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(54) MOBILE COMMUNICATION DEVICE AND OTHER DEVICES WITH CARDIOVASCULAR MONITORING CAPABILITY

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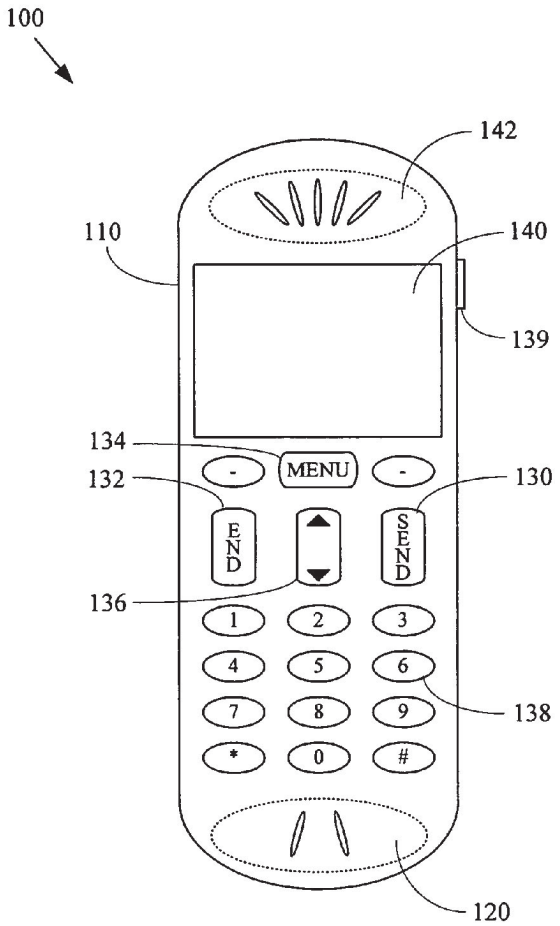
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(52) **U.S. Cl.** **600/509**

(57) **ABSTRACT**

A general-purpose mobile communication device, general-purpose computer user-interface device, and other non-health-related electronic devices with cardiovascular monitoring capability. Various aspects of the present invention may comprise a general-purpose mobile communication device (e.g., a cellular telephone, portable email device, personal digital assistant, etc.) comprising a communication interface module adapted to communicate with a general-purpose communication network, and at least one module operational to acquire cardiac information from a user of the general-purpose mobile communication device. The general-purpose communication device may, for example, comprise a cardiac sensor (e.g., electrodes) disposed on the mobile communication device, which may be utilized to acquire cardiac information during use of the mobile communication device. Various aspects of the present invention may also comprise a non-health related electronic device (e.g., a general-purpose mobile communication device, general-purpose user-interface device for a general-purpose computer, gaming controller, etc.) that, during normal non-health-related utilization, acquire, analyze and/or communicate user health-related information.



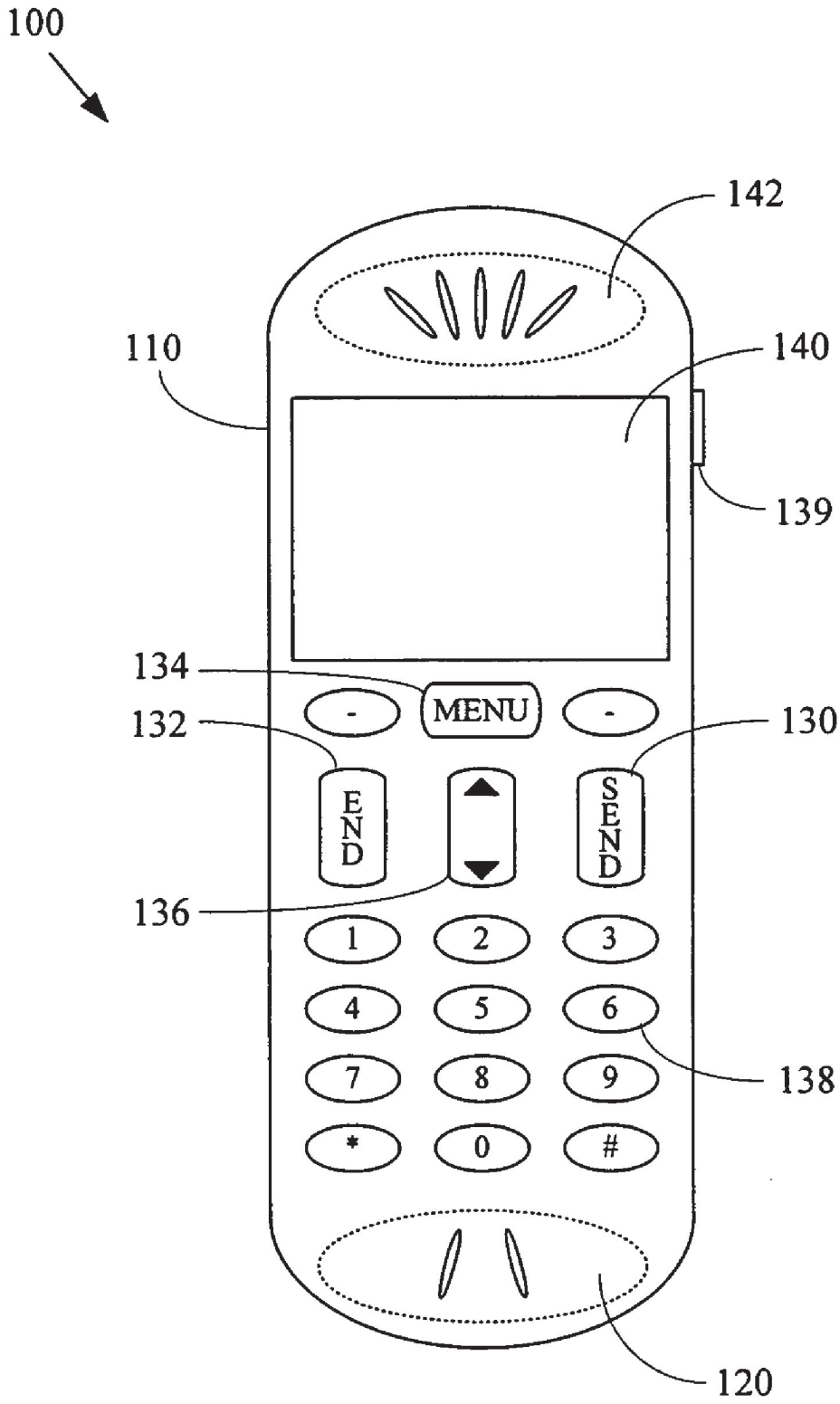

100
142
110
140
139
134
MENU
132
130
END
SEND
136
1
2
3
4
5
6
7
8
9
*
0
#
138
120

Figure 1

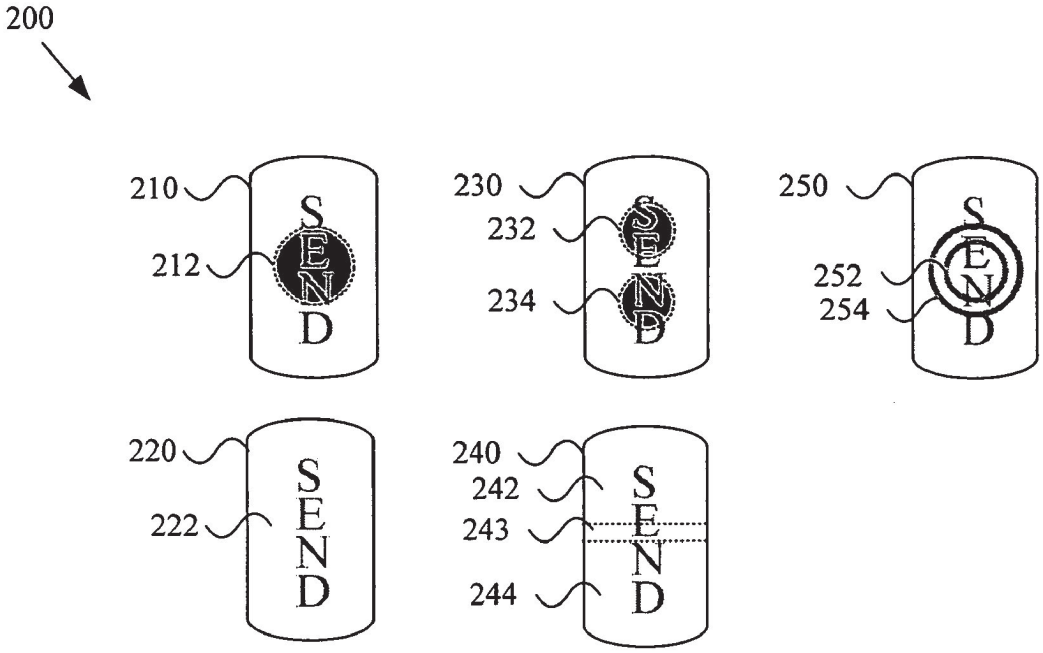


Figure 2

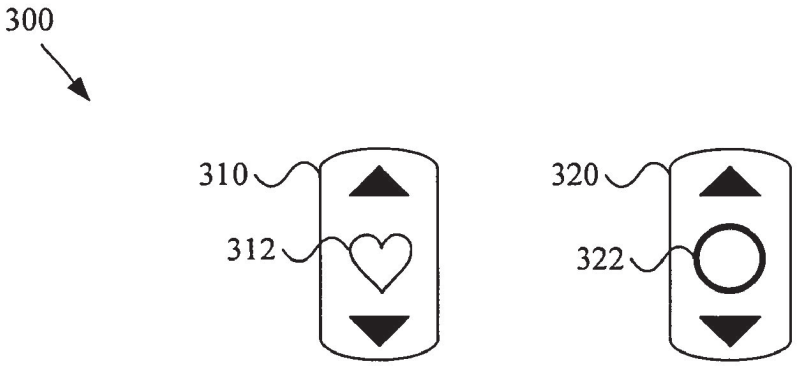


Figure 3

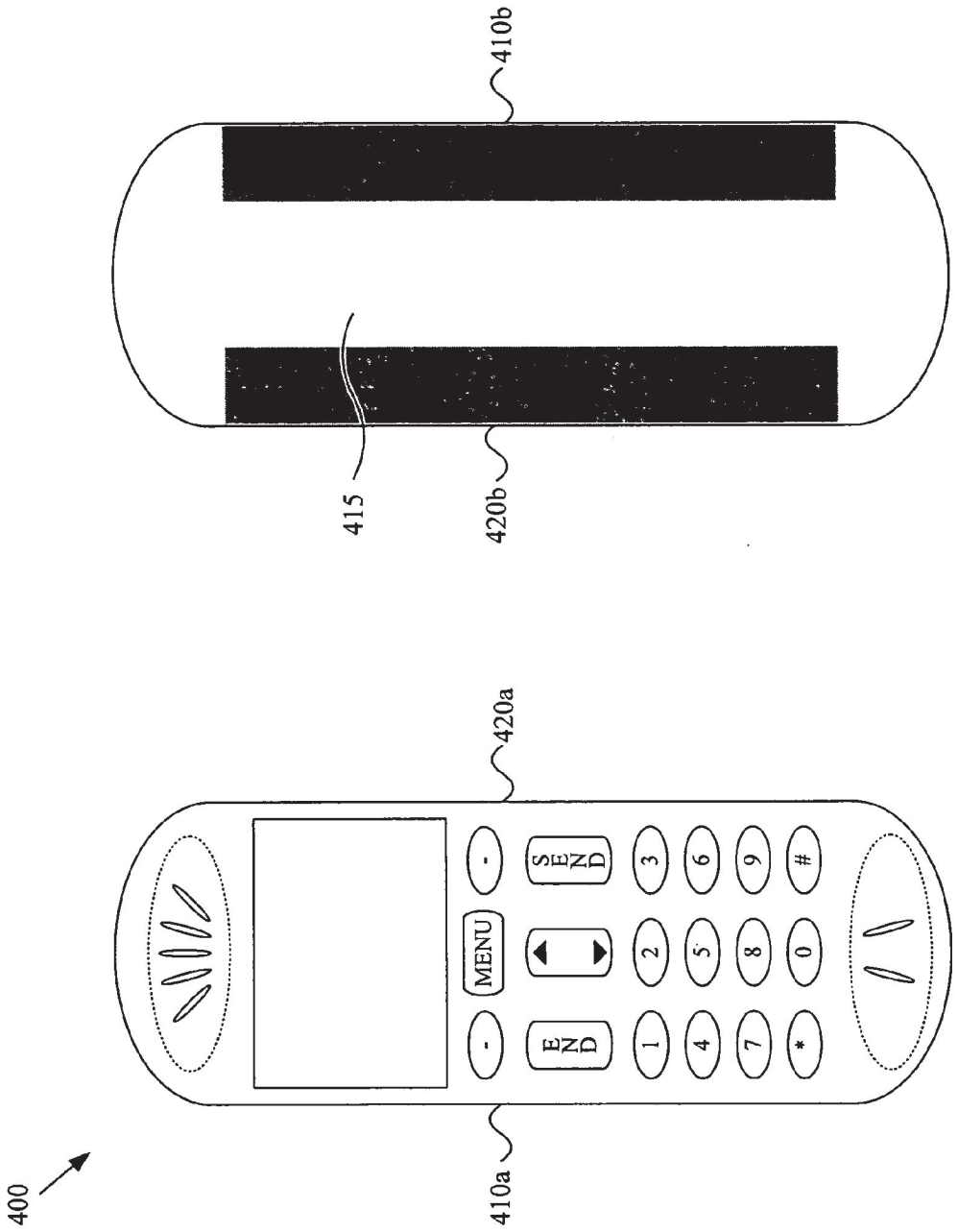


Figure 4

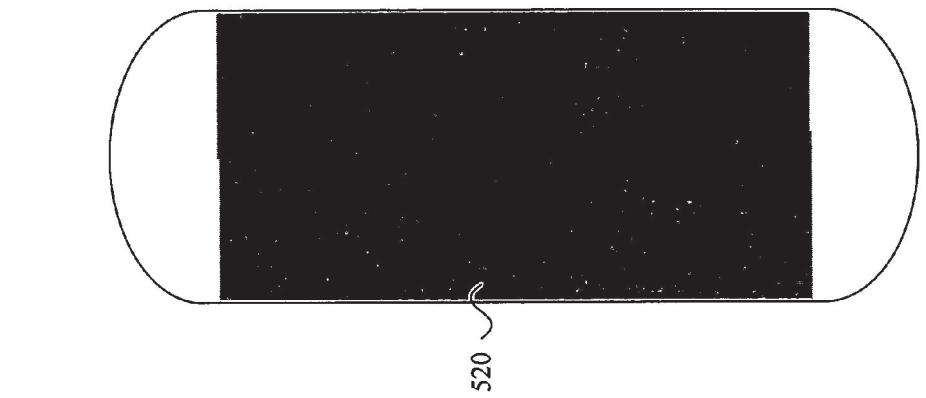
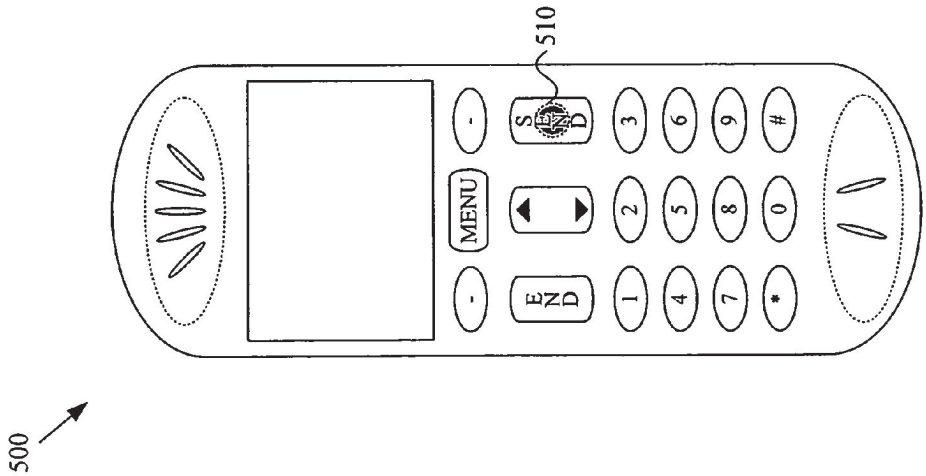


Figure 5



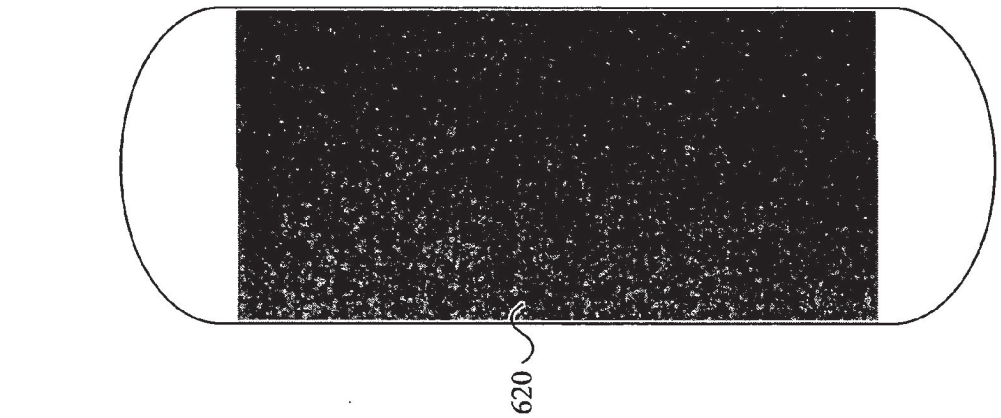
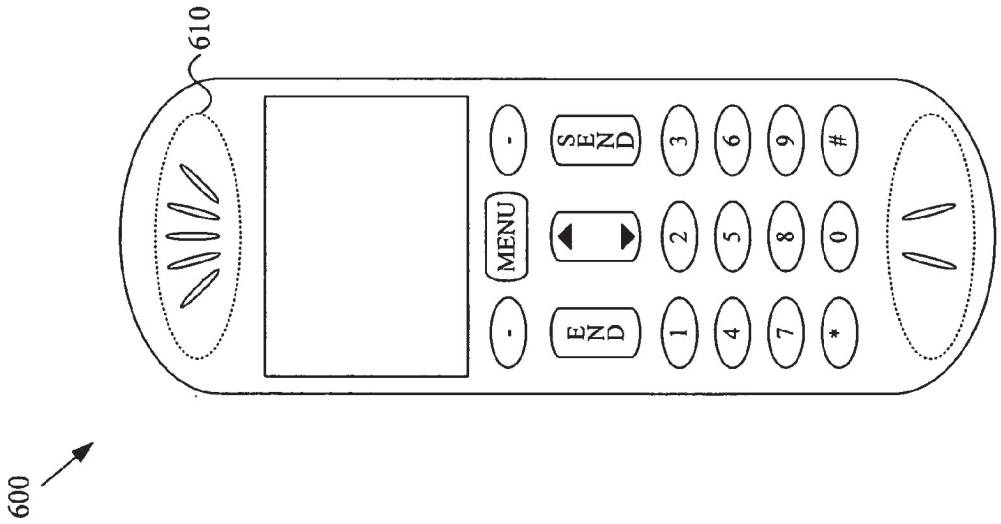


Figure 6



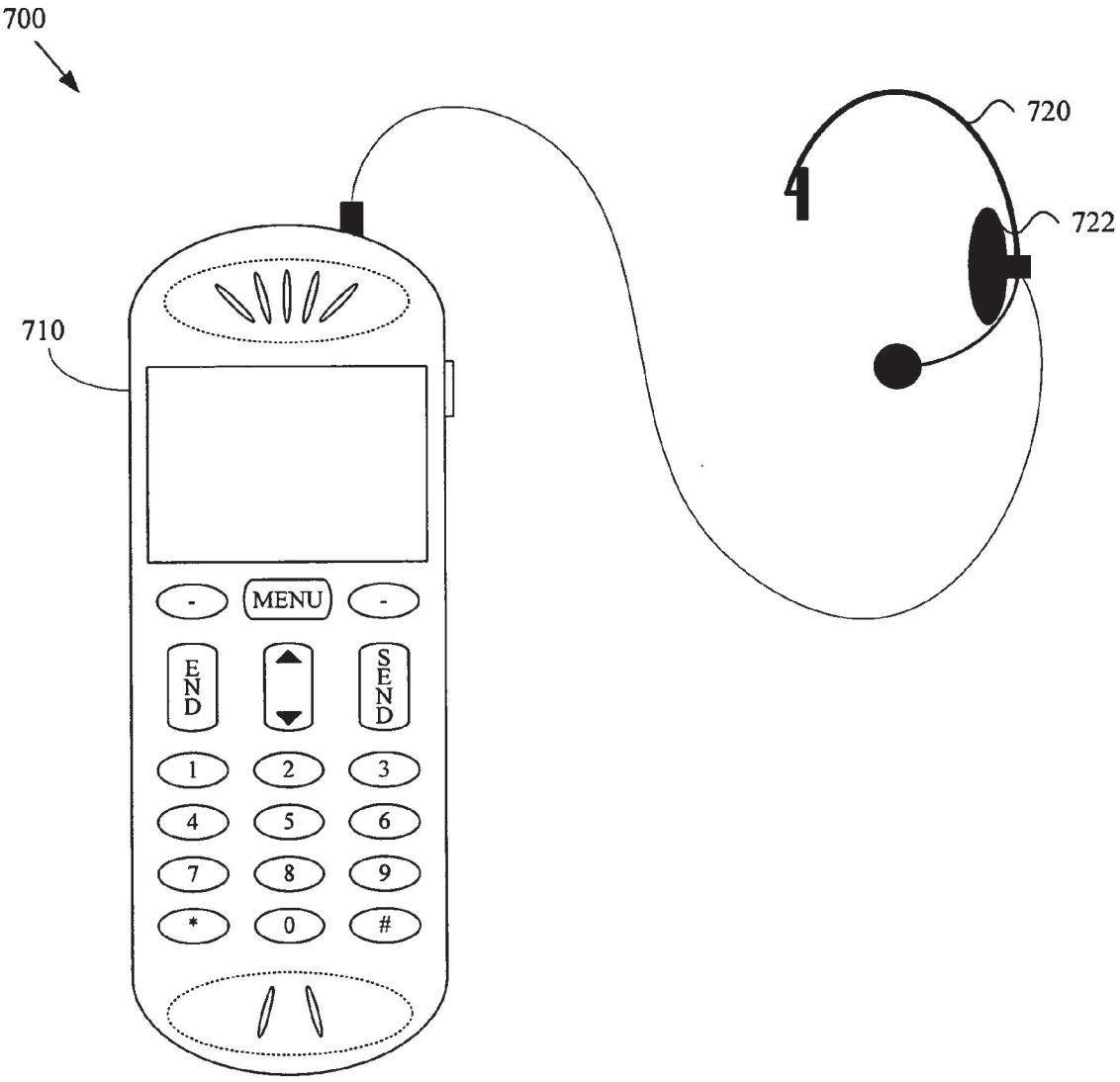


Figure 7

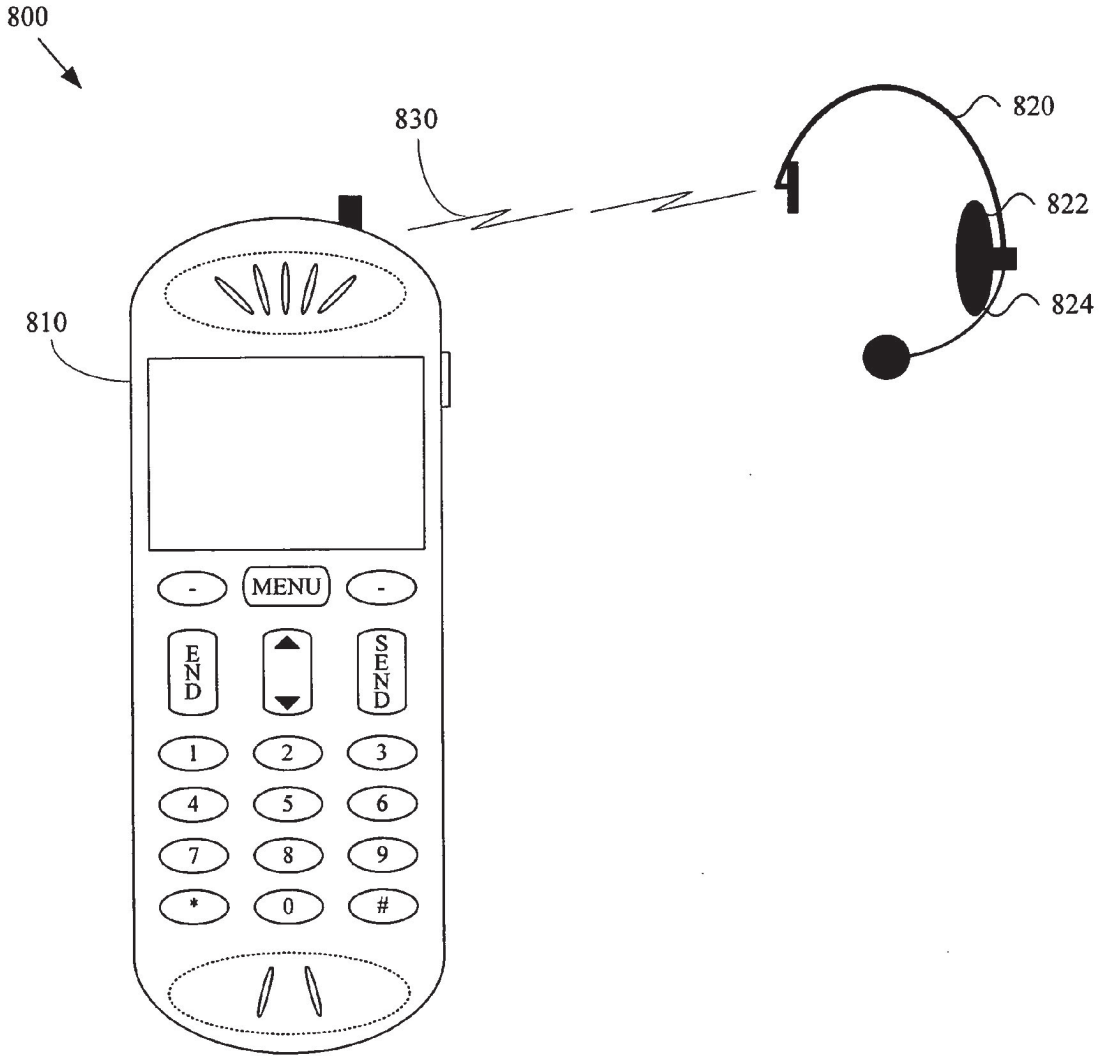


Figure 8

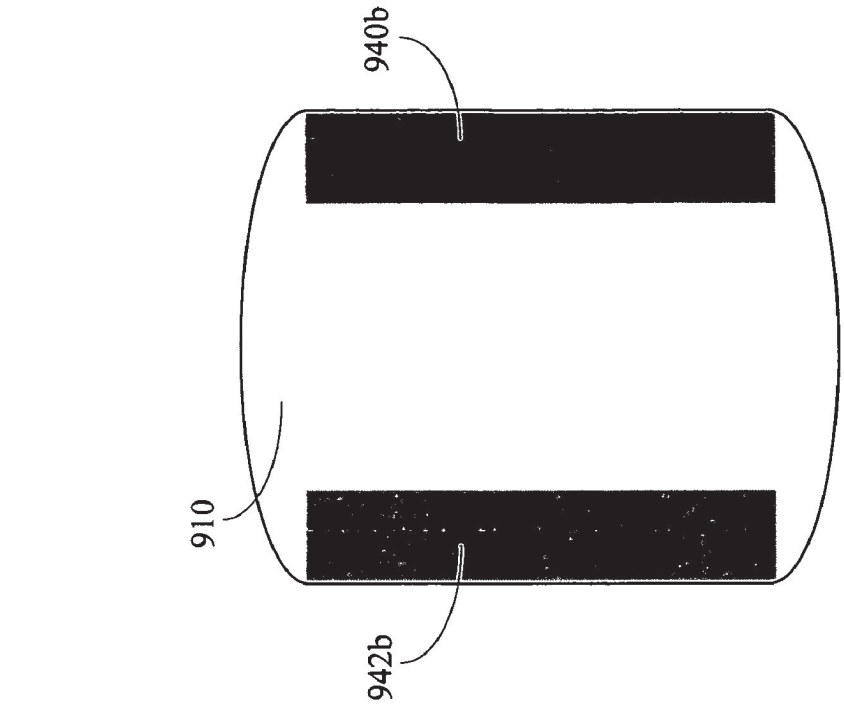
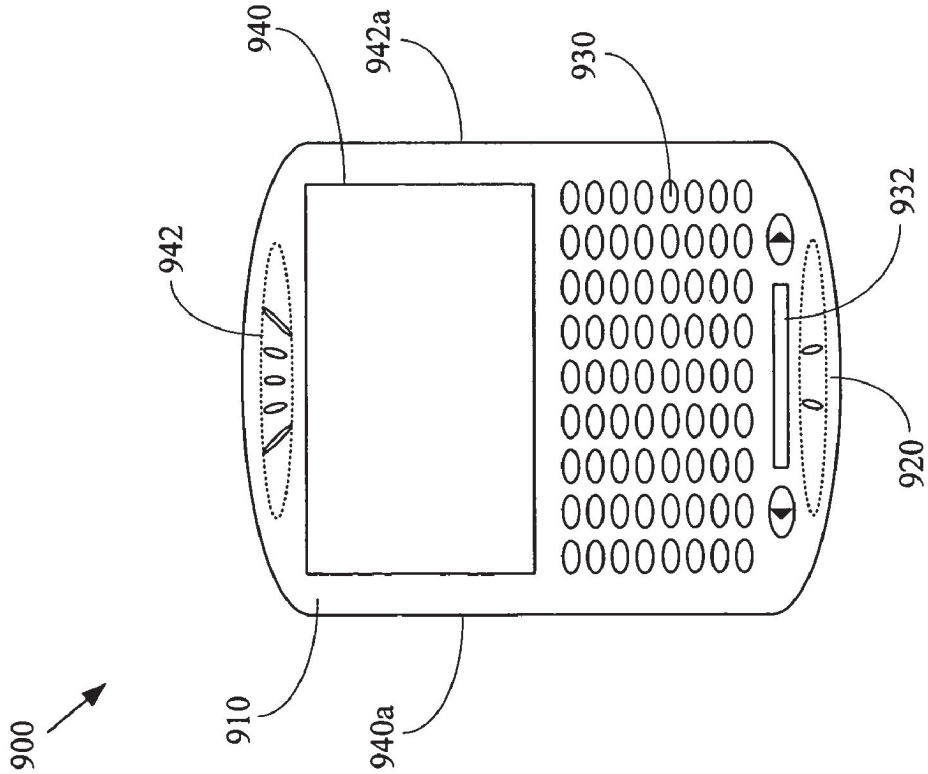


Figure 9



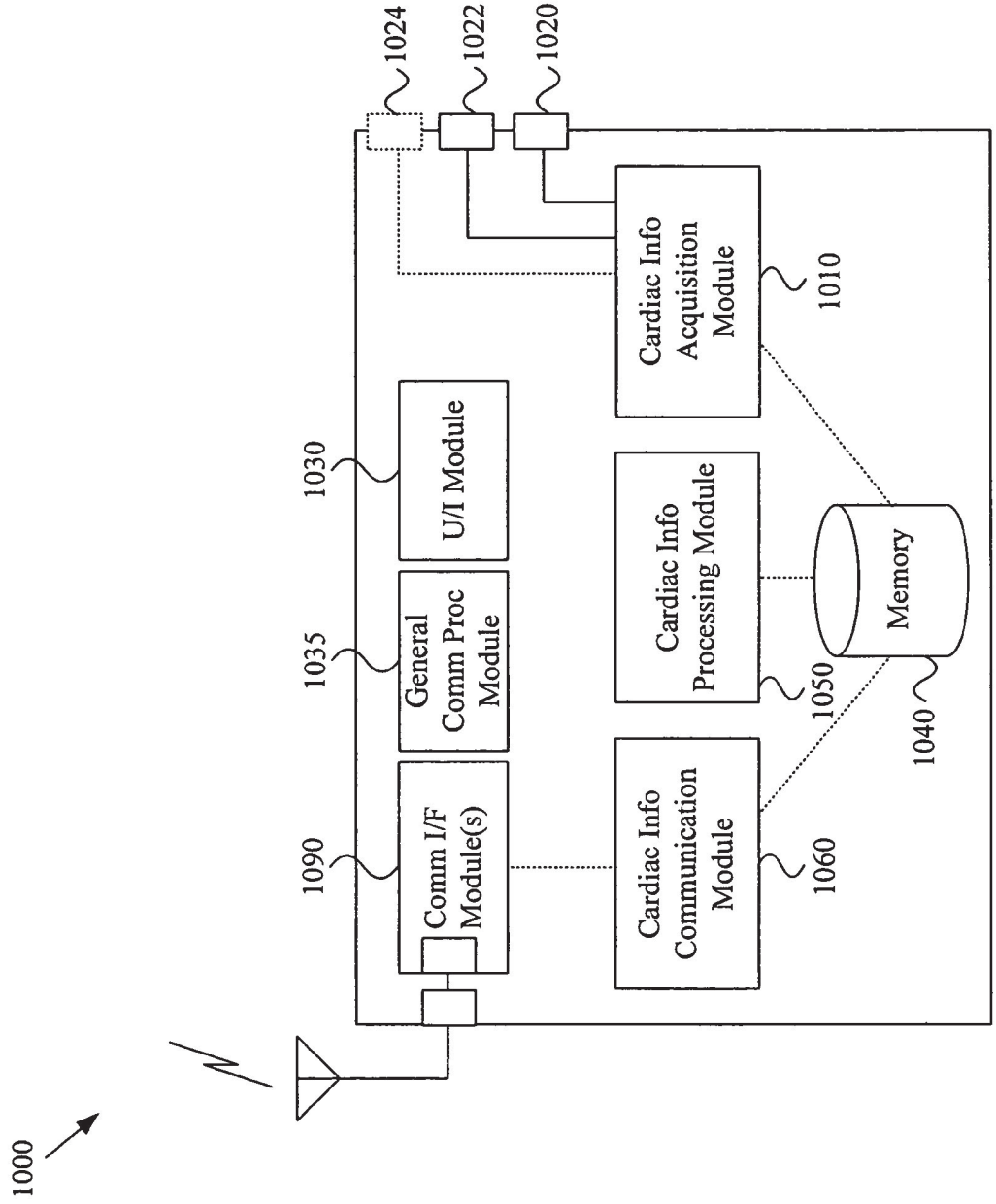

1000
1024
1022
1020
Cardiac Info Acquisition Module
1010
U/I Module
1030
General Comm Proc Module
1035
Comm I/F Module(s)
1090
Cardiac Info Processing Module
1050
Memory
1040
Cardiac Info Communication Module
1060

Figure 10

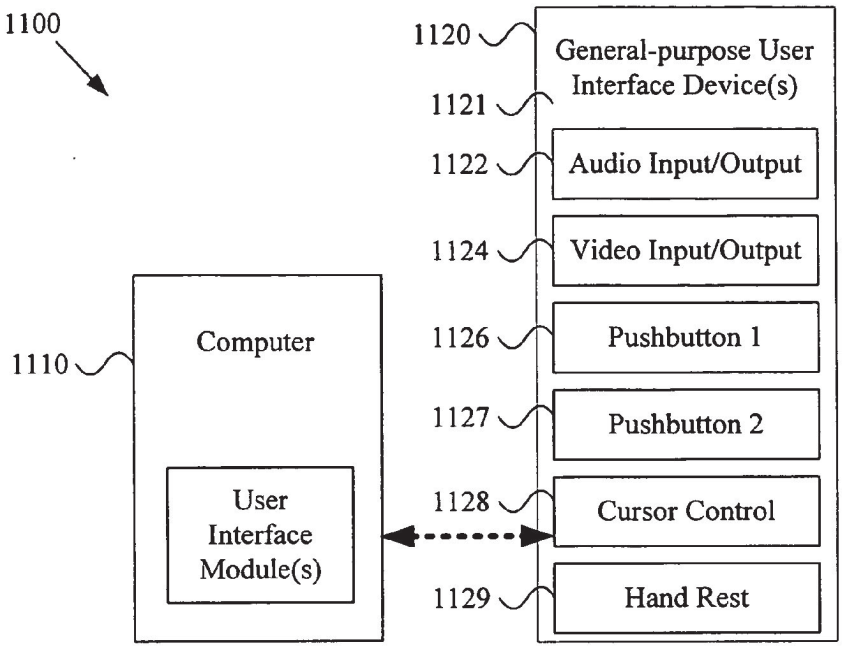


Figure 11

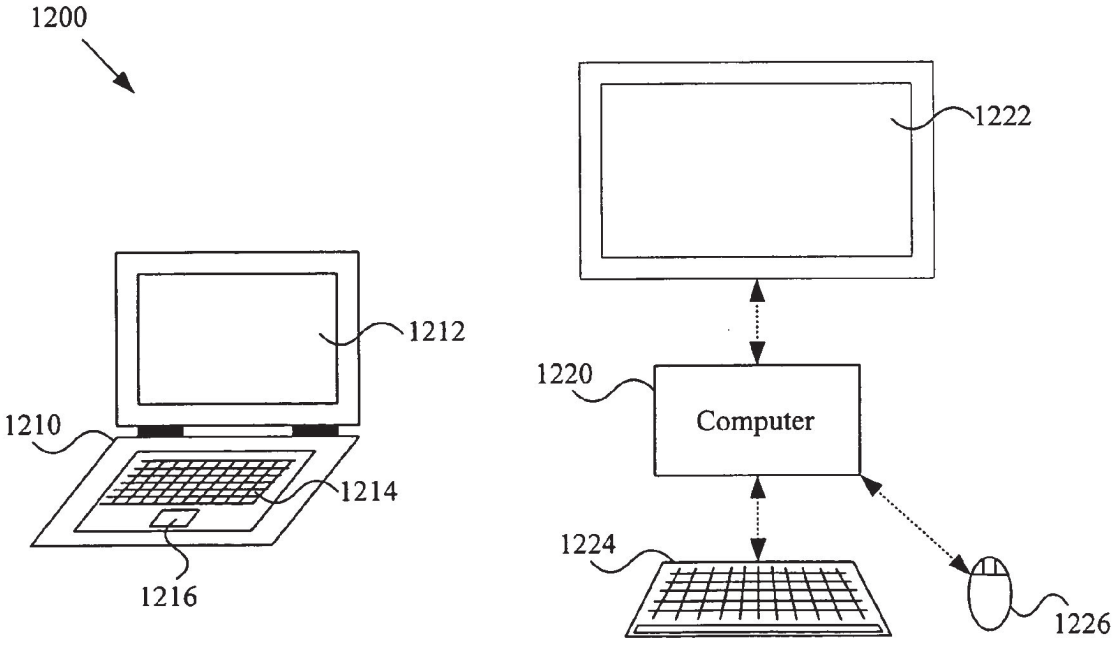


Figure 12

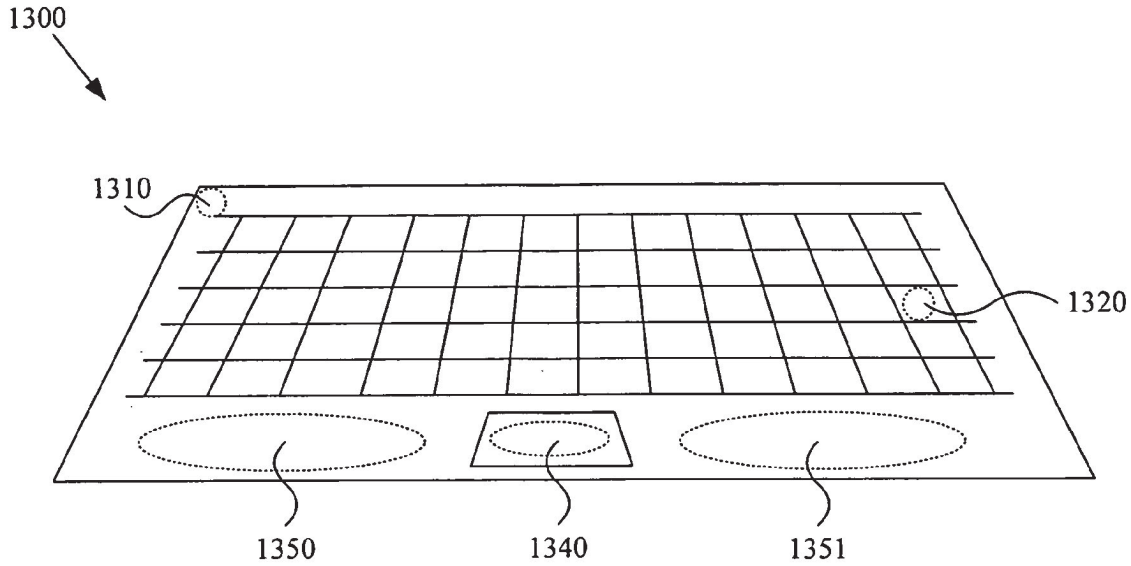


Figure 13

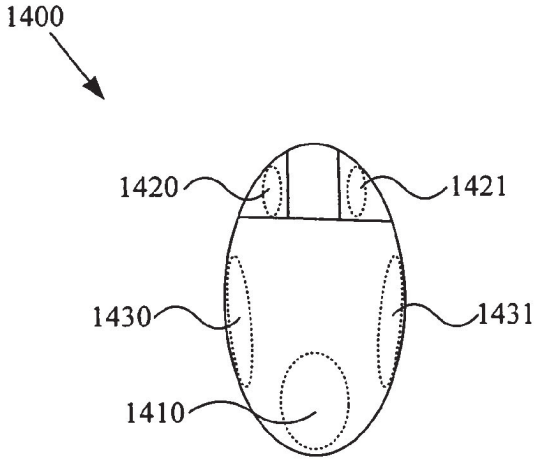


Figure 14

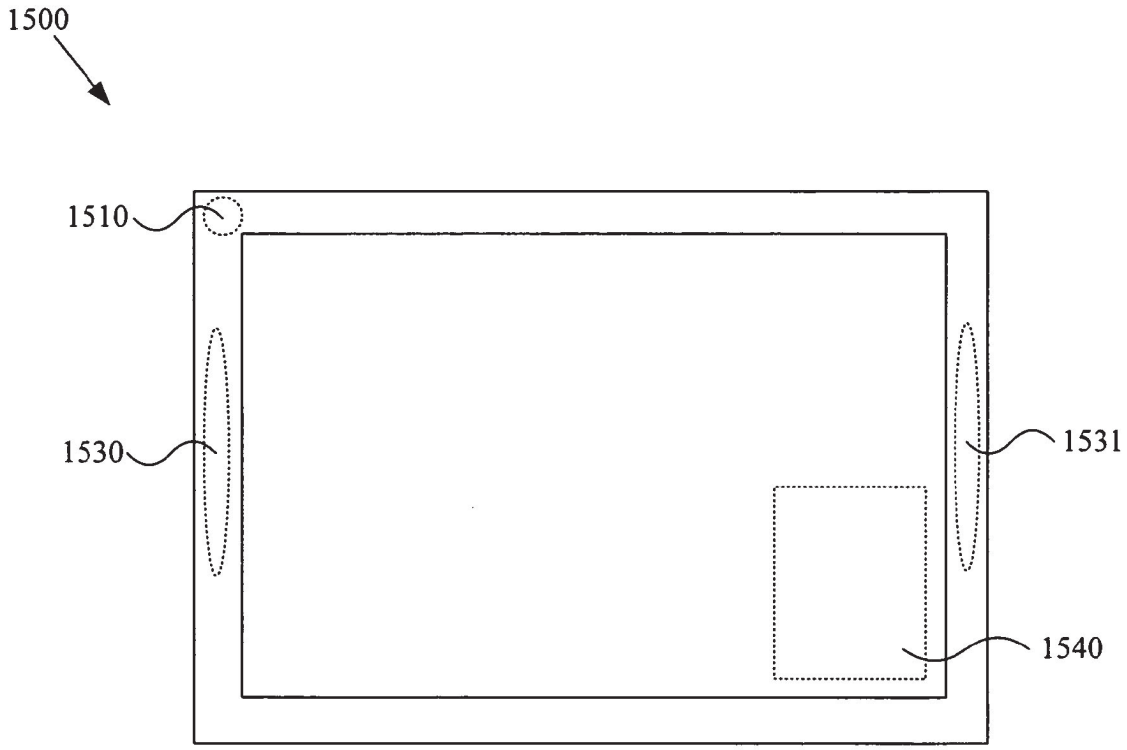


Figure 15

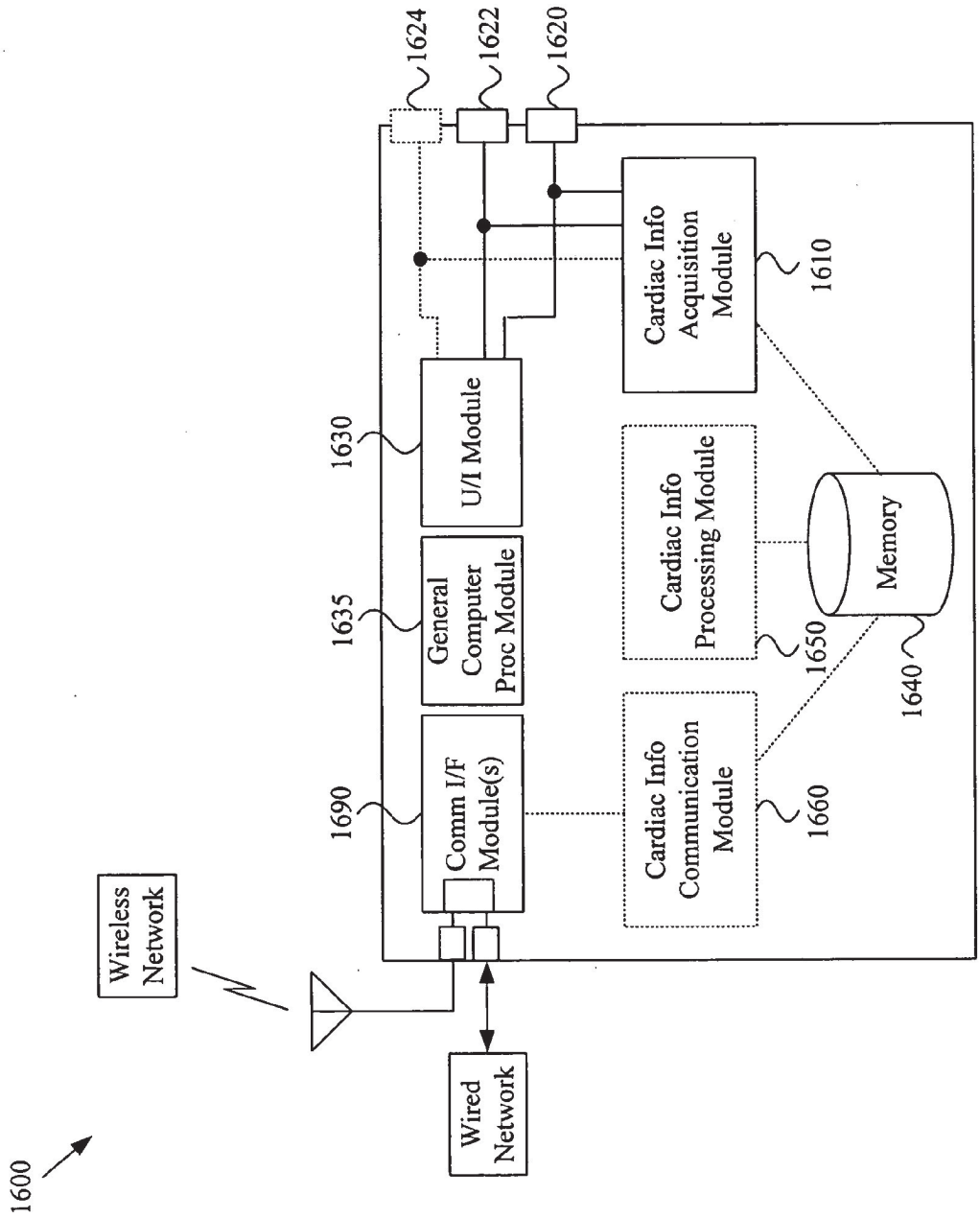

1600
Wireless Network
Wired Network
1690
Comm I/F Module(s)
1635
General Computer Proc Module
1630
U/I Module
1624
1622
1620
Cardiac Info Acquisition Module
1610
Cardiac Info Processing Module
1650
Cardiac Info Communication Module
1660
Memory
1640

Figure 16

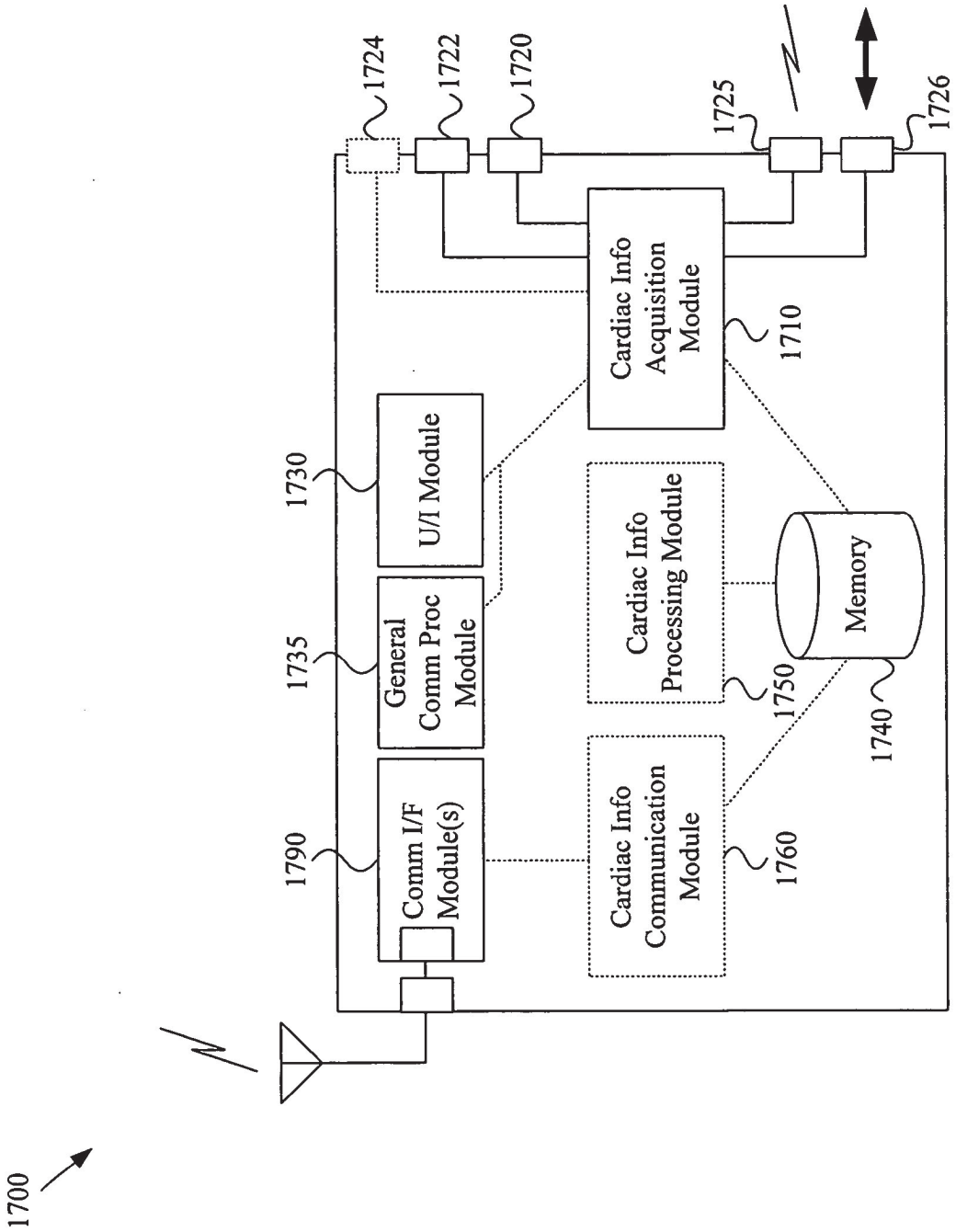

1700
1724
1722
1720
1725
1726
Cardiac Info Acquisition Module
1710
1730
U/I Module
1735
General Comm Proc Module
1790
Comm I/F Module(s)
Cardiac Info Processing Module
1750
Memory
1740
Cardiac Info Communication Module
1760

Figure 17

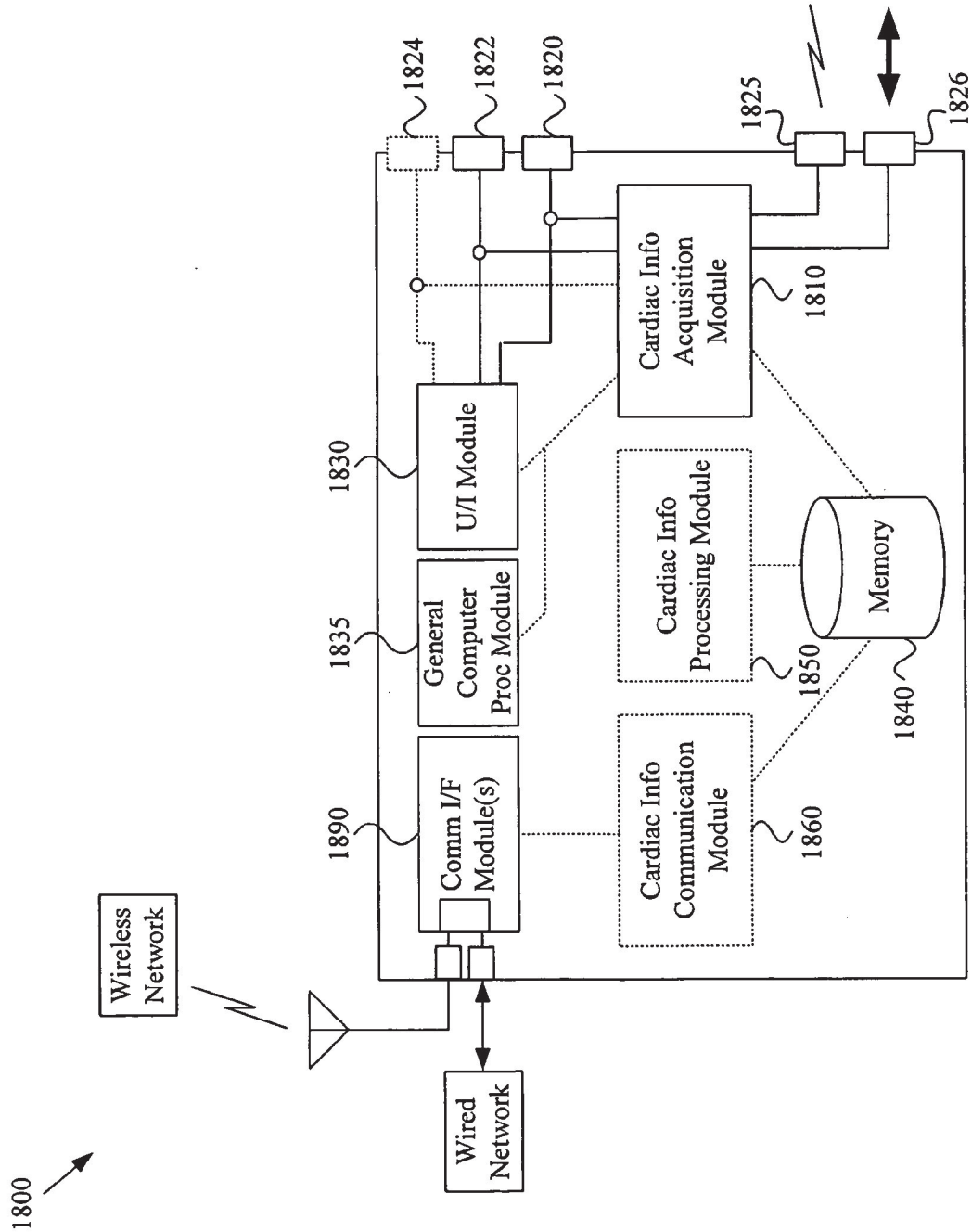

1800
Wireless Network
Wired Network
Comm I/F Module(s)
1890
General Computer Proc Module
1835
U/I Module
1830
1824
1822
1820
Cardiac Info Communication Module
1860
Cardiac Info Processing Module
1850
Memory
1840
Cardiac Info Acquisition Module
1810
1825
1826

Figure 18

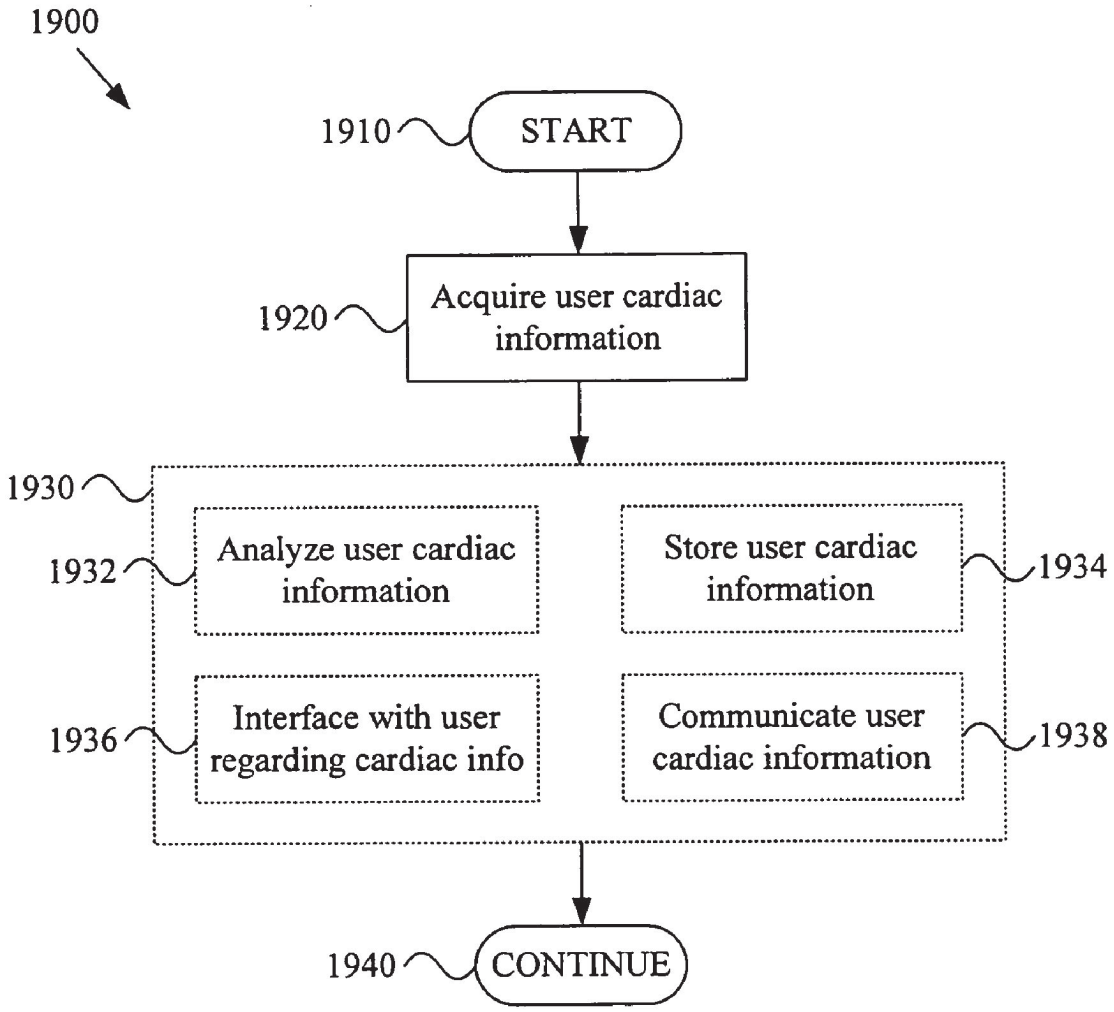

1900
1910
START
1920
Acquire user cardiac information
1930
1932
Analyze user cardiac information
1934
Store user cardiac information
1936
Interface with user regarding cardiac info
1938
Communicate user cardiac information
1940
CONTINUE

Figure 19

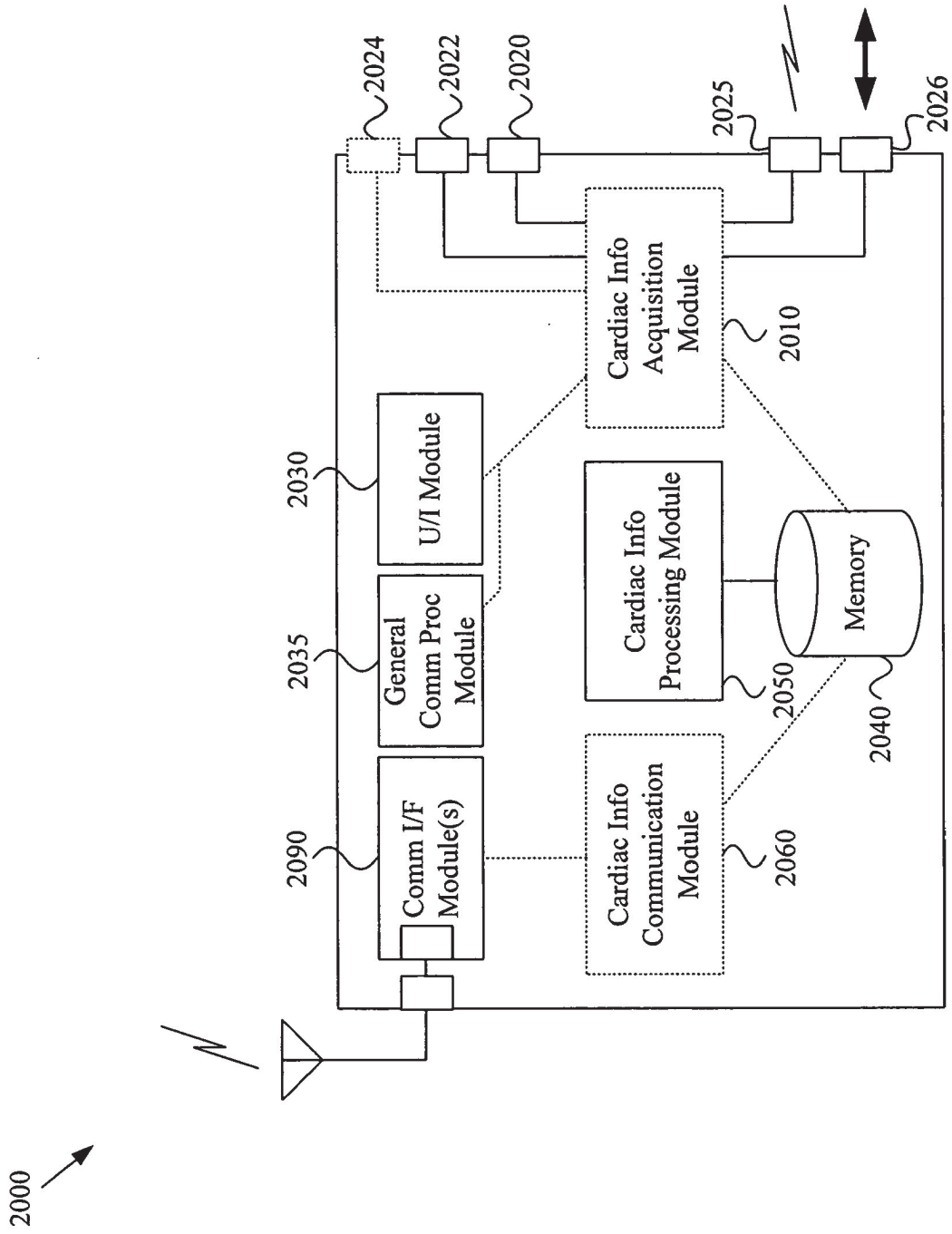

2000
2024
2022
2020
2025
2026
Cardiac Info Acquisition Module
2010
U/I Module
2030
General Comm Proc Module
2035
Cardiac Info Processing Module
Memory
2050
2040
Comm I/F Module(s)
2090
Cardiac Info Communication Module
2060

Figure 20

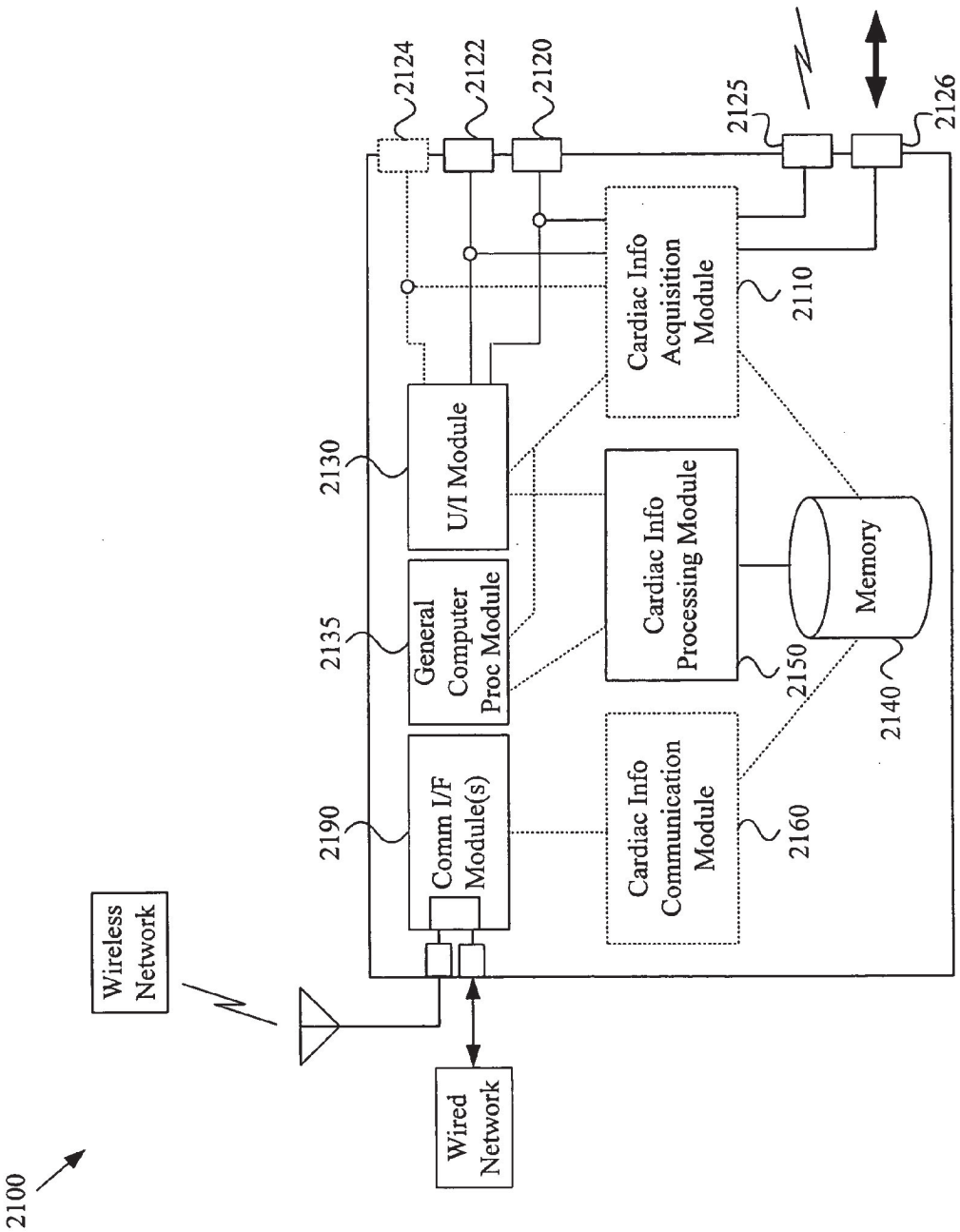

2100
Wireless Network
Wired Network
2190
Comm I/F Module(s)
2135
General Computer Proc Module
2130
U/I Module
2160
Cardiac Info Communication Module
2150
Cardiac Info Processing Module
2140
Memory
2110
Cardiac Info Acquisition Module
2124
2122
2120
2125
2126

Figure 21

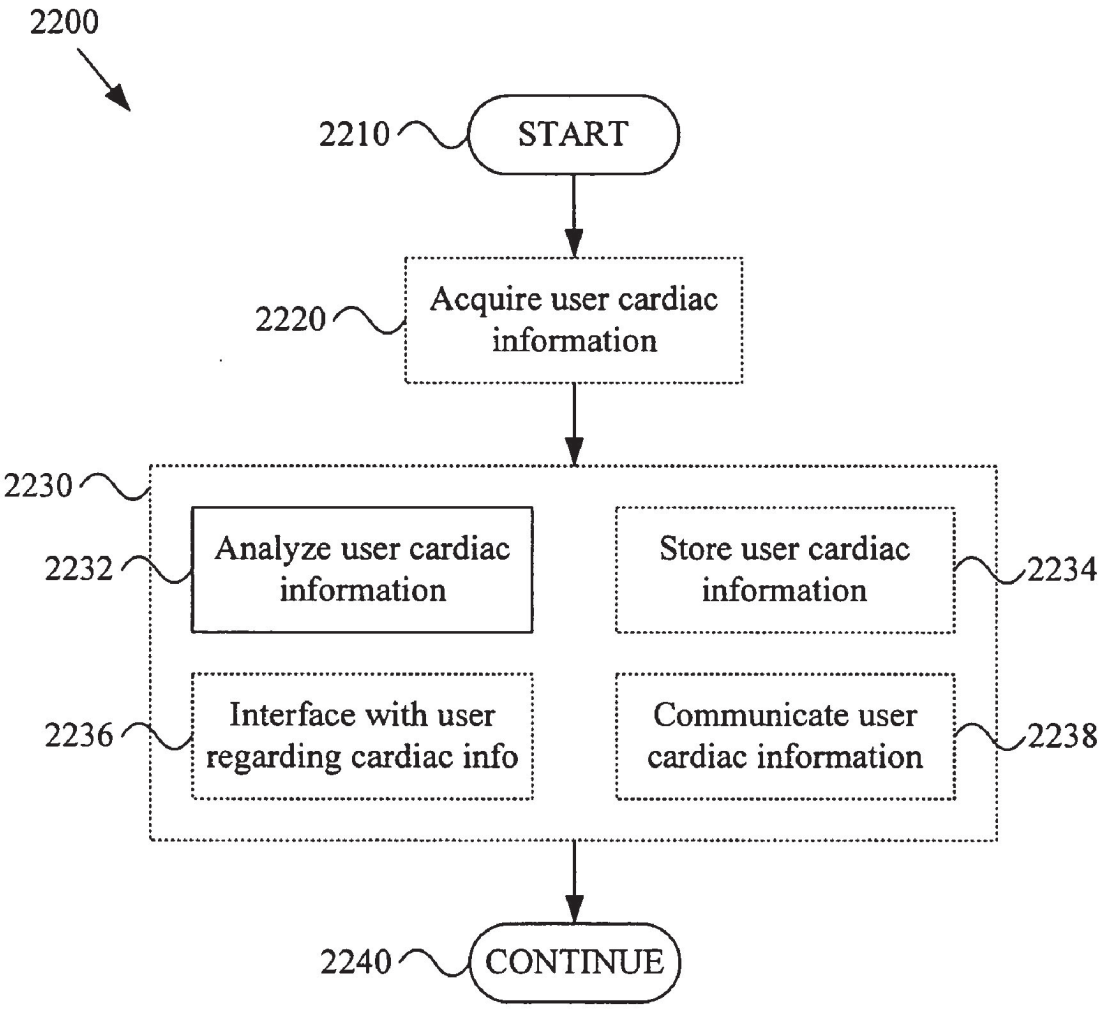

2200
2210
START
2220
Acquire user cardiac information
2230
2232
Analyze user cardiac information
Store user cardiac information
2234
2236
Interface with user regarding cardiac info
Communicate user cardiac information
2238
2240
CONTINUE

Figure 22

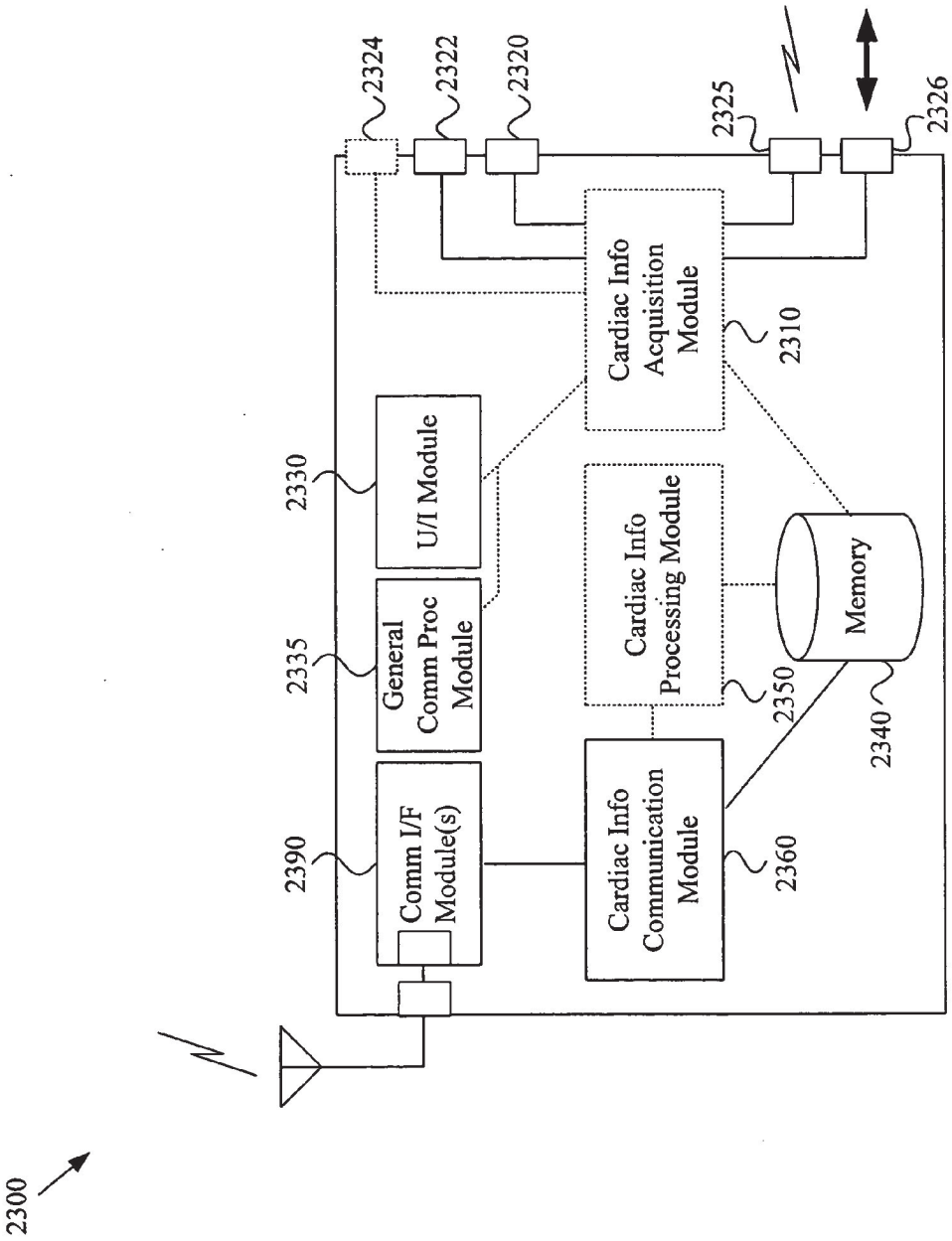

2300
2324
2322
2320
2325
2326
Cardiac Info Acquisition Module
2310
U/I Module
2330
General Comm Proc Module
2335
Cardiac Info Processing Module
2350
Memory
2340
Comm I/F Module(s)
2390
Cardiac Info Communication Module
2360

Figure 23

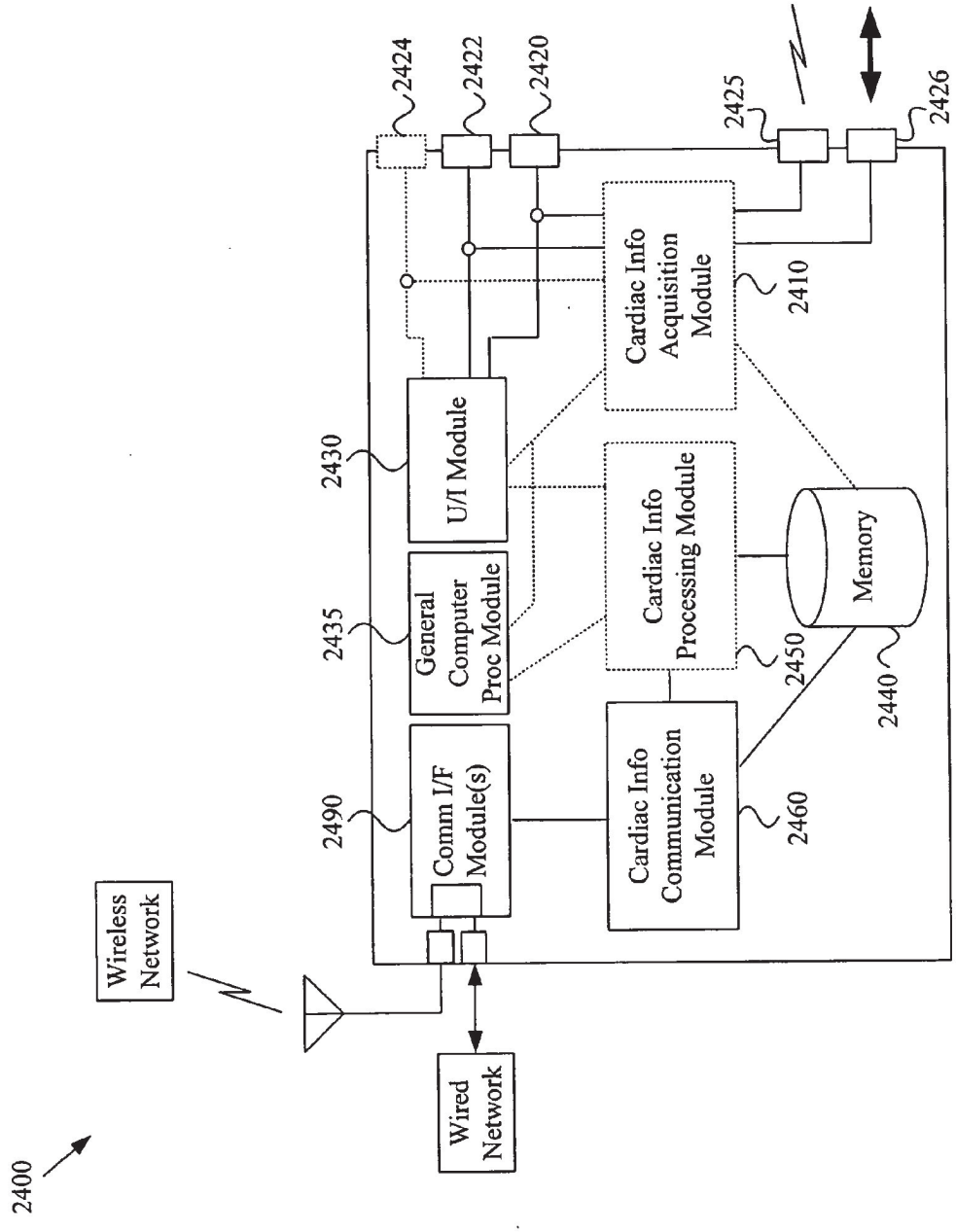

2400
Wireless Network
Wired Network
2490
Comm I/F Module(s)
2435
General Computer Proc Module
2430
U/I Module
2424
2422
2420
2425
2426
Cardiac Info Acquisition Module
2410
Cardiac Info Processing Module
2450
Memory
2440
Cardiac Info Communication Module
2460

Figure 24

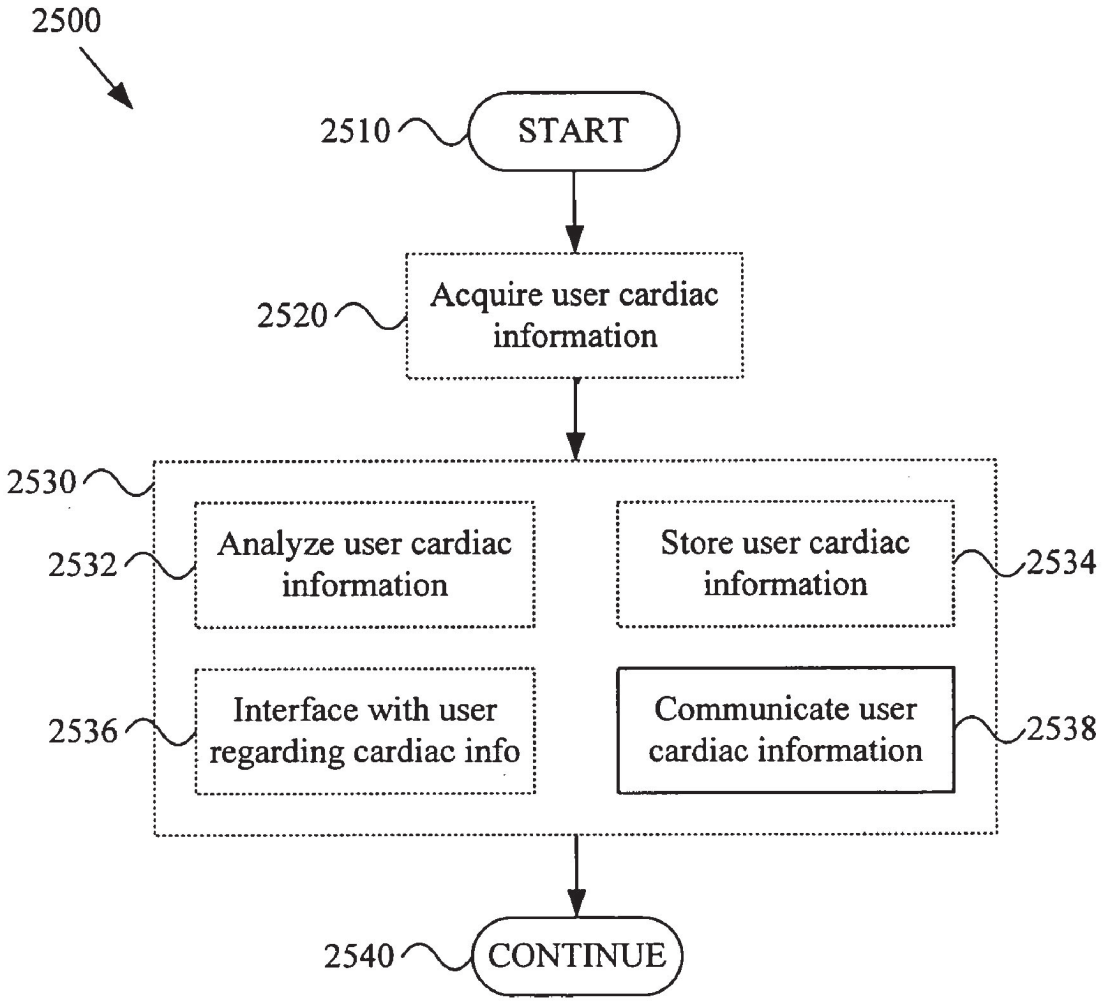

2500
2510
START
2520
Acquire user cardiac information
2530
2532
Analyze user cardiac information
Store user cardiac information
2534
2536
Interface with user regarding cardiac info
Communicate user cardiac information
2538
2540
CONTINUE

Figure 25

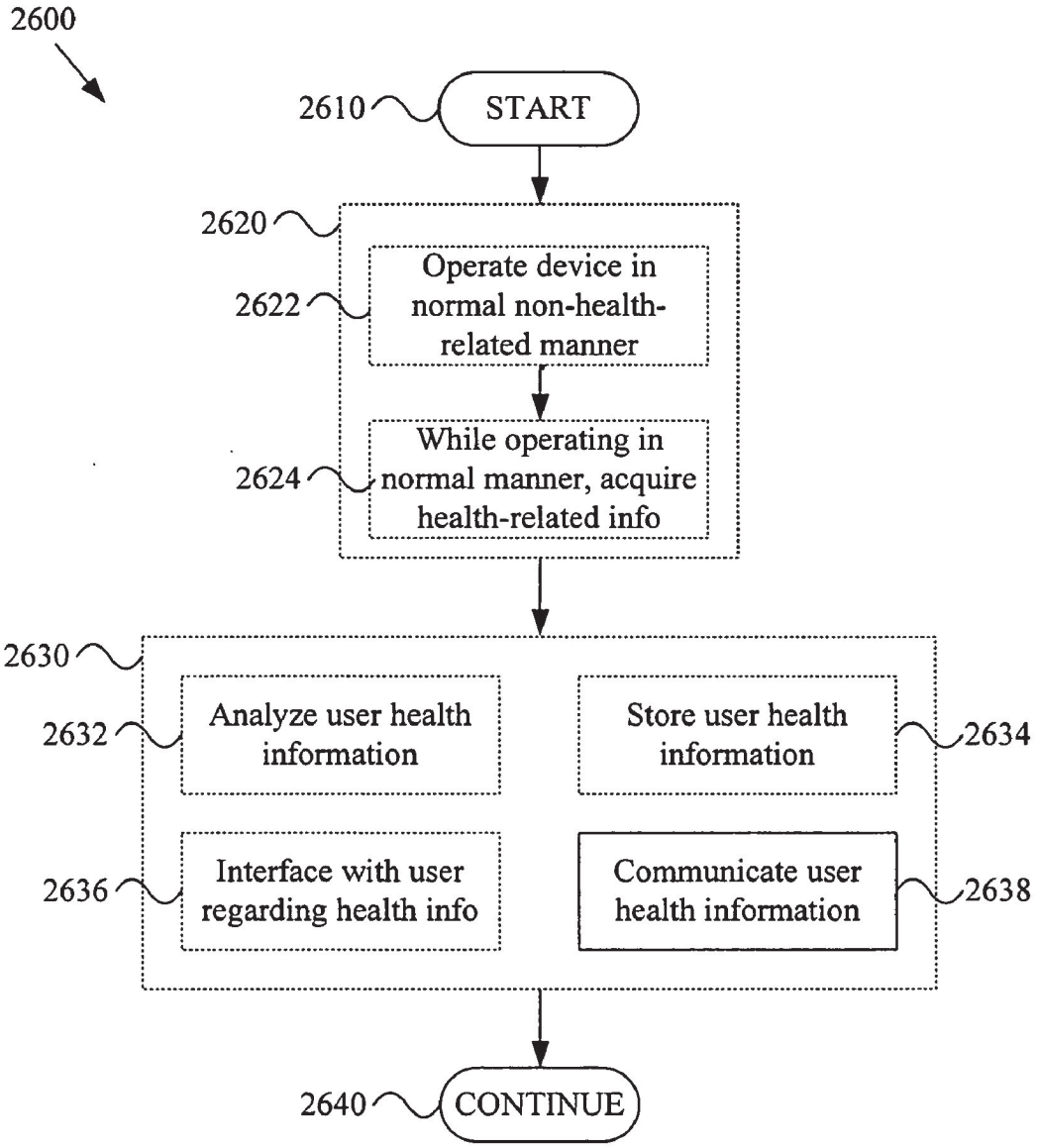

2600
2610
START
2620
Operate device in normal non-health-related manner
2622
While operating in normal manner, acquire health-related info
2624
2630
Analyze user health information
2632
Store user health information
2634
Interface with user regarding health info
2636
Communicate user health information
2638
2640
CONTINUE

Figure 26

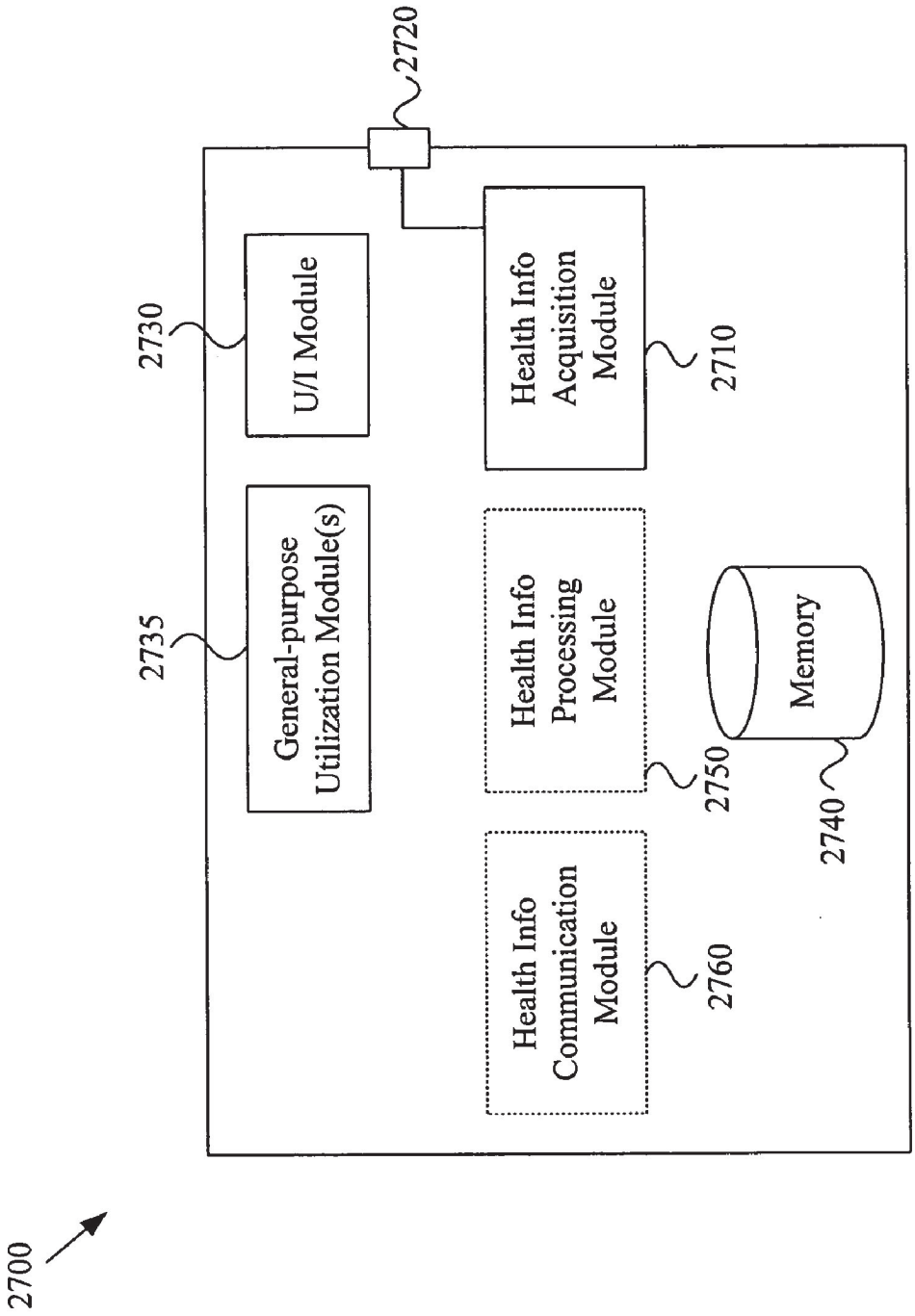

2700
2720
2730
U/I Module
2735
General-purpose Utilization Module(s)
Health Info Acquisition Module
2710
Health Info Processing Module
2750
Memory
2740
Health Info Communication Module
2760

Figure 27

MOBILE COMMUNICATION DEVICE AND OTHER DEVICES WITH CARDIOVASCULAR MONITORING CAPABILITY

BACKGROUND OF THE INVENTION

[0001] A substantial portion of cardiovascular problems exhibit detectable symptoms. In various scenarios where an individual is being monitored, medical assistance may be obtained based on monitored heart beat characteristics before a particular heart problem becomes fatal.

[0002] Present cardiovascular monitoring systems are cumbersome and inconvenient. Additionally, in most fatal incidents involving various cardiovascular pathologies, the individual had no prior knowledge of any cardiac issues that would have caused the individual to seek medical assistance and possibly obtain dedicated heart monitoring apparatus.

[0003] Further limitations and disadvantages of conventional and traditional approaches will become apparent to one of skill in the art, through comparison of such systems with the present invention as set forth in the remainder of the present application with reference to the drawings.

BRIEF SUMMARY OF THE INVENTION

[0004] Various aspects of the present invention provide a mobile communication device, general-purpose computer user interface device, and other electronic devices with cardiovascular monitoring capability.

[0005] These and other advantages, aspects and novel features of the present invention, as well as details of illustrative aspects thereof, will be more fully understood from the following description and drawings.

BRIEF DESCRIPTION OF SEVERAL VIEWS OF THE DRAWINGS

[0006] FIG. **1** is a diagram illustrating an exemplary mobile communication device, in accordance with various aspects of the present invention.

[0007] FIG. **2** is a block diagram illustrating exemplary electrodes, in accordance with various aspects of the present invention.

[0008] FIG. **3** is a block diagram illustrating exemplary electrodes, in accordance with various aspects of the present invention.

[0009] FIG. **4** is a diagram illustrating an exemplary mobile communication device, in accordance with various aspects of the present invention.

[0010] FIG. **5** is a diagram illustrating an exemplary mobile communication device, in accordance with various aspects of the present invention.

[0011] FIG. **6** is a diagram illustrating an exemplary mobile communication device, in accordance with various aspects of the present invention.

[0012] FIG. **7** is a diagram illustrating an exemplary mobile communication device, in accordance with various aspects of the present invention.

[0013] FIG. **8** is a diagram illustrating an exemplary mobile communication device, in accordance with various aspects of the present invention.

[0014] FIG. **9** is a diagram illustrating an exemplary mobile communication device, in accordance with various aspects of the present invention.

[0015] FIG. **10** is a block diagram illustrating portions of an exemplary mobile communication device, in accordance with various aspects of the present invention.

[0016] FIG. **11** is a diagram illustrating portions of an exemplary computer system and/or user interface device, in accordance with various aspects of the present invention.

[0017] FIG. **12** is a diagram illustrating exemplary general-purpose computer user interface devices, in accordance with various aspects of the present invention.

[0018] FIG. **13** is a diagram illustrating an exemplary general-purpose computer keyboard, in accordance with various aspects of the present invention.

[0019] FIG. **14** is a diagram illustrating an exemplary general-purpose computer mouse, in accordance with various aspects of the present invention.

[0020] FIG. **15** is a diagram illustrating an exemplary video display device, in accordance with various aspects of the present invention.

[0021] FIG. **16** is a block diagram illustrating exemplary computer and/or general-purpose computer user interface device modules, in accordance with various aspects of the present invention.

[0022] FIG. **17** is a block diagram illustrating various portions of an exemplary mobile communication device, in accordance with various aspects of the present invention.

[0023] FIG. **18** is a block diagram illustrating various portions of an exemplary computer system, in accordance with various aspects of the present invention.

[0024] FIG. **19** is a flow diagram illustrating an exemplary method, in a mobile communication device or other device, for acquiring cardiac information of a user, in accordance with various aspects of the present invention.

[0025] FIG. **20** is a block diagram illustrating various portions of an exemplary mobile communication device, in accordance with various aspects of the present invention.

[0026] FIG. **21** is a block diagram illustrating various portions of an exemplary computer system, in accordance with various aspects of the present invention.

[0027] FIG. **22** is a block diagram illustrating an exemplary method, in a mobile communication device or other device, for analyzing cardiac information of a user, in accordance with various aspects of the present invention.

[0028] FIG. **23** is a block diagram illustrating various portions of an exemplary mobile communication device, in accordance with various aspects of the present invention.

[0029] FIG. **24** is a block diagram illustrating various portions of an exemplary computer system, in accordance with various aspects of the present invention.

[0030] FIG. **25** is a block diagram illustrating an exemplary method, in portable communication device or other device, for communicating cardiac information, in accordance with various aspects of the present invention.

AliveCor Exhibit 1005
AliveCor, Inc. v. Apple Inc.
IPR2023-00950, U.S. Patent No. 10,076,257
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[0031] FIG. **26** is a block diagram illustrating an exemplary method, in an electronic device, for communicating cardiac information, in accordance with various aspects of the present invention.

[0032] FIG. **27** is a block diagram illustrating various portions of an exemplary electronic device, in accordance with various aspects of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0033] FIG. **1** is a diagram illustrating an exemplary mobile communication device **100** in accordance with various aspects of the present invention. The mobile communication device **100** may comprise characteristics of any of a large variety of mobile communication devices (e.g., general-purpose mobile communication devices). For example and without limitation, the mobile communication device **100** may comprise characteristics of a cellular or portable telephone. The mobile communication device **100** may, for example, comprise characteristics of a personal digital assistant with mobile communication capability, portable email device, pager, etc. The scope of various aspects of the present invention should not be limited by characteristics of any particular mobile communication device (e.g., a general-purpose mobile communication device).

[0034] The exemplary mobile communication device **100** ("MCD") may comprise a main body portion **110**. The MCD **100** may also comprise various user input features, for example, a microphone **120** and various pushbuttons. Such pushbuttons may, for example and without limitation, comprise a send button **130**, an end button **132**, a menu button **134**, a scroll button **136**, a numeric button **138** and a volume control button **139**. The MCD **100** may also comprise various user output features, for example, a display **140** (which may also function as a touch screen input feature) and a speaker **142**. Various input and output features of the exemplary MCD **100** will be discussed below. It should be recognized that various aspects of the present invention should not be limited by characteristics of the particular user input and output features illustrated in FIG. **1**. Various aspects of the present invention are readily extensible to other MCD features.

[0035] The exemplary mobile communication device **100** may comprise at least one cardiac sensor (e.g., one or more electrodes, an audio monitoring or acoustical detection device, etc.) that is adapted to detect cardiac activity of a user of the MCD **100**. Such electrodes may, for example, be adapted to detect cardiac activity of a user that is conductively coupled to the electrodes (e.g., by touching the electrodes). Such electrodes may be incorporated into the MCD **100** in any of a variety of manners. The following discussion will present various exemplary electrode placements.

[0036] The following discussion will generally discuss cardiac sensing electrodes. Note, however, that various aspects of the present invention also apply to other cardiac sensors (e.g., audio monitoring devices). In a non-limiting exemplary scenario, the microphone **120** of the mobile communication device **100** may be utilized as a cardiac sensor. In another non-limiting exemplary scenario, an audio sensor or detector may be disposed in any of a number of locations of the mobile communication device **100**, examples of which will be provided in the following electrode placement discussion.

[0037] Electrodes may generally comprise conductive material. For example, an electrode may comprise a metallic surface exposed for user contact. Also for example, an electrode may be formed from conductive plastic (or another material) that may be integrated into various molded components of the mobile communication device. For example, various conductive plastics (e.g., graphite-impregnated plastic or the like) may provide sufficient conductivity for an electrode to perform adequately. It should be recognized that the scope of various aspects of the present invention should not be limited by characteristics of particular electrodes or electrode placements.

[0038] Electrodes (or other sensors) may be shaped, positioned or formed with various physical features to enhance collection of cardiovascular information from a user. For example and without limitation, an electrode may comprise one or more projections to enhance conductive contact with a user. Also, an electrode may comprise one or more depressions or indentations to enhance conductive contact with a user.

[0039] Electrodes may also be identified for the user in any of a variety of manners or may be generally concealed from the user. For example and without limitation, as provided in non-limiting examples in FIG. **3**, an electrode may comprise a visible or tactile indicium to indicate the location of the electrode to a user. For example, the first pushbutton **310** comprises a heart-shaped indium **312** (or other visible characteristic) to notify a user of the location of the electrode and also the function of the electrode. Also for example, the second pushbutton **320** comprises a circular projection (or other tactile characteristic) to notify a user of the location of the electrode. In general, the location and/or function of an electrode may be identified to a user in any of variety of manners.

[0040] As mentioned above, in various non-limiting configurations, an electrode (or all electrodes) or other sensor may be substantially concealed (or hidden) from a user. For example and without limitation, an electrode may comprise molded conductive plastic with little or no visible indication of the electrode presence. In various exemplary scenarios, a user need not be aware of the presence of the electrode.

[0041] In general, one or more electrodes (or other sensors) may be positioned such that the one or more electrodes contact a user during normal (or typical) use of the MCD **100**. Such normal use may, for example, comprise talking on a telephone, reading messages, perusing a phone book, typing a message, initiating a phone call, sending an email message, entering information in a notepad, etc.).

[0042] For example, an electrode (or other sensor) may be disposed on a pushbutton of the MCD **100**. As illustrated in FIG. **1**, an electrode may be disposed on any, any combination of, or all of alphanumeric pushbuttons (e.g., pushbutton **138**), a send button **130**, an end button **132**, a menu button **134**, a scroll button **136** (or other cursor moving feature, for example, a touch pad, thumbwheel, track ball, eraser tip controller, etc.), a volume control button **139** (or other volume-control feature), etc. Such electrode placement may, for example, provide for electrode contact with a user while the user is pushing a particular one or more pushbuttons.

[0043] Also for example, an electrode (or other sensor) may be placed on a main body portion **110** of the MCD **100**. For example, such a main body portion **110** may comprise the portion of the MCD **100** that is generally held in the hand during normal use of the MCD **100**. As will be shown in later figures, one or more electrodes may be placed on side or rear portions of the main body portion **100**. Such placement may, for example, provide for electrode contact with a user's hand during use of the MCD **100**.

[0044] Further for example, an electrode (or other sensor) may be placed on (or proximate to) an audio output portion **142** (e.g., a speaker) of the MCD **100**. Such a placement may, for example, provide for electrode contact with an ear or cheek of a user of the MCD **100**. Also for example, an electrode may be disposed on a video display device **140** (e.g., a border of the display or integrated into a touch screen).

[0045] A plurality of electrodes (or other sensors) may be disposed in any of a variety of locations, non-limiting examples of dual-electrode placement will now be presented. For example, first and second electrodes may be disposed on a main body portion **110** of the MCD **100**. FIG. **4** provides a non-limiting example of such electrode placement. The mobile communication device **400** illustrated in FIG. **4** may comprise a left side portion **410** and a right side portion **420**. A first electrode may, for example, be placed on the left side portion **410** (e.g., placed on or molded into region **410***b*), and a second electrode may, for example, be placed on the right side portion **420** (e.g., placed on or molded into region **420***b*). In various exemplary configurations (e.g., where regions **410***b* and **420***b* include conductive plastic), an insulating region **415** may separate regions **410***b* and **420***b*.

[0046] In another exemplary configuration, electrodes may be disposed on a main body portion **110** of the MCD **100** and a pushbutton (e.g., **130**, **132**, **134**, **136**, **138** and **139**) of the MCD **100**. FIG. **5** provides a non-limiting example of such electrode placement. The mobile communication device **500** illustrated in FIG. **5** may comprise a first electrode **510** positioned on a send button, and a second electrode disposed on the back **520** of the mobile communication device **500**.

[0047] In yet another exemplary configuration, electrodes may be disposed on a same pushbutton of the mobile communication device **100**. In such an exemplary configuration, a user may, for example, contact both electrodes while operating the pushbutton. FIG. **2** provides non-limiting examples of such placement. A first exemplary pushbutton **210** comprises a single electrode **212** (e.g., metallic or conductive plastic) disposed on the pushbutton **210**. An entire second exemplary pushbutton **220** may serve as an electrode. For example, such a pushbutton **220** may be metallic or may be molded from conductive plastic. A third exemplary pushbutton **230** comprises a first electrode **232** and a second electrode **234** disposed on the exemplary pushbutton **230**. A fourth exemplary pushbutton **240** comprises a first electrode **242** (e.g., a first conductive plastic region) and a second electrode **244** (e.g., a second conductive plastic region) separated by an insulating portion **243** (e.g., non-conductive plastic). A fifth exemplary pushbutton **250** comprises a first electrode **252** and a second electrode **254** shaped and disposed as concentric rings on the exemplary pushbutton **250**.

[0048] It should be recognized that the exemplary pushbuttons **210-250** illustrated in FIG. **2** are merely exemplary, and accordingly, the scope of various aspects of the present invention should not be limited by particular characteristics of the exemplary pushbuttons **210-250**.

[0049] In another non-limiting exemplary configuration, a first electrode may be disposed on a first pushbutton of the MCD **100**, and a second electrode may be disposed on a second pushbutton of the MCD **100**. Such placement may, for example, provide for a user to be generally contacting at least one of the first and second electrodes during use of a keypad. Also such placement may, for example, provide for convenient access for a user to contact both the first and second electrodes simultaneously (e.g., with different hands or different fingers).

[0050] In a further non-limiting exemplary configuration, a first electrode may be disposed on a handheld portion of the MCD **100**, and a second electrode may be disposed on (or proximate) an earpiece of the MCD **100**. FIG. **6** provides a non-limiting illustration of such placement. For example, the mobile communication device **600** may comprise a main body portion **620** and an audio output portion **610** (e.g., an earpiece). A first electrode may be disposed on the main body portion **620** (e.g., molded into the main body portion **620** or positioned on the main body portion **620**). A second electrode may be disposed on the audio output portion **610** (e.g., molded into the audio output portion **610** or positioned on the audio output portion **610**). Such electrode placement may, for example, provide for user contact with both electrodes during the process of listening to the MCD **100**.

[0051] Though the previous exemplary illustrations generally discuss one or two electrodes, it should be recognized that more than two electrodes might also be utilized. For example, the MCD **100** may be adapted to detect cardiac activity of a user that is conductively coupled to at least two of a first, second and third (or N) electrodes.

[0052] In general, one or more electrodes may be disposed in any of a variety of locations on the MCD **100** and related components (e.g., peripheral components). Accordingly, the scope of various aspects of the present invention should not be limited by characteristics of any particular electrode placement.

[0053] As illustrated in FIG. **7**, a mobile communication device **700** may comprise a main body portion **710** and a second portion **720** that is separate from the main body portion **710**. For example and without limitation, such a second portion **720** may comprise characteristics of a headset, earphone, microphone or other hands-free mechanism (or adapter). In the non-limiting exemplary illustration in FIG. **7**, the second portion **720** may comprise an earpiece comprising an electrode **722** (or other sensor). In such an exemplary configuration, an electrode need not necessarily be placed on or near the main portion **710** of the mobile communication device **700**.

[0054] As illustrated in FIG. **8**, a mobile communication device **800** may comprise a main body portion **810** and a second portion **820** that is separate from the main body portion **810**. For example and without limitation, such a second portion **820** may comprise characteristics of a headset, earphone, microphone or other hands-free mechanism (or adapter). In the non-limiting exemplary illustration in

FIG. **8**, the second portion **820** may comprise at least a first electrode **822** and a second electrode **824** (or other sensor arrangement), information from which may be wirelessly communicated to the main body portion **810**.

[**0055**] As mentioned previously, a mobile communication device may comprise characteristics of any of a variety of mobile communication devices. Though the previous illustrations were generally directed to an illustrative mobile telephone, the scope of various aspects of the present invention should by no means be limited by characteristics of a mobile telephone. For example and without limitation, FIG. **9** is a diagram illustrating an exemplary mobile communication device **900** in accordance with various aspects of the present invention. The exemplary mobile communication device **900** may generally comprise characteristics of a portable email device or personal digital assistant.

[**0056**] The exemplary mobile communication device **900** may, for example and without limitation, share various characteristics with the exemplary mobile communication devices (or portions thereof) illustrated in FIGS. **1-8** and discussed previously. For example, the exemplary mobile communication device **900** may comprise a main body portion **910**, an audio input portion **920**, various pushbuttons (e.g., a space bar **932** and alphanumeric button **930**, an output display **940**, an audio output portion **942**, etc.). The exemplary mobile communication device **900** may also comprise a left side portion **940** and right side portion **942**. Analogous to the previously discussed mobile communication devices, the exemplary mobile communication device **900** may comprise one or more electrodes on any of a variety of components and in any of a variety of locations.

[**0057**] In another non-limiting exemplary scenario, a mobile communication device may be utilized in an automobile environment. For example and without limitation, an automobile may comprise a mobile communication device permanently, pseudo-permanently or temporarily located in the automobile. In such a scenario, one or more cardiac sensors may be positioned in locations within the automobile (e.g., in one or more positions in which a user may readily contact such sensors). For example and without limitation, one or more cardiac sensors (e.g., electrodes) may be disposed on a steering wheel, shifting lever or other commonly contacted automobile component. In one example, a first cardiac sensing electrode may be disposed on a left side of a steering wheel, and a second cardiac sensing electrode may be disposed on a right side of a steering wheel. In such an exemplary configuration, each of the left and right hands may advantageously contact respective cardiac sensors for extended periods of time and also during stressful situations. Also, in such an exemplary configuration, sensor information may, for example, be communicated (as exemplified in FIGS. **7** and **8**) to the mobile communication device by wire or wirelessly.

[**0058**] FIG. **10** is a block diagram illustrating an exemplary mobile communication device **1000** ("MCD") (or portions thereof) in accordance with various aspects of the present invention. Various exemplary modules will be addressed in more detail later. The exemplary MCD **1000** may, for example, comprise a first electrode **1020** and a second electrode **1022** (and, for example, a third or Nth electrode **1024**). Alternatively for example, the exemplary MCD **1000** may comprise any of a variety of sensors (e.g., audio sensors) for monitoring cardiac activity. The exemplary MCD **1000** may also comprise a cardiac information acquisition module **1010** that is coupled to the first and second electrodes **1020**, **1022** and utilizes the first and second electrodes **1020**, **1022** to detect and acquire various cardiac (i.e., heart-related) signals from a user.

[**0059**] The cardiac information acquisition module **1010** may then, for example, store acquired cardiac information in a memory **1040**. As will be explained later, the mobile communication device **1000** may also comprise a cardiac information processing module **1050** that processes acquired cardiac information and a cardiac information communication module **1060** that communicates acquired cardiac information or analysis results to another system. The exemplary mobile communication device **1000** is also illustrated with various general communication components, including a U/I module **1030**, general communication processing module **135** and communication interface module(s) **1090**.

[**0060**] Summarizing portions of the previous discussion, various aspects of the present invention provide a mobile communication device (and other electronic devices) with cardiovascular monitoring capability.

[**0061**] FIG. **11** is a diagram illustrating an exemplary computer system **1100**, including a computer **1110** and an exemplary general-purpose user interface device **1120**, in accordance with various aspects of the present invention. The exemplary general-purpose user interface device **1120** may, for example and without limitation, share various characteristics with the exemplary mobile communication devices, and portions thereof, illustrated in FIGS. **1-10** and discussed previously. The following discussion will generally refer to FIG. **11**, with occasional reference to FIGS. **12-15**.

[**0062**] The computer system **1110** may comprise characteristics of any of a variety of computer system types. For example and without limitation, the computer system **1110** may comprise characteristics of a desktop computer, laptop or notebook computer, handheld computer, mainframe computer, etc.

[**0063**] The general-purpose computer user interface device **1120** may generally be considered to be a computer user interface device like that typically utilized in general interaction with a computer. In other words, the general-purpose computer user interface device **1120** is not dedicated to the acquisition of cardiac information. For example and without limitation, as illustrated in FIGS. **12-15**, the user interface device **1120** may comprise characteristics of a keyboard or keypad, mouse, cursor control device, video I/O device, audio I/O device, gaming controller, or other computer user interface devices that are used during the course of general (or typical) user interaction with a computer.

[**0064**] The exemplary user interface device **1120** is illustrated with a non-limiting exemplary set of user interface components (or modules). For example, the user interface device **1120** may comprise a main body portion **1121** (e.g., a primary casing or housing for the user interface device).

[**0065**] The user interface device **1120** may also comprise one or more audio input/output devices **1122**. Such devices may, for example and without limitation, comprise speakers, earphones, headsets, microphones, etc. The user interface device **1120** may also comprise one or more video input/

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output devices **1124**. Such devices may, for example and without limitation, comprise video displays, CRTs, LCD displays, plasma displays, touch screen displays, etc.

[**0066**] The user interface device **1120** may also comprise one or more pushbuttons (e.g., the first pushbutton **1126** and second pushbutton **1127**). Such pushbuttons may comprise any of a variety of characteristics, some of which were discussed previously with regard to the pushbuttons of the mobile communication device (or portions thereof) illustrated in FIGS. **1-10**. The pushbuttons may, for example and without limitation, comprise keyboard or keypad keys, mouse buttons, volume controllers, scroll controllers, selection buttons, up/down or left/right arrows, etc.

[**0067**] The user interface device **1120** may also comprise one or more cursor control features **1128**. Such cursor control features **1128** may, for example and without limitation, comprise characteristics of a touch pad, mouse pad, eraser head controller, trackball, thumb wheel, etc. The user interface device **1120** may also comprise one or more hand rest portions **1129**. For example and without limitation, such hand rest portions **1129** may comprise palm or wrist contact points on a keyboard, a palm-resting place on a mouse, etc.

[**0068**] Various user interface features were discussed previously. Any one, combination of, or all of such user interface features may comprise one or more cardiac sensors (e.g., an electrode, plurality of electrodes, audio input device, etc.) that are adapted to detect cardiac activity of a user of the user interface device **1120**. For example, such electrodes may be adapted to detect cardiac activity of user that is conductively coupled to electrodes (e.g., by touching the electrodes). Various electrode characteristics were discussed previously with regard to the mobile communication device (and portions thereof) illustrated in FIGS. **1-10**. For the sake of brevity, only a portion of the previous discussion will be repeated here. It should be noted that various electrode characteristics discussed previously (e.g., electrode formation, placement, shape, size, integration, identification, numbers, features, etc.) apply to the user interface devices discussed herein as well as the mobile communication device(s) discussed previously.

[**0069**] For example, an electrode (or other sensor) may be disposed on a first pushbutton **1126** or second pushbutton **1127** of the user interface device **1120**. Also for example, an electrode may be disposed on a hand rest **1129**, hand-held portion and/or main body portion **1121** of the user interface device **1120**. Additionally for example, an electrode may be disposed on a side portion of the user interface device **1120** or on a portion of the user interface device **1120** that is separate from the main body portion **1121**. Further for example, an electrode may be disposed on a cursor control component **1128** of the user interface device **1120** (e.g., a touch pad, eraser-head cursor control feature, thumb wheel, trackball, active mouse pad, etc.). Still further for example, an electrode may be disposed on a volume control feature (e.g., of an audio input/output device **1122**) or on a touch screen (or other portion) of a video input/output device **1124**.

[**0070**] In general, one or more electrodes (or other sensors) may be disposed on the user interface device **1120** such that the electrodes contact a user during normal use of the user interface device. Such normal use may, for example and without limitation, comprise typing on a keyboard or keypad, listening to a headset, typing or entering information with pushbuttons, controlling a cursor, interacting with a monitor, utilizing a mouse, utilizing a game controller to play a video game, etc.

[**0071**] First and second (or more) electrodes (or other sensors) may be disposed in various positions relative to the user interface device **1120** and each other. For example and without limitation, a first electrode may be disposed on the main body portion **1121** of the user interface device **1120**, and a second electrode may also be disposed on the main body portion **1121** of the user interface device **1120**. Also for example, a first electrode may be disposed on the main body portion **1121** of the user interface device **1120**, and a second electrode may be disposed on a pushbutton **1126** of the user interface device **1120**. Further for example, a first electrode and second electrode may both be disposed on the first pushbutton **1126**. Still further for example, a first electrode may be disposed on the first pushbutton **1126**, and a second electrode may be disposed on the second pushbutton **1127**. In another example, first and/or second electrodes may be disposed on a feature of the general-purpose computer user interface device **1120** that is dedicated to detecting cardiac activity.

[**0072**] The previously discussed electrode placements are merely exemplary, and the scope of various aspects of the present invention should not be limited by characteristics of any particular electrode placement.

[**0073**] The following discussion will present various non-limiting exemplary general-purpose computer user interface devices. The purpose of such presentation is to provide specific illustrations of generally broader aspects of the present invention. Accordingly, the scope of various aspects of the present invention should not be limited by characteristics of the exemplary illustrations.

[**0074**] FIG. **12** is a diagram illustrating exemplary general-purpose computer user interface devices **1200**, in accordance with various aspects of the present invention. An exemplary desktop computer system **1220** comprises a display device **1222**, which may, for example, comprise a touch screen. The desktop computer system **1220** also comprises a keyboard **1224** and a mouse **1226**. The display device **1222**, keyboard **1224** and mouse **1226** are all examples of general-purpose computer user interface devices. The exemplary laptop computer system **1210** comprises a display **1212** (which may comprise touch screen capability), a keyboard **1214** and a touch pad **1216** for cursor control. The display **1212**, keyboard **1214** and touch pad **1216** are all examples of general-purpose computer user interface devices.

[**0075**] As with the various exemplary mobile communication devices (and portions thereof) illustrated in FIGS. **1-10** and discussed previously, though the following computer user interface device examples will generally refer to cardiac sensing electrodes, the scope of various aspects of the present invention readily extend to other cardiac sensing devices (e.g., audio monitoring or acoustical sensing devices).

[**0076**] FIG. **13** is a diagram illustrating an exemplary general-purpose computer keyboard **1300**, in accordance with various aspects of the present invention. The exemplary keyboard **1300** may, for example, comprise one or more cardiac sensors **1310** (e.g. electrodes and/or acoustic sensors) on a main body portion of the keyboard. For example, one

example, comprise an electrode on a first hand rest **1350** and/or an electrode on a second hand rest **1351**. The keyboard **1300** may also comprise an electrode **1340** disposed on a touch pad, and one or more electrodes **1320** disposed on a pushbutton (e.g., a key) of the keyboard **1300**.

[**0077**] FIG. **14** is a diagram illustrating an exemplary general-purpose computer mouse **1400**, in accordance with various aspects of the present invention. The exemplary mouse **1400** may, for example, comprise an electrode **1410** on a central main body portion of the mouse **1400**. Also for example, the mouse **1400** may comprise an electrode **1430** on a first side of the mouse **1400** and/or an electrode **1431** on a second side of the mouse **1400**. Further for example, the mouse **1400** may comprise one or more electrodes **1420** on a left-click pushbutton of the mouse **1400** and/or one or more electrodes **1421** on a right-click pushbutton of the mouse **1400**.

[**0078**] FIG. **15** is a diagram illustrating an exemplary computer display device **1500**, in accordance with various aspects of the present invention. The display device **1500** may, for example, comprise an electrode **1510** on a border portion of the display device **1500**. Also for example, the display device **1500** may comprise an electrode **1530** on a first side of the display device **1500** and/or an electrode **1531** on a second side of the display device **1500**. Further for example, the display device **1500** may comprise one or more electrodes **1540** on a touch screen portion of the display device **1500**.

[**0079**] Though not illustrated here, as discussed previously with regard to the mobile communication devices (or portions thereof) illustrated in FIGS. **1-10**, the user interface device may also comprise characteristics of a headset (e.g., including a speaker and/or microphone) or earpiece. Also for example, though not necessarily considered to be "general-purpose," various aspects of the present invention may be extended to various computer attachments, such as, for example, gaming controllers and various peripherals.

[**0080**] It should be recognized that various aspects of the present invention may also be applied to other electronic devices. For example, as mentioned previously, various gaming controllers (e.g., joysticks, consoles, firearm simulators, pads, pushbuttons, etc.) may comprise cardiac sensors disposed on commonly contacted components, which would enable the collection of cardiac information from a user of such devices. In such a non-limiting exemplary scenario, cardiac information obtained from such sensors may be utilized for health purposes and other purposes. For example and without limitation, information from various sensors (e.g., electrodes or acoustical sensors) disposed on a gaming control may be utilized to control operation of the video game. For example, information obtained from various sensors may reflect stress level, anxiety, relaxation, etc. A video game may then, for example, utilize such information to modify characteristics of a game to achieve a particular emotional or physical goal.

[**0081**] FIG. **16** is a block diagram illustrating an exemplary computer system **1600**, in accordance with various aspects of the present invention. The exemplary modules of the computer system **1600** are merely illustrative and should by no means limit the scope of various aspects of the present invention.

[**0082**] The exemplary computer system **1600** may, for example, comprise a first U/I device port **1620** (for coupling to a first U/I device comprising at least one cardiac electrode or other sensor) and a second U/I port **1622** (for coupling to a second U/I device comprising at least one cardiac electrode or other sensor). The exemplary computer system **1600** may also comprise a third U/I port **1624** or any number of U/I ports (some or all of which may be adapted to couple various modules to various user interface devices having one or more cardiac electrodes). The exemplary computer system **1600** may also comprise a cardiac information acquisition module **1610** that is coupled to the first and second U/I ports **1620**, **1622** and which utilizes various electrodes (or other sensors) of a first and/or second U/I interface device coupled to the first and/or second U/I ports **1620**, **1622** to detect and acquire various cardiac signals from a user. Note that one or more user interface modules **1630** may also be coupled to the U/I ports **1620**, **1622**, and **1624**.

[**0083**] The cardiac information acquisition module **1610** may then, for example, store acquired cardiac information in a memory **1640**. As will be explained later, the exemplary computer system **1600** may also comprise a cardiac information processing module **1650** that processes acquired cardiac information and a cardiac information communication module **1660** that communicates acquired cardiac information or analysis results to another system (e.g., through a communication interface module **1690**, either wired, tethered or wireless).

[**0084**] Summarizing portions of the previous discussion, various aspects of the present invention provide a general-purpose computer user interface device with cardiovascular monitoring capability.

[**0085**] FIG. **17** is a block diagram illustrating various portions of an exemplary mobile communication device **1700**, in accordance with various aspects of the present invention. The exemplary mobile communication device **1700** may, for example and without limitation, share various characteristics with the mobile communication devices, and other exemplary devices, illustrated in FIGS. **1-16** and discussed previously.

[**0086**] The exemplary mobile communication device **1700** ("MCD") may comprise characteristics of any of a variety of mobile communication devices, some of which were discussed previously. For example and without limitation, the MCD **1700** may comprise characteristics of a portable phone, cellular phone, portable email device, portable computer with mobile communication capability, paging device, etc.

[**0087**] The exemplary MCD **1700** may be adapted to acquire cardiac information from a user of the mobile communication device **1700**. The exemplary MCD **1700** may, for example, comprise a communication interface module **1790** (e.g., a general-purpose communication interface module). The communication interface module **1790** may, for example, be adapted to perform communications between the mobile communication device **1700** and one or more general communication -networks. The exemplary MCD **1700** may also comprise a general communication processing module **1735** that is generally adapted to support general communication between the MCD **1700** and one or more communication networks, and a user interface module **1730** that is generally adapted to provide a user interface between a user of the MCD **1700** and the MCD **1700**.

[**0088**] The exemplary MCD **1700** may also comprise a cardiac information acquisition module **1710** that is adapted

to acquire cardiac information from a user of the MCD **1700**. In a first non-limiting exemplary scenario, the cardiac information acquisition module **1710** may be adapted to interface with a cardiac sensor (e.g., electrodes or an acoustical sensor). Such a cardiac sensor may, for example, be disposed on the MCD **1700**. As a non-limiting example, the exemplary MCD **1700** may comprise a first electrode **1720** and a second electrode **1722** (e.g., and a third electrode **1724** or Nth electrode) disposed on the MCD **1700** (e.g., in a manner conducive to making contact with a user during normal use of the MCD **1700**). Various exemplary characteristics of such a cardiac sensor or electrodes were discussed previously.

[**0089**] As another non-limiting example, the exemplary MCD **1700** may comprise various cardiac sensor communication ports (e.g., the first cardiac sensor communication port **1725** and the second cardiac sensor communication port **1726**), which may, for example, be adapted to communicate with cardiac sensing components and/or circuits and systems separate from, and communicatively coupled to, the MCD **1700**. Such external cardiac sensing components may, for example, be disposed on various devices coupled to the MCD **1700** (e.g., user I/O components, hands-free components, etc.), some of which were discussed previously. In various non-limiting exemplary scenarios, such an external cardiac sensing component may also comprise characteristics of cardiac sensing devices disposed within the user's body (e.g., independently or combined with a pacemaker or defibrillator).

[**0090**] The cardiac information acquisition module **1710** may, for example, be adapted to communicate with any of a variety of cardiac sensing components and/or systems (e.g., through the cardiac sensor communication ports **1725**, **1726**). Such communication may, for example, be governed by standard and/or proprietary communication protocols. Non-limiting examples of such communication protocols may comprise Bluetooth, IEEE 802.11, UWB, IEEE 802.15, Zigbee, etc. Further for example, such communication may be governed, at least in part, by a propriety protocol that is customized for the communication of cardiac information. In general, the cardiac information acquisition module **1710** may utilize various communication ports (e.g., the first cardiac sensor communication port **1725** and second cardiac sensor communication port **1726**) to receive cardiac information over any of a variety of communication networks (e.g., LANs, PANs, WANs, the Internet, etc.).

[**0091**] The cardiac information acquisition module **1710** may, for example, be adapted to acquire cardiac information from a user of the MCD **1700** continually or in response to any of a variety of causes and conditions. For example and without limitation, the cardiac information acquisition module **1710** may be adapted to detect user interaction with a cardiac sensor, and acquire cardiac information in response to, at least in part, detecting user interaction with a cardiac sensor. For example, such user interaction may comprise a user of the MCD **1700** conductively contacting one or more cardiac monitoring electrodes.

[**0092**] Also for example, the cardiac information acquisition module **1710** may be adapted to detect an incoming communication (e.g., through a cardiac sensor communication port) regarding cardiac information, and acquire cardiac information in response to, at least in part, detecting such an incoming communication. Further for example, the cardiac information acquisition module **1710** may be adapted to detect use of the MCD **1700** by a user, and acquire cardiac information in response to, at least in part, detecting such use. The cardiac information acquisition module **1710** may, for example, be adapted to interface with the user interface module **1730** and/or the general communication processing module **1735** to determine when the MCD **1700** is being utilized by the user.

[**0093**] The cardiac information acquisition module **1710** may, for example, be adapted to periodically attempt to acquire cardiac information from a user or may be adapted to continually attempt to acquire such information. The cardiac information acquisition module **1710** may also, for example, be adapted to acquire cardiac information from a user governed by acquisition constraints or directives included in a profile (e.g., stored in the memory **1740**). Such a profile may, for example, include information-directing behavior of the cardiac information acquisition module **1710** (e.g., timing behavior, triggering behavior, sensor interface behavior, UI behavior, etc.).

[**0094**] The cardiac information acquisition module **1710** may, for example, be adapted to acquire cardiac information from a user of the MCD **1700** in response to a user command (e.g., as received through the user interface module **1730**). Additionally, for example, the cardiac information acquisition module **1710** may be adapted to acquire cardiac information from a user of the MCD **1700** in response to a command or request received from another communication system (e.g., through the communication interface module **1790** and/or the general communication processing module **1735**).

[**0095**] The cardiac information acquisition module **1710** may, for example, be adapted to acquire cardiac information from the user in any of a variety of manners. For example, the module **1710** may be adapted to utilize the user interface module **1730** to communicate with the user before, during and/or after the acquisition process. For example, the cardiac information acquisition module **1710** may utilize the user interface module **1730** to instruct the user about a procedure to follow or to provide results of cardiac information acquisition to the user.

[**0096**] In acquiring cardiac information, the cardiac information acquisition module **1710** may, for example, interact with one or more cardiac sensors (e.g., cardiac electrodes). Such interaction may, for example, comprise transmitting and/or receiving digital or analog signals. Such interaction may, for example, comprise digitally sampling received analog signals prior to digital storage, processing and/or communication. Such interaction may, for example, be generally governed by the nature (e.g., active or passive nature) of a particular cardiac sensor.

[**0097**] The cardiac information acquisition module **1710** may also, for example, be adapted to identify the user of the MCD **1700**. For example, such identification (or authentication) may be utilized in an exemplary scenario where a variety of users may be utilizing the MCD **1700**. In such an exemplary scenario, the acquisition module **1710** may be adapted to acquire cardiac information for a plurality of different users and to segment such information according to user identity.

[**0098**] After the acquisition of user cardiac information, the MCD **1700** may perform various additional functions,

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some of which will be discussed later. For example and without limitation, the MCD **1700** may store, analyze and/or communicate acquired cardiac information. For example, the cardiac information acquisition module **1710** may store acquired cardiac information (or a portion thereof) in the memory **1740**. Other modules of the MCD **1700** may then access such stored information from the memory **1740**. Such memory **1740** may, for example, comprise characteristics of volatile or non-volatile memory (e.g., so that cardiac information may be saved between powered-up sessions of the MCD **1700**). In a non-limiting exemplary scenario where the cardiac information acquisition module **1710** acquires cardiac information from a plurality of users, the acquisition module **1710** may store at least a portion of such acquired information in the memory **1740** (e.g., indexed by user identification).

[**0099**] The previous exemplary mobile communication device **1700** illustration was presented to provide specific illustrations of various generally broader aspects of the present invention. Various aspects of the present invention may also be applied to other electronic devices. For example and without limitation, a general-purpose computer may be adapted to be communicatively coupled to a general-purpose computer user interface device (e.g., as discussed previously) and comprise at least one module adapted to interface with such a general-purpose computer user interface device to acquire user cardiac information.

[**0100**] FIG. **18** is a block diagram illustrating various portions of an exemplary computer system **1800**, in accordance with various aspects of the present invention. The exemplary computer system **1800** may, for example and without limitation, share various characteristics with the exemplary computer system **1600** illustrated in FIG. **16** and discussed previously.

[**0101**] The exemplary computer system **1800** may, for example, comprise a first U/I device port **1820** (for coupling to a first U/I device comprising at least one cardiac sensor or electrode) and a second U/I device port **1822** (for coupling to a second U/I device comprising at least one cardiac sensor or electrode). The exemplary computer system **1800** may also comprise a third U/I device port **1824** or any number of U/I device ports (some or all of which may be adapted to couple various modules to various user interface devices having one or more cardiac sensors).

[**0102**] Similar to the exemplary mobile communication device **1700** of FIG. **17**, the exemplary computer system **1800** may comprise one or more cardiac information communication ports (e.g., the first cardiac communication port **1825** and the second cardiac communication port **1826**).

[**0103**] Similar to the exemplary mobile communication device **1700** of FIG. **17**, the exemplary computer system **1800** may also comprise a cardiac information acquisition module **1810** that may be coupled to the first and second U/I ports **1820**, **1822** and which utilizes various sensors or electrodes of a first and/or second U/I interface device coupled to the first and/or second U/I ports **1820**, **1822** to detect and acquire various cardiac signals from a user. The exemplary cardiac information acquisition module **1810** may also, for example, be coupled to the first and second cardiac communication ports **1825**, **1826** and adapted to receive cardiac information from various sensing devices transmitting such information. In general, the exemplary cardiac information acquisition module **1810** may share various characteristics with the cardiac information acquisition module **1710** of the exemplary mobile communication device **1700** illustrated in FIG. **17** and discussed previously.

[**0104**] FIG. **19** is a block diagram illustrating an exemplary method **1900**, in a mobile communication device (or other device), for acquiring cardiac information of a user, in accordance with various aspects of the present invention. The exemplary method **1900** may, for example and without limitation, share various functional characteristics with the exemplary mobile communication device **1700** and computer system **1800** illustrated in FIGS. **17-18** and discussed previously.

[**0105**] The exemplary method **1900** may begin executing at step **1910** for any of variety of reasons, some of which were discussed previously with regard to the MCD **1700** of FIG. **17**. The exemplary method **1900** may, at step **1920**, comprise acquiring user cardiac information (e.g., from a user of a mobile communication device or general-purpose computer user interface device). Such acquisition was generally discussed previously with regard to the MCD **1700** of FIG. **17** (e.g., the cardiac information acquisition module **1710** and various related modules).

[**0106**] The exemplary method **1900** may, at step **1930**, comprise performing various additional functions related to the cardiac information acquired at step **1920**. For example and without limitation, step **1932** may comprise analyzing at least a portion of acquired cardiac information. Various characteristics of such analysis will be discussed later. Also for example, step **1934** may comprise storing at least a portion of acquired cardiac information in a memory. Non-limiting examples of storage were discussed previously with regard to the cardiac information acquisition module **1710** and memory **1740** of the exemplary MCD of FIG. **17**. Further for example, step **1936** may comprise interfacing with a user regarding the acquired cardiac information. Non-limiting examples of such user interaction were discussed previously with regard to the cardiac information acquisition module **1710** and the U/I module **1730** of the exemplary MCD of FIG. **17**. Still further for example, step **1938** may comprise communicating acquired user cardiac information with other communication systems. Various characteristics of such communication will be discussed later.

[**0107**] The exemplary method **1900** may, at step **1940**, comprise performing any of a variety of continued processing. Such continued processing may, for example, comprise acquiring, communicating and/or analyzing additional cardiac information. Various non-limiting examples of such continued processing were presented previously and will also be presented later.

[**0108**] FIG. **20** is a block diagram illustrating various portions of an exemplary mobile communication device **2000**, in accordance with various aspects of the present invention. The exemplary mobile communication device **2000** may, for example and without limitation, share various characteristics with the exemplary mobile communication devices and other devices illustrated in FIGS. **1-19** and discussed previously. For example, the mobile communication device **2000** may comprise characteristics of any of a variety of mobile communication devices.

[**0109**] The exemplary mobile communication device **2000** may comprise a [illegible]