US012392338B2

(12) **United States Patent**
O'Callaghan et al.

(10) **Patent No.: US 12,392,338 B2**
(45) **Date of Patent: Aug. 19, 2025**

(54) **SELF-RECHARGING STAND-ALONE MONITORING SYSTEM**

(71) Applicant: **Cornell Pump Company LLC**, Clackamas, OR (US)

(72) Inventors: **Colin O'Callaghan**, Portland, OR (US); **Adam Lindeman**, Oregon City, OR (US); **Erick Johnson**, Gresham, OR (US); **William James Warren**, Boring, OR (US)

(73) Assignee: **Cornell Pump Company LLC**, Clackamas, OR (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 49 days.

(21) Appl. No.: **18/165,741**

(22) Filed: **Feb. 7, 2023**

(65) **Prior Publication Data**

US 2023/0250818 A1 Aug. 10, 2023

Related U.S. Application Data

(60) Provisional application No. 63/308,735, filed on Feb. 10, 2022.

(51) **Int. Cl.**

F04B 51/00 (2006.01)
H02S 20/30 (2014.01)
H02S 40/38 (2014.01)

(52) **U.S. Cl.**

CPC ***F04B 51/00*** (2013.01); ***H02S 20/30*** (2014.12); ***H02S 40/38*** (2014.12); *F04B 2203/0206* (2013.01); *F04B 2205/09* (2013.01); *F04B 2207/702* (2013.01)

(58) **Field of Classification Search**

CPC F04B 17/006; F04B 51/00; H02J 2300/22; H02J 2300/24
USPC 280/651
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,405,086	A *	4/1995	Kranzle	B08B 3/026 239/310
10,178,449	B1	1/2019	Struhsaker	
10,477,395	B2	11/2019	Bahrami et al.	
10,865,155	B2	12/2020	Do	

(Continued)

FOREIGN PATENT DOCUMENTS

CN	106020088	A	10/2016
CN	206190465	U *	5/2017

OTHER PUBLICATIONS

Liu, 'Mobile Photovoltaic Water Pump'—CN 206190465 Machine Translation (Year: 2016).*

(Continued)

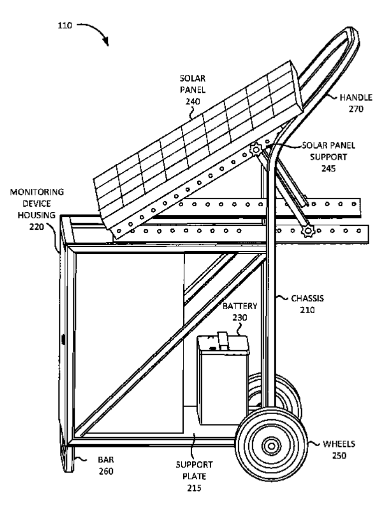
Primary Examiner — Kenneth J Hansen

(74) *Attorney, Agent, or Firm* — Fish & Richardson P.C.

(57) **ABSTRACT**

A device for monitoring pump equipment may include a pump monitoring device comprising sensor devices configured to monitor the pump equipment, a controller configured to configure the sensor devices and collect sensor data from the sensor devices, and a wireless transceiver configured to communicate with a cellular base station. The device may further include a battery configured to provide power to the pump monitoring device; a solar panel; a charging system to charge the battery using the solar panel; and a chassis configured to secure the pump monitoring system, battery, solar panel, and charging system into a self-contained mobile monitoring device.

17 Claims, 11 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

2006/0078435	A1	4/2006	Burza	
2007/0210236	A1*	9/2007	Yungner	B60P 3/14 248/678
2010/0109601	A1	5/2010	Coyle et al.	
2013/0192332	A1*	8/2013	Scheffler	G01N 33/007 73/1.06
2013/0255665	A1*	10/2013	Nickel	F24S 10/45 126/595
2013/0310631	A1*	11/2013	Lee	G06F 1/3218 600/16
2015/0226805	A1	8/2015	Albers et al.	
2019/0203578	A1	7/2019	Hecht et al.	
2019/0335688	A1	11/2019	Tirupathi et al.	
2020/0131893	A1*	4/2020	McCreery	B65H 75/425
2020/0242855	A1	7/2020	Sandu et al.	
2022/0135317	A1*	5/2022	Pulak	F04B 23/02 222/64

OTHER PUBLICATIONS

Meah, K. et al., "Solar photovoltaic water pumping for remote locations", Renewable and Sustainable Energy Reviews, vol. 12, Issue 2, Feb. 2008, pp. 472-487.

* cited by examiner

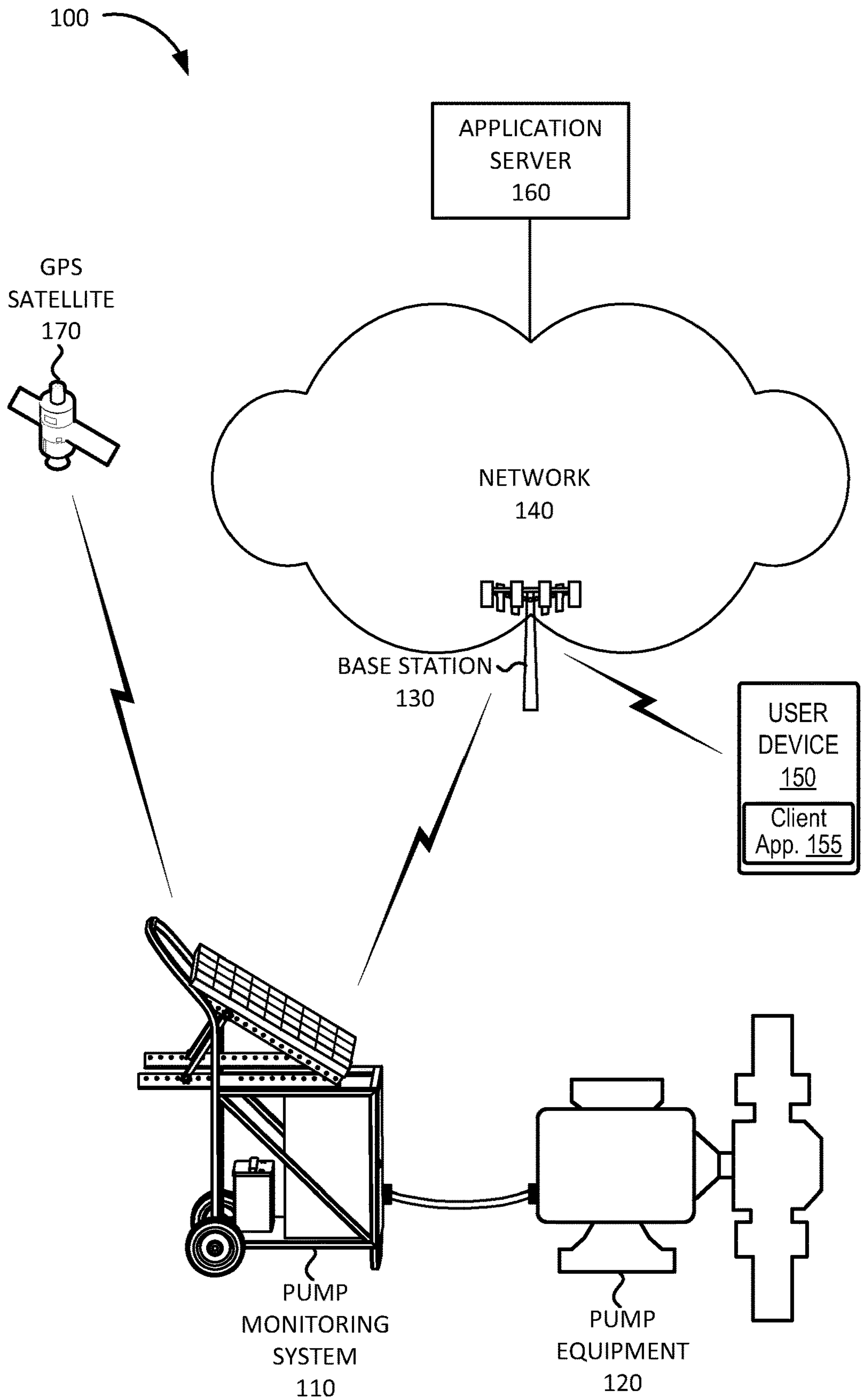

100
APPLICATION SERVER 160
GPS SATELLITE 170
NETWORK 140
BASE STATION 130
USER DEVICE 150
Client App. 155
PUMP MONITORING SYSTEM 110
PUMP EQUIPMENT 120

FIG. 1

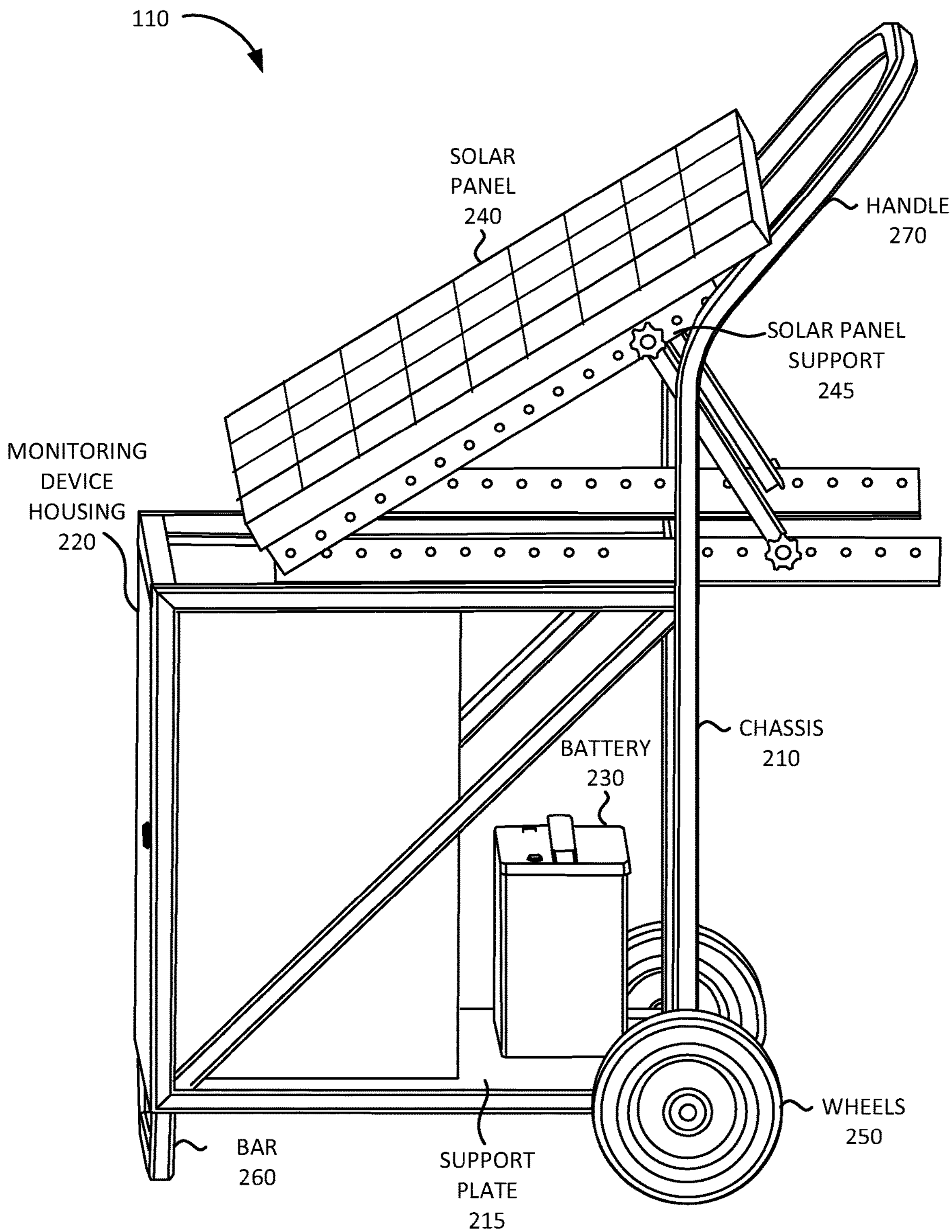

110
SOLAR
PANEL
240
HANDLE
270
SOLAR PANEL
SUPPORT
245
MONITORING
DEVICE
HOUSING
220
CHASSIS
210
BATTERY
230
WHEELS
250
BAR
260
SUPPORT
PLATE
215

FIG. 2

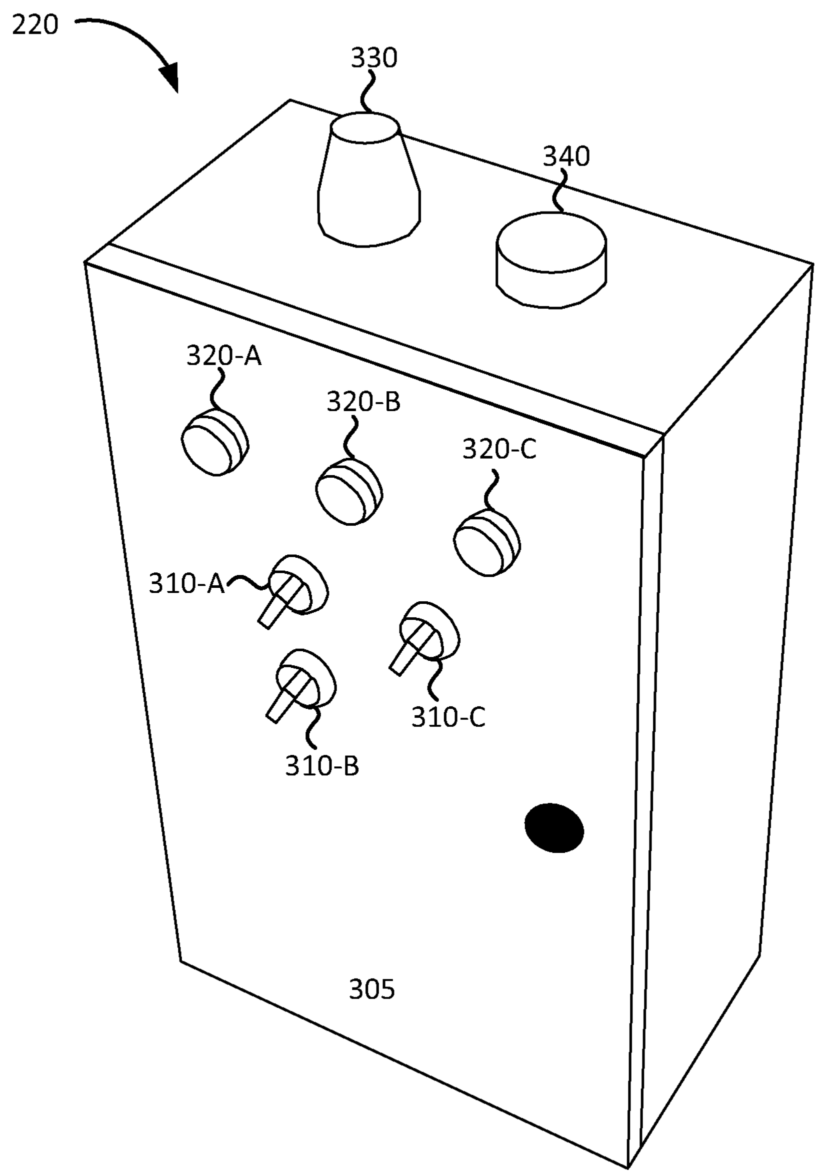


FIG. 3

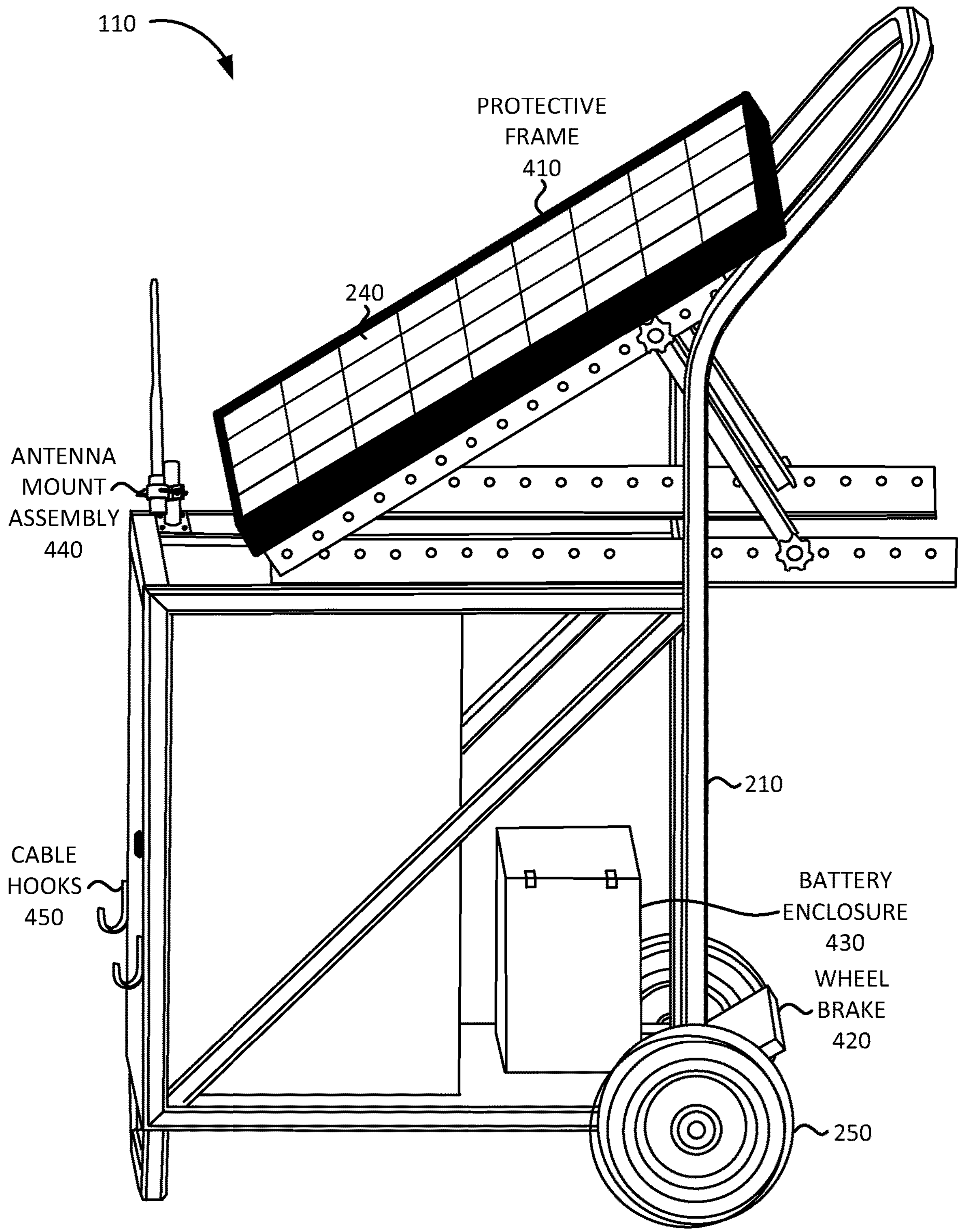

110
PROTECTIVE
FRAME
410
240
ANTENNA
MOUNT
ASSEMBLY
440
210
CABLE
HOOKS
450
BATTERY
ENCLOSURE
430
WHEEL
BRAKE
420
250

FIG. 4

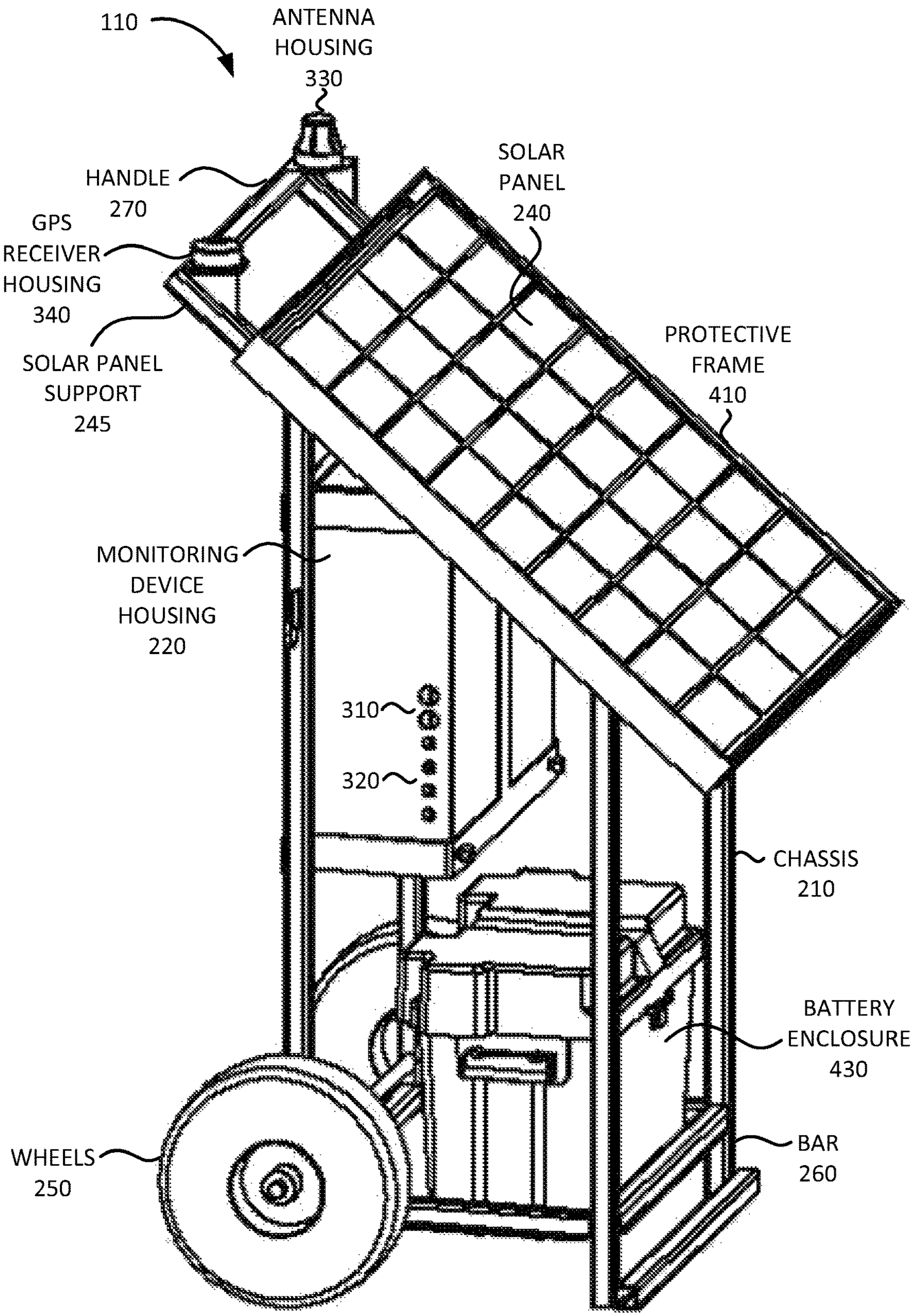

110
ANTENNA HOUSING 330
HANDLE 270
GPS RECEIVER HOUSING 340
SOLAR PANEL SUPPORT 245
SOLAR PANEL 240
PROTECTIVE FRAME 410
MONITORING DEVICE HOUSING 220
310
320
CHASSIS 210
BATTERY ENCLOSURE 430
WHEELS 250
BAR 260

FIG. 5A

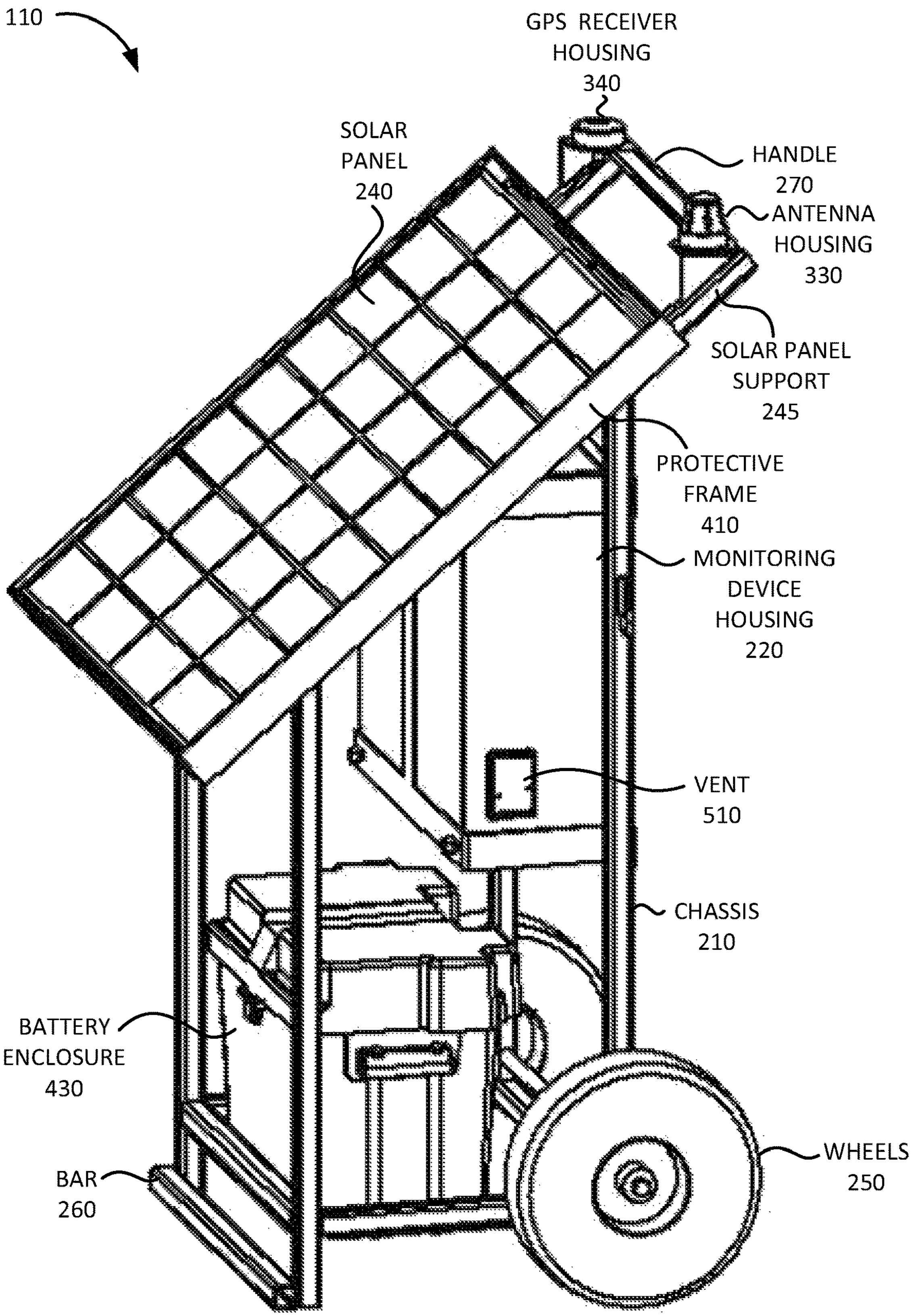

110
GPS RECEIVER HOUSING 340
SOLAR PANEL 240
HANDLE 270
ANTENNA HOUSING 330
SOLAR PANEL SUPPORT 245
PROTECTIVE FRAME 410
MONITORING DEVICE HOUSING 220
VENT 510
CHASSIS 210
BATTERY ENCLOSURE 430
WHEELS 250
BAR 260

FIG. 5B

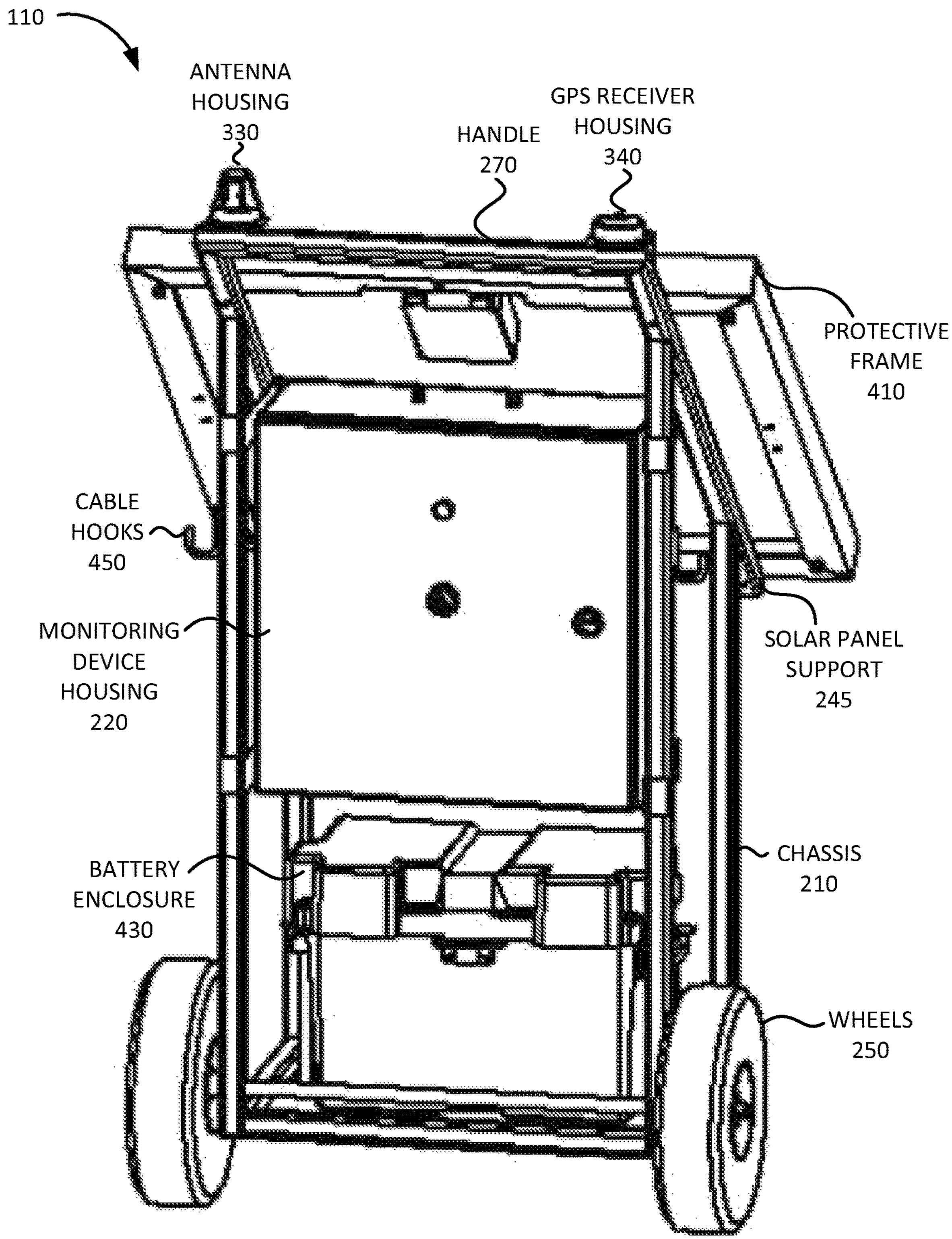

110
ANTENNA
HOUSING
330
HANDLE
270
GPS RECEIVER
HOUSING
340
PROTECTIVE
FRAME
410
CABLE
HOOKS
450
MONITORING
DEVICE
HOUSING
220
SOLAR PANEL
SUPPORT
245
BATTERY
ENCLOSURE
430
CHASSIS
210
WHEELS
250

FIG. 5C

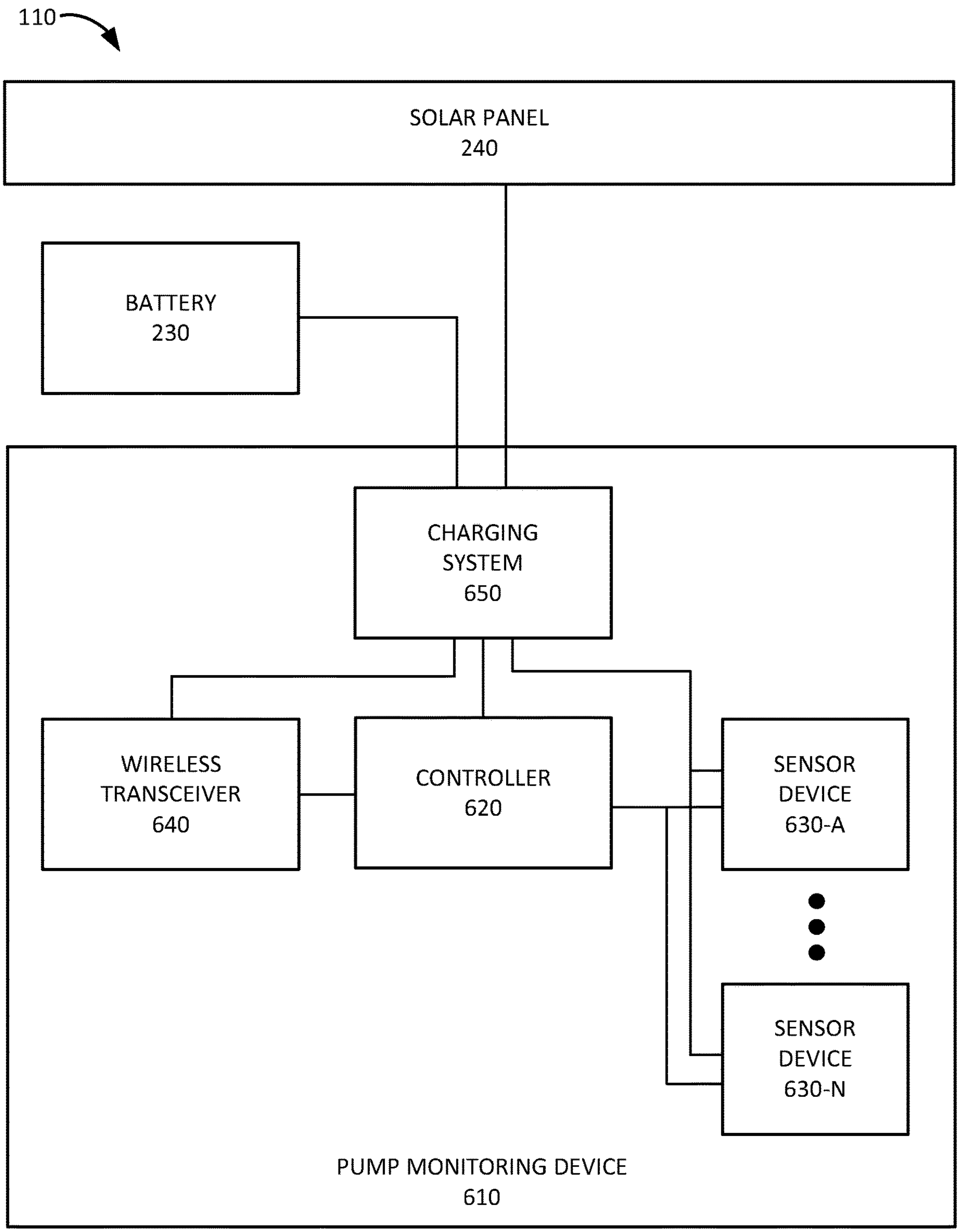

110
SOLAR PANEL
240
BATTERY
230
CHARGING
SYSTEM
650
WIRELESS
TRANSCEIVER
640
CONTROLLER
620
SENSOR
DEVICE
630-A
SENSOR
DEVICE
630-N
PUMP MONITORING DEVICE
610

FIG. 6

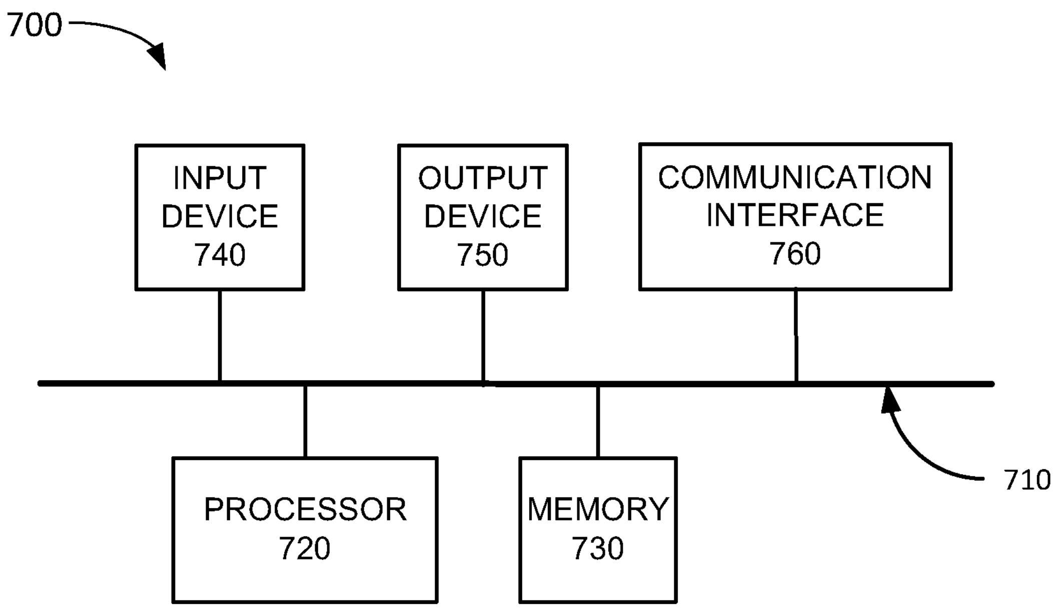

700
INPUT DEVICE 740
OUTPUT DEVICE 750
COMMUNICATION INTERFACE 760
PROCESSOR 720
MEMORY 730
710

FIG. 7

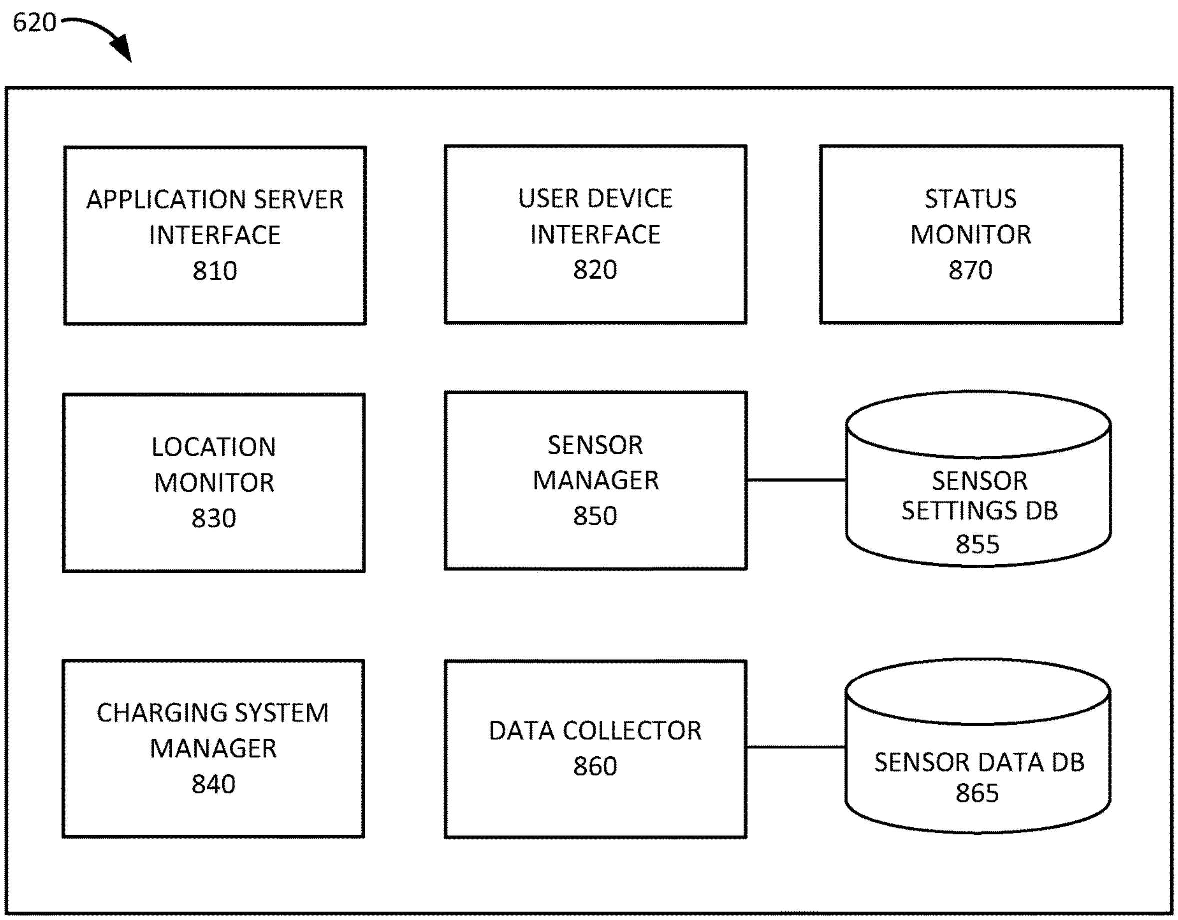

620
APPLICATION SERVER INTERFACE 810
USER DEVICE INTERFACE 820
STATUS MONITOR 870
LOCATION MONITOR 830
SENSOR MANAGER 850
SENSOR SETTINGS DB 855
CHARGING SYSTEM MANAGER 840
DATA COLLECTOR 860
SENSOR DATA DB 865

FIG. 8

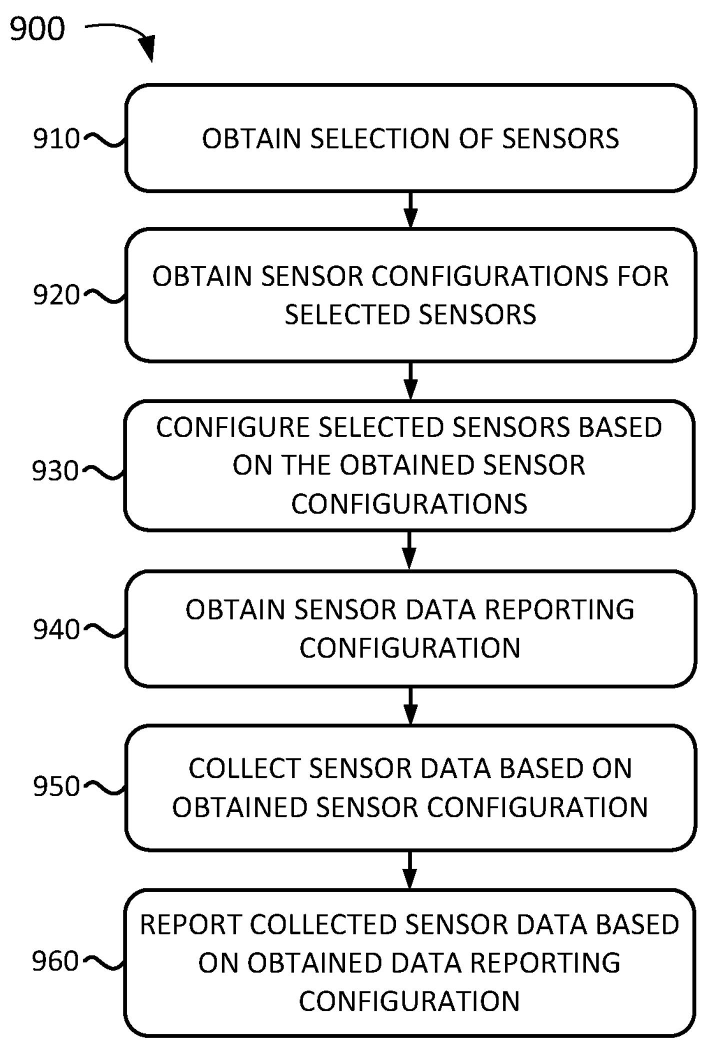

900
910
OBTAIN SELECTION OF SENSORS
920
OBTAIN SENSOR CONFIGURATIONS FOR SELECTED SENSORS
930
CONFIGURE SELECTED SENSORS BASED ON THE OBTAINED SENSOR CONFIGURATIONS
940
OBTAIN SENSOR DATA REPORTING CONFIGURATION
950
COLLECT SENSOR DATA BASED ON OBTAINED SENSOR CONFIGURATION
960
REPORT COLLECTED SENSOR DATA BASED ON OBTAINED DATA REPORTING CONFIGURATION

FIG. 9

SELF-RECHARGING STAND-ALONE MONITORING SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority under 35 U.S.C. § 119, based on U.S. Provisional Application No. 63/308,735, filed Feb. 10, 2022, the disclosure of which is incorporated by reference herein.

BACKGROUND OF THE INVENTION

A pump system may be installed in a remote and/or temporary location. Examples of such systems include systems for hydraulic fracturing for oil extraction or pumps for municipal wastewater bypass systems. Such pump systems often require tracking of system conditions and are not in proximity to an available power source. As a result, a large and power-hungry monitoring system may need to be connected to a nearby generator, requiring significant installation effort and regular local maintenance, in order to keep track of conditions and adjust pumps appropriately based on the conditions. Thus, monitoring a pump system in a remote location presents various challenges.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram of a network environment in which systems and methods described here may be implemented;

FIG. **2** is a diagram of a pump monitoring system according to an implementation described herein;

FIG. **3** is a diagram of a monitoring device housing according to an implementation described herein;

FIG. **4** is another diagram of a pump monitoring system according to an implementation described herein;

FIGS. **5**A, **5**B, and **5**C are diagrams of another implementation of a pump monitoring system according to an implementation described herein;

FIG. **6** is a diagram illustrating exemplary components of a pump monitoring system according to an implementation described herein;

FIG. **7** is a diagram illustrating exemplary components of a device that may be included in a component of a pump monitoring system according to an implementation described herein;

FIG. **8** is a diagram of exemplary functional components of the controller of a pump monitoring system according to an implementation described herein; and

FIG. **9** is a flow diagram of a pump monitoring process according to an implementation described herein.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following detailed description refers to the accompanying drawings. The same reference numbers in different drawings may identify the same or similar elements. Also, the following detailed description does not limit the invention.

Implementations described herein relate to systems and methods of pump monitoring using a self-charging, self-contained mobile pump monitoring system. A system for monitoring pump equipment may include a pump monitoring device that includes a set of sensor devices configured to monitor pump equipment, and/or includes a set of interfaces for coupling to one or more sensor devices installed and/or attached to the pump equipment. The sensor devices may include, for example, a flow meter, a fluid level meter, a vibration sensor, a temperature sensor, a pressure sensor, and/or another type of sensor.

The pump monitoring device may further include a controller to configure the sensor devices and collect sensor data from the sensor devices and a wireless transceiver configured to communicate with a cellular base station to report the collected sensor data to another device, such as an application server. The system may further include a battery configured to provide power to the pump monitoring device, a solar panel, and a charging system to charge the battery using the solar panel. The charging system may be configured to use power from the battery to power the pump monitoring device, when the battery power is above a battery power threshold, and use power from the solar panel to power the pump monitoring device and/or charge the battery, when the battery is associated with a battery power below the battery power threshold.

The system may also include a chassis configured to secure the pump monitoring device, battery, solar panel, and charging system into a self-contained mobile monitoring system. The chassis may include a cart with wheels and a handle for ease of transport over uneven ground to a remote location. For example, the cart may include a pair of wheels on one side and a bar on the other side to keep the cart level when not in motion. Furthermore, the solar panel may be secured to the chassis in a position that protects the solar panel from impact if the chassis tips over.

The controller may be configured to receive selection of one or more of the sensors to use to collect sensor data, obtain a sensor configuration for the selected one or more sensors, configure the selected one or more sensors based on the obtained sensor configuration, collect sensor data based on the obtained sensor configuration, and report the collected sensor data via the wireless transceiver. The sensor configuration may include, for example, a calibration process to perform, a range of sensor values over which to gather sensor data, a threshold sensor value to generate an alert, a pulse generation parameter for generating a pulse to gather sensor data, and/or another type of sensor configuration.

For example, the controller may be configured to set a threshold sensor value for a sensor, detect that the threshold has been reached or exceeded via data collected from the sensor, generate an alert based on the detected threshold sensor value, and transmit the generated alert to an application server, or to another device/system, using the wireless transceiver.

In some implementations, the system may include additional features, such as a foot brake to engage the wheels and secure the wheels in place when the cart is not in motion, a protective frame around the solar panel to protect from impact damage, one or more cable hooks to facilitate management of cables between the pump equipment and the monitoring device, and/or one or more mounting assemblies for an antenna for the wireless receiver, an antenna for a Global Position System (GPS) receiver, and/or another type of antenna, as described in detail below.

FIG. **1** is a diagram illustrating an exemplary environment **100** in which systems and/or methods described herein may be implemented. As illustrated, environment **100** may include a pump monitoring system **110**, a pump equipment **120**, a base station **130**, a network **140**, a user device **150** that includes a client application **155**, an application server **160**, and a GPS satellite **170**.

Pump monitoring system **110** may monitor pump equipment **120**. Pump monitoring system **110** may include a self-charging, self-contained mobile pump monitoring system. Pump monitoring system **110** include a chassis, such as a metal cart with wheels, that houses a pump monitoring device, a battery, a charging system, and a solar panel. The pump monitoring device may include a controller, a set of sensors and/or sensor interfaces, a wireless transceiver configured to communicate with base station **130** using cellular wireless signals, and/or a GPS receiver to determine a location of pump monitoring system **110** based on signals received from one or more GPS satellites **170**. Pump monitoring system **110** may receive instructions from application server **160** and/or user device **150** to configure one or more sensor to collect sensor data for pump equipment **120** and report the collected sensor data to application server **170** and/or user device **150**.

Pump equipment **120** may include pumps, electric motors, and/or other types of rotating equipment for moving fluid, for example, through a conduit, such as a pipe, moving fluid into or out of a storage or holding tank, pumping fluid out of or into the ground, and/or otherwise move fluid. In some implementations, pump equipment **120** may include one or more sensors installed in and/or on pump equipment **120** and pump monitoring system **110** may include one or more sensor interfaces that may be coupled to the installed sensors using wired and/or wireless connections. Additionally, or alternatively, pump monitoring system **110** may include one or more movable sensors that may be stored on the chassis of pump monitoring system **110** and attached to pump equipment **120**, and/or otherwise interface with pump equipment **120**, to collect sensor data relating to operation of pump equipment **120**, when pump monitoring system **110** is moved into location.

Base station **130** may include a cellular wireless base station, such as a Fifth Generation (5G) New Radio (NR) base station (e.g., a gNodeB), a Fourth Generation (4G) Long Term Evolution (LTE) base station (e.g., an eNodeB), or a base station associated with another generation (e.g., Third Generation (3G), etc.). Base station **130** may include a radio frequency (RF) transceiver configured to communicate with user equipment (UE) devices attached to base station **130**, such as user device **150**. Furthermore, a wireless transceiver in pump monitoring system **110** may attach to base station **130** as a UE device. Base station **130** may enable connection to network **140**. In some implementations, pump monitoring system **110** may communicate with base station **130** using a machine-to-machine (M2M) communication method, such as, for example, Machine Type Communication (MTC), enhanced MTC communication (eMTC) (also known as Cat-M1), a Low Power Wide Area (LPWA) technology such as Narrow Band (NB) Internet of Things (NB-IoT) technology, and/or another type of M2M communication method.

Network **140** may include one or more wired, wireless and/or optical networks that are capable of receiving and transmitting data, voice and/or video signals. For example, network **140** may include a Radio Access Network (RAN) and/or a core network associated with the RAN (e.g., a 4G core network, a 5G core network, etc.), an Internet Protocol (IP) multimedia subsystem (IMS) network, a Multi-Access Edge Computing (MEC) network, a local area network (LAN), a wide area network (WAN), a personal area network (PAN) (e.g., a wireless PAN (WPAN)), a wireless local area network (WLAN), an intranet, the Internet, a satellite network, a metropolitan area network (MAN), an autonomous system (AS) on the Internet, an optical network, a satellite network, and/or another type of packet switched network or circuit-switched network that is capable of transmitting data from pump monitoring system **110** to other devices, such as user device **150** and/or application server **160**.

User device **150** includes a device that has computational and cellular wireless communication capabilities. User device **150** may attach to base station **130** as a UE device. User device **150** may be implemented as a mobile device, a portable device, a stationary device, a device operated by a user, or a device not operated by a user. For example, user device **150** may be implemented as hand-held mobile wireless communication device (e.g., a smartphone), a computer, a tablet, a wearable device, or some other type of wireless communication device. User device **150** may include client application (or "app") **155**. Client application **155** may be programmed/configured to connect to pump monitoring system **110** and provide instructions to pump monitoring system **110** and/or receive sensor data from pump monitoring system **110**. Additionally, or alternatively, client application **155** may enable a user, such as a party associated with monitoring the operation of pump equipment **120**, to connect to application server **160** to provide instructions to pump monitoring system **110** and/or receive sensor data from pump monitoring system **110**.

Application server **160** may include one or more computer devices, such as server devices, configured to connect to pump monitoring system **110** and provide instructions to pump monitoring system **110** and/or receive sensor data from pump monitoring system **110**. According to an implementation, application server **160** may use one or more Application Programming Interfaces (APIs) to enable users send and/or receive data from pump monitoring system **110**.

Although FIG. **1** shows exemplary components of environment **100**, in other implementations, environment **100** may include fewer components, different components, differently arranged components, or additional components than depicted in FIG. **1**. Additionally, or alternatively, one or more components of environment **100** may perform functions described as being performed by one or more other components of environment **100**. For example, while FIG. **1** illustrates a single pump monitoring system **110**, pump equipment **120**, base station **130**, network **140**, user device **150**, application server **160**, and/or GPS satellite **170** for illustrative purposes, in practice, environment **100** may include multiple pump monitoring systems **110**, pump equipment **120**, base stations **130**, networks **140**, user devices **150**, application servers **160**, and/or GPS satellites **170**.

FIG. **2** is a diagram of pump monitoring system **110** according to an implementation described herein. As shown in FIG. **2**, pump monitoring system **110** may include a chassis **210**, a support plate **215**, a monitoring device housing **220**, a battery **230**, a solar panel **240**, a solar panel support **245**, wheels **250**, a bar **260**, and a handle **270**.

Chassis **210** may include a frame made from metal and/or another type of structural material, such as a structural plastic, composite, etc. As an example, chassis **210** may be manufactured from powder-coated steel. As another example, chassis **210** may be manufactured from stainless steel, galvanized steel, aluminum, and/or another type of metal. Chassis **210** may provide structural support and secure monitoring device housing **220**, battery **230**, and solar panel **240**. Chassis **210** may be in the form of a cart structure with rectangular sides and may include diagonal support beams. The sides and/or diagonal support beams may be manufactured from structural tubing beams having a rectangular cross-section, H-profile beams, C-profile beams, L-profile beams, solid bar beams, and/or other types of beams.

Chassis **210** may include support plate **215** to support monitoring device housing **220** and battery **230**. Support plate **215** may be manufactured from metal, structural plastic, structural composite, and/or another type of material. Chassis **210** may include wheels **250** and handle **270** to enable a person to move pump monitoring system **110** to and from a remote location. Bar **260** may raise the side of chassis **210** that is opposite wheels **250** so that chassis **210** is level and/or horizontal to the ground when not in motion. A user may tip pump monitoring system **110** backwards using handle **270** to lift bar **260** off the ground and enable wheels **250** to rotate when pushing pump monitoring system **110** to a desired location. Bar **260** may prevent pump monitoring system **110** from moving when chassis **210** is not tipped back and contacting the ground. Handle **270** may extend to a height so that pump monitoring system **110** may be comfortably pushed by a person of average height. In some implementations, the height of handle **270** may be adjustable (not shown in FIG. **2**).

Wheels **250** may enable pump monitoring system **110** to be pushed over uneven ground. In some implementations, wheels **250** may include flat-free tires, such as tires made from a plastic or composite material that resists punctures. In other implementations, wheels **250** may include inflatable tires. Wheels **250** may be of sufficient diameter to enable pump monitoring system **110** to be easily moved over unpaved surfaces (e.g., at least 6 inches in diameter, etc.). Furthermore, in some implementations, wheels **250** may include additional features to ease movement over uneven terrain, such as knobby tires and/or shock suspensions (not shown in FIG. **2**). Furthermore, in some implementations, pump monitoring system **110** may include four wheels rather what two wheels and bar **260**, to facilitate moving pump monitoring system **110**.

Monitoring device housing **220** may provide a dust-resistant and water-resistant enclosure to protect internal components of a pump monitoring device described further below. Monitoring device housing **220** may be manufactured from a structural plastic material, metal, composite, and/or another type of material. In some implementations, monitoring device housing **220** may meet one or more industrial standards for water-proof submersion. Monitoring device housing **220** is further described below with reference to FIG. **3**.

Battery **230** may include a rechargeable battery, such as a 12 Volt rechargeable battery. Battery **230** may include a flooded lead-acid battery, a sealed valve regulated lead-acid (VRLA) battery, an absorbent glass mat (AGM) battery, a gel battery, a lithium-ion battery, a nickel-metal hydride battery, and/or another type of battery **230**. Battery **230** may power the components of the pump monitoring device inside monitoring device housing **220** and be charged from solar panel **240** using a charging system included in the pump monitoring device.

Solar panel **240** may include a set of solar cells to capture sunlight and charge battery **230** and/or provide power to the pump monitoring device inside monitoring device housing **220** when the power supplied by battery **230** is insufficient to meet the power demand of the components of the pump monitoring device. Solar panel **240** may include monocrystalline solar cells, polycrystalline solar cells, thin film solar cells, and/or another type of solar cells. The type and/or size of solar panel **240** may be selected to meet the maximum power demand of the components of the pump monitoring device indefinitely or over long periods of time (e.g., days or weeks) if battery **230** fails. For example, in some implementations, solar panel **240** may have a capacity of 300 Watts (W) or more.

Solar panel support **245** may provide structural support to solar panel **240** and secure solar panel **240** to chassis **210**. In some implementations, solar panel support **245** may be manufactured from the same type of beam as chassis **210**. In other implementations, solar panel support **245** may be manufactured from a different type of structural material, such as, for example, perforated flat beams, square tubes, strut channels, L-shaped angles, etc. Solar panel support **245** may angle solar panel **240** with respect to the upper surface and/or base of chassis **210** to enable solar panel **240** to maximize the amount of sunlight solar panel **240** is able to receive.

In some implementations, solar panel support **245** may be positioned on chassis **210** in a position that protects solar panel **240** from impact if chassis **210** tips over. For example, solar panel support **245** may position solar panel **240** so that solar panel **240** is positioned back from the front of chassis **210** (i.e., the side with bar **260**) so that solar panel **240** does not impact the ground if chassis **210** tips forward. Additionally, or alternatively, solar panel support **245** may position solar panel **240** so that solar panel **240** is recessed with respect to the sides of chassis **210** so that solar panel **240** does not impact the ground if chassis **210** falls sideways. Moreover, handle **270** may protect solar panel **240** by preventing solar panel **240** from impacting the ground if chassis **210** falls backwards.

The angle of solar panel support **245** with respect to chassis **210** may be fixed or adjustable. In some implementations, the angle of solar panel **240** may be fixed with respect to chassis (e.g., at 45 degrees, 30 degrees, etc.). In other implementations, solar panel support **245** may be adjustable so that the angle of solar panel **240** may be adjusted with respect to chassis **210** in order to position solar panel **240** to maximize the amount of sunlight absorbed by solar panel **240**. Solar panel support **245** may be adjustable in one or more of x, y, and/or z planes and thus may have multiple degrees of freedom to tilt and rotate. Furthermore, in some implementations, solar panel support **245** may include a motor (not shown in FIG. **2**) to adjust the angle of solar panel support **245**. For example, a controller in the pump monitoring device may configured to use the motor to automatically adjust the angle of solar panel support **245** to track the position of the sun to maximize the amount of sunlight received by solar panel **240** during different times of the day.

Although FIG. **2** shows exemplary components of pump monitoring system **110**, in other implementations, pump monitoring system **110** may include fewer components, different components, differently arranged components, or additional components than depicted in FIG. **2**. Additionally, or alternatively, one or more components of pump monitoring system **110** may perform functions described as being performed by one or more other components of pump monitoring system **110**.

FIG. **3** is a diagram of monitoring device housing **220** according to an implementation described herein. As shown in FIG. **3**, monitoring device housing **220** may include a front panel **305**, a set of ports **310**, a set of indicators **320**, an antenna housing **330**, and a GPS receiver housing **340**.

Front panel **305** may provide access to the pump monitoring device inside monitoring device housing **220**. Ports **310** A-C may include removable covers to provide access to connectors for attaching cables for connecting external sensors to the pump monitoring device. Thus, connections internal to monitoring device housing **220** may be accessed through ports **310** and used for wired connections for external sensors to be applied to pump equipment **120** or sensors installed in or on pump equipment **120**. In some implementations, sensors need not use ports **310** and may connect wirelessly to pump monitoring device to report sensor data.

Indicators **320** A-C may provide indicator lights for components of pump monitoring system **110**. For example, indicators **320** may include one or more light-emitting diodes (LEDs) indicating the status of particular components. As an example, a lit indicator light may indicate that a particular component is functioning correctly. As another example, a first color light (e.g., green) may indicate that the particular component is functioning correctly and a second color light (e.g., red) may indicate an error status or malfunction for the particular component. Indicators **320** may include an indicator for the pump monitoring device, an indicator for battery **230**, an indicator for solar panel **240**, etc. Additionally, indicators **230** may include an indicator for a controller of the pump monitoring device, an indicator for a transceiver of the pump monitoring device, an indicator for a charging system, an indicator for a particular sensor, etc. Antenna housing **330** may house a cellular wireless antenna. GPS receiver housing **340** may house a GPS receiver antenna.

Although FIG. **3** shows exemplary components of monitoring device housing **220**, in other implementations, monitoring device housing **220** may include fewer components, different components, differently arranged components, or additional components than depicted in FIG. **3**. Additionally, or alternatively, one or more components of monitoring device housing **220** may perform functions described as being performed by one or more other components of monitoring device housing **220**. For example, while FIG. **3** illustrates three ports **310** A-C and three indicators **320** A-C for illustrative purposes, monitoring device housing **220** may include more, or fewer, number of ports **310** and/or indicators **320**. Moreover, ports **310** and/or indicators **320** may be located on a different surface of monitoring device housing **220** rather than front panel **305**.

FIG. **4** is a second diagram of pump monitoring system **110** according to an implementation described herein. As shown in FIG. **4**, in some implementations, pump monitoring system **110** may include features in addition to the features explained above with respect to FIG. **2**. Thus, in addition to the features described above with respect to FIG. **2**, pump monitoring system **110** may include a protective frame **410**, a wheel brake **420**, a battery enclosure **430**, an antenna mount assembly **440**, and/or cable hooks **450**.

Protective frame **410** may enclose the sides of solar panel **240** and protect solar panel **240** from impact damage. Protective frame **410** may be manufactured from impact and/or shock absorbent plastic (e.g., thermoplastic polyurethane, neoprene, silicone, polystyrene, etc.) or a combination of shock absorbent plastic and rubber.

Wheel brake **420** may apply a brake to wheels **250** when engaged. For example, a user may apply pressure to wheel brake **420** with a foot to engage wheel brake **420** and apply a mechanism to prevent wheels **250** from turning. Battery enclosure **430** may provide a dust-resistant and water-spray resistant enclosure to protect battery **230**. Battery enclosure **430** may be manufactured from a structural plastic material, metal, composite, and/or another type of material. In some implementations, battery enclosure **430** may meet one or more industrial standards for water-proof submersion.

Antenna mount assembly **440** may include hardware and/or fasteners for securing an antenna to chassis **210**, such as a cellular wireless antenna for communicating with base station **130**. Cable hooks **450** may be attached to chassis **210** to provide a support for cables from ports **310** to sensors on or in pump equipment **120**.

Although FIG. **4** shows exemplary components of pump monitoring system **110**, in other implementations, pump monitoring system **110** may include fewer components, different components, differently arranged components, or additional components than depicted in FIG. **4**. Additionally, or alternatively, one or more components of pump monitoring system **110** may perform functions described as being performed by one or more other components of pump monitoring system **110**.

FIGS. **5**A, **5**B, and **5**C are diagrams of another implementation of pump monitoring system **110** according to an implementation described herein. FIG. **5**A illustrates a right-side view of pump monitoring system **110**, FIG. **5**B illustrates a left side view of pump monitoring system **110**, and FIG. **5**C illustrates a rear view of pump monitoring system **110**. As shown in FIG. **5**A, monitoring device housing **220** may be elevated above battery enclosure **430** to accommodate a larger battery enclosure **430**. Furthermore, the elevated position of monitoring device housing **220** shown in FIGS. **5**A, **5**B, and **5**C may facilitate connecting of wired connections for external sensors to be applied to pump equipment **120** as well as connecting wiring between battery **230**, solar panel **240**, and monitoring device housing **220** by a user located behind pump monitoring system **110**. Additionally, the elevated position of monitoring device housing **220** may help protect the components inside monitoring device housing **220** in case of flooding.

As shown in FIG. **5**A, ports **310** and/or indicators **320** may be located on a side panel of monitoring device housing **220** (e.g., a right side, etc.) and the other side of monitoring device housing **220** (e.g., the left side, etc.) may include a vent **510**. Wire passthroughs for connecting battery **230** and/or solar panel **240** to the monitoring device inside monitoring device housing **220** may be located in the bottom panel of monitoring device housing **220** (not shown in FIGS. **5**A, **5**B, and **5**C). Furthermore, antenna housing **330** and GPS receiver housing **340** may located in an elevated position on pump monitoring system **110** (e.g., on handle **270**) to facilitate better wireless transmission and reception. Additionally, cable hooks **450** may be located at the rear of chassis **210**.

FIG. **6** is a diagram illustrating exemplary components of pump monitoring system **110** according to an implementation described herein. As shown in FIG. **6**, pump monitoring system **110** may include a pump monitoring device **610**, battery **230**, and solar panel **240**. Pump monitoring device **610** may include a controller **620**, a set of sensor devices **630**-A to **630**-N (referred to herein collectively as "sensor devices **630**" and individually as "sensor device **630**"), a wireless transceiver **640**, and a charging system **650**. According to an implementation, one or more of controller **620**, sensor devices **630**-A to **630**-N, wireless transceiver **640**, and/or charging system **650** may be installed on a printed circuit board, an etched wiring board, or a printed circuit assembly.

Controller **620** may control the operation of sensor devices **630**, wireless transceiver **640**, and/or charging system **650**. Exemplary functional components of controller **620** are described below with reference to FIG. **7**. Sensor device **630** may include a sensor device for monitoring pump equipment **120** or an interface and/or controller for interfacing with an external sensor device installed in or on pump equipment **120** or applied to pump equipment **120**. For example, sensor devices **630** may include an interface connected to port **310** and port **310** may be coupled to wiring connected to an external sensor that is attached to pump equipment **120**. Additionally, or alternatively, sensor device **630** may include a wireless transceiver, or use wireless transceiver **640** to establish a wireless connection with a sensor using a wireless personal area network (WPAN) communication method (e.g., based on the Institute of Electrical and Electronics Engineers (IEEE) 802.15 suite of standards, etc.).

Sensor device **630** may include, or interface with, a flow meter to measure a fluid volume and/or fluid mass passing through a particular location during a specified time period. As an example, a flow meter may be installed in a pipe and/or pump associated with pump equipment **120** and sensor device **630** may include an interface to connect to an output port associated with the flow meter. The installed flow meter may include a mechanical flow meter, a pressure flow meter, an optical flow meter, a vortex flow meter, a thermal mass flow meter, an ultrasonic flow meter, and/or another type of flow meter. As another example, a flow meter may include a mobile and non-intrusive flow meter associated with pump monitoring system **110** and connected to a controller in sensor device **630** via port **310**, such as an ultrasonic flow meter, a sonar flow meter, and/or another type of mobile flow meter. A controller associated with sensor device **630** may be configurable to generate a particular ultrasound pulse profile to collect sensor data using the ultrasonic flow meter.

Sensor device **630** may interface with a fluid level meter. As an example, a fluid level meter may be installed in a pump, pipe, and/or storage tank associated with pump equipment **120** and sensor device **630** may include an interface and/or controller to connect to an output port associated with the fluid level meter. Sensor device **630** may include a controller configurable to adjust parameters associated with the fluid level meter, such as to adjust alert level thresholds.

Sensor device **630** may include, or interface with, a vibration sensor. A vibration sensor may include an accelerometer and/or another type of vibration sensor that may be attached to a particular surface of pump equipment **120** to measure vibration along two or three respective axes (e.g., x-, y-, and/or z-axes) and connected to a sensor interface and/or controller via a wired connection to port **310**. The vibration data collected using the vibration sensor may be used, for example, to identify a rotational speed of pump equipment **120** and/or determine if pump equipment **20** is experiencing a problem. Sensor device **630** may include a signal amplifier, a signal filter, and/or a controller configurable to adjust parameters associated with the vibration sensor, signal amplifier, and/or signal filter, based on, for example, environmental conditions.

Sensor device **630** may include, or interface with, a temperature sensor. A temperature sensor may include a thermocouple and/or another type of temperature sensor that may be attached to pump equipment **120** to monitor the temperature of pump equipment **120**. Sensor device **630** may include a controller configurable to adjust parameters associated with the temperature sensor, such as a temperature threshold based on, for example, environmental or other conditions.

Sensor device **630** may interface with a pressure sensor. As an example, a pressure sensor may be installed in a pump, pipe, and/or storage tank associated with pump equipment **120** and sensor device **630** may include an interface and/or controller to connect to an output port associated with the pressure sensor. Sensor device **630** may include a controller configurable to adjust parameters associated with the pressure sensor, such as, for example, a pressure threshold.

Wireless transceiver **640** may include a cellular radio transceiver, which may operate according to a cellular standard that enables communication with base station **130**, such as the Third Generation Partnership Project (3GPP) Fourth Generation (4G) and/or Fifth Generation (5G) mobile wireless standards. Furthermore, wireless transceiver **640** may be configured for one or more M2M communications methods, such as eMTC, NB-IoT, etc. Additionally, wireless transceiver **640** may include a WPAN radio transceiver for a wireless personal area network (e.g., using IEEE 802.15 standards or Bluetooth®), a GPS receiver, and/or a radio transceiver operating in an unlicensed spectrum (e.g., 900 MHz, 2.4 GHz).

Charging system **650** may manage power usage of pump monitoring system **110**. For example, charging system **650** may monitor the power capacity (e.g., voltage) of battery **230**, power consumption of pump monitoring device **610**, and/or power supplied by solar panel **240**. Charging system **650** may be configured to use power from battery **230** to power pump monitoring device **610**, when the battery power is above a battery power threshold, and use power from solar panel **240** to power pump monitoring device **610** and/or charge battery **230**, when the battery is associated with a battery power below the battery power threshold. In some implementations, controller **620** may configure charging system **650** for a particular setting, such the battery power threshold, how much of available power from solar panel **240** to use to charge battery **230** and how much power to provide to pump monitoring device **610**, etc.

Although FIG. **6** shows exemplary components of pump monitoring system **110**, in other implementations, pump monitoring system **110** may include fewer components, different components, differently arranged components, or additional components than depicted in FIG. **6**. Additionally, or alternatively, one or more components of pump monitoring system **110** may perform functions described as being performed by one or more other components of pump monitoring system **110**.

FIG. **7** is a diagram illustrating exemplary components of a device **700** that may be included in a component of a pump monitoring system according to an implementation described herein. Controller **620**, sensor device **630**, wireless transceiver **640**, charging system **650**, user device **150**, and/or application server **160** may each include one or more devices **700**. As shown in FIG. **7**, device **700** may include a bus **710**, a processor **720**, a memory **730**, an input device **740**, an output device **750**, and a communication interface **760**.

Bus **710** may include a path that permits communication among the components of device **700**. Processor **720** may include any type of single-core processor, multi-core processor, microprocessor, latch-based processor, central processing unit (CPU), graphics processing unit (GPU), tensor processing unit (TPU), hardware accelerator, and/or processing logic (or families of processors, microprocessors, and/or processing logics) that interprets and executes instructions. In other embodiments, processor **720** may include an application-specific integrated circuit (ASIC), a field-programmable gate array (FPGA), application specific instruction-set processors (ASIPs), a system-on-chip (SoCs), and/or another type of integrated circuit or processing logic.

Memory **730** may include any type of dynamic storage device that may store information and/or instructions, for execution by processor **720**, and/or any type of non-volatile storage device that may store information for use by processor **720**. For example, memory **730** may include a random access memory (RAM), dynamic random access memory (DRAM), or another type of dynamic storage device, a read-only memory (ROM) device, a programmable read only memory (PROM), a static random access memory (SRAM), a single in-line memory module (SIMM), a dual in-line memory module (DIMM), a flash memory (e.g., a NAND flash, a NOR flash, etc.), or another type of static storage device, a content addressable memory (CAM), a magnetic and/or optical recording memory device and its corresponding drive (e.g., a hard disk drive, optical drive, etc.), and/or a removable form of memory, such as a flash memory. Alternatively, or additionally, memory **630** may include a Micro-Electromechanical System (MEMS)-based storage medium, and/or a nanotechnology-based storage medium.

Input device **740** may allow an operator to input information into device **700**. Input device **740** may include, for example, a keyboard, a mouse, a pen, a microphone, a remote control, an audio capture device, an image and/or video capture device, a touch-screen display, and/or another type of input device. In some implementations, device **700** may be managed remotely and may not include input device **640**. In other words, device **700** may be "headless" and may not include a keyboard, for example.

Output device **750** may output information to an operator of device **700**. Output device **750** may include a display, a panel of indicator lights, a printer, a speaker, and/or another type of output device. For example, device **700** may include a display, which may include a liquid-crystal display (LCD) for displaying content to the user, a set of indicators **320**, etc. In some implementations, device **700** may be managed remotely and may not include output device **750**. In other words, device **700** may be "headless" and may not include a display, for example.

Communication interface **760** may include a transceiver that enables device **700** to communicate with other devices and/or systems via wireless communications (e.g., radio frequency, infrared, and/or visual optics, etc.), wired communications (e.g., conductive wire, twisted pair cable, coaxial cable, transmission line, fiber optic cable, and/or waveguide, etc.), or a combination of wireless and wired communications. Communication interface **760** may include a transmitter that converts baseband signals to radio frequency (RF) signals and/or a receiver that converts RF signals to baseband signals. Communication interface **760** may be coupled to an antenna for transmitting and receiving RF signals.

Communication interface **760** may include a logical component that includes input and/or output ports, input and/or output systems, and/or other input and output components that facilitate the transmission of data to, and/or reception of data from, other devices. For example, communication interface **760** may include a network interface card (e.g., Ethernet card) for wired communications and/or a wireless network interface (e.g., a WiFi) card for wireless communications. Communication interface **760** may also include a universal serial bus (USB) port for communications over a cable, a Bluetooth™ wireless interface, a radio-frequency identification (RFID) interface, a near-field communications (NFC) wireless interface, and/or any other type of interface that converts data from one form to another form.

As described in detail herein, device **700** may perform certain operations relating to, for example, configuring sensor devices **630** and/or collecting and reporting data collected by sensor devices **630**. Device **700** may perform these operations in response to processor **720** executing software instructions contained in a computer-readable medium, such as memory **730**. A computer-readable medium may be defined as a non-transitory memory device. A memory device may be implemented within a single physical memory device or spread across multiple physical memory devices. The software instructions may be read into memory **730** from another computer-readable medium or from another device. The software instructions contained in memory **730** may cause processor **720** to perform processes described herein. Alternatively, hardwired circuitry may be used in place of, or in combination with, software instructions to implement processes described herein. Thus, implementations described herein are not limited to any specific combination of hardware circuitry and software.

Although FIG. **7** shows exemplary components of device **700**, in other implementations, device **700** may include fewer components, different components, additional components, or differently arranged components than depicted in FIG. **7**. Additionally, or alternatively, one or more components of device **700** may perform one or more tasks described as being performed by one or more other components of device **700**.

FIG. **8** is a diagram of exemplary functional components of controller **620** according to an exemplary implementation described herein. The functional components of controller **620** may be implemented, for example, via processor **720** executing instructions from memory **730**. Alternatively, some or all of the functional components of controller **620** may be implemented via hard-wired circuitry. As shown in FIG. **8**, controller **620** may include an application server interface **810**, a user device interface **820**, a location monitor **830**, a charging system manager **840**, a sensor manager **850**, a sensor settings database (DB) **855**, a data collector **860**, a sensor data DB **865**, and a status monitor **870**.

Application server interface **810** may be configured to communicate with application server **160**. For example, application server interface **810** may establish an Internet Protocol (IP) connection with application server **160** and receive a set of configuration selections or settings for sensor devices **630** and/or send collected sensor data to application server **160**. User device interface **820** may be configured to communicate with client application **155** running on user device **150**. For example, user device interface **820** may establish an IP connection with client application **155** and receive a set of configuration settings for sensor devices **630** and/or send collected sensor data to client application **155**.

Location monitor **830** may monitor the location of pump monitoring system **110** using GPS information received from GPS satellite **170**. Location monitor **830** may store and/or report the location of pump monitoring system **110** to application server **160** and/or user device **150**. Charging system manager **840** may manage charging system **650**. For example, charging system manager **840** may provide one or more settings to charging system **650** and/or receive information from charging system **650** that may be reported to client application **155** and/or application server **160**, such as the power level of battery **230**, the power being generated by solar panel **240**, the power being consumed by pump monitoring device **610** and/or particular components of pump monitoring device **610**, and/or other types of information.

Sensor manager **850** may manage sensor devices **630**. For example, sensor manager **850** may receive one or more sensor configurations or settings and/or sensor data reporting configurations from client application **155** and/or application server **160**, store the received configurations in sensor settings DB **855**, and apply the stored configurations to sensor devices **630** and/or to data collector **860**. The configurations may include, for example, which sensor devices **630** to activate, a calibration process to perform to ensure sensor devices **630** are performing properly and calibrated, a range of sensor values over which to gather sensor data, a threshold sensor value to generate an alert, a pulse generation parameter for generating a pulse to gather sensor data (e.g., for an ultrasonic flow sensor), a data sampling interval and/or frequency, a data reporting interval and/or frequency, and/or other types of configurations or settings.

Data collector **860** may collect sensor data using the activated sensor devices **630** based on a set of data collection configurations and store the collected sensor data in sensor data DB **865**. Furthermore, data collector **860** may automatically report the collected sensor data to client application **155** and/or application server **160** based on a data reporting configuration.

Status monitor **870** may monitor the status of pump monitoring system **110** and send status reports to application server **160** and/or client application **155** at particular intervals and/or in response to detecting an alert condition. For example, status monitor **870** may report the status reported by indicators **320** and/or the status of various components of pump monitoring system **110**, such as whether any error states or malfunctions have been detected. Furthermore, status monitor **870** may report which sensor devices **630** have been activated, which ports **310** are being used, how much capacity is being used by battery **230**, how much power is being used by pump monitoring system **110** or by particular components of pump monitoring system **110**, how much power solar panel **240** is generating, and/or other types of status information.

FIG. **9** is a flow diagram of a pump monitoring process according to an implementation described herein. In some implementations, process **900** of FIG. **9** may be performed by pump monitoring device **610**. In other implementations, some or all of process **900** may be performed by another device or a group of devices separate from pump monitoring device **610**.

As shown in FIG. **9**, process **900** may include obtaining a selection of sensors (block **910**), obtaining sensor configurations for the selected sensors (block **920**), and configuring the selected sensors based on the obtained sensor configurations (block **930**). For example, pump monitoring device **610** may attach to base station **130** using wireless transceiver **640**. Furthermore, pump monitoring device **610** may be associated with a Uniform Resource Locator (URL), IP address, Mobile Directory Number (MDN), and/or another identifier that enables client application **155** and/or application server **160** to establish a connection with pump monitoring device **610** and send instructions to pump monitoring device **510**.

Pump monitoring device **610** may receive a selection of sensor devices **630** to activate and a set of configurations for particular sensor devices **630** that have been activated. Pump monitoring device **610** may apply the configuration settings to sensor devices **630**. The configurations may include, for example, a calibration process to perform, a range of sensor values over which to gather sensor data, one or more threshold sensor values to generate an alert, a pulse generation parameter for generating a pulse to gather sensor data (e.g., for an ultrasonic flow sensor), a data sampling interval and/or frequency of measuring or monitoring, and/or other types sensor configuration parameters values.

In some implementations, sensor settings for sensor devices **630**, and/or transmission settings for wireless transceiver **640**, may depend on whether power is being provided by battery **230** or solar panel **240**. As an example, sensor manager **850** may select a configuration with fewer features and less power consumption if the capacity of battery **230** is below a threshold or if power is being consumed from solar panel **240**, such as select a lower sampling frequency, a lower sensor data reporting frequency, etc. As another example, sensor manager **850** may select a higher threshold for sending an alert if the capacity of battery **230** is below a threshold or if power is being consumed from solar panel **240**.

Process **900** may further include obtaining a sensor data reporting configuration (block **940**), collect sensor data based on the obtained sensor configuration (block **950**), and report the collected sensor data based on the obtained sensor data reporting configuration (block **960**). For example, pump monitoring device **610** may receive a data sampling interval and/or frequency of monitoring, a data reporting interval and/or frequency, a URL or other identifier for reporting the collected sensor data, parameters to include in the reported sensor data (e.g., the location of pump monitoring system **110**, an identifier associate with pump equipment **120**, etc.), conditions for reporting an alert based on a particular threshold, and/or other types of sensor data reporting configurations.

Data collector **860** may collect and report sensor data based on the received sensor data reporting configurations. As an example, data collector **860** may upload collected sensor data values to a URL to application server **160**, user device **150**, and/or other devices, at particular intervals. As another example, data collector **860** may set a threshold sensor value for sensor device **630**, detect that the threshold sensor value has been reached or exceeded by a collected sensor value, generate an alert based on the detected sensor value, and transmit the alert to the data reporting URL (or to an alert URL different from the data reporting URL, application server **160**, user device **150**, etc.) via base station **130**. Furthermore, in addition to reporting collected sensor data, status monitor **870** may report a status of pump monitoring system **110** at particular intervals or in response to a detected alert condition.

While implementations described herein refer to monitoring pump equipment, pump monitoring system **110** may be used, in other implementations, to monitor other types of systems in remote locations that may be monitored with a set of sensors, such as, for example, Industrial IoT (IIoT) devices or systems, drill equipment, mining equipment, power generating stations, weather stations, and/or other types of remote machinery or monitoring devices.

In the preceding specification, various preferred embodiments have been described with reference to the accompanying drawings. It will, however, be evident that various modifications and changes may be made thereto, and additional embodiments may be implemented, without departing from the broader scope of the invention as set forth in the claims that follow. The specification and drawings are accordingly to be regarded in an illustrative rather than restrictive sense. The use of the term or phrase "embodiment" or "embodiments" does not necessarily refer to all embodiments described, nor does it necessarily refer to the same embodiment, nor are separate or alternative embodiments necessarily mutually exclusive of other embodiment(s). The same applies to the term "implementation," "implementations," etc.

For example, while a series of blocks have been described with respect to FIG. **9**, the order of the blocks may be modified in other implementations. Further, non-dependent blocks and/or signals may be performed in parallel.

It will be apparent that systems and/or methods, as described above, may be implemented in many different forms of software, firmware, and hardware in the implementations illustrated in the figures. The actual software code or specialized control hardware used to implement these systems and methods is not limiting of the embodiments. Thus, the operation and behavior of the systems and methods were described without reference to the specific software code—it being understood that software and control hardware can be designed to implement the systems and methods based on the description herein.

Further, certain portions, described above, may be implemented as a component that performs one or more functions. A component, as used herein, may include hardware, such as a processor, an ASIC, or a FPGA, or a combination of hardware and software (e.g., a processor executing software).

It should be emphasized that the terms "comprises"/"comprising" when used in this specification are taken to specify the presence of stated features, integers, steps or components but does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

The term "logic," as used herein, may refer to a combination of one or more processors configured to execute instructions stored in one or more memory devices, may refer to hardwired circuitry, and/or may refer to a combination thereof. Furthermore, a logic may be included in a single device or may be distributed across multiple, and possibly remote, devices.

For the purposes of describing and defining the present invention, it is additionally noted that the term "substantially" is utilized herein to represent the inherent degree of uncertainty that may be attributed to any quantitative comparison, value, measurement, or other representation. The term "substantially" is also utilized herein to represent the degree by which a quantitative representation may vary from a stated reference without resulting in a change in the basic function of the subject matter at issue.

No element, act, or instruction used in the present application should be construed as critical or essential to the embodiments unless explicitly described as such. Also, as used herein, the article terms "a," "an," and "the" are intended to be interpreted to include one or more items. Further, the phrase "based on" is intended to be interpreted as "based, at least in part, on," unless explicitly stated otherwise. The term "and/or" is intended to be interpreted to include any and all combinations of one or more of the associated items. The word "exemplary" is used herein to mean "serving as an example." Any embodiment or implementation described as "exemplary" is not necessarily to be construed as preferred or advantageous over other embodiments or implementations.

Use of ordinal terms such as "first," "second," "third," etc., in the claims to modify a claim element does not by itself connote any priority, precedence, or order of one claim element over another, the temporal order in which acts of a method are performed, the temporal order in which instructions executed by a device are performed, etc., but are used merely as labels to distinguish one claim element having a certain name from another element having a same name (but for use of the ordinal term) to distinguish the claim elements.

What is claimed is:

1. A device for monitoring pump equipment, comprising:

a pump monitoring device comprising:

a plurality of interface devices configured to interface with a plurality of sensor devices located on or in the pump equipment, wherein the pump equipment is external to the device for monitoring the pump equipment, and wherein the plurality of interface devices includes at least one interface device configured to interface with a pump sensor that monitors the pump equipment;

a controller configured to configure the plurality of sensor devices and collect sensor data from the plurality of sensor devices; and

a wireless transceiver configured to communicate with a cellular base station;

a battery configured to provide power to the pump monitoring device;

a solar panel;

a charging system to charge the battery using the solar panel;

a waterproof housing that encloses the pump monitoring device and the charging system, wherein the waterproof housing includes a plurality of ports coupled to the plurality of interface devices, and wherein the controller is to configure the plurality of sensor devices located on or in the pump equipment via the plurality of interface devices and the plurality of ports; and

a chassis configured to secure the pump monitoring device, battery, solar panel, and charging system into a self-contained mobile monitoring device,

wherein the wireless transceiver is coupled to an upper surface of the chassis, and

wherein the solar panel is coupled to the upper surface of the chassis.

2. The device of claim **1**, wherein the controller is further configured to:

obtain a sensor configuration for particular ones of the plurality of sensor devices;

configure the particular ones of the plurality of sensor devices based on the obtained sensor configuration;

collect sensor data based on the obtained sensor configuration; and

report the collected sensor data via the wireless transceiver.

3. The device of claim **2**, wherein the sensor configuration for a sensor device of the plurality of sensor devices includes at least one of:

a calibration process to perform;

a range of sensor values over which to gather sensor data;

a threshold sensor value to generate an alert; or

a pulse generation parameter for generating a pulse to gather sensor data.

4. The device of claim **2**, wherein the controller is further configured to:

set a threshold sensor value for a sensor device of the plurality of sensor devices;

detect the threshold sensor value in data collected from the sensor device;

generate an alert based on the detected threshold sensor value; and

transmit the generated alert to an application server using the wireless transceiver.

5. The device of claim 1, wherein the plurality of interface devices includes an interface device configured to interface with at least one of:

a flow meter;

a fluid level meter;

a vibration sensor;

a temperature sensor; or

a pressure sensor.

6. The device of claim 1, wherein the solar panel is secured to the chassis in a position that protects the solar panel from impact if the chassis tips over.

7. The device of claim 1, further comprising:

a pair of wheels at a first side of the chassis; and

a bar at a second side of the chassis to keep the chassis level.

8. The device of claim 7, further comprising:

a foot brake configured to engage the pair of wheels.

9. The device of claim 1, further comprising:

a protective frame around the solar panel.

10. The device of claim 1, further comprising:

a mounting assembly for an antenna for the wireless transceiver.

11. The device of claim 1, further comprising:

at least one cable hook.

12. The device of claim 1, further comprising:

a support for the solar panel, wherein the support is configured to adjust an angle of the solar panel with respect to a base of the chassis.

13. The device of claim 1, wherein the waterproof housing meets an industrial standard for waterproof submersion.

14. The device of claim 1, further comprising:

a waterproof battery enclosure that encloses the battery.

15. The device of claim 14, wherein the waterproof housing is elevated above the waterproof battery enclosure.

16. The device of claim 1, further comprising:

an antenna connected to the pump monitoring device; and

an antenna housing enclosing the antenna.

17. The device of claim 1, further comprising:

a Global Positioning System (GPS) receiver connected to the pump monitoring device; and

a GPS receiver housing enclosing the GPS receiver.

* * * * *