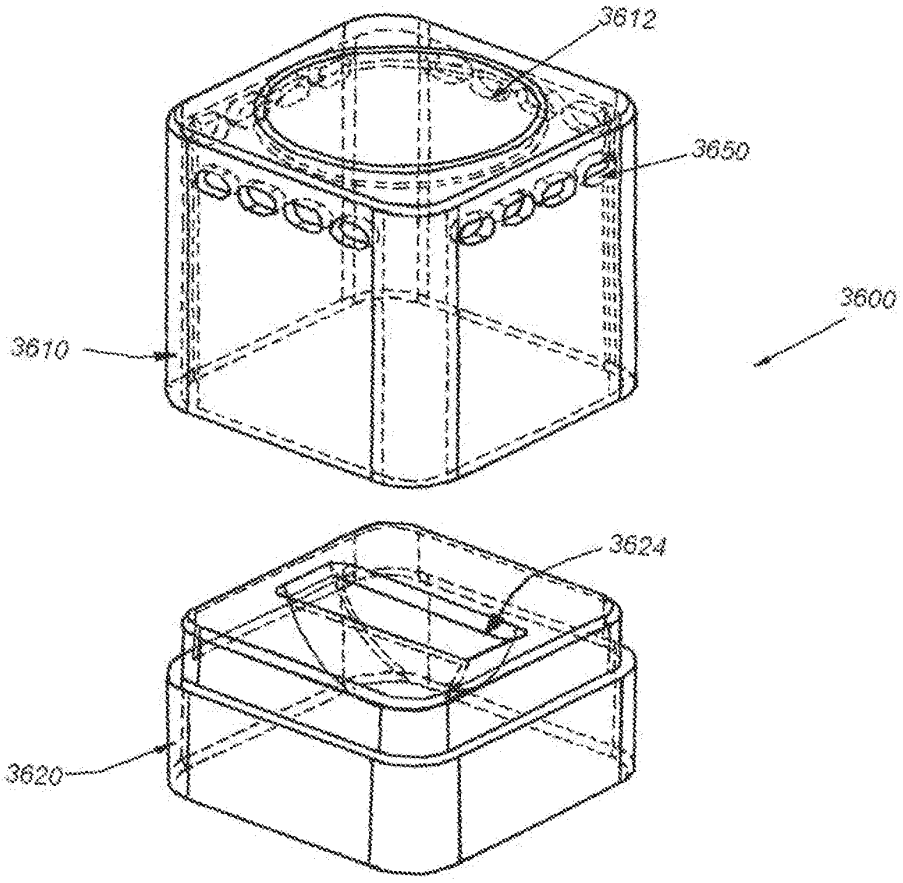


FIG. 36

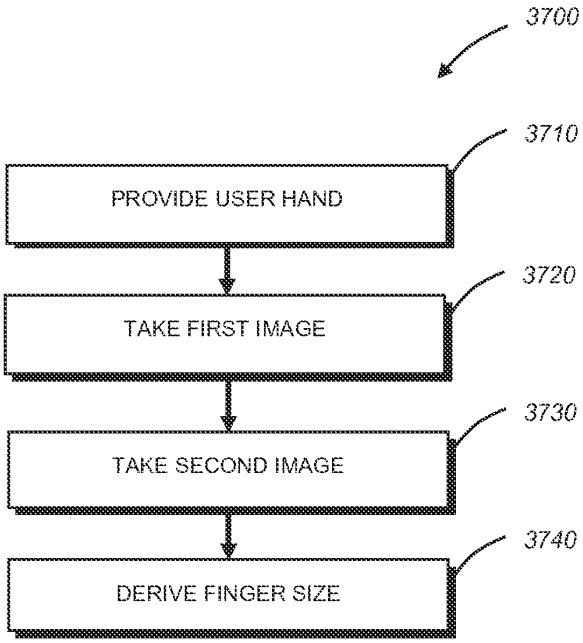

3700
3710
PROVIDE USER HAND
3720
TAKE FIRST IMAGE
3730
TAKE SECOND IMAGE
3740
DERIVE FINGER SIZE

FIG. 37

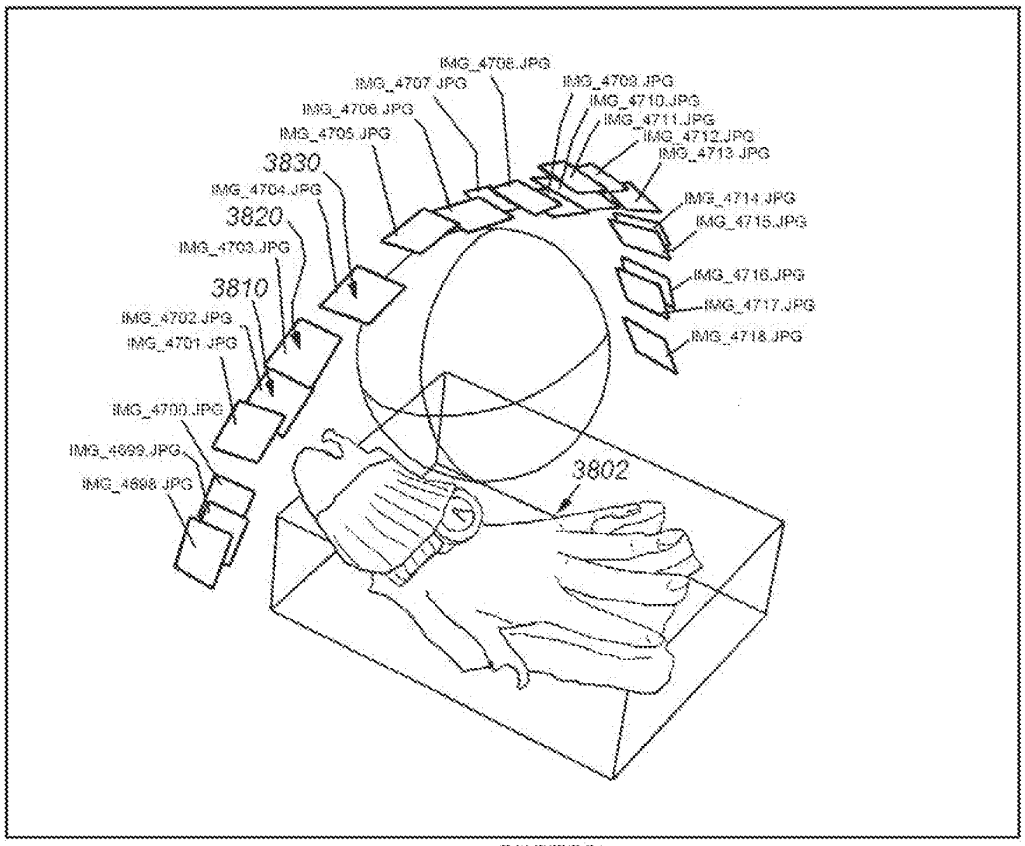

IMG_4706.JPG
IMG_4707.JPG
IMG_4708.JPG
IMG_4705.JPG
IMG_4709.JPG
IMG_4710.JPG
IMG_4711.JPG
IMG_4712.JPG
IMG_4713.JPG
3830
IMG_4704.JPG
3820
IMG_4703.JPG
3810
IMG_4702.JPG
IMG_4701.JPG
IMG_4700.JPG
IMG_4699.JPG
IMG_4698.JPG
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IMG_4716.JPG
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IMG_4718.JPG
3802
PHOTOS
IMG_4702.JPG
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IMG_4704.JPG
IMG_4705.JPG
IMG_4706.JPG
IMG_4707.JPG
IMG_4708.JPG
3812
3822
3832

FIG. 38

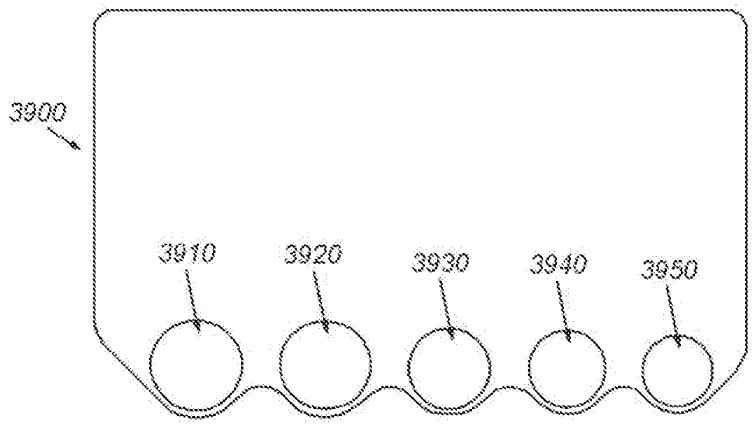


FIG. 39

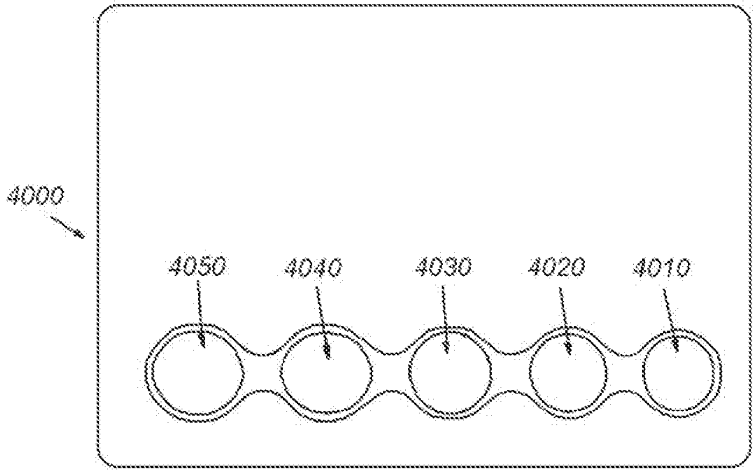


FIG. 40

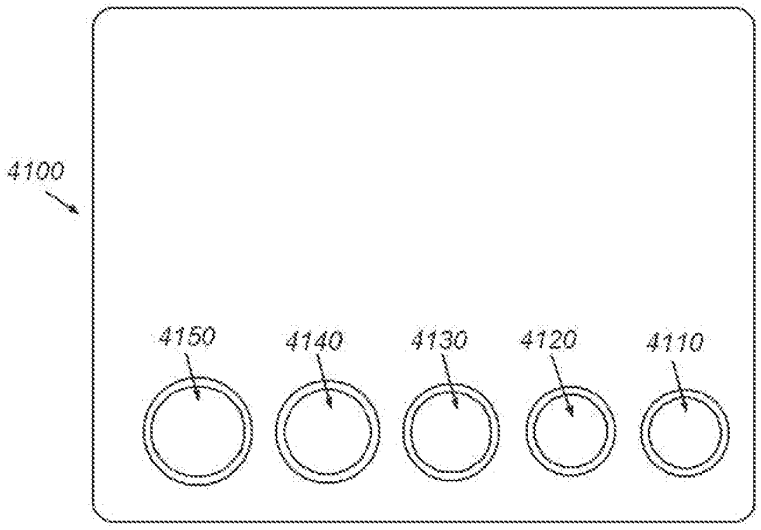


FIG. 41

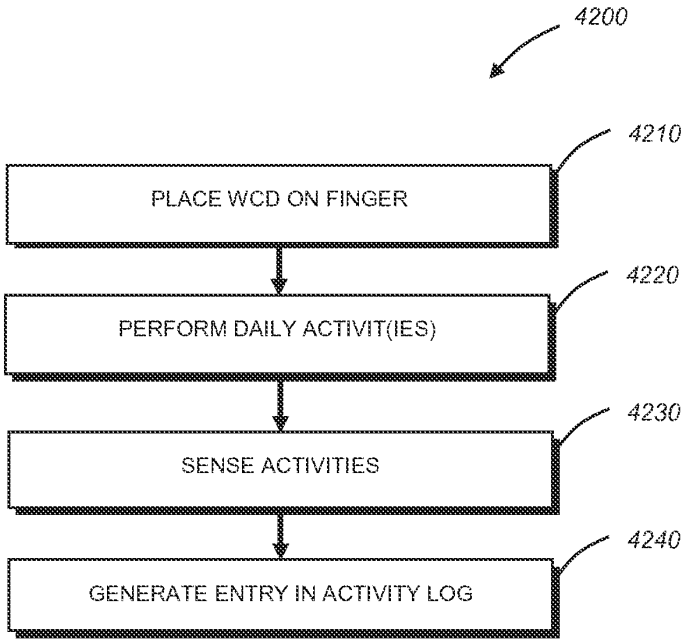

4200
4210
PLACE WCD ON FINGER
4220
PERFORM DAILY ACTIVIT(IES)
4230
SENSE ACTIVITIES
4240
GENERATE ENTRY IN ACTIVITY LOG

FIG. 42

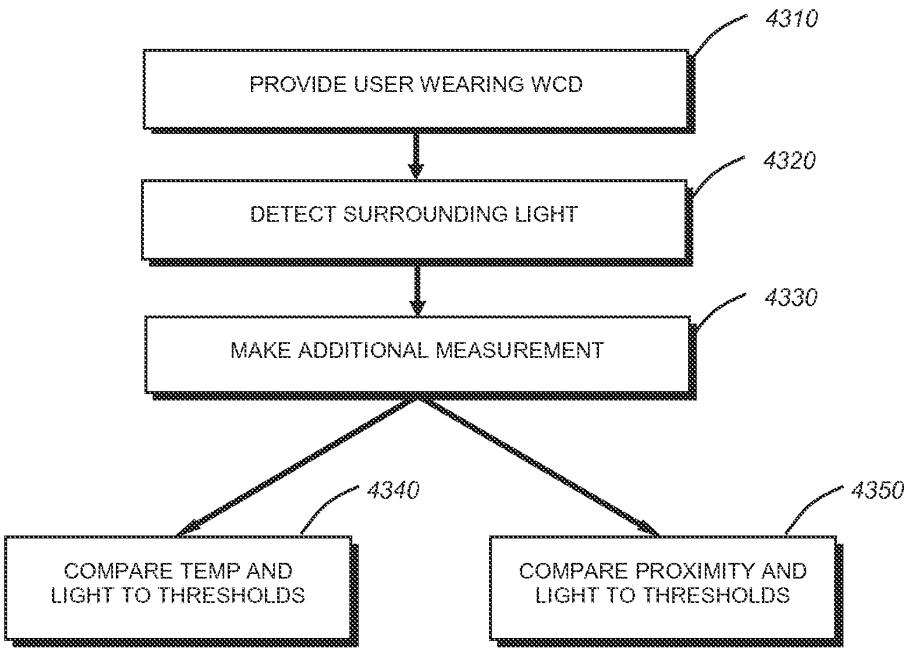

4310
PROVIDE USER WEARING WCD
4320
DETECT SURROUNDING LIGHT
4330
MAKE ADDITIONAL MEASUREMENT
4340
COMPARE TEMP AND LIGHT TO THRESHOLDS
4350
COMPARE PROXIMITY AND LIGHT TO THRESHOLDS

FIG. 43

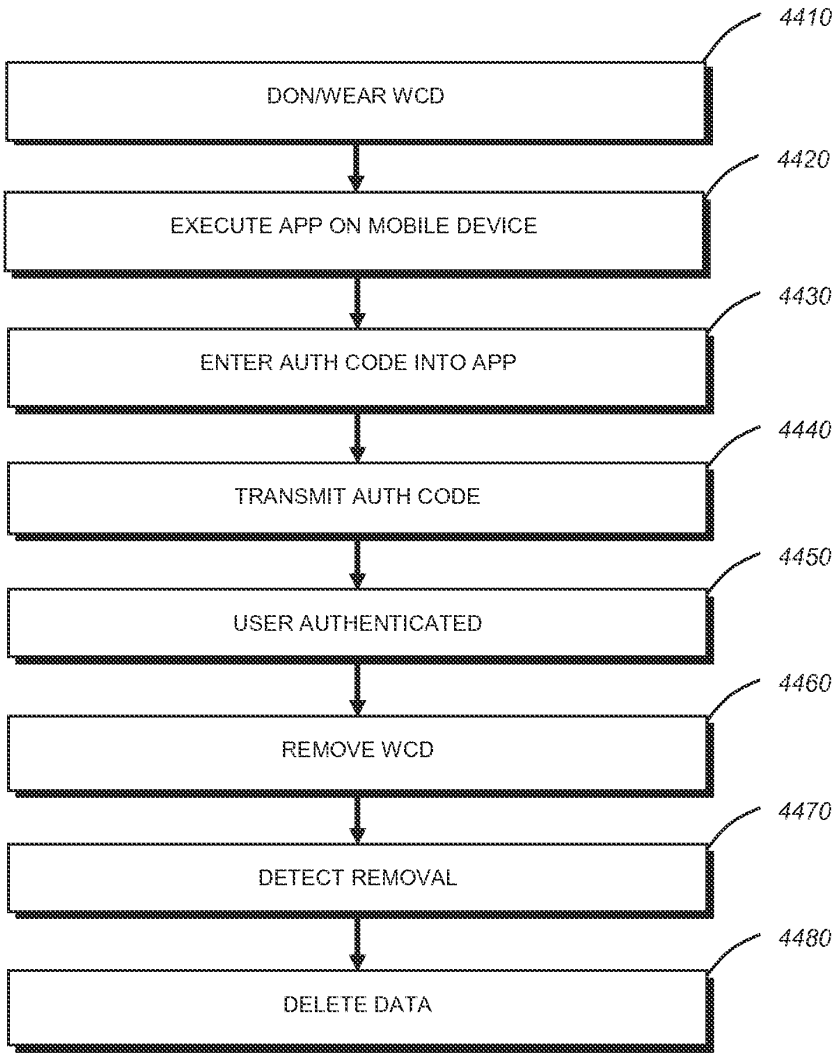

4410
DON/WEAR WCD
4420
EXECUTE APP ON MOBILE DEVICE
4430
ENTER AUTH CODE INTO APP
4440
TRANSMIT AUTH CODE
4450
USER AUTHENTICATED
4460
REMOVE WCD
4470
DETECT REMOVAL
4480
DELETE DATA

FIG. 44

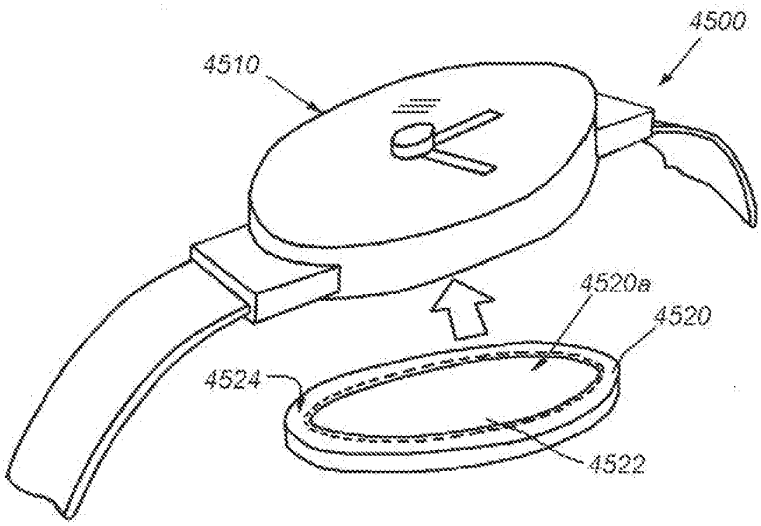


FIG. 45A

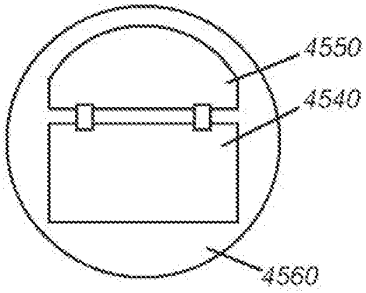


FIG. 45B

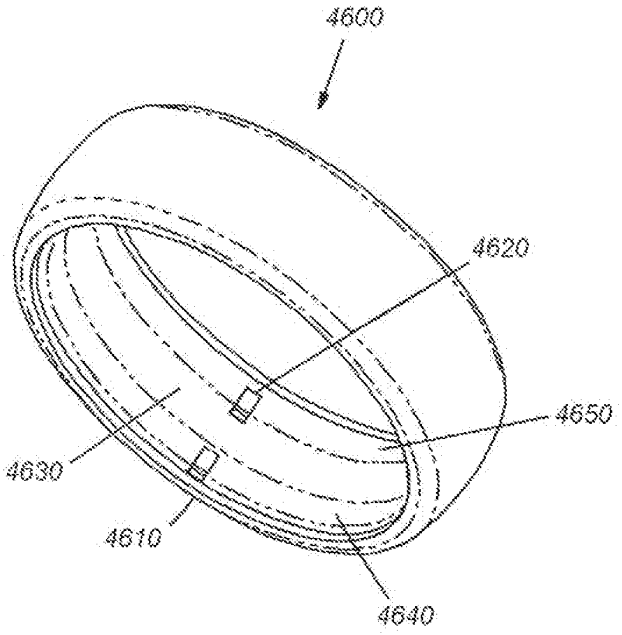


FIG. 46

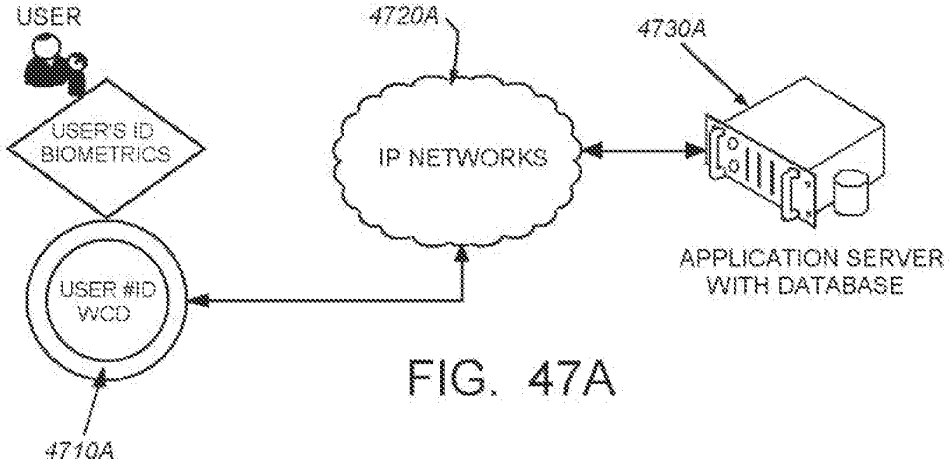


FIG. 47A

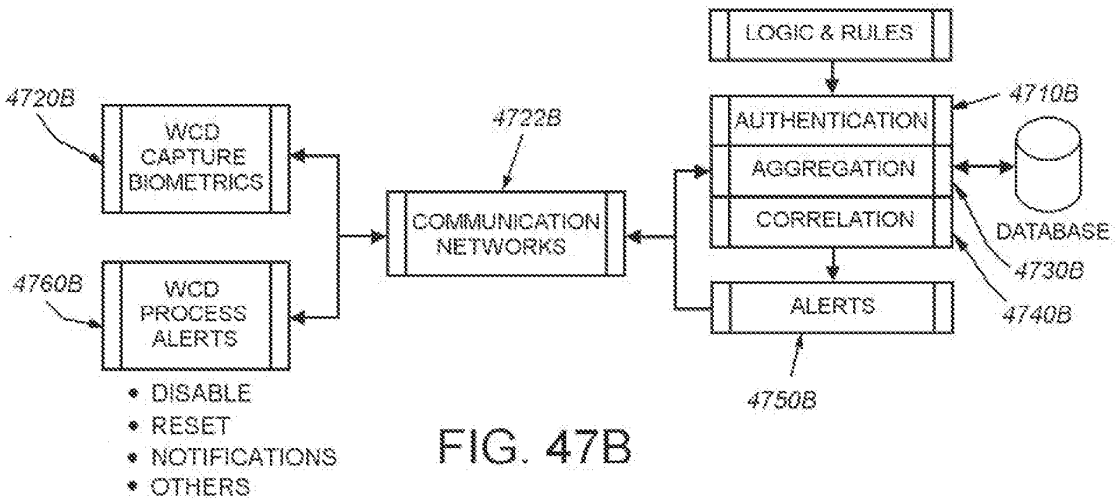


FIG. 47B

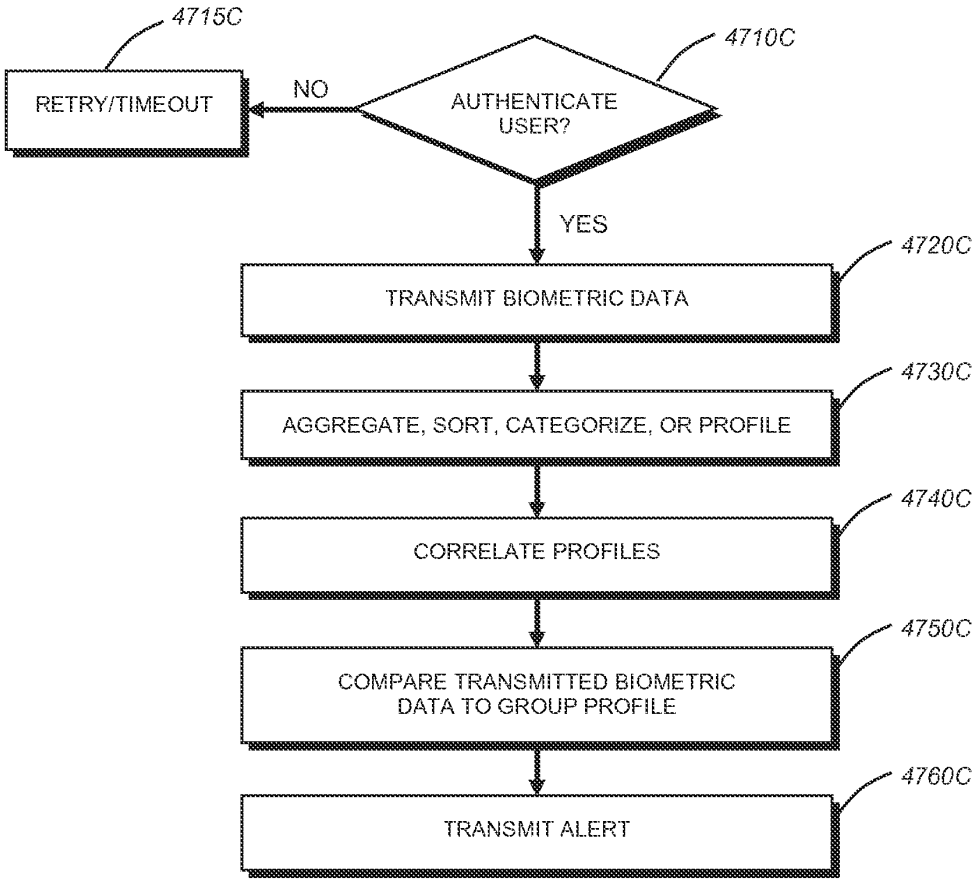

4715C
RETRY/TIMEOUT
NO
4710C
AUTHENTICATE USER?
YES
4720C
TRANSMIT BIOMETRIC DATA
4730C
AGGREGATE, SORT, CATEGORIZE, OR PROFILE
4740C
CORRELATE PROFILES
4750C
COMPARE TRANSMITTED BIOMETRIC DATA TO GROUP PROFILE
4760C
TRANSMIT ALERT

FIG. 47C

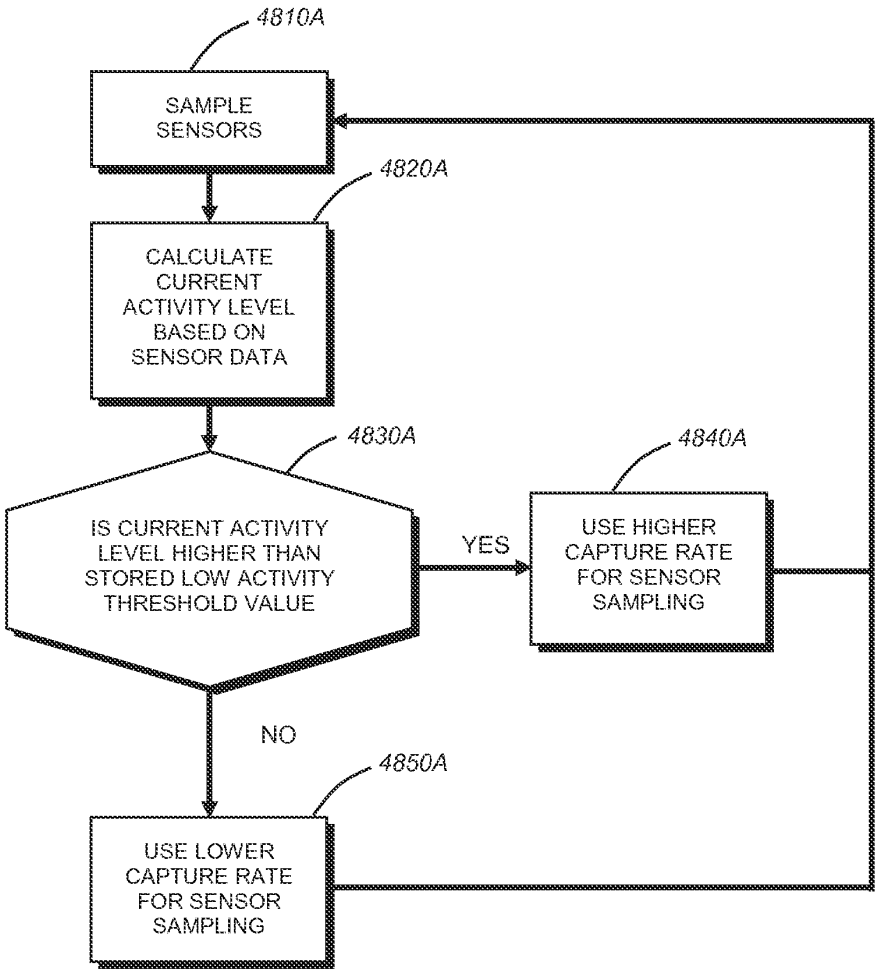

4810A
SAMPLE SENSORS
4820A
CALCULATE CURRENT ACTIVITY LEVEL BASED ON SENSOR DATA
4830A
IS CURRENT ACTIVITY LEVEL HIGHER THAN STORED LOW ACTIVITY THRESHOLD VALUE
YES
4840A
USE HIGHER CAPTURE RATE FOR SENSOR SAMPLING
NO
4850A
USE LOWER CAPTURE RATE FOR SENSOR SAMPLING

FIG. 48A

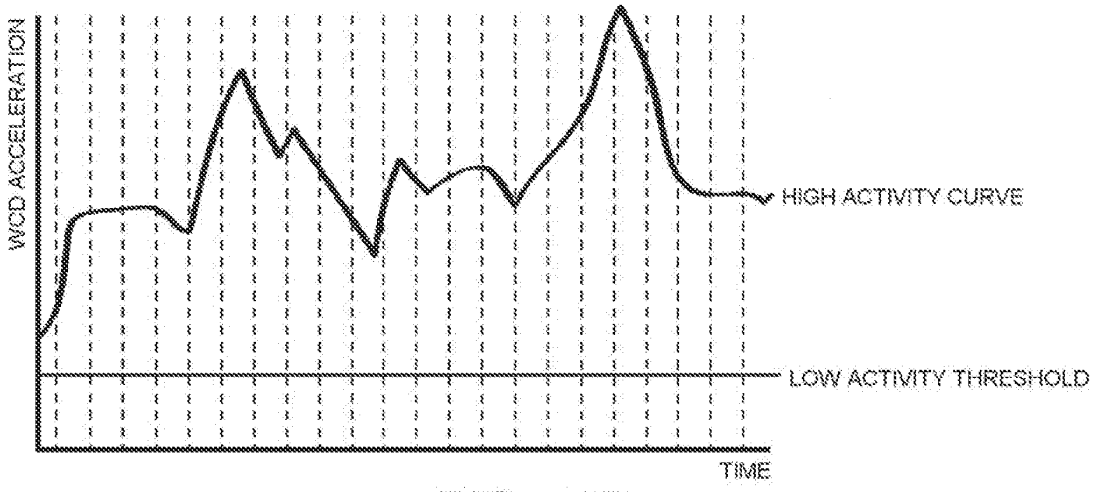


FIG. 48B

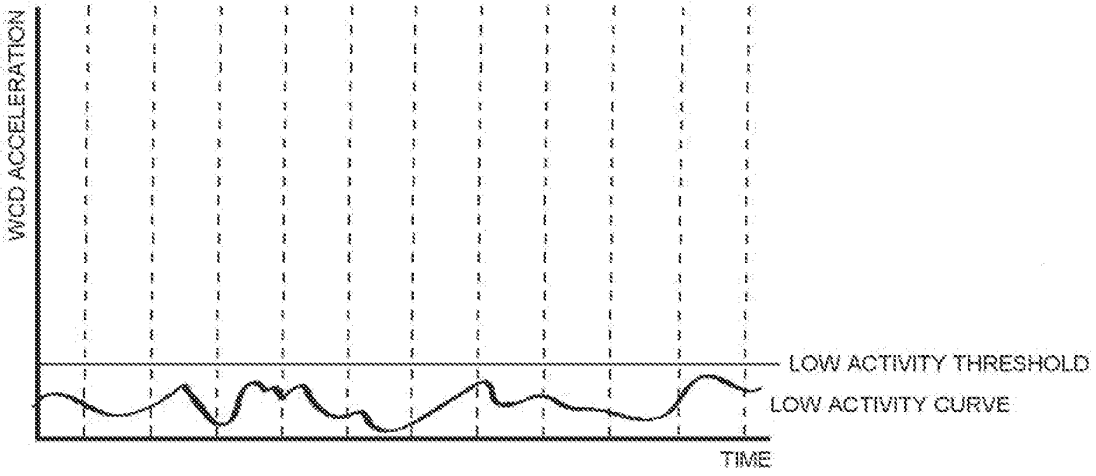


FIG. 48D

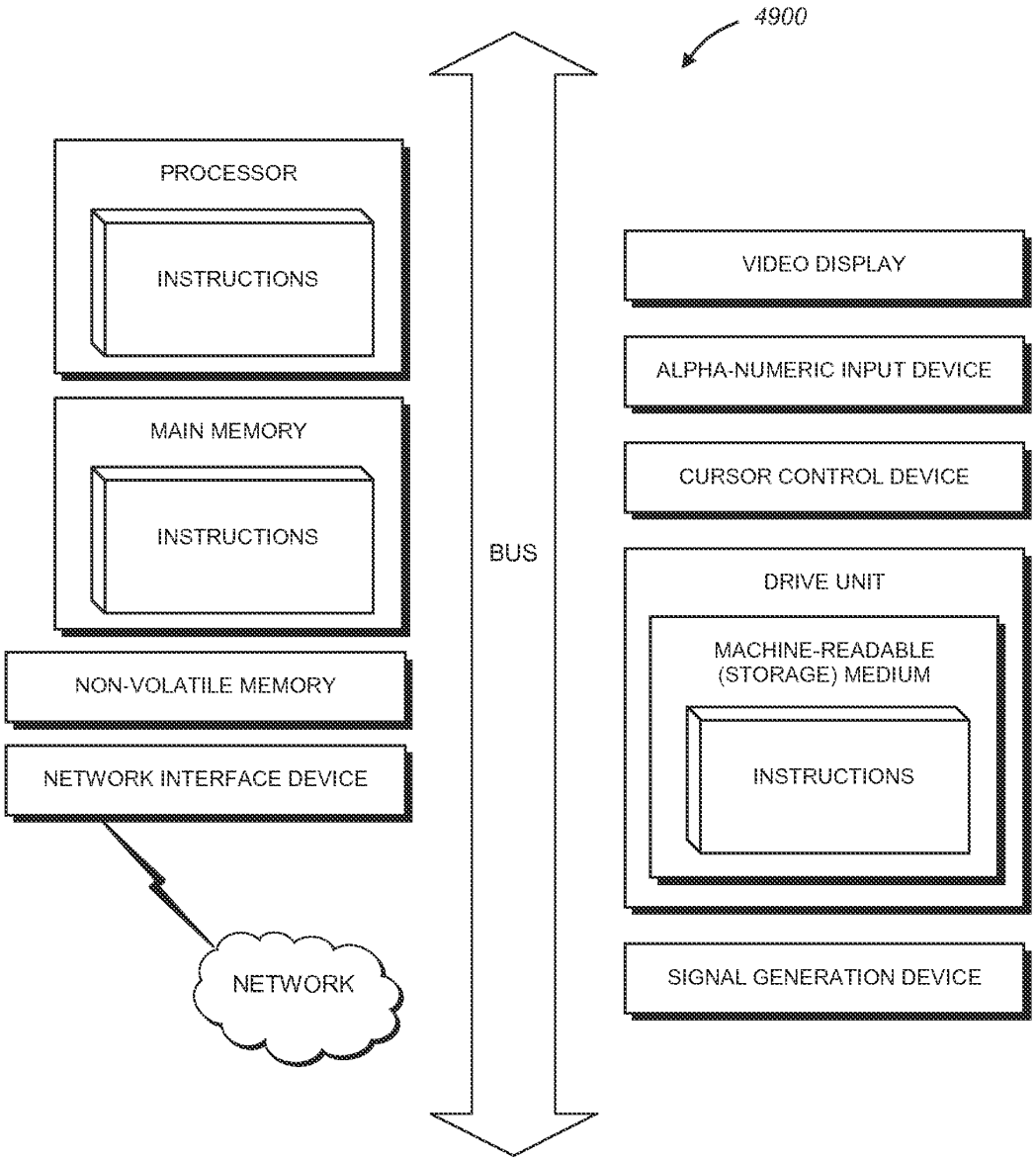

4900
PROCESSOR
INSTRUCTIONS
MAIN MEMORY
INSTRUCTIONS
NON-VOLATILE MEMORY
NETWORK INTERFACE DEVICE
NETWORK
BUS
VIDEO DISPLAY
ALPHA-NUMERIC INPUT DEVICE
CURSOR CONTROL DEVICE
DRIVE UNIT
MACHINE-READABLE (STORAGE) MEDIUM
INSTRUCTIONS
SIGNAL GENERATION DEVICE

FIG. 49

PATENT
Docket No.: 340/0002

UNITED STATES PATENT APPLICATION

of

Curt C. von Badinski
Michael J. Strasser
and
Peter Twiss

for a

WEARABLE COMPUTING DEVICE

Petitioner Samsung Ex-1004, 0607

WEARABLE COMPUTING DEVICE

RELATED APPLICATIONS

[0001] This application claims the benefit of United States Provisional Application Serial No. 62/006,835, filed June 2, 2014, entitled WEARABLE COMPUTING DEVICE and United States Provisional Application Serial No. 61/910,201, filed November 29, 2013, entitled FINGER RING DEVICE FOR ACTIVITY MONITORING OR FESTURAL INPUT, the entire disclosures of which is herein incorporated by reference.

FIELD OF THE INVENTION

[0002] This invention is in the field of wearable electronic devices.

BACKGROUND OF THE INVENTION

[0003] Wearable electronics are an emerging technology with many applications for the wearer. They can improve lifestyles, ease access to technology and help monitor activity within the wearer's body. However, many current wearable electronics are bulky and can be intrusive or interfere with a person's daily life. In this regard, the wearer may not be comfortable wearing the device for extended periods of time.

SUMMARY OF THE INVENTION

[0004] This invention overcomes the disadvantages of the prior art by providing a wearable computing device (WCD) in the shape of a ring. The wearable computing device can be worn for extended periods of time and can take many measurements and perform various functions because of its form factor and position on the finger of a user.

[0005] One aspect of the disclosure provides a wearable computing device, comprising: an interior wall; an exterior wall; a flexible printed circuit board disposed between the interior wall and the exterior wall; at least one component disposed on the flexible printed circuit board; and wherein at least one of the interior wall and the exterior

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wall defines a window that facilitates at least one of data transmission, battery recharge, and status indication.

[0006] In one example, the window comprises an internal window defined by the interior wall.

[0007] In one example, the window comprises an exterior window defined by the exterior wall.

[0008] In one example, the window comprises a plurality of exterior windows defined by the exterior wall.

[0009] In one example, the plurality of exterior windows comprises a first exterior window and a second exterior window, wherein the first exterior window facilities battery charging and the second exterior window facilities data transmission.

[0010] In one example, at least one concentrated photovoltaic cell, an antenna, and at least one LED are accessible via the window.

[0011] Another aspect of the disclosure provides a wearable computing device, comprising: an internal housing portion configured to be disposed near a finger of a user; a flexible printed circuit board arranged around a portion of a circumference of an interior surface of the internal housing; at least one component disposed on the flexible printed circuit board; and an external housing portion configured to seal the at least one component and the printed circuit board in an internal space defined by the interior surface of the internal housing.

[0012] In one example, the external housing portion comprises a substantially transparent external potting.

[0013] In one example, the at least one component comprises at least one LED configured to emit at least one of visible light, infrared radiation, and ultraviolet radiation through the external potting.

[0014] In one example, the at least one component comprises a concentrated photovoltaic cell configured to receive concentrated light through the transparent external potting.

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[0015] In one example, the flexible printed circuit board includes a plurality of stiffener elements configured to engage with a corresponding plurality of flanges disposed on the internal housing portion.

[0016] Another aspect of the disclosure provides a wearable computing device, comprising: an external housing portion; a flexible printed circuit board arranged around a portion of a circumference of an interior surface of the external housing; at least one component disposed on the flexible printed circuit board; and an internal housing portion configured to seal the at least one component and the printed circuit board in an internal space defined by the interior surface of the external housing.

[0017] In one example, the internal housing portion comprises a substantially transparent internal potting.

[0018] In one example, the at least one component comprises at least one LED configured to emit at least one of visible light, infrared radiation, and ultraviolet radiation through the internal potting.

[0019] In one example, the at least one component comprises a concentrated photovoltaic cell configured to receive concentrated light through the transparent internal potting.

[0020] In one example, the flexible printed circuit board includes a plurality of stiffener elements configured to engage with a corresponding plurality of flanges disposed on the external housing portion.

[0021] Another aspect of the disclosure provides a system, comprising: a wearable computing device, including a housing and a photovoltaic element disposed at least partially within the housing; and a base assembly, the base assembly including a concentrated light source directed at the photovoltaic element.

[0022] In one example, the wearable computing device includes at least one ferrous element disposed within the housing, and wherein the base assembly includes at least one magnetic element disposed therein.

[0023] In one example, the concentrated light source is arranged circumferentially around the wearable computing device when the wearable computing device is engaged with the base assembly.

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[0024] In one example, the concentrated light source comprises at least one of a laser diode and a light emitting diode (LED).

[0025] In one example, a housing of the WCD defines an opening through which the WCD is configured to receive concentrated light.

[0026] In one example, the base assembly comprises an optical element for focusing concentrated light emitted from the concentrated light source.

[0027] In one example, the optical element comprises a lens and is selected from the group consisting of concave, convex, plano-concave, plano-convex.

[0028] In one example, the WCD comprises at least one transparent potting configured to allow concentrated light to pass therethrough.

[0029] In one example, the WCD is ring-shaped and the base assembly comprises at least one post configured to engaged with a finger space of the WCD.

[0030] In one example, the photovoltaic cell comprises a plurality of photovoltaic cells.

[0031] Another aspect of the disclosure provides an enclosure for a wearable computing device, the enclosure comprising: a base defining a receptacle for receiving the wearable computing; a lid configured to engage with the base to substantially enclose the wearable computing device, the lid having an optical element configured to direct incident electromagnetic radiation to a photovoltaic cell disposed on the wearable computing device to allow charging thereof.

[0032] In one example, the lid includes a plurality of vent holes that prevent overheating within the enclosure.

[0033] In one example, the optical element comprises a lens.

[0034] In one example, the lens has a focal length and wherein a distance between a central portion of the lens and the photovoltaic cell is greater than or less than the focal length.

[0035] Another aspect of the disclosure provides a timepiece system, comprising: a timepiece having a substantially planar under surface; and a timepiece computing device adhered to the planar under surface, the timepiece computing device being substantially cylindrical and comprising: a processor; a memory; and at least one sensor.

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[0036] Another aspect of the disclosure provides a wearable computing device system, comprising: a wearable computing device; an attachment frame coupled to the wearable computing device; and an optical element removably coupled to the attachment frame, wherein the optical element is configured to direct electromagnetic radiation to a photovoltaic cell disposed on a surface of the wearable computing device to allow for charging of the wearable computing device.

[0037] In one example, the attachment frame is removably coupled to the wearable computing device.

[0038] In one example, the attachment frame engages with an inward-facing surface of the wearable computing device.

[0039] Another aspect of the disclosure provides a method of identifying an authorized user of a wearable computing device, comprising: illuminating a portion of a skin surface of the user; imaging the portion of the skin surface of the user to generate at least one first image; generating a reference capillary map corresponding to the user based at least in part on the at least one image.

[0040] In one example, the method further includes rotating the wearable computing device during the illuminating and imaging steps.

[0041] In one example, the method further includes imaging the portion of the skin surface of the user to generate at least one second image; and comparing the at least one second image to the reference capillary map in order to authenticate the user.

[0042] Another aspect of the disclosure provides a method of navigating, comprising: gesturing in a first direction while wearing a wearable computing device; comparing the first direction to a predetermined direction in a predetermined set of directions; providing feedback based on the comparison of the first direction of the predetermined direction.

[0043] In one example, the gesture comprises pointing a finger and the first direction comprises a first heading.

[0044] Another aspect of the disclosure provides a method of regulating temperature, comprising: measuring a skin temperature of a user via a first temperature sensor; measuring an ambient temperature via a second temperature sensor; comparing

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the skin temperature to a predetermined threshold temperature; and adjusting the ambient temperature based in part on the comparison.

[0045] In one example, measuring the skin temperature comprises measuring the skin temperature via a first temperature sensor disposed at an inward facing surface of a wearable computing device.

[0046] In one example, measuring the ambient temperature comprises measuring the ambient temperature via a second temperature sensor disposed at an outward facing surface of the wearable computing device.

[0047] Another aspect of the disclosure provides a method for controlling appliances, comprising: identifying a position of a first appliance in a room; gesturing a first gesture in a direction of the first appliance; identifying the direction of the first direction via a wearable computing device; issuing a controlling command to the first appliance based in part on the identified direction of the gesture.

[0048] Another aspect of the disclosure provides a method of generating an alert, comprising: authenticating a first wearer of a first wearable computing device as a first authenticated user; transmitting first biometric data associated with the first wearer; associating the first biometric data with a first profile associated with the first wearer of the first wearable computing device; comparing the first biometric data with a group profile comprising aggregated biometric data from a plurality of distinct wearers of a plurality of distinct wearable computing devices; and generating an alert if the first biometric data falls outside of a predetermined threshold set by the aggregated biometric data.

[0049] In one example, the biometric data comprises at least one of heart rate; ECG profile; blood sugar, and blood pressure.

[0050] In one example, the plurality of distinct wearers share a common trait, resulting in their aggregation into the group profile.

[0051] In one example, the common trait comprises at least one of: age, gender, profession, and location.

[0052] Another aspect of the disclosure provides a method of determine a sampling rate of a wearable computing device, comprising: determining an activity level

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of a wearer of a wearable computing device based at least in part on data from at least one sensor disposed onboard the wearable computing device; comparing the activity level to a predetermined activity threshold; and increasing a first sensor sampling rate if the activity level is above a predetermined activity threshold.

[0053] In one example, the method further includes decreasing the first sensor sampling rate if the activity level is below a predetermined activity threshold.

[0054] In one example, the predetermined activity threshold comprises an acceleration measurement.

BRIEF DESCRIPTION OF THE DRAWINGS

[0055] The invention description below refers to the accompanying drawings, of which:

[0056] FIG. 1A is a perspective view of a WCD illustrating an exterior window in accordance with some embodiments;

[0057] FIG. 1B is a perspective view of the WCD of FIG. 1A illustrating an interior window in accordance with some embodiments;

[0058] FIG. 1C is a perspective view of an alternative WCD design of the ring of FIG. 1A in accordance with some embodiments;

[0059] FIG. 2 is an abstract functional diagram illustrating example components within the WCD in accordance with some embodiments;

[0060] FIG. 3A is a view of an exterior window of a WCD with example components exposed in accordance with some embodiments;

[0061] FIG. 3B is a view of an interior window of a WCD with example components exposed in accordance with some embodiments;

[0062] FIG. 3C is a view of the exterior windows of an alternative WCD with example components exposed in accordance with some embodiments;

[0063] FIG. 4 is an exploded view of a WCD illustrating a battery and a flexible circuit which are configured to fit inside the housing of the WCD in accordance with some embodiments;

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[0064] FIG. 5 is a perspective view of the flexible circuit of FIG. 4 in accordance with some embodiments;

[0065] FIG. 6 is an exploded view of a WCD with an alternative charging mechanism in accordance with some embodiments;

[0066] FIG. 7 is a perspective view of an alternative design of a WCD in accordance with some embodiments;

[0067] FIG. 8 is an exploded view of the WCD of FIG. 7 illustrating another alternative charging mechanism in accordance with some embodiments;

[0068] FIG. 9A is a perspective view of a charging device for the ring station in accordance with some embodiments;

[0069] FIG. 9B is an abstract diagram illustrating a partial structure of the charging station of FIG. 9A in accordance with some embodiments;

[0070] FIG. 10 is an example screenshot illustrating a user interface of a mobile application coupled to the WCD and displaying fitness monitoring readings in accordance with some embodiments;

[0071] FIG. 11 is an example screenshot illustrating a user interface of a mobile application coupled to the WCD and displaying sensor readings (e.g., for calibration purposes) in accordance with some embodiments;

[0072] Fig. 12A is a perspective view of a wearable computing device (WCD) according to one or more aspects of the disclosure;

[0073] Fig. 12B is a side view of a WCD according to one or more aspects of the disclosure;

[0074] Fig. 12C is a front view of the WCD according to one or more aspects of the disclosure;

[0075] Fig. 12D is a cross section of the WCD along the line A-A of Fig. 12C;

[0076] Fig. 12E is a perspective view of the internal housing without external potting;

[0077] Fig. 12F is a perspective view of the internal housing with a portion of the external potting removed and showing one or more components and printed circuit board (PCB);

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[0078] Fig. 13 is a cross section of a WCD according to another aspect of the disclosure;

[0079] Fig. 14A is a cross section of a WCD according to another aspect of the disclosure;

[0080] Fig. 14B is a perspective view of the PCB and stiffener element of Fig. 14A;

[0081] Fig. 14C is a perspective view of the PCB and stiffener element of Fig. 14A;

[0082] Fig. 14D shows a cross section of the WCD at a point in time when the PCB is being inserted into the internal space and prior to the application of potting;

[0083] Fig. 14E is a cross section of the WCD of after a potting material has been applied subsequent to the WCD of Fig. 14D;

[0084] Fig. 15A depicts a perspective view of a WCD according to another aspect of the disclosure;

[0085] Fig. 15B is an exploded view of the WCD of Fig. 15A;

[0086] Fig. 16A is an exploded view of a housing and a PCB of a WCD according to one or more aspects of the disclosure;

[0087] Fig. 16B is a cross section of Fig. 16A along line B-B;

[0088] Fig. 16C is a perspective view of the WCD with potting material;

[0089]

[0090] Fig. 17A depicts a cross section of a WCD employing charging by concentrated light source according to one or more aspects of the disclosure;

[0091] Fig. 17B depicts a cross section of a WCD employing charging by concentrated light source according to another aspect of the disclosure;

[0092] Fig. 17C is a perspective view of a base assembly and WCD 700 according to one or more aspects of the disclosure;

[0093] Fig. 17D depicts a perspective view of internal components of the base assembly 750 and WCD 700 according to another aspect of the disclosure;

[0094] Figs. 17E-F depict other CPV configurations according to one or more aspects of the disclosure;

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[0095] Fig. 17G is perspective view of a WCD and base assembly with a 1x3 CPV arrangement;

[0096] Fig. 18A depicts a cross section of a WCD 800 employing charging by concentrated light source according to another of the disclosure;

[0097] Fig. 18B depicts a cross section of a WCD employing charging by concentrated light source according to another of the disclosure;

[0098] Fig. 19A depicts a cross section of a WCD employing charging by concentrated light source according to another of the disclosure;

[0099] Fig. 19B depicts a cross section of a WCD employing charging by concentrated light source according to another of the disclosure;

[00100] Fig. 19C depicts a schematic diagram of magnets that can be used in a WCD and/or base assembly according to one or more aspects of the disclosure;

[00101] Fig. 19D depicts a schematic diagram of magnets that can be used in a WCD and/or base assembly according to one or more aspects of the disclosure

[00102] Fig. 19E is a perspective view of a WCD and a base assembly according to one or more aspects of the disclosure;

[00103] Fig. 20A is a cross section of a WCD engaged with a base assembly 1050 according to one or more aspects of the disclosure;

[00104] Fig. 20B is a perspective view of a PCB 1040b with a CPV 1030b and ferrous element 1020b configuration according to one or more aspects of the disclosure;

[00105] Fig. 20C is a perspective view of a PCB with a CPV 1030c and ferrous element 1020c configuration according to one or more aspects of the disclosure;

[00106] Fig. 20D is a perspective view of a magnet and a concentrated light source 1070d according to one or more aspects of the disclosure;

[00107] Fig. 21A is a schematic view of a WCD showing components used for identifying the wearer of the WCD;

[00108] Figs. 21B-C are perspective views of a skin surface according to one or more aspects of the disclosure;

[00109] Fig. 22A is a perspective view of a user employing ECG monitoring according to one or more aspects of the disclosure;

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[00110] Fig. 22B is a view of a human with an electric pathway though his body according to one or more aspects of the disclosure;

[00111] Fig. 22C is a perspective view of a WCD that can employ ECG monitoring according to one aspect of the disclosure;

[00112] Fig. 23A is a perspective view of the hand of a user in various positions employing the navigational features of the WCD;

[00113] Fig. 23B is a flow chart depicting a method of providing feedback to a user according to one or more aspects of the disclosure;

[00114] Fig. 24A is a schematic diagram of a system 1400 for controlling an environment of a user according to one or more aspects of the disclosure;

[00115] Fig. 24B is a side view of a WCD showing one or more temperatures sensors according to one or more aspects of the disclosure

[00116] Fig. 24C is a system diagram of a system for controlling home appliances according to one or more aspects of the disclosure;

[00117] Fig. 24D is a flow chart depicting a method of controlling home appliances according to one or more aspects of the disclosure;

[00118] Fig. 25 is a perspective view of the hand of a user employing a two-factor authentication technique according to one or more aspects of the disclosure;

[00119] Fig. 26A is a schematic view of a charging apparatus for charging the WCD according to one or more aspects of the disclosure;

[00120] Fig. 26B shows a WCD including an RF antenna and charging circuitry;

[00121] Fig. 26C is a block diagram of the charging apparatus according to one aspect of the disclosure;

[00122] Fig. 26D is a schematic view of the charging apparatus of Fig. 26A and the WCD of Fig. 26B according to one or more aspects of the disclosure;

[00123] Fig. 27A is a pictorial diagram and Fig. 27B is a block diagram of a WCD employing flash storage according to one or more aspects of the disclosure;

[00124] Fig. 28A is a schematic diagram of one or more WCDs performing proximity functions according to one or more aspects of the disclosure;

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[00125] Fig. 28B is a schematic diagram of one or more WCDs performing proximity functions according to one or more aspects of the disclosure;

[00126] Fig. 29A is a flow chart depicting a method of initiating gesture input according to one or more aspects of the disclosure;

[00127] Fig. 29B is a chart showing acceleration vs. time as measured by the accelerometer of the WCD;

[00128] Fig. 30 is a perspective view of a WCD 2000 employing a reset function;

[00129] Fig. 31A is a perspective view of a WCD including an LED indicator according to one or more aspects of the disclosure;

[00130] Figs. 31B and 31C are cross sections along line C-C of a WCD employing an LED indicator according to one or more aspects of the disclosure;

[00131] Fig. 32 is flow chart depicting a method of communicating with a near field communication (NFC) device according to one or more aspects of the disclosure;

[00132] Fig. 33A depicts a perspective view of a WCD assembly according to one or more aspects of the disclosure;

[00133] Figs. 33B-D depict exploded views of the WCD assembly of Fig. 33A;

[00134] Fig. 33E depicts a cross sectional view of the WCD assembly along A-A;

[00135] Figs. 34A-B depict a WCD assembly according to one or more aspects of the disclosure;

[00136] Fig. 35A depicts an enclosure or case for storing a WCD according to one or more aspects of the disclosure;

[00137] Fig. 35B is a cross sectional view of the assembled enclosure of Fig. 35A along the line B-B;

[00138] Fig. 35C depicts a cross sectional view of the assembled enclosure of Fig. 35B along line A-A;

[00139] Fig. 36 depicts an enclosure including air vents according to one or more aspects of the disclosure;

[00140] Fig. 37 depicts a method of sizing a finger according to one or more aspects of the disclosure;

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[00141] Fig. 38 is a pictorial diagram showing a plurality of image perspectives of a user's hand;

[00142] Fig. 39 depicts a sizing tool for sizing the finger of a user;

[00143] Fig. 40 depicts a sizing tool for sizing the finger of a user according to an alternate example;

[00144] Fig. 41 depicts yet another alternate example of a sizing tool for sizing the finger of a user;

[00145] Fig. 42 depicts a method of monitoring activity according to one or more aspects of the disclosure;

[00146] Fig. 43 depicts a method of determining whether a user is wearing gloves according to one or more aspects of the disclosure;

[00147] Fig. 44 depicts a method of securing data onboard the WCD according to one or more aspects of the disclosure;

[00148] Fig. 45A is a timepiece system according to one or more aspects of the disclosure;

[00149] Fig 45B is a bottom view of the TCD;

[00150] Fig. 46 depicts a WCD with a pair of LED indicators disposed at an inward-facing portion of the WCD;

[00151] Fig. 47A is a system for generating and managing alerts according to one or more aspects of the disclosure;

[00152] Fig. 47B depicts a block process diagram for generating and managing alerts according to one or more aspects of the disclosure;

[00153] Fig. 47C is a flow chart depicting a method for generating and managing alerts according to one or more aspects of the disclosure

[00154] Fig. 48A is a method for variable sampling according to one or more aspects of the disclosure; Fig. 48B and 48c are graphs depicting one or more aspects of the sample method of Fig. 48A; and

[00155] Fig. 49 is a diagrammatic representation of a machine in the example form of a computer system within which a set of instructions, for causing the machine to perform any one or more of the methodologies discussed herein, may be executed.

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DETAILED DESCRIPTION

[00156] The present disclosure describes a wearable computing device (WCD) that enables a wearable fitness monitor(s)/computer(s) which is suitable for prolonged usage with accurate results. The WCD can be in the form of a ring that can be worn on the finger of a human (or animal) user. Although the WCD of the present disclosure is depicted as a ring that can be worn on the finger of a user, other shapes, designs, and form factors can be utilized for the WCD. For example, the WCD can be in the form of a wrist band, bracelet, necklace, earring, or any other type of wearable accessory. In this regard, references to the finger of a user in the present application can be considered to apply to other portions of a human body depending on the form of the WCD, such as wrist, neck, ear, etc.

[00157] The term "coupled" as used herein means connected directly to or connected through one or more intervening components or circuits. Any of the signals provided over various buses described herein may be time-multiplexed with other signals and provided over one or more common buses. Additionally, the interconnection between circuit elements or software blocks may be shown as buses or as single signal lines. Each of the buses may alternatively be a single signal line, and each of the single signal lines may alternatively be buses, and a single line or bus might represent any one or more of a myriad of physical or logical mechanisms for communication (e.g., a network) between components. The present embodiments are not to be construed as limited to specific examples described herein but rather to include within their scope all embodiments defined by the appended claims.

[00158] FIG. 1A is a perspective view 100 of a WCD 110 illustrating an exterior window 120 in accordance with some embodiments, and FIG. 1B is a perspective view 102 of the WCD 110 of FIG. 1A illustrating an interior window 130.

[00159] As previously mentioned, it is recognized in the present disclosure that conventional wearable fitness monitors such as clip-on devices, wristbands, or watch-type monitors still often suffer from inaccuracy mainly because they lack constant and consistent ways to read from the body areas they aim to monitor. It can also be an extra

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burden for the person to remember and wear such conventional fitness monitors each time the person perform exercises in order to create an accurate history tracking the exercise activities.

[00160] Accordingly, the present embodiments of the WCD 110 can function as fitness monitors/computer which is suitable for prolonged usage so as to create accurate results. In addition or as an alternative to fitness monitoring, as will be discussed in more detail below, the WCD 110 can function as a remote input device through, for example, gesture recognition. In some embodiments, the WCD 110 can further function as a sleep monitor, a heart rate sensor, a cardiac monitor a body temperature detector, or the like. It is noted that, for those embodiments which can function as a cardiac monitor (e.g., that measures electrocardiogram (EKG)), it may be necessary to establish a closed loop (e.g., for the electrical measurement of EKG) across the heart. As such, in some of those embodiments, a separate conductive pad can be coupled to the WCD 110 so that a user can pinch the pad with fingers on an opposite hand,

[00161] Specifically, in some embodiments of the present disclosure, the WCD 110 can be worn by the user (e.g., on a finger) for fitness, physical activity, biological data monitoring as well as for gestural input or other suitable purposes. As shown in FIGS. 1A and 1B, the WCD 110 can include the exterior window 120 on its exterior wall for input/output data transmission and reception, battery recharge, or status indication. The WCD 110 can also include the interior window 130 on its interior wall for various monitoring or sensing activities. The form factor of the WCD 110 allows it to be worn for prolonged hours with constant and consistent contact with the skin area, thereby creating a more reliable and extended recording (e.g., as compared to aforementioned conventional fitness monitors) of the user's fitness activity, physical exercise, as well as health information such as heart rates and body temperature. More implementation details regarding the WCD 110 are discussed below.

[00162] FIG. 1C is a perspective view of an alternative WCD design 112 of the WCD 110 of FIG. 1A in accordance with some embodiments. As shown in FIG. 1C, the WCD 112 includes a second exterior window 124 in addition to a first exterior window 122. The two exterior windows 122 and 124 can include spacing between the two

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windows 122 and 124 so that the mechanical strength of the housing structure of the WCD 112 may be stronger than that of the WCD 110, which is shown to include one single exterior window 120. Further, in some embodiments, radio antennas (e.g., Bluetooth) or other sensitive circuitry can be positioned in the second exterior window 124 away from the first exterior window 122 so that quality of reception may be improved.

[00163] FIG. 2 is an abstract functional diagram 200 illustrating example components within the WCD (e.g., WCD 110) in accordance with some embodiments. As shown in diagram 200, the WCD 110 can include a processor module 210, a plurality of sensor modules 220, a status indicator module 230, a power generation and management module 240, a communication module 250, a memory 260, and miscellaneous modules 270 (e.g., a real-time clock (RTC) crystal oscillator as illustrated in FIG. 2). The WCD 110 can also include a battery module 280 that provides electrical power for the WCD 110. In some embodiments, the battery 280 can be of a lithium-polymer type or a zinc-polymer type. It is noted that modules illustrated in diagram 200 are for purposes of facilitating a better understanding of the present embodiments; other suitable modules may be included in the WCD 110 and are not shown for simplicity. As used herein, the term "components" is considered to generally include any of the modules depicted and/or described in Fig. 2, as well as any other modules described herein.

[00164] It is noted that the aforementioned modules are intended for purposes of enabling the present embodiments, rather than limiting. As such, a person of ordinary skill in the art will understand that the present disclosure covers apparent alternatives, modifications, and equivalents (e.g., combining or separating the modules) made to the techniques described herein. For example, in some embodiments, a portion of the communication module 250 (e.g., the Bluetooth Chip as shown in FIG. 2) can be combined into the processor module 210. For another example, one or more modules herein can be combined into one to form a system-on-the-chip (SOC).

[00165] The processor module 210 can have generic characteristics similar to general purpose processors or may be application specific integrated circuitry that provides arithmetic and control functions to the WCD 110. The processor can be any type

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of processor, such as a processor manufactured by AMtel, Freescale, Nordic Semiconductor, Intel®, AMD®, or an ARM® type processor. The processor module 210 can include a dedicated cache memory (not shown for simplicity). The processor module 210 is coupled to all modules 220-270 in the WCD 110, either directly or indirectly, for data and control signal transmission.

[00166] The memory 260 may include any suitable type of storage device including, for example, ROM, such as Mask ROM, PROM, EPROM, EEPROM; NVRAM, such as Flash memory; Early stage NVRAM, such as nvSRAM, FeRAM, MRAM, or PRAM, or any other type, such as, CBRAM, SONOS, RRAM, Racetrack memory, NRAM, Millipede memory, or FJG. Other types of data memory can be employed as such are available in the form factor desired.

[00167] In addition to storing instructions which can be executed by the processor module 210, the memory 260 can also store data generated from the processor module 210. It is noted that the memory 260 can be an abstract representation of a generic storage environment. According to some embodiments, the memory 260 may be comprised of one or more actual memory chips or modules. In some embodiments, the memory 260 can function as a temporary storage (e.g., for firmware updates, and/or for avoiding accidental malfunctions (such as so-called "bricking")).

[00168] In accordance with one or more embodiments, the sensor modules 220 can include various sub-modules for the WCD 110 to perform different monitoring or sensing activities. A view 302 of the interior window (e.g., window 130) of a WCD (e.g., WCD 110) with example components exposed is shown in FIG. 3B. As shown in the example of FIG. 3B, the sensor modules 220 can include a temperature sensor 320a, a red light emitting diode (LED) 320b, a light sensor 320c, and an infra-red LED 320d. Among the sensors in the sensor modules 220, those sensors (e.g., sensors 320a-320d) which are directly related to biological sign monitoring can be configured and positioned in a way that is close to the skin (e.g., facing the interior window 130 of the WCD 110). Although not shown in FIG. 3B for simplicity, the sensor modules 220 can further include sensors that are not directly related to biological sign monitoring; some examples of these sensors include accelerometers, gyroscopes, vibration, sensors (e.g., a magnetometer or a digital

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compass), or other suitable sensors (e.g., for gesture recognition). The magnetometer can measure the strength and/or direction of a prevailing magnetic field. In this regard, the magnetometer can be used during global positioning and/or navigation. In particular, the magnetometer can be used to measure a directional heading when the WCD is in motion and can supplement position data where the WCD is out of communication range. In one or more embodiments, the accelerometers in the sensor modules 220 can detect movements in multiple (e.g., 3) dimensions or axes. The accelerometer can measure force of acceleration of the WCD and can measure gestures performed by a user while wearing the WCD. In other examples, the accelerometer can detect acceleration of the user while wearing the WCD. This can permit tracking of activity level, such as steps taken or number of laps swum in a pool.

[00169] The temperature sensor can be any type of sensor that detects temperature, such as a thermistor, PTC, NTC, etc. In another example, the temperature sensor can use IR light emitted from an object to calculate a surface temperature of the object in a manner clear to those of ordinary skill in the art.

[00170] Together, the processor module 210 and the sensor modules 220 can enable the WCD 110 to perform multiple functions including, for example, pedometer, sleep monitor (e.g., which monitors sleep quality), heart rate sensor, pulse oximetry, skin (and in select embodiments, ambient) temperature. In addition, some embodiments of the WCD 110 can further function as a gesture input device. In particular, the present embodiments recognize that the WCD 110 can detect finger motions or gestures which may be difficult for conventional fitness sensors to detect, such as a tap, a snap, a knock on the table, and the like. In some embodiments, the WCD 110 can utilize the accelerometer to measure the activity level (e.g., arm movement) in conjunction with the measured heart rate to determine if the user is walking horizontally, running, swimming, or climbing stairs. Other activities can be identified by the WCD 110 may include biking or sleeping.

[00171] In some embodiments, the WCD 110 can also be programmed to learn particular gestures or physical exercise from the user using, for example, a training mode. For example, the user can instruct (e.g., using a computer or a mobile device of the user)

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the WCD 110 to enter the training mode and perform the gesture or physical exercise; the WCD 110 can record the readings from the sensor modules 220, recognize patterns therefrom, and store the result in, for example the memory 260, so that such gesture or exercise can be recognized by the WCD 110 after the training. The WCD 110 can be configured (e.g., via a mobile application running on a mobile device of the user) so that the recognized gestures can perform functions designated by the user, such as clicks, swipes, unlocks, or media player controls. In one embodiment, the WCD 110 can include near field communication (NFC) chips so that certain functions (e.g., unlocking a smart phone) can be performed when the WCD 110 touches upon or otherwise be detected by another NFC device. In some embodiments, the unlocking function of the WCD 110 can also unlock a user device (e.g., a phone) via the communication module 250 (e.g., Bluetooth) by the WCD 110 transmitting a proper unlock code.

[00172] Moreover, the WCD 110 can function as a key or a control device for keyless access to home, automobile, or other suitable user authentication processes. The WCD 110 can also be integrated with games and game consoles so that it can function as an input device to those games and consoles. In some embodiments, the WCD 110 can be adapted for use in medical and home health monitoring, or as a transportation safety device (e.g., that broadcasts emergency messages to relevant authorities). Additional examples of sensors/functionalities of the WCD 110 can include an inertial measurement unit (IMU) (e.g., for more complex gesture recognition, a near-infrared (NIR) spectrometer (e.g., for measuring light absorption and deriving blood glucose / blood alcohol / CO2 content), a Galvanic skin response sensor (e.g., for measuring sweat / nervousness), an electrocardiogram (ECG or EKG), and so forth.

[00173] In some embodiments, the processor module 210 can determine (e.g., based on identified physical activities, routine pattern, and/or time) a frequency at which one or more sensors in the sensor modules 220 should operate. Because it is recognized in the present disclosure that the heart rate of a human being typically does not vary too widely (e.g., beyond a certain percentage of what has been previously measured), in some embodiments, the WCD 110 can automatically adjust the sensor modules 220 (e.g., to slow down) so as to save power. More specifically, some embodiments of the WCD 110

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can include a phase-locked loop or logic to predict the pulse width by determining lower and upper ranges in which the heart rate is predicted to be, thus only powering up the sensor modules 220 at the time of the predicted heartbeats. For one example, if the WCD 110 determines that the user is at sleep (e.g., based on the heart rate, the body temperature, together with the movements detected by the accelerometer and/or the vibration detector), the WCD 110 can slow down its heart rate detection frequency (e.g., from 1 measurement per second to 1 measurement per 10 seconds) and skip the measurement of several heartbeats because it is unlikely that the heart rate will change drastically during that period. Conversely, if the WCD 110 determines that the user is performing a high intensity physical exercise, the WCD 110 can increase the frequency of monitoring and recording of the sensor modules 220.

[00174] In accordance with one or more embodiments, the WCD 110 also includes various modules coupled to the processor module 210 for, by way of example but not limitation, input/output data transmission, battery recharge, or status indication. A view 300 of the exterior window (e.g., window 120) of a WCD (e.g., WCD 110) with example components exposed is shown in FIG. 3A. As shown in the example of FIG. 3A, the modules configured to face the exterior window 120 of the WCD 110 can include parts from the status indicator module 230, the power generation and management module 240, and the communication module 250.

[00175] Specifically, one embodiment of the WCD 110 includes the status indicator module 230 coupled to the processor module 210 to indicate various statuses. In some embodiments, the status indicator module 230 includes a light emitting diode (LED) 330, such as shown in FIG. 3A. The LED 330 can be a single red/green/blue (RGB) LED. In other embodiments, the status indicator module 230 can include other suitable types of indicator devices including, for example, a single color LED, an electrophoretic ink (or "e-ink") display, a persistent display, or the like. In accordance with some embodiments, the WCD 110 can utilize the indicator module 230 (e.g., via the RGB LED 330 through the exterior window 130) to visually communicate with the user. For example, a red color can be displayed (e.g., for a predetermined period of time) by the LED 330 that the WCD 110 needs to be recharged, and a green color can be displayed

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to indicate that the WCD 110 is fully charged. For another example, a blue color can be displayed when the communication module 250 is in use. In one or more embodiments, the user can program a fitness goal (e.g., a target heart rate) to the WCD 110 so that, for example, a green color can be displayed when the heart rate is below the target, a yellow color can be displayed when the target is reached, and a red color can be displayed when the heart rate is above a certain percentage of the set target. Some embodiments of the WCD 110 include the communication module 250 for wireless data transmission. Particularly, in some embodiments, the communication module 250 includes one Bluetooth chip and a Bluetooth antenna 350, such as shown in FIG. 3A. One or more embodiments of the WCD 110 also provides the capability of storing activity logs (e.g., in the memory 260). More specifically, fitness activities, exercise histories, as well as recorded biological signs such as heart rate and body temperature, can be stored onboard in the memory 260 of the WCD 110. Each data entry in the activity logs can be time-stamped using, for example, an onboard real-time clock (e.g., which may be included in miscellaneous modules 270). For power saving and other purposes, the activity log can be downloaded (e.g., via the communication module 250) when requested by the user. In other embodiments, the activity log can be pushed (e.g., via email or other suitable means) by the WCD 110 to a user device at a time designated by the user. In some embodiments, the memory 260 can store up to a full week worth of activity logs.

[00176] The WCD 110 can include the power generation and management module 240 for recharging the battery 280 and for providing electrical power to various modules 210-270 in the WCD 110. Particularly, in some embodiments, the power generation and management module 240 includes one or more concentrated photovoltaic (CPV) cells 340, such as shown in FIG. 3A. The CPV cells 340 can be high-efficiency tandem solar cells and can be attached on the flexible printed circuit (e.g., circuit 415, 515). Because the small form factor of the embodiments of the WCD 110, CPV cells 340, which can absorb more light energy from a wider spectrum of light than the traditional solar cells, are used. In some embodiments, multiple (e.g., 3) CPV cells 340 can be configured in series to provide sufficient voltage and/or current for charging the battery 280.

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[00177] According to some embodiments, the WCD can include one or more sensing or imaging devices that can be any type of device capable of detecting electromagnetic radiation, such as visible light, IR, NIR, UV, etc. In one example, the device is an imaging device, such as a CMOS or CCD camera.

[00178] According to some embodiments, the WCD 110 can be placed or docked into a charging station for recharging. A perspective view 900 of an example charging station 910 for the WCD 110 is shown in FIG. 9A. The charging station 910 can have concentrated light source circumferentially around the WCD 110 so that the user does not have to be concerned with whether the WCD 110 is facing the right direction for charging. Some embodiments of the charging station 910 can include a light distribution means that takes a single light source and distributes the light all around. An abstract diagram illustrating a partial structure of the light distribution means inside the charging device of FIG. 9A is shown in FIG. 9B. It is noted that, even with the charging station 910, for some embodiments, regular outdoor sunlight or other ambient light source can still function as a secondary source of energy so that the CPV cells 340 on the WCD 110 can extend the operational time provided by the battery 280.

[00179] Additionally or alternatively, energy source attached to the power generation and management module 240 can be passive; for example, some embodiments provides that a clip with a concentrator lens can be attached to the WCD 110 in a way such that the power generation and management module 240 can charge the battery 280 using natural sunlight. In an alternative embodiment, gemstone(s) (e.g., sapphire, diamond, or other suitable materials) in the shape of a dome or with faceted protrusion can be configured to concentrate/magnify light energy while also serving as a decorative feature.

[00180] In some alternative embodiments, the power generation and management module 240 can include electromagnetic induction charging coil so that a WCD (e.g., ring 610) can be charged using an inductive charger. FIG. 6 shows an exploded view 600 of such alternative embodiment of WCD with the inductive charging mechanism including the charging coil 640, as well as battery 680, housing 612, and rigid-flex PCBA 615. However, it is noted that there may be a need to manufacture the inductive charging

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coil 640 in different sizes that correspond to different ring sizes. Further, it is noted that the efficiency of the electromagnetic induction charging mechanism may be adversely affected by the adoption of a metallic housing. Additionally or alternatively, to avoid multiple sized coils mounted to the edge of the ring, the coil can be placed on the inner or outer sides of the ring by positioning the coil beneath a window in the metal housing of the ring.

[00181] In order to achieve optimal power management of the WCD, one or more of the components can be selected to minimize power usage. For example, a processor, memory, or any other component can be selected based on rated power usage. In one example, it may be desirable to select components that draw current on the order of microamps in order to extend the battery life of the WCD and to allow the WCD to perform health/activity monitoring functions between charging sessions.

[00182] In still some other alternative embodiments, the power generation and management module 240 can include thermoelectric generator (TEG) modules so that a WCD (e.g., WCD 710, 810) can be charged by the difference between the body temperature and the ambient temperature. FIG. 7 is a perspective view 700 of such alternative design, and FIG. 8 is an exploded view 800 of the WCD 710 of FIG. 7. Also shown in FIGS. 7 and 8 is an alternative design of the housing for the WCD where the ring includes an outer ring 812a, an inner ring 812b, and insulators 814a and 814b. However, it is noted that utilizing TEGs for charging the battery may be less than ideal since the difference between body temperature and ambient temperature might not be great enough to fully charge the battery, and that in many occasions (e.g., during sleep), the temperature difference needed for TEG to generate electricity may quickly disappear (e.g., since the WCD 710, 810 may be covered inside the comforter).

[00183] The battery can be any type of battery, such as a rechargeable battery. The battery can be a thin, flexible lithium ceramic chemistry battery. In another example, the battery can be a circular formed lithium polymer or lithium ion battery. The battery can provide power to any of the components described above. In one example, the battery can be a lithium cell integrated directly with the flexible PCB described above. Other

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implementations can integrated the battery directly onto the housing to reduce the volume of space taken up by battery packaging.

[00184] The WCD can also include one or more polymer or piezo actuators for providing appropriate haptic or physical feedback and alerts to a user while the user is wearing the ring. The piezo actuator can also provide audible feedback to a user.

[00185] As previously mentioned, the WCD 110 can be used with a software application (e.g., a mobile phone application for the Apple iOS or the Google Android OS) which can run on the user's computing device (e.g., a mobile device such as a smart phone). Specifically, the software application can facilitate the mobile device of the user to couple to the WCD 110 (e.g., via the communication module 250) for data communication, such as downloading activity logs, changing configuration and preferences, training the WCD. The software application can also generate a user interface showing the results or readings from the health and fitness tracking performed by the WCD 110. FIG. 10 is an example screenshot illustrating such user interface 1000 displaying fitness monitoring readings in accordance with some embodiments.

[00186] Further, the WCD 110 can be used for gesture input, and the software application can facilitate the user to customize gesture input and control. FIG. 11 is an example screenshot illustrating such user interface 1100 displaying sensor readings (e.g., for calibration purposes) in accordance with some embodiments. In one or more embodiments, the WCD 110 can also be used directly with other Bluetooth enabled devices such as electronic locks or keyless car entry. In other examples, the WCD 110 can also control other devices via a smartphone and other Wireless LAN enabled devices such as home automation systems.

[00187] FIG. 3C is a view 304 of two exterior windows of an alternative WCD (e.g., WCD 112 of FIG. 3C) with example components exposed in accordance with some embodiments. The components 330, 340, and 350 shown in FIG. 3C function similarly to those components described in FIG. 3A. However, some components (e.g., antenna 350) can be positioned to face a different exterior window than the exterior window the rest of the components face. This may increase the mechanical strength of the housing structure of the ring, and/or may reduce signal interference among the components.

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[00188] FIG. 4 is an exploded view 400 showing an exemplary WCD 410 (e.g., WCD 110) illustrating a battery 480 and a flexible circuit 415 which are configured to fit inside a housing 412 of the WCD 410. It is recognized by the present disclosure that a human being's finger can come in various different sizes and so should the WCD 410. In order to reduce the cost of manufacturing different sizes of printed circuits, in some embodiments, the modules 210-270 (of FIG. 2) are formed on a flexible or rigid-flex printed circuit (FPC) board, an example 500 of which is shown as FPC 515 in FIG. 5. In particular, one or more embodiments provide that the FPC 515 and the battery 480 are not specific to a ring size, and that the same circuitry and/or battery can fit a multitude of sizes.

[00189] According to some embodiments, the WCD 410 provides a desirable form factor for a user to wear it for a prolonged period of time. The edges and the shape of the WCD 410 can be configured in a way that is comfortable and ergonomic; for example, the finished parts of the embodiments are to be free from burrs and sharp edges. The material which forms the housing portion of the WCD 410 can include medical grade metallic alloys that reduce the likelihood of allergic reactions. Examples of the housing material include stainless steel, tungsten carbide, titanium alloy, silver, platinum or gold.

[00190] In the examples shown in FIG. 4, the U-shape of the ring housing 412 allows for the flexible PCB 415 to be inserted into the edge of the WCD 410. The windows (e.g., windows 120, 130) on the walls of the WCD 410 can align with the operating circuitry to allow, for example, battery charging, Bluetooth connection, and user feedback LED/micro display on the outer wall, and biological feedback sensors (e.g., pulse oximetry, temperature sensor) on the inner wall. In one or more embodiments, the WCD 410 can be completely sealed using potting epoxy. The sealing epoxy can be transparent to allow light to pass through for the CPVs and sensors. In some embodiments, the WCD 410 can be potted with two different compounds. In these embodiments, the body of the WCD 410 can be filled with clear material, and the edge of the WCD 410 can be filled with an opaque material so that different colors can be incorporated (e.g., as a decorative element). It is noted that sealing the assembly using potting epoxy can also bring the additional benefit of making the WCD 410 completely

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or almost completely waterproof as well as increasing the structural rigidity of the WCD 410.

[00191] **I. Internal Housing/External Potting**

[00192] Fig. 12A is a perspective view and Fig. 12B is a side view of a WCD 1200 according to one or more aspects of the disclosure. The WCD 1200 can be in the shape of a ring and can be worn on any of the five fingers (including the thumb) of (typically) a human user. In this regard, the WCD 1200 can define an interior diameter d_1 and exterior diameter d_2. The interior diameter d_1 can be defined as the distance between opposing points on the interior surface of the ring, with the interior surface being the portion of the WCD facing the finger of a user while the device is worn by the user. The interior surface of the WCD can generally define a finger space for receiving the finger of the user. The exterior diameter d_2 can be defined as the diameter between opposing points on the exterior surface of the ring, with the exterior surface being the portion of the WCD opposed to the interior surface and facing away from the finger of the user.

[00193] The interior diameter d_1 and exterior diameter d_2 can be any size to accommodate any finger size. In one example, d_2 is determined by d_1 plus a thickness of any components and/or flexible circuit boards disposed within the WCD. Additionally, although depicted as being circular, the finger space of the WCD 1200 can be any shape, such as ovular, elliptical, or the like, to accommodate users with atypical finger profiles. In these examples, the dimensions of the interior and/or exterior diameter may be measured according to other variables, such as length, width, major diameter, minor diameter, etc. By way of non-limiting example, the WCD interior diameter d_1 (the diameter generally defining the ring size) can be in an approximate range of 12mm to 24mm so as to accommodate finger sizes ranging from a small child to a larger adult, and on any acceptable finger, including the thumb. The exterior diameter d_2 can also be any reasonable size or shape, and can define an approximate range of between 18mm and 30mm. Likewise, the thickness between diameters d_1 and d_2 can vary widely, but can typically reside in an approximate range of 1.5mm to 3 mm. The width WR of the WCD along the direction of finger extension (finger longitudinal direction) is widely variable,

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and can be selected, in part to accommodate internal and external components. In a non-limiting example, the width WR is in a range of approximately 3mm to 8mm.

[00194] The WCD 1200 can include an overall housing 1210 that includes an internal housing 1212 and an external potting or encapsulant 1214. Together, the internal housing 1212 and external potting 1214 combine to form the overall form factor of the WCD 1200, in addition to providing a housing for one or more electronic components stored within the housing 1210 of the WCD 1200, as will be described in greater detail below.

[00195] The internal housing 1212 can be formed of any material, such as a nonconductive material, a conductive material, a ferrous material and/or a nonferrous metal, composite material (e.g. carbon-fiber and/or glass fiber composite) a dielectric material, or a combination of any of the above. In one example, the material of the inner housing 1212 is conductive and nonferrous, such as aluminum, titanium, or stainless steel. In other examples, the internal housing can be formed of a polymer, such as plastic. The external potting 1214 can be formed of any material, solid or gelatinous, that can provide resistance to shock and/or vibration and can prevent moisture and/or debris from entering the housing 1210 of the WCD 1200, such as silicone, epoxy, polyester resin or any other polymer.

[00196] In one example, the external potting 1214 can be transparent. In this regard, the transparent external potting can allow electromagnetic radiation, such as visible, IR, or UV light sources from inside the housing 1210 to pass through the external potting 1214 without the need of a window or discontinuity in the external potting 1214 and without changing the optical properties of the radiation. In the same vein, electromagnetic radiation sources, such as visible, IR, or UV light, external to the housing can pass through the external potting 1214 and can be detected by, sensed by, or fall incident upon internal components of the WCD 1200 without the need for a window or discontinuity in the housing and without changing the optical properties of the radiation. In another example, the external potting 1214 can be tinted. The tint can be cosmetic and can prevent the internal components of the WCD to be visible by the user. In this regard, depending on the tint, optical properties of light passing therethough may

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be slightly changed. For example, certain colors of the light can be filtered and can result in decreased power transmission. The above description regarding external potting 1214 can be applied to any of the pottings described below.

[00197] The internal housing 1212 can define a window 1216. In one example, the internal housing is formed of a material that completely or partially prevents light (or other electromagnetic radiation) from passing through the internal housing 1212. In this regard, the internal housing 1212 can define the window 1216 to allow for such radiation to pass through the housing 1212. As shown, the window 1216 can be generally elliptical-shaped, but can be any other suitable shape according to other examples, such as rectangular, circular, ovular, etc. Since the window 116 is defined by the internal housing 1212, the window 1216 can face the finger of the user while the user is wearing the WCD 1200, which can provide many advantageous features and implementations, as will be described in greater detail below.

[00198] Fig. 12C is a front view of the WCD and Fig. 12D is a cross section of the WCD 1200 along the line A-A of Fig. 12C. As shown, the internal housing 1212 can have a generally U-shaped internal surface 1212a to accommodate one or more internal components and can define a pair of flanges 1212b and 1212c. The external potting 1214 can extend between the flanges 1212b and 1212c of the internal housing to provide an internal space 1220 to accommodate one or more components. By virtue of the external potting 1214, the internal space 1220 defined by the internal surface 1212a and the external potting 1214 can be hermetically sealed, thereby preventing debris, dust, moisture, or any other unwanted fluids or materials from interacting with the internal components of the WCD 1200. Although not depicted, the internal components can reside within the internal space 1220, and the external potting 1214 can be disposed immediately atop the components to provide the seal.

[00199] Fig. 12E is a perspective view of the internal housing 1212 without external potting 1214. As shown, the internal surface 1212a defines a generally U-shaped surface for receiving the components.

[00200] Fig. 12F is a perspective view of the internal housing 1212 with a portion of the external potting 1214 removed and showing one or more components 1230 and

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printed circuit board (PCB) 1240. The components and PCB can be constructed as flex circuits, thereby allowing the components 1230 and PCB 1240 to be geometrically configured within the ring shaped internal space 1220. The PCB 1240 can be any type of flexible material clear to those of skill, such as polyimide, PEEK, etc. Additionally, the PCB could be rigid-flex whereby panels of RF4 are connected together with a flexible substrate.

[00201] As shown, the PCB 1240 and the components 1230 can be disposed within the internal space 1220 generally defined by the internal surface 1220a and the flanges 1220b-c. The PCB 1240 can define one or more folding regions 1242 that allow the PCB 1240 to conform to the circumference and/or perimeter of the internal surface 1212a. The PCB 1240 can extend around at least a portion, or up to an entire circumference, of the internal surface 1212a. In one example, the size of the internal diameter d_1 of the WCD can determine the portion of the internal surface 1212a around which the PCB 1240 extends. Illustratively, for a larger ring size and a larger internal diameter d_1, the PCB 1240 can extend only a portion (an arc) of the overall circumference, while for smaller ring sizes a greater portion (arc) of the circumference can be employed to accommodate PCB 1240 and the internal components 1230. The adjacent portions of PCB can form an arc angle therebetween by virtue of the folding regions disposed therebetween, allowing for the PCB to be conform to the internal surface 1212a.

[00202] **II. External Housing/Internal Potting**

[00203] Fig. 13 is a cross section of a WCD 1300 according to another aspect of the disclosure and illustrative embodiments. In this example, the WCD 1300 includes a housing 1310 that includes an external housing 1312 and an internal potting or encapsulant 1314. The external housing 1312 includes an internal surface 1312a that has a generally C-shaped cross section—but alternate cross section shapes, such shapes with an external notch or groove. The external housing includes flanges 1312b-c that extend toward each other, beyond portions of the internal surface 1312a, to define a partially enclosed internal space 1320. In an assembled state, the WCD 1300 can include a battery 1330, a PCB 1340, and components 1350, which can be at least partially or completely disposed within the partially enclosed internal space 1320. The internal

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potting 1314 can extend between the flanges 1312b-c and can seal the partially enclosed internal space 1320. The components can be encapsulated by the internal potting 1314. The PCB 1340 and components 1350 can extend along an inner circumference of the internal surface 1312a

[00204] Illustratively, the external housing 1312 can be formed of the same materials as the internal housing 1212 described above, and the internal potting 1314 can be formed of the same materials as the external potting 1214 described above. As also described above, the internal potting 1314 can be transparent and the external housing 1312 can define one or more windows according to one or more aspects of the disclosure.

[00205] Fig. 14A is a cross section of a WCD according to another aspect of the disclosure and illustrative embodiment. In this example, the WCD 1400 includes a housing 1410,internal surface 1412a, an internal or external housing 1412, an internal or external potting 1414, an internal space 1420, a battery 1430, a flexible circuit 1440, and one or more components 1450. This example is similar to the examples described above with respect to Figs. 12 and 13, except the addition of a stiffener element 1442 and the flanges 1412b-c extend further into the space 1420 toward one another such that the flanges 1412b-c overlap with the stiffener element 1442.

[00206] Fig. 14B is a perspective view of the PCB and stiffener element of Fig. 14A. As shown in FIG. 14B, the stiffener element 1442 extends beyond an overall width *w* of the PCB 1440 and extends wider than a distance between flanges 1412b-c. The stiffener element is disposed between folding regions 1444. The PCB 1440 can include one or more stiffener elements 1442 attached thereto, and the elements 1442 can be disposed periodically (in separated intervals) along a length *l* of the PCB 1440. As shown in Fig. 14C, the stiffener element 1442 can be disposed underneath the flexible circuit 1440, e.g., on a face of the flexible circuit 1440 opposed to the face on which the components 1450 are disposed, and can be permanently or semi-permanently attached thereto. The stiffener element can be implemented in any of the configurations described, and in particular, with either the internal housing/external potting arrangement or the external housing/internal potting arrangement.

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[00207] The stiffener element 1442 can be formed of any material, such as polyamide or thin FR4, depending on construction of the PCB 1440. In particular, the material of the stiffener can be chosen to be more or less flexible than the PCB 1440. In one example, the stiffener element 1442 can be a polyamide stiffener disposed on a back surface of a flexible PCB. In another example, the stiffener element 1442 can be FR4 and can be substantially flush with respect to the flanges 1412b-c. In this regard, the stiffener element can extend substantially the distance between flanges 1412b-c and may not deform upon insertion into the space 1420. The stiffener element can include surface features disposed on an edge thereof, with the edge facing one of the flanges 1412b-c. The surface features can include a sawtooth profile (e.g., intersecting straight lines at acute angles), or any other type of feature capable of providing an interference fit between flanges 1412b-c.

[00208] Fig. 14D shows a cross section of the WCD at a point in time during assembly/manufacture when the PCB 1440 is being inserted into the internal space 1420 and prior to the application of potting 1414. As shown, the stiffener 1442 contacts the flanges 1412b-c of the housing 1410 by virtue of the width *w* of the stiffener element 1442. Upon an application of force, the PCB 1440 and stiffener 1442 assembly can be inserted into the internal space 1420. In this regard, the stiffener element has a predetermined flexibility that allows for a certain amount of flexion, as shown in Fig. 14D. The flexion allows for the flexible circuit 1440 to be inserted within the internal space 1420 and can prevent the flexible circuit 1440 from being removed or from accidentally falling out once inserted. In this regard, the flexible circuit 1440 is held in place within the space 1420 by virtue of the width of the stiffener element 1442 and the distance between the flanges 1412b-c. Once inserted, the potting 1414 can be applied free of the concern of improper positioning of the flexible circuit 1440.

[00209] Fig. 14E is a cross section of the WCD of after a potting material 1414 has been applied subsequent to the WCD of Fig. 14D.

[00210] **III. Inner/outer bands**

[00211] Fig. 15A depicts a perspective view of a WCD 1500 according to another aspect of the disclosure. In this example, the WCD includes a housing 1510 that includes

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an internal housing 1512 and an external housing 1514. The internal housing 1512 can be similar to the internal housing described above with respect to internal housing 1212, and the external housing can be similar to the external housing described above with respect to external housing 1312. The internal housing 1512 can include one or more windows 1516 that can allow electromagnetic radiation (e.g. visible and near-visible light) to pass therethrough, allowing it to fall incident upon components disposed within the housing 1510 and allowing EM radiation sources (e.g. visible light, RF, IR, etc.) within the housing to exit the housing.

[00212] Fig.15B is an exploded view of the WCD 1500. As shown, the WCD can include internal housing and external housing 1512 and1514. The WCD can further include a PCB 1540 and components 1550. Once the housings 1512-1514 are assembled and the PCB 1540 and components 1550 are assembled within space defined between the housings 1512-414, potting layers 1502 and 1504 can be applied to seal the WCD at both sides thereof to ensure a secure seal.

[00213] **IV. Inner/outer bands with U shaped window**

[00214] Fig. 16A is an exploded view of a housing 1610 and a PCB of a WCD according to one or more aspects of the disclosure. The WCD 1600 comprises a housing 1610 with an integral inner wall and outer wall 1612 and 1614. The housing can be made of any material, such as any material described above with respect to the internal/external housing structures. In this example, the inner and outer walls 1612,1614 each define a window in the shape cutaway portions 1616. The cutaway portions are bounded on three sides by the walls 1612 and 1614 and unbounded at the other side thereof. The cutaway portions 1616 can be aligned with one another to ensure transmission of radiation into/out of the housing 1610. The space1620 between the inner and outer walls 1612,1614 can receive a PCB 1640, battery, components, etc.

[00215] Fig.16B is a cross section of Fig.16A along line B-B. As shown, the inner and outer walls 1612,1614 are directly connected by a floor 1618. The space 1620 is defined by the space between the inner and outer walls 1612,1614 and the floor 1618.

[00216] Fig.16C is a perspective view of the WCD with potting material 1630. As described above, the PCB, battery, and components can be disposed within the space.

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Once disposed therein, a potting 1630 can be provided atop the components and within the cutaway portion 1616. The potting 1630 can be transparent to allow for transmission of light through the cutaway portions 1616.

[00217] **V. Charging By Concentrated Light Source**

[00218] According to one aspect of the disclosure, the WCD can be charged by an external concentrated light source, e.g., laser light, laser diode, etc. In this regard, the photovoltaic device described above can include a concentrated photovoltaic element (CPV) that is constructed and arranged to receive concentrated light from the concentrated light source, e.g., laser light from a laser diode, light from a light emitting diode (LED), etc., and converting the received concentrated light into an electric current. The photovoltaic device can also generate power from nonconcentrated light sources, such as office lighting and ambient sunlight. The electric current can be used to charge one or more batteries stored within the housing of the WCD.

[00219] Fig.17A depicts a cross section of a WCD employing charging by concentrated light source according to one or more aspects of the disclosure. In this example, the WCD 1700 can include a housing material 1710. The WCD can include a PCB 1720 and a concentrated photovoltaic cell 1730. The WCD can be positioned adjacent a base assembly or base station 1750. The base assembly 1750 can be connected to an external power source 1765 and can have internal circuitry 1760 to power one or more concentrated light sources 1770, e.g., one or more laser diodes and/or one or more LEDs, disposed within the base assembly 1750. In this example, the concentrated light source 1770 comprises one or more laser diodes.

[00220] The base assembly 1750 can define a first opening 1752 at one portion thereof to allow the concentrated light 1780 to exit the housing of the base assembly1750. As shown in the diagram of Fig.17A, the concentrated light 1780 is generated by the concentrated light source 1770 and exits the housing of the base assembly 1750 via a first opening 1752. The concentrated light 1780 then enters into the WCD by a second opening 1712 in the housing of the WCD 1700 where it can fall upon the CPV 1730. Once the concentrated laser light falls upon the CPV 1730, the CPV 1730 can convert the incident concentrated light into a current that can be used to directly power one or more

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components within the WCD and/or can be used to charge one or more rechargeable batteries onboard the WCD.

[00221] The concentrated light source 1770, as described above, can be any type of light source that is arranged to generate concentrated light, such as an LED or a laser diode. The concentrated light can be any type of concentrated and/or coherent electromagnetic radiation, such as laser light and/or LED light. The concentrated light can have any desired intensity or wavelength, according to the characteristics of the CPV 1730.

[00222] In one example, the source 1770 can be a 200 mW laser diode that produces red or green laser light. This can generate approximately 80mW (or typically less) of power in the WCD where the CPV 1730 includes a plurality of groups of photovoltaics configured in series or in parallel with one another. Each group of photovoltaics can include one or more CPV cells. In another example, the CPV can include a single group of photovoltaics.

[00223] The base assembly 1750 described above can include additional components that can interact with the WCD 1700. For example, the base assembly can include one or more antennas that can communicate according to one or more wireless protocols, such as 3G, 4G, WiFi, Bluetooth®, NFC, or the like, for direct or indirect wired or wireless communication with the WCD or mobile device. In addition to the charging methods above, the base assembly can employ inductive charging techniques.

[00224] Fig.17B depicts a cross section of a WCD employing charging by concentrated light source according to another aspect of the disclosure. In this example, the concentrated light source 1770 comprises an LED. Further, the base assembly comprises an optical element 1790 positioned adjacent to the concentrated light source1770 for focusing the LED light onto the CPV inside the WCD. The optical element 1790 can be any type of optical element, such as a lens. The lens can be formed of any material, such as glass, plastic, etc., and can be any type of lens, such as concave, convex, plano-concave, plano-convex, etc. In this example, the optical element 1790 includes a plano-concave, with the concave portion facing the concentrated light source 1770. In the example where the source 1770 is an LED, the LED emits light in many

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directions. The optical element 1790 can focus the emitted LED light to focus as much of the LED light as possible onto the CPV of the WCD. The optical element 1790 can be disposed at least partially or completely within the first opening 1752. In some implementations, the optical element may not be necessary due to LEDs with substantially focused light.

[00225] Fig.17C is a perspective view of a base assembly 1750 and WCD 1700 according to one or more aspects of the disclosure. As shown, the WCD 1700 is in the shape of a ring and the base assembly 1750 includes a post 1754 for receiving the ring. The post 1754 can be cylindrical and can be sized and shaped according to an internal diameter of the WCD in order for the WCD to be received on an external surface of the post. The first opening 1752 of the base assembly 1750 is formed on a portion of the post 1754 such that, when the WCD 1700 is stored on the post, the second opening 1712 can be aligned with the first opening 1752 to ensure alignment of the CPV and the concentrated light source. The base assembly can receive/transmit power and/or data via external input/output 1795, which can be a DC power input, a USB input connection or any other acceptable connection/form factor.

[00226] Fig.17D depicts a perspective view of internal components of the base assembly 1750 and WCD 1700 according to another aspect of the disclosure. In this figure, the respective housings of the base assembly and WCD have been omitted, thereby showing a plurality of concentrated light sources 1770, optical elements 1790, and a plurality of CPVs 1730 disposed on mounting substrates 1775 on a PCB. In this example, the WCD can include a plurality of CPVs and the base assembly can include a plurality of sources. This allows for a greater current to be generated during charging and for faster charging times of the WCD. The CPVs and concentrated light sources can correspondingly be disposed in a line, with a constant or variable pitch between respective elements. In this regard, the optical element can include corresponding concavities with the same pitch.

[00227] Figs.17E-F depicts other CPV configurations according to one or more aspects of the disclosure. As shown in Fig.17E, the CPVs 1730 can be arranged in a 1x4 array, while Fig.17F depicts the CPVs arranged in a 2x2 array. In addition to the

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examples shown in the above figures, the WCD can include any number of CPVs according to any number of geometric configurations.

[00228] Fig.17G is perspective view of a WCD and base assembly with a 1x3 CPV arrangement. As shown, the WCD can include a 1x3 array of CPVs and the base assembly can include a corresponding 1x3 array of concentrated light sources. As indicated by the arrow, a user can then rotate the WCD on the base assembly in order to align the respective first and second openings, as well as the CPV and concentrated light sources.

[00229] Fig.18A depicts a cross section of a WCD 1800 employing charging by concentrated light source 1870 according to another aspect of the disclosure. In this example, the WCD includes an internal/external housing portion 1810 and an internal/external potting portion 1820, as described above. In this regard, the base assembly 1850 includes a first opening 1852, but is free of a second opening on the WCD. The concentrated light 1880 passes through the transparent potting portion and falls incident upon the CPV cell 1830. In this example, the source can be a laser diode.

[00230] Fig.18B depicts a cross section of a WCD employing charging by concentrated light source according to another of the disclosure. In this example, the concentrated light source 1870 includes one or more LEDs and the base includes one or more optical elements 1890 for focusing the concentrated light 1880. The LEDs may be of different wavelengths to provide power to two or more junctions in the triple junction CPV cell.

[00231] Fig.19A depicts a cross section of a WCD 1900 employing charging by concentrated light source 1970 according to another of the disclosure. In this example, the WCD and/or the base assembly 1950 can employ one or more magnetic and/or ferrous materials to ensure alignment between the concentrated light source and the CPV cell. Such alignment can improve charging efficiency of the WCD.

[00232] The base assembly includes a first opening 1952 and the WCD includes a second opening 1912 to allow for concentrated light to fall incident upon the CPV 1930. In this example, the second opening is formed on an external housing portion of the

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WCD. In this arrangement, the base assembly can charge the WCD from an exterior of the WCD, rather than an internal charging method as identified above.

[00233] The WCD can include a ferrous or other suitable (e.g. ferromagnetic) material 1920, such as steel, disposed within the housing 1910. In this example, the ferrous material is disposed in a space defined between an internal housing and an external housing. The ferrous material can surround the CPV.

[00234] The base assembly can include corresponding magnets 1960 that can cause an attractive force between the WCD and the base assembly into an optimal configuration for charging. The magnets can be disposed within the base assembly and can surround the concentrated light source. The magnets 1960 can be formed of a rare earth material, such as neodymium or any other acceptable material that provides a requisite magnetic field strength.

[00235] Fig.19B depicts a cross section of a WCD 1900b employing charging by concentrated light source 1980b according to another of the disclosure. The CPV 1930b of the WCD1900 is charged from an interior portion, such as by a base assembly 1950b with a post 1954b. Similarly, the WCD can include a ferrous material 1920b disposed within the housing1910b and the base assembly1950b can include a magnet 1960b.

[00236] Fig.19C depicts a schematic diagram of magnets 1920c,1960c that can be used in a WCD and/or base assembly, including a CPV 1930d and concentrated light source 1930d, according to one or more aspects of the disclosure. As shown, the magnets and/or ferrous/ferromagnetic materials can be axially polarized, with each having a respective north pole and south pole. In this regard, the WCD can have axially polarized magnets 1920c with a south pole S facing toward the base assembly, and the base assembly can have axially polarized magnets 1960c with a north pole N facing toward the WCD. The attractive force between the north and south poles can ensure alignment of the CPV 1930c of the WCD and the source 1970c base.

[00237] Fig.1919D depicts a schematic diagram of magnets that can be used in a WCD and/or base assembly according to one or more aspects of the disclosure. In this example, the base assembly includes axially polarized magnet 1960d, with a north pole N

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facing toward the WCD. The WCD can include ferrous steel 1920d, with an attractive force between the ferrous steel and the north pole of the base assembly magnet.

[00238] Fig.19E is a perspective view of a WCD and a base assembly according to one or more aspects of the disclosure. As shown, the WCD 1900e can be received by a post 1954e of a base assembly 1950e. The respective magnets1960e and/or ferrous materials 1920e are shown in phantom to illustrate their positioning with respect to the WCD and base assembly devices and the CPV1930e as well as the concentrated light source 1970e.

[00239] Fig. 20A is a cross section of a WCD 2000 engaged with a base assembly 2050 according to one or more aspects of the disclosure. In this example, the magnets 2060 can surround the concentrated light source 2070, and the WCD can include a ferrous steel 2020, CPV 2022, and battery 2024 disposed within an internal/external potting 2014 of the WCD. The ferrous steel 2020 can be disposed on a face of the PCB 2040 and can be encapsulated by the internal/external potting 2014. The base assembly can include one or more optical elements 2090 for focusing the concentrated light 2080.

[00240] Fig. 20B is a perspective view of a PCB 2040b with a CPV 2030b and ferrous element 2020b configuration according to one or more aspects of the disclosure. In this example, the ferrous element 2020b comprises a steel ring that can surround a CPV 2030b and can be disposed on the PCB 2040b.

[00241] Fig.20C is a perspective view of a PCB 2040c with a CPV 2030c and ferrous element 2020c configuration according to one or more aspects of the disclosure. In this example, the ferrous element 2020c comprises a plurality of rectangular bars disposed on the PCB. In this way, the ferrous element 2020c can be coated to be reflowed onto the PCB.

[00242] Fig.20D is a perspective view of a magnet 2060d and a concentrated light source 2070d according to one or more aspects of the disclosure. As shown, the magnet 2060d can include a ring that can extend around a circumference of the concentrated light source 2070d. The magnetic ring can be attracted to the ferrous steel ring and/or the rectangular ferrous steel examples set forth in 20A-C above.

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[00243] In some examples, the WCD can be adapted to uniquely identify the wearer of the WCD using, for example biometric features unique to the user.

[00244] Fig.21A is a schematic view of a WCD 2100 showing components used for identifying the wearer of the WCD. As shown, the WCD2100 can include one or more infrared illumination sources 2110 and an infrared CMOS imaging device 2120. The finger 2190 can extend through the finger space of the WCD and the IR source 2110 can illuminate a portion of the skin of the finger 2190. The IR CMOS imaging device 2120 can receive light that has been reflected from the skin surface and produce an image of the skin of the finger 2190. As shown, the IR source2110 and the imaging device 2120 are positioned near the interior surface of the WCD, e.g., the surface facing the skin of the finger. The IR illumination can pass through a window provided on the interior housing or can pass through a transparent potting material.

[00245] During the imaging process, the WCD 2100 can be rotated about an axis passing through the center of the finger space and along the longitudinal direction of the finger. In this regard, the imager 2120 can capture a larger swath of the skin surface than if the WCD 2100 were held stationary with respect to the finger during the imaging process.

[00246] At the time of first use, or any time thereafter, the user can generate a reference capillary map in order to identify himself/herself as the authorized user of the WCD. As described above, the user can rotate the WCD around the finger to capture image data of an analyzed section of skin 2192 and on or more capillaries 2194 of the user currently wearing the WCD. The image data can correspond to an overall analyzed section of the skin 2196 of the wearer. The image data of the capillaries can be used to generate a reference capillary map of the wearer, which can be stored in the memory, such as flash memory or EEPROM, of the WCD.

[00247] When the same user puts the WCD on his or her finger after generation of the reference capillary map, the WCD can capture image data of the wearer's skin surface that can be compared to the reference capillary map stored in the memory. In this regard, the user need not rotate the device around the finger. Instead, the WCD can compare a subset of the gathered image data to a corresponding subset of reference capillary map. If

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there a match, within a predetermine error tolerance, the WCD can uniquely identify the wearer as an authorized user of the WCD and as the unique individual who generated the reference capillary map. Once authorized, the wearer can have access to certain functions, features, data, or other content that is not otherwise available without authorization. In another example, the identification can be a step in a transaction or other type of authorization, such as an electronic payment, bank transaction, etc. If the gathered data does not match the reference capillary map, then the user may be prevented from accessing certain features on the WCD.

[00248] Illustratively, the comparison process between sensed capillaries and some or all of the capillary map can be implemented using basic pattern recognition algorithms (processes) instantiated in the electronics of the WCD. Such processes can rely on edge detection and similar techniques that should be clear to those of skill in the art and can be sourced from various commercial vendors of biometric recognition software.

[00249] In another example, the illumination can include NIR illumination and can project radiation into the skin of the finger. The reflected NIR illumination can then be analyzed to determine one or more characteristics of the blood, such as blood alcohol levels, blood glucose levels, and blood oxygenation levels. In this regard, the WCD analyzes the reflected radiation to identify wavelengths that were absorbed from the projected radiation by the blood of the user. Techniques and processed used in conjunction with commercially available venous oximeters (for example) can be employed to undertake certain readings.

[00250] Fig. 22A is a perspective view of a user employing ECG monitoring according to one or more aspects of the disclosure. In this example, the user can wear the WCD2200 on a first finger 2210 of first hand 2220, and can touch a second finger 2230 of a second hand 2240 to an exterior surface of the WCD 2200. This can provide an electric pathway 2250 through the body, as shown in FIG. 22B, allowing for the transmission of electrical current between distant portions of the body.

[00251] Fig. 22C is a perspective view of a WCD that can employ ECG monitoring according to one aspect of the disclosure. In this example, the WCD 2200 includes an internal/external housing 2250 with a conductive pad2260. The conductive

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pad 2260 can be electrically isolated from the external/internal housing 2250 of the WCD, thereby providing distinct and isolated electrical contacts on the WCD. The internal/external housing 2250 can be in electrical communication with the first finger2210 of the first hand, while the conductive pad 2260 can be in electrical communication with the second finger 2230 of the second hand. In this regard, an electrical path 2250 is formed through the respective hands 2220, 2240 and through the rest of the user's body, particularly through the chest. In this regard, the WCD can take various electrical measurements of the user, such as ECG. The ECG measurement can include measurements of the various waveforms, such as P-U waveforms. The WCD can store such ECG data in a memory and/or can communicate the data to a wirelessly connected mobile device. In another example, the WCD can employ electrically isolated internal and external housings, such as those described above. In this regard, the conductive pad may not be utilized, and the user can wear the WCD on a first finger and apply the second finger anywhere on the external housing.

[00252] The WCD can also serve as a monitor for those who are mobility impaired or who are prone to falls, such as disabled persons and/or retired persons. The accelerometer onboard the WCD detect a fall of the user via a sudden change in acceleration data. The WCD, in conjunction with a mobile device and/or one or more base stations positioned around the home of the user, can determine the position of the user within the house. For example, the mobile device can employ GPS capabilities, and either the mobile device or the base stations can use GPS in combination with WiFi signal strengths to determine the location of the user within the house. The WCD can then issue an alert, either directly on indirectly (via the mobile device or base station) to a third party that a fall has occurred. The alert can be a phone call, text message, e-mail, or any other type of communication. The third party can then take appropriate measures to aid the fallen user.

[00253] The WCD can also monitor heart rate and/or temperature, in addition to the other monitored characteristics described above. If any of the monitored characteristics is abnormal, e.g., measured parameters outside of a predetermined threshold range, an alert can be sent to a third party. In some examples, the third party

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can be a medical health professional, such as a doctor, nurse, caretaker, etc. It is noted that, for those embodiments which can function as a cardiac monitor (e.g., that measures electrocardiogram (EKG)), it can be necessary to establish a closed loop (e.g., for the electrical measurement of EKG) across the heart. As such, in some of those embodiments, a separate conductive pad or other skin-contacting structure/probe can be coupled to the WCD so that a user can pinch the pad with fingers on an opposite hand.

[00254] Since the WCD has the form factor of a ring, the WCD is designed to be worn over long periods of time by a user with little to no discomfort or interference. In this regard, the WCD can monitor the above-described, monitored characteristics over long periods of time (e.g. weeks, months, etc.), and determine trends in the data. For example, the WCD can measure heart rate over a long period of time and determine a unique resting heart rate for a user. If the user's heart rate deviates from the resting heart rate, the WCD can be arranged to issue an alert to a third party. In one specific example, the WCD can use appropriate processes to analyze both the trends of monitored characteristics, as well as current accelerometer data. In this way, if a person's heart rate deviates from a resting heart rate, but the accelerometer indicates that the user is exercising and/or engaging in strenuous activity that provides an equivalent workout, then the WCD may not issue an alert in this circumstance.

[00255] Fig.23A is a perspective view of the hand of a user in various positions employing the navigational features of the WCD. As described above, the WCD can communicate with a mobile device though one or more wireless communication protocols. The mobile device can include a processor and a memory and can execute a map application/process that can provide turn-by-turn walking or driving directions to the user based on the user's GPS location. A portion of those directions can include information regarding heading, distance to travel at that heading, waypoints, and the direction of next turn. By way of the wireless communication, the mobile device can communicate one or more of pieces of information relating to directions, such as the heading. Once the heading is received the WCD, the WCD can give feedback to the user regarding the actual heading measured by the onboard magnetometer and the heading set

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forth in the direction information. In one example, the feedback can be haptic or physical feedback provided by one or more actuators, such as the actuators 670 described above.

[00256] Fig. 23A depicts a user's hand in various positions of navigation, each hand including a WCD worn thereon. In this example, the heading provided by the mobile device is the heading 2335, which represents the direction in front of the hand position2330. In this regard, if the user gestures, e.g., points a ring finger, in the direction of the correct heading, the WCD 2300 can give feedback to the user indicating the correct heading. The feedback can include, for example, an LED indicator 2310 showing a green visible light. In the example of hand position2320, the finger is gesturing in a direction to the left of the correct course 2325. In this way, the WCD 2300 can provide feedback to correct the heading of the user. Such feedback can include illumination of an LED indicator showing (e.g.) a red visible light. Similarly, hand 2340 is gesturing in direction 2345, which is to the right of the correct/appropriate direction. The WCD can provide (e.g.) a blue indicator informing the user to change heading.

[00257] Fig.23B is a flow chart 2300B depicting a method of providing feedback to a user according to one or more aspects of the disclosure. At block 2310B, a user can establish a communication link between a WCD and a mobile device. At block2320B, the user can generate or request a set of directions at the mobile device, including information/data regarding heading, distance to travel at that heading, and the direction of next turn. At block 2330B, the mobile device can transmit at least one of the information items/datum regarding heading, distance to travel at that heading, and the direction of next turn. At 2340B, the WCD can take a measurement of heading by measuring a heading associated with an explicit gesture by the user's finger donning the ring. Such gesture can include pointing in a proposed heading of travel. At block 2350B, the WCD can compare the measured or proposed heading to the correct heading provided by the mobile device. At 2360B, the WCD can provide feedback to the user based on the comparison at 2350B, e.g., if the user is gesturing in the correct direction, a green LED indicator may appear. In other examples, if the gesture is in a direction that does not correspond with the correct direction, a (e.g.) blue or red indicator can appear. In one

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specific example, indicators representing left and right course alterations can be different so a user can easily discern a correct direction of travel.

[00258] Fig. 24A is a schematic diagram of a system 2400 for controlling an environment of a user according to one or more aspects of the disclosure. As shown, the WCD can be connected, wired or wirelessly, to one or more appliances in the home of a user. The system 2400 can include a WCD 2410, a thermostat 2420, a wireless access point (e.g., WiFi router) 2430, and a mobile device 2440. The WCD can be wirelessly connected (e.g., link 2415) to both the thermostat and the mobile device by any type of wireless communication protocol, such as Bluetooth. The access point can be wirelessly connected to the thermostat and the mobile device by any type of wireless communication protocol, such as WiFi. It is noted that a wide range of commercially available appliances, thermostats, lighting controllers, home controllers, and the like, can interface with the WCD using WiFi or another conventional/proprietary communication protocol, as described further below.

[00259] The WCD 2410 can include one or more temperature sensors. In one example, the WCD can include at least one internal facing temperature sensor 2410a and an at least one outward facing temperature sensor 2410b, as shown at Fig. 24B. The inward facing temperature sensor 2410a can be near the skin of a user when the user is wearing the ring, and can therefore measure the skin temperature of the user. The outward facing temperature sensors 2410b can be disposed away from the finger of the user, and can therefore be arranged to measure an ambient temperature of the room in which the user currently resides with sufficient thermal isolation from the user's hand and his/her body heat. In particular, in order to ensure accurate ambient temperature measurements, the WCD can employ a combination of multiple light sensors 2410c and outward facing temperature sensors 2410b. In this regard, the temperature sensor 2410b associated with the light sensor 2410c that receives the most light can be the most accurate, as it is most likely that this sensor is furthest from the finger or palm of the user. In another example, the WCD can employ multiple outwardly facing temperature sensors 2410b and compare the temperature values of each to the inward facing sensor 2410a.

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The WCD can then select the most accurate temperature value from the outward facing sensors.

[00260] Based on the measured skin temperature and measured ambient temperature, the WCD can automatically adjust the thermostat 2420 to alter the ambient temperature of the room. In this regard, if a user's skin temperature is too high, the WCD can instruct the thermostat 2420 to lower the ambient temperature. Similarly, if the user's skin temperature is too cold, the WCD can instruct the thermostat 2420 to raise the temperature. The WCD 2410 can instruct the thermostat (and/or an HVAC controller) directly, e.g., via a direct wireless link 2415, or indirectly, e.g., via one or more of the mobile device 2440 and the access point 2430. The WCD can also use historic temperature data to develop trend temperature data.

[00261] In another example, the WCD can be part of a system 2400C for controlling home appliances. The system 2400C can include a WCD 2410C, one or more home appliances 2420C, and an access point 2430C. Such home appliances 2420C can include, for example, a television, lights, speakers, microwave, range, stove, oven, etc. Each of the home appliances can include an antenna that allows the respective home appliances to communicate wirelessly with one or more access points 2430C. In one example, the appliances can include a ScenSor DW1000 chip provided by DecaWave. In this way, the locations of the appliances in the room can be determined to an accuracy of approximately 10 cm. The location of the WCD 2410C can also be determined, using the above-referenced chip, or by using signal strengths of one or more base stations.

[00262] Having established the position of one or more home appliances and the user in a room, the user can make a gesture to control such home appliances 2420C. For example, the user can point at the TV (while wearing the WCD) in order to turn it on/off. Knowing the position of the user and the position of the TV, the direction of the gesture and the type of gesture can indicate what action to take on which device. The accelerometer and/or magnetometer on the WCD can be used to create a vector to the object to control, and a wireless packet can bet sent to a wireless access point to control the respective appliance.

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[00263] Fig. 24D is a flow chart depicting a method 2400D of controlling home appliances according to one or more aspects of the disclosure. At block 2410D, the locations of one or more home appliances in a room and/or house can be ascertained/determined. As described above, the appliances can include a processor configured to identify location within a room. At block 2420D, the location of the WCD is determined. At block 2430D, the user can make a gesture toward a home appliance to exert control over the home appliance. Such gesture can include a snap, a point, etc. At block 2440D, the accelerometer and/or magnetometer on the WCD can be used to create a vector to the object to control. At block 2450D, a wireless packet can bet sent to a wireless access point to control the respective appliance. The access point can then issue the command to the respective appliance.

[00264] Fig.25 is a perspective view of the hand of a user employing a two-factor authentication technique according to one or more aspects of the disclosure.

[00265] As shown, the user 2500 is wearing a WCD 2510 and is approaching a locked door 2520 with an access node 2530 associated therewith. The access node 2530 can be a wireless access node of a conventional or custom arrangement, and can communicate wirelessly according to any type of wireless protocol, such as WiFi or Bluetooth. As the user approaches the door 2520, the WCD 2510 can initiate a communication link, e.g., Bluetooth or WiFi, with the access node 2530. In this way, the WCD and the access node can engage in one or more handshaking or query procedures to verify the WCD. For example, the access node 2530 can detect a MAC address, IP address, or other alphanumeric identifier associated with the WCD and compare it to a list of authorized users. Such network-based communication processes should also be clear to those of skill.

[00266] Once the MAC address or other identifier is verified, the user can engage in a pre-defined gesture 2550 to complete the authentication procedure. The gesture 2550 can be any type of hand and/or finger motion that can be performed by the user. In this regard, the accelerometer or magnetometer can detect the gesture 2550 performed by the user and provide the gesture information to the access node. If the provided gesture information corresponds with an authorized gesture stored at or accessible by the access

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node, then the user may be granted authorization and the door can be unlocked. The authorized gesture can be a general authorized gesture for all users, or can be a specific gesture authorized only for the particular MAC address.

[00267] In addition to a door, the method above can be use to gain access to other features, such as unlocking a mobile phone, unlocking a car door, starting a car. The authentication technique above is advantageous in that it can eliminate extraneous authentication devices, such as key fobs for a car, a door, keypads for entry control, etc., and can provide a secure two-factor authentication technique to avoid unwanted access. More generally any type of keyless entry system (e.g. a keypad, card-reader, keyless lock, etc.) can be equipped with appropriate communication interfaces (RF, IR, etc.) to communicate with the WCD and operate based on a gesture and/or proximity of the user using the techniques described above. The WCD can also be employed generally in this manner to activate or deactivate a residential or commercial alarm system—substituting, for example, for a key fob used for this purpose.

[00268] Fig. 26A is a schematic view of a charging apparatus for charging the WCD according to one or more aspects of the disclosure. As shown, a mobile device 2610 can be received within a case 2620. The mobile device 2610 can be electrically connected to the case 2620 via a port 2610a on the mobile device 2610 and a connector 2620a on the case 2620. As shown in phantom, the case 2620 can include an integrated battery 2630 within the case that can charge the mobile device via the connector or can charge a WCD, as will be described in greater detail below.

[00269] The integrated battery can be connected to an antenna 2640 disposed on or within the case 2620 that can emit an RF signal, as shown in the block diagram in Fig. 26C. The RF signal can have a power of less than 500mW and a frequency of 13.56MHz. The RF signal can be emitted in all directions around the case such that it can be received by a WCD in proximity to the case.

[00270] Fig. 26B shows a WCD 2650 including an RF antenna 2660 and charging circuitry 2670. The RF antenna 2640 can be disposed within the housing 2680 and can receive the RF signal emitted by the case 2620 and convert it to a current that can be used to charge the WCD battery (not shown). This can advantageously allow the user to

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charge the WCD without removing the WCD from the finger. As shown in Fig. 26D, the charging can occur whenever the WCD is in close proximity to the case, such as when a user talking on the phone or merely handling the phone. In another implementation, the case can utilize inductive charging to charge the WCD. In this regard, the case can include an induction coil subjected to a predetermined current to produce a magnetic field. A corresponding induction coil within the housing of the WCD can be subjected to the magnetic field to produce a current that can charge the onboard battery in accordance with know electromagnetic principles.

[00271] Fig. 27A is a pictorial diagram and Fig. 27B is a block diagram of a WCD employing flash storage according to one or more aspects of the disclosure. As described above, the WCD 2700 can include a housing 2710, an antenna 2720, and an integrated circuit (IC) 2730 including a flash memory 2740. The IC and the flash memory can be disposed within the housing 2710. The flash memory 2740 can be powered by a battery 2750 and connected to the IC 2730, which can be implemented as a system-on-a-chip (SoC) IC 2760. The IC can include Bluetooth Low Energy (BLE) capability to allow for communication with another device. The flash memory can be used to store data, or can be used in any of the authentication techniques described above. The WCD can transmit data stored on the flash memory to another device 2780 via the BLE connection, or can receive data and store the data on the flash memory.

[00272] Fig. 28A is a schematic diagram of one or more WCDs performing proximity functions according to one or more aspects of the disclosure. The WCD can detect a strength of an RF signal received by its antenna, and calculate a distance to the source of the RF signal using a Received Signal Strength Indicator (RSSI). In one example, the RF signal can be from a mobile device, an access point, or another WCD. The use of RSSI can have many applications in proximity detection. For example, the WCD can be placed on a child and can be connected to mobile device held by a parent. If the WCD travels a predetermined distance from the mobile device, the WCD can issue an alert to the mobile device, thereby alerting the parent that the child has wandered too far. In another example, the parent can wear a first WCD and the child can wear a second WCD. The first WCD can alert the parent that a child has wandered too far.

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[00273] A single user can wear a first WCD 2800 on a first finger on a first hand and a second WCD 2810 on a second finger on a second hand. In this regard, the user can measure the relative distance between the first and second fingers using an RSSI via a wireless link 2830 between the WCDs 2800, 2810, such as a BLE connection. This can be used to measure an approximate dimension of an object held in both hands or to estimate a mid-air measurement.

[00274] In some examples, a first user can wear a first WCD 2800 and a second user can wear a second WCD 2810. The RSSI can be collected over a period of time and the processor can analyze the data to develop trends or statistics. For example, the RSSI data can indicate that the first and second users have spent a certain amount of time together and can serve as a relationship monitor.

[00275] The WCD can also detect when the first user and second user are holding hands. Fig. 28B is a schematic diagram of one or more WCDs 2800, 2810 performing proximity functions according to one or more aspects of the disclosure. Similar to the ECG monitoring techniques described above, a circuit can be formed when the users hold hands 2840 (with the respective hands wearing the WCDs). The circuit can be used to transmit data and/or electrical impulses between the respective WCDs via the circuit. The WCDs can collect data regarding the length of time that the users are holding hands and, in combination with the amount of time spent together, monitor the relationship of the two users. In addition, the WCD can collect data regarding communication between the users, e.g., e-mail, social media, etc. Based on all of the above factors, the WCD can develop a relationship score between respective WCD users, with a higher relationship score indicating more and more frequent interactions.

[00276] Fig.29A is a flow chart depicting a method of initiating gesture input according to one or more aspects of the disclosure. The WCD can be used to perform one or more commands, or to instruct another device, such as a mobile device, to perform one or more commands. Such commands can include, initiate sleep state of WCD, initiate sleep mode or default mode of WCD, powering off/on of the WCD, turning on/off an LED light of the WCD, powering on/off of a mobile device, placing a phone call on the mobile device, etc. The user can establish one or more custom gestures to initiate any

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of the commands above. For example, the user can select a command to be customized from a number of commands. Once selected, the user can perform a custom gesture to be associated with that command. In some examples, the user can perform the custom gesture multiple times to allow the WCD to better identify the gesture and to develop error tolerances for registering the gesture.

[00277] At block 2910, the user can perform a first gesture. In this example, the user can perform a finger snap. At block 2920, WCD can register the gesture, via the accelerometer and/or the magnetometer. At block 2930, the accelerometer can send an interrupt signal to the processor. At block 2940, the processor can wake from a sleep or default system state. At block 2950, the processor can monitor the accelerometer for a second gesture, at which point the user can perform a second gesture. If the second gesture matches a gesture in the gesture command database, then the WCD can perform the associated command. If not, the WCD can return to the sleep state.

[00278] Fig.29B is a chart 2900B showing an exemplary graph of acceleration vs. time as measured by the accelerometer of the WCD. As shown at peak2910B, the gesture can only be registered if it reaches a predetermined acceleration threshold. If the gesture performed at 2910 meets the threshold, it can proceed to block2930 where the interrupt procedure is performed.

[00279] Fig. 30 is a perspective view of a WCD 3000 employing an illustrative reset function and associated procedure/process. As shown, the WCD 3000 can be removed from the finger of the user in order to initiate a system reset of the WCD. In one example, the system reset can be initiated by spinning about a rotation axis R at a predetermined speed. The predetermined speed can be any value, and in one example is a rotational velocity. Upon performing the reset procedure at the predetermined speed, operation of the WCD 3000 can be interrupted and the onboard components of the 3000 can power off, and revert to factory default settings. Additionally, a series of movements can initiate a rest, such as putting the ring on a table and turning it over several times.

[00280] Fig. 31A is a perspective view of a WCD including an LED indicator according to one or more aspects of the disclosure. As shown, the WCD 3100 can include an internal/external housing 3112 and an internal/external potting 3114. The

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WCD can include an LED 3120 that can be visible through the internal/external potting 3114.

[00281] Figs. 31B and 31C are cross sections along line C-C of a WCD employing an LED indicator according to one or more aspects of the disclosure. As described above, the WCD 3100 can have an internal and/or external potting 3114 that can be transparent. This allows light sources within the housing to pass through the potting without changing, or with minimal change to, the optical properties of the light. In this way, a light source 3120, such as an LED, can be disposed on the PCB 3140 and can be powered at least partially by battery 3130. The LED can be encapsulated by the potting 3112 and can project light through the potting 3112. As shown in Fig. 31B, the LED 3120 can include a vertical LED, while 31C depicts a right angle LED. The vertical LED can project light along direction L1, while the right angle LED can project light along direction L2. When light is projected along L2, the light can travel around a circumference of the finger of the user. . Note that, according to aspects of the disclosure, the potting can be generally adapted in whole or in part to condition, filter or modify the wavelengths and/or projection qualities of light by for example, embedding lensmatic components, applying light-diffusive additives, light attenuating filter materials, etc.

[00282] Fig. 32 is flow chart depicting a method 3200 of communicating with a near field communication (NFC) device according to one or more aspects of the disclosure.

[00283] In some examples, the WCD can enable or disable NFC or change the functionality of a NFC device. For example, the WCD can itself engage in NFC with another computing device, or the WCD can be connected via wireless link to a computing device that engages in NFC with a different computing device. In certain existing NFC devices, NFC will connect and begin transmitting data as soon as it is queried. In the present example, NFC is enabled or begin transmitting data exclusively upon performing of a pre-determined gesture. However, a variety of other transmission processes can be implemented—for example a periodic chirp or handshake request by the WCD for communication with appropriate devices.

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[00284] At block 3210, a NFC capable device is provided. The device can be any type of device, such as a laptop, tablet, mobile device, or dedicated NFC device.

[00285] At block 3220, the WCD initiates a connection with the NFC device. The connection can be a direct connection via NFC, or an indirection connection via an intermediate device. At this point, no data has yet been transmitted between the WCD and the NFC device.

[00286] At block 3230, a user performs a predetermined gesture that is registered by the WCD. The gesture can be any type of gesture, such as a point, a snap, waving the hand, etc.

[00287] At block 3240, data transmission begins between the NFC device and the WCD.

[00288] In other examples, the user can perform another gesture to cease NFC communication. The gesture can be the same gesture as described above or a different gesture. Additionally, the user can remove the ring to disable the NFC. Upon donning the ring the user will be prompted by the application on the mobile device to re-authenticate by entering a PIN, whereby the proper PIN results in re-enabling the NFC functionality.

[00289] In yet another example, the WCD device employing NFC can be configured on the fly to map to different data sets stored thereon. For example, the WCD device employing NFC can employ data thereon to make purchases, e.g., account information, data to access a building, e.g., a key fob, and data thereon to board public transportation, e.g., smart card, metro card, etc. A user can perform a predetermined different gesture for each of the above data sets to access the data. Once accessed, the WCD device employing NFC can initiate a link with another computing device to initiate a transaction, to open a door, or to board public transportation, etc.

[00290] VII. Optical Element and Attachment Frame

[00291] Fig. 33A depicts a perspective view of a WCD assembly 3300 according to one or more aspects of the disclosure, while Figs. 33B-D depict exploded views of the WCD assembly and 33E depicts a cross sectional view of the WCD assembly along A-A. In this example, the WCD assembly 3300 includes a WCD 3310, an attachment frame

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3320, and an optical element 3330. The WCD 3310 can be any of the WCD examples described above or below in the present application.

[00292] The attachment frame 3320 is releasably attached to the WCD3310. The optical element 3330 is itself releasably attachable to the attachment frame 3320. In this regard, the attachment frame 3320 provides an attachment interface between the WCD 3310 and the optical element 3330, thereby allowing the optical element 3330 to be at a fixed position in space with respect to the WCD 3310 or any portion thereof. The attachment frame3320 can be made of any material, such as a metal, polymer, etc. Any type of polymer can be used, such as thermosetting plastics, thermoplastics, PETE, polycarbonate, polyethylene, LDPE, or any other type of plastic.

[00293] The attachment frame can be sized and shaped to fit along the curved surface of the WCD. For example, the attachment frame can have a curved undersurface to allow a flush fit with the curved surface of the WCD. The attachment frame can have any shape, size, or radius of curvature depending on the size and shape of the WCD.

[00294] The attachment frame 3320 includes a first retaining a portion 3322 and a pair of second retaining portions 3324. The first retaining portion 3322 defines a conical recess 3322a configured to receive the optical element 3330, and provides a generally unoccluded pathway for light to pass through the optical element and onto the WCD. Although depicted as defining a conical or frustoconical shape, the recess 3322a can be any other shape depending on the shape of the optical element 3330. Each of the second retaining portions3324 includes a respective locking feature 3324a. The respective locking features3324 and a extend from the second it retaining portion3324 toward one another such that a distance between the respective locking features is greater than a distance between the remaining portions of the second retaining portions. As shown in Fig. 33E, the locking features engage with an inward-facing surface 3350 of the WCD to ensure a secure fit. In one example, the inward-facing surface of the WCD may itself have one or more features 3360 to engage with the locking features of the second retaining portions. Such one or more WCD features can include projected surfaces, recesses, or any other type a feature to allow for engagement with the attachment frame.

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[00295] The optical element 3330 can be made of any material capable of modifying, e.g., focusing, incident electromagnetic radiation, such as visible light, ultraviolet light, infrared light, or any other type of electromagnetic radiation. In some examples, the optical element 3330 can be constructed from a polymer, such as any of the polymers identified above. In another example, the optical element can be made of glass, quartz, diamond, zirconium, or any other material capable of focusing light. More generally, the optical element 3330 is formed with a general outward appearance simulative of a faceted jewel with an appropriate tint or coloration (including clear/white). The term "jewel" can also be used in the alternative to describe the optical element 3330 herein.

[00296] The WCD can include CPV cell 3312 that can be disposed directly underneath the attachment frame 3320 and optical element 3330 when assembled. In other examples, the CPV can be positioned within the housing and can receive electromagnetic radiation via a transparent potting material. In this regard, incident light striking the optical element 3330 can be focused on to the CPV cell to allow for charging of the internal battery of the WCD. The optical element 3330 provides an increased charging efficiency when compared to the CPV exclusively receiving ambient light, since the ambient light is collected/gathered from a wider field, and then focused onto the CPV by the optical element 3330. In one example, a focal length of the optical element 3330 is different than a distance between the optical element and the CPV. For example, the focal length can be greater than or less than the distance between the optical element and the CPV. This can be advantageous in various aspects of the disclosure so as to avoid the light from focusing at a focal point directly on the CPV, which could cause damage to the CPV itself by over-concentrating the light at that single point of the overall CPV surface.

[00297] Figs.34A-B depict a WCD assembly 3400 according to one or more aspects of the disclosure. In this example, the attachment frame 3420 does not extend to an inward-facing surface of the WCD 3410, but is instead form entirely on the outside-facing surface of the WCD. In some examples, the attachment frame 3420 can be semi-permanently or permanently affixed to the outward-facing surface of the WCD and can have a plurality of retaining portions (mounting prongs) 3422 that at least partially define

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a recess 3422a for receiving the optical element. As shown in Fig.34B, the optical element 3430 is releasably attached to the attachment frame 3420. This configuration can be particularly desirable, as it exhibits ornamental similarities to a traditional engagement ring while still having the increased functionality of the WCD. Note that while not shown, the mounting prongs can include small hook ends springably retain the optical element 3430 when attached, but that can release the optical element based upon a prying motion. A customized grasping tool (not shown) can also be employed to remove (and attach) the optical element in this example.

[00298] **VI. Enclosure/Packaging**

[00299] Fig. 35A depicts an enclosure or case 3500 for storing a WCD according to one or more aspects of the disclosure. As shown, the enclosure3500 includes a lid 3510 and a base 3520. The lid 3510 and base 3520 can engage via a recessed portion 3522 formed in the base 3520 to provide a substantially sealed interior environment.

[00300] The lid 3510 can be cuboidal in external dimensions, or define any other type of geometric shape that allows sufficient internal volume to contain the WCD. For example a custom design shape (polyhedral, etc.) can be employed. In this example, the top portion3510 is substantially cuboidal as shown, including rounded edges rather than vertices. The lid can be substantially transparent to allow viewing of the WCD while enclosed therein, and can be made of any type of material, such as a polymer, glass, etc. The lid can also be mounted with pins on a hinge.

[00301] The base 3520 can be cuboidal, or any other type of geometric shape. In this example, the bottom portion is substantially cuboidal, including rounded edges rather than vertices as shown. The bottom portion can be made of any material and can be transparent or opaque.

[00302] The base 3520 can define a receptacle 3524 for receiving the WCD3505. The receptacle 3524 can be sized and shaped to receive the WCD 3505 and in this example is semicylindrical, e.g., a portion of a cylinder. The radius of the semicylinder can be slightly larger than a radius of the WCD in order to accommodate the WCD securely. The receptacle can lined with a soft material to allow for a soft, safe material to receive the WCD, such as a silicone, thermoplastic, fabric, felt, or other material.

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[00303] Fig.35B is a cross sectional view of the assembled enclosure3500 shown above along the line B-B. As shown, when assembled, the WCD 3505 fits securely within the receptacle 3524. The interior of the lid3510 can be sized and shaped to conform to the shape of the WCD such that the WCD is completely surrounded and enclosed by the lid 3510, while in other examples, the lid3510 can be sized and shaped to allow for airspace 3514 between the lid surface and the WCD.

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PATENT
Docket No.: 340/0002

UNITED STATES PATENT APPLICATION

of

Curt C. von Badinski
Michael J. Strasser
and
Peter Twiss

for a

WEARABLE COMPUTING DEVICE

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WEARABLE COMPUTING DEVICE

RELATED APPLICATIONS

[0001] This application claims the benefit of United States Provisional Application Serial No. 62/006,835, filed June 2, 2014, entitled WEARABLE COMPUTING DEVICE and United States Provisional Application Serial No. 61/910,201, filed November 29, 2013, entitled FINGER RING DEVICE FOR ACTIVITY MONITORING OR FESTURAL INPUT, the entire disclosures of which is herein incorporated by reference.

FIELD OF THE INVENTION

[0002] This invention is in the field of wearable electronic devices.

BACKGROUND OF THE INVENTION

[0003] Wearable electronics are an emerging technology with many applications for the wearer. They can improve lifestyles, ease access to technology and help monitor activity within the wearer's body. However, many current wearable electronics are bulky and can be intrusive or interfere with a person's daily life. In this regard, the wearer may not be comfortable wearing the device for extended periods of time.

SUMMARY OF THE INVENTION

[0004] This invention overcomes the disadvantages of the prior art by providing a wearable computing device (WCD) in the shape of a ring. The wearable computing device can be worn for extended periods of time and can take many measurements and perform various functions because of its form factor and position on the finger of a user.

[0005] One aspect of the disclosure provides a wearable computing device, comprising: an interior wall; an exterior wall; a flexible printed circuit board disposed between the interior wall and the exterior wall; at least one component disposed on the flexible printed circuit board; and wherein at least one of the interior wall and the exterior

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wall defines a window that facilitates at least one of data transmission, battery recharge, and status indication.

[0006] In one example, the window comprises an internal window defined by the interior wall.

[0007] In one example, the window comprises an exterior window defined by the exterior wall.

[0008] In one example, the window comprises a plurality of exterior windows defined by the exterior wall.

[0009] In one example, the plurality of exterior windows comprises a first exterior window and a second exterior window, wherein the first exterior window facilities battery charging and the second exterior window facilities data transmission.

[0010] In one example, at least one concentrated photovoltaic cell, an antenna, and at least one LED are accessible via the window.

[0011] Another aspect of the disclosure provides a wearable computing device, comprising: an internal housing portion configured to be disposed near a finger of a user; a flexible printed circuit board arranged around a portion of a circumference of an interior surface of the internal housing; at least one component disposed on the flexible printed circuit board; and an external housing portion configured to seal the at least one component and the printed circuit board in an internal space defined by the interior surface of the internal housing.

[0012] In one example, the external housing portion comprises a substantially transparent external potting.

[0013] In one example, the at least one component comprises at least one LED configured to emit at least one of visible light, infrared radiation, and ultraviolet radiation through the external potting.

[0014] In one example, the at least one component comprises a concentrated photovoltaic cell configured to receive concentrated light through the transparent external potting.

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[0015] In one example, the flexible printed circuit board includes a plurality of stiffener elements configured to engage with a corresponding plurality of flanges disposed on the internal housing portion.

[0016] Another aspect of the disclosure provides a wearable computing device, comprising: an external housing portion; a flexible printed circuit board arranged around a portion of a circumference of an interior surface of the external housing; at least one component disposed on the flexible printed circuit board; and an internal housing portion configured to seal the at least one component and the printed circuit board in an internal space defined by the interior surface of the external housing.

[0017] In one example, the internal housing portion comprises a substantially transparent internal potting.

[0018] In one example, the at least one component comprises at least one LED configured to emit at least one of visible light, infrared radiation, and ultraviolet radiation through the internal potting.

[0019] In one example, the at least one component comprises a concentrated photovoltaic cell configured to receive concentrated light through the transparent internal potting.

[0020] In one example, the flexible printed circuit board includes a plurality of stiffener elements configured to engage with a corresponding plurality of flanges disposed on the external housing portion.

[0021] Another aspect of the disclosure provides a system, comprising: a wearable computing device, including a housing and a photovoltaic element disposed at least partially within the housing; and a base assembly, the base assembly including a concentrated light source directed at the photovoltaic element.

[0022] In one example, the wearable computing device includes at least one ferrous element disposed within the housing, and wherein the base assembly includes at least one magnetic element disposed therein.

[0023] In one example, the concentrated light source is arranged circumferentially around the wearable computing device when the wearable computing device is engaged with the base assembly.

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[0024] In one example, the concentrated light source comprises at least one of a laser diode and a light emitting diode (LED).

[0025] In one example, a housing of the WCD defines an opening through which the WCD is configured to receive concentrated light.

[0026] In one example, the base assembly comprises an optical element for focusing concentrated light emitted from the concentrated light source.

[0027] In one example, the optical element comprises a lens and is selected from the group consisting of concave, convex, plano-concave, plano-convex.

[0028] In one example, the WCD comprises at least one transparent potting configured to allow concentrated light to pass therethrough.

[0029] In one example, the WCD is ring-shaped and the base assembly comprises at least one post configured to engaged with a finger space of the WCD.

[0030] In one example, the photovoltaic cell comprises a plurality of photovoltaic cells.

[0031] Another aspect of the disclosure provides an enclosure for a wearable computing device, the enclosure comprising: a base defining a receptacle for receiving the wearable computing; a lid configured to engage with the base to substantially enclose the wearable computing device, the lid having an optical element configured to direct incident electromagnetic radiation to a photovoltaic cell disposed on the wearable computing device to allow charging thereof.

[0032] In one example, the lid includes a plurality of vent holes that prevent overheating within the enclosure.

[0033] In one example, the optical element comprises a lens.

[0034] In one example, the lens has a focal length and wherein a distance between a central portion of the lens and the photovoltaic cell is greater than or less than the focal length.

[0035] Another aspect of the disclosure provides a timepiece system, comprising: a timepiece having a substantially planar under surface; and a timepiece computing device adhered to the planar under surface, the timepiece computing device being substantially cylindrical and comprising: a processor; a memory; and at least one sensor.

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[0036] Another aspect of the disclosure provides a wearable computing device system, comprising: a wearable computing device; an attachment frame coupled to the wearable computing device; and an optical element removably coupled to the attachment frame, wherein the optical element is configured to direct electromagnetic radiation to a photovoltaic cell disposed on a surface of the wearable computing device to allow for charging of the wearable computing device.

[0037] In one example, the attachment frame is removably coupled to the wearable computing device.

[0038] In one example, the attachment frame engages with an inward-facing surface of the wearable computing device.

[0039] Another aspect of the disclosure provides a method of identifying an authorized user of a wearable computing device, comprising: illuminating a portion of a skin surface of the user; imaging the portion of the skin surface of the user to generate at least one first image; generating a reference capillary map corresponding to the user based at least in part on the at least one image.

[0040] In one example, the method further includes rotating the wearable computing device during the illuminating and imaging steps.

[0041] In one example, the method further includes imaging the portion of the skin surface of the user to generate at least one second image; and comparing the at least one second image to the reference capillary map in order to authenticate the user.

[0042] Another aspect of the disclosure provides a method of navigating, comprising: gesturing in a first direction while wearing a wearable computing device; comparing the first direction to a predetermined direction in a predetermined set of directions; providing feedback based on the comparison of the first direction of the predetermined direction.

[0043] In one example, the gesture comprises pointing a finger and the first direction comprises a first heading.

[0044] Another aspect of the disclosure provides a method of regulating temperature, comprising: measuring a skin temperature of a user via a first temperature sensor; measuring an ambient temperature via a second temperature sensor; comparing

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the skin temperature to a predetermined threshold temperature; and adjusting the ambient temperature based in part on the comparison.

[0045] In one example, measuring the skin temperature comprises measuring the skin temperature via a first temperature sensor disposed at an inward facing surface of a wearable computing device.

[0046] In one example, measuring the ambient temperature comprises measuring the ambient temperature via a second temperature sensor disposed at an outward facing surface of the wearable computing device.

[0047] Another aspect of the disclosure provides a method for controlling appliances, comprising: identifying a position of a first appliance in a room; gesturing a first gesture in a direction of the first appliance; identifying the direction of the first direction via a wearable computing device; issuing a controlling command to the first appliance based in part on the identified direction of the gesture.

[0048] Another aspect of the disclosure provides a method of generating an alert, comprising: authenticating a first wearer of a first wearable computing device as a first authenticated user; transmitting first biometric data associated with the first wearer; associating the first biometric data with a first profile associated with the first wearer of the first wearable computing device; comparing the first biometric data with a group profile comprising aggregated biometric data from a plurality of distinct wearers of a plurality of distinct wearable computing devices; and generating an alert if the first biometric data falls outside of a predetermined threshold set by the aggregated biometric data.

[0049] In one example, the biometric data comprises at least one of heart rate; ECG profile; blood sugar, and blood pressure.

[0050] In one example, the plurality of distinct wearers share a common trait, resulting in their aggregation into the group profile.

[0051] In one example, the common trait comprises at least one of: age, gender, profession, and location.

[0052] Another aspect of the disclosure provides a method of determine a sampling rate of a wearable computing device, comprising: determining an activity level

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of a wearer of a wearable computing device based at least in part on data from at least one sensor disposed onboard the wearable computing device; comparing the activity level to a predetermined activity threshold; and increasing a first sensor sampling rate if the activity level is above a predetermined activity threshold.

[0053] In one example, the method further includes decreasing the first sensor sampling rate if the activity level is below a predetermined activity threshold.

[0054] In one example, the predetermined activity threshold comprises an acceleration measurement.

BRIEF DESCRIPTION OF THE DRAWINGS

[0055] The invention description below refers to the accompanying drawings, of which:

[0056] FIG. 1A is a perspective view of a WCD illustrating an exterior window in accordance with some embodiments;

[0057] FIG. 1B is a perspective view of the WCD of FIG. 1A illustrating an interior window in accordance with some embodiments;

[0058] FIG. 1C is a perspective view of an alternative WCD design of the ring of FIG. 1A in accordance with some embodiments;

[0059] FIG. 2 is an abstract functional diagram illustrating example components within the WCD in accordance with some embodiments;

[0060] FIG. 3A is a view of an exterior window of a WCD with example components exposed in accordance with some embodiments;

[0061] FIG. 3B is a view of an interior window of a WCD with example components exposed in accordance with some embodiments;

[0062] FIG. 3C is a view of the exterior windows of an alternative WCD with example components exposed in accordance with some embodiments;

[0063] FIG. 4 is an exploded view of a WCD illustrating a battery and a flexible circuit which are configured to fit inside the housing of the WCD in accordance with some embodiments;

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[0064] FIG. 5 is a perspective view of the flexible circuit of FIG. 4 in accordance with some embodiments;

[0065] FIG. 6 is an exploded view of a WCD with an alternative charging mechanism in accordance with some embodiments;

[0066] FIG. 7 is a perspective view of an alternative design of a WCD in accordance with some embodiments;

[0067] FIG. 8 is an exploded view of the WCD of FIG. 7 illustrating another alternative charging mechanism in accordance with some embodiments;

[0068] FIG. 9A is a perspective view of a charging device for the ring station in accordance with some embodiments;

[0069] FIG. 9B is an abstract diagram illustrating a partial structure of the charging station of FIG. 9A in accordance with some embodiments;

[0070] FIG. 10 is an example screenshot illustrating a user interface of a mobile application coupled to the WCD and displaying fitness monitoring readings in accordance with some embodiments;

[0071] FIG. 11 is an example screenshot illustrating a user interface of a mobile application coupled to the WCD and displaying sensor readings (e.g., for calibration purposes) in accordance with some embodiments;

[0072] Fig. 12A is a perspective view of a wearable computing device (WCD) according to one or more aspects of the disclosure;

[0073] Fig. 12B is a side view of a WCD according to one or more aspects of the disclosure;

[0074] Fig. 12C is a front view of the WCD according to one or more aspects of the disclosure;

[0075] Fig. 12D is a cross section of the WCD along the line A-A of Fig. 12C;

[0076] Fig. 12E is a perspective view of the internal housing without external potting;

[0077] Fig. 12F is a perspective view of the internal housing with a portion of the external potting removed and showing one or more components and printed circuit board (PCB);

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[0078] Fig. 13 is a cross section of a WCD according to another aspect of the disclosure;

[0079] Fig. 14A is a cross section of a WCD according to another aspect of the disclosure;

[0080] Fig. 14B is a perspective view of the PCB and stiffener element of Fig. 14A;

[0081] Fig. 14C is a perspective view of the PCB and stiffener element of Fig. 14A;

[0082] Fig. 14D shows a cross section of the WCD at a point in time when the PCB is being inserted into the internal space and prior to the application of potting;

[0083] Fig. 14E is a cross section of the WCD of after a potting material has been applied subsequent to the WCD of Fig. 14D;

[0084] Fig. 15A depicts a perspective view of a WCD according to another aspect of the disclosure;

[0085] Fig. 15B is ~~a side view~~ an exploded view of the WCD of Fig. 15A;

~~**[0086]** Fig. 15C is an exploded view of the WCD;~~

[0087] Fig. 16A is an exploded view of a housing and a PCB of a WCD according to one or more aspects of the disclosure;

[0088] Fig. 16B is a cross section of Fig. 16A along line B-B;

[0089] Fig. 16C is a perspective view of the WCD with potting material;

[0090]

[0091] Fig. 17A depicts a cross section of a WCD employing charging by concentrated light source according to one or more aspects of the disclosure;

[0092] Fig. 17B depicts a cross section of a WCD employing charging by concentrated light source according to another aspect of the disclosure;

[0093] Fig. 17C is a perspective view of a base assembly and WCD 700 according to one or more aspects of the disclosure;

[0094] Fig. 17D depicts a perspective view of internal components of the base assembly 750 and WCD 700 according to another aspect of the disclosure;

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[0095] Figs. 17E-F depict other CPV configurations according to one or more aspects of the disclosure;

[0096] Fig. 17G is perspective view of a WCD and base assembly with a 1x3 CPV arrangement;

[0097] Fig. 18A depicts a cross section of a WCD 800 employing charging by concentrated light source according to another of the disclosure;

[0098] Fig. 18B depicts a cross section of a WCD employing charging by concentrated light source according to another of the disclosure;

[0099] Fig. 19A depicts a cross section of a WCD employing charging by concentrated light source according to another of the disclosure;

[00100] Fig. 19B depicts a cross section of a WCD employing charging by concentrated light source according to another of the disclosure;

[00101] Fig. 19C depicts a schematic diagram of magnets that can be used in a WCD and/or base assembly according to one or more aspects of the disclosure;

[00102] Fig. 19D depicts a schematic diagram of magnets that can be used in a WCD and/or base assembly according to one or more aspects of the disclosure

[00103] Fig. 19E is a perspective view of a WCD and a base assembly according to one or more aspects of the disclosure;

[00104] Fig. 20A is a cross section of a WCD engaged with a base assembly 1050 according to one or more aspects of the disclosure;

[00105] Fig. 20B is a perspective view of a PCB 1040b with a CPV 1030b and ferrous element 1020b configuration according to one or more aspects of the disclosure;

[00106] Fig. 20C is a perspective view of a PCB with a CPV 1030c and ferrous element 1020c configuration according to one or more aspects of the disclosure;

[00107] Fig. 20D is a perspective view of a magnet and a concentrated light source 1070d according to one or more aspects of the disclosure;

[00108] Fig. 21A is a schematic view of a WCD showing components used for identifying the wearer of the WCD;

[00109] Figs. 21B-C are perspective views of a skin surface according to one or more aspects of the disclosure;

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[00110] Fig. 22A is a perspective view of a user employing ECG monitoring according to one or more aspects of the disclosure;

[00111] Fig. 22B is a view of a human with an electric pathway though his body according to one or more aspects of the disclosure;

[00112] Fig. 22C is a perspective view of a WCD that can employ ECG monitoring according to one aspect of the disclosure;

[00113] Fig. 23A is a perspective view of the hand of a user in various positions employing the navigational features of the WCD;

[00114] Fig. 23B is a flow chart depicting a method of providing feedback to a user according to one or more aspects of the disclosure;

[00115] Fig. 24A is a schematic diagram of a system 1400 for controlling an environment of a user according to one or more aspects of the disclosure;

[00116] Fig. 24B is a side view of a WCD showing one or more temperatures sensors according to one or more aspects of the disclosure

[00117] Fig. 24C is a system diagram of a system for controlling home appliances according to one or more aspects of the disclosure;

[00118] Fig. 24D is a flow chart depicting a method of controlling home appliances according to one or more aspects of the disclosure;

[00119] Fig. 25 is a perspective view of the hand of a user employing a two-factor authentication technique according to one or more aspects of the disclosure;

[00120] Fig. 26A is a schematic view of a charging apparatus for charging the WCD according to one or more aspects of the disclosure;

[00121] Fig. 26B shows a WCD including an RF antenna and charging circuitry;

[00122] Fig. 26C is a block diagram of the charging apparatus according to one aspect of the disclosure;

[00123] Fig. 26D is a schematic view of the charging apparatus of Fig. 26A and the WCD of Fig. 26B according to one or more aspects of the disclosure;

[00124] Fig. 27A is a pictorial diagram and Fig. 27B is a block diagram of a WCD employing flash storage according to one or more aspects of the disclosure;

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[00125] Fig. 28A is a schematic diagram of one or more WCDs performing proximity functions according to one or more aspects of the disclosure;

[00126] Fig. 28B is a schematic diagram of one or more WCDs performing proximity functions according to one or more aspects of the disclosure;

[00127] Fig. 29A is a flow chart depicting a method of initiating gesture input according to one or more aspects of the disclosure;

[00128] Fig. 29B is a chart showing acceleration vs. time as measured by the accelerometer of the WCD;

[00129] Fig. 30 is a perspective view of a WCD 2000 employing a reset function;

[00130] Fig. 31A is a perspective view of a WCD including an LED indicator according to one or more aspects of the disclosure;

[00131] Figs. 31B and 31C are cross sections along line C-C of a WCD employing an LED indicator according to one or more aspects of the disclosure;

[00132] Fig. 32 is flow chart depicting a method of communicating with a near field communication (NFC) device according to one or more aspects of the disclosure;

[00133] Fig. 33A depicts a perspective view of a WCD assembly according to one or more aspects of the disclosure;

[00134] Figs. 33B-D depict exploded views of the WCD assembly of Fig. 33A;

[00135] Fig. 33E depicts a cross sectional view of the WCD assembly along A-A;

[00136] Figs. 34A-B depict a WCD assembly according to one or more aspects of the disclosure;

[00137] Fig. 35A depicts an enclosure or case for storing a WCD according to one or more aspects of the disclosure;

[00138] Fig. 35B is a cross sectional view of the assembled enclosure of Fig. 35A along the line B-B;

[00139] Fig. 35C depicts a cross sectional view of the assembled enclosure of Fig. 35B along line A-A;

[00140] Fig. 36 depicts an enclosure including air vents according to one or more aspects of the disclosure;

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[00141] Fig. 37 depicts a method of sizing a finger according to one or more aspects of the disclosure;

[00142] Fig. 38 is a pictorial diagram showing a plurality of image perspectives of a user's hand;

[00143] Fig. 39 depicts a sizing tool for sizing the finger of a user;

[00144] Fig. 40 depicts a sizing tool for sizing the finger of a user according to an alternate example;

[00145] Fig. 41 depicts yet another alternate example of a sizing tool for sizing the finger of a user;

[00146] Fig. 42 depicts a method of monitoring activity according to one or more aspects of the disclosure;

[00147] Fig. 43 depicts a method of determining whether a user is wearing gloves according to one or more aspects of the disclosure;

[00148] Fig. 44 depicts a method of securing data onboard the WCD according to one or more aspects of the disclosure;

[00149] Fig. 45A is a timepiece system according to one or more aspects of the disclosure;

[00150] Fig 45B is a bottom view of the TCD;

[00151] Fig. 46 depicts a WCD with a pair of LED indicators disposed at an inward-facing portion of the WCD;

[00152] Fig. 47A is a system for generating and managing alerts according to one or more aspects of the disclosure;

[00153] Fig. 47B depicts a block process diagram for generating and managing alerts according to one or more aspects of the disclosure;

[00154] Fig. 47C is a flow chart depicting a method for generating and managing alerts according to one or more aspects of the disclosure

[00155] Fig. 48A is a method for variable sampling according to one or more aspects of the disclosure; Fig. 48B and 48c are graphs depicting one or more aspects of the sample method of Fig. 48A; and

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[00156] Fig. 49 is a diagrammatic representation of a machine in the example form of a computer system within which a set of instructions, for causing the machine to perform any one or more of the methodologies discussed herein, may be executed.

DETAILED DESCRIPTION

[00157] The present disclosure describes a wearable computing device (WCD) that enables a wearable fitness monitor(s)/computer(s) which is suitable for prolonged usage with accurate results. The WCD can be in the form of a ring that can be worn on the finger of a human (or animal) user. Although the WCD of the present disclosure is depicted as a ring that can be worn on the finger of a user, other shapes, designs, and form factors can be utilized for the WCD. For example, the WCD can be in the form of a wrist band, bracelet, necklace, earring, or any other type of wearable accessory. In this regard, references to the finger of a user in the present application can be considered to apply to other portions of a human body depending on the form of the WCD, such as wrist, neck, ear, etc.

[00158] The term "coupled" as used herein means connected directly to or connected through one or more intervening components or circuits. Any of the signals provided over various buses described herein may be time-multiplexed with other signals and provided over one or more common buses. Additionally, the interconnection between circuit elements or software blocks may be shown as buses or as single signal lines. Each of the buses may alternatively be a single signal line, and each of the single signal lines may alternatively be buses, and a single line or bus might represent any one or more of a myriad of physical or logical mechanisms for communication (e.g., a network) between components. The present embodiments are not to be construed as limited to specific examples described herein but rather to include within their scope all embodiments defined by the appended claims.

[00159] FIG. 1A is a perspective view 100 of a WCD 110 illustrating an exterior window 120 in accordance with some embodiments, and FIG. 1B is a perspective view 102 of the WCD 110 of FIG. 1A illustrating an interior window 130.

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[00160] As previously mentioned, it is recognized in the present disclosure that conventional wearable fitness monitors such as clip-on devices, wristbands, or watch-type monitors still often suffer from inaccuracy mainly because they lack constant and consistent ways to read from the body areas they aim to monitor. It can also be an extra burden for the person to remember and wear such conventional fitness monitors each time the person perform exercises in order to create an accurate history tracking the exercise activities.

[00161] Accordingly, the present embodiments of the WCD 110 can function as fitness monitors/computer which is suitable for prolonged usage so as to create accurate results. In addition or as an alternative to fitness monitoring, as will be discussed in more detail below, the WCD 110 can function as a remote input device through, for example, gesture recognition. In some embodiments, the WCD 110 can further function as a sleep monitor, a heart rate sensor, a cardiac monitor a body temperature detector, or the like. It is noted that, for those embodiments which can function as a cardiac monitor (e.g., that measures electrocardiogram (EKG)), it may be necessary to establish a closed loop (e.g., for the electrical measurement of EKG) across the heart. As such, in some of those embodiments, a separate conductive pad can be coupled to the WCD 110 so that a user can pinch the pad with fingers on an opposite hand,

[00162] Specifically, in some embodiments of the present disclosure, the WCD 110 can be worn by the user (e.g., on a finger) for fitness, physical activity, biological data monitoring as well as for gestural input or other suitable purposes. As shown in FIGS. 1A and 1B, the WCD 110 can include the exterior window 120 on its exterior wall for input/output data transmission and reception, battery recharge, or status indication. The WCD 110 can also include the interior window 130 on its interior wall for various monitoring or sensing activities. The form factor of the WCD 110 allows it to be worn for prolonged hours with constant and consistent contact with the skin area, thereby creating a more reliable and extended recording (e.g., as compared to aforementioned conventional fitness monitors) of the user's fitness activity, physical exercise, as well as health information such as heart rates and body temperature. More implementation details regarding the WCD 110 are discussed below.

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[00163] FIG. 1C is a perspective view of an alternative WCD design 112 of the WCD 110 of FIG. 1A in accordance with some embodiments. As shown in FIG. 1C, the WCD 112 includes a second exterior window 124 in addition to a first exterior window 122. The two exterior windows 122 and 124 can include spacing between the two windows 122 and 124 so that the mechanical strength of the housing structure of the WCD 112 may be stronger than that of the WCD 110, which is shown to include one single exterior window 120. Further, in some embodiments, radio antennas (e.g., Bluetooth) or other sensitive circuitry can be positioned in the second exterior window 124 away from the first exterior window 122 so that quality of reception may be improved.

[00164] FIG. 2 is an abstract functional diagram 200 illustrating example components within the WCD (e.g., WCD 110) in accordance with some embodiments. As shown in diagram 200, the WCD 110 can include a processor module 210, a plurality of sensor modules 220, a status indicator module 230, a power generation and management module 240, a communication module 250, a memory 260, and miscellaneous modules 270 (e.g., a real-time clock (RTC) crystal oscillator as illustrated in FIG. 2). The WCD 110 can also include a battery module 280 that provides electrical power for the WCD 110. In some embodiments, the battery 280 can be of a lithium-polymer type or a zinc-polymer type. It is noted that modules illustrated in diagram 200 are for purposes of facilitating a better understanding of the present embodiments; other suitable modules may be included in the WCD 110 and are not shown for simplicity. As used herein, the term "components" is considered to generally include any of the modules depicted and/or described in Fig. 2, as well as any other modules described herein.

[00165] It is noted that the aforementioned modules are intended for purposes of enabling the present embodiments, rather than limiting. As such, a person of ordinary skill in the art will understand that the present disclosure covers apparent alternatives, modifications, and equivalents (e.g., combining or separating the modules) made to the techniques described herein. For example, in some embodiments, a portion of the communication module 250 (e.g., the Bluetooth Chip as shown in FIG. 2) can be

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combined into the processor module 210. For another example, one or more modules herein can be combined into one to form a system-on-the-chip (SOC).

[00166] The processor module 210 can have generic characteristics similar to general purpose processors or may be application specific integrated circuitry that provides arithmetic and control functions to the WCD 110. The processor can be any type of processor, such as a processor manufactured by AMtel, Freescale, Nordic Semiconductor, Intel®, AMD®, or an ARM® type processor. The processor module 210 can include a dedicated cache memory (not shown for simplicity). The processor module 210 is coupled to all modules 220-270 in the WCD 110, either directly or indirectly, for data and control signal transmission.

[00167] The memory 260 may include any suitable type of storage device including, for example, ROM, such as Mask ROM, PROM, EPROM, EEPROM; NVRAM, such as Flash memory; Early stage NVRAM, such as nvSRAM, FeRAM, MRAM, or PRAM, or any other type, such as, CBRAM, SONOS, RRAM, Racetrack memory, NRAM, Millipede memory, or FJG. Other types of data memory can be employed as such are available in the form factor desired.

[00168] In addition to storing instructions which can be executed by the processor module 210, the memory 260 can also store data generated from the processor module 210. It is noted that the memory 260 can be an abstract representation of a generic storage environment. According to some embodiments, the memory 260 may be comprised of one or more actual memory chips or modules. In some embodiments, the memory 260 can function as a temporary storage (e.g., for firmware updates, and/or for avoiding accidental malfunctions (such as so-called "bricking")).

[00169] In accordance with one or more embodiments, the sensor modules 220 can include various sub-modules for the WCD 110 to perform different monitoring or sensing activities. A view 302 of the interior window (e.g., window 130) of a WCD (e.g., WCD 110) with example components exposed is shown in FIG. 3B. As shown in the example of FIG. 3B, the sensor modules 220 can include a temperature sensor 320a, a red light emitting diode (LED) 320b, a light sensor 320c, and an infra-red LED 320d. Among the sensors in the sensor modules 220, those sensors (e.g., sensors 320a-320d) which are

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directly related to biological sign monitoring can be configured and positioned in a way that is close to the skin (e.g., facing the interior window 130 of the WCD 110). Although not shown in FIG. 3B for simplicity, the sensor modules 220 can further include sensors that are not directly related to biological sign monitoring; some examples of these sensors include accelerometers, gyroscopes, vibration, sensors (e.g., a magnetometer or a digital compass), or other suitable sensors (e.g., for gesture recognition). The magnetometer can measure the strength and/or direction of a prevailing magnetic field. In this regard, the magnetometer can be used during global positioning and/or navigation. In particular, the magnetometer can be used to measure a directional heading when the WCD is in motion and can supplement position data where the WCD is out of communication range. In one or more embodiments, the accelerometers in the sensor modules 220 can detect movements in multiple (e.g., 3) dimensions or axes. The accelerometer can measure force of acceleration of the WCD and can measure gestures performed by a user while wearing the WCD. In other examples, the accelerometer can detect acceleration of the user while wearing the WCD. This can permit tracking of activity level, such as steps taken or number of laps swum in a pool.

[00170] The temperature sensor can be any type of sensor that detects temperature, such as a thermistor, PTC, NTC, etc. In another example, the temperature sensor can use IR light emitted from an object to calculate a surface temperature of the object in a manner clear to those of ordinary skill in the art.

[00171] Together, the processor module 210 and the sensor modules 220 can enable the WCD 110 to perform multiple functions including, for example, pedometer, sleep monitor (e.g., which monitors sleep quality), heart rate sensor, pulse oximetry, skin (and in select embodiments, ambient) temperature. In addition, some embodiments of the WCD 110 can further function as a gesture input device. In particular, the present embodiments recognize that the WCD 110 can detect finger motions or gestures which may be difficult for conventional fitness sensors to detect, such as a tap, a snap, a knock on the table, and the like. In some embodiments, the WCD 110 can utilize the accelerometer to measure the activity level (e.g., arm movement) in conjunction with the measured heart rate to determine if the user is walking horizontally, running, swimming,

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or climbing stairs. Other activities can be identified by the WCD 110 may include biking or sleeping.

[00172] In some embodiments, the WCD 110 can also be programmed to learn particular gestures or physical exercise from the user using, for example, a training mode. For example, the user can instruct (e.g., using a computer or a mobile device of the user) the WCD 110 to enter the training mode and perform the gesture or physical exercise; the WCD 110 can record the readings from the sensor modules 220, recognize patterns therefrom, and store the result in, for example the memory 260, so that such gesture or exercise can be recognized by the WCD 110 after the training. The WCD 110 can be configured (e.g., via a mobile application running on a mobile device of the user) so that the recognized gestures can perform functions designated by the user, such as clicks, swipes, unlocks, or media player controls. In one embodiment, the WCD 110 can include near field communication (NFC) chips so that certain functions (e.g., unlocking a smart phone) can be performed when the WCD 110 touches upon or otherwise be detected by another NFC device. In some embodiments, the unlocking function of the WCD 110 can also unlock a user device (e.g., a phone) via the communication module 250 (e.g., Bluetooth) by the WCD 110 transmitting a proper unlock code.

[00173] Moreover, the WCD 110 can function as a key or a control device for keyless access to home, automobile, or other suitable user authentication processes. The WCD 110 can also be integrated with games and game consoles so that it can function as an input device to those games and consoles. In some embodiments, the WCD 110 can be adapted for use in medical and home health monitoring, or as a transportation safety device (e.g., that broadcasts emergency messages to relevant authorities). Additional examples of sensors/functionalities of the WCD 110 can include an inertial measurement unit (IMU) (e.g., for more complex gesture recognition, a near-infrared (NIR) spectrometer (e.g., for measuring light absorption and deriving blood glucose / blood alcohol / CO2 content), a Galvanic skin response sensor (e.g., for measuring sweat / nervousness), an electrocardiogram (ECG or EKG), and so forth.

[00174] In some embodiments, the processor module 210 can determine (e.g., based on identified physical activities, routine pattern, and/or time) a frequency at which

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one or more sensors in the sensor modules 220 should operate. Because it is recognized in the present disclosure that the heart rate of a human being typically does not vary too widely (e.g., beyond a certain percentage of what has been previously measured), in some embodiments, the WCD 110 can automatically adjust the sensor modules 220 (e.g., to slow down) so as to save power. More specifically, some embodiments of the WCD 110 can include a phase-locked loop or logic to predict the pulse width by determining lower and upper ranges in which the heart rate is predicted to be, thus only powering up the sensor modules 220 at the time of the predicted heartbeats. For one example, if the WCD 110 determines that the user is at sleep (e.g., based on the heart rate, the body temperature, together with the movements detected by the accelerometer and/or the vibration detector), the WCD 110 can slow down its heart rate detection frequency (e.g., from 1 measurement per second to 1 measurement per 10 seconds) and skip the measurement of several heartbeats because it is unlikely that the heart rate will change drastically during that period. Conversely, if the WCD 110 determines that the user is performing a high intensity physical exercise, the WCD 110 can increase the frequency of monitoring and recording of the sensor modules 220.

[00175] In accordance with one or more embodiments, the WCD 110 also includes various modules coupled to the processor module 210 for, by way of example but not limitation, input/output data transmission, battery recharge, or status indication. A view 300 of the exterior window (e.g., window 120) of a WCD (e.g., WCD 110) with example components exposed is shown in FIG. 3A. As shown in the example of FIG. 3A, the modules configured to face the exterior window 120 of the WCD 110 can include parts from the status indicator module 230, the power generation and management module 240, and the communication module 250.

[00176] Specifically, one embodiment of the WCD 110 includes the status indicator module 230 coupled to the processor module 210 to indicate various statuses. In some embodiments, the status indicator module 230 includes a light emitting diode (LED) 330, such as shown in FIG. 3A. The LED 330 can be a single red/green/blue (RGB) LED. In other embodiments, the status indicator module 230 can include other suitable types of indicator devices including, for example, a single color LED, an

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electrophoretic ink (or "e-ink") display, a persistent display, or the like. In accordance with some embodiments, the WCD 110 can utilize the indicator module 230 (e.g., via the RGB LED 330 through the exterior window 130) to visually communicate with the user. For example, a red color can be displayed (e.g., for a predetermined period of time) by the LED 330 that the WCD 110 needs to be recharged, and a green color can be displayed to indicate that the WCD 110 is fully charged. For another example, a blue color can be displayed when the communication module 250 is in use. In one or more embodiments, the user can program a fitness goal (e.g., a target heart rate) to the WCD 110 so that, for example, a green color can be displayed when the heart rate is below the target, a yellow color can be displayed when the target is reached, and a red color can be displayed when the heart rate is above a certain percentage of the set target. Some embodiments of the WCD 110 include the communication module 250 for wireless data transmission. Particularly, in some embodiments, the communication module 250 includes one Bluetooth chip and a Bluetooth antenna 350, such as shown in FIG. 3A. One or more embodiments of the WCD 110 also provides the capability of storing activity logs (e.g., in the memory 260). More specifically, fitness activities, exercise histories, as well as recorded biological signs such as heart rate and body temperature, can be stored onboard in the memory 260 of the WCD 110. Each data entry in the activity logs can be time-stamped using, for example, an onboard real-time clock (e.g., which may be included in miscellaneous modules 270). For power saving and other purposes, the activity log can be downloaded (e.g., via the communication module 250) when requested by the user. In other embodiments, the activity log can be pushed (e.g., via email or other suitable means) by the WCD 110 to a user device at a time designated by the user. In some embodiments, the memory 260 can store up to a full week worth of activity logs.

[00177] The WCD 110 can include the power generation and management module 240 for recharging the battery 280 and for providing electrical power to various modules 210-270 in the WCD 110. Particularly, in some embodiments, the power generation and management module 240 includes one or more concentrated photovoltaic (CPV) cells 340, such as shown in FIG. 3A. The CPV cells 340 can be high-efficiency tandem solar cells and can be attached on the flexible printed circuit (e.g., circuit 415, 515). Because

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the small form factor of the embodiments of the WCD 110, CPV cells 340, which can absorb more light energy from a wider spectrum of light than the traditional solar cells, are used. In some embodiments, multiple (e.g., 3) CPV cells 340 can be configured in series to provide sufficient voltage and/or current for charging the battery 280.

[00178] According to some embodiments, the WCD can include one or more sensing or imaging devices that can be any type of device capable of detecting electromagnetic radiation, such as visible light, IR, NIR, UV, etc. In one example, the device is an imaging device, such as a CMOS or CCD camera.

[00179] According to some embodiments, the WCD 110 can be placed or docked into a charging station for recharging. A perspective view 900 of an example charging station 910 for the WCD 110 is shown in FIG. 9A. The charging station 910 can have concentrated light source circumferentially around the WCD 110 so that the user does not have to be concerned with whether the WCD 110 is facing the right direction for charging. Some embodiments of the charging station 910 can include a light distribution means that takes a single light source and distributes the light all around. An abstract diagram illustrating a partial structure of the light distribution means inside the charging device of FIG. 9A is shown in FIG. 9B. It is noted that, even with the charging station 910, for some embodiments, regular outdoor sunlight or other ambient light source can still function as a secondary source of energy so that the CPV cells 340 on the WCD 110 can extend the operational time provided by the battery 280.

[00180] Additionally or alternatively, energy source attached to the power generation and management module 240 can be passive; for example, some embodiments provides that a clip with a concentrator lens can be attached to the WCD 110 in a way such that the power generation and management module 240 can charge the battery 280 using natural sunlight. In an alternative embodiment, gemstone(s) (e.g., sapphire, diamond, or other suitable materials) in the shape of a dome or with faceted protrusion can be configured to concentrate/magnify light energy while also serving as a decorative feature.

[00181] In some alternative embodiments, the power generation and management module 240 can include electromagnetic induction charging coil so that a WCD (e.g.,

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ring 610) can be charged using an inductive charger. FIG. 6 shows an exploded view 600 of such alternative embodiment of WCD with the inductive charging mechanism including the charging coil 640, as well as battery 680, housing 612, and rigid-flex PCBA 615. However, it is noted that there may be a need to manufacture the inductive charging coil 640 in different sizes that correspond to different ring sizes. Further, it is noted that the efficiency of the electromagnetic induction charging mechanism may be adversely affected by the adoption of a metallic housing. Additionally or alternatively, to avoid multiple sized coils mounted to the edge of the ring, the coil can be placed on the inner or outer sides of the ring by positioning the coil beneath a window in the metal housing of the ring.

[00182] In order to achieve optimal power management of the WCD, one or more of the components can be selected to minimize power usage. For example, a processor, memory, or any other component can be selected based on rated power usage. In one example, it may be desirable to select components that draw current on the order of microamps in order to extend the battery life of the WCD and to allow the WCD to perform health/activity monitoring functions between charging sessions.

[00183] In still some other alternative embodiments, the power generation and management module 240 can include thermoelectric generator (TEG) modules so that a WCD (e.g., WCD 710, 810) can be charged by the difference between the body temperature and the ambient temperature. FIG. 7 is a perspective view 700 of such alternative design, and FIG. 8 is an exploded view 800 of the WCD 710 of FIG. 7. Also shown in FIGS. 7 and 8 is an alternative design of the housing for the WCD where the ring includes an outer ring 812a, an inner ring 812b, and insulators 814a and 814b. However, it is noted that utilizing TEGs for charging the battery may be less than ideal since the difference between body temperature and ambient temperature might not be great enough to fully charge the battery, and that in many occasions (e.g., during sleep), the temperature difference needed for TEG to generate electricity may quickly disappear (e.g., since the WCD 710, 810 may be covered inside the comforter).

[00184] The battery can be any type of battery, such as a rechargeable battery. The battery can be a thin, flexible lithium ceramic chemistry battery. In another example, the

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battery can be a circular formed lithium polymer or lithium ion battery. The battery can provide power to any of the components described above. In one example, the battery can be a lithium cell integrated directly with the flexible PCB described above. Other implementations can integrated the battery directly onto the housing to reduce the volume of space taken up by battery packaging.

[00185] The WCD can also include one or more polymer or piezo actuators for providing appropriate haptic or physical feedback and alerts to a user while the user is wearing the ring. The piezo actuator can also provide audible feedback to a user.

[00186] As previously mentioned, the WCD 110 can be used with a software application (e.g., a mobile phone application for the Apple iOS or the Google Android OS) which can run on the user's computing device (e.g., a mobile device such as a smart phone). Specifically, the software application can facilitate the mobile device of the user to couple to the WCD 110 (e.g., via the communication module 250) for data communication, such as downloading activity logs, changing configuration and preferences, training the WCD. The software application can also generate a user interface showing the results or readings from the health and fitness tracking performed by the WCD 110. FIG. 10 is an example screenshot illustrating such user interface 1000 displaying fitness monitoring readings in accordance with some embodiments.

[00187] Further, the WCD 110 can be used for gesture input, and the software application can facilitate the user to customize gesture input and control. FIG. 11 is an example screenshot illustrating such user interface 1100 displaying sensor readings (e.g., for calibration purposes) in accordance with some embodiments. In one or more embodiments, the WCD 110 can also be used directly with other Bluetooth enabled devices such as electronic locks or keyless car entry. In other examples, the WCD 110 can also control other devices via a smartphone and other Wireless LAN enabled devices such as home automation systems.

[00188] FIG. 3C is a view 304 of two exterior windows of an alternative WCD (e.g., WCD 112 of FIG. 3C) with example components exposed in accordance with some embodiments. The components 330, 340, and 350 shown in FIG. 3C function similarly to those components described in FIG. 3A. However, some components (e.g., antenna 350)

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can be positioned to face a different exterior window than the exterior window the rest of the components face. This may increase the mechanical strength of the housing structure of the ring, and/or may reduce signal interference among the components.

[00189] FIG. 4 is an exploded view 400 showing an exemplary WCD 410 (e.g., WCD 110) illustrating a battery 480 and a flexible circuit 415 which are configured to fit inside a housing 412 of the WCD 410. It is recognized by the present disclosure that a human being's finger can come in various different sizes and so should the WCD 410. In order to reduce the cost of manufacturing different sizes of printed circuits, in some embodiments, the modules 210-270 (of FIG. 2) are formed on a flexible or rigid-flex printed circuit (FPC) board, an example 500 of which is shown as FPC 515 in FIG. 5. In particular, one or more embodiments provide that the FPC 515 and the battery 480 are not specific to a ring size, and that the same circuitry and/or battery can fit a multitude of sizes.

[00190] According to some embodiments, the WCD 410 provides a desirable form factor for a user to wear it for a prolonged period of time. The edges and the shape of the WCD 410 can be configured in a way that is comfortable and ergonomic; for example, the finished parts of the embodiments are to be free from burrs and sharp edges. The material which forms the housing portion of the WCD 410 can include medical grade metallic alloys that reduce the likelihood of allergic reactions. Examples of the housing material include stainless steel, tungsten carbide, titanium alloy, silver, platinum or gold.

[00191] In the examples shown in FIG. 4, the U-shape of the ring housing 412 allows for the flexible PCB 415 to be inserted into the edge of the WCD 410. The windows (e.g., windows 120, 130) on the walls of the WCD 410 can align with the operating circuitry to allow, for example, battery charging, Bluetooth connection, and user feedback LED/micro display on the outer wall, and biological feedback sensors (e.g., pulse oximetry, temperature sensor) on the inner wall. In one or more embodiments, the WCD 410 can be completely sealed using potting epoxy. The sealing epoxy can be transparent to allow light to pass through for the CPVs and sensors. In some embodiments, the WCD 410 can be potted with two different compounds. In these embodiments, the body of the WCD 410 can be filled with clear material, and the edge of

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the WCD 410 can be filled with an opaque material so that different colors can be incorporated (e.g., as a decorative element). It is noted that sealing the assembly using potting epoxy can also bring the additional benefit of making the WCD 410 completely or almost completely waterproof as well as increasing the structural rigidity of the WCD 410.

[00192] **I. Internal Housing/External Potting**

[00193] Fig. 12A is a perspective view and Fig. 12B is a side view of a WCD 1200 according to one or more aspects of the disclosure. The WCD 1200 can be in the shape of a ring and can be worn on any of the five fingers (including the thumb) of (typically) a human user. In this regard, the WCD 1200 can define an interior diameter d_1 and exterior diameter d_2. The interior diameter d_1 can be defined as the distance between opposing points on the interior surface of the ring, with the interior surface being the portion of the WCD facing the finger of a user while the device is worn by the user. The interior surface of the WCD can generally define a finger space for receiving the finger of the user. The exterior diameter d_2 can be defined as the diameter between opposing points on the exterior surface of the ring, with the exterior surface being the portion of the WCD opposed to the interior surface and facing away from the finger of the user.

[00194] The interior diameter d_1 and exterior diameter d_2 can be any size to accommodate any finger size. In one example, d_2 is determined by d_1 plus a thickness of any components and/or flexible circuit boards disposed within the WCD. Additionally, although depicted as being circular, the finger space of the WCD 1200 can be any shape, such as ovular, elliptical, or the like, to accommodate users with atypical finger profiles. In these examples, the dimensions of the interior and/or exterior diameter may be measured according to other variables, such as length, width, major diameter, minor diameter, etc. By way of non-limiting example, the WCD interior diameter d_1 (the diameter generally defining the ring size) can be in an approximate range of 12mm to 24mm so as to accommodate finger sizes ranging from a small child to a larger adult, and on any acceptable finger, including the thumb. The exterior diameter d_2 can also be any reasonable size or shape, and can define an approximate range of between 18mm and 30mm. Likewise, the thickness between diameters d_1 and d_2 can vary widely, but can

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typically reside in an approximate range of 1.5mm to 3 mm. The width WR of the WCD along the direction of finger extension (finger longitudinal direction) is widely variable, and can be selected, in part to accommodate internal and external components. In a non-limiting example, the width WR is in a range of approximately 3mm to 8mm.

[00195] The WCD 1200 can include an overall housing 1210 that includes an internal housing 1212 and an external potting or encapsulant 1214. Together, the internal housing 1212 and external potting 1214 combine to form the overall form factor of the WCD 1200, in addition to providing a housing for one or more electronic components stored within the housing 1210 of the WCD 1200, as will be described in greater detail below.

[00196] The internal housing 1212 can be formed of any material, such as a nonconductive material, a conductive material, a ferrous material and/or a nonferrous metal, composite material (e.g. carbon-fiber and/or glass fiber composite) a dielectric material, or a combination of any of the above. In one example, the material of the inner housing 1212 is conductive and nonferrous, such as aluminum, titanium, or stainless steel. In other examples, the internal housing can be formed of a polymer, such as plastic. The external potting 1214 can be formed of any material, solid or gelatinous, that can provide resistance to shock and/or vibration and can prevent moisture and/or debris from entering the housing 1210 of the WCD 1200, such as silicone, epoxy, polyester resin or any other polymer.

[00197] In one example, the external potting 1214 can be transparent. In this regard, the transparent external potting can allow electromagnetic radiation, such as visible, IR, or UV light sources from inside the housing 1210 to pass through the external potting 1214 without the need of a window or discontinuity in the external potting 1214 and without changing the optical properties of the radiation. In the same vein, electromagnetic radiation sources, such as visible, IR, or UV light, external to the housing can pass through the external potting 1214 and can be detected by, sensed by, or fall incident upon internal components of the WCD 1200 without the need for a window or discontinuity in the housing and without changing the optical properties of the radiation. In another example, the external potting 1214 can be tinted. The tint can be

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cosmetic and can prevent the internal components of the WCD to be visible by the user. In this regard, depending on the tint, optical properties of light passing therethough may be slightly changed. For example, certain colors of the light can be filtered and can result in decreased power transmission. The above description regarding external potting 1214 can be applied to any of the pottings described below.

[00198] The internal housing 1212 can define a window 1216. In one example, the internal housing is formed of a material that completely or partially prevents light (or other electromagnetic radiation) from passing through the internal housing 1212. In this regard, the internal housing 1212 can define the window 1216 to allow for such radiation to pass through the housing 1212. As shown, the window 1216 can be generally elliptical-shaped, but can be any other suitable shape according to other examples, such as rectangular, circular, ovular, etc. Since the window 116 is defined by the internal housing 1212, the window 1216 can face the finger of the user while the user is wearing the WCD 1200, which can provide many advantageous features and implementations, as will be described in greater detail below.

[00199] Fig. 12C is a front view of the WCD and Fig. 12D is a cross section of the WCD 1200 along the line A-A of Fig. 12C. As shown, the internal housing 1212 can have a generally U-shaped internal surface 1212a to accommodate one or more internal components and can define a pair of flanges 1212b and 1212c. The external potting 1214 can extend between the flanges 1212b and 1212c of the internal housing to provide an internal space 1220 to accommodate one or more components. By virtue of the external potting 1214, the internal space 1220 defined by the internal surface 1212a and the external potting 1214 can be hermetically sealed, thereby preventing debris, dust, moisture, or any other unwanted fluids or materials from interacting with the internal components of the WCD 1200. Although not depicted, the internal components can reside within the internal space 1220, and the external potting 1214 can be disposed immediately atop the components to provide the seal.

[00200] Fig. 12E is a perspective view of the internal housing 1212 without external potting 1214. As shown, the internal surface 1212a defines a generally U-shaped surface for receiving the components.

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[00201] Fig. 12F is a perspective view of the internal housing 1212 with a portion of the external potting 1214 removed and showing one or more components 1230 and printed circuit board (PCB) 1240. The components and PCB can be constructed as flex circuits, thereby allowing the components 1230 and PCB 1240 to be geometrically configured within the ring shaped internal space 1220. The PCB 1240 can be any type of flexible material clear to those of skill, such as polyimide, PEEK, etc. Additionally, the PCB could be rigid-flex whereby panels of RF4 are connected together with a flexible substrate.

[00202] As shown, the PCB 1240 and the components 1230 can be disposed within the internal space 1220 generally defined by the internal surface 1220a and the flanges 1220b-c. The PCB 1240 can define one or more folding regions 1242 that allow the PCB 1240 to conform to the circumference and/or perimeter of the internal surface 1212a. The PCB 1240 can extend around at least a portion, or up to an entire circumference, of the internal surface 1212a. In one example, the size of the internal diameter d_1 of the WCD can determine the portion of the internal surface 1212a around which the PCB 1240 extends. Illustratively, for a larger ring size and a larger internal diameter d_1, the PCB 1240 can extend only a portion (an arc) of the overall circumference, while for smaller ring sizes a greater portion (arc) of the circumference can be employed to accommodate PCB 1240 and the internal components 1230. The adjacent portions of PCB can form an arc angle therebetween by virtue of the folding regions disposed therebetween, allowing for the PCB to be conform to the internal surface 1212a.

[00203] **II. External Housing/Internal Potting**

[00204] Fig. 13 is a cross section of a WCD 1300 according to another aspect of the disclosure and illustrative embodiments. In this example, the WCD 1300 includes a housing 1310 that includes an external housing 1312 and an internal potting or encapsulant 1314. The external housing 1312 includes an internal surface 1312a that has a generally C-shaped cross section—but alternate cross section shapes, such shapes with an external notch or groove. The external housing includes flanges 1312b-c that extend toward each other, beyond portions of the internal surface 1312a, to define a partially enclosed internal space 1320. In an assembled state, the WCD 1300 can include a

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battery 1330, a PCB 1340, and components 1350, which can be at least partially or completely disposed within the partially enclosed internal space 1320. The internal potting 1314 can extend between the flanges 1312b-c and can seal the partially enclosed internal space 1320. The components can be encapsulated by the internal potting 1314. The PCB 1340 and components 1350 can extend along an inner circumference of the internal surface 1312a

[00205] Illustratively, the external housing 1312 can be formed of the same materials as the internal housing 1212 described above, and the internal potting 1314 can be formed of the same materials as the external potting 1214 described above. As also described above, the internal potting 1314 can be transparent and the external housing 1312 can define one or more windows according to one or more aspects of the disclosure.

[00206] Fig. 14A is a cross section of a WCD according to another aspect of the disclosure and illustrative embodiment. In this example, the WCD 1400 includes a housing 1410,internal surface 1412a, an internal or external housing 1412, an internal or external potting 1414, an internal space 1420, a battery 1430, a flexible circuit 1440, and one or more components 1450. This example is similar to the examples described above with respect to Figs. 12 and 13, except the addition of a stiffener element 1442 and the flanges 1412b-c extend further into the space 1420 toward one another such that the flanges 1412b-c overlap with the stiffener element 1442.

[00207] Fig. 14B is a perspective view of the PCB and stiffener element of Fig. 14A. As shown in FIG. 14B, the stiffener element 1442 extends beyond an overall width *w* of the PCB 1440 and extends wider than a distance between flanges 1412b-c. The stiffener element is disposed between folding regions 1444. The PCB 1440 can include one or more stiffener elements 1442 attached thereto, and the elements 1442 can be disposed periodically (in separated intervals) along a length *l* of the PCB 1440. As shown in Fig. 14C, the stiffener element 1442 can be disposed underneath the flexible circuit 1440, e.g., on a face of the flexible circuit 1440 opposed to the face on which the components 1450 are disposed, and can be permanently or semi-permanently attached thereto. The stiffener element can be implemented in any of the configurations

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described, and in particular, with either the internal housing/external potting arrangement or the external housing/internal potting arrangement.

[00208] The stiffener element 1442 can be formed of any material, such as polyamide or thin FR4, depending on construction of the PCB 1440. In particular, the material of the stiffener can be chosen to be more or less flexible than the PCB 1440. In one example, the stiffener element 1442 can be a polyamide stiffener disposed on a back surface of a flexible PCB. In another example, the stiffener element 1442 can be FR4 and can be substantially flush with respect to the flanges 1412b-c. In this regard, the stiffener element can extend substantially the distance between flanges 1412b-c and may not deform upon insertion into the space 1420. The stiffener element can include surface features disposed on an edge thereof, with the edge facing one of the flanges 1412b-c. The surface features can include a sawtooth profile (e.g., intersecting straight lines at acute angles), or any other type of feature capable of providing an interference fit between flanges 1412b-c.

[00209] Fig. 14D shows a cross section of the WCD at a point in time during assembly/manufacture when the PCB 1440 is being inserted into the internal space 1420 and prior to the application of potting 1414. As shown, the stiffener 1442 contacts the flanges 1412b-c of the housing 1410 by virtue of the width *w* of the stiffener element 1442. Upon an application of force, the PCB 1440 and stiffener 1442 assembly can be inserted into the internal space 1420. In this regard, the stiffener element has a predetermined flexibility that allows for a certain amount of flexion, as shown in Fig. 14D. The flexion allows for the flexible circuit 1440 to be inserted within the internal space 1420 and can prevent the flexible circuit 1440 from being removed or from accidentally falling out once inserted. In this regard, the flexible circuit 1440 is held in place within the space 1420 by virtue of the width of the stiffener element 1442 and the distance between the flanges 1412b-c. Once inserted, the potting 1414 can be applied free of the concern of improper positioning of the flexible circuit 1440.

[00210] Fig. 14E is a cross section of the WCD of after a potting material 1414 has been applied subsequent to the WCD of Fig. 14D.

[00211] **III. Inner/outer bands**

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[00212] Fig. 15A depicts a perspective view of a WCD 1500 according to another aspect of the disclosure. In this example, the WCD includes a housing 1510 that includes an internal housing 1512 and an external housing 1514. The internal housing 1512 can be similar to the internal housing described above with respect to internal housing 1212, and the external housing can be similar to the external housing described above with respect to external housing 1312. The internal housing 1512 can include one or more windows 1516 that can allow electromagnetic radiation (e.g. visible and near-visible light) to pass therethrough, allowing it to fall incident upon components disposed within the housing 1510 and allowing EM radiation sources (e.g. visible light, RF, IR, etc.) within the housing to exit the housing.

[00213] Fig.15B is an exploded view of the WCD 1500. As shown, the WCD can include internal housing and external housing 1512 and1514. The WCD can further include a PCB 1540 and components 1550. Once the housings 1512-1514 are assembled and the PCB 1540 and components 1550 are assembled within space defined between the housings 1512-414, potting layers 1502 and 1504 can be applied to seal the WCD at both sides thereof to ensure a secure seal.

[00214] **IV. Inner/outer bands with U shaped window**

[00215] Fig. 16A is an exploded view of a housing 1610 and a PCB of a WCD according to one or more aspects of the disclosure. The WCD 1600 comprises a housing 1610 with an integral inner wall and outer wall 1612 and 1614. The housing can be made of any material, such as any material described above with respect to the internal/external housing structures. In this example, the inner and outer walls 1612,1614 each define a window in the shape cutaway portions 1616. The cutaway portions are bounded on three sides by the walls 1612 and 1614 and unbounded at the other side thereof. The cutaway portions 1616 can be aligned with one another to ensure transmission of radiation into/out of the housing 1610. The space1620 between the inner and outer walls 1612,1614 can receive a PCB 1640, battery, components, etc.

[00216] Fig.16B is a cross section of Fig.16A along line B-B. As shown, the inner and outer walls 1612,1614 are directly connected by a floor 1618. The space 1620 is defined by the space between the inner and outer walls 1612,1614 and the floor 1618.

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[00217] Fig.16C is a perspective view of the WCD with potting material 1630. As described above, the PCB, battery, and components can be disposed within the space. Once disposed therein, a potting 1630 can be provided atop the components and within the cutaway portion 1616. The potting 1630 can be transparent to allow for transmission of light through the cutaway portions 1616.

[00218] **V. Charging By Concentrated Light Source**

[00219] According to one aspect of the disclosure, the WCD can be charged by an external concentrated light source, e.g., laser light, laser diode, etc. In this regard, the photovoltaic device described above can include a concentrated photovoltaic element (CPV) that is constructed and arranged to receive concentrated light from the concentrated light source, e.g., laser light from a laser diode, light from a light emitting diode (LED), etc., and converting the received concentrated light into an electric current. The photovoltaic device can also generate power from nonconcentrated light sources, such as office lighting and ambient sunlight. The electric current can be used to charge one or more batteries stored within the housing of the WCD.

[00220] Fig.17A depicts a cross section of a WCD employing charging by concentrated light source according to one or more aspects of the disclosure. In this example, the WCD 1700 can include a housing material 1710. The WCD can include a PCB 1720 and a concentrated photovoltaic cell 1730. The WCD can be positioned adjacent a base assembly or base station 1750. The base assembly 1750 can be connected to an external power source 1765 and can have internal circuitry 1760 to power one or more concentrated light sources 1770, e.g., one or more laser diodes and/or one or more LEDs, disposed within the base assembly 1750. In this example, the concentrated light source 1770 comprises one or more laser diodes.

[00221] The base assembly 1750 can define a first opening 1752 at one portion thereof to allow the concentrated light 1780 to exit the housing of the base assembly1750. As shown in the diagram of Fig.17A, the concentrated light 1780 is generated by the concentrated light source 1770 and exits the housing of the base assembly 1750 via a first opening 1752. The concentrated light 1780 then enters into the WCD by a second opening 1712 in the housing of the WCD 1700 where it can fall upon the CPV 1730.

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Once the concentrated laser light falls upon the CPV 1730, the CPV 1730 can convert the incident concentrated light into a current that can be used to directly power one or more components within the WCD and/or can be used to charge one or more rechargeable batteries onboard the WCD.

[00222] The concentrated light source 1770, as described above, can be any type of light source that is arranged to generate concentrated light, such as an LED or a laser diode. The concentrated light can be any type of concentrated and/or coherent electromagnetic radiation, such as laser light and/or LED light. The concentrated light can have any desired intensity or wavelength, according to the characteristics of the CPV 1730.

[00223] In one example, the source 1770 can be a 200 mW laser diode that produces red or green laser light. This can generate approximately 80mW (or typically less) of power in the WCD where the CPV 1730 includes a plurality of groups of photovoltaics configured in series or in parallel with one another. Each group of photovoltaics can include one or more CPV cells. In another example, the CPV can include a single group of photovoltaics.

[00224] The base assembly 1750 described above can include additional components that can interact with the WCD 1700. For example, the base assembly can include one or more antennas that can communicate according to one or more wireless protocols, such as 3G, 4G, WiFi, Bluetooth®, NFC, or the like, for direct or indirect wired or wireless communication with the WCD or mobile device. In addition to the charging methods above, the base assembly can employ inductive charging techniques.

[00225] Fig.17B depicts a cross section of a WCD employing charging by concentrated light source according to another aspect of the disclosure. In this example, the concentrated light source 1770 comprises an LED. Further, the base assembly comprises an optical element 1790 positioned adjacent to the concentrated light source1770 for focusing the LED light onto the CPV inside the WCD. The optical element 1790 can be any type of optical element, such as a lens. The lens can be formed of any material, such as glass, plastic, etc., and can be any type of lens, such as concave, convex, plano-concave, plano-convex, etc. In this example, the optical element 1790

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includes a plano-concave, with the concave portion facing the concentrated light source 1770. In the example where the source 1770 is an LED, the LED emits light in many directions. The optical element 1790 can focus the emitted LED light to focus as much of the LED light as possible onto the CPV of the WCD. The optical element 1790 can be disposed at least partially or completely within the first opening 1752. In some implementations, the optical element may not be necessary due to LEDs with substantially focused light.

[00226] Fig.17C is a perspective view of a base assembly 1750 and WCD 1700 according to one or more aspects of the disclosure. As shown, the WCD 1700 is in the shape of a ring and the base assembly 1750 includes a post 1754 for receiving the ring. The post 1754 can be cylindrical and can be sized and shaped according to an internal diameter of the WCD in order for the WCD to be received on an external surface of the post. The first opening 1752 of the base assembly 1750 is formed on a portion of the post 1754 such that, when the WCD 1700 is stored on the post, the second opening 1712 can be aligned with the first opening 1752 to ensure alignment of the CPV and the concentrated light source. The base assembly can receive/transmit power and/or data via external input/output 1795, which can be a DC power input, a USB input connection or any other acceptable connection/form factor.

[00227] Fig.17D depicts a perspective view of internal components of the base assembly 1750 and WCD 1700 according to another aspect of the disclosure. In this figure, the respective housings of the base assembly and WCD have been omitted, thereby showing a plurality of concentrated light sources 1770, optical elements 1790, and a plurality of CPVs 1730 disposed on mounting substrates 1775 on a PCB. In this example, the WCD can include a plurality of CPVs and the base assembly can include a plurality of sources. This allows for a greater current to be generated during charging and for faster charging times of the WCD. The CPVs and concentrated light sources can correspondingly be disposed in a line, with a constant or variable pitch between respective elements. In this regard, the optical element can include corresponding concavities with the same pitch.

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[00228] Figs.17E-F depicts other CPV configurations according to one or more aspects of the disclosure. As shown in Fig.17E, the CPVs 1730 can be arranged in a 1x4 array, while Fig.17F depicts the CPVs arranged in a 2x2 array. In addition to the examples shown in the above figures, the WCD can include any number of CPVs according to any number of geometric configurations.

[00229] Fig.17G is perspective view of a WCD and base assembly with a 1x3 CPV arrangement. As shown, the WCD can include a 1x3 array of CPVs and the base assembly can include a corresponding 1x3 array of concentrated light sources. As indicated by the arrow, a user can then rotate the WCD on the base assembly in order to align the respective first and second openings, as well as the CPV and concentrated light sources.

[00230] Fig.18A depicts a cross section of a WCD 1800 employing charging by concentrated light source 1870 according to another aspect of the disclosure. In this example, the WCD includes an internal/external housing portion 1810 and an internal/external potting portion 1820, as described above. In this regard, the base assembly 1850 includes a first opening 1852, but is free of a second opening on the WCD. The concentrated light 1880 passes through the transparent potting portion and falls incident upon the CPV cell 1830. In this example, the source can be a laser diode.

[00231] Fig.18B depicts a cross section of a WCD employing charging by concentrated light source according to another of the disclosure. In this example, the concentrated light source 1870 includes one or more LEDs and the base includes one or more optical elements 1890 for focusing the concentrated light 1880. The LEDs may be of different wavelengths to provide power to two or more junctions in the triple junction CPV cell.

[00232] Fig.19A depicts a cross section of a WCD 1900 employing charging by concentrated light source 1970 according to another of the disclosure. In this example, the WCD and/or the base assembly 1950 can employ one or more magnetic and/or ferrous materials to ensure alignment between the concentrated light source and the CPV cell. Such alignment can improve charging efficiency of the WCD.

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[00233] The base assembly includes a first opening 1952 and the WCD includes a second opening 1912 to allow for concentrated light to fall incident upon the CPV 1930. In this example, the second opening is formed on an external housing portion of the WCD. In this arrangement, the base assembly can charge the WCD from an exterior of the WCD, rather than an internal charging method as identified above.

[00234] The WCD can include a ferrous or other suitable (e.g. ferromagnetic) material 1920, such as steel, disposed within the housing 1910. In this example, the ferrous material is disposed in a space defined between an internal housing and an external housing. The ferrous material can surround the CPV.

[00235] The base assembly can include corresponding magnets 1960 that can cause an attractive force between the WCD and the base assembly into an optimal configuration for charging. The magnets can be disposed within the base assembly and can surround the concentrated light source. The magnets 1960 can be formed of a rare earth material, such as neodymium or any other acceptable material that provides a requisite magnetic field strength.

[00236] Fig.19B depicts a cross section of a WCD 1900b employing charging by concentrated light source 1980b according to another of the disclosure. The CPV 1930b of the WCD1900 is charged from an interior portion, such as by a base assembly 1950b with a post 1954b. Similarly, the WCD can include a ferrous material 1920b disposed within the housing1910b and the base assembly1950b can include a magnet 1960b.

[00237] Fig.19C depicts a schematic diagram of magnets 1920c,1960c that can be used in a WCD and/or base assembly, including a CPV 1930d and concentrated light source 1930d, according to one or more aspects of the disclosure. As shown, the magnets and/or ferrous/ferromagnetic materials can be axially polarized, with each having a respective north pole and south pole. In this regard, the WCD can have axially polarized magnets 1920c with a south pole S facing toward the base assembly, and the base assembly can have axially polarized magnets 1960c with a north pole N facing toward the WCD. The attractive force between the north and south poles can ensure alignment of the CPV 1930c of the WCD and the source 1970c base.

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[00238] Fig.1919D depicts a schematic diagram of magnets that can be used in a WCD and/or base assembly according to one or more aspects of the disclosure. In this example, the base assembly includes axially polarized magnet 1960d, with a north pole N facing toward the WCD. The WCD can include ferrous steel 1920d, with an attractive force between the ferrous steel and the north pole of the base assembly magnet.

[00239] Fig.19E is a perspective view of a WCD and a base assembly according to one or more aspects of the disclosure. As shown, the WCD 1900e can be received by a post 1954e of a base assembly 1950e. The respective magnets1960e and/or ferrous materials 1920e are shown in phantom to illustrate their positioning with respect to the WCD and base assembly devices and the CPV1930e as well as the concentrated light source 1970e.

[00240] Fig. 20A is a cross section of a WCD 2000 engaged with a base assembly 2050 according to one or more aspects of the disclosure. In this example, the magnets 2060 can surround the concentrated light source 2070, and the WCD can include a ferrous steel 2020, CPV 2022, and battery 2024 disposed within an internal/external potting 2014 of the WCD. The ferrous steel 2020 can be disposed on a face of the PCB 2040 and can be encapsulated by the internal/external potting 2014. The base assembly can include one or more optical elements 2090 for focusing the concentrated light 2080.

[00241] Fig. 20B is a perspective view of a PCB 2040b with a CPV 2030b and ferrous element 2020b configuration according to one or more aspects of the disclosure. In this example, the ferrous element 2020b comprises a steel ring that can surround a CPV 2030b and can be disposed on the PCB 2040b.

[00242] Fig.20C is a perspective view of a PCB 2040c with a CPV 2030c and ferrous element 2020c configuration according to one or more aspects of the disclosure. In this example, the ferrous element 2020c comprises a plurality of rectangular bars disposed on the PCB. In this way, the ferrous element 2020c can be coated to be reflowed onto the PCB.

[00243] Fig.20D is a perspective view of a magnet 2060d and a concentrated light source 2070d according to one or more aspects of the disclosure. As shown, the magnet 2060d can include a ring that can extend around a circumference of the concentrated light

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source 2070d. The magnetic ring can be attracted to the ferrous steel ring and/or the rectangular ferrous steel examples set forth in 20A-C above.

[00244] In some examples, the WCD can be adapted to uniquely identify the wearer of the WCD using, for example biometric features unique to the user.

[00245] Fig.21A is a schematic view of a WCD 2100 showing components used for identifying the wearer of the WCD. As shown, the WCD2100 can include one or more infrared illumination sources 2110 and an infrared CMOS imaging device 2120. The finger 2190 can extend through the finger space of the WCD and the IR source 2110 can illuminate a portion of the skin of the finger 2190. The IR CMOS imaging device 2120 can receive light that has been reflected from the skin surface and produce an image of the skin of the finger 2190. As shown, the IR source2110 and the imaging device 2120 are positioned near the interior surface of the WCD, e.g., the surface facing the skin of the finger. The IR illumination can pass through a window provided on the interior housing or can pass through a transparent potting material.

[00246] During the imaging process, the WCD 2100 can be rotated about an axis passing through the center of the finger space and along the longitudinal direction of the finger. In this regard, the imager 2120 can capture a larger swath of the skin surface than if the WCD 2100 were held stationary with respect to the finger during the imaging process.

[00247] At the time of first use, or any time thereafter, the user can generate a reference capillary map in order to identify himself/herself as the authorized user of the WCD. As described above, the user can rotate the WCD around the finger to capture image data of an analyzed section of skin 2192 and on or more capillaries 2194 of the user currently wearing the WCD. The image data can correspond to an overall analyzed section of the skin 2196 of the wearer. The image data of the capillaries can be used to generate a reference capillary map of the wearer, which can be stored in the memory, such as flash memory or EEPROM, of the WCD.

[00248] When the same user puts the WCD on his or her finger after generation of the reference capillary map, the WCD can capture image data of the wearer's skin surface that can be compared to the reference capillary map stored in the memory. In this regard,

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the user need not rotate the device around the finger. Instead, the WCD can compare a subset of the gathered image data to a corresponding subset of reference capillary map. If there a match, within a predetermine error tolerance, the WCD can uniquely identify the wearer as an authorized user of the WCD and as the unique individual who generated the reference capillary map. Once authorized, the wearer can have access to certain functions, features, data, or other content that is not otherwise available without authorization. In another example, the identification can be a step in a transaction or other type of authorization, such as an electronic payment, bank transaction, etc. If the gathered data does not match the reference capillary map, then the user may be prevented from accessing certain features on the WCD.

[00249] Illustratively, the comparison process between sensed capillaries and some or all of the capillary map can be implemented using basic pattern recognition algorithms (processes) instantiated in the electronics of the WCD. Such processes can rely on edge detection and similar techniques that should be clear to those of skill in the art and can be sourced from various commercial vendors of biometric recognition software.

[00250] In another example, the illumination can include NIR illumination and can project radiation into the skin of the finger. The reflected NIR illumination can then be analyzed to determine one or more characteristics of the blood, such as blood alcohol levels, blood glucose levels, and blood oxygenation levels. In this regard, the WCD analyzes the reflected radiation to identify wavelengths that were absorbed from the projected radiation by the blood of the user. Techniques and processed used in conjunction with commercially available venous oximeters (for example) can be employed to undertake certain readings.

[00251] Fig. 22A is a perspective view of a user employing ECG monitoring according to one or more aspects of the disclosure. In this example, the user can wear the WCD2200 on a first finger 2210 of first hand 2220, and can touch a second finger 2230 of a second hand 2240 to an exterior surface of the WCD 2200. This can provide an electric pathway 2250 through the body, as shown in FIG. 22B, allowing for the transmission of electrical current between distant portions of the body.

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[00252] Fig. 22C is a perspective view of a WCD that can employ ECG monitoring according to one aspect of the disclosure. In this example, the WCD 2200 includes an internal/external housing 2250 with a conductive pad2260. The conductive pad 2260 can be electrically isolated from the external/internal housing 2250 of the WCD, thereby providing distinct and isolated electrical contacts on the WCD. The internal/external housing 2250 can be in electrical communication with the first finger2210 of the first hand, while the conductive pad 2260 can be in electrical communication with the second finger 2230 of the second hand. In this regard, an electrical path 2250 is formed through the respective hands 2220, 2240 and through the rest of the user's body, particularly through the chest. In this regard, the WCD can take various electrical measurements of the user, such as ECG. The ECG measurement can include measurements of the various waveforms, such as P-U waveforms. The WCD can store such ECG data in a memory and/or can communicate the data to a wirelessly connected mobile device. In another example, the WCD can employ electrically isolated internal and external housings, such as those described above. In this regard, the conductive pad may not be utilized, and the user can wear the WCD on a first finger and apply the second finger anywhere on the external housing.

[00253] The WCD can also serve as a monitor for those who are mobility impaired or who are prone to falls, such as disabled persons and/or retired persons. The accelerometer onboard the WCD detect a fall of the user via a sudden change in acceleration data. The WCD, in conjunction with a mobile device and/or one or more base stations positioned around the home of the user, can determine the position of the user within the house. For example, the mobile device can employ GPS capabilities, and either the mobile device or the base stations can use GPS in combination with WiFi signal strengths to determine the location of the user within the house. The WCD can then issue an alert, either directly on indirectly (via the mobile device or base station) to a third party that a fall has occurred. The alert can be a phone call, text message, e-mail, or any other type of communication. The third party can then take appropriate measures to aid the fallen user.

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[00254] The WCD can also monitor heart rate and/or temperature, in addition to the other monitored characteristics described above. If any of the monitored characteristics is abnormal, e.g., measured parameters outside of a predetermined threshold range, an alert can be sent to a third party. In some examples, the third party can be a medical health professional, such as a doctor, nurse, caretaker, etc. It is noted that, for those embodiments which can function as a cardiac monitor (e.g., that measures electrocardiogram (EKG)), it can be necessary to establish a closed loop (e.g., for the electrical measurement of EKG) across the heart. As such, in some of those embodiments, a separate conductive pad or other skin-contacting structure/probe can be coupled to the WCD so that a user can pinch the pad with fingers on an opposite hand.

[00255] Since the WCD has the form factor of a ring, the WCD is designed to be worn over long periods of time by a user with little to no discomfort or interference. In this regard, the WCD can monitor the above-described, monitored characteristics over long periods of time (e.g. weeks, months, etc.), and determine trends in the data. For example, the WCD can measure heart rate over a long period of time and determine a unique resting heart rate for a user. If the user's heart rate deviates from the resting heart rate, the WCD can be arranged to issue an alert to a third party. In one specific example, the WCD can use appropriate processes to analyze both the trends of monitored characteristics, as well as current accelerometer data. In this way, if a person's heart rate deviates from a resting heart rate, but the accelerometer indicates that the user is exercising and/or engaging in strenuous activity that provides an equivalent workout, then the WCD may not issue an alert in this circumstance.

[00256] Fig.23A is a perspective view of the hand of a user in various positions employing the navigational features of the WCD. As described above, the WCD can communicate with a mobile device though one or more wireless communication protocols. The mobile device can include a processor and a memory and can execute a map application/process that can provide turn-by-turn walking or driving directions to the user based on the user's GPS location. A portion of those directions can include information regarding heading, distance to travel at that heading, waypoints, and the direction of next turn. By way of the wireless communication, the mobile device can

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communicate one or more of pieces of information relating to directions, such as the heading. Once the heading is received the WCD, the WCD can give feedback to the user regarding the actual heading measured by the onboard magnetometer and the heading set forth in the direction information. In one example, the feedback can be haptic or physical feedback provided by one or more actuators, such as the actuators 670 described above.

[00257] Fig. 23A depicts a user's hand in various positions of navigation, each hand including a WCD worn thereon. In this example, the heading provided by the mobile device is the heading 2335, which represents the direction in front of the hand position2330. In this regard, if the user gestures, e.g., points a ring finger, in the direction of the correct heading, the WCD 2300 can give feedback to the user indicating the correct heading. The feedback can include, for example, an LED indicator 2310 showing a green visible light. In the example of hand position2320, the finger is gesturing in a direction to the left of the correct course 2325. In this way, the WCD 2300 can provide feedback to correct the heading of the user. Such feedback can include illumination of an LED indicator showing (e.g.) a red visible light. Similarly, hand 2340 is gesturing in direction 2345, which is to the right of the correct/appropriate direction. The WCD can provide (e.g.) a blue indicator informing the user to change heading.

[00258] Fig.23B is a flow chart 2300B depicting a method of providing feedback to a user according to one or more aspects of the disclosure. At block 2310B, a user can establish a communication link between a WCD and a mobile device. At block2320B, the user can generate or request a set of directions at the mobile device, including information/data regarding heading, distance to travel at that heading, and the direction of next turn. At block 2330B, the mobile device can transmit at least one of the information items/datum regarding heading, distance to travel at that heading, and the direction of next turn. At 2340B, the WCD can take a measurement of heading by measuring a heading associated with an explicit gesture by the user's finger donning the ring. Such gesture can include pointing in a proposed heading of travel. At block 2350B, the WCD can compare the measured or proposed heading to the correct heading provided by the mobile device. At 2360B, the WCD can provide feedback to the user based on the comparison at 2350B, e.g., if the user is gesturing in the correct direction, a green LED

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indicator may appear. In other examples, if the gesture is in a direction that does not correspond with the correct direction, a (e.g.) blue or red indicator can appear. In one specific example, indicators representing left and right course alterations can be different so a user can easily discern a correct direction of travel.

[00259] Fig. 24A is a schematic diagram of a system 2400 for controlling an environment of a user according to one or more aspects of the disclosure. As shown, the WCD can be connected, wired or wirelessly, to one or more appliances in the home of a user. The system 2400 can include a WCD 2410, a thermostat 2420, a wireless access point (e.g., WiFi router) 2430, and a mobile device 2440. The WCD can be wirelessly connected (e.g., link 2415) to both the thermostat and the mobile device by any type of wireless communication protocol, such as Bluetooth. The access point can be wirelessly connected to the thermostat and the mobile device by any type of wireless communication protocol, such as WiFi. It is noted that a wide range of commercially available appliances, thermostats, lighting controllers, home controllers, and the like, can interface with the WCD using WiFi or another conventional/proprietary communication protocol, as described further below.

[00260] The WCD 2410 can include one or more temperature sensors. In one example, the WCD can include at least one internal facing temperature sensor 2410a and an at least one outward facing temperature sensor 2410b, as shown at Fig. 24B. The inward facing temperature sensor 2410a can be near the skin of a user when the user is wearing the ring, and can therefore measure the skin temperature of the user. The outward facing temperature sensors 2410b can be disposed away from the finger of the user, and can therefore be arranged to measure an ambient temperature of the room in which the user currently resides with sufficient thermal isolation from the user's hand and his/her body heat. In particular, in order to ensure accurate ambient temperature measurements, the WCD can employ a combination of multiple light sensors 2410c and outward facing temperature sensors 2410b. In this regard, the temperature sensor 2410b associated with the light sensor 2410c that receives the most light can be the most accurate, as it is most likely that this sensor is furthest from the finger or palm of the user. In another example, the WCD can employ multiple outwardly facing temperature sensors

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