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(54) PORTABLE CHARGER WITHOUT A BATTERY FOR WEARABLE DEVICES

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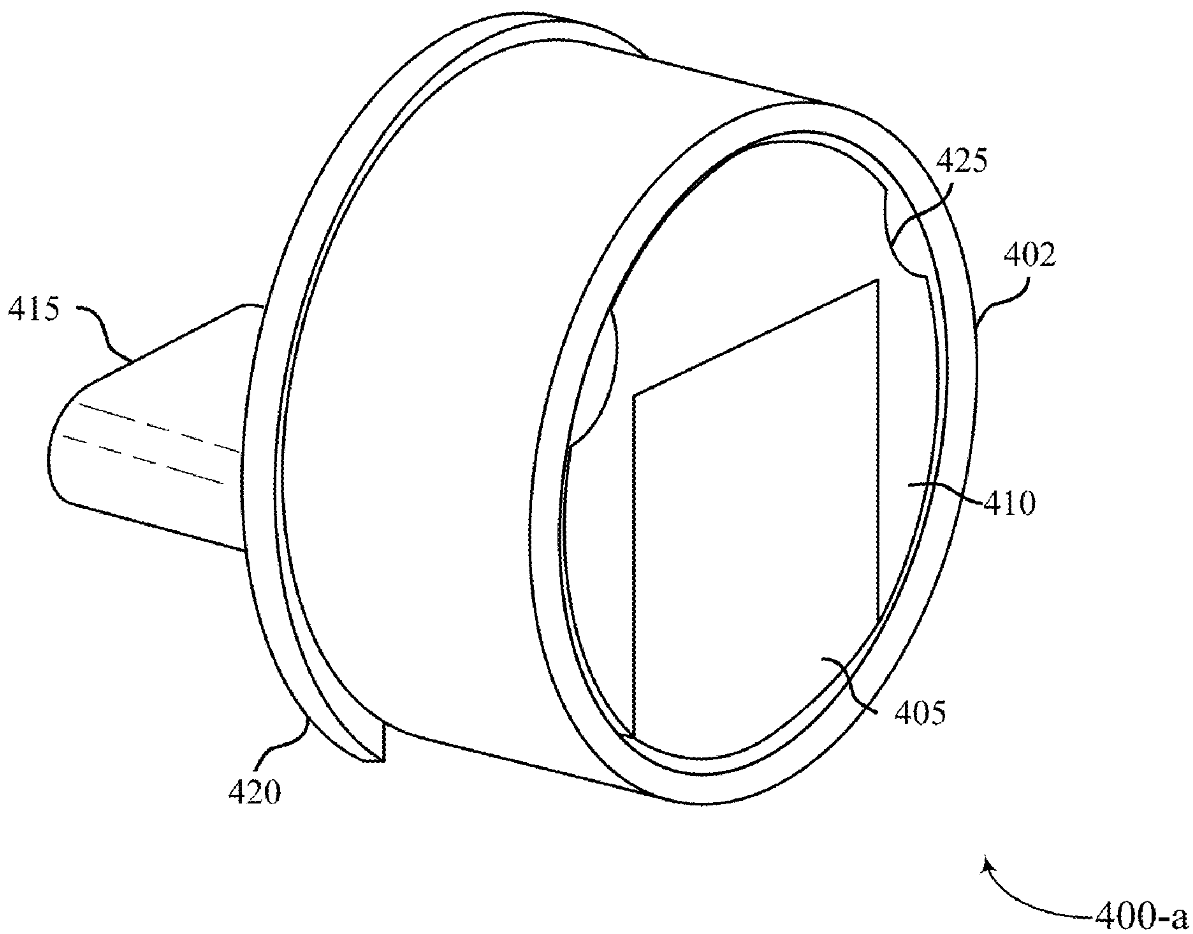
(57) **ABSTRACT**

Methods, systems, and devices for charging a wearable device are described. According to the techniques described herein, a portable charger for a wearable ring device may be configured to charge the wearable device in multiple charging orientations. The portable charger may include a plug component that can connect to external power sources. The portable charger may operate in multiple orientations. For example, the portable charger may have a retaining component that can be oriented opposite to the plug component in a "travel" orientation such that the wearable ring device may be secured onto the portable charger while the portable charger is connected to the external power source. The retaining component may be oriented on a same side as the plug component in a "home" orientation such that the user may remove the wearable ring device from the portable charger while the portable charger is connected to the external power source.



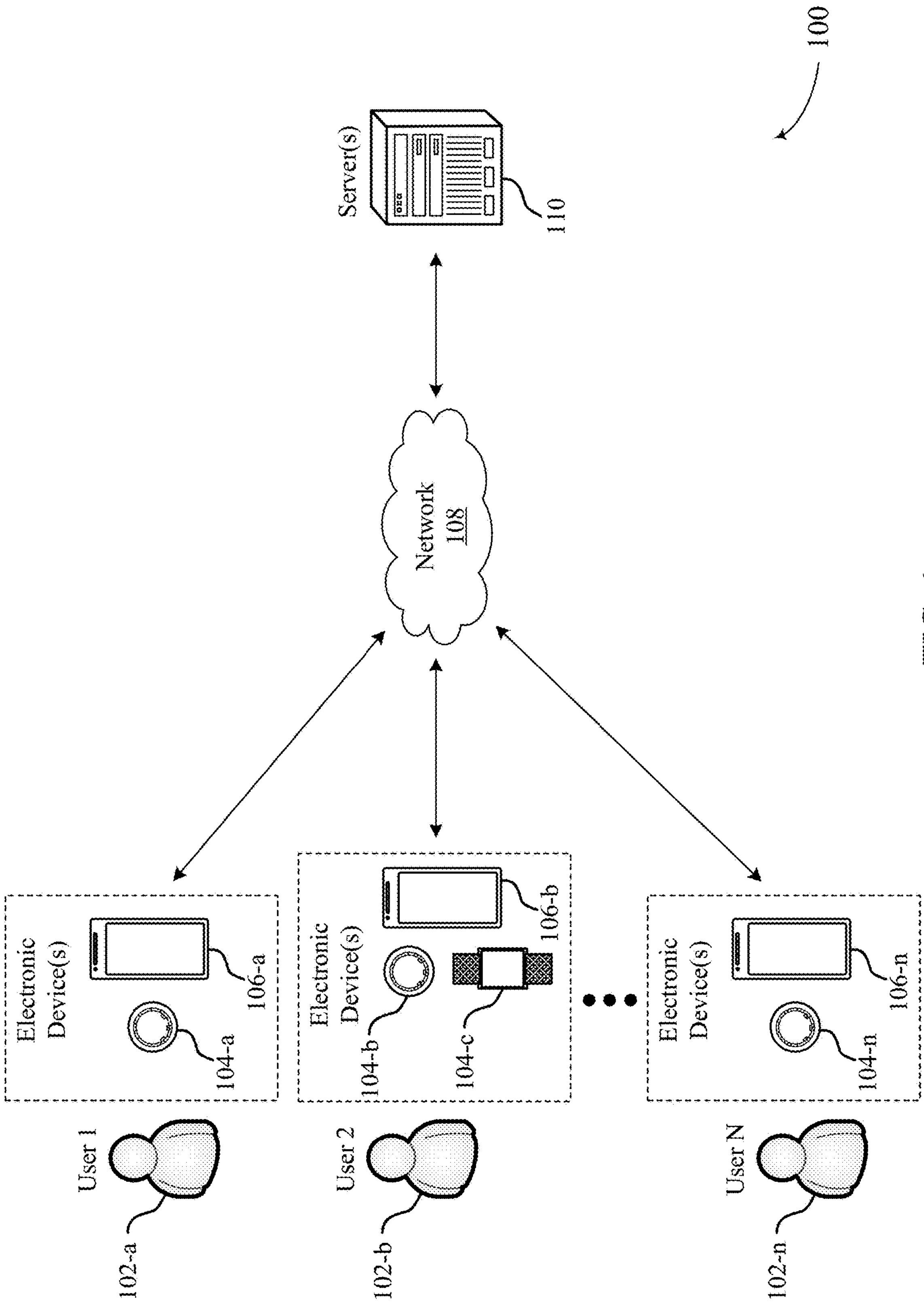

100
Server(s)
110
Network
108
Electronic
Device(s)
106-a
104-a
User 1
102-a
Electronic
Device(s)
106-b
104-b
104-c
User 2
102-b
Electronic
Device(s)
106-n
104-n
User N
102-n

FIG. 1

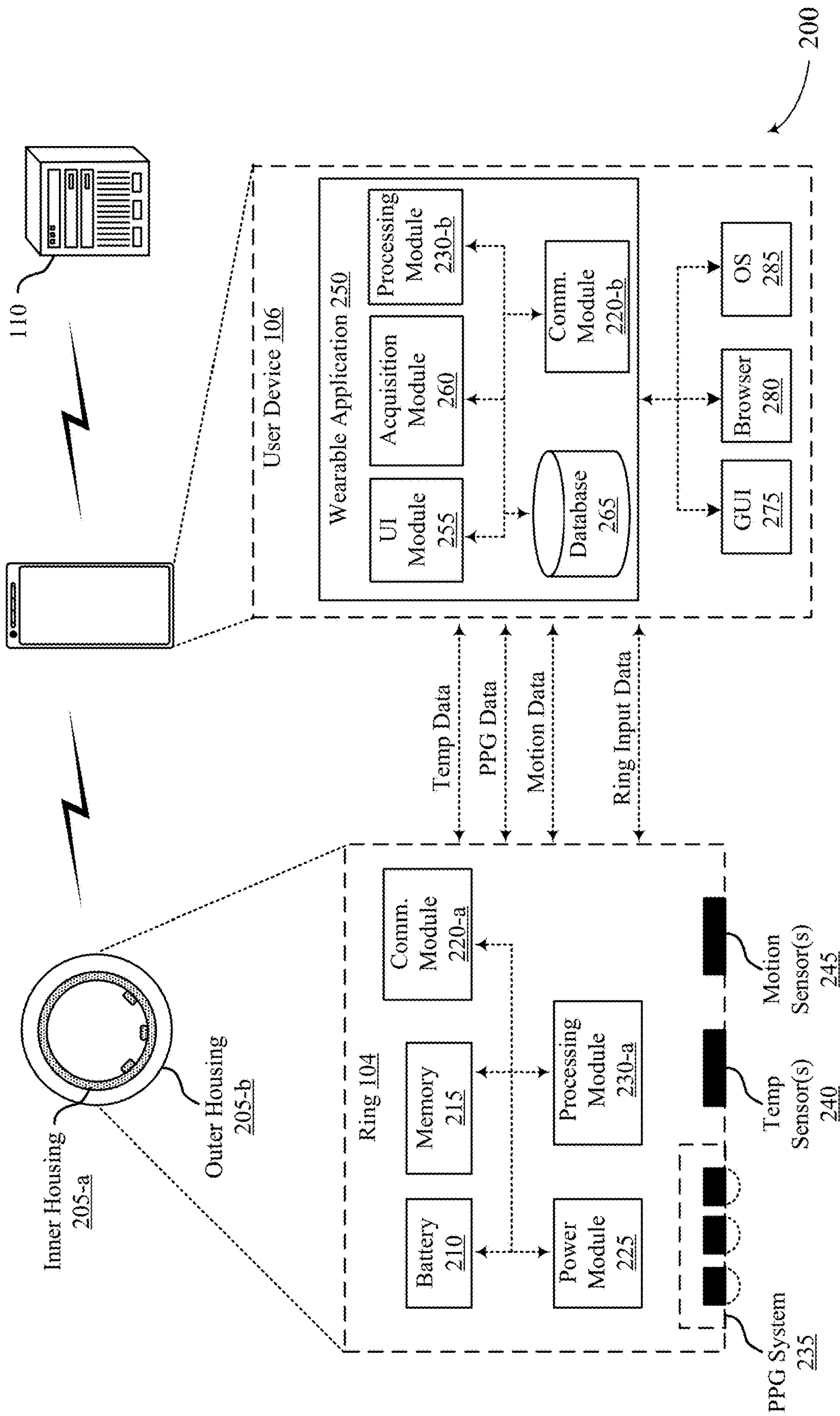

200
110
User Device 106
Wearable Application 250
UI Module 255
Acquisition Module 260
Processing Module 230-b
Database 265
Comm. Module 220-b
GUI 275
Browser 280
OS 285
Temp Data
PPG Data
Motion Data
Ring Input Data
Inner Housing 205-a
Outer Housing 205-b
Ring 104
Battery 210
Memory 215
Comm. Module 220-a
Power Module 225
Processing Module 230-a
PPG System 235
Temp Sensor(s) 240
Motion Sensor(s) 245

FIG. 2

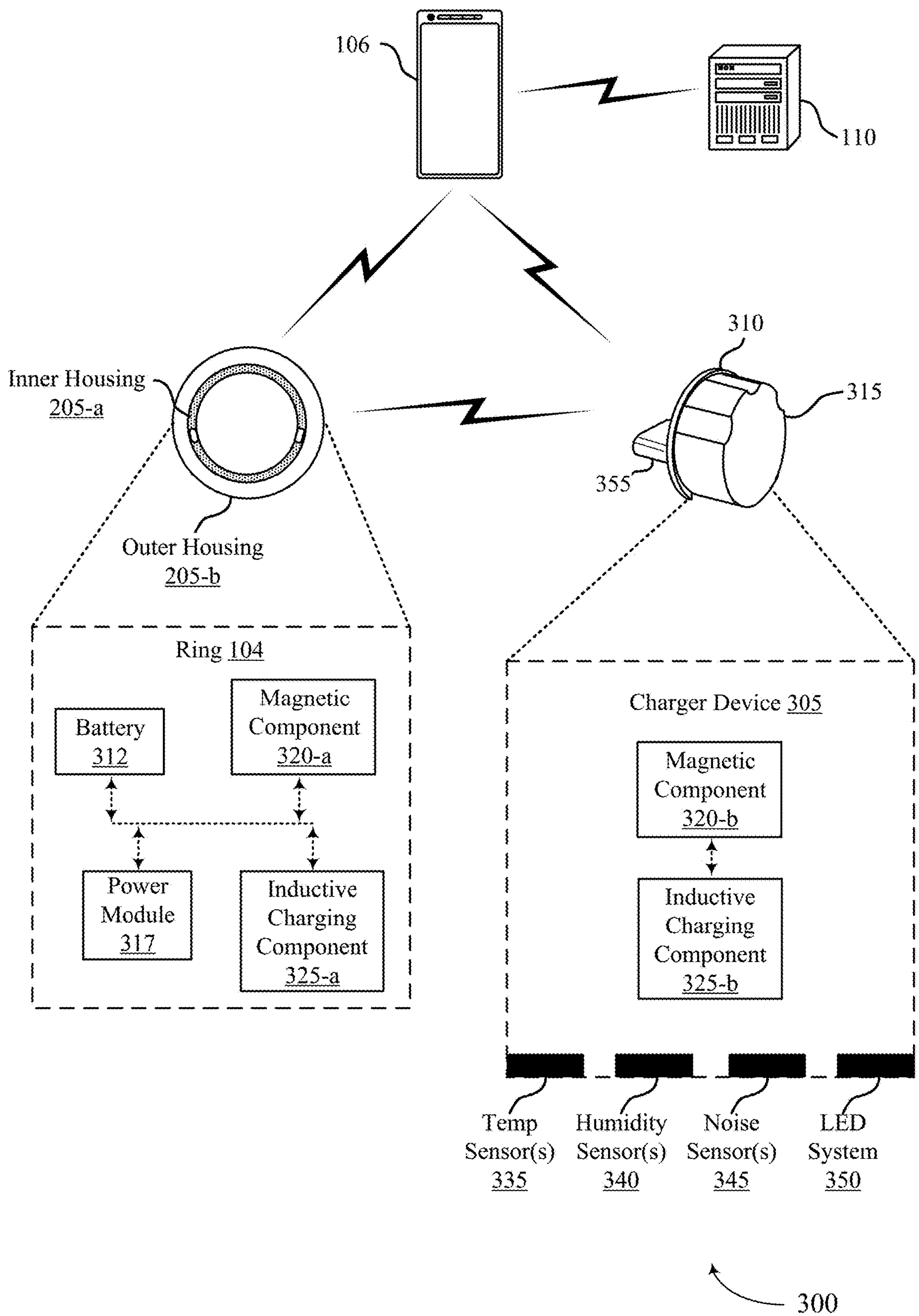

106
110
310
315
355
Inner Housing 205-a
Outer Housing 205-b
Ring 104
Battery 312
Magnetic Component 320-a
Power Module 317
Inductive Charging Component 325-a
Charger Device 305
Magnetic Component 320-b
Inductive Charging Component 325-b
Temp Sensor(s) 335
Humidity Sensor(s) 340
Noise Sensor(s) 345
LED System 350
300

FIG. 3

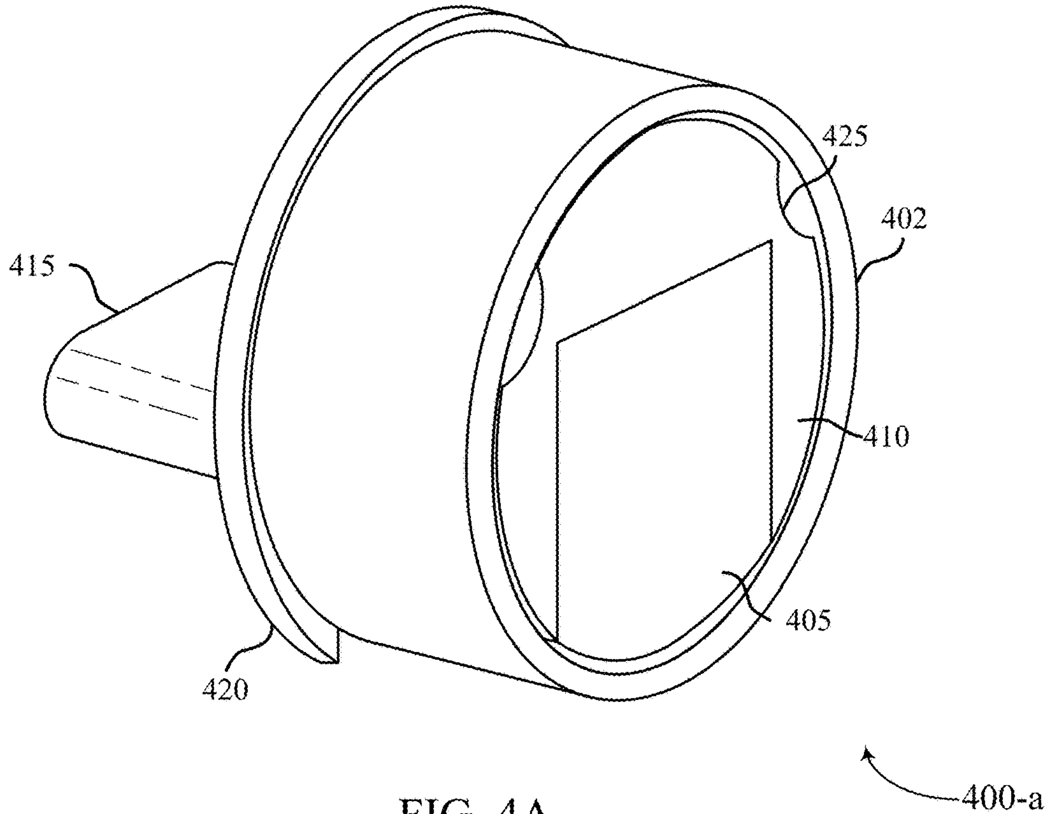


FIG. 4A

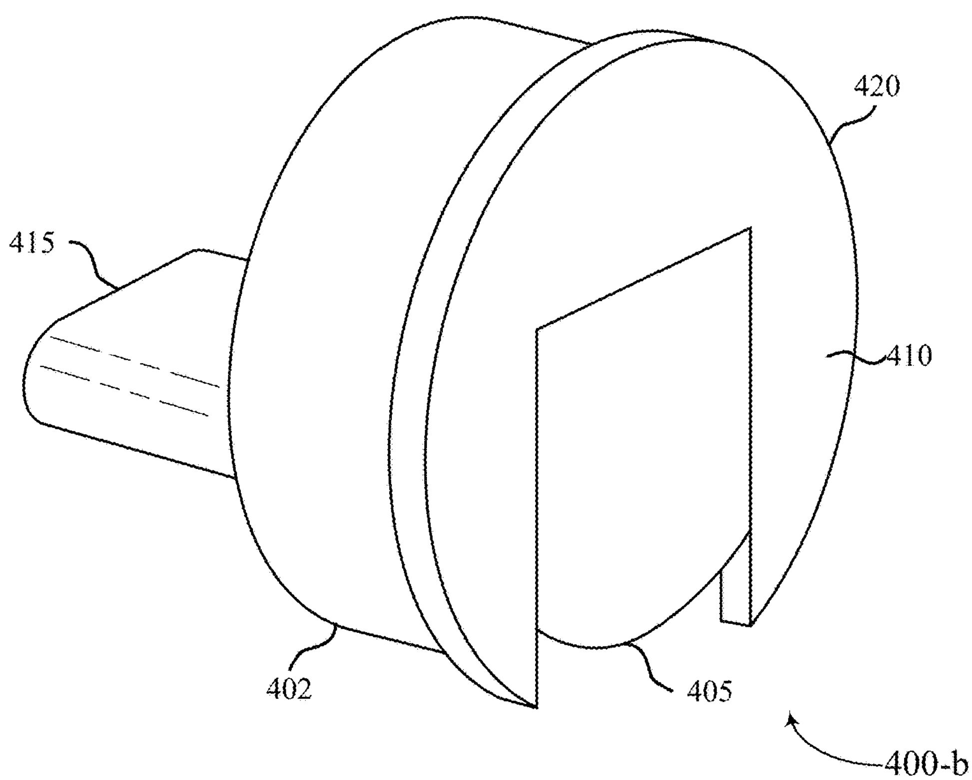


FIG. 4B

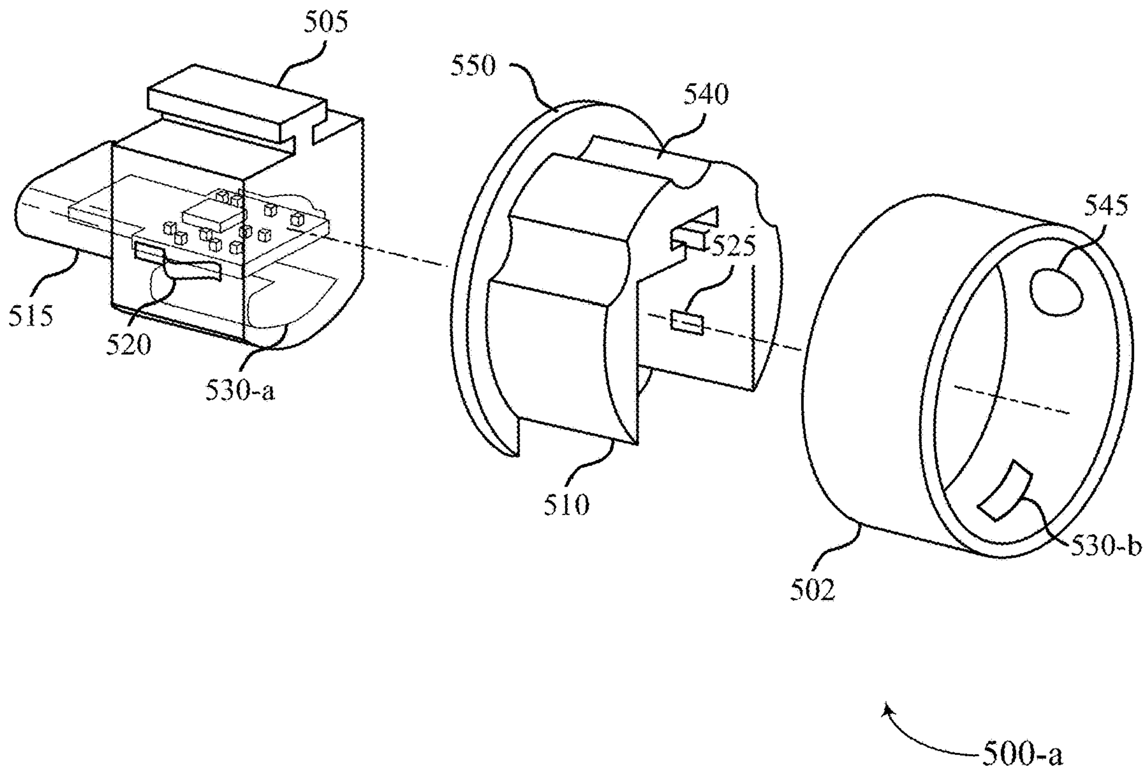

505
550
540
545
525
515
520
530-a
510
530-b
502
500-a

FIG. 5A

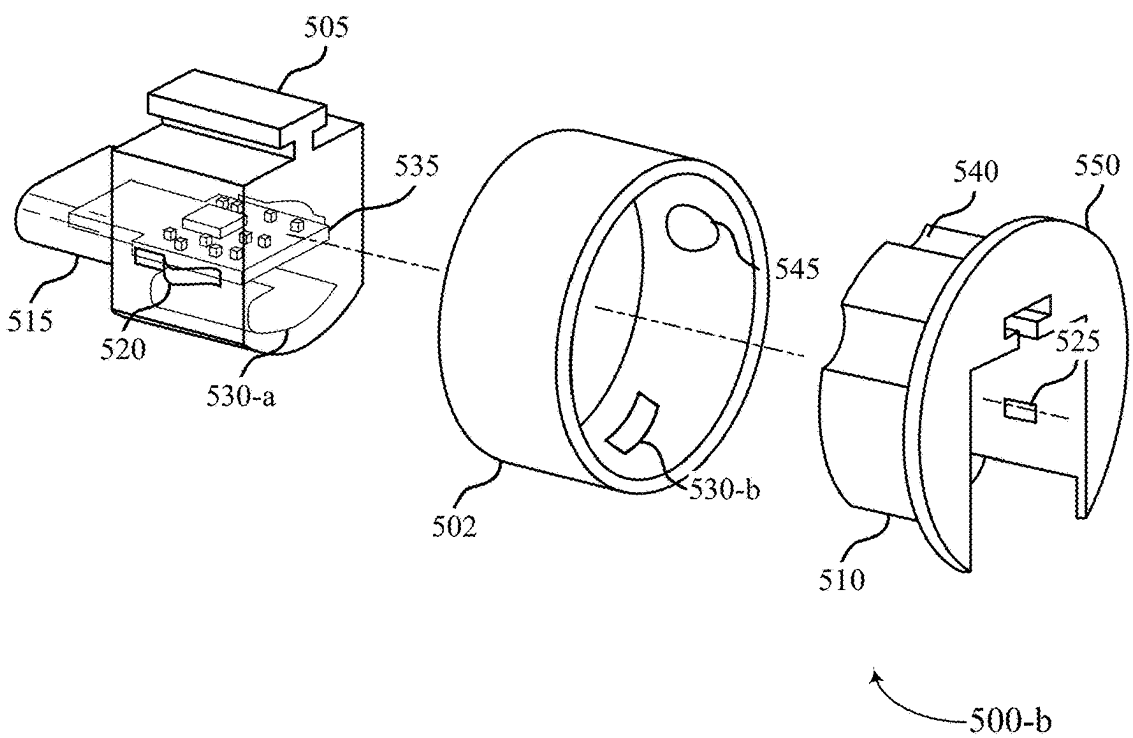

505
535
540
550
545
515
520
530-a
525
530-b
502
510
500-b

FIG. 5B

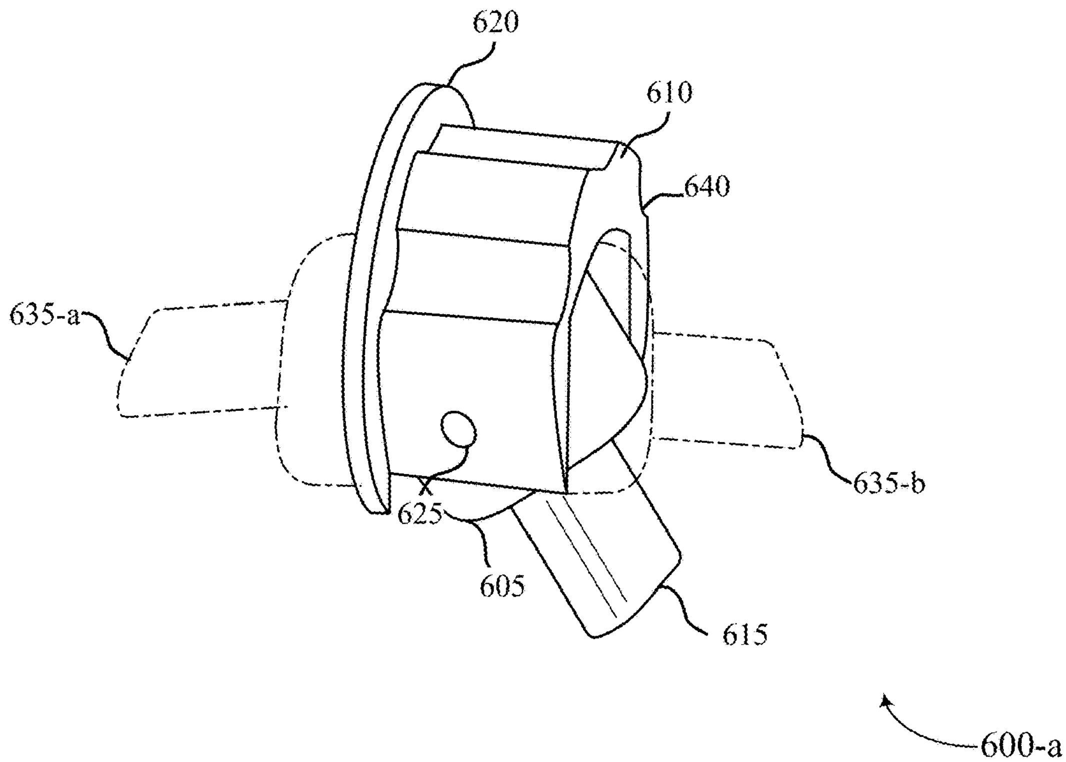

620
610
640
635-a
635-b
625
605
615
600-a

FIG. 6A

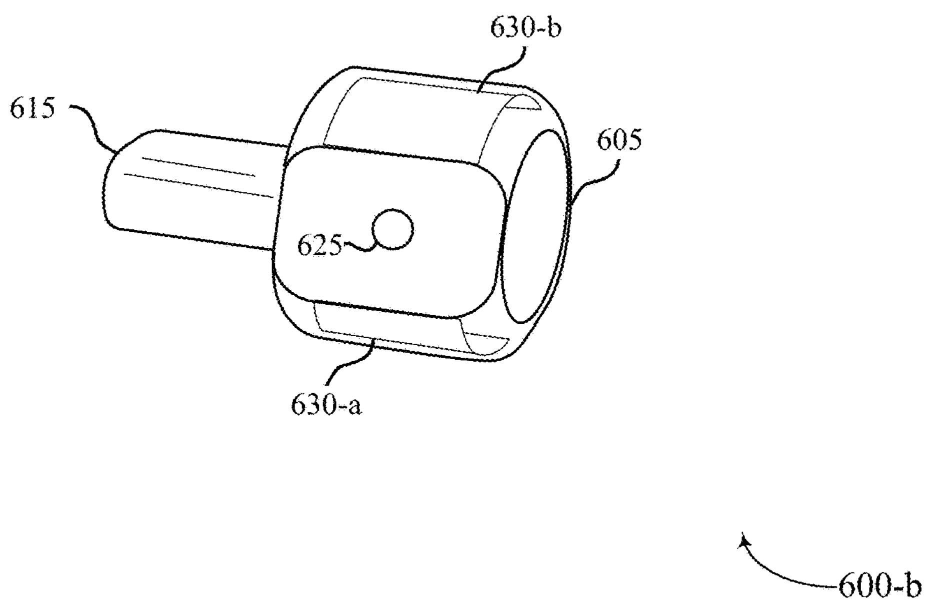

630-b
615
605
625
630-a
600-b

FIG. 6B

PORTABLE CHARGER WITHOUT A BATTERY FOR WEARABLE DEVICES

FIELD OF TECHNOLOGY

[0001] The following relates to wearable devices and data processing, including a portable charger without a battery for wearable devices.

BACKGROUND

[0002] Some wearable devices may be configured to collect data from users and may use a rechargeable battery to power one or more sensors associated with collecting the data. In some examples, the user may want to charge the rechargeable battery without using a bulky charging device (e.g., when the user is traveling).

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] FIG. **1** illustrates an example of a system that supports a portable charger without a battery for wearable devices in accordance with aspects of the present disclosure.

[0004] FIG. **2** illustrates an example of a system that supports a portable charger without a battery for wearable devices in accordance with aspects of the present disclosure.

[0005] FIG. **3** shows an example of a system that supports a portable charger without a battery for wearable devices in accordance with aspects of the present disclosure.

[0006] FIGS. **4**A and **4**B show examples of charging diagrams that support a portable charger without a battery for wearable devices in accordance with aspects of the present disclosure.

[0007] FIGS. **5**A and **5**B show examples of charging diagrams that support a portable charger without a battery for wearable devices in accordance with aspects of the present disclosure.

[0008] FIGS. **6**A and **6**B show examples of charging diagrams that support a portable charger without a battery for wearable devices in accordance with aspects of the present disclosure.

DETAILED DESCRIPTION

[0009] Some users of wearable ring devices may use a portable or travel charger to charge the wearable ring devices. In some examples, the travel chargers may include a charger post with one or more inductive charging components and a battery that may power the inductive charging components. However, portable chargers including such batteries may be costly to manufacture, may be bulky, and may have a low charging efficiency (e.g., below 50%), which may decrease user experience. Additionally, the wearable ring device may not be secure on the charger post, and may easily fall off while transporting, which may also decrease user experience.

[0010] Accordingly, as described herein, a portable charger device for a wearable ring device may not include a battery component and may be configured to charge a wireless device in multiple charging orientations. The portable charger device may include a plug component (e.g., a Universal Serial Bus (USB) Type-C (USB-C) plug) that can connect to external power sources (e.g., a third party device such as a computer, phone, portable battery, or a USB-C wall outlet adapter). The portable charger device may operate in multiple orientations, including a "home" orientation and a "travel" orientation. For example, the portable charger device may have a retaining component that can be oriented opposite to the plug component in the "travel" orientation such that the wearable ring device may be secured onto the portable charger device while the portable charger device is connected to the external power source. The retaining component may be oriented on a same side as the plug component in the "home" orientation such that the user may easily remove the wearable ring device from the portable charger device while the portable charger device is connected to the external power source.

[0011] In some examples, the plug component may be hinged such that the user may "flip" the portable charger device from the travel orientation to the home orientation. In such examples, the size of the portable charger device may be specific to a wearable ring device size. In some examples, the portable charger device may include a separate component (e.g., a size adapter component) that can be connected to the plug component in either the home or travel orientation. That is, the size adapter component may include the retaining component, and may be "snapped" into place on the plug component with the retaining component either on the same side as or on the opposite side from the plug component. In such examples, the plug component may be common across wearable ring device sizes, and the size adapter component may be specific to a wearable ring device size.

[0012] Aspects of the disclosure are initially described in the context of systems supporting physiological data collection from users via wearable devices. Aspects of the disclosure are further illustrated by and described with reference to charger diagrams that relate to a portable charger without a battery for wearable devices.

[0013] FIG. **1** illustrates an example of a system **100** that supports a portable charger without a battery for wearable devices in accordance with aspects of the present disclosure. The system **100** includes a plurality of electronic devices (e.g., wearable devices **104**, user devices **106**) that may be worn and/or operated by one or more users **102**. The system **100** further includes a network **108** and one or more servers **110**.

[0014] The electronic devices may include any electronic devices known in the art, including wearable devices **104** (e.g., ring wearable devices, watch wearable devices, etc.), user devices **106** (e.g., smartphones, laptops, tablets). The electronic devices associated with the respective users **102** may include one or more of the following functionalities: 1) measuring physiological data, 2) storing the measured data, 3) processing the data, 4) providing outputs (e.g., via GUIs) to a user **102** based on the processed data, and 5) communicating data with one another and/or other computing devices. Different electronic devices may perform one or more of the functionalities.

[0015] Example wearable devices **104** may include wearable computing devices, such as a ring computing device (hereinafter "ring") configured to be worn on a user's **102** finger, a wrist computing device (e.g., a smart watch, fitness band, or bracelet) configured to be worn on a user's **102** wrist, and/or a head mounted computing device (e.g., glasses/goggles). Wearable devices **104** may also include bands, straps (e.g., flexible or inflexible bands or straps), stick-on sensors, and the like, that may be positioned in other locations, such as bands around the head (e.g., a forehead headband), arm (e.g., a forearm band and/or bicep band), and/or leg (e.g., a thigh or calf band), behind the ear, under the armpit, and the like. Wearable devices **104** may also be attached to, or included in, articles of clothing. For example, wearable devices **104** may be included in pockets and/or pouches on clothing. As another example, wearable device **104** may be clipped and/or pinned to clothing, or may otherwise be maintained within the vicinity of the user **102**. Example articles of clothing may include, but are not limited to, hats, shirts, gloves, pants, socks, outerwear (e.g., jackets), and undergarments. In some implementations, wearable devices **104** may be included with other types of devices such as training/sporting devices that are used during physical activity. For example, wearable devices **104** may be attached to, or included in, a bicycle, skis, a tennis racket, a golf club, and/or training weights.

[0016] Much of the present disclosure may be described in the context of a ring wearable device **104**. Accordingly, the terms "ring **104**," "wearable device **104**," and like terms, may be used interchangeably, unless noted otherwise herein. However, the use of the term "ring **104**" is not to be regarded as limiting, as it is contemplated herein that aspects of the present disclosure may be performed using other wearable devices (e.g., watch wearable devices, necklace wearable device, bracelet wearable devices, earring wearable devices, anklet wearable devices, and the like).

[0017] In some aspects, user devices **106** may include handheld mobile computing devices, such as smartphones and tablet computing devices. User devices **106** may also include personal computers, such as laptop and desktop computing devices. Other example user devices **106** may include server computing devices that may communicate with other electronic devices (e.g., via the Internet). In some implementations, computing devices may include medical devices, such as external wearable computing devices (e.g., Holter monitors). Medical devices may also include implantable medical devices, such as pacemakers and cardioverter defibrillators. Other example user devices **106** may include home computing devices, such as internet of things (IoT) devices (e.g., IoT devices), smart televisions, smart speakers, smart displays (e.g., video call displays), hubs (e.g., wireless communication hubs), security systems, smart appliances (e.g., thermostats and refrigerators), and fitness equipment.

[0018] Some electronic devices (e.g., wearable devices **104**, user devices **106**) may measure physiological parameters of respective users **102**, such as photoplethysmography waveforms, continuous skin temperature, a pulse waveform, respiration rate, heart rate, heart rate variability (HRV), actigraphy, galvanic skin response, pulse oximetry, blood oxygen saturation (SpO2), blood sugar levels (e.g., glucose metrics), and/or other physiological parameters. Some electronic devices that measure physiological parameters may also perform some/all of the calculations described herein. Some electronic devices may not measure physiological parameters, but may perform some/all of the calculations described herein. For example, a ring (e.g., wearable device **104**), mobile device application, or a server computing device may process received physiological data that was measured by other devices.

[0019] In some implementations, a user **102** may operate, or may be associated with, multiple electronic devices, some of which may measure physiological parameters and some of which may process the measured physiological parameters. In some implementations, a user **102** may have a ring (e.g., wearable device **104**) that measures physiological parameters. The user **102** may also have, or be associated with, a user device **106** (e.g., mobile device, smartphone), where the wearable device **104** and the user device **106** are communicatively coupled to one another. In some cases, the user device **106** may receive data from the wearable device **104** and perform some/all of the calculations described herein. In some implementations, the user device **106** may also measure physiological parameters described herein, such as motion/activity parameters.

[0020] For example, as illustrated in FIG. **1**, a first user **102**-*a* (User **1**) may operate, or may be associated with, a wearable device **104**-*a* (e.g., ring **104**-*a*) and a user device **106**-*a* that may operate as described herein. In this example, the user device **106**-*a* associated with user **102**-*a* may process/store physiological parameters measured by the ring **104**-*a*. Comparatively, a second user **102**-*b* (User **2**) may be associated with a ring **104**-*b*, a watch wearable device **104**-*c* (e.g., watch **104**-*c*), and a user device **106**-*b*, where the user device **106**-*b* associated with user **102**-*b* may process/store physiological parameters measured by the ring **104**-*b* and/or the watch **104**-*c*. Moreover, an nth user **102**-*n* (User N) may be associated with an arrangement of electronic devices described herein (e.g., ring **104**-*n*, user device **106**-*n*). In some aspects, wearable devices **104** (e.g., rings **104**, watches **104**) and other electronic devices may be communicatively coupled to the user devices **106** of the respective users **102** via Bluetooth, Wi-Fi, and other wireless protocols. Moreover, in some cases, the wearable device **104** and the user device **106** may be included within (or make up) the same device. For example, in some cases, the wearable device **104** may be configured to execute an application associated with the wearable device **104**, and may be configured to display data via a GUI.

[0021] In some implementations, the rings **104** (e.g., wearable devices **104**) of the system **100** may be configured to collect physiological data from the respective users **102** based on arterial blood flow within the user's finger. In particular, a ring **104** may utilize one or more light-emitting components, such as LEDs (e.g., red LEDs, green LEDs) that emit light on the palm-side of a user's finger to collect physiological data based on arterial blood flow within the user's finger. In general, the terms light-emitting components, light-emitting elements, and like terms, may include, but are not limited to, LEDs, micro LEDs, mini LEDs, laser diodes (LDs) (e.g., vertical cavity surface-emitting lasers (VCSELs), and the like.

[0022] In some cases, the system **100** may be configured to collect physiological data from the respective users **102** based on blood flow diffused into a microvascular bed of skin with capillaries and arterioles. For example, the system **100** may collect PPG data based on a measured amount of blood diffused into the microvascular system of capillaries and arterioles. In some implementations, the ring **104** may acquire the physiological data using a combination of both green and red LEDs. The physiological data may include any physiological data known in the art including, but not limited to, temperature data, accelerometer data (e.g., movement/motion data), heart rate data, HRV data, blood oxygen level data, or any combination thereof.

[0023] The use of both green and red LEDs may provide several advantages over other solutions, as red and green LEDs have been found to have their own distinct advantages when acquiring physiological data under different conditions (e.g., light/dark, active/inactive) and via different parts of the body, and the like. For example, green LEDs have been found to exhibit better performance during exercise. Moreover, using multiple LEDs (e.g., green and red LEDs) distributed around the ring **104** has been found to exhibit superior performance as compared to wearable devices that utilize LEDs that are positioned close to one another, such as within a watch wearable device. Furthermore, the blood vessels in the finger (e.g., arteries, capillaries) are more accessible via LEDs as compared to blood vessels in the wrist. In particular, arteries in the wrist are positioned on the bottom of the wrist (e.g., palm-side of the wrist), meaning only capillaries are accessible on the top of the wrist (e.g., back of hand side of the wrist), where wearable watch devices and similar devices are typically worn. As such, utilizing LEDs and other sensors within a ring **104** has been found to exhibit superior performance as compared to wearable devices worn on the wrist, as the ring **104** may have greater access to arteries (as compared to capillaries), thereby resulting in stronger signals and more valuable physiological data.

[0024] The electronic devices of the system **100** (e.g., user devices **106**, wearable devices **104**) may be communicatively coupled to one or more servers **110** via wired or wireless communication protocols. For example, as shown in FIG. **1**, the electronic devices (e.g., user devices **106**) may be communicatively coupled to one or more servers **110** via a network **108**. The network **108** may implement transfer control protocol and internet protocol (TCP/IP), such as the Internet, or may implement other network **108** protocols. Network connections between the network **108** and the respective electronic devices may facilitate transport of data via email, web, text messages, mail, or any other appropriate form of interaction within a computer network **108**. For example, in some implementations, the ring **104**-*a* associated with the first user **102**-*a* may be communicatively coupled to the user device **106**-*a*, where the user device **106**-*a* is communicatively coupled to the servers **110** via the network **108**. In additional or alternative cases, wearable devices **104** (e.g., rings **104**, watches **104**) may be directly communicatively coupled to the network **108**.

[0025] The system **100** may offer an on-demand database service between the user devices **106** and the one or more servers **110**. In some cases, the servers **110** may receive data from the user devices **106** via the network **108**, and may store and analyze the data. Similarly, the servers **110** may provide data to the user devices **106** via the network **108**. In some cases, the servers **110** may be located at one or more data centers. The servers **110** may be used for data storage, management, and processing. In some implementations, the servers **110** may provide a web-based interface to the user device **106** via web browsers.

[0026] In some aspects, the system **100** may detect periods of time that a user **102** is asleep, and classify periods of time that the user **102** is asleep into one or more sleep stages (e.g., sleep stage classification). For example, as shown in FIG. **1**, User **102**-*a* may be associated with a wearable device **104**-*a* (e.g., ring **104**-*a*) and a user device **106**-*a*. In this example, the ring **104**-*a* may collect physiological data associated with the user **102**-*a*, including temperature, heart rate, HRV, respiratory rate, and the like. In some aspects, data collected by the ring **104**-*a* may be input to a machine learning classifier, where the machine learning classifier is configured to determine periods of time that the user **102**-*a* is (or was) asleep. Moreover, the machine learning classifier may be configured to classify periods of time into different sleep stages, including an awake sleep stage, a rapid eye movement (REM) sleep stage, a light sleep stage (non-REM (NREM)), and a deep sleep stage (NREM). In some aspects, the classified sleep stages may be displayed to the user **102**-*a* via a GUI of the user device **106**-*a*. Sleep stage classification may be used to provide feedback to a user **102**-*a* regarding the user's sleeping patterns, such as recommended bedtimes, recommended wake-up times, and the like. Moreover, in some implementations, sleep stage classification techniques described herein may be used to calculate scores for the respective user, such as Sleep Scores, Readiness Scores, and the like.

[0027] In some aspects, the system **100** may utilize circadian rhythm-derived features to further improve physiological data collection, data processing procedures, and other techniques described herein. The term circadian rhythm may refer to a natural, internal process that regulates an individual's sleep-wake cycle, that repeats approximately every 24 hours. In this regard, techniques described herein may utilize circadian rhythm adjustment models to improve physiological data collection, analysis, and data processing. For example, a circadian rhythm adjustment model may be input into a machine learning classifier along with physiological data collected from the user **102**-*a* via the wearable device **104**-*a*. In this example, the circadian rhythm adjustment model may be configured to "weight," or adjust, physiological data collected throughout a user's natural, approximately 24-hour circadian rhythm. In some implementations, the system may initially start with a "baseline" circadian rhythm adjustment model, and may modify the baseline model using physiological data collected from each user **102** to generate tailored, individualized circadian rhythm adjustment models that are specific to each respective user **102**.

[0028] In some aspects, the system **100** may utilize other biological rhythms to further improve physiological data collection, analysis, and processing by phase of these other rhythms. For example, if a weekly rhythm is detected within an individual's baseline data, then the model may be configured to adjust "weights" of data by day of the week. Biological rhythms that may require adjustment to the model by this method include: 1) ultradian (faster than a day rhythms, including sleep cycles in a sleep state, and oscillations from less than an hour to several hours periodicity in the measured physiological variables during wake state; 2) circadian rhythms; 3) non-endogenous daily rhythms shown to be imposed on top of circadian rhythms, as in work schedules; 4) weekly rhythms, or other artificial time periodicities exogenously imposed (e.g., in a hypothetical culture with 12 day "weeks," 12 day rhythms could be used); 5) multi-day ovarian rhythms in women and spermatogenesis rhythms in men; 6) lunar rhythms (relevant for individuals living with low or no artificial lights); and 7) seasonal rhythms.

[0029] The biological rhythms are not always stationary rhythms. For example, many women experience variability in ovarian cycle length across cycles, and ultradian rhythms are not expected to occur at exactly the same time or periodicity across days even within a user. As such, signal processing techniques sufficient to quantify the frequency composition while preserving temporal resolution of these rhythms in physiological data may be used to improve detection of these rhythms, to assign phase of each rhythm to each moment in time measured, and to thereby modify adjustment models and comparisons of time intervals. The biological rhythm-adjustment models and parameters can be added in linear or non-linear combinations as appropriate to more accurately capture the dynamic physiological baselines of an individual or group of individuals.

[0030] In some aspects, the respective devices of the system **100** may support techniques for a charging device (e.g., a portable charger for a wearable device **104**) without a battery. For example, the charging device may include one or more portions that may be reconfigured into a first charging orientation and a second charging orientation. In the first charging orientation, the charging device may include a flange that may be on a same side of a charger post as a power receiving component (e.g., such that the wearable device **104** may be easily removed from the charger base). In the second charging orientation, the charging device may include the flange that may be on a different (e.g., opposite) side of the charger post as the power receiving component (e.g., such that the wearable device **104** may not be easily removed from the charger base when the power receiving component is coupled to an external power source).

[0031] It should be appreciated by a person skilled in the art that one or more aspects of the disclosure may be implemented in a system **100** to additionally or alternatively solve other problems than those described above. Furthermore, aspects of the disclosure may provide technical improvements to "conventional" systems or processes as described herein. However, the description and appended drawings only include example technical improvements resulting from implementing aspects of the disclosure, and accordingly do not represent all of the technical improvements provided within the scope of the claims.

[0032] FIG. **2** illustrates an example of a system **200** that supports a portable charger without a battery for wearable devices in accordance with aspects of the present disclosure. The system **200** may implement, or be implemented by, system **100**. In particular, system **200** illustrates an example of a ring **104** (e.g., wearable device **104**), a user device **106**, and a server **110**, as described with reference to FIG. **1**.

[0033] In some aspects, the ring **104** may be configured to be worn around a user's finger, and may determine one or more user physiological parameters when worn around the user's finger. Example measurements and determinations may include, but are not limited to, user skin temperature, pulse waveforms, respiratory rate, heart rate, HRV, blood oxygen levels (SpO2), blood sugar levels (e.g., glucose metrics), and the like.

[0034] The system **200** further includes a user device **106** (e.g., a smartphone) in communication with the ring **104**. For example, the ring **104** may be in wireless and/or wired communication with the user device **106**. In some implementations, the ring **104** may send measured and processed data (e.g., temperature data, photoplethysmogram (PPG) data, motion/accelerometer data, ring input data, and the like) to the user device **106**. The user device **106** may also send data to the ring **104**, such as ring **104** firmware/configuration updates. The user device **106** may process data. In some implementations, the user device **106** may transmit data to the server **110** for processing and/or storage.

[0035] The ring **104** may include a housing **205** that may include an inner housing **205**-*a* and an outer housing **205**-*b*. In some aspects, the housing **205** of the ring **104** may store or otherwise include various components of the ring including, but not limited to, device electronics, a power source (e.g., battery **210**, and/or capacitor), one or more substrates (e.g., printable circuit boards) that interconnect the device electronics and/or power source, and the like. The device electronics may include device modules (e.g., hardware/software), such as: a processing module **230**-*a*, a memory **215**, a communication module **220**-*a*, a power module **225**, and the like. The device electronics may also include one or more sensors. Example sensors may include one or more temperature sensors **240**, a PPG sensor assembly (e.g., PPG system **235**), and one or more motion sensors **245**.

[0036] The sensors may include associated modules (not illustrated) configured to communicate with the respective components/modules of the ring **104**, and generate signals associated with the respective sensors. In some aspects, each of the components/modules of the ring **104** may be communicatively coupled to one another via wired or wireless connections. Moreover, the ring **104** may include additional and/or alternative sensors or other components that are configured to collect physiological data from the user, including light sensors (e.g., LEDs), oximeters, and the like.

[0037] The ring **104** shown and described with reference to FIG. **2** is provided solely for illustrative purposes. As such, the ring **104** may include additional or alternative components as those illustrated in FIG. **2**. Other rings **104** that provide functionality described herein may be fabricated. For example, rings **104** with fewer components (e.g., sensors) may be fabricated. In a specific example, a ring **104** with a single temperature sensor **240** (or other sensor), a power source, and device electronics configured to read the single temperature sensor **240** (or other sensor) may be fabricated. In another specific example, a temperature sensor **240** (or other sensor) may be attached to a user's finger (e.g., using adhesives, wraps, clamps, spring loaded clamps, etc.). In this case, the sensor may be wired to another computing device, such as a wrist worn computing device that reads the temperature sensor **240** (or other sensor). In other examples, a ring **104** that includes additional sensors and processing functionality may be fabricated.

[0038] The housing **205** may include one or more housing **205** components. The housing **205** may include an outer housing **205**-*b* component (e.g., a shell) and an inner housing **205**-*a* component (e.g., a molding). The housing **205** may include additional components (e.g., additional layers) not explicitly illustrated in FIG. **2**. For example, in some implementations, the ring **104** may include one or more insulating layers that electrically insulate the device electronics and other conductive materials (e.g., electrical traces) from the outer housing **205**-*b* (e.g., a metal outer housing **205**-*b*). The housing **205** may provide structural support for the device electronics, battery **210**, substrate(s), and other components. For example, the housing **205** may protect the device electronics, battery **210**, and substrate(s) from mechanical forces, such as pressure and impacts. The housing **205** may also protect the device electronics, battery **210**, and substrate(s) from water and/or other chemicals.

[0039] The outer housing **205**-*b* may be fabricated from one or more materials. In some implementations, the outer housing **205**-*b* may include a metal, such as titanium, that may provide strength and abrasion resistance at a relatively light weight. The outer housing **205**-*b* may also be fabricated from other materials, such polymers. In some implementations, the outer housing **205**-*b* may be protective as well as decorative.

[0040] The inner housing **205**-*a* may be configured to interface with the user's finger. The inner housing **205**-*a* may be formed from a polymer (e.g., a medical grade polymer) or other material. In some implementations, the inner housing **205**-*a* may be transparent. For example, the inner housing **205**-*a* may be transparent to light emitted by the PPG light emitting diodes (LEDs). In some implementations, the inner housing **205**-*a* component may be molded onto the outer housing **205**-*b*. For example, the inner housing **205**-*a* may include a polymer that is molded (e.g., injection molded) to fit into an outer housing **205**-*b* metallic shell.

[0041] The ring **104** may include one or more substrates (not illustrated). The device electronics and battery **210** may be included on the one or more substrates. For example, the device electronics and battery **210** may be mounted on one or more substrates. Example substrates may include one or more printed circuit boards (PCBs), such as flexible PCB (e.g., polyimide). In some implementations, the electronics/battery **210** may include surface mounted devices (e.g., surface-mount technology (SMT) devices) on a flexible PCB. In some implementations, the one or more substrates (e.g., one or more flexible PCBs) may include electrical traces that provide electrical communication between device electronics. The electrical traces may also connect the battery **210** to the device electronics.

[0042] The device electronics, battery **210**, and substrates may be arranged in the ring **104** in a variety of ways. In some implementations, one substrate that includes device electronics may be mounted along the bottom of the ring **104** (e.g., the bottom half), such that the sensors (e.g., PPG system **235**, temperature sensors **240**, motion sensors **245**, and other sensors) interface with the underside of the user's finger. In these implementations, the battery **210** may be included along the top portion of the ring **104** (e.g., on another substrate).

[0043] The various components/modules of the ring **104** represent functionality (e.g., circuits and other components) that may be included in the ring **104**. Modules may include any discrete and/or integrated electronic circuit components that implement analog and/or digital circuits capable of producing the functions attributed to the modules herein. For example, the modules may include analog circuits (e.g., amplification circuits, filtering circuits, analog/digital conversion circuits, and/or other signal conditioning circuits). The modules may also include digital circuits (e.g., combinational or sequential logic circuits, memory circuits etc.).

[0044] The memory **215** (memory module) of the ring **104** may include any volatile, non-volatile, magnetic, or electrical media, such as a random access memory (RAM), read-only memory (ROM), non-volatile RAM (NVRAM), electrically-erasable programmable ROM (EEPROM), flash memory, or any other memory device. The memory **215** may store any of the data described herein. For example, the memory **215** may be configured to store data (e.g., motion data, temperature data, PPG data) collected by the respective sensors and PPG system **235**. Furthermore, memory **215** may include instructions that, when executed by one or more processing circuits, cause the modules to perform various functions attributed to the modules herein. The device electronics of the ring **104** described herein are only example device electronics. As such, the types of electronic components used to implement the device electronics may vary based on design considerations.

[0045] The functions attributed to the modules of the ring **104** described herein may be embodied as one or more processors, hardware, firmware, software, or any combination thereof. Depiction of different features as modules is intended to highlight different functional aspects and does not necessarily imply that such modules must be realized by separate hardware/software components. Rather, functionality associated with one or more modules may be performed by separate hardware/software components or integrated within common hardware/software components.

[0046] The processing module **230**-*a* of the ring **104** may include one or more processors (e.g., processing units), microcontrollers, digital signal processors, systems on a chip (SOCs), and/or other processing devices. The processing module **230**-*a* communicates with the modules included in the ring **104**. For example, the processing module **230**-*a* may transmit/receive data to/from the modules and other components of the ring **104**, such as the sensors. As described herein, the modules may be implemented by various circuit components. Accordingly, the modules may also be referred to as circuits (e.g., a communication circuit and power circuit).

[0047] The processing module **230**-*a* may communicate with the memory **215**. The memory **215** may include computer-readable instructions that, when executed by the processing module **230**-*a*, cause the processing module **230**-*a* to perform the various functions attributed to the processing module **230**-*a* herein. In some implementations, the processing module **230**-*a* (e.g., a microcontroller) may include additional features associated with other modules, such as communication functionality provided by the communication module **220**-*a* (e.g., an integrated Bluetooth Low Energy transceiver) and/or additional onboard memory **215**.

[0048] The communication module **220**-*a* may include circuits that provide wireless and/or wired communication with the user device **106** (e.g., communication module **220**-*b* of the user device **106**). In some implementations, the communication modules **220**-*a*, **220**-*b* may include wireless communication circuits, such as Bluetooth circuits and/or Wi-Fi circuits. In some implementations, the communication modules **220**-*a*, **220**-*b* can include wired communication circuits, such as USB communication circuits. Using the communication module **220**-*a*, the ring **104** and the user device **106** may be configured to communicate with each other. The processing module **230**-*a* of the ring may be configured to transmit/receive data to/from the user device **106** via the communication module **220**-*a*. Example data may include, but is not limited to, motion data, temperature data, pulse waveforms, heart rate data, HRV data, PPG data, and status updates (e.g., charging status, battery charge level, and/or ring **104** configuration settings). The processing module **230**-*a* of the ring may also be configured to receive updates (e.g., software/firmware updates) and data from the user device **106**.

[0049] The ring **104** may include a battery **210** (e.g., a rechargeable battery **210**). An example battery **210** may include a Lithium-Ion or Lithium-Polymer type battery **210**, although a variety of battery **210** options are possible. The battery **210** may be wirelessly charged. In some implementations, the ring **104** may include a power source other than the battery **210**, such as a capacitor. The power source (e.g., battery **210** or capacitor) may have a curved geometry that matches the curve of the ring **104**. In some aspects, a charger or other power source may include additional sensors that may be used to collect data in addition to, or that supplements, data collected by the ring **104** itself. Moreover, a charger or other power source for the ring **104** may function as a user device **106**, in which case the charger or other power source for the ring **104** may be configured to receive data from the ring **104**, store and/or process data received from the ring **104**, and communicate data between the ring **104** and the servers **110**.

[0050] In some aspects, the ring **104** includes a power module **225** that may control charging of the battery **210**. For example, the power module **225** may interface with an external wireless charger that charges the battery **210** when interfaced with the ring **104**. The charger may include a datum structure that mates with a ring **104** datum structure to create a specified orientation with the ring **104** during charging. The power module **225** may also regulate voltage (s) of the device electronics, regulate power output to the device electronics, and monitor the state of charge of the battery **210**. In some implementations, the battery **210** may include a protection circuit module (PCM) that protects the battery **210** from high current discharge, over voltage during charging, and under voltage during discharge. The power module **225** may also include electro-static discharge (ESD) protection.

[0051] The one or more temperature sensors **240** may be electrically coupled to the processing module **230**-*a*. The temperature sensor **240** may be configured to generate a temperature signal (e.g., temperature data) that indicates a temperature read or sensed by the temperature sensor **240**. The processing module **230**-*a* may determine a temperature of the user in the location of the temperature sensor **240**. For example, in the ring **104**, temperature data generated by the temperature sensor **240** may indicate a temperature of a user at the user's finger (e.g., skin temperature). In some implementations, the temperature sensor **240** may contact the user's skin. In other implementations, a portion of the housing **205** (e.g., the inner housing **205**-*a*) may form a barrier (e.g., a thin, thermally conductive barrier) between the temperature sensor **240** and the user's skin. In some implementations, portions of the ring **104** configured to contact the user's finger may have thermally conductive portions and thermally insulative portions. The thermally conductive portions may conduct heat from the user's finger to the temperature sensors **240**. The thermally insulative portions may insulate portions of the ring **104** (e.g., the temperature sensor **240**) from ambient temperature.

[0052] In some implementations, the temperature sensor **240** may generate a digital signal (e.g., temperature data) that the processing module **230**-*a* may use to determine the temperature. As another example, in cases where the temperature sensor **240** includes a passive sensor, the processing module **230**-*a* (or a temperature sensor **240** module) may measure a current/voltage generated by the temperature sensor **240** and determine the temperature based on the measured current/voltage. Example temperature sensors **240** may include a thermistor, such as a negative temperature coefficient (NTC) thermistor, or other types of sensors including resistors, transistors, diodes, and/or other electrical/electronic components.

[0053] The processing module **230**-*a* may sample the user's temperature over time. For example, the processing module **230**-*a* may sample the user's temperature according to a sampling rate. An example sampling rate may include one sample per second, although the processing module **230**-*a* may be configured to sample the temperature signal at other sampling rates that are higher or lower than one sample per second. In some implementations, the processing module **230**-*a* may sample the user's temperature continuously throughout the day and night. Sampling at a sufficient rate (e.g., one sample per second) throughout the day may provide sufficient temperature data for analysis described herein.

[0054] The processing module **230**-*a* may store the sampled temperature data in memory **215**. In some implementations, the processing module **230**-*a* may process the sampled temperature data. For example, the processing module **230**-*a* may determine average temperature values over a period of time. In one example, the processing module **230**-*a* may determine an average temperature value each minute by summing all temperature values collected over the minute and dividing by the number of samples over the minute. In a specific example where the temperature is sampled at one sample per second, the average temperature may be a sum of all sampled temperatures for one minute divided by sixty seconds. The memory **215** may store the average temperature values over time. In some implementations, the memory **215** may store average temperatures (e.g., one per minute) instead of sampled temperatures in order to conserve memory **215**.

[0055] The sampling rate, which may be stored in memory **215**, may be configurable. In some implementations, the sampling rate may be the same throughout the day and night. In other implementations, the sampling rate may be changed throughout the day/night. In some implementations, the ring **104** may filter/reject temperature readings, such as large spikes in temperature that are not indicative of physiological changes (e.g., a temperature spike from a hot shower). In some implementations, the ring **104** may filter/reject temperature readings that may not be reliable due to other factors, such as excessive motion during exercise (e.g., as indicated by a motion sensor **245**).

[0056] The ring **104** (e.g., communication module) may transmit the sampled and/or average temperature data to the user device **106** for storage and/or further processing. The user device **106** may transfer the sampled and/or average temperature data to the server **110** for storage and/or further processing.

[0057] Although the ring **104** is illustrated as including a single temperature sensor **240**, the ring **104** may include multiple temperature sensors **240** in one or more locations, such as arranged along the inner housing **205**-*a* near the user's finger. In some implementations, the temperature sensors **240** may be stand-alone temperature sensors **240**. Additionally, or alternatively, one or more temperature sensors **240** may be included with other components (e.g., packaged with other components), such as with the accelerometer and/or processor.

[0058] The processing module **230**-*a* may acquire and process data from multiple temperature sensors **240** in a similar manner described with respect to a single temperature sensor **240**. For example, the processing module **230** may individually sample, average, and store temperature data from each of the multiple temperature sensors **240**. In other examples, the processing module **230**-*a* may sample the sensors at different rates and average/store different values for the different sensors. In some implementations, the processing module **230**-*a* may be configured to determine a single temperature based on the average of two or more temperatures determined by two or more temperature sensors **240** in different locations on the finger.

[0059] The temperature sensors **240** on the ring **104** may acquire distal temperatures at the user's finger (e.g., any finger). For example, one or more temperature sensors **240** on the ring **104** may acquire a user's temperature from the underside of a finger or at a different location on the finger. In some implementations, the ring **104** may continuously acquire distal temperature (e.g., at a sampling rate). Although distal temperature measured by a ring **104** at the finger is described herein, other devices may measure temperature at the same/different locations. In some cases, the distal temperature measured at a user's finger may differ from the temperature measured at a user's wrist or other external body location. Additionally, the distal temperature measured at a user's finger (e.g., a "shell" temperature) may differ from the user's core temperature. As such, the ring **104** may provide a useful temperature signal that may not be acquired at other internal/external locations of the body. In some cases, continuous temperature measurement at the finger may capture temperature fluctuations (e.g., small or large fluctuations) that may not be evident in core temperature. For example, continuous temperature measurement at the finger may capture minute-to-minute or hour-to-hour temperature fluctuations that provide additional insight that may not be provided by other temperature measurements elsewhere in the body.

[0060] The ring **104** may include a PPG system **235**. The PPG system **235** may include one or more optical transmitters that transmit light. The PPG system **235** may also include one or more optical receivers that receive light transmitted by the one or more optical transmitters. An optical receiver may generate a signal (hereinafter "PPG" signal) that indicates an amount of light received by the optical receiver. The optical transmitters may illuminate a region of the user's finger. The PPG signal generated by the PPG system **235** may indicate the perfusion of blood in the illuminated region. For example, the PPG signal may indicate blood volume changes in the illuminated region caused by a user's pulse pressure. The processing module **230**-*a* may sample the PPG signal and determine a user's pulse waveform based on the PPG signal. The processing module **230**-*a* may determine a variety of physiological parameters based on the user's pulse waveform, such as a user's respiratory rate, heart rate, HRV, oxygen saturation, and other circulatory parameters.

[0061] In some implementations, the PPG system **235** may be configured as a reflective PPG system **235** where the optical receiver(s) receive transmitted light that is reflected through the region of the user's finger. In some implementations, the PPG system **235** may be configured as a transmissive PPG system **235** where the optical transmitter(s) and optical receiver(s) are arranged opposite to one another, such that light is transmitted directly through a portion of the user's finger to the optical receiver(s).

[0062] The number and ratio of transmitters and receivers included in the PPG system **235** may vary. Example optical transmitters may include light-emitting diodes (LEDs). The optical transmitters may transmit light in the infrared spectrum and/or other spectrums. Example optical receivers may include, but are not limited to, photosensors, phototransistors, and photodiodes. The optical receivers may be configured to generate PPG signals in response to the wavelengths received from the optical transmitters. The location of the transmitters and receivers may vary. Additionally, a single device may include reflective and/or transmissive PPG systems **235**.

[0063] The PPG system **235** illustrated in FIG. **2** may include a reflective PPG system **235** in some implementations. In these implementations, the PPG system **235** may include a centrally located optical receiver (e.g., at the bottom of the ring **104**) and two optical transmitters located on each side of the optical receiver. In this implementation, the PPG system **235** (e.g., optical receiver) may generate the PPG signal based on light received from one or both of the optical transmitters. In other implementations, other placements, combinations, and/or configurations of one or more optical transmitters and/or optical receivers are contemplated.

[0064] The processing module **230**-*a* may control one or both of the optical transmitters to transmit light while sampling the PPG signal generated by the optical receiver. In some implementations, the processing module **230**-*a* may cause the optical transmitter with the stronger received signal to transmit light while sampling the PPG signal generated by the optical receiver. For example, the selected optical transmitter may continuously emit light while the PPG signal is sampled at a sampling rate (e.g., 250 Hz).

[0065] Sampling the PPG signal generated by the PPG system **235** may result in a pulse waveform that may be referred to as a "PPG." The pulse waveform may indicate blood pressure vs time for multiple cardiac cycles. The pulse waveform may include peaks that indicate cardiac cycles. Additionally, the pulse waveform may include respiratory induced variations that may be used to determine respiration rate. The processing module **230**-*a* may store the pulse waveform in memory **215** in some implementations. The processing module **230**-*a* may process the pulse waveform as it is generated and/or from memory **215** to determine user physiological parameters described herein.

[0066] The processing module **230**-*a* may determine the user's heart rate based on the pulse waveform. For example, the processing module **230**-*a* may determine heart rate (e.g., in beats per minute) based on the time between peaks in the pulse waveform. The time between peaks may be referred to as an interbeat interval (IBI). The processing module **230**-*a* may store the determined heart rate values and IBI values in memory **215**.

[0067] The processing module **230**-*a* may determine HRV over time. For example, the processing module **230**-*a* may determine HRV based on the variation in the *IBIs*. The processing module **230**-*a* may store the HRV values over time in the memory **215**. Moreover, the processing module **230**-*a* may determine the user's respiratory rate over time. For example, the processing module **230**-*a* may determine respiratory rate based on frequency modulation, amplitude modulation, or baseline modulation of the user's IBI values over a period of time. Respiratory rate may be calculated in breaths per minute or as another breathing rate (e.g., breaths per 30 seconds). The processing module **230**-*a* may store user respiratory rate values over time in the memory **215**.

[0068] The ring **104** may include one or more motion sensors **245**, such as one or more accelerometers (e.g., 6-D accelerometers) and/or one or more gyroscopes (gyros). The motion sensors **245** may generate motion signals that indicate motion of the sensors. For example, the ring **104** may include one or more accelerometers that generate acceleration signals that indicate acceleration of the accelerometers.

As another example, the ring **104** may include one or more gyro sensors that generate gyro signals that indicate angular motion (e.g., angular velocity) and/or changes in orientation. The motion sensors **245** may be included in one or more sensor packages. An example accelerometer/gyro sensor is a Bosch BM1160 inertial micro electro-mechanical system (MEMS) sensor that may measure angular rates and accelerations in three perpendicular axes.

[0069] The processing module **230**-*a* may sample the motion signals at a sampling rate (e.g., 50 Hz) and determine the motion of the ring **104** based on the sampled motion signals. For example, the processing module **230**-*a* may sample acceleration signals to determine acceleration of the ring **104**. As another example, the processing module **230**-*a* may sample a gyro signal to determine angular motion. In some implementations, the processing module **230**-*a* may store motion data in memory **215**. Motion data may include sampled motion data as well as motion data that is calculated based on the sampled motion signals (e.g., acceleration and angular values).

[0070] The ring **104** may store a variety of data described herein. For example, the ring **104** may store temperature data, such as raw sampled temperature data and calculated temperature data (e.g., average temperatures). As another example, the ring **104** may store PPG signal data, such as pulse waveforms and data calculated based on the pulse waveforms (e.g., heart rate values, IBI values, HRV values, and respiratory rate values). The ring **104** may also store motion data, such as sampled motion data that indicates linear and angular motion.

[0071] The ring **104**, or other computing device, may calculate and store additional values based on the sampled/calculated physiological data. For example, the processing module **230** may calculate and store various metrics, such as sleep metrics (e.g., a Sleep Score), activity metrics, and readiness metrics. In some implementations, additional values/metrics may be referred to as "derived values." The ring **104**, or other computing/wearable device, may calculate a variety of values/metrics with respect to motion. Example derived values for motion data may include, but are not limited to, motion count values, regularity values, intensity values, metabolic equivalence of task values (METs), and orientation values. Motion counts, regularity values, intensity values, and METs may indicate an amount of user motion (e.g., velocity/acceleration) over time. Orientation values may indicate how the ring **104** is oriented on the user's finger and if the ring **104** is worn on the left hand or right hand.

[0072] In some implementations, motion counts and regularity values may be determined by counting a number of acceleration peaks within one or more periods of time (e.g., one or more 30 second to 1 minute periods). Intensity values may indicate a number of movements and the associated intensity (e.g., acceleration values) of the movements. The intensity values may be categorized as low, medium, and high, depending on associated threshold acceleration values. METs may be determined based on the intensity of movements during a period of time (e.g., 30 seconds), the regularity/irregularity of the movements, and the number of movements associated with the different intensities.

[0073] In some implementations, the processing module **230**-*a* may compress the data stored in memory **215**. For example, the processing module **230**-*a* may delete sampled data after making calculations based on the sampled data. As another example, the processing module **230**-*a* may average data over longer periods of time in order to reduce the number of stored values. In a specific example, if average temperatures for a user over one minute are stored in memory **215**, the processing module **230**-*a* may calculate average temperatures over a five minute time period for storage, and then subsequently erase the one minute average temperature data. The processing module **230**-*a* may compress data based on a variety of factors, such as the total amount of used/available memory **215** and/or an elapsed time since the ring **104** last transmitted the data to the user device **106**.

[0074] Although a user's physiological parameters may be measured by sensors included on a ring **104**, other devices may measure a user's physiological parameters. For example, although a user's temperature may be measured by a temperature sensor **240** included in a ring **104**, other devices may measure a user's temperature. In some examples, other wearable devices (e.g., wrist devices) may include sensors that measure user physiological parameters. Additionally, medical devices, such as external medical devices (e.g., wearable medical devices) and/or implantable medical devices, may measure a user's physiological parameters. One or more sensors on any type of computing device may be used to implement the techniques described herein.

[0075] The physiological measurements may be taken continuously throughout the day and/or night. In some implementations, the physiological measurements may be taken during portions of the day and/or portions of the night. In some implementations, the physiological measurements may be taken in response to determining that the user is in a specific state, such as an active state, resting state, and/or a sleeping state. For example, the ring **104** can make physiological measurements in a resting/sleep state in order to acquire cleaner physiological signals. In one example, the ring **104** or other device/system may detect when a user is resting and/or sleeping and acquire physiological parameters (e.g., temperature) for that detected state. The devices/systems may use the resting/sleep physiological data and/or other data when the user is in other states in order to implement the techniques of the present disclosure.

[0076] In some implementations, as described previously herein, the ring **104** may be configured to collect, store, and/or process data, and may transfer any of the data described herein to the user device **106** for storage and/or processing. In some aspects, the user device **106** includes a wearable application **250**, an operating system (OS), a web browser application (e.g., web browser **280**), one or more additional applications, and a GUI **275**. The user device **106** may further include other modules and components, including sensors, audio devices, haptic feedback devices, and the like. The wearable application **250** may include an example of an application (e.g., "app") that may be installed on the user device **106**. The wearable application **250** may be configured to acquire data from the ring **104**, store the acquired data, and process the acquired data as described herein. For example, the wearable application **250** may include a user interface (UI) module **255**, an acquisition module **260**, a processing module **230**-*b*, a communication module **220**-*b*, and a storage module (e.g., database **265**) configured to store application data.

[0077] In some cases, the wearable device **104** and the user device **106** may be included within (or make up) the same device. For example, in some cases, the wearable device **104** may be configured to execute the wearable application **250**, and may be configured to display data via the GUI **275**.

[0078] The various data processing operations described herein may be performed by the ring **104**, the user device **106**, the servers **110**, or any combination thereof. For example, in some cases, data collected by the ring **104** may be pre-processed and transmitted to the user device **106**. In this example, the user device **106** may perform some data processing operations on the received data, may transmit the data to the servers **110** for data processing, or both. For instance, in some cases, the user device **106** may perform processing operations that require relatively low processing power and/or operations that require a relatively low latency, whereas the user device **106** may transmit the data to the servers **110** for processing operations that require relatively high processing power and/or operations that may allow relatively higher latency.

[0079] In some aspects, the ring **104**, user device **106**, and server **110** of the system **200** may be configured to evaluate sleep patterns for a user. In particular, the respective components of the system **200** may be used to collect data from a user via the ring **104**, and generate one or more scores (e.g., Sleep Score, Readiness Score) for the user based on the collected data. For example, as noted previously herein, the ring **104** of the system **200** may be worn by a user to collect data from the user, including temperature, heart rate, HRV, and the like. Data collected by the ring **104** may be used to determine when the user is asleep in order to evaluate the user's sleep for a given "sleep day." In some aspects, scores may be calculated for the user for each respective sleep day, such that a first sleep day is associated with a first set of scores, and a second sleep day is associated with a second set of scores. Scores may be calculated for each respective sleep day based on data collected by the ring **104** during the respective sleep day. Scores may include, but are not limited to, Sleep Scores, Readiness Scores, and the like.

[0080] In some cases, "sleep days" may align with the traditional calendar days, such that a given sleep day runs from midnight to midnight of the respective calendar day. In other cases, sleep days may be offset relative to calendar days. For example, sleep days may run from 6:00 pm (18:00) of a calendar day until 6:00 pm (18:00) of the subsequent calendar day. In this example, 6:00 pm may serve as a "cut-off time," where data collected from the user before 6:00 pm is counted for the current sleep day, and data collected from the user after 6:00 pm is counted for the subsequent sleep day. Due to the fact that most individuals sleep the most at night, offsetting sleep days relative to calendar days may enable the system **200** to evaluate sleep patterns for users in such a manner that is consistent with their sleep schedules. In some cases, users may be able to selectively adjust (e.g., via the GUI) a timing of sleep days relative to calendar days so that the sleep days are aligned with the duration of time that the respective users typically sleep.

[0081] In some implementations, each overall score for a user for each respective day (e.g., Sleep Score, Readiness Score) may be determined/calculated based on one or more "contributors," "factors," or "contributing factors." For example, a user's overall Sleep Score may be calculated based on a set of contributors, including: total sleep, efficiency, restfulness, REM sleep, deep sleep, latency, timing, or any combination thereof. The Sleep Score may include any quantity of contributors. The "total sleep" contributor may refer to the sum of all sleep periods of the sleep day. The "efficiency" contributor may reflect the percentage of time spent asleep compared to time spent awake while in bed, and may be calculated using the efficiency average of long sleep periods (e.g., primary sleep period) of the sleep day, weighted by a duration of each sleep period. The "restfulness" contributor may indicate how restful the user's sleep is, and may be calculated using the average of all sleep periods of the sleep day, weighted by a duration of each period. The restfulness contributor may be based on a "wake up count" (e.g., sum of all the wake-ups (when user wakes up) detected during different sleep periods), excessive movement, and a "got up count" (e.g., sum of all the got-ups (when user gets out of bed) detected during the different sleep periods).

[0082] The "REM sleep" contributor may refer to a sum total of REM sleep durations across all sleep periods of the sleep day including REM sleep. Similarly, the "deep sleep" contributor may refer to a sum total of deep sleep durations across all sleep periods of the sleep day including deep sleep. The "latency" contributor may signify how long (e.g., average, median, longest) the user takes to go to sleep, and may be calculated using the average of long sleep periods throughout the sleep day, weighted by a duration of each period and the number of such periods (e.g., consolidation of a given sleep stage or sleep stages may be its own contributor or weight other contributors). Lastly, the "timing" contributor may refer to a relative timing of sleep periods within the sleep day and/or calendar day, and may be calculated using the average of all sleep periods of the sleep day, weighted by a duration of each period.

[0083] By way of another example, a user's overall Readiness Score may be calculated based on a set of contributors, including: sleep, sleep balance, heart rate, HRV balance, recovery index, temperature, activity, activity balance, or any combination thereof. The Readiness Score may include any quantity of contributors. The "sleep" contributor may refer to the combined Sleep Score of all sleep periods within the sleep day. The "sleep balance" contributor may refer to a cumulative duration of all sleep periods within the sleep day. In particular, sleep balance may indicate to a user whether the sleep that the user has been getting over some duration of time (e.g., the past two weeks) is in balance with the user's needs. Typically, adults need 7-9 hours of sleep a night to stay healthy, alert, and to perform at their best both mentally and physically. However, it is normal to have an occasional night of bad sleep, so the sleep balance contributor takes into account long-term sleep patterns to determine whether each user's sleep needs are being met. The "resting heart rate" contributor may indicate a lowest heart rate from the longest sleep period of the sleep day (e.g., primary sleep period) and/or the lowest heart rate from naps occurring after the primary sleep period.

[0084] Continuing with reference to the "contributors" (e.g., factors, contributing factors) of the Readiness Score, the "HRV balance" contributor may indicate a highest HRV average from the primary sleep period and the naps happening after the primary sleep period. The HRV balance contributor may help users keep track of their recovery status by comparing their HRV trend over a first time period (e.g., two weeks) to an average HRV over some second, longer time period (e.g., three months). The "recovery index" contributor may be calculated based on the longest sleep period. Recovery index measures how long it takes for a user's resting heart rate to stabilize during the night. A sign of a very good recovery is that the user's resting heart rate stabilizes during the first half of the night, at least six hours before the user wakes up, leaving the body time to recover for the next day. The "body temperature" contributor may be calculated based on the longest sleep period (e.g., primary sleep period) or based on a nap happening after the longest sleep period if the user's highest temperature during the nap is at least 0.5° C. higher than the highest temperature during the longest period. In some aspects, the ring may measure a user's body temperature while the user is asleep, and the system **200** may display the user's average temperature relative to the user's baseline temperature. If a user's body temperature is outside of their normal range (e.g., clearly above or below 0.0), the body temperature contributor may be highlighted (e.g., go to a "Pay attention" state) or otherwise generate an alert for the user.

[0085] In some aspects, the system **200** may support techniques for a charging device (e.g., a portable charger for a wearable device **104**) without a battery. For example, the charging device may include one or more portions that may be reconfigured into a first charging orientation and a second charging orientation. In the first charging orientation, the charging device may include a flange that may be on a same side of a charger post as a power receiving component (e.g., such that the wearable device **104** may be easily removed from the charger base). In the second charging orientation, the charging device may include the flange that may be on a different (e.g., opposite) side of the charger post as the power receiving component (e.g., such that the wearable device **104** may not be easily removed from the charger base when the power receiving component is coupled to an external power source).

[0086] FIG. **3** shows an example of a system **300** that supports a portable charger without a battery for wearable devices in accordance with aspects of the present disclosure. The system **300** may implement, or be implemented by system **100**, system **200**, or both. In particular, system **300** illustrates an example of a ring **104** (e.g., wearable device **104**), as described with reference to FIGS. **1** and **2**, and a charger device **305**.

[0087] In some aspects, the ring **104** may be configured to be worn around a user's finger and may measure one or more user physiological parameters when worn around the user's finger. Example measurements and determinations may include, but are not limited to, user skin temperature, pulse waveforms, respiratory rate, heart rate, HRV, blood oxygen levels, and the like.

[0088] The system **300** further includes a charger device **305**. The ring **104** may be in wireless and/or wired communication with a user device **106** and/or server **110**. Similarly, the charger device **305** may be in wireless and/or wired communication with a user device **106**, the ring **104**, a server **110**, or any combination thereof. In some implementations, the charger device **305** may send measured and processed data (e.g., temperature data, humidity data, noise data, and the like) to the user device **106**, the ring **104**, or both. Various data processing procedures described herein may be performed by any of the components of system **300**, including the ring **104**, charger device **305**, user device **106**, server **110**, or any combination thereof. In this regard, the charger device **305** (e.g., charger device) may include one or more processors. As will be described in further detail herein, the one or more processors of the charger device **305** may be configured to evaluate physiological data collected from the ring **104** in order to identify satisfaction of trigger conditions used to trigger the display system **350** to display different types of data/information.

[0089] Data may be collected and analyzed via one or more components of the system **300**. Moreover, in some implementations, the charger device **305** may be configured to collect and analyze data, including ambient temperature data, noise data, and the like. For example, the user device **106** may determine a correlation between sleep data from the ring **104** and the measured and processed data from the charger device **305** (e.g., if the air temperature is relatively high, a user of the ring **104** may wake up throughout a sleep duration). In other words, data collected via the charger device **305** (e.g., ambient air temperature data, noise data) may be used to further analyze physiological data collected via the ring **104**, and identify relationships between the user's physiological data and their surrounding environment (e.g., how the user's surroundings affect their physiological data).

[0090] The ring **104** may include an inner housing **205**-*a* and an outer housing **205**-*b*, as described with reference to FIG. **2**. In some aspects, the housing **205** of the ring **104** may store or otherwise include various components of the ring **104** including, but not limited to, device electronics (e.g., a power module **317**, which may be an example of a power module **225** as described with reference to FIG. **2**), a power source (e.g., battery **312**, which may be an example of a battery **210** as described with reference to FIG. **2**, and/or capacitor), one or more substrates (e.g., printable circuit boards) that interconnect the device electronics and/or power source, and the like. In some examples, the housing **205** may also store a magnetic component **320**-*a* (e.g., ferrite tape, other charging magnet, a transmitter coil, a rare earth magnet, or the like) and an inductive charging component **325** (e.g., inductive charging component **325**-*a*).

[0091] The ring **104** shown and described with reference to FIGS. **2** and **3** is provided solely for illustrative purposes. As such, the ring **104** may include additional or alternative components as those illustrated in FIGS. **2** and **3**. Other rings **104** that provide functionality described herein may be fabricated. For example, rings **104** with fewer components (e.g., sensors) may be fabricated. In a specific example, a ring **104** may include ferrite tape, which may act as both the magnetic component **320**-*a* and the inductive charging component **325**-*a*. In other cases, the ring **104** may include a dedicated charger magnet. For example, the ring **104** may include a metal plate and/or ferrite tape disposed proximate to a charger magnet.

[0092] In some cases, the ring **104** may be in electronic communication with the charger device **305**. The charger device **305** may charge the battery **312** of the ring **104**. The charger device **305** may include a support, which may store or otherwise include various components of the charger device **305**. In some aspects, the support of the charger device **305** may store or otherwise include various components of the charger device **305** including, but not limited to, a magnetic component **320**-*b* (e.g., ferrite tape, a transmitter coil, a rare earth magnet, or the like) and an inductive charging component **325**-*b*.

[0093] In some cases, the magnetic component **320**-*b* of the charger device **305** may include multiple magnets arranged according to a pattern based on a polarity of each magnet. For example, each magnet may have a polarity facing outward towards the surface of the charger device **305** to attract the magnetic component **320**-*a* of the ring **104** with an opposite polarity. The charging component **325**-*b* of the charger device **305** (e.g., transmitter coil, ferrite tape) may couple with charging component **325**-*a* of the ring **104** (e.g., receiver coil, ferrite tape) to charge the battery **312** of the ring **104**. In some examples, the charging component **325**-*a* and the charging component **325**-*b* may support charging of the battery **312** via direct electrical coupling (e.g., of contacts at the surface of the charger device **305** and the ring **104**). Additionally, or alternatively, the charging component **325**-*a* and the charging component **325**-*b* may be examples of inductive charging components, which may support charging of the battery **312** via indirect electrical coupling. Inductive charging may also be referred to as wireless charging and may allow power to transfer from the charger device **305** to the battery **312** of the ring **104** using electromagnetic induction.

[0094] In some cases, the ring **104** may be configured to fit around a support **315** (e.g., charging post) of the charger device **305**, where the magnetic components **320**-*b* are configured to attract the magnetic components **320**-*b* and to align the ring **104** in the correct radial orientation for charging and secure the ring **104** onto the charger device **305**. That is, the magnetic components **320** may be configured to align the inductive charging components **325** to facilitate inductive charging for the ring. In some cases, the charger device **305** may include one or more indentation features (e.g., on an external radial surface of the support **315**) that may be configured to receive one or more protrusions (e.g., dome-shaped protrusions) of the ring **104** when the ring is placed onto the charger device **305** (e.g., in the correct radial orientation).

[0095] In some examples, the charger device **305** may include one or more temperature sensors **335**. The temperature sensors **335** may measure an average air temperature over a duration, may continuously measure air temperature, or both. Similarly, the charger device **305** may include one or more humidity sensors **340**. The humidity sensors **340** may measure an average humidity level over a duration, may continuously measure humidity level, or both. The humidity sensors **340** may measure the humidity as a percentage (e.g., 35% humidity). The charger device **305** may include one or more noise sensors **345**. The noise sensors **345** may measure a noise level (e.g., in decibels) averaged over a duration, continuously, or both. The charger device **305** may store the humidity measurements, the temperature measurements, the noise measurements, or a combination thereof.

[0096] The charger device **305** may include any type of sensor known in the art and may be configured to collect any type of data which may be used to provide insight into a user's environment and overall health. For example, the charger device **305** may include light sensors configured to measure an amount of light and/or type of light (e.g., wavelength). In such cases, the system **300** may be configured to determine whether light levels and/or which types of light may result positively or negatively affect a user's sleep and health (e.g., determine if blue light is more disruptive to a user's sleep as compared to red light). By way of another example, the charger device **305** may include air quality sensors configured to measure air quality, pollutants, allergens, and the like. Data collected via sensors of the charger device **305** may be leveraged to determine how a user's surrounding environment may affect their physiological data, sleep, and overall health. A processing module, such as a processing module **230** as described with reference to FIG. **2**, at the user device **106** or at the charger device **305** may process the data from the temperature sensors **335**, the humidity sensors **340**, the noise sensors **345**, light sensors, air quality sensors, or a combination thereof.

[0097] In some examples, the user device **106** and/or charger device **305** may process the data from the temperature sensors **335**, the humidity sensors **340**, the noise sensors **345**, or a combination thereof in conjunction with data from the ring **104**. For example, the user device **106** may receive physiological data collected by the ring **104** which reflects one or more sleep cycles of a user and may use the data from the sensors at the charger device **305** to determine a correlation between the collected physiological data and data collected by the charger device **305**. For example, the user device **106** may determine a correlation over a time interval between data collected by the charger device **305** (e.g., ambient temperature data, humidity data, noise data, and the like) with a quality of sleep for the user (as determined by collected physiological data). In other words, the system **300** may be configured to identify whether high/low temperature, humidity, and/or noise levels result in a disruption of the user's sleep cycles (e.g., low ambient temperature and humidity levels result in higher quality sleep, higher noise levels result in lower quality sleep).

[0098] Although the charger device **305** is illustrated as including temperature sensors **335**, humidity sensors **340**, and noise sensors **345**, the charger device **305** may include any quantity and type of sensors in one or more locations. For example, the charger device **305** may also include a motion sensor, a light sensor, or the like.

[0099] In some implementations, the charger device **305** may include a wired or wireless power source. For example, in some cases, the charger device **305** may be coupled with an electrical outlet or other power source. The charger device **305** may therefore include a power receiving component **355** (e.g., a USB-C connector) to receive power from one or more external sources (e.g., an outlet, a user device, a computer, and so on). In other cases, the charger device **305** may be coupled with the ring **104** (e.g., magnetically coupled, mechanically snapped onto) the ring **104** while the ring **104** is being worn so that the ring **104** may be charged (and continue to collect physiological data) as it is worn.

[0100] In some cases, the charger device **305** may include a display system **350**. The display system **350** may display one or more indications to a user of the ring **104** (e.g., via one or more LEDs, OLEDs, or an LCD). For example, the display system **350** may display a battery level of the battery **312**, a battery health/charge status (e.g., end of battery life), a time of day, connectivity issues, and so on. The display system **350** may, additionally, or alternatively, display one or more alerts to the user (e.g., action items prompting the user to perform an action, and the like). In some examples, the display system **350** may display a battery level of the battery **312** of the ring **104** as a percentage of total battery by displaying the numbers of the percentage, by illuminating a portion of LEDs (e.g., if a battery level is at 50%, 5 of 10 LEDs may be displayed), or the like. The LEDs in the display system **350** may be oriented in any arrangement on the charger device **305**, may be any color combination (e.g., red LED, blue LED, green LED), and there may be any quantity of LEDs in the display system **350**.

[0101] In some cases, the charger device **305** may include one or more parts that may be reconfigured to various charging positions. For example, the support **315** may include a flange **310** that may be configured to prevent the ring **104** from sliding off of the charger device **305**. In some examples, the charger device **305** may be reconfigured into a first charging orientation in which the flange **310** is on a same side of the support **315** as the power receiving component **355** and a second charging orientation in which the flange **310** is on a different (e.g., opposite) side of the support **315** as the power receiving component **355**. Accordingly, the charger device **305** may support the first charging orientation in which the ring **104** may be removed from the charger device **305** when the power receiving component **355** is coupled with an external power source and the second charging orientation in which the ring **104** may not be removed from the charger device **305** when the power receiving component **355** is coupled with an external power source. The first and second charging orientations are described herein in further detail with reference to FIGS. **4**-**6**.

[0102] FIGS. **4**A and **4**B show examples of a charging diagram **400**-*a* and a charging diagram **400**-*b* that support a portable charger without a battery for wearable devices in accordance with aspects of the present disclosure. The charging diagrams **400** may implement or may be implemented by aspects of the system **100**, the system **200**, or the system **300**. For example, the charging diagrams **400** illustrate examples of a wearable ring device **402** and a charging device, as described herein with reference to FIGS. **1** through **3**.

[0103] As illustrated with reference to the charging diagrams **400**, a charging device for a wearable ring device **402** may include a charging post **405** and a support post **410**. The charging post **405** may include an outer housing (e.g., a plastic housing), a power receiving component **415**, and at least one charging component (e.g., inductive charging component, charging coil) configured to charge a rechargeable battery of the wearable ring device **402** by transferring power from the power receiving component **415** to the wearable ring device **402**. For example, the power receiving component may be a plug (e.g., a USB-C plug) that may connect (e.g., plug in) to an external power source. The external power source may be, for example, a laptop computer, a cell phone, a rechargeable portable battery, a power outlet, and so on. The charging post **405** may comprise one or more circuit components (e.g., a PCB module, a printed wiring board (PWB) module) to transfer power from the power receiving component **415** to the at least one charging component. The charging component may accordingly charge the rechargeable battery of the wearable ring device **402** when an inductive charging component of the wearable ring device **402** is within a threshold distance from (e.g., in contact with) the at least one charging component.

[0104] The support post **410** may be configured to receive the wearable ring device **402**. For example, the support post **410** may have an outer circumferential surface that is smaller in diameter than an inner circumferential surface of the wearable ring device **402** such that the wearable ring device **402** may fit around the support post **410**. In some examples, the support post **410** may include a receiving "hole" in which the charging post **405** may fit. For example, the receiving hole may extend through a width of the support post, and may overlap a portion of the outer circumferential surface of the support post **410**. Accordingly, at least one portion of an outer surface of the charging post **405** may be in contact with a portion of the inner circumferential surface of the wearable ring device **402** when the support post is positioned within the receiving hole and when the wearable ring device **402** is mounted onto the charging device. The inductive charging component of the wearable ring device **402** may therefore be within the threshold distance from (e.g., in contact with) the one or more charging components of the charging post **405** when the wearable ring device **402** is mounted onto the charging device.

[0105] In some examples, a size of the charging device or one or more components of the charging device (e.g., the support post **410**) may be based on a size of the wearable ring device **402**. For example, the support post **410** may be a ring-specific support post **410** with a diameter that is specific to a diameter of the wearable ring device **402**. In some examples, a size of the charging device or one or more components of the charging device may be adjustable (e.g., to accommodate multiple sizes of the wearable ring device **402**). For example, one or more components of the charging device (e.g., the support post **410**, one or more components of the support post **410**) may move in relation to one another to change a diameter size and therefore to fit more than one size of wearable ring device **402**. In some examples, the charging device may include one or more magnetic components configured to attract one or more magnetic components of the wearable ring device **402** (e.g., to secure the wearable ring device onto the charging device).

[0106] In some examples, the support post **410** may include one or more indentations **425** along the outer circumferential surface that may be configured to receive one or more protrusions (e.g., dome-shaped protrusions) along the inner circumferential surface of the wearable ring device **402**. That is, to mount the wearable ring device **402** onto the charging device, a user may orient the wearable ring device **402** in a first radial position in which the one or more protrusions are aligned with the one or more indentations **425** of the support post **410**. The user may accordingly "slide" the wearable ring device **402** onto the charging device in the radial orientation such that the one or more indentations **425** receive the one or more protrusions.

[0107] The radial orientation may be an orientation in which the inductive charging component of the wearable ring device **402** is within the threshold distance from (e.g., in contact with) the one or more charging components of the charging post **405**. As an illustrative example, with reference to FIGS. **4**A and **4**B, in the radial orientation, the inductive charging component of the wearable ring device may be along a bottom of the inner circumferential surface of the wearable ring device **402**, and the one or more charging components of the charging post **405** may be along a bottom of the outer circumferential surface of the charging device (e.g., on the charging post **405**).

[0108] The support post **410** may include a retaining component **420** (e.g., a flange component). The retaining component **420** may be on one side of the support post **410** (e.g., in a first position along the width of the support post **410**). The retaining component **420** may have a diameter that is greater than the diameter of the outer circumferential surface of the support post **410**. For example, the retaining component **420** may have a diameter that is greater than the diameter of the inner circumferential surface of the wearable ring device **402** such that the wearable ring device **402** may not slide off of the support post **410** over the retaining component **420**. That is, the user may remove the wearable ring device **402** from the charging device by sliding the wearable ring device **402** in a direction away from the retaining component **420**, but may not remove the wearable ring device **402** from the charging device by sliding the wearable ring device **402** in a direction towards the retaining component **420**.

[0109] The charging device may be configured to transition between more than one charging orientations. For example, the charging device may be configured to operate (e.g., to charge the wearable ring device **402**) in a first charging orientation (e.g., a "home" orientation, as illustrated with reference to FIG. **4**A) or in a second charging orientation (e.g., a "travel" orientation, as illustrated with reference to FIG. **4**B).

[0110] As illustrated with reference to FIG. **4**A, in the first charging orientation, the retaining component **420** may be on a same side of the support post **410** as the power receiving component **415**. Accordingly, the user of the charging device may easily slide the wearable ring device **402** onto and off of the charging device when the power receiving component is connected to an external power source (e.g., when the charging device is plugged in).

[0111] As illustrated with reference to FIG. **4**B, in the second charging orientation, the retaining component **420** may be on a different side of the support post **410** from the power receiving component **415** (e.g., an opposite side). Accordingly, the user of the charging device may not easily slide the wearable ring device **402** onto and off of the charging device when the power receiving component is connected to an external power source (e.g., when the charging device is plugged in). That is, the user may slide the wearable ring device **402** onto the charging device prior to plugging the charging device into an external power source. The user may remove (e.g., unplug) the charging device from the external power source prior to removing the wearable ring device **402** from the charging device. Accordingly, in the second charging orientation, the wearable ring device **402** may be secured onto the charging device, and the user may therefore travel while charging the wearable ring device **402** (e.g., charging from a portable power source, such as a cell phone, laptop, or portable battery) without the wearable ring device **402** moving off of the charging device.

[0112] In some examples, to transition between the first charging orientation and the second charging orientation, the charging device may comprise separate pieces (e.g., a separate support post **410** and a separate or removable charging post **405**) that may interface (e.g., connect) in either of the first charging orientation or the second charging orientation. Such a charging device is described in further detail with reference to FIGS. **5**A and **5**B. Additionally, or alternatively, the charging device may comprise a hinge component connecting the charging post **405** and the support post **410**. The charging device may therefore transition between the first charging orientation and the second charging orientation via the hinge component. Such a charging device is described in further detail with reference to FIGS. **6**A and **6**B.

[0113] FIGS. **5**A and **5**B show examples of a charging diagram **500**-*a* and a charging diagram **500**-*b* that support a portable charger without a battery for wearable devices in accordance with aspects of the present disclosure. The charging diagrams **500** may implement or may be implemented by aspects of the system **100**, the system **200**, the system **300**, or the charging diagrams **400**. For example, the charging diagrams **500** illustrate examples of a wearable ring device **502** and a charging device, as described herein with reference to FIGS. **1** through **4**.

[0114] In some aspects, a charging device for a wearable ring device **502** may include a charging post **505** and a removable support post **510**. The charging post **505** may include an outer housing (e.g., a plastic housing) encasing one or more circuit components (e.g., a PCB or PWB module **535**), a power receiving component **515** (e.g., a USB-C connector), and a charging component **530**-*a* (e.g., an inductive charging component). The PWB module **535** may be configured to transfer power from an external power source (e.g., an external battery, a laptop device, a phone, a wall outlet) via the power receiving component **515** to the charging component **530**-*a* to charge a rechargeable battery of the wearable ring device **502**. For example, the charging component **530**-*a* may charge the rechargeable battery of the wearable ring device **502** when the charging component **530**-*a* is within a threshold distance from (e.g., in contact with) a charging component **530**-*b* of the wearable ring device **502**.

[0115] The removable support post **510** may be configured to interface with the charging post **505** via a receiving "hole" in the support post **510**. That is, the support post **510** may have an outer circumferential surface, and may have a hole that extends through the width of the support post **510** such that the charging post **505** may fit within the support post **510**. The receiving hole may overlap a portion of the outer circumferential surface such that a portion of the support post **510** (e.g., the charging component **530**-*a*) may be uncovered by the support post **510**. Accordingly, the charging component **530**-*a* may be within the threshold distance from (e.g., in contact with) the charging component **530**-*b* when the wearable ring device **502** is mounted onto the charging device. In some examples, the charging component **530**-*a* may align with the outer circumferential surface of the support post **510** when the charging post **505** is positioned within the receiving hole.

[0116] In some examples, the removable support post **510** and the charging post **505** may comprise one or more components configured to secure the charging post **505** within the receiving hole of the support post **510**. For example, the receiving hole of the support post **510** may comprise a shaped hole portion (e.g., a T-shaped portion, as illustrated with reference to FIGS. **4**A and **4**B), and the charging post **505** may comprise a shaped protrusion portion configured to fit within the shaped hole portion. Accordingly, the charging post **505** may not slide out of the gap in the outer circumferential surface of the support post **510**.

[0117] Additionally, or alternatively, an interior wall of the receiving hole of the support post **510** may include one or more indentations **525** configured to interface with one or more clip portions **520** (e.g., metal clips) of the charging post **505**. In some examples, the one or more clip portions **520** may compress inwards towards an outer surface of the housing of the charging post **505** while a user "slides" the charging post into the receiving hole. The one or more clip portions **520** may decompress outwards into the one or more indentations **525** such that the charging post **505** may not slide out of the receiving hole (e.g., until the user applies a threshold amount of pressure to compress the clip portions **520** and push the charging post **505** out of the receiving hole).

[0118] In some examples, the outer circumferential surface of the support post may include one or more indentations **540** configured to receive one or more protrusions **545** on an inner circumferential surface of the wearable ring device **502** (e.g., protrusions housing one or more components configured to perform measurements of physiological data of the user). For example, to mount the wearable ring device **502** onto the charging device, the user may orient the wearable ring device **502** in a radial orientation in which the one or more protrusions **545** are aligned with the one or more indentations **540** of the support post **510**. The user may accordingly "slide" the wearable ring device **502** onto the charging device in the radial orientation such that the one or more indentations **540** receive the one or more protrusions **545**.

[0119] The radial orientation may be an orientation in which the charging component **530**-*b* of the wearable ring device **502** is within the threshold distance from (e.g., in contact with) the charging component **530**-*a* of the charging post **505**. As an illustrative example, with reference to FIGS. **5**A and **5**B, in the radial orientation, the charging component **530**-*b* may be along a bottom of the inner circumferential surface of the wearable ring device **502**, and the charging component **530**-*a* of the charging post **505** may be along a bottom of the outer circumferential surface of the charging device (e.g., on the charging post **505**).

[0120] The removable support post **510** may include a retaining component **550** (e.g., a flange component). The retaining component **550** may be on one side of the support post **510** (e.g., in a first position along the width of the support post **510**). The retaining component **550** may have a diameter that is greater than the diameter of the outer circumferential surface of the support post **510**. For example, the retaining component **550** may have a diameter that is greater than the diameter of the inner circumferential surface of the wearable ring device **502** such that the wearable ring device **502** may not slide off of the support post **510** over the retaining component **550**. That is, the user may remove the wearable ring device **502** from the charging device by sliding the wearable ring device **502** in a direction away from the retaining component **550**, but may not remove the wearable ring device **502** from the charging device by sliding the wearable ring device **502** in a direction towards the retaining component **550**.

[0121] The removable support post **510** may be configured to interface with the charging post **505** in more than one charging orientation. For example, the charging post **505** may slide into the receiving hole of the removable support post **510** in a first charging orientation (e.g., a "home" orientation, as illustrated with reference to FIG. **5**A) or in a second charging orientation (e.g., a "travel" orientation, as illustrated with reference to FIG. **5**B). In some examples, the one or more indentations **525** in the inner wall of the receiving hole of the support post **510** may be configured to interface with the one or more clip portions **520** in either of the first charging orientation or the second charging orientation.

[0122] As illustrated with reference to FIG. **5**A, in the first charging orientation (e.g., a "home" orientation), the retaining component **550** may be on a same side of the support post **510** as the power receiving component **515**. Such a charging orientation is described in further detail with reference to FIG. **4**A. As illustrated with reference to FIG. **5**B, in the second charging orientation (e.g., a "travel" orientation), the retaining component **550** may be on a different side of the support post **510** from the power receiving component **515** (e.g., an opposite side). Such a charging orientation is described in further detail with reference to FIG. **4**B.

[0123] In some examples, a size of the removable support post **510** may be based on a size of the wearable ring device **502**. For example, a diameter of the outer circumferential surface of the support post **510** may be smaller than a diameter of the inner circumferential surface of the wearable ring device **502** such that the wearable ring device **502** may fit around the support post **510** (e.g., excepting the retaining component **550**). In some examples, one or more other removable support posts (e.g., of one or more other sizes different from the size of the removable support post **510**) may be configured to interface with the charging post **505**. Accordingly, the user may charge a different wearable ring device (e.g., of a different size than the wearable ring device **502**) using the charging post **505** and the one or more other removable support posts. In such examples, the one or more other removable support posts may comprise receiving holes that are a same size and shape as the receiving hole of the support post **510** (e.g., to fit around the charging post **505**).

[0124] FIGS. **6**A and **6**B show examples of a charging diagram **600**-*a* and a charging diagram **600**-*b* that support a portable charger without a battery for wearable devices in accordance with aspects of the present disclosure. The charging diagrams **600** may implement or may be implemented by aspects of the system **100**, the system **200**, the system **300**, the charging diagrams **400**, or the charging diagrams **500**. For example, the charging diagrams **600** may be implemented by a wearable device **102** (e.g., a ring, a bracelet, or another device) and may include a charging device, as described herein with reference to FIGS. **1** through **5**.

[0125] In some aspects, a charging device for a wearable ring device may include a charging post **605** and a support post **610**. The charging post **605** may include an outer housing (e.g., a plastic housing) encasing one or more circuit components (e.g., a PCB or PWB module), a power receiving component **615** (e.g., a USB-C connector), and a charging component **630**-*a* and a charging component **630**-*b* (e.g., inductive charging components). The PWB module may be configured to transfer power from an external power source (e.g., a rechargeable portable battery, a laptop device, a cell phone, a wall outlet) via the power receiving component **615** to the charging component **630**-*a* and/or the charging component **530**-*b* to charge a rechargeable battery of the wearable ring device. For example, the charging component **630**-*a* and/or the charging component **630**-*b* may charge the rechargeable battery of the wearable ring device when one of the charging component **630**-*a* or the charging component **630**-*b* is within a threshold distance from (e.g., in contact with) an inductive charging component of the wearable ring device.

[0126] The support post **610** may be connected to the charging post **605** via a hinge component **625**. The hinge component **625** may rotate the charging post **605** with respect to the support post **610** (e.g., from a first charging orientation **635**-*a* to a second charging orientation **635**-*b*). In some examples, the charging component **630**-*a* and the charging component **630**-*b* may be in a first position and a second position, respectively, on a circumferential surface of the charging post **605**. Accordingly, the charging component **630**-*a* may align with the outer circumferential surface of the support post **510** when the charging post **605** is in the charging orientation **635**-*a* and the charging component **630**-*b* may align with the outer circumferential surface of the support post **610** when the charging post **605** is in the charging orientation **635**-*b*.

[0127] In some examples, the outer circumferential surface of the support post may include one or more indentations **640** configured to receive one or more protrusions on an inner circumferential surface of the wearable device (e.g., protrusions housing one or more components configured to perform measurements of physiological data of a user). For example, to mount the wearable ring device onto the charging device, the user may orient the wearable ring device in a radial orientation in which the one or more protrusions are aligned with the one or more indentations **640** of the support post **610**. The user may accordingly "slide" the wearable ring device onto the charging device in the radial orientation such that the one or more indentations **640** receive the one or more protrusions.

[0128] The radial orientation may be an orientation in which the inductive charging component of the wearable ring device is within the threshold distance from (e.g., in contact with) the charging component **630**-*a* or the charging component **630**-*b* of the charging post **605**. As an illustrative example, with reference to FIGS. **5**A and **5**B, in the radial orientation, the inductive charging component of the wearable ring device may be along a bottom of the inner circumferential surface of the wearable ring device. In the charging orientation **635**-*a*, the charging component **630**-*a* of the charging post **605** may be along a bottom of the outer circumferential surface of the charging device. In the charging orientation **635**-*b*, the charging component **630**-*b* of the charging post **605** may be along a bottom of the outer circumferential surface of the charging device.

[0129] The support post **610** may include a retaining component **620** (e.g., a flange component). The retaining component **620** may be on one side of the support post **610** (e.g., in a first position along the width of the support post **610**). The retaining component **620** may have a diameter that is greater than the diameter of the outer circumferential surface of the support post **610**. For example, the retaining component **620** may have a diameter that is greater than the diameter of the inner circumferential surface of the wearable ring device such that the wearable ring device may not slide off of the support post **610** over the retaining component **620**. That is, the user may remove the wearable ring device from the charging device by sliding the wearable ring device in a direction away from the retaining component **620**, but may not remove the wearable ring device from the charging device by sliding the wearable ring device in a direction towards the retaining component **620**. In some examples, a size of the charging device (e.g., including the support post **610** and the charging post **605**) may be based on a size of the wearable ring device. For example, a diameter of the outer circumferential surface of the charging device may be smaller than a diameter of the inner circumferential surface of the wearable ring device such that the wearable ring device may fit around the charging device (e.g., excepting the retaining component **620**).

[0130] The charging device may be configured to transition between the charging orientation **635**-*a* and the charging orientation **635**-*b* via the hinge component **625**. In the charging orientation **635**-*a* (e.g., a "home" orientation), the retaining component **620** may be on a same side of the support post **610** as the power receiving component **615**. Such a charging orientation is described in further detail with reference to FIG. **4**A. In the charging orientation **635**-*b* (e.g., a "travel" orientation), the retaining component **620** may be on a different side of the support post **610** from the power receiving component **615** (e.g., an opposite side). Such a charging orientation is described in further detail with reference to FIG. **4**B.

[0131] It should be noted that the methods described above describe possible implementations, and that the operations and the steps may be rearranged or otherwise modified and that other implementations are possible. Furthermore, aspects from two or more of the methods may be combined.

[0132] A method by an apparatus is described. The method may include a support post configured to receive a wearable ring device, the support post comprising a retaining component configured to retain the wearable ring device onto the support post, a charging post comprising an outer housing, a power receiving component configured to receive power from one or more external power sources, and a first charging component configured to transfer the power from the power receiving component to the wearable ring device to recharge a rechargeable battery of the wearable ring device, wherein the charging device is configured to, and transition between a first charging orientation and a second charging orientation, wherein the first charging orientation comprises an orientation in which the retaining component is on a same side of the support post as the power receiving component and the second charging orientation comprises an orientation in which the retaining component is on a different side of the support post from the power receiving component.

[0133] An apparatus is described. The apparatus may include one or more memories storing processor executable code, and one or more processors coupled with the one or more memories. The one or more processors may individually or collectively be operable to execute the code to cause the apparatus to a support post configure to receive a wearable ring device, the support post comprising a retaining component configured to retain the wearable ring device onto the support post, a charge post comprising an outer housing, a power receiving component configured to receive power from one or more external power sources, and a first charging component configured to transfer the power from the power receiving component to the wearable ring device to recharge a rechargeable battery of the wearable ring device, wherein the charging device is configured to, and transition between a first charge orientation and a second charging orientation, wherein the first charging orientation comprises an orientation in which the retaining component is on a same side of the support post as the power receiving component and the second charging orientation comprises an orientation in which the retaining component is on a different side of the support post from the power receiving component.

[0134] Another apparatus is described. The apparatus may include means for a support post configured to receive a wearable ring device, the support post comprising a retaining component configured to retain the wearable ring device onto the support post, means for a charging post comprising an outer housing, a power receiving component configured to receive power from one or more external power sources, and a first charging component configured to transfer the power from the power receiving component to the wearable ring device to recharge a rechargeable battery of the wearable ring device, wherein the charging device is configured to, and means for transition between a first charging orientation and a second charging orientation, wherein the first charging orientation comprises an orientation in which the retaining component is on a same side of the support post as the power receiving component and the second charging orientation comprises an orientation in which the retaining component is on a different side of the support post from the power receiving component.

[0135] A non-transitory computer-readable medium storing code is described. The code may include instructions executable by one or more processors to a support post configure to receive a wearable ring device, the support post comprising a retaining component configured to retain the wearable ring device onto the support post, a charge post comprising an outer housing, a power receiving component configured to receive power from one or more external power sources, and a first charging component configured to transfer the power from the power receiving component to the wearable ring device to recharge a rechargeable battery of the wearable ring device, wherein the charging device is configured to, and transition between a first charge orientation and a second charging orientation, wherein the first charging orientation comprises an orientation in which the retaining component is on a same side of the support post as the power receiving component and the second charging orientation comprises an orientation in which the retaining component is on a different side of the support post from the power receiving component.

[0136] In some examples of the method, apparatus, and non-transitory computer-readable medium described herein, the charging device may include operations, features, means, or instructions for a hinge component connecting the support post and the charging post, wherein, to transition between the first charging orientation and the second charging orientation, the hinge component may be configured to and rotate the charging post with respect to the support post.

[0137] In some examples of the method, apparatus, and non-transitory computer-readable medium described herein, a second charging component configured to transfer the power from the power receiving component to the wearable ring device to recharge the rechargeable battery of the wearable ring device, wherein the first charging component and the second charging component may be located on a first position on a circumferential surface of the charging post and a second position on the circumferential surface of the charging post, respectively.

[0138] In some examples of the method, apparatus, and non-transitory computer-readable medium described herein, the first charging component may be positioned on an outer circumferential surface of the charging device when the charging device may be in the first charging orientation and the second charging component may be positioned on the outer circumferential surface of the charging device when the charging device may be in the second charging orientation.

[0139] In some examples of the method, apparatus, and non-transitory computer-readable medium described herein, the support post may include operations, features, means, or instructions for a removable support post configured to interface with the charging post in either of the first charging orientation or the second charging orientation.

[0140] In some examples of the method, apparatus, and non-transitory computer-readable medium described herein, the removable support post may include operations, features, means, or instructions for an outer circumferential surface and a receiving hole extending a width of the support post and overlapping a portion of the outer circumferential surface to create a gap in the outer circumferential surface.

[0141] Some examples of the method, apparatus, and non-transitory computer-readable medium described herein may further include operations, features, means, or instructions for receive the charging post via the receiving hole, wherein the first charging component of the charging post may be positioned to align with the outer circumferential surface of the removable support post in either of the first charging orientation or the second charging orientation.

[0142] In some examples of the method, apparatus, and non-transitory computer-readable medium described herein, the support post may include operations, features, means, or instructions for one or more indentations configured to interface with one or more clip components of the charging post in either of the first charging orientation or the second charging orientation.

[0143] In some examples of the method, apparatus, and non-transitory computer-readable medium described herein, a diameter of the retaining component may be greater than a diameter of the support post.

[0144] In some examples of the method, apparatus, and non-transitory computer-readable medium described herein, a size of one or more components of the charging device may be based at least in part on a size of the wearable ring device.

[0145] In some examples of the method, apparatus, and non-transitory computer-readable medium described herein, the support post may include operations, features, means, or instructions for one or more indentations on an outer circumferential surface of the support post, the one or more indentations configured to interface with one or more dome-shaped protrusions on an inner circumferential surface of the wearable ring device.

[0146] In some examples of the method, apparatus, and non-transitory computer-readable medium described herein, one or more magnetic components configured to attract one or more magnetic components of the wearable ring device.

[0147] In some examples of the method, apparatus, and non-transitory computer-readable medium described herein, the one or more external power sources comprise one or more of a cell phone, a laptop, a rechargeable portable battery, or a power outlet.

[0148] In some examples of the method, apparatus, and non-transitory computer-readable medium described herein, the power receiving component comprises a Universal Serial Bus Type-C connector.

[0149] The description set forth herein, in connection with the appended drawings, describes example configurations and does not represent all the examples that may be implemented or that are within the scope of the claims. The term "exemplary" used herein means "serving as an example, instance, or illustration," and not "preferred" or "advantageous over other examples." The detailed description includes specific details for the purpose of providing an understanding of the described techniques. These techniques, however, may be practiced without these specific details. In some instances, well-known structures and devices are shown in block diagram form in order to avoid obscuring the concepts of the described examples.

[0150] In the appended figures, similar components or features may have the same reference label. Further, various components of the same type may be distinguished by following the reference label by a dash and a second label that distinguishes among the similar components. If just the first reference label is used in the specification, the description is applicable to any one of the similar components having the same first reference label irrespective of the second reference label.

[0151] Information and signals described herein may be represented using any of a variety of different technologies and techniques. For example, data, instructions, commands, information, signals, bits, symbols, and chips that may be referenced throughout the above description may be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or any combination thereof.

[0152] The various illustrative blocks and modules described in connection with the disclosure herein may be implemented or performed with a general-purpose processor, a DSP, an ASIC, an FPGA or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general-purpose processor may be a microprocessor, but in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices (e.g., a combination of a DSP and a microprocessor, multiple microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration).

[0153] The functions described herein may be implemented in hardware, software executed by a processor, firmware, or any combination thereof. If implemented in software executed by a processor, the functions may be stored on or transmitted over as one or more instructions or code on a computer-readable medium. Other examples and implementations are within the scope of the disclosure and appended claims. For example, due to the nature of software, functions described above can be implemented using software executed by a processor, hardware, firmware, hardwiring, or combinations of any of these. Features implementing functions may also be physically located at various positions, including being distributed such that portions of functions are implemented at different physical locations. Also, as used herein, including in the claims, "or" as used in a list of items (for example, a list of items prefaced by a phrase such as "at least one of" or "one or more of") indicates an inclusive list such that, for example, a list of at least one of A, B, or C means A or B or C or AB or AC or BC or ABC (i.e., A and B and C). Also, as used herein, the phrase "based on" shall not be construed as a reference to a closed set of conditions. For example, an exemplary step that is described as "based on condition A" may be based on both a condition A and a condition B without departing from the scope of the present disclosure. In other words, as used herein, the phrase "based on" shall be construed in the same manner as the phrase "based at least in part on."

[0154] Computer-readable media includes both non-transitory computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A non-transitory storage medium may be any available medium that can be accessed by a general purpose or special purpose computer. By way of example, and not limitation, non-transitory computer-readable media can comprise RAM, ROM, electrically erasable programmable ROM (EEPROM), compact disk (CD) ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other non-transitory medium that can be used to carry or store desired program code means in the form of instructions or data structures and that can be accessed by a general-purpose or special-purpose computer, or a general-purpose or special-purpose processor. Also, any connection is properly termed a computer-readable medium. For example, if the software is transmitted from a website, server, or other remote source using a coaxial cable, fiber optic cable, twisted pair, digital subscriber line (DSL), or wireless technologies such as infrared, radio, and microwave, then the coaxial cable, fiber optic cable, twisted pair, DSL, or wireless technologies such as infrared, radio, and microwave are included in the definition of medium. Disk and disc, as used herein, include CD, laser disc, optical disc, digital versatile disc (DVD), floppy disk and Blu-ray disc where disks usually reproduce data magnetically, while discs reproduce data optically with lasers. Combinations of the above are also included within the scope of computer-readable media.

[0155] The description herein is provided to enable a person skilled in the art to make or use the disclosure. Various modifications to the disclosure will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other variations without departing from the scope of the disclosure. Thus, the disclosure is not limited to the examples and designs described herein, but is to be accorded the broadest scope consistent with the principles and novel features disclosed herein.

What is claimed is:

1. A charging device, comprising:

a support post configured to receive a wearable ring device, the support post comprising a retaining component configured to retain the wearable ring device onto the support post;

a charging post comprising an outer housing, a power receiving component configured to receive power from one or more external power sources, and a first charging component configured to transfer the power from the power receiving component to the wearable ring device to recharge a rechargeable battery of the wearable ring device, wherein the charging device is configured to:

transition between a first charging orientation and a second charging orientation, wherein the first charging orientation comprises an orientation in which the retaining component is on a same side of the support post as the power receiving component and the second charging orientation comprises an orientation in which the retaining component is on a different side of the support post from the power receiving component.

2. The charging device of claim **1**, wherein the charging device further comprises:

a hinge component connecting the support post and the charging post, wherein, to transition between the first charging orientation and the second charging orientation, the hinge component is configured to:

rotate the charging post with respect to the support post.

3. The charging device of claim **2**, further comprising:

a second charging component configured to transfer the power from the power receiving component to the wearable ring device to recharge the rechargeable battery of the wearable ring device, wherein the first charging component and the second charging component are located on a first position on a circumferential surface of the charging post and a second position on the circumferential surface of the charging post, respectively.

4. The charging device of claim **3**, wherein the first charging component is positioned on an outer circumferential surface of the charging device when the charging device is in the first charging orientation, and wherein the second charging component is positioned on the outer circumferential surface of the charging device when the charging device is in the second charging orientation.

5. The charging device of claim **1**, wherein the support post comprises:

a removable support post configured to interface with the charging post in either of the first charging orientation or the second charging orientation.

6. The charging device of claim **5**, wherein the removable support post comprises:

an outer circumferential surface and a receiving hole extending a width of the support post and overlapping a portion of the outer circumferential surface to create a gap in the outer circumferential surface.

7. The charging device of claim **6**, wherein, to interface with the charging post, the removable support post is configured to receive the charging post via the receiving hole, wherein the first charging component of the charging post is positioned to align with the outer circumferential surface of the removable support post in either of the first charging orientation or the second charging orientation.

8. The charging device of claim **5**, wherein the support post further comprises:

one or more indentations configured to interface with one or more clip components of the charging post in either of the first charging orientation or the second charging orientation.

9. The charging device of claim **1**, wherein a diameter of the retaining component is greater than a diameter of the support post.

10. The charging device of claim **1**, wherein a size of one or more components of the charging device is based at least in part on a size of the wearable ring device.

11. The charging device of claim **1**, wherein the support post comprises:

one or more indentations on an outer circumferential surface of the support post, the one or more indentations configured to interface with one or more protrusions on an inner circumferential surface of the wearable ring device.

12. The charging device of claim **1**, further comprising:

one or more magnetic components configured to attract one or more magnetic components of the wearable ring device.

13. The charging device of claim **1**, wherein the one or more external power sources comprise one or more of a cell phone, a laptop, a rechargeable portable battery, or a power outlet.

14. The charging device of claim **1**, wherein the power receiving component comprises a Universal Serial Bus Type-C connector.

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