

[0252] In some embodiments, the operation on the second electronic device (e.g., 600B) includes capturing biometric data (e.g., using a biometric sensor of the second electronic device). In some embodiments, the biometric data that is captured by the second electronic device (e.g., 600b) is heart-related data (e.g., ECG data, BPM data).

[0253] In some embodiments, the first portion of the tutorial includes a plurality of graphical indications of possible results (e.g., 620, 622, 624, 626, heart rhythm evaluation results, heart rate measurements) of the operation (e.g., an ECG recording operation, a BPM measurement operation) performed on the second electronic device (e.g., 600b).

[0254] In some embodiments, the operation is evaluating a medical characteristic (of the user) including a heart rhythm evaluation (e.g., an electrocardiogram reading) and a heart rate evaluation (e.g., a BPM reading), and the possible results are selected from the group consisting of: a normal result (e.g., for the heart rhythm evaluation and/or for the heart rate evaluation), an abnormal heart rhythm pattern result (e.g., signs of Atrial Fibrillation), an abnormal heart rate result (e.g., BPM above a high threshold or below a low threshold, such as BPM over 150 or BPM below 50), and an inconclusive result (e.g., based on a poor reading).

[0255] In some embodiments, while displaying at least a first possible result (e.g., 624) of the possible results, where the first possible result includes a portion of (the text of) a first result summary (e.g., 624B, text summarizing medical characteristics related to the respective result), the first electronics device (e.g., 600A) detects, via the one or more input devices, a user activation of an expand affordance (e.g., 624C) associated with the first result summary. Providing the expand affordance while displaying at least the first possible result of the possible results, where the first possible result includes the portion of the first result summary improves visual feedback by indicating to the user that only a portion of the first result summary is not currently displayed, and that the expand affordance can be selected to cause all of the first result summary to be displayed. Providing improved visual feedback to the user enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently. In some embodiments, in

response to detecting the user activation of the expand affordance (e.g., 624C), the first electronic device (e.g., 600A) displays, on the display (e.g., 602), all of (the text of) the first result summary.

[0256] In some embodiments, the plurality of graphical indications of possible results (e.g., 620, 622, 624, 626) include a first graphical indication (e.g., 620) that includes display of a first animation (e.g., 620A) related to a first possible result and a second graphical indication (e.g., 622) that includes a second animation (e.g., 622A) related to a second possible result, and the first animation and the second animation are synchronized. In some embodiments, the first animation and the second animations are dynamic animations that include a beating heart animation and tachogram-like features that depict a rhythm and rate of a heartbeat.

[0257] In some embodiments, while displaying, on the display (e.g., 602), the plurality of graphical indications (e.g., 620, 622, 624, 626) of possible results, the first electronic device (e.g., 600A) detects, via the one or more input devices, a scrolling gesture (e.g., a scroll on the touch layer of the display). In some embodiments, in response to detecting the scrolling gesture, the first electronic device (e.g., 600A) scrolls the plurality of graphical indications (e.g., 620, 622, 624, 626). In some embodiments, the first electronic device (e.g., 600A) displays, on the display (e.g., 602), a third graphical indication (e.g., 624) that includes a third animation (e.g., 624A) related to a third possible result, where the third animation is synchronized with the first animation (e.g., 620A) and the second animation (e.g., 622A).

[0258] In some embodiments, the first animation (e.g., 620A) includes a first portion of the animation (e.g., beating heart) that is animated at a fixed location and a second portion of the animation (e.g., dot) that animatedly moves from the fixed location to a second location. In some embodiments, the object follows a tachogram-like pattern when leaving the heart-shaped animation. In some embodiments, a first object of the first dynamic animation and a second object of the second dynamic animation repeatedly (continuously) leave their respective heart-shaped animations synchronously. Providing an animation (e.g., first animation 620A) for a graphical indication (e.g., one of 620, 622, 624, 626) of possible results improves visual feedback by indicating to the user that the operation discussed by the tutorial relates to heart monitoring, as shown in the animation, and providing visual guidance as to how each possible

result derived from the heart monitoring operation differ. Providing improved visual feedback to the user enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0259] In some embodiments, the first portion of the tutorial (e.g., 614, 616, 618, 630, 632) includes a limitations indication (e.g., 630, explaining to the user the limits of the operation, showing a list of medical characteristics that cannot be determined by the operation) that includes one or more medical characteristics that cannot be derived from the operation. Providing the limitations indication (e.g., 630) in the first portion of the tutorial improves visual feedback by visually indicating to the user, during the setup process (such that the user is more likely to be made aware), the one or more medical characteristics that cannot be derived from the operation. Providing improved visual feedback to the user enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0260] The first electronic device 600A receives (716) (e.g., after the user has carried out the instructions on the second electronic device (e.g., 600B), via a wireless radio communication between the devices), from the second electronic device (e.g., 600B), an indication that the instructions have been carried out (on the second electronic device).

[0261] In some embodiments, prior to receiving (e.g., via a wireless radio communication between the devices), from the second electronic device (e.g., 600B), the indication that the instructions have been carried out, the first electronic device (e.g., 600A) receives (712), from the second electronic device (e.g., 600B) (e.g., via the wireless radio communication between the devices), an indication that the instructions have begun to be carried out (on the second electronic device). In some embodiments, in response to receiving the indication that the instructions have begun to be carried out, the first electronic device (e.g., 600A) displays (714), on the display (e.g., 602), an indication (e.g., 820, a “recording in progress” page of the tutorial)

that the instructions are being carried out on the second electronic device. Displaying, on the display (e.g., 602), the indication that the instructions are being carried out on the second electronic device (e.g., 600B) in response to receiving the indication that the instructions have begun to be carried out enhances visual feedback by visually indicating to the user that the operation is being successfully carried out on the second electronic device (and thus that the setup process is proceeding along as intended). Providing improved visual feedback to the user enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0262] In response to receiving the indication that the instructions have been carried out, the first electronic device (e.g., 600A) displays (718), on the display (e.g., 602), a second portion of the tutorial (e.g., 828, a “completion” page) that is different from the first portion. Displaying, on the display (e.g., 602), the second portion of the tutorial that is different from the first portion in response to receiving the indication that the instructions have been carried out improves visual feedback by indicating to the user that the operation performed on the second electronic device has been completed (e.g., and thus that the setup process has been successfully completed and that the operation is available for future use). Providing improved visual feedback to the user enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0263] In some embodiments, the second portion of the tutorial (e.g., 828, a “completion” page) includes a graphical animation (e.g., a tachogram-like animation) that represents (biometric) information obtained from the operation on the second electronic device.

[0264] In some embodiments, after displaying, on the display (e.g., 602), the second portion of the tutorial (e.g., 828), the first electronic device (e.g., 600A) displays (720), on the display (e.g., 602), a user interface of a health application (e.g., 650, 656, 660).

[0265] In some embodiments, the first electronic device (e.g., 600A) detects (722), via the one or more input devices, a user activation of an affordance (e.g., 658A, an ECG affordance) for viewing recorded biometric information (e.g., recorded ECG and BPM readings). In some embodiments, the affordance (e.g., 658A) for viewing existing recordings of biometric information includes an indication of a number of existing recordings of biometric information (e.g., a number of recorded ECG and/or BPM readings). Providing the indication of the number of existing recordings of biometric information in the affordance for viewing existing recordings of biometric information improves visual feedback by conveniently conveying to the user the number of existing recordings that can be viewed in the health application. Providing improved visual feedback to the user enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0266] In some embodiments, in response to detecting the user activation of the affordance (e.g., 658A) for viewing existing recordings of biometric information, the first electronic device (e.g., 600A) displays (724), on the display (e.g., 602), a first plurality of representations (e.g., 662A-662C) corresponding to existing recordings of biometric information. In some embodiments, a representation of an existing recording of biometric information (e.g., 662A-662C) includes a tachogram corresponding to the recording, an evaluation result of the recording, the number of symptoms (if any) associated with the recording, and a heart rate (BPM) recorded by the recording. Displaying, on the display (e.g., 602), the first plurality of representations (e.g., 662A-662C) corresponding to existing recordings of biometric information in response to detecting the user activation of the affordance for viewing existing recordings of biometric information improves visual feedback by conveniently providing to the user representations of some existing recordings (e.g., some of the most recent recordings) that may be of most relevance to the user. Providing improved visual feedback to the user enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device)

which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0267] In some embodiments, the first plurality of representations of existing recordings of biometric information (e.g., 662A-66C) include a first representation (e.g., 662C) corresponding to a first existing recording with an abnormal evaluation result (e.g., an abnormal heart rhythm, such as a Atrial Fibrillation condition), where the first representation (e.g., 662C) includes an indication of the abnormal evaluation result that is displayed with a first visual characteristic (e.g., highlighted with a warning color, such as yellow). In some embodiments, the plurality of representations of existing recordings of biometric information (e.g., 662A-66C) include a fourth representation (e.g., 662A) corresponding to a fourth existing recording with a normal evaluation result, and the fourth representation includes an indication of the normal evaluation result that is displayed with a second visual characteristic (e.g., a default color) different from the first visual characteristic.

[0268] In some embodiments, the first plurality of representations of existing recordings of biometric information (e.g., 662A-66C) include a second representation (e.g., 662A, 662B) corresponding to a second existing recording associated with user-specified symptoms, where the second representation includes an indication of the number of user-specified symptoms associated with the second existing recording (e.g., “2 Symptoms,” “No Symptoms”). In some embodiments, the first plurality of representations of existing recordings of biometric information (e.g., 662A-66C) include a third representation (e.g., 662C) corresponding to a third existing recording not associated with any user-specified symptoms (e.g., because the user did not specify any symptoms for the recording), where the third representation does not include an indication of user-specified symptoms associated with the third existing recording. Providing the second representation (e.g., 662A, 662B) corresponding to the second existing recording associated with user-specified symptoms improves visual feedback by conveniently indicating to the user whether or not (and if yes, how many) symptoms were previously selected by the user for the recording (e.g., thereby allowing the user to quickly recognize whether a particular recording by correspond to a more serious reading, if there are many user-specified symptoms associated with the recording). Providing improved visual feedback to the user enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the

user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently. In some embodiments, the user-specified symptoms cannot be modified after the symptoms have been specified and saved (by the user on the second electronic device).

[0269] In some embodiments, further in response to detecting the user activation of the affordance (e.g., 658A) for viewing recorded biometric information, the first electronic device (e.g., 600A) displays (726), on the display (e.g., 602), a plurality of sort affordances (e.g., 664A-664H, to filter visible recordings by the type of evaluation results, such as normal results, abnormal heart rhythm results, or abnormal heart rate results) including a first sort affordance and a second sort affordance. In some embodiments, the first sort affordance includes an indication of a number of existing recordings of biometric information associated with the first type of evaluation result, and the second sort affordance includes an indication of a number of existing recordings of biometric information associated with the second type of evaluation result. In some embodiments, the first electronic device (e.g., 600A) detects (728), via the one or more input devices, a user activation of the first sort affordance.

[0270] In some embodiments, in response to detecting the user activation of the first sort affordance, the first electronic device (e.g., 600A) displays (730), on the display (e.g., 602), a second plurality of representations (e.g., by replacing the first plurality of representations) corresponding to existing recordings of biometric information, where the second plurality of representations correspond to existing recordings associated with a first type of evaluation result (e.g., a normal result, an abnormal heart rhythm result, an abnormal heart rate result, an inconclusive result). In some embodiments, the first electronic device (e.g., 600A) detects (732), via the one or more input devices, a user activation of the second sort affordance.

[0271] In some embodiments, in response to detecting user activation of the second sort affordance, the first electronic device (e.g., 600A) displays (734), on the display (e.g., 602), a third plurality of representations (e.g., by replacing the first plurality of representations) corresponding to existing recordings of biometric information, where the third plurality of representations correspond to existing recordings associated with a second type of evaluation

result. In some embodiments, the second and third plurality of representations have corresponding overlapping existing recordings, if one or more existing recordings are associated with both the first type of evaluation result and the second type of evaluation result.

[0272] In some embodiments, the first electronic device (e.g., 600A) detects, via the one or more input devices, a user selection of a first representation (e.g., 662A) of the first plurality of representations (e.g., 662A-66C) corresponding to a first existing recording corresponding to a first evaluation result. In some embodiments, in response to detecting the user selection of the first representation, the first electronic device (e.g., 600A) displays a first details view (e.g., 666) of the first existing recording.

[0273] In some embodiments, while displaying the first details view (e.g., 666) of the first existing recording, the first electronic device (e.g., 600A) detects, via the one or more input devices, a user activation of an information affordance (e.g., 670, an “i” icon). In some embodiments, in response to detecting the user activation of the information affordance (e.g., 670), the first electronic device (e.g., 600A) displays, on the display (e.g., 602), a result summary (e.g., text summarizing medical characteristics related to the respective result) and an animation from a corresponding possible result from the first portion of the tutorial (e.g., where the possible result from the tutorial corresponds to the evaluation result of the first existing recording).

[0274] In some embodiments, while displaying the first details view (e.g., 666) of the first existing recording corresponding to a first evaluation result, the first electronic device (e.g., 600A) detects, via the one or more input devices, a user activation of an export affordance (e.g., 672, marked as “share as a PDF”). In some embodiments, in response to detecting user activation of the export affordance (e.g., 672), the first electronic device (e.g., 600A) creates (and subsequently transmitting to an intended recipient) a document that includes information concerning the first existing recording (e.g., information about the user, date and time of the recording, a tachogram of the (ECG) recording, the evaluation result of the recording). In some embodiments, the biometric data (e.g., ECG data) of the recording is included in the document without any filtering (of the data from the recording). (Automatically) generating and (automatically) transmitting the document (to an intended recipient) in response to detecting the user activation of the information affordance reduces the number of inputs needed from the user

to create a transmittal document summarized a recording and subsequently transmitting the document to an intended recipient. Reducing the number of inputs needed to perform an operation enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently. In some embodiments, the user-specified symptoms cannot be modified after the symptoms have been specified and saved (by the user on the second electronic device).

[0275] Note that details of the processes described above with respect to method 700 (e.g., FIGS. 7A-7C) are also applicable in an analogous manner to the methods described below. For example, method 900 optionally includes one or more of the characteristics of the various methods described above with reference to method 700. For another example, method 1100 optionally includes one or more of the characteristics of the various methods described above with reference to method 700. For another example, method 1300 optionally includes one or more of the characteristics of the various methods described above with reference to method 700. For another example, method 1500 optionally includes one or more of the characteristics of the various methods described above with reference to method 700. For brevity, these details are not repeated below.

[0276] FIGS. 8A-8S illustrate exemplary user interfaces for recording biometric information for use in health monitoring. The user interfaces in these figures are used to illustrate the processes described below, including the processes in FIGS. 9A-9B. The exemplary user interfaces in these figures relate generally to monitoring health using recorded biometric information, and are not limited to a specific type of biometric information. Only for the sake of convenience, the exemplary user interfaces in these figures are described with reference to a type of biometric information—electrocardiogram (hereinafter “ECG”) information.

[0277] FIG. 8A illustrates a first electronic device 800A (e.g., corresponding to second electronic device 600B). In some embodiments, first electronic device 800A is a smartwatch. In some embodiments, first electronic device 800A has a display 802 and one or more input devices (e.g., including a touch layer of display 802 and one or more mechanical buttons, such as a

rotating crown). In some embodiments, first electronic device 800A includes one or more biometric sensors (e.g., for recording ECG information, for detecting heart rhythm and heart rate of the user) comprising one or more electrodes integrated in an input device 804 (e.g., a mechanical input device, such as a depressible, rotating crown) of first electronic device 800A. In some embodiments, the one or more biometric sensors of first electronic device 800A further comprise one or more electrodes of (e.g., integrated in) a housing portion (e.g., the backplate) of first electronic device 800A, where the one or more electrodes integrated in the input device operate in conjunction with the one or more electrodes of the housing portion to capture biometric information (e.g., ECG information). Features concerning the one or more biometric sensors of first electronic device 800A used to capture biometric information (e.g., ECG information) is described in greater detail in Appendix A.

[0278] FIG. 8A illustrates first electronic device 800A displaying, on display 802, a user interface 806 of an ECG application (e.g., corresponding to user interface 644 of the ECG application described with reference to FIGS. 6A-6AE).

[0279] In some embodiments, similar to user interface 644, user interface 806 includes an animation 808 (e.g., a fluid animation, corresponding to animation 646 of user interface 644) that depicts a particular shape (e.g., a heart). In some examples, as shown in FIG. 8A, animation 808 comprises a plurality of dynamic objects (e.g., circular objects) that form the particular shape (e.g., a heart), where the shape appears three-dimensional and is visually fluid as the plurality of dynamic objects constantly move while maintaining the structure of the shape.

[0280] In some embodiments, while displaying animation 808 in the particular shape (e.g., a heart), user interface 806 displays a notification message 810 (e.g., corresponding to notification message 648 of user interface 644) indicating to the user that an action must be performed (by the user) on the device to proceed with an ECG recording (to capture heart rhythm and heart rate information). In some embodiments, notification message 810 instructs the user of the type of input (e.g., a touch or contact on the input device that is below a threshold amount such that the input does not “click” the input device) and that the input must be maintained on the input device (e.g., for the duration of the recording).

[0281] In some embodiments, prior to displaying user interface 806 of the ECG application (e.g., while first electronic device 800A is displaying a user interface of a different application or the display is off), the device detects (e.g., using a second biometric sensor that measures heart rate information without user input) heart rate information of the user for a period of time (e.g., 1 minute) and determines that the detected heart rate is above a threshold rate (e.g., above 150 BPM). In some embodiments, upon detecting that the detected heart rate is above the threshold rate for at least the period of time, the device displays, on display 802, a notification informing the user of the (continuous) high heart rate and requests that the user monitor his or her heart health using the ECG application.

[0282] In FIG. 8B, while displaying, on display 802, user interface 806 of the ECG application, first electronic device 800A detects a user input 801 on input device 804 in accordance with the instructions from notification message 810. In some embodiments, user input 801 is a continuous touch or contact on the input device that is below a threshold amount (e.g., an input that does not “click” the input device). In some embodiments, upon detecting (and continuing to detect) user input 801 on input device 804, the plurality of dynamic objects forming animation 808 transition from their initial pattern (e.g., of a shape) towards a different pattern, as shown in FIG. 8B. In some embodiments, upon detecting (and continuing to detect) user input 801, first electronic device 800A ceases to display, on display 802, notification message 810.

[0283] FIG. 8C illustrates first electronic device 800A continuing to detect user input 801 on input device 804. In some embodiments, while continuing to detect user input 801 on input device 804, the plurality of dynamic objects forming animation 808 continue to transition toward and begin to form a different pattern (e.g., a grid of a tachogram). In some embodiments, first electronic device 800A displays, in user interface 806 (e.g., below animation 808), a timer 810 (e.g., a countdown timer of a predetermined amount of time, such as 30 seconds) that indicates the amount of time remaining to complete the ECG recording. In some embodiments, first electronic device 800A displays, in user interface 806 (e.g., below timer 810), a notification message 812 instructing the user to maintain the input on input device 804 (e.g., stating “Touch the crown and try to hold still”) to successfully complete the ECG recording.

[0284] FIG. 8D illustrates first electronic device 800A further continuing to detect user input 801 on input device 804. In some embodiments, as the user continues to maintain user input 801 on input device 804, first electronic device 800A begins recording ECG information. In some embodiments, while recording the ECG information, the device displays, in user interface 806, a BPM indicator 814 showing the heart rate being detected by the recording. In some embodiments, while recording ECG information, the device further displays, over animation 808 (which, during a recording, forms a grid-like pattern), a tachogram 816 that graphically depicts the ongoing recording. In some embodiments, while recording ECG information, timer 810 continuously reflects (e.g., by counting down) the remaining time to successfully complete the recording.

[0285] FIG. 8E illustrates a second electronic device 800B (e.g., corresponding to first electronic device 600A described with reference to FIGS. 6A-6AE). In some embodiments, second electronic device 800B is a smartphone that is paired with first electronic device 800A (e.g., via a short-range wireless communication radio connection, such as a Bluetooth connection). In FIG. 8E, second electronic device 800B is displaying, on a display 818, a user interface 820 of a health application that is associated with the ECG application running on first electronic device 800A. In some embodiments, while recording ECG information on first electronic device 800A, second electronic device 800B displays, in user interface 820 of the health application associated with the ECG application, an indication 822 that ECG recording is on-going on first electronic device 800A. In some examples, indication 822 includes a graphical indication portion (e.g., illustrating an image corresponding to the device being used to perform the recording) and a text indication portion (e.g., stating “Recording in Progress”).

[0286] FIG. 8F illustrates first electronic device 800A displaying, on display 802, user interface 806 of the ECG application while the device is continuing to perform the ECG recording from FIG. 8E. In FIG. 8F, during the ECG recording, the device detects that user input 801 on input device 804 is lost (e.g., because the user lifted the finger used for the input away from input device 804). In some embodiments, in response to detecting that the user input on input device 804 is lost, the device displays, in user interface 806, a message indication 824 (e.g., stating “Please keep your finger on the crown”) requesting that the user restore the user input on input device 804 in order to continue with the ECG recording. In some embodiments, while the

user input is lost on input device 804, the device continues to count down towards the end of the recording (which is indicated by timer 810). In some embodiments, while the user input is lost on input device 804, the device pauses the recording until the user input is restored on input device 804. In some embodiments, in response to detecting that the user input is lost on the input device 804, the first electronic device 800A resets the value of timer 810 (e.g., to the initial 30 seconds value) and restarts the recording if the user input is restored (e.g., restored within a predetermined time).

[0287] In some embodiments, if the user input on input device 804 is not restored within a time limit (e.g., 5 seconds), first electronic device 800A (automatically) terminates the recording and transitions back to the initial user interface of FIG. 8A. In some embodiments, if the user input on input device 804 is restored within the time limit (e.g., 5 seconds), the device (automatically) continues the recording (e.g., and re-starts the timer, if paused). In some embodiments, the time limit (e.g., 5 seconds) for restoring the input is reset once the user input is restored. That is, if the user input is lost for a second time during a recording, the device (automatically) terminates the recording and transitions back to the initial user interface of FIG. 8A if the full time limit (e.g., 5 seconds) lapses without the user restoring the user input.

[0288] In FIG. 8G, first electronic device 800A again detects user input 801 on input device 804 before the time limit (e.g., 5 seconds) has lapsed from when the user input was lost in FIG. 8F. Because the user input on input device 804 was restored prior to expiration of the time limit (e.g., 5 seconds), the device continues the ECG recording without (automatically) terminating the recording.

[0289] FIG. 8H illustrates first electronic device 800A continuing to detect user input 801 on input device 804 and the device continuing the ECG recording from FIG. 8G. In some embodiments, timer 810 continues to indicate the time remaining to complete the recording (e.g., “1 second”).

[0290] FIG. 8I illustrates user interface 806 of the ECG application upon completion of the recording (which is indicated by timer 810 showing no time remaining). In some embodiments, upon completion of a recording, the plurality of dynamic objects forming animation 808 re-

transitions from the grid-like pattern during the recording toward their initial pattern (e.g., of a shape, such as heart) prior to the recording.

[0291] FIG. 8J illustrates first electronic device 800A and second electronic device 800B (immediately) after completing the ECG recording. In some embodiments, upon completing the ECG recording, first electronic device 800A transmits (e.g., via a Bluetooth connection) data of the ECG recording to second electronic device 800B. In some embodiments, upon completing the ECG recording, first electronic device 800A transmits (e.g., via a LTE or WiFi connection) data of the ECG recording to an external server, where the external server is also accessible by second electronic device 800B. In some embodiments, first electronic device 800A can record and locally store a plurality of ECG recordings and transmit the plurality of ECG recordings to second electronic device 800B.

[0292] In some embodiments, (immediately) after completing the ECG recording, first electronic device 800A displays, on display 802, user interface 806 of the ECG application with animation 808 in its initial pattern (e.g., a fluid heart-shaped pattern) and at least a portion of a summary page 826 that includes an evaluation result (e.g., “Regular Result”) and other related information about the completed recording. In some embodiments, summary page 826 slides onto the display from an edge of the display (e.g., a bottom edge of the display).

[0293] In some embodiments, (immediately) after completing the ECG recording, second electronic device 800B displays, in the health application, a summary page 828 of the health application associated with the ECG application on second electronic device 800A, where summary page 828 includes a representation 830 of the completed recording. In some embodiments, representation 830 includes the evaluation result (e.g., “Regular Rhythm”), the heart rate reading (e.g., in BPM), and a graphical depiction (e.g., a tachogram) of the recording. In some embodiments, summary page 828 includes an affordance 832 for leaving the summary page.

[0294] FIG. 8K illustrates first electronic device 800A displaying, on display 802, (at least a portion of) summary page 826 corresponding to the ECG recording. In some embodiments, summary page 826 includes a summary region 834 that includes an indication 834A of the evaluation result (e.g., “Regular Rhythm”) and an indication 834B of the heart rate reading (e.g.,

in BPM). In some embodiments, summary region 834 also includes a information affordance 836 for viewing a detailed description about the respective evaluation result (e.g., where the detailed description corresponds to the text description shown in possible results page 618 of the tutorial described with reference to FIGS. 6A-6AE). In some embodiments, summary page 826 includes an indication 838 of whether a particular medical characteristic (e.g., signs of Atrial Fibrillation, signs of irregular heart rhythm) was determined from the recording. In some embodiments, summary page 826 includes a symptoms region 840 that includes an affordance 842 for associating one or more symptoms to the reading. In some embodiments, while displaying summary page 826, the device maintains display of animation 808 (e.g., in its initial shape as shown in FIG. 8A) in the background of the summary page (e.g., in a lighter shade so that the summary page is easily legible to the user).

[0295] FIGS. 8L-8O illustrate a plurality of different error notification messages that can be displayed in user interface 806 of the ECG application while recording ECG information. In FIG. 8L, while performing a first ECG recording corresponding to a user input 803 on input device 804, first electronic device 800A detects movement of the user input on input device 804 above a threshold amount (e.g., there is movement with the user's contact with input device 804, where the amount of the movement is above a threshold amount of movement). In some embodiments, in response to detecting the movement of the user input on input device 804 above the threshold amount (e.g., for at least a period of time, such as 5 seconds), first electronic device 800A displays (e.g., below timer 810), a notification message 844 (e.g., stating "Try not to move your arm") requesting that the user restrict movement of user input 803 during the recording.

[0296] In FIG. 8M, a period of time (e.g., 5 seconds) after displaying notification message 844, and while continuing to perform the first ECG recording corresponding to user input 803 on input device 804, first electronic device 800A continues to detect movement of the user input on input device 804 above the threshold amount. In some embodiments, in response to continuing (e.g., for another period of time, such as 5 seconds, after displaying the initial notification message 844), first electronic device 800A displays (e.g., below timer 810, replaces display of notification message 844 with) a notification message 846 (e.g., stating "It may help to rest your arm on a table or in your lap") indicating that the user could try resting his/her arm on a surface to stabilize the user input on input device 804.

[0297] In FIG. 8N, while performing a second ECG recording corresponding to a user input 805 on input device 804, first electronic device 800A detects a press input on input device 804, where the force of the press is above a threshold amount (e.g., such that the user “clicks” input device 804). In some embodiments, in response to detecting the press input on input device 804, first electronic device 800A displays (e.g., below timer 810) a notification message 848 (e.g., stating “You do not need to click the crown”) informing the user that input device 804 does not need to be “clicked” to perform the recording, and/or informing the user that less force can be used for the input on input device 804 to successfully complete the recording.

[0298] In FIG. 8O, while performing a third ECG recording corresponding to a user input 807 on input device 804, first electronic device 800A detects (e.g., as in FIG. 8F), that user input 807 on input device 804 is lost (e.g., because the user lifted the finger used for the input away from input device 804). In some embodiments, in response to detecting that the user input on (e.g., the user’s contact with) input device 804 is lost, first electronic device 800A displays (e.g., below timer 810) a notification message 850 (e.g., corresponding to notification message 824, stating “Please keep your finger on the crown”) requesting that the user restore the user input on input device 804 to continue with the ECG recording.

[0299] FIG. 8P illustrates first electronic device 800A displaying, on display 802, user interface 806 of the ECG application while performing an ECG recording corresponding to a user input 809 on input device 804 (e.g., after an initial threshold time period (e.g., 5 seconds) has passed from the initiation of the recording). In some embodiments, the required duration of an ECG recording is 30 seconds. As indicated by timer 810 (e.g., showing “20 seconds”) in FIG. 8P, 10 seconds have passed since the initiation of the recording. In some embodiments, first electronic device 800A displays a tachogram 816 corresponding to a visual illustration of the ECG recording.

[0300] In FIG. 8Q, first electronic device 800A loses detection of user input 809 on input device 804. In some embodiments, in response to (e.g., immediately in response to or within a short period of time, such as 1 second) losing detection of the user input on input device 804, first electronic device 800A resets the ECG recording (e.g., terminates the previous recording and prepares to start a new recording), as indicated by timer 810 (e.g., which now shows “30

seconds,” the full duration of a recording. In some embodiments, first electronic device 800A causes the remaining time indicated in timer 810 to “rewind” back to (e.g., count back up to) the initial duration in response to losing detection of the user input on input device 804. In some embodiments, first electronic device 800A causes tachogram 816 to show a “silent” tachogram, thereby further indicating to the user that ECG information is not being captured.

[0301] In some embodiments (e.g., after resetting the recording), upon detecting that the user input on input device 804 has not been restored for a at least a predetermined period of time (e.g., 2.5 seconds), first electronic device 800A displays, in user interface 806 of the ECG application, a notification message 852 (e.g., stating “Hold your finger on the crown”) requesting that the user restore the input on input device 804, as shown in FIG. 8R. In some embodiments (e.g., in addition to displaying notification message 852), the devices displays (e.g., re-displays) animation 808 in its initial pattern (e.g., a heart shape), as first described with reference to FIG. 8A. In some embodiments, the plurality of dynamic objects forming animation forming animation 808 dynamically transition from the grid-like pattern of FIG. 8Q to its initial pattern (e.g., a heart shape) of FIG. 8R.

[0302] In some embodiments (e.g., after resetting the recording), upon detecting that the user input on input device 804 has not been restored for at least the predetermined period of time (e.g., 2.5 seconds), first electronic device 800A alternatively displays, in user interface 806 of the ECG application, animation 808 in its initial pattern (e.g., a heart shape) but forgoes displaying notification message 852, as shown in FIG. 8S.

[0303] In some embodiments, first electronic device 800A first transitions from the user interface of FIG. 8Q to the user interface of FIG. 8R upon detecting that the user input on input device 804 has not been restored for a first predetermined period of time (e.g., 2.5 seconds), and then transitions from the user interface of FIG. 8R to the user interface of FIG. 8S upon detecting that the user input on input device 804 has not been restored for a second predetermined period of time (e.g., which is the same as or different from the first predetermined period of time) after the first predetermined period of time has passed.

[0304] FIGS. 9A-9B are a flow diagram illustrating a method recording biometric information for health monitoring, in accordance with some embodiments. Method 900 is

performed at a first electronic device (e.g., 100, 300, 500, 600B, 800A) with a display and one or more input devices including a biometric sensor (e.g., a set of one or more sensors, such as electrodes, configured to measure electrical activity correlated to portions of the heart of a user of the electronic device). Some operations in method 900 are, optionally, combined, the orders of some operations are, optionally, changed, and some operations are, optionally, omitted.

[0305] As described below, method 900 provides an intuitive way for managing health monitoring. The method reduces the cognitive burden on a user for managing health monitoring, thereby creating a more efficient human-machine interface. For battery-operated computing devices, enabling a user to manage health monitoring faster and more efficiently conserves power and increases the time between battery charges.

[0306] The first electronic device (e.g., 800A) displays (908), on the display (e.g., 802), a first user interface (e.g., of a health monitoring application or a health data measurement application, main user interface 806 of the ECG application, as shown in FIG. 8A) indicating that the first electronic device (e.g., 800A) is ready to detect biometric information (e.g., ECG data, BPM data, heart-related data). Displaying, on the display (e.g., 802), the first user interface indicating that the first electronic device (e.g., 800A) is ready to detect biometric information provides visual feedback by indicating that biometric information is ready to be recorded on the first electronic device. Providing improved visual feedback to the user enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0307] In some embodiments, prior to displaying the first user interface (e.g., 806 of FIG. 8A), the first electronic device (e.g., 800A) displays (902) a homescreen (e.g., 1012) that includes an application affordance (e.g., 1014) corresponding to a health monitoring application (e.g., for monitoring heart health, such as the ECG application). Displaying, on the display (e.g., 802), the application affordance corresponding to the health monitoring application on the homescreen provides visual feedback by indicating to the user that the health monitoring application can be accessed from the homescreen of the first electronic device (e.g., 800A).

Providing improved visual feedback to the user enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently. In some embodiments, the first electronic device (e.g., 800A) detects (904), via the one or more input devices, a user activation of the application affordance. In some embodiments, in response to detecting the user activation of the application affordance, the first electronic device (e.g., 800A) displays (906), on the display (e.g., 802), the first user interface (e.g., 806).

[0308] In some embodiments, a (text) notification (e.g., 810) requesting the first input on the biometric sensor (e.g., 804) is displayed in the first user interface (e.g., 806 of FIG. 8A) after a predetermined amount of time (e.g., 5 seconds) has passed after detecting the user activation of the application affordance. In some embodiments, the notification (e.g., 810) instructs the user to place a finger on the first input device (e.g., 804). Providing the notification (e.g., 810) requesting the first input on the biometric sensor in the first user interface after the predetermined amount of time has passed after detecting the user activation of the application affordance provides the user with more control of the device by helping the user avoid unintentionally an unintended operation (e.g., by selecting a wrong button or affordance) and simultaneously allowing the user to recognize that the input on the biometric sensor is required to proceed with the recording operation. Providing additional control of the device (without cluttering the user interface with additional displayed controls) enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0309] In some embodiments, the recorded biometric information includes an electrocardiogram recording derived from the biometric information detected by the biometric sensor (e.g., 804). In some embodiments, the biometric sensor (e.g., 804) is a contact-based sensor, and the first input with the biometric sensor (e.g., 804) satisfies the first criteria when a contact (e.g., from a finger of a user) is detected on the biometric sensor (e.g., 804).

[0310] The first electronic device (e.g., 800A) detects (910) a first input with the biometric sensor (e.g., 804) that satisfies first criteria (e.g., user contact with the biometric sensor, movement below a threshold, electrical interference below a threshold).

[0311] In response to detecting the first input with the biometric sensor (e.g., 804), the first electronics device (e.g., 800A) starts (912) to record biometric information detected by the biometric sensor (e.g., 804). Also in response to detecting the first input with the biometric sensor (e.g., 804), the first electronic device (e.g., 800A) displays (914), on the display (e.g., 802), a second user interface (e.g., 806 of FIG. 8D) (e.g., a measurement page of a health application) that is different from the first user interface (e.g., 806 of FIG. 8A), where the second user interface (e.g., 806 of FIG. 8D) includes an indication of progress (e.g., 810) in recording the biometric information. In some embodiments, the indication of progress (e.g., 810) is a countdown timer (e.g., showing a countdown in seconds from a predetermined start time to zero). Displaying, on the second user interface (e.g., 806 of FIG. 8D), the indication of progress (e.g., 810) in recording the biometric information improves visual feedback by indicating to the user that the recording is being carried out and the duration for which the user must maintain the input to continue with the recording. Providing improved visual feedback to the user enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0312] After recording at least a portion of the biometric information, the first electronic device (e.g., 800A) detects (912), via the one or more input devices, that the first criteria are no longer met (e.g., user contact with the biometric sensor 804 is lost).

[0313] In response to detecting that the first criteria are no longer met for a first period of time (e.g., 5 seconds), the first electronic device (e.g., 800A) resets (918) the indication of progress (e.g., 810) in recording the biometric information and maintaining display of the second user interface (e.g., 806 of FIG. 8D). Resetting the indication of progress (e.g., 810) while maintaining display of the second user interface (e.g., 806 of FIG. 8D) in response to detecting that the first criteria are no longer met for a first period of time provides the user with more

control of the device by helping the user avoid unintentionally leaving the health monitoring application while simultaneously allowing the user to easily continue with the recording without having to manually re-initiate the recording or the health monitoring application. Providing additional control of the device (without cluttering the user interface with additional displayed controls) enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0314] In response to detecting that the first criteria are no longer met for a second period of time that is longer than the first period of time (e.g., longer than 5 seconds), the first electronic device (e.g., 800A) replaces (920) display of the second user interface (e.g., 806 of FIG. 8D) with the first user interface (e.g., 806 of FIG. 8A). Replacing display of the second user interface (e.g., 806 of FIG. 8D) with the first user interface (e.g., 806 of FIG. 8A) in response to detecting that the first criteria are no longer met for a second period of time that is longer than the first period of time improves visual feedback by visually indicating to the user that the recording has been stopped and that a new recording can be re-initiated by the user. Providing improved visual feedback to the user enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0315] In some embodiments, the first user interface (e.g., 806 of FIG. 8A) includes a graphical animation (e.g., of a shape, such as a heart, 808 of FIG. 8A) indicating (to the user) that the first electronic device (e.g., 800A) is ready to detect biometric information, where the graphical animation is comprised of a plurality of moving objects (e.g., 808, circular dots) forming a first shape (e.g., a heart shape). Providing the graphical animation (e.g., 808 of FIG. 8A) to the user that the first electronic device (e.g., 800A) is ready to detect biometric information provides visual feedback about the current state of the application and indicates to that the user can proceed with a recording. Providing improved visual feedback to the user enhances the operability of the device and makes the user-device interface more efficient

(e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0316] In some embodiments, the plurality of moving objects (e.g., 808) of the graphical animation transitions from the first shape (e.g., a heart shape) to a second shape (e.g., a grid shape) different from the first shape as the display transitions from the first user interface to the second user interface.

[0317] In some embodiments, further in response to detecting that the first criteria are no longer met for the first period of time, the first electronic device (e.g., 800A) transitions the plurality of moving objects (e.g., 808) of the graphical animation to an interstitial shape between the first shape (e.g., a heart shape) and the second shape (e.g., a grid shape).

[0318] In some embodiments, while displaying the second user interface (e.g., 806 of FIG. 8D) and recording the biometric information (e.g., heart rhythm information, heart rate information), the first electronic device (e.g., 800A) displays, within the graphical animation that is in the second shape (e.g., 808 of FIG. 8D, a grid), a visual representation of the recorded biometric information, where the recorded biometric information is filtered and scaled such that the visual representation of the recorded biometric information can be displayed within the graphical animation. Displaying the visual representation of the recorded biometric information while displaying the second user interface (e.g., 806 of FIG. 8D) and recording the biometric information improves visual feedback by allowing the user to view the current state and progress of the recording and indicating to the user that the recording is being carried out. Providing improved visual feedback to the user enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0319] In some embodiments, the second user interface (e.g., 806 of FIG. 8D) includes a (dynamic) graphical representation (e.g., a dynamic tachogram-like animation) that corresponds to a visualization of the biometric information from the recorded biometric information and a

(countdown) timer (e.g., 810) indicating (to the user) the amount of time remaining to complete the recording of the biometric information. In some embodiments, the biometric information that is recorded is heart-related data, and the graphical representation is a dynamic animation that includes a tachogram to reflect the data obtained from the biometric sensor (e.g., 804).

[0320] In some embodiments, while recording the biometric information, the first electronic device (e.g., 800A) detects, via the one or more input devices, that second criteria are met. In some embodiments, in response to detecting that the second criteria are met, the first electronic device (e.g., 800A) displays, in the second user interface (e.g., 806 of FIG. 8D, below the indication of progress 810), a (text) notification (e.g., 824) related to the second criteria. Displaying, on the second user interface (e.g., 806 of FIG. 8D), the notification (e.g., 824) related to the second criteria in response to detecting that the second criteria are met provides the user with more control of the device by quickly indicating to the user that one or more actions need to be taken by the user to maintain a recording. Providing additional control of the device (without cluttering the user interface with additional displayed controls) enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0321] In some embodiments, the second criteria is met when an amount of movement (of the device caused by the user) above a threshold is detected, and the notification (e.g., 844) indicates (to the user) that the amount of movement should be decreased. In some embodiments, the notification (e.g., 844) notifies the user that too much movement is detected. In some embodiments, the notification (e.g., 844) further notifies the user to constrain his/her movements.

[0322] In some embodiments, the second criteria is met when the amount of movement (of the device caused by the user) above the threshold is detected for at least a third period of time, and the notification (e.g., 846) indicates (to the user) that the first electronic device should be moved to a resting position (e.g., on a table). In some embodiments, if the first electronic device is a smartwatch, the notification (e.g., 846) instructs the user to rest his/her arm on a table.

[0323] In some embodiments, the second criteria is met when a second input (e.g., a press input, a click input) having a type that is different from the type of the first input is detected on a first input device (e.g., 804, a crown, a mechanical button, a rotating button), and the notification (e.g., 848) indicates (to the user) that the second input should not be repeated on the first input device. In some embodiments, the biometric sensor includes one or more electrodes integrated in the first input device (e.g., 804) (e.g., operating in conjunction with one or more electrodes integrated in a housing portion (e.g., backplate) of the first electronic device (e.g., 800A). In some embodiments, the second input is a press/click input on the first input device (e.g., 804), and the notification (e.g., 848) notifies that the user should not press/click the first input device (e.g., 804).

[0324] In some embodiments, the second criteria is met when the first input is no longer detected (e.g., discontinued, interrupted) by the biometric sensor (e.g., 804) when recording of the biometric information is not yet completed, and the notification (e.g., 850) indicates (to the user) that the first input should be maintained on the biometric sensor (e.g., 804). In some embodiments, the first electronic device (e.g., 800A) detects that the first input is no longer detected when the user discontinues contact with the biometric sensor (e.g., 804) while recording of the biometric information is still ongoing. In some embodiments, the notification (e.g., 850) instructs the user to re-establish contact with (e.g., by placing his/her finger back on) the biometric sensor (e.g., 804).

[0325] In some embodiments, after taking a first recording of first biometric information and a second recording of second biometric information different from the first biometric information (e.g., where the first recording and the second recording are different recordings that were taken at different times), the first electronic device (e.g., 800A) transmits (922), to a second electronic device (e.g., 800B, a smartphone paired with the smartwatch), the recorded first biometric information and the recorded second biometric information.

[0326] In some embodiments, (e.g., while not displaying the application corresponding to the first and second user interfaces on the display) the first electronic device (e.g., 800A) detects (924) (e.g., via a second biometric sensor that measures heart rate information without user input) heart rate information (of the user) for a predetermined amount of time. In some

embodiments, in accordance with a determination that the detected heart rate information meets a first condition (e.g., above a threshold, such as 150 BPM, above a threshold for a certain amount of time), the first electronic device (e.g., 800A) displays (926), on the display (e.g., 802), a notification indicating a high heart rate. Displaying, on the display (e.g., 802), the notification indicating the high heart rate in accordance with the determination that the detected heart rate information meets the first condition improves visual feedback by quickly informing the user of the high heart rate. Providing improved visual feedback to the user enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0327] In some embodiments, the first electronic device (e.g., 800A) detects (928), via the one or more input devices, a user activation of the notification. In some embodiments, in response to detecting the user activation of the notification, the first electronic device (e.g., 800A) displays (930), on the display (e.g., 802), the first user interface (e.g., 806 of FIG. 8A, so that the user can check his/her electrocardiogram recording using the application corresponding to the first user interface). Displaying, on the display (e.g., 802) the first user interface (e.g., 806 of FIG. 8A) in response to detecting the user activation of the notification reduces the number of inputs needed to launch the application corresponding to the first user interface when the device detects the high heart rate of the user. Reducing the number of inputs needed to perform an operation enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0328] Note that details of the processes described above with respect to method 900 (e.g., FIGS. 9A-9B) are also applicable in an analogous manner to the methods described above and below. For example, method 700 optionally includes one or more of the characteristics of the various methods described above with reference to method 900. For another example, method 1100 optionally includes one or more of the characteristics of the various methods described above with reference to method 900. For another example, method 1300 optionally includes one

or more of the characteristics of the various methods described above with reference to method 900. For another example, method 1500 optionally includes one or more of the characteristics of the various methods described above with reference to method 900. For brevity, these details are not repeated below.

[0329] FIGS. 10A-10J illustrate exemplary user interfaces for health monitoring, in accordance with some embodiments. The exemplary user interfaces in these figures are used to illustrate the processes described below, including the processes in FIG. 11. The exemplary user interfaces in these figures relate generally to monitoring health using recorded biometric information, and are not limited to a specific type of biometric information. Only for the sake of convenience, the exemplary user interfaces in these figures are described with reference to a type of biometric information—electrocardiogram (hereinafter “ECG”) information.

[0330] FIG. 10A illustrates a first electronic device 1000 (e.g., corresponding to second electronic device 600B, first electronic device 800A). In some embodiments, first electronic device 1000A is a smartwatch. In some embodiments, first electronic device 1000A has a display 1002 and one or more input devices (e.g., including a touch layer of display 1002 and one or more mechanical buttons, such as a rotating crown). In some embodiments, first electronic device 1000 includes one or more biometric sensors (e.g., for recording ECG information, for detecting heart rhythm and heart rate of the user) comprising one or more electrodes integrated in an input device 1004 (e.g., a mechanical input device, such as a depressible, rotating crown) of first electronic device 1000. In some embodiments, the one or more biometric sensors of first electronic device 1000 further comprise one or more electrodes of (e.g., integrated in) a housing portion (e.g., the backplate) of first electronic device 1000, where the one or more electrodes integrated in the input device operate in conjunction with the one or more electrodes of the housing portion to capture biometric information (e.g., ECG information). Features concerning the one or more biometric sensors of first electronic device 1000 used to capture biometric information (e.g., ECG information) is described in greater detail in Appendix A.

[0331] In some embodiments, first electronic device 1000 is configured to detect and respond to activation of input device 1004 (e.g., respond by performing a first predefined

operation or a second predefined operation), where the activation is different from and independent of the capture of biometric information (e.g., ECG information).

[0332] FIG. 10A illustrates first electronic device 1000 displaying, on display 1002, a user interface 1006 of an ECG application (e.g., corresponding to user interface 644 of the ECG application described with reference to FIGS. 6A-6AE and user interface 806 of the ECG application described with reference to FIGS. 8A-8S). In some embodiments, the ECG application is configured to cause first electronic device 1000 to capture biometric information without detecting the activation of input device 1004.

[0333] In some embodiments, user interface 1006 includes an animation 1008 (e.g., a fluid animation, corresponding to animation 646 of user interface 644 and animation 808 of user interface 806) that depicts a particular shape (e.g., a heart). In some examples, as shown in FIG. 10A, animation 1008 comprises a plurality of dynamic objects (e.g., circular objects) that form the particular shape (e.g., a heart), where the shape appears three-dimensional and is visually fluid as the plurality of dynamic objects constantly move while maintaining the structure of the shape. In some examples, the plurality of dynamic objects forming animation 1008 have a consistent visual characteristic (e.g., the same color).

[0334] In some embodiments, while displaying animation 1008 in the particular shape (e.g., a heart), user interface 1006 displays a notification message 1010 (e.g., corresponding to notification message 648 of user interface 644 and notification message 810 of user interface 806, stating “Hold your finger on the crown”) indicating to the user that an action must be performed (by the user) on the device to proceed with recording the user’s ECG information. In some embodiments, notification message 1010 instructs the user of the type of input (e.g., a touch or contact on input device 1004 that is below a threshold amount such that the input does not “click” input device 1004) and that the input must be maintained on input device 1004 (e.g., for the duration of the recording).

[0335] In some embodiments, while displaying user interface 1006 of the ECG application as shown in FIG. 10A, first electronic device 1000 detects a press input 1001 on input device 1004, where the press input is an input on input device 1004 with a pressing force above a threshold amount such that the input “clicks” input device 1004.

[0336] In some embodiments, in response to detecting press input 1001 while displaying user interface 1006 of the ECG application as shown in FIG. 10A, first electronic device 1000 displays, on display 1002 (e.g., replaces display of user interface 1006 with), a home user interface 1012 (e.g., a main user interface of the operating system of the device), as shown in FIG. 10B. In some embodiments, home user interface 1012 includes a plurality of icons corresponding to different applications installed on the device, including an icon 1014 corresponding to the ECG application.

[0337] FIG. 10C illustrates first electronic device 1000, while displaying user interface 1006 of the ECG application, detecting (and maintaining) a user input 1003 (e.g., a continuous touch or contact of a finger on input device 1000) on input device 1004 to begin an ECG recording (e.g., as described with reference to FIGS. 8A-8C). In some embodiments, upon beginning the ECG recording, the dynamic plurality of objects (e.g., circular objects) of animation 1008 transitions from their initial fluid shape in FIG. 10A to a grid-like shape. In some embodiments, upon beginning the ECG recording, the device displays, in user interface 1006, a timer 1016 (e.g., below animation 1010) indicating the remaining amount of time to complete the recording (e.g., initially 30 seconds). In some embodiments, upon beginning the ECG recording, the device displays, in user interface 1006 (e.g., below timer 1016), a notification message 1018 (e.g., stating “Touch the crown and try to hold still”) requesting that the user maintain (a stable) user input 1003 on input device 1004 during the recording of the ECG information.

[0338] FIG. 10D illustrates first electronic device 1000 recording ECG information from the user, where a initial threshold time period (e.g., 5 seconds) has not passed since the initiation of the recording (e.g., as indicated by timer 1016, which shows that 3 seconds have passed since the initiation of the recording). In some embodiments, while the initial threshold time period has not yet passed, first electronic device 1000 detects a press input 1005 on input device 1004, where the press input is an input on input device 1004 with a pressing force above a threshold amount such that the input “clicks” input device 1004. In some embodiments, in response to detecting press input 1005 on input device 1004 while the initial threshold time period has not yet passed, first electronic device 1000 (automatically) terminates the recording and displays user interface 1006 of the ECG application as shown in FIG. 10A.

[0339] FIG. 10E illustrates first electronic device recording ECG information from the user, where the initial threshold time period (e.g., 5 seconds) has passed since the initiation of the recording (e.g., as indicated by timer 1016, which shows that 6 seconds have passed since the initiation of the recording). In some embodiments, after the initial threshold time period has passed, first electronic device 1000 detects a press input 1007 (e.g., similar to press input 1005) on input device 1004, where the press input is an input on input device 1004 with a pressing force above a threshold amount such that the input “clicks” input device 1004. In some embodiments, in response to detecting press input 1007 on input device 1004 after the initial threshold time period (e.g., 5 seconds) has passed, first electronic device 1000 does not terminate the recording. In some embodiments, (instead of terminating the recording) first electronic device 1000 displays, in user interface 1006, a notification message 1020 (e.g., stating “You do not need to click the crown”) indicating that there is no need to “click” input device 1004 during the recording or to successfully complete the recording.

[0340] In some embodiments, after detecting press input 1007 on input device 1004 after the initial threshold time period (e.g., 5 seconds) has passed, in response to which first electronic device 1000 does not terminate the recording, the device detects a second press input (e.g., similar to press input 1007) after detecting press input 1007 but before a predetermined amount of time (e.g., 2.5 seconds) has passed since detecting press input 1007. In some embodiments, in response to detecting the second press input after detecting press input 1007 but before the predetermined amount of time (e.g., 2.5 seconds) has passed since detecting press input 1007, first electronic device 1000 (automatically) terminates the recording and displays user interface 1006 of the ECG application as shown in FIG. 10A.

[0341] In some embodiments, after detecting press input 1007 on input device 1004 after the initial threshold time period (e.g., 5 seconds) has passed, in response to which first electronic device 1000 does not terminate the recording, the device detects a second press input (e.g., similar to press input 1007) after detecting press input 1007 and after a predetermined amount of time (e.g., 2.5 seconds) has passed since detecting press input 1007. In some embodiments, (instead of terminating the recording) first electronic device 1000 displays, in user interface 1006, a notification message 1020 (e.g., stating “You do not need to click the crown”) indicating that there is no need to “click” input device 1004 during the recording or to successfully complete the

recording. In summary, in some embodiments and while recording is underway, termination of recording occurs if two inputs are received within a predetermined period (e.g., within rapid succession (e.g., within 2.5 seconds)). In contrast, in some embodiments, if two inputs are received but spaced apart by more than the predetermined period (e.g., within 2.5 seconds) the recording is not cancelled.

[0342] FIG. 10F illustrates first electronic device 1000 performing an ECG recording on the ECG application with, as indicated by timer 1016 of user interface 1006 (e.g., showing “20 Seconds”), 20 seconds remaining to complete the recording. In FIG. 10F, the initial threshold time period (e.g., 5 seconds) has passed since the initiation of the recording. In some embodiments, after the initial threshold time period (e.g., 5 seconds) has passed since the initiation of the recording, first electronic device 1000 detects a user input a press input 1009 (or a press-and-hold input) on input device 1004, where the press input is an input on input device 1004 with a pressing force above a threshold amount such that the input “clicks” input device 1004 (e.g., and the pressing force is maintained for at least a period of time, such as 1 second). In some embodiments, in response to detecting press input 1009 on input device 1004 after the initial threshold time period (e.g., 5 seconds) has passed, first electronic device 1000 does not terminate the recording and displays, in user interface 1006, a notification message 1020 (e.g., stating “You do not need to click the crown”) indicating that there is no need to “click” input device 1004 during the recording or to successfully complete the recording.

[0343] In some embodiments, at least a predetermined amount of time (e.g., 5 seconds) after detecting user input 1009, first electronic device 1000 detects a press a press-and-hold input 1011 on input device 1004, where the press-and-hold input is an input on input device 1004 with a pressing force above a threshold amount such that the input “clicks” input device 1004, and input device 1004 is “clicked” for at least a threshold period of time (e.g., 1 second). In some embodiments, in response to detecting press-and-hold input 1011 on input device 1004 while the initial threshold time period has not yet passed, first electronic device 1000 (automatically) displays, on display 1002 (e.g., replaces display of user interface 1006 of the ECG application with), a user interface 1022 of a virtual assistant (e.g., a virtual assistant controlled by the operating system of the device), as shown in FIG. 10G.

[0344] FIGS. 10H-10J illustrate first electronic device 1000 receiving an electronic communication (e.g., a phone call, a text message, an email message) while the device is performing an ECG recording. In FIG. 10H, the received electronic communication (e.g., a text message from “Jane Appleseed”) is represented as a notification 1026 corresponding to the electronic communication. The electronic communication (represented as notification 1026) is received while first electronic device 1000 is performing an ECG recording (e.g., from user input 1013 on input device 1004).

[0345] FIG. 10I illustrates first electronic device 1000 displaying, on display 1002, a summary page 1028 of the ECG recording (e.g., corresponding to summary page 826 described with reference to FIGS. 8J-8K) upon completing the ECG recording. In FIG. 10J, upon (or subsequent to) completing the recording (and displaying summary page 1028 corresponding to the recording), first electronic device 1000 displays, on display 1002, a notification alert 1030 corresponding to the electronic communication (e.g., the text message from “Jane Appleseed”) that was received during the recording. In some embodiments, if one or more additional electronic communications were received during the recording, the device also provides one or more notification alerts corresponding to the received electronic communications upon (or subsequent to) completing the recording.

[0346] In some embodiments, upon (or prior to) beginning an ECG recording, first electronic device 1000 automatically disables a wireless communication radio (e.g., a LTE connection) of the device. In some embodiments, upon (or in response to) completing the ECG recording, first electronic device 1000 automatically re-enables the wireless communication radio on the device.

[0347] In some embodiments, upon (or prior to) beginning an ECG recording, first electronic device 1000 automatically disables a haptic feedback controller (e.g., a haptic actuator) of the device. In some embodiments, upon (or in response to) completing the ECG recording, first electronic device 1000 automatically re-enables the haptic feedback controller of the device.

[0348] FIG. 11 is a flow diagram illustrating a method for using an input device for health monitoring, in accordance with some embodiments. Method 1100 is performed at a device (e.g., 100, 300, 500, 600B, 800A, 1000) with a display and one or more input devices including a first input device with an integrated biometric sensor (e.g., a rotatable and depressible watch crown

with integrated biometric sensors comprising one or more electrodes for detecting characteristics of the user's heart). Some operations in method 1100 are, optionally, combined, the orders of some operations are, optionally, changed, and some operations are, optionally, omitted.

[0349] As described below, method 1100 provides an intuitive way for managing health monitoring. The method reduces the cognitive burden on a user for managing health monitoring, thereby creating a more efficient human-machine interface. For battery-operated computing devices, enabling a user to manage health monitoring faster and more efficiently conserves power and increases the time between battery charges.

[0350] The first electronic device (e.g., 1000) displays (1102), on the display (e.g., 1002), a user interface (e.g., 1006 of FIG. 10A) of an application (e.g., a health application, such as a health monitoring application or a health data measurement application) for capturing biometric information (e.g., ECG data, BPM data, heart-related data) from the biometric sensor (e.g., 1004).

[0351] In some embodiments, the first electronic device (e.g., 1000) is configured to detect and respond to activation of the first input device (e.g., 1004, respond by performing the predefined operation or a second predefined operation), where the activation is different from and independent of the capture of biometric information.

[0352] In some embodiments, the application is configured to cause the first electronic device (e.g., 1000) to capture the biometric information without detecting the activation of the first input device (e.g., 1004).

[0353] While displaying the user interface (e.g., 1006 of FIG. 10A) of the application for capturing biometric information from the biometric sensor (e.g., 1004), the first electronic device (e.g., 1000) detects (1104) a first activation of the first input device (e.g., 1004, a pressing of the first input device, such as a rotating crown, past a threshold amount to cause a "click" of the crown).

[0354] In response to detecting the first activation of the first input device (e.g., 1004, a press on the first input device) and while capturing biometric information from the biometric sensor

(e.g., 1004), in accordance with a determination that the first activation of the first input device (e.g., 1004) was detected when first criteria are met (e.g., the device has captured less than a predetermined amount of biometric information and/or the first input device has been activated within at least a threshold amount of time, such as 5 seconds), where the first criteria are based on progress toward capturing biometric information with the biometric sensor (e.g., 1004), the first electronic device (e.g., 1000) performs (1106) a predefined operation associated with the first input device (e.g., 1004) that interrupts capture of the biometric information (e.g., scrolling of a displayed content, exiting a currently active application, activation of a digital assistant function). Performing the predefined operation associated with the first input device (e.g., 1004) that interrupts the capture of biometric information in accordance with the determination that the first activation of the first input device (e.g., 1004) was detected when the first criteria are met provides the user with more control of the device by enabling the user to interrupt the capture of biometric information in certain situations through an input on the first input device. Providing additional control options without cluttering the UI with additional displayed controls enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0355] Also in response to detecting the first activation of the first input device (e.g., 1004, a press on the first input device) and while capturing biometric information from the biometric sensor (e.g., 1004), in accordance with a determination that the first activation of the first input device (e.g., 1004) was detected when the first criteria are not met, the first electronic device (e.g., 1000) continues (1108) to capture the biometric information without performing the predefined operation associated with the first input device (e.g., 1004). Continuing to capture the biometric information without performing the predefined operation associated with the first input device (e.g., 1004) in accordance with the determination that the first activation of the first input device was detected when the first criteria are not met provides the user with more control of the device by enabling the user continue with the capturing of the biometric information in certain situations without having to manually re-initiate the recording process. Providing additional control options without cluttering the UI with additional displayed controls enhances the

operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0356] In some embodiments, prior to capturing the biometric information (e.g., while displaying an introductory animation, such as animation 808 of main user interface 806 as shown in FIG. 8A), the first electronic device (e.g., 1000) detects a second activation of the first input device (e.g., 1004). In some embodiments, in response to detecting the second activation of the first input device (e.g., 1004), the first electronic device (e.g., 1000) performs the predefined operation (e.g., performing the predefined operation without determining whether capture of biometric information is occurring).

[0357] In some embodiments, the predefined operation includes displaying, on the display (e.g., 1002), a predefined user interface (e.g., 1012, a homescreen that includes one or more affordances for launching an application). In some embodiments, displaying the predefined user interface (e.g., 1012) includes closing or suspending any currently active or running application (e.g., the application for capturing biometric information).

[0358] In some embodiments, the predefined operation includes displaying, on the display (e.g., 1002), a user interface (e.g., 1022) of a digital virtual assistant (e.g., by replacing display of the user interface (e.g., 1006) of the application for capturing biometric information).

[0359] In some embodiments, the first criteria are met when capturing the biometric information has occurred for less than a first threshold amount of time (e.g., 5 seconds).

[0360] In some embodiments, after continuing to capture the biometric information without performing the predefined operation associated with the first input device (e.g., 1004), the first electronic device (e.g., 1000) detects (1110) a second activation of the first input device (e.g., 1004). In some embodiments, in response to detecting the second activation of the first input device (e.g., 1004), in accordance with a determination that the second activation of the first input device (e.g., 1004) was detected within a predetermined time (e.g., 5 seconds) after detecting the first activation of the first input device (e.g., 1004), the first electronic device (e.g.,

1000) performs (1112) the predefined operation associated with the first input device (e.g., 1004) that interrupts capture of the biometric information. Performing the predefined operation associated with the first input device (e.g., 1004) that interrupts the capture of the biometric information in accordance with the determination that the second activation of the first input device was detected within the predetermined time after detecting the first activation of the first input device provides the user with more control of the device and reduces the number of inputs needed to interrupt the capturing of the biometric information by allowing the user to quickly and easily interrupt the capturing of biometric information using the first input device. Providing additional control of the device and reducing the number of inputs needed to perform an operation enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0361] In some embodiments, in response to detecting the second activation of the first input device (e.g., 1004), in accordance with a determination that the second activation of the first input device (e.g., 1004) was detected after the predetermined time after detecting the first activation of the first input device (e.g., 1004), the first electronic device (e.g., 1000) continues (1114) to capture the biometric information without performing the predefined operation associated with the first input device (e.g., 1004). Continuing to capture the biometric information without performing the predefined operation associated with the first input device (e.g., 1004) in accordance with the determination that the second activation of the first input device was detected after the predetermined time after detecting the first activation of the first input device provides the user with more control of the device by helping the user avoid unintentionally interrupting the capturing of the biometric information and simultaneously allowing the user to recognize that another and/or different input is required to interrupt the capturing of the biometric information. Providing additional control of the device (without cluttering the user interface with additional displayed controls) enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which,

additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0362] In some embodiments, upon (or prior to) capturing the biometric information (e.g., heart rhythm information, heart rate information) from the biometric sensor (e.g., 1004), the first electronic device (e.g., 1000) automatically disables a haptic feedback controller (e.g., a haptic actuator associated with the first input device) of the first electronic device (e.g., 1000). In some embodiments, upon (or in response to) completing capturing the biometric information, the first electronic device (e.g., 1000) automatically re-enables the haptic feedback controller.

[0363] In some embodiments, upon (or prior to) capturing the biometric information (e.g., heart rhythm information, heart rate information) from the biometric sensor, the first electronic device (e.g., 1000) automatically disables a wireless communication radio (e.g., LTE connection) of the first electronic device (e.g., 1000) and prevents a first type of notification (e.g., 1026, of a message, of an alert, a type of notification other than a timer notification) from being displayed, where the first type of notification includes a notification corresponding to an electronic communication (e.g., a text message, an email, a phone call) received while the capturing the biometric information. In some embodiments, the notifications that are prevented from being displayed do not include a timer notification. In some embodiments, upon (or in response to) completing capturing the biometric information, the first electronic device (e.g., 1000) automatically re-enables the wireless communication radio and allows the first type of notification (e.g., 1030) to be displayed.

[0364] Note that details of the processes described above with respect to method 1100 (e.g., FIG. 11) are also applicable in an analogous manner to the methods described above and below. For example, method 700 optionally includes one or more of the characteristics of the various methods described above with reference to method 1100. For another example, method 900 optionally includes one or more of the characteristics of the various methods described above with reference to method 1100. For example, method 1300 optionally includes one or more of the characteristics of the various methods described above with reference to method 1100. For example, method 1500 optionally includes one or more of the characteristics of the various

methods described above with reference to method 1100. For brevity, these details are not repeated below.

[0365] FIGS. 12A-12S illustrate exemplary user interfaces for managing aspects of health monitoring. The user interfaces in these figures are used to illustrate the processes described below, including the processes in FIGS. 13A-13B. The exemplary user interfaces in these figures relate generally to monitoring health using recorded biometric information, and are not limited to a specific type of biometric information. Only for the sake of convenience, the exemplary user interfaces in these figures are described with reference to a type of biometric information—electrocardiogram (hereinafter “ECG”) information.

[0366] FIG. 12A illustrates a first electronic device 1200 (e.g., corresponding to second electronic device 600B, first electronic device 800A, and/or first electronic device 1000). In some embodiments, first electronic device 1200 is a smartwatch. In some embodiments, first electronic device 1200 has a display 1202 and one or more input devices (e.g., including a touch layer of display 1202 and one or more mechanical buttons, such as a rotating crown). In some embodiments, first electronic device 1200 includes one or more biometric sensors (e.g., for recording ECG information, for detecting heart rhythm and heart rate of the user) comprising one or more electrodes integrated in an input device 1204 (e.g., a mechanical input device, such as a depressible, rotating crown) of first electronic device 1200. In some embodiments, the one or more biometric sensors of first electronic device 1200 further comprise one or more electrodes of (e.g., integrated in) a housing portion (e.g., the backplate) of first electronic device 1200, where the one or more electrodes integrated in the input device operate in conjunction with the one or more electrodes of the housing portion to capture biometric information (e.g., ECG information). Features concerning the one or more biometric sensors of first electronic device 1200 used to capture biometric information (e.g., ECG information) is described in greater detail in Appendix A.

[0367] In FIG. 12A, first electronic device 1200 displays, on display 1202, a summary page 1206 (e.g., corresponding to summary page 826 and summary page 1028) of an ECG application for a completed ECG recording, where the evaluation result of the completed ECG recording is a “regular rhythm” result, as indicated by indication 1208A of summary region 1208. In some

embodiments, summary region 1208 also includes an indication 1208B of a heart rate reading (e.g., in BPM) of the completed ECG recording. In some embodiments, while displaying summary page 1206, the device displays (e.g., maintains display of) an animation (e.g., corresponding to animation 808 shown in FIG. 8A, in its initial shape as shown in FIG. 8A) in the background of the summary page (e.g., in a lighter shade so that the summary page is easily legible to the user).

[0368] In some embodiments, summary region 1208 also includes a information affordance 1210 for viewing a detailed description about the respective evaluation result. In some embodiments, while displaying summary page 1206, first electronic device 1200 detects (e.g., via a touch input) a user activation 1201 of information affordance 1210.

[0369] FIG. 12B illustrates first electronic device 1200 displaying, on display 1202, at least a portion of a information page 1212 that includes description about medical characteristics of its respective result. In some embodiments, the description included in information page 1212 corresponds to the text description shown in possible results page 618 of the tutorial described with reference to FIGS. 6A-6AE. In FIG. 12B, first electronic device 1200 detects a scrolling input 1203 on input device 1204 (e.g., a rotating of input device 1204, a rotating crown) in the direction of the bottom of the page. In some embodiments, the page can be scrolled via a scrolling touch gesture on the display. In response to detecting the scrolling input, first electronic device 1200 scrolls information page 1212 towards the bottom of the page.

[0370] FIG. 12C illustrates first electronic device 1200 displaying, on display 1202, the bottom portion of information page 1212 of the ECG application. In some embodiments, information page 1212 includes (e.g., at the end of the page), a return affordance 1214 for returning to the previous page of the ECG application. In some embodiments, while displaying information page 1212, first electronic device 1200 detects (e.g., via a touch input) a user activation 1205 of return affordance 1214. In response to detecting user activation 1205 of return affordance 1214, first electronic device 1200 again displays, on display 1202 (e.g., replaces display of information page 1212 with), summary page 1206, as shown in FIG. 12D.

[0371] In FIG. 12D, while displaying, on display 1202, summary page 1206, first electronic device 1200 detects a scrolling input 1207 on input device 1204 (e.g., a rotating of the input

device, a rotating crown). In some embodiments, in response to detecting scrolling input 1207 on input device 1204, first electronic device 1200 scrolls summary page 1206 to reveal additional items of the page, as shown in FIG. 12E.

[0372] In some embodiments, as shown in FIG. 12E, summary page 1206 includes a symptoms region 1216 that includes an affordance 1218 for associating (e.g., via user selection from a list of symptoms) one or more symptoms to the ECG recording represented by the summary page. In some embodiments, as also shown in FIG. 12E, summary page 1206 includes an emergency contact affordance 1220 (e.g., for seeking immediate medical care, for contacting 911). In some embodiments, in response to detecting a user selection of emergency contact affordance 1220, first electronic device 1200 initiates a phone call to an emergency contact (e.g., 911).

[0373] In FIG. 12E, while displaying symptoms region 1216 of summary page 1206, first electronic device 1200 detects (e.g., via a touch input) a user activation 1209 of affordance 1218 for associating one or more symptoms to the ECG recording. In some embodiments, in response to detecting user activation 1209 of affordance 1218, first electronic device 1200 displays, on display 1202 (e.g., replaces display of summary page 1206 with), a symptoms page 1222, as shown in FIG. 12F.

[0374] In some embodiments, symptoms page 1222 includes a selectable symptoms list 1224 that includes a plurality of symptoms options, of which one or more of the listed symptoms can be selected by the user from the list. In some examples, a symptom option of selectable symptoms list 1224 is a “Light headed or dizzy” option. In some examples, a symptom option of selectable symptoms list 1224 is a “Fainting or near fainting spells” option. In some examples, a symptom option of selectable symptoms list 1224 is a “Shortness of breath” option. In some examples, a symptom option of selectable symptoms list 1224 is a “Chest pain” option. In some examples, a symptom option of selectable symptoms list 1224 is an “Other” option (e.g., for indicating one or more symptoms that are not listed in the selectable symptoms list). In some examples, a symptom option of selectable symptoms list 1224 is a “None” option (e.g., for indicating that the user is not experiencing (or was not experiencing during the time of the ECG recording) any abnormal symptoms).

[0375] In FIG. 12G, while displaying, on display 1202, selectable symptoms list 1224 of symptoms page 1222, first electronic device 1200 detects (e.g., via touch inputs) a user selection 1211 of a first symptom option 1224A (e.g., a “Shortness of breath” option) and a user selection of 1213 of a second symptom option 1224B (e.g., a “Chest pain” option). In response to detecting user selection 1211 of first symptom option 1224A and user selection 1213 of second symptom option 1224B, first electronic device 1200 displays, in selectable symptoms list 1224, an indication 1226A (e.g., a marking of the option, such as a checkmark) of first symptom option 1224A and an indication 1226B (e.g., a marking of the option, such as a checkmark) of second symptom option 1224B, as shown in FIG. 12H. In some embodiments, user-specified symptoms can be added (via symptoms page 1222) to evaluation results that correspond to “regular” results, as is the case in FIGS. 12A-12H.

[0376] In some embodiments, first electronic device 1200 detects a scrolling gesture (e.g., via a scrolling touch gesture, via a rotating input on input device 1204, a rotating crown) on symptoms page 1222 and, in response to the scrolling gesture, scrolls the page to reveal a bottom portion of the page. In some embodiments, as shown in FIG. 12H, symptoms page 1222 includes (e.g., at the bottom of the page) a return affordance 1228 for confirming the selection of symptoms from selectable symptoms list 1224 to associate with the ECG recording and for returning to summary page 1206. In FIG. 12H, first electronic device 1200 detects (e.g., via a touch input) a user activation 1215 of return affordance 1228.

[0377] In some embodiments, in response to detecting user activation 1215 of return affordance 1228, if at least one of the user-specified symptoms are determined to be “serious” symptoms (e.g., symptoms that may require immediate medical attention), first electronic device 1200 displays, on the display 1202, an alert page 1230, as shown in FIG. 12I. In some embodiments, alert page 1230 includes an emergency contact affordance 1232 which, when activated by the user, causes the device to initiate a process for seeking immediate medical attention (e.g., by initiating an emergency call to an emergency contact, by initiating a 911 call). In some embodiments, alert page 1230 includes a return affordance 1234 for returning to summary page 1206 (e.g., without contacting an emergency contact).

[0378] In some embodiments, in response to detecting user activation 1215 of return affordance 1228, if none of the user-specified symptoms are determined to be “serious” symptoms (e.g., symptoms that may require immediate medical attention), first electronic device 1200 (automatically) displays summary page 1206 without displaying alert page 1230.

[0379] In FIG. 12I, while displaying, on display 1202, alert page 1230, first electronic device detects (e.g., via a touch input) a user activation 1217 of return affordance 1234 from alert page 1230. In some embodiments, in response to detecting user activation 1217 of return affordance 1234, first electronic device 1200 again displays, on display 1202 (e.g., replaces display of alert page 1230 with), an updated symptoms region 1236 (e.g., corresponding to previous symptoms region 1216) of summary page 1206, as shown in FIG. 12J, where updated symptoms region 1236 includes a list of the user-specified symptoms from selectable symptoms list 1224.

[0380] In some embodiments, updated symptoms region 1236 further includes an edit affordance 1238 for returning to symptoms page 1222 to modify the user-specified symptoms from selectable symptoms list 1224. In some embodiments, the user-specified symptoms of an ECG recording cannot be modified (either at first electronic device 1200 or at a second electronic device paired to first electronic device 1200, such as a smartphone) upon leaving the ECG application while on that recording.

[0381] In FIG. 12J, while displaying updated symptoms region 1236 in summary page 1206 (after having received user-specified symptoms for the recording), first electronic device 1200 detects a scrolling input 1219 on input device 1204 (e.g., a rotating of input device 1204, a rotating crown) towards the bottom of summary page 1206. In some embodiments, in response to detecting scrolling input 1219 on input device 1204, first electronic device 1200 scrolls summary page towards the bottom of the page.

[0382] FIG. 12K illustrates first electronic device 1200 displaying, on display 1202, a bottom portion of summary page 1206. In some embodiments, summary page 1206 includes an emergency contact affordance 1240 for initiating a process for seeking immediate medical attention (e.g., initiating an emergency call to an emergency contact, initiating a 911 call). In some embodiments, summary page 1206 includes a return affordance 1242 for confirming selections (e.g., user specified symptoms) made via summary page 1206 and for returning to a

mina user interface 1244 of the ECG application (e.g., corresponding to user interface 644 described with reference to FIGS. 6A-6AE, user interface 806 described with reference to FIGS. 8A-8S, and user interface 1006 described with reference to FIGS. 10A-10J), as shown in FIG. 12L.

[0383] In some embodiments, within a summary region (e.g., 1248) of a summary page (e.g., 1206), an indication of the evaluation result of an ECG recording (e.g., “regular,” “Atrial Fibrillation,” “high heart rate,” “low heart rate,” “inconclusive”) is highlighted with a warning visual characteristic (e.g., a warning color, such as yellow) if the result is an abnormal result (e.g., “Atrial Fibrillation,” “high heart rate,” “low heart rate”) different from a default visual characteristic (e.g., a default color). Similarly, in some embodiments, within a summary region of a summary page, an indication of the heart rate measurement of an ECG recording (e.g., the BPM) is highlighted with the warning visual characteristic (e.g., a warning color, such as yellow) if the heart rate is abnormal high (e.g., above 100 BPM) or abnormally low (e.g., below 50 BPM). In some embodiments, if one of the evaluation result or heart rate measurement is abnormal, both the indication of the evaluation result and the indication of the heart rate measurement are displayed with warning visual characteristic

[0384] FIG. 12M illustrates a full expanded view of an example summary page 1246 corresponding to a first ECG recording performed using first electronic device 1200. As indicated by a summary region 1248, the first ECG recording has an Atrial Fibrillation result (an abnormal result), as shown by an evaluation result indication 1248A (e.g., showing “Atrial Fibrillation”), with a normal heart rate (e.g., between 50-100 BPM), as shown by a BPM indication 1248B (e.g., showing “80 BPM”). In some embodiments, evaluation result indication 1248A is highlighted with the warning visual characteristic (e.g., text “Atrial Fibrillation” is displayed in a warning color, such as yellow, instead of a default color) and BPM indication 1248B is not highlighted with the warning visual characteristic (e.g., text “80 BPM” is displayed in a default color, such as white).

[0385] FIG. 12N illustrates a full expanded view of an example summary page 1250 corresponding to a second ECG recording performed using first electronic device 1200. As indicated by a summary region 1252, the second ECG recording has an Atrial Fibrillation result

(an abnormal result), as shown by an evaluation result indication 1252A (e.g., showing “Atrial Fibrillation”), with a high heart rate (e.g., over 100 BPM), as shown by a BPM indication 1252B (e.g., showing “120 BPM”). In some embodiments, evaluation result indication 1252A is highlighted with the warning visual characteristic (e.g., text “Atrial Fibrillation” is displayed in a warning color, such as yellow, instead of a default color) and BPM indication 1252B is also highlighted with the warning visual characteristic (e.g., text “120 BPM” is displayed in the warning color, such as yellow).

[0386] FIG. 12O illustrates a full expanded view of an example summary page 1254 corresponding to a third ECG recording performed using first electronic device 1200. As indicated in summary page 1254, the measured heart rate of the third ECG recording was too low (e.g., below 50 BPM) to check for Atrial Fibrillation. An evaluation result indication 1256A (e.g., showing “Heart rate under 50”) of a summary region 1256 indicates a low heart rate result (an abnormal result) with a BPM indication 1256B (e.g., showing “46 BPM”) of summary region 1256 showing the low heart rate. In some embodiments, evaluation result indication 1256A is highlighted with the warning visual characteristic (e.g., text “Heart rate under 50” is displayed in a warning color, such as yellow) and BPM indication 1256B is also highlighted with the warning visual characteristic (e.g., text “46 BPM” is displayed in the warning color, such as yellow).

[0387] FIG. 12P illustrates a full expanded view of an example summary page 1258 corresponding to a fourth ECG recording performed using first electronic device 1200. As indicated by a summary region 1260, the fourth ECG recording has a regular rhythm result (a normal result, a non-Atrial Fibrillation result), as shown by an evaluation result indication 1260A (e.g., showing “Regular Rhythm”), with a high heart rate (e.g., over 100 BPM), as shown by a BPM indication 1260B (e.g., showing “120 BPM”). In some embodiments, evaluation result indication 1260A is not highlighted with the warning visual characteristic (e.g., text “Regular Rhythm” is displayed in a default color, such as white) and BPM indication 1260B is highlighted with the warning visual characteristic (e.g., text “120 BPM” is displayed in the warning color, such as yellow).

[0388] In some embodiments, as indicated by an alternate summary region 1261, if the heart rhythm result is a normal result (e.g., a non-Atrial Fibrillation result) and the heart rate result is

an abnormal result (e.g., a high or low heart rate result), evaluation result 1261A of summary region 1261 indicates the abnormal heart rate result (e.g., by stating “Heart rate over 100,” “Heart rate over 150,” “Heart rate below 50”) while BPM indication 1261B is maintained. In some embodiments, evaluation result indication 1261A is highlighted with the warning visual characteristic (e.g., text “Heart rate over 100” is displayed in a warning color, such as yellow) and BPM indication 1261B is highlighted with the warning visual characteristic (e.g., text “120 BPM” is displayed in the warning color, such as yellow).

[0389] FIG. 12Q illustrates a full expanded view of an example summary page 1262 corresponding to a fifth ECG recording performed using first electronic device 1200. As indicated in summary page 1262, the measured heart rate of the fifth ECG recording was too high (e.g., over 150 BPM) to check for Atrial Fibrillation. An evaluation result indication 1264A (e.g., showing “Heart rate over 150”) of a summary region 1264 indicates a high heart rate result (an abnormal result) with a BPM indication 1264B (e.g., showing “152 BPM”) of summary region 1264 showing the high heart rate. In some embodiments, evaluation result indication 1264A is highlighted with the warning visual characteristic (e.g., text “Heart rate over 150” is displayed in the warning color, such as yellow) and BPM indication 1264B is also highlighted with the warning visual characteristic (e.g., text “152 BPM” is displayed in the warning color, such as yellow).

[0390] FIG. 12R illustrates a full expanded view of an example summary page 1266 corresponding to a sixth ECG recording performed using first electronic device 1200. As indicated by a summary region 1268, the sixth ECG recording has a regular result (a normal result, a non-Atrial Fibrillation result), as shown by an evaluation result indication 1268A (e.g., showing “Regular Rhythm”), with a normal heart rate (e.g., 50-100 BPM), as shown by a BPM indication 1268B (e.g., showing “80 BPM”). In some embodiments, evaluation result indication 1268A is not highlighted with the warning visual characteristic (e.g., text “Regular Rhythm” is displayed in the default color, such as white) and BPM indication 1268B is also not highlighted with the warning visual characteristic (e.g., text “80 BPM” is displayed in the default color, such as white).

[0391] FIG. 12S illustrates a full expanded view of an example summary page 1270 corresponding to a seventh ECG recording performed using first electronic device 1200. As indicated by a summary region 1272, the seventh ECG recording has an inconclusive result (e.g., due to a poor reading), as shown by an evaluation result indication 1272A (e.g., showing “Inconclusive”), with an inconclusive heart rate, as shown by a BPM indication 1272B. In some embodiments, evaluation result indication 1272A is not highlighted with the warning visual characteristic (e.g., text “Inconclusive” is displayed in the default color, such as white) and BPM indication 1272B is also not highlighted with the warning visual characteristic (e.g., text “—BPM” is displayed in the default color, such as white). In some embodiments, summary page 1270 of an inconclusive results includes a text description explaining to the user why the evaluation was inconclusive.

[0392] FIGS. 13A-13B are a flow diagram illustrating a method for managing aspects of health monitoring, in accordance with some embodiments. Method 1300 is performed at a device (e.g., 100, 300, 500, 600B, 800A, 1000, 1200) with a display and one or more input devices (e.g., a rotatable and depressible watch crown with integrated biometric sensors (e.g., comprising one or more electrodes) for detecting characteristics of the user’s heart (e.g., 1204), a touchscreen of the display, a mechanical button, a biometric sensor). Some operations in method 1300 are, optionally, combined, the orders of some operations are, optionally, changed, and some operations are, optionally, omitted.

[0393] As described below, method 1300 provides an intuitive way for managing health monitoring. The method reduces the cognitive burden on a user for managing health monitoring, thereby creating a more efficient human-machine interface. For battery-operated computing devices, enabling a user to manage health monitoring faster and more efficiently conserves power and increases the time between battery charges.

[0394] The first electronic device (e.g., 1200) captures (1302) biometric information with a biometric sensor that is in communication with the first electronic device (e.g., comprising one or more electrodes integrated an input device (e.g., 1204) operating in conjunction with one or more electrodes of a housing portion (e.g., backplate) of the first electronic device).

[0395] The first electronic device (e.g., 1200) displays (1304), on the display (e.g., 1202), a representation (e.g., 1208) of an evaluation of a medical characteristic (e.g., related to heart health) determined based on the biometric information (e.g., ECG data, BPM data, heart-related data) captured by the biometric sensor. Displaying, on the display (e.g., 1202), the representation of the evaluation of the medical characteristic improves visual feedback by enabling the user to quickly and easily see the result of the evaluation based on the captured biometric information. Providing improved visual feedback to the user enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0396] In some embodiments, upon (or prior to) capturing the biometric information with the biometric sensor, the first electronic device (e.g., 1200) automatically disables a wireless communication radio (e.g., RF circuitry 108, a LTE connection) of the first electronic device and prevents notifications (e.g., of a message, of an alert) from being displayed. Automatically disabling the wireless communication radio of the first electronic device (e.g., 1200) and preventing notifications from being displayed enables the user to perform more accurate recordings of biometric information without manually disabling certain other functions of the device that may interrupt or interfere with the capturing of the biometric information. Performing an operation without requiring user input enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently. In some embodiments, the notifications that are prevented from being displayed do not include a timer notification.

[0397] In some embodiments, upon (or in response to) completing capture of the biometric information, the first electronic device (e.g., 1200) automatically re-enables the wireless communication radio (e.g., RF circuitry 108, a LTE connection) and allows notifications to be displayed. Automatically re-enabling the wireless communication radio and allowing notifications to be displayed upon completing capture of the biometric information reduces the

number of inputs required from the user to control the device by enabling the user to bypass having to manually re-enable the wireless communication radio and allow notifications to be displayed. Reducing the number of inputs needed to perform an operation enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0398] In some embodiments, the medical characteristic includes a heart rhythm characteristic (e.g., a characteristic corresponding to 1208A) and a heart rate characteristic (e.g., a characteristic corresponding to 1208B), and the displayed representation of the evaluation of the medical characteristic includes a heart rhythm evaluation (e.g., a electrocardiogram evaluation, 1208a) summary and a heart rate evaluation (e.g., a BPM reading, 1208B) summary.

[0399] In some embodiments, the heart rhythm evaluation summary (e.g., 1252A) is displayed with a first visual characteristic (e.g., a first color, a warning color such as yellow) and the heart rate evaluation summary (e.g., 1252B) is displayed with the first visual characteristic when the heart rhythm evaluation corresponds to an abnormal result and the heart rate evaluation corresponds to an abnormal result. Displaying the heart rhythm evaluation summary (e.g., 1252A) with the first visual characteristic and the heart rate evaluation summary (e.g., 1252B) with the first visual characteristic when the heart rhythm evaluation corresponds to an abnormal result and the heart rate evaluation corresponds to an abnormal result improves visual feedback by enabling the user to quickly and easily recognize the out of the evaluation result and whether the evaluation result should be paid closer attention to (e.g., for further medical attention). Providing improved visual feedback to the user enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently. In some embodiments, the heart rhythm analysis evaluation (e.g., 1252A) corresponds to an abnormal result if an abnormal rhythm pattern is detected (e.g., signs of Atrial Fibrillation). In some embodiments, the heart rate evaluation (e.g., 1252B) corresponds to an abnormal result if the rate is greater than a high limit number (e.g., 100 BPM).

[0400] In some embodiments, the heart rhythm evaluation summary (e.g., 1248A) is displayed with the first visual characteristic and the heart rate evaluation summary (e.g., 1248B) is not displayed with the first visual characteristic when the heart rhythm evaluation corresponds to an abnormal result (e.g., signs of Atrial Fibrillation) and the heart rate evaluation corresponds to a normal result (e.g., 60-100 BPM). Displaying the heart rhythm evaluation summary (e.g., 1248A) with the first visual characteristic and not displaying the heart rate evaluation summary (e.g., 1248B) with the first visual characteristic when the heart rhythm evaluation corresponds to an abnormal result and the heart rate evaluation corresponds to a normal result improves visual feedback by enabling the user to quickly and easily recognize and differentiate between an abnormal result and a normal result, and whether an evaluation result should be paid closer attention to (e.g., for further medical attention). Providing improved visual feedback to the user enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0401] In some embodiments, the heart rate evaluation summary (e.g., 1260A) is displayed with the first visual characteristic and the heart rhythm evaluation summary (e.g., 1260B) is not displayed with the first visual characteristic when the heart rate evaluation corresponds to an abnormal result (e.g., BPM below 50 or above 100) and the heart rhythm evaluation (e.g., 1260A) corresponds to a normal result. Displaying heart rate evaluation summary (e.g., 1260A) with the first visual characteristic and not displaying the heart rhythm evaluation summary (e.g., 1260B) with the first visual characteristic when the heart rate evaluation corresponds to an abnormal result (e.g., BPM below 50 or above 100) and the heart rhythm evaluation corresponds to a normal result improves visual feedback by enabling the user to quickly and easily recognize and differentiate between an abnormal result and a normal result, and whether an evaluation result should be paid closer attention to (e.g., for further medical attention). Providing improved visual feedback to the user enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage

and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0402] In some embodiments, the heart rate evaluation summary (e.g., 1264A) is displayed with a first visual characteristic and the heart rhythm evaluation summary (e.g., 1264B) is displayed with the first visual characteristic when the heart rate evaluation corresponds to a highly abnormal result (e.g., BPM over 150 or below 50) such that a determination cannot be made on the heart rhythm evaluation. Displaying the heart rate evaluation summary (e.g., 1264A) and the heart rhythm evaluation summary (e.g., 1264B) with the first visual characteristic when the heart rate evaluation corresponds to a highly abnormal result (e.g., BPM over 150 or below 50) such that a determination cannot be made on the heart rhythm evaluation improves visual feedback by enabling the user to quickly and easily recognize that the result corresponds to a highly abnormal result and that the evaluation result should be paid closer attention to (e.g., for further medical attention). Providing improved visual feedback to the user enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0403] In some embodiments, in accordance with a determination that the evaluation of the medical characteristic cannot be determined (e.g., because the biometric information captured by the biometric sensor is incomplete or is of poor quality), the first electronic device (e.g., 1200) displays (1306), in the representation of the evaluation, an indication that the evaluation was inconclusive (e.g., 1272A). In some embodiments, the evaluation also includes a text description (e.g., 1270) explaining to the user why the evaluation was inconclusive (e.g., due to a poor reading from the biometric sensor). Providing the text description explaining to the user why the evaluation result was inconclusive improves visual feedback and provides the user with more control of the device by enabling the user to easily understand why the evaluation result and inconclusive (e.g., such that the user can take a new recording that addresses a reason for the inconclusive result). Improving visual feedback to the user and providing additional control of the device (without cluttering the user interface with additional displayed controls) enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the

user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0404] While displaying the representation (e.g., 1208) of the evaluation of the medical characteristic, the first electronic device (e.g., 1200) detects (1308), via the one or more input devices, a sequence of one or more inputs (e.g., a sequence of one or more touch inputs on a touchscreen of the display (e.g., 1209, 1211, 1213)) to add user-specified symptoms (e.g., 1224) to the evaluation of the medical characteristic. In some embodiments, one or more symptoms are displayed in a list for user selection. Providing one or more symptoms as a list for user selection reduces the number of inputs required from the user to provide the one or more symptoms (e.g., allows the user to not have to type the one or more symptoms). Reducing the number of inputs needed to perform an operation enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently. In some embodiments, the user selects one or more symptoms from the provided list of symptoms.

[0405] In some embodiments, while displaying, on the display (e.g. 1202), the representation (e.g., 1208) of the evaluation of the medical characteristic (e.g., a result of the evaluation, data from the evaluation, such as BPM), the first electronic device (e.g., 1200) detects, via a first input device (e.g., 1204), a scrolling input (e.g., 1207). In some embodiments, the first input device is a rotating crown (e.g., 1204) and the scrolling input is a rotation of the rotating crown (e.g., 1207). In some embodiments, the first input device is the touch layer of the display and the scrolling input is a scrolling touch gesture on the display (e.g., 1202). Further in such embodiments, in response to detecting the scrolling input, the first electronic device (e.g., 1200) scrolls a second user interface (e.g., 1206) that includes the representation of the evaluation of the medical characteristic. Additionally in such embodiments, the first electronic device (e.g., 1200) displays, on the display (e.g., 1202), an add-symptoms affordance (e.g., 1216) for adding the user-specified symptoms to the evaluation. Displaying, on the display (e.g., 1202), the add-symptoms affordance for adding the user-specified symptoms to the evaluation provides visual

feedback by allowing the user to quickly recognize how to add one or more symptoms to an evaluation result. Providing improved visual feedback to the user enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0406] In some embodiments, the user-specified symptoms include a first symptom (e.g., 1226B) corresponding to a serious symptom (e.g., a symptom that may require immediate medical attention), and a first representation of the one or more representations of user-specified symptoms corresponding to the first symptom is displayed with a first visual characteristic (e.g., a warning color, such as yellow). In some embodiments, the user-specified symptoms include a second symptom (e.g., 1226A) corresponding to a non-serious symptom, and a second representation of the one or more representations of user-specified symptoms corresponding to the second symptom is displayed with a second visual characteristic (e.g., a non-warning color, a default color) that is different from the first visual characteristic.

[0407] In some embodiments, the evaluation of the medical characteristic is a normal result (no abnormalities detected, e.g., a normal result as discussed above with respect to method 700 and FIG. 6H) and the sequence of one or more inputs (e.g., 1209, 1211, 1213) to add the user-specified symptoms is detected while displaying the representation of the evaluation corresponding to the normal result. Thus, in some embodiments, one or more symptoms can be added to an evaluation with no abnormal results.

[0408] In some embodiments, while displaying the representation (e.g., 1208) of the evaluation of the medical characteristic, the first electronic device (e.g., 1200) detects, via the one or more input devices (e.g., 1202), a user activation of an information affordance (e.g., 1210). In such embodiments, in response to detecting the user activation of the information affordance, the first electronic device (e.g., 1200) displays, on the display (e.g., 1202), text information (e.g., 1212) related to the evaluation. Displaying, on the display (e.g., 1202), the text information (e.g., 1212) related to the evaluation in response to detecting the user activation of the information affordance provides more control of the device by enabling the user to easily

access more information related to the evaluation result. Providing additional control options (without cluttering the user interface with additional displayed controls) enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently. In some embodiments, the displayed text information related to the evaluation corresponds to the text information presented for the same type of evaluation during the onboarding process, as described in method 700 (e.g., FIGS. 6F-6L).

[0409] In response to detecting the sequence of one or more inputs (e.g., 1209, 1211, 1213), in accordance with a determination that at least one of the user-specified symptoms meet respective criteria, the first electronic device (e.g., 1200) displays (1310), on the display (e.g., 1202), a first user interface (e.g., a Symptom Alert user interface 1230) that includes an affordance (e.g., 1232) that, when activated, initiates a process for seeking immediate medical attention (e.g., initiating an emergency call, initiating a 911 call). Displaying, on the display (e.g., 1202), the first user interface (e.g., 1230) that includes the affordance that, when activated, initiates the process for seeking immediate medical attention improves user control of the device by enabling the user to quickly and easily recognize that immediate medical attention may be necessary and enables the user to easily and conveniently initiate a process for seeking immediate medical attention. Providing additional control options and reducing the number of inputs needed to perform an operation enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0410] In response to detecting the sequence of one or more inputs (e.g., 1209, 1211, 1213), in accordance with a determination that (all of) the user-specified symptoms do not meet the respective criteria, the first electronic device (e.g., 1200) displays (1312), on the display (e.g., 1202), the representation of the evaluation of the medical characteristic and one or more representations of user-specified symptoms without displaying the first user interface (e.g.,

without displaying interface 1230). Displaying, on the display (e.g., 1202), the representation of the evaluation of the medical characteristic and the one or more representations of the user-specified symptoms without displaying the first user interface (e.g., 1230) improves visual feedback by enabling the user to easily view the evaluation and the user-specified symptoms upon user selection of the symptoms. Providing improved visual feedback to the user enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0411] In some embodiments, further in accordance with a determination that (all of) the user-specified symptoms do not meet the respective criteria, the first electronic device (e.g., 1200) detects (1312), via the one or more input devices (e.g., 1204), a scrolling gesture (e.g., a rotation of a rotating crow (e.g., 1219), a scrolling input on the touch layer of the display). In some embodiments, in response to detecting, via the one or more input devices, the scrolling gesture, the first electronic device (e.g., 1200) displays (1314), on the display (e.g., 1202), an option for seeking medical attention (e.g., a selectable text allowing the user to initiate a process for contacting 911 (e.g., 1240)). Displaying, on the display (e.g., 1202), the option for seeking medical attention in response to detecting the scrolling gesture improves user control of the device by providing the user with a quick and easy method for seeking medical attention, if the user determines that medical attention is needed. Providing additional control options (without cluttering the user interface with additional displayed controls) enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0412] In some embodiments, subsequent to detecting the sequence of one or more inputs (e.g., 1209, 1211, 1213), the first electronic device (e.g., 1200) detects (1316) a user activation (e.g., 1221) of a confirmation button (e.g., 1242). In such embodiments, in response to (or subsequent to) detecting the user activation of the confirmation button, the first electronic device (e.g., 1200) transmits (1318) (e.g., via a wireless communication radio of the device) the

evaluation of the medical characteristic from the first electronic device (e.g., 1200) to a second electronic device (e.g., 100, 300, 500, 600A), a smartphone that is paired with the first electronic device) for display of a corresponding representation of the evaluation of the medical characteristic on the second electronic device.

[0413] In some embodiments, the user-specified symptoms (e.g., 1226A, 1226B) cannot be modified after detecting the user activation of the confirmation button.

[0414] Note that details of the processes described above with respect to method 1300 (e.g., FIGS. 13A-13B) are also applicable in an analogous manner to the methods described above and below. For example, method 700 optionally includes one or more of the characteristics of the various methods described above with reference to method 1300. For another example, method 900 optionally includes one or more of the characteristics of the various methods described above with reference to method 1300. For another example, method 1100 optionally includes one or more of the characteristics of the various methods described above with reference to method 1300. For another example, method 1500 optionally includes one or more of the characteristics of the various methods described above with reference to method 1300. For brevity, these details are not repeated below.

[0415] FIGS. 14A-14I illustrate exemplary user interfaces for providing a health condition alert. The user interfaces in these figures are used to illustrate the processes described below, including the processes in FIG. 15. The exemplary user interfaces in these figures relate generally to providing a health condition alert, such as a heart condition alert, and are not limited to providing a specific type of health condition-related alert. Only for the sake of convenience, the exemplary user interfaces in these figures are described with reference to a type of heart-related condition—Atrial Fibrillation.

[0416] FIG. 14A illustrates a first electronic device 1400A (e.g., a smartphone similar to first electronic device 600A) with a display 1402 and one or more input devices. In some embodiments, the one or more input devices include a touch layer of display 1402 for detecting touch input, one or more image sensors 1404 (e.g., a camera, a depth sensor), a first mechanical button 1406 configured to perform one or more operations (e.g., and including an integrated biometric sensor, such as a fingerprint sensor), and a second mechanical button 1408 configured

to perform one or more operations. In some embodiments, first electronic device 1400A includes a wireless communication radio (e.g., for LTE, Bluetooth, WiFi connections). In some embodiments, first electronic device 1400A is paired with a second electronic device (e.g., a smartwatch). In some embodiments, the second electronic device corresponds to second electronic device 1400B described below with reference to FIGS. 14H-14J. In some embodiments, second electronic device 1400B includes a plurality of biometric sensors, including a biometric sensor (comprising one or more photodiode sensors) enclosed in a housing of the second electronic device and an integrated biometric sensor (e.g., integrated with an input device, such as a rotatable input device, of the second electronic device).

[0417] FIG. 14A illustrates first electronic device 1400A displaying, on display 1402, a first page 1410 of a setup process for performing initial setup of Atrial Fibrillation-detection management features (e.g., of an associated health application), where heart-related information (e.g., heart rhythm information) used to determine Atrial Fibrillation is captured using a second electronic device (e.g., second electronic device 1400B) paired with first electronic device 1400A. In some embodiments, first page 1410 of the setup process includes a graphical indication region 1410A that graphically indicates (e.g., via a static image, via an animation) a function of the Atrial Fibrillation-detection management features (e.g., recording heart rhythm information). In some embodiments, first page 1410 of the setup process includes a text description region 1410B describing background information relevant to the use of the Atrial Fibrillation-detection management features.

[0418] In some embodiments, first page 1410 of the setup process includes a date of birth entry field 1410C for receiving a user input corresponding to the user's date of birth, where the user's date of birth is used to determine whether the user meets a minimum age requirement (e.g., 22 years of age) to use the Atrial Fibrillation-detection management features. In some embodiments, date of birth entry field 1410C indicates (e.g., by stating "Required") that the user's date of birth must be entered in order to proceed with the setup process. In some embodiments, date of birth entry field 1410C includes scrollable month, day, and year fields.

[0419] In some embodiments, first page 1410 of the setup process does not include date of birth entry field 1410C. In some embodiments, first page 1410 of the setup process includes

(e.g., in addition to or alternatively to date of birth entry field 1410C) an age restriction message (e.g., stating “You must be 22 years or older”) indicating to the user that the user must meet the minimum age requirement.

[0420] In some embodiments, first page 1410 of the setup process includes an affordance 1410D for proceeding with the tutorial. In FIG. 14A, while displaying first page 1410 of the Atrial Fibrillation-detection management setup process and after having received an input corresponding to the user’s date of birth in entry field 1410C, first electronic device 1400A detects (e.g., via a touch input) a user activation 1401 of affordance 1410D for proceeding with the setup process.

[0421] In some embodiments, in accordance with a determination that the minimum age requirement is not met (e.g., a determination made in response to detecting user activation 1401), first electronic device 1400A displays, on display 1402, an error notification (e.g., stating “The Atrial Fibrillation-detection management features are not intended for use by people under 22”) indicating that the user does not meet the requisite minimum age requirement. In some embodiments, the error notification is overlaid on first page 1410 of the setup process. In some embodiments, while displaying the error notification, the background of the display (displaying first page 1410) is dimmed (thereby emphasizing the displayed error notification).

[0422] In some embodiments, in response to detecting user activation 1401 (and in accordance with a determination that the minimum age requirement is met), first electronic device 1400A displays, on display 1402 (e.g., replaces display of first page 1410 with), a second page 1412 of the setup process, as shown in FIG. 14B.

[0423] FIG. 14B illustrates first electronic device 1400A displaying, on display 1402, second page 1412 of the setup process for enabling Atrial Fibrillation-detection management features. In some embodiments, second page 1412 of the setup process includes an animation region 1412A that graphically indicates (e.g., via a static image, via an animation) a feature of Atrial Fibrillation detection (e.g., that heart-related information can be captured at several different times during time period to determine whether Atrial Fibrillation exists). In some embodiments, second page 1412 of the setup process includes a text description region 1412B that describes how the Atrial Fibrillation-detection features are implemented (using a second electronic device,

such as second electronic device 1400B). In some embodiments, second page 1412 of the setup process includes an affordance 1412C for proceeding with the setup process.

[0424] In FIG. 14B, while displaying second page 1412 of the Atrial Fibrillation-detection management setup process, first electronic device 1400A detects (e.g., via a touch input) a user activation 1403 of affordance 1412C for proceeding with the setup process. In some embodiments, in response to detecting user activation 1403, first electronic device 1400A displays, on display 1402 (e.g., replaces display of second page 1412 with), a third page 1414 of the setup process, as shown in FIG. 14C.

[0425] In some embodiments, third page 1414 of the setup process indicates to the user (e.g., via a text description) one or more limitations of Atrial-Fibrillation evaluation results that are determined from heart-related information captured using the second electronic device (e.g., second electronic device 1400B) (e.g., using a biometric sensor of the second electronic device comprising one or more photodiode sensors). In some examples, third page 1414 of the setup process includes a list 1414A of one or more functional characteristics of the Atrial Fibrillation-detection features and/or medical characteristics that cannot be determined from the captured heart-related information (e.g., heart attack, blood clots/stroke). In some embodiments, third page 1414 of the setup process includes (e.g., at the bottom of the page), an affordance 1414B for proceeding with the tutorial.

[0426] In FIG. 14C, while displaying, on display 1402, third page 1414 of the setup process, first electronic device 1400A detects (e.g., via a touch input) a user activation 1405 of affordance 1414B for proceeding with the setup process. In some embodiments, in response to detecting user activation 1405 of affordance 1414B, the device displays, on display 1402, a fourth page 1416 of the setup process, as shown in FIG. 14D.

[0427] FIG. 14D shows first electronic device 1400A displaying, on display 1402, fourth page 1416 of the setup process. In some embodiments, fourth page 1416 of the setup process includes a graphical indication region 1416A and a text indication region 1416B that provides instructions on how to view and manage Atrial Fibrillation-detection features when Atrial Fibrillation is determined based on heart-related information (e.g., captured at different times) captured using the second electronic device (e.g., second electronic device 1400B).

[0428] In some embodiments, fourth page 1416 of the setup process includes a notification activation affordance 1416C (e.g., showing “Turn on AFib Notifications”) for enabling notifications on first electronic device 1400A and/or second electronic device 1400B when Atrial Fibrillation is determined (using heart-related information captured using the second electronic device). In some embodiments, while displaying fourth page 1416 of the setup process, first electronic device 1400A detects (e.g., via a touch input) a user activation 1407 of notification activation affordance 1416C. In some embodiments, in response to detecting user activation 1407, first electronic device 1400A activates notifications to be displayed on first electronic device 1400A and/or second electronic device 1400B when Atrial Fibrillation is determined.

[0429] FIG. 14E illustrates first electronic device 1400A displaying, on display 1402, a heart data user interface 1418 of a health application associated with the Atrial Fibrillation-detection features (e.g., operating after activation of notifications as described with respect to FIGS. 14A-14D). In some embodiments, the health application is accessible via a corresponding icon on a home user interface of the operating system of first electronic device 1400A.

[0430] In some embodiments, heart data user interface 1418 of the health application includes a heart rate affordance 1420. In some embodiments, heart rate affordance 1420 includes an indication of a range of the user’s heart rate measured (e.g., via second electronic device 1400B) during a certain period of time (e.g., today). In some embodiments, in response to detecting a user selection on heart rate affordance 1420, heart data user interface 1418 displays a graphical depiction of the heart rate information summarized by heart rate affordance 1420 within a graphical depiction region 1422 of the user interface (and further highlights the affordance with a particular visual characteristic, such as a different color, to indicate to the user that the heart rate affordance is currently selected by the user).

[0431] In some embodiments, heart data user interface 1418 of the health application includes an Atrial Fibrillation affordance 1424. In some embodiments, Atrial Fibrillation affordance 1424 includes an indication of the number of heart-related readings taken during a certain period of time (e.g., “Today (4 Readings)”) by the second electronic device (e.g., second electronic device 1400B) (e.g., using a biometric sensor comprising one or more photodiode sensors of the second electronic device). In some embodiments, Atrial Fibrillation affordance

1424 includes an information affordance 1424A for viewing and managing information about existing heart-related recordings taken by the second electronic device (e.g., using a biometric sensor comprising one or more photodiode sensors) to detect Atrial Fibrillation.

[0432] In FIG. 14E, while displaying heart data user interface 1418 with Atrial Fibrillation affordance 1424 visible on display 1402, first electronic device 1400A detects (e.g., via a touch input) a user activation 1409 of information affordance 1424A of Atrial Fibrillation affordance 1424. In some embodiments, in response to detecting user activation 1409 of information affordance 1424A, first electronic device 1400A displays, on display 1402, an Atrial Fibrillation management user interface 1426, as shown in FIG. 14F.

[0433] FIG. 14F illustrates first electronic device 1400A displaying, on display 1402, an Atrial Fibrillation management user interface 1426. In some embodiments, Atrial Fibrillation management user interface 1426 includes an alert log indication region 1426A indicating Atrial Fibrillation alerts (if any) that have been generated upon detection of the condition using the second electronic device (e.g., second electronic device 1400B). In some embodiments, if Atrial Fibrillation has not yet been detected (and thus no Atrial Fibrillation alerts have been generated), alert log indication region 1426A indicates (e.g., by stating “No data”) that alerts have not yet been generated for Atrial Fibrillation detection.

[0434] In some embodiments, Atrial Fibrillation management user interface 1426 includes a recent analysis indication 1426B indicating the time(s) of one or more most recent measurements of heart-related information made by the second electronic device (e.g., second electronic device 1400B) (e.g., using a biometric sensor comprising one or more photodiode sensors of the second electronic device). In some embodiments, the one or more recent measurements shown in recent analysis indication 1426B only include heart-related information captured after an Atrial Fibrillation alert has been presented (if any) by first electronic device 1400A and/or second electronic device 1400B.

[0435] In some embodiments, Atrial Fibrillation management user interface 1426 includes a show all affordance 1426C for viewing a record of all past measurements of heart-related information using the second electronic device (e.g., second electronic device 1400B) (e.g., using a biometric sensor comprising one or more photodiode sensors of the second electronic device).

[0436] In some embodiments, Atrial Fibrillation management user interface 1426 includes an indication 1426D (e.g., a brief textual description) of how Atrial Fibrillation is detected by the second electronic device (e.g., second electronic device 1400B). In some embodiments, Atrial Fibrillation management user interface 1426 includes a learn more affordance 1426E for viewing additional information (e.g., expounding upon the description shown in indication 1426D) about the Atrial Fibrillation-detection features.

[0437] In some embodiments, Atrial Fibrillation management user interface 1426 includes a disable notifications affordance 1426F for disabling notifications from being presented (on first electronic device 1400A and/or second electronic device 1400B) when Atrial Fibrillation is detected.

[0438] FIG. 14G illustrates first electronic device 1400A displaying, on display 1402, Atrial Fibrillation management user interface 1426 after two previous Atrial Fibrillation alerts have been presented at first electronic device 1400A and/or second electronic device 1400B, as indicated in alert log indication region 1426A. In FIG. 14G, alert log indication region 1426A includes a first alert log 1428A corresponding to a first Atrial Fibrillation alert (upon a first detection of Atrial Fibrillation) and a second alert log 1428B corresponding to a second Atrial Fibrillation alert (upon a second detection of Atrial Fibrillation different from / separate from the first detection of Atrial Fibrillation).

[0439] In some embodiments, an alert log (e.g., first alert log 1428A and second alert log 1428B) includes a time at which the alert was generated. In some embodiments, in response to detecting a user activation of an alert log, first electronic device 1400A displays, on display 1402, a detailed alert log page that includes more detailed information about the captured heart-related information corresponding to the alert log (e.g., heart rate information, separate non-contiguous number of times during which the heart-related information was captured).

[0440] FIG. 14H illustrates second electronic device 1400B (e.g., paired with first electronic device 1400A and including a biometric sensor comprising one or more photodiode sensors for detecting heart-related information) displaying, on a display 1430, an Atrial Fibrillation notification 1432 corresponding to a received Atrial Fibrillation alert. In some embodiments, in response to detecting a user activation (e.g., via a touch input on display 1430 or via a scrolling

gesture (e.g., a rotation of a rotating input device of second electronic device 1400B or a scrolling input on display 1430 of second electronic device 1400B)) of Atrial Fibrillation notification 1432, second electronic device 1400B displays, on display 1430, an Atrial Fibrillation alert 1434, as shown in FIG. 14I.

[0441] In some embodiments, Atrial Fibrillation alert 1434 includes an indication 1434A (e.g., a textual description) describing the reason for the alert (e.g., a detection of Atrial Fibrillation) and an explanation of the medical condition (e.g., Atrial Fibrillation) associated with the alert. In some embodiments, Atrial Fibrillation alert 1434 includes an indication 1434B listing the one or more times (corresponding to measurements of heart-related information taken by second electronic device 1400B (e.g., using a biometric sensor comprising one or more photodiode sensors)) during which Atrial Fibrillation was detected by the device. In some embodiments, indication 1434B includes (not shown in FIG. 14I) one or more times and dates (e.g., within the previous 48 hours) during which Atrial Fibrillation was detected by the device. In some embodiments, Atrial Fibrillation alert 1434 includes an indication 1434C indicating that medical attention may be required (e.g., stating “If you have not been diagnosed with Atrial Fibrillation by a physician, you should discuss with your doctor”). In some embodiments, Atrial Fibrillation alert 1434 includes an indication 1434D warning that the user should not take a medical action (e.g., changing medication or treatments) without consulting a physician.

[0442] In some embodiments, Atrial Fibrillation alert 1434 includes an ECG affordance 1436 for taking more detailed heart-related information using an ECG application of second electronic device 1400B (e.g., corresponding to the ECG application discussed above with respect to FIGS. 6A-6AE, 8A-8S, 10A-10J, and 12A-12S). In some embodiments, the more detailed heart-related information captured using the ECG application relates to the condition (e.g., Atrial Fibrillation) detected by second electronic device 1400B without using the ECG application. In some embodiments, using the ECG application, the more detailed heart-related information is captured by one or more biometric sensors of second electronic device 1400B that comprise one or more electrodes of (e.g., integrated in) an input device (e.g., a rotatable and depressible input device) of second electronic device 1400B and one or more electrodes of (e.g., integrated in) a housing portion (e.g., the backplate) of second electronic device 1400B, where the one or more electrodes integrated in the input device operate in conjunction with the one or more electrodes of the

housing portion to capture the more detailed heart-related information (e.g., ECG information). Features concerning the one or more biometric sensors of second electronic device 1400B used to capture the more detailed heart-related information (e.g., ECG information) is described in greater detail in Appendix A. In some embodiments, Atrial Fibrillation alert 1434 includes a dismiss affordance 1438 for dismissing the alert (e.g., without proceeding to the ECG application to record more detailed heart-related information).

[0443] FIG. 15 is a flow diagram illustrating a method for providing a health condition alert, in accordance with some embodiments. Method 1500 is performed at a device (e.g., 100, 300, 500, 600B, 800A, 1000, 1200, 1400B) with a display and one or more input devices (e.g., a rotatable and depressible input device with an integrated biometric sensor(s) (e.g., comprising one or more electrodes) for detecting characteristics of the user's heart (e.g., 1204), a touch-sensitive surface, a mechanical button). The device is operably connected to a plurality of biometric sensors (e.g., a physical activity tracking sensor; a sensor integrated into electronic device; a plurality of sensors discrete from the electronic device that are connected (e.g., wireless connected) to the device). Some operations in method 1500 are, optionally, combined, the orders of some operations are, optionally, changed, and some operations are, optionally, omitted.

[0444] As described below, method 1500 provides an intuitive way for providing a health condition alert. The method reduces the cognitive burden on a user for managing a health condition, thereby creating a more efficient human-machine interface. For battery-operated computing devices, enabling a user to manage health monitoring faster and more efficiently conserves power and increases the time between battery charges.

[0445] The electronic device (e.g., 1400B) receives (1502) (e.g., via an internal connection from an integrated sensor of the electronic device (e.g., 1400), via a wireless connection from a discrete sensor) first biometric information from a first biometric sensor of the plurality of biometric sensors. In some embodiments, the first biometric sensor comprises one or more photodiode sensors (e.g., enclosed in a housing of the electronic device). In some embodiments, the first biometric information comprises biometric information recorded at a first time and biometric information recorded at a second time different from (e.g., spaced apart from, non-contiguous with) the first time (e.g., a common time on a different day of the week).

[0446] In response to receiving the first biometric information and in accordance with a determination that the first biometric information satisfies first criteria (e.g., because the first biometric information includes heart rate or rhythm information that is abnormal and, optionally, because during a predetermined period of time (e.g., 48 hours), the electronic device (e.g., 1400B) has detected a threshold number of readings (e.g., five readings) having indications of irregular heart rate or rhythm), the electronic device (e.g., 1400B) displays (1504), on the display (e.g., 1430), an alert (e.g., 1434) including a first affordance (e.g., 1436) for detecting additional biometric information (e.g., using an ECG application on the electronic device). Displaying an alert that includes a first affordance for detecting additional biometric information in response to receiving the first biometric information and in accordance with a determination that the first biometric information satisfies first criteria improves visual feedback by quickly (and in an easily-recognizable method) indicating to the user that an action (e.g., measuring additional biometric information) can be taken on the device. Providing improved visual feedback to the user enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently. In some embodiments, the biometric information relates to heart-related information. In some embodiments, the first criteria comprises abnormal heart rhythm information.

[0447] In some embodiments, the alert (e.g., 1434) includes one or more times (e.g., 1434B) during which the first biometric information was recorded by the electronic device. In some embodiments, the alert includes an indication (e.g., 1434A, a text description) of a medical condition (e.g., abnormal heart rhythm, Atrial Fibrillation) identified based on the first biometric information. In some embodiments, the alert includes an indication (e.g., 1434C, a text description) to seek medical attention. Including an indication to seek medical attention enhances the operability of the device by quickly and efficiently indicating to the user an action relating to information provided by the device can be taken. Enhancing the operability of the device makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which,

additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0448] The electronic device (e.g., 1400B) receives (1506), via the one or more input devices, user activation of the first affordance (e.g., 1436).

[0449] Subsequent to receiving the user activation of the first affordance (e.g., 1436), the electronic device (e.g., 1400B) receives (1512) (e.g., using the ECG application) second biometric information (e.g., more detailed heart rhythm information, ECG information) associated with the first biometric information from (at least) a second biometric sensor (e.g., a biometric sensor integrated with an input device (e.g., 636, 804, 1004, 1204, such as a rotatable input device) of the plurality of biometric sensors that is different from the first biometric sensor. In some embodiments, the second biometric sensor is integrated with a first input device (e.g., 636, 804, 1004, 1204, a rotatable and depressible input device) of the one or more input devices. In some embodiments, a first type of input on the first input device (e.g., 629, 801, 1005, such as a non-press input or a contact input, activates a feature(s) associated with activation of the second biometric sensor but does not activate a feature(s) associated with activation of the first input device.

[0450] In some embodiments, in response to receiving the user activation of the first affordance (e.g., 1436) and prior to receiving the second biometric information, the electronic device (e.g., 1400B) displays (1508), on the display (e.g., 1430), a first application (e.g., 806, 1006, an ECG application) associated with receiving the second biometric information. Displaying the first application associated with receiving the second biometric information in response to receiving the user activation of the first affordance and prior to receiving the second biometric information improves visual feedback by enabling the user to quickly and easily recognize that the second biometric information to be captured relates to features of the first application. Providing improved visual feedback to the user enhances the operability of the device and makes the user-device interface more efficient (e.g., by helping the user to provide proper inputs and reducing user mistakes when operating/interacting with the device) which, additionally, reduces power usage and improves battery life of the device by enabling the user to use the device more quickly and efficiently.

[0451] In some embodiments, subsequent to displaying the first application (e.g., 806, 1006, an ECG application) and prior to receiving the second biometric information, the electronic device (e.g., 1400B) detects (1510) a user input (e.g., 629, 801, 1005, a non-press input, a contact input) on a first input device (e.g., 636, 804, 1004, 1204, a rotatable and depressible input device) of the one or more input devices, where the second biometric sensor is integrated with the first input device. In some embodiments, in response to detecting the user input, the electronic device receives the second biometric information from the second biometric sensor.

[0452] In some embodiments, the second biometric information is received from the second biometric sensor while the user input (e.g., 629, 801, 1005, a non-press input, a contact input) is maintained on the first input device (e.g., 636, 804, 1004, 1204, a rotatable and depressible input device). In some embodiments, in response to detecting that the user input is no longer maintained on the first input device, the electronic device (e.g., 1400B) ceases receiving the second biometric information from the second biometric sensor. In some embodiments, if the user input is restored within a predetermined period of time, the electronic device resumes receiving the second biometric information from the second biometric sensor.

[0453] Note that details of the processes described above with respect to method 1500 (e.g., FIG. 15) are also applicable in an analogous manner to the methods described above. For example, method 700 optionally includes one or more of the characteristics of the various methods described above with reference to method 1500. For another example, method 900 optionally includes one or more of the characteristics of the various methods described above with reference to method 1500. For another example, method 1100 optionally includes one or more of the characteristics of the various methods described above with reference to method 1500. For another example, method 1300 optionally includes one or more of the characteristics of the various methods described above with reference to method 1500. For brevity, these details are not repeated below.

[0454] The foregoing description, for purpose of explanation, has been described with reference to specific embodiments. However, the illustrative discussions above are not intended to be exhaustive or to limit the invention to the precise forms disclosed. Many modifications and variations are possible in view of the above teachings. The embodiments were chosen and

described in order to best explain the principles of the techniques and their practical applications. Others skilled in the art are thereby enabled to best utilize the techniques and various embodiments with various modifications as are suited to the particular use contemplated.

[0455] Although the disclosure and examples have been fully described with reference to the accompanying drawings, it is to be noted that various changes and modifications will become apparent to those skilled in the art. Such changes and modifications are to be understood as being included within the scope of the disclosure and examples as defined by the claims.

[0456] As described above, one aspect of the present technology is the gathering and use of data available from various sources to improve the delivery to users of invitational content or any other content that may be of interest to them. The present disclosure contemplates that in some instances, this gathered data may include personal information data that uniquely identifies or can be used to contact or locate a specific person. Such personal information data can include demographic data, location-based data, telephone numbers, email addresses, home addresses, or any other identifying information.

[0457] The present disclosure recognizes that the use of such personal information data, in the present technology, can be used to the benefit of users. For example, the personal information data can be used to deliver targeted content that is of greater interest to the user. Accordingly, use of such personal information data enables calculated control of the delivered content. Further, other uses for personal information data that benefit the user are also contemplated by the present disclosure.

[0458] The present disclosure further contemplates that the entities responsible for the collection, analysis, disclosure, transfer, storage, or other use of such personal information data will comply with well-established privacy policies and/or privacy practices. In particular, such entities should implement and consistently use privacy policies and practices that are generally recognized as meeting or exceeding industry or governmental requirements for maintaining personal information data private and secure. For example, personal information from users should be collected for legitimate and reasonable uses of the entity and not shared or sold outside of those legitimate uses. Further, such collection should occur only after receiving the informed consent of the users. Additionally, such entities would take any needed steps for safeguarding

and securing access to such personal information data and ensuring that others with access to the personal information data adhere to their privacy policies and procedures. Further, such entities can subject themselves to evaluation by third parties to certify their adherence to widely accepted privacy policies and practices.

[0459] Despite the foregoing, the present disclosure also contemplates embodiments in which users selectively block the use of, or access to, personal information data. That is, the present disclosure contemplates that hardware and/or software elements can be provided to prevent or block access to such personal information data. For example, in the case of advertisement delivery services, the present technology can be configured to allow users to select to “opt in” or “opt out” of participation in the collection of personal information data during registration for services. In another example, users can select not to provide location information for targeted content delivery services. In yet another example, users can select to not provide precise location information, but permit the transfer of location zone information.

[0460] Therefore, although the present disclosure broadly covers use of personal information data to implement one or more various disclosed embodiments, the present disclosure also contemplates that the various embodiments can also be implemented without the need for accessing such personal information data. That is, the various embodiments of the present technology are not rendered inoperable due to the lack of all or a portion of such personal information data. For example, content can be selected and delivered to users by inferring preferences based on non-personal information data or a bare minimum amount of personal information, such as the content being requested by the device associated with a user, other non-personal information available to the content delivery services, or publically available information.

WEARABLE DEVICE WITH ELECTRODES FOR SENSING BIOLOGICAL PARAMETERS

FIELD

[0001] The described embodiments relate generally to a watch or other electronic device (*e.g.*, another type of wearable electronic device). More particularly, the described embodiments relate to techniques for providing, on a watch or other wearable electronic device, electrodes for sensing biological parameters. The electrodes may be variously provided on a crystal surface, crown, button, or housing member of the watch or other electronic device.

BACKGROUND

[0002] A watch or other electronic device may include a set of sensors for determining a set of biological parameters of a user that wears the watch or other electronic device. Circuitry associated with the set of sensors may generate, for example, electrical signals (or values) corresponding to voltages at, forces applied to, or amounts of light incident on, the sensors. The various signals or values may be correlated to, or used to derive, various biological parameters of the user, such as a heart rate of the user.

SUMMARY

[0003] Embodiments of the systems, devices, methods, and apparatus described in the present disclosure are directed to a watch or other electronic device (*e.g.*, another type of wearable electronic device) having a set of one or more electrodes that may be used to sense or determine biological parameters of a user that wears the watch or other electronic device. The biological parameters may include, for example, an echocardiogram (ECG) for the user.

[0004] In a first aspect, the present disclosure describes an electronic device. The electronic device includes a housing, which housing includes a crystal. The crystal has a first surface interior to the electronic device and a second surface exterior to the electronic device. A physical vapor deposition (PVD) deposited thin film first electrode is on the second surface of the crystal. The electronic device also includes a second electrode that is positioned to be contacted by a finger of a user of the electronic device while the first electrode is positioned against skin of the user. The electronic device includes a processor operable to determine a biological parameter of the user based on voltages at the first electrode and the second electrode while the user is in contact with the first electrode and the second electrode.

[0005] In another aspect, the present disclosure describes a watch body. The watch body has a housing that includes a crystal. The crystal has a first surface interior to the watch body, and a second surface exterior to the watch body. A crown assembly associated with the watch body includes a shaft extending through an aperture in the housing and a user-rotatable crown attached to the shaft. The crown is exterior to the housing. The electronic device includes a first electrode and a second electrode on the second surface of the crystal, and a third electrode on a surface of the user-rotatable crown. The third electrode is positioned to be contacted by a finger of a user while the first electrode and the second electrode are positioned against a wrist of the user. The electronic device includes a processor operable to determine a biological parameter of the user based on voltages at the first electrode, the second electrode, and the third electrode while the user is in contact with the first electrode, the second electrode, and the third electrode.

[0006] In still another aspect of the disclosure, another electronic device is described. The electronic device includes a housing, a conductive rotatable shaft extending through an aperture in the housing, and a conductive crown that is mechanically and electrically connected to the

shaft. The crown is exterior to the housing. The electronic device further includes a conductive shaft retainer, mechanically and electrically connected to the shaft, interior to the housing. Also included in the electronic device is a spring-biased conductor. The spring-biased conductor is in mechanical and electrical contact with at least one of the shaft and the shaft retainer. A circuit, electrically connected to the spring-biased conductor, is in electrical communication with the crown via the spring-biased conductor, the shaft retainer, and the shaft.

[0007] In addition to the exemplary aspects and embodiments described above, further aspects and embodiments will become apparent by reference to the drawings and by study of the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The disclosure will be readily understood by the following detailed description in conjunction with the accompanying drawings, wherein like reference numerals designate like structural elements, and in which:

[0009] FIG. 1A shows an example of an electronic device that may incorporate a set of electrodes;

[0010] FIG. 1B shows an example of a watch that may incorporate a set of electrodes;

[0011] FIG. 2 shows an exploded view of components that may be attached to a crystal mounted in a back side housing member of a watch body;

[0012] FIGS. 3A-3E illustrate an example of coatings that may be deposited on the interior and exterior surfaces of the crystal shown in FIG. 2;

[0013] FIG. 4 shows a cross-section of the crystal shown in FIG. 3B;

[0014] FIG. 5 shows a cross-section of the crystal shown in FIGS. 3C and 3D;

[0015] FIG. 6 shows an example layer construction of an ITO-based electrode;

[0016] FIGS. 7A-7C show alternative electrical connections between an electrode on an exterior surface of a crystal that forms part of a housing of an electronic device and an electrical contact interior to the electronic device;

[0017] FIGS. 8A-8D show alternative crystal configurations, and alternative attachments of crystals to other housing members of an electronic device;

[0018] FIG. 9 shows the exterior surfaces (*e.g.*, the skin-facing surfaces) of the back side housing member and crystal shown in FIG. 2, with masks and electrodes applied to the crystal as described with reference to FIGS. 3A-3E, 4, 5, and 7A-7C;

[0019] FIG. 10 shows the sensor subsystem of FIG. 2 mounted on the crystal shown in FIG. 2;

[0020] FIG. 11 shows an exploded view of a crown assembly;

[0021] FIG. 12 shows an assembled cross-section of the crown assembly shown in FIG. 11;

[0022] FIG. 13 shows an elevation of a watch body capable of sensing a biological parameter;

[0023] FIG. 14 shows a cross-section of the crown assembly shown in FIGS. 11 and 12, as viewed from an edge of a watch body;

[0024] FIG. 15 shows a schematic of an electronic device that may be used for acquiring an ECG or other biological parameter from a user of the electronic device;

[0025] FIG. 16 shows an example method of determining a biological parameter of a user wearing a watch or other wearable electronic device; and

[0026] FIG. 17 shows a sample electrical block diagram of an electronic device such as a watch or other wearable electronic device.

[0027] The use of cross-hatching or shading in the accompanying figures is generally provided to clarify the boundaries between adjacent elements and also to facilitate legibility of the figures. Accordingly, neither the presence nor the absence of cross-hatching or shading conveys or indicates any preference or requirement for particular materials, material properties, element proportions, element dimensions, commonalities of similarly illustrated elements, or any other characteristic, attribute, or property for any element illustrated in the accompanying figures.

[0028] Additionally, it should be understood that the proportions and dimensions (either relative or absolute) of the various features and elements (and collections and groupings thereof) and the boundaries, separations, and positional relationships presented therebetween, are provided in the accompanying figures merely to facilitate an understanding of the various embodiments described herein and, accordingly, may not necessarily be presented or illustrated to scale, and are not intended to indicate any preference or requirement for an illustrated embodiment to the exclusion of embodiments described with reference thereto.

DETAILED DESCRIPTION

[0030] Reference will now be made in detail to representative embodiments illustrated in the accompanying drawings. It should be understood that the following description is not intended to limit the embodiments to one preferred embodiment. To the contrary, it is intended to cover alternatives, modifications, and equivalents as can be included within the spirit and scope of the described embodiments as defined by the appended claims.

[0031] The following disclosure relates to techniques for providing a set of electrodes 102 on the surface of an electronic device 100, as shown in FIG. 1A, and to techniques for using the set of electrodes to sense voltages or signals indicative of one or more biological parameters of a user who is in contact with the set of electrodes 102. In some embodiments, the set of electrodes 102 may be provided on one surface of the electronic device 100. In other embodiments (as shown), the set of electrodes 102 may include electrodes provided on different surfaces of the electronic device, such as a first electrode 102a provided on a first surface 104a of the electronic device 100, and a second electrode 102b provided on a second surface 104b of the electronic device 100. Providing electrodes on different surfaces of a device may make it easier for a user to place different body parts in contact with different electrodes. For example, a user may place one or more of the electrodes 102 (including the first electrode 102a) in contact with their wrist, and may touch another one or more of the electrodes 102 (including the second electrode 102b) with a finger of their opposite hand. A processor 106 of the electronic device 100, or a processor remote from the electronic device 100, may determine, from the voltages or signals (*e.g.*, from stored digital samples or values representing the voltages or signals), the biological parameter(s) of the user. The biological parameter(s) may include, for example, an electrocardiogram (ECG) for the user.

[0032] In some embodiments, one or two thin film electrodes may be PVD deposited on a transparent or translucent surface, such as a crystal or other structure, that forms part of a housing of an electronic device. More particularly, the electrode(s) may be deposited on a surface of the crystal that forms part of a housing for the electronic device. In the case of watch (*i.e.*, a type of electronic device), an additional electrode may be positioned on a user-rotatable

crown in a watch body, on a button of the watch, or on another crystal or non-crystal surface of a housing that defines the watch body. As used herein, the term “crystal” refers to any transparent, semi-transparent, or translucent surface made out of glass, a crystalline material (such as sapphire or zirconia), plastic, or the like, whether or not such material has a crystal atomic structure. Thus, it should be appreciated that the term “crystal,” as used herein, encompasses amorphous solids as well as crystalline solids.

[0033] The electrode(s) on the exterior surface of the crystal may be connected to electrical contacts within the electronic device by depositing the electrode material such that it wraps around an edge or perimeter of the crystal, and onto an interior surface of the crystal. The electrical contacts may be on the interior surface of the crystal. In other embodiments, the electrode(s) may be formed on the exterior surface of the crystal, and thru-crystal vias that are filled or coated with a conductive material may connect the electrode(s) to electrical contacts within the electronic device.

[0034] When an electrode is provided on a crown of an electronic device, the crown may be conductive or have a conductive surface, and the conductive portion of the crown may be coupled to a conductive rotatable shaft that extends through an aperture in a device housing. An end of the shaft interior to the housing, or a conductive shaft retainer interior to the housing, may be in mechanical and electrical contact with a spring-biased conductor that carries electrical signals between the shaft or shaft retainer and a circuit, thereby providing electrical communication between the crown and the circuit.

[0035] A processor of an electronic device (e.g., the processor 106) may be operable to determine a biological parameter of a user based on voltages at various electrodes (e.g., at the set of electrodes 102). In some cases, the biological parameter may be an ECG for a user of the electronic device. For example, when a watch has a first electrode on an exterior surface of a crystal and a second electrode on a crown, the user's fastening of the watch to their wrist may place the first electrode in contact with skin on the user's wrist. To acquire an ECG, the user may touch a conductive portion of the crown with a finger on their opposite hand (e.g., the watch may be attached to a wrist adjacent one hand, and the crown may be touched with a finger of the opposite hand), thereby completing a circuit between the first electrode and the second electrode

through the user's arms and chest. In some cases, the watch may have a third electrode, also on the exterior surface of the crystal, which grounds the user to the watch. The third electrode may be used to reject noise from ECG signals. The electrodes may be positioned on different surfaces, or different portions of surfaces, in various embodiments.

[0036] The electrode(s) on the exterior surface of the crystal may be positioned at the periphery of the crystal, or otherwise positioned to enable a sensor subsystem to emit and receive light through the crystal. The light may be emitted into, and reflected from, a user's skin to determine other biological parameters of the user, such as a heart rate, blood pressure, pulse, blood oxygenation, glucose level, and so on.

[0037] These and other embodiments are discussed with reference to FIGS. 1-17. However, those skilled in the art will readily appreciate that the detailed description given herein with respect to these figures is for explanatory purposes only and should not be construed as limiting.

[0038] FIG. 1B shows an example of a watch 110 that incorporates a set of electrodes. The watch may include a watch body 112 and a watch band 114. Other devices that may incorporate a set of electrodes include other wearable electronic devices, other timekeeping devices, other health monitoring or fitness devices, other portable computing devices, mobile phones (including smart phones), tablet computing devices, digital media players, or the like.

[0039] The watch body 112 may include a housing 116. The housing 116 may include a front side housing member that faces away from a user's skin when the watch 110 is worn by a user, and a back side housing member that faces toward the user's skin. Alternatively, the housing 116 may include a singular housing member, or more than two housing members. The one or more housing members may be metallic, plastic, ceramic, crystal, or other types of housing members (or combinations of such materials).

[0040] A crystal 118 may be mounted to a front side of the watch body 112 (*i.e.*, facing away from a user's skin) and may protect a display mounted within the housing 116. The display may be viewable by a user through the crystal 118. In some cases, the crystal 118 may be part of a display stack, which display stack may include a touch sensing or force sensing capability. The display may be configured to depict a graphical output of the watch 110, and a user may interact

with the graphical output (*e.g.*, using a finger or stylus). As one example, the user may select (or otherwise interact with) a graphic, icon, or the like presented on the display by touching or pressing on the display at the location of the graphic. The crystal 118 may form a part of the housing 116. In some examples, the crystal 118 may be a sapphire crystal. The crystal 118 may also be formed of glass, plastic, or other materials.

[0041] In some embodiments, the watch body 112 may include an additional crystal (not shown) that forms a part of the housing 116. The additional crystal may have one or more electrodes thereon (*e.g.*, as described with reference to FIGS. 2, 3C, 3D, 4-6, 7A-7C, 8A-8D, 9, 10, and 15).

[0042] The watch body 112 may include at least one input device or selection device, such as a crown assembly, scroll wheel, knob, dial, button, or the like, which input device may be operated by a user of the watch 110. For example, the housing 116 may include an aperture through which a shaft extends. A crown 120 may be attached to the shaft, and may be accessible to a user exterior to the housing 116. The crown 120 may be manipulated by a user to rotate or translate the shaft. The shaft may be mechanically, electrically, magnetically, and/or optically coupled to components within the housing 116 as one example. A user's manipulation of the crown 120 and shaft may be used, in turn, to manipulate or select various elements displayed on the display, to adjust a volume of a speaker, to turn the watch 110 on or off, and so on. The housing 116 may also include an aperture through which a button 122 protrudes. In some embodiments, the crown 120, scroll wheel, knob, dial, button 122, or the like may be conductive, or have a conductive surface, and a signal route may be provided between the conductive portion of the crown 120, scroll wheel, knob, dial, button 122, or the like and a circuit within the watch body 112. In some embodiments, the crown 120 may be part of a crown assembly as described with reference to FIGS. 11, 12, 14, and 15.

[0043] The housing 116 may include structures for attaching the watch band 114 to the watch body 112. In some cases, the structures may include elongate recesses or apertures through which ends of the watch band 114 may be inserted and attached to the watch body 112. In other cases (not shown), the structures may include indents (*e.g.*, dimples or depressions) in the

housing 116, which indents may receive ends of spring pins that are attached to or threaded through ends of a watch band to attach the watch band to the watch body.

[0044] The watch band 114 may be used to secure the watch 110 to a user, another device, a retaining mechanism, and so on.

[0045] In some examples, the watch 110 may lack the crystal 118, the display, the crown 120, or the button 122. For example, the watch 110 may include an audio input or output interface, a touch input interface, a haptic (force) input or output interface, or other input or output interface that does not require the display, crown 120, or button 122. The watch 110 may also include the afore-mentioned input or output interfaces in addition to the display, crown 120, or button 122. When the watch 110 lacks the display, the front side of the watch 110 may be covered by the crystal 118, or by a metallic or other type of housing member.

[0046] FIG. 2 shows an exploded view of components that may be attached to a crystal 204 mounted in a back side housing member 202 of a watch body. In some examples, the components may be part of the watch body 112 shown in FIG. 1B, and may be mounted within the housing 116 shown in FIG. 1B. By way of example, FIG. 2 shows the components in relation to a back side housing member 202 (*i.e.*, a skin-facing housing member) of a watch body such as the watch body 112. Also by way of example, the back side housing member 202 includes apertures 240 through which ends of a watch band may be inserted and attached to a watch body including the back side housing member 202. Alternatively, a watch band may be attached to the watch body 112 in other ways.

[0047] A crystal 204 (*e.g.*, a skin-facing crystal) may be mounted to the back side housing member 202 and form a part of the housing of a watch body (*e.g.*, a part of the watch body 112). The crystal 204 may have a first surface that is interior to the watch body and a second surface that is exterior to the watch body. By way of example, the crystal 204 has a round perimeter 206 and be fitted to a round aperture in the back side housing member 202. In other examples, the crystal 204 may have a perimeter that is square, oval, or some other shape. Similarly, the aperture in the back side housing member 202 may be square, oval, or some other shape. The perimeter 206 of the crystal 204 and the perimeter of the aperture need not have the same shape (*e.g.*, the perimeter of the aperture in the back side housing member 202 may be smaller and

differently shaped than the perimeter 206 of the crystal 204). In some examples, the crystal 204 may be a sapphire crystal. The crystal 204 may also be formed of glass, plastic, or other materials. The crystal 204 may be transparent to all wavelengths of light or just some wavelengths of light.

[0048] The exterior surface of the crystal 204 may have a set of electrodes 242 thereon. The electrodes 242 may be positioned at the periphery of the crystal 204 (or in other locations) to enable optical communication between a sensor subsystem 216 interior to a watch body and a medium (*e.g.*, skin) exterior to the watch body. The optical communication may occur through the crystal 204, and in some cases through a number of apertures formed in one or more masks 224 applied to the crystal 204. Example constructions of the electrodes 242 and masks 224 are described with reference to FIGS. 3C, 3D, 3E, 4-6, 7A-7C, 8A-8D, 9, 10, and 15. In other examples, the electrodes 242 may be formed of a transparent material, as described with reference to FIG. 6, and the sensor subsystem 216 may transmit/receive light through the electrodes 242.

[0049] In some cases, the interior components shown in FIG. 2 may be attached to (and in some cases mounted directly on) the first or interior surface of the crystal 204. The components may include a lens 208, a light filter 210, one or more adhesives 212, 214, a sensor subsystem 216, circuitry or a processing subsystem 218, a magnet 220, or a magnetic shield 222.

[0050] The lens 208 may abut, be attached to (*e.g.*, be mounted directly on), or formed on the first or interior surface of the crystal 204. By way of example, the lens 208 is aligned with the center of the crystal 204. In some cases, the inner or exterior surface of the crystal 204 may have a mask 224 thereon (*e.g.*, an ink mask or dark mask, and in some cases a plurality of masks). The mask 224 may define an aperture 226 (*e.g.*, a first aperture or central aperture) that allows light of at least one wavelength to pass through the crystal 204, and the lens 208 may be aligned with the aperture 226. In some cases, the lens 208 may be or include a Fresnel lens, a spherical lens, a diffuser film, or the like.

[0051] In some cases, the light filter 210 may include one or more segments 228, and each segment 228 may be attached to (*e.g.*, laminated to) the interior surface of the crystal 204 and positioned on the interior surface (*e.g.*, adjacent or around the lens 208) to prevent a set of one or

more light receivers on the sensor subsystem 216 from receiving a portion of the light that is emitted by a set of one or more light emitters on the sensor subsystem 216. The set of light emitters and set of light receivers are not shown in FIG. 2, and may be mounted to an underside of the sensor subsystem 216. When the crystal 204 includes the mask 224, the mask 224 may further define a second aperture 230a, or a set of apertures 230 including the second aperture 230a. The second aperture 230a or set of apertures 230 may be positioned adjacent or around the first aperture 226. In these embodiments, the segments 228 of the light filter 210 (or a light filter ring or other light filter configuration) may be aligned with (*e.g.*, may cover) each of the apertures in the set of apertures 230.

[0052] As an example, FIG. 2 shows a mask 224 that defines a set of eight radial apertures 230 around a central aperture 226. Each segment 228 of the light filter 210 may block (*e.g.*, absorb) a portion of light emitted by a set of light emitters that is mounted on the sensor subsystem 216, which portion of light reflects from a surface too close to (or within) the crystal 204 (*e.g.*, the exterior surface of the crystal 204, imperfections within the crystal 204, or a medium too close to the crystal 204), such that the reflected light is not useful in a sensing operation for which the sensor subsystem 216 is designed. For example, when the sensor subsystem 216 is configured to determine a biological parameter of a user, light reflected from the crystal 204, or from the outer layer of skin of the user, may not have any relation to the biological parameter being determined and may not be useful. In some examples, the light filter 210 or segments 228 thereof may include at least one of a light control film, a light polarizer, an anti-reflective film, a reflective film, or a light absorber.

[0053] In some embodiments, the mask 224 may represent multiple masks, and different masks may allow different wavelengths of light to pass through the crystal 204, as described for example with reference to FIGS. 3A-3E and 4.

[0054] The sensor subsystem 216 may include a substrate 232 on which the set of one or more light emitters (*e.g.*, LEDs) and the set of one or more light receivers (*e.g.*, photodetectors, such as photodiodes) are mounted. The light emitter(s) and light receiver(s) may be mounted or positioned on the substrate 232 to emit and receive light through the crystal 204. The sensor subsystem 216 may be attached to the crystal 204 by one or more adhesives 212/214, such as

pressure sensitive adhesives (PSAs) or heat-activated films (HAFs). In some cases, the set of light emitters may be centrally mounted on the substrate 232, and a first wall may be attached to (e.g., formed on or bonded to) an underside of the substrate 232 surrounding the set of light emitters. The first wall may be attached to the interior surface of the crystal 204 using a first ring of adhesive 212. The set of light receivers may be mounted on the substrate 232 around the set of light emitters, between the first wall and a second wall attached to (e.g., formed on or bonded to) the underside of the substrate 232. The second wall may be attached to the interior surface of the crystal 204 using a second ring of adhesive 214.

[0055] The substrate 232 of the sensor subsystem 216 may include various contacts, pads, traces, or other conductive structures 234 that enable the processing subsystem 218 to be electrically coupled to the set of light emitters and set of light receivers of the sensor subsystem 216. The processing subsystem 218 may include a substrate 236 (e.g., a printed circuit board (PCB)) that is mounted to the sensor subsystem 216, and thereby to the crystal 204, via the conductive structures 234 and/or additional adhesive between the substrates 232, 236 of the sensor subsystem 216 and the processing subsystem 218. The substrates 232, 236 may also or alternatively be connected using mechanical fasteners (e.g., screws). The processing subsystem 218 may activate the light emitters and light receivers to perform a sensor function (e.g., to determine a heart rate). In some cases, the processing subsystem 218 may be mounted to another structure within the watch body, and may be electrically connected to the conductive structures 234 of the sensor subsystem 216 by a flex circuit or other conductors.

[0056] In some embodiments, the substrate 236 of the processing subsystem 218 may have a hole 238 therein, and the magnet 220 may be aligned with the hole 238 and abutted to (or mounted on) the substrate 232. In some cases, the magnet 220 may be adhesively bonded to the substrate 232 of the sensor subsystem 216. The magnet 220 may inductively couple to a battery charger used for charging a battery included within the watch body, which battery may power components of the watch including the components of the sensor subsystem 216 and the processing subsystem 218.

[0057] The magnetic shield 222 may abut (or be mounted on) the magnet 220. In some cases, the magnetic shield 222 may be adhesively bonded to the magnet 220. The magnetic shield may

direct magnetic flux associated with the magnet 220 toward and out the crystal 204 to improve inductive battery charging performance for a battery included within the watch body.

[0058] Direct or indirect mounting of the components shown in FIG. 2 to the interior surface of the crystal 204 can reduce the height of the components when stacked.

[0059] FIGS. 3A-3E illustrate one example of coatings that may be deposited on the interior and exterior surfaces of the crystal 204 shown in FIG. 2. As shown in FIG. 3A, a first mask 300 (*e.g.*, a first ink mask) that is opaque to infrared (IR) and visible light may be deposited (*e.g.*, PVD deposited) on the interior surface 302 of the crystal 204. In some examples, the first mask 300 may include an inner ring 300a and an outer ring 300b that define a central first aperture 304 and a concentric second aperture 306 (*i.e.*, a second aperture 306 that is concentric with the first aperture 304). The central first aperture 304 may be positioned above light emitters of the sensor subsystem 216 described with reference to FIG. 2 (and above the optional lens 208), and the concentric second aperture 306 may be positioned above light receivers of the sensor subsystem 216. The inner ring 300a of the first mask may prevent the light receivers from receiving light that is unlikely to have passed through a user's skin after passing through the central first aperture 304. The outer ring 300b of the first mask may in some cases be provided for cosmetic reasons, and in some cases may not be provided.

[0060] FIG. 3B shows a second mask 308 (*e.g.*, a second ink mask) that is opaque to visible light but transparent to IR light. The second mask 308 may be deposited (*e.g.*, PVD deposited) on the interior surface 302 of the crystal 204. The second mask 308 may be deposited on the crystal 204 over the concentric second aperture 306 in the first mask 300, and may overlap the inner and outer rings 300a, 300b of the first mask, as shown in FIG. 4. The second mask 308 may define a plurality of visible light apertures 310 above respective light receivers of the sensor subsystem 216, while allowing IR light to pass through the entirety of the concentric second aperture 306. This may increase the amount of IR light received by the light receivers. The second mask 308 may also define an optional aperture above a condensation detector 312. In some cases, the second mask 308 may look visually similar to the first mask 300 (*e.g.*, both masks may be dark masks, such that it may be impossible or difficult for a user to visually distinguish the first and second masks 300, 308).

[0061] FIGS. 3C and 3D show an example of PVD deposited first and second electrodes 314a, 314b on the interior and exterior surfaces 302, 316 of the crystal 204. The first and second electrodes 314a, 314b may be arc-shaped and positioned at the periphery of the crystal 204. The first and second electrodes 314a, 314b may be sized based on factors such as: providing a sufficient area to provide good electrical contact between the electrodes 314a, 314b and skin (which may improve electrical sensor efficiency); providing electrodes 314a, 314b of a size that do not substantially interfere with an antenna or other electrical structures of a device (which may improve wireless communication efficiency); or providing electrodes 314a, 314b positioned to allow optical communication through the crystal 204 (which may improve optical communication efficiency). The first and second electrodes 314a, 314b may be separated from one another by a pair of gaps 318a, 318b.

[0062] The first and second electrodes 314a, 314b may be deposited on both the interior and exterior surfaces 302, 316 of the crystal 204 and may wrap around the edge (or perimeter) of the crystal 204. The material used to form the first and second electrodes 314a, 314b may be patterned to form electrical contacts 320a, 320b (*e.g.*, tabs) on the interior surface 302 of the crystal 204. The first and second electrodes 314a, 314b may overlap the first mask 300 (or outer ring 300b of the first mask) on the interior surface 302 of the crystal 204, such that the first mask 300 is positioned between the first and second electrodes 314a, 314b and the interior surface 302 of the crystal 204. Thus, the material used to form the electrodes 314a, 314b may need to have properties that enable the material to adhere to a crystal surface (*e.g.*, a sapphire surface) and a mask (*e.g.*, an ink mask). The material or materials used to form the electrodes 314a, 314b may also have properties, singularly or in combination, such as: a low impedance and good conductivity (*e.g.*, a low DC resistance); a low electrode-to-skin impedance; a high hardness to reduce scratching of the electrodes 314a, 314b; a higher elastic modulus than the crystal 204 (*e.g.*, to mitigate the likelihood that a crack in an electrode 314 propagates through the crystal 204); compatibility with an HAF or other adhesive; and good biocompatibility (*e.g.*, not likely to cause an adverse reaction to a user of a device).

[0063] FIG. 3E shows an example deposition of adhesive 322 on the interior surface 302 of the crystal 204. The adhesive 322 may be deposited in inner and outer rings 322a, 322b, as described with reference to FIG. 2. The inner ring 322a of adhesive may be positioned on the

inner ring 300a of the first mask. The outer ring 322b of adhesive may be positioned on the second mask 308, outward from the plurality of apertures 310 in the second mask 308. In some cases, the adhesive 322 may include a PSA or HAF.

[0064] FIG. 4 shows a cross-section of a portion of the crystal 204 shown in FIG. 3B, and illustrates an overlap between the first and second masks 300, 308. The second mask 308 may overlap the first mask (e.g., outer ring 300b) on the interior surface 302 of the crystal 204 such that the first mask 300 is positioned between the second mask 308 and the interior surface 302 of the crystal 204.

[0065] FIG. 5 shows a cross-section of the crystal 204 shown in FIG. 3C or 3D, and illustrates an overlap between the first electrode 314a (or second electrode) and the first mask 300 (e.g., outer ring 300b of the first mask). The first electrode 314a may overlap the first mask 300 (or outer ring 300b of the first mask) on the interior surface 302 of the crystal 204, such that the first mask 300 is positioned between the first electrode 314a and the interior surface 302 of the crystal 204.

[0066] In some embodiments, the electrodes 314a, 314b shown in FIGS. 3C, 3D, and 5 may be formed using indium titanium oxide (ITO) or another transparent material. In these embodiments, the electrodes 314a, 314b may be transparent to light emitted by a sensor subsystem positioned below the crystal 204, and thus the electrodes 314a, 314b may extend over a greater portion (or all) of the exterior surface 316 of the crystal 204. FIG. 6 shows an example layer construction of ITO-based electrodes. As shown, the stack 600 may include a layer 602 of aluminum oxide (Al_2O_3) on the crystal, a layer 604 of ITO on the layer 602 of aluminum oxide, a first layer 606 of silicon dioxide (SiO_2) on the layer 604 of aluminum oxide, a layer 608 of silicon nitride (Si_3N_4) on the first layer 606 of silicon dioxide, a second layer 610 of silicon dioxide on the layer 608 of silicon nitride, and a layer 612 of diamond like carbon, or another hard coating, on the second layer 610 of silicon dioxide. Alternatively, the layer 608 of silicon nitride and second layer 610 of silicon dioxide may not be deposited, or only the layer 604 of ITO may be deposited, or just the layer 604 of ITO layer and first layer 606 of silicon dioxide may be deposited. Other variations in the number or types of layers may also be used to form the stack 600. Each of the layers may be transparent to IR or visible light.

[0067] FIGS. 7A-7C show alternative electrical connections between an electrode (*e.g.*, an electrode on an exterior surface of a crystal that forms part of a housing of an electronic device) and an electrical contact interior to the electronic device. In some examples, the crystals shown in FIGS. 7A-7C may have circular perimeters. In other examples, the crystals may have perimeters that are oval-shaped, square-shaped, rectangular-shaped, and so on. The techniques described with reference to FIGS. 7A-7C can be applied to crystals having various perimeter shapes, to crystals having different compositions, and so on. In some embodiments, the features shown in FIGS. 7A-7C may be replicated to electrically connect more than one electrode on an exterior surface of an electronic device to components interior to the electronic device.

[0068] In FIG. 7A, the electrode 700 may be a thin film electrode that is PVD deposited on a surface 702 of a crystal 704. The surface 702 on which the electrode 700 is deposited may be a surface of the crystal 704 that is exterior to an electronic device (*i.e.*, the electrode 700 may be deposited on an exterior surface 702 of the crystal 704). As shown, a conductive material used to form the electrode 700 may be deposited on the crystal 704 such that the material wraps around an edge 706 or perimeter of the crystal 704 to form an electrical contact 708 on a surface 710 of the crystal 704 that is interior to the electronic device (*i.e.*, on an interior surface 710 of the crystal 704). In some cases, the electrical contact 708 may be a tab that traces a much smaller arc about the periphery of the crystal 704 than the electrode 700 (as shown, for example, in FIGS. 3C, 3D, and 3E). In other cases, the electrical contact 708 may be arc-shaped and trace an arc that is similar in size to an arc traced by the electrode 700 on the exterior surface 702 of the crystal 704.

[0069] In some cases, the conductive material(s) used to form the electrode 700 and electrical contact 708 may be deposited on the exterior surface 702, edge 706, and interior surface 710 of the crystal 704 in a single operation (or single set of operations in which the material(s) are deposited on the exterior surface 702, edge 706, and interior surface 710 of the crystal 704). In other cases, the material(s) used to form the electrode 700 may be deposited on the edge 706 or interior surface 710 of the crystal 704 in operations that are performed separately from one or more operations in which the electrode 700 is deposited on the exterior surface 702 of the crystal 704. In these latter examples, the material(s) may be deposited such that the materials overlap. In

some cases, a set of one or more materials used to form the electrode 700 may differ from a set of one or more materials deposited on the edge 706 or interior surface 710 of the crystal 704.

[0070] In some embodiments, the conductive material(s) deposited on the exterior surface 702, edge 706, and interior surface 710 of the crystal 704 may include a layer of erbium. In some embodiments, the layer of erbium may be coated with a layer of a stainless steel (SUS) or a layer of diamond like carbon (DLC). In other embodiments, only the electrode 700 or edge 706 of the crystal 704 may be coated with a layer of stainless steel or DLC. In some examples, the layer of erbium may be coated with a PVD deposited layer of Aluminum Titanium Nitride (AlTiN) or Chromium Silicon Carbonitride (CrSiCN).

[0071] In some embodiments, one or more masks (e.g., one or more ink masks) may be applied to the interior surface of the crystal (e.g., as described with reference to FIGS. 3A-3E, 4, and 5). In these embodiments, one or more of the conductive materials used to form the electrode 700 and electrical contact 708 may be applied over the mask(s). The conductive material(s), and the manner in which the conductive material(s) are deposited on the crystal 704, may therefore be selected to ensure adhesion of the conductive material(s) to the crystal 704 and to the ink or other material used to form the mask(s).

[0072] As shown in FIG. 7A, a peripheral band of the interior surface 710 of the crystal 704 may be mounted to a recessed ledge 712 in another housing member 714 of the electronic device (e.g., with the crystal 704 overlapping the housing member 714). In such an embodiment, the crystal 704 may be attached to the housing member 714 using an adhesive 716, such as a heat activated film (HAF). The adhesive 716 or conductive material(s), and the manner in which the crystal 704 is attached to the housing member 714, may therefore be selected to ensure adhesion of the crystal 704 to the housing member 714.

[0073] The electrical contact 708 may have a great enough width (e.g., a great enough width along a radius of the crystal 704) that the electrical contact 708 extends past the recessed ledge 712 in the housing member 714 when the crystal 704 is mounted to the housing member 714, making the electrical contact 708 accessible interior to the electronic device. In some cases, a flex circuit, other flexible conductor, or other conductive element may be soldered or otherwise

electrically connected to the electrical contact 708, to enable a signal to be received from or applied to the electrode 700.

[0074] In FIG. 7B, the electrode 718 may be a thin film electrode that is PVD deposited on a surface 720 of a crystal 722. The surface 720 on which the electrode 718 is deposited may be a surface of the crystal 722 that is exterior to an electronic device (*i.e.*, the electrode 718 may be deposited on an exterior surface 720 of the crystal 722). Prior to or after depositing the electrode 718 on the crystal 722, a thru-crystal via 724 may be drilled or otherwise cut into the crystal 722. The thru-crystal via 724 may extend from the exterior surface 720 of the crystal 722 (or electrode 718) to the interior surface 726 of the crystal 722. The via 724 may be coated or filled with a conductive material 728 such as stainless steel (SUS), and the conductive material 728 may be covered by, overlap, or otherwise electrically connect to the electrode 718. In some cases, the conductive material 728 in the via 724 may be molded or glued in the via 724. The conductive material 728 may provide an electrical contact 730 on a surface 726 of the crystal 722 that is interior to an electronic device (*i.e.*, on an interior surface of the crystal). In some cases, the conductive material 728 in the via 724 may overlap a portion of the interior surface 726 of the crystal 722, or may be connected to another conductive element deposited on the interior surface 726 of the crystal 722.

[0075] The conductive material(s) used to form the electrode 718 and deposited in the via 724 may be the same or different. In some embodiments, the conductive material(s) used to form the electrode 718 may include a layer of erbium. The layer of erbium may or may not be coated with a layer of a stainless steel (SUS) or a layer of diamond like carbon (DLC). In some examples, the layer of erbium may be coated with a PVD deposited layer of Aluminum Titanium Nitride (AlTiN) or Chromium Silicon Carbon Nitride (CrSiCN).

[0076] As shown in FIG. 7B, a peripheral band of the interior surface 726 of the crystal 722 may be mounted to a recessed ledge 732 in another housing member 734 of the electronic device (*e.g.*, with the crystal 722 overlapping the housing member 734). In such an embodiment, the crystal 722 may be attached to the housing member 734 using an adhesive 736, such as a HAF. The adhesive 736, and the manner in which the crystal 722 is attached to the housing member 734, may therefore be selected to ensure adhesion of the crystal 722 to the housing member 734.

[0077] When the crystal 722 is mounted to the housing member 734, the via 724 may be positioned such that it overlaps the recessed ledge 732 or is interior to the recessed ledge 732, making the electrical contact 730 accessible interior to the electronic device. In some cases, a flex circuit, other flexible conductor, or other conductive element may be soldered or otherwise electrically connected to the electrical contact 730, to enable a signal to be received from or applied to the electrode 718.

[0078] In FIG. 7C, the electrode 738 may be a metallic arc-shaped element mounted between a crystal 740 and another housing member 742 of an electronic device. In some embodiments, the electrode 738 may be a singular metallic ring-shaped electrode (*e.g.*, one electrode). In these embodiments, a peripheral band of a surface of the crystal 740 that is interior to the electronic device (*e.g.*, an interior surface 744 of the crystal 740) may be mounted to a recessed ledge 746 in the electrode 738 (*e.g.*, with the crystal 740 overlapping the electrode 738), and the electrode 738 may be mounted to a recessed ledge 750 in the housing member 742 (*e.g.*, with the electrode 738 overlapping the housing member 742). In other embodiments, the electrode 738 may be arc-shaped and may be one of two or more arc-shaped electrodes between the crystal 740 and the housing member 742. In these embodiments, a peripheral band of the interior surface of the crystal 740 may be mounted to recessed ledges 746 in multiple arc-shaped electrodes 738 (*e.g.*, with the crystal 740 overlapping the electrodes 738), and each of the arc-shaped electrodes 738 may be mounted to the recessed ledge 750 in the housing member 742 (*e.g.*, with the electrodes 738 overlapping the housing member 742). In some cases, the multiple arc-shaped electrodes 738 may be electrically isolated from each other by flexible seals or gaskets, or by rigid separators (*e.g.*, rigid extensions of the housing member 742, which rigid extensions may include extensions of the recessed ledge 750 to which the electrodes 738 are mounted). In some cases, the electrode 738 may be mounted to the housing member 742 before the crystal 740 is mounted to the electrode 738.

[0079] The electrode 738 may be formed of a conductive material such as erbium. In some embodiments, the electrode 738 may be coated with a layer of stainless steel (SUS) or DLC. Alternatively, the electrode may be formed of stainless steel (SUS) or DLC. In some examples, the layer of erbium may be coated with a PVD deposited layer of Aluminum Titanium Nitride (AlTiN) or Chromium Silicon Carbon Nitride (CrSiCN). A surface 754 of the electrode 738

interior to the electronic device may provide an electrical contact for connecting components interior to the electronic device to the electrode 738.

[0080] In some cases, an edge 756 or perimeter of the crystal 740 may be abutted directly to the electrode 738, and an edge 758 of the electrode 738 may be abutted directly to the housing member 742. In other cases, an adhesive, seal, gasket, or filler may fill a gap between the crystal 740 and the electrode 738 or a gap between the electrode 738 and the housing member 742.

[0081] As shown in FIG. 7C, a peripheral band of the interior surface 744 of the crystal 740 may be mounted to a recessed ledge 746 in the electrode 738, and a peripheral band of an interior surface 754 of the electrode 738 may be mounted to the housing member 742. In such an embodiment, the crystal 740 may be attached to the electrode 738 or the electrode 738 may be attached to the housing member 742 using an adhesive 748 or 752, such as a HAF. The adhesive 748 or 752, and manner in which the respective elements are attached, may therefore be selected to ensure adhesion of the crystal 740 to the electrode 738 (or adhesion of the electrode 738 to the housing member 742).

[0082] When the electrode 738 is mounted to the housing member 742, the electrode 738 may be positioned such that it overlaps the recessed ledge 750 or is interior to the recessed ledge 750, making the electrode 738 accessible interior to the electronic device. In some cases, a flex circuit, other flexible conductor, or other conductive element may be soldered or otherwise electrically connected to the electrode 738, to enable a signal to be received from or applied to the electrode 738.

[0083] FIGS. 8A-8D show alternative crystal profiles, and alternative attachments (*e.g.*, structural attachments) of crystals to other housing members of an electronic device. In some examples, the crystals may have circular perimeters. In other examples, the crystals may have perimeters that are oval-shaped, square-shaped, rectangular-shaped, and so on. The techniques described with reference to FIGS. 8A-8D can be applied to crystals having various perimeter shapes, to crystals having different compositions, and so on. Each of FIGS. 8A-8D shows an exterior surface (*e.g.*, a back surface) of an electronic device, such as a watch, and a cross-section of the exterior surface of the electronic device.

[0084] In FIG. 8A, a crystal 800 is mounted to another housing member 802 of an electronic device. The crystal 800 includes an exterior surface 804 that forms a part of the exterior surface of the electronic device, and an interior surface 806 that faces components interior to the electronic device.

[0085] A peripheral band of the interior surface 806 of the crystal 800 may be mounted to a recessed ledge 864 in the housing member 802 (*e.g.*, with the crystal 800 overlapping the housing member 802). In such an embodiment, the crystal 800 may be attached to the housing member 802 using an adhesive, such as a HAF. The adhesive, and the manner in which the crystal 800 is attached to the housing member 802, may be selected to ensure adhesion of the crystal 800 to the housing member 802.

[0086] The crystal 800 may be variously configured, but in FIG. 8A, an inner portion 808 of the interior surface 806 of the crystal 800, such as a portion of the crystal interior to a number of thru-crystal vias 810, is flat. An outer portion 812 of the interior surface 806, such as a portion outside the number of thru-crystal vias 810, is concave or inwardly-sloped (downwardly-sloped in the figure) with respect to the inner portion 808 of the interior surface 806. In contrast, the exterior surface 804 of the crystal 800 may be convex. Thus, the thickness of the crystal 800 may vary to some degree from its center axis to its perimeter.

[0087] In some embodiments, one or more arc-shaped electrodes 814 (*e.g.*, two electrodes) may be positioned around the exterior surface 804 of the crystal 800, inward from the perimeter of the crystal 800. In other embodiments, the electrodes 814 may have other shapes or may extend to or around the perimeter. The electrodes 814 may be PVD deposited thin film electrodes. In some cases, the electrodes 814 may be connected to interior components of the electronic device by the thru-crystal vias 810, which in some cases may be drilled or formed through the flat inner portion 808 of the interior surface 806 of the crystal 800. In other cases, the electrodes 814 may be connected to interior components of the electronic device by conductive material that wraps around the edge or perimeter of the crystal 800, or in any of the ways shown in FIGS. 7A-7C.

[0088] In some cases, components such as a sensor subsystem may be mounted to the inner, flat portion of the interior surface 806 of the crystal 800.

[0089] In FIG. 8B, a crystal 816 is mounted to another housing member 818 of an electronic device. The crystal 816 includes an exterior surface 820 that forms a part of the exterior surface of the electronic device, and an interior surface 822 that faces components interior to the electronic device.

[0090] A peripheral band of the interior surface 822 of the crystal 816 may be mounted to a recessed ledge 824 in the housing member 818 (*e.g.*, with the crystal 816 overlapping the housing member 818). In such an embodiment, the crystal 816 may be attached to the housing member 818 using an adhesive, such as a HAF. The adhesive, and the manner in which the crystal 816 is attached to the housing member 818, may be selected to ensure adhesion of the crystal 816 to the housing member 818.

[0091] The crystal 816 may be variously configured, but in FIG. 8B, the crystal 816 has a uniform thickness. The interior surface 822 of the crystal 816 may be concave, and the exterior surface 820 of the crystal 816 may be convex. To provide a flat surface for mounting components (*e.g.*, a sensor subsystem) to the crystal 816, a secondary crystal 826 having a convex exterior surface 828 and a flat interior surface 866 may be mounted to an inner portion of the interior surface 822 of the crystal 816. The secondary (or interior) crystal 826 may be mounted to the primary (or exterior) crystal 816 using a transparent adhesive. In some cases, the secondary crystal 826 may be mounted to the primary crystal 816 interior to a number of thru-crystal vias 830.

[0092] In some embodiments, one or more arc-shaped electrodes 832 (*e.g.*, two electrodes) may be positioned around the exterior surface of the crystal 816, inward from the perimeter of the crystal 816. In other embodiments, the electrodes 832 may have other shapes or may extend to or around the perimeter. The electrodes 832 may be PVD deposited thin film electrodes. In some cases, the electrodes 832 may be connected to interior components of the electronic device by the thru-crystal vias 830. In other cases, the electrodes 832 may be connected to interior components of the electronic device by conductive material that wraps around the edge or perimeter of the crystal 816, or in any of the ways shown in FIGS. 7A-7C.

[0093] FIGS. 8C and 8D each show a crystal mounted to another housing member of an electronic device. The crystal includes an exterior surface that forms a part of the exterior surface

of the electronic device, and an interior surface that faces components interior to the electronic device. In each of FIGS. 8C and 8D, the crystal has a flat interior surface and a convex exterior surface. The crystals shown in FIGS. 8C and 8D may be easier to manufacture than the crystals shown in FIGS. 8A and 8B.

[0094] In FIG. 8C, a crystal 834 is mounted to another housing member 836 of an electronic device. The crystal 834 includes an exterior surface 838 that forms a part of the exterior surface of the electronic device, and an interior surface 840 that faces components interior to the electronic device.

[0095] A peripheral band of the interior surface 840 of the crystal 834 may be mounted to a recessed ledge 842 in the housing member (*e.g.*, with the crystal 834 overlapping the housing member 836). In such an embodiment, the crystal 834 may be attached to the housing member 836 using an adhesive, such as a HAF. The adhesive, and the manner in which the crystal 834 is attached to the housing member 836, may be selected to ensure adhesion of the crystal 834 to the housing member 836.

[0096] In some embodiments, one or more arc-shaped electrodes 844 (*e.g.*, two electrodes) may be positioned around the perimeter of the exterior surface 838 of the crystal 834. In other embodiments, the electrodes 844 may have other shapes or other positions on the exterior surface 838 of the crystal 834. The electrodes 844 may be PVD deposited thin film electrodes. In some cases, the electrodes 844 may be connected to interior components of the electronic device by conductive material that wraps around the edge or perimeter of the crystal 834, or in any of the ways shown in FIGS. 7A-7C.

[0097] In some cases, components such as a sensor subsystem may be mounted to the interior surface 840 of the crystal 834.

[0098] In FIG. 8D, a crystal 860 is mounted to another housing member 846 of an electronic device, similarly to how the crystal 834 is mounted to another housing member 836 in FIG. 8C. For example, a peripheral band of the interior surface 848 of the crystal 860 may be mounted to a recessed ledge 850 in the housing member 846 (*e.g.*, with the crystal 860 overlapping the housing member 846). The crystal 860 may be attached to the housing member 846 using an

adhesive, such as a HAF. The adhesive, and the manner in which the crystal 860 is attached to the housing member 846, may be selected to ensure adhesion of the crystal 860 to the housing member 846.

[0099] The housing member 846 to which the crystal 860 is mounted may be mounted to yet another housing member (*e.g.*, a second housing member 852). A peripheral band of the interior surface 854 of the first housing member 846 may be mounted to a recessed ledge 856 in the second housing member 852 (*e.g.*, with the first housing member 846 overlapping the second housing member 852). The first housing member 846 may be attached to the second housing member 852 using an adhesive, such as a HAF. The adhesive, and the manner in which the first housing member 846 is attached to the second housing member 852, may be selected to ensure adhesion of the first housing member 846 to the second housing member 852. In some cases, the first housing member 846 may electrically insulate the electrodes 858 on the crystal 860 from the second housing member 852, or may provide a transition between incompatible materials, or may provide a carrier for the crystal 860, or may facilitate assembly of the housing of the electronic device.

[0100] In some embodiments, one or more arc-shaped electrodes 858 (*e.g.*, two electrodes) may be positioned around the perimeter of the exterior surface of the crystal 860. In other embodiments, the electrodes 858 may have other shapes or other positions on the exterior surface 862 of the crystal 860. The electrodes 858 may be PVD deposited thin film electrodes. In some cases, the electrodes 858 may be connected to interior components of the electronic device by conductive material that wraps around the edge or perimeter of the crystal, or in any of the ways shown in FIGS. 7A-7C.

[0101] In some cases, components such as a sensor subsystem may be mounted to the interior surface 848 of the crystal 860.

[0102] FIG. 9 shows the exterior surfaces (*e.g.*, the skin-facing surfaces) of the back side housing member 202 and crystal 204 shown in FIG. 2, with masks and electrodes applied to the crystal 204 as described with reference to FIGS. 3A-3E, 4, 5, and 7A-7C.

[0103] The exterior surface of the crystal 204 may have a first electrode 242a and a second electrode 242b that are PVD deposited thereon. In some cases, the first and second electrodes 242a, 242b may be arc-shaped (*e.g.*, semi-circle-shaped), and may be positioned around the central aperture 226 and set of apertures 230 formed in the masks represented by mask 224 (shown in FIG. 2). The first and second electrodes 242a, 242b may extend to the edge of the crystal 204, and in some cases may wrap around the perimeter of the crystal 204 to the interior surface of the crystal 204, or be connected to conductive vias formed in the crystal 204, or otherwise electrically connect to elements within a watch body that apply a signal to, or receive a signal sensed by, one or both of the first and second electrodes 242a, 242b. In some cases, the first and second electrodes 242a, 242b may be electrically insulated from the back side housing member 202 (*e.g.*, by a non-conductive gasket or adhesive), or the back side housing member 202 may be non-conductive. In some cases, the first and second electrodes 242a, 242b may be formed of, or include, erbium.

[0104] FIG. 10 shows the sensor subsystem 216 of FIG. 2 mounted on the crystal shown in FIG. 2. FIG. 10 also shows a flex circuit 1000, surrounding the sensor subsystem 216, which may provide electrical connections between the electrodes 242 and the sensor subsystem 216 while also providing a ground that operates as an electrical noise mitigation barrier (or E-shield) between the sensor subsystem 216 and the electrodes 242. The electrodes 242 are not shown in FIG. 10, but are connected to the electrical contacts 1002, which electrical contacts 1002 are on the interior surface of the crystal 204 and connected to both traces in the flex circuit 1000 and the electrodes 242 (which are on the exterior surface of the crystal 204). Traces in the flex circuit 1000 may be connected to the electrical contacts 1002 via a conductive epoxy, and may connect the electrical contacts 1002 to the sensor subsystem 216. A processor 1004 may be part of the sensor subsystem 216, and the processor 1004 may be connected to another processor or other circuitry via a flex circuit 1006.

[0105] Turning now to FIGS. 11 and 12, there is shown an example of a crown assembly 1100, as may be provided in a watch body as shown in FIG. 1B. FIG. 11 shows an exploded view of the crown assembly 1100, and FIG. 12 shows an assembled cross-section of the crown assembly 1100, as viewed from the front or rear face of a watch body. The crown assembly 1100 may include a conductive rotatable shaft 1102 configured to extend through an aperture in a

housing 1200, such as the housing described with reference to FIG. 1B. A user-rotatable crown 1104 may be mechanically connected (*i.e.*, attached) to the shaft 1102 exterior to the housing 1200. The crown 1104 may be rotated by a user of an electronic device, to in turn rotate the shaft 1102. In some cases, the crown 1104 may also be pulled or pushed by the user to translate the shaft 1102 along its axis. The crown 1104 may be electrically connected to a circuit within the housing 1200, but electrically isolated from the housing 1200.

[0106] The crown 1104 may be electrically connected to the shaft 1102. In some cases, at least part of the crown 1104 and at least part of the shaft 1102 may be molded, machined, or otherwise formed together (*e.g.*, from a same material, such as a conductive ceramic or stainless steel).

[0107] In some embodiments, the crown 1104 may be formed of a conductive ceramic or stainless steel (or have a conductive ceramic or stainless steel core). The core may be coated in a PVD deposited layer of erbium, which core and/or layer of erbium functions as an electrode. In some embodiments, the crown 1104 may have a conductive center portion 1202 surrounded by a ring 1204 of non-conductive material (or other insulator). The non-conductive ring 1204 may help prevent shorting of the crown 1104 to the housing 1200. The ring 1204 of non-conductive material may in some cases be surrounded by another ring 1206 of conductive material. In some embodiments, the crown 1104 may have a conductive surface covered by a thin non-conductive coating. The non-conductive coating may provide a dielectric for capacitive coupling between the conductive surface and skin of a user of the crown 1104 (or an electronic device that includes the crown assembly 1100). In the same or different embodiments, the crown 1104 may have a non-conductive coating on a surface of the crown 1104 facing the housing 1200.

[0108] A shaft retainer 1106 may be mechanically connected to the shaft 1102, interior to the housing 1200 (*e.g.*, interior to a watch body housing), after the shaft is inserted through the aperture in the housing 1200 with the crown 1104 positioned exterior to the housing 1200. In some cases, the shaft retainer 1106 may include a nut, and the shaft 1102 may have a threaded male portion that engages a threaded female portion of the nut. In some cases, the shaft retainer 1106 may be conductive, or have a conductive coating thereon, and mechanical connection of the shaft retainer 1106 to the shaft 1102 may form an electrical connection between the shaft retainer

1106 and the shaft 1102. In an alternative embodiment (not shown), the shaft retainer 1106 may be integrally formed with the shaft 1102, and the shaft 1102 may be inserted through the aperture in the housing 1200 from inside the housing 1200 and then attached to the crown 1104 (*e.g.*, the crown 1104 may screw onto the shaft 1102).

[0109] In some embodiments, a collar 1108 may be aligned with the aperture in the housing 1200, and a collar retainer 1110 may be coupled to the collar 1108 to retain the collar 1108 to the housing 1200 from a side of the housing 1200 opposite a side of the housing 1200 in which the collar 1108 is inserted. In some embodiments, the collar retainer 1110 may be coupled to the collar 1108 via threads on a male portion of the collar 1108 and corresponding threads on a female portion of the collar retainer 1110. Optionally, a gasket 1112 (*e.g.*, an I-ring) made of a synthetic rubber and fluoropolymer elastomer (*e.g.*, Viton), silicone, or another compressible material may be placed over the collar 1108 prior to insertion of the collar 1108 through the aperture, and attachment of the collar retainer 1110 to the collar 1108 may compress the gasket 1112. The compressed gasket 1112 may provide stability to the collar 1108 and collar retainer 1110, or provide a moisture barrier between the collar 1108 and the housing 1200. The collar 1108 and collar retainer 1110 may be attached to one another, and thereby to the housing 1200, prior to insertion of the shaft 1102 through the collar 1108. Another gasket 1114 (*e.g.*, a Y-ring) made of Viton, silicone, or another compressible material may be placed over the collar 1108, before or after insertion of the collar 1108 through the aperture, but before the shaft 1102 is inserted through the collar 1108. The second gasket 1114 may provide a moisture barrier between the crown 1104 and the housing 1200 or the crown 1104 and the collar 1108.

[0110] Also prior to inserting the shaft 1102 through the collar 1108, and in some cases prior to inserting the collar 1108 into the aperture in the housing 1200, an insulator 1116 may be inserted into or deposited on the interior of the collar 1108, or placed around or deposited on the shaft 1102. The insulator 1116 may also be inserted, placed, or deposited as the shaft 1102 is inserted into the collar 1108. In some cases, the insulator 1116 may include a non-conductive sleeve or bushing (*e.g.*, a plastic sleeve) inserted (*e.g.*, press-fit) into the collar 1108 (*e.g.*, into a portion of the collar 1108 positioned interior to the housing 1200). The insulator 1116 may also or alternatively include a non-conductive sleeve over-molded on the collar (*e.g.*, molded within the aperture in the collar 1108 and over a surface of the collar 1108 facing the crown 1104). The

insulator 1116 may also or alternatively include a non-conductive coating on the collar 1108 (e.g., on an inner surface of the collar 1108), or a non-conductive coating on the shaft 1102, or a set of one or more non-conductive gaskets surrounding the shaft 1102. When the shaft 1102 is inserted into the collar 1108, the insulator 1116 may be positioned between the shaft 1102 and the collar 1108 and help to insulate a conductive portion of the shaft 1102 (or the entire shaft 1102) from the collar 1108.

[0111] Another insulator 1118 may be positioned between the shaft retainer 1106 and the collar retainer 1110. For example, a non-conductive (e.g., plastic) washer, plate, or shim may be attached to the interior of the collar retainer 1110, between the shaft retainer 1106 and the collar retainer 1110. In some cases, the non-conductive washer may be carried by a plate 1120, such as a plate formed of stainless steel. In these cases, the non-conductive washer may be mounted to the interior of the collar retainer 1110 by welding (e.g., laser welding) the plate 1120 to the collar retainer 1110. The non-conductive washer or other element may provide a bearing surface for the shaft retainer 1106.

[0112] As shown in FIGS. 11 and 12, one or more O-rings 1122, 1124 or other gaskets may be placed over the shaft 1102 before the shaft 1102 is inserted into the collar 1108. The O-rings 1122, 1124 may be formed of a synthetic rubber and fluoropolymer elastomer, silicone, or another compressible material. In some cases, the O-rings 1122, 1124 may provide a seal between the shaft 1102 and the collar 1108. The O-rings 1122, 1124 may also function as an insulator between the shaft 1102 and the collar 1108. In some embodiments, the O-rings 1122, 1124 may be fitted to recesses in the shaft 1102. Additionally, a low-friction ring 1208 or filler may be placed around the top of the collar 1108, between the crown 1104 and the collar 1108. Alternatively, the low-friction ring 1208 or filler may be attached to the crown 1104, between the crown 1104 and the collar 1108. In some embodiments, the shaft 1102 may be smooth (not shown) and rotate within a thicker or closer fitting insulator 1116 without use of the O-rings 1122, 1124.

[0113] In some embodiments, a bracket 1126 may be attached (e.g., laser welded) to the collar retainer 1110 or another element within the housing 1200. The bracket 1126 may support a spring-biased conductor 1128 and maintain the spring-biased conductor 1128 in mechanical and

electrical contact with the shaft retainer 1106 (or in some cases with an end of the shaft 1102, such as when the shaft extends through the shaft retainer (not shown)). As shown, the spring-biased conductor 1128 may include a shear plate that is spring-biased about an axis 1138, which axis 1138 is perpendicular to and radially outward from a second axis 1140 of the shaft 1102. By way of example, the shear plate is shown to be circular, although the shear plate could also have other shapes. In some embodiments, the surface of the shear plate that abuts the shaft retainer 1106 or shaft end may be hardened (*e.g.*, with a PVD deposited coating of cobalt chromium (CoCr or hard chromium)) to mitigate the likelihood of the shaft retainer 1106 or shaft end wearing through the shear plate after multiple rotations or translations of the shaft 1102. The shear plate (and in some cases the entirety of the spring-biased conductor 1128) may be plated with gold or another material to improve electrical conductivity (*e.g.*, prior to coating the shear plate with a hardener). In some cases, the spring-biased conductor 1128 may be formed (*e.g.*, stamped or bent) from a piece of metal (*e.g.*, stainless steel). In other cases, the spring-biased conductor 1128 may be formed in other ways. The length and thickness of the shear plate, perpendicular to the axis of the shaft 1102, can be optimized to provide a balance between a high enough spring constant to ensure good electrical contact between the shear plate and the shaft retainer 1106 or shaft end (even during rotation of the shaft 1102), on one hand, and a low enough spring constant to mitigate the likelihood that the shaft retainer 1106 or shaft end will wear through the shear plate (or through a coating thereon). A flat or relatively flat shear plate can reduce the dimension of the crown assembly 1100 along the axis 1140 of the shaft 1102.

[0114] In some embodiments, a majority or entirety of the shaft 1102, shaft retainer 1106, or crown 1104 may be coated with a non-conductive coating, but for an external conductive surface of the crown 1104 and a portion of the shaft 1102 or shaft retainer 1106 that contacts the spring-biased conductor 1128.

[0115] When the shaft 1102 is translatable, translation of the shaft 1102 into the housing 1200 (*e.g.*, into the housing of a watch body) may cause the spring-biased conductor 1128 (or the shear plate thereof) to deform. However, the spring bias of the spring-biased conductor 1128 may cause the spring-biased conductor 1128 (or the shear plate thereof) to maintain electrical contact with the shaft retainer or shaft end, regardless of whether the shaft 1102 is in a first position or a second position with reference to translation of the shaft 1102. The spring-biased

conductor 1128 may be electrically connected to a circuit, such as a circuit formed on or in a substrate 1130 such as a flex circuit or printed circuit board (PCB). In some cases, the spring-biased conductor 1128 may be surface-mounted to the circuit substrate 1130 (such as soldered or otherwise mechanically connected, for example by using a surface-mount technology process). A conductive grease may be deposited between the shaft retainer 1106 or shaft 1102 and the shear plate or other member of the spring-biased conductor 1128. The circuit may be in electrical communication with the crown 1104 via the spring-biased conductor 1128, the shaft retainer 1106, and the shaft 1102 (or when an end of the shaft 1102 protrudes through the shaft retainer 1106, the circuit may be in electrical communication with the crown 1104 via the spring-biased conductor 1128 and the shaft 1102).

[0116] A tactile (tac) switch 1210, such as a dome switch, may be electrically connected to the circuit and mechanically connected to the circuit substrate 1130. In some cases, the tac switch 1210 may be surface-mounted to the circuit substrate 1130 (such as soldered or otherwise mechanically connected). The shear plate of the spring-biased conductor 1128 may be positioned between the shaft retainer 1106 and the tac switch 1210. The tac switch 1210 may be operable responsive to translation of the shaft 1102. Thus, when a user presses on the crown 1104, the shaft 1102 may translate into the housing 1200 (*e.g.*, into the housing of a watch body) and actuate the tac switch 1210, placing the tac switch 1210 in one of a number of states. When the user releases pressure on the crown 1104 or pulls the crown 1104 outward from the housing 1200, the tac switch 1210 may retain the state in which it was placed when pressed, or advance to another state, or toggle between two states, depending on the type or configuration of the tac switch 1210.

[0117] The circuit to which the tac switch 1210 and spring-biased conductor 1128 are electrically connected may be part of, or electrically connected to, one or more circuits that carry portions of an optical encoder 1132 and other circuit elements, such as an interface 1134 to the electrodes described with reference to FIGS. 3C, 3D, 3E, 4-6, 7A-7C, and 8A-8D, 9, and 10, or a processor that receives and processes signals received from or provided to the crown 1104 or other electrodes. By way of example, FIG. 11 shows a circuit 1136 (*e.g.*, a flex circuit or PCB) to which a set of one or more light emitters and light detectors of an optical encoder 1132 is connected. The light emitter(s) may illuminate an encoder pattern or other rotating portion of the

optical encoder 1132, which encoder pattern or other rotating portion of the optical encoder 1132 may be carried on (*e.g.*, formed on, printed on, *etc.*) the shaft retainer 1106. The light detector(s) may receive reflections of the light emitted by the light emitter(s), and a processor may determine a direction of rotation, speed of rotation, angular position, translation, or other state(s) of the crown 1104 and shaft 1102.

[0118] The spring-biased conductor 1128 may be connected to a processor. The processor may be mounted or coupled to one or more of the circuits shown in FIG. 11. The processor may determine whether a user is touching the crown 1104, or determine a biological parameter of the user based on a signal received from or provided to the user via the crown 1104, or determine other parameters based on signals received from or provided to the crown 1104. In some cases, the processor may operate the crown and electrodes described in FIGS. 3C, 3D, 3E, 4-6, 7A-7C, 8A-8D, and 9-12 as an electrocardiograph and provide an ECG to a user of a watch including the crown and electrodes.

[0119] In an alternate embodiment of the crown assembly 1100 shown in FIGS. 11 and 12, the spring-biased conductor 1128 may include a conductive brush that is biased to contact a side of the shaft 1102 or a side of the shaft retainer 1106. The conductive brush may maintain electrical contact with the shaft 1102 or shaft retainer 1106 through rotation or translation of the shaft 1102, and may be electrically connected to a circuit such as the circuit that supports the tac switch 1210.

[0120] FIG. 13 shows an elevation of a watch body 1300 capable of sensing a biological parameter. The watch body 1300 may be an example of the watch body described with reference to FIG. 1B. The watch body 1300 is defined by a housing 1302, and the housing 1302 may include a first crystal 1304 that is part of or a display or display cover, a second crystal 1306 having an exterior surface that supports one or more electrodes 1308 (*e.g.*, as described with reference to FIGS. 3C, 3D, 3E, 4-6, 7A-7C, 8A-8D, 9, and 10), one or more other housing members 1310 defining sidewalls of the watch body 1300, and a crown 1312. The watch body 1300 may be abutted to a user's wrist 1314 or other body part, and may be adhered to the user by a watch band or other element (not shown). When abutted to a user's wrist 1314, the electrodes 1308 on the second crystal 1306 may contact the user's skin. The user may touch a conductive

portion of the crown 1312 with a finger 1316. The user may touch the crown 1312 in various ways, depending on where the crown 1312 is conductive, and depending on the user's preference. In some cases, the user may touch the crown 1312 while also touching their wrist. However, high skin-to-skin impedance tends to reduce the likelihood that signals will travel from the electrodes 1308, through their wrist 1314 to their finger 1316, and subsequently to the crown 1312 (or vice versa). The intended signal path for acquiring an ECG is between one of the electrodes 1308 on the second crystal 1306 and the crown 1312 via both of the user's arms and chest.

[0121] FIG. 14 shows a cross-section of the crown assembly 1100 shown in FIGS. 11 and 12, as viewed from an edge of a watch body (*e.g.*, an edge to which a watch band might be attached). The crown assembly 1100 shown in FIG. 14 differs from the crown assembly shown in FIGS. 11 and 12 in that the crown 1104 has a somewhat different configuration. For example, the crown 1104 has a conductive center portion 1400 surrounded by a non-conductive ring 1402. The non-conductive ring may be attached to the conductive center portion 1400 by an adhesive 1404.

[0122] As shown in FIG. 14, the crown assembly 1100 may be positioned adjacent a crystal 1406 under which a display may be mounted. In some cases, the display may be a touch-sensitive display. In some embodiments, the display may also be a force-sensitive display. FIG. 14 shows one example of a force sensor 1408 for a force-sensitive display, in which a compressible gasket 1410 is bounded by first and second capacitive plates 1412, 1414 and positioned between the crystal 1406 and the housing 1200.

[0123] FIG. 15 shows a schematic 1500 of an electronic device that may be used for acquiring an ECG or other biological parameter from a user of the electronic device. In some cases, the electronic device may include a watch body. As shown, the electronic device may include a first electrode 1502 on a crystal 1504, an optional second electrode 1506 on the crystal 1504, and a third electrode 1508 on the surface of a user-rotatable crown 1510. The third electrode 1508 may be operable to be contacted by a finger of a user while the first electrode 1502 (and optional second electrode 1506) are positioned against a user's skin (*e.g.*, against the wrist of the user). A processor 1512, which in some cases may be provided in an integrated circuit (IC), an application-specific integrated circuit (ASIC), a field programmable gate array (FPGA), a system

in package (SIP), a system on a chip (SOC), *etc.*, may be operable to acquire an ECG from the user, or determine another biological parameter of, the user. The ECG or other biological parameter may be determined based on voltages at the first, optional second, and third electrodes 1502, 1506, 1508 while the user is in contact with the first, optional second, and third electrodes 1502, 1506, 1508.

[0124] In some cases, voltages may be sensed at just the first and third electrodes 1502, 1508. In other cases, the second electrode 1506 may be grounded to the electronic device, thereby the user to the electronic device, and the voltage at the second electrode 1506 (*i.e.*, the ground voltage) may be used to remove noise generated by the electronic device or other environmental sources from the signals measured at the first and third electrodes 1502, 1508. This may result in more accurate readings (or processing) of the first and third voltages.

[0125] As shown, a signal or voltages at the first electrode 1502 may be amplified by a first amplifier 1514, and a signal or voltages at the third electrode 1508 may be amplified by a second amplifier 1516.

[0126] FIG. 16 shows an example method 1600 of determining a biological parameter of a user wearing a watch or other wearable electronic device, such as a watch or wearable electronic device described herein.

[0127] At block 1602, a ground voltage is optionally applied to a user via a first electrode on the electronic device. The first electrode may be on an exterior surface of a crystal that forms part of a housing of the electronic device. The operation(s) at 1602 may be performed, for example, by the processor described with reference to FIG. 15, using one of the electrodes described with reference to FIGS. 3C, 3D, 3E, 4-6, 7A-7C, 8A-D, 9, 10, and 15.

[0128] At block 1604, a first voltage or signal is sensed at a second electrode on the electronic device. The second electrode may also be on the exterior surface of the crystal. The operation(s) at 1604 may be performed, for example, by the processor described with reference to FIG. 15, using one of the electrodes described with reference to FIGS. 3C, 3D, 3E, 4-6, 7A-7C, 8A-D, 9, 10, and 15.

[0129] At block 1606, a second voltage or signal is sensed at a third electrode on the electronic device. The third electrode may also be on a user-rotatable crown of the electronic device, on a button of the electronic device, or on another surface of the housing of the electronic device. In some embodiments, the ground voltage is applied and the first voltage or signal is sensed on a wrist of one arm of the user, and the second voltage or signal is sensed on a fingertip of the user (with the fingertip belonging to a finger on a hand on the other arm of the user). The operation(s) at 1606 may be performed, for example, by the processor described with reference to FIG. 15, using one of the electrodes described with reference to FIGS. 3C, 3D, 3E, 4-6, 7A-7C, 8A-D, 9, 10, and 15.

[0130] At block 1608, the biological parameter of the user may be determined from the optional ground voltage, the first voltage or signal, and the second voltage or signal. The ground voltage may provide a reference for the first and second voltages or signals, or may otherwise be used to reject noise from the first and second voltages or signals. When the first and second voltages are obtained from different parts of the user's body, the biological parameter may be an echocardiogram for the user. The operation(s) at 1608 may be performed, for example, by the processor described with reference to FIG. 15.

[0131] FIG. 17 shows a sample electrical block diagram of an electronic device 1700, which electronic device may in some cases take the form of any of the watches or other wearable electronic devices described with reference to FIGS. 1-15, or other portable or wearable electronic devices. The electronic device 1700 can include a display 1705 (e.g., a light-emitting display), a processor 1710, a power source 1715, a memory 1720 or storage device, a sensor 1725, and an input/output (I/O) mechanism 1730 (e.g., an input/output device, input/output port, or haptic input/output interface). The processor 1710 can control some or all of the operations of the electronic device 1700. The processor 1710 can communicate, either directly or indirectly, with some or all of the components of the electronic device 1700. For example, a system bus or other communication mechanism 1735 can provide communication between the processor 1710, the power source 1715, the memory 1720, the sensor 1725, and the input/output mechanism 1730.

[0132] The processor 1710 can be implemented as any electronic device capable of processing, receiving, or transmitting data or instructions. For example, the processor 1710 can

be a microprocessor, a central processing unit (CPU), an application-specific integrated circuit (ASIC), a digital signal processor (DSP), or combinations of such devices. As described herein, the term “processor” is meant to encompass a single processor or processing unit, multiple processors, multiple processing units, or other suitably configured computing element or elements.

[0133] It should be noted that the components of the electronic device 1700 can be controlled by multiple processors. For example, select components of the electronic device 1700 (*e.g.*, a sensor 1725) may be controlled by a first processor and other components of the electronic device 1700 (*e.g.*, the display 1705) may be controlled by a second processor, where the first and second processors may or may not be in communication with each other. In some cases, the processor 1710 may determine a biological parameter of a user of the electronic device, such as an ECG for the user.

[0134] The power source 1715 can be implemented with any device capable of providing energy to the electronic device 1700. For example, the power source 1715 may be one or more batteries or rechargeable batteries. Additionally or alternatively, the power source 1715 can be a power connector or power cord that connects the electronic device 1700 to another power source, such as a wall outlet.

[0135] The memory 1720 can store electronic data that can be used by the electronic device 1700. For example, the memory 1720 can store electrical data or content such as, for example, audio and video files, documents and applications, device settings and user preferences, timing signals, control signals, and data structures or databases. The memory 1720 can be configured as any type of memory. By way of example only, the memory 1720 can be implemented as random access memory, read-only memory, Flash memory, removable memory, other types of storage elements, or combinations of such devices.

[0136] The electronic device 1700 may also include one or more sensors 1725 positioned almost anywhere on the electronic device 1700. The sensor(s) 1725 can be configured to sense one or more type of parameters, such as but not limited to, pressure, light, touch, heat, movement, relative motion, biometric data (*e.g.*, biological parameters), and so on. For example, the sensor(s) 1725 may include a heat sensor, a position sensor, a light or optical sensor, an accelerometer, a pressure transducer, a gyroscope, a magnetometer, a health monitoring sensor,

and so on. Additionally, the one or more sensors 1725 can utilize any suitable sensing technology, including, but not limited to, capacitive, ultrasonic, resistive, optical, ultrasound, piezoelectric, and thermal sensing technology. In some examples, the sensors 1725 may include one or more of the electrodes described herein (*e.g.*, one or more electrodes on an exterior surface of a crystal that forms part of a housing for the electronic device 1700 and/or an electrode on a crown, button, or other housing member of the electronic device).

[0137] The I/O mechanism 1730 can transmit and/or receive data from a user or another electronic device. An I/O device can include a display, a touch sensing input surface, one or more buttons (*e.g.*, a graphical user interface “home” button), one or more cameras, one or more microphones or speakers, one or more ports such as a microphone port, and/or a keyboard. Additionally or alternatively, an I/O device or port can transmit electronic signals via a communications network, such as a wireless and/or wired network connection. Examples of wireless and wired network connections include, but are not limited to, cellular, Wi-Fi, Bluetooth, IR, and Ethernet connections.

[0138] The foregoing description, for purposes of explanation, uses specific nomenclature to provide a thorough understanding of the described embodiments. However, it will be apparent to one skilled in the art that the specific details are not required in order to practice the described embodiments. Thus, the foregoing descriptions of the specific embodiments described herein are presented for purposes of illustration and description. They are not targeted to be exhaustive or to limit the embodiments to the precise forms disclosed. It will be apparent to one of ordinary skill in the art that many modifications and variations are possible in view of the above teachings.

CLAIMS

What is claimed is:

1. An electronic device, comprising:
 - a housing;
 - a crystal affixed to the housing and comprising:
 - a first surface interior to the electronic device; and
 - a second surface exterior to the electronic device;
 - a first electrode on the second surface of the crystal;
 - a second electrode positioned to be contacted by a user of the electronic device while the first electrode is positioned against skin of the user; and
 - a processor operable to determine a biological parameter of the user based on voltages at the first electrode and the second electrode; wherein
 - the voltages are measured while the user is in contact with the first electrode and the second electrode.
2. The electronic device of claim 1, further comprising a crown assembly, wherein:
 - the crown assembly comprises:
 - a shaft extending through an aperture in the housing; and
 - a user-rotatable crown attached to the shaft exterior to the housing; and
 - the second electrode comprises a surface of the user-rotatable crown.
3. The electronic device of claim 1, further comprising a button protruding through an aperture in the housing; wherein
 - the second electrode comprises a surface of the button.
4. The electronic device of claim 1, wherein the second electrode is formed on a non-crystal surface of the housing.

5. The electronic device of claim 1, wherein the first electrode wraps around an edge of the crystal and extends to the first surface.
6. The electronic device of claim 5, further comprising an ink mask on the first surface of the crystal; wherein
 - the first electrode overlaps the ink mask; and
 - the ink mask is positioned between the first surface of the crystal and the first electrode.
7. The electronic device of claim 1, wherein the crystal is formed from sapphire.
8. The electronic device of claim 1, further comprising a conductive via extending from the first electrode to the first surface of the crystal.
9. The electronic device of claim 1, wherein:
 - the housing further comprises a housing member;
 - the crystal overlaps the housing member; and
 - an adhesive attaches the crystal to the housing member.
10. The electronic device of claim 9, wherein the adhesive comprises a heat activated film.
11. An electronic watch, comprising:
 - a housing;
 - a crystal affixed to the housing and comprising:
 - a first surface interior to the watch body; and
 - a second surface exterior to the watch body;
 - a crown assembly comprising:
 - a shaft extending through an aperture in the housing; and
 - a user-rotatable crown attached to the shaft exterior to the housing;
 - a first electrode on the second surface of the crystal;
 - a second electrode on the second surface of the crystal;

a third electrode on a surface of the user-rotatable crown, the third electrode positioned to be contacted by a finger of a user while the first electrode and the second electrode are positioned against a portion of the user; and

a processor operable to determine an electrocardiogram of the user based on voltages at the first electrode, the second electrode, and the third electrode.

12. The watch body of claim 11, wherein each of the first electrode and the second electrode is arc-shaped and positioned at a periphery of the crystal.

13. The watch body of claim 11, wherein each of the first electrode and the second electrode wraps around an edge of the crystal to the first surface.

14. An electronic device, comprising:

a housing;

a shaft extending through an aperture in the housing;

a crown, mechanically and electrically connected to the shaft and exterior to the housing;

a shaft retainer, mechanically and electrically connected to the shaft and interior to the housing;

a spring-biased conductor, mechanically and electrically connected to at least one of the shaft or the shaft retainer; and

a circuit, electrically connected to the spring-biased conductor; wherein

the circuit is in electrical communication with the crown via the spring-biased conductor, the shaft retainer, and the shaft.

15. The electronic device of claim 14, further comprising:

a collar aligned with the aperture in the housing and positioned around the shaft;

a collar retainer coupled to the collar to retain the collar to the housing; and

an insulator between the shaft and the collar.

16. The electronic device of claim 15, wherein the insulator comprises a non-conductive coating on the shaft.

17. The electronic device of claim 15, further comprising a second insulator between the shaft retainer and the collar retainer.
18. The electronic device of claim 14, wherein the conductive crown comprises:
 - a conductive center portion; and
 - a ring of non-conductive material surrounding the conductive center portion.
19. The electronic device of claim 14, wherein the crown has a conductive surface covered by a non-conductive coating, the non-conductive coating providing a dielectric for capacitive coupling between the crown and skin of a user of the electronic device.
20. The electronic device of claim 14, wherein the crown has a non-conductive coating on a surface of the crown facing the housing.
21. The electronic device of claim 14, further comprising an optical encoder carried by the shaft retainer.
22. The electronic device of claim 14, further comprising a tactile switch; wherein
 - the shaft is translatable;
 - the spring-biased conductor comprises a shear plate biased to contact at least one of an end of the shaft or the shaft retainer;
 - the shear plate is deformable responsive to translation of the shaft; and
 - the tactile switch is operable responsive to translation of the shaft.
23. The electronic device of claim 14, further comprising a tactile switch; wherein
 - the shaft is translatable;
 - the spring-biased conductor comprises a conductive brush biased to contact at least one of a side of the shaft or the shaft retainer; and
 - the tactile switch is operable responsive to translation of the shaft.

24. The electronic device of claim 14, wherein:
the circuit comprises a flex circuit; and
the spring-biased conductor is surface-mounted to the flex circuit.

ABSTRACT

An electronic device, such as a watch, has a housing that includes a crystal. The crystal has a first surface interior to the electronic device, and a second surface exterior to the electronic device. One or more electrodes are deposited on the exterior surface of the crystal by physical vapor deposition (PVD). An additional electrode is operable to be contacted by a finger of a user of the electronic device while the first electrode is positioned against skin of the user. The additional electrode may be positioned on a user-rotatable crown of the electronic device, on a button of the electronic device, or on another surface of the housing of the electronic device. A processor of the electronic device is operable to determine a biological parameter of the user based on voltages at the electrodes. The biological parameter may be an echocardiogram.

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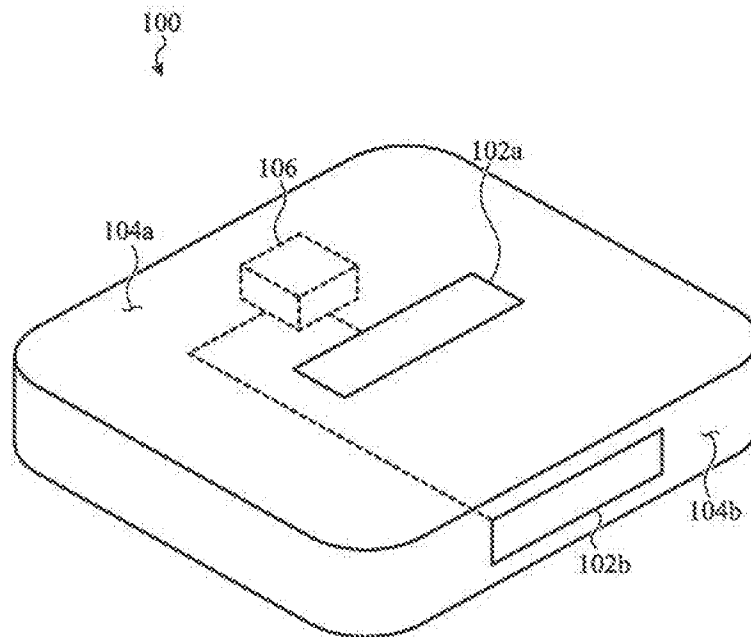


FIG. 1A

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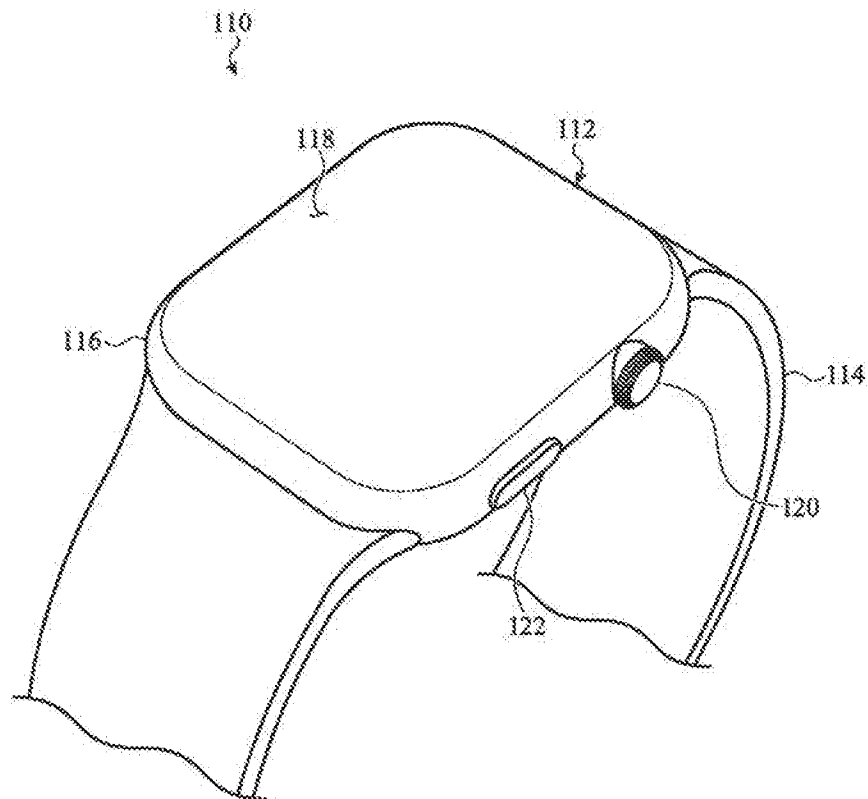


FIG. 1B

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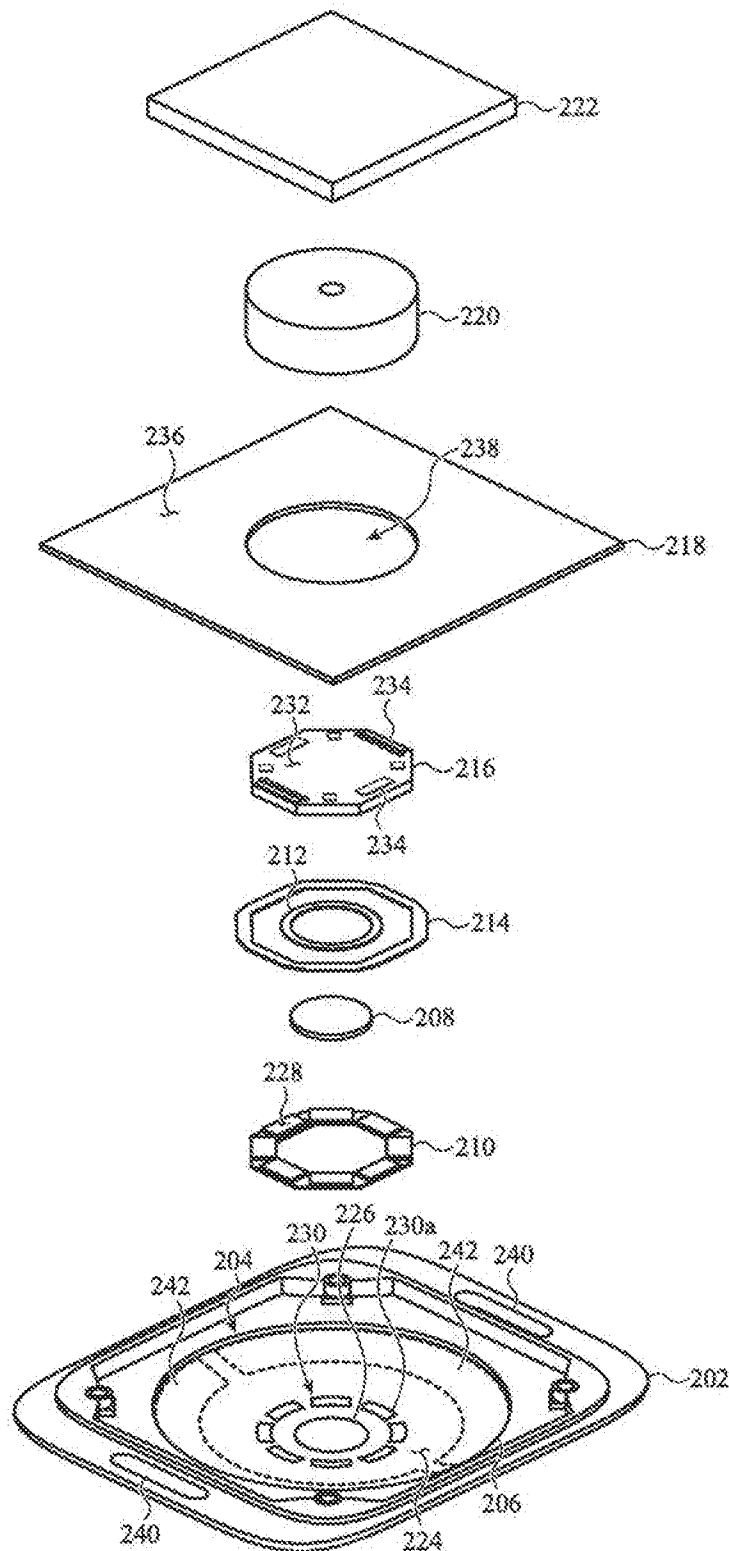


FIG. 2

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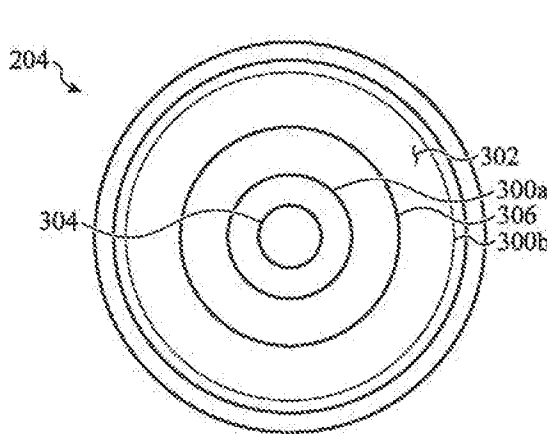


FIG. 3A

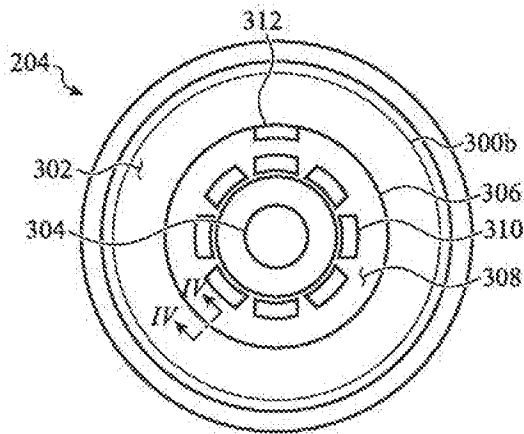


FIG. 3B

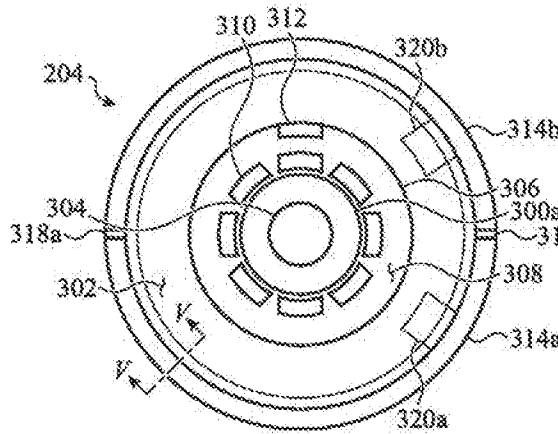


FIG. 3C

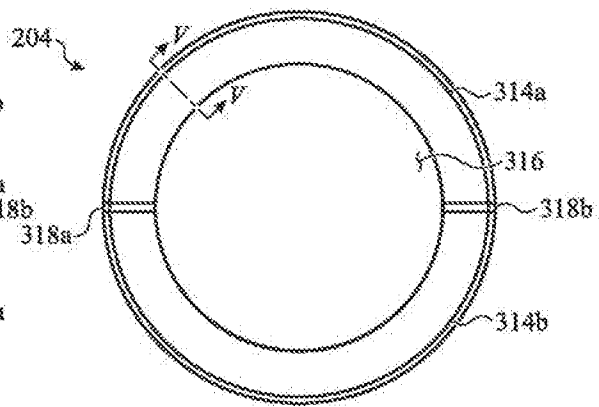


FIG. 3D

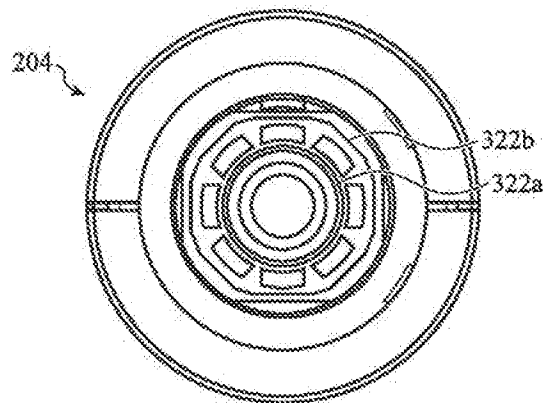


FIG. 3E

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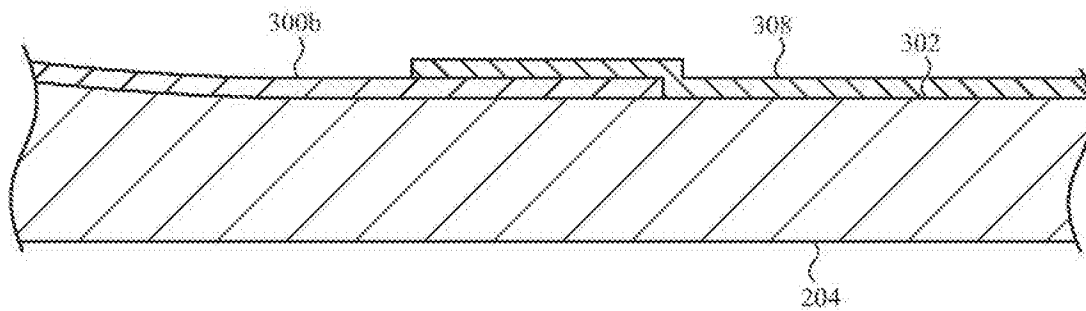


FIG. 4

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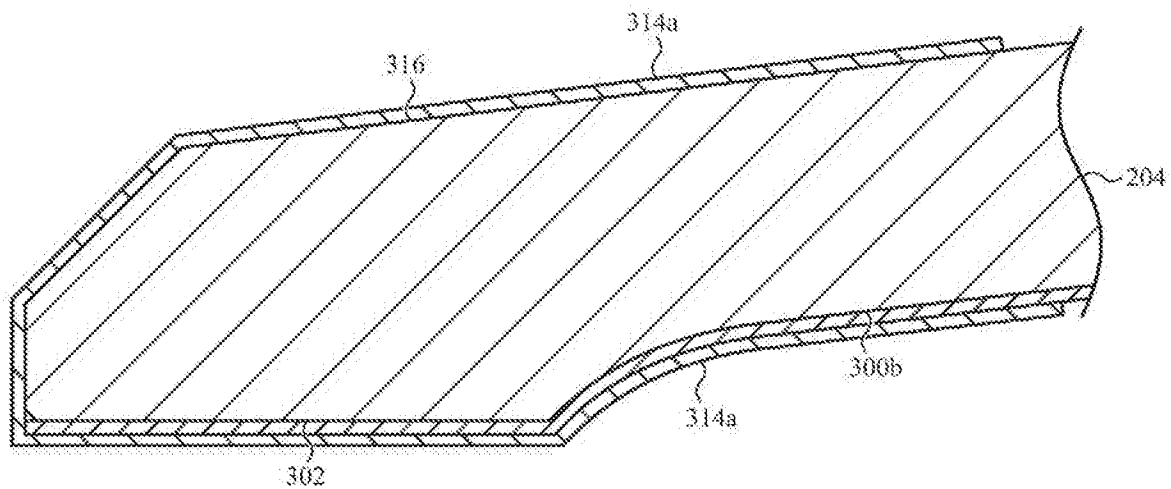


FIG. 5

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600
↓

DLC	612
SiO ₂	610
Si ₃ N ₄	608
SiO ₂	606
ITO	604
Al ₂ O ₃	602
CRYSTAL	204

FIG. 6

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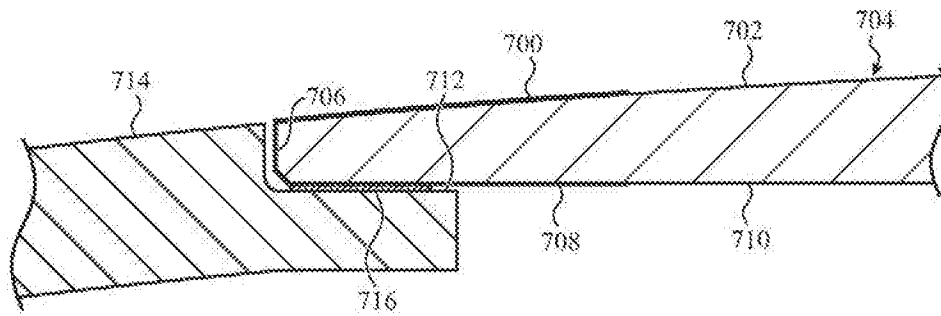


FIG. 7A

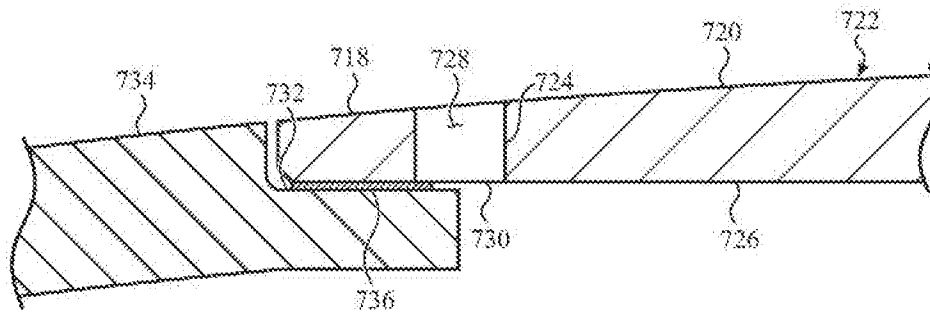


FIG. 7B

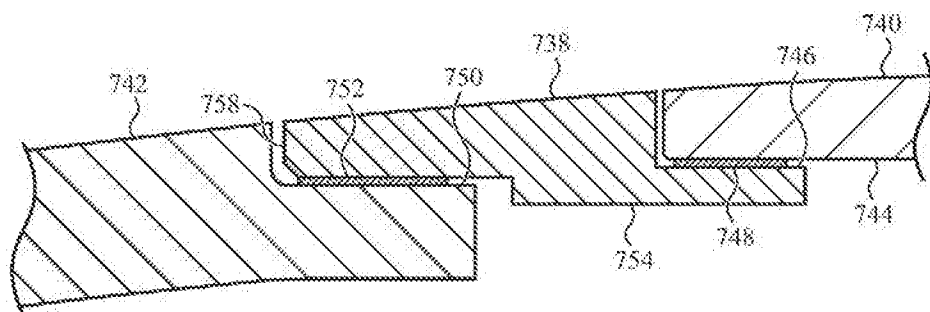


FIG. 7C

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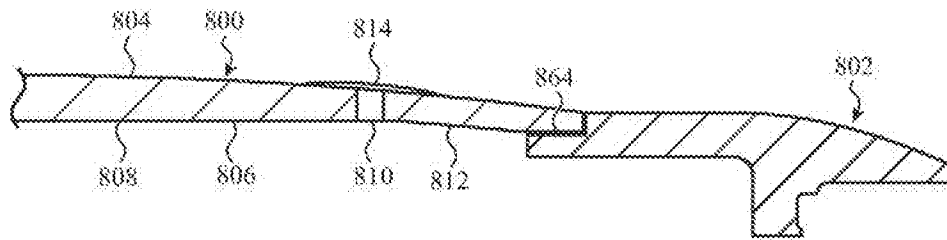


FIG. 8A

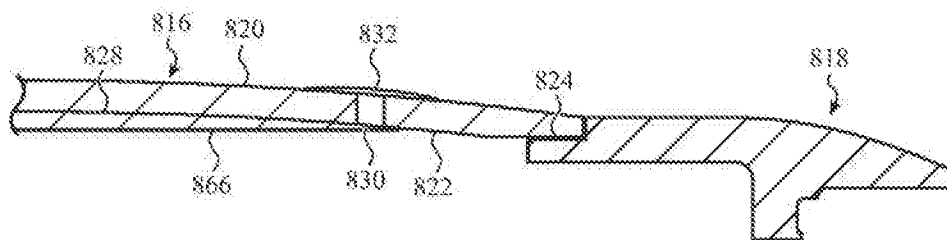


FIG. 8B

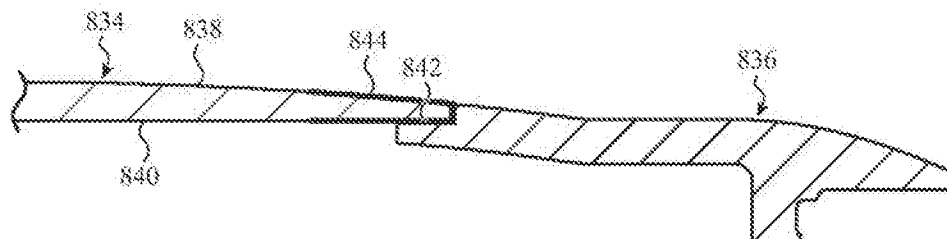


FIG. 8C

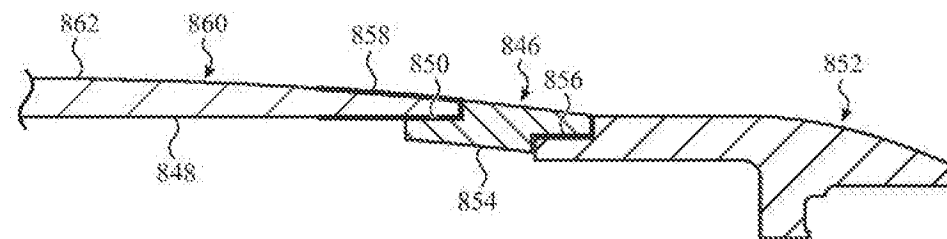


FIG. 8D

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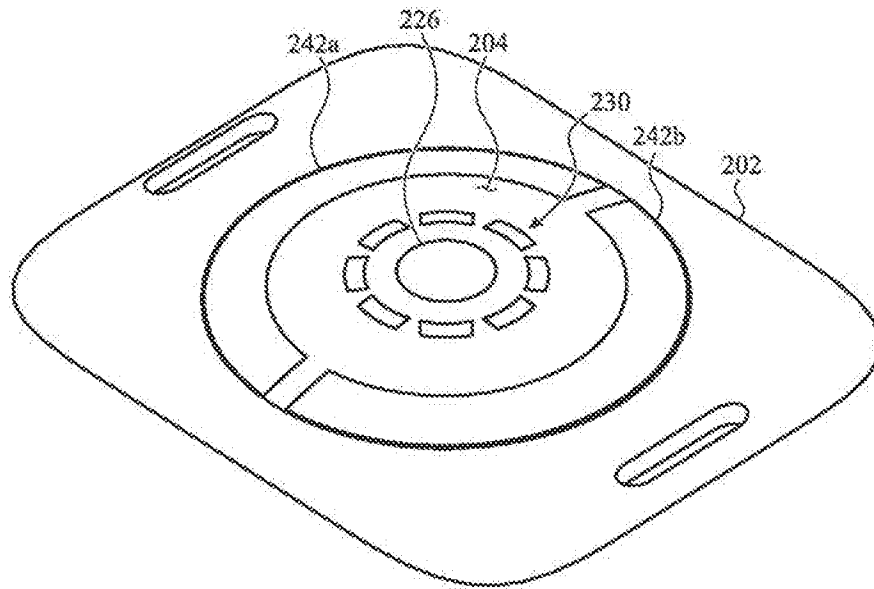


FIG. 9

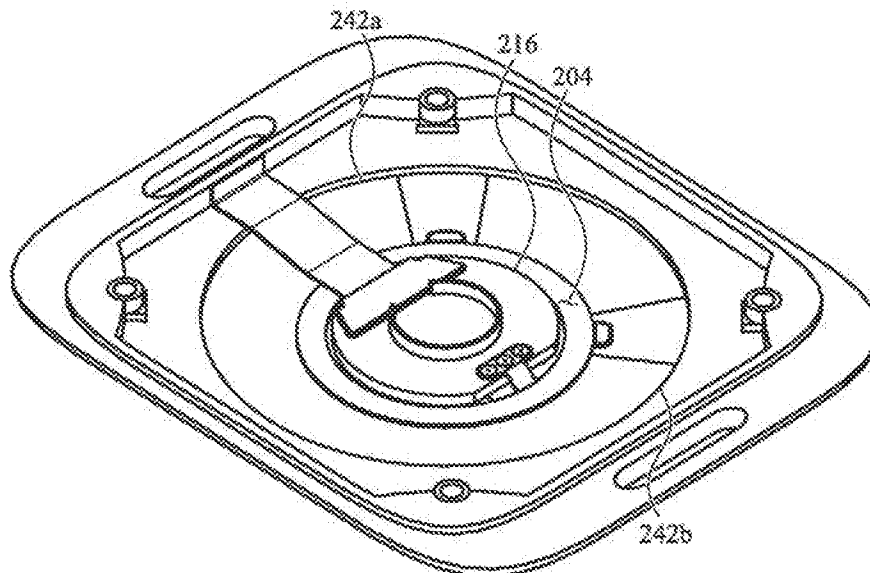


FIG. 10

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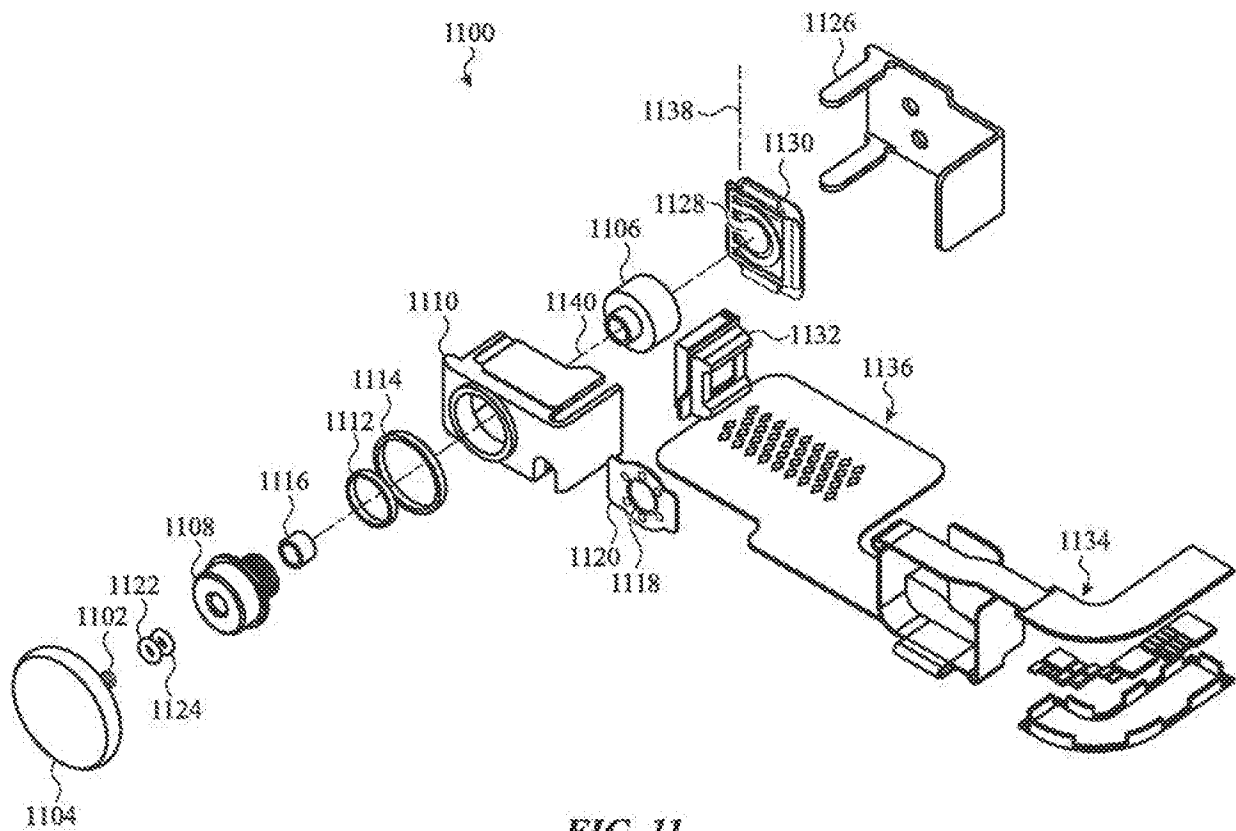
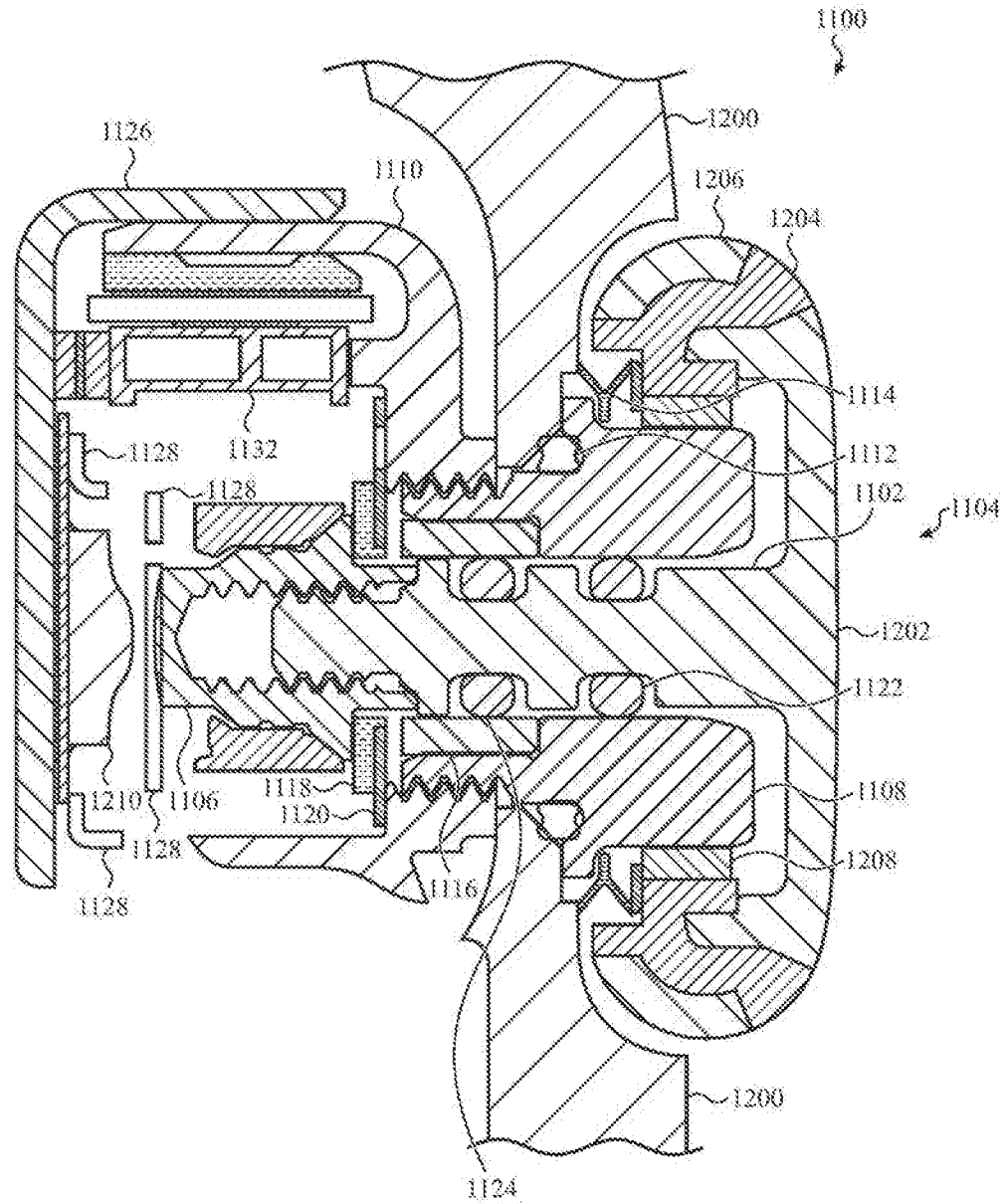


FIG. 11

FIG. 12



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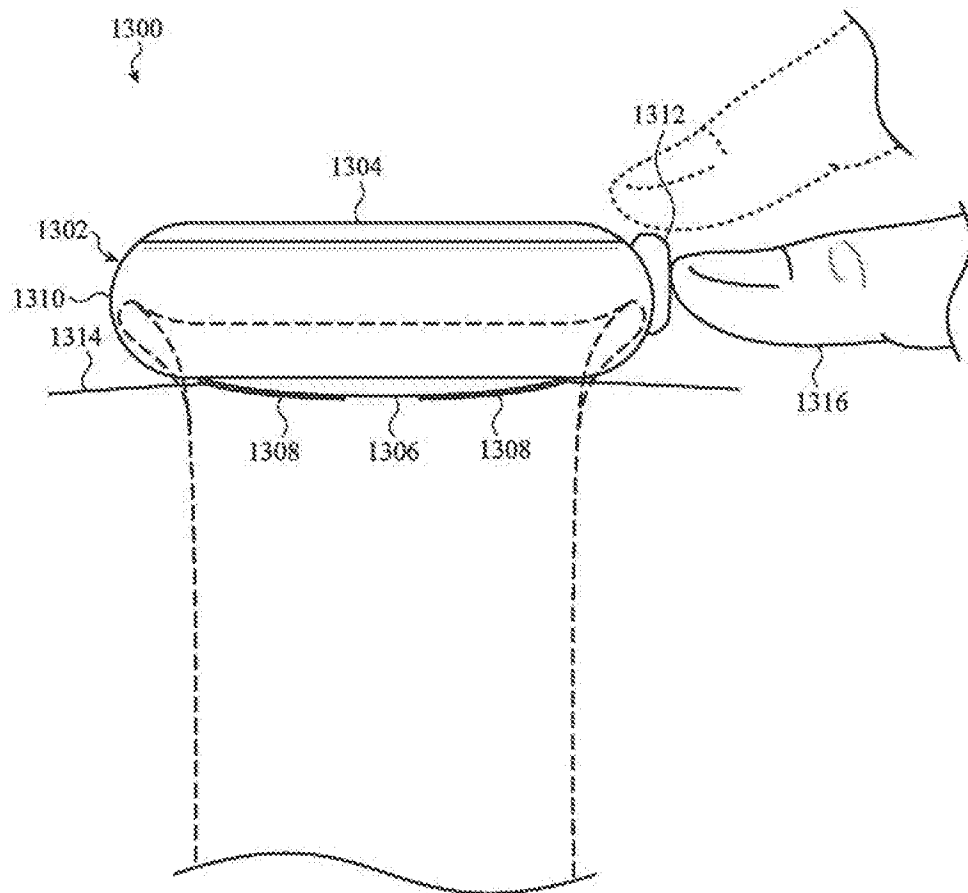


FIG. 13

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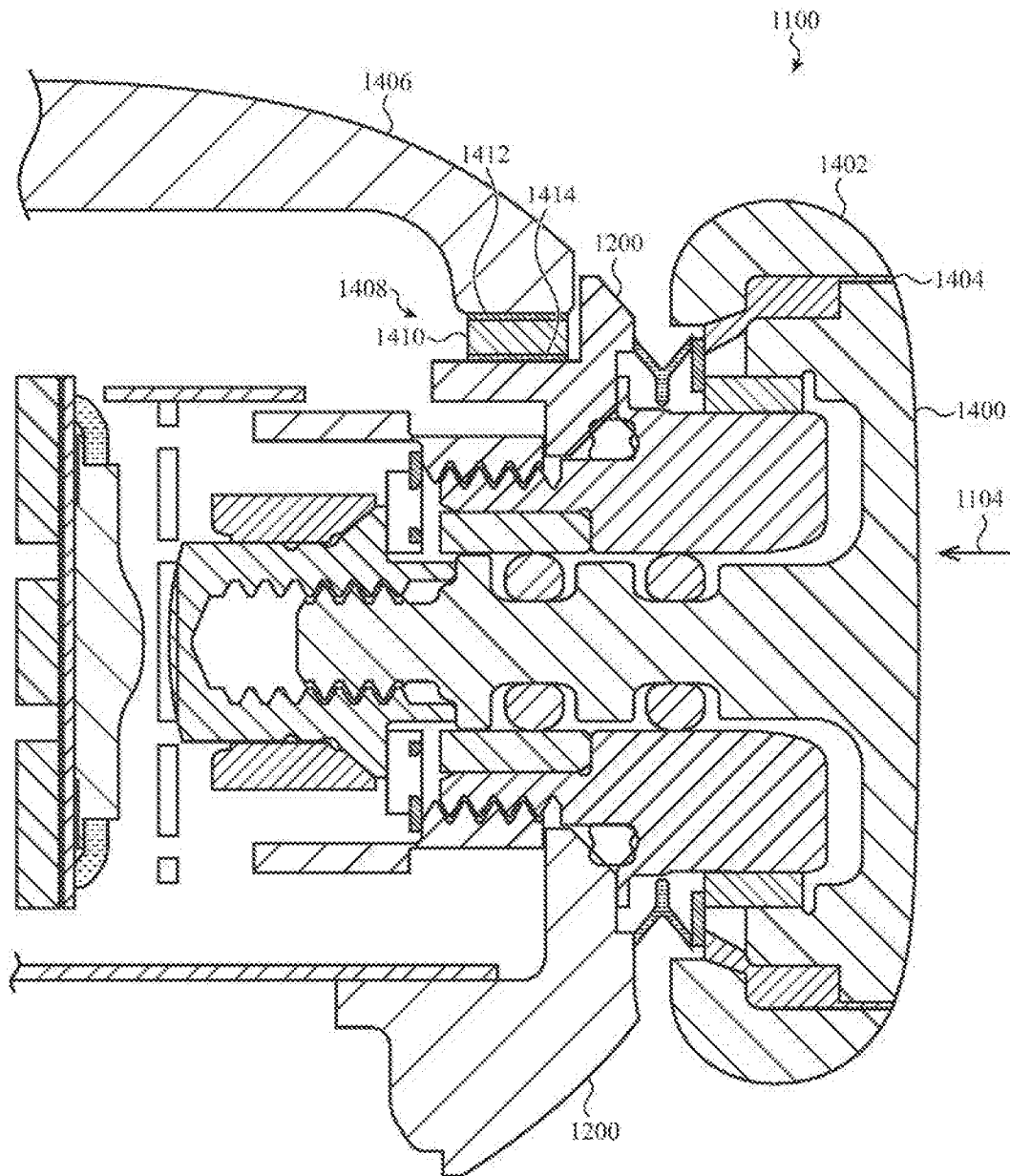


FIG. 14

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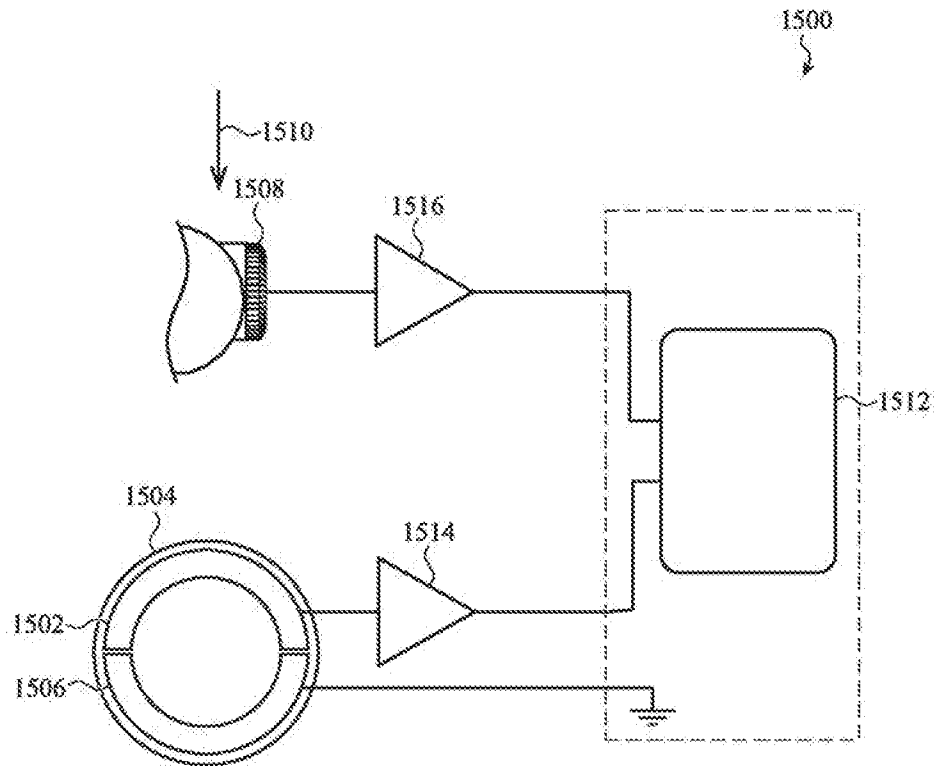


FIG. 15

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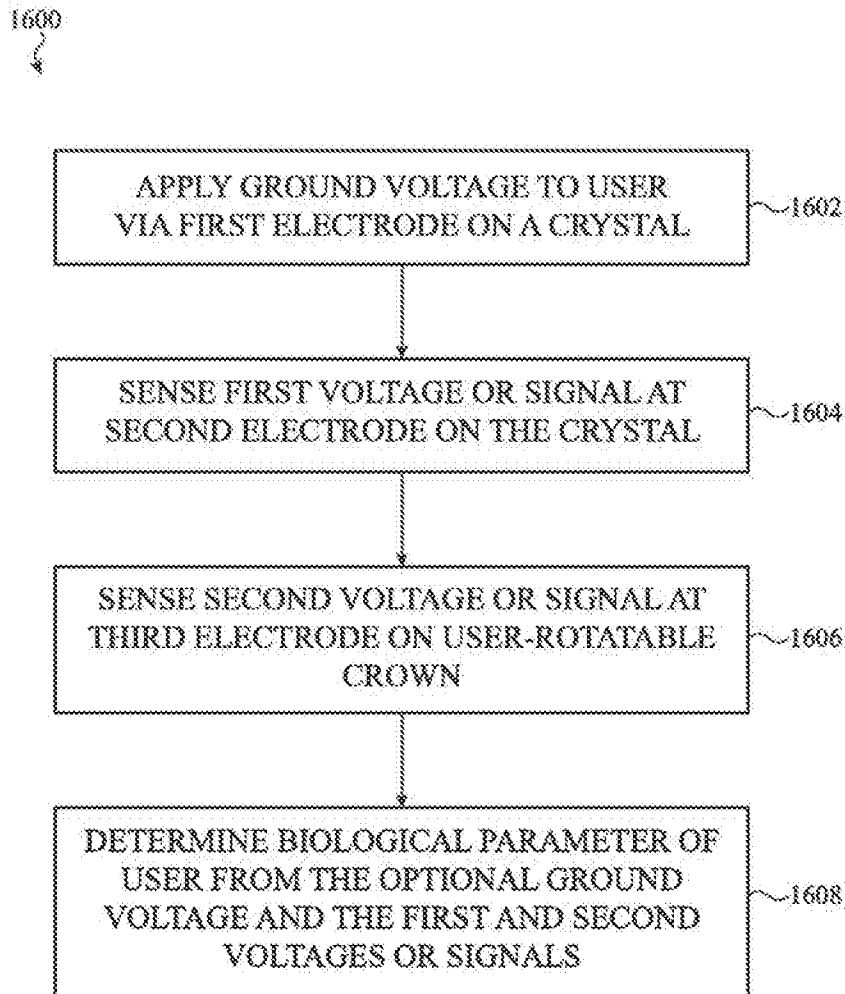


FIG. 16

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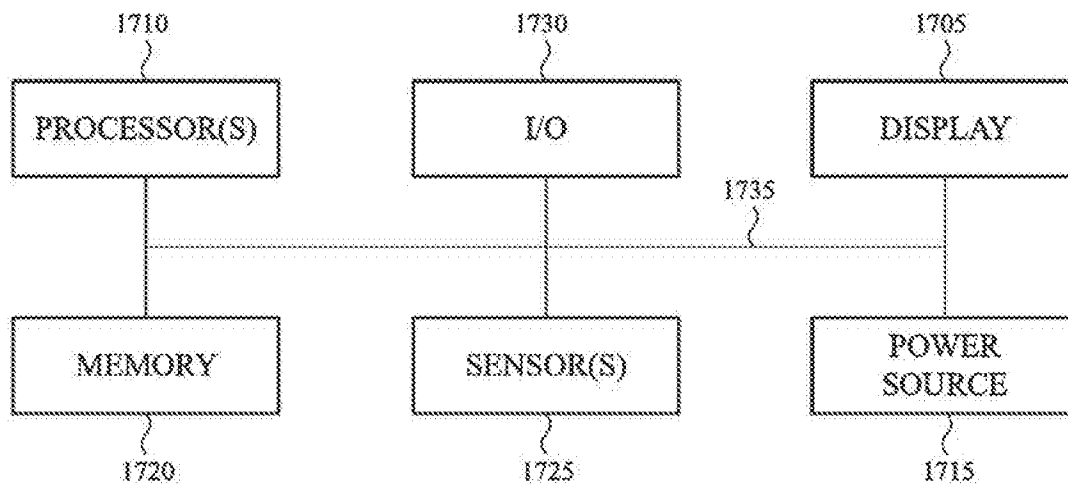


FIG. 17

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Document Date: 09/27/2018

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- Appendix

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