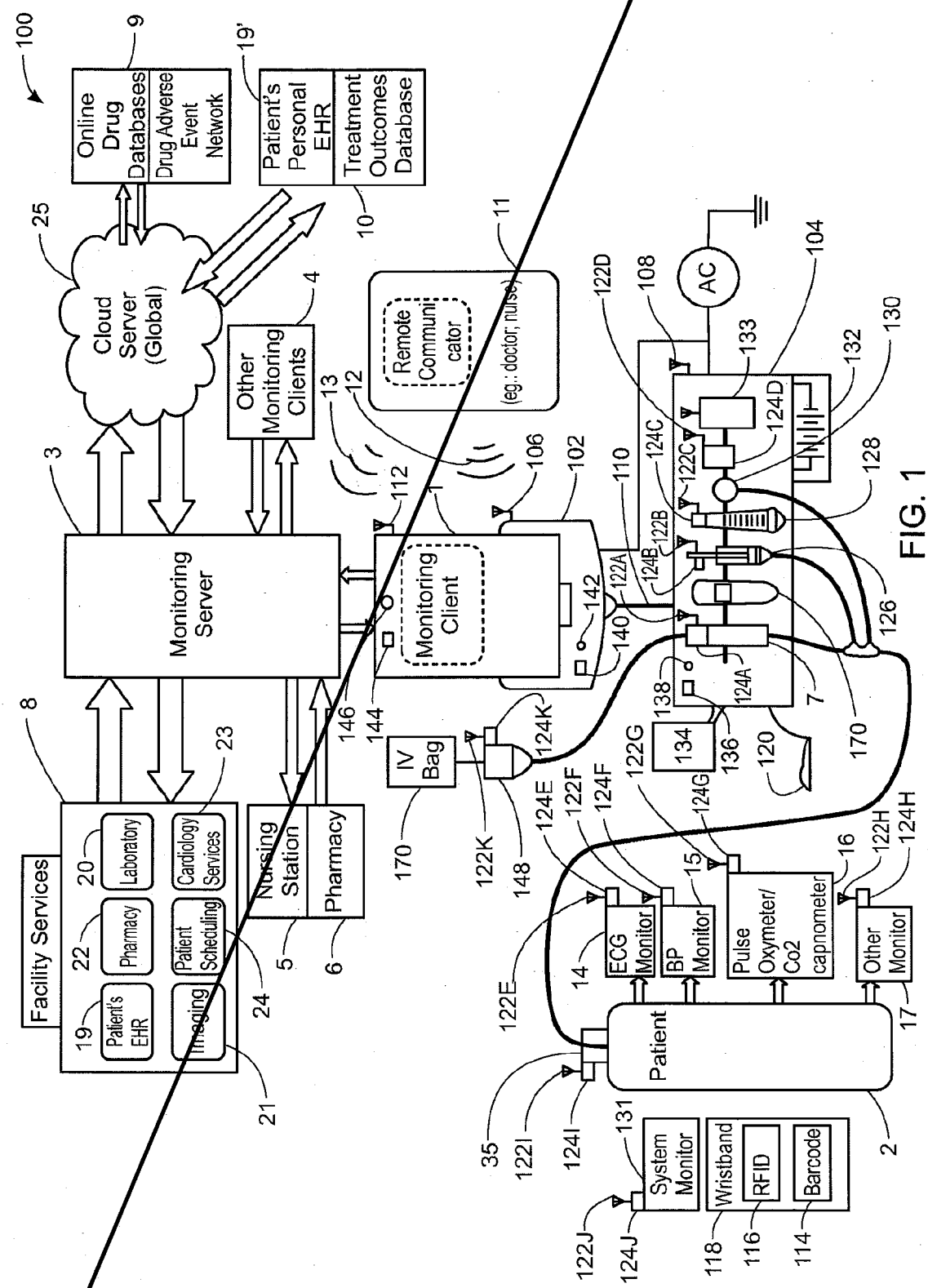

100
Online Drug Databases
Drug Adverse Event Network
9
Patient's Personal EHR
Treatment Outcomes Database
19'
10
25
Cloud Server (Global)
Other Monitoring Clients
4
Remote Communicator
(eg.: doctor; nurse)
11
3
Monitoring Server
Monitoring Client
1
13
12
112
106
102
110
142
140
144
146
8
Facility Services
Patient's EHR
Pharmacy
Laboratory
Cardiology Services
Patient Scheduling
Imaging
19
22
20
23
24
21
Nursing Station
Pharmacy
5
6
IV Bag
170
122K
148
124K
122A
124B
122B
124C
122C
124D
122D
108
AC
104
133
132
130
128
126
170
7
124A
138
136
134
120
124E
122F
124F
122G
124G
15
16
122H
124H
ECG Monitor
BP Monitor
Pulse Oxymeter/ Co2 capnometer
Other Monitor
14
17
122E
Patient
2
35
122I
124I
131
System Monitor
Wristband
RFID
Barcode
122J
124J
118
116
114

FIG. 1

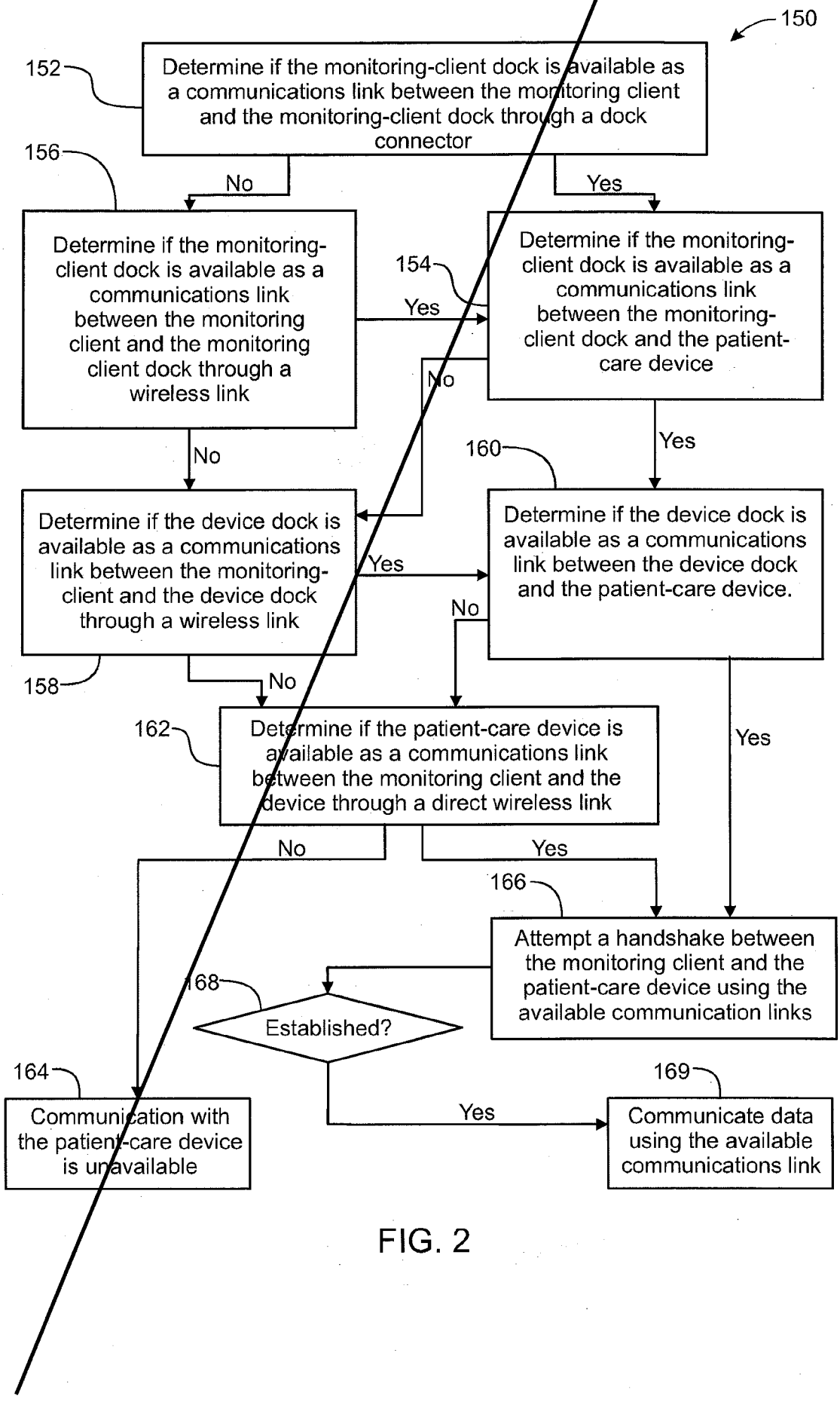

150
152
Determine if the monitoring-client dock is available as a communications link between the monitoring client and the monitoring-client dock through a dock connector
156
No
Yes
Determine if the monitoring-client dock is available as a communications link between the monitoring client and the monitoring client dock through a wireless link
154
Yes
Determine if the monitoring-client dock is available as a communications link between the monitoring-client dock and the patient-care device
No
No
Yes
160
Determine if the device dock is available as a communications link between the monitoring-client and the device dock through a wireless link
Yes
Determine if the device dock is available as a communications link between the device dock and the patient-care device.
No
158
No
162
Determine if the patient-care device is available as a communications link between the monitoring client and the device through a direct wireless link
Yes
No
Yes
166
Attempt a handshake between the monitoring client and the patient-care device using the available communication links
168
Established?
164
Communication with the patient-care device is unavailable
Yes
169
Communicate data using the available communications link

FIG. 2

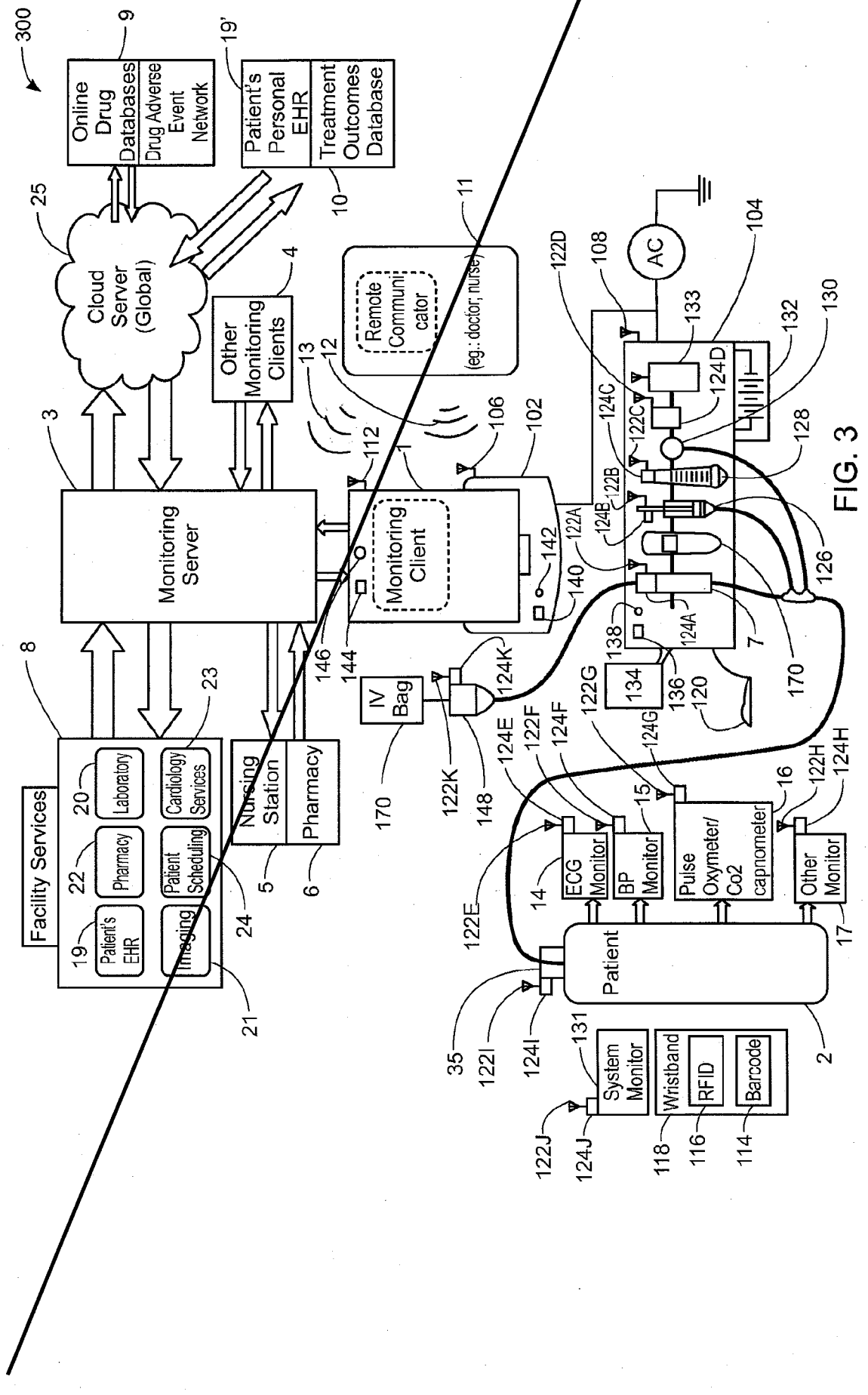

300
Online Drug Databases
Drug Adverse Event Network
Patient's Personal EHR
Treatment Outcomes Database
Cloud Server (Global)
Other Monitoring Clients
Remote Communicator
(eg.: doctor; nurse)
Monitoring Server
Monitoring Client
Facility Services
Laboratory
Pharmacy
Cardiology Services
Patient's EHR
Imaging
Patient Scheduling
Nursing Station
Pharmacy
IV Bag
AC
ECG Monitor
BP Monitor
Pulse Oxymeter/ Co2 capnometer
Other Monitor
Patient
System Monitor
Wristband
RFID
Barcode

FIG. 3

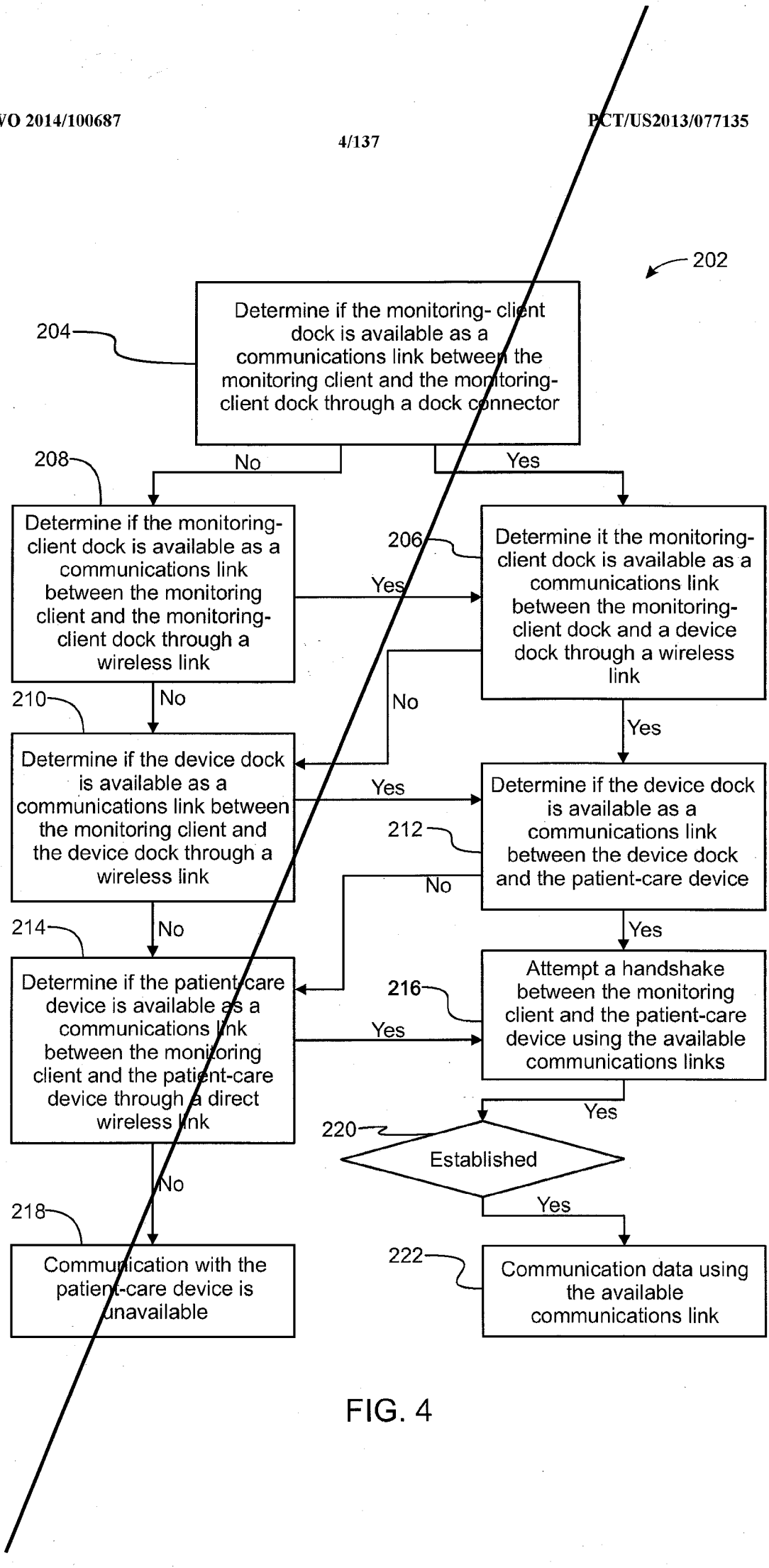

202
204
Determine if the monitoring- client dock is available as a communications link between the monitoring client and the monitoring-client dock through a dock connector
No
Yes
208
Determine if the monitoring-client dock is available as a communications link between the monitoring client and the monitoring-client dock through a wireless link
206
Determine it the monitoring-client dock is available as a communications link between the monitoring-client dock and a device dock through a wireless link
Yes
No
210
Determine if the device dock is available as a communications link between the monitoring client and the device dock through a wireless link
Yes
No
212
Determine if the device dock is available as a communications link between the device dock and the patient-care device
Yes
No
214
Determine if the patient-care device is available as a communications link between the monitoring client and the patient-care device through a direct wireless link
Yes
No
216
Attempt a handshake between the monitoring client and the patient-care device using the available communications links
Yes
220
Established
Yes
No
218
Communication with the patient-care device is unavailable
222
Communication data using the available communications link

FIG. 4

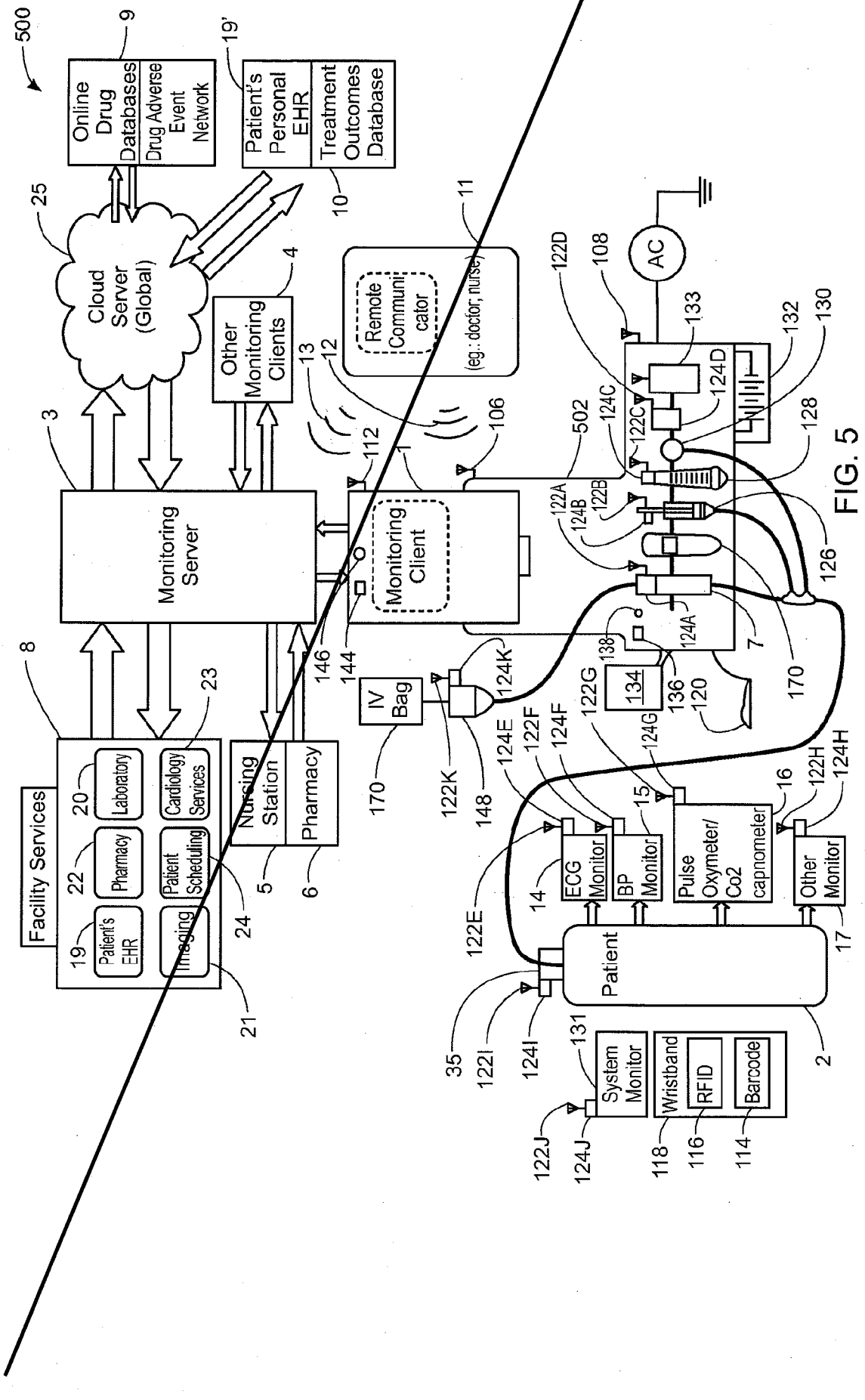

500
Online Drug Databases
Drug Adverse Event Network
Patient's Personal EHR
Treatment Outcomes Database
Cloud Server (Global)
Other Monitoring Clients
Remote Communicator
(eg.: doctor, nurse)
Monitoring Server
Monitoring Client
Facility Services
Laboratory
Pharmacy
Patient's EHR
Cardiology Services
Patient Scheduling
Imaging
Nursing Station
Pharmacy
IV Bag
AC
ECG Monitor
BP Monitor
Pulse Oxymeter/ Co2 capnometer
Other Monitor
Patient
System Monitor
Wristband
RFID
Barcode

FIG. 5

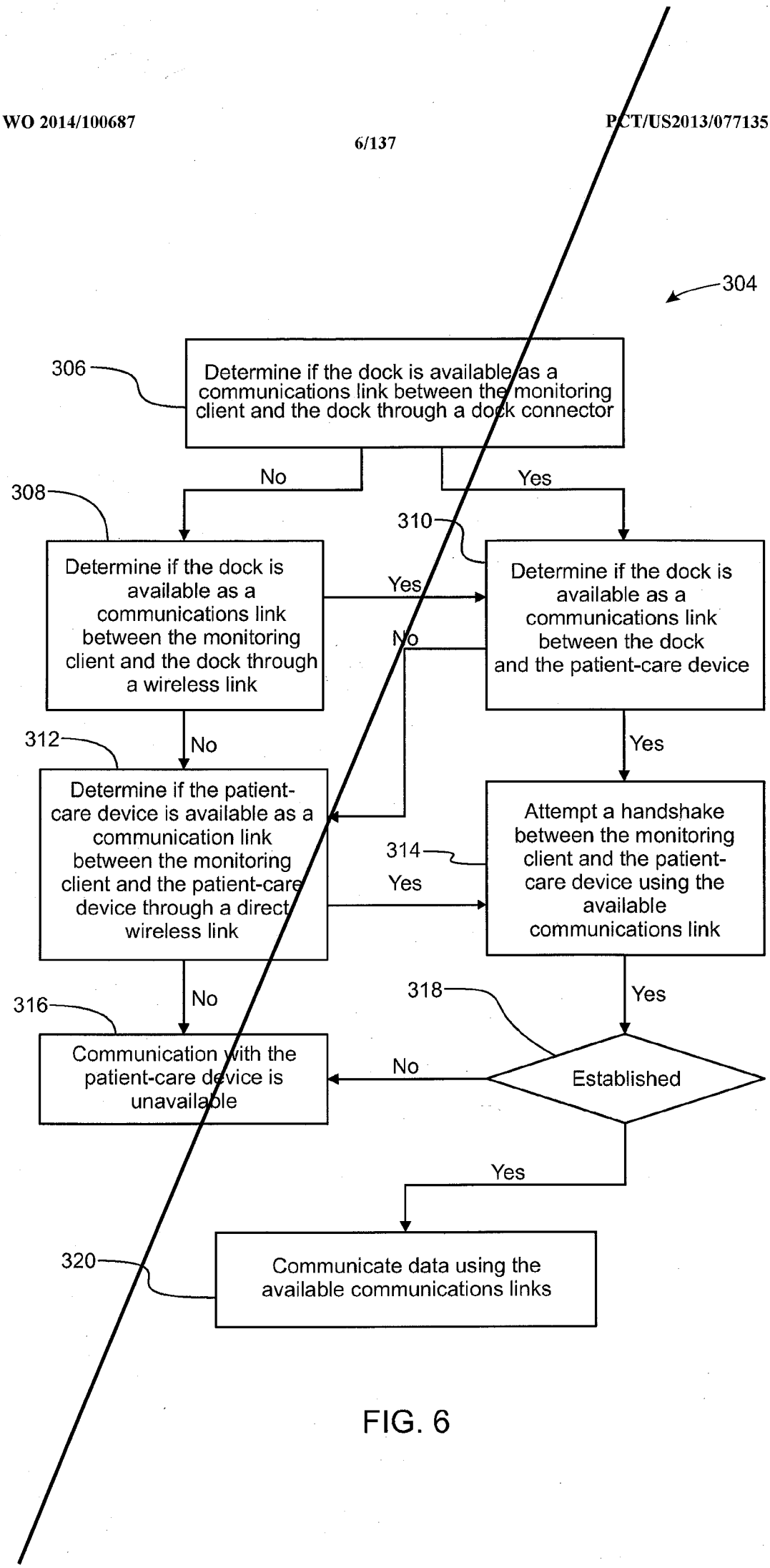

304
306
Determine if the dock is available as a communications link between the monitoring client and the dock through a dock connector
No
Yes
308
Determine if the dock is available as a communications link between the monitoring client and the dock through a wireless link
310
Determine if the dock is available as a communications link between the dock and the patient-care device
Yes
No
312
No
Yes
Determine if the patient-care device is available as a communication link between the monitoring client and the patient-care device through a direct wireless link
314
Attempt a handshake between the monitoring client and the patient-care device using the available communications link
Yes
316
No
318
Yes
Communication with the patient-care device is unavailable
No
Established
Yes
320
Communicate data using the available communications links

FIG. 6

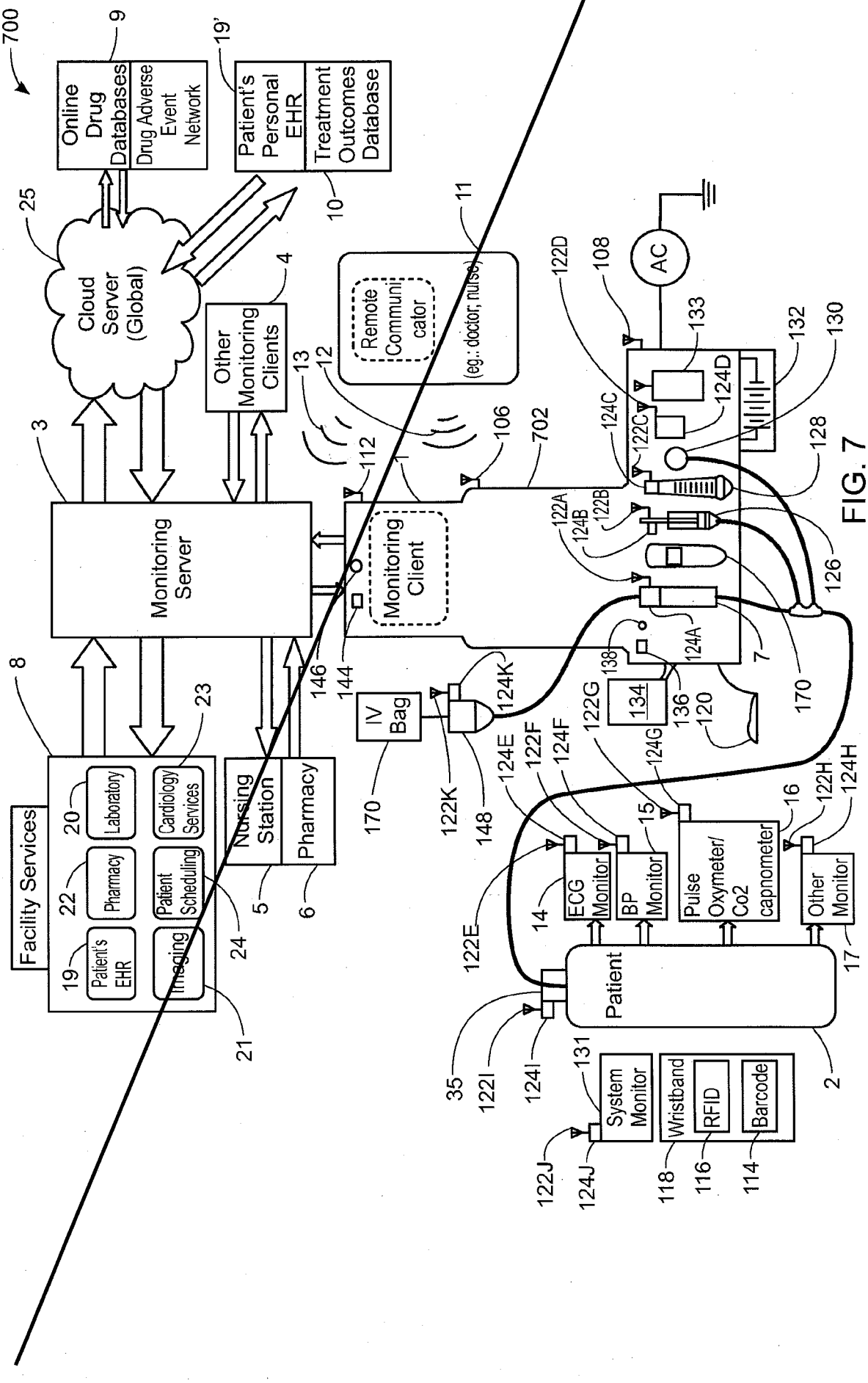
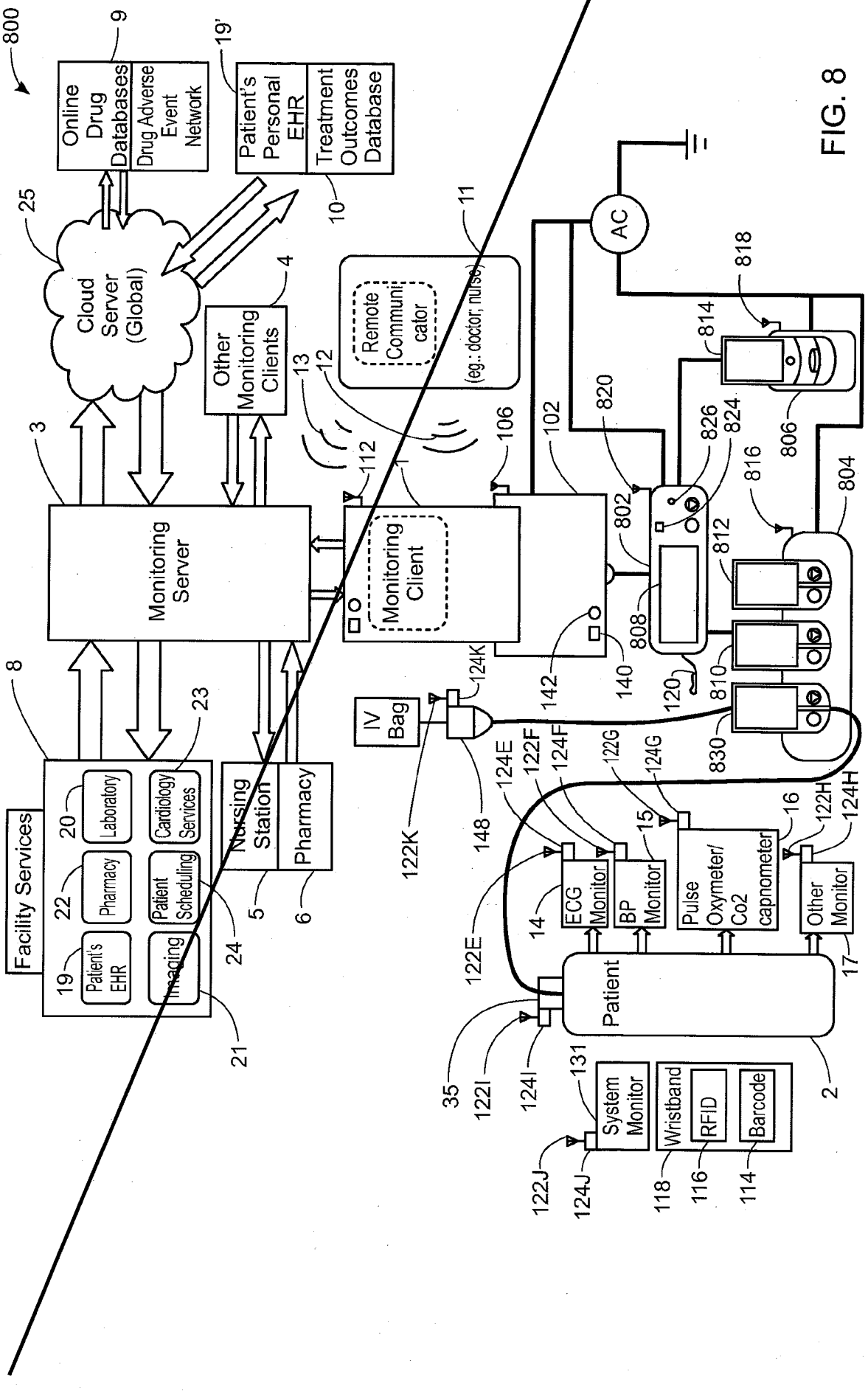

700
Online Drug Databases
Drug Adverse Event Network
Patient's Personal EHR
Treatment Outcomes Database
Cloud Server (Global)
Other Monitoring Clients
Remote Communi cator
(eg.: doctor; nurse)
Monitoring Server
Monitoring Client
Facility Services
Laboratory
Pharmacy
Patient's EHR
Cardiology Services
Patient Scheduling
Imaging
Nursing Station
Pharmacy
IV Bag
AC
ECG Monitor
BP Monitor
Pulse Oxymeter/ Co2 capnometer
Other Monitor
Patient
System Monitor
Wristband
RFID
Barcode

FIG. 7


800
Online Drug Databases
Drug Adverse Event Network
Patient's Personal EHR
Treatment Outcomes Database
Cloud Server (Global)
Other Monitoring Clients
Remote Communicator
(eg.: doctor; nurse)
Monitoring Server
Monitoring Client
Facility Services
Laboratory
Pharmacy
Patient's EHR
Cardiology Services
Patient Scheduling
Imaging
Nursing Station
Pharmacy
IV Bag
AC
ECG Monitor
BP Monitor
Pulse Oxymeter/ Co2 capnometer
Other Monitor
Patient
System Monitor
Wristband
RFID
Barcode
FIG. 8

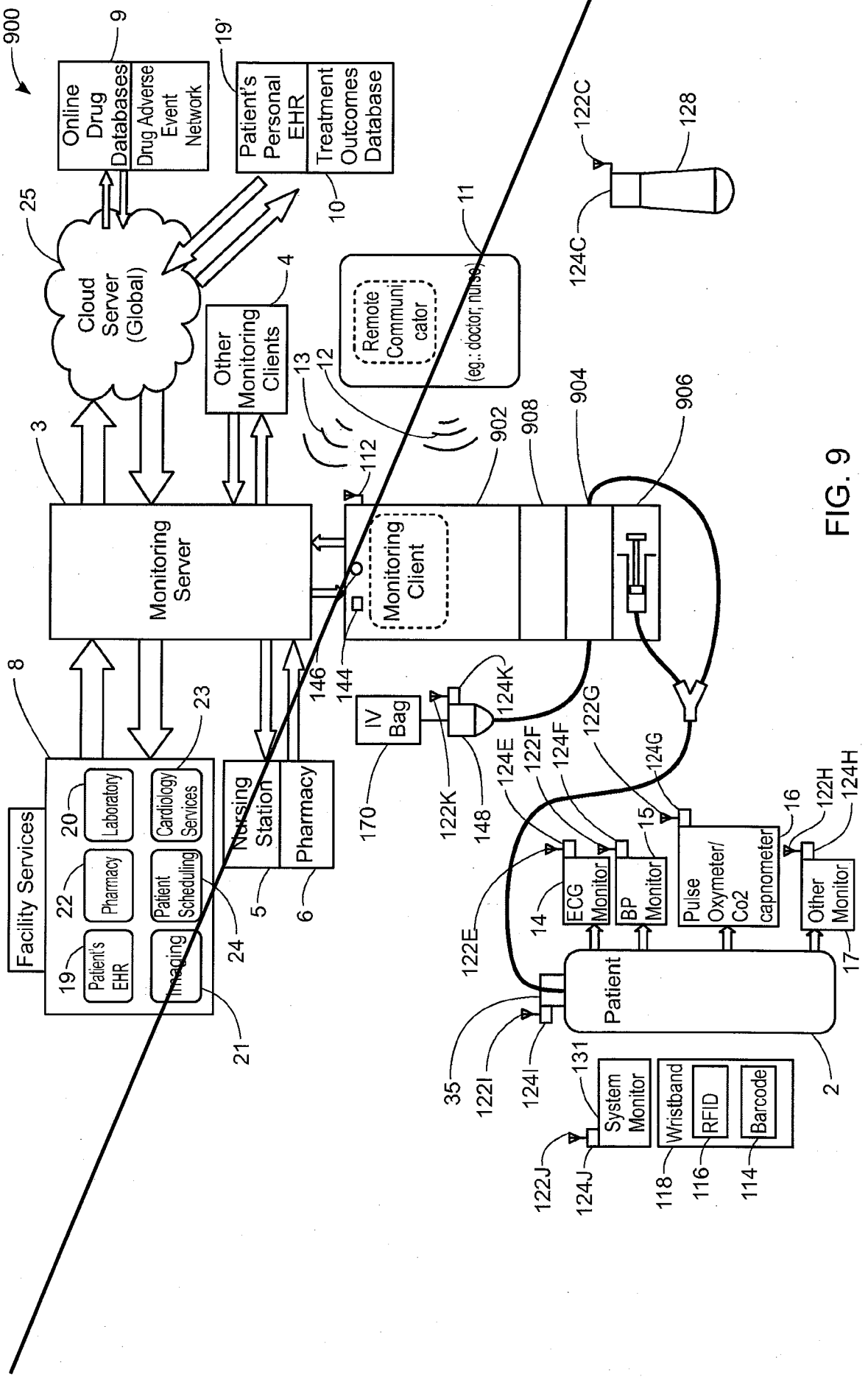

900
Online Drug Databases
Drug Adverse Event Network
Patient's Personal EHR
Treatment Outcomes Database
Cloud Server (Global)
Other Monitoring Clients
Remote Communicator
(eg.: doctor; nurse)
Monitoring Server
Monitoring Client
IV Bag
Facility Services
Laboratory
Cardiology Services
Pharmacy
Patient Scheduling
Patient's EHR
Imaging
Nursing Station
Pharmacy
ECG Monitor
BP Monitor
Pulse Oxymeter/ Co2 capnometer
Other Monitor
Patient
System Monitor
Wristband
RFID
Barcode

FIG. 9

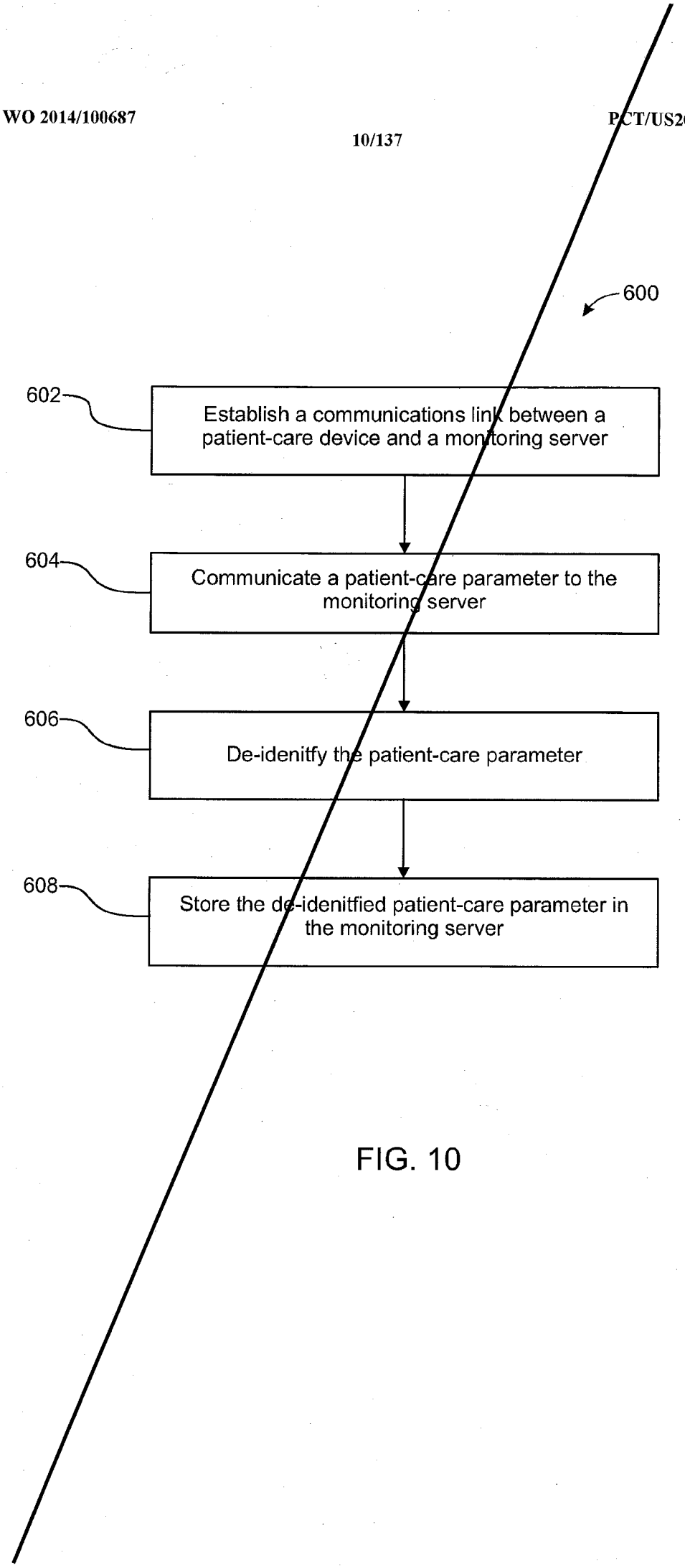

600
602
Establish a communications link between a patient-care device and a monitoring server
604
Communicate a patient-care parameter to the monitoring server
606
De-idenitfy the patient-care parameter
608
Store the de-idenitfied patient-care parameter in the monitoring server

FIG. 10

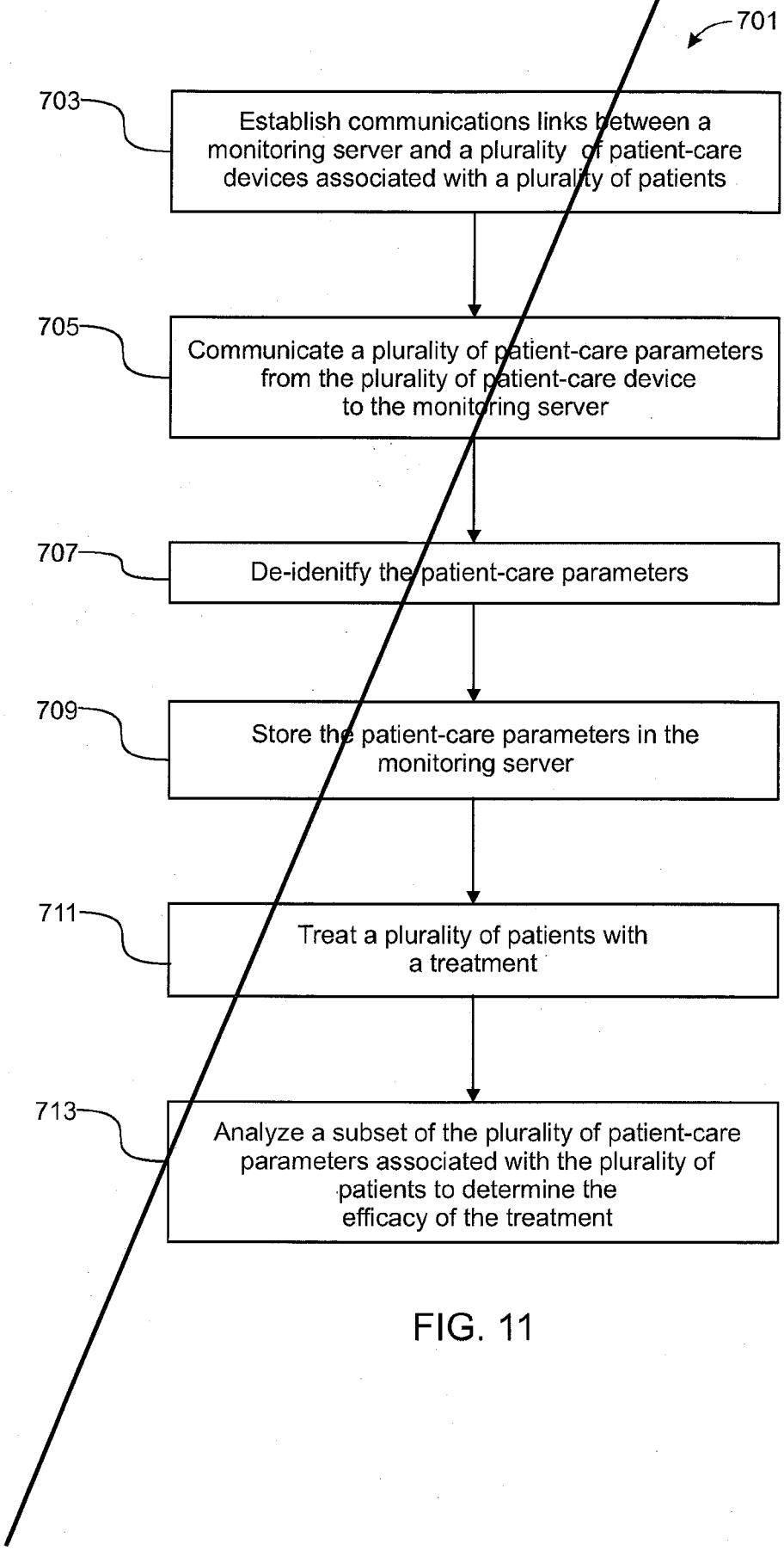

701
703
Establish communications links between a monitoring server and a plurality of patient-care devices associated with a plurality of patients
705
Communicate a plurality of patient-care parameters from the plurality of patient-care device to the monitoring server
707
De-idenitfy the patient-care parameters
709
Store the patient-care parameters in the monitoring server
711
Treat a plurality of patients with a treatment
713
Analyze a subset of the plurality of patient-care parameters associated with the plurality of patients to determine the efficacy of the treatment

FIG. 11

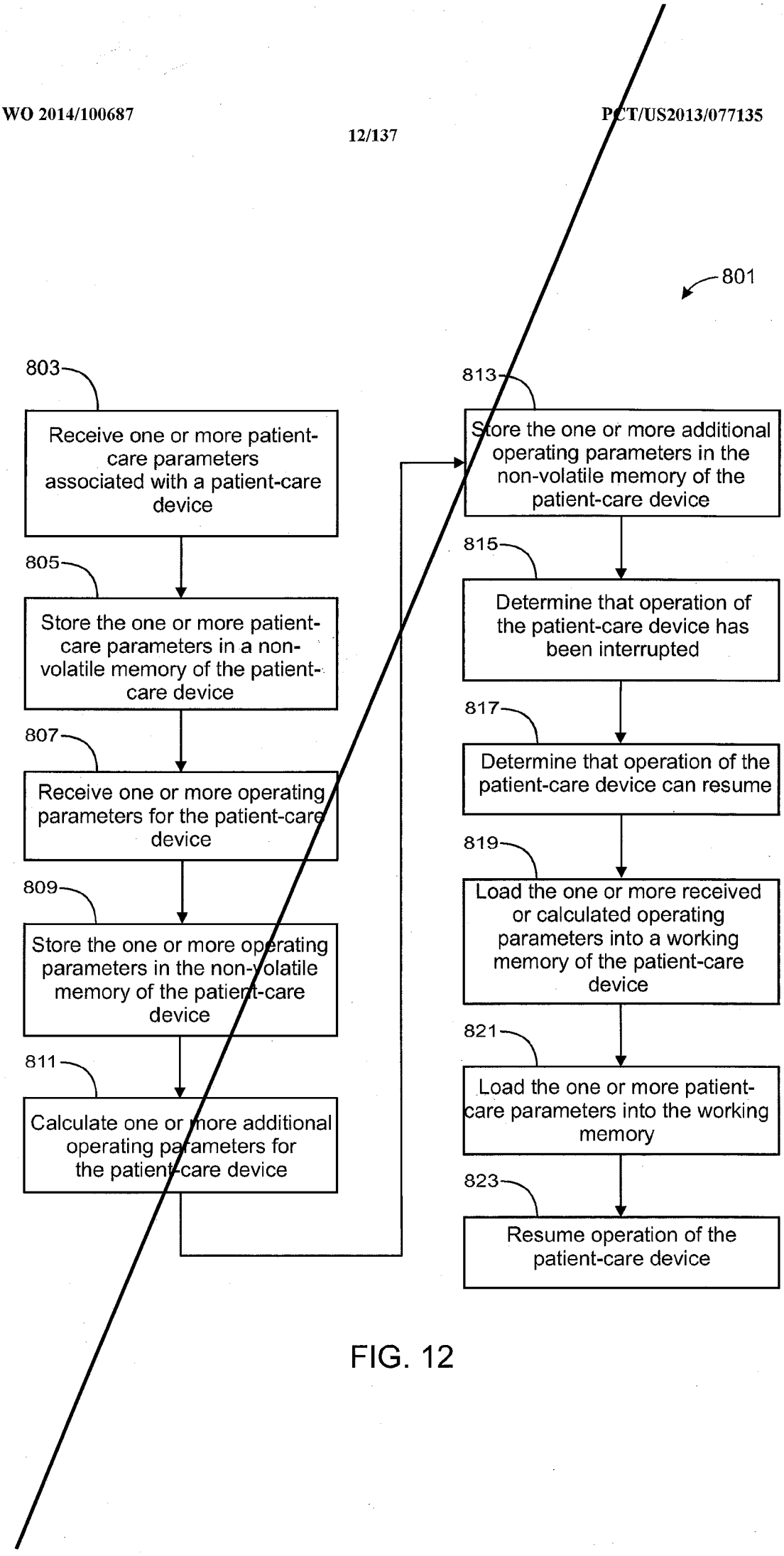

801
803
Receive one or more patient-care parameters associated with a patient-care device
805
Store the one or more patient-care parameters in a non-volatile memory of the patient-care device
807
Receive one or more operating parameters for the patient-care device
809
Store the one or more operating parameters in the non-volatile memory of the patient-care device
811
Calculate one or more additional operating parameters for the patient-care device
813
Store the one or more additional operating parameters in the non-volatile memory of the patient-care device
815
Determine that operation of the patient-care device has been interrupted
817
Determine that operation of the patient-care device can resume
819
Load the one or more received or calculated operating parameters into a working memory of the patient-care device
821
Load the one or more patient-care parameters into the working memory
823
Resume operation of the patient-care device

FIG. 12

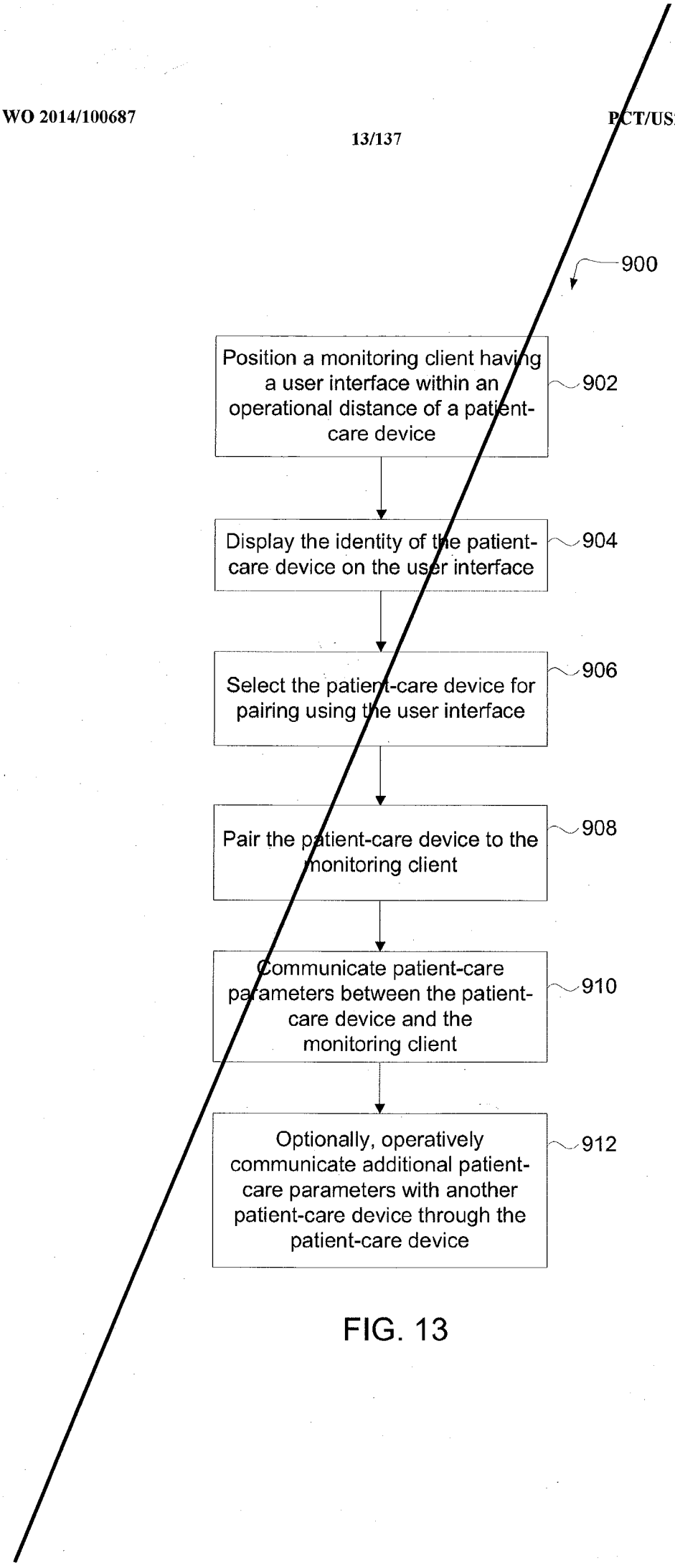

900
Position a monitoring client having a user interface within an operational distance of a patient-care device
902
Display the identity of the patient-care device on the user interface
904
Select the patient-care device for pairing using the user interface
906
Pair the patient-care device to the monitoring client
908
Communicate patient-care parameters between the patient-care device and the monitoring client
910
Optionally, operatively communicate additional patient-care parameters with another patient-care device through the patient-care device
912

FIG. 13

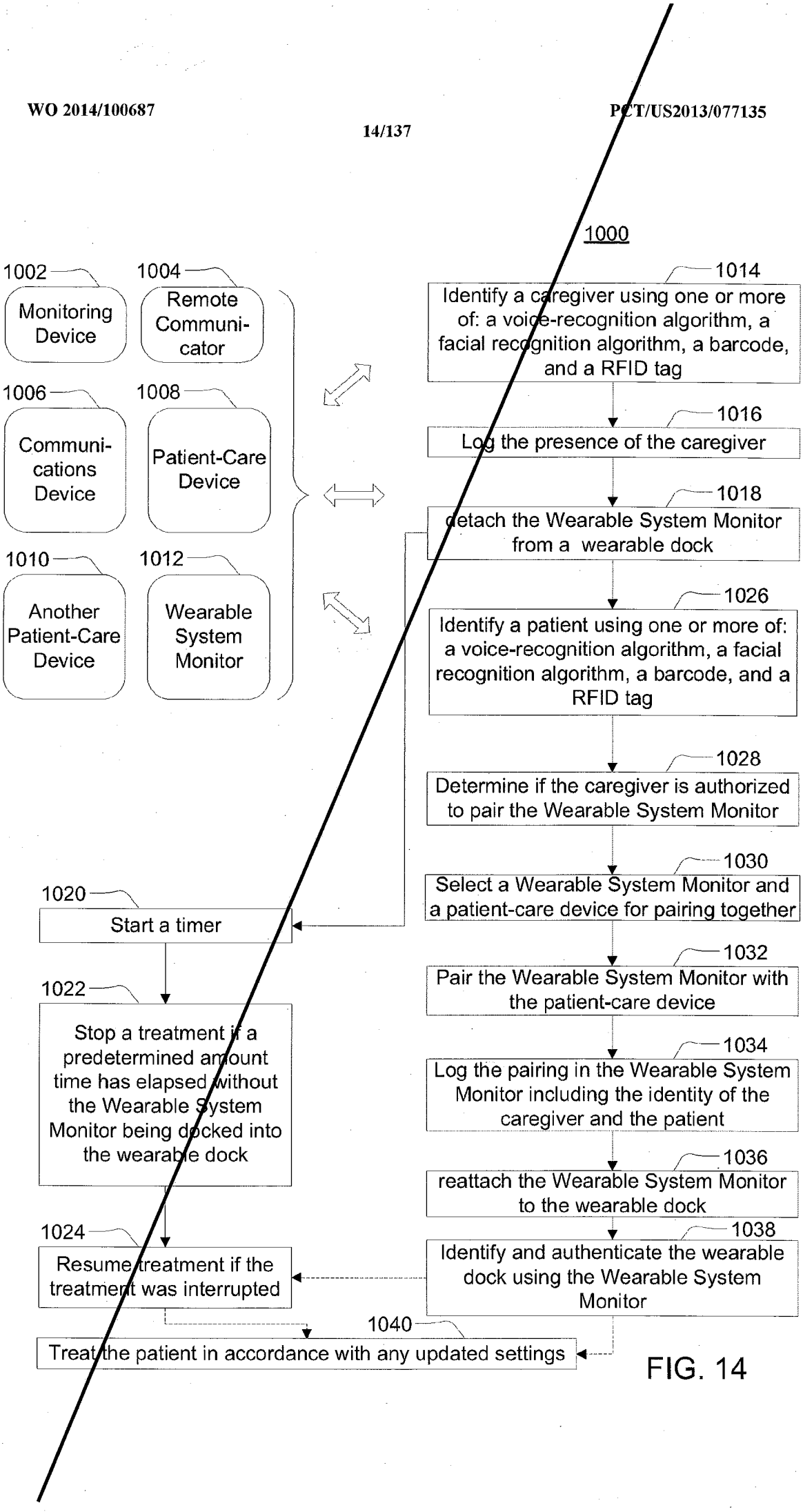

1000
1002
Monitoring Device
1004
Remote Communi-cator
1006
Communi-cations Device
1008
Patient-Care Device
1010
Another Patient-Care Device
1012
Wearable System Monitor
1014
Identify a caregiver using one or more of: a voice-recognition algorithm, a facial recognition algorithm, a barcode, and a RFID tag
1016
Log the presence of the caregiver
1018
detach the Wearable System Monitor from a wearable dock
1026
Identify a patient using one or more of: a voice-recognition algorithm, a facial recognition algorithm, a barcode, and a RFID tag
1028
Determine if the caregiver is authorized to pair the Wearable System Monitor
1030
Select a Wearable System Monitor and a patient-care device for pairing together
1032
Pair the Wearable System Monitor with the patient-care device
1034
Log the pairing in the Wearable System Monitor including the identity of the caregiver and the patient
1036
reattach the Wearable System Monitor to the wearable dock
1038
Identify and authenticate the wearable dock using the Wearable System Monitor
1020
Start a timer
1022
Stop a treatment if a predetermined amount time has elapsed without the Wearable System Monitor being docked into the wearable dock
1024
Resume treatment if the treatment was interrupted
1040
Treat the patient in accordance with any updated settings

FIG. 14

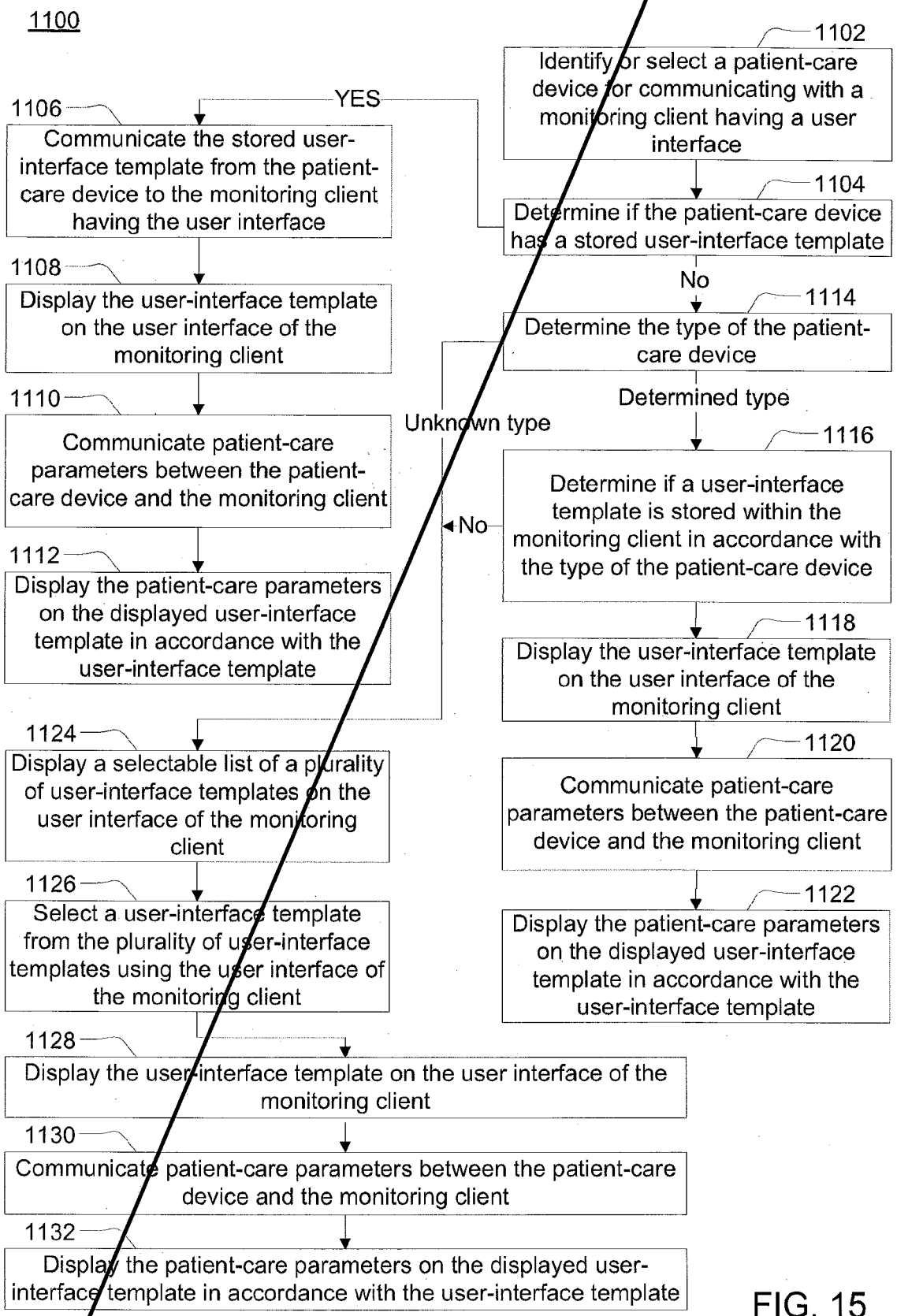

1100
1102
Identify or select a patient-care device for communicating with a monitoring client having a user interface
1104
Determine if the patient-care device has a stored user-interface template
YES
No
1106
Communicate the stored user-interface template from the patient-care device to the monitoring client having the user interface
1108
Display the user-interface template on the user interface of the monitoring client
1110
Communicate patient-care parameters between the patient-care device and the monitoring client
1112
Display the patient-care parameters on the displayed user-interface template in accordance with the user-interface template
1114
Determine the type of the patient-care device
Determined type
Unknown type
1116
Determine if a user-interface template is stored within the monitoring client in accordance with the type of the patient-care device
No
1118
Display the user-interface template on the user interface of the monitoring client
1120
Communicate patient-care parameters between the patient-care device and the monitoring client
1122
Display the patient-care parameters on the displayed user-interface template in accordance with the user-interface template
1124
Display a selectable list of a plurality of user-interface templates on the user interface of the monitoring client
1126
Select a user-interface template from the plurality of user-interface templates using the user interface of the monitoring client
1128
Display the user-interface template on the user interface of the monitoring client
1130
Communicate patient-care parameters between the patient-care device and the monitoring client
1132
Display the patient-care parameters on the displayed user-interface template in accordance with the user-interface template

FIG. 15

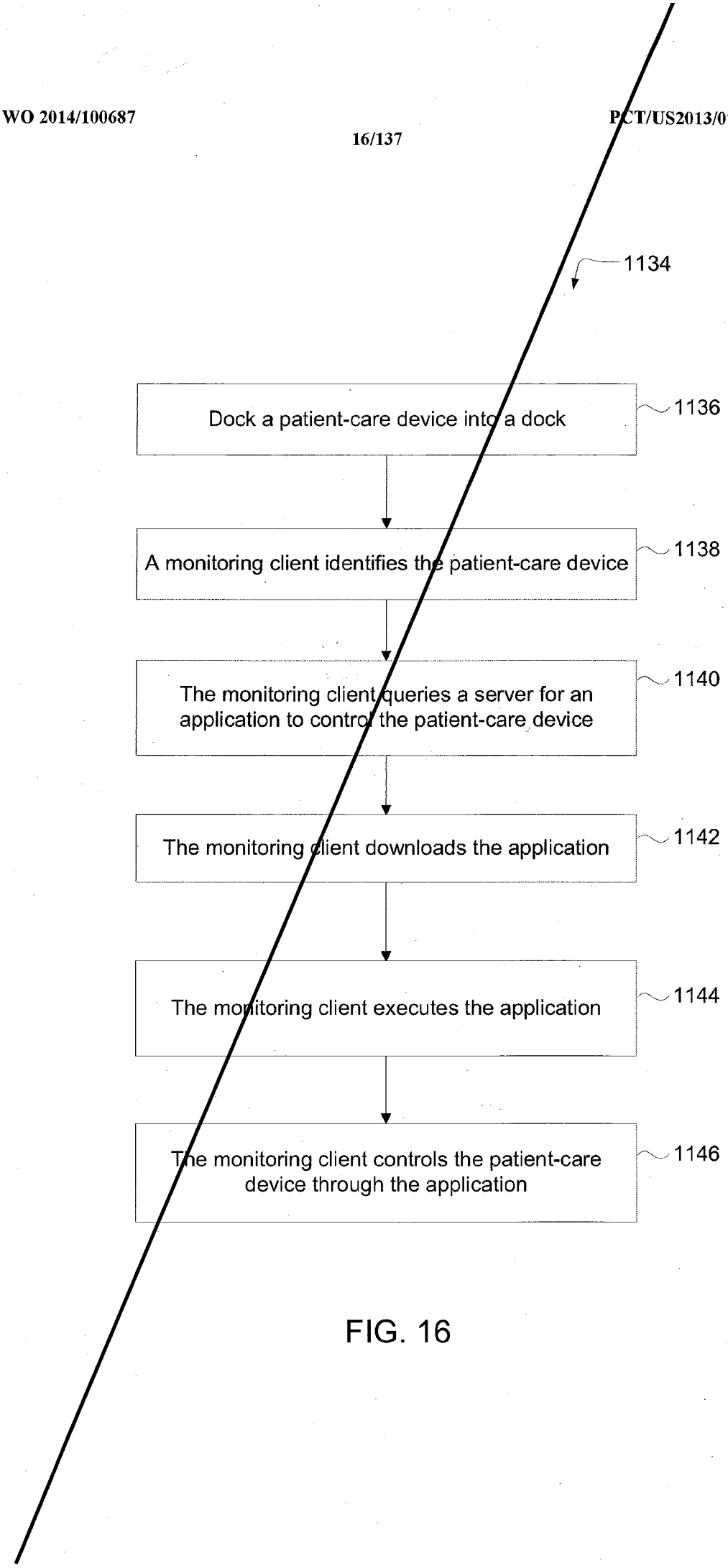

1134
Dock a patient-care device into a dock
1136
A monitoring client identifies the patient-care device
1138
The monitoring client queries a server for an application to control the patient-care device
1140
The monitoring client downloads the application
1142
The monitoring client executes the application
1144
The monitoring client controls the patient-care device through the application
1146

FIG. 16

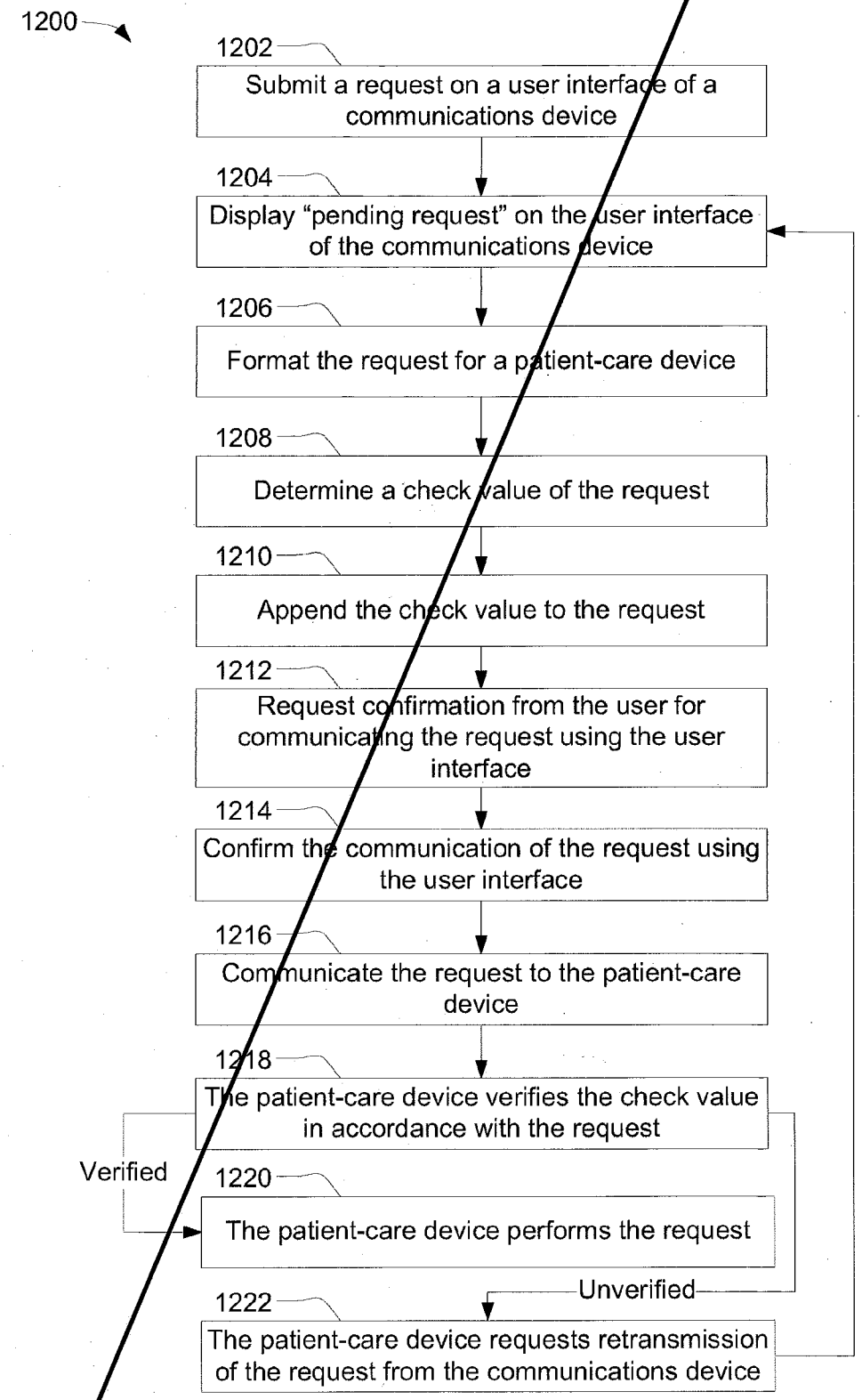

1200
1202
Submit a request on a user interface of a communications device
1204
Display "pending request" on the user interface of the communications device
1206
Format the request for a patient-care device
1208
Determine a check value of the request
1210
Append the check value to the request
1212
Request confirmation from the user for communicating the request using the user interface
1214
Confirm the communication of the request using the user interface
1216
Communicate the request to the patient-care device
1218
The patient-care device verifies the check value in accordance with the request
Verified
1220
The patient-care device performs the request
Unverified
1222
The patient-care device requests retransmission of the request from the communications device

FIG. 17

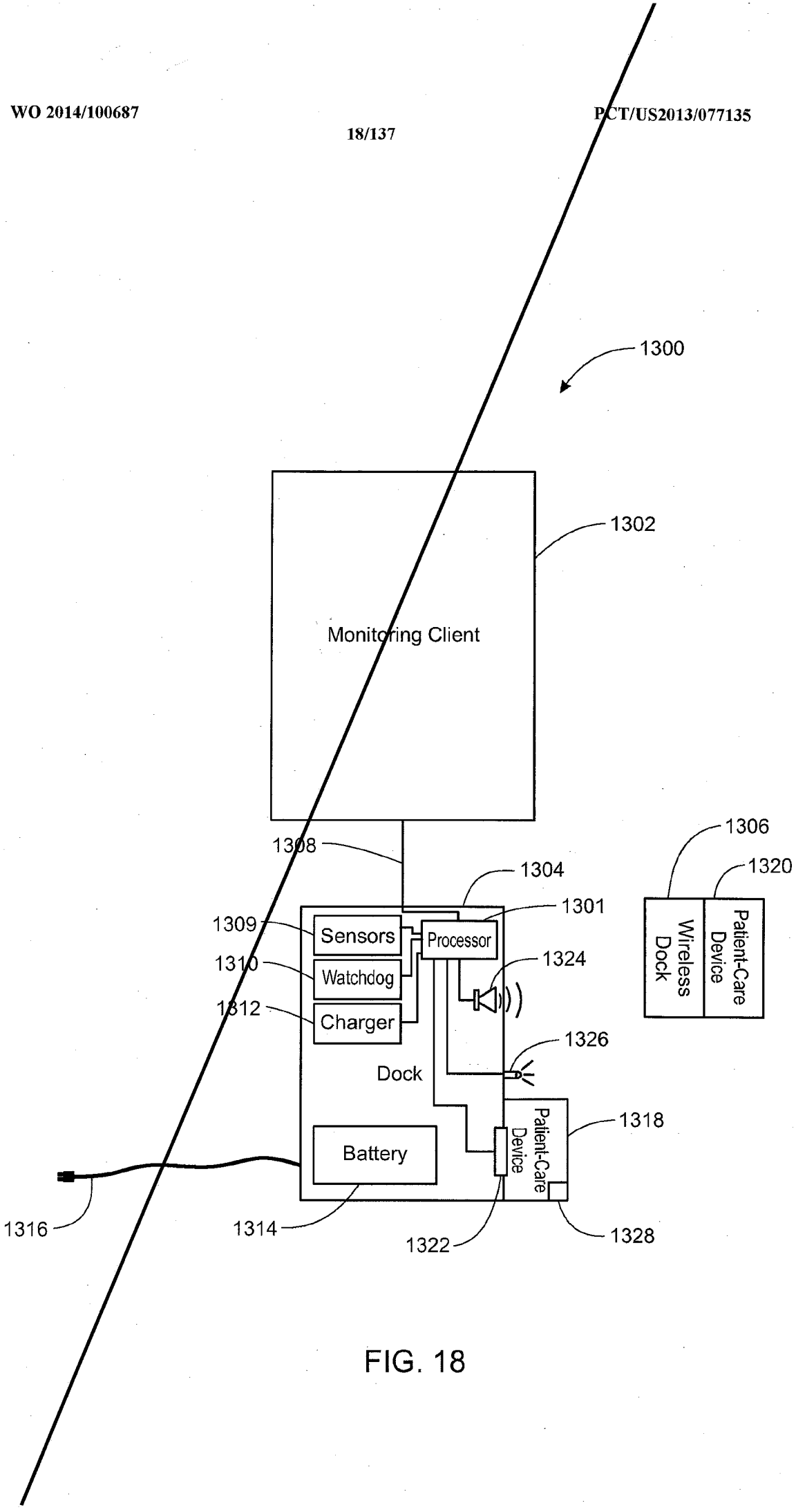

1300
1302
Monitoring Client
1308
1304
1301
1309
Sensors
Processor
1310
Watchdog
1324
1312
Charger
1326
Dock
1318
Patient-Care Device
Battery
1316
1314
1322
1328
1306
1320
Wireless Dock
Patient-Care Device

FIG. 18

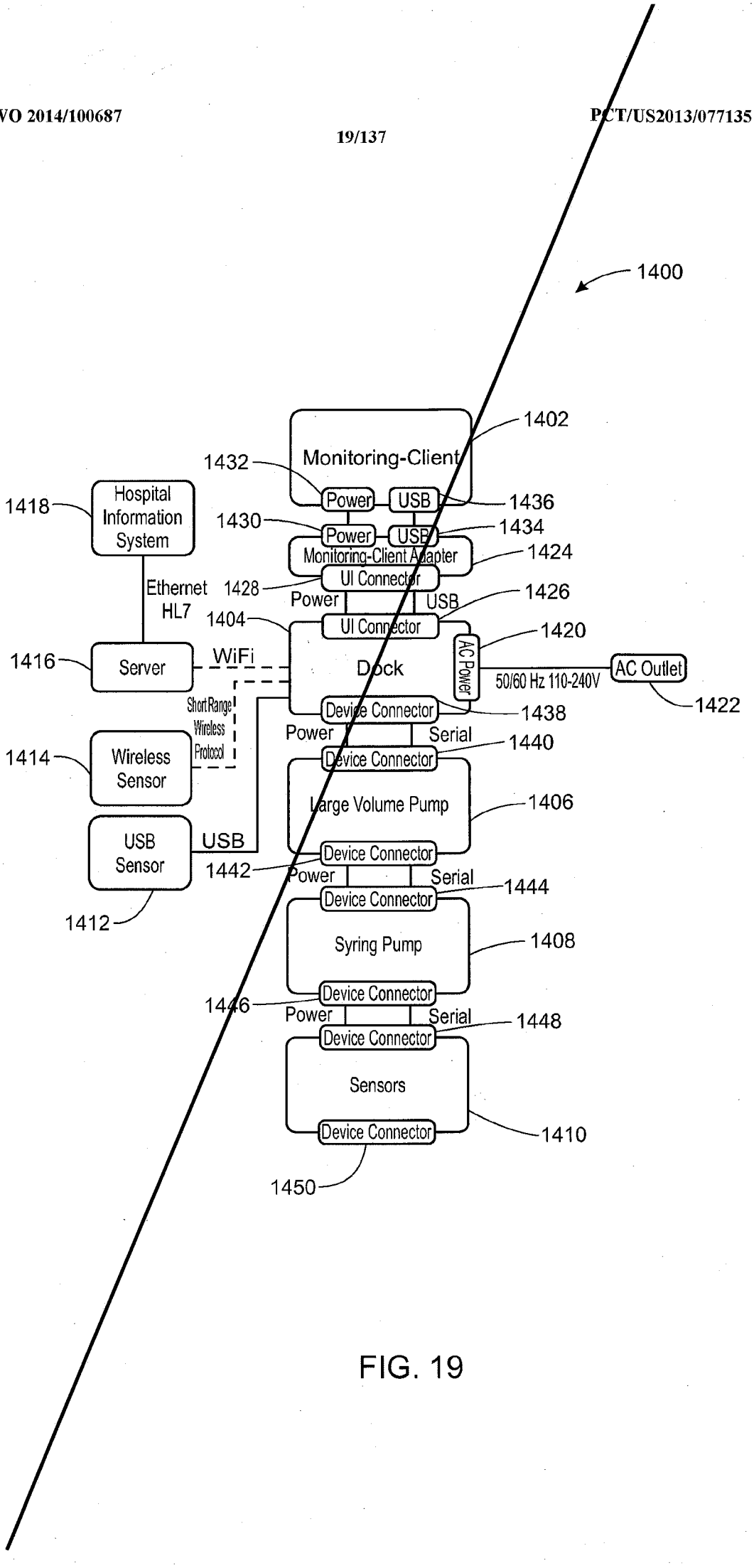

1400
Monitoring-Client
1402
1432
Power
USB
1436
1430
Power
USB
1434
Monitoring-Client Adapter
1424
UI Connector
1428
Power
USB
1426
1404
UI Connector
1420
Dock
AC Power
AC Outlet
50/60 Hz 110-240V
1422
Device Connector
1438
Power
Serial
Device Connector
1440
Large Volume Pump
1406
Device Connector
Power
Serial
1444
Device Connector
Syring Pump
1408
Device Connector
1446
Power
Serial
1448
Device Connector
Sensors
Device Connector
1410
1450
Hospital Information System
1418
Ethernet HL7
Server
1416
WiFi
Short Range Wireless Protocol
Wireless Sensor
1414
USB
USB Sensor
1442
1412

FIG. 19

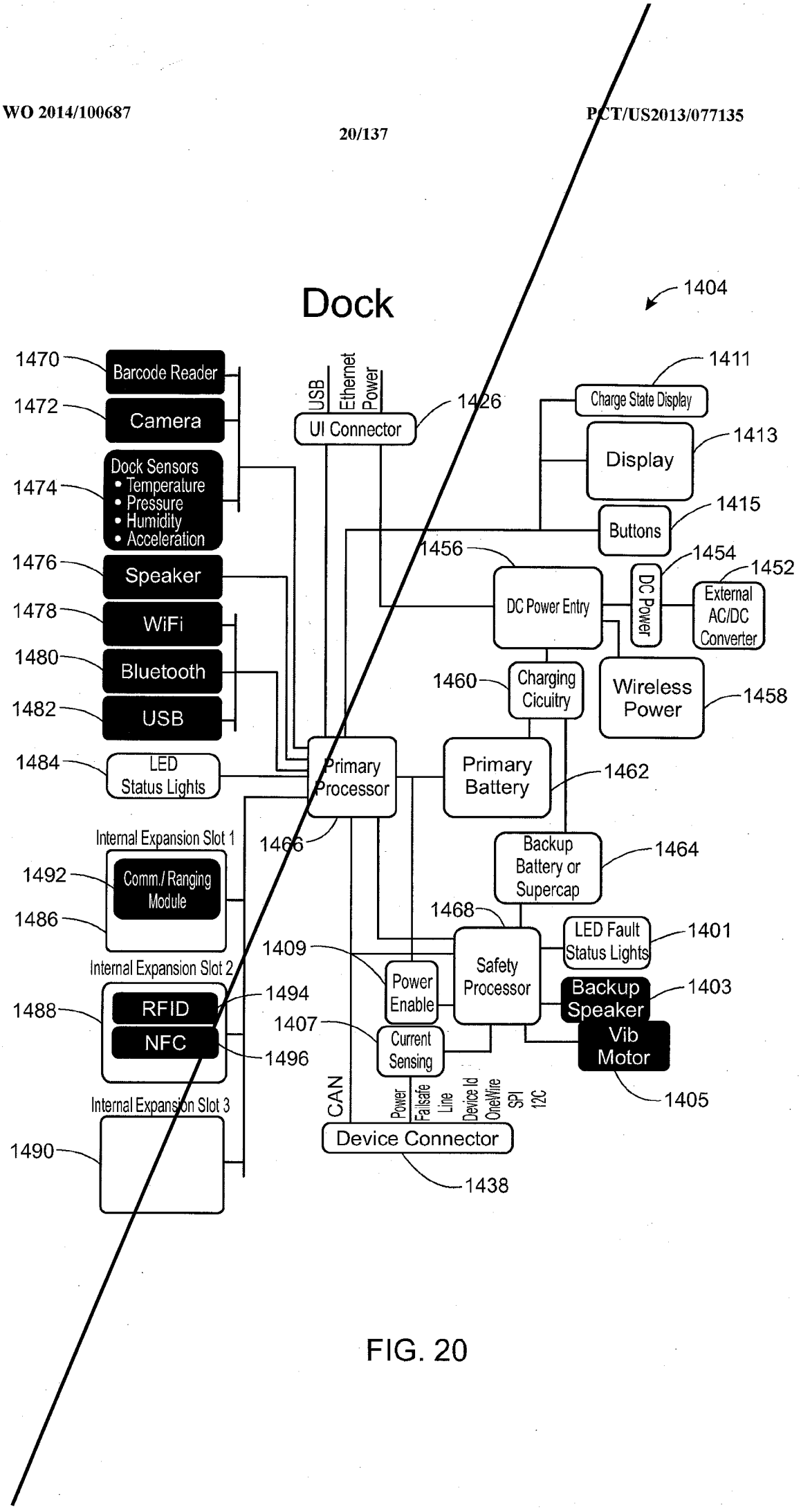

Dock
1404
1470
Barcode Reader
1472
Camera
1474
Dock Sensors
• Temperature
• Pressure
• Humidity
• Acceleration
1476
Speaker
1478
WiFi
1480
Bluetooth
1482
USB
1484
LED Status Lights
USB
Ethernet
Power
UI Connector
1426
1411
Charge State Display
1413
Display
1415
Buttons
1456
DC Power Entry
1454
DC Power
1452
External AC/DC Converter
1460
Charging Cicuitry
Wireless Power
1458
Primary Processor
Primary Battery
1462
1466
Backup Battery or Supercap
1464
Internal Expansion Slot 1
1492
Comm./ Ranging Module
1486
Internal Expansion Slot 2
1488
RFID
NFC
1494
1496
1468
LED Fault Status Lights
1401
1409
Power Enable
Safety Processor
Backup Speaker
1403
1407
Current Sensing
Vib Motor
1405
Internal Expansion Slot 3
1490
CAN
Power
Failsafe
Line
Device Id
OneWire
SPI
I2C
Device Connector
1438

FIG. 20

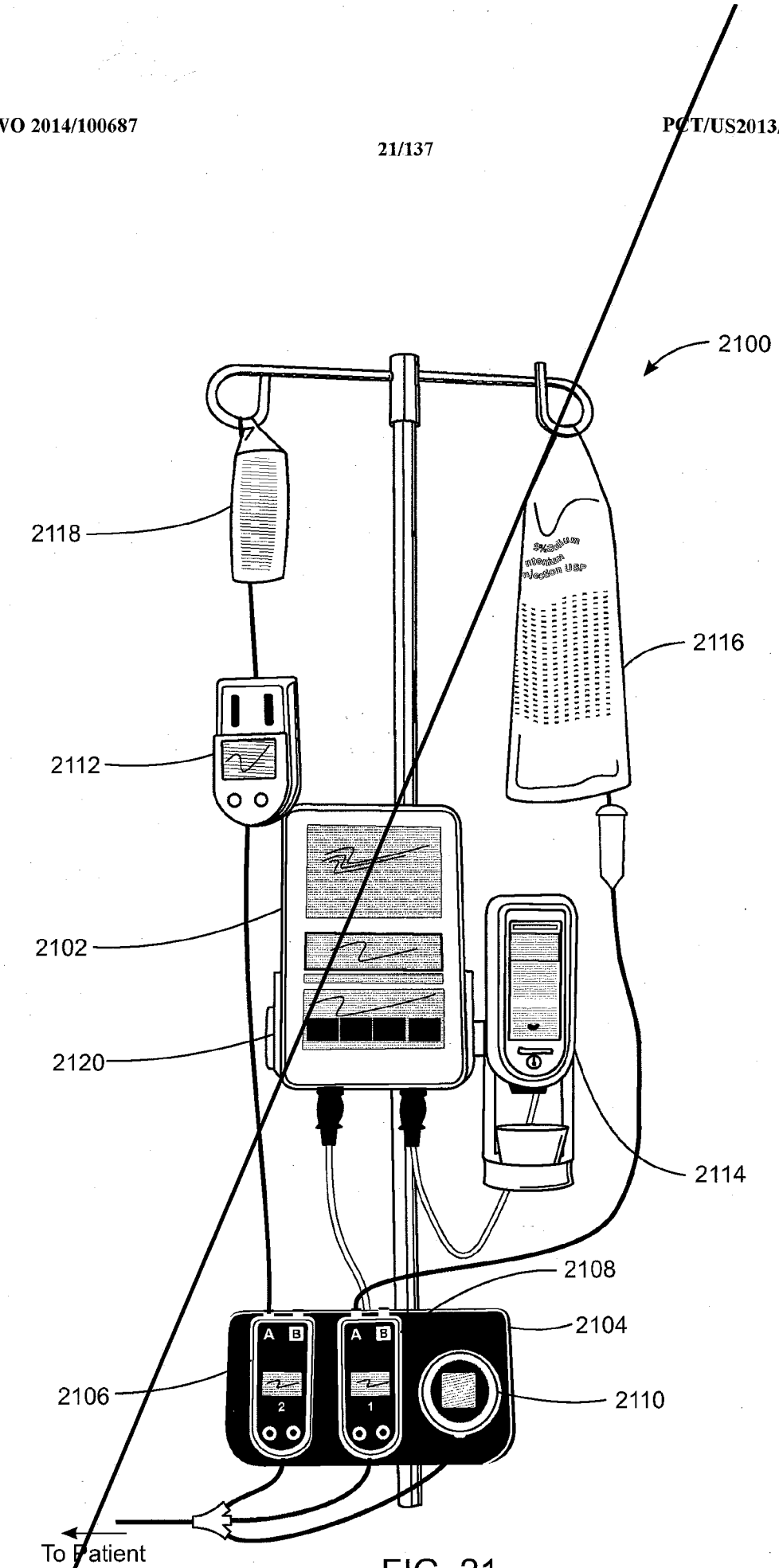

2100
2118
2116
2112
2102
2120
2114
2108
2104
2106
2110
A
B
2
1
To Patient

FIG. 21

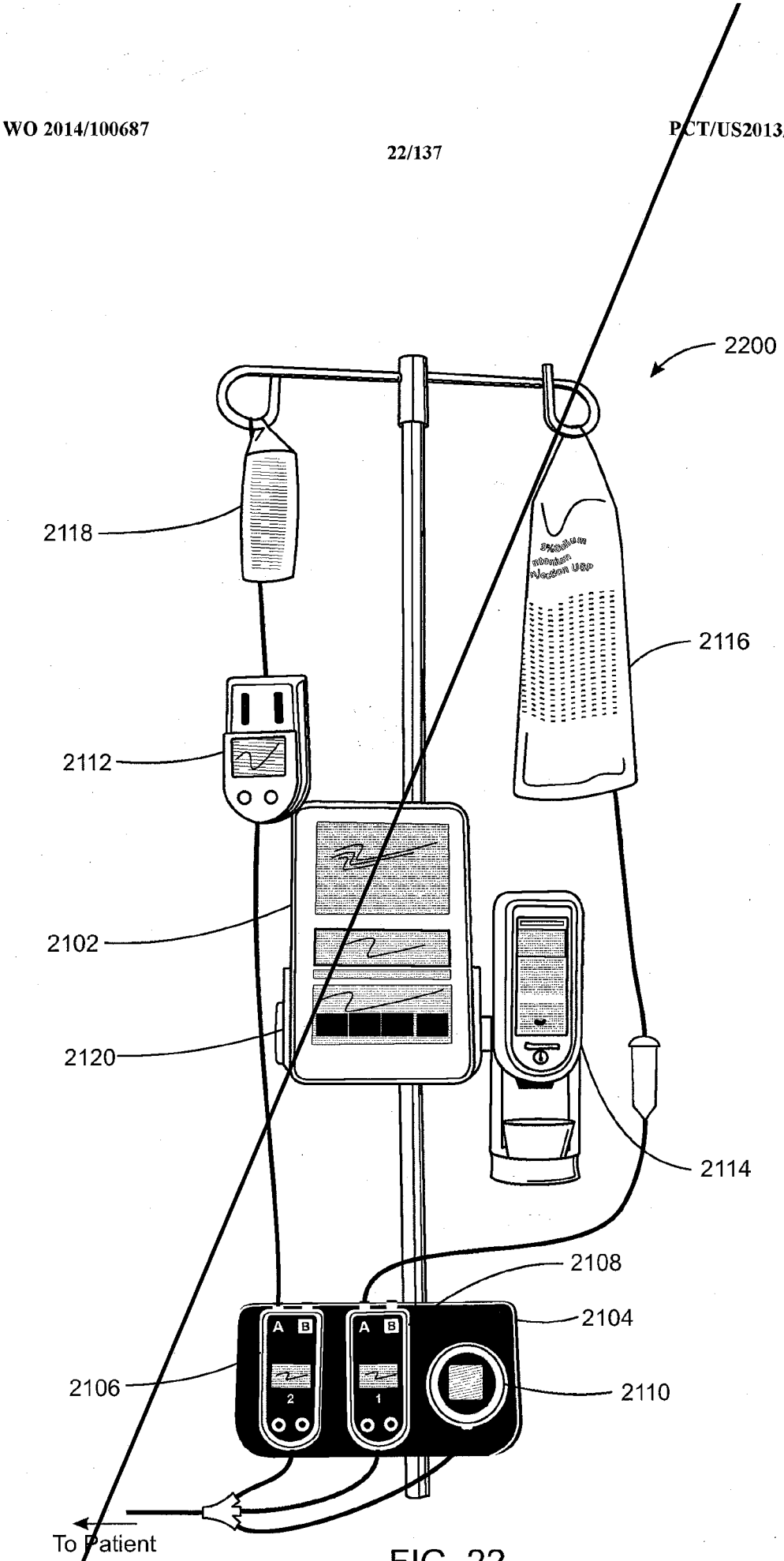

2200
2118
2116
2112
2102
2120
2114
2108
2104
2106
2110
A
B
2
1
To Patient

FIG. 22

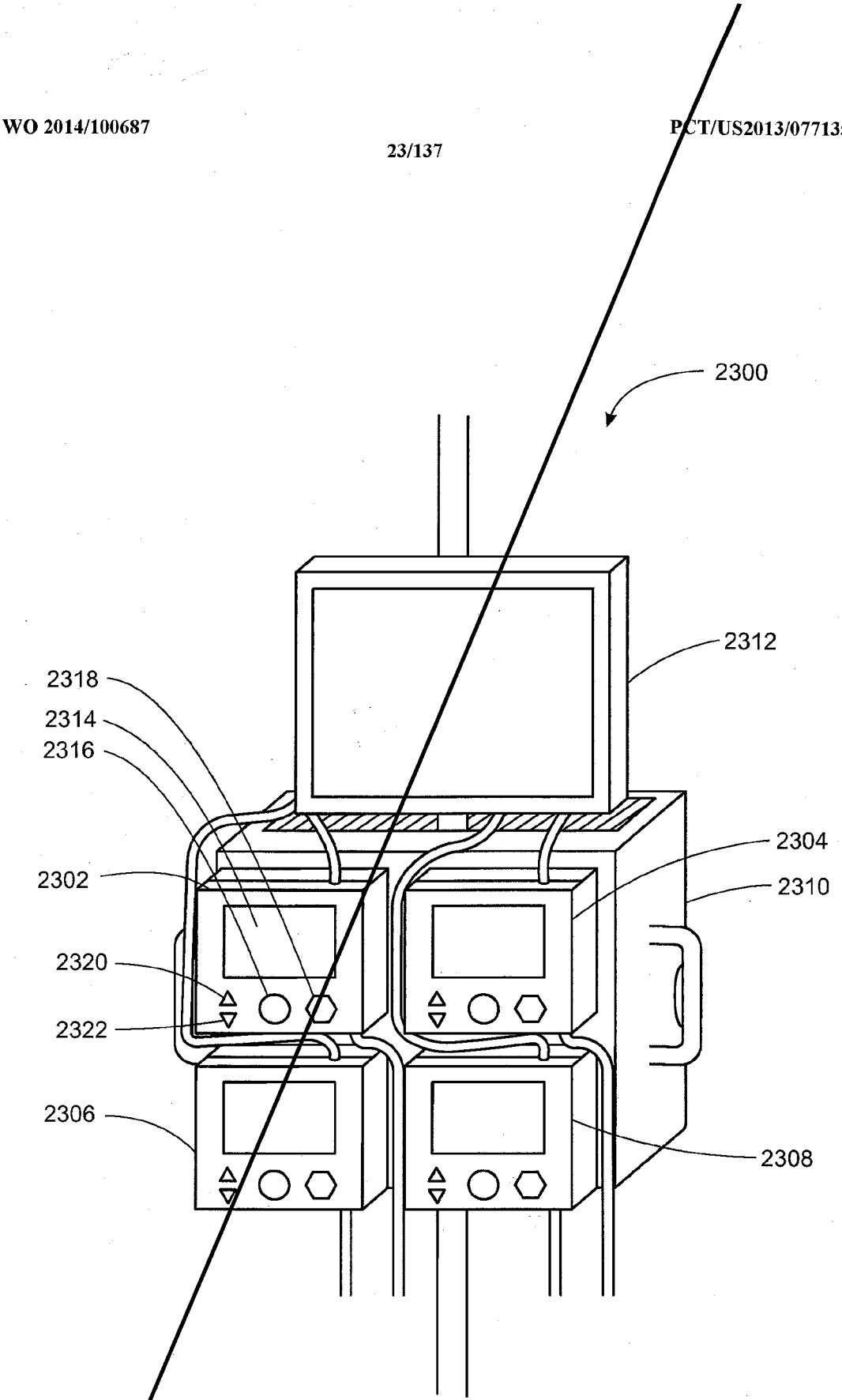


FIG. 23

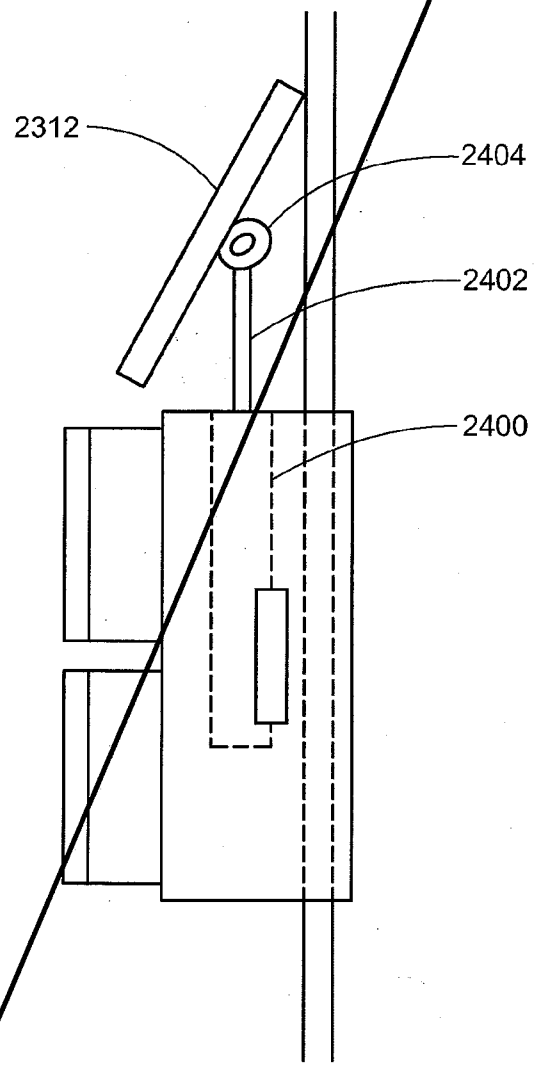


FIG. 24

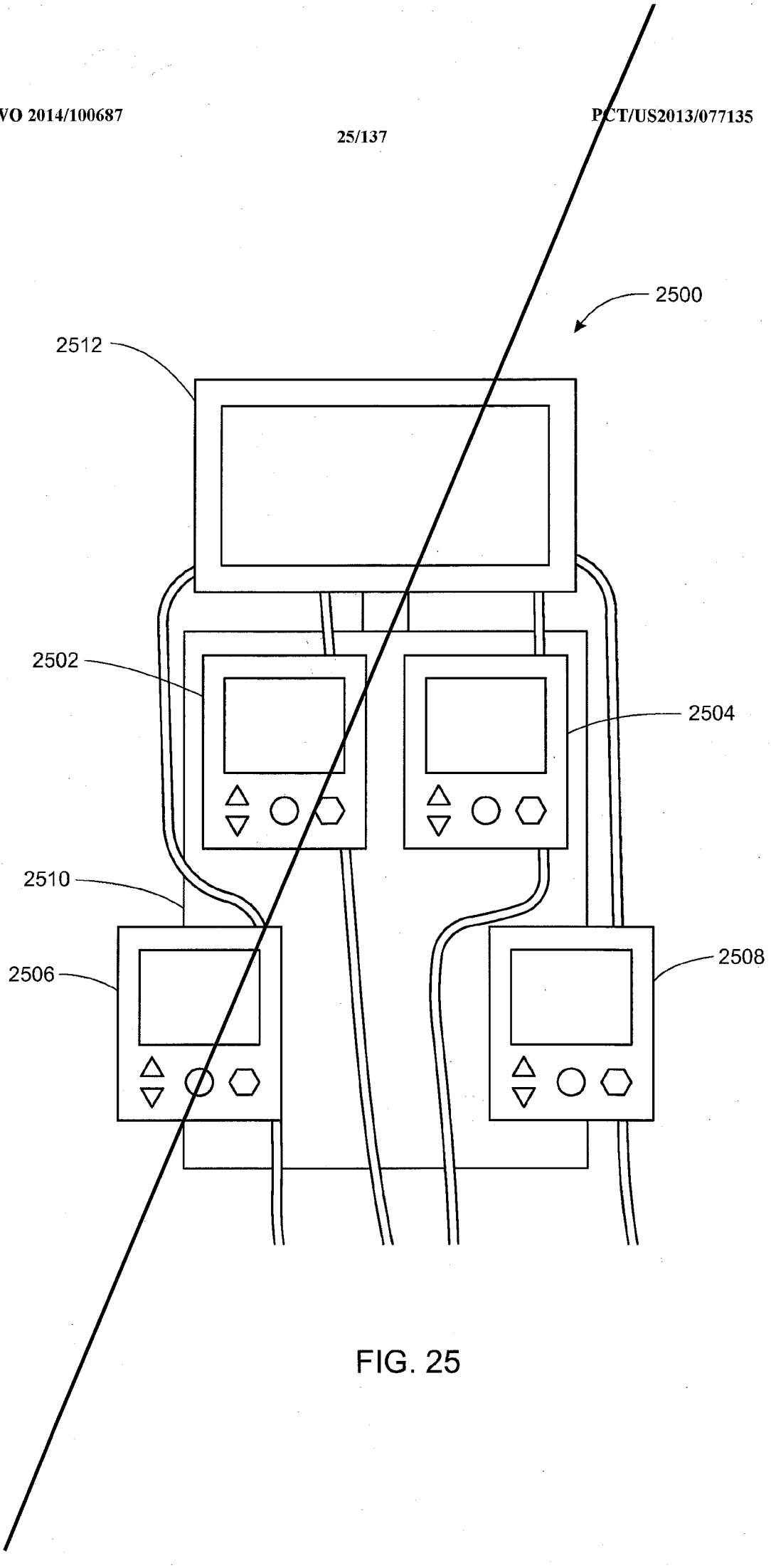


FIG. 25

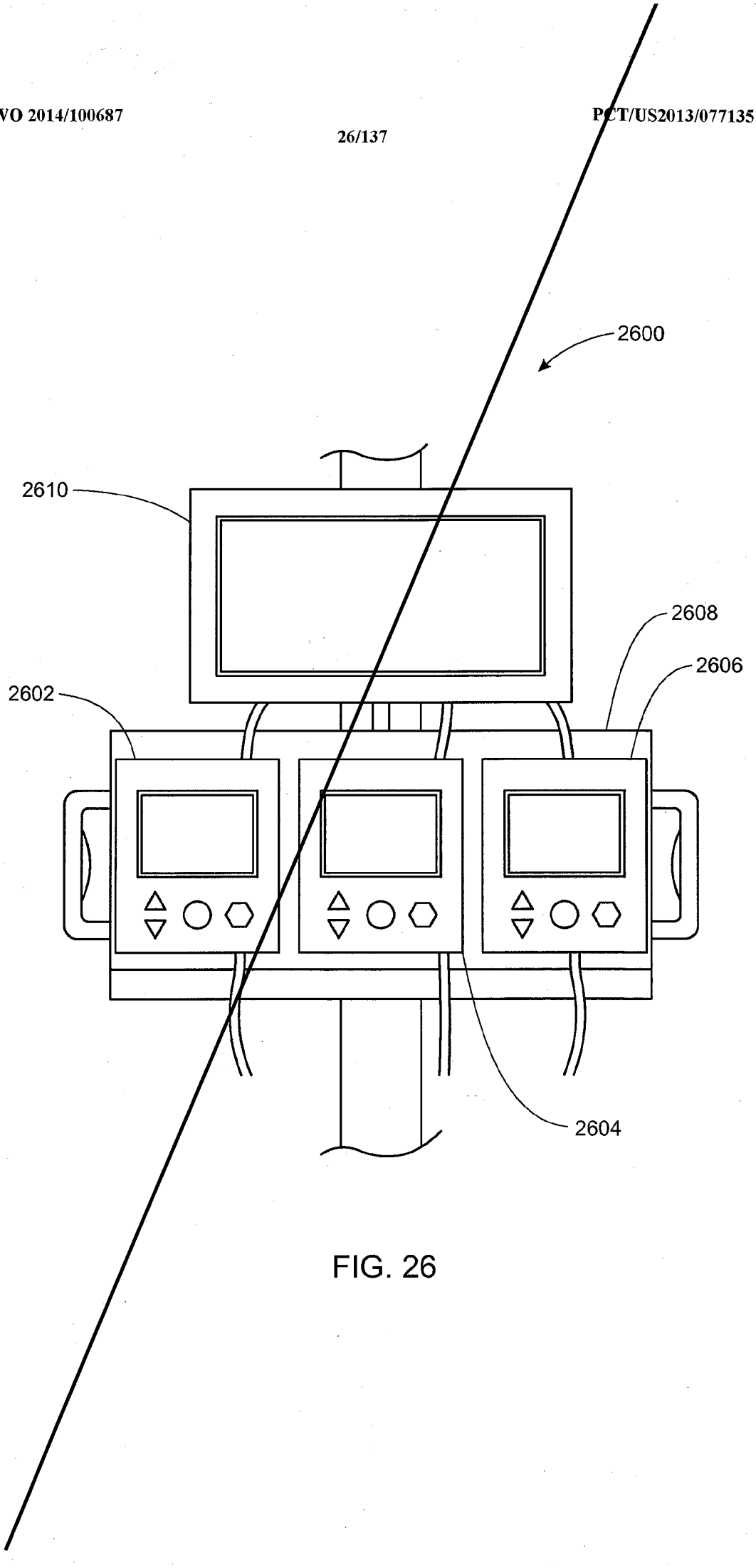


FIG. 26

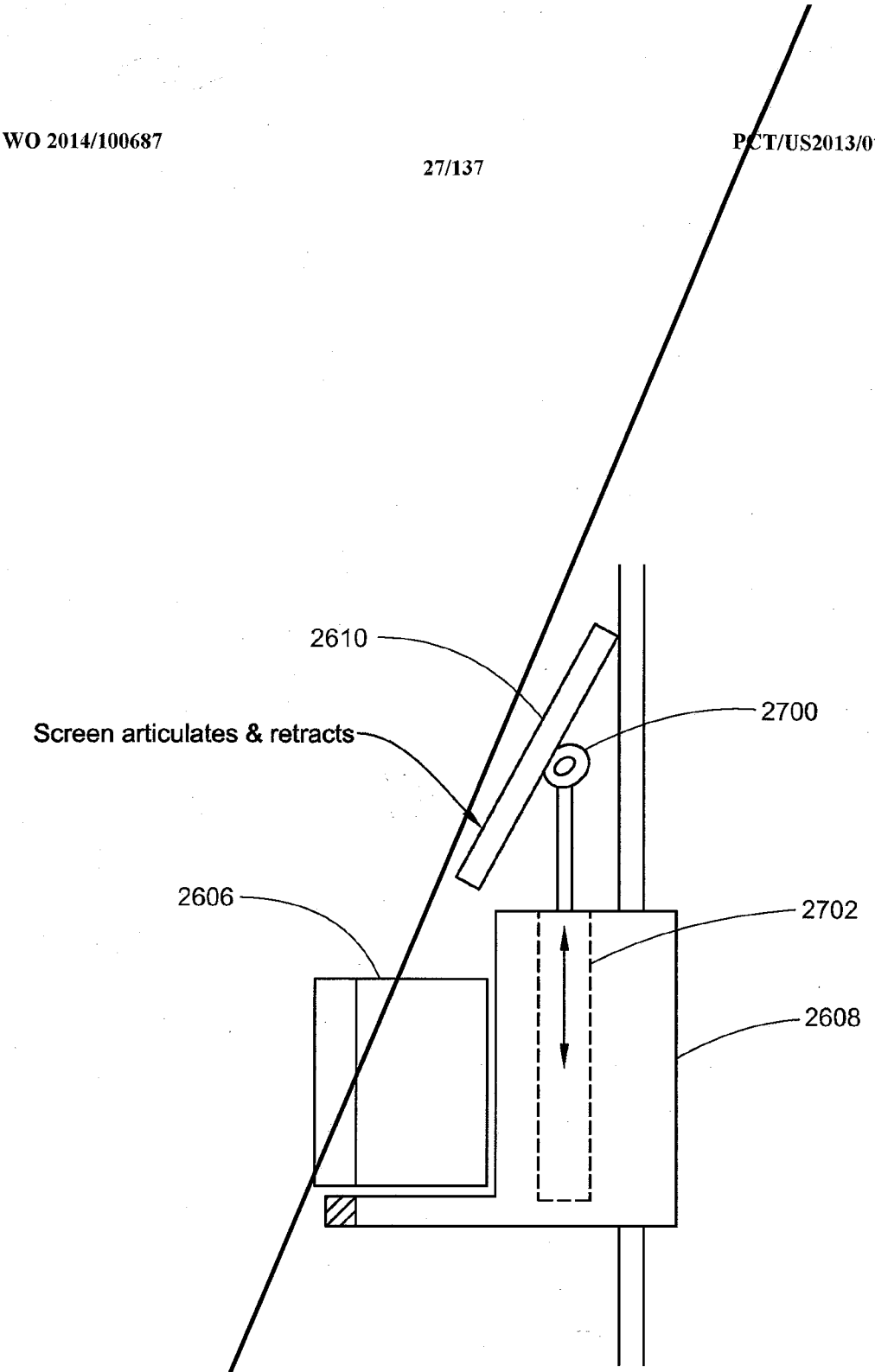


FIG. 27

2900
2902
2914
2904
2901
2910

FIG. 29

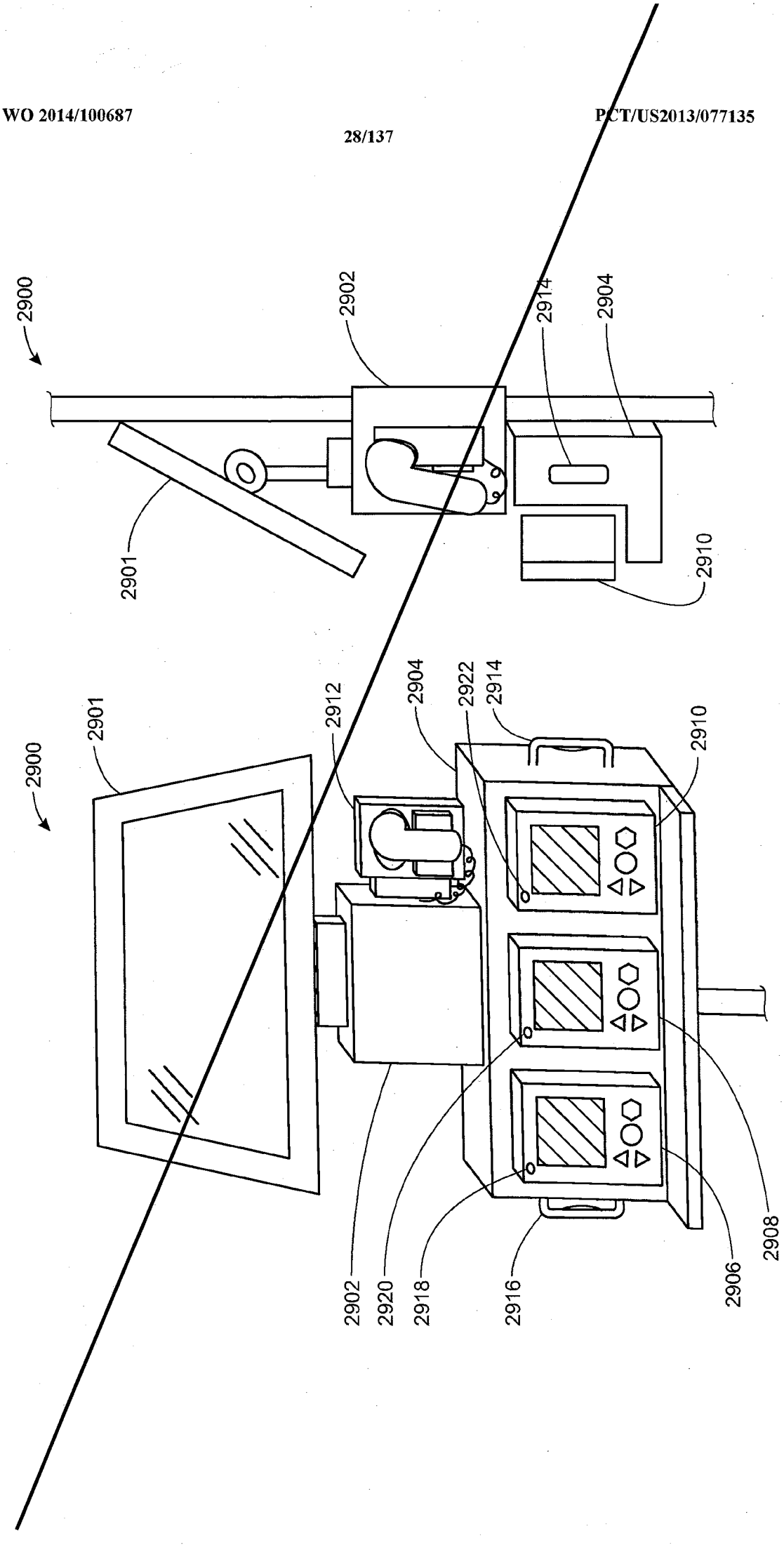

2900
2901
2912
2904
2922
2914
2910
2902
2920
2918
2916
2906
2908

FIG. 28

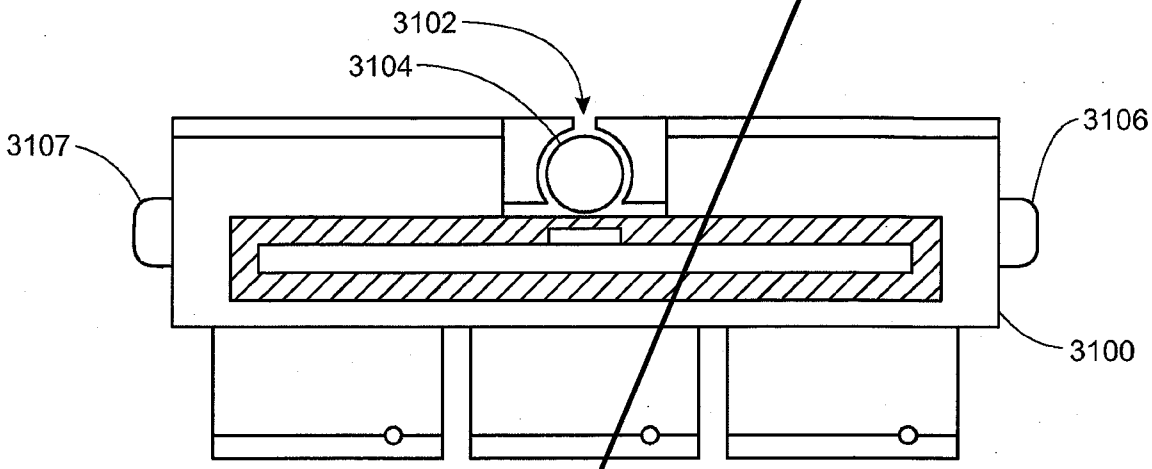


FIG. 30

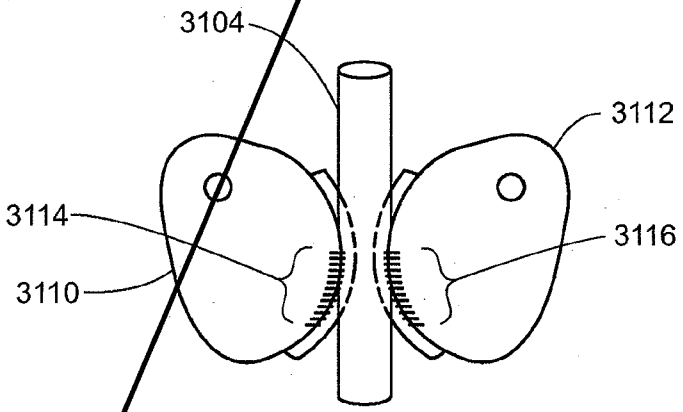


FIG. 31

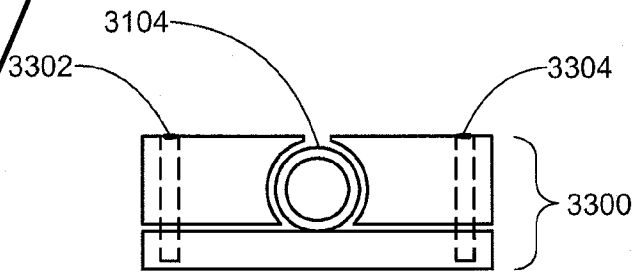


FIG. 32

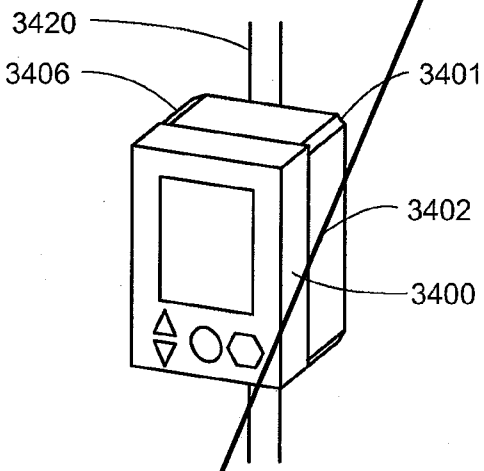


FIG. 33

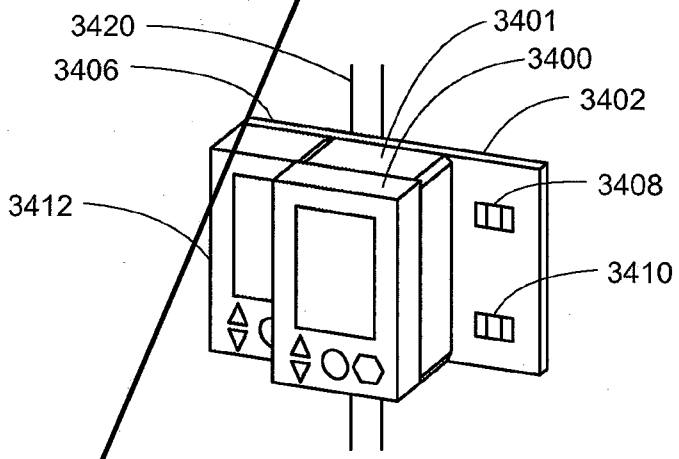


FIG. 34

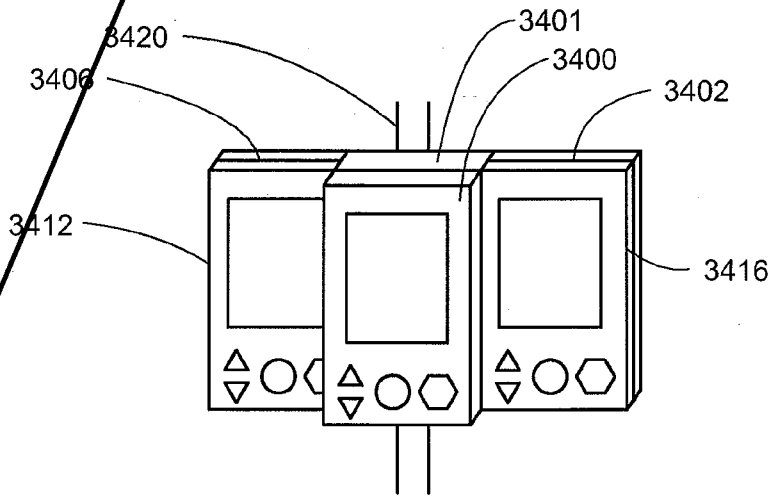


FIG. 35

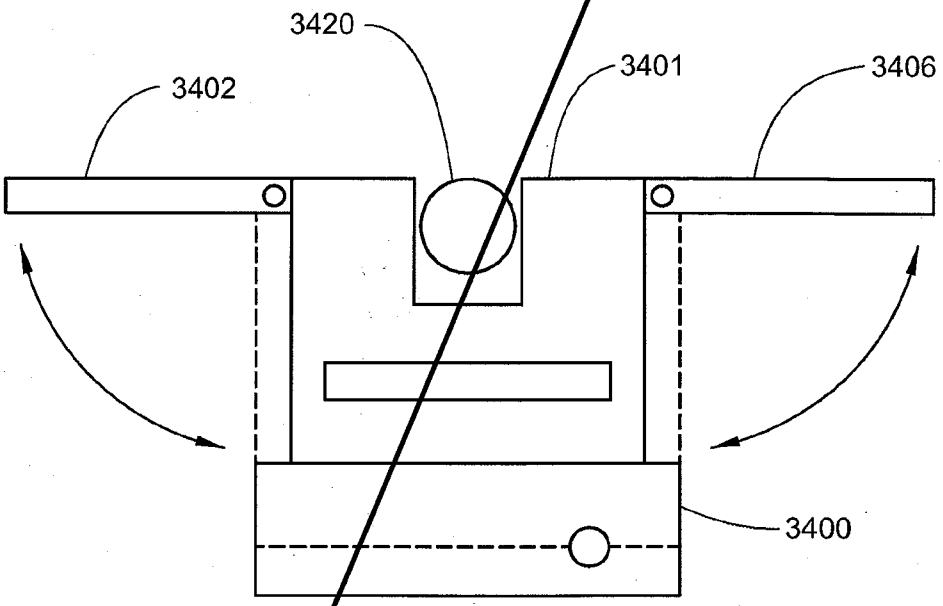


FIG. 36

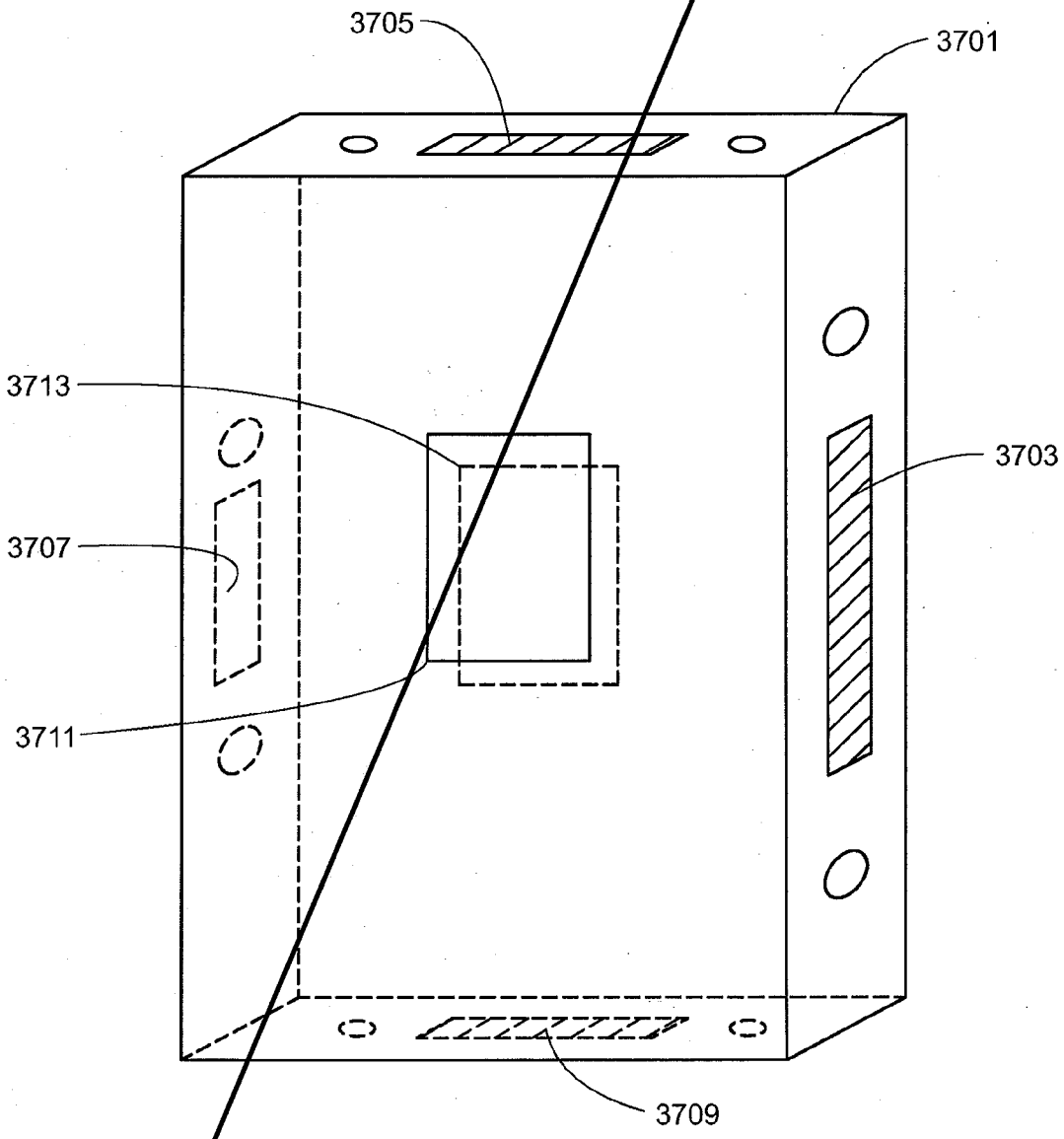


FIG. 37

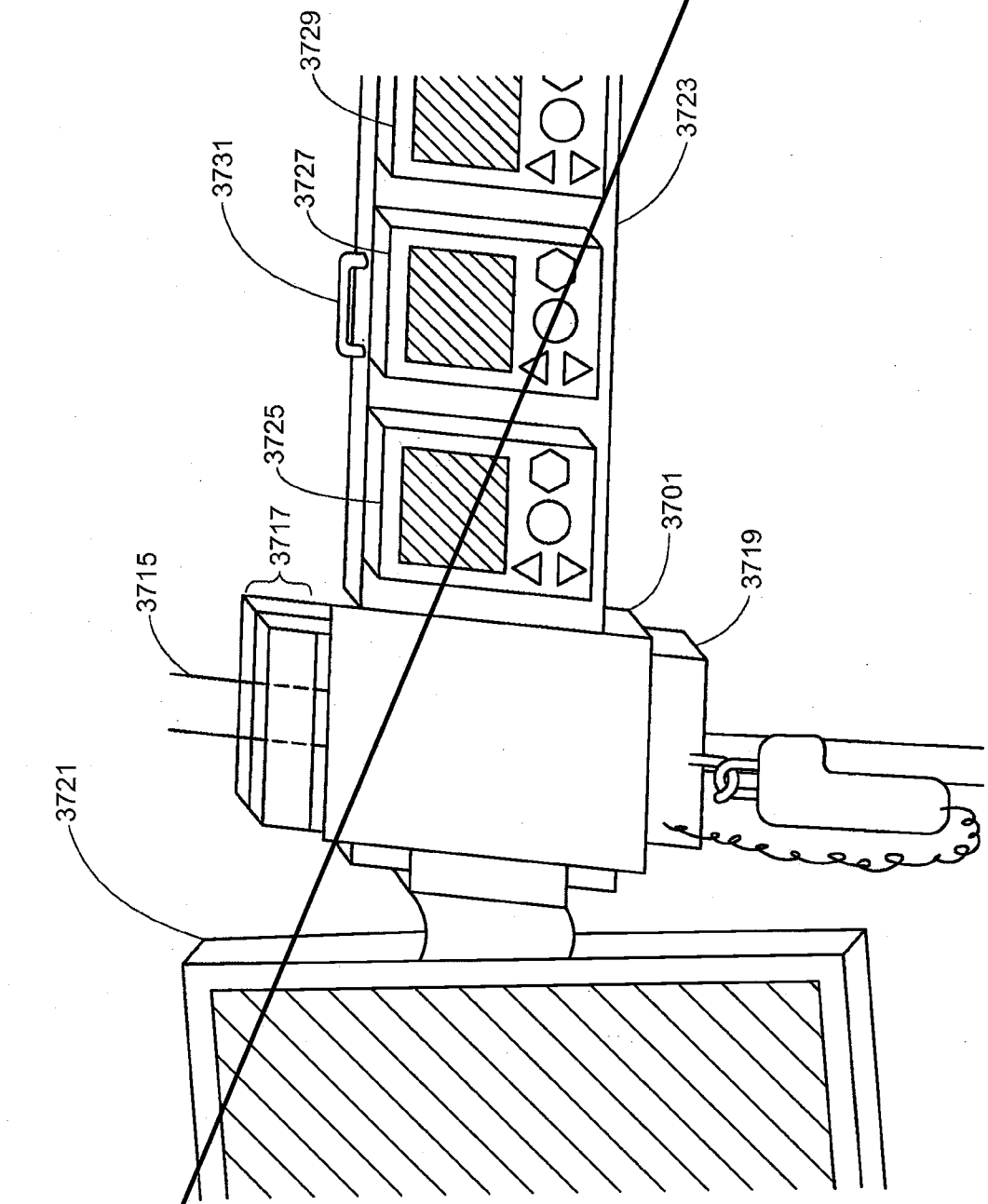


FIG. 38

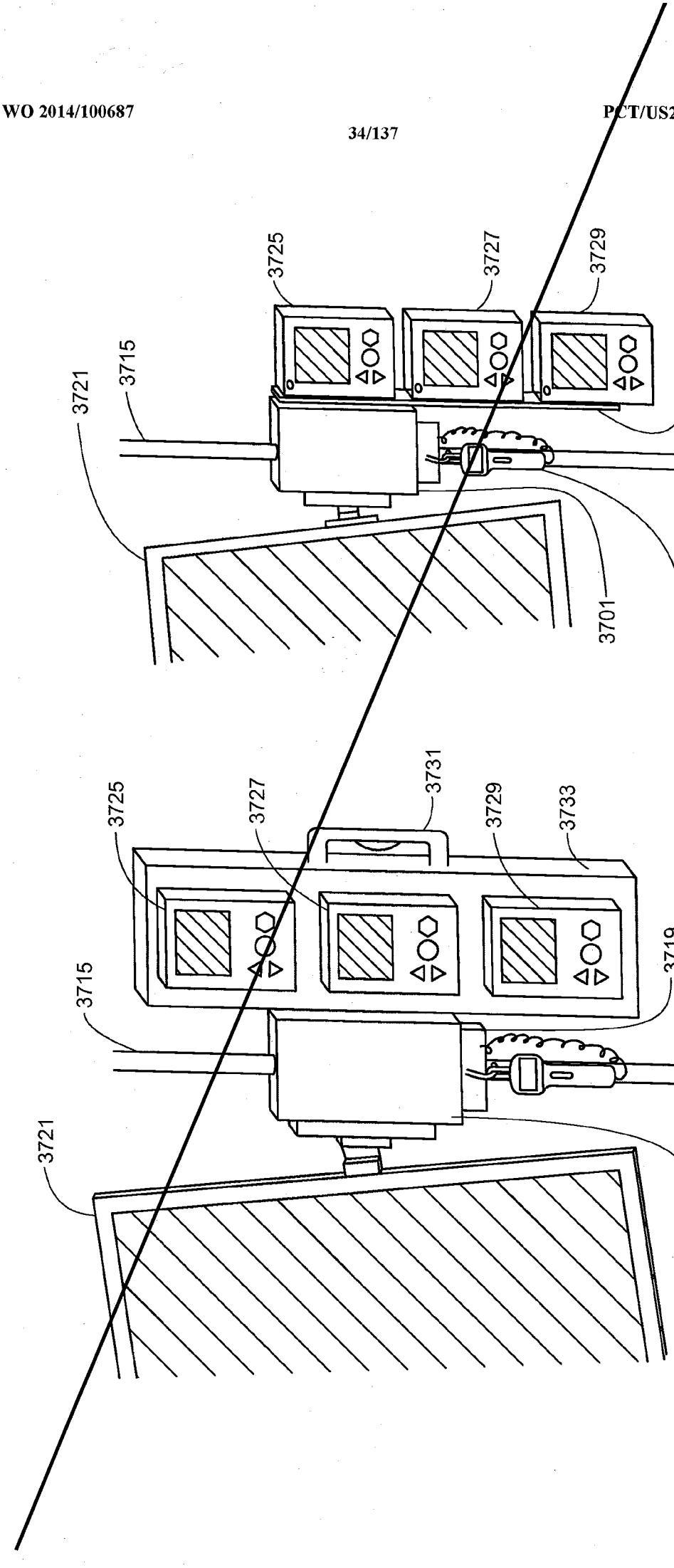


FIG. 40

FIG. 39

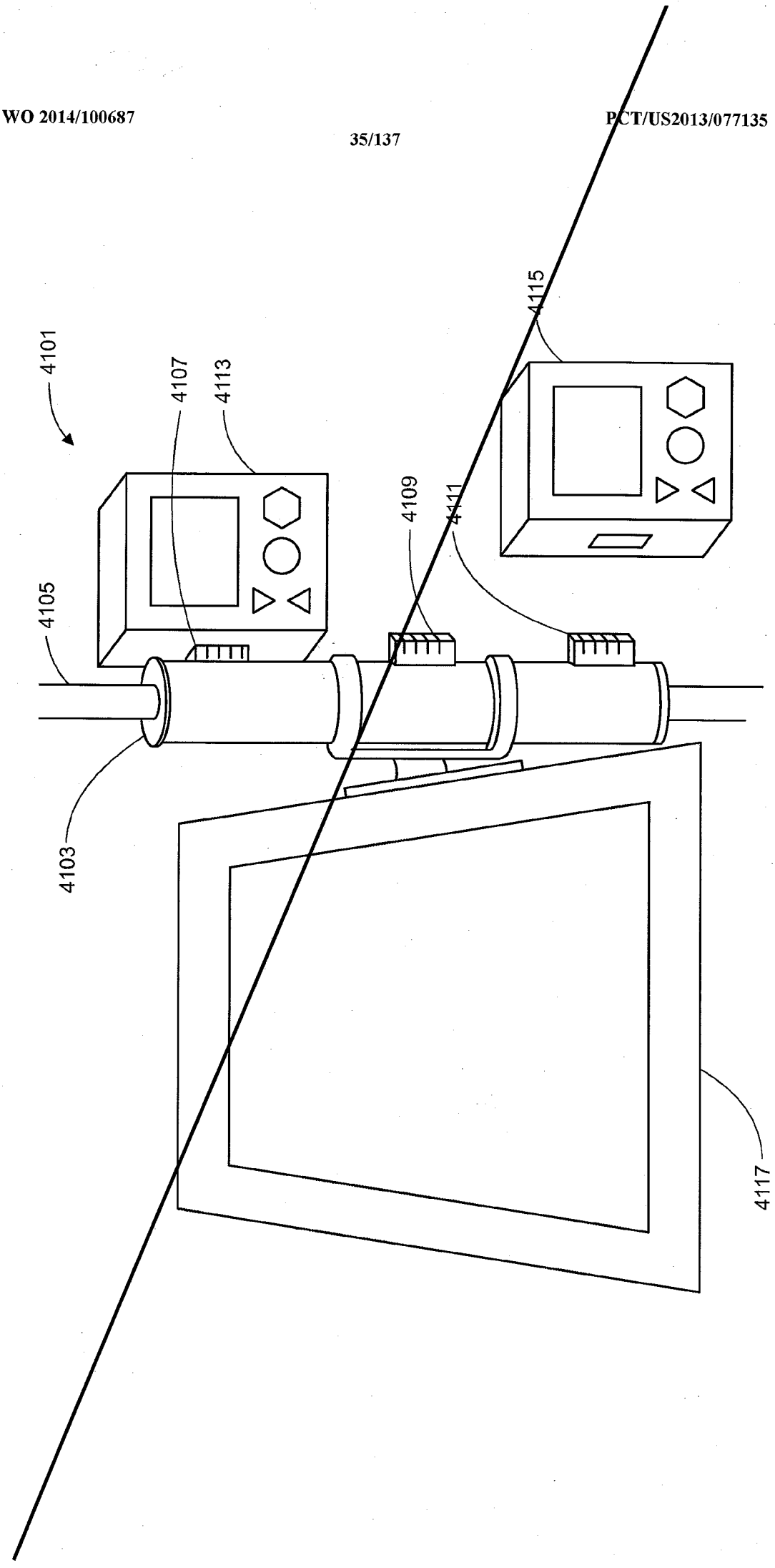


FIG. 41

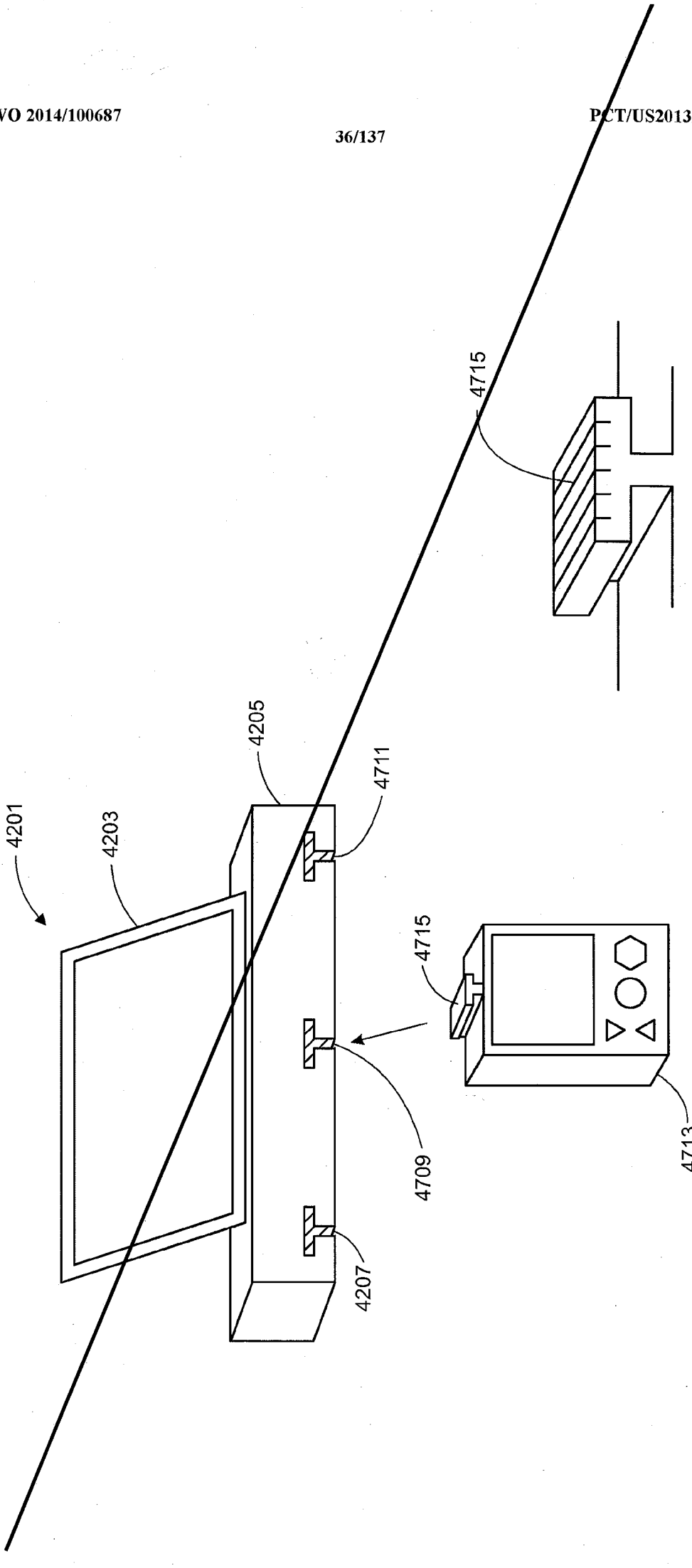


FIG. 42

FIG. 43

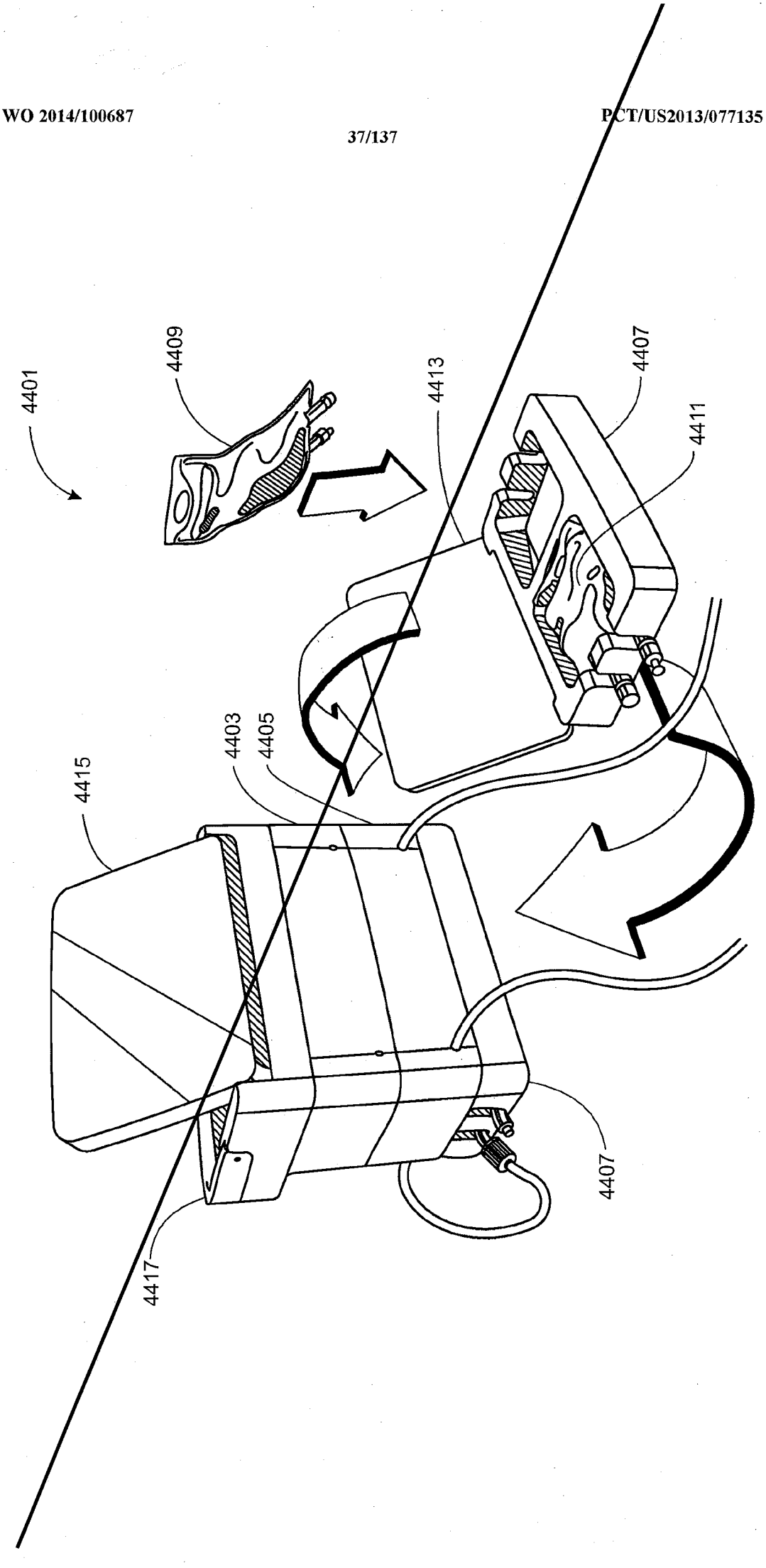


FIG. 44

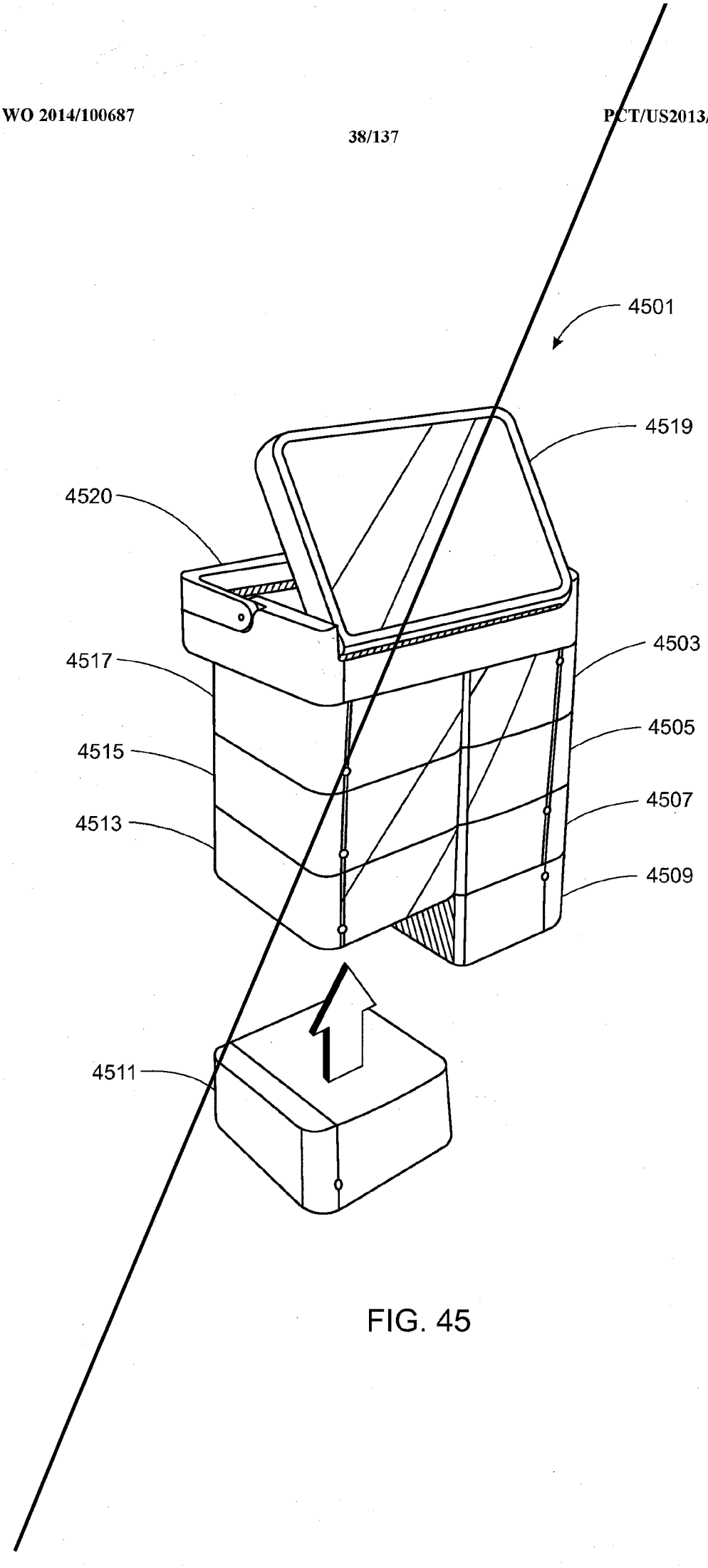


FIG. 45

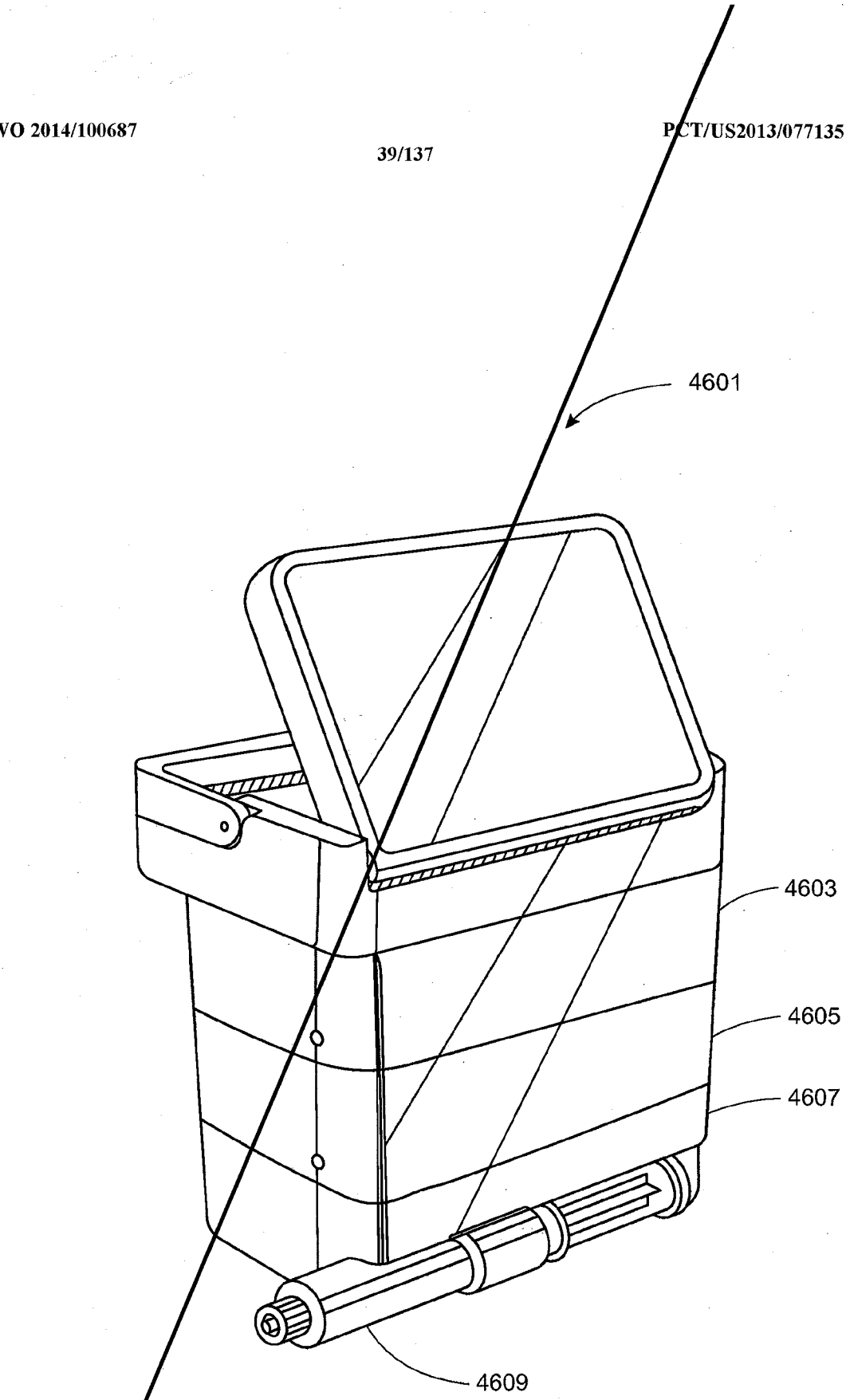


FIG. 46

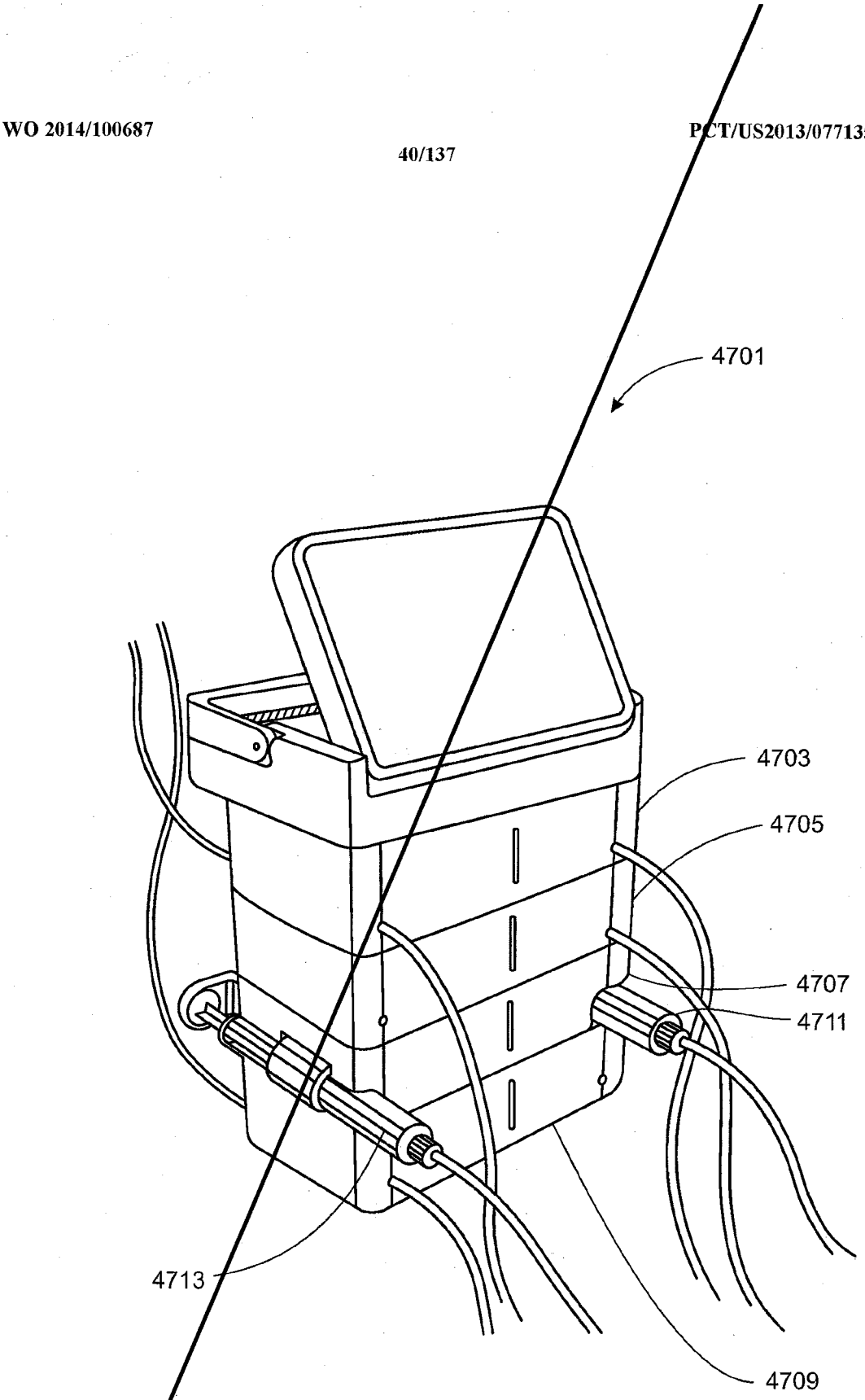


FIG. 47

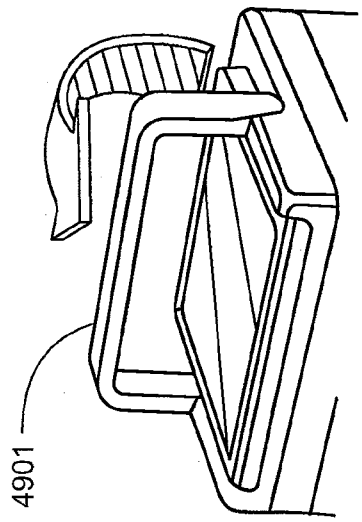


FIG. 49

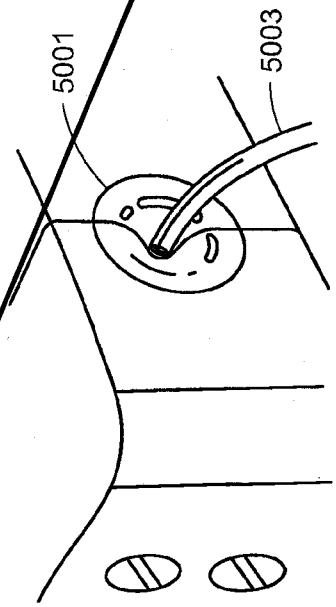


FIG. 50

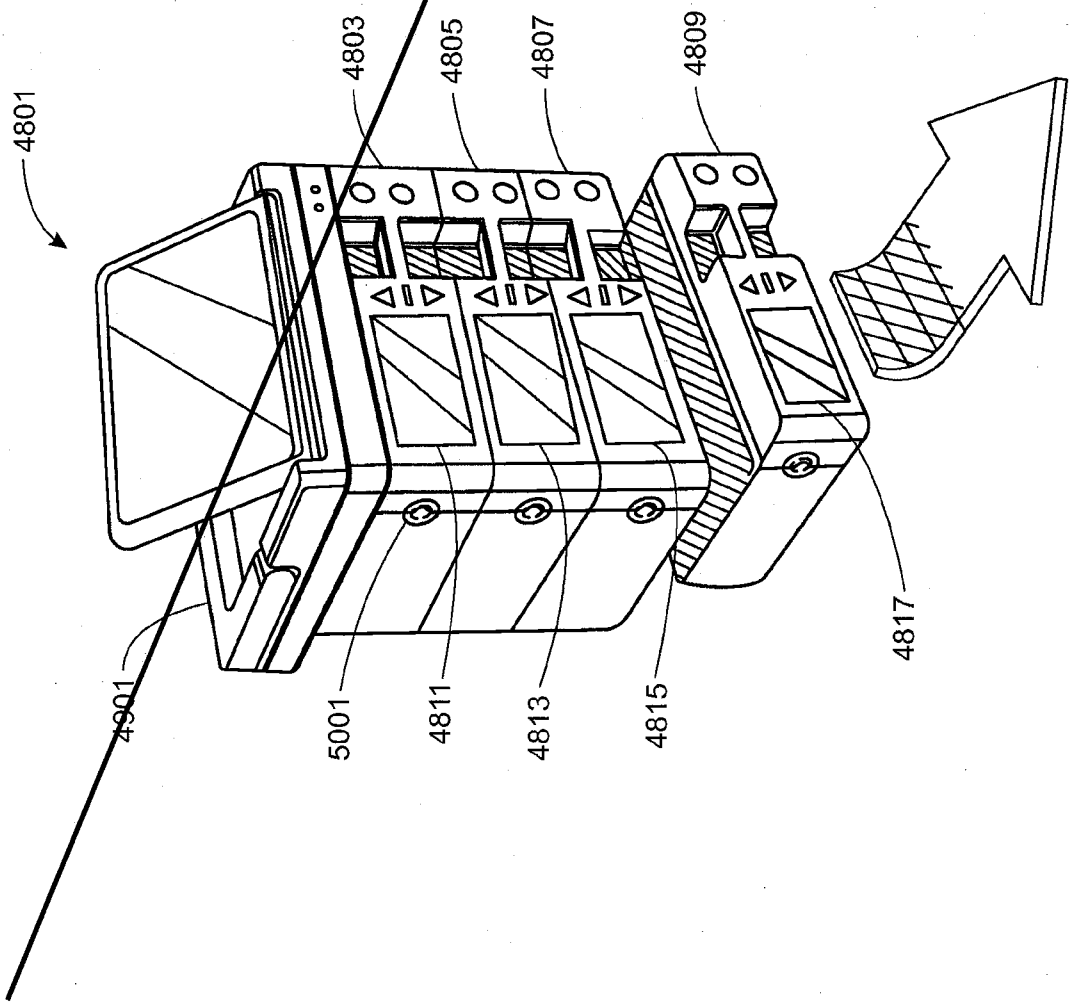


FIG. 48

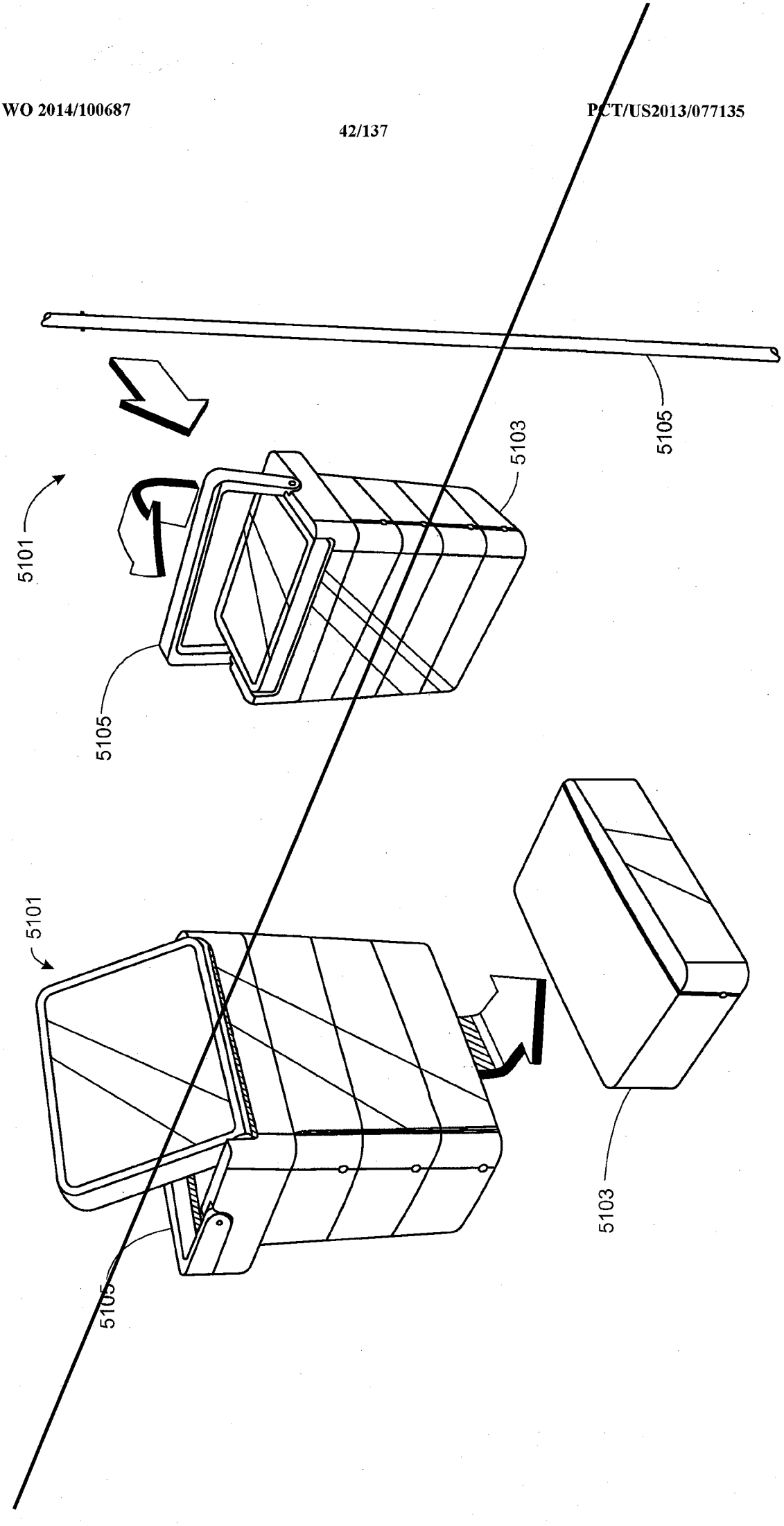


FIG. 52

FIG. 51

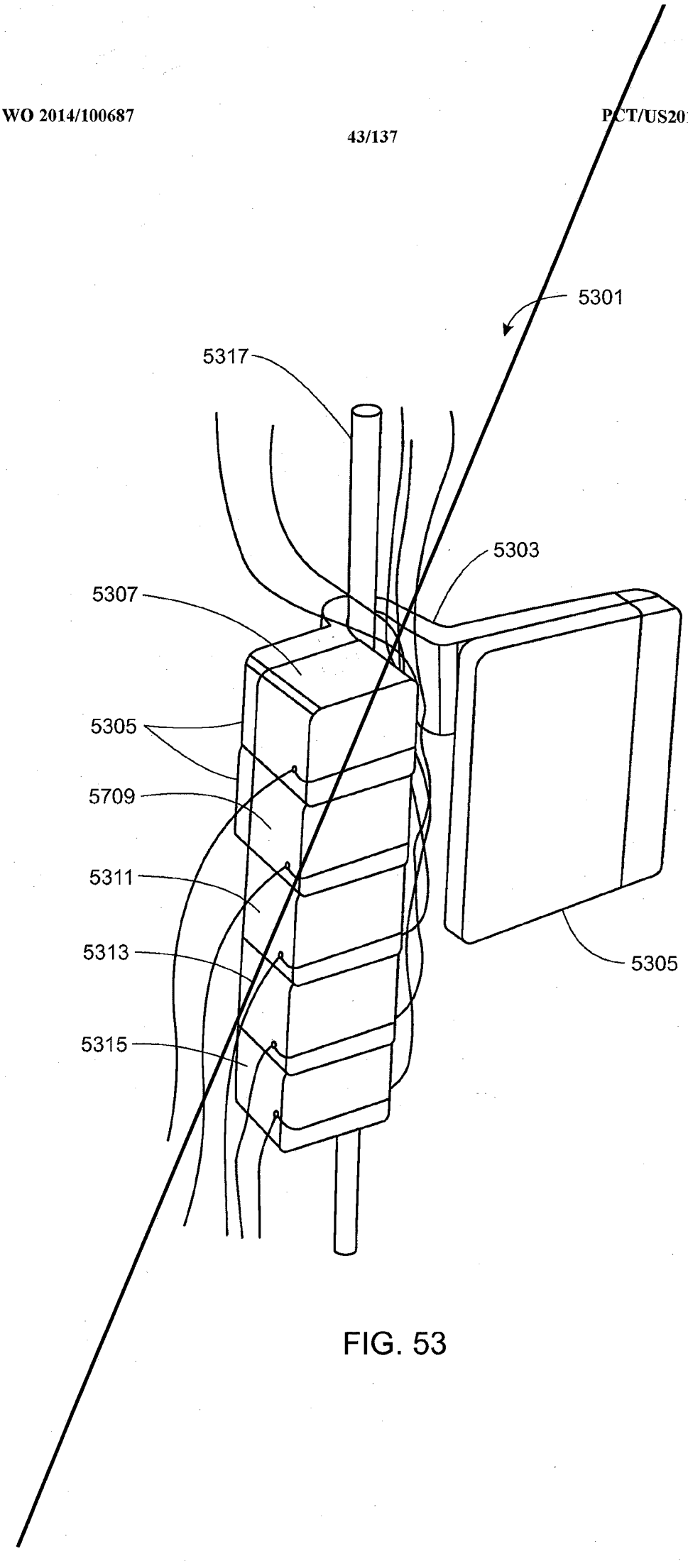


FIG. 53

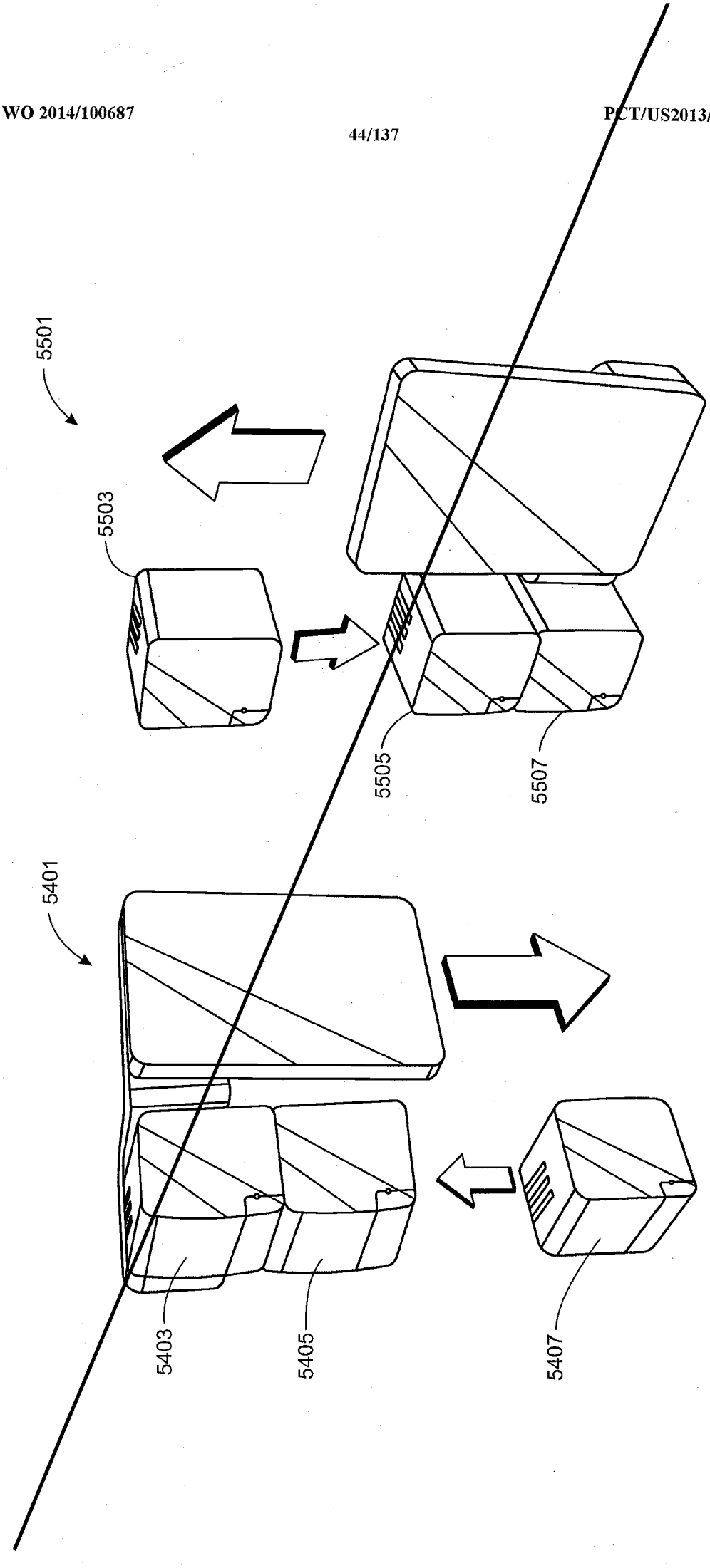


FIG. 55

FIG. 54

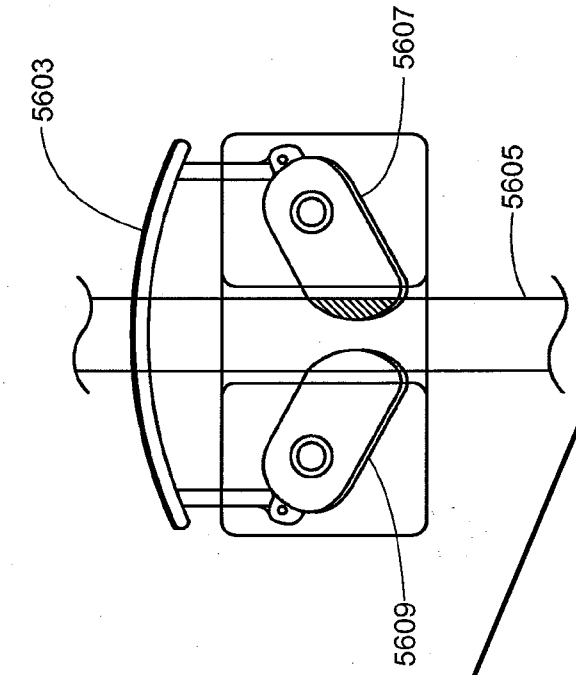


FIG. 57

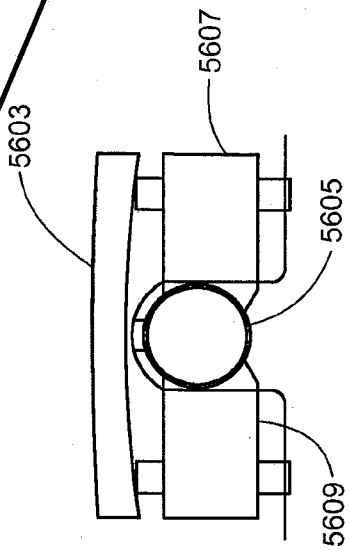


FIG. 58

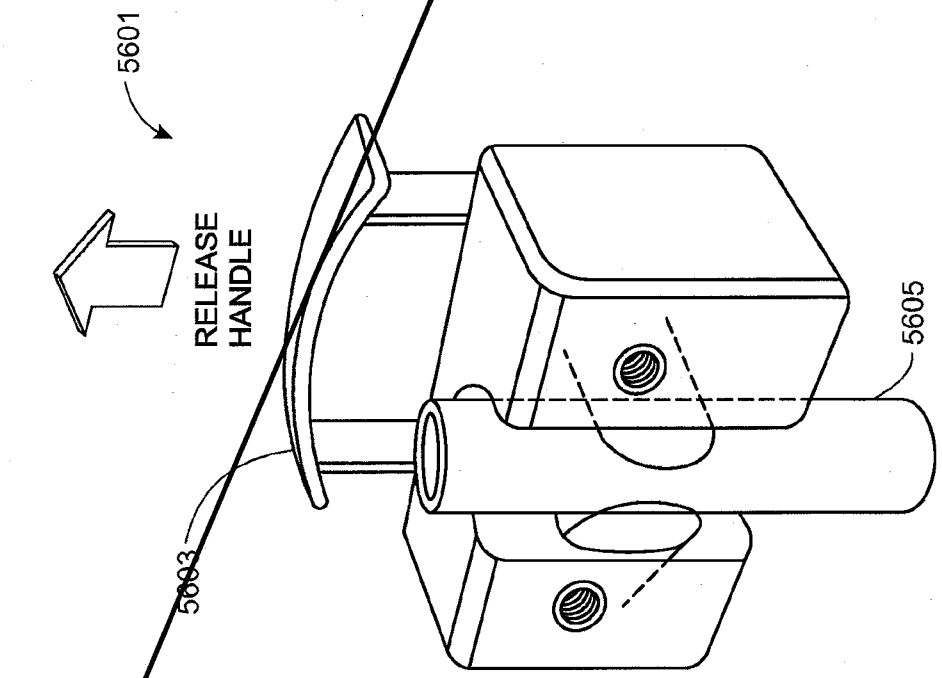


FIG. 56

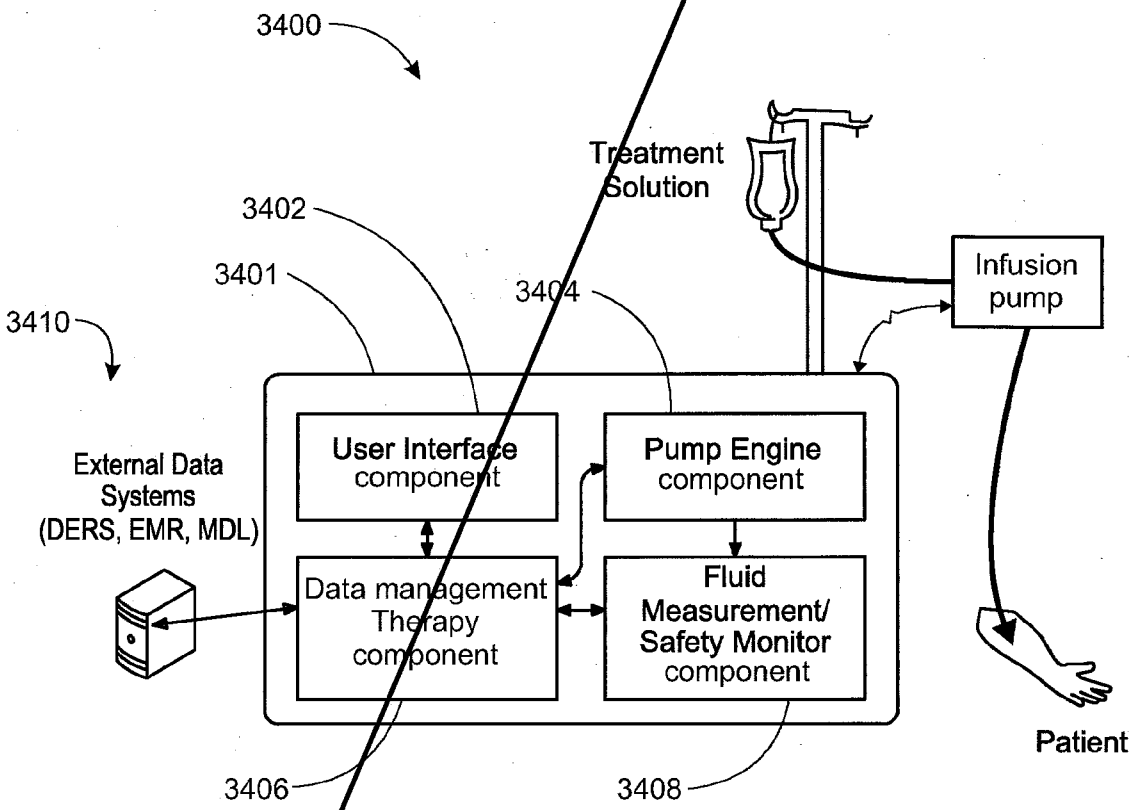

3400
Treatment Solution
3402
3401
3404
Infusion pump
3410
External Data Systems (DERS, EMR, MDL)
User Interface component
Pump Engine component
Data management Therapy component
Fluid Measurement/ Safety Monitor component
Patient
3406
3408

FIG. 59

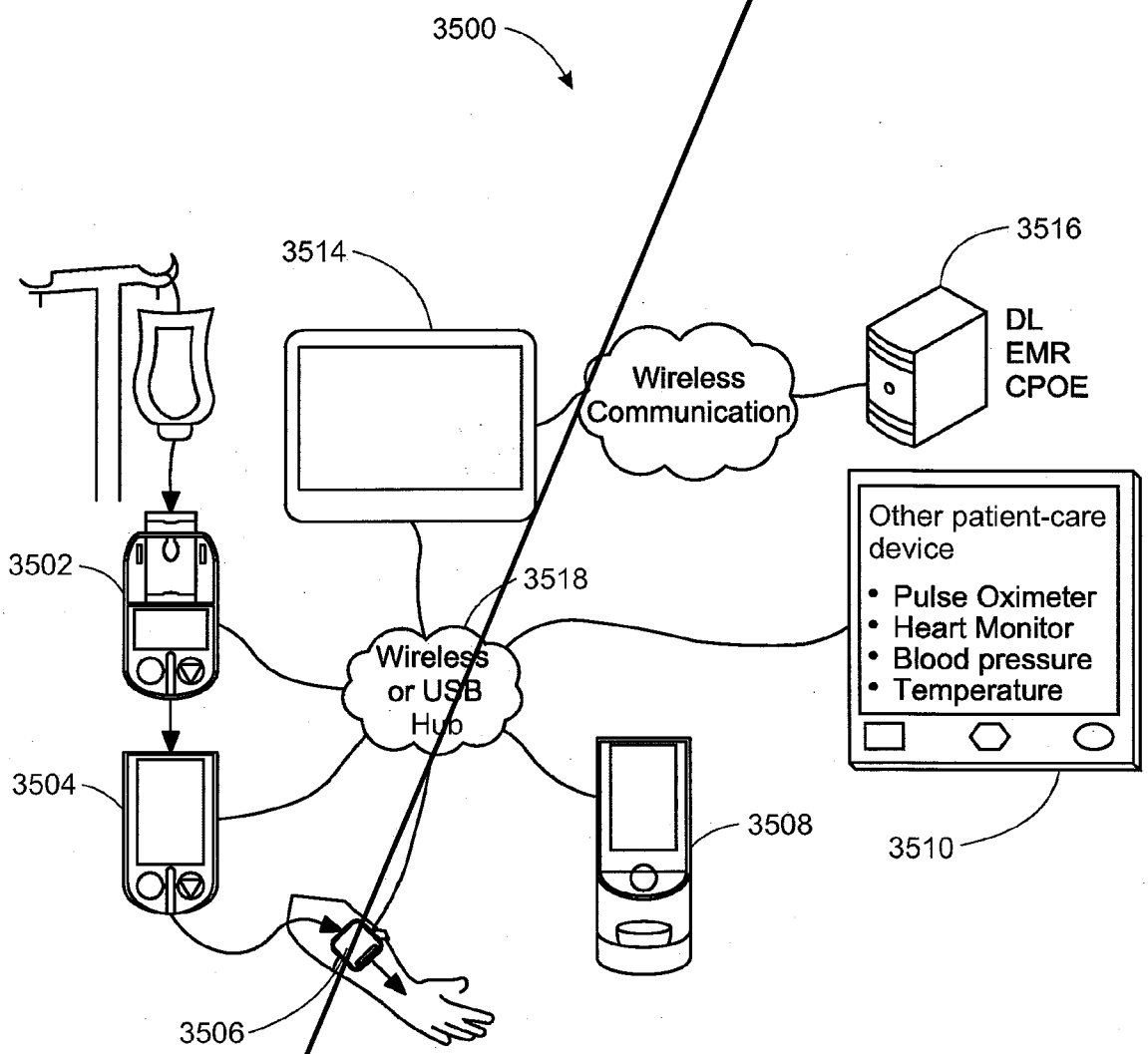

3500
3514
3516
DL
EMR
CPOE
Wireless
Communication
Other patient-care
device
• Pulse Oximeter
• Heart Monitor
• Blood pressure
• Temperature
3502
3518
Wireless
or USB
Hub
3504
3508
3510
3506

FIG. 60

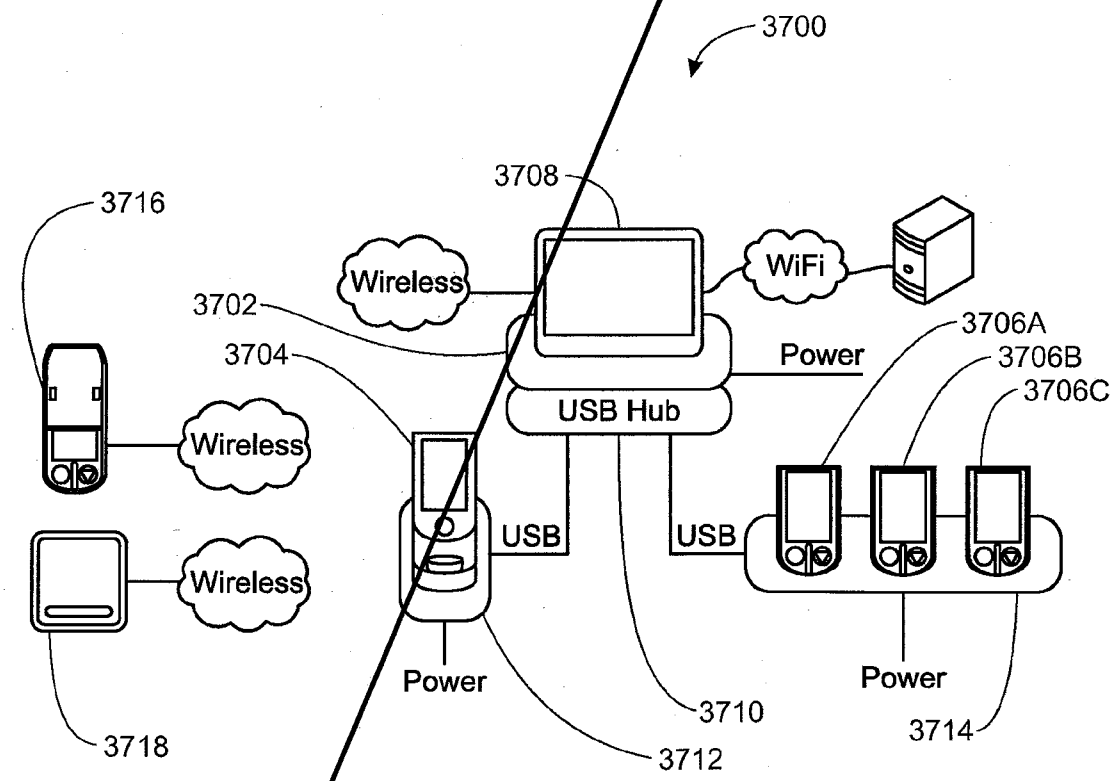

3700
3708
3716
Wireless
WiFi
3702
3704
3706A
3706B
3706C
Power
USB Hub
Wireless
Wireless
USB
USB
Power
Power
3710
3712
3714
3718

FIG. 61

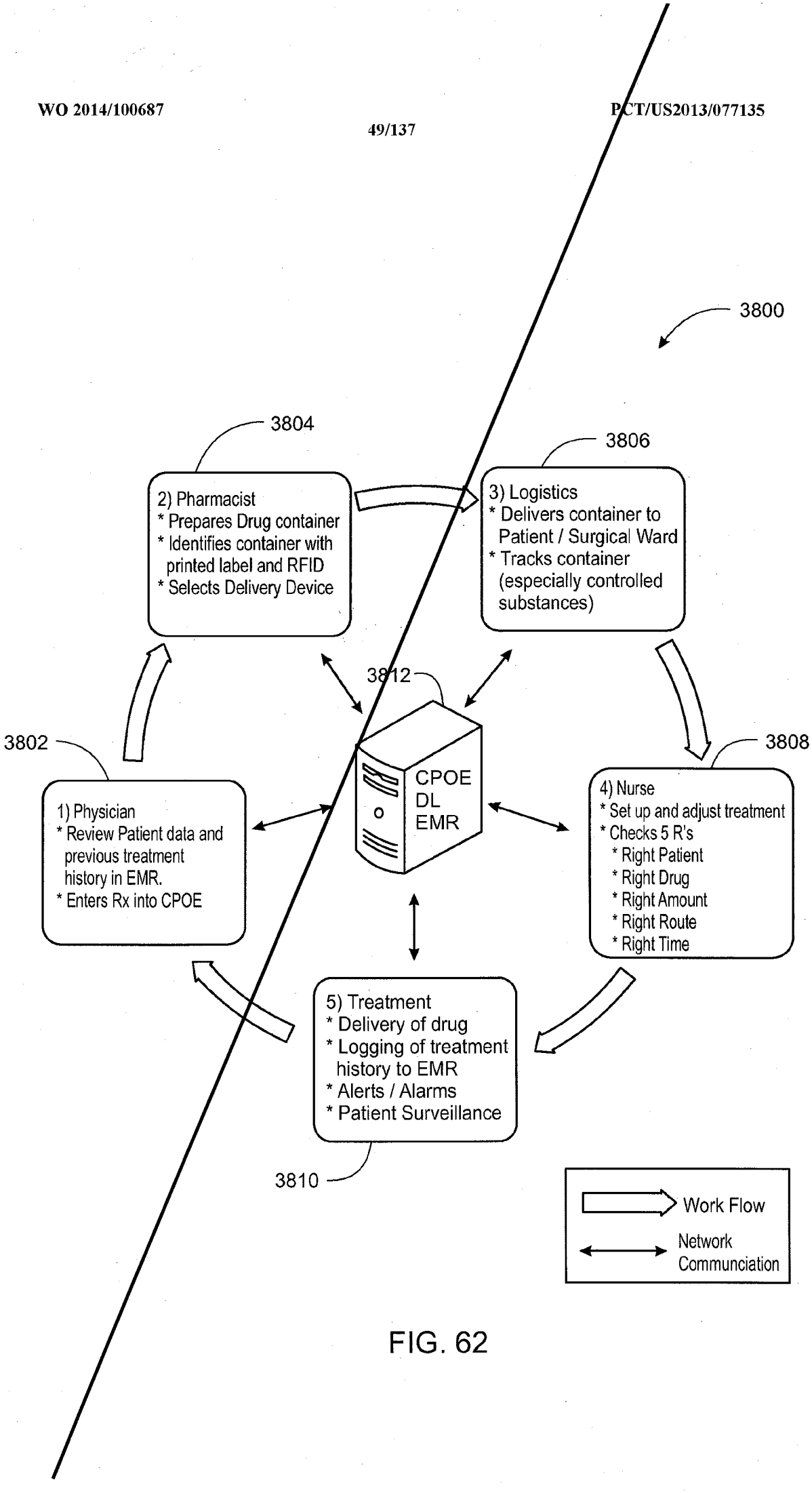

3800
3804
2) Pharmacist
* Prepares Drug container
* Identifies container with printed label and RFID
* Selects Delivery Device
3806
3) Logistics
* Delivers container to Patient / Surgical Ward
* Tracks container (especially controlled substances)
3812
CPOE
DL
EMR
3802
1) Physician
* Review Patient data and previous treatment history in EMR.
* Enters Rx into CPOE
3808
4) Nurse
* Set up and adjust treatment
* Checks 5 R's
* Right Patient
* Right Drug
* Right Amount
* Right Route
* Right Time
5) Treatment
* Delivery of drug
* Logging of treatment history to EMR
* Alerts / Alarms
* Patient Surveillance
3810
Work Flow
Network Communciation

FIG. 62

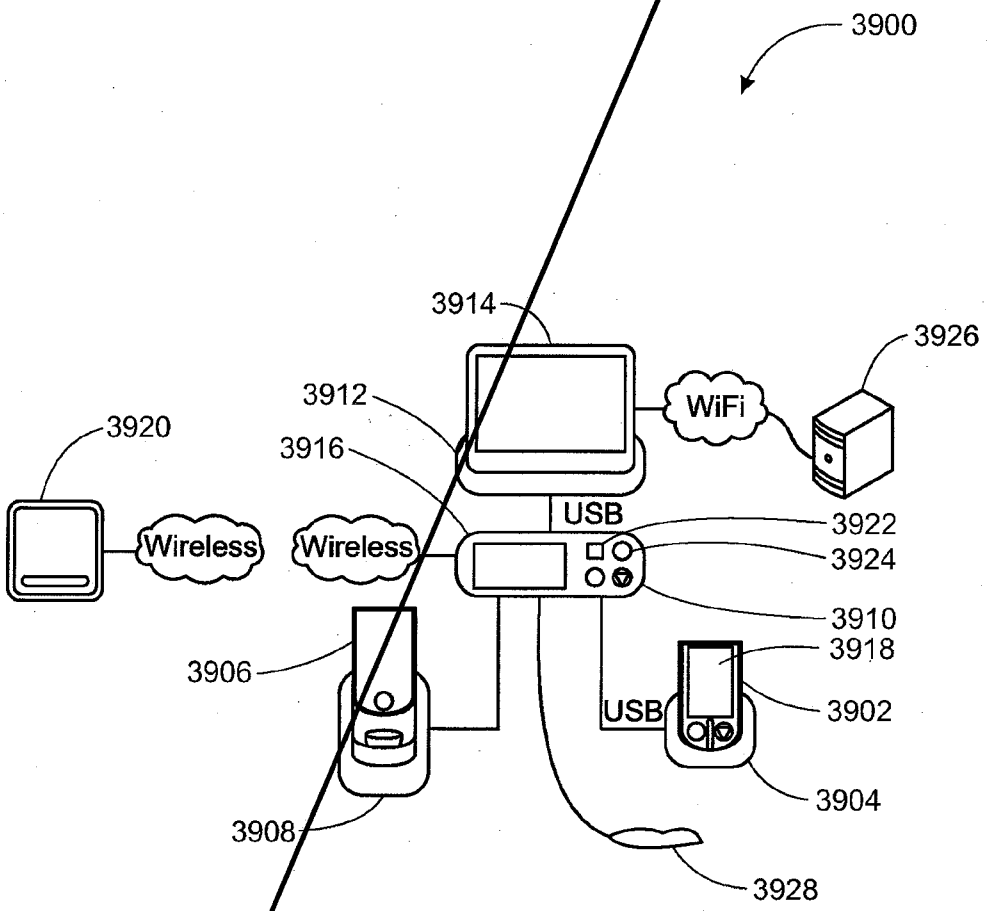

3900
3914
3926
3912
WiFi
3920
3916
USB
3922
Wireless
Wireless
3924
3910
3906
3918
USB
3902
3904
3908
3928

FIG. 63

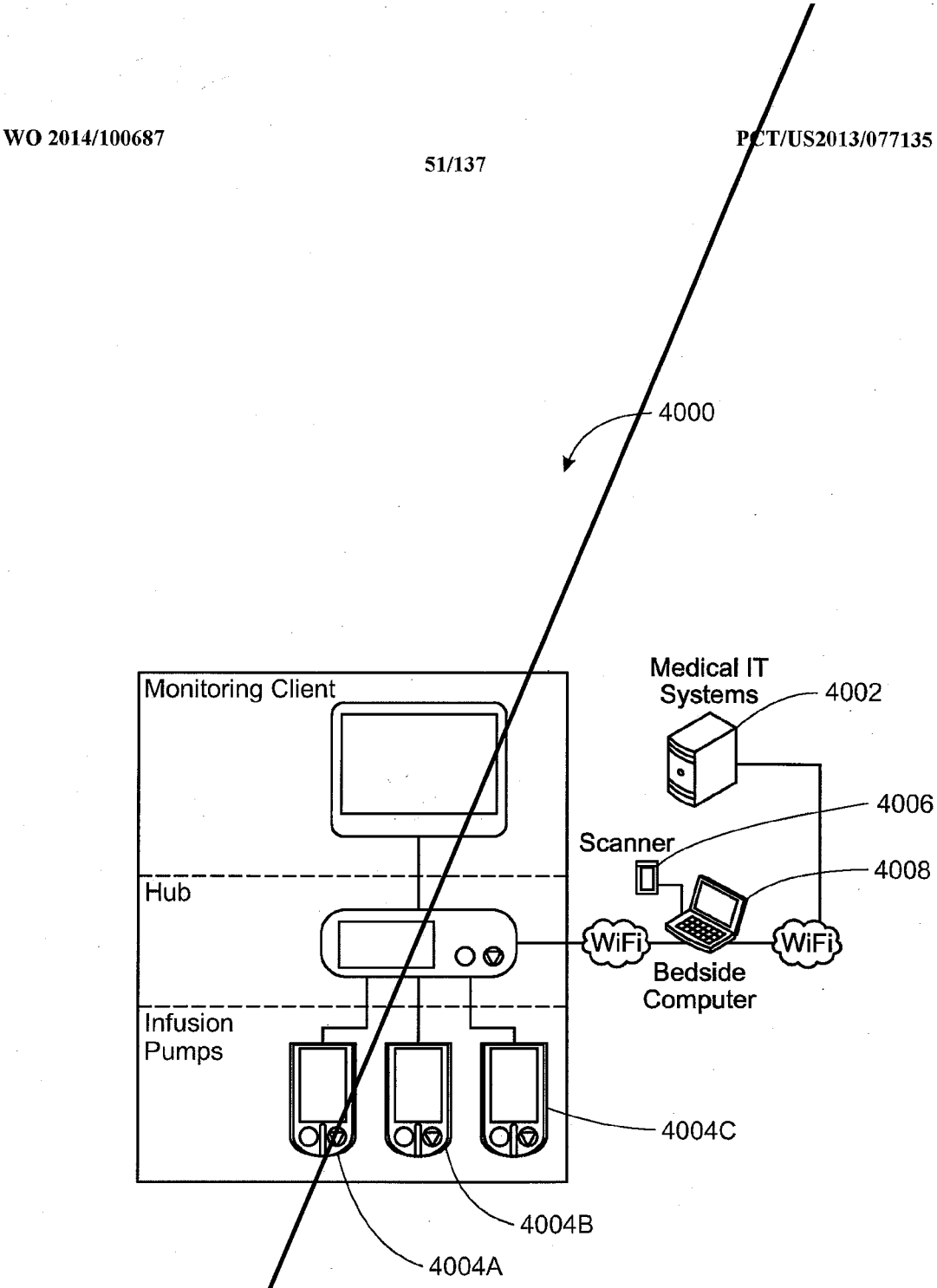

4000
Monitoring Client
Hub
Infusion Pumps
Medical IT Systems
4002
4006
Scanner
4008
WiFi
WiFi
Bedside Computer
4004C
4004B
4004A

FIG. 64

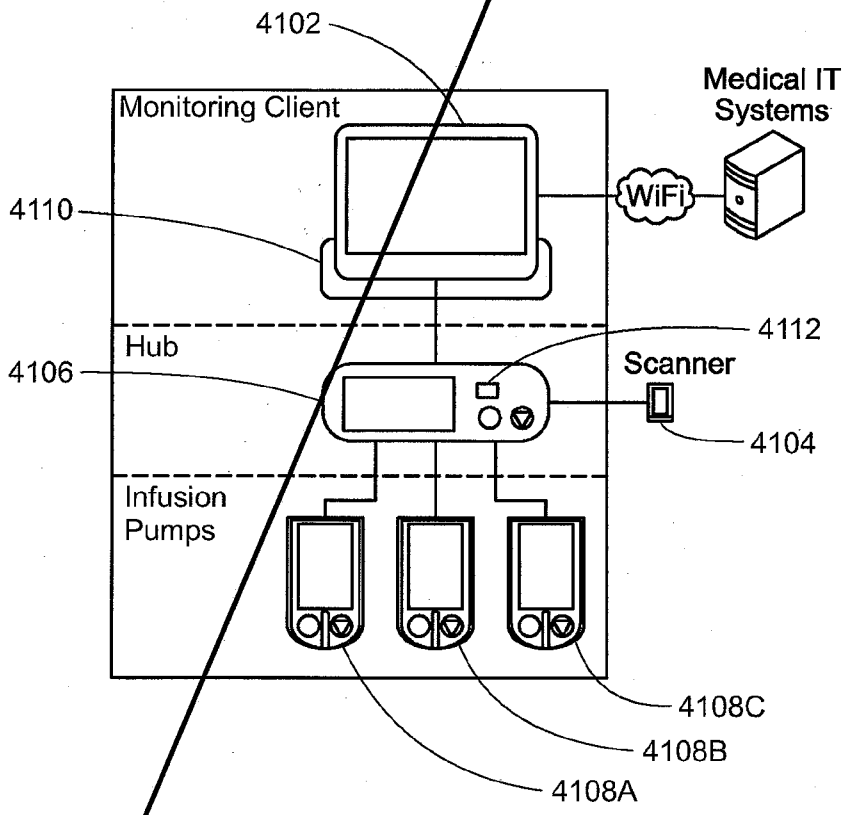

4102
Monitoring Client
Medical IT Systems
WiFi
4110
Hub
4112
Scanner
4106
4104
Infusion Pumps
4108C
4108B
4108A

FIG. 65

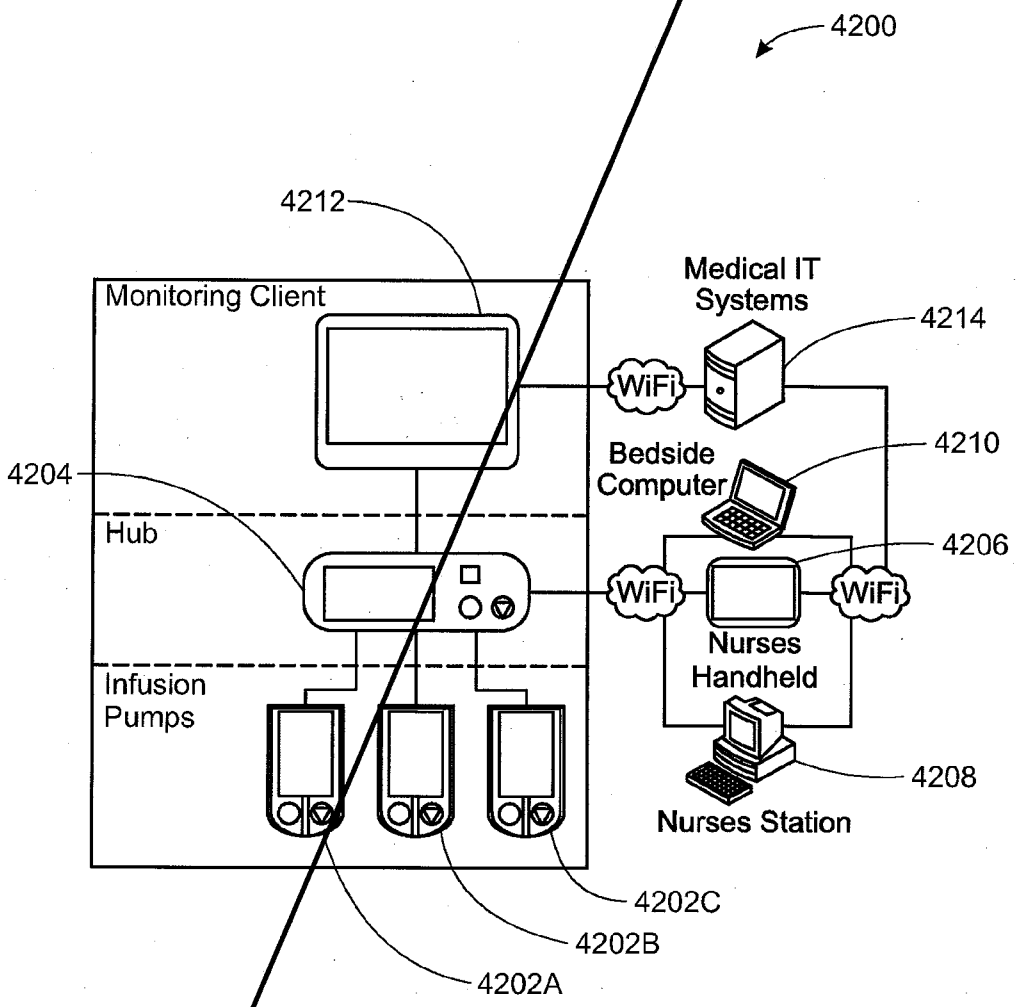

4200
4212
Monitoring Client
Medical IT Systems
4214
WiFi
4210
Bedside Computer
4204
Hub
4206
WiFi
WiFi
Nurses Handheld
Infusion Pumps
4208
Nurses Station
4202C
4202B
4202A

FIG. 66

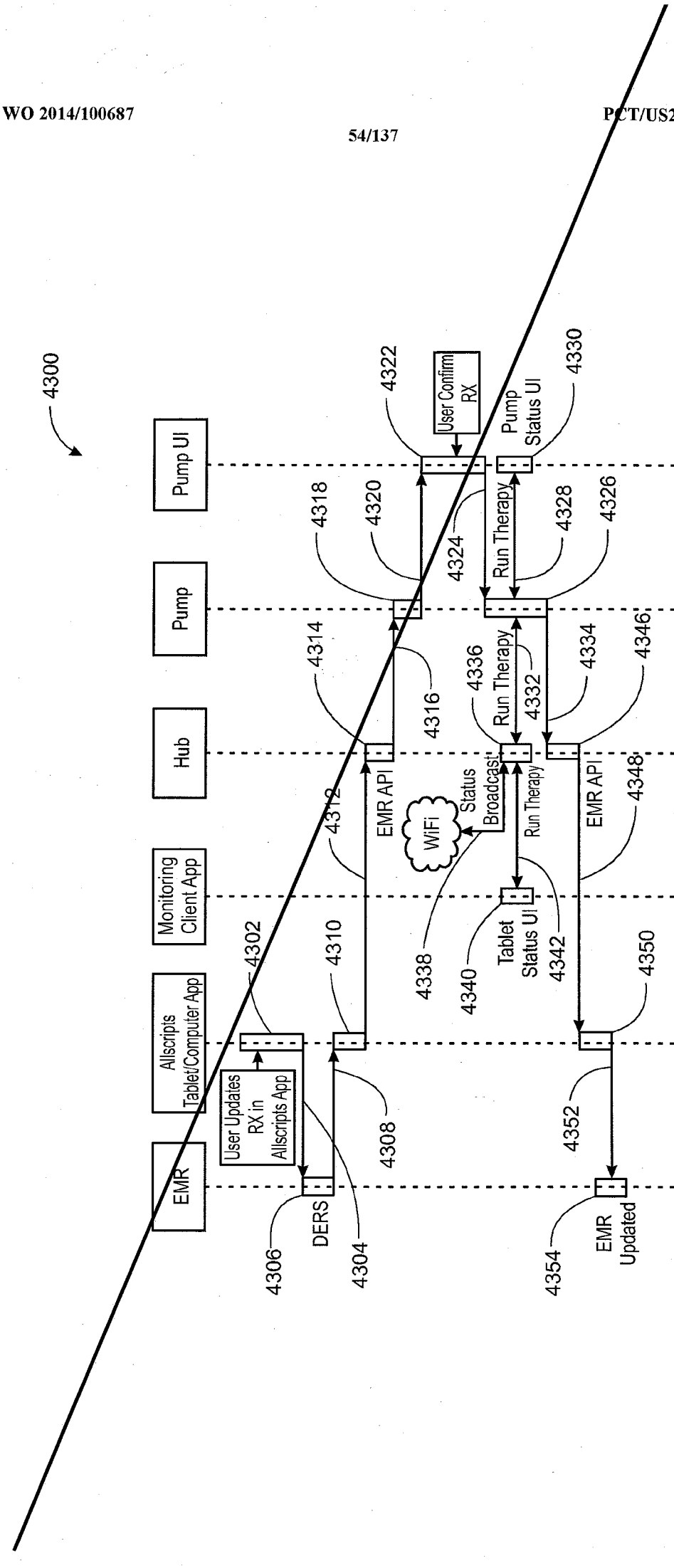

4300
EMR
Allscripts Tablet/Computer App
Monitoring Client App
Hub
Pump
Pump UI
4302
4304
4306
4308
4310
4312
4314
4316
4318
4320
4322
4324
4326
4328
4330
4332
4334
4336
4338
4340
4342
4346
4348
4350
4352
4354
User Updates RX in Allscripts App
DERS
EMR API
WiFi
Status Broadcast
Tablet Status UI
User Confirm RX
Run Therapy
Pump Status UI
Run Therapy
Run Therapy
EMR API
EMR Updated

FIG. 67

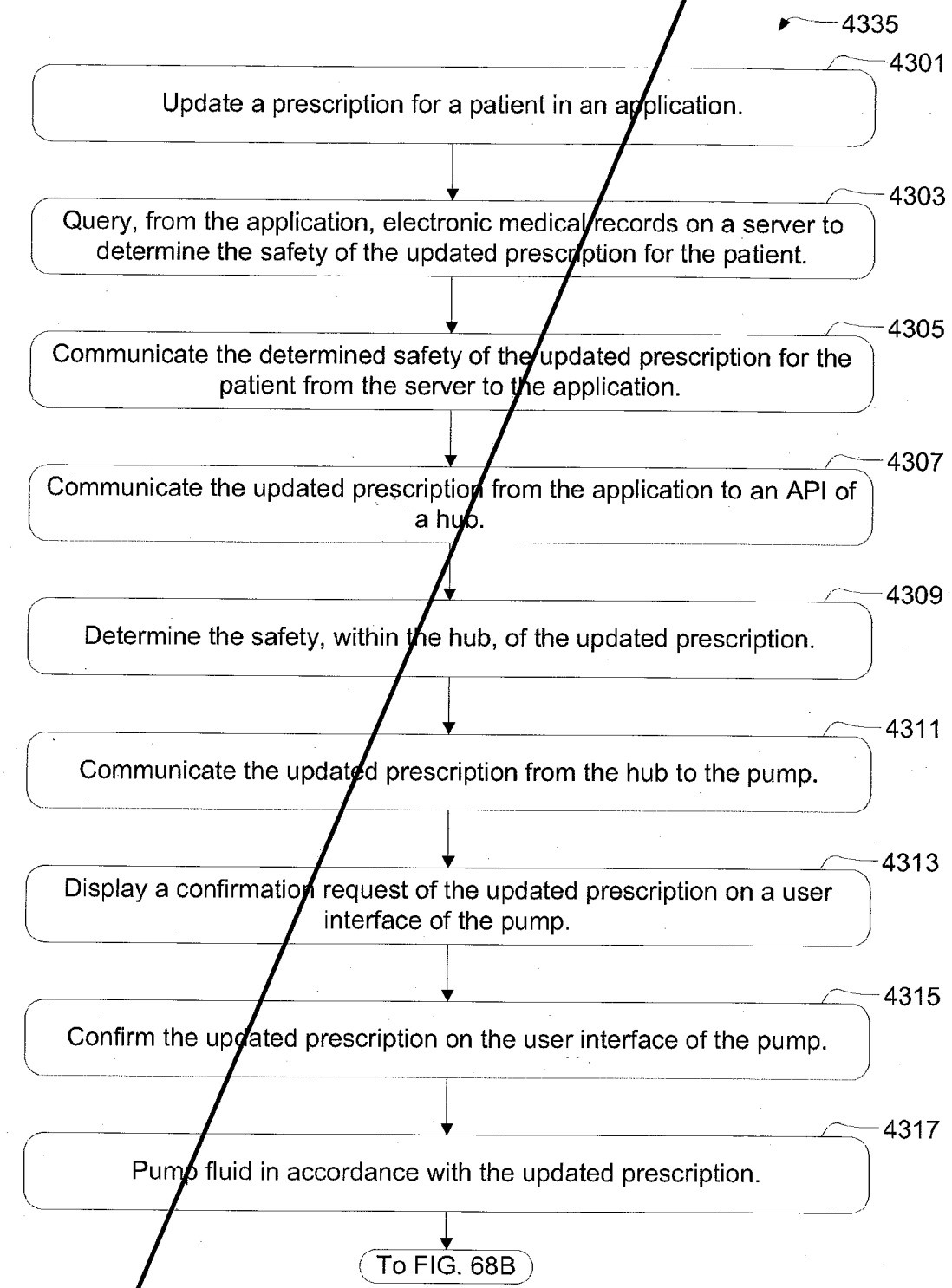

4335
4301
Update a prescription for a patient in an application.
4303
Query, from the application, electronic medical records on a server to determine the safety of the updated prescription for the patient.
4305
Communicate the determined safety of the updated prescription for the patient from the server to the application.
4307
Communicate the updated prescription from the application to an API of a hub.
4309
Determine the safety, within the hub, of the updated prescription.
4311
Communicate the updated prescription from the hub to the pump.
4313
Display a confirmation request of the updated prescription on a user interface of the pump.
4315
Confirm the updated prescription on the user interface of the pump.
4317
Pump fluid in accordance with the updated prescription.
To FIG. 68B

FIG. 68A

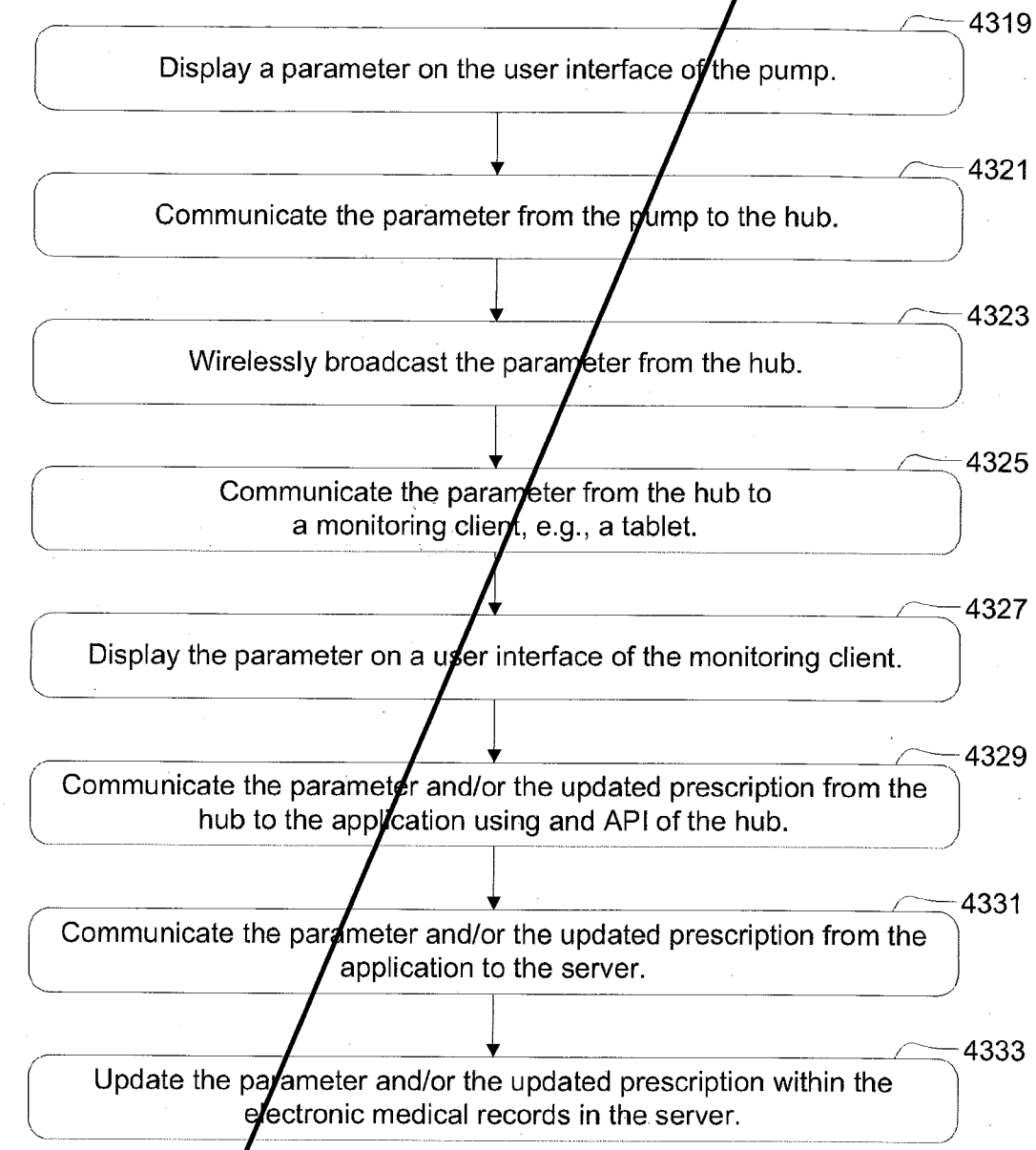

4319
Display a parameter on the user interface of the pump.
4321
Communicate the parameter from the pump to the hub.
4323
Wirelessly broadcast the parameter from the hub.
4325
Communicate the parameter from the hub to a monitoring client, e.g., a tablet.
4327
Display the parameter on a user interface of the monitoring client.
4329
Communicate the parameter and/or the updated prescription from the hub to the application using and API of the hub.
4331
Communicate the parameter and/or the updated prescription from the application to the server.
4333
Update the parameter and/or the updated prescription within the electronic medical records in the server.

FIG. 68B

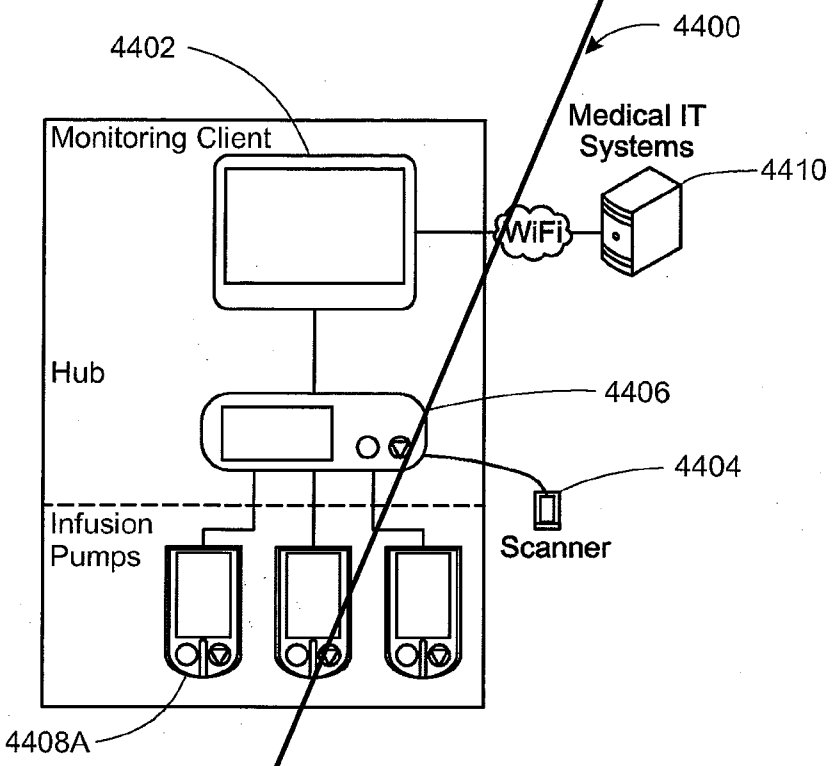

4400
4402
Monitoring Client
Medical IT Systems
4410
WiFi
Hub
4406
4404
Infusion Pumps
Scanner
4408A

FIG. 69

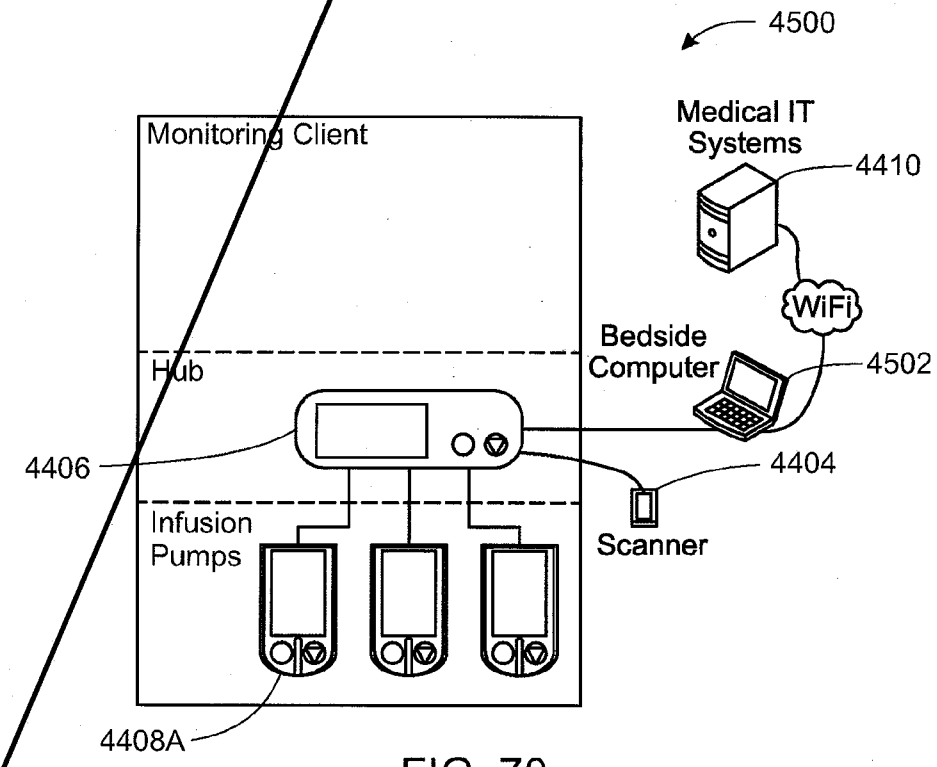

4500
Medical IT Systems
4410
Monitoring Client
WiFi
Bedside Computer
4502
Hub
4406
4404
Infusion Pumps
Scanner
4408A

FIG. 70

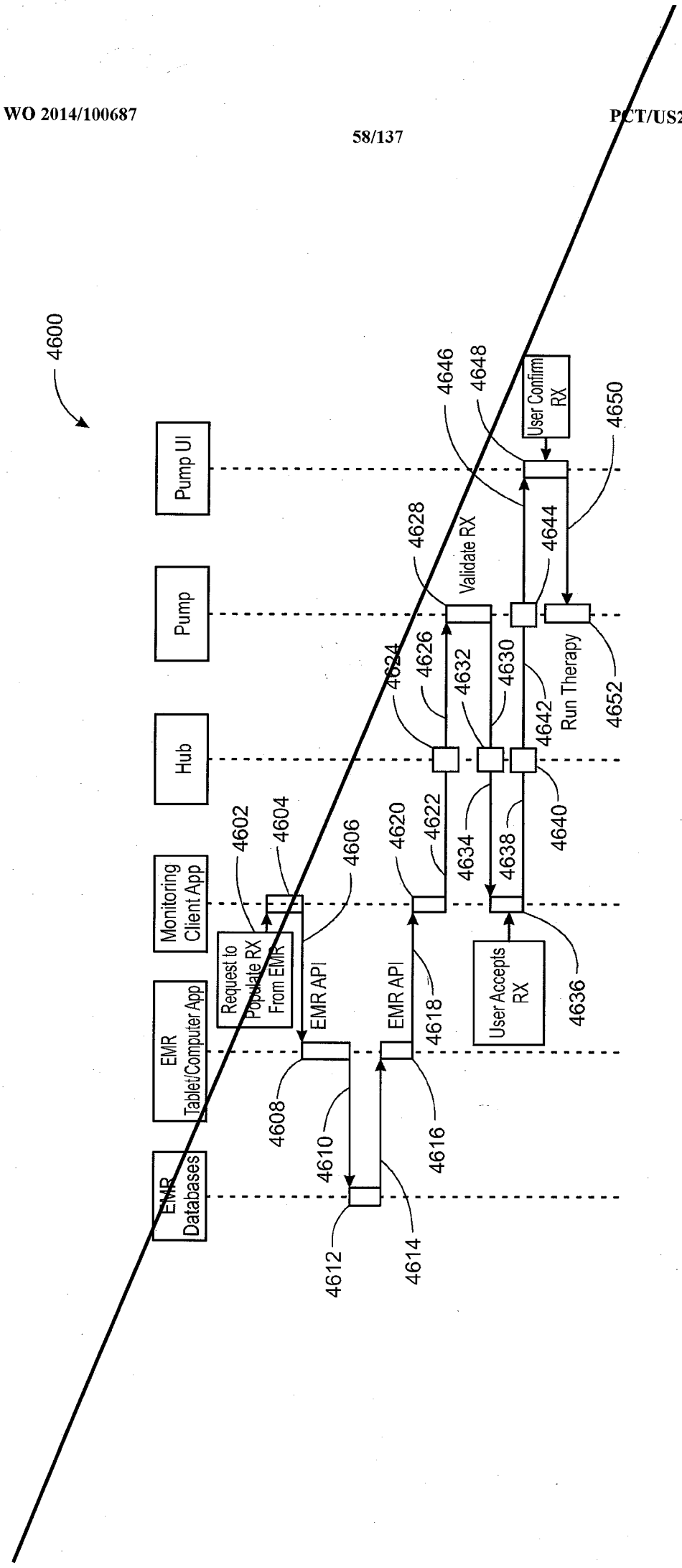

4600
Pump UI
Pump
Hub
Monitoring Client App
EMR Tablet/Computer App
EMR Databases
4602
4604
4606
4608
4610
4612
4614
4616
4618
4620
4622
4624
4626
4628
4630
4632
4634
4636
4638
4640
4642
4644
4646
4648
4650
4652
Request to Populate RX From EMR
EMR API
EMR API
Validate RX
User Accepts RX
User Confirm RX
Run Therapy

FIG. 71

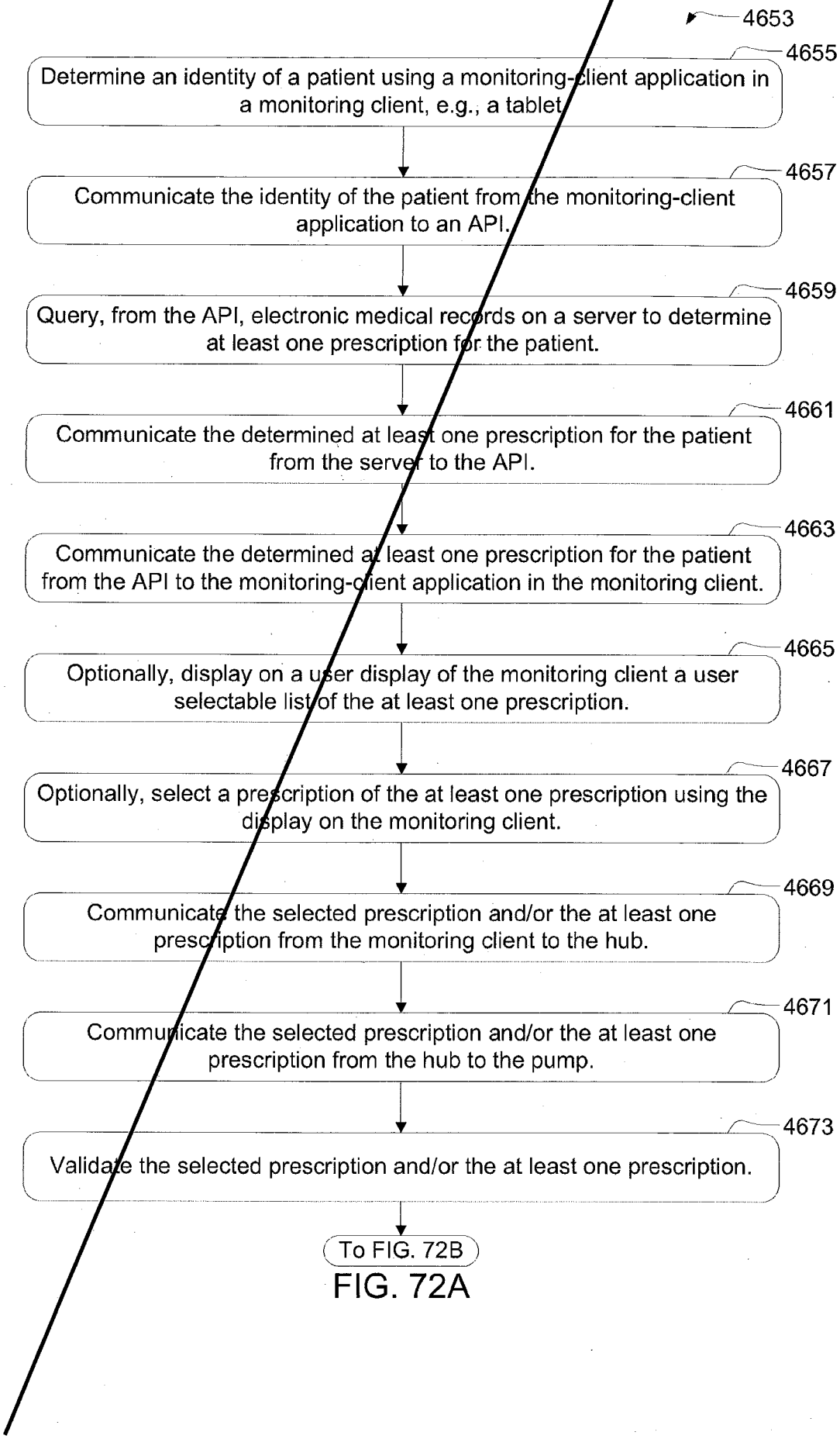

4653
4655
Determine an identity of a patient using a monitoring-client application in a monitoring client, e.g., a tablet.
4657
Communicate the identity of the patient from the monitoring-client application to an API.
4659
Query, from the API, electronic medical records on a server to determine at least one prescription for the patient.
4661
Communicate the determined at least one prescription for the patient from the server to the API.
4663
Communicate the determined at least one prescription for the patient from the API to the monitoring-client application in the monitoring client.
4665
Optionally, display on a user display of the monitoring client a user selectable list of the at least one prescription.
4667
Optionally, select a prescription of the at least one prescription using the display on the monitoring client.
4669
Communicate the selected prescription and/or the at least one prescription from the monitoring client to the hub.
4671
Communicate the selected prescription and/or the at least one prescription from the hub to the pump.
4673
Validate the selected prescription and/or the at least one prescription.
To FIG. 72B

FIG. 72A

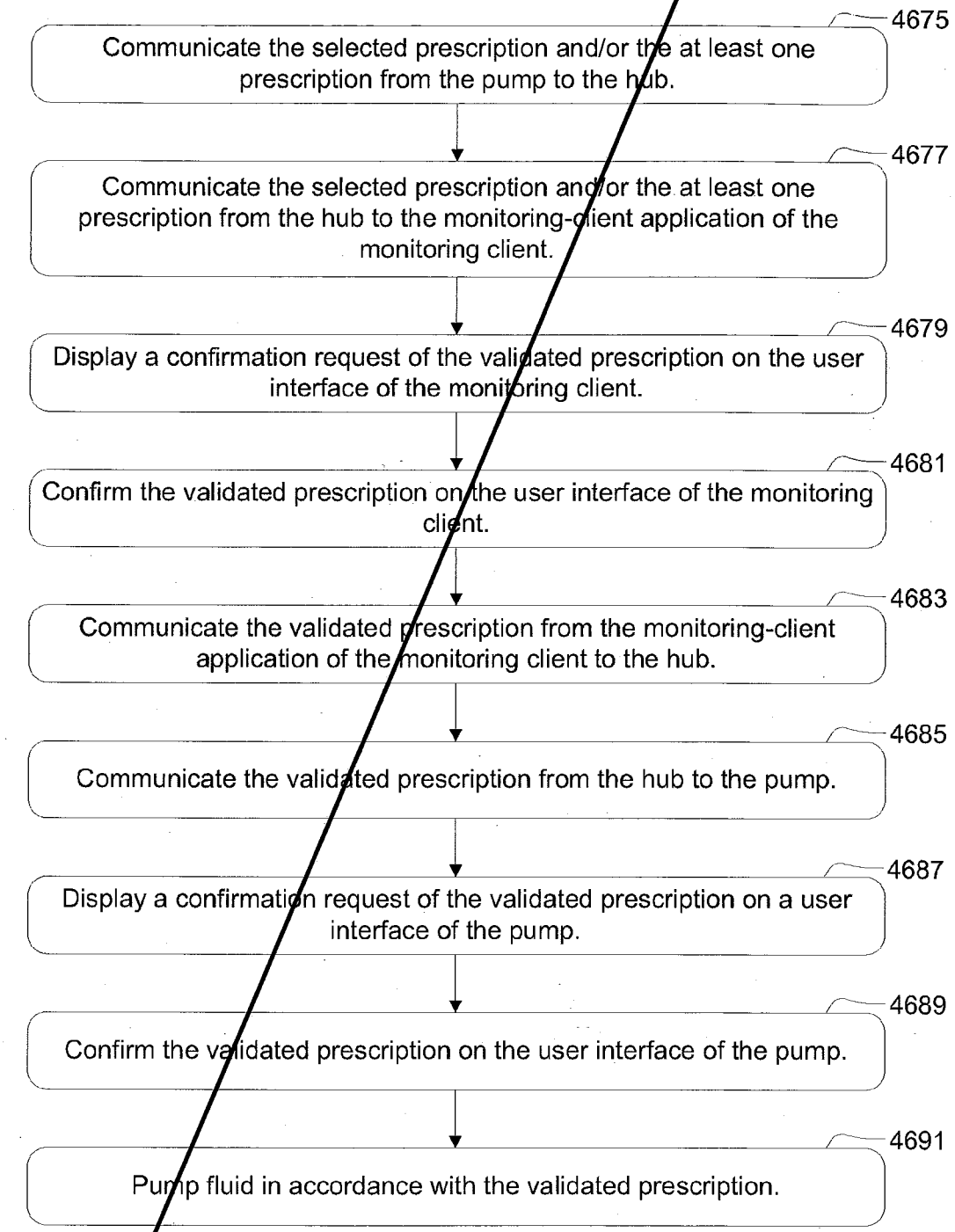

4675
Communicate the selected prescription and/or the at least one prescription from the pump to the hub.
4677
Communicate the selected prescription and/or the at least one prescription from the hub to the monitoring-client application of the monitoring client.
4679
Display a confirmation request of the validated prescription on the user interface of the monitoring client.
4681
Confirm the validated prescription on the user interface of the monitoring client.
4683
Communicate the validated prescription from the monitoring-client application of the monitoring client to the hub.
4685
Communicate the validated prescription from the hub to the pump.
4687
Display a confirmation request of the validated prescription on a user interface of the pump.
4689
Confirm the validated prescription on the user interface of the pump.
4691
Pump fluid in accordance with the validated prescription.

FIG. 72B

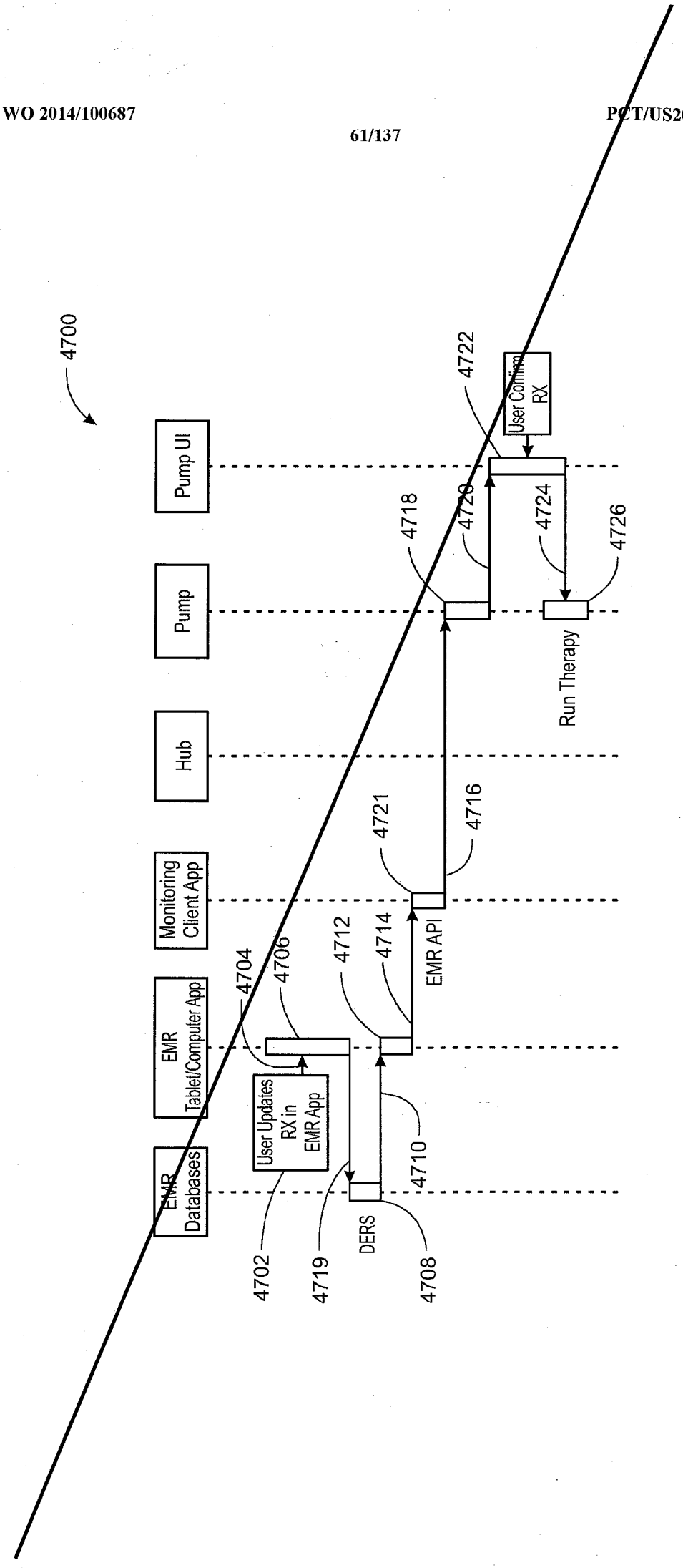

4700
Pump UI
Pump
Hub
Monitoring Client App
EMR Tablet/Computer App
EMR Databases
4722
User Confirm RX
4718
4720
4724
4726
Run Therapy
4721
4716
EMR API
4712
4714
4704
4706
User Updates RX in EMR App
4710
DERS
4702
4719
4708

FIG. 73

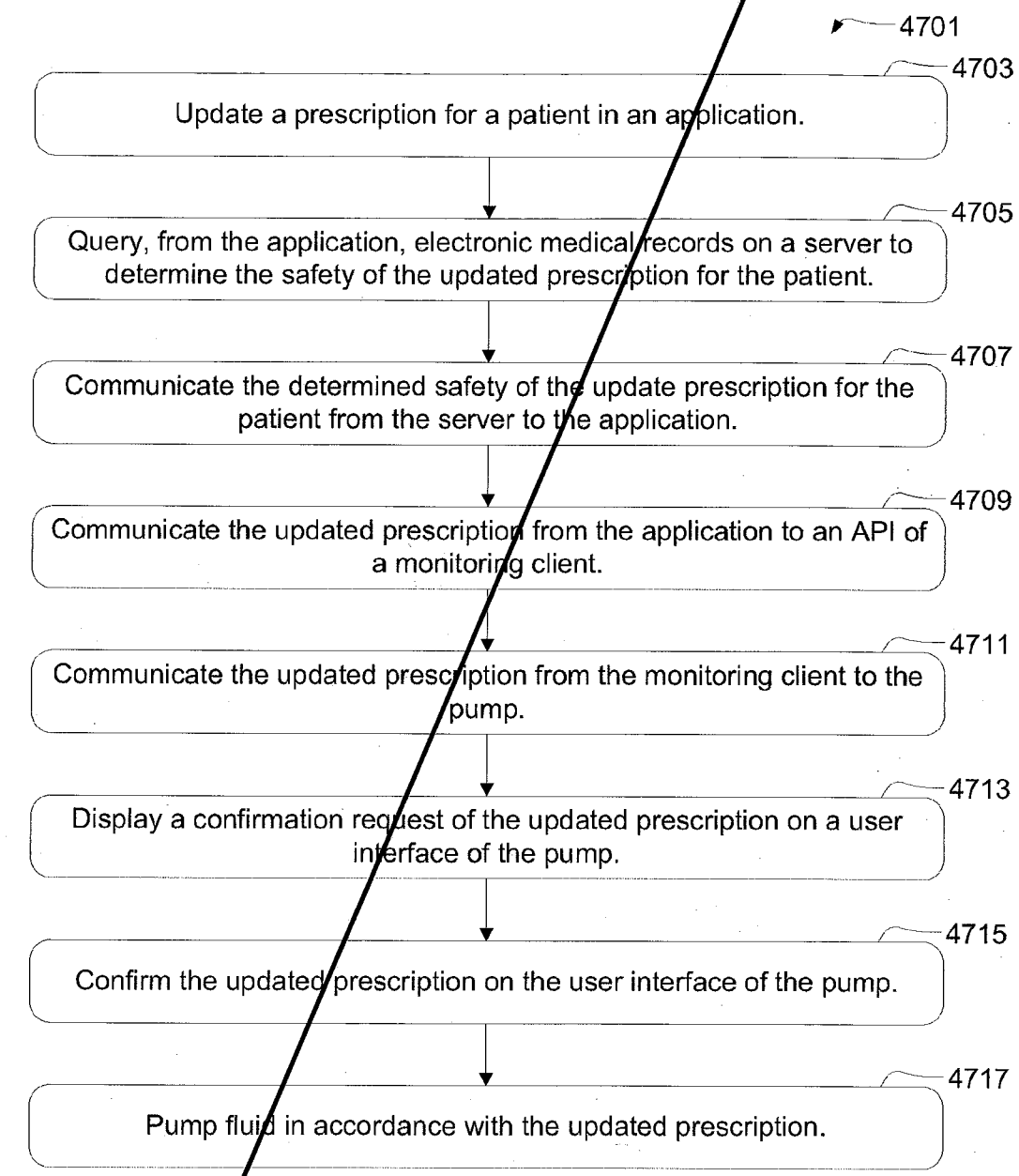

4701
4703
Update a prescription for a patient in an application.
4705
Query, from the application, electronic medical records on a server to determine the safety of the updated prescription for the patient.
4707
Communicate the determined safety of the update prescription for the patient from the server to the application.
4709
Communicate the updated prescription from the application to an API of a monitoring client.
4711
Communicate the updated prescription from the monitoring client to the pump.
4713
Display a confirmation request of the updated prescription on a user interface of the pump.
4715
Confirm the updated prescription on the user interface of the pump.
4717
Pump fluid in accordance with the updated prescription.

FIG. 74

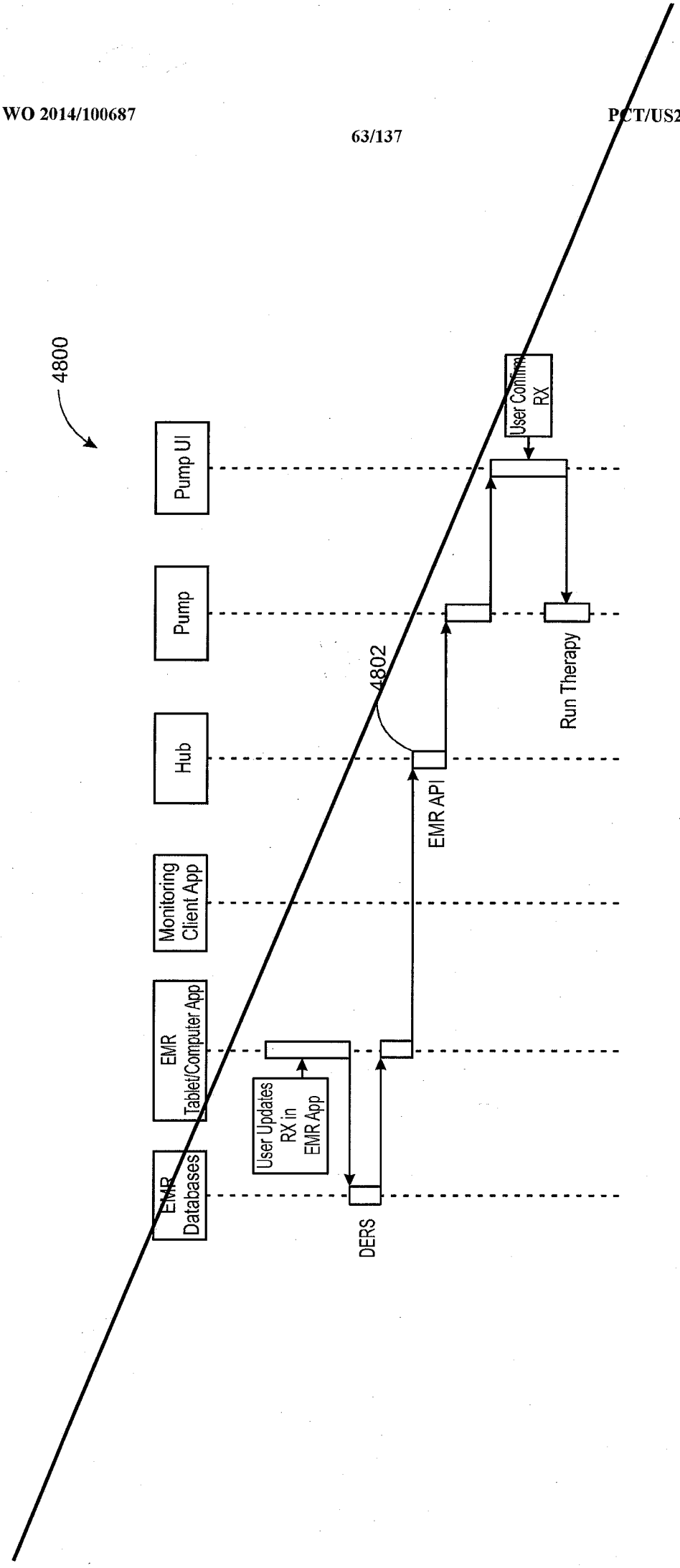

4800
Pump UI
Pump
Hub
Monitoring Client App
EMR Tablet/Computer App
EMR Databases
User Updates RX in EMR App
DERS
EMR API
4802
Run Therapy
User Confirms RX

FIG. 75

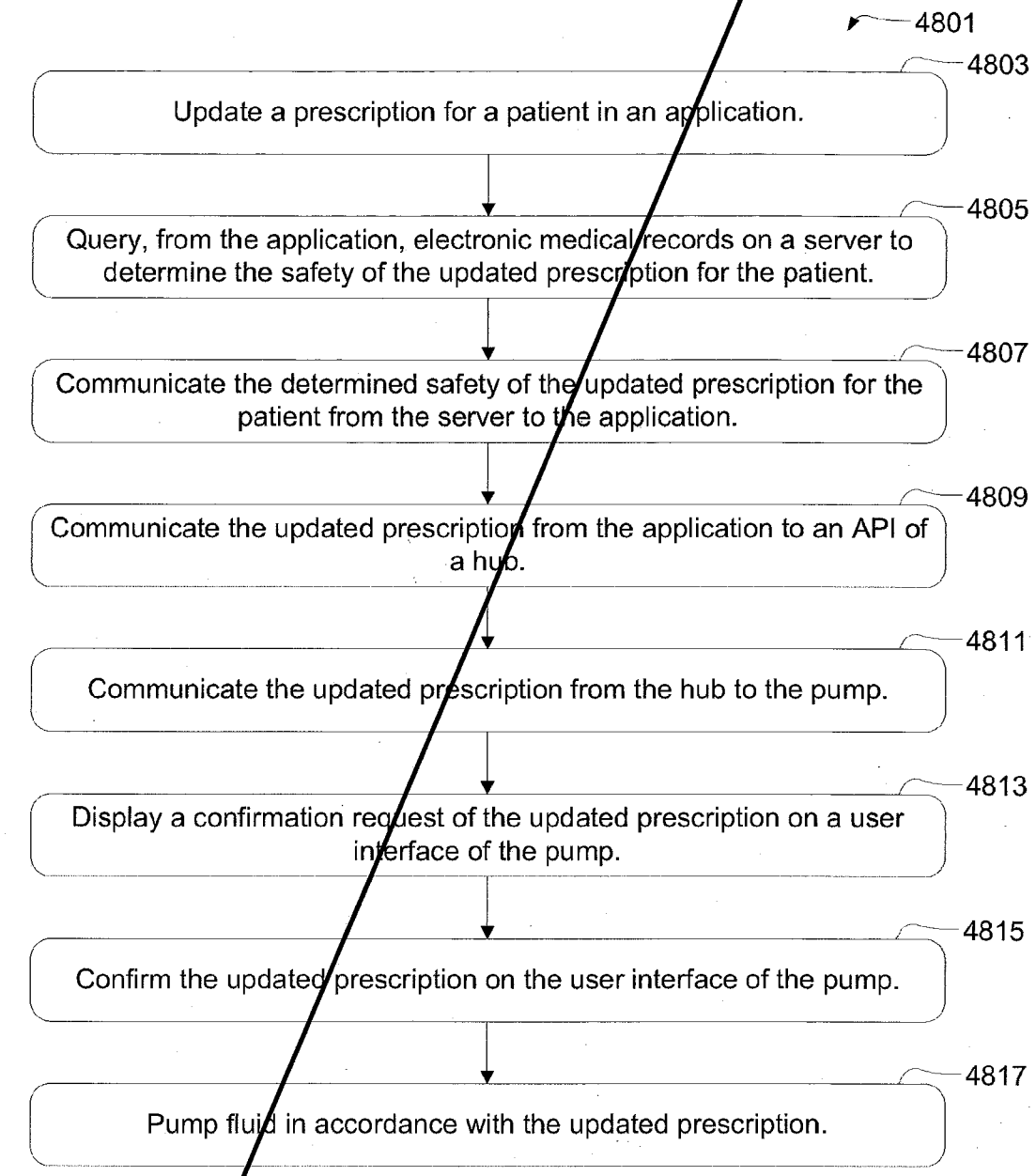

4801
4803
Update a prescription for a patient in an application.
4805
Query, from the application, electronic medical records on a server to determine the safety of the updated prescription for the patient.
4807
Communicate the determined safety of the updated prescription for the patient from the server to the application.
4809
Communicate the updated prescription from the application to an API of a hub.
4811
Communicate the updated prescription from the hub to the pump.
4813
Display a confirmation request of the updated prescription on a user interface of the pump.
4815
Confirm the updated prescription on the user interface of the pump.
4817
Pump fluid in accordance with the updated prescription.

FIG. 76

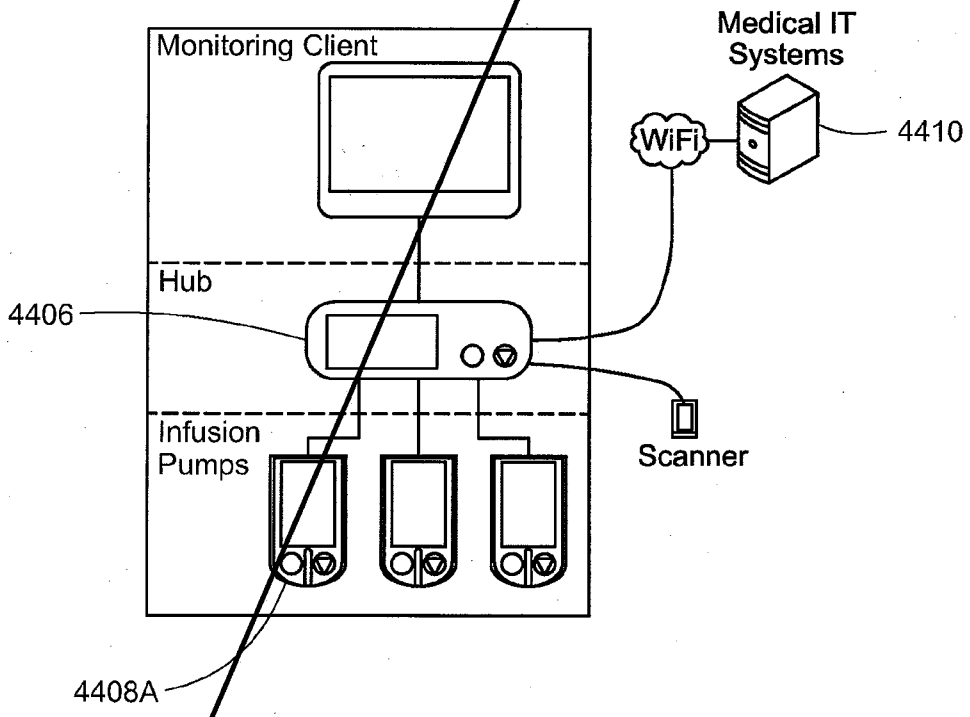

Monitoring Client
Medical IT Systems
WiFi
4410
Hub
4406
Infusion Pumps
Scanner
4408A

FIG. 77

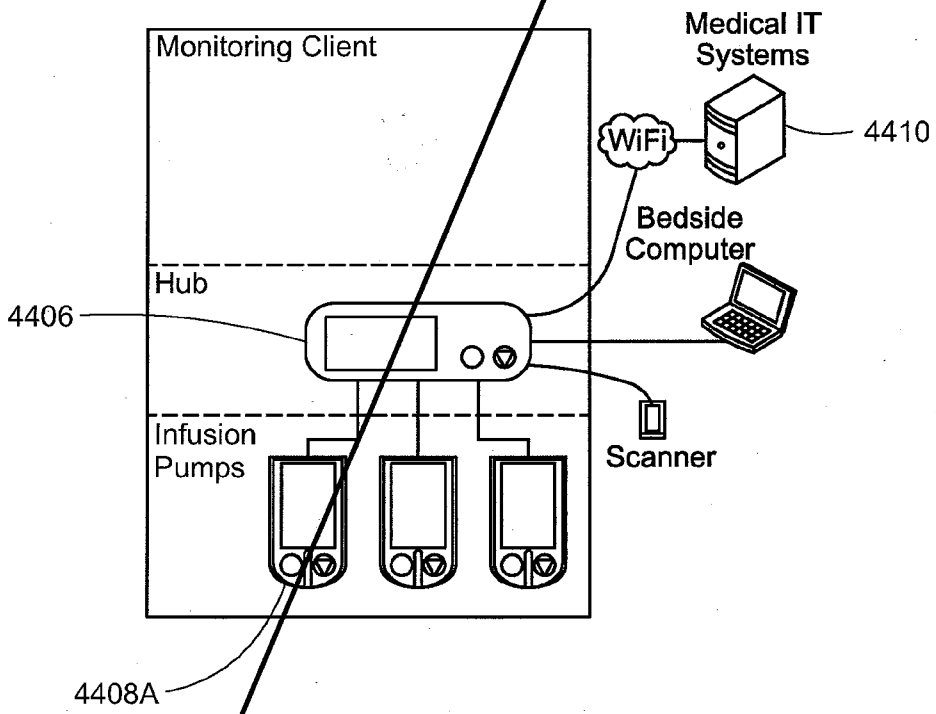

Monitoring Client
Medical IT Systems
WiFi
4410
Bedside Computer
Hub
4406
Infusion Pumps
Scanner
4408A

FIG. 78

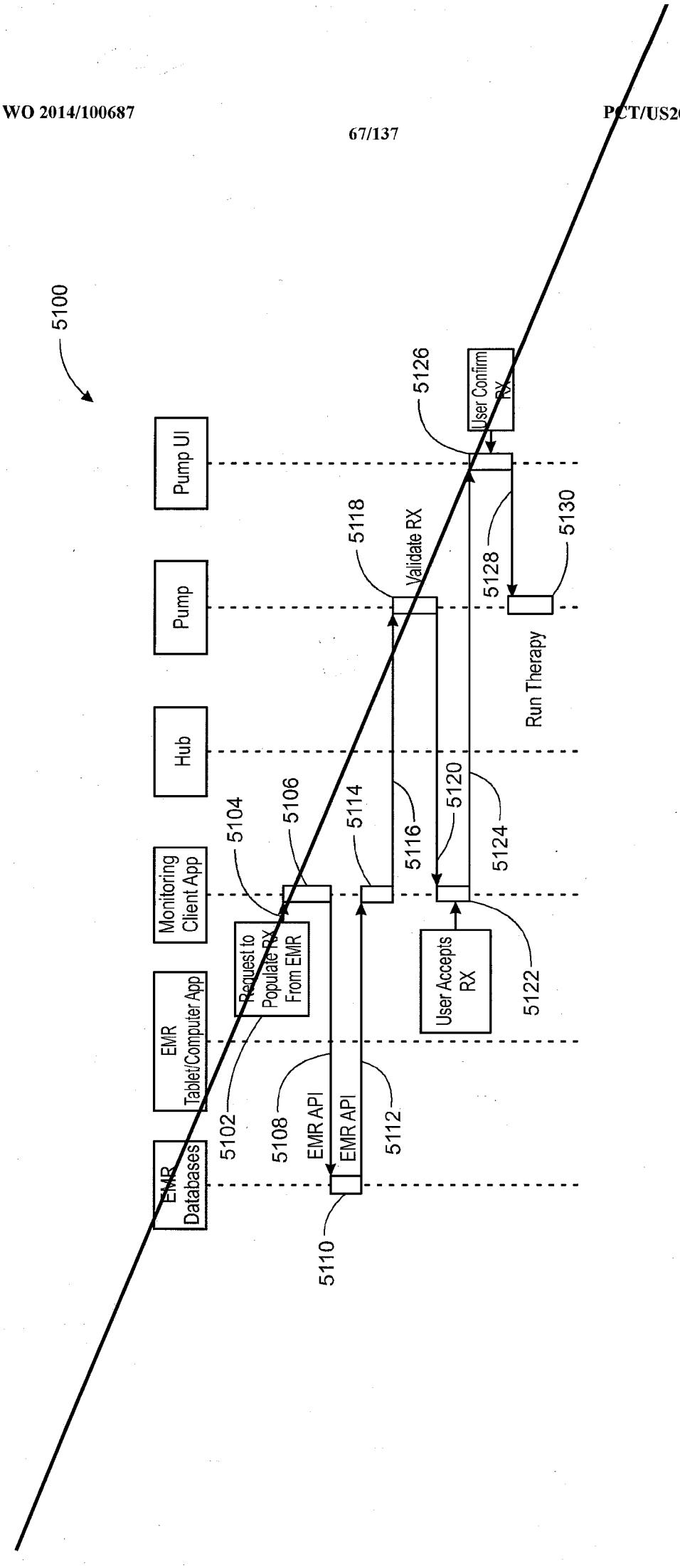

5100
EMR Databases
EMR Tablet/Computer App
Monitoring Client App
Hub
Pump
Pump UI
5102
Request to Populate RX From EMR
5104
5106
5108
EMR API
5110
EMR API
5112
5114
5116
Validate RX
5118
5120
User Accepts RX
5122
5124
User Confirm RX
5126
5128
Run Therapy
5130

FIG. 79

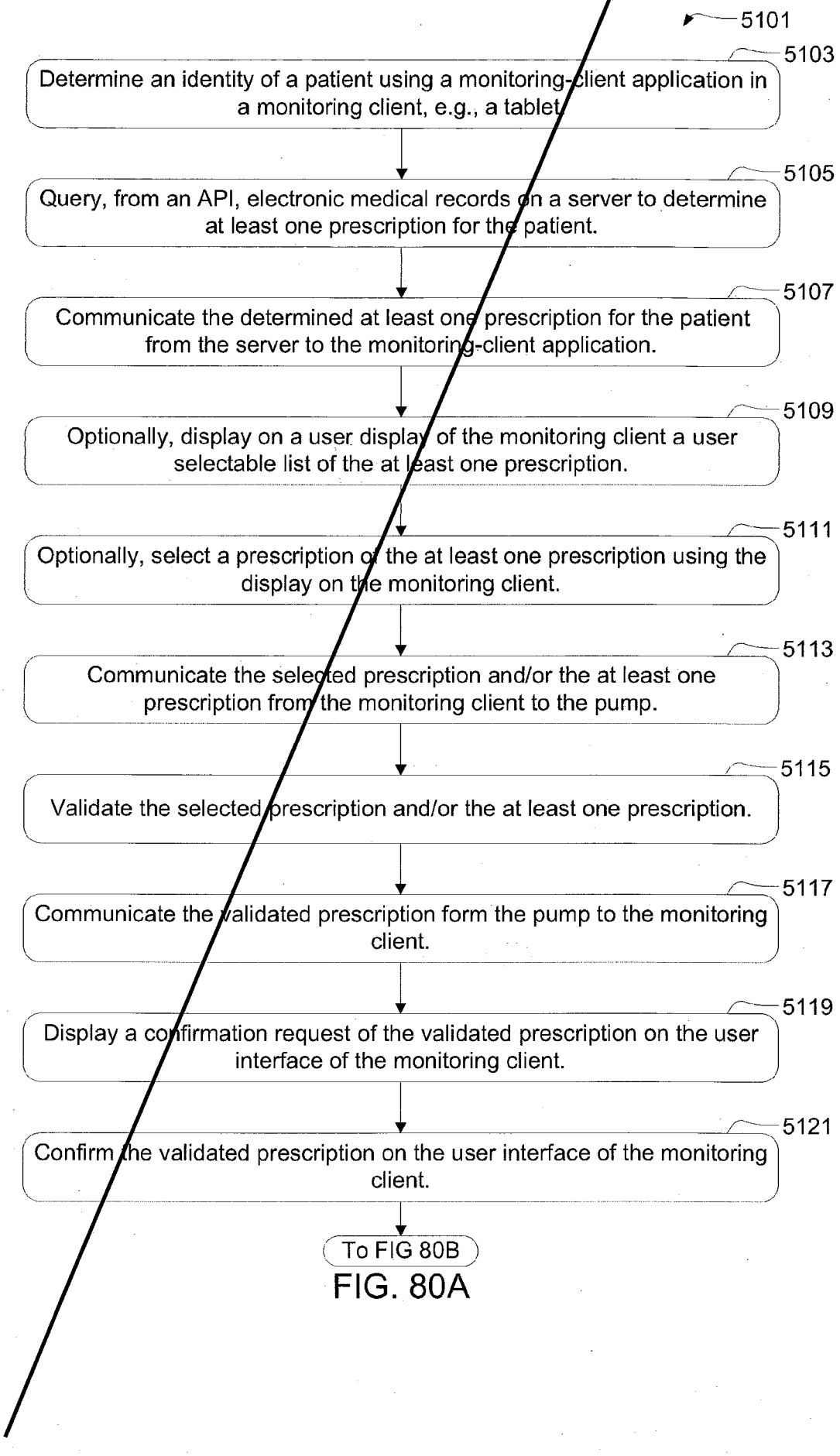

5101
5103
Determine an identity of a patient using a monitoring-client application in a monitoring client, e.g., a tablet.
5105
Query, from an API, electronic medical records on a server to determine at least one prescription for the patient.
5107
Communicate the determined at least one prescription for the patient from the server to the monitoring-client application.
5109
Optionally, display on a user display of the monitoring client a user selectable list of the at least one prescription.
5111
Optionally, select a prescription of the at least one prescription using the display on the monitoring client.
5113
Communicate the selected prescription and/or the at least one prescription from the monitoring client to the pump.
5115
Validate the selected prescription and/or the at least one prescription.
5117
Communicate the validated prescription form the pump to the monitoring client.
5119
Display a confirmation request of the validated prescription on the user interface of the monitoring client.
5121
Confirm the validated prescription on the user interface of the monitoring client.
To FIG 80B

FIG. 80A

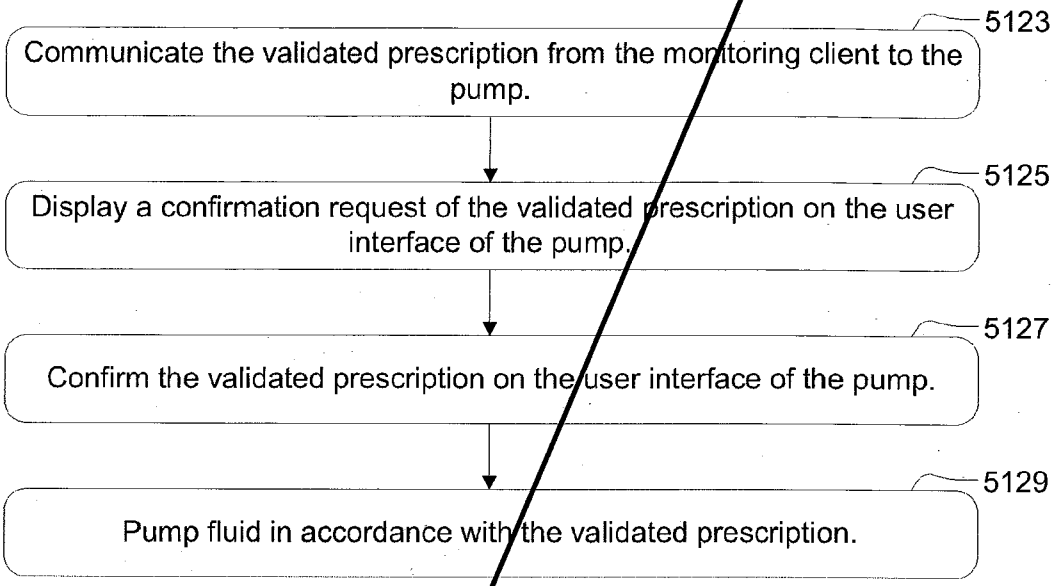

5123
Communicate the validated prescription from the monitoring client to the pump.
5125
Display a confirmation request of the validated prescription on the user interface of the pump.
5127
Confirm the validated prescription on the user interface of the pump.
5129
Pump fluid in accordance with the validated prescription.

FIG. 80B

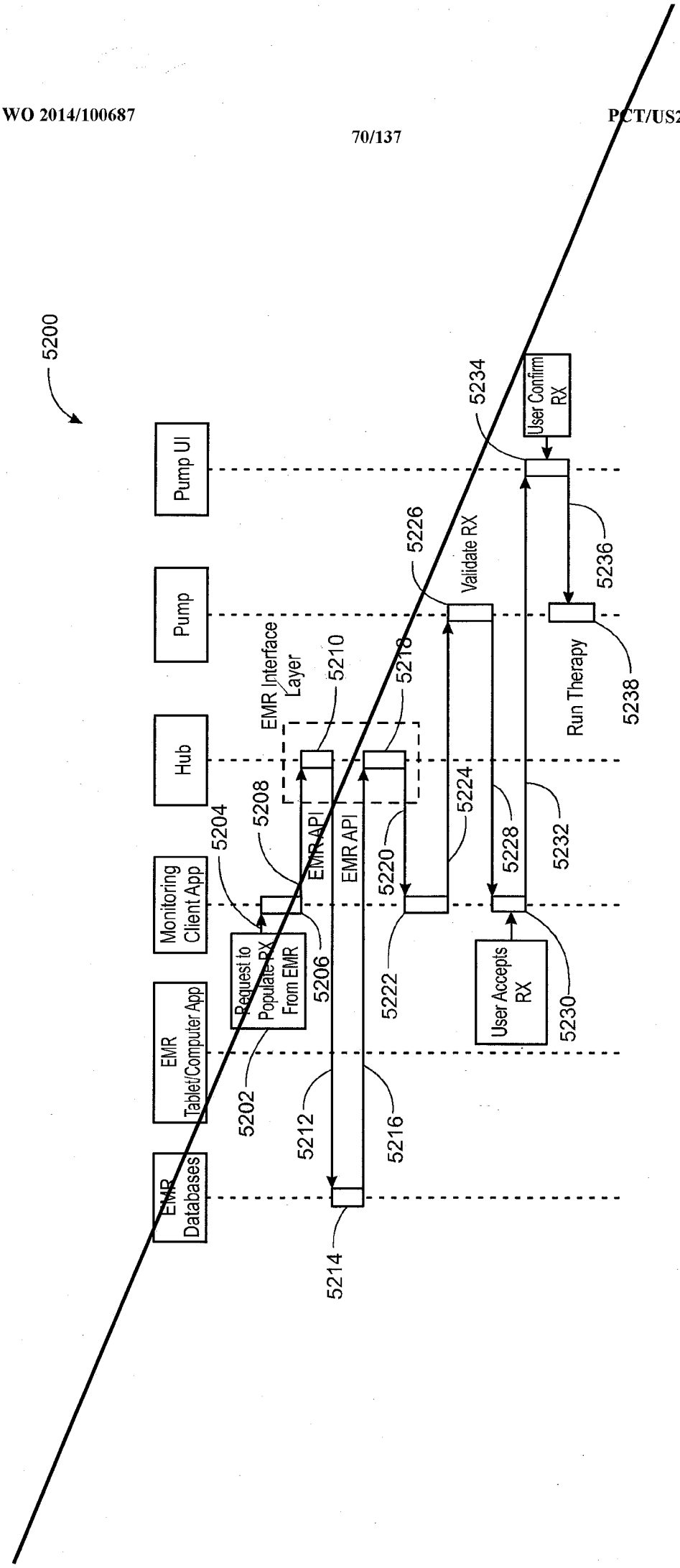

5200
Pump UI
Pump
Hub
Monitoring Client App
EMR Tablet/Computer App
EMR Databases
EMR Interface Layer
EMR API
EMR API
Request to Populate RX From EMR
Validate RX
User Accepts RX
User Confirm RX
Run Therapy
5202
5204
5206
5208
5210
5212
5214
5216
5218
5220
5222
5224
5226
5228
5230
5232
5234
5236
5238

FIG. 81

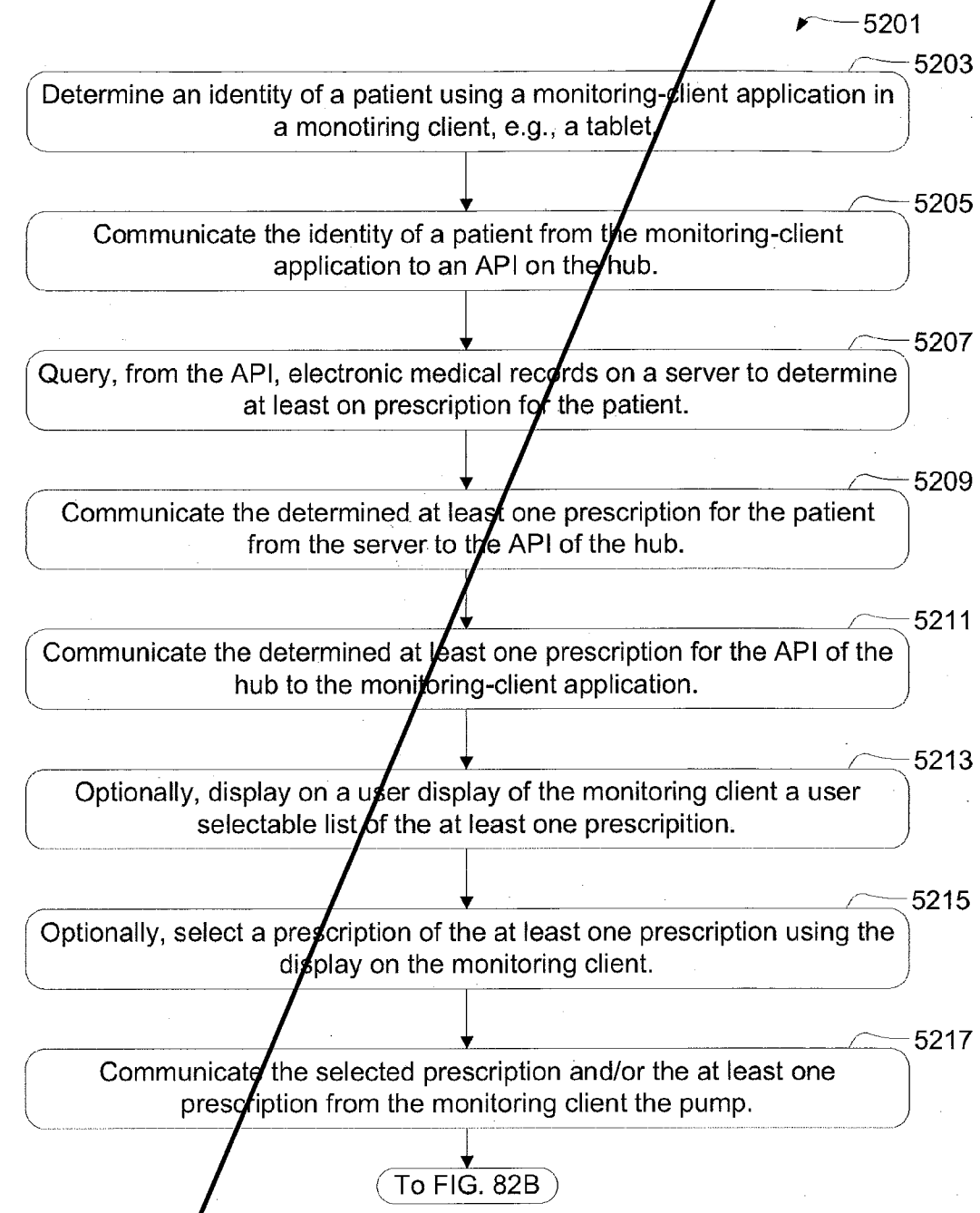

5201
5203
Determine an identity of a patient using a monitoring-client application in a monotiring client, e.g., a tablet.
5205
Communicate the identity of a patient from the monitoring-client application to an API on the hub.
5207
Query, from the API, electronic medical records on a server to determine at least on prescription for the patient.
5209
Communicate the determined at least one prescription for the patient from the server to the API of the hub.
5211
Communicate the determined at least one prescription for the API of the hub to the monitoring-client application.
5213
Optionally, display on a user display of the monitoring client a user selectable list of the at least one prescripition.
5215
Optionally, select a prescription of the at least one prescription using the display on the monitoring client.
5217
Communicate the selected prescription and/or the at least one prescription from the monitoring client the pump.
To FIG. 82B

FIG. 82A

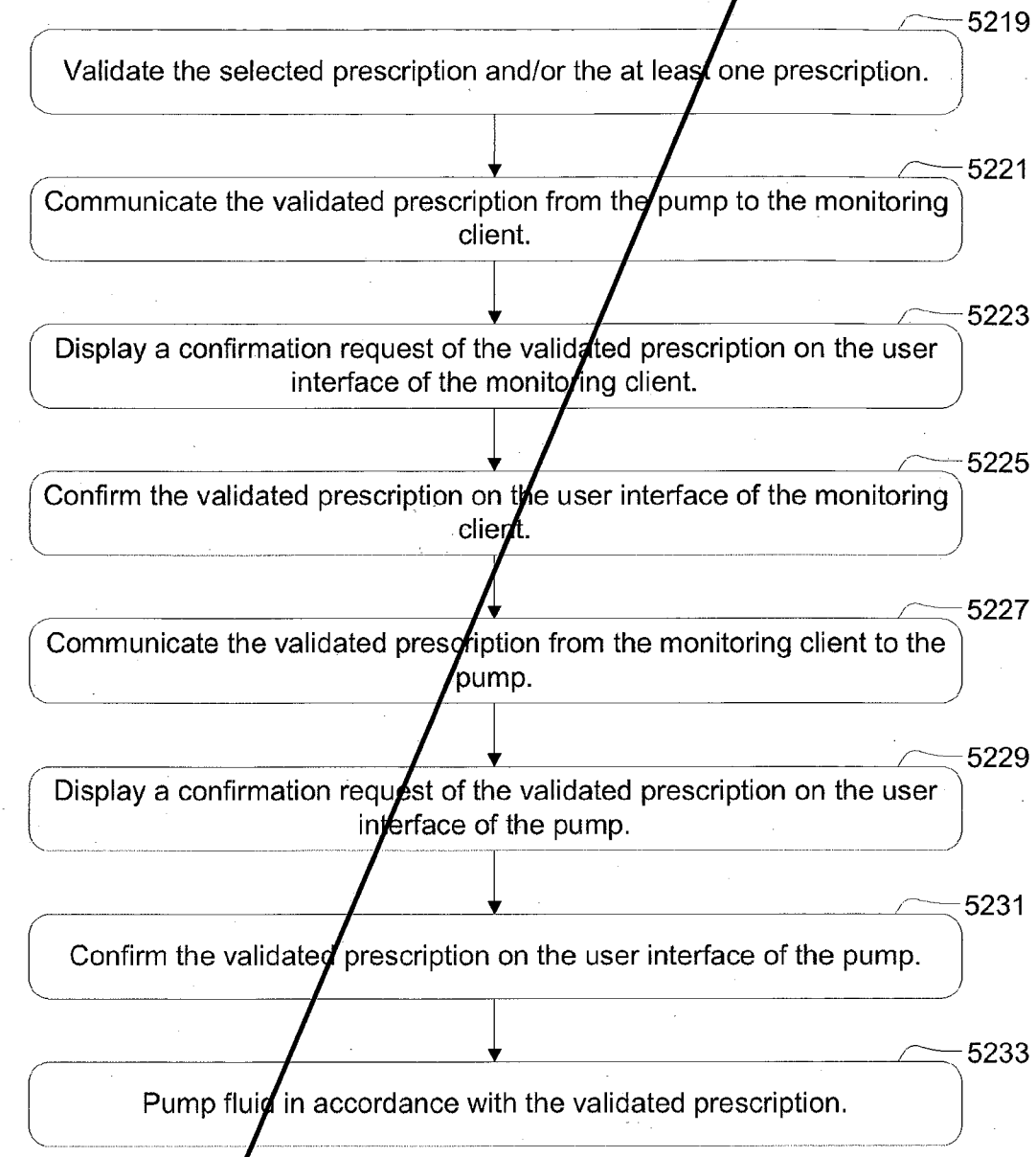

5219
Validate the selected prescription and/or the at least one prescription.
5221
Communicate the validated prescription from the pump to the monitoring client.
5223
Display a confirmation request of the validated prescription on the user interface of the monitoring client.
5225
Confirm the validated prescription on the user interface of the monitoring client.
5227
Communicate the validated prescription from the monitoring client to the pump.
5229
Display a confirmation request of the validated prescription on the user interface of the pump.
5231
Confirm the validated prescription on the user interface of the pump.
5233
Pump fluid in accordance with the validated prescription.

FIG. 82B

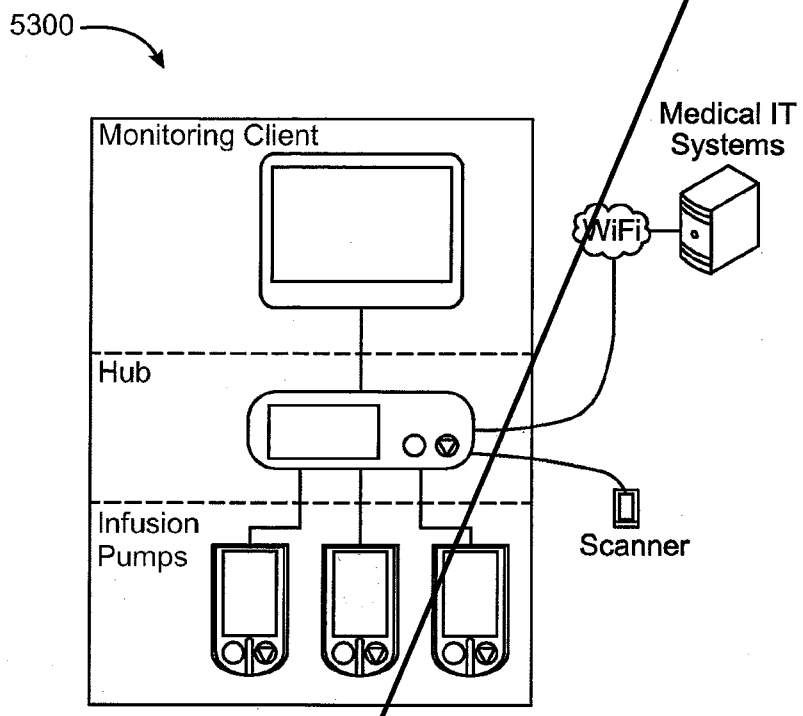

5300
Monitoring Client
Hub
Infusion Pumps
Medical IT Systems
WiFi
Scanner

FIG. 83

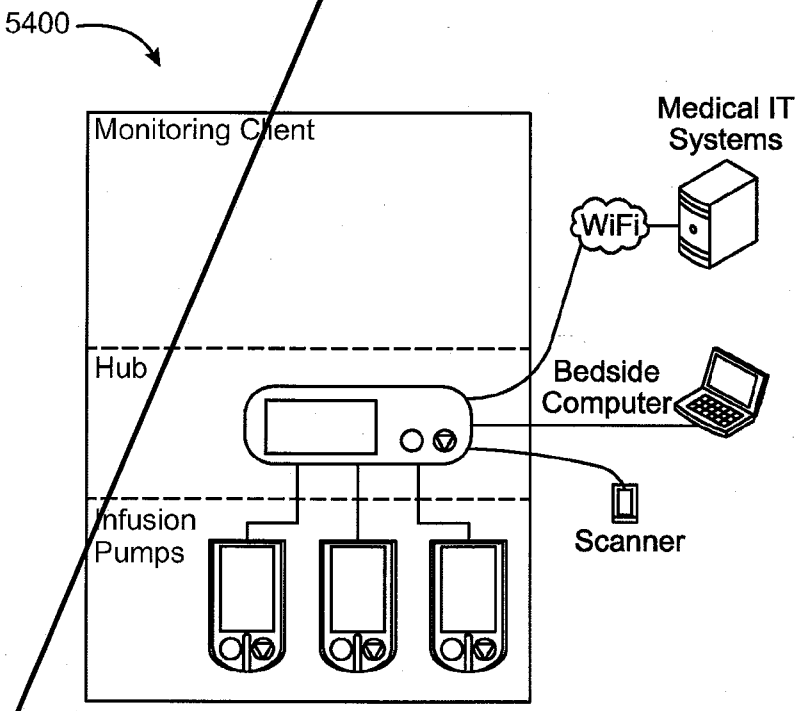

5400
Monitoring Client
Hub
Infusion Pumps
Medical IT Systems
WiFi
Bedside Computer
Scanner

FIG. 84

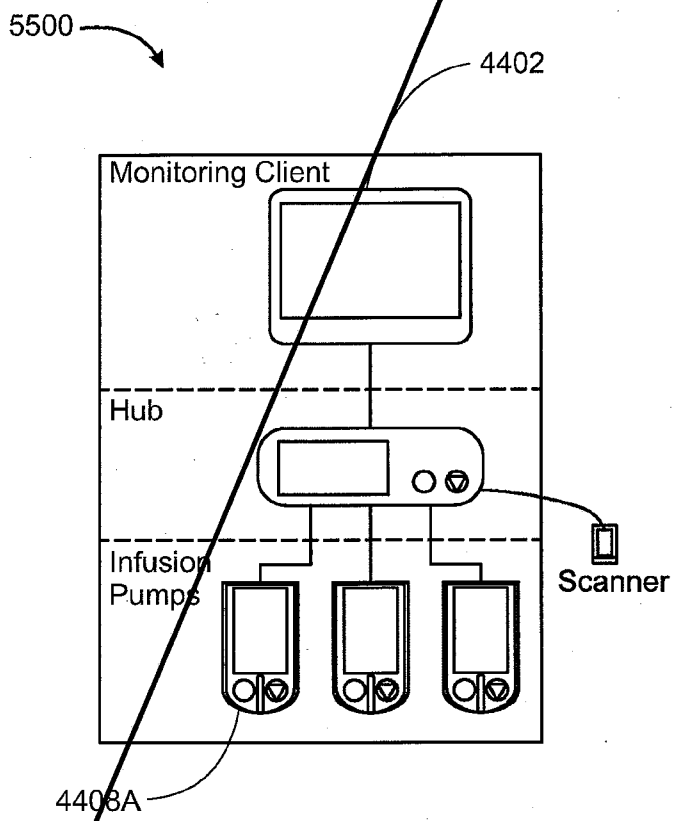

5500
4402
Monitoring Client
Hub
Infusion Pumps
Scanner
4408A

FIG. 85

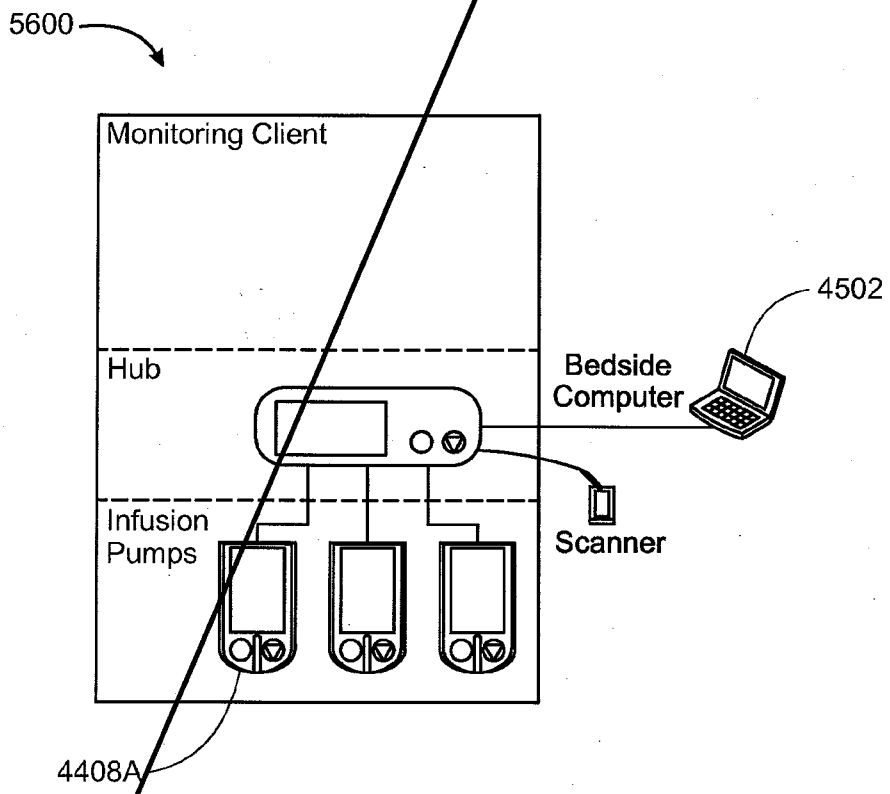

5600
Monitoring Client
Hub
Infusion Pumps
4408A
4502
Bedside Computer
Scanner

FIG. 86

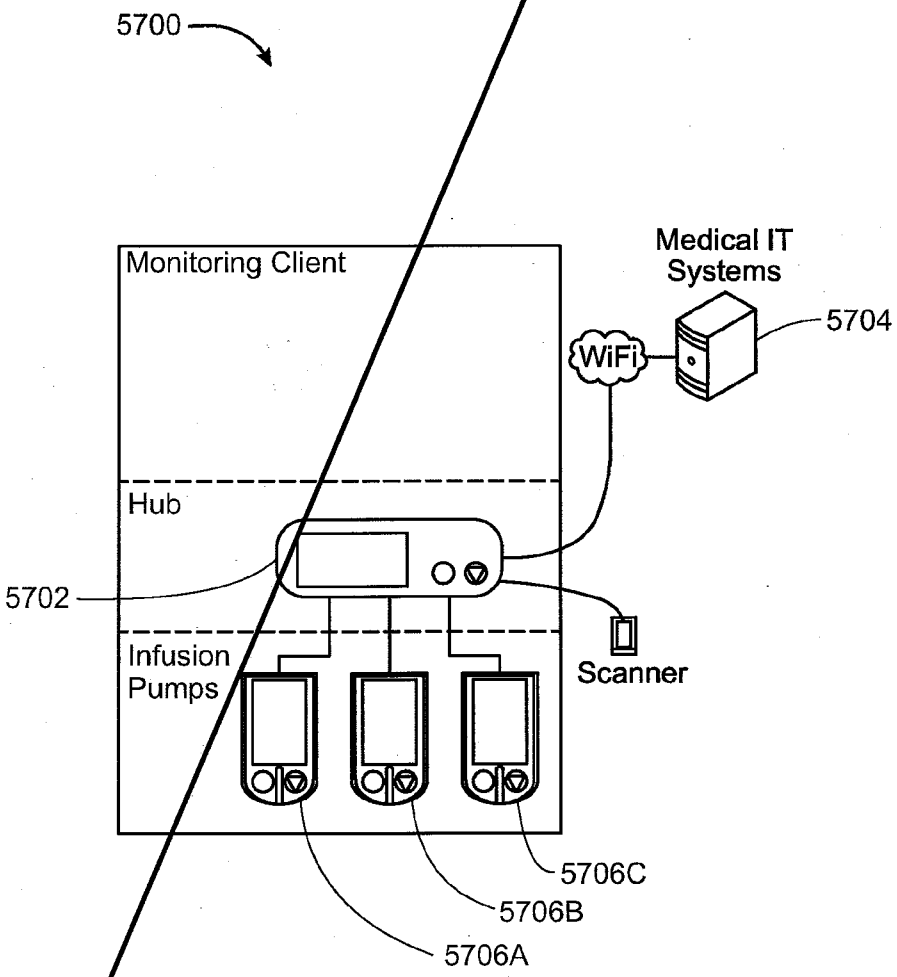

5700
Monitoring Client
Medical IT Systems
5704
WiFi
Hub
5702
Infusion Pumps
Scanner
5706C
5706B
5706A

FIG. 87

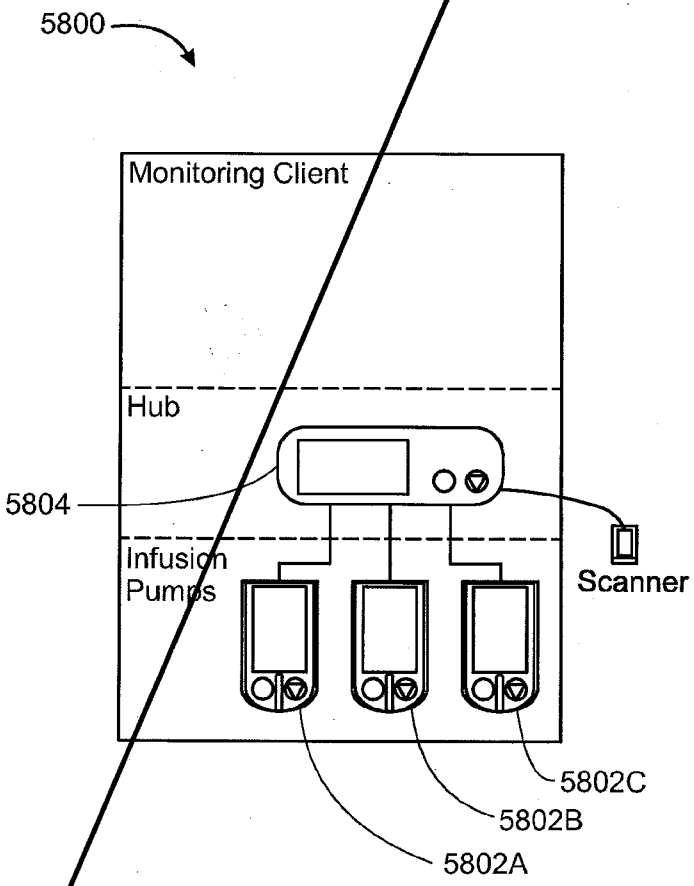

5800
Monitoring Client
Hub
5804
Infusion Pumps
Scanner
5802C
5802B
5802A

FIG. 88

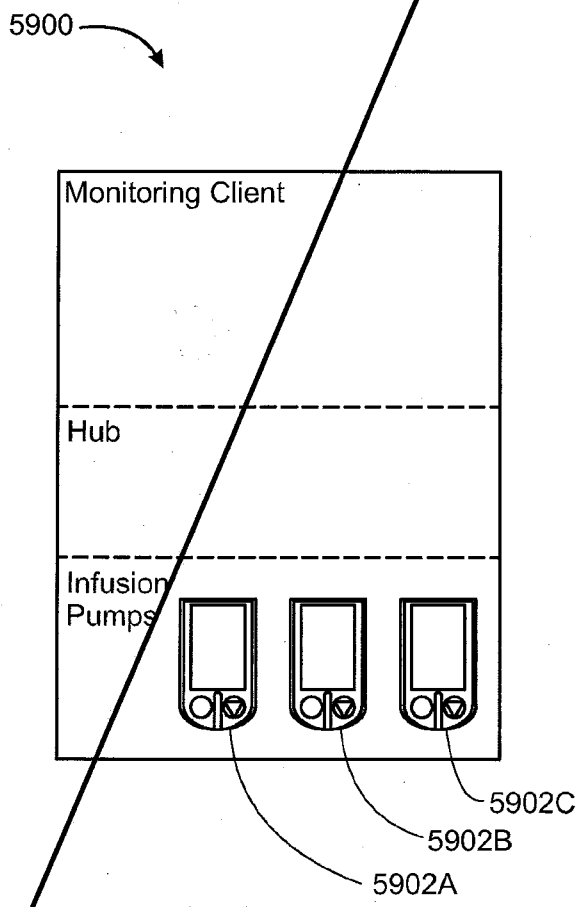
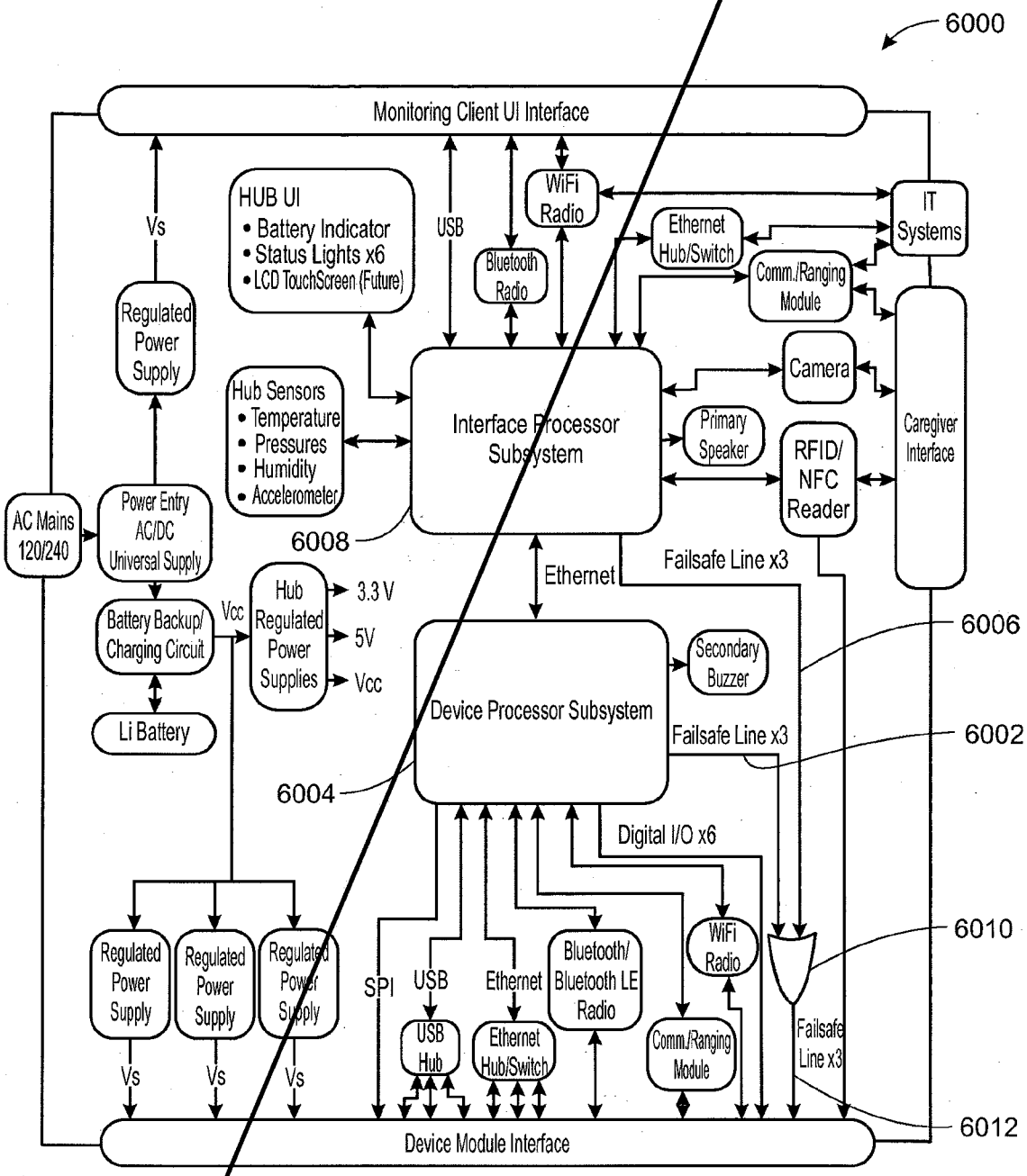

5900
Monitoring Client
Hub
Infusion Pumps
5902C
5902B
5902A

FIG. 89



Note 1: The supply voltage (Vs) to the Devices could be programmed or a constant

FIG. 90

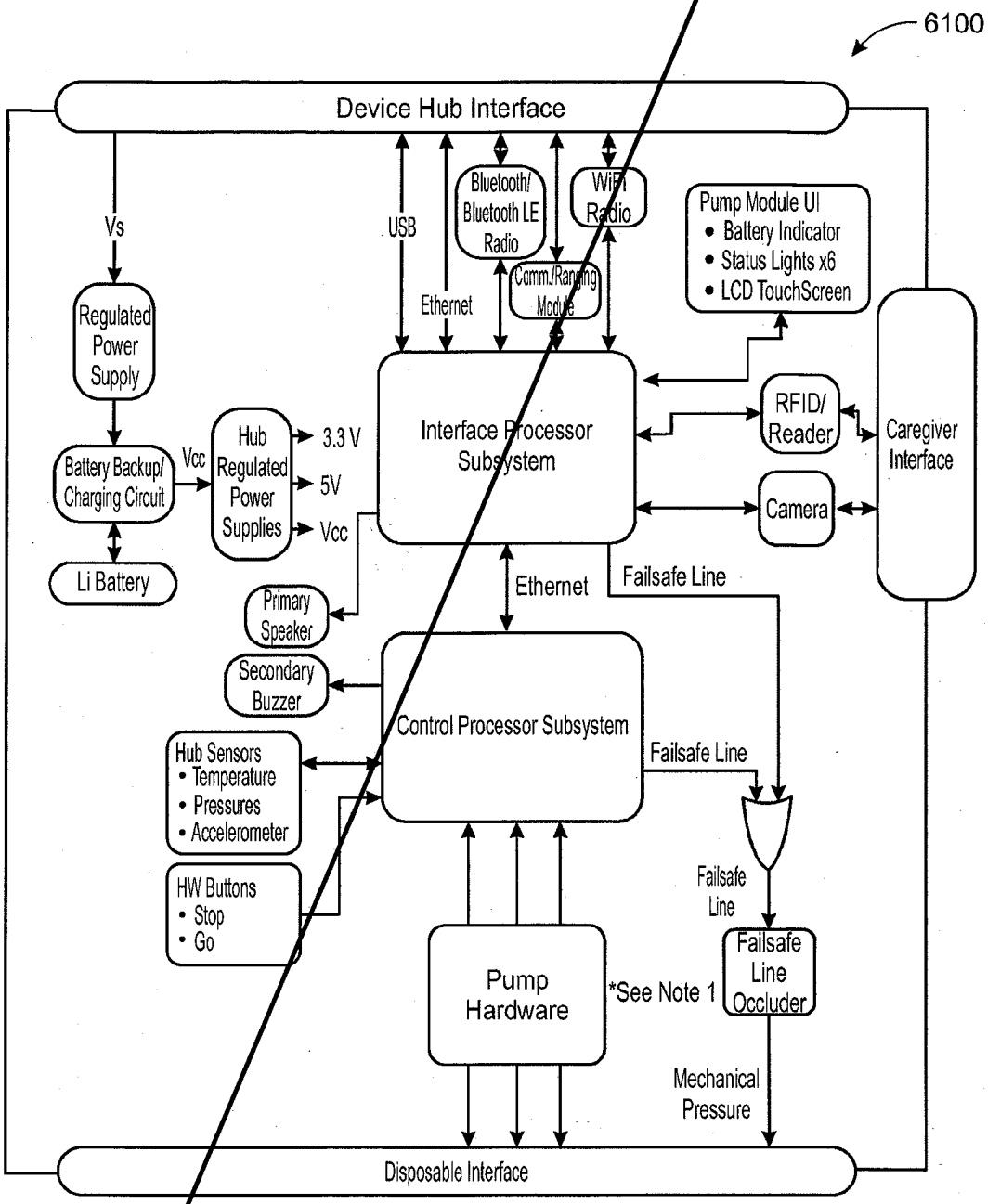

6100
Device Hub Interface
Vs
USB
Bluetooth/ Bluetooth LE Radio
WiFi Radio
Ethernet
Comm/Ranging Module
Pump Module UI
• Battery Indicator
• Status Lights x6
• LCD TouchScreen
Regulated Power Supply
Interface Processor Subsystem
RFID/ Reader
Caregiver Interface
Battery Backup/ Charging Circuit
Vcc
Hub Regulated Power Supplies
3.3 V
5V
Vcc
Camera
Li Battery
Primary Speaker
Ethernet
Failsafe Line
Secondary Buzzer
Control Processor Subsystem
Hub Sensors
• Temperature
• Pressures
• Accelerometer
Failsafe Line
HW Buttons
• Stop
• Go
Failsafe Line
Pump Hardware
*See Note 1
Failsafe Line Occluder
Mechanical Pressure
Disposable Interface

FIG. 91

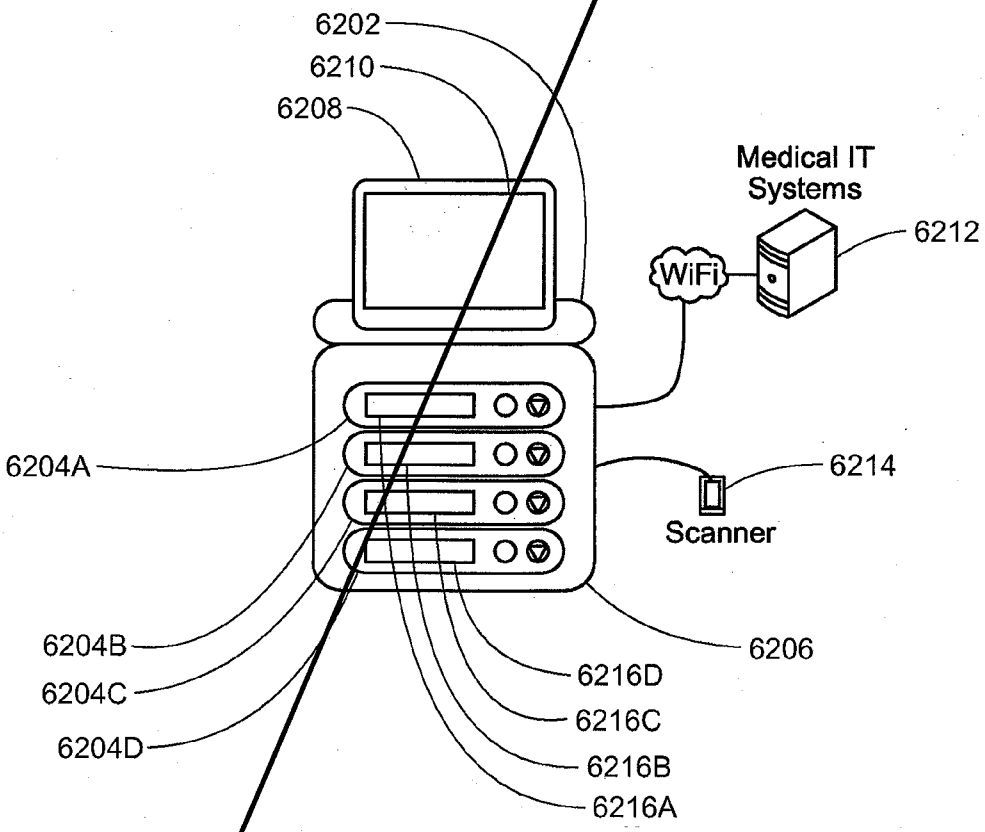

6202
6210
6208
Medical IT Systems
6212
WiFi
6204A
6214
Scanner
6204B
6206
6204C
6216D
6216C
6204D
6216B
6216A

FIG. 92

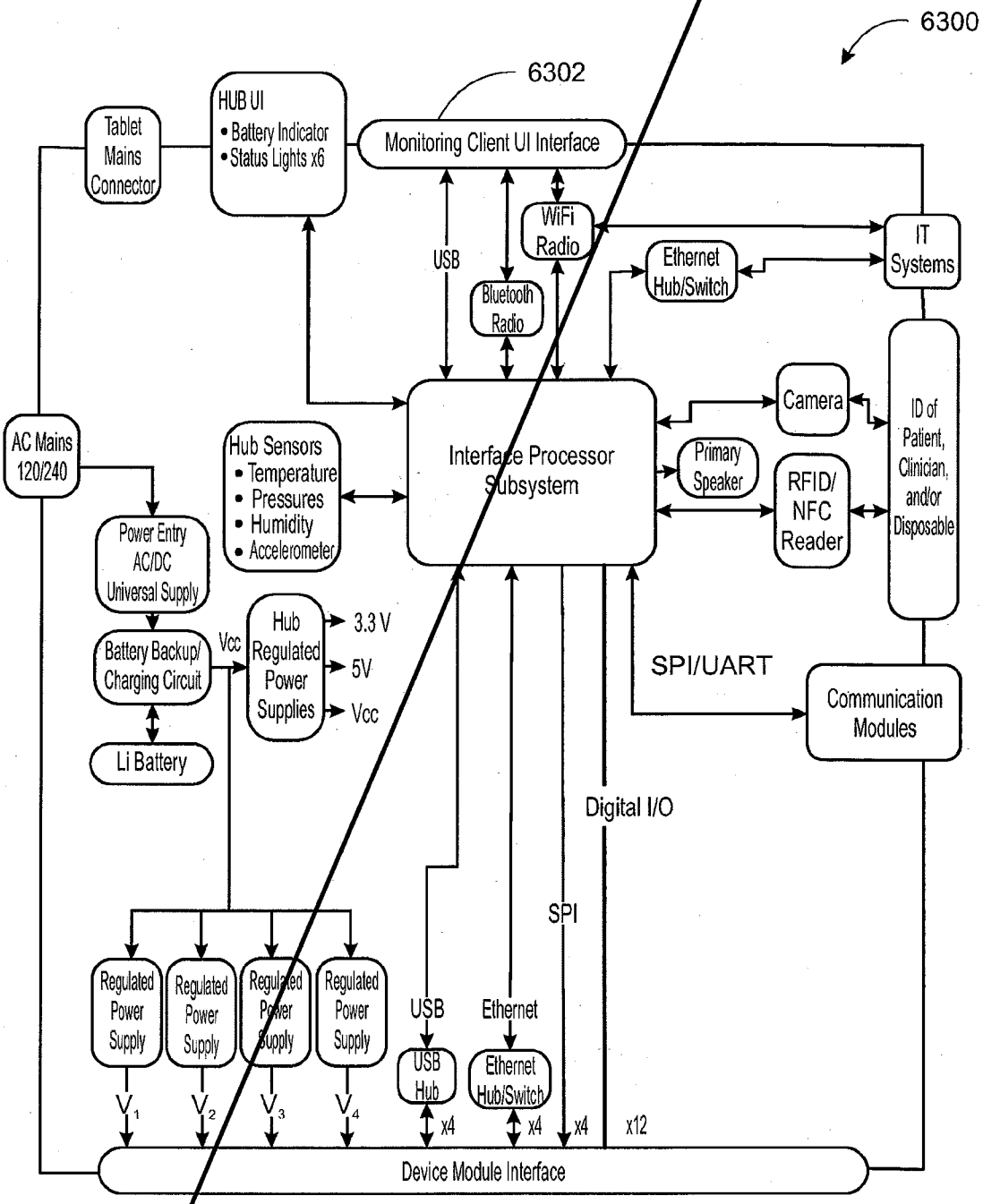

6300
6302
HUB UI
• Battery Indicator
• Status Lights x6
Tablet Mains Connector
Monitoring Client UI Interface
WiFi Radio
IT Systems
USB
Bluetooth Radio
Ethernet Hub/Switch
Camera
ID of Patient, Clinician, and/or Disposable
AC Mains 120/240
Hub Sensors
• Temperature
• Pressures
• Humidity
• Accelerometer
Interface Processor Subsystem
Primary Speaker
RFID/ NFC Reader
Power Entry AC/DC Universal Supply
Battery Backup/ Charging Circuit
Vcc
Hub Regulated Power Supplies
3.3 V
5V
Vcc
Li Battery
SPI/UART
Communication Modules
Digital I/O
SPI
Regulated Power Supply
Regulated Power Supply
Regulated Power Supply
Regulated Power Supply
USB
Ethernet
USB Hub
Ethernet Hub/Switch
V1
V2
V3
V4
x4
x4
x4
x12
Device Module Interface

FIG. 93

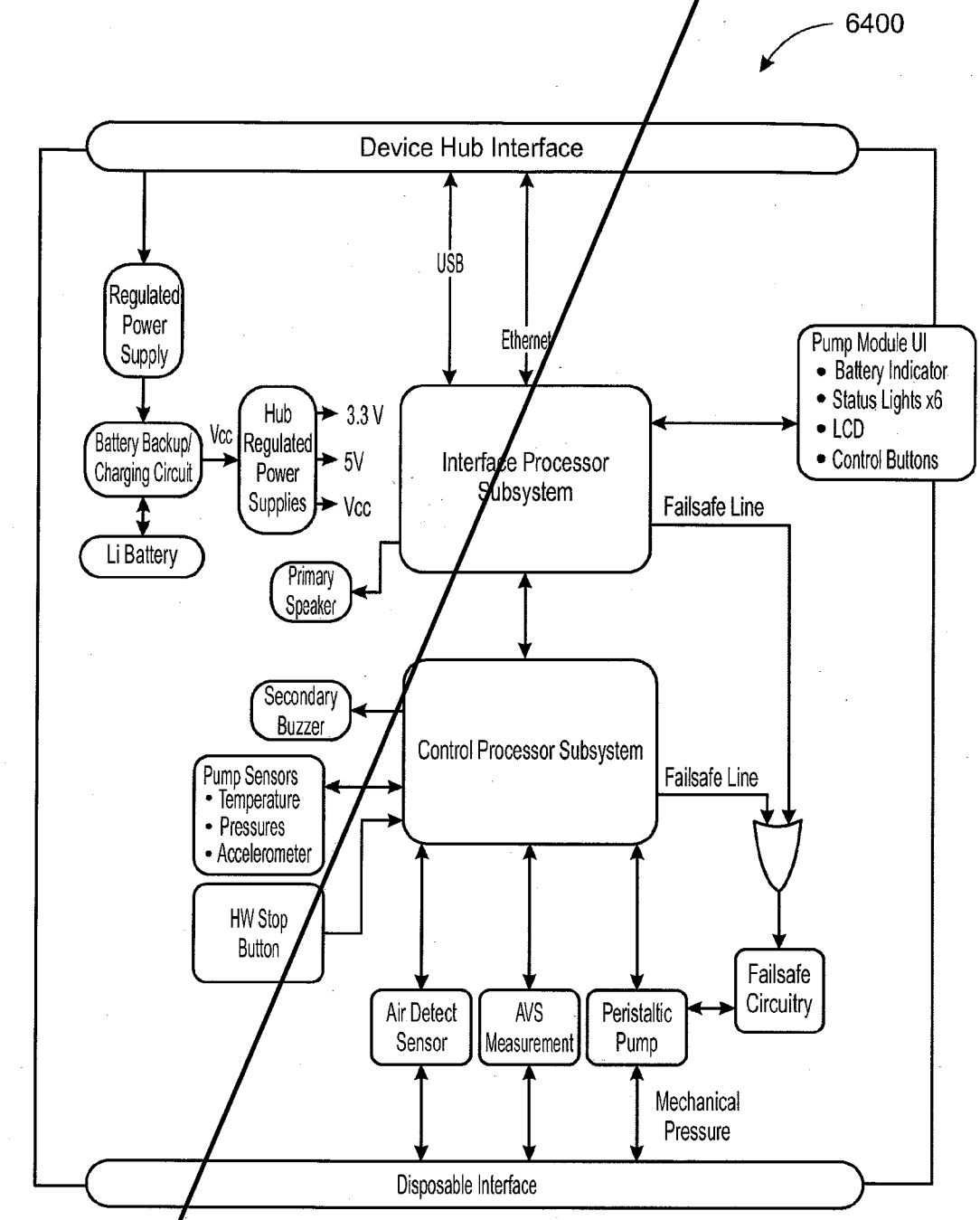

6400
Device Hub Interface
USB
Ethernet
Regulated Power Supply
Battery Backup/ Charging Circuit
Vcc
Hub Regulated Power Supplies
3.3 V
5V
Vcc
Li Battery
Primary Speaker
Interface Processor Subsystem
Pump Module UI
• Battery Indicator
• Status Lights x6
• LCD
• Control Buttons
Failsafe Line
Secondary Buzzer
Control Processor Subsystem
Failsafe Line
Pump Sensors
• Temperature
• Pressures
• Accelerometer
HW Stop Button
Failsafe Circuitry
Air Detect Sensor
AVS Measurement
Peristaltic Pump
Mechanical Pressure
Disposable Interface

FIG. 94

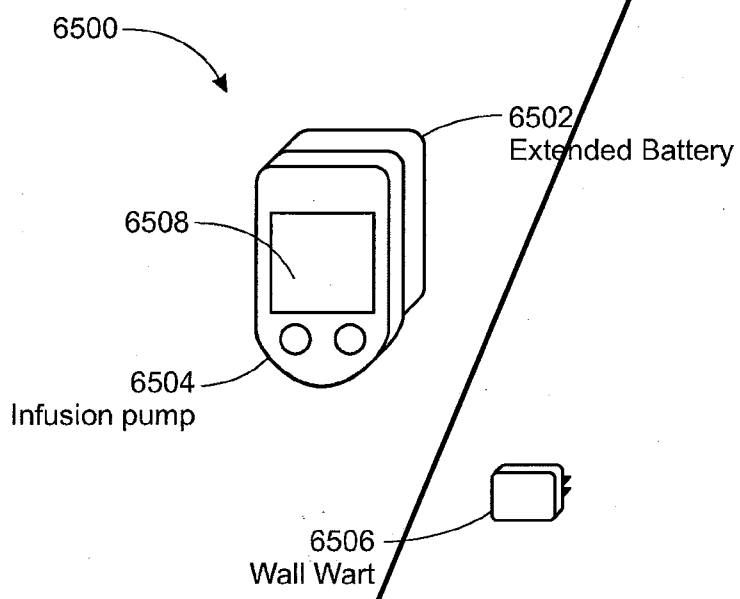

6500
6502
Extended Battery
6508
6504
Infusion pump
6506
Wall Wart

FIG. 95

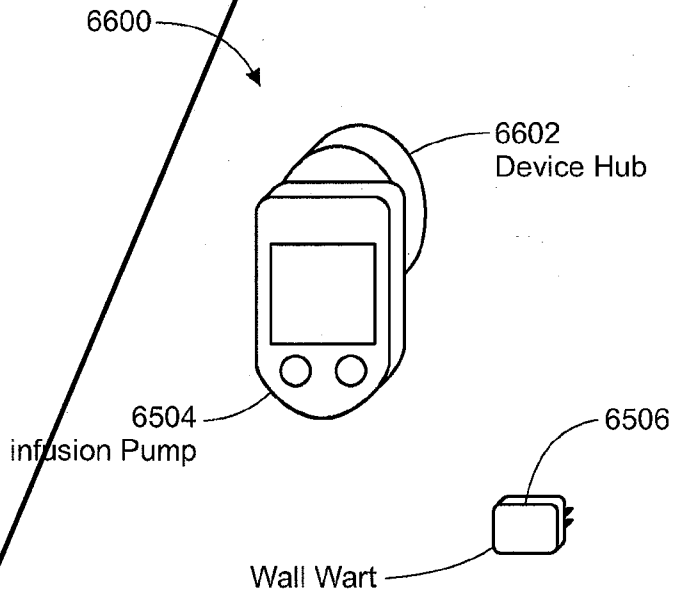

6600
6602
Device Hub
6504
infusion Pump
6506
Wall Wart

FIG. 96

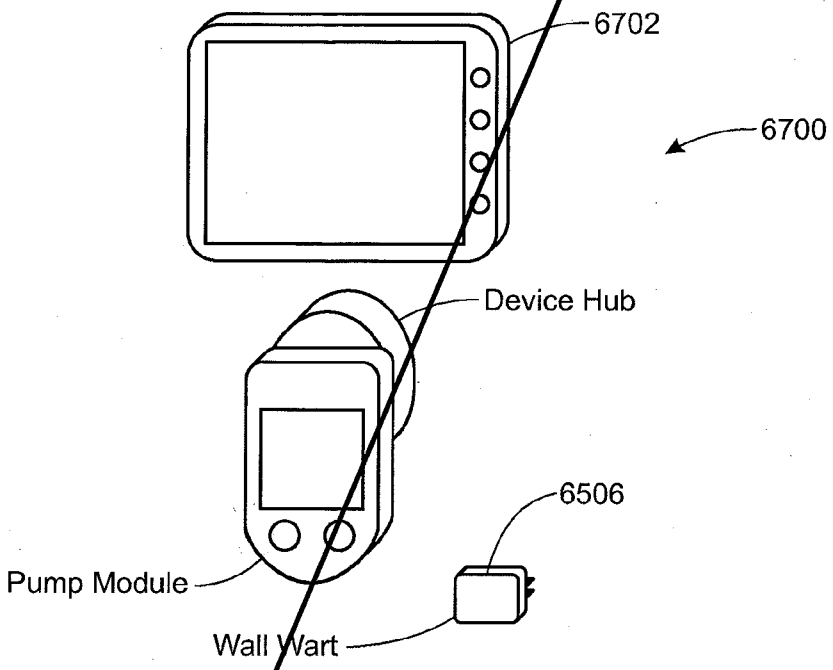

6702
6700
Device Hub
6506
Pump Module
Wall Wart

FIG. 97

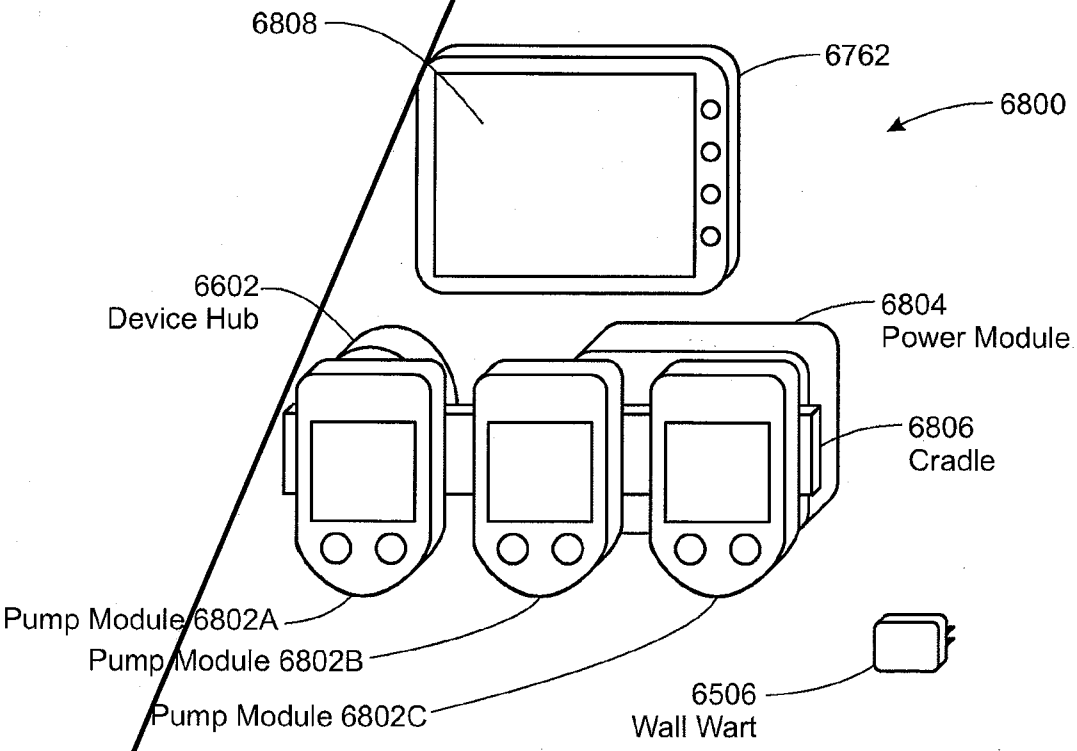

6808
6762
6800
6602
Device Hub
6804
Power Module
6806
Cradle
Pump Module 6802A
Pump Module 6802B
Pump Module 6802C
6506
Wall Wart

FIG. 98

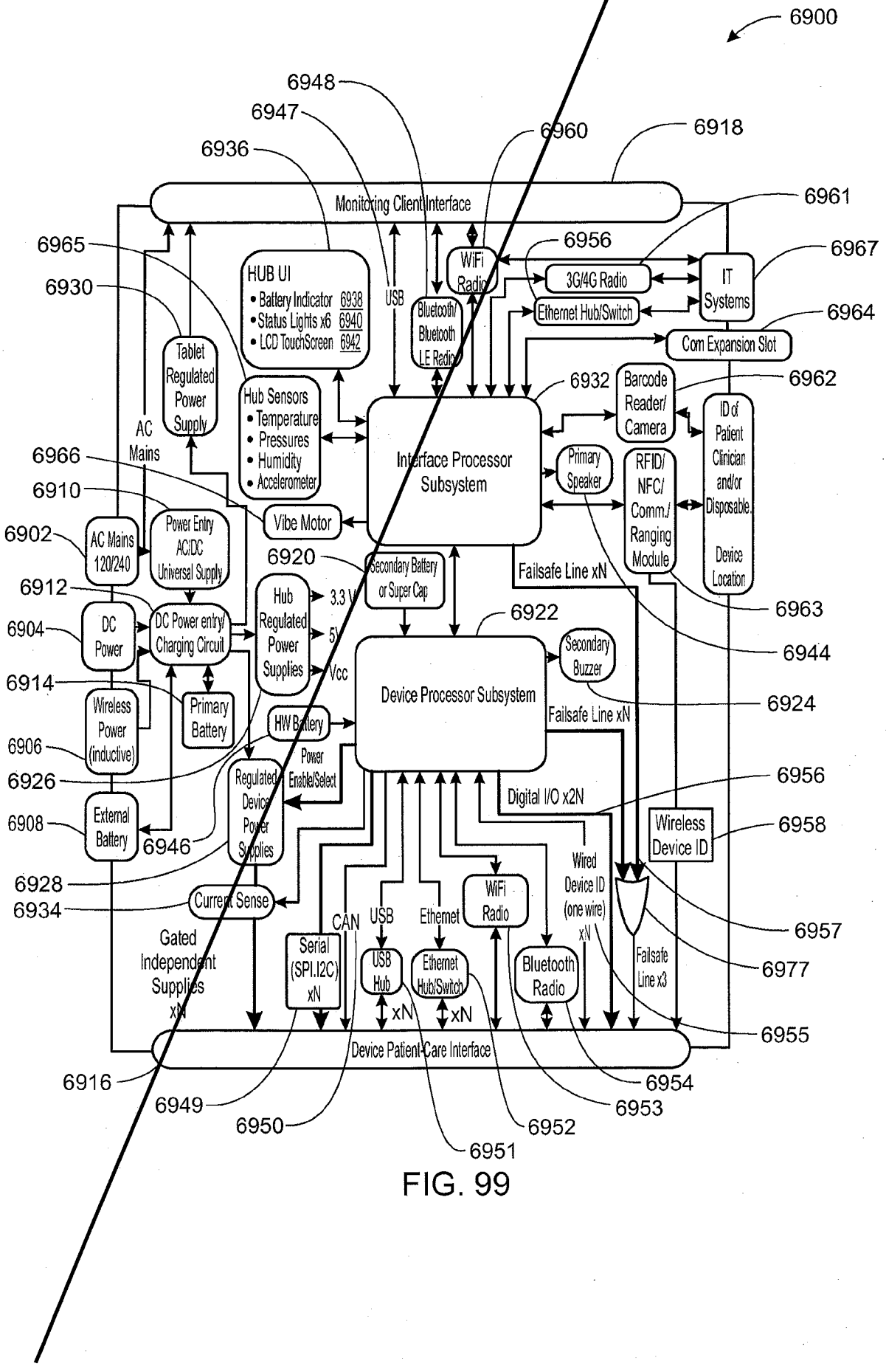

6900
6948
6947
6936
6960
6918
Monitoring Client Interface
6961
6965
6930
HUB UI
• Battery Indicator 6938
• Status Lights x6 6940
• LCD TouchScreen 6942
USB
WiFi Radio
6956
3G/4G Radio
Ethernet Hub/Switch
IT Systems
6967
6964
Com Expansion Slot
Bluetooth/ Bluetooth LE Radio
Tablet Regulated Power Supply
Hub Sensors
• Temperature
• Pressures
• Humidity
• Accelerometer
6932
Barcode Reader/ Camera
6962
AC Mains
Interface Processor Subsystem
Primary Speaker
RFID/ NFC/ Comm./ Ranging Module
ID of Patient Clinician and/or Disposable
Device Location
6966
6910
Vibe Motor
6902
AC Mains 120/240
Power Entry AC/DC Universal Supply
6920
Secondary Battery or Super Cap
Failsafe Line xN
6912
6922
6963
6904
DC Power
DC Power entry/ Charging Circuit
Hub Regulated Power Supplies
3.3 V
5V
Vcc
6944
6914
Wireless Power (inductive)
Primary Battery
Device Processor Subsystem
Secondary Buzzer
6924
HW Battery
Failsafe Line xN
6906
6926
Power Enable/Select
Regulated Device Power Supplies
6956
Digital I/O x2N
6908
External Battery
6946
Wireless Device ID
6958
6928
6934
Current Sense
CAN
USB
Ethernet
WiFi Radio
Wired Device ID (one wire)
xN
6957
Gated Independent Supplies xN
Serial (SPI,I2C) xN
USB Hub
Ethernet Hub/Switch
Bluetooth Radio
Failsafe Line x3
6977
xN
xN
6955
Device Patient-Care Interface
6916
6954
6949
6953
6950
6952
6951

FIG. 99

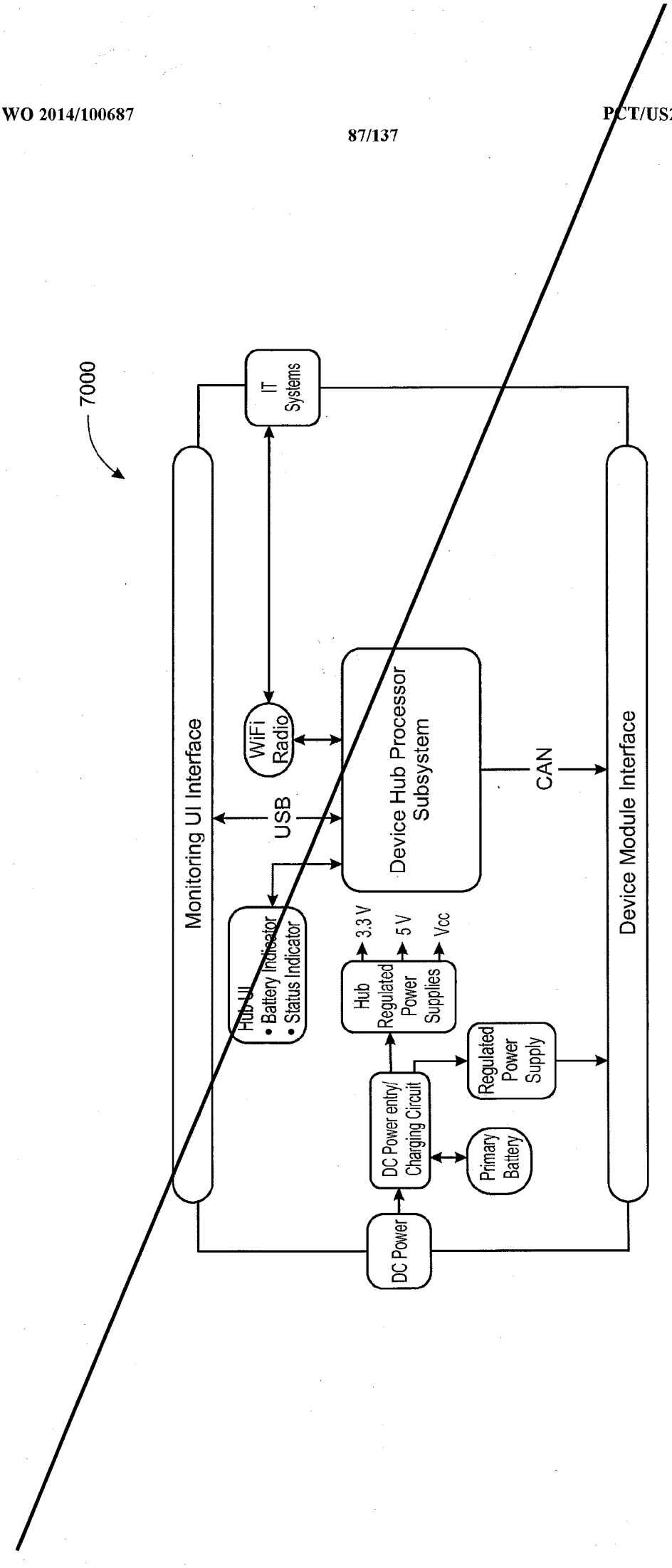

7000
IT Systems
Monitoring UI Interface
WiFi Radio
USB
Device Hub Processor Subsystem
CAN
Device Module Interface
Hub UI
• Battery Indicator
• Status Indicator
3.3 V
5 V
Vcc
Hub Regulated Power Supplies
Regulated Power Supply
DC Power entry/ Charging Circuit
Primary Battery
DC Power

FIG. 100

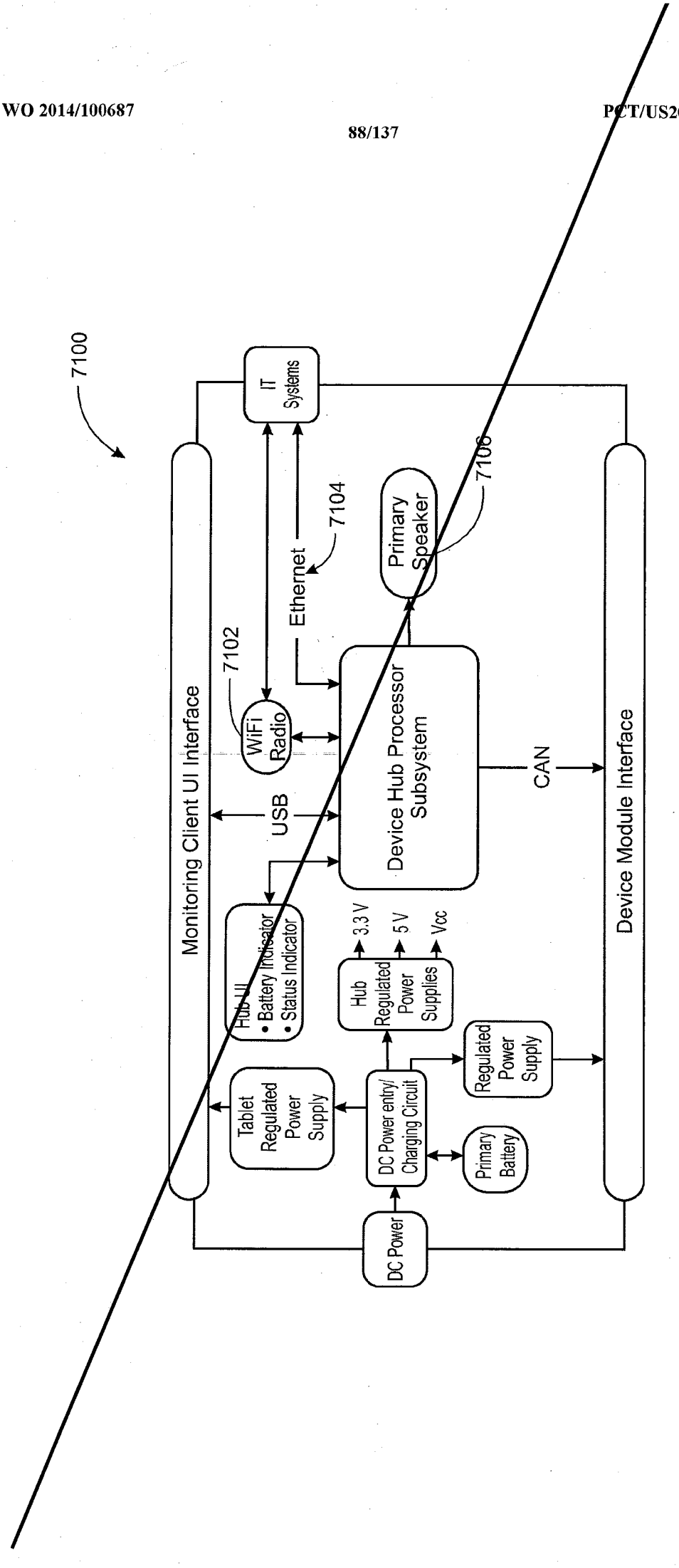

7100
IT Systems
7104
Ethernet
7106
Primary Speaker
7102
WiFi Radio
Monitoring Client UI Interface
USB
Device Hub Processor Subsystem
CAN
Device Module Interface
Hub UI
• Battery Indicator
• Status Indicator
3.3 V
5 V
Vcc
Hub Regulated Power Supplies
Regulated Power Supply
Tablet Regulated Power Supply
DC Power entry/ Charging Circuit
Primary Battery
DC Power

FIG. 101

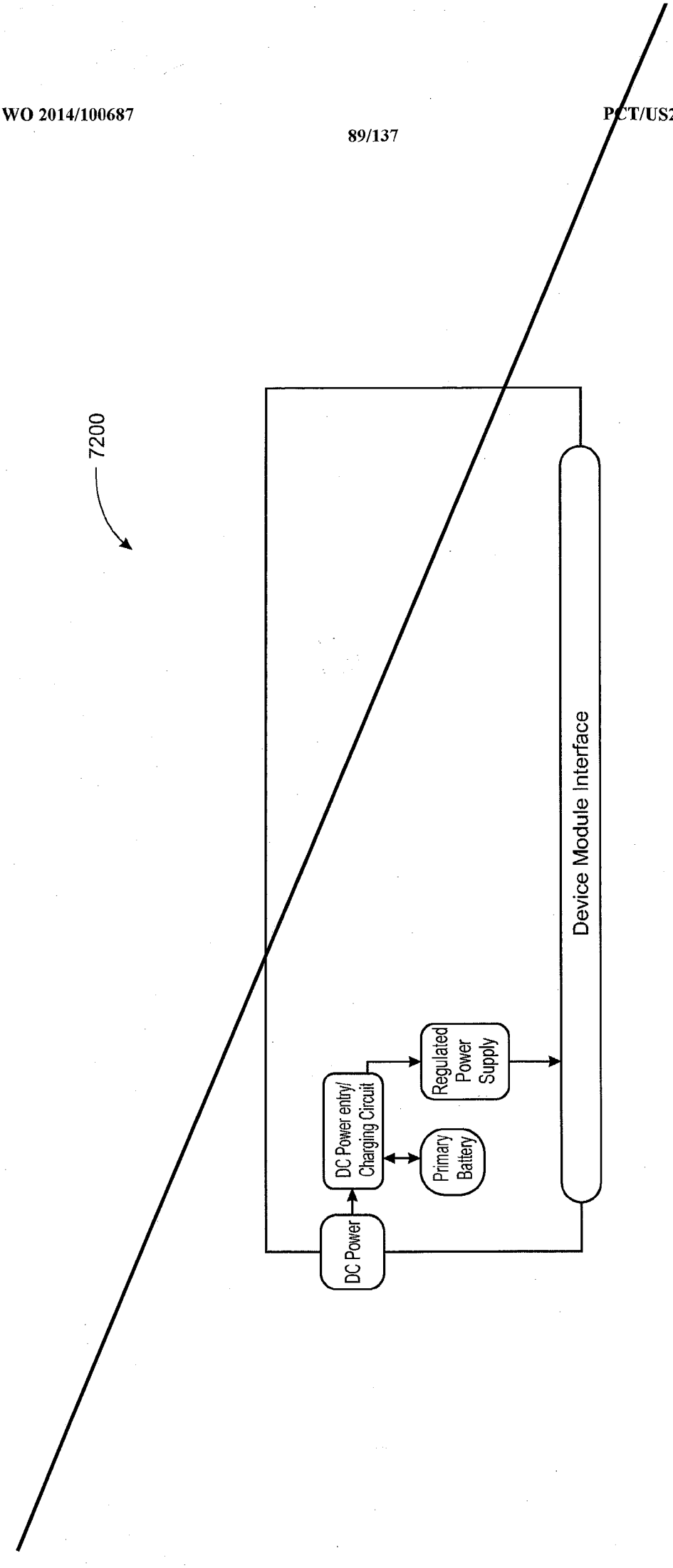

7200
Device Module Interface
DC Power
DC Power entry/ Charging Circuit
Primary Battery
Regulated Power Supply

FIG. 102

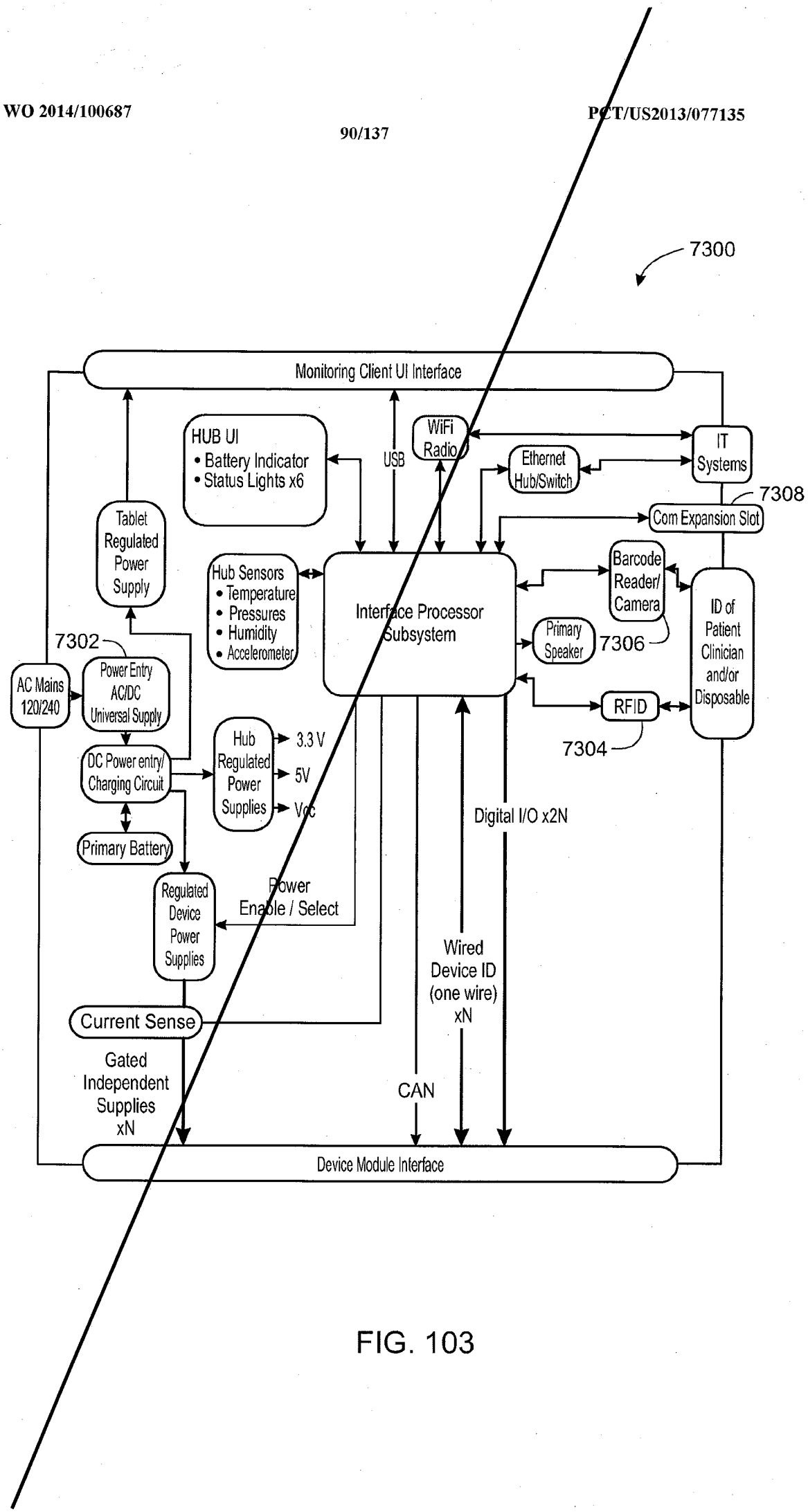

7300
Monitoring Client UI Interface
HUB UI
• Battery Indicator
• Status Lights x6
USB
WiFi Radio
Ethernet Hub/Switch
IT Systems
7308
Com Expansion Slot
Tablet Regulated Power Supply
Hub Sensors
• Temperature
• Pressures
• Humidity
• Accelerometer
Interface Processor Subsystem
Barcode Reader/ Camera
Primary Speaker
7306
ID of Patient Clinician and/or Disposable
7302
AC Mains 120/240
Power Entry AC/DC Universal Supply
RFID
7304
Hub Regulated Power Supplies
3.3 V
5V
Vcc
DC Power entry/ Charging Circuit
Primary Battery
Digital I/O x2N
Regulated Device Power Supplies
Power Enable / Select
Wired Device ID (one wire) xN
Current Sense
Gated Independent Supplies xN
CAN
Device Module Interface

FIG. 103

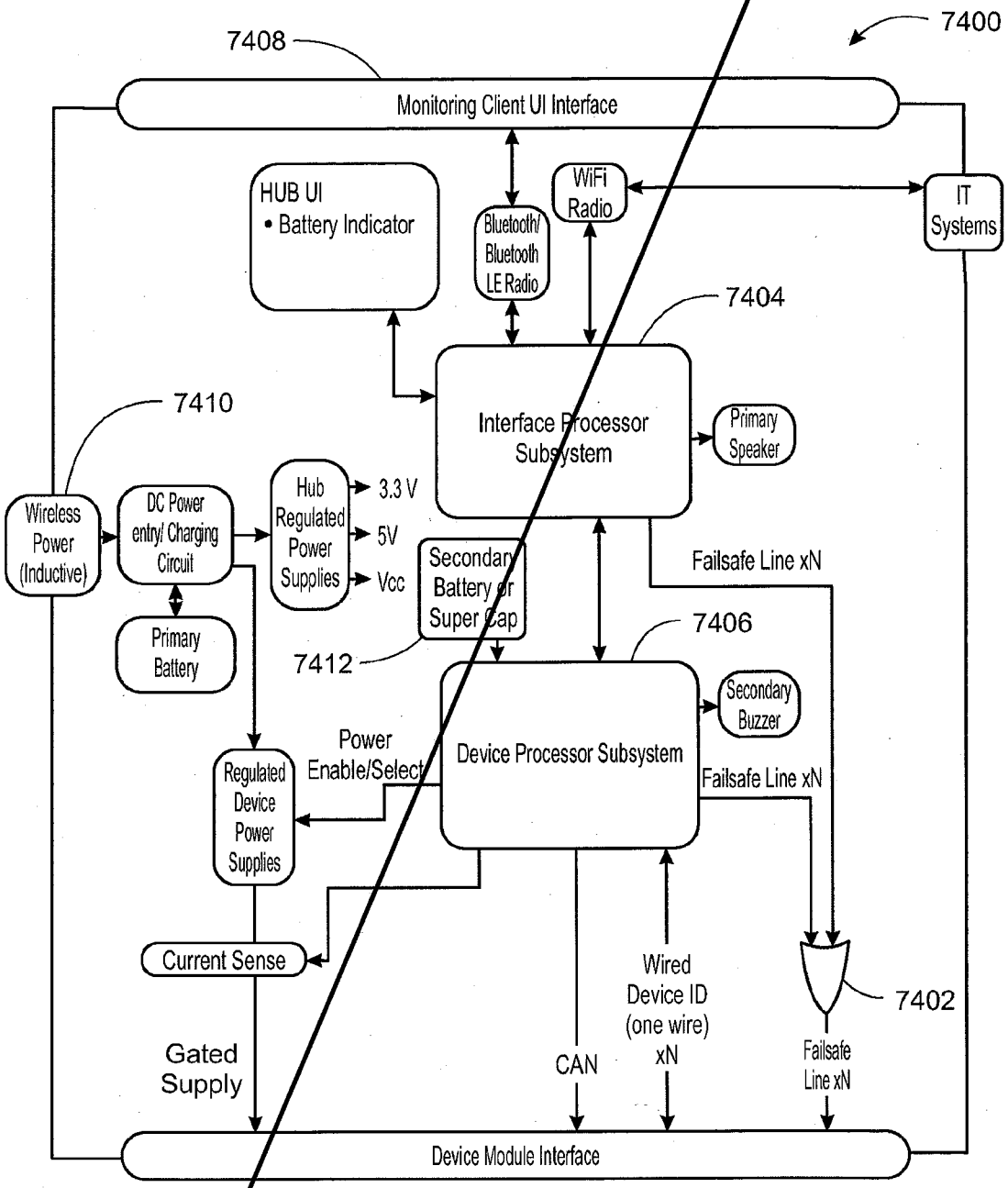

7400
7408
Monitoring Client UI Interface
HUB UI
• Battery Indicator
Bluetooth/
Bluetooth
LE Radio
WiFi
Radio
IT
Systems
7404
Interface Processor
Subsystem
Primary
Speaker
7410
Wireless
Power
(Inductive)
DC Power
entry/ Charging
Circuit
Hub
Regulated
Power
Supplies
3.3 V
5V
Vcc
Primary
Battery
Secondary
Battery or
Super Cap
7412
Failsafe Line xN
7406
Secondary
Buzzer
Device Processor Subsystem
Power
Enable/Select
Regulated
Device
Power
Supplies
Failsafe Line xN
Current Sense
Wired
Device ID
(one wire)
xN
7402
Gated
Supply
CAN
Failsafe
Line xN
Device Module Interface

FIG. 104

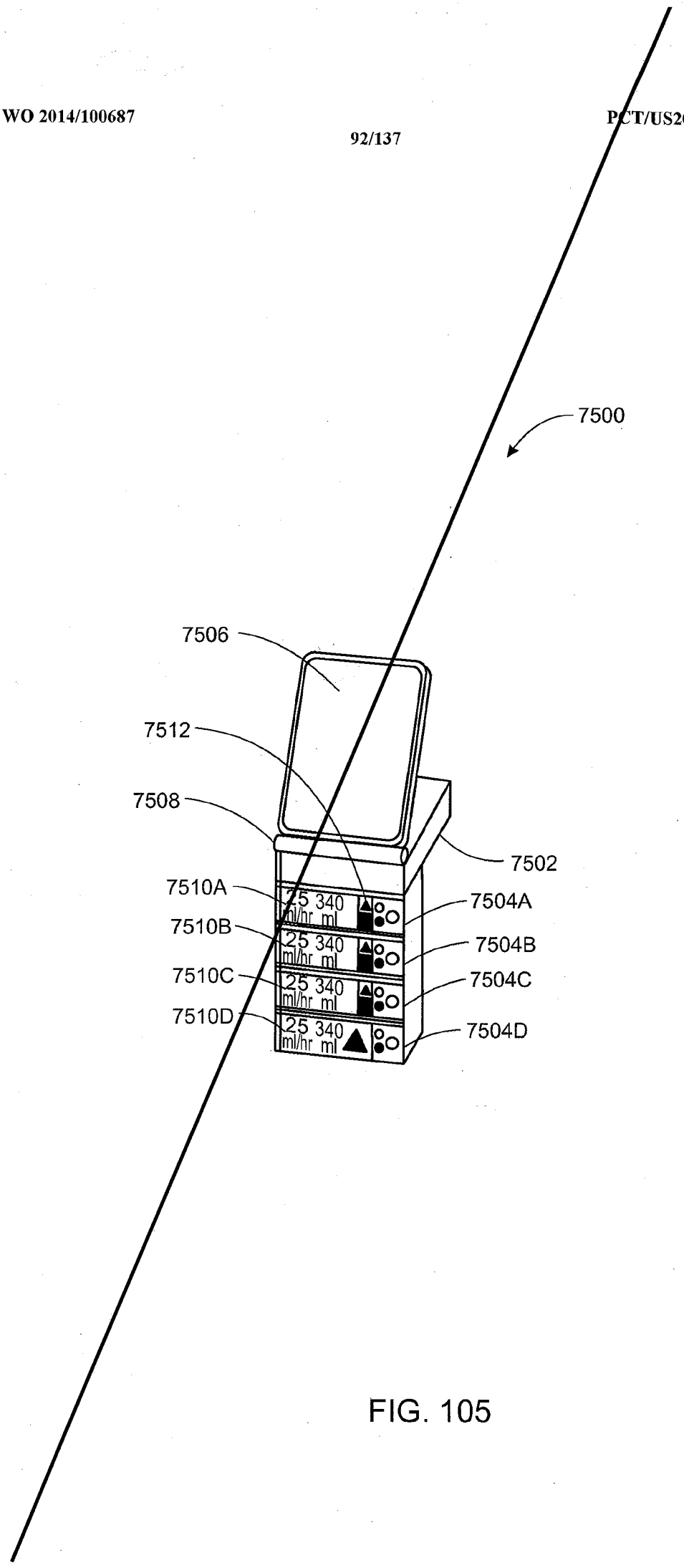

7500
7506
7512
7508
7502
7510A
7504A
7510B
7504B
7510C
7504C
7510D
7504D
25 340
ml/hr ml

FIG. 105

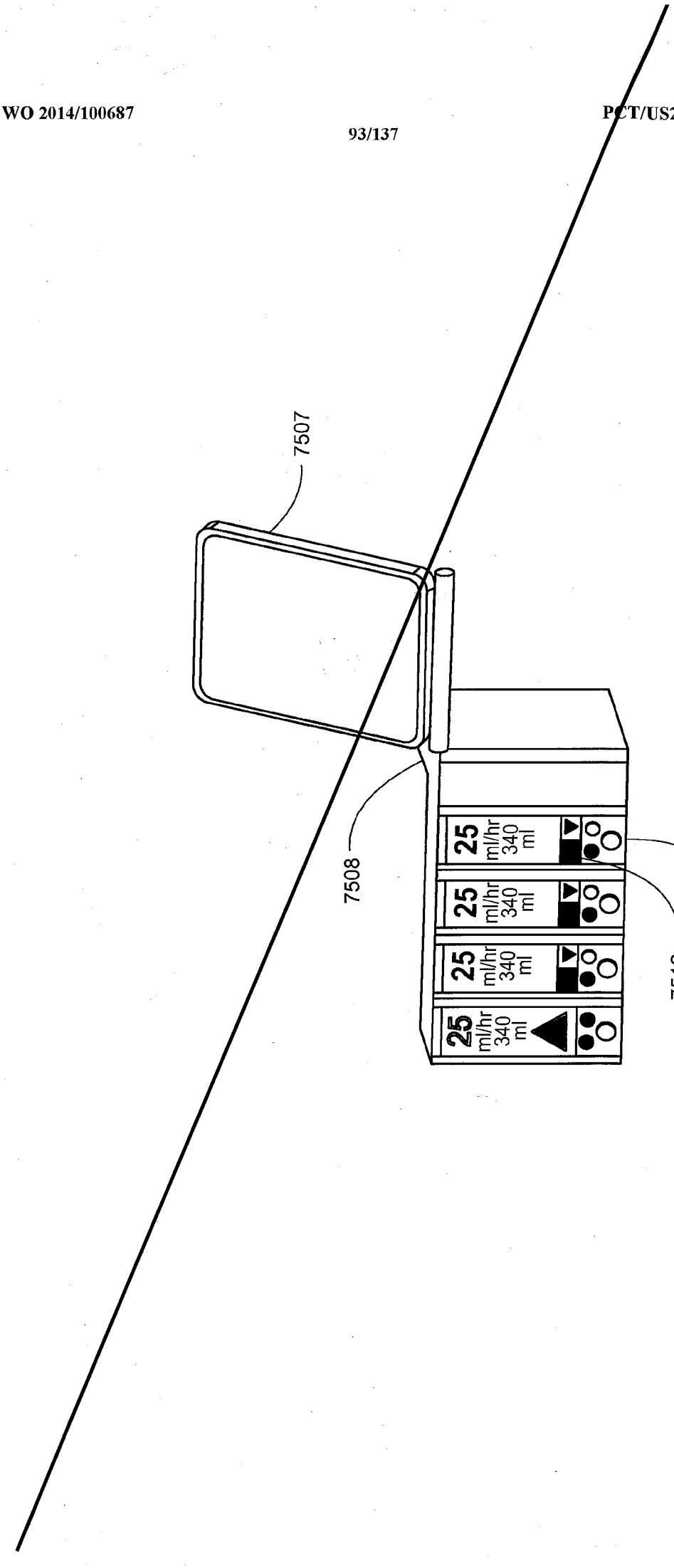

7507
7508
25 ml/hr 340 ml
25 ml/hr 340 ml
25 ml/hr 340 ml
25 ml/hr 340 ml
7512
7504A

FIG. 106

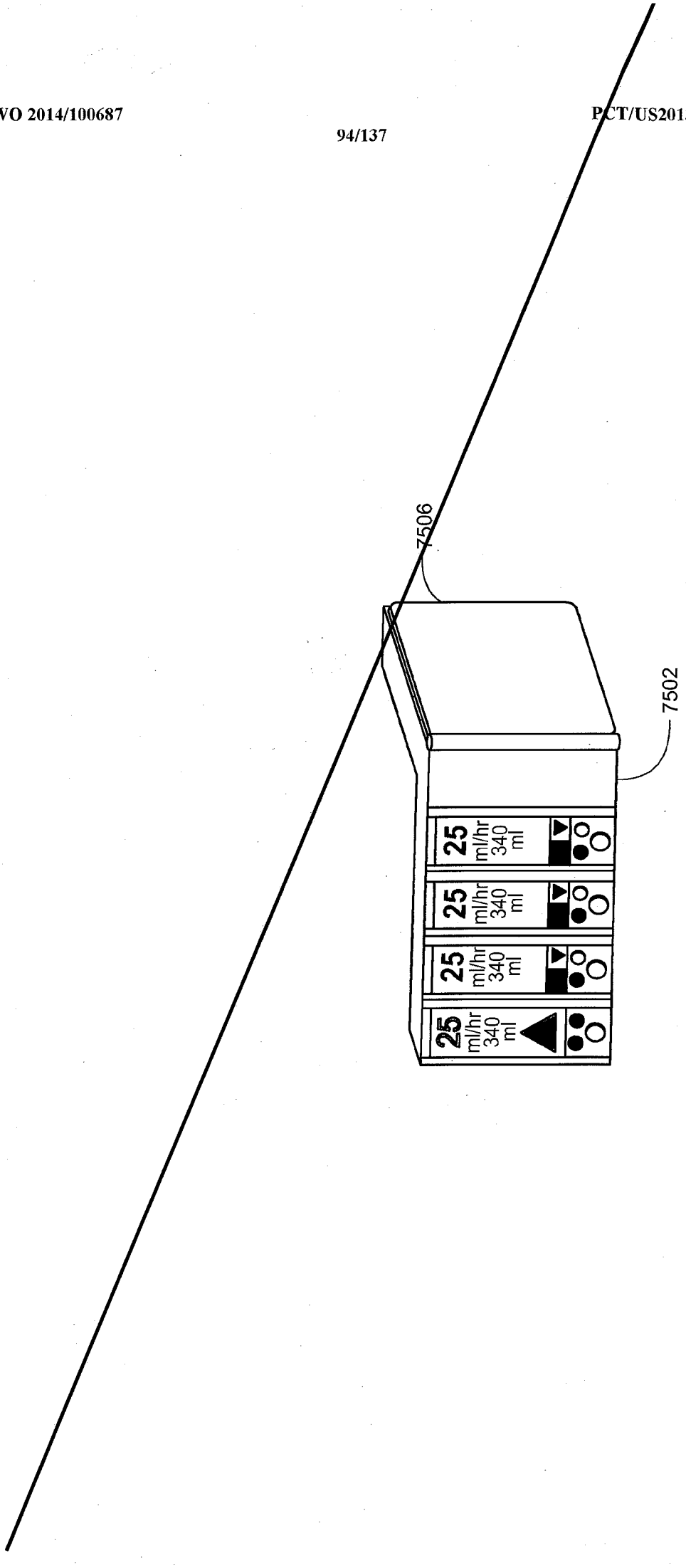

7506
7502
25 ml/hr 340 ml
25 ml/hr 340 ml
25 ml/hr 340 ml
25 ml/hr 340 ml

FIG. 107

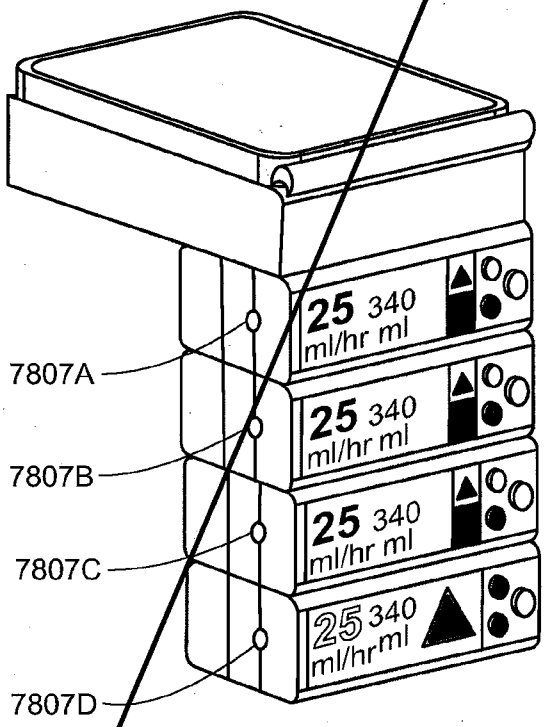

25 340
ml/hr ml
25 340
ml/hr ml
25 340
ml/hr ml
25 340
ml/hr ml
7807A
7807B
7807C
7807D

FIG. 108

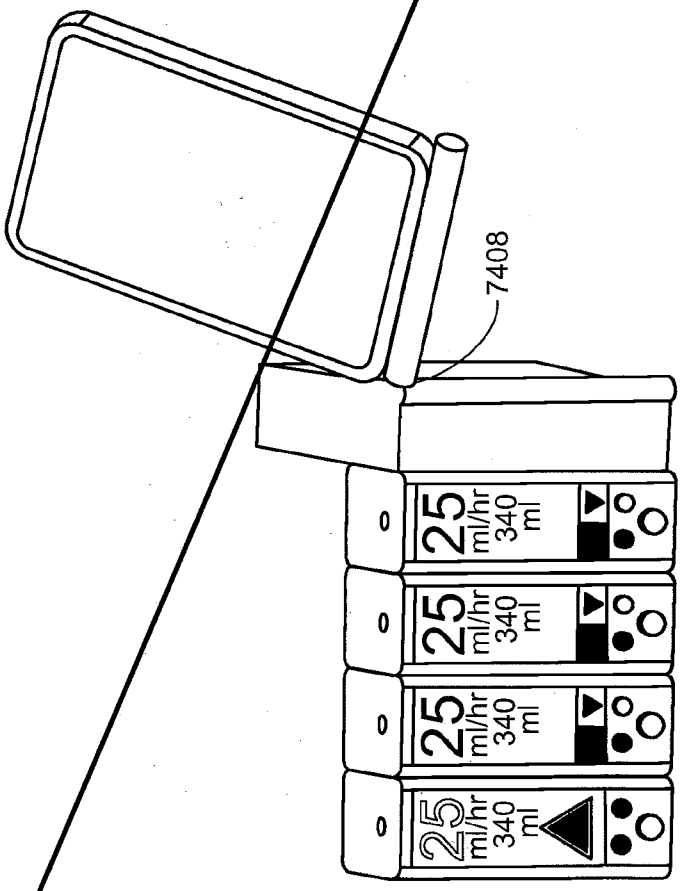


FIG. 109

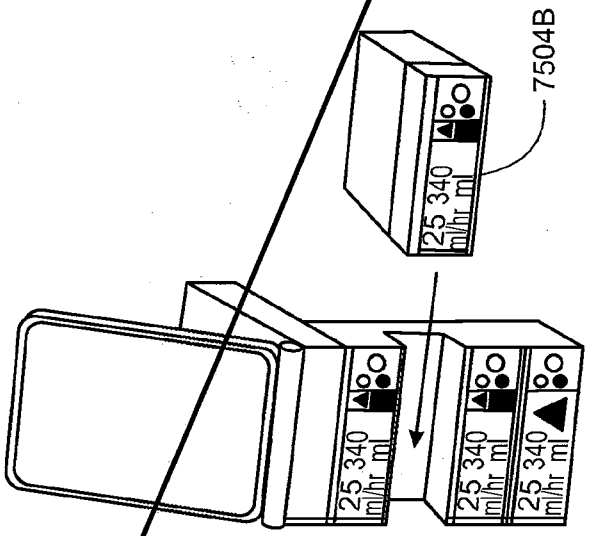


FIG. 110

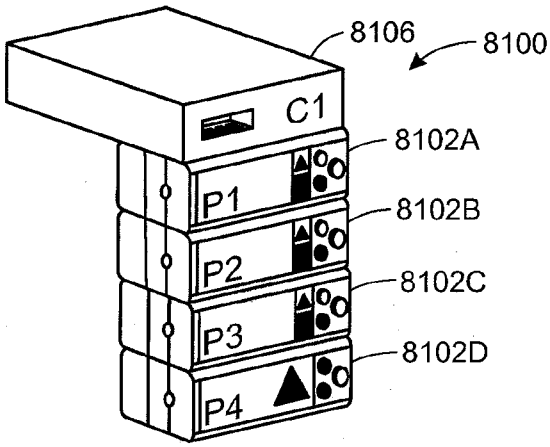


FIG. 111

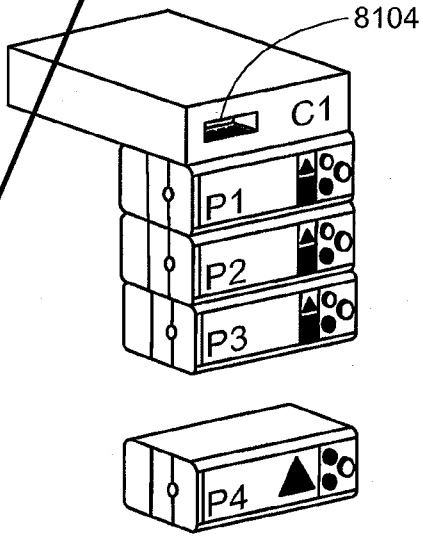


FIG. 112

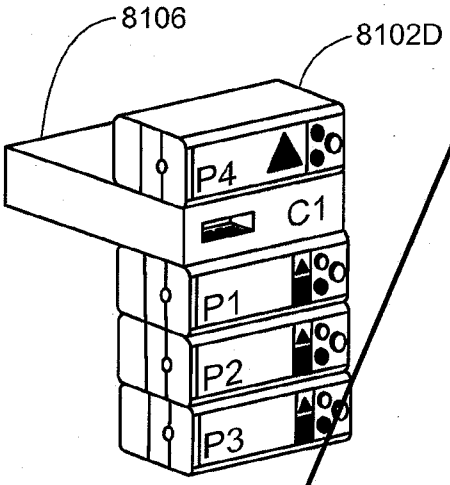


FIG. 113

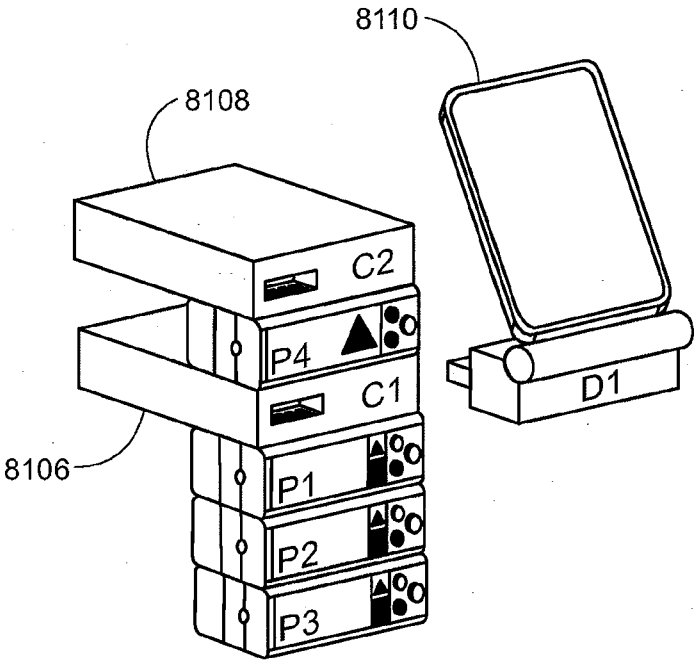


FIG. 114

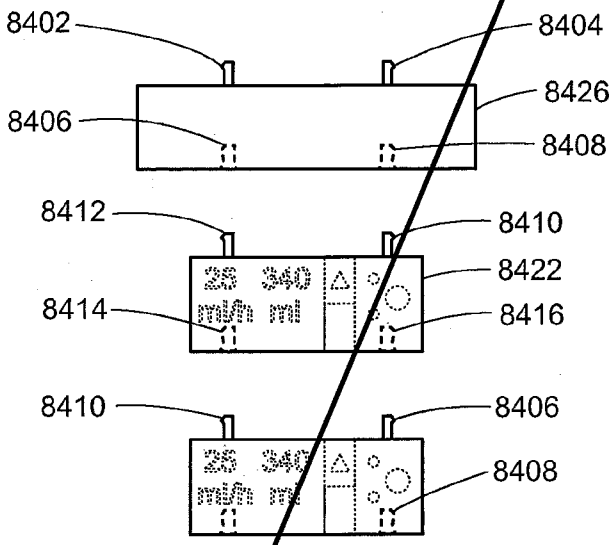


FIG. 115

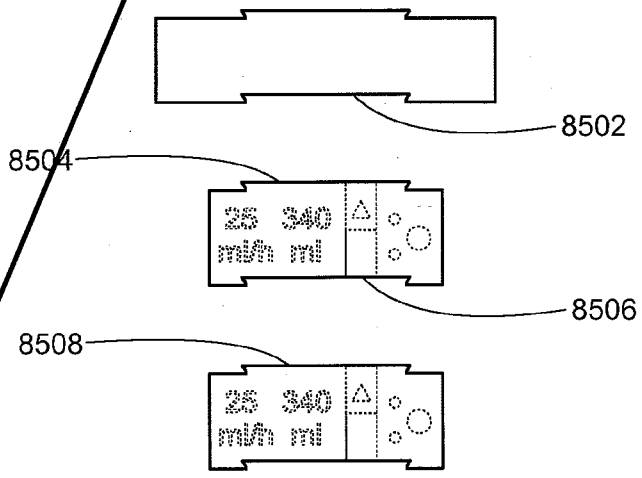


FIG. 116

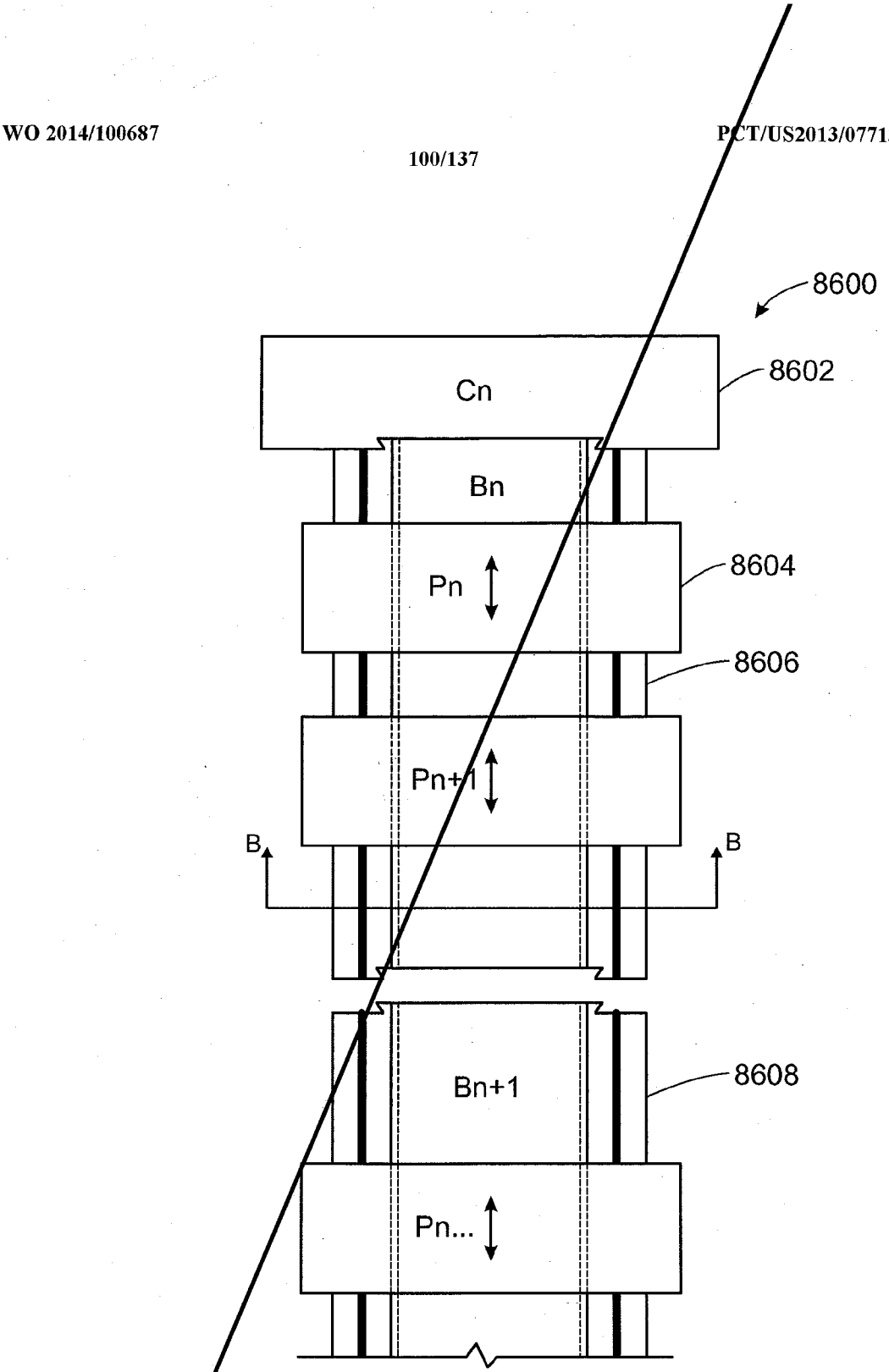


FIG. 117

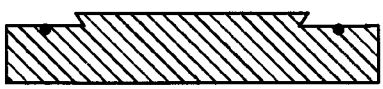


FIG. 118

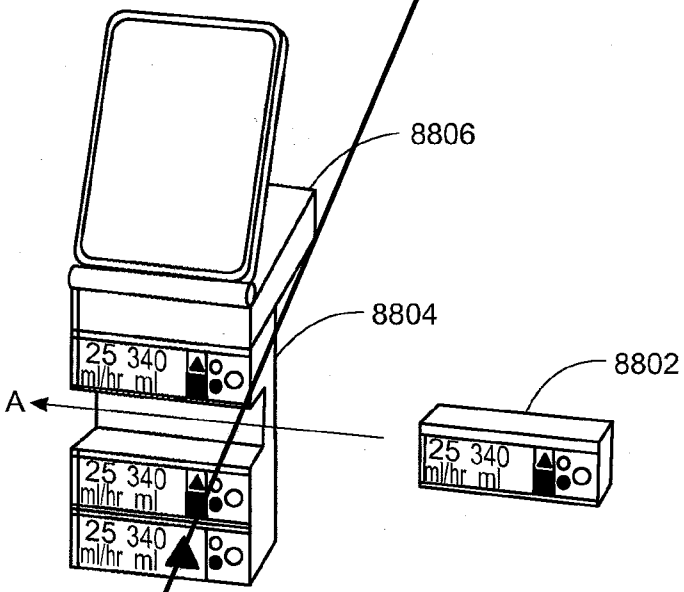

8806
8804
8802
A
25 340
ml/hr ml
25 340
ml/hr ml
25 340
ml/hr ml
25 340
ml/hr ml

FIG. 119

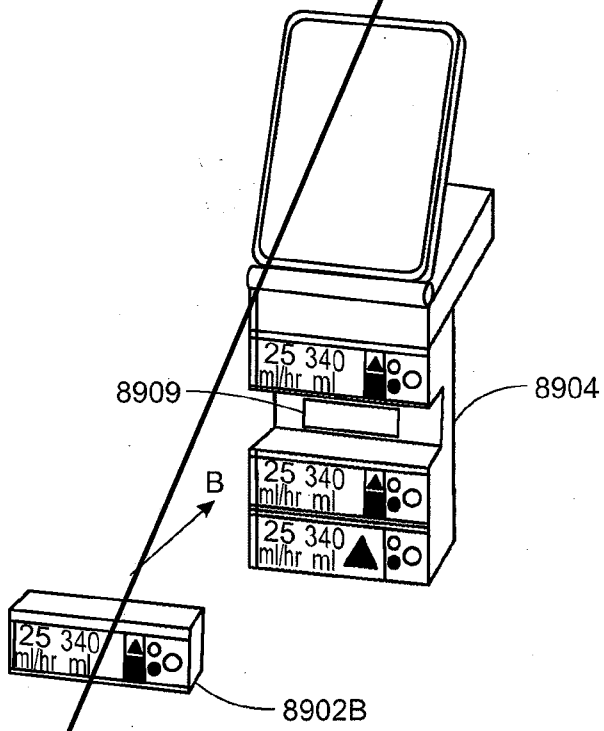


FIG. 120

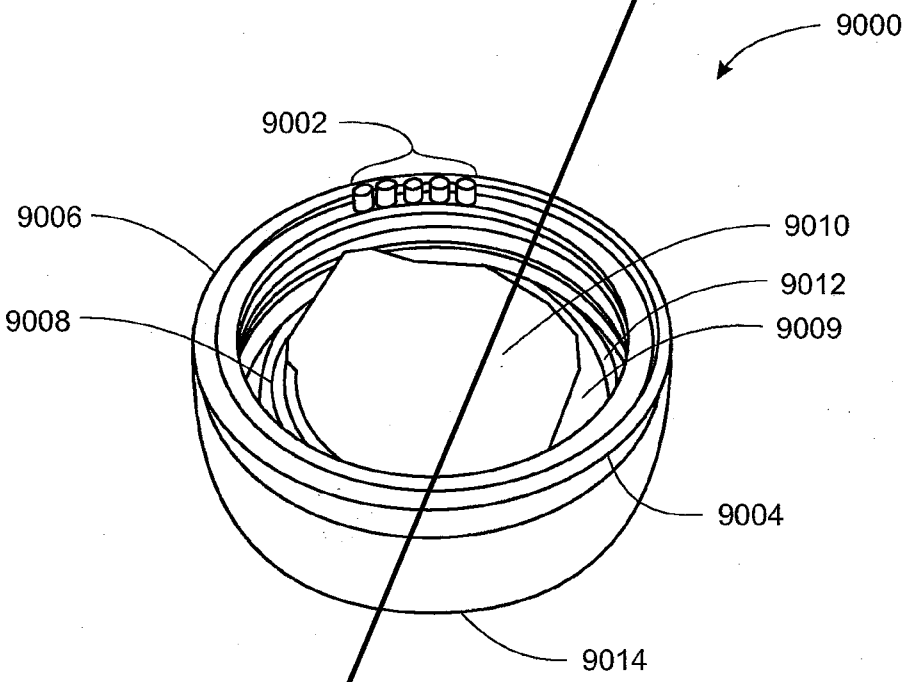


FIG. 121

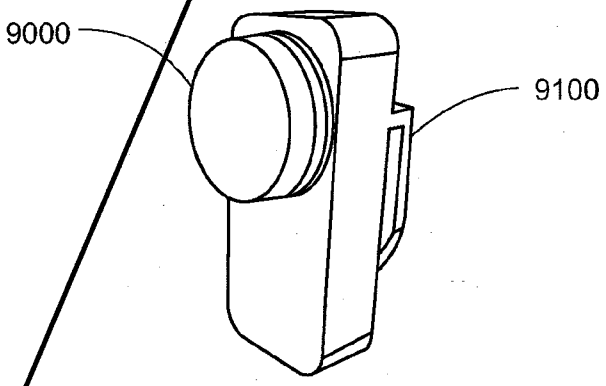


FIG. 122

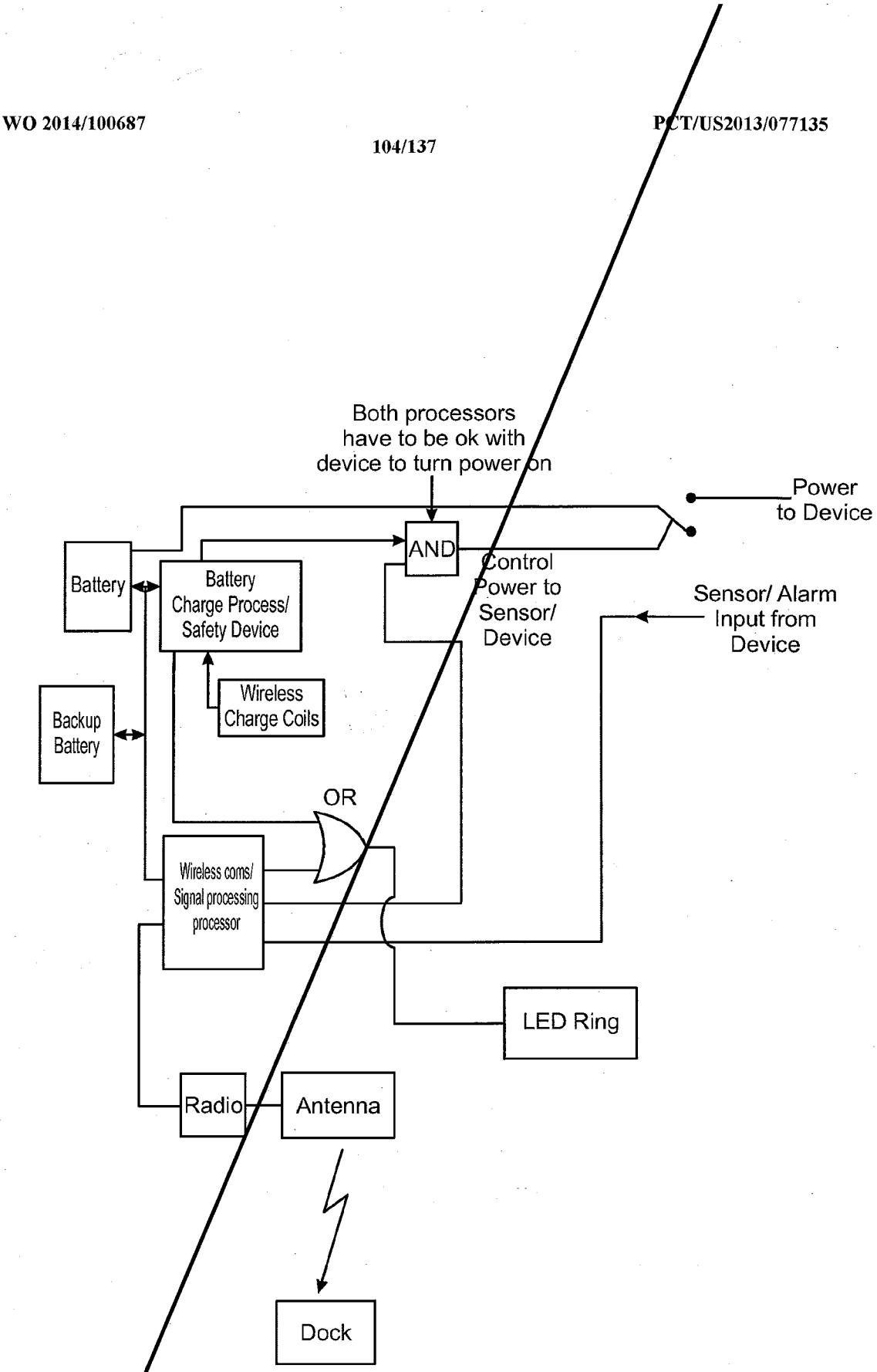

Both processors have to be ok with device to turn power on
Power to Device
AND
Control Power to Sensor/ Device
Sensor/ Alarm Input from Device
Battery
Battery Charge Process/ Safety Device
Wireless Charge Coils
Backup Battery
OR
Wireless coms/ Signal processing processor
LED Ring
Radio
Antenna
Dock

FIG. 123

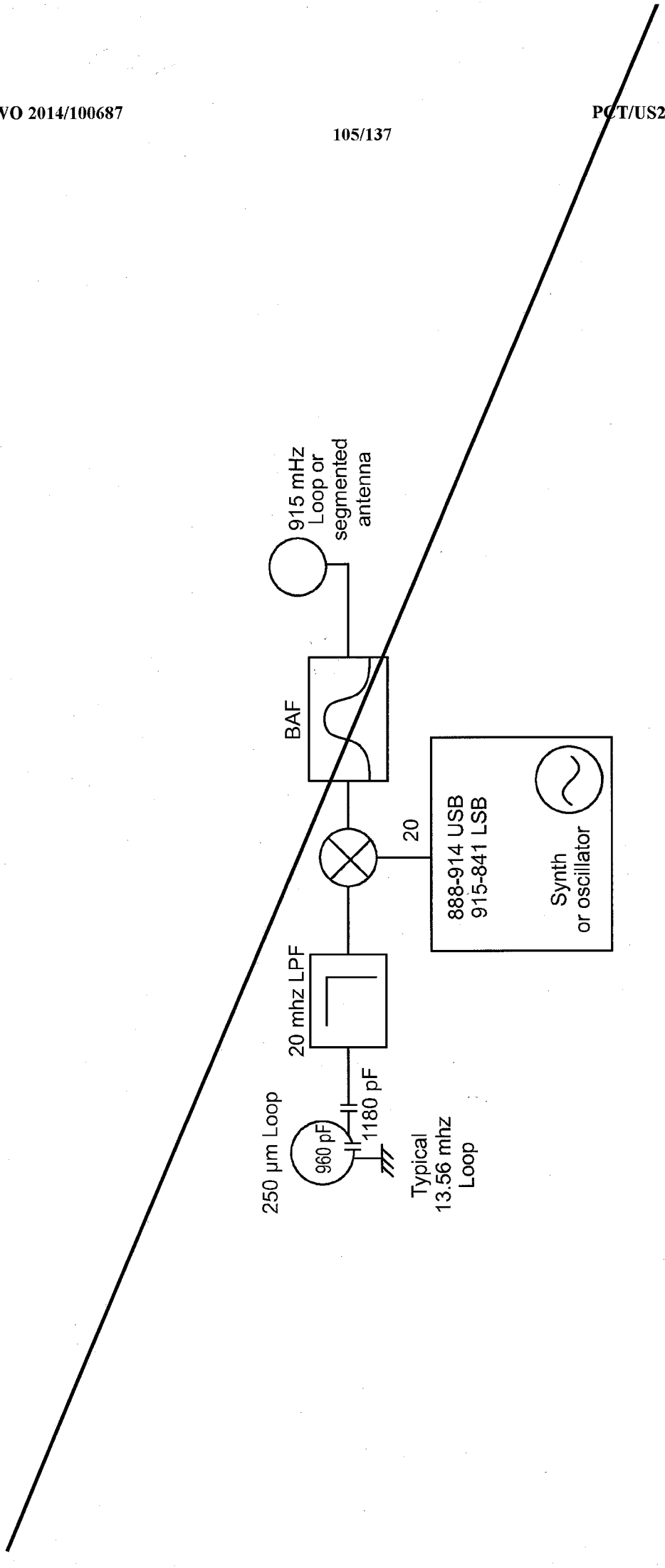

915 mHz
Loop or
segmented
antenna
BAF
20
888-914 USB
915-841 LSB
Synth
or oscillator
20 mhz LPF
250 µm Loop
960 pF
1180 pF
Typical
13.56 mhz
Loop

FIG. 124

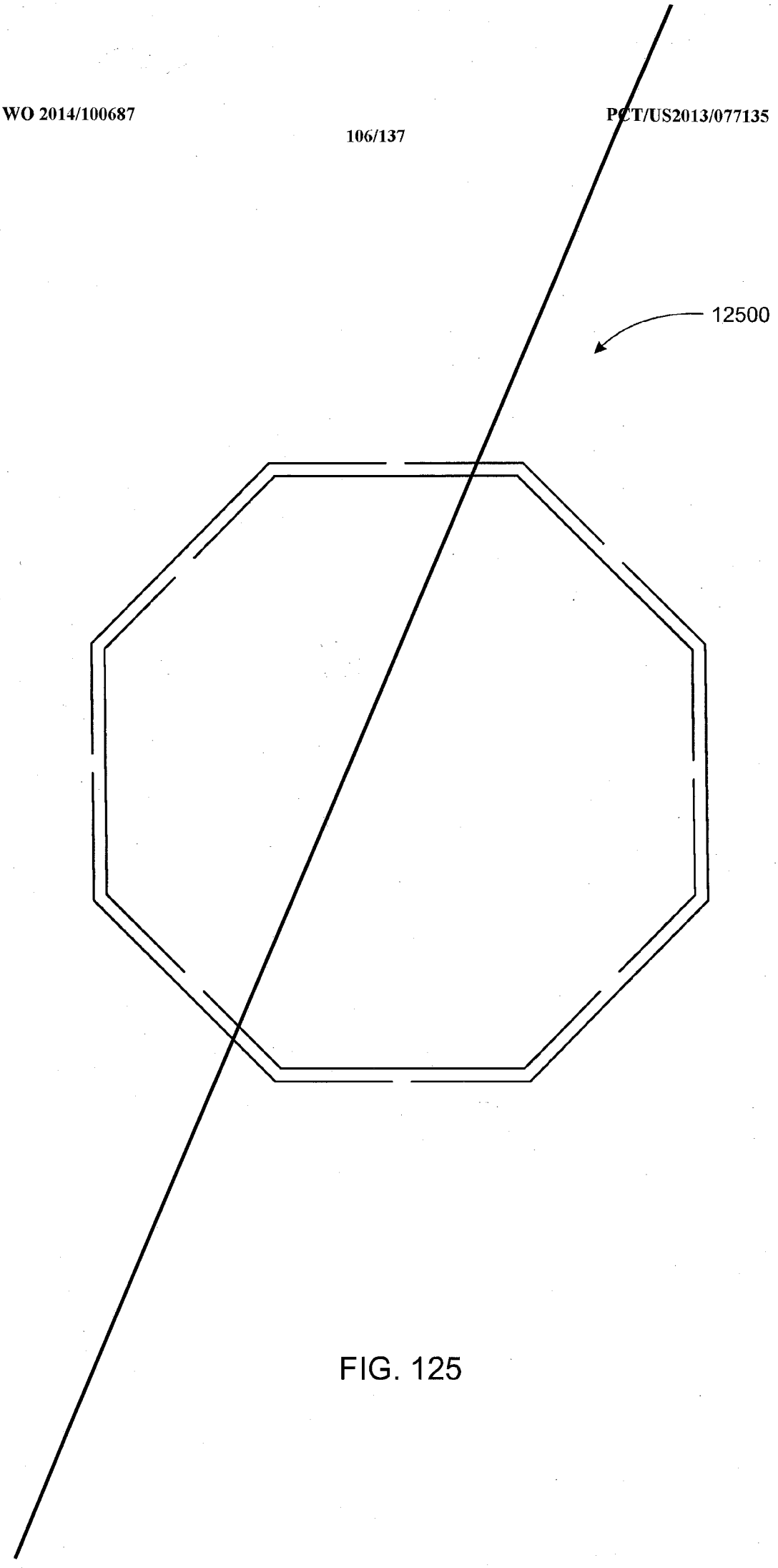


FIG. 125

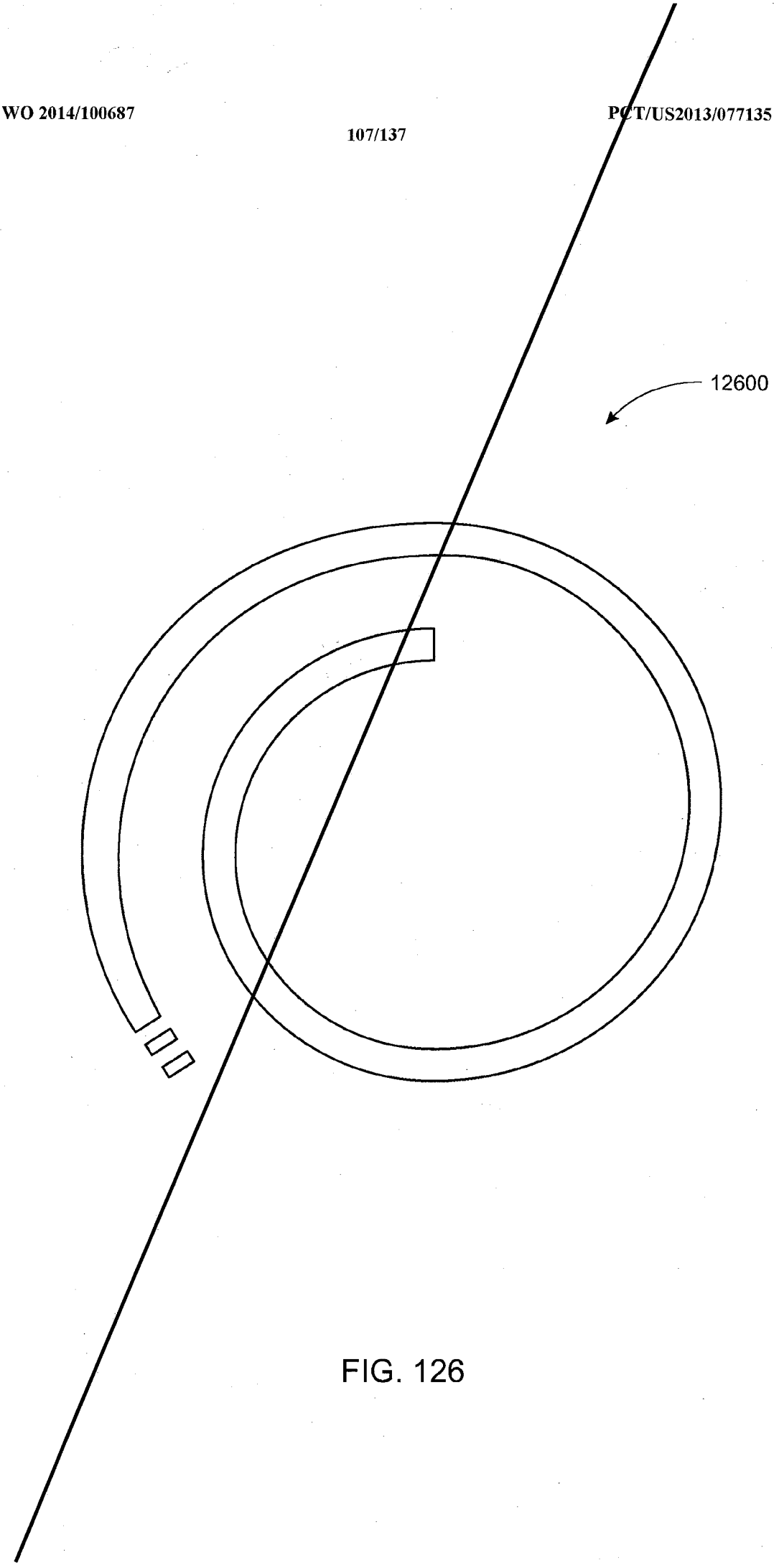


FIG. 126

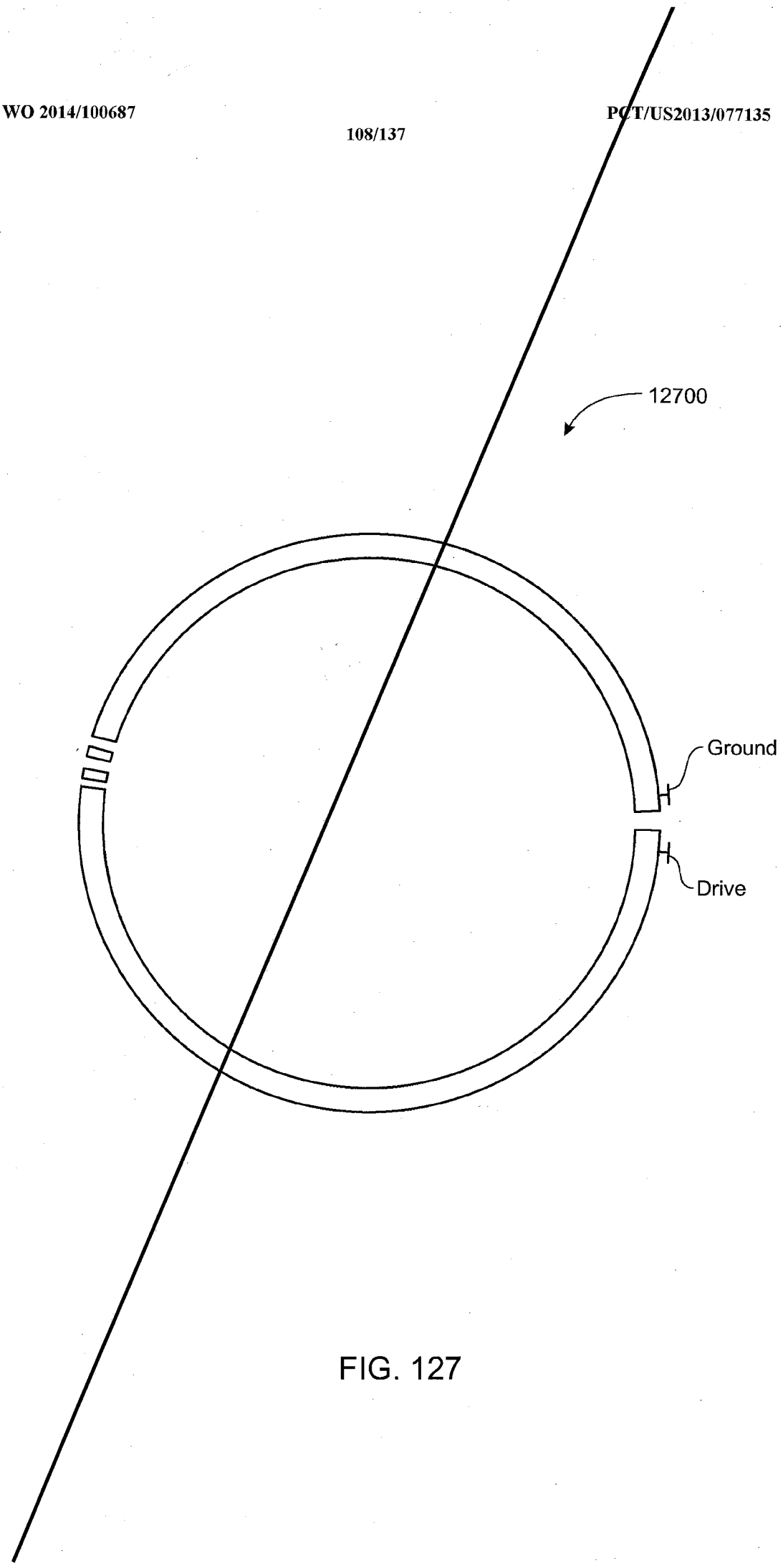


FIG. 127

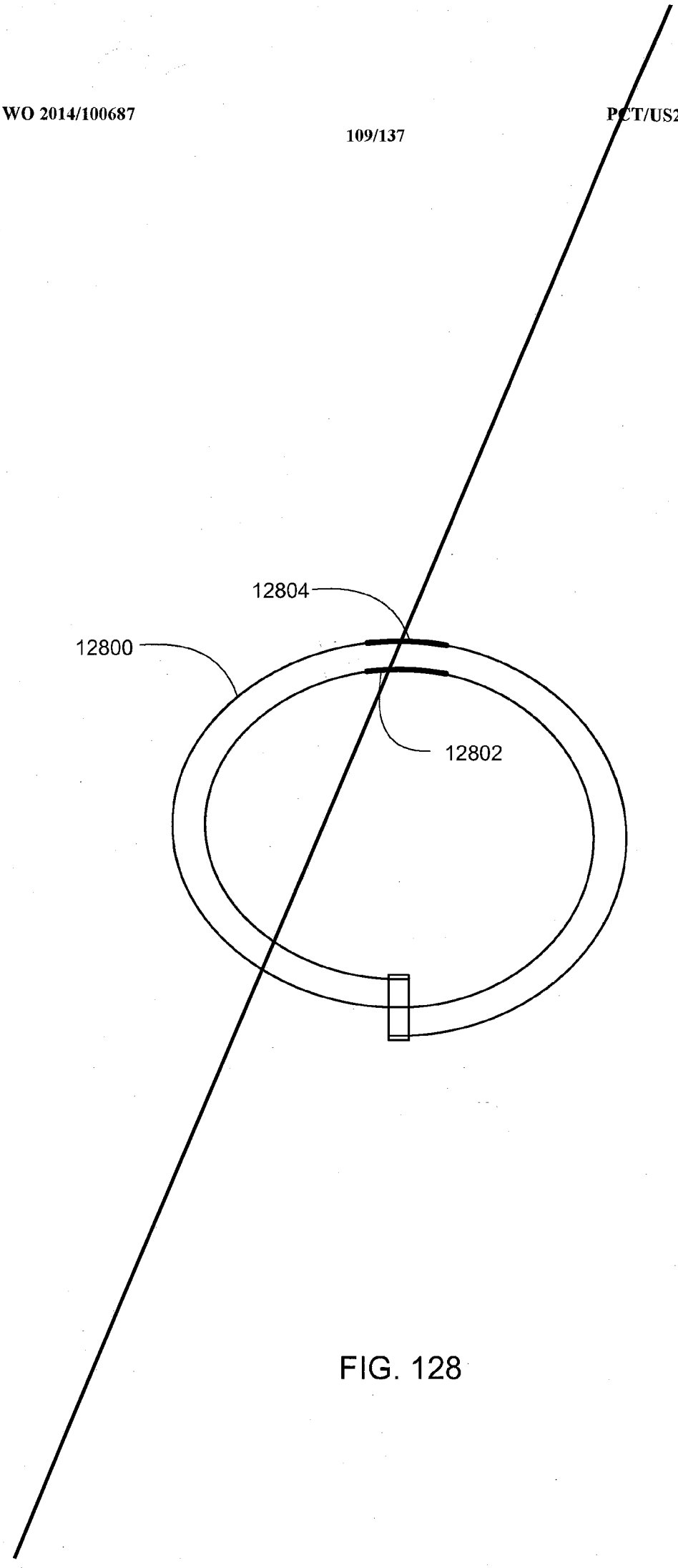


FIG. 128

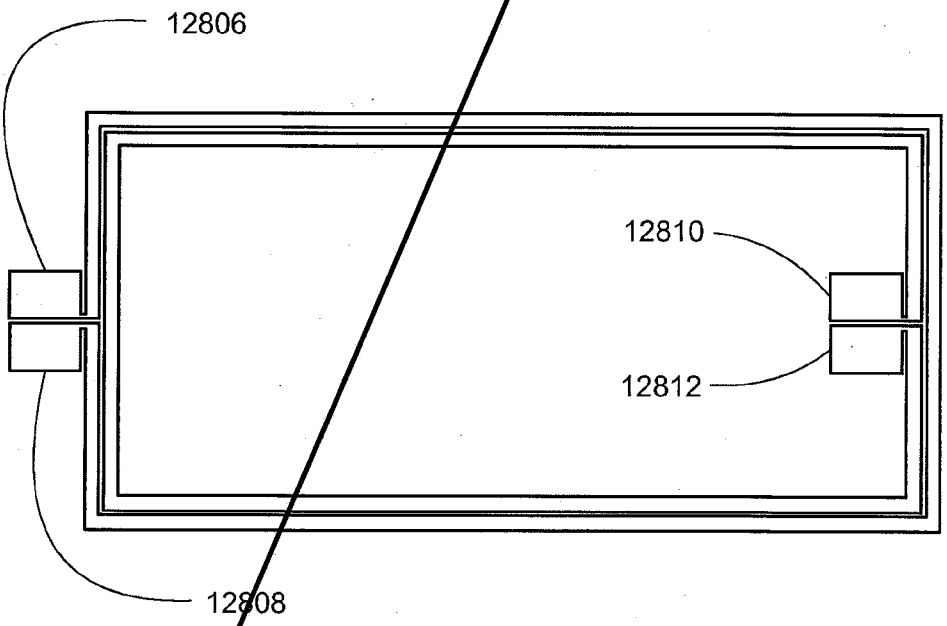


FIG. 129

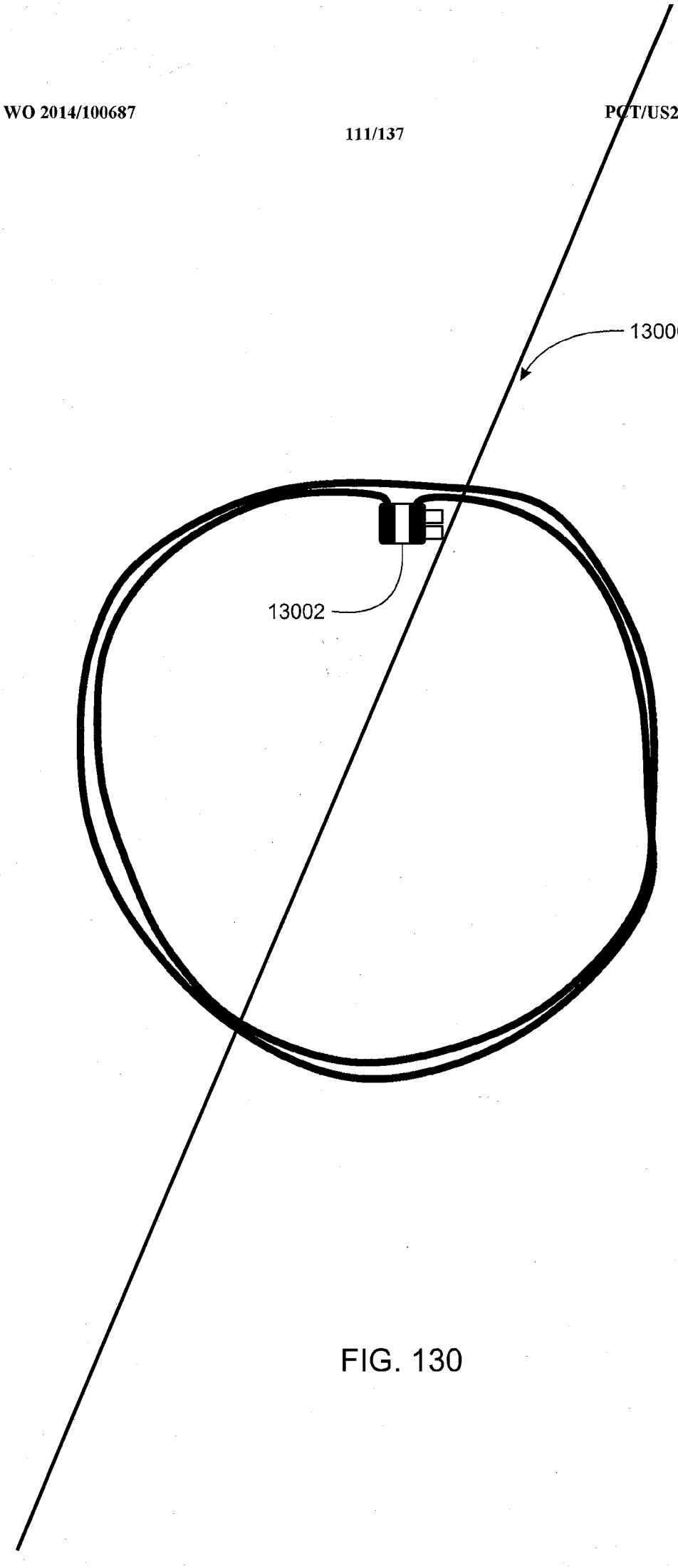


FIG. 130

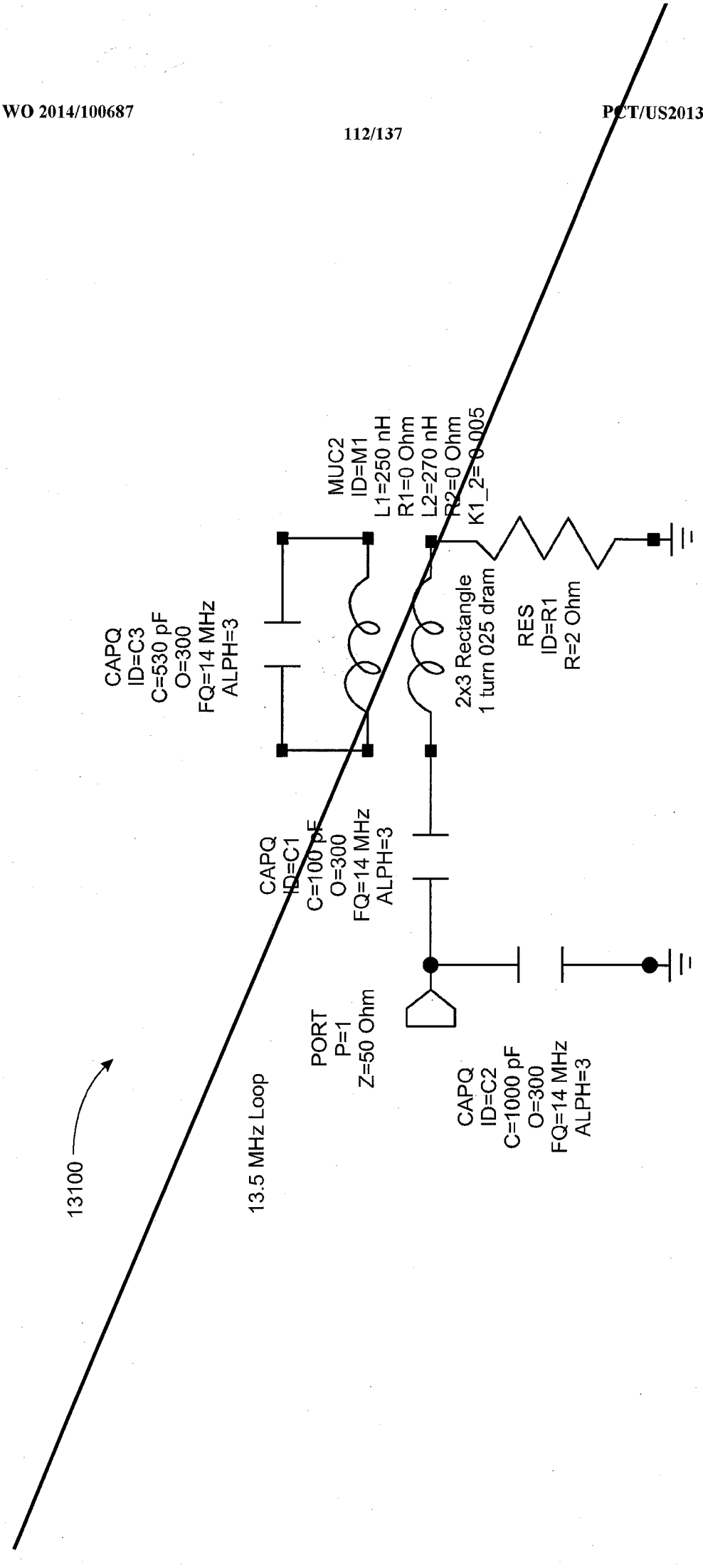

13100
13.5 MHz Loop
CAPQ
ID=C3
C=530 pF
O=300
FQ=14 MHz
ALPH=3
MUC2
ID=M1
L1=250 nH
R1=0 Ohm
L2=270 nH
R2=0 Ohm
K1_2=0.005
2x3 Rectangle
1 turn 025 dram
RES
ID=R1
R=2 Ohm
CAPQ
ID=C1
C=100 pF
O=300
FQ=14 MHz
ALPH=3
PORT
P=1
Z=50 Ohm
CAPQ
ID=C2
C=1000 pF
O=300
FQ=14 MHz
ALPH=3

FIG. 131

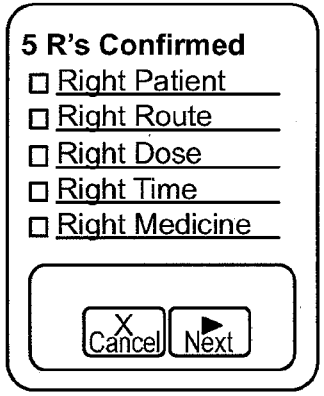


FIG. 132

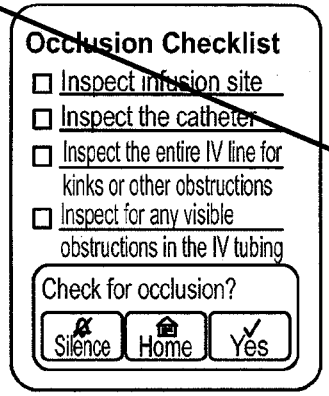


FIG. 133

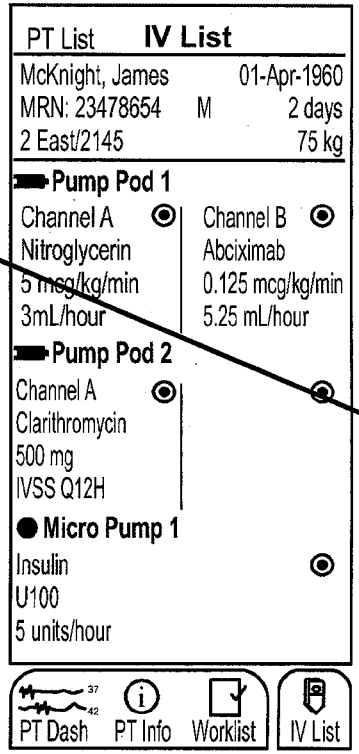


FIG. 134

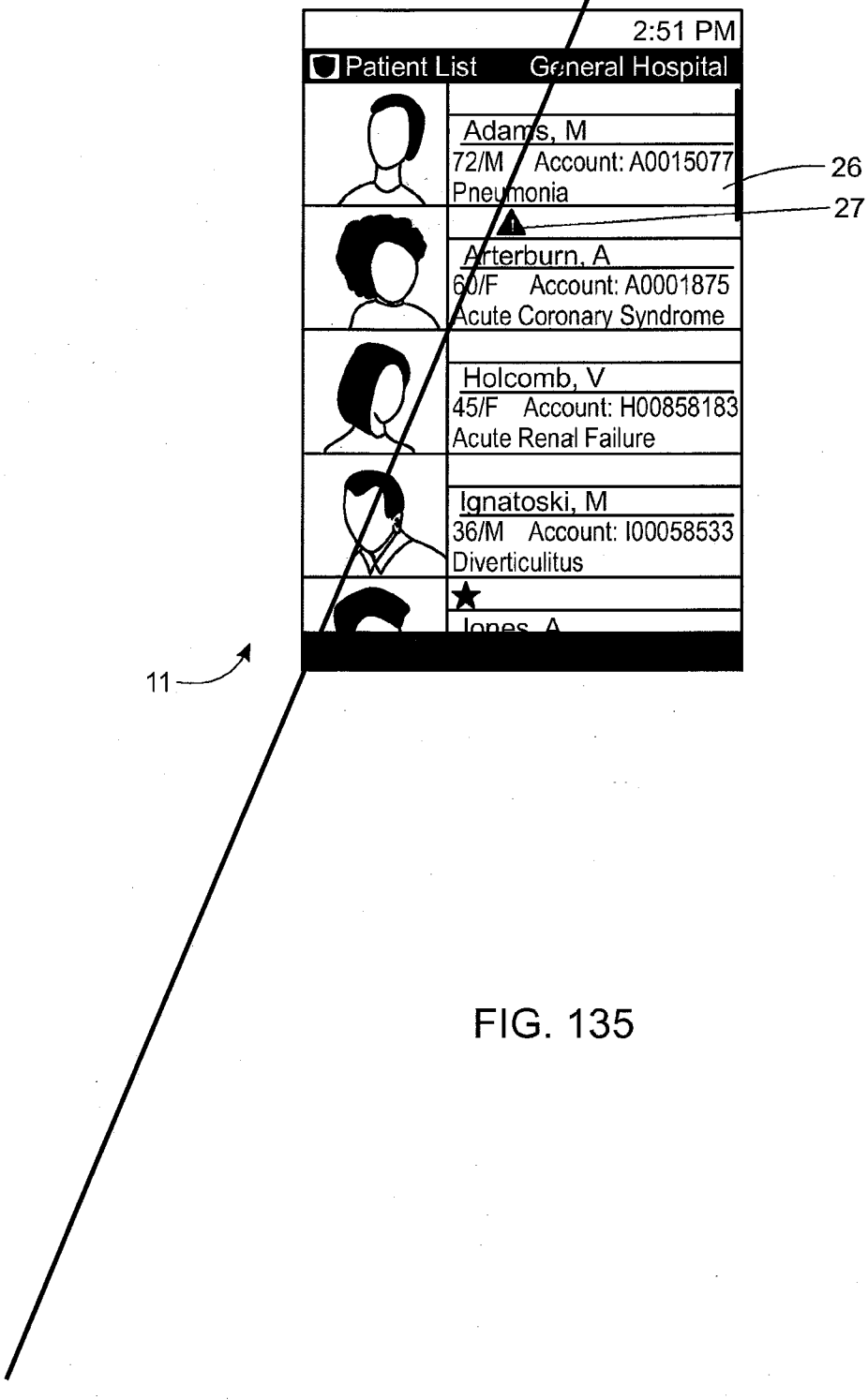

2:51 PM
Patient List
General Hospital
Adams, M
72/M Account: A0015077
Pneumonia
Arterburn, A
60/F Account: A0001875
Acute Coronary Syndrome
Holcomb, V
45/F Account: H00858183
Acute Renal Failure
Ignatoski, M
36/M Account: I00058533
Diverticulitus
Jones, A
26
27
11

FIG. 135

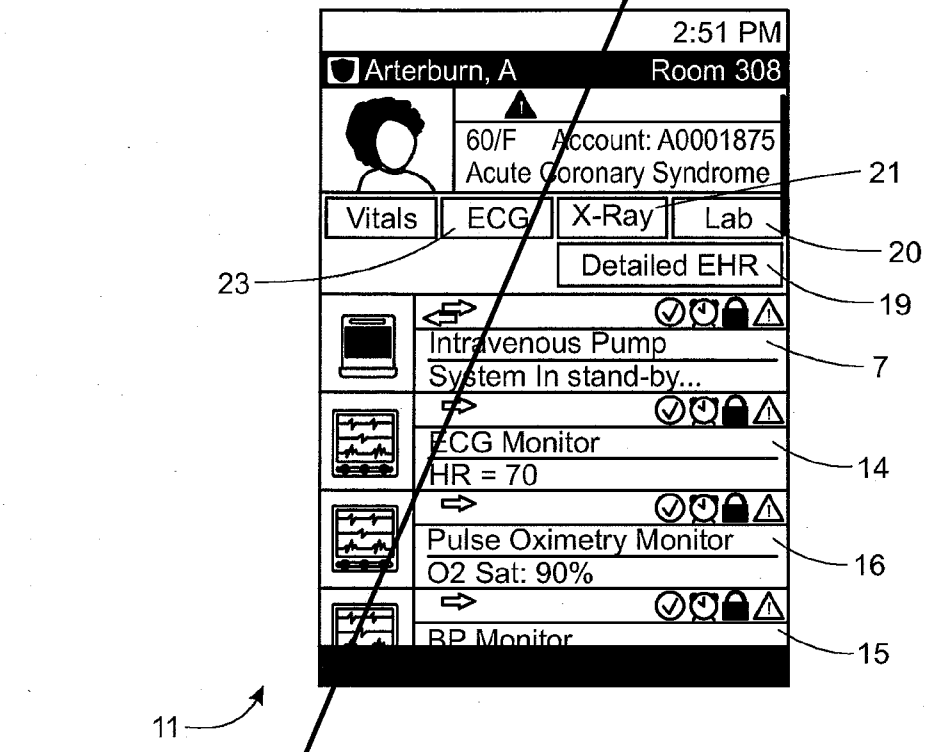

2:51 PM
Arterburn, A
Room 308
60/F Account: A0001875
Acute Coronary Syndrome
Vitals
ECG
X-Ray
Lab
Detailed EHR
Intravenous Pump
System In stand-by...
ECG Monitor
HR = 70
Pulse Oximetry Monitor
O2 Sat: 90%
BP Monitor
11
15
16
14
7
19
20
21
23

FIG. 136

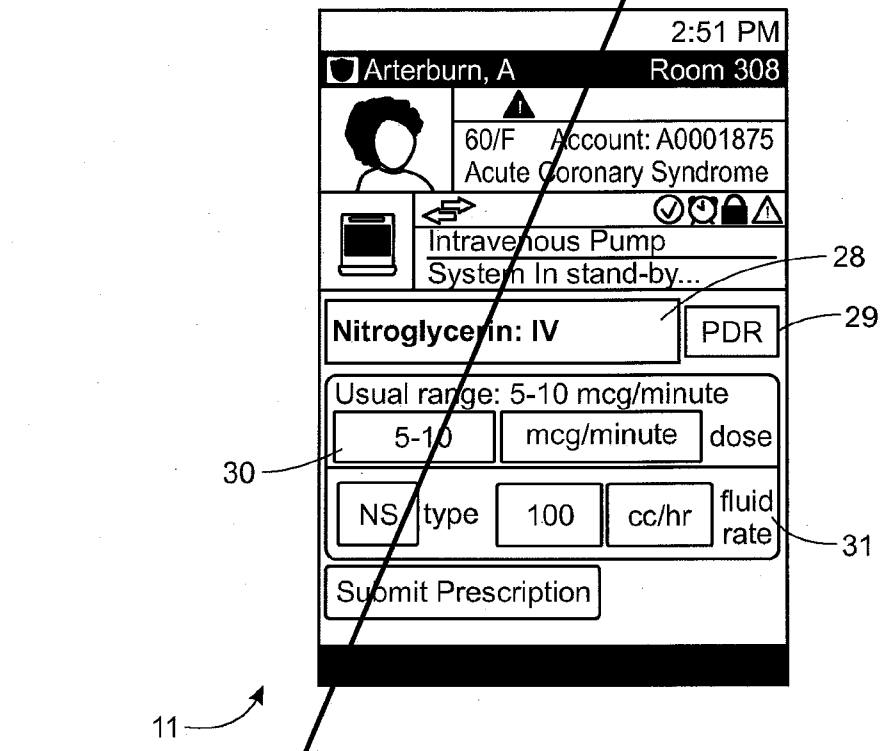

2:51 PM
Arterburn, A
Room 308
60/F Account: A0001875
Acute Coronary Syndrome
Intravenous Pump
System In stand-by...
Nitroglycerin: IV
PDR
Usual range: 5-10 mcg/minute
5-10
mcg/minute
dose
NS
type
100
cc/hr
fluid rate
Submit Prescription
11
28
29
30
31

FIG. 137

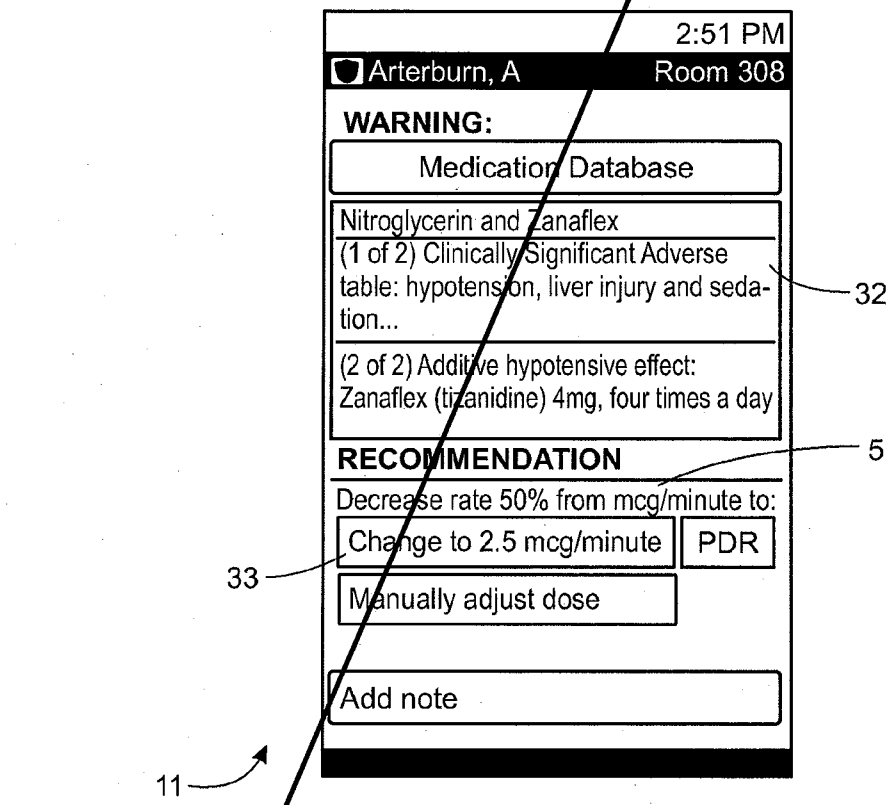

2:51 PM
Arterburn, A
Room 308
WARNING:
Medication Database
Nitroglycerin and Zanaflex
(1 of 2) Clinically Significant Adverse table: hypotension, liver injury and sedation...
(2 of 2) Additive hypotensive effect: Zanaflex (tizanidine) 4mg, four times a day
RECOMMENDATION
Decrease rate 50% from mcg/minute to:
Change to 2.5 mcg/minute
PDR
Manually adjust dose
Add note
11
32
33
5

FIG. 138

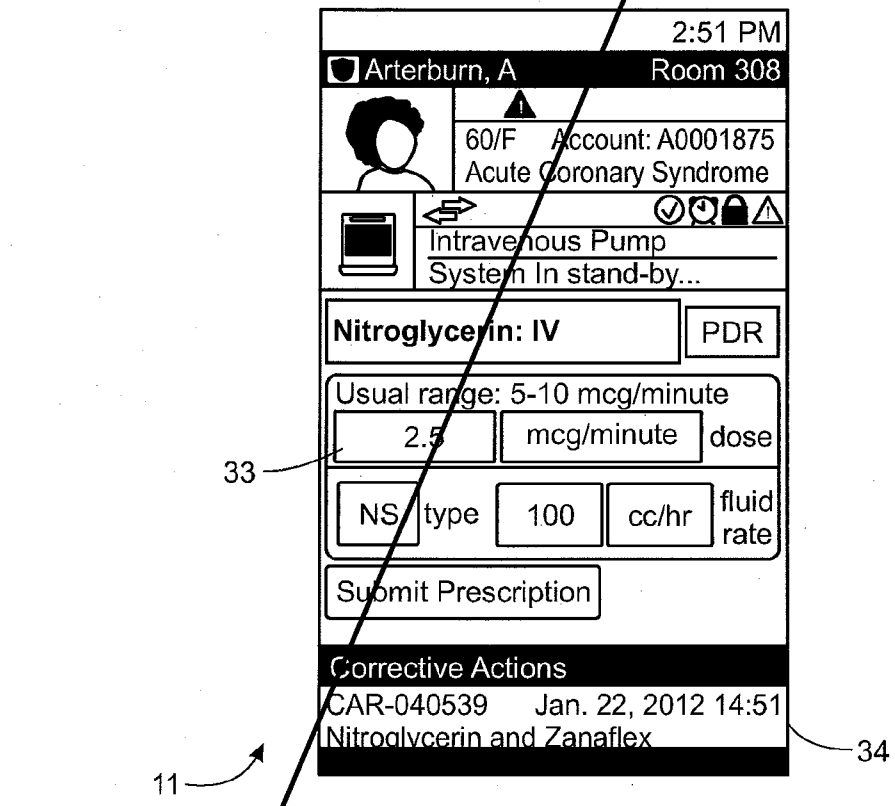

2:51 PM
Arterburn, A
Room 308
60/F Account: A0001875
Acute Coronary Syndrome
Intravenous Pump
System In stand-by...
Nitroglycerin: IV
PDR
Usual range: 5-10 mcg/minute
2.5
mcg/minute
dose
NS
type
100
cc/hr
fluid rate
Submit Prescription
Corrective Actions
CAR-040539 Jan. 22, 2012 14:51
Nitroglycerin and Zanaflex
33
34
11

FIG. 139

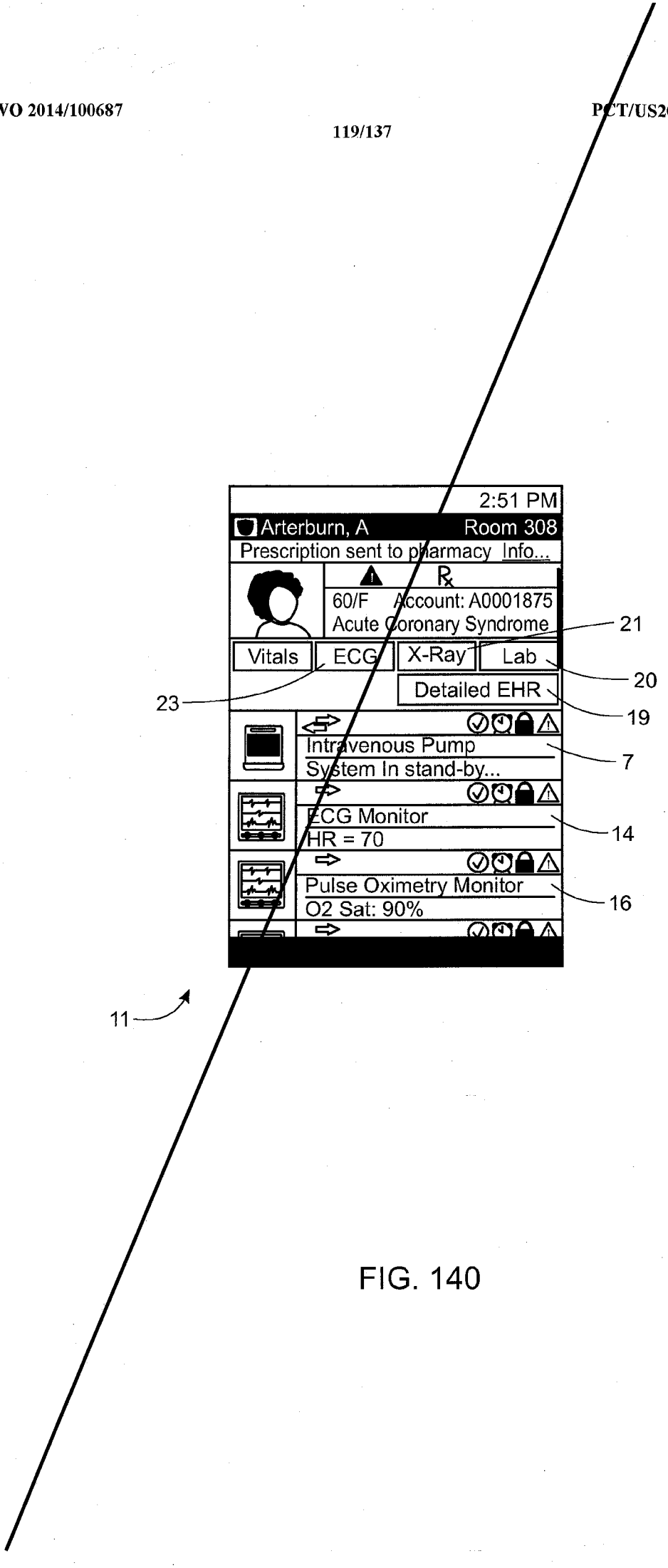

2:51 PM
Arterburn, A
Room 308
Prescription sent to pharmacy Info...
60/F Account: A0001875
Acute Coronary Syndrome
Vitals
ECG
X-Ray
Lab
Detailed EHR
Intravenous Pump
System In stand-by...
ECG Monitor
HR = 70
Pulse Oximetry Monitor
O2 Sat: 90%
11
23
21
20
19
7
14
16

FIG. 140

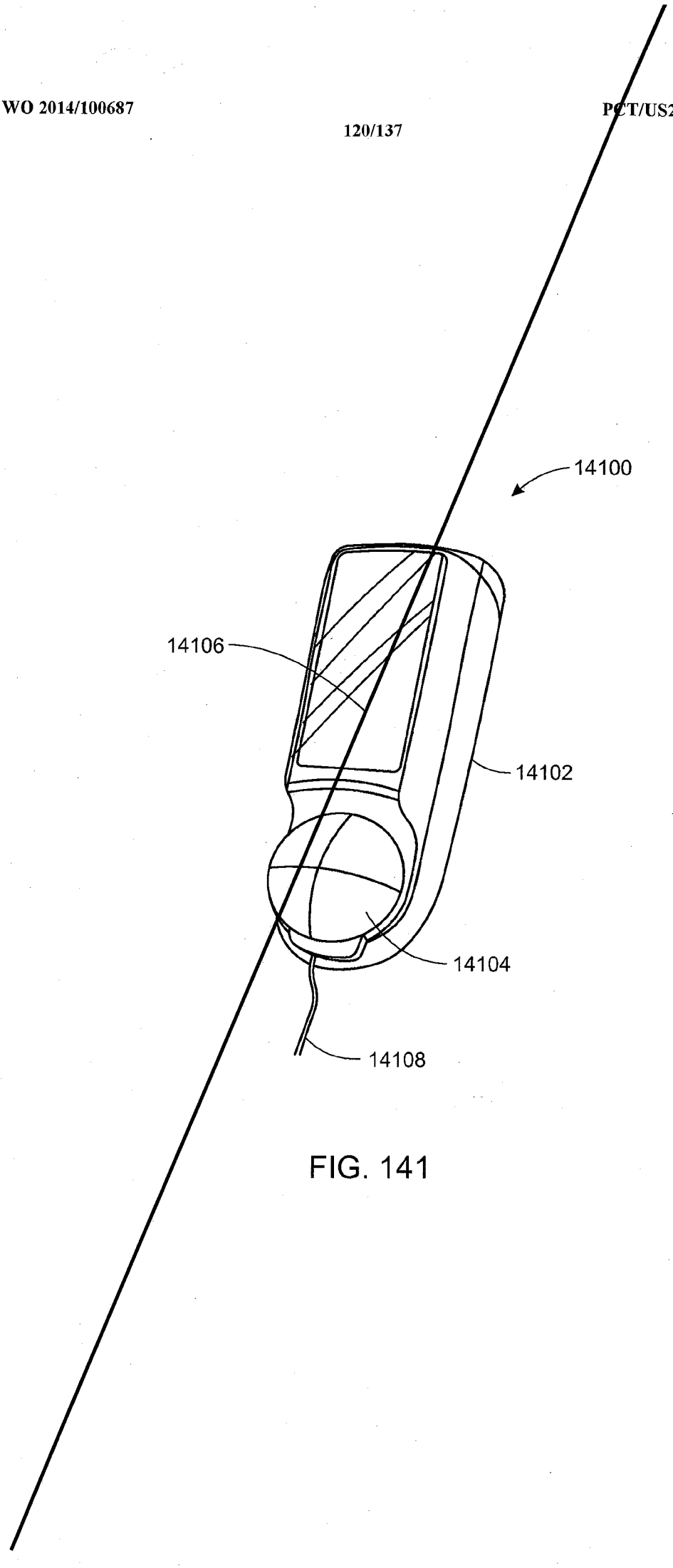


FIG. 141

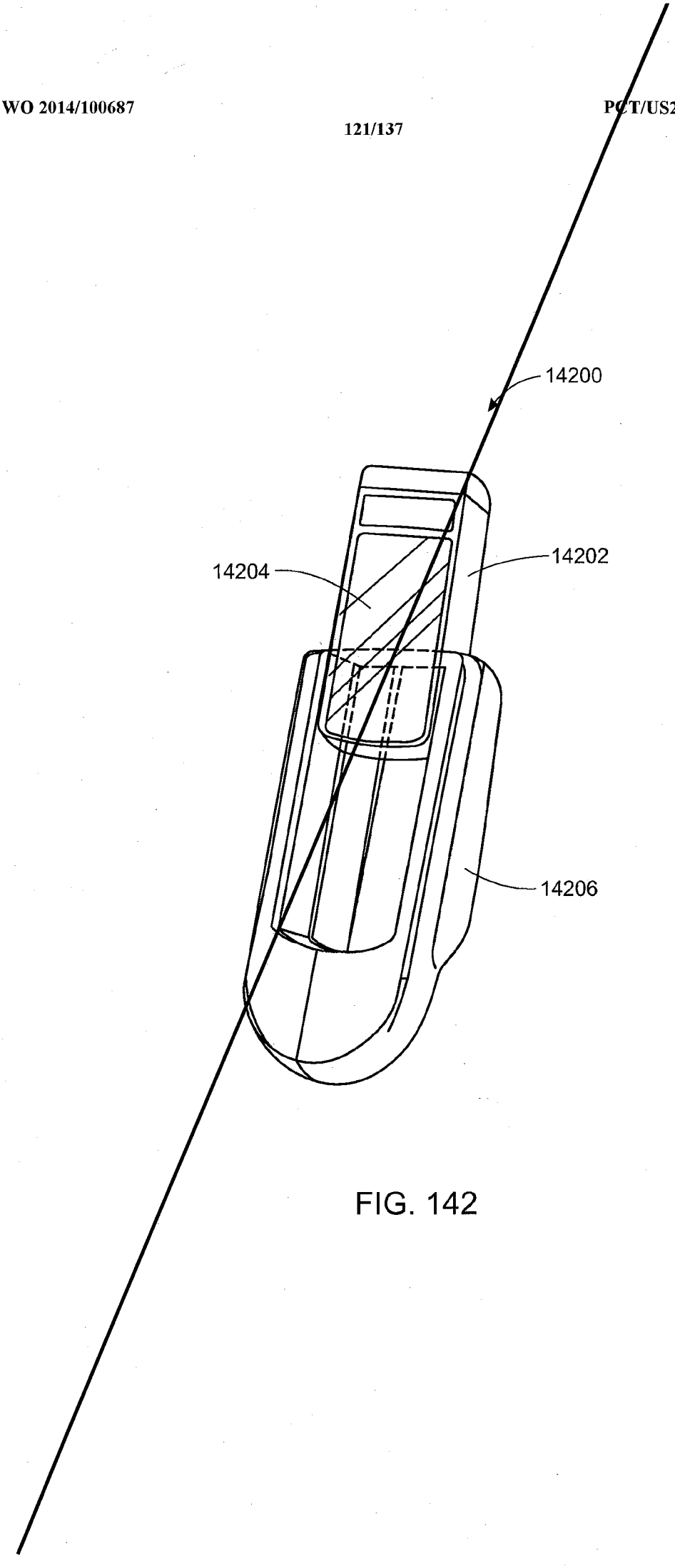


FIG. 142

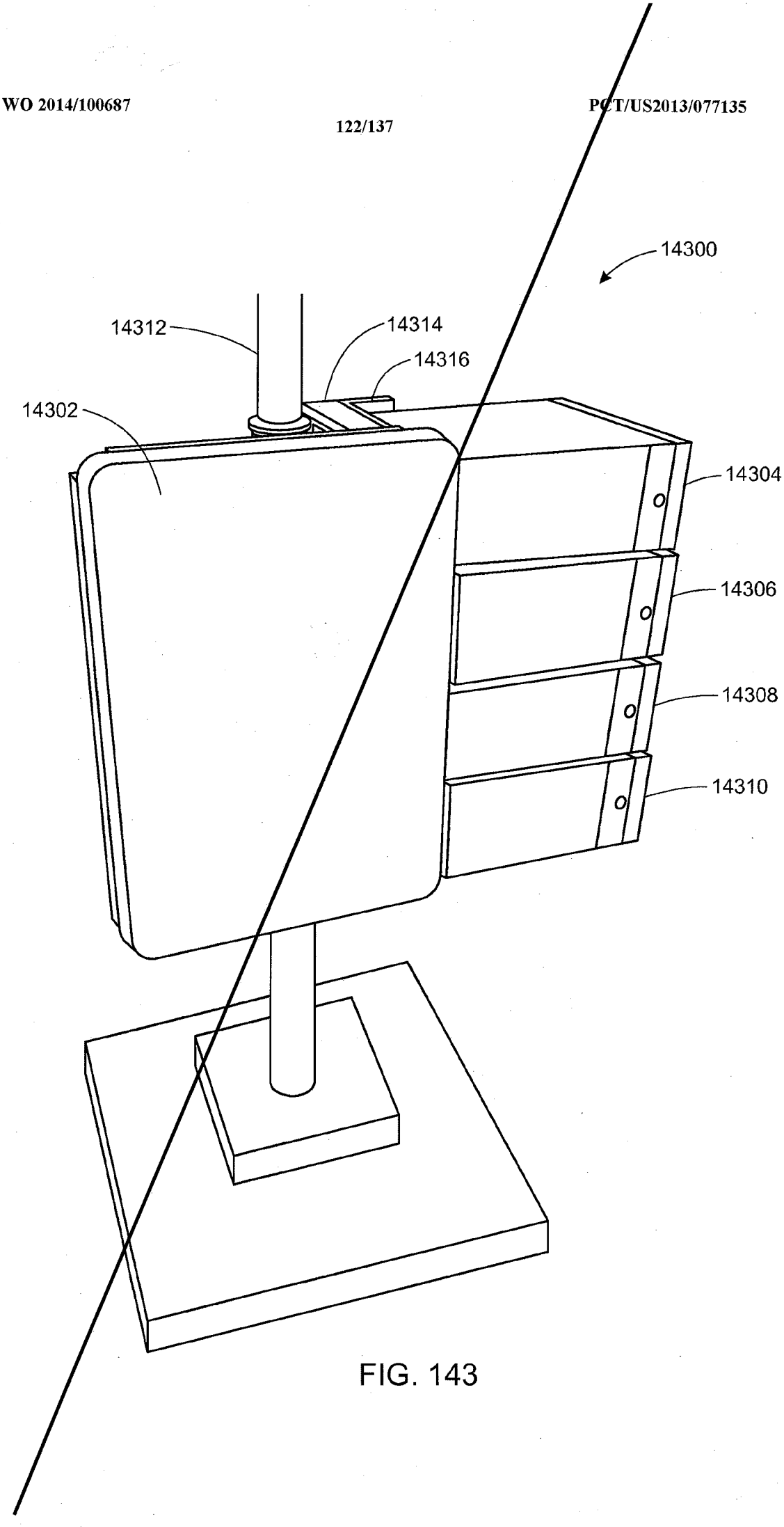


FIG. 143

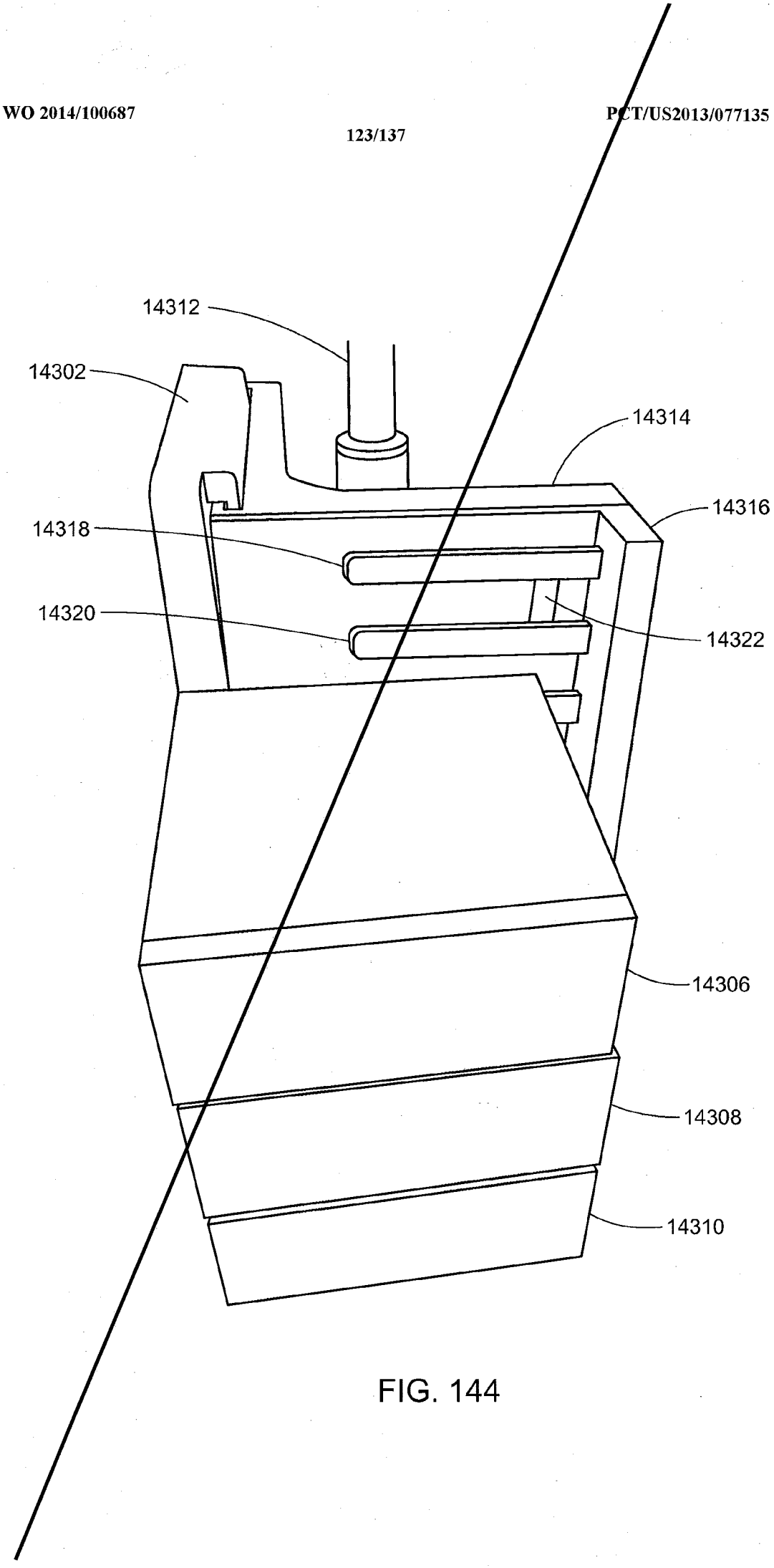

14312
14302
14314
14316
14318
14320
14322
14306
14308
14310

FIG. 144

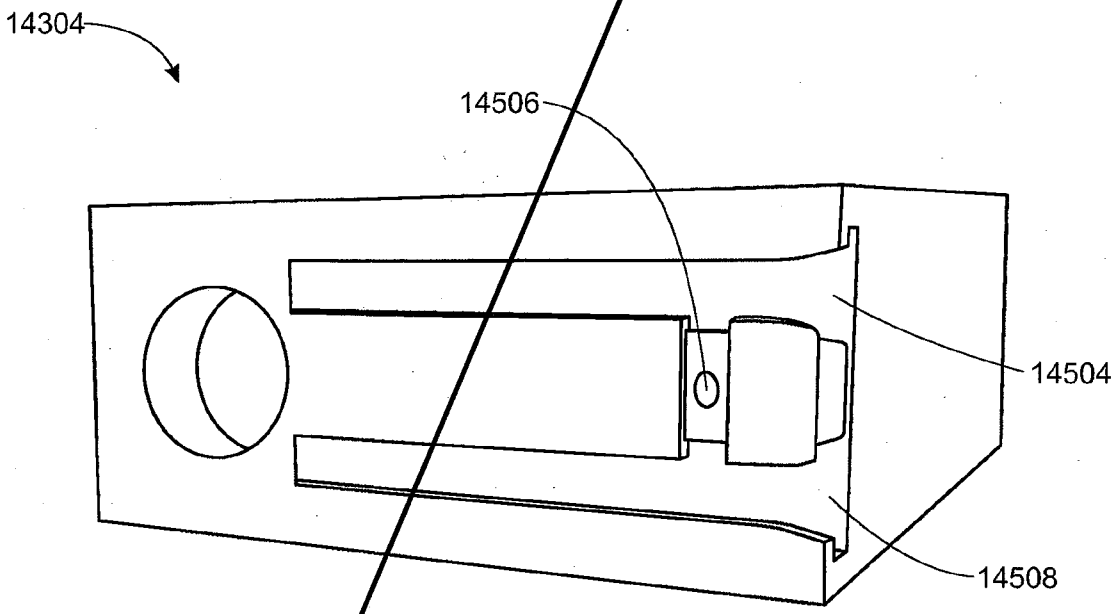


FIG. 145

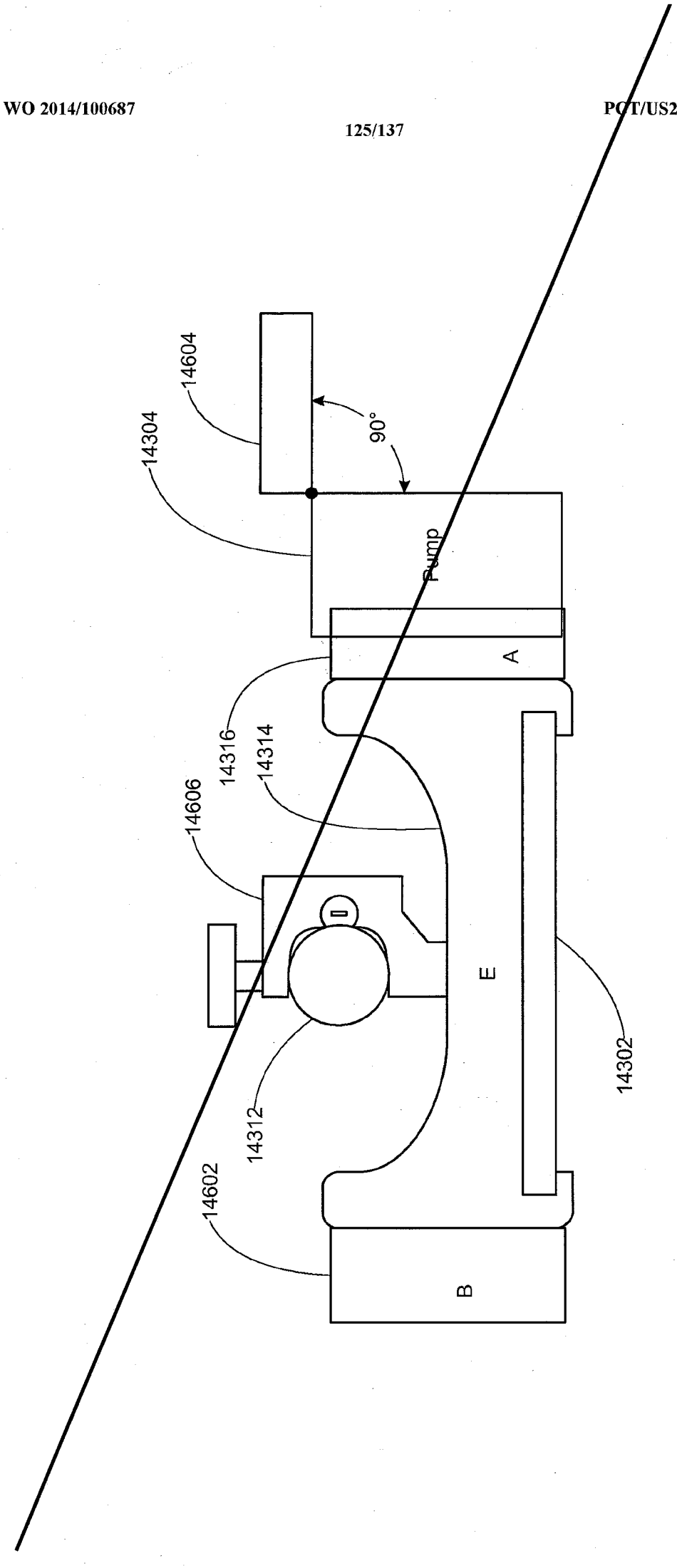

14604
14304
90°
Pump
A
14316
14314
14606
D
E
14302
14312
14602
B

FIG. 146

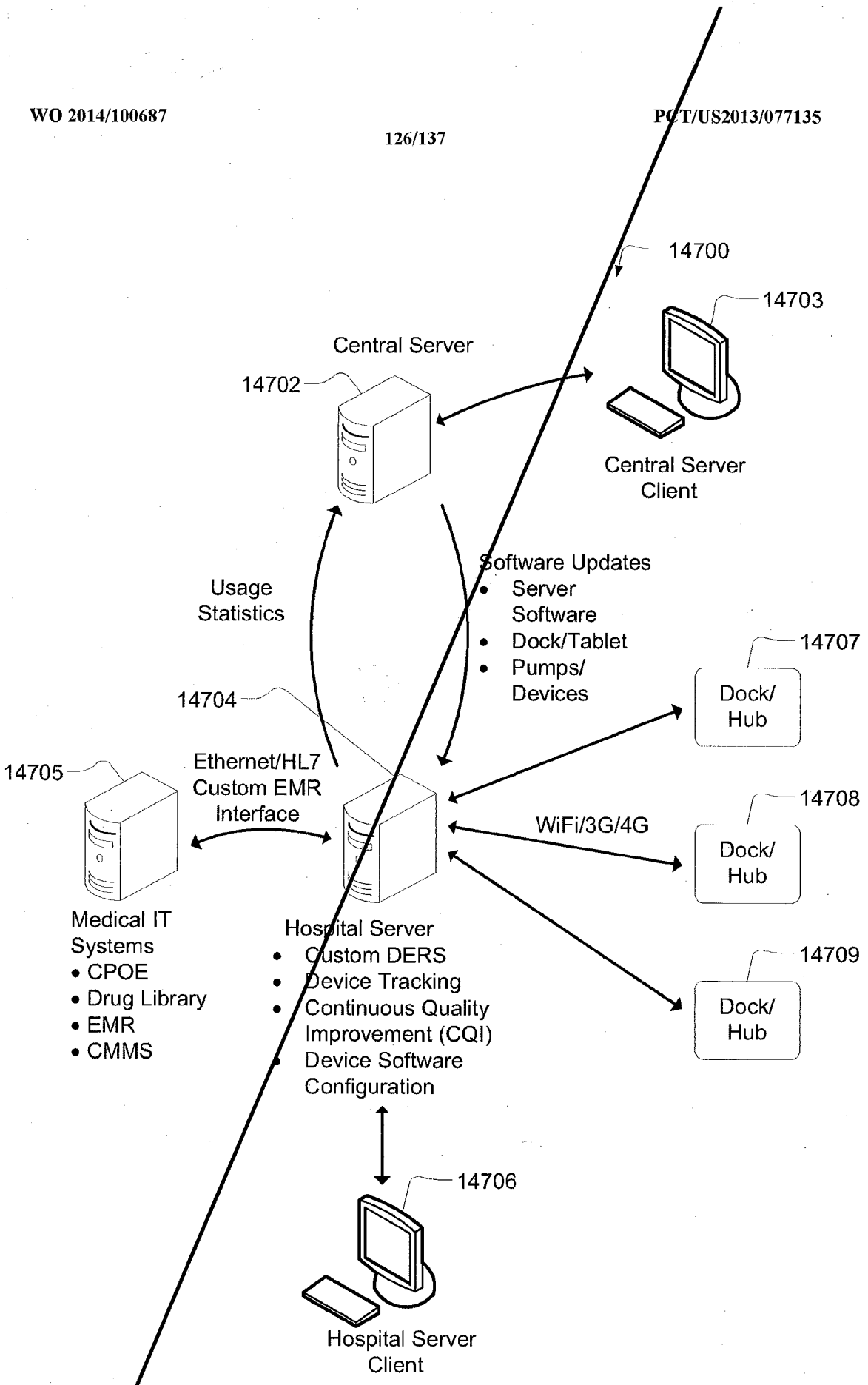

14700
14703
Central Server
14702
Central Server Client
Software Updates
• Server Software
• Dock/Tablet
• Pumps/ Devices
Usage Statistics
14707
14704
Dock/ Hub
14705
Ethernet/HL7 Custom EMR Interface
14708
WiFi/3G/4G
Dock/ Hub
Medical IT Systems
• CPOE
• Drug Library
• EMR
• CMMS
Hospital Server
• Custom DERS
• Device Tracking
• Continuous Quality Improvement (CQI)
• Device Software Configuration
14709
Dock/ Hub
14706
Hospital Server Client

FIG. 147

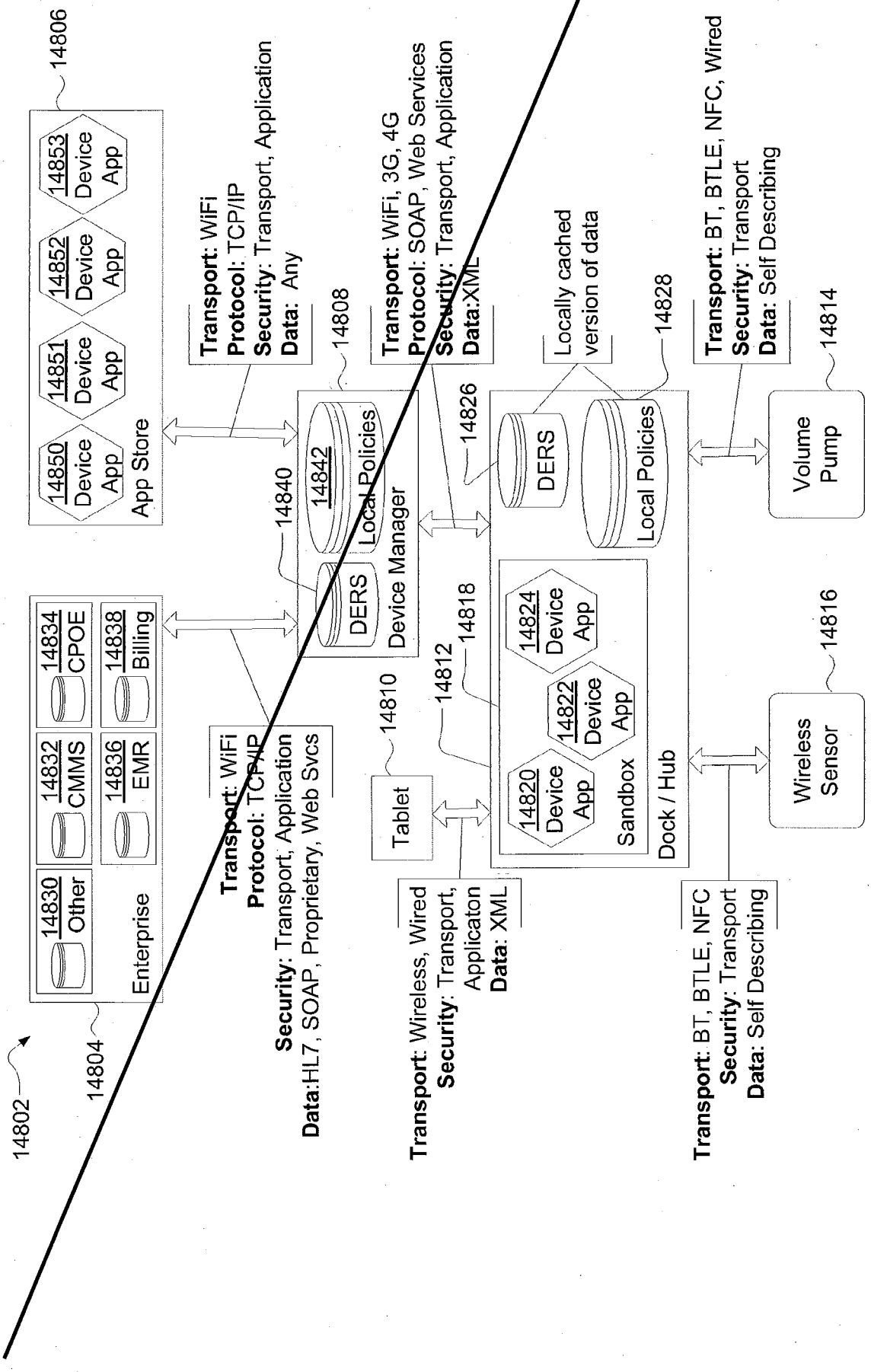

14802
14804
Enterprise
14830 Other
14832 CMMS
14834 CPOE
14836 EMR
14838 Billing
Transport: WiFi
Protocol: TCP/IP
Security: Transport, Application
Data: HL7, SOAP, Proprietary, Web Svcs
14806
App Store
14850 Device App
14851 Device App
14852 Device App
14853 Device App
Transport: WiFi
Protocol: TCP/IP
Security: Transport, Application
Data: Any
14840
14842 Local Policies
DERS
Device Manager
14808
Transport: WiFi, 3G, 4G
Protocol: SOAP, Web Services
Security: Transport, Application
Data:XML
14826
Locally cached version of data
DERS
Local Policies
14828
Transport: BT, BTLE, NFC, Wired
Security: Transport
Data: Self Describing
Volume Pump
14814
14810
Tablet
14812
14818
14824 Device App
14822 Device App
14820 Device App
Sandbox
Dock / Hub
Transport: Wireless, Wired
Security: Transport, Applicaton
Data: XML
Wireless Sensor
14816
Transport: BT, BTLE, NFC
Security: Transport
Data: Self Describing

FIG. 148

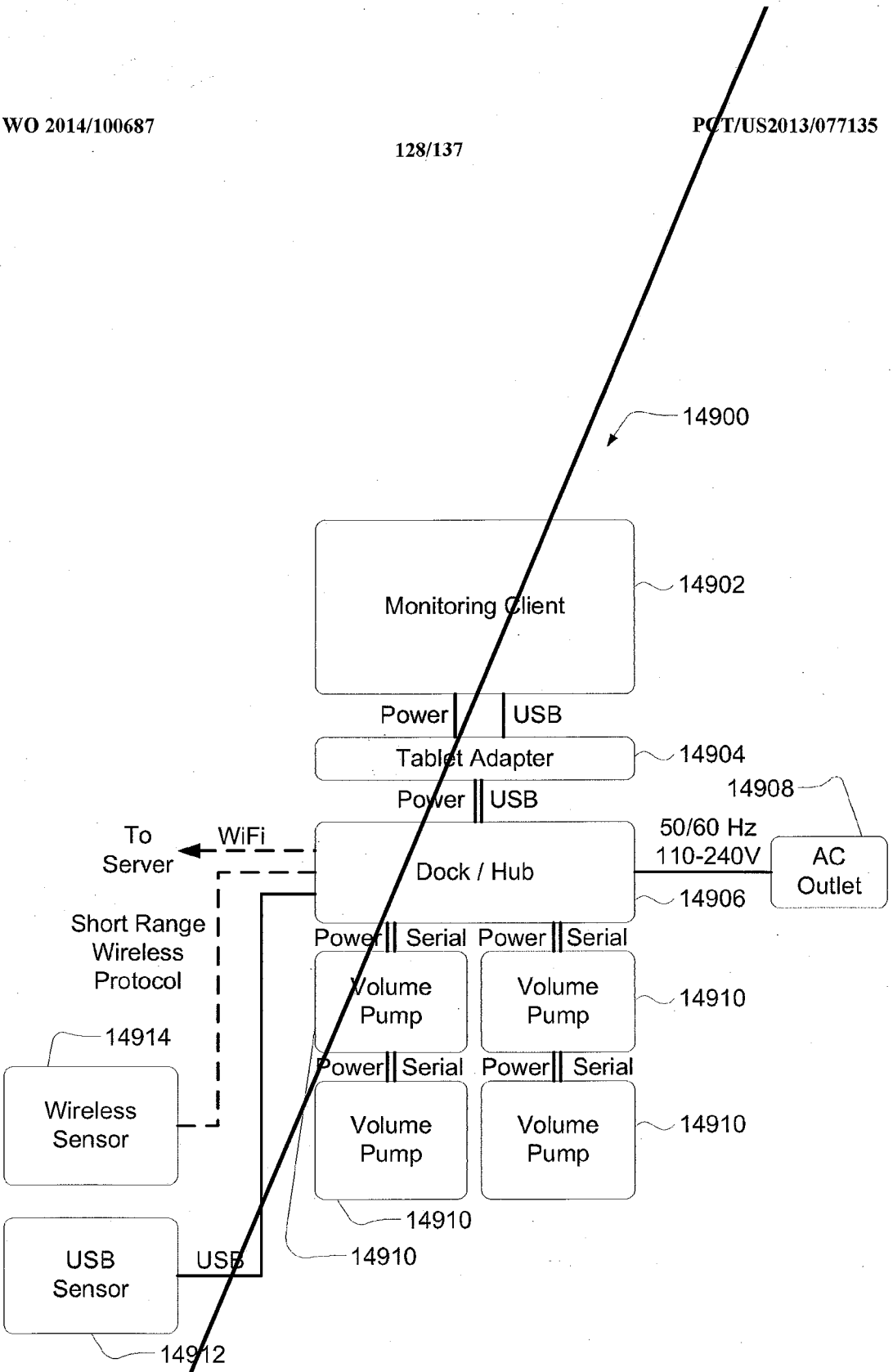

14900
Monitoring Client
14902
Power
USB
Tablet Adapter
14904
Power
USB
14908
To Server
WiFi
Dock / Hub
50/60 Hz
110-240V
AC Outlet
14906
Short Range Wireless Protocol
Power
Serial
Power
Serial
Volume Pump
Volume Pump
14910
14914
Power
Serial
Power
Serial
Wireless Sensor
Volume Pump
Volume Pump
14910
14910
USB Sensor
USB
14910
14912

FIG. 149

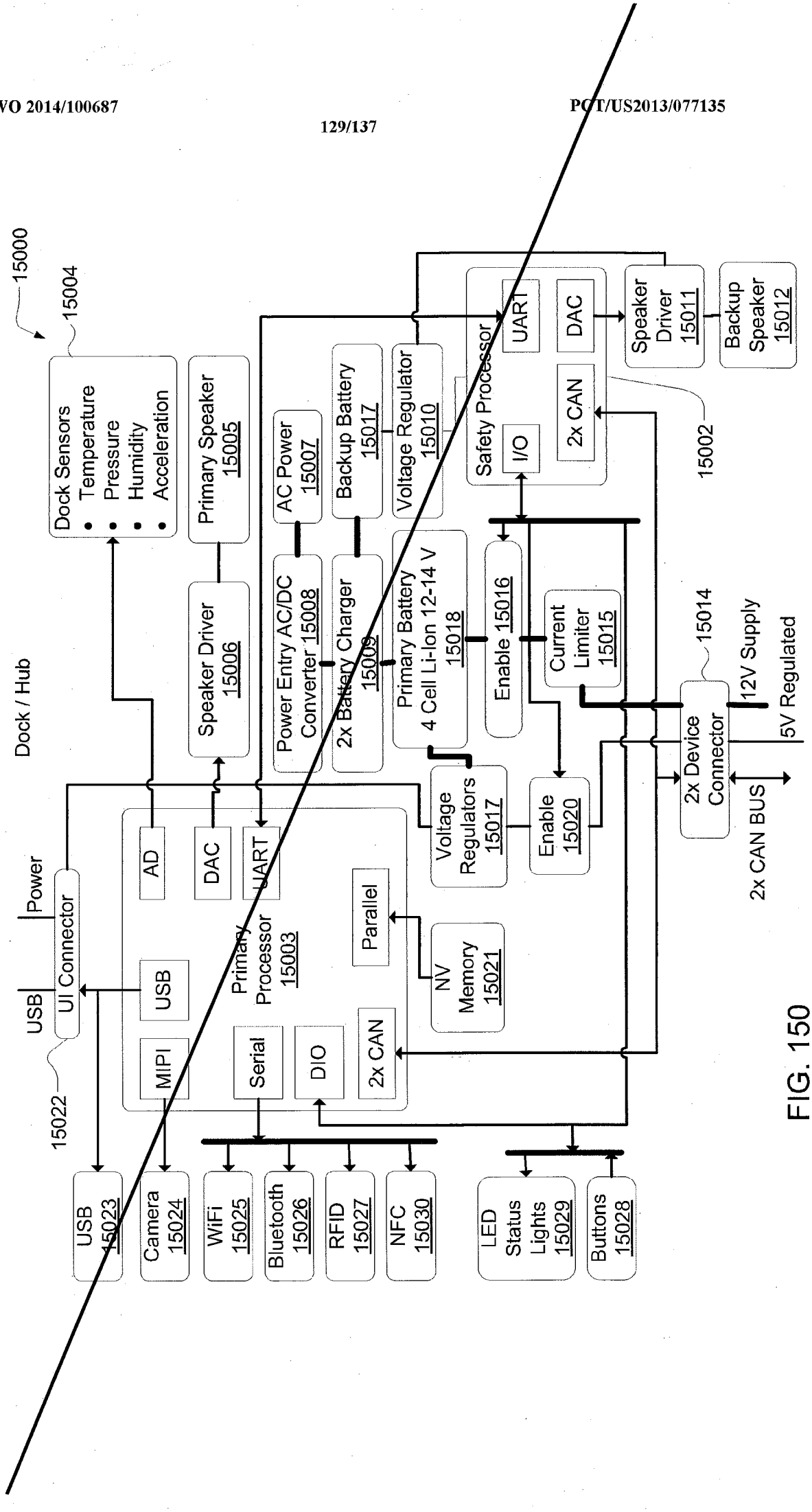

15000
15004
Dock Sensors
• Temperature
• Pressure
• Humidity
• Acceleration
Primary Speaker 15005
AC Power 15007
Backup Battery 15017
Voltage Regulator 15010
Safety Processor
UART
DAC
I/O
2x CAN
15002
Speaker Driver 15011
Backup Speaker 15012
Dock / Hub
Speaker Driver 15006
Power Entry AC/DC Converter 15008
2x Battery Charger 15009
Primary Battery 4 Cell Li-Ion 12-14 V 15018
Enable 15016
Current Limiter 15015
15014
2x Device Connector
12V Supply
5V Regulated
2x CAN BUS
Power
USB
UI Connector
15022
AD
DAC
UART
Primary Processor 15003
USB
MIPI
Serial
DIO
2x CAN
Parallel
NV Memory 15021
Voltage Regulators 15017
Enable 15020
USB 15023
Camera 15024
WiFi 15025
Bluetooth 15026
RFID 15027
NFC 15030
LED Status Lights 15029
Buttons 15028

FIG. 150

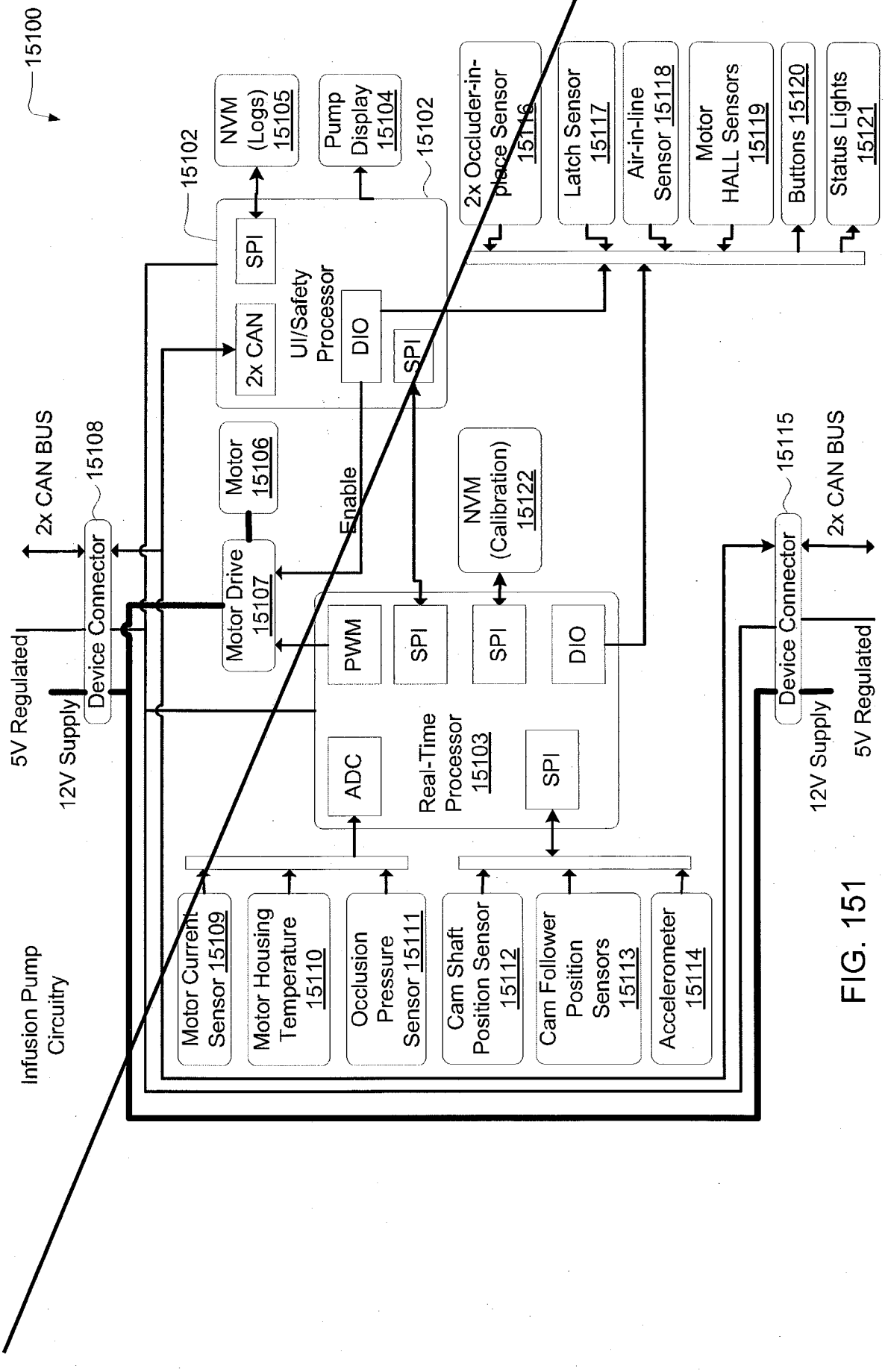

15100
Infusion Pump Circuitry
Motor Current Sensor 15109
Motor Housing Temperature 15110
Occlusion Pressure Sensor 15111
Cam Shaft Position Sensor 15112
Cam Follower Position Sensors 15113
Accelerometer 15114
Real-Time Processor 15103
ADC
PWM
SPI
SPI
SPI
DIO
Motor Drive 15107
Motor 15106
Enable
NVM (Calibration) 15122
5V Regulated
12V Supply
Device Connector
15108
2x CAN BUS
15115
UI/Safety Processor
2x CAN
SPI
DIO
SPI
15102
15102
NVM (Logs) 15105
Pump Display 15104
2x Occluder-in-place Sensor 15116
Latch Sensor 15117
Air-in-line Sensor 15118
Motor HALL Sensors 15119
Buttons 15120
Status Lights 15121

FIG. 151

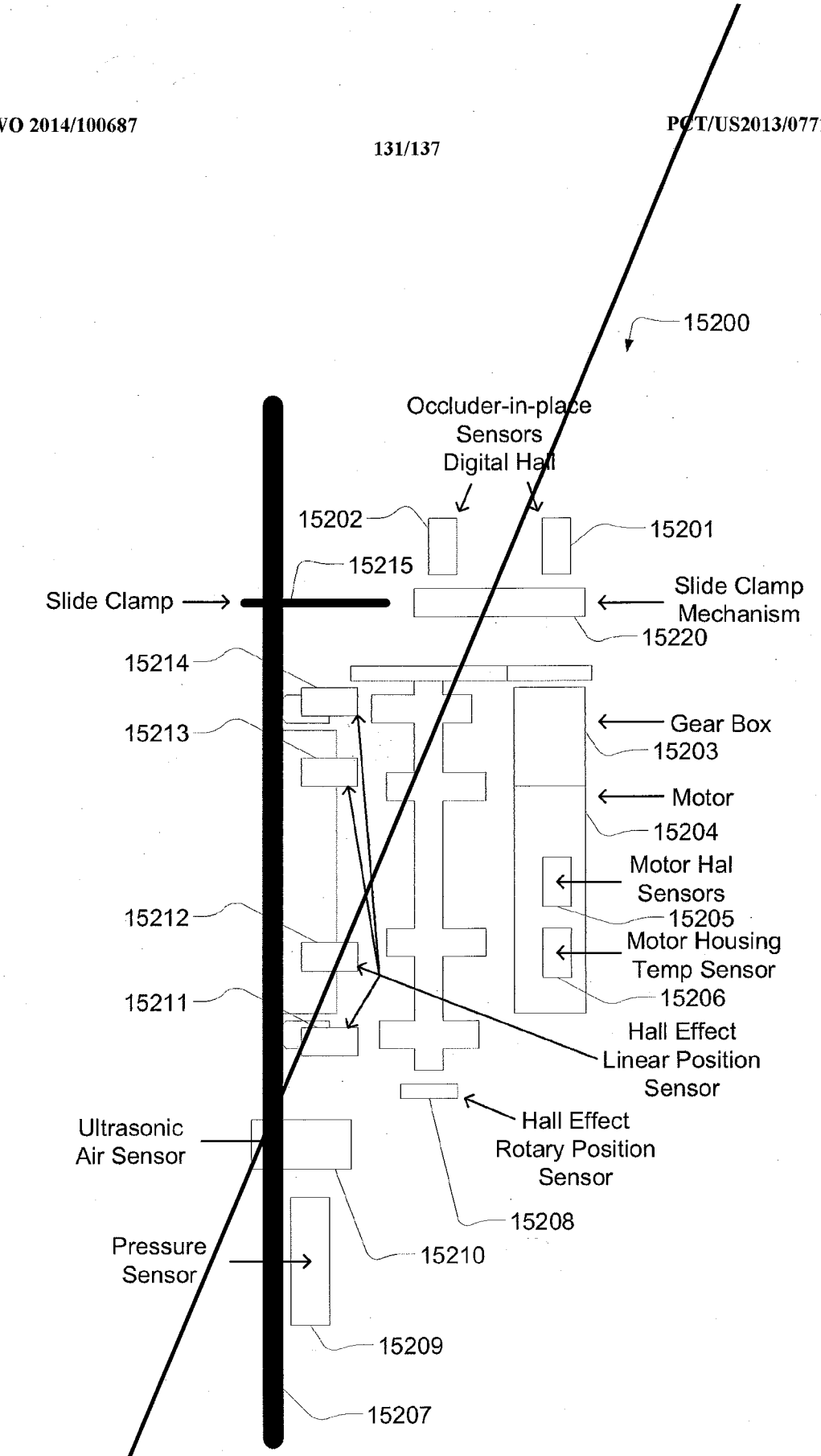

15200
Occluder-in-place Sensors Digital Hall
15202
15201
15215
Slide Clamp
Slide Clamp Mechanism
15220
15214
15213
Gear Box
15203
Motor
15204
Motor Hal Sensors
15205
15212
Motor Housing Temp Sensor
15206
15211
Hall Effect Linear Position Sensor
Hall Effect Rotary Position Sensor
Ultrasonic Air Sensor
15208
Pressure Sensor
15210
15209
15207

FIG. 152

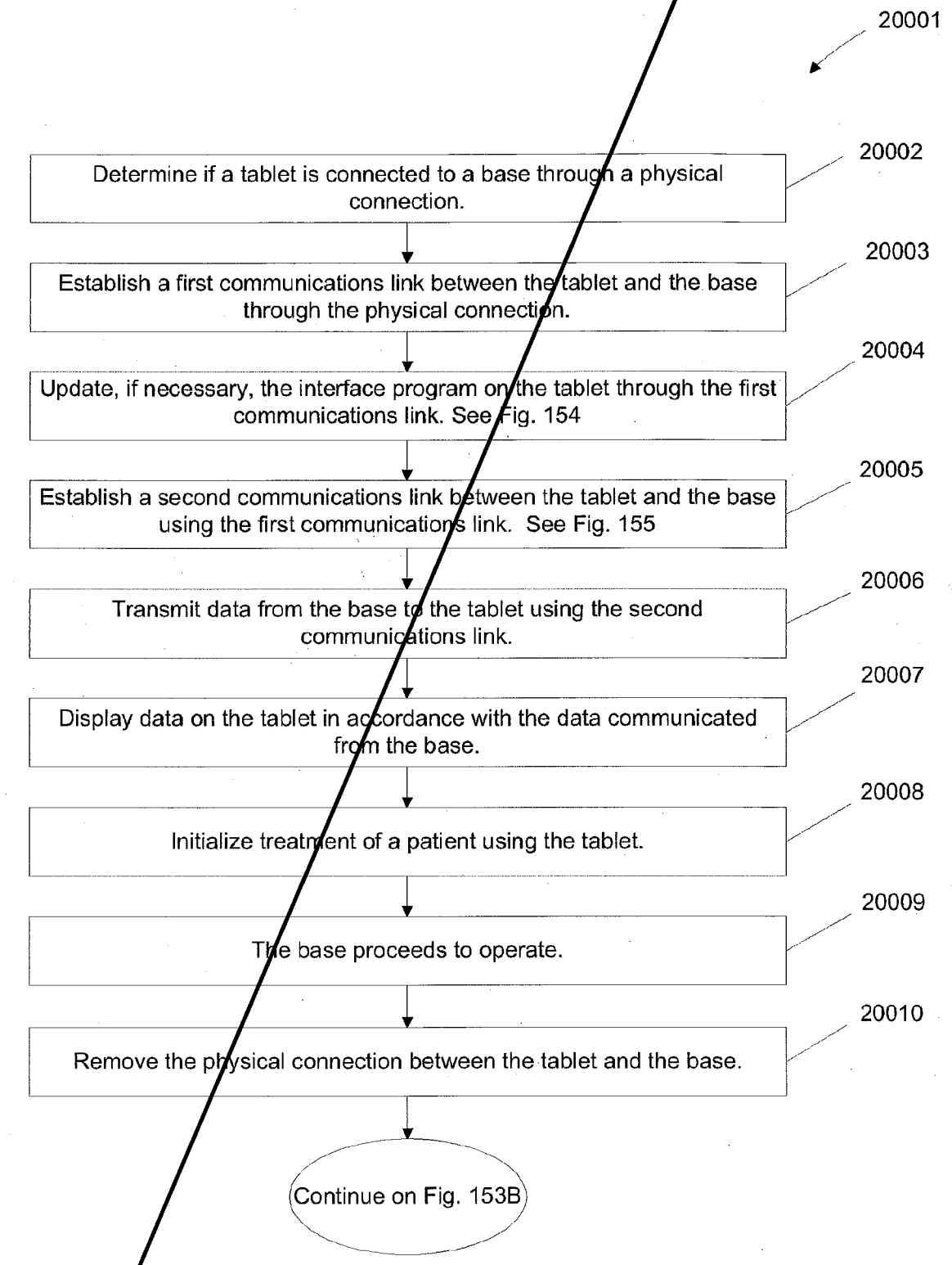

20001
Determine if a tablet is connected to a base through a physical connection.
20002
Establish a first communications link between the tablet and the base through the physical connection.
20003
Update, if necessary, the interface program on the tablet through the first communications link. See Fig. 154
20004
Establish a second communications link between the tablet and the base using the first communications link. See Fig. 155
20005
Transmit data from the base to the tablet using the second communications link.
20006
Display data on the tablet in accordance with the data communicated from the base.
20007
Initialize treatment of a patient using the tablet.
20008
The base proceeds to operate.
20009
Remove the physical connection between the tablet and the base.
20010
Continue on Fig. 153B

Fig. 153A

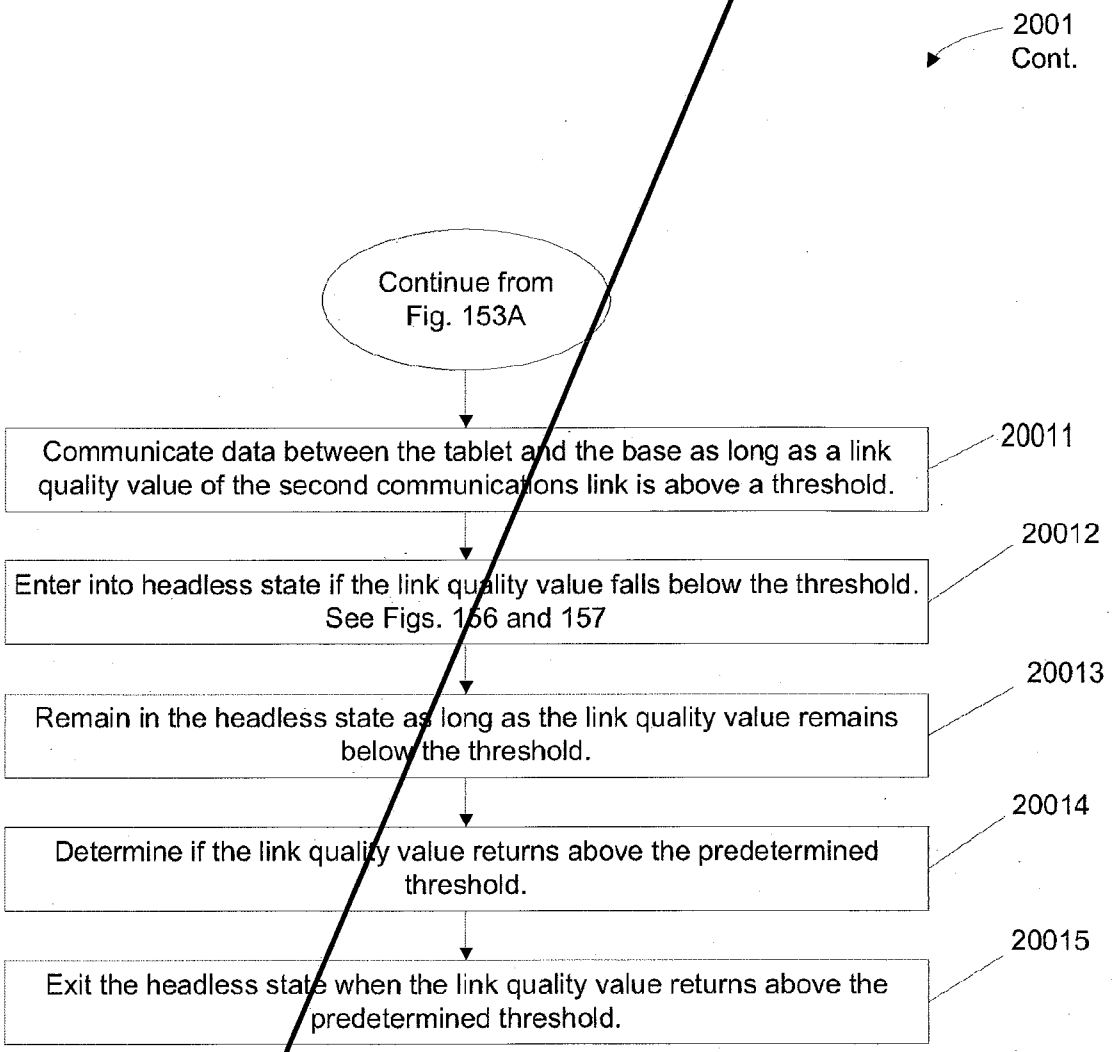

2001
Cont.
Continue from Fig. 153A
Communicate data between the tablet and the base as long as a link quality value of the second communications link is above a threshold.
20011
Enter into headless state if the link quality value falls below the threshold. See Figs. 156 and 157
20012
Remain in the headless state as long as the link quality value remains below the threshold.
20013
Determine if the link quality value returns above the predetermined threshold.
20014
Exit the headless state when the link quality value returns above the predetermined threshold.
20015

Fig. 153B

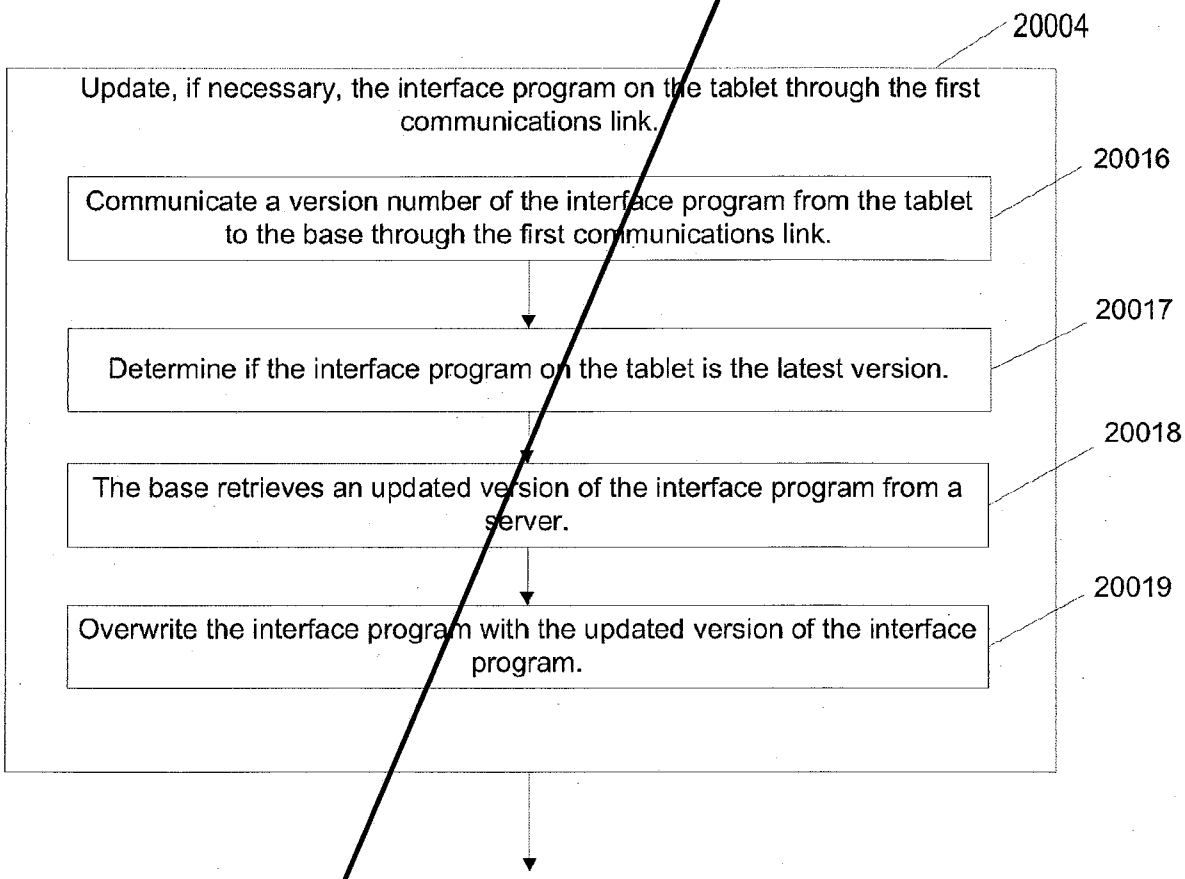

20004
Update, if necessary, the interface program on the tablet through the first communications link.
20016
Communicate a version number of the interface program from the tablet to the base through the first communications link.
20017
Determine if the interface program on the tablet is the latest version.
20018
The base retrieves an updated version of the interface program from a server.
20019
Overwrite the interface program with the updated version of the interface program.

Fig. 154

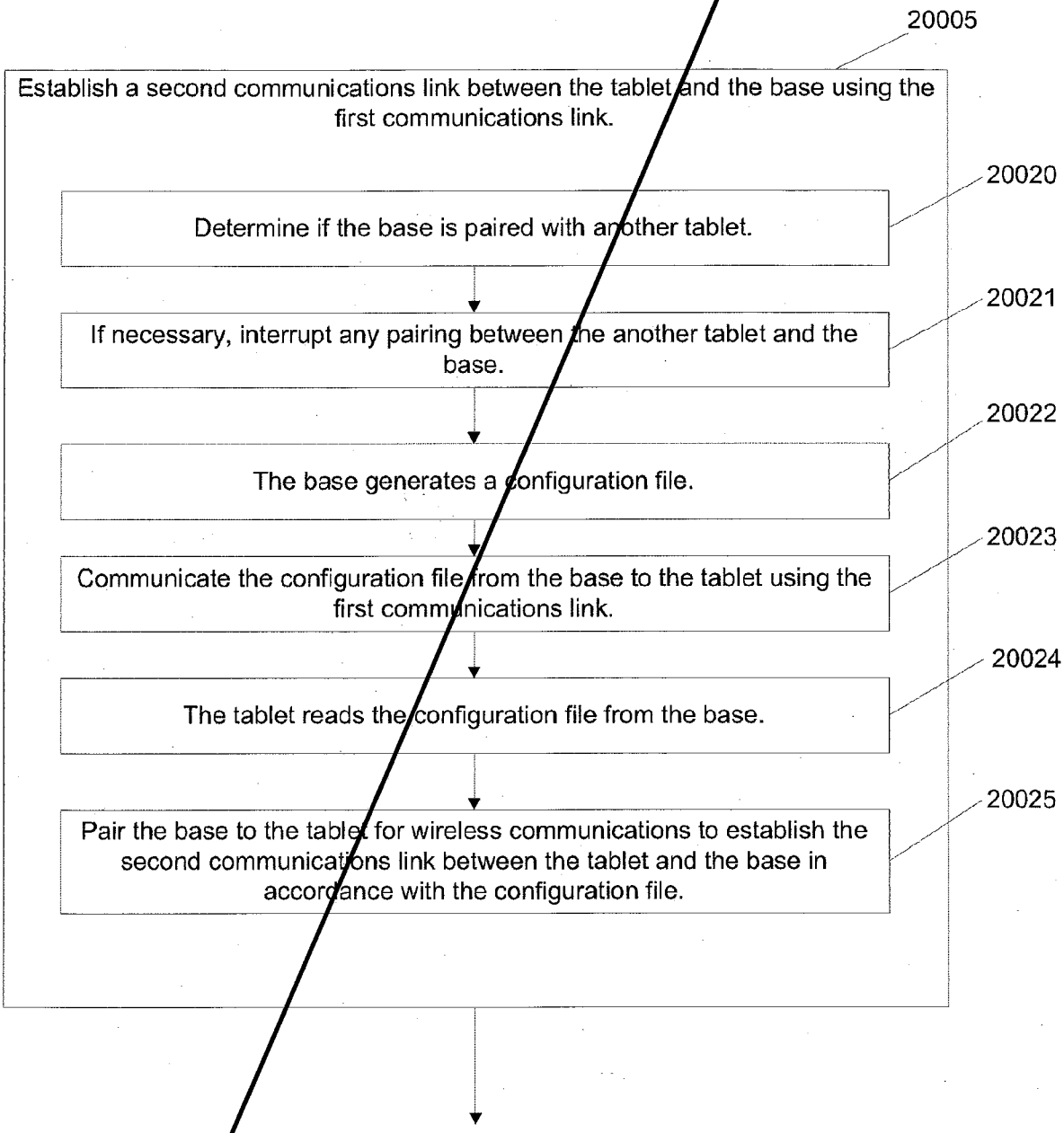

20005
Establish a second communications link between the tablet and the base using the first communications link.
20020
Determine if the base is paired with another tablet.
20021
If necessary, interrupt any pairing between the another tablet and the base.
20022
The base generates a configuration file.
20023
Communicate the configuration file from the base to the tablet using the first communications link.
20024
The tablet reads the configuration file from the base.
20025
Pair the base to the tablet for wireless communications to establish the second communications link between the tablet and the base in accordance with the configuration file.

Fig. 155

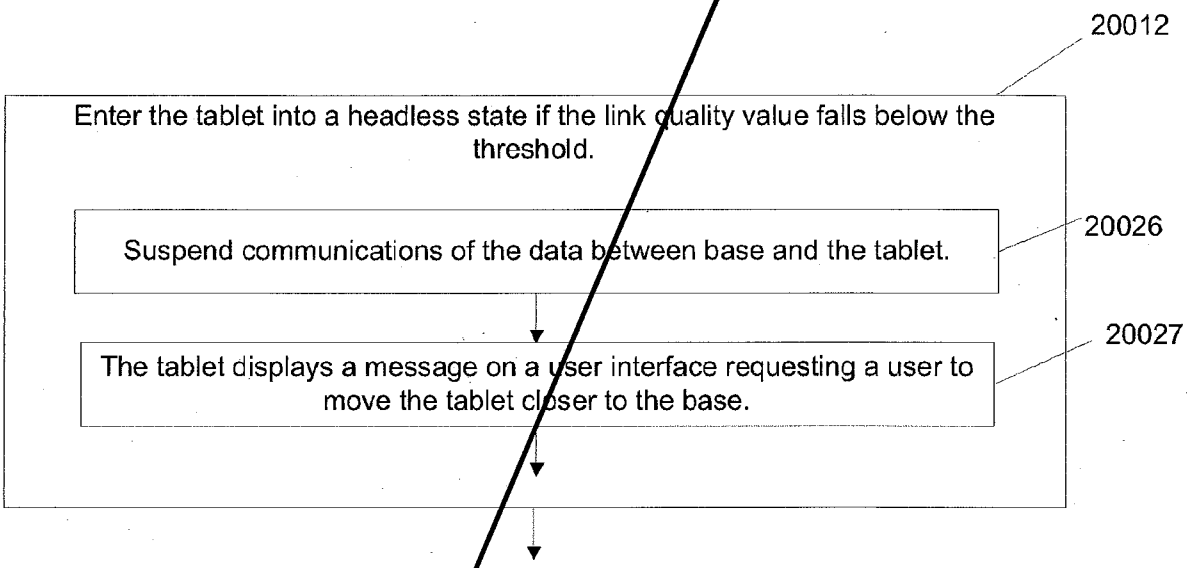

20012
Enter the tablet into a headless state if the link quality value falls below the threshold.
Suspend communications of the data between base and the tablet.
20026
The tablet displays a message on a user interface requesting a user to move the tablet closer to the base.
20027

Fig. 156

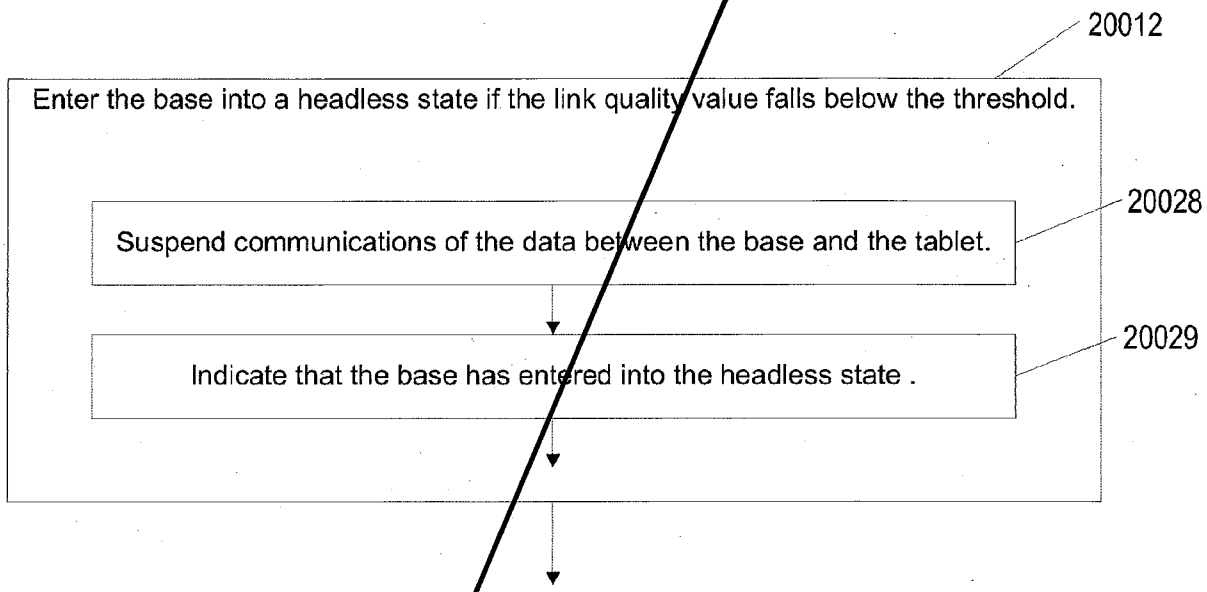
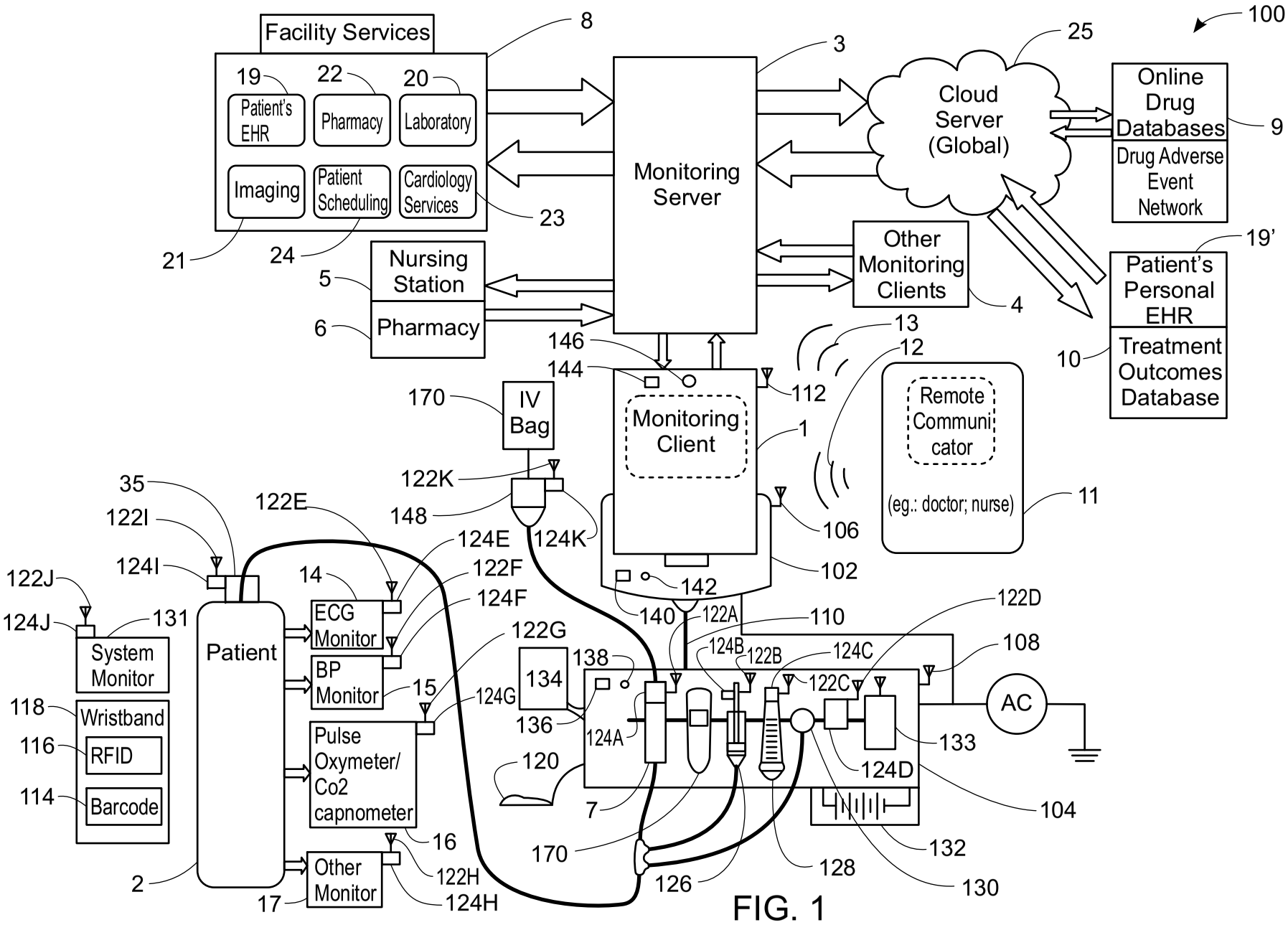

20012
Enter the base into a headless state if the link quality value falls below the threshold.
Suspend communications of the data between the base and the tablet.
20028
Indicate that the base has entered into the headless state .
20029

Fig. 157



Facility Services
Patient's EHR
Pharmacy
Laboratory
Imaging
Patient Scheduling
Cardiology Services
Monitoring Server
Cloud Server (Global)
Online Drug Databases
Drug Adverse Event Network
Patient's Personal EHR
Treatment Outcomes Database
Other Monitoring Clients
Nursing Station
Pharmacy
Monitoring Client
Remote Communicator
(eg.: doctor; nurse)
IV Bag
Patient
ECG Monitor
BP Monitor
Pulse Oxymeter/ Co2 capnometer
Other Monitor
System Monitor
Wristband
RFID
Barcode
AC
100
8
3
25
9
19
22
20
21
24
23
5
6
4
19'
10
13
12
146
144
112
1
170
122K
148
124K
106
11
102
142
140
35
122I
124I
122E
124E
122F
124F
14
122J
124J
131
122G
138
134
136
124A
124B
122B
124C
122C
122D
108
133
124D
104
132
130
128
126
170
7
120
15
124G
118
116
114
16
122H
124H
17
2

FIG. 1

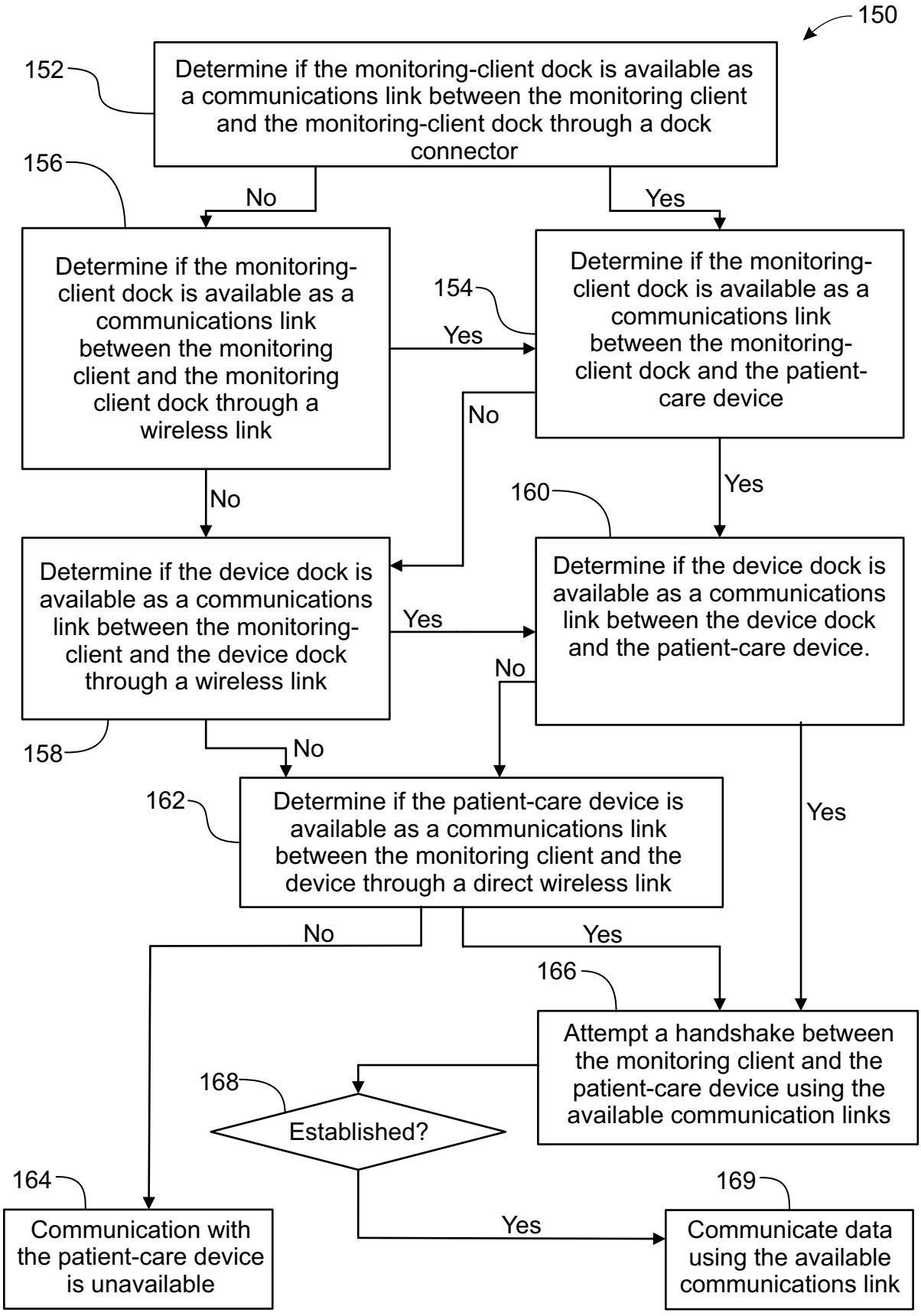

150
152
Determine if the monitoring-client dock is available as a communications link between the monitoring client and the monitoring-client dock through a dock connector
156
No
Yes
Determine if the monitoring-client dock is available as a communications link between the monitoring client and the monitoring client dock through a wireless link
154
Yes
Determine if the monitoring-client dock is available as a communications link between the monitoring-client dock and the patient-care device
No
Yes
No
160
Determine if the device dock is available as a communications link between the monitoring-client and the device dock through a wireless link
Yes
Determine if the device dock is available as a communications link between the device dock and the patient-care device.
No
158
No
Yes
162
Determine if the patient-care device is available as a communications link between the monitoring client and the device through a direct wireless link
No
Yes
166
Attempt a handshake between the monitoring client and the patient-care device using the available communication links
168
Established?
164
Communication with the patient-care device is unavailable
Yes
169
Communicate data using the available communications link

FIG. 2

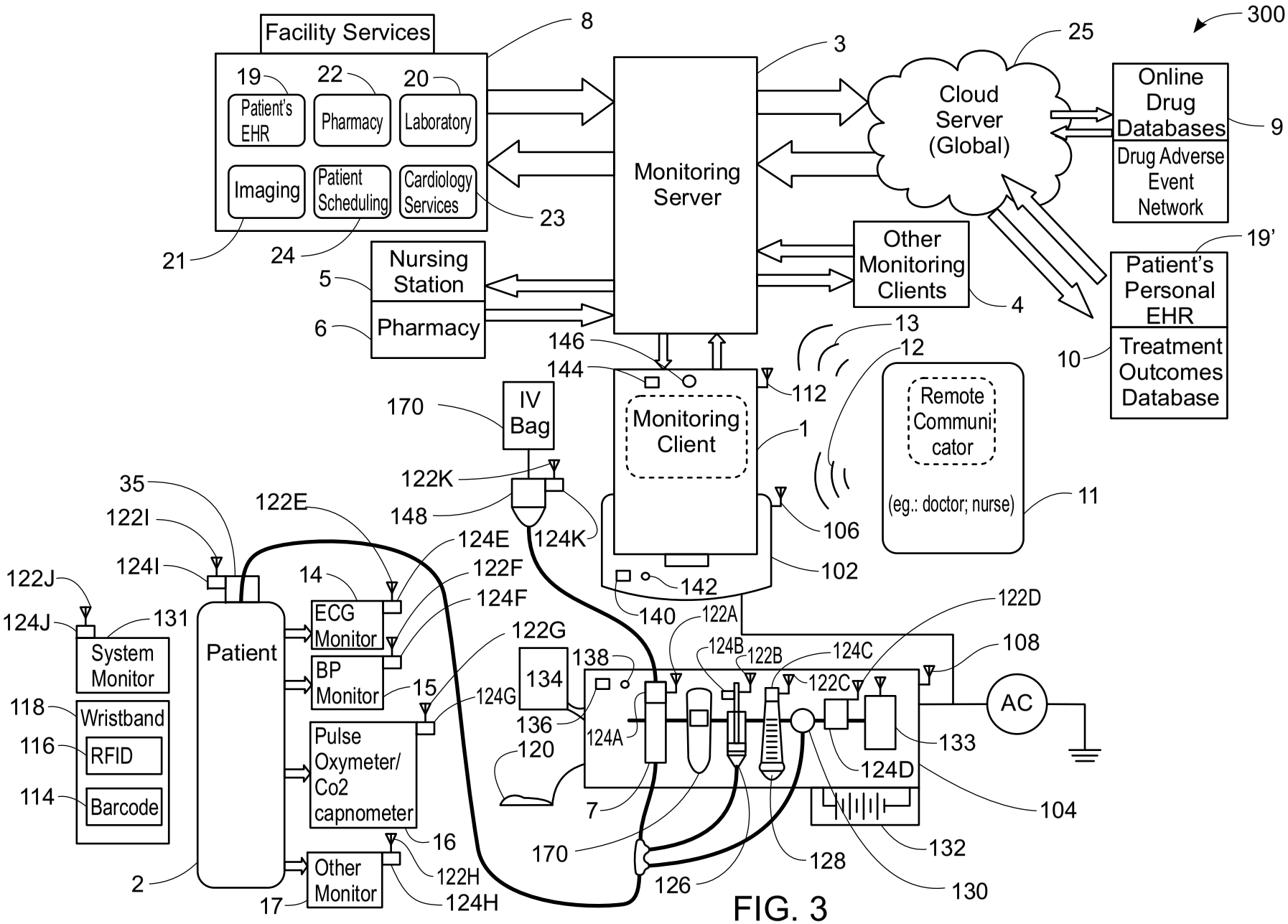

300
Facility Services
8
19
Patient's EHR
22
Pharmacy
20
Laboratory
Imaging
Patient Scheduling
Cardiology Services
23
21
24
Nursing Station
5
Pharmacy
6
Monitoring Server
3
Cloud Server (Global)
25
Online Drug Databases
9
Drug Adverse Event Network
Other Monitoring Clients
4
19'
Patient's Personal EHR
10
Treatment Outcomes Database
146
144
112
13
12
Monitoring Client
1
Remote Communicator
(eg.: doctor; nurse)
11
170
IV Bag
122K
148
124K
106
102
142
140
35
122I
124I
122E
124E
122F
124F
14
ECG Monitor
BP Monitor
15
122G
124G
Pulse Oxymeter/ Co2 capnometer
16
Other Monitor
17
122H
124H
2
Patient
122J
124J
131
System Monitor
118
Wristband
116
RFID
114
Barcode
134
138
136
120
7
170
126
122A
124B
122B
124C
122C
124A
122D
108
AC
133
124D
104
132
128
130

FIG. 3

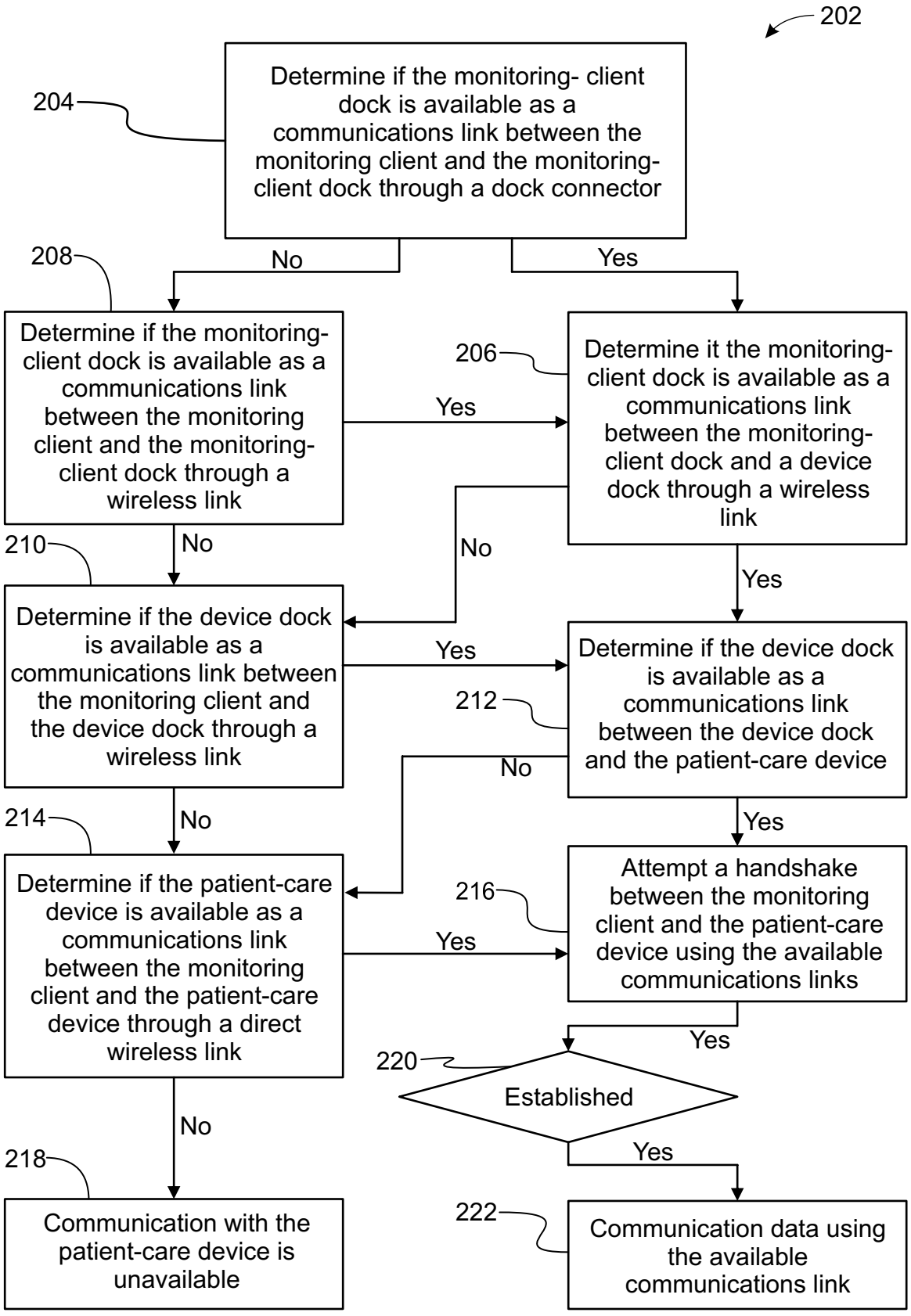

202
Determine if the monitoring- client dock is available as a communications link between the monitoring client and the monitoring-client dock through a dock connector
204
No
Yes
208
Determine if the monitoring-client dock is available as a communications link between the monitoring client and the monitoring-client dock through a wireless link
206
Determine it the monitoring-client dock is available as a communications link between the monitoring-client dock and a device dock through a wireless link
Yes
No
210
Determine if the device dock is available as a communications link between the monitoring client and the device dock through a wireless link
Yes
No
212
Determine if the device dock is available as a communications link between the device dock and the patient-care device
Yes
No
214
Determine if the patient-care device is available as a communications link between the monitoring client and the patient-care device through a direct wireless link
Yes
216
Attempt a handshake between the monitoring client and the patient-care device using the available communications links
Yes
220
Established
Yes
No
218
Communication with the patient-care device is unavailable
222
Communication data using the available communications link

FIG. 4

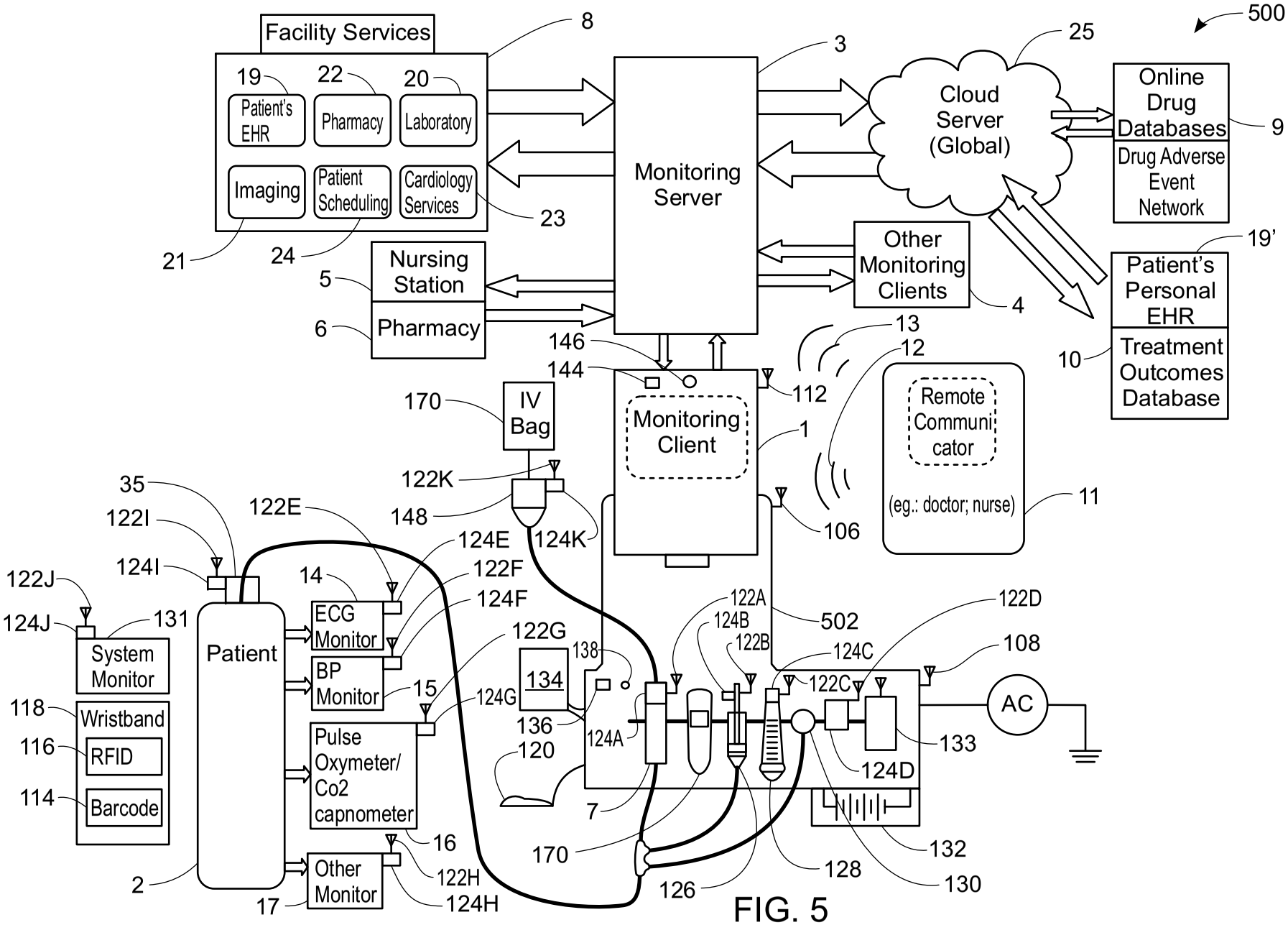

500
Facility Services
8
19
Patient's EHR
22
Pharmacy
20
Laboratory
Imaging
Patient Scheduling
Cardiology Services
23
21
24
Nursing Station
5
Pharmacy
6
Monitoring Server
3
Cloud Server (Global)
25
Online Drug Databases
9
Drug Adverse Event Network
Other Monitoring Clients
4
19'
Patient's Personal EHR
10
Treatment Outcomes Database
146
144
Monitoring Client
1
112
13
12
Remote Communi cator
(eg.: doctor; nurse)
11
106
170
IV Bag
122K
148
124K
35
122I
124I
122E
124E
122F
124F
14
ECG Monitor
BP Monitor
15
122G
124G
134
138
136
120
124A
122A
124B
122B
502
124C
122C
122D
108
AC
133
124D
132
130
128
126
170
7
122J
124J
131
System Monitor
118
Wristband
116
RFID
114
Barcode
Patient
Pulse Oxymeter/ Co2 capnometer
16
Other Monitor
17
122H
124H
2

FIG. 5

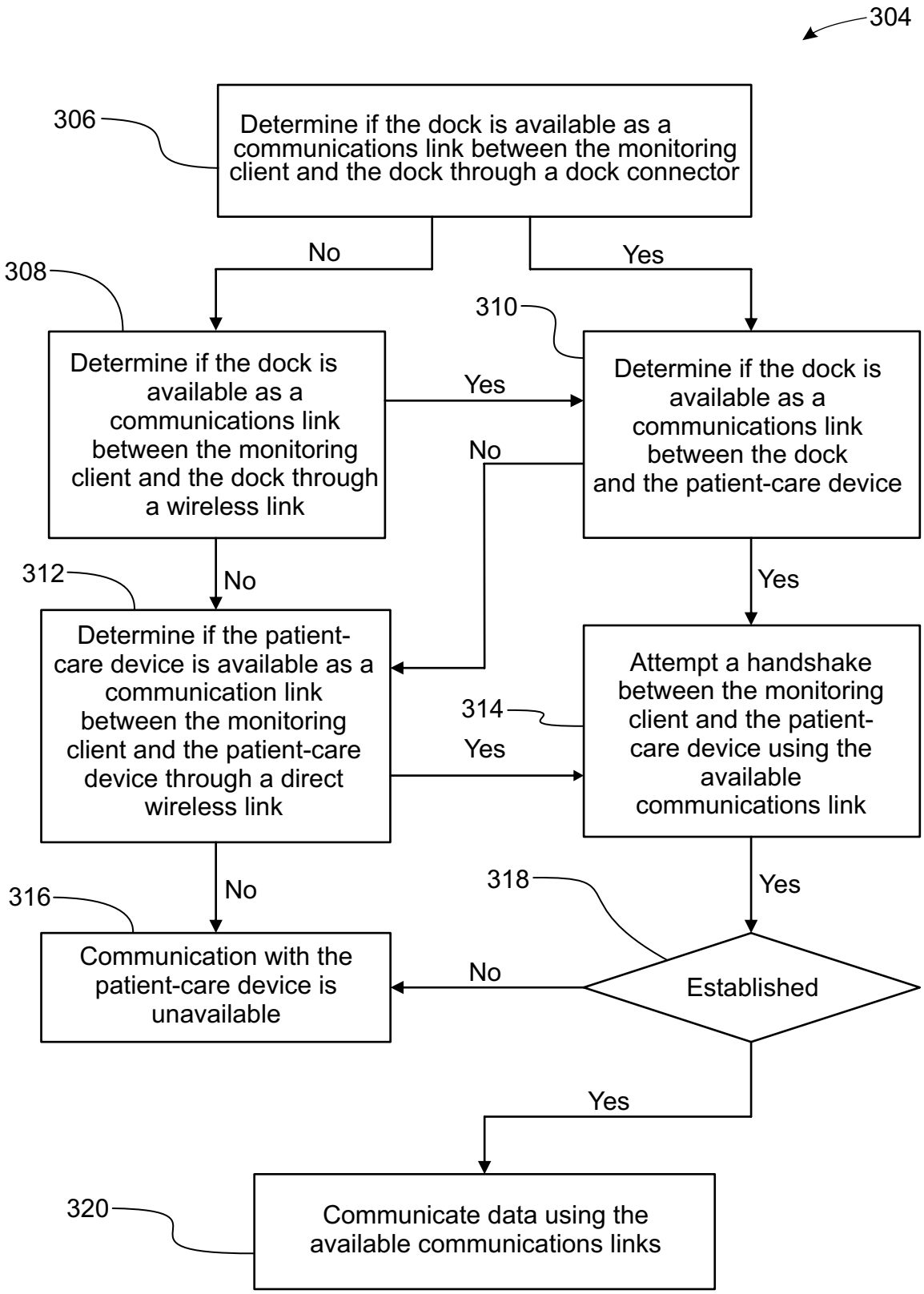

304
306
Determine if the dock is available as a communications link between the monitoring client and the dock through a dock connector
No
Yes
308
310
Determine if the dock is available as a communications link between the monitoring client and the dock through a wireless link
Yes
Determine if the dock is available as a communications link between the dock and the patient-care device
No
No
Yes
312
Determine if the patient-care device is available as a communication link between the monitoring client and the patient-care device through a direct wireless link
314
Yes
Attempt a handshake between the monitoring client and the patient-care device using the available communications link
No
Yes
316
318
Communication with the patient-care device is unavailable
No
Established
Yes
320
Communicate data using the available communications links

FIG. 6

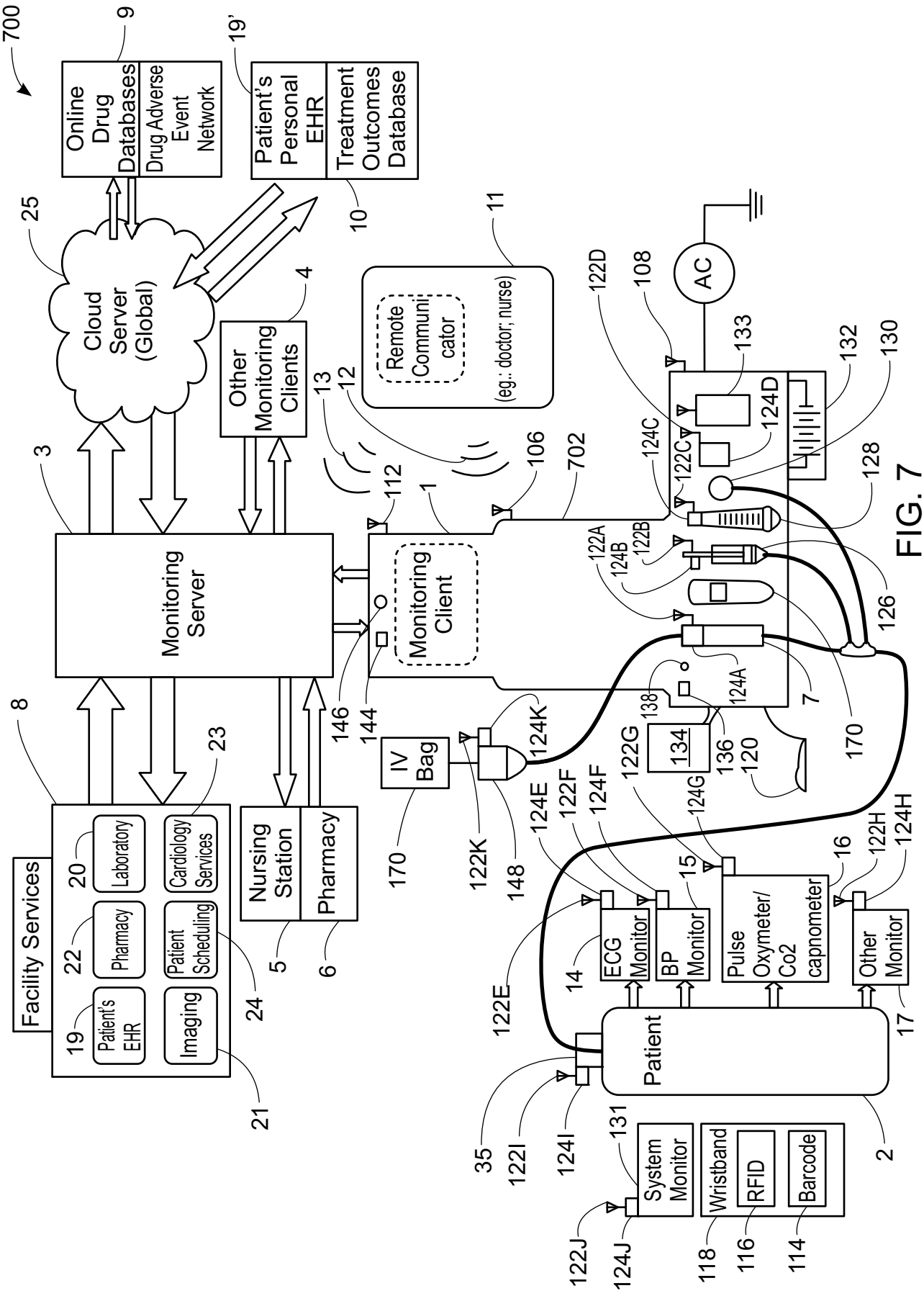

700
Online Drug Databases
Drug Adverse Event Network
Patient's Personal EHR
Treatment Outcomes Database
Cloud Server (Global)
Other Monitoring Clients
Remote Communicator
(eg.: doctor; nurse)
Monitoring Server
Monitoring Client
AC
IV Bag
Facility Services
Laboratory
Pharmacy
Patient's EHR
Cardiology Services
Patient Scheduling
Imaging
Nursing Station
Pharmacy
ECG Monitor
BP Monitor
Pulse Oxymeter/ Co2 capnometer
Other Monitor
Patient
System Monitor
Wristband
RFID
Barcode

FIG. 7

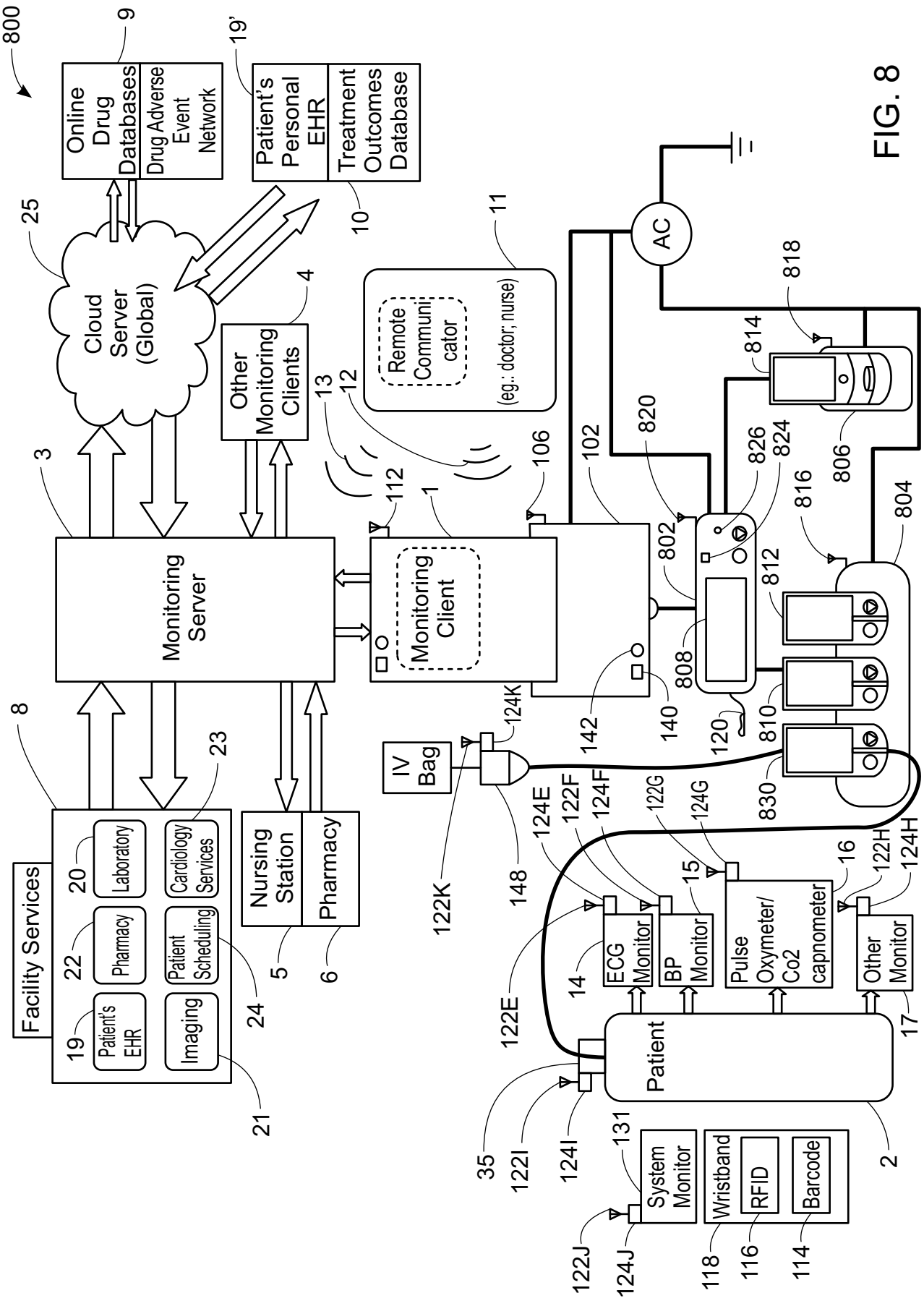

800
Online Drug Databases
Drug Adverse Event Network
9
Patient's Personal EHR
Treatment Outcomes Database
19'
10
25
Cloud Server (Global)
Other Monitoring Clients
4
3
Monitoring Server
Monitoring Client
1
Remote Communi cator
(eg.: doctor; nurse)
11
13
12
112
106
102
AC
818
814
806
820
826
824
816
804
802
812
808
140
142
120
810
830
IV Bag
124K
122K
148
124E
122F
124F
122G
124G
15
16
122H
124H
122E
14
ECG Monitor
BP Monitor
Pulse Oxymeter/ Co2 capnometer
Other Monitor
17
Patient
2
35
122I
124I
131
System Monitor
122J
124J
Wristband
RFID
Barcode
118
116
114
Facility Services
8
20
Laboratory
22
Pharmacy
19
Patient's EHR
Cardiology Services
Patient Scheduling
Imaging
23
24
21
Nursing Station
5
Pharmacy
6

FIG. 8

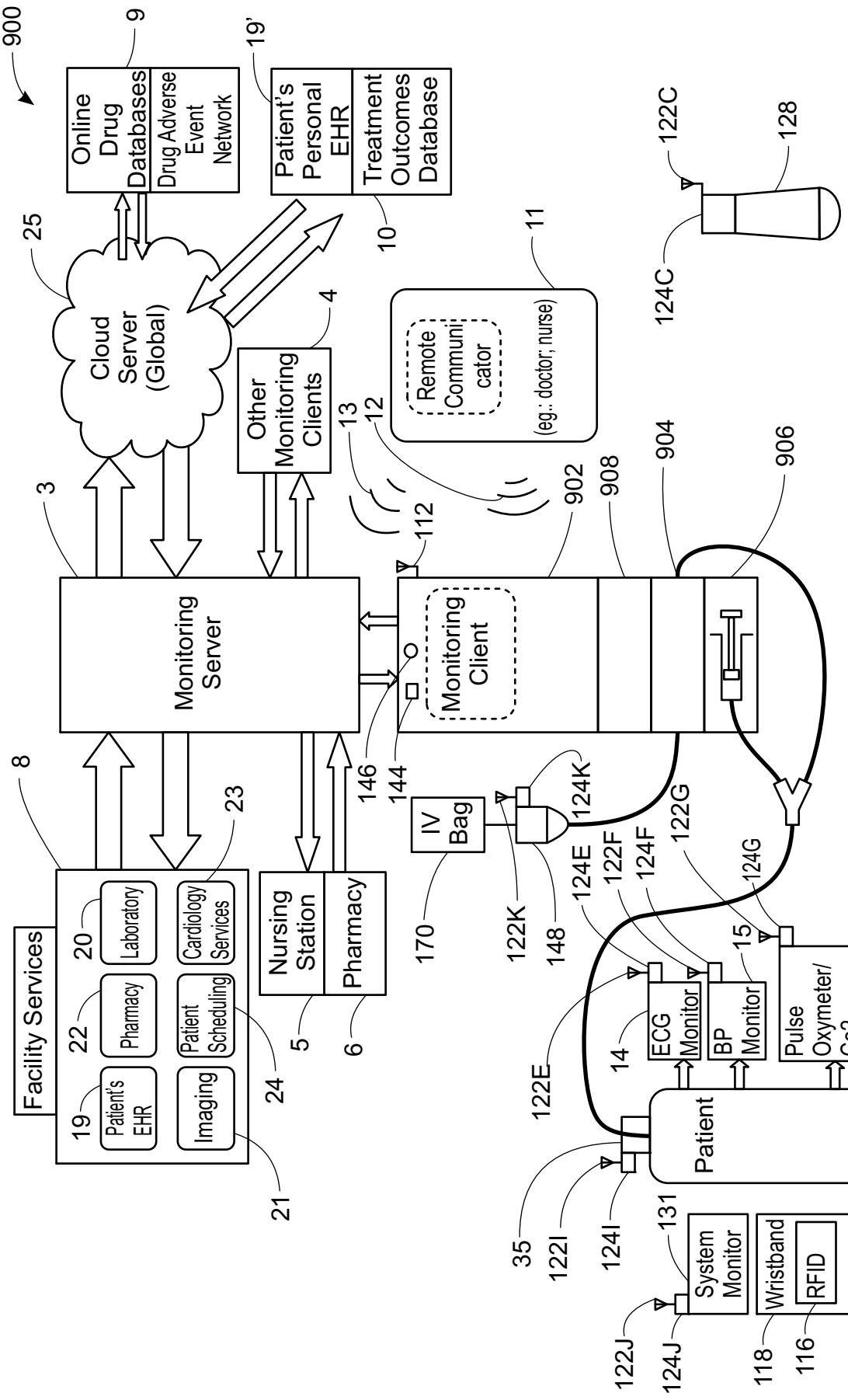

900
Online Drug Databases
Drug Adverse Event Network
9
Patient's Personal EHR
Treatment Outcomes Database
19'
10
Cloud Server (Global)
25
Other Monitoring Clients
4
Remote Communicator
(eg.: doctor; nurse)
11
13
12
112
902
908
904
906
3
Monitoring Server
Monitoring Client
146
144
122C
124C
128
Facility Services
8
Laboratory
20
Pharmacy
22
Patient's EHR
19
Imaging
21
Cardiology Services
23
Patient Scheduling
24
Nursing Station
5
Pharmacy
6
IV Bag
170
122K
124K
148
122E
124E
122F
124F
122G
124G
15
ECG Monitor
14
BP Monitor
Pulse Oxymeter/ Co2 capnometer
16
Other Monitor
17
122H
124H
Patient
2
35
122I
124I
131
System Monitor
122J
124J
Wristband
118
RFID
116
Barcode
114

FIG. 9

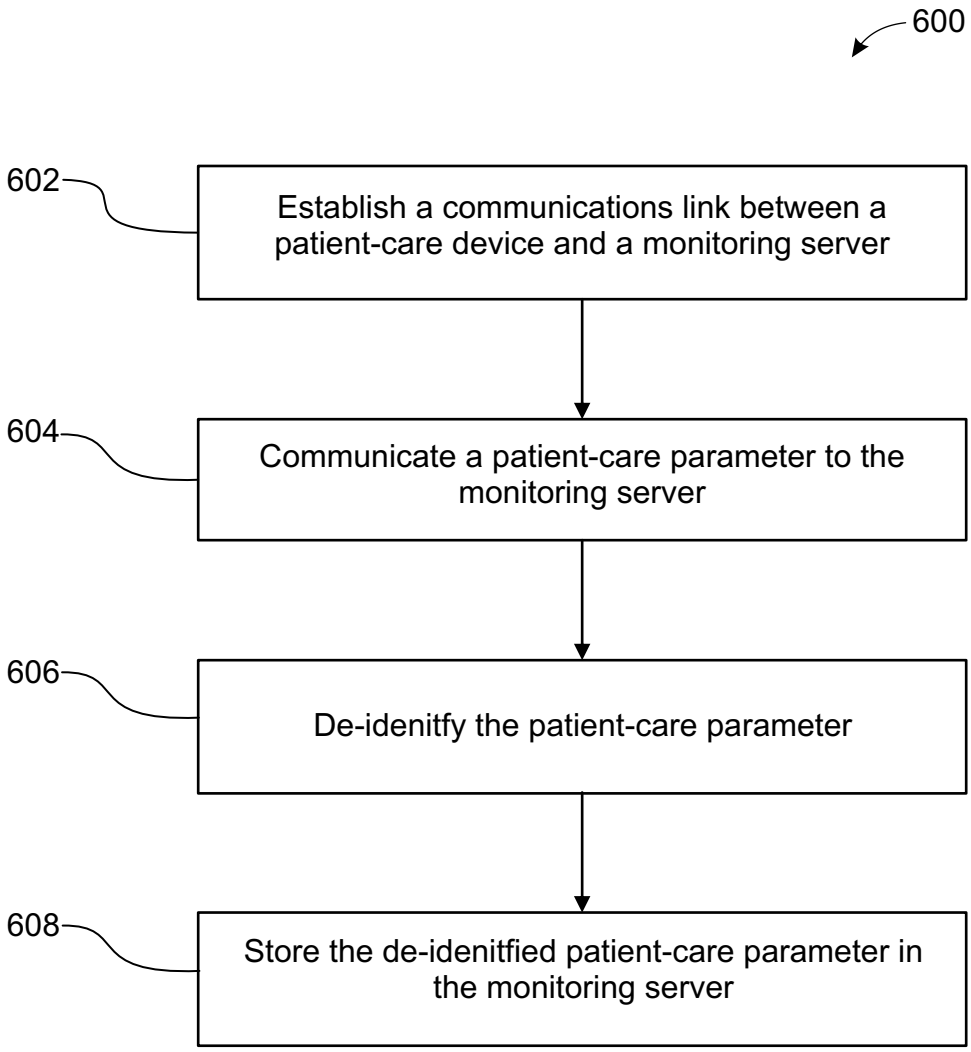

600
602
Establish a communications link between a patient-care device and a monitoring server
604
Communicate a patient-care parameter to the monitoring server
606
De-idenitfy the patient-care parameter
608
Store the de-idenitfied patient-care parameter in the monitoring server

FIG. 10

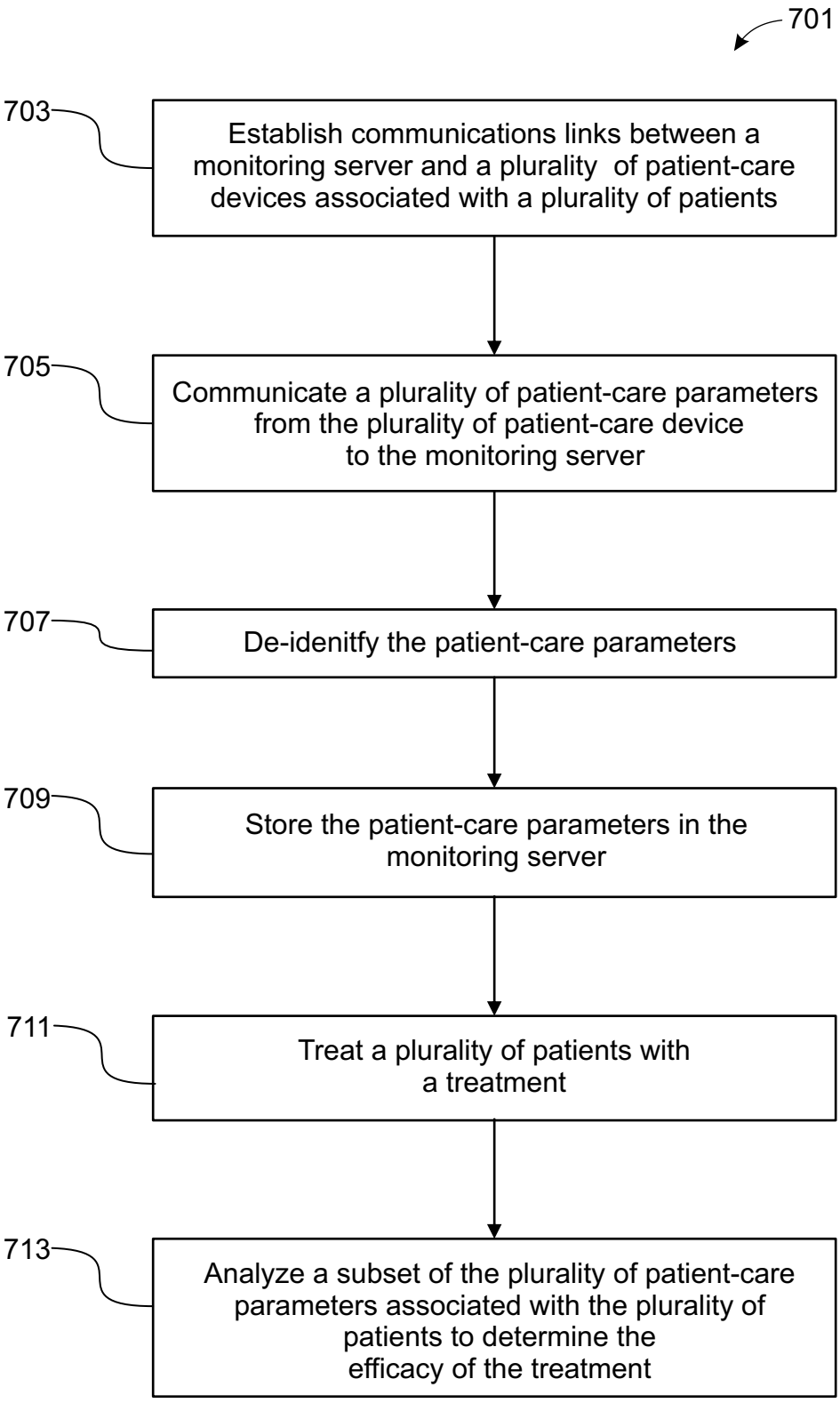

701
703
Establish communications links between a monitoring server and a plurality of patient-care devices associated with a plurality of patients
705
Communicate a plurality of patient-care parameters from the plurality of patient-care device to the monitoring server
707
De-idenitfy the patient-care parameters
709
Store the patient-care parameters in the monitoring server
711
Treat a plurality of patients with a treatment
713
Analyze a subset of the plurality of patient-care parameters associated with the plurality of patients to determine the efficacy of the treatment

FIG. 11

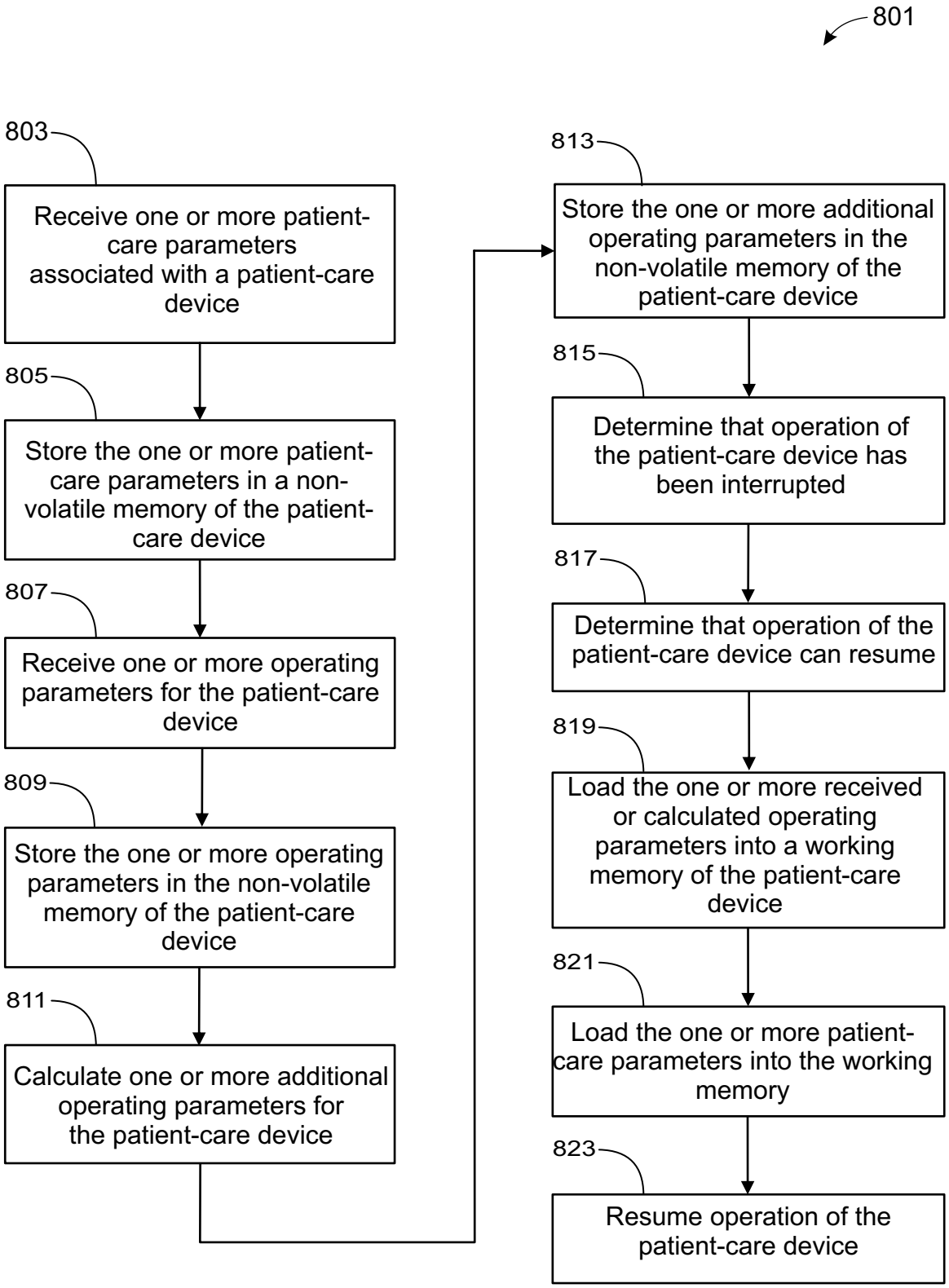

801
803
Receive one or more patient-care parameters associated with a patient-care device
805
Store the one or more patient-care parameters in a non-volatile memory of the patient-care device
807
Receive one or more operating parameters for the patient-care device
809
Store the one or more operating parameters in the non-volatile memory of the patient-care device
811
Calculate one or more additional operating parameters for the patient-care device
813
Store the one or more additional operating parameters in the non-volatile memory of the patient-care device
815
Determine that operation of the patient-care device has been interrupted
817
Determine that operation of the patient-care device can resume
819
Load the one or more received or calculated operating parameters into a working memory of the patient-care device
821
Load the one or more patient-care parameters into the working memory
823
Resume operation of the patient-care device

FIG. 12

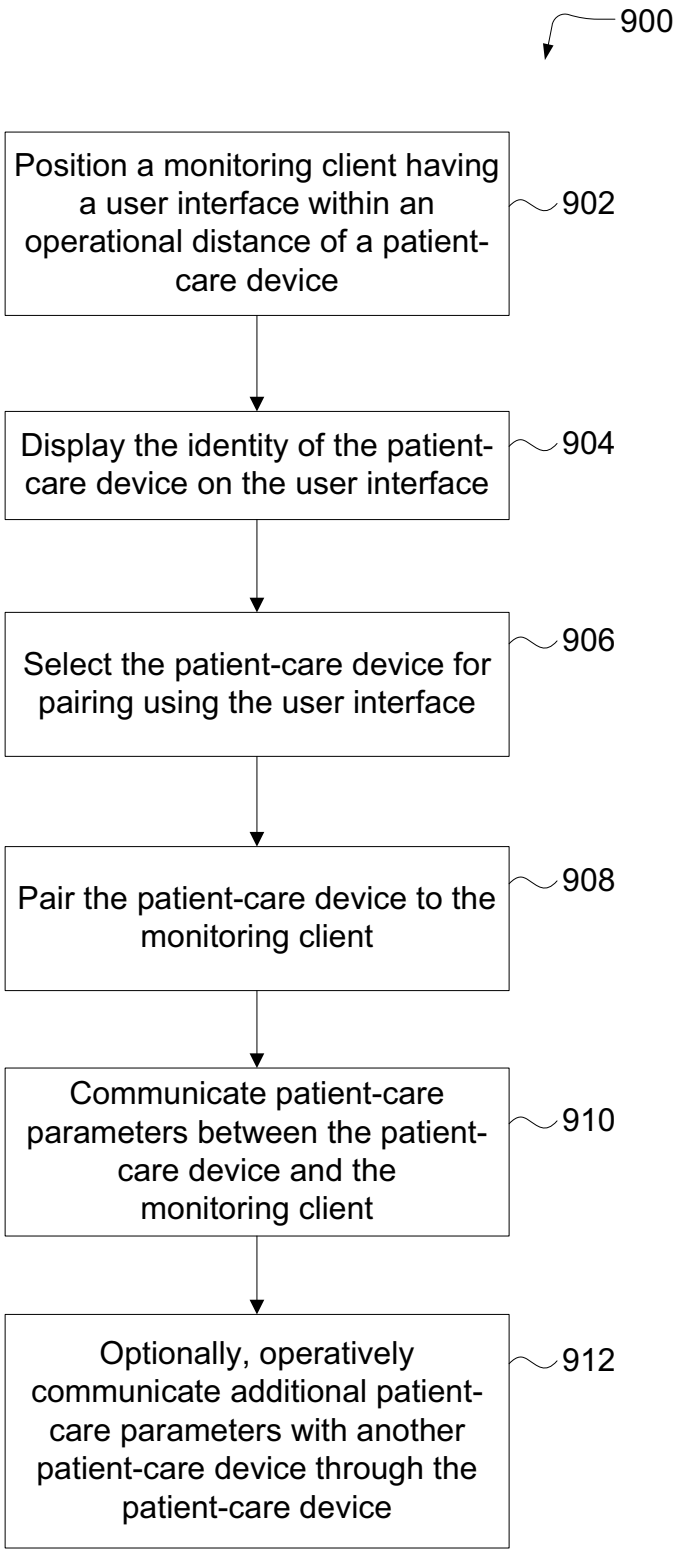

900
Position a monitoring client having a user interface within an operational distance of a patient-care device
902
Display the identity of the patient-care device on the user interface
904
Select the patient-care device for pairing using the user interface
906
Pair the patient-care device to the monitoring client
908
Communicate patient-care parameters between the patient-care device and the monitoring client
910
Optionally, operatively communicate additional patient-care parameters with another patient-care device through the patient-care device
912

FIG. 13

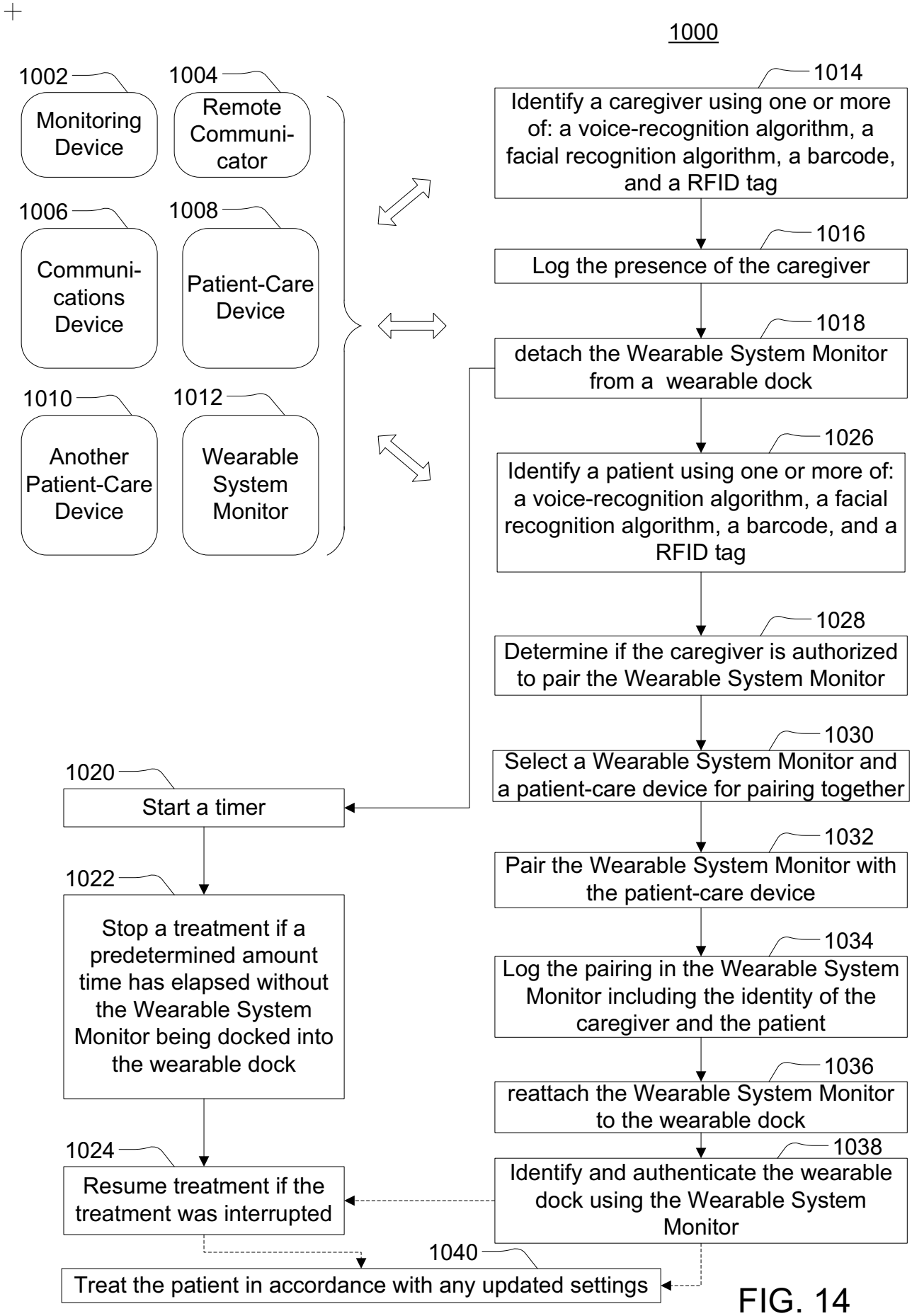

1000
1002
Monitoring Device
1004
Remote Communi-cator
1006
Communi-cations Device
1008
Patient-Care Device
1010
Another Patient-Care Device
1012
Wearable System Monitor
1014
Identify a caregiver using one or more of: a voice-recognition algorithm, a facial recognition algorithm, a barcode, and a RFID tag
1016
Log the presence of the caregiver
1018
detach the Wearable System Monitor from a wearable dock
1020
Start a timer
1022
Stop a treatment if a predetermined amount time has elapsed without the Wearable System Monitor being docked into the wearable dock
1024
Resume treatment if the treatment was interrupted
1026
Identify a patient using one or more of: a voice-recognition algorithm, a facial recognition algorithm, a barcode, and a RFID tag
1028
Determine if the caregiver is authorized to pair the Wearable System Monitor
1030
Select a Wearable System Monitor and a patient-care device for pairing together
1032
Pair the Wearable System Monitor with the patient-care device
1034
Log the pairing in the Wearable System Monitor including the identity of the caregiver and the patient
1036
reattach the Wearable System Monitor to the wearable dock
1038
Identify and authenticate the wearable dock using the Wearable System Monitor
1040
Treat the patient in accordance with any updated settings

FIG. 14

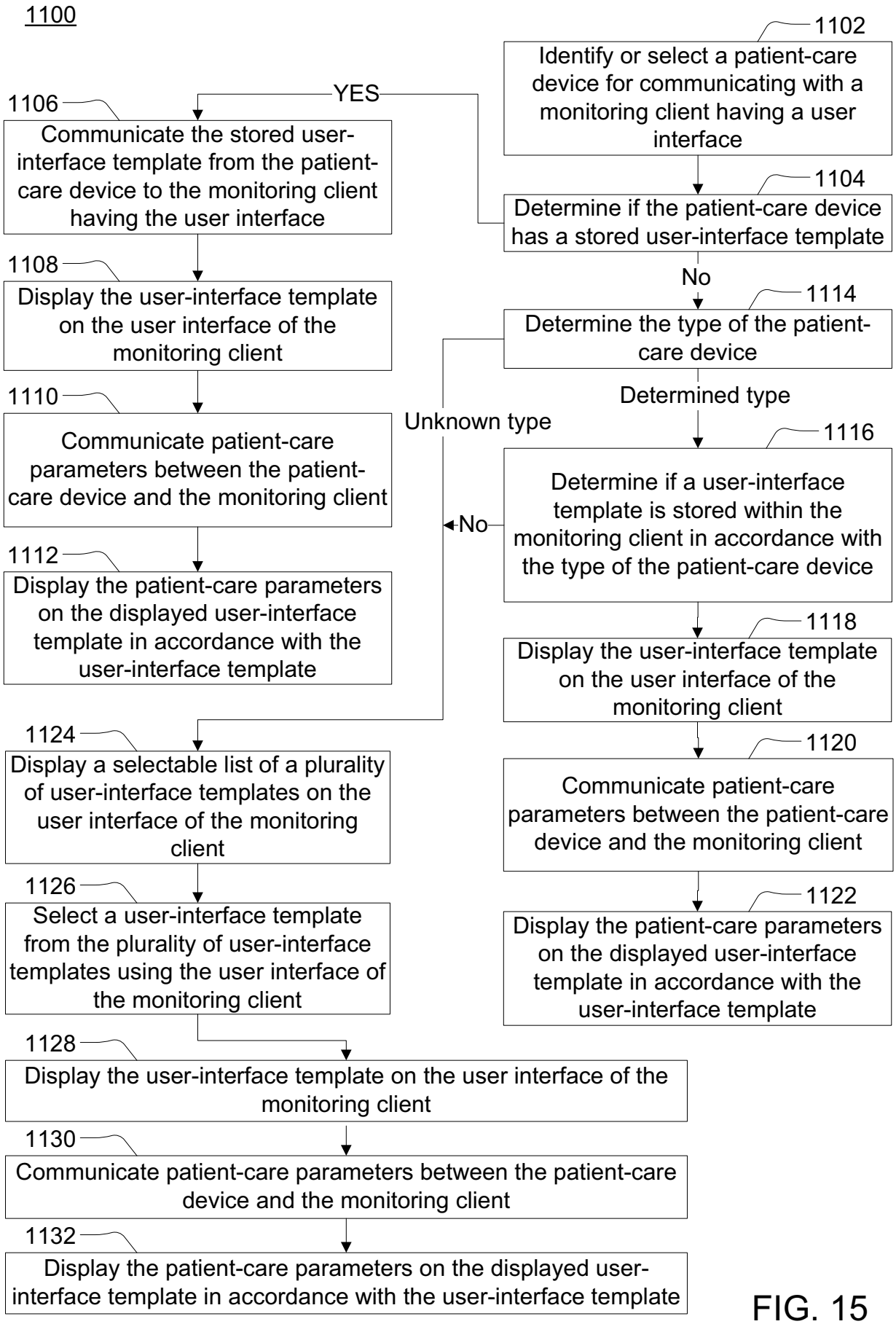

1100
1102
Identify or select a patient-care device for communicating with a monitoring client having a user interface
1104
Determine if the patient-care device has a stored user-interface template
YES
No
1106
Communicate the stored user-interface template from the patient-care device to the monitoring client having the user interface
1108
Display the user-interface template on the user interface of the monitoring client
1110
Communicate patient-care parameters between the patient-care device and the monitoring client
1112
Display the patient-care parameters on the displayed user-interface template in accordance with the user-interface template
1114
Determine the type of the patient-care device
Determined type
Unknown type
1116
Determine if a user-interface template is stored within the monitoring client in accordance with the type of the patient-care device
No
1118
Display the user-interface template on the user interface of the monitoring client
1120
Communicate patient-care parameters between the patient-care device and the monitoring client
1122
Display the patient-care parameters on the displayed user-interface template in accordance with the user-interface template
1124
Display a selectable list of a plurality of user-interface templates on the user interface of the monitoring client
1126
Select a user-interface template from the plurality of user-interface templates using the user interface of the monitoring client
1128
Display the user-interface template on the user interface of the monitoring client
1130
Communicate patient-care parameters between the patient-care device and the monitoring client
1132
Display the patient-care parameters on the displayed user-interface template in accordance with the user-interface template

FIG. 15

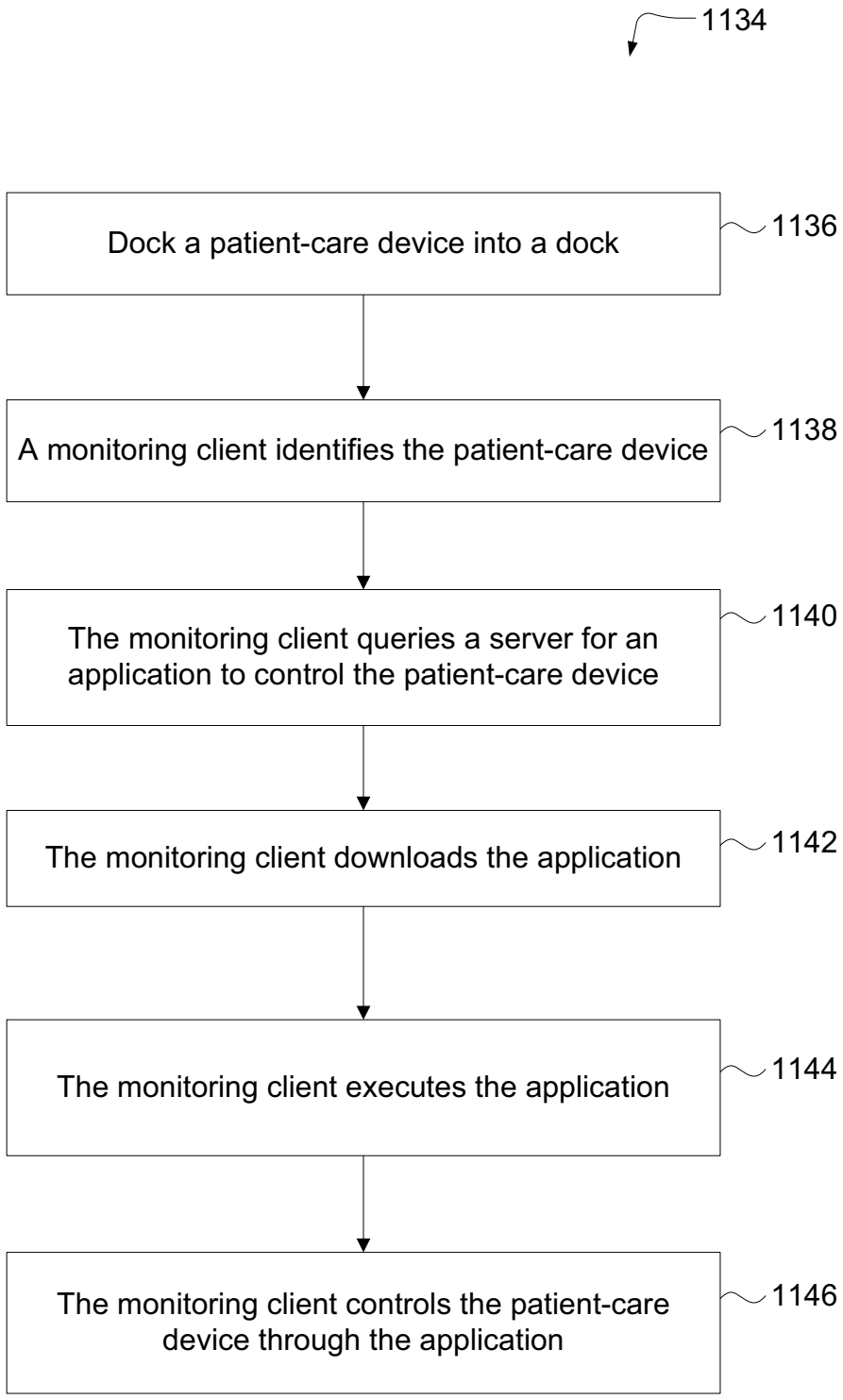

1134
Dock a patient-care device into a dock
1136
A monitoring client identifies the patient-care device
1138
The monitoring client queries a server for an application to control the patient-care device
1140
The monitoring client downloads the application
1142
The monitoring client executes the application
1144
The monitoring client controls the patient-care device through the application
1146

FIG. 16

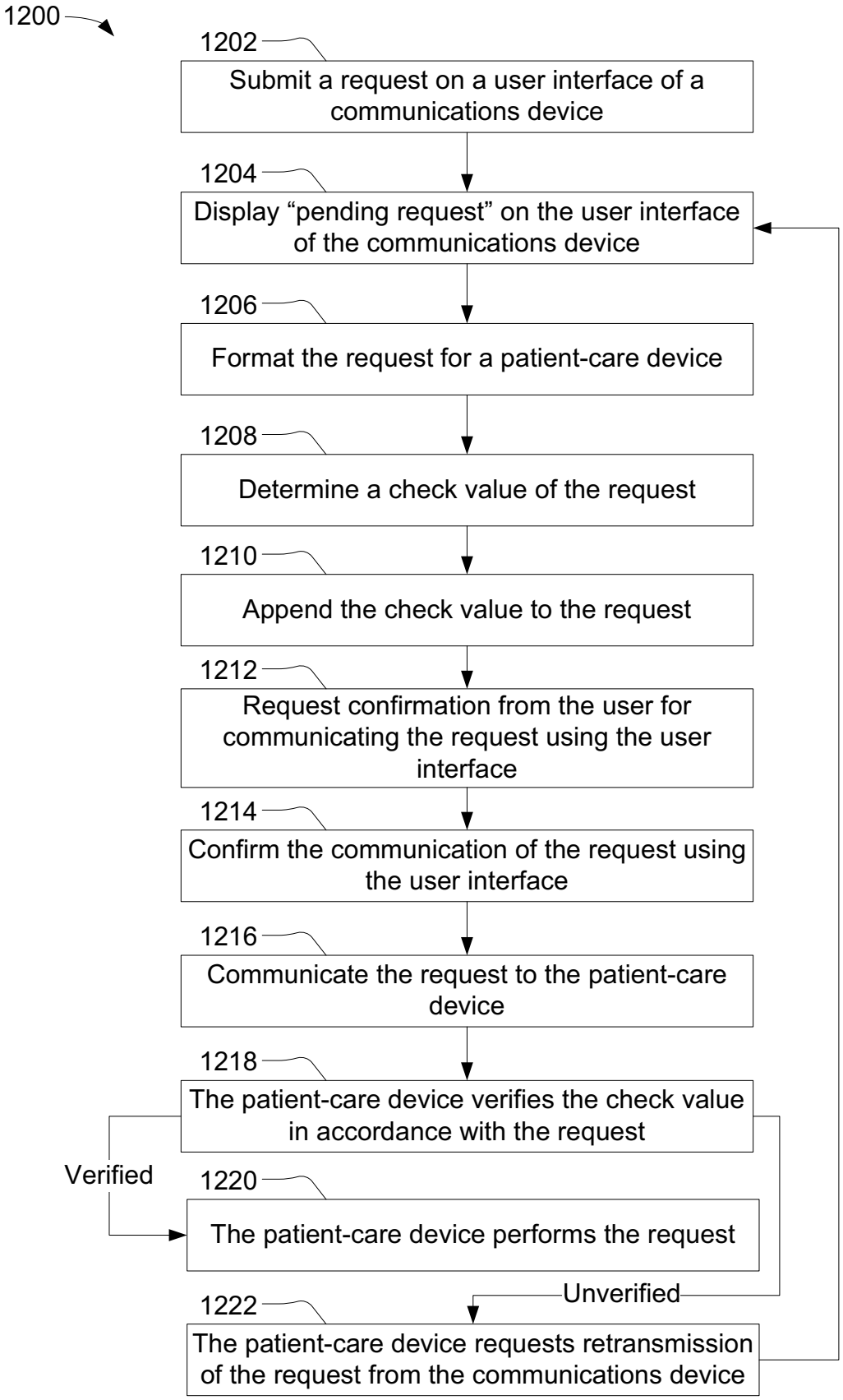

1200
1202
Submit a request on a user interface of a communications device
1204
Display “pending request” on the user interface of the communications device
1206
Format the request for a patient-care device
1208
Determine a check value of the request
1210
Append the check value to the request
1212
Request confirmation from the user for communicating the request using the user interface
1214
Confirm the communication of the request using the user interface
1216
Communicate the request to the patient-care device
1218
The patient-care device verifies the check value in accordance with the request
Verified
1220
The patient-care device performs the request
Unverified
1222
The patient-care device requests retransmission of the request from the communications device

FIG. 17

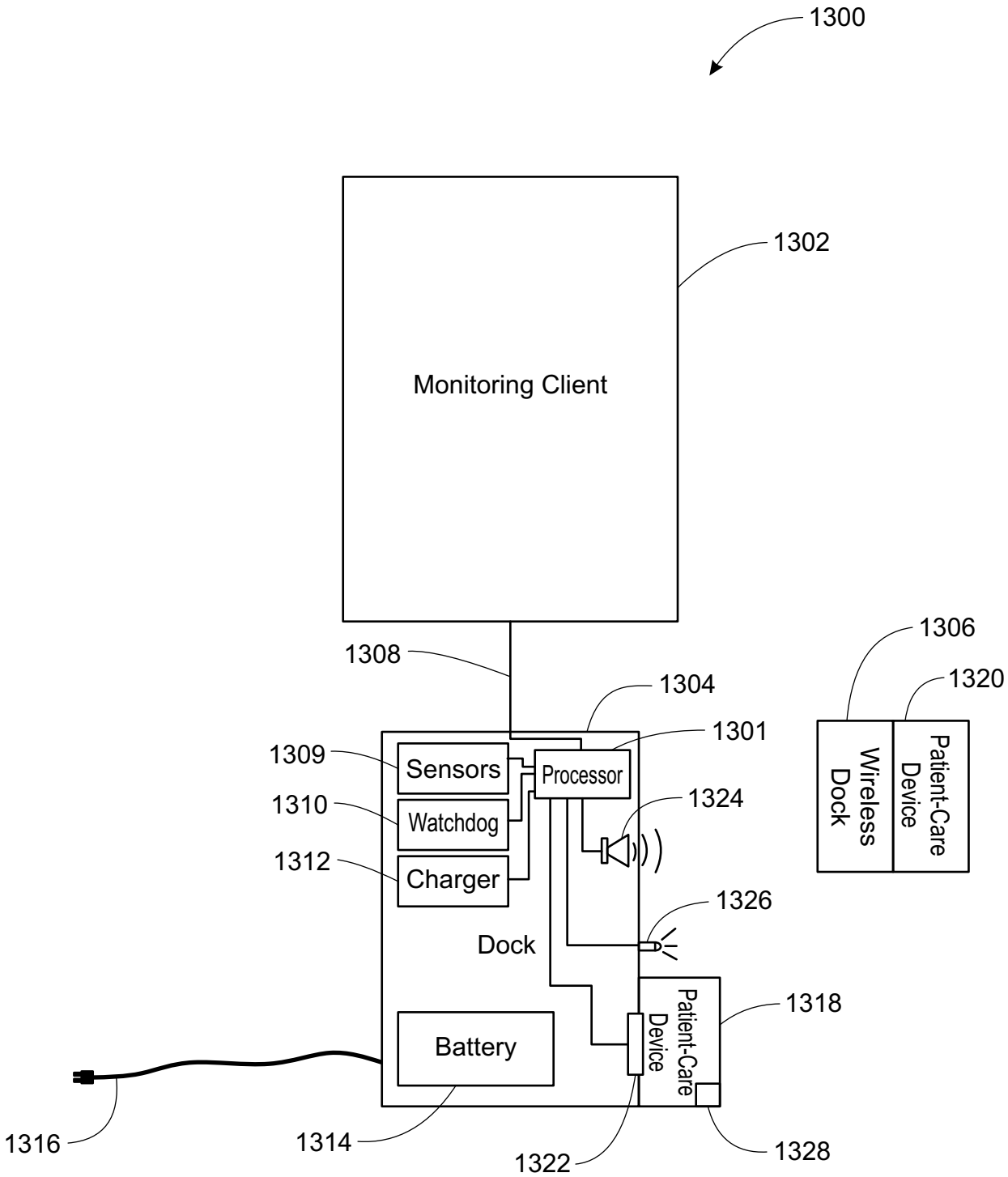

1300
1302
Monitoring Client
1308
1304
1301
1309
Sensors
Processor
1310
Watchdog
1324
1312
Charger
1326
Dock
1318
Patient-Care Device
Battery
1316
1314
1322
1328
1306
1320
Wireless Dock
Patient-Care Device

FIG. 18

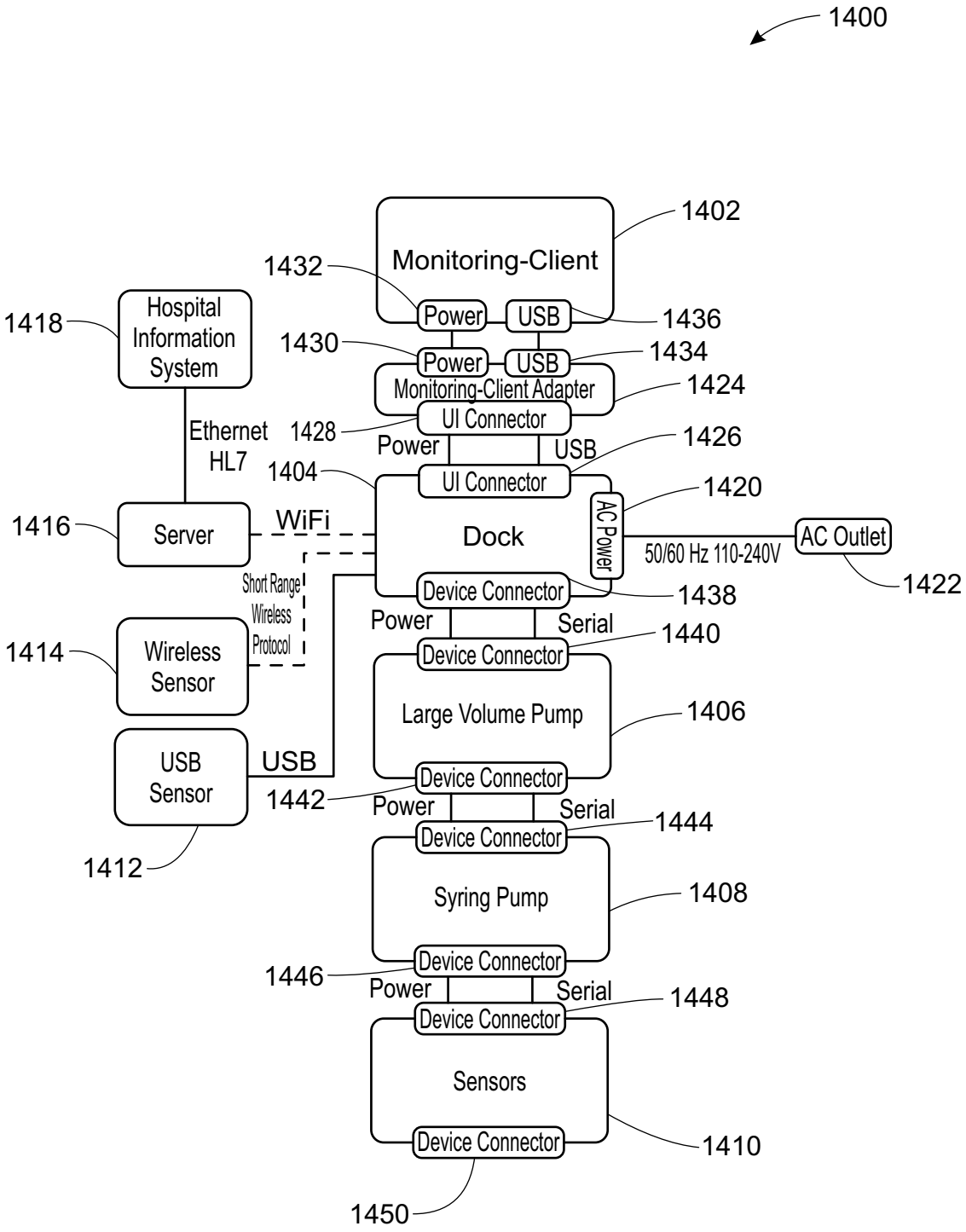

1400
1402
Monitoring-Client
1432
Power
USB
1436
1418
Hospital Information System
1430
Power
USB
1434
Monitoring-Client Adapter
1424
Ethernet HL7
1428
UI Connector
Power
USB
1426
1404
UI Connector
1420
1416
Server
WiFi
Dock
AC Power
AC Outlet
50/60 Hz 110-240V
1422
Short Range Wireless Protocol
Device Connector
1438
Power
Serial
1414
Wireless Sensor
Device Connector
1440
Large Volume Pump
1406
USB Sensor
USB
Device Connector
1442
Power
Serial
Device Connector
1444
1412
Syring Pump
1408
Device Connector
1446
Power
Serial
1448
Device Connector
Sensors
Device Connector
1410
1450

FIG. 19

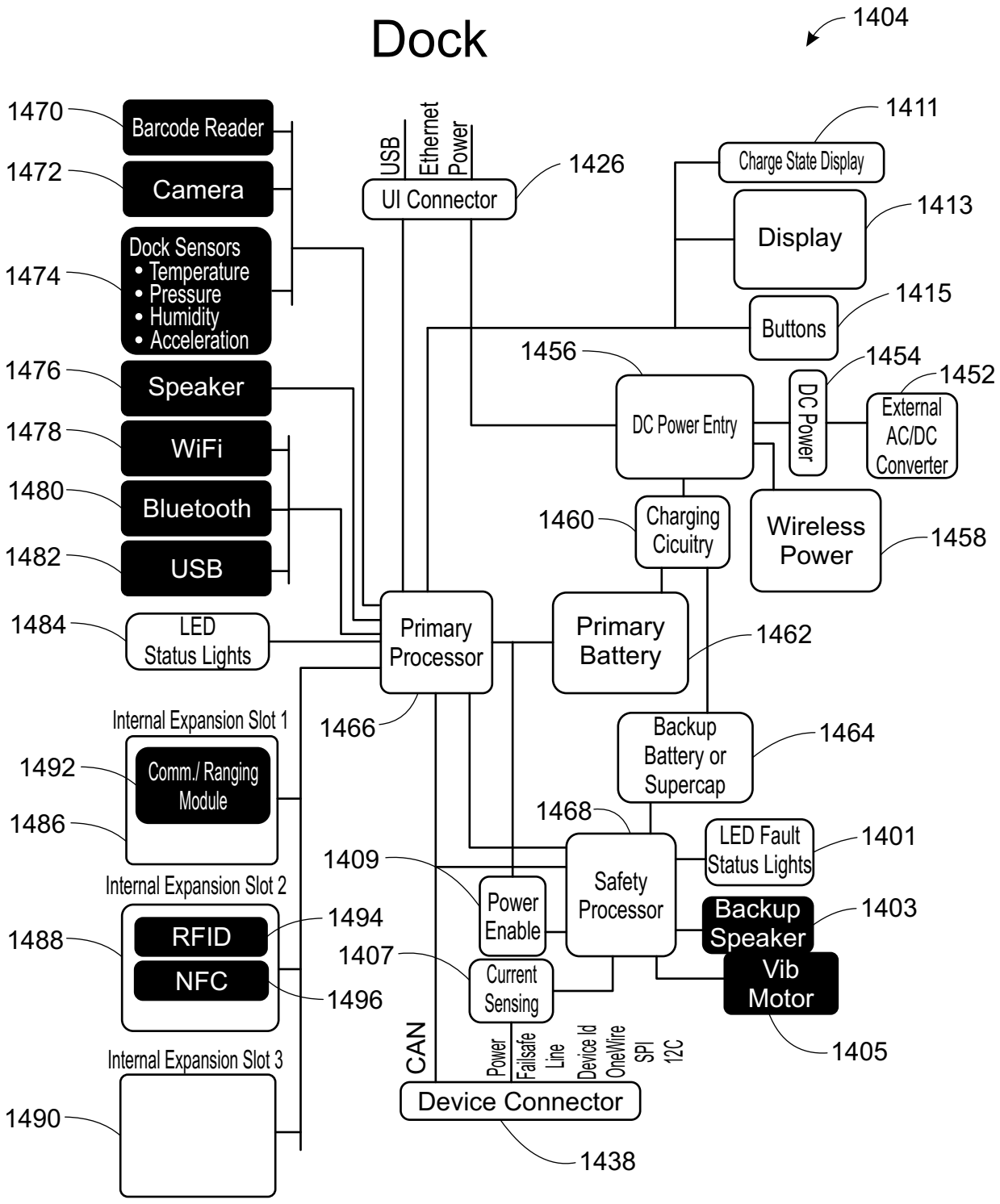

Dock
1404
1470
Barcode Reader
1472
Camera
1474
Dock Sensors
• Temperature
• Pressure
• Humidity
• Acceleration
1476
Speaker
1478
WiFi
1480
Bluetooth
1482
USB
1484
LED
Status Lights
USB
Ethernet
Power
UI Connector
1426
1411
Charge State Display
Display
1413
Buttons
1415
1456
DC Power Entry
DC Power
1454
1452
External
AC/DC
Converter
1460
Charging
Cicuitry
Wireless
Power
1458
Primary
Processor
Primary
Battery
1462
1466
Backup
Battery or
Supercap
1464
Internal Expansion Slot 1
1492
Comm./ Ranging
Module
1486
1468
LED Fault
Status Lights
1401
1409
Safety
Processor
Internal Expansion Slot 2
Power
Enable
Backup
Speaker
1403
1488
RFID
NFC
1494
1496
1407
Current
Sensing
Vib
Motor
1405
Internal Expansion Slot 3
1490
CAN
Power
Failsafe
Line
Device Id
OneWire
SPI
I2C
Device Connector
1438

FIG. 20

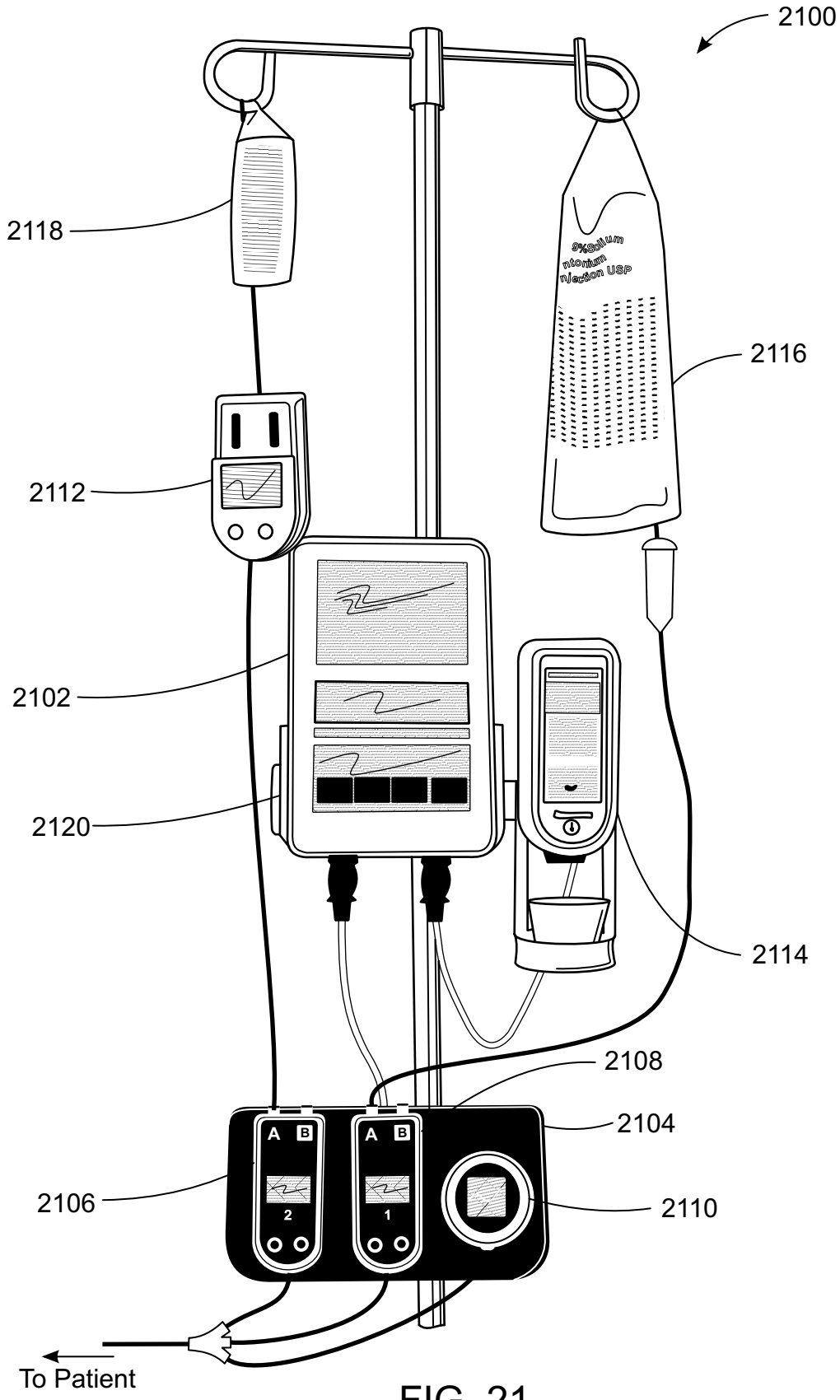

2100
2118
2116
2112
2102
2120
2114
2108
2104
2106
2110
A
B
2
1
To Patient

FIG. 21

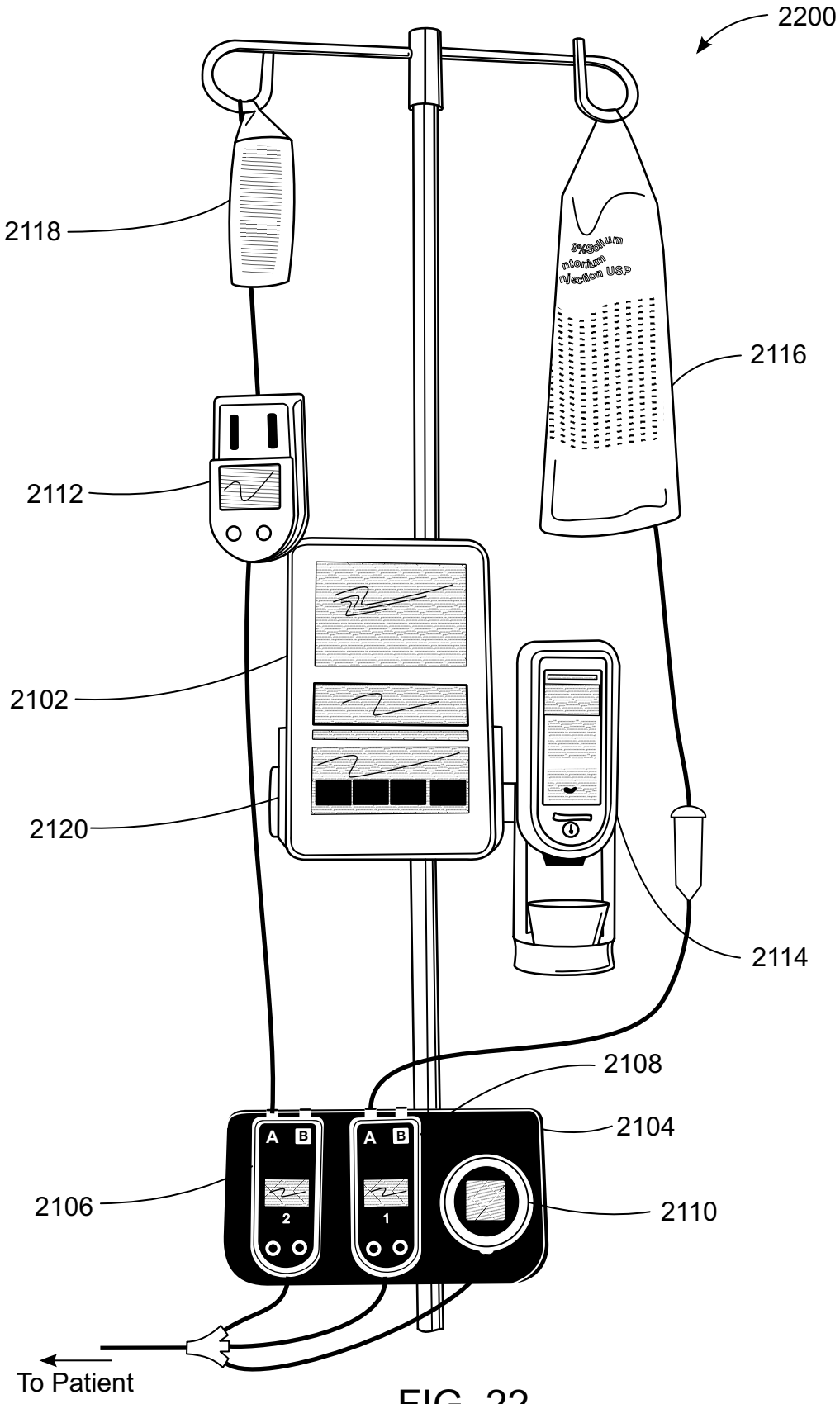

2200
2118
2116
2112
2102
2120
2114
2108
2104
2106
2110
A
B
2
1
To Patient

FIG. 22

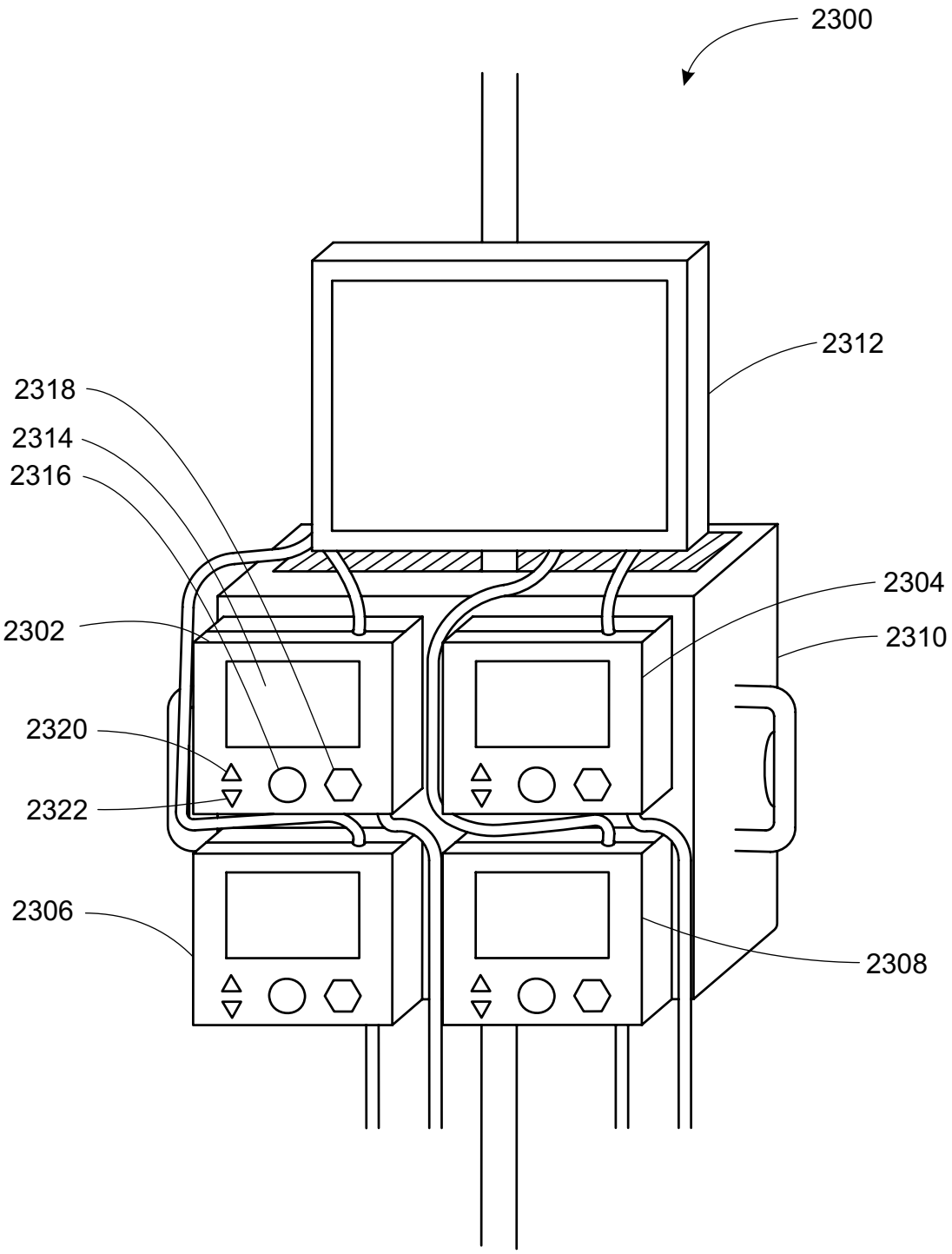


FIG. 23

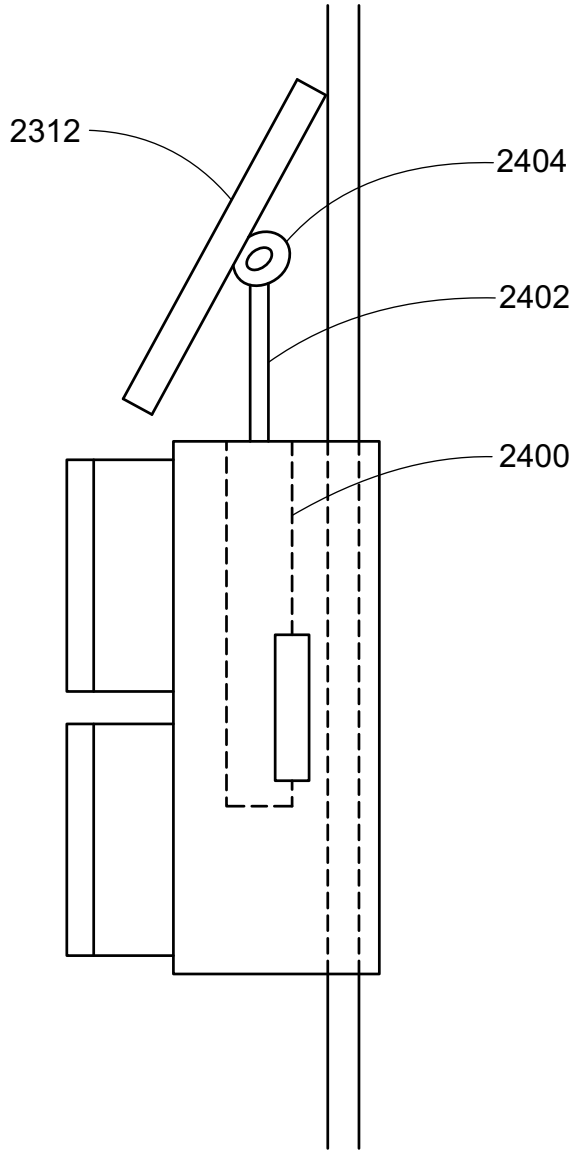


FIG. 24

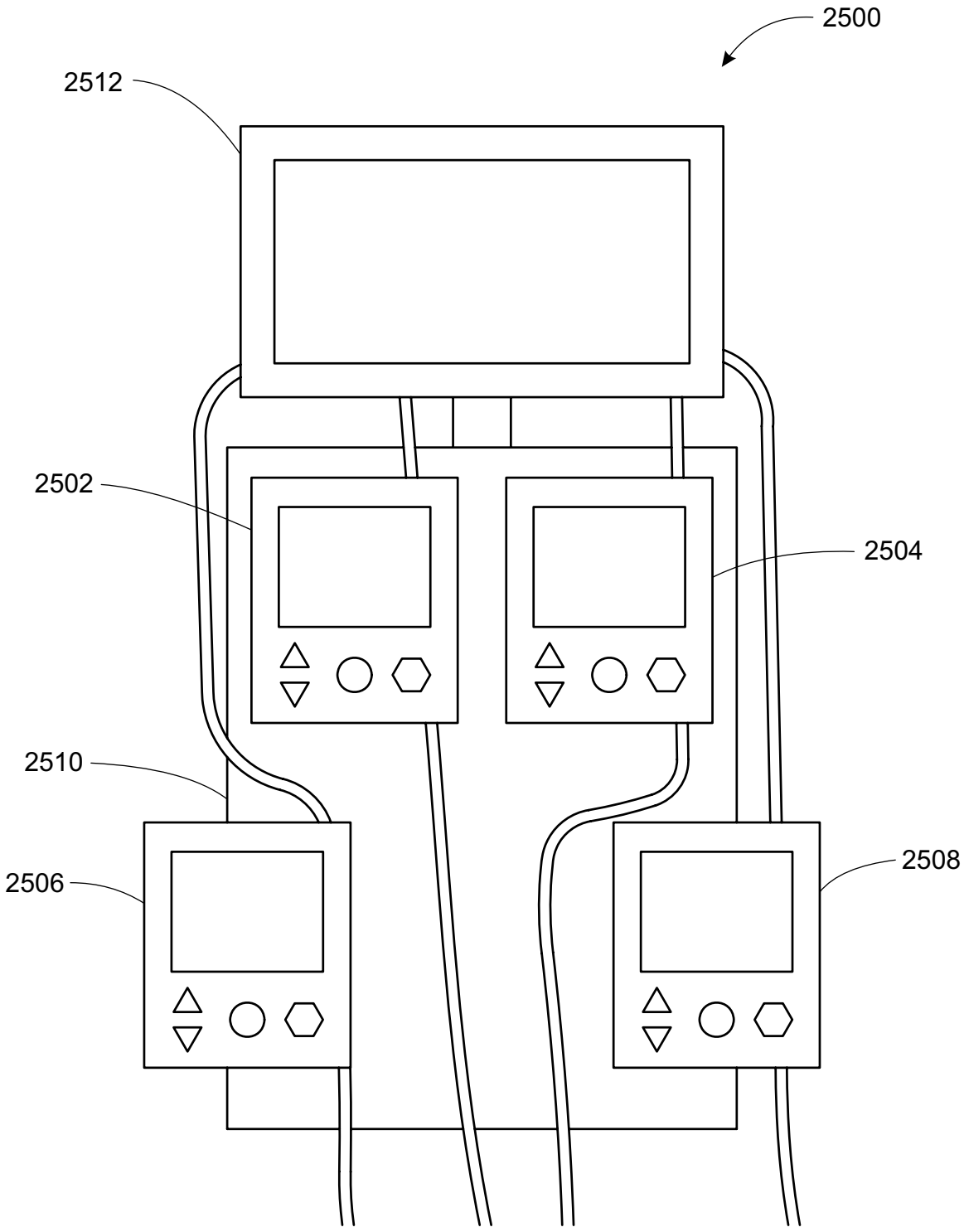


FIG. 25

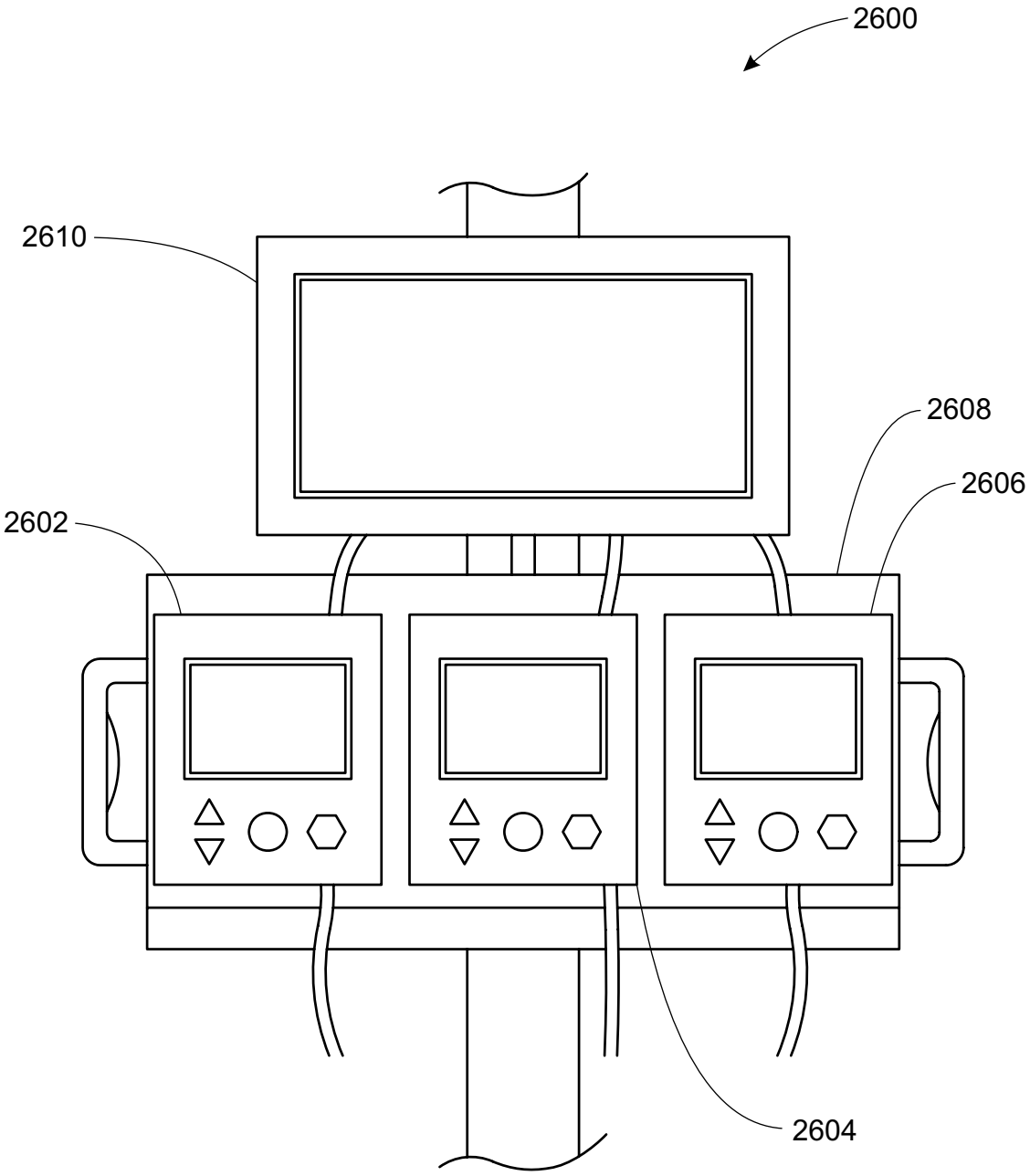


FIG. 26

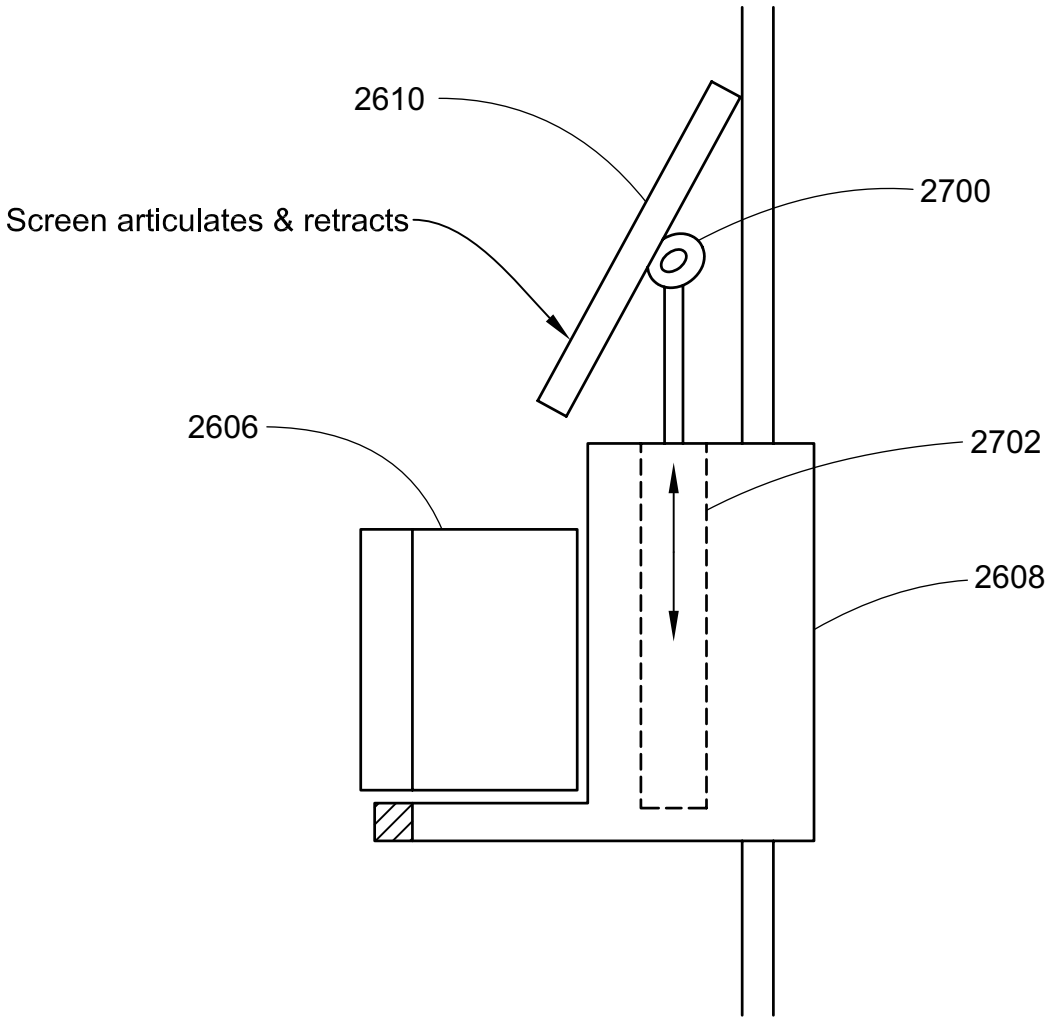


FIG. 27

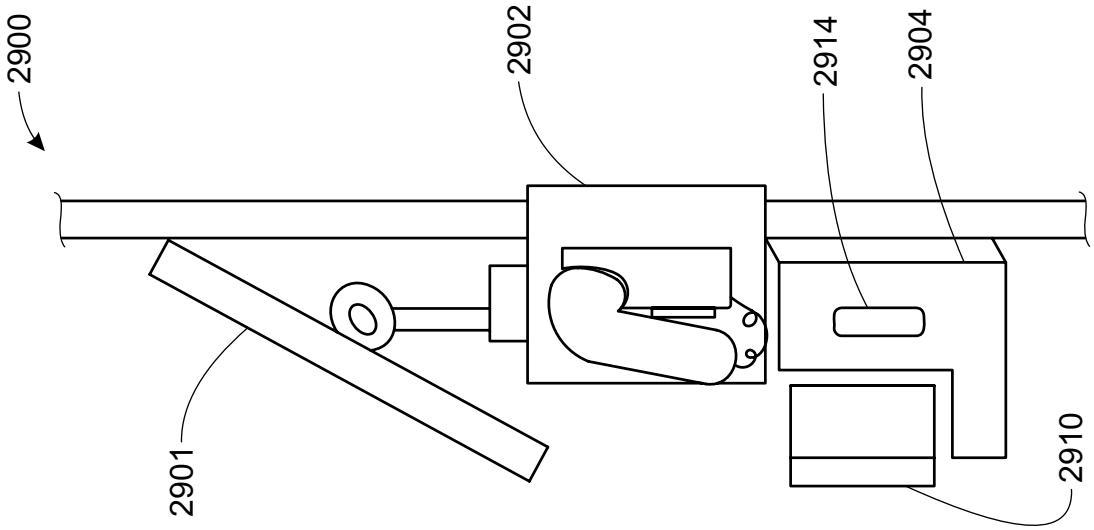

2900
2902
2914
2904
2901
2910

FIG. 29

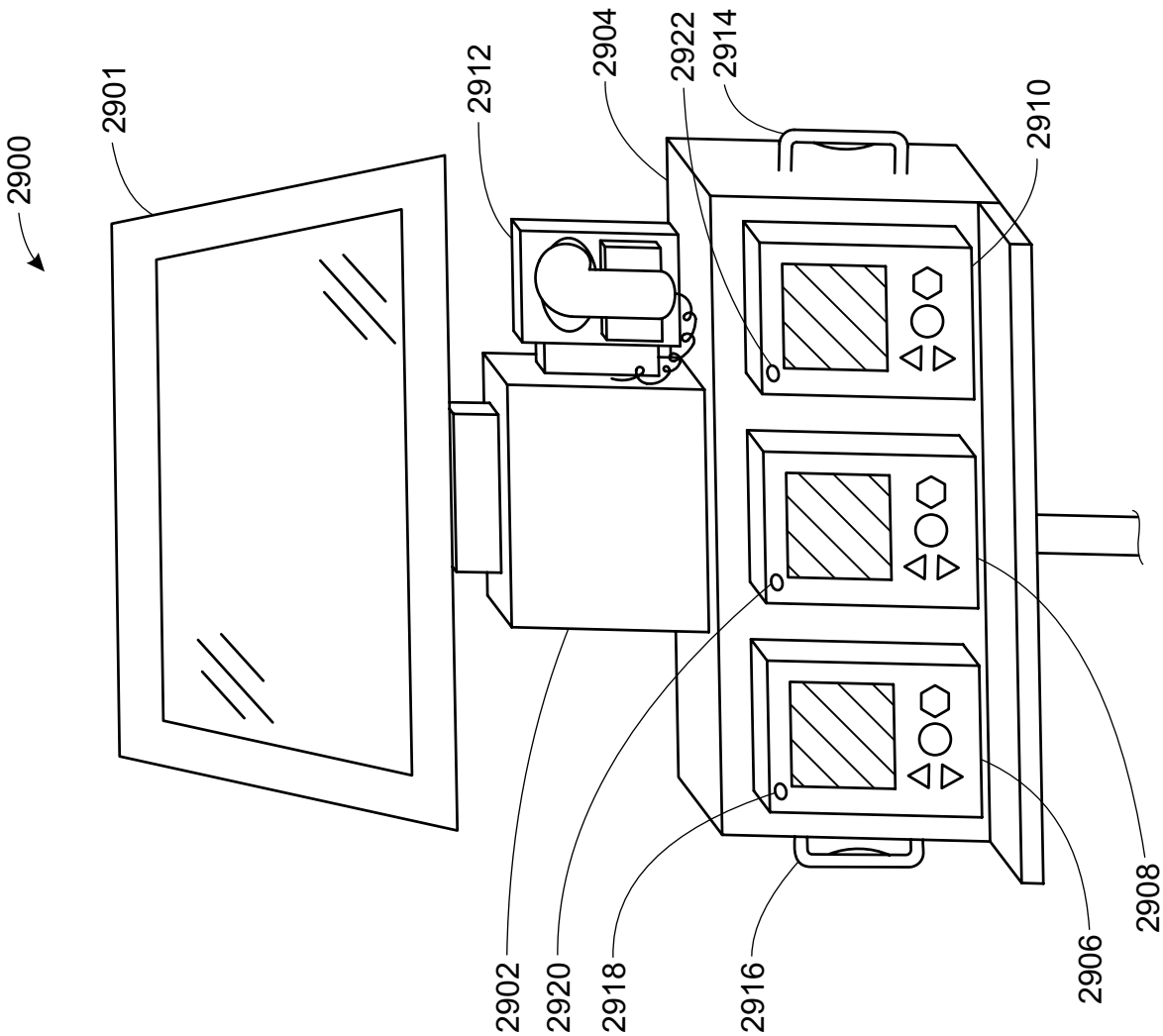

2900
2901
2912
2904
2922
2914
2910
2902
2920
2918
2916
2906
2908

FIG. 28

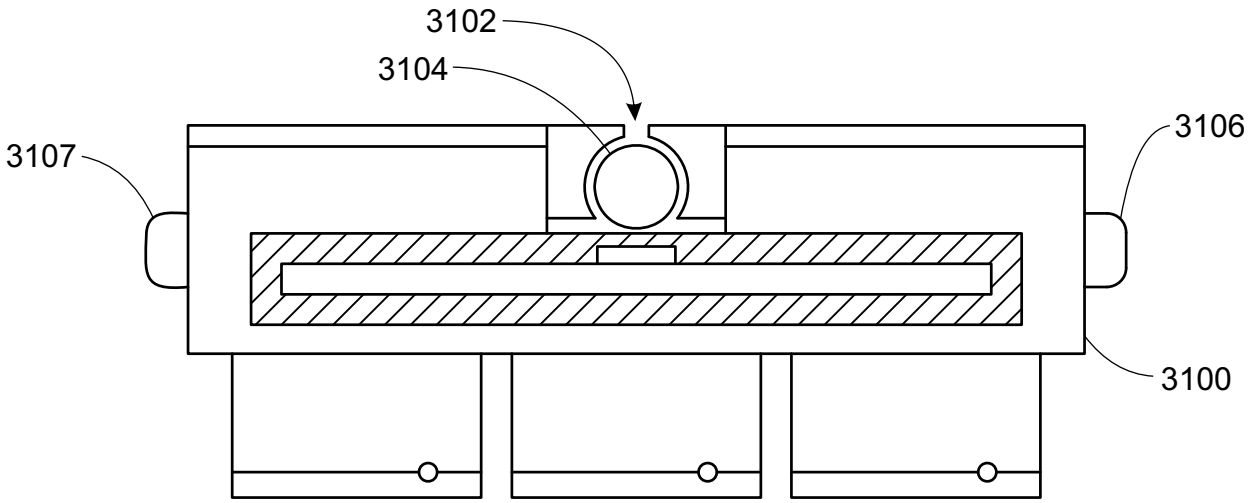


FIG. 30

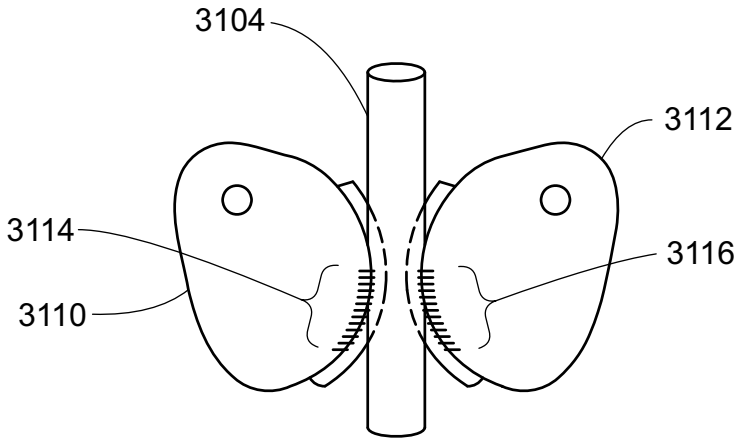


FIG. 31

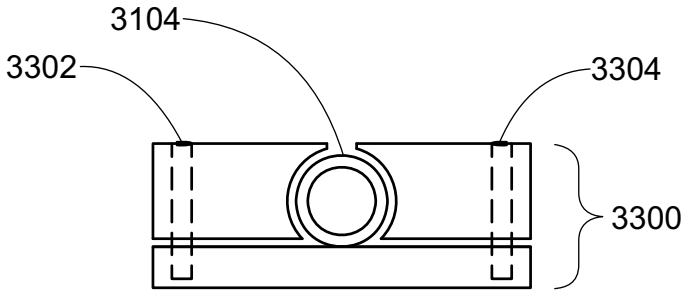


FIG. 32

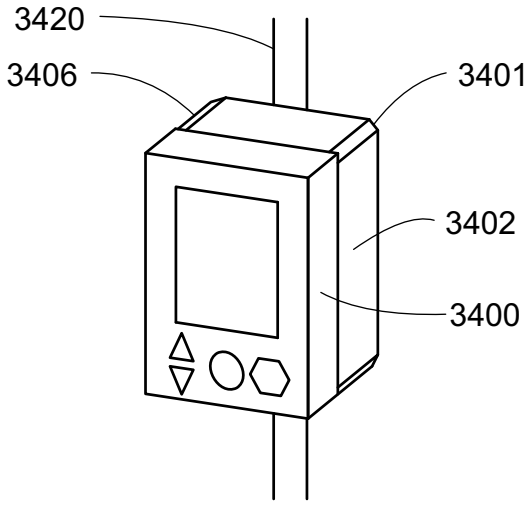


FIG. 33

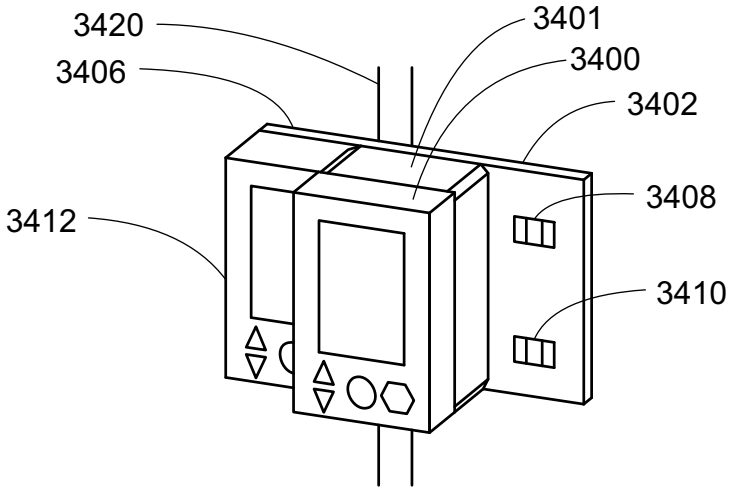


FIG. 34

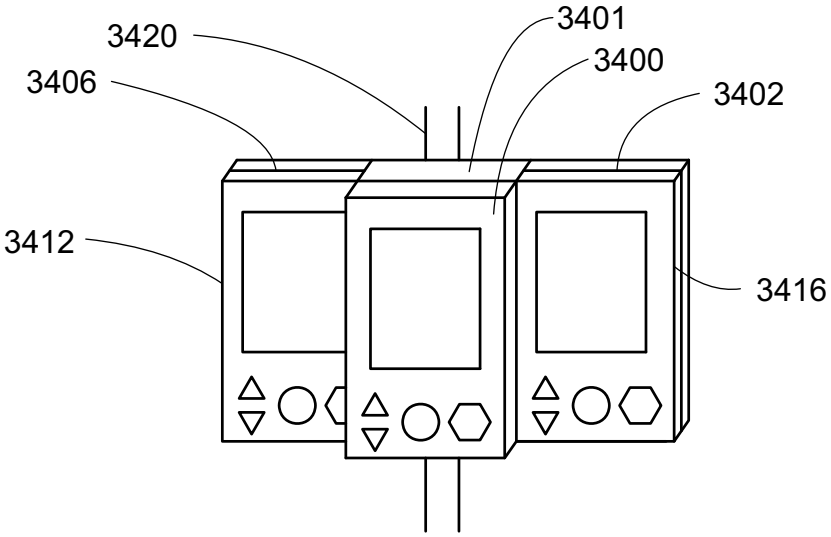


FIG. 35

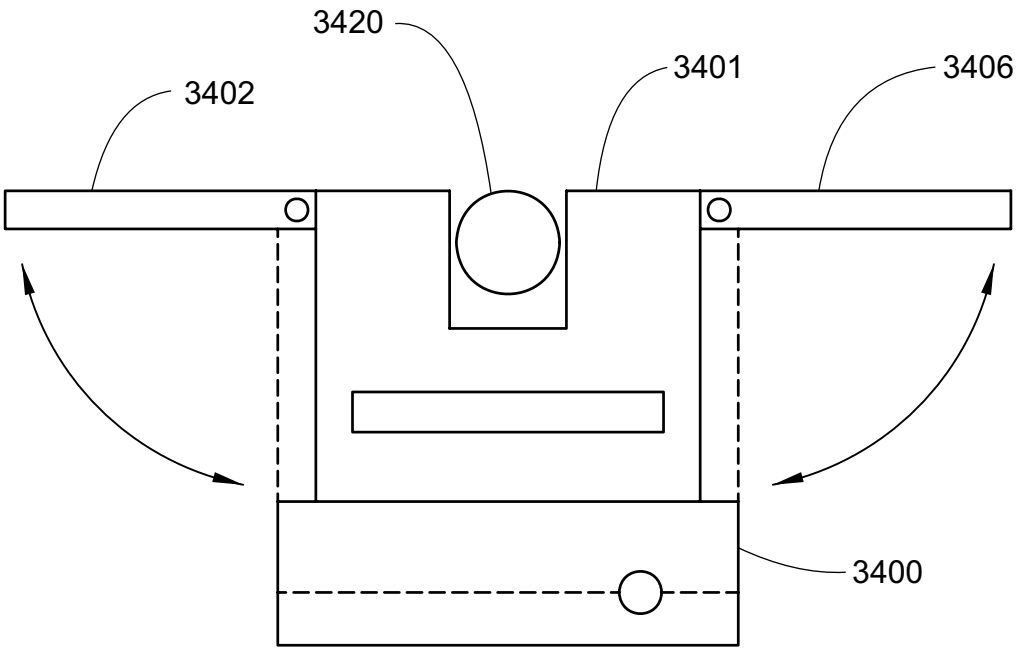


FIG. 36

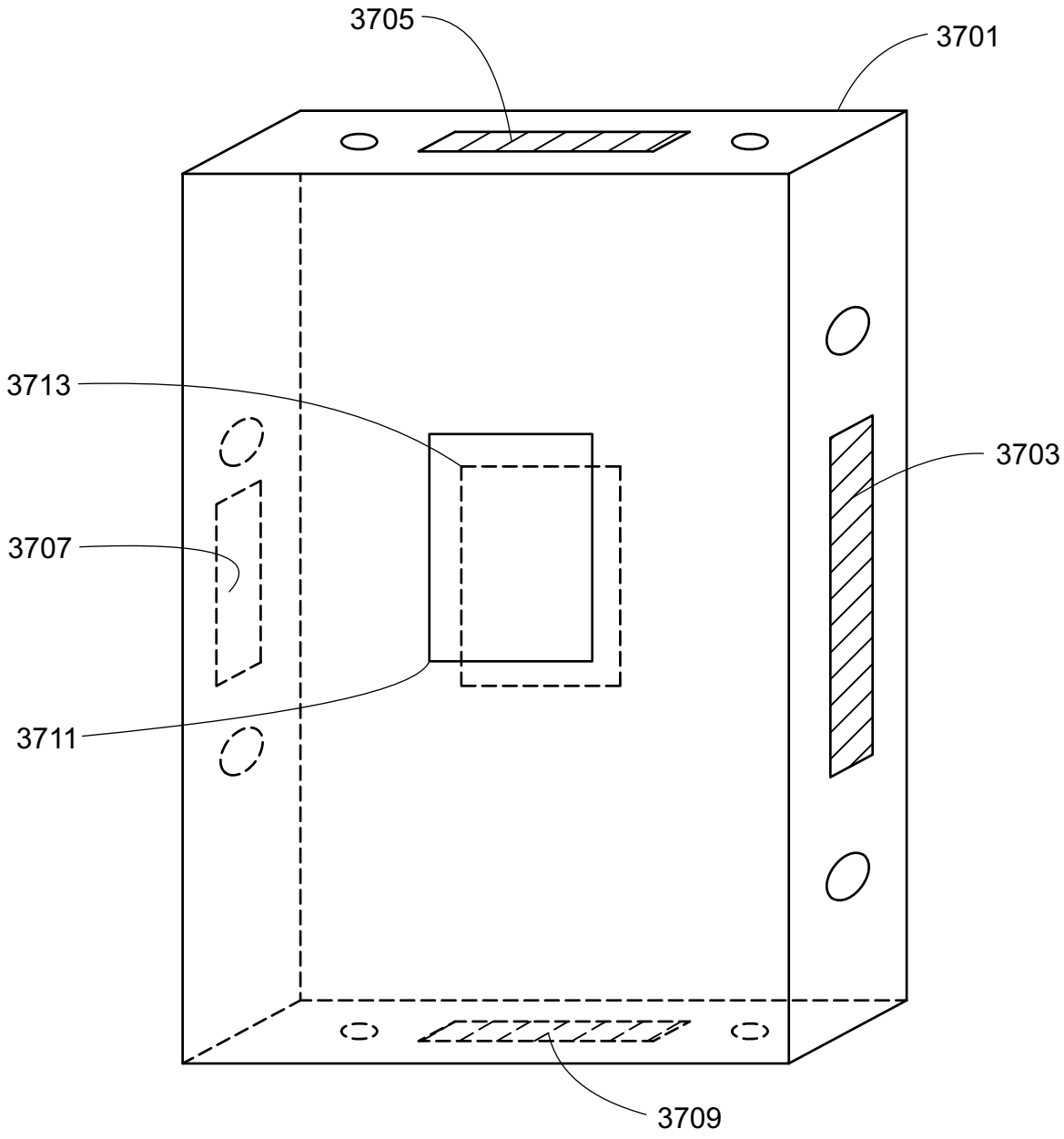


FIG. 37

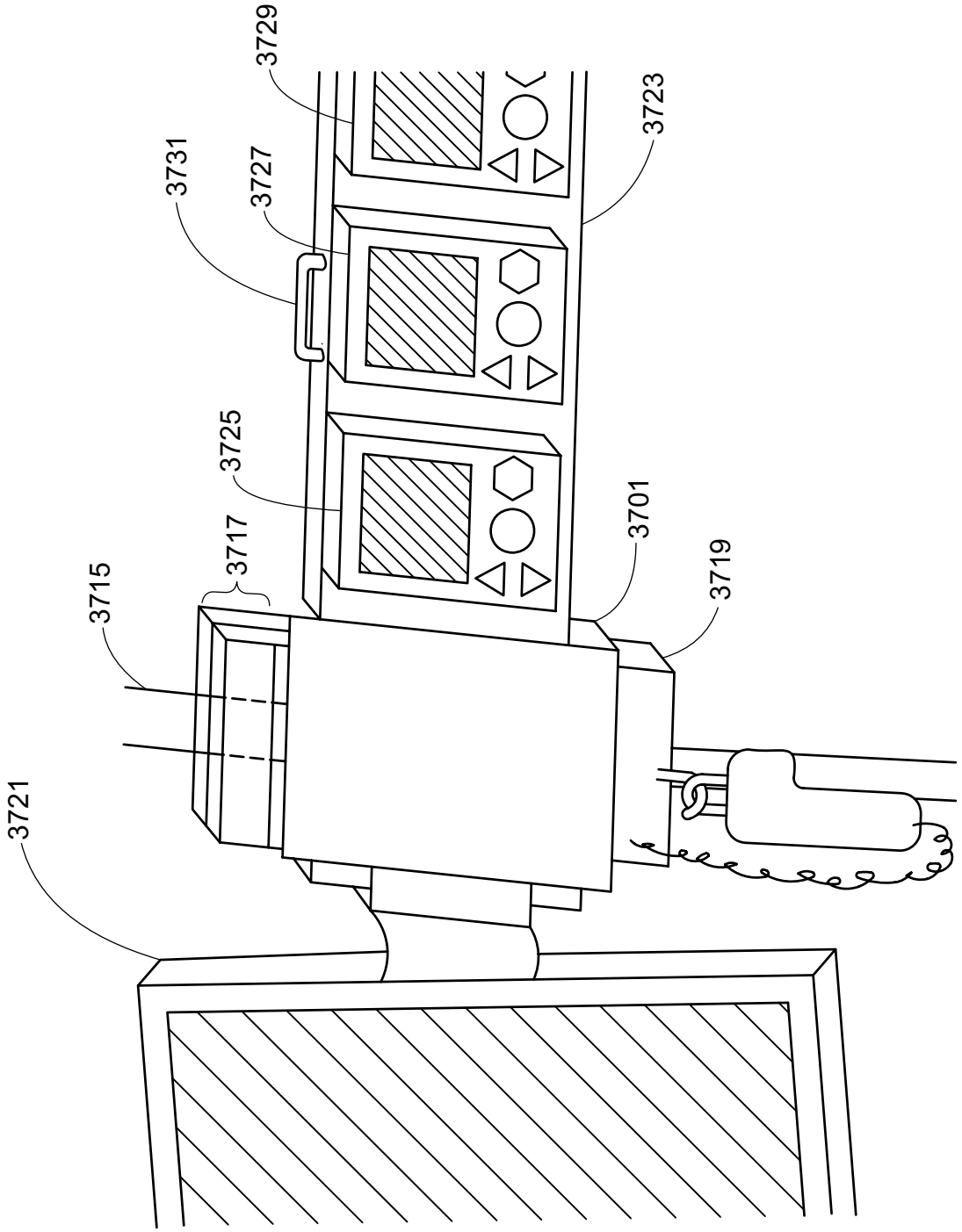


FIG. 38

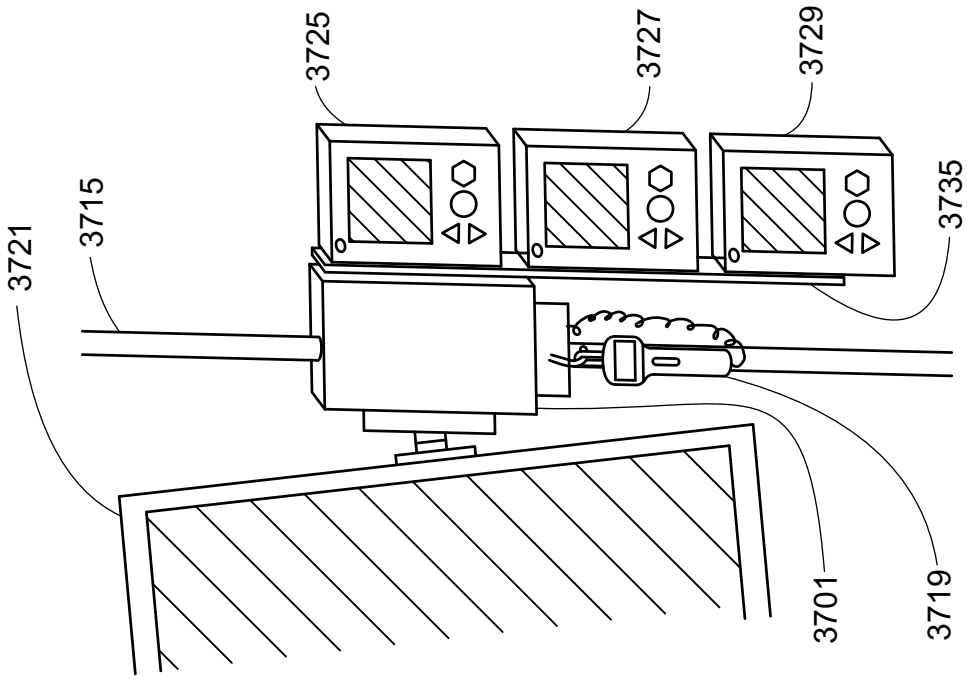

3725
3727
3729
3735
3715
3721
3701
3719

FIG. 40

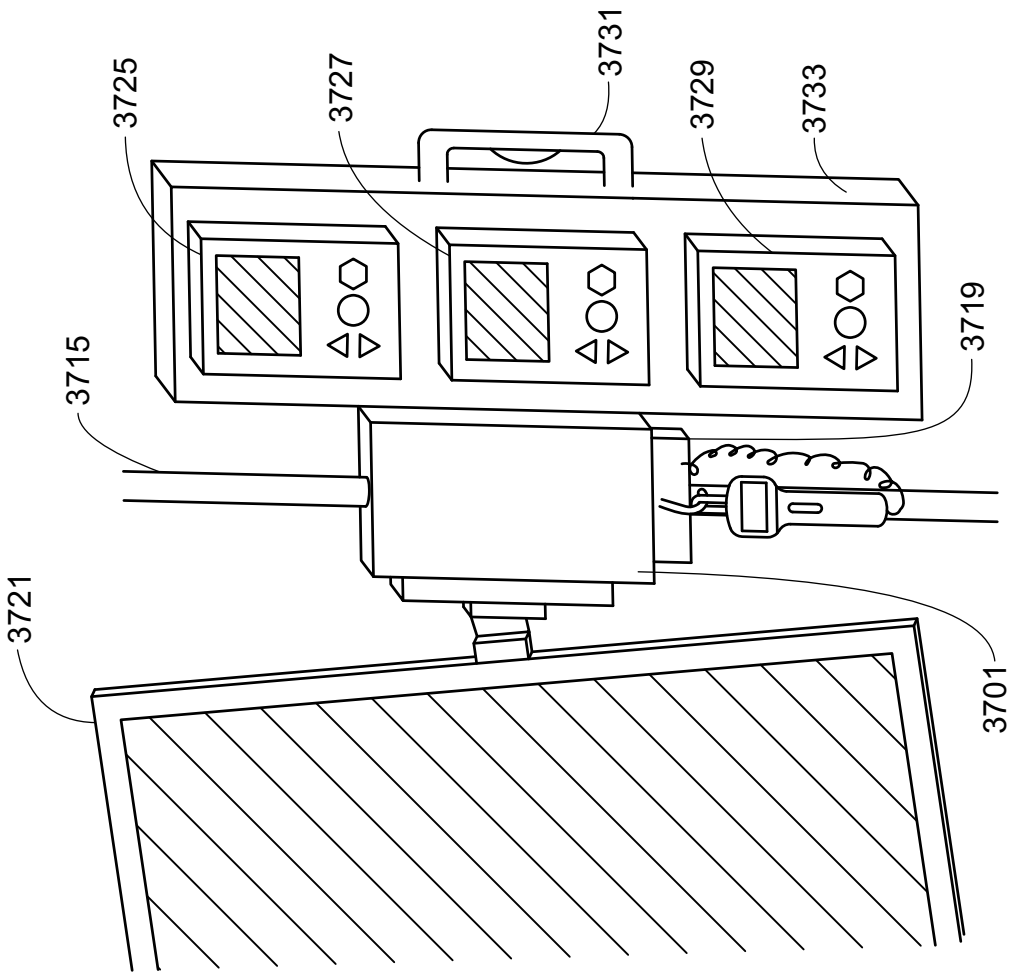

3731
3725
3727
3729
3733
3719
3715
3721
3701

FIG. 39

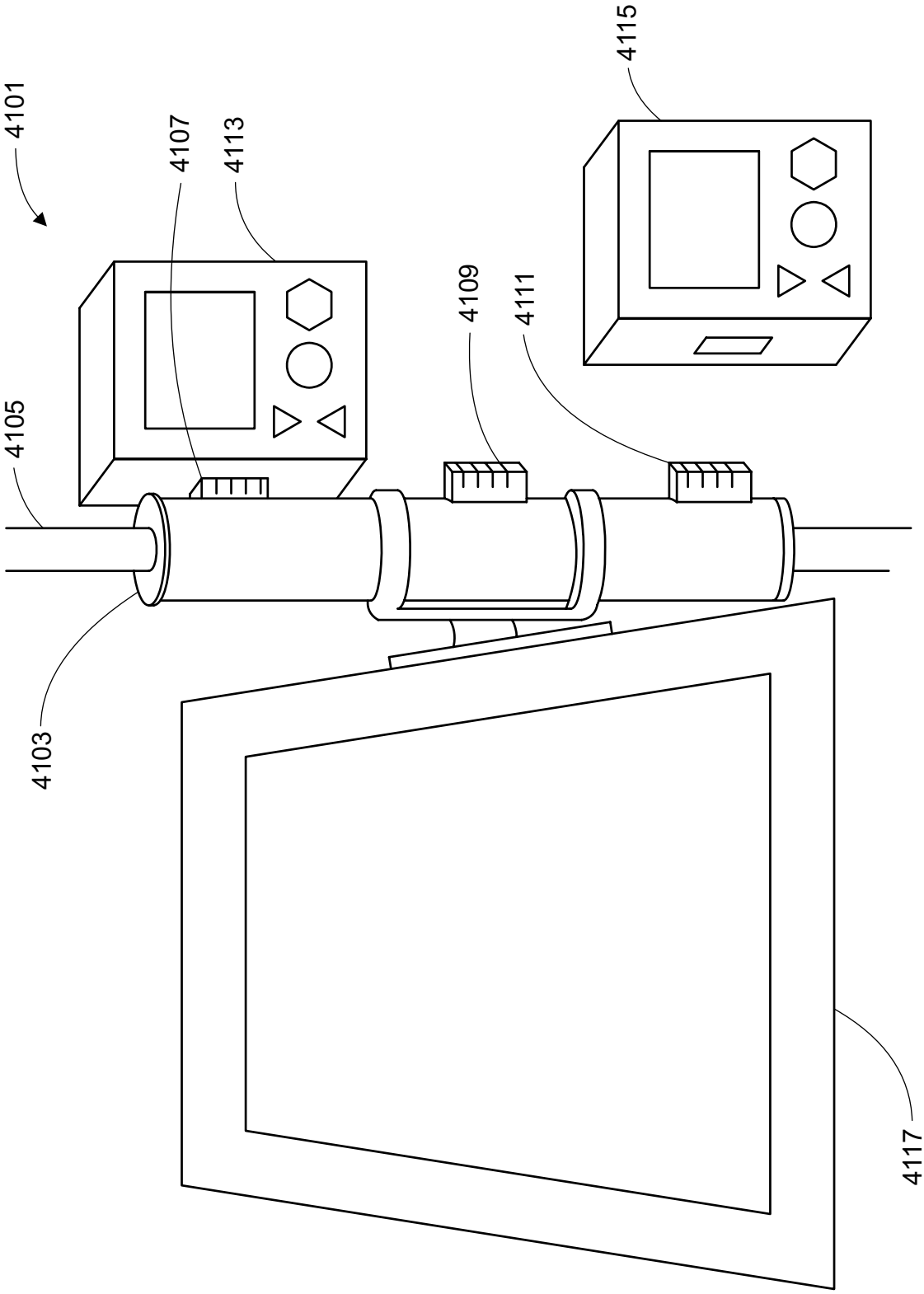


FIG. 41

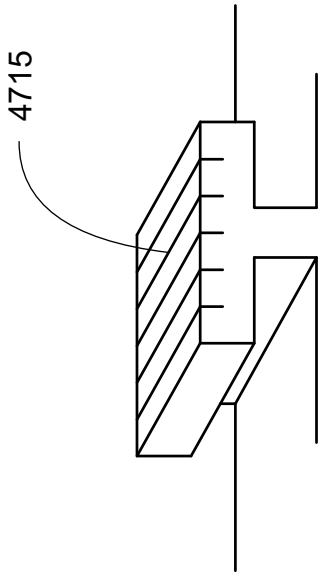


FIG. 43

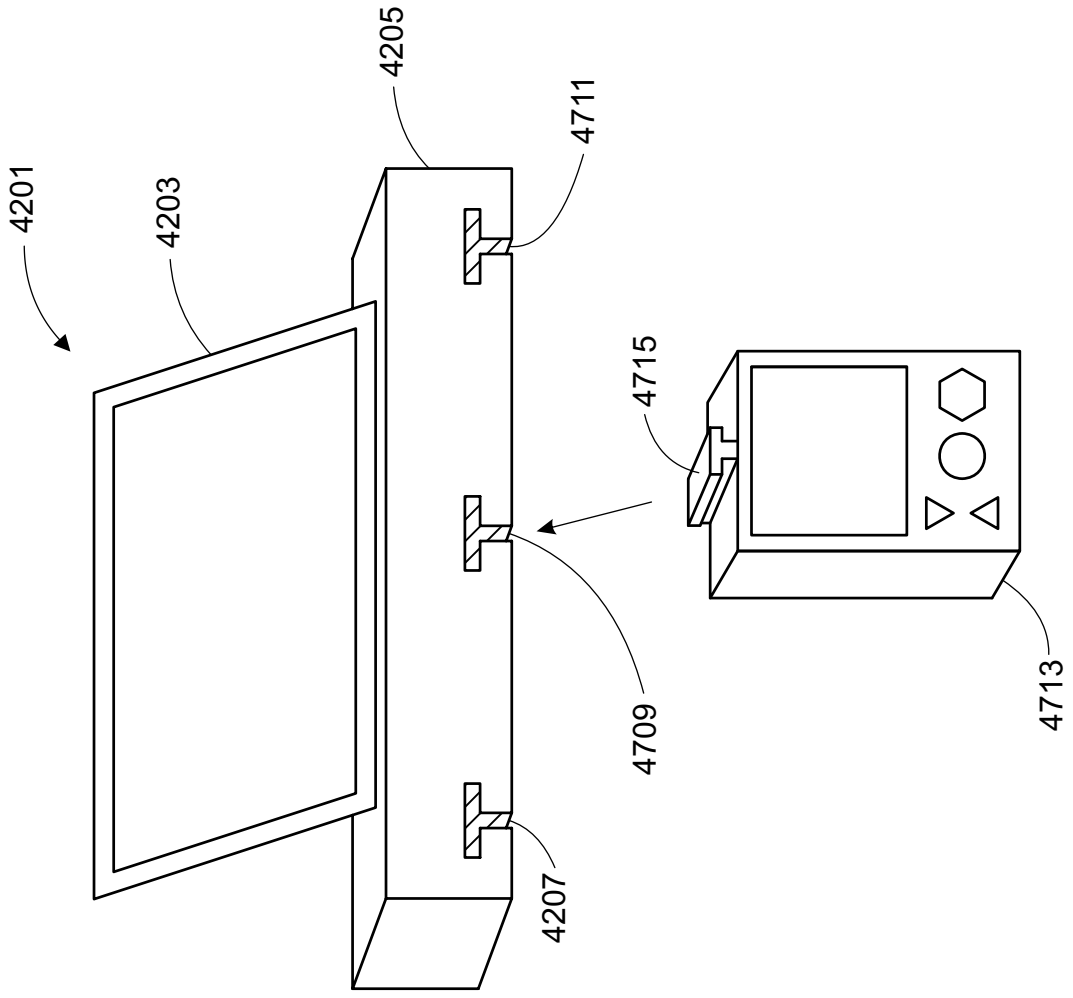


FIG. 42

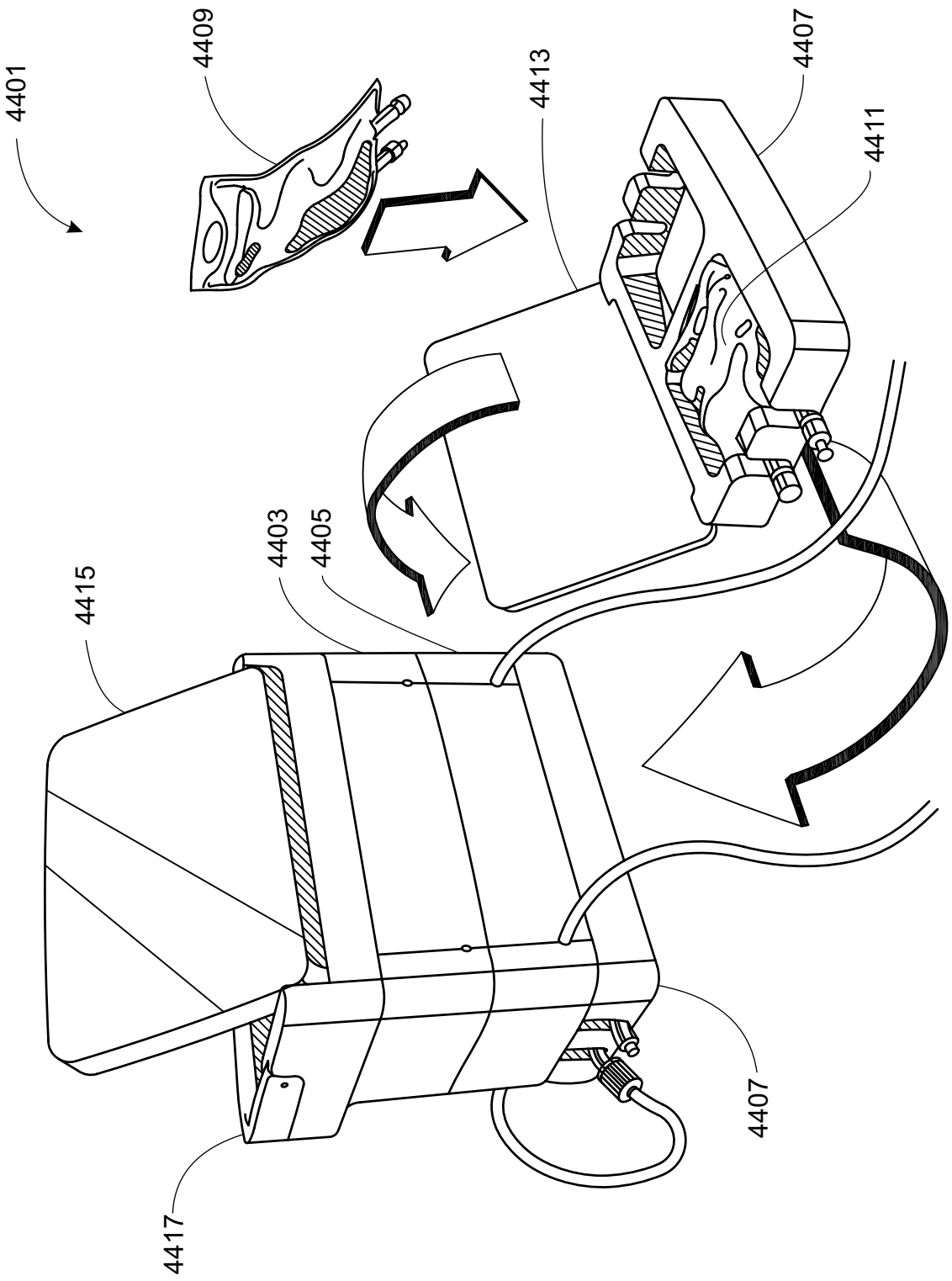


FIG. 44

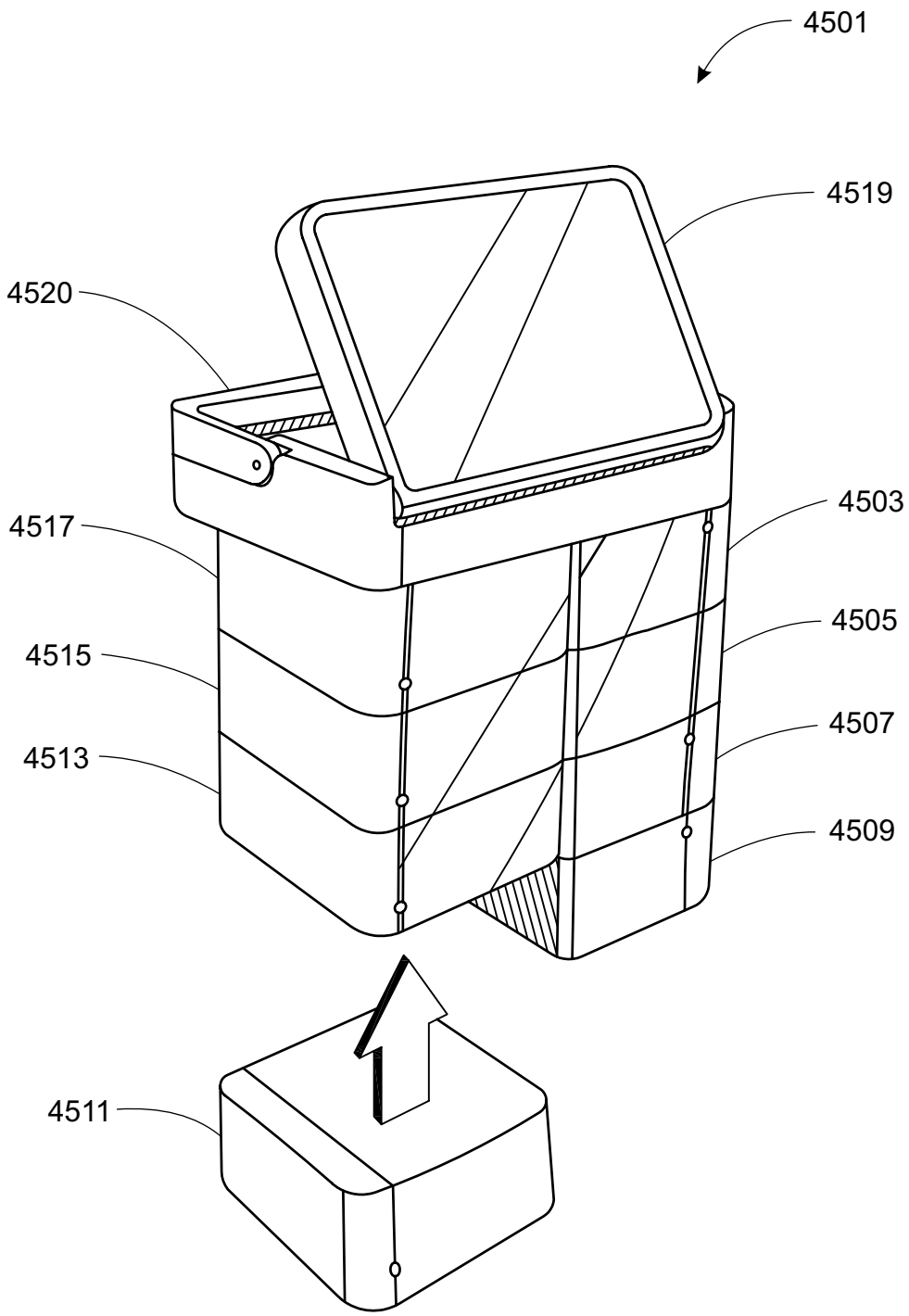


FIG. 45

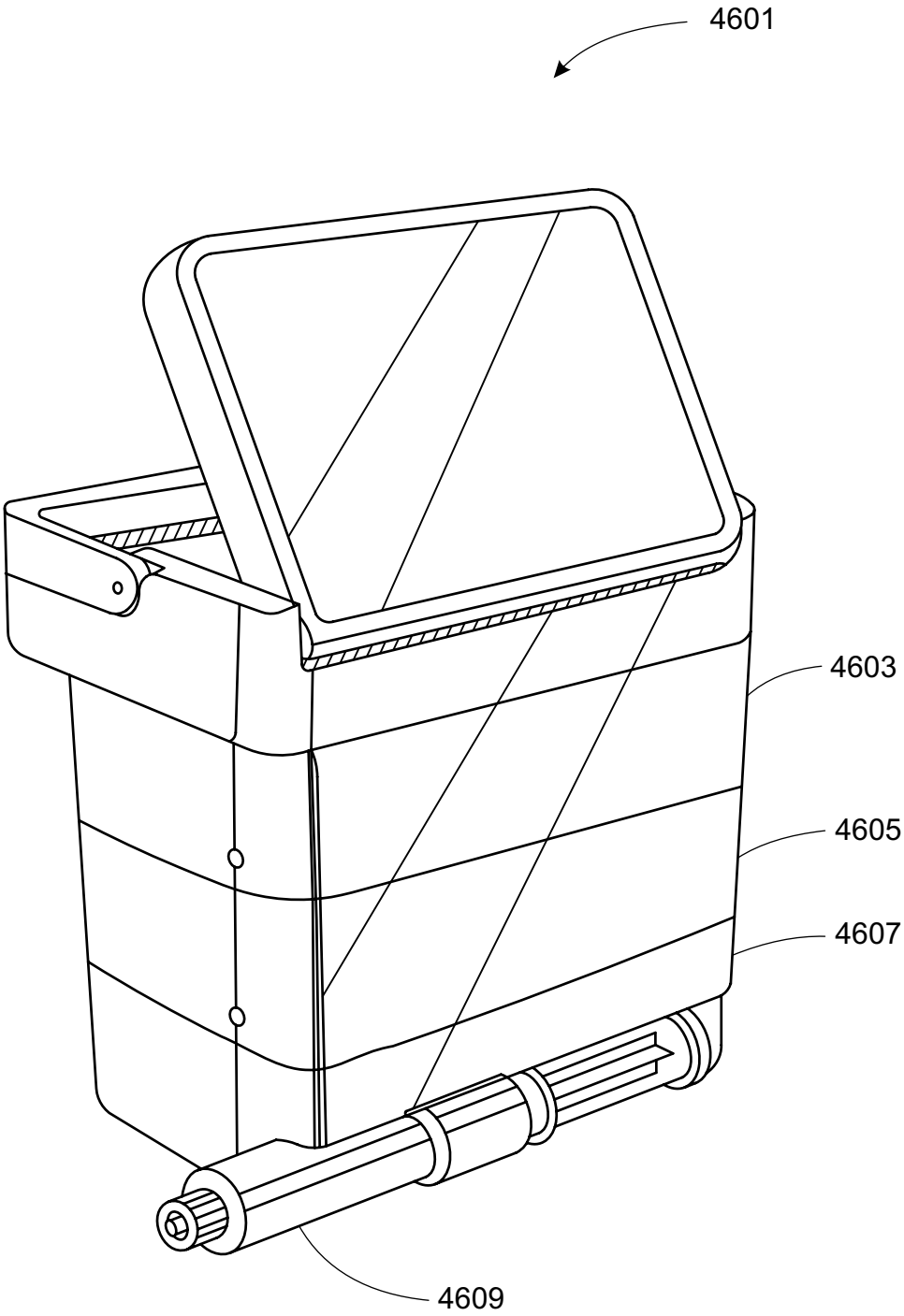


FIG. 46

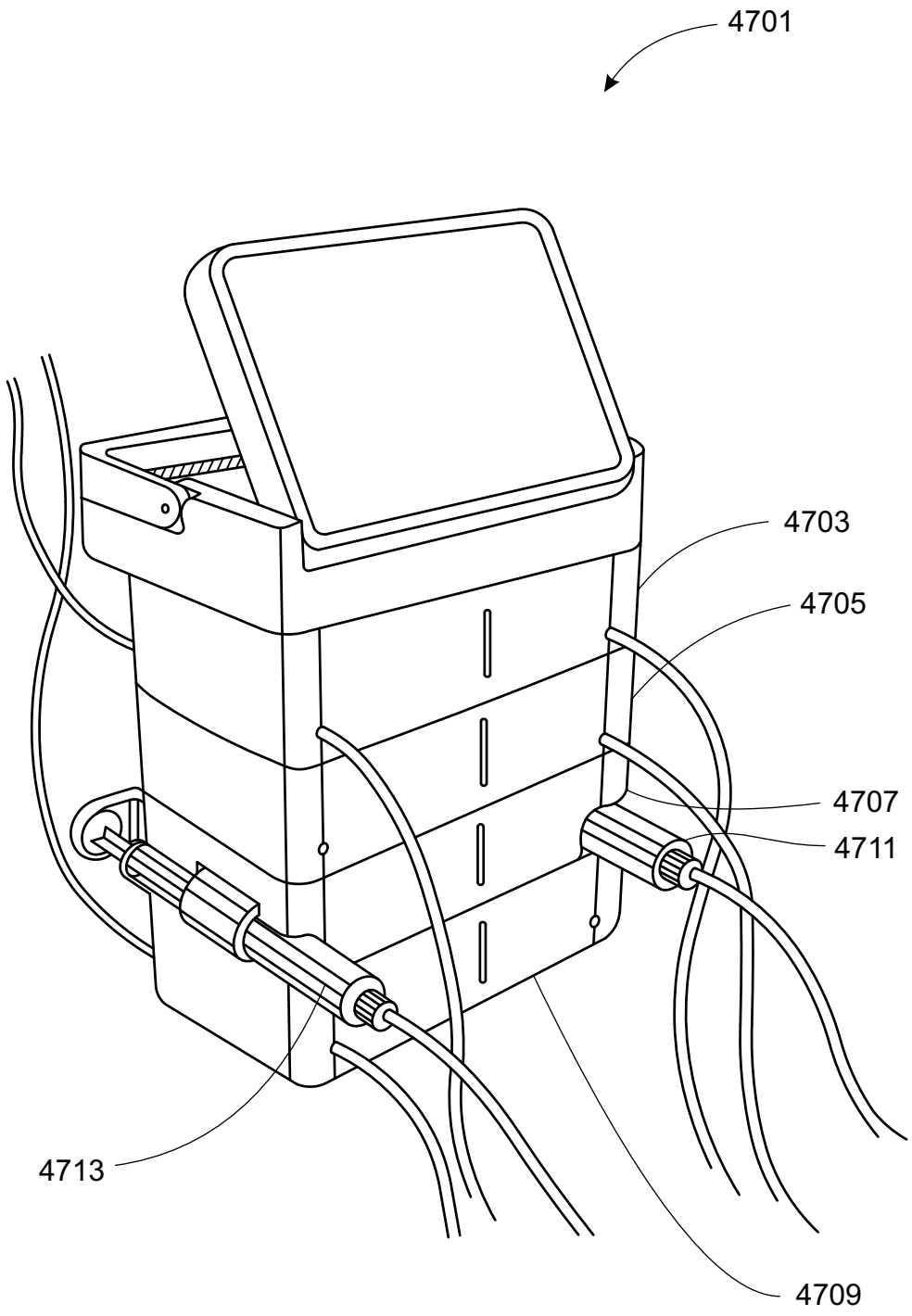


FIG. 47

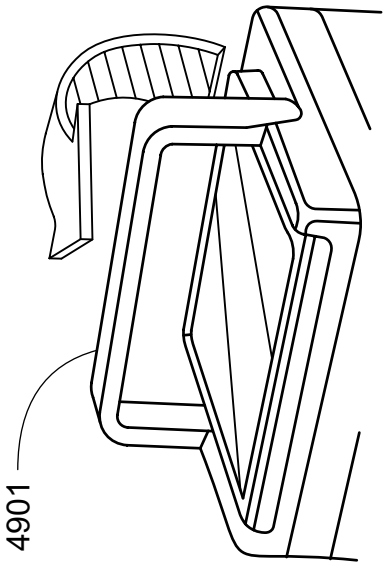


FIG. 49

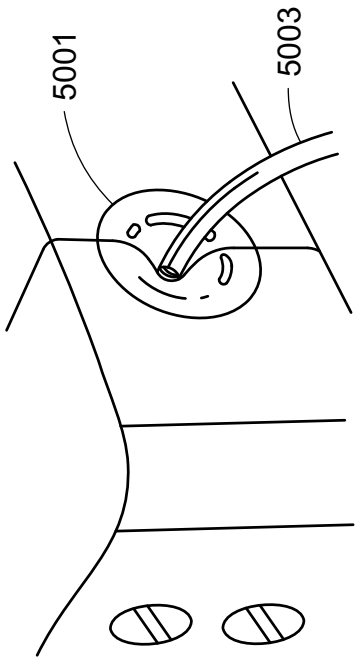


FIG. 50

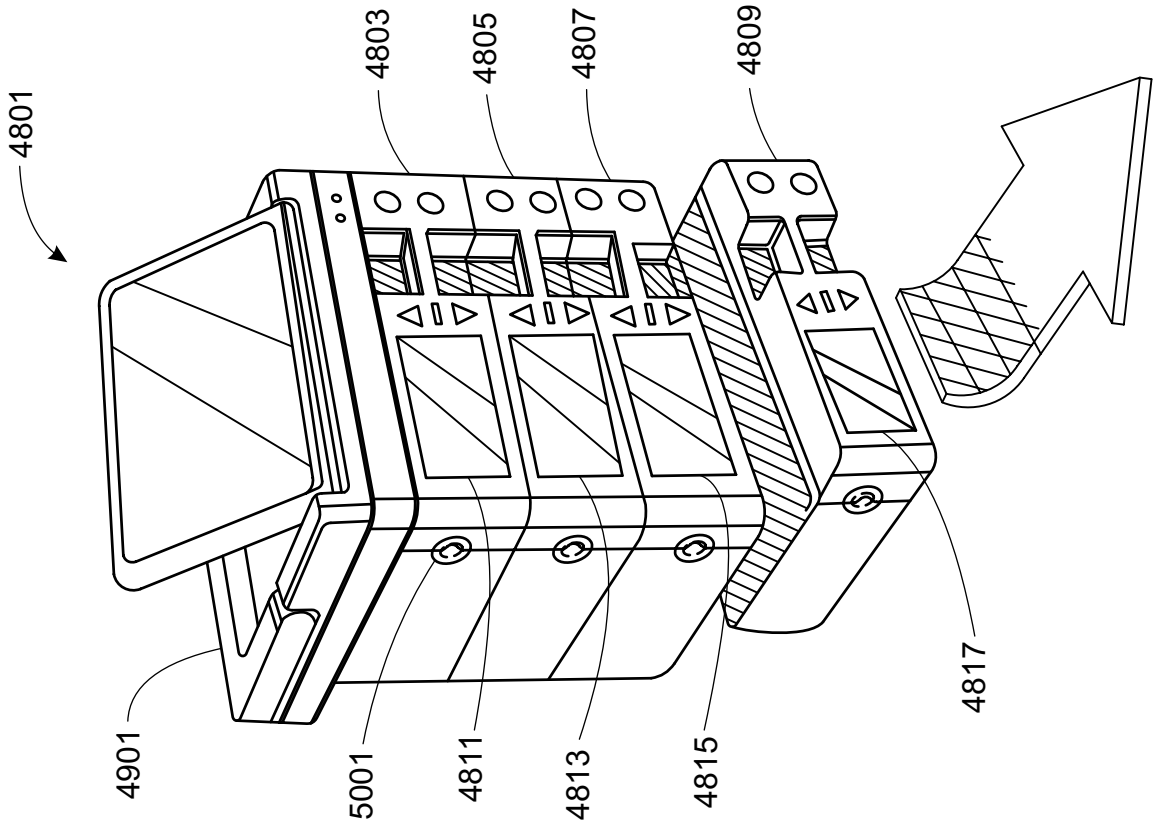


FIG. 48

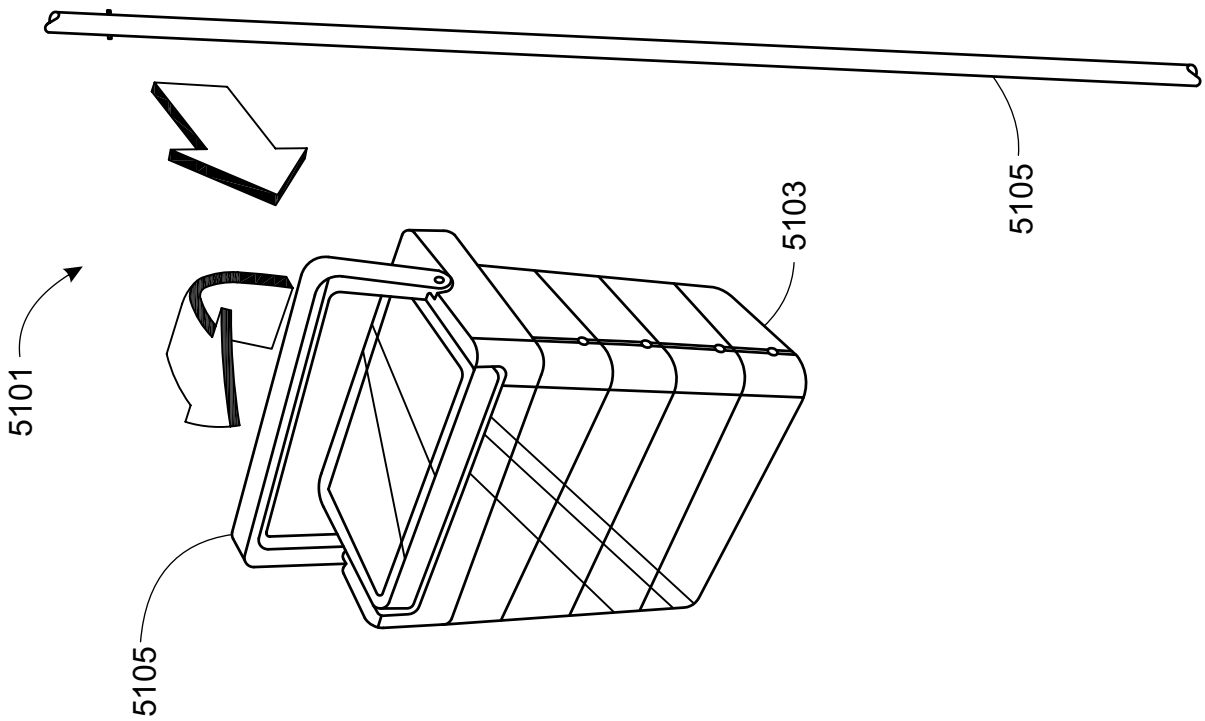


FIG. 52

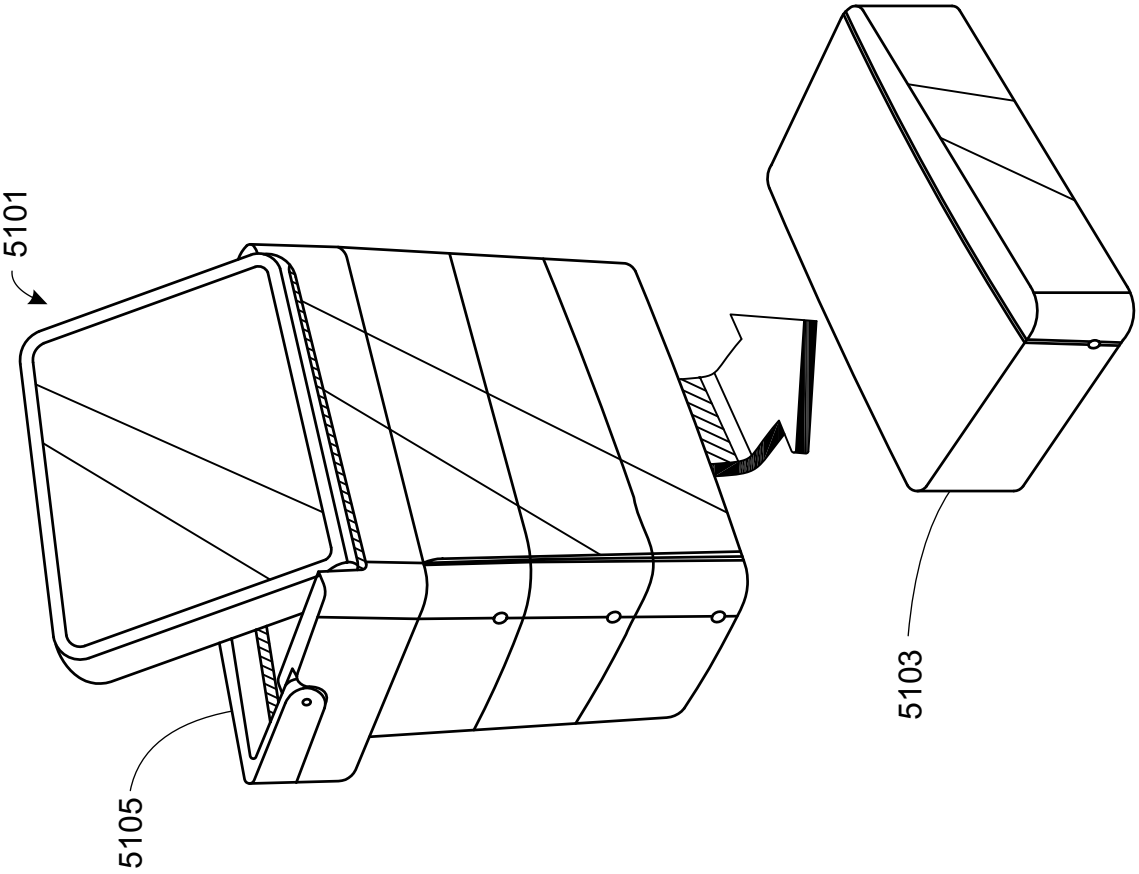


FIG. 51

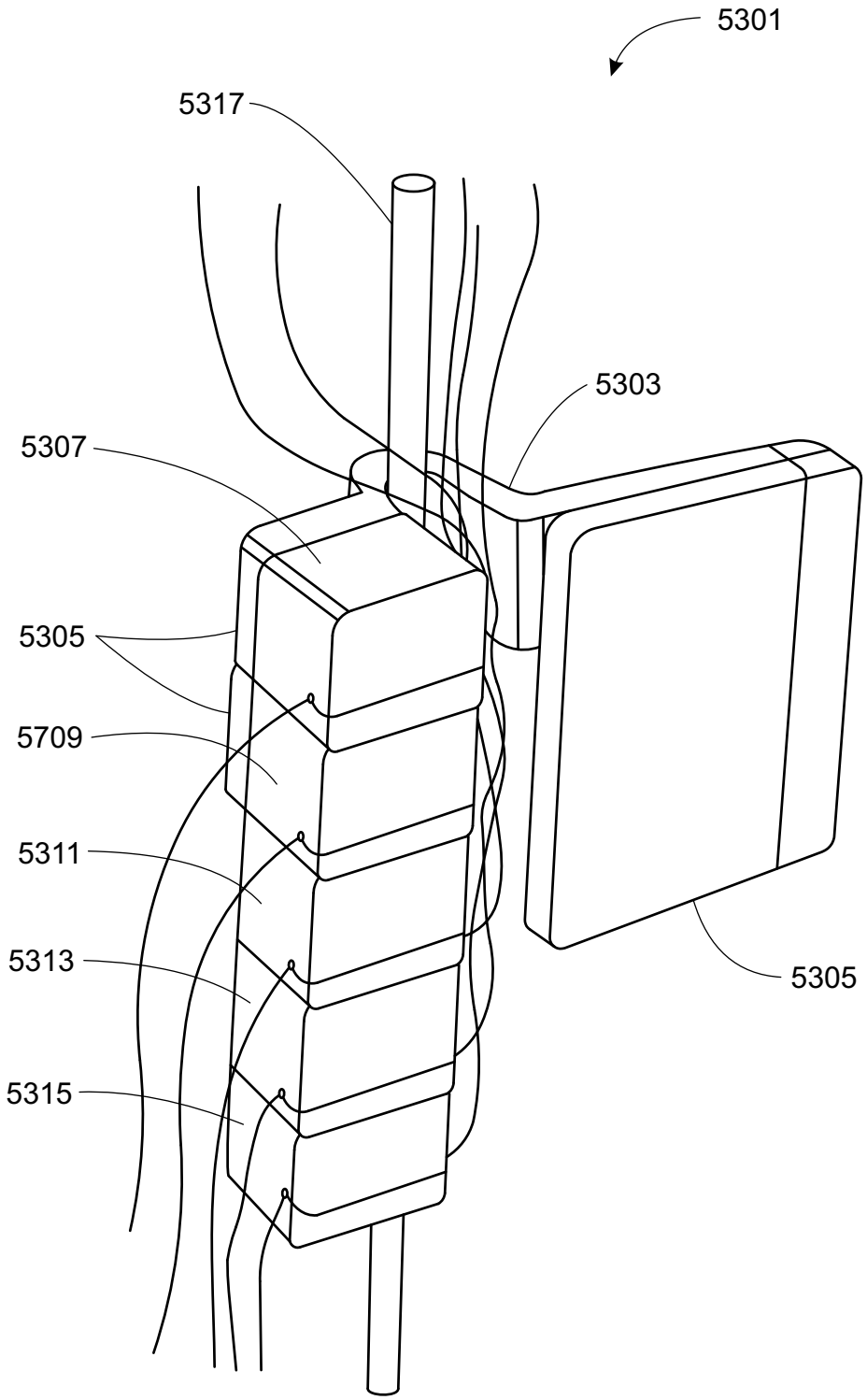


FIG. 53

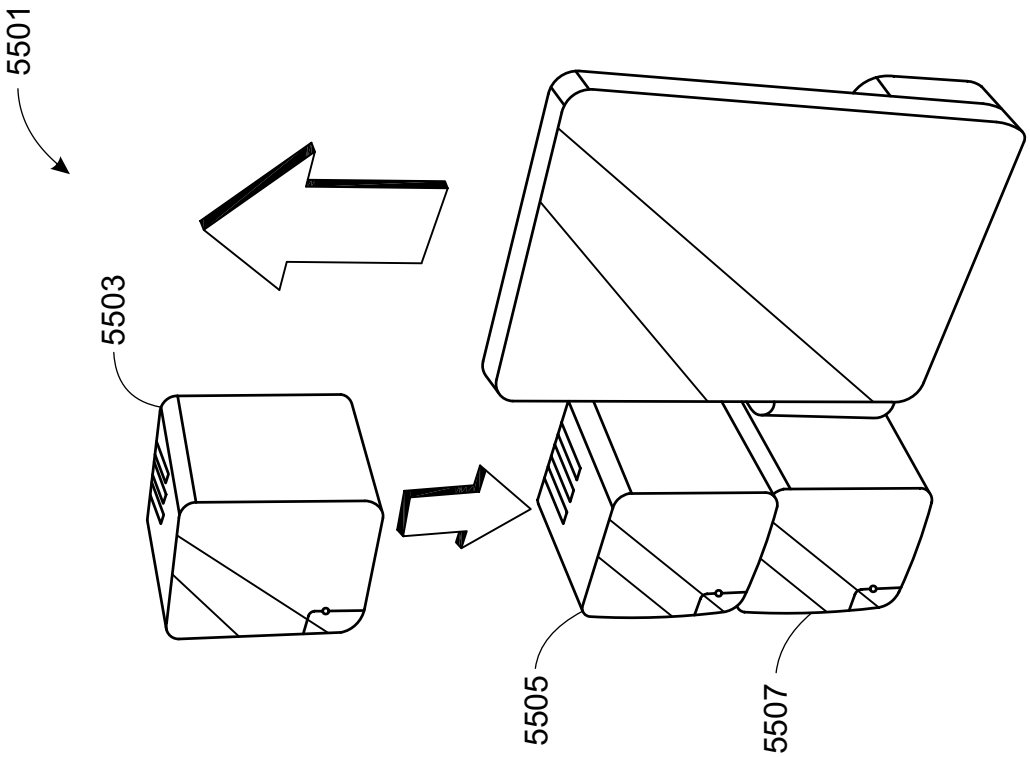


FIG. 55

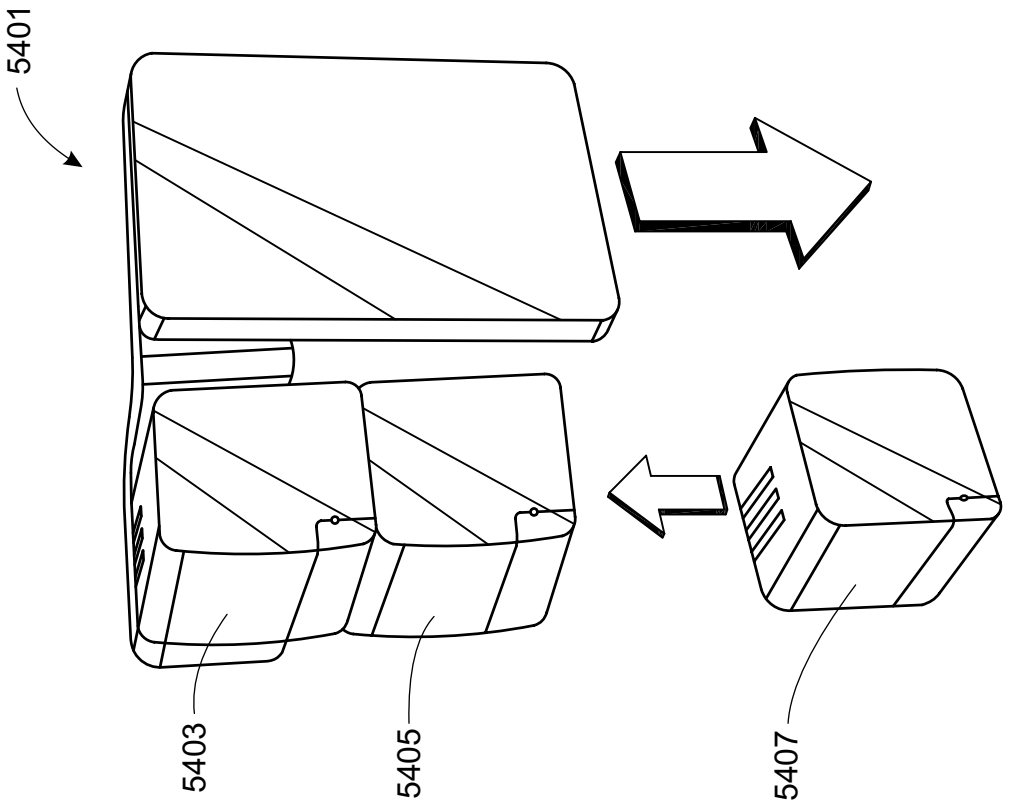


FIG. 54

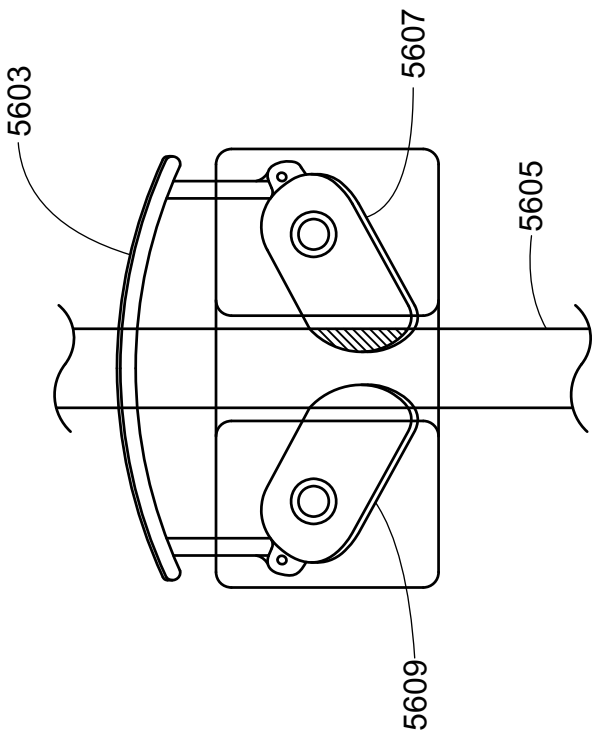


FIG. 57

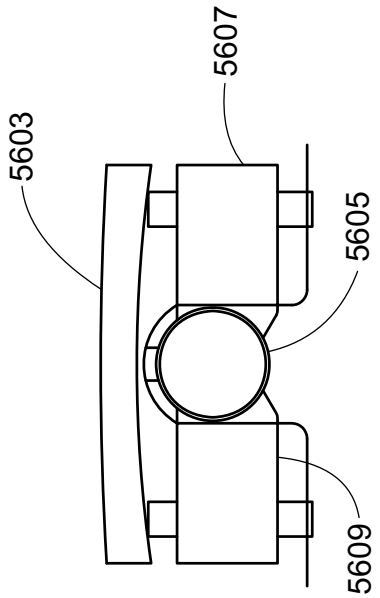


FIG. 58

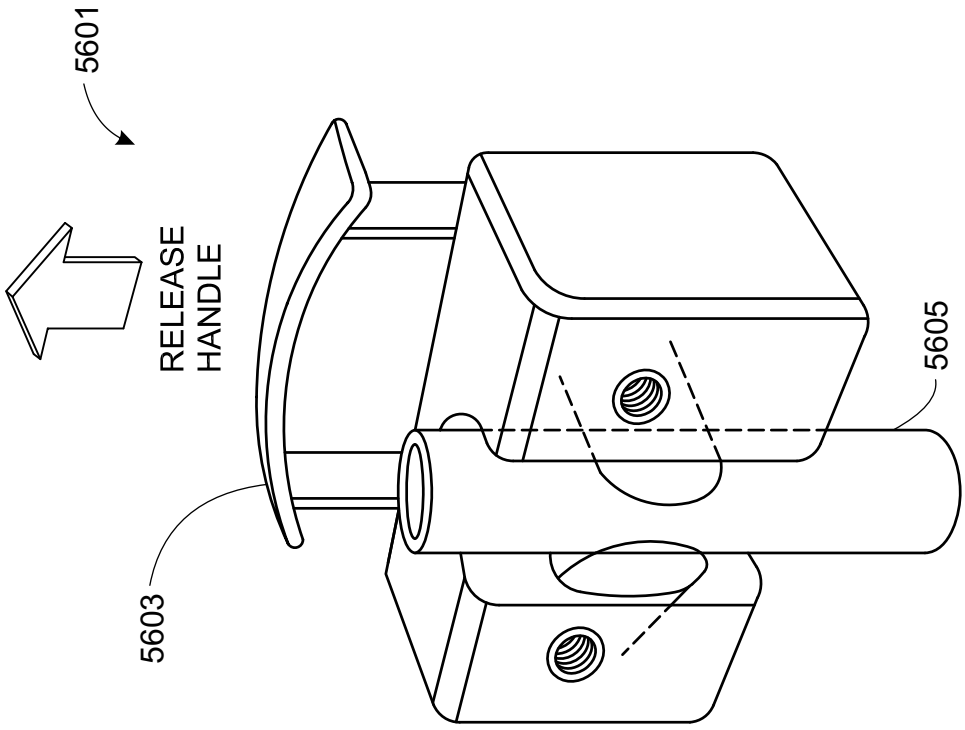


FIG. 56

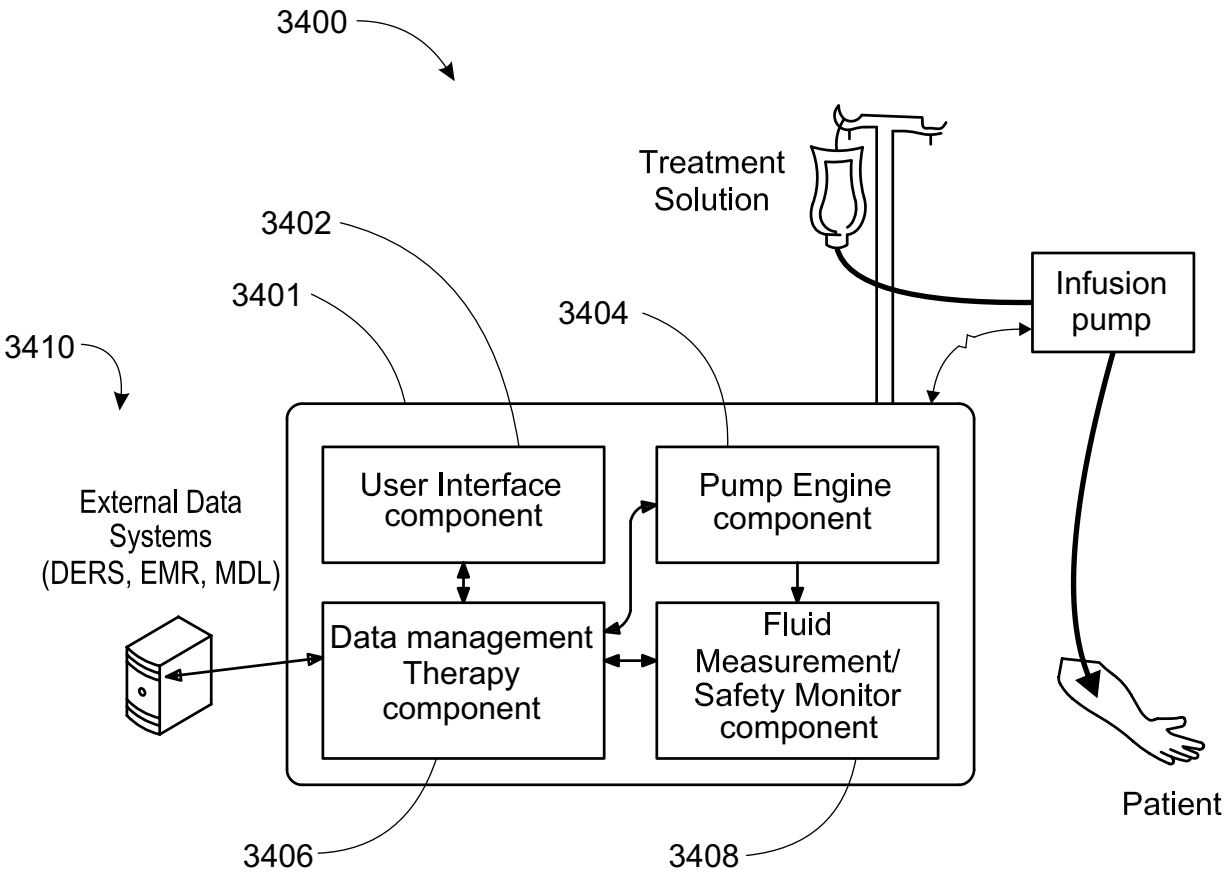

3400
Treatment Solution
3402
3401
3404
Infusion pump
3410
External Data Systems (DERS, EMR, MDL)
User Interface component
Pump Engine component
Data management Therapy component
Fluid Measurement/ Safety Monitor component
Patient
3406
3408

FIG. 59

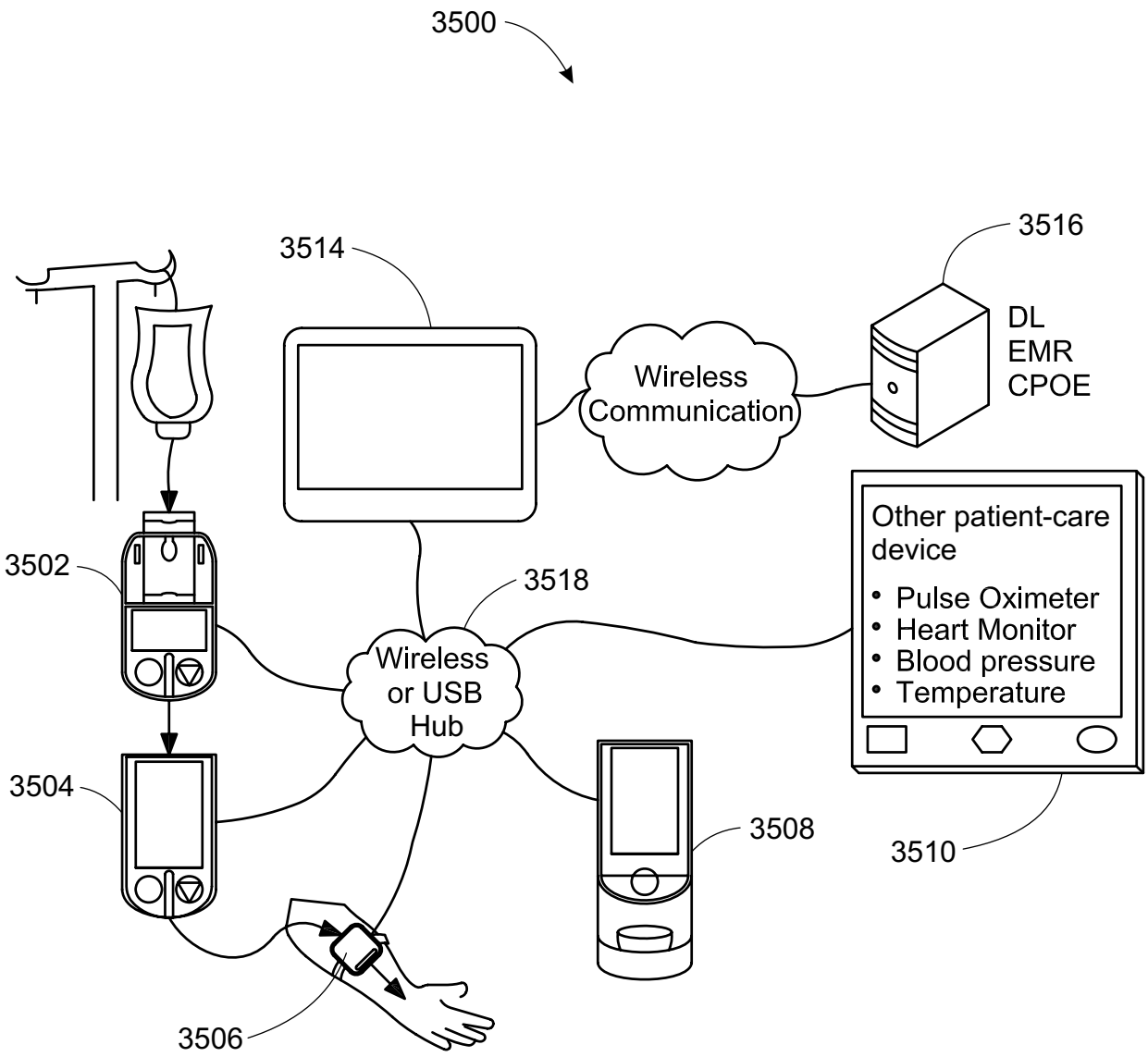

3500
3514
3516
DL
EMR
CPOE
Wireless
Communication
Other patient-care
device
• Pulse Oximeter
• Heart Monitor
• Blood pressure
• Temperature
3502
3518
Wireless
or USB
Hub
3504
3508
3510
3506

FIG. 60

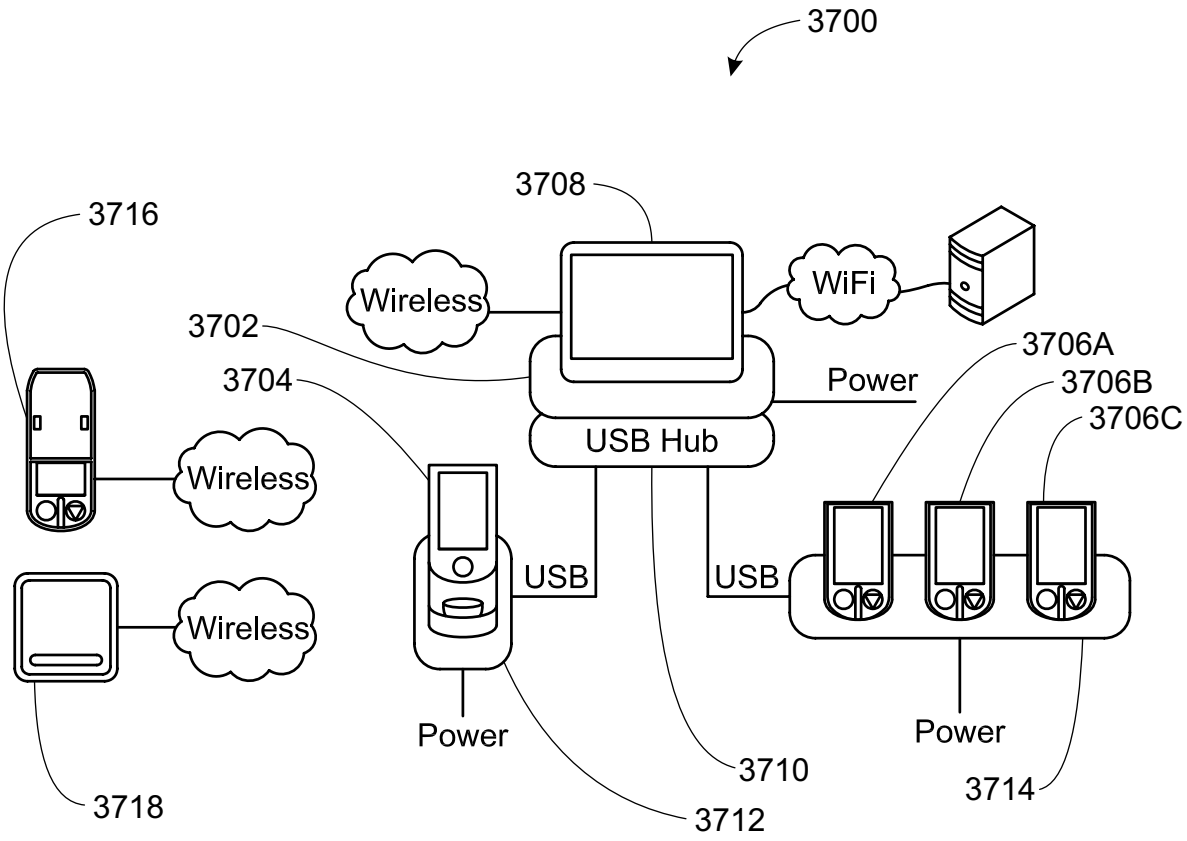

3700
3708
3716
Wireless
WiFi
3702
3706A
3704
Power
3706B
3706C
USB Hub
Wireless
USB
USB
Wireless
Power
Power
3710
3718
3712
3714

FIG. 61

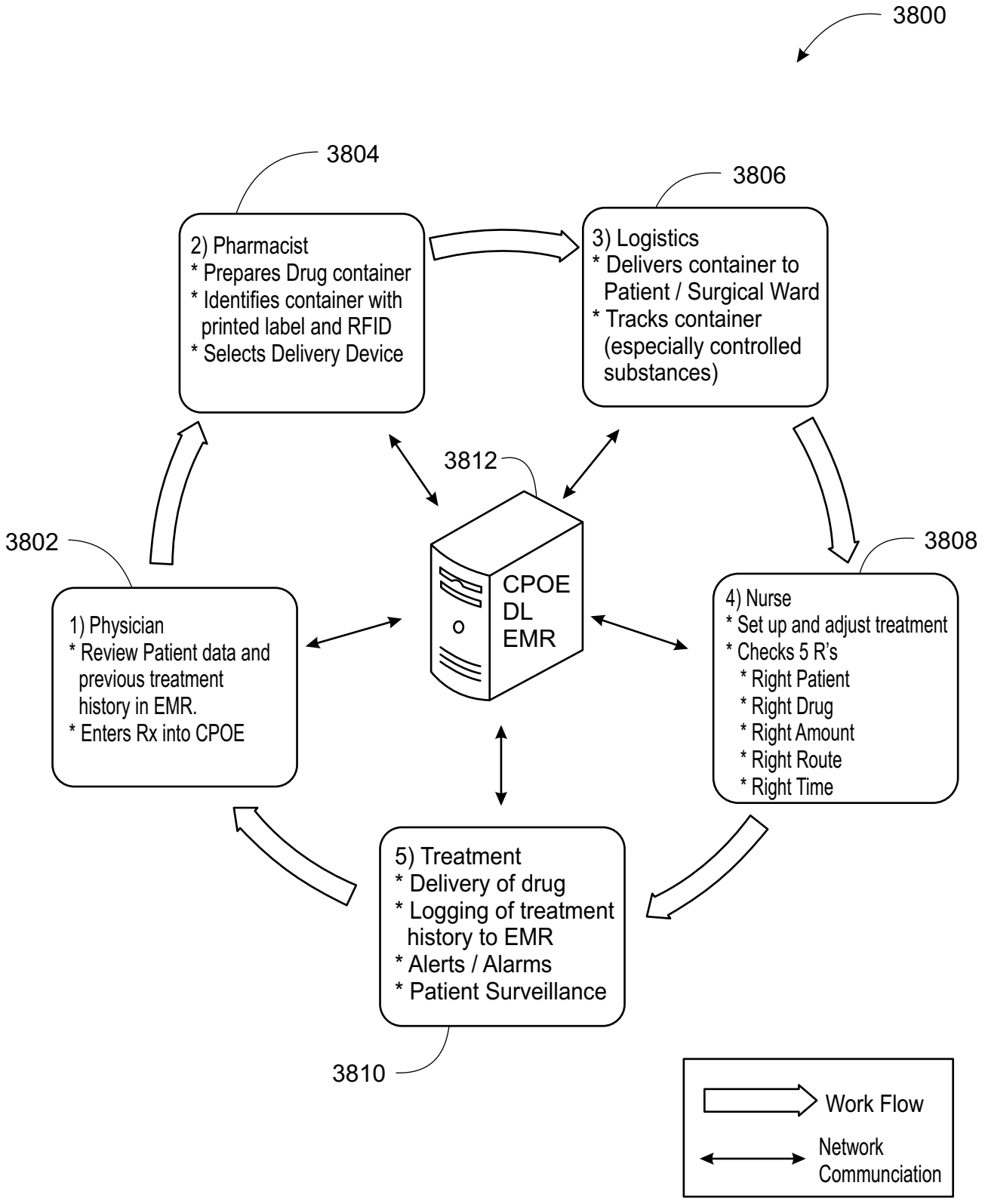

3800
3804
2) Pharmacist
* Prepares Drug container
* Identifies container with printed label and RFID
* Selects Delivery Device
3806
3) Logistics
* Delivers container to Patient / Surgical Ward
* Tracks container (especially controlled substances)
3812
CPOE
DL
EMR
3802
1) Physician
* Review Patient data and previous treatment history in EMR.
* Enters Rx into CPOE
3808
4) Nurse
* Set up and adjust treatment
* Checks 5 R's
* Right Patient
* Right Drug
* Right Amount
* Right Route
* Right Time
5) Treatment
* Delivery of drug
* Logging of treatment history to EMR
* Alerts / Alarms
* Patient Surveillance
3810
Work Flow
Network Communciation

FIG. 62

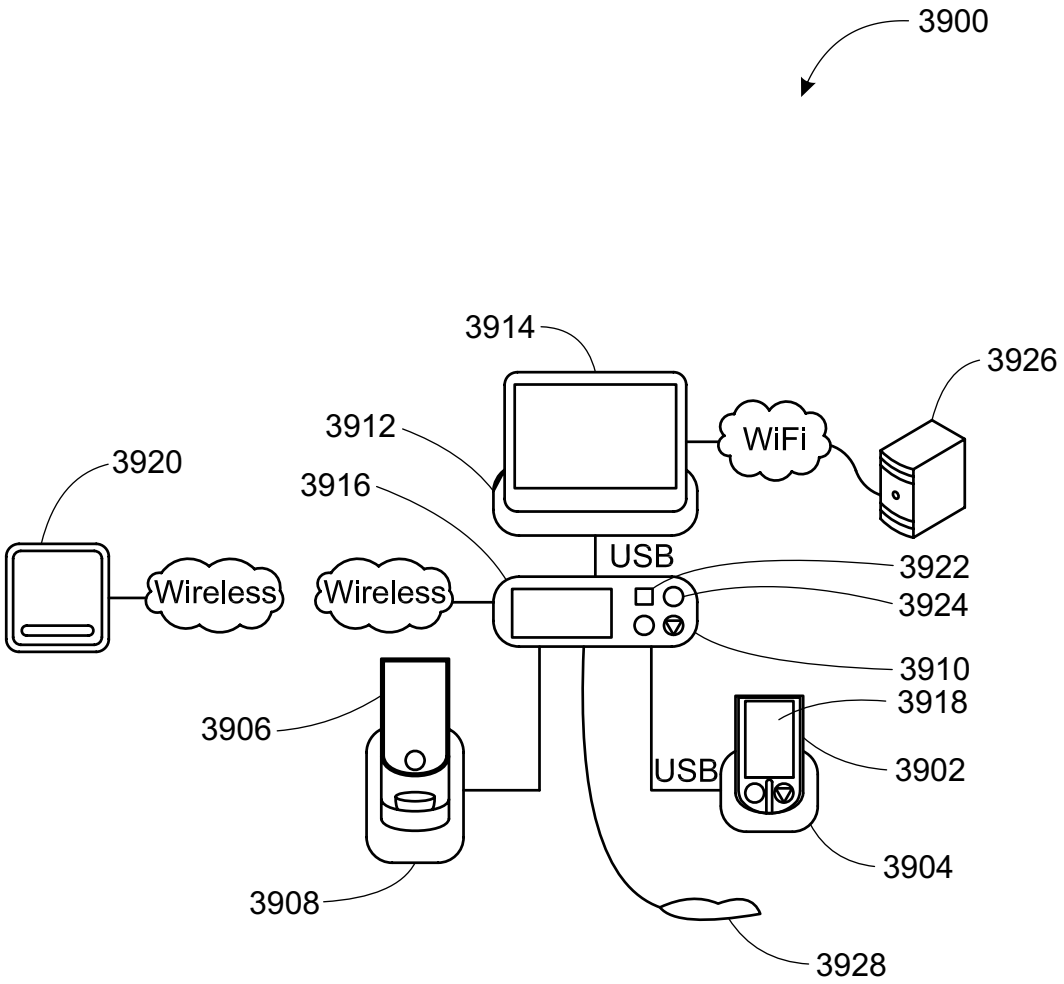

3900
3914
3926
3912
WiFi
3920
3916
USB
3922
Wireless
Wireless
3924
3910
3906
3918
USB
3902
3904
3908
3928

FIG. 63

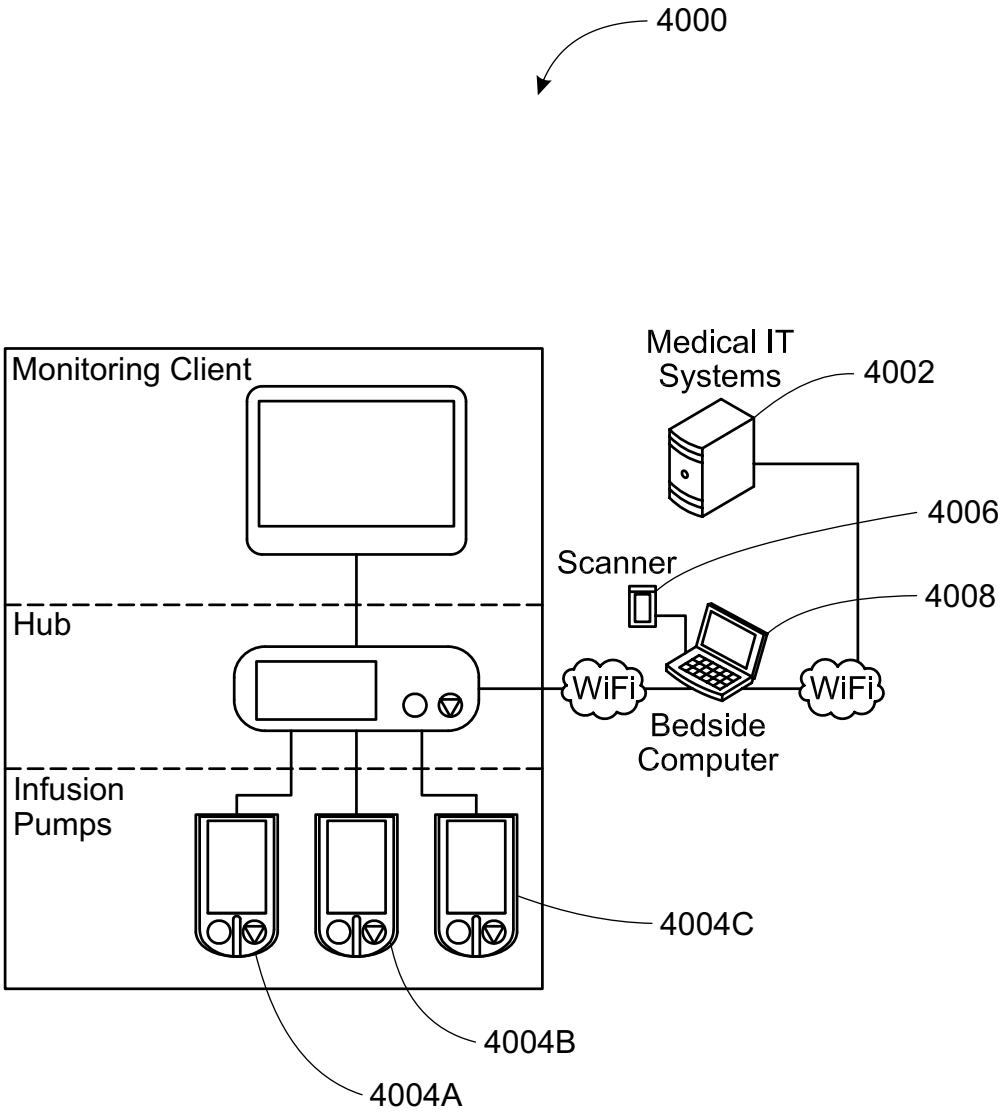

4000
Monitoring Client
Medical IT Systems
4002
4006
Scanner
4008
Hub
WiFi
WiFi
Bedside Computer
Infusion Pumps
4004C
4004B
4004A

FIG. 64

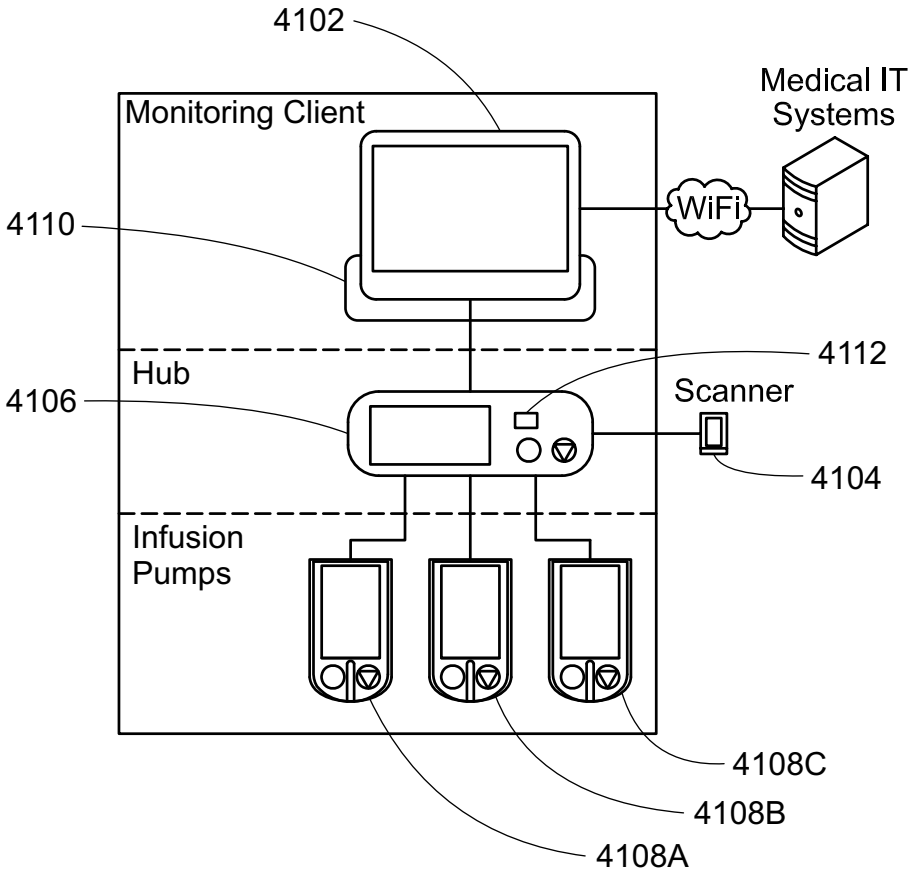

4102
Medical IT Systems
Monitoring Client
WiFi
4110
4112
Hub
Scanner
4106
4104
Infusion Pumps
4108C
4108B
4108A

FIG. 65

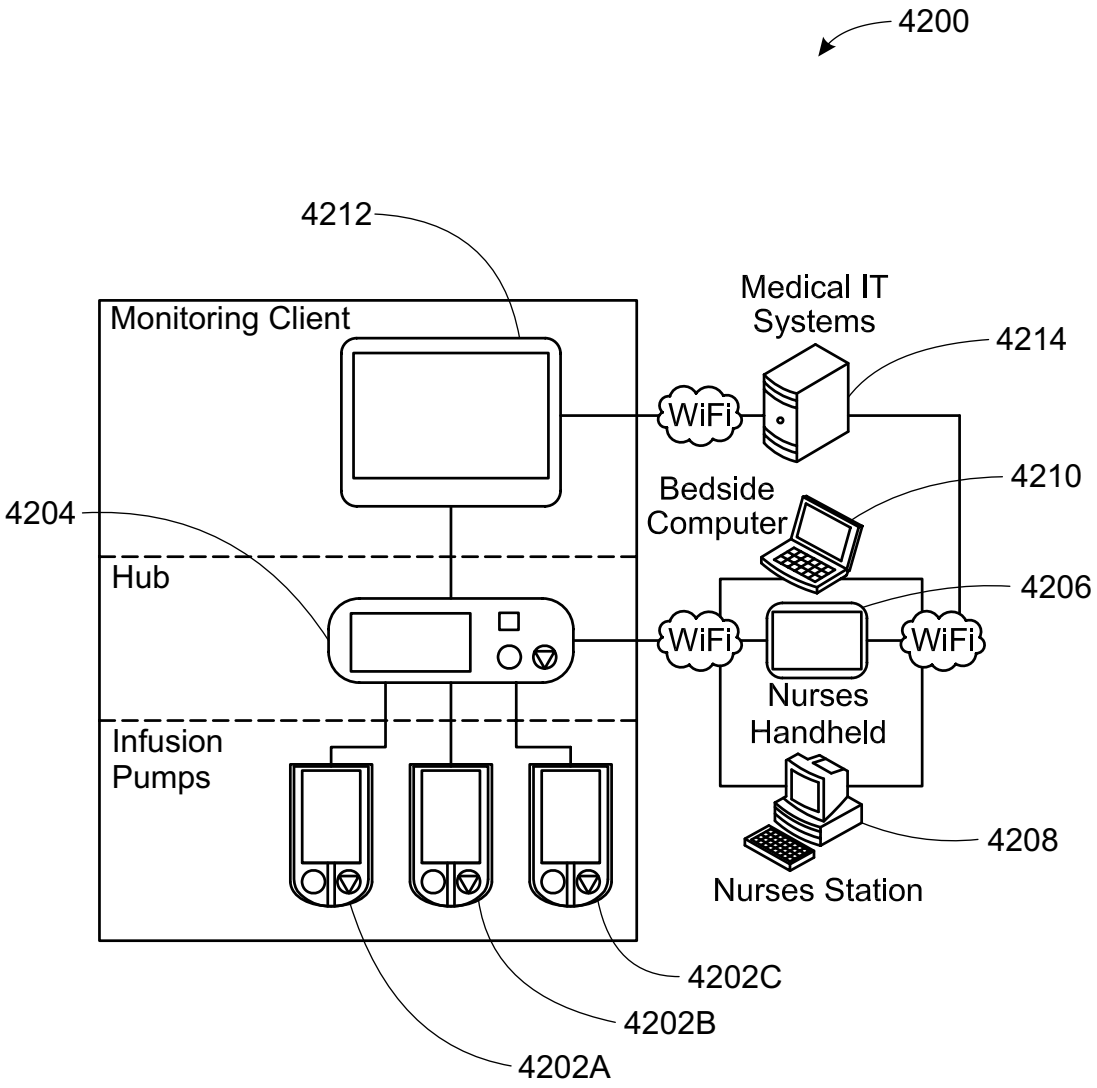

4200
4212
Monitoring Client
Medical IT
Systems
4214
WiFi
4210
Bedside
Computer
4204
Hub
4206
WiFi
WiFi
Nurses
Handheld
Infusion
Pumps
4208
Nurses Station
4202C
4202B
4202A

FIG. 66

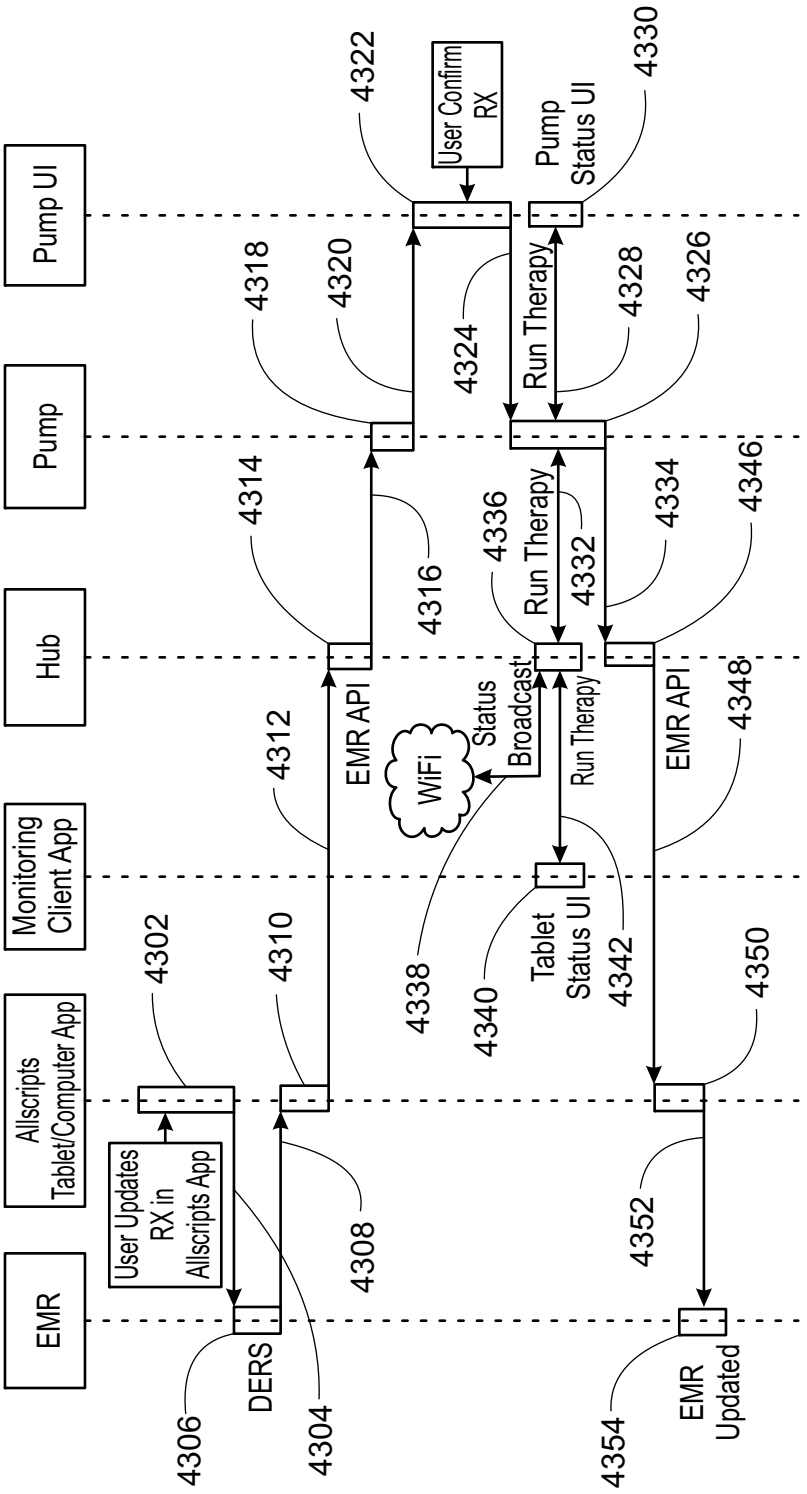

4300
EMR
Allscripts Tablet/Computer App
Monitoring Client App
Hub
Pump
Pump UI
User Updates RX in Allscripts App
DERS
EMR API
WiFi
Status Broadcast
Run Therapy
Tablet Status UI
EMR API
User Confirm RX
Pump Status UI
Run Therapy
Run Therapy
EMR Updated
4302
4310
4312
4314
4316
4318
4320
4322
4324
4326
4328
4330
4332
4334
4336
4338
4340
4342
4346
4348
4350
4352
4354
4304
4306
4308

FIG. 67

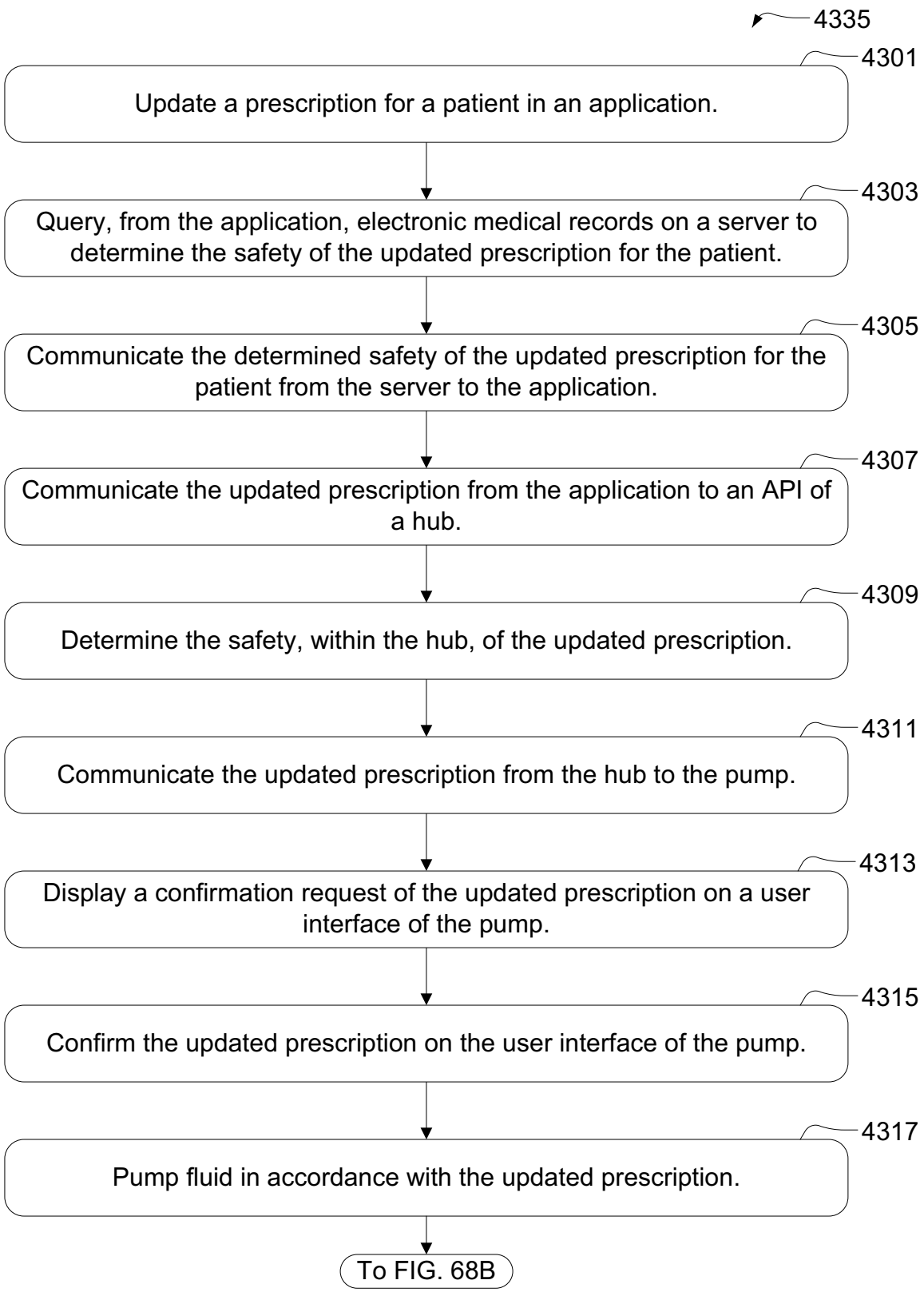

4335
4301
Update a prescription for a patient in an application.
4303
Query, from the application, electronic medical records on a server to determine the safety of the updated prescription for the patient.
4305
Communicate the determined safety of the updated prescription for the patient from the server to the application.
4307
Communicate the updated prescription from the application to an API of a hub.
4309
Determine the safety, within the hub, of the updated prescription.
4311
Communicate the updated prescription from the hub to the pump.
4313
Display a confirmation request of the updated prescription on a user interface of the pump.
4315
Confirm the updated prescription on the user interface of the pump.
4317
Pump fluid in accordance with the updated prescription.
To FIG. 68B

FIG. 68A

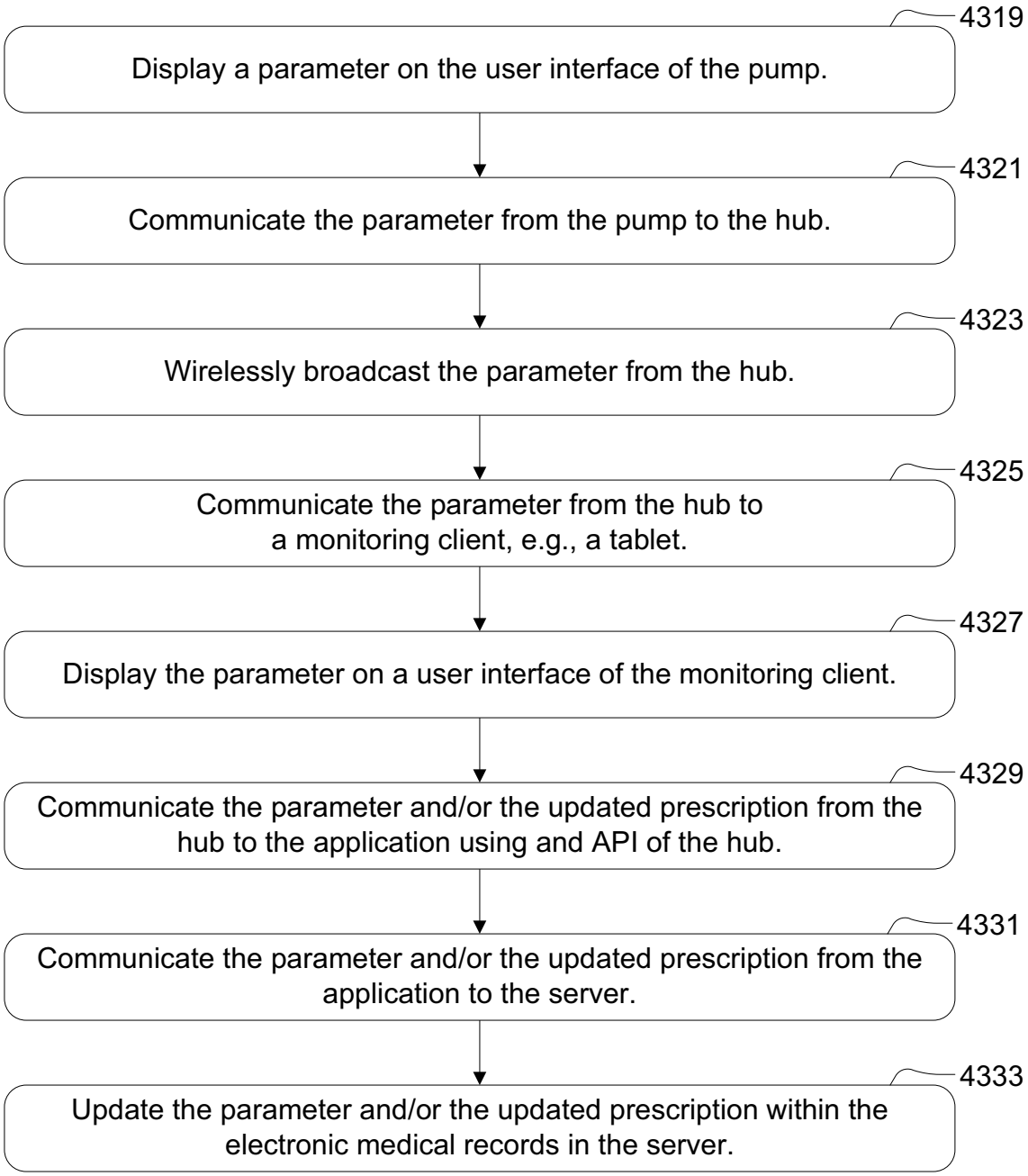

4319
Display a parameter on the user interface of the pump.
4321
Communicate the parameter from the pump to the hub.
4323
Wirelessly broadcast the parameter from the hub.
4325
Communicate the parameter from the hub to a monitoring client, e.g., a tablet.
4327
Display the parameter on a user interface of the monitoring client.
4329
Communicate the parameter and/or the updated prescription from the hub to the application using and API of the hub.
4331
Communicate the parameter and/or the updated prescription from the application to the server.
4333
Update the parameter and/or the updated prescription within the electronic medical records in the server.

FIG. 68B

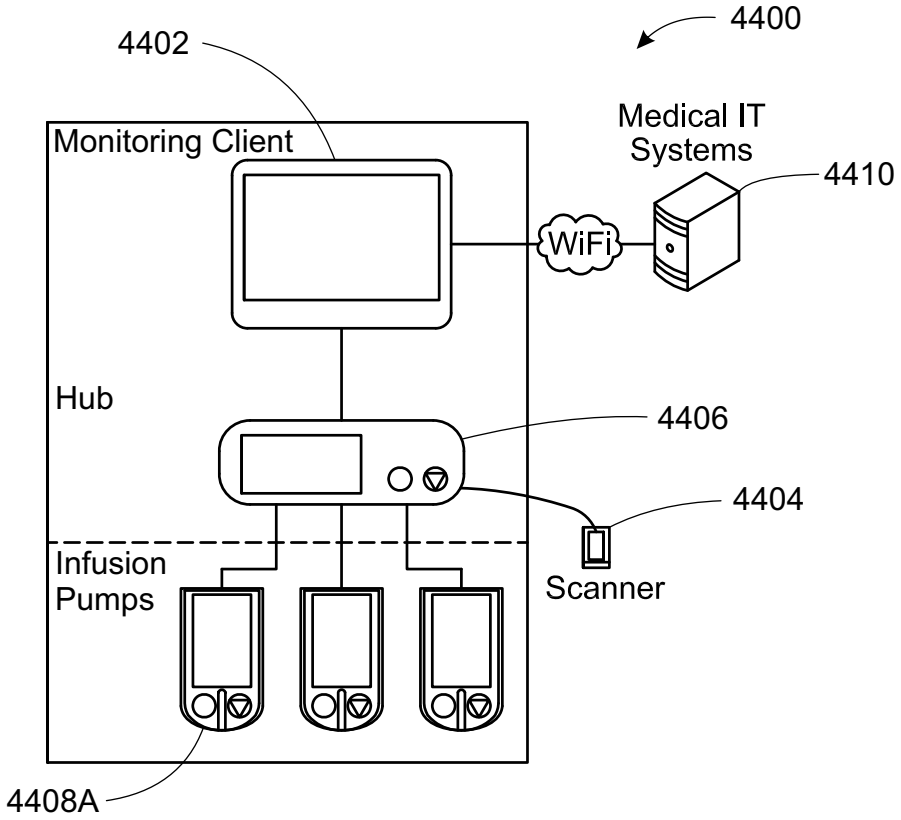

4400
4402
Monitoring Client
Medical IT
Systems
4410
WiFi
Hub
4406
4404
Infusion
Pumps
Scanner
4408A

FIG. 69

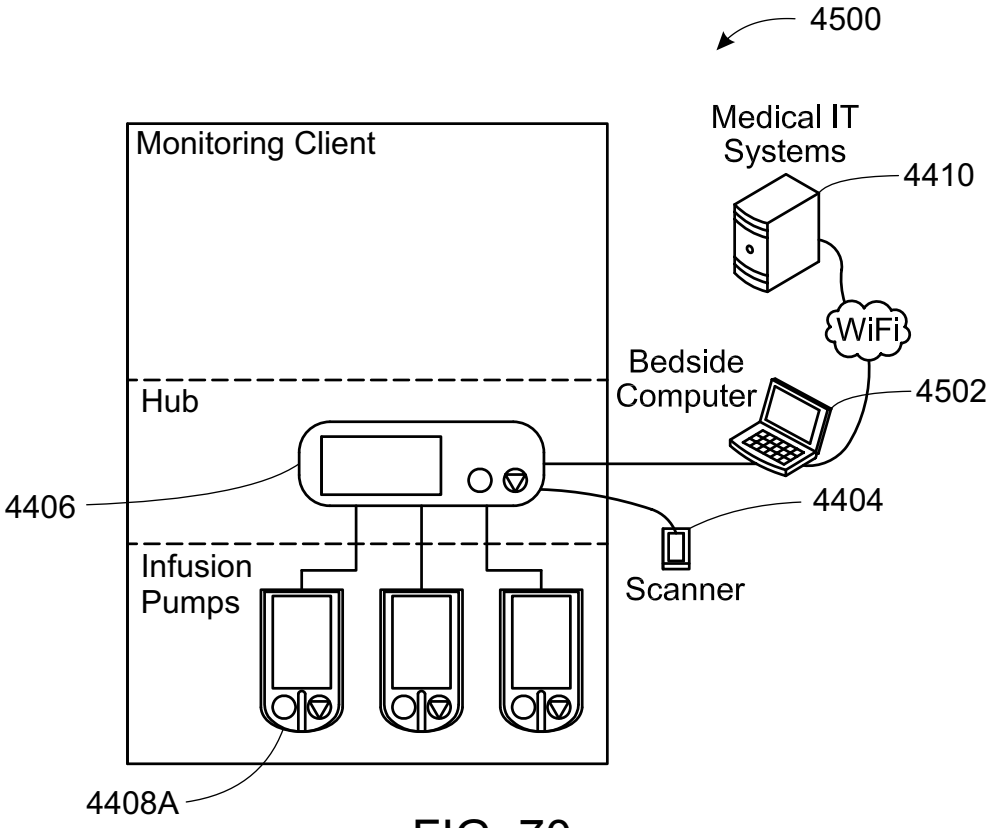

4500
Monitoring Client
Medical IT
Systems
4410
WiFi
Bedside
Computer
4502
Hub
4406
4404
Infusion
Pumps
Scanner
4408A

FIG. 70

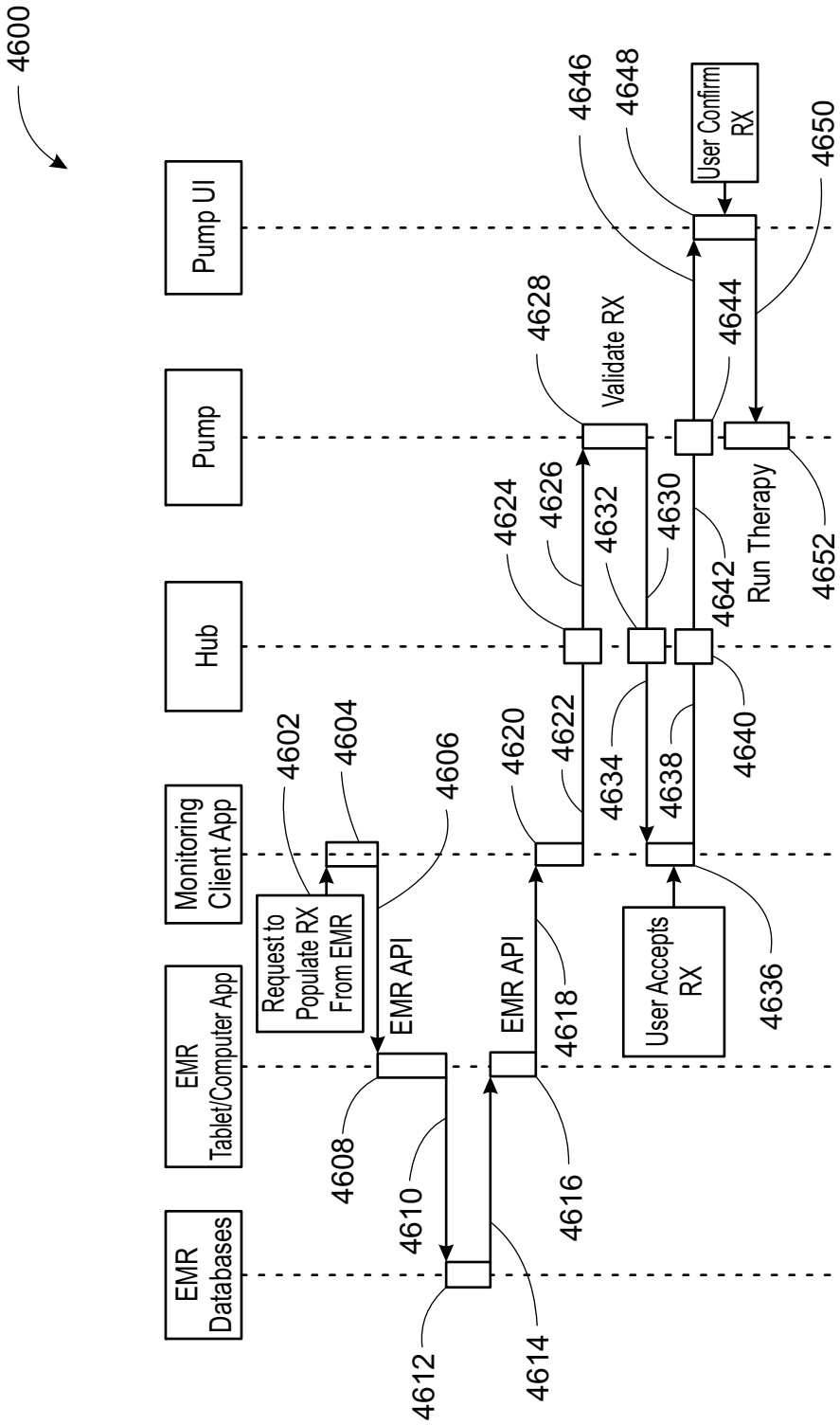

4600
EMR Databases
EMR Tablet/Computer App
Monitoring Client App
Hub
Pump
Pump UI
Request to Populate RX From EMR
EMR API
EMR API
User Accepts RX
Validate RX
User Confirm RX
Run Therapy
4602
4604
4606
4608
4610
4612
4614
4616
4618
4620
4622
4624
4626
4628
4630
4632
4634
4636
4638
4640
4642
4644
4646
4648
4650
4652

FIG. 71

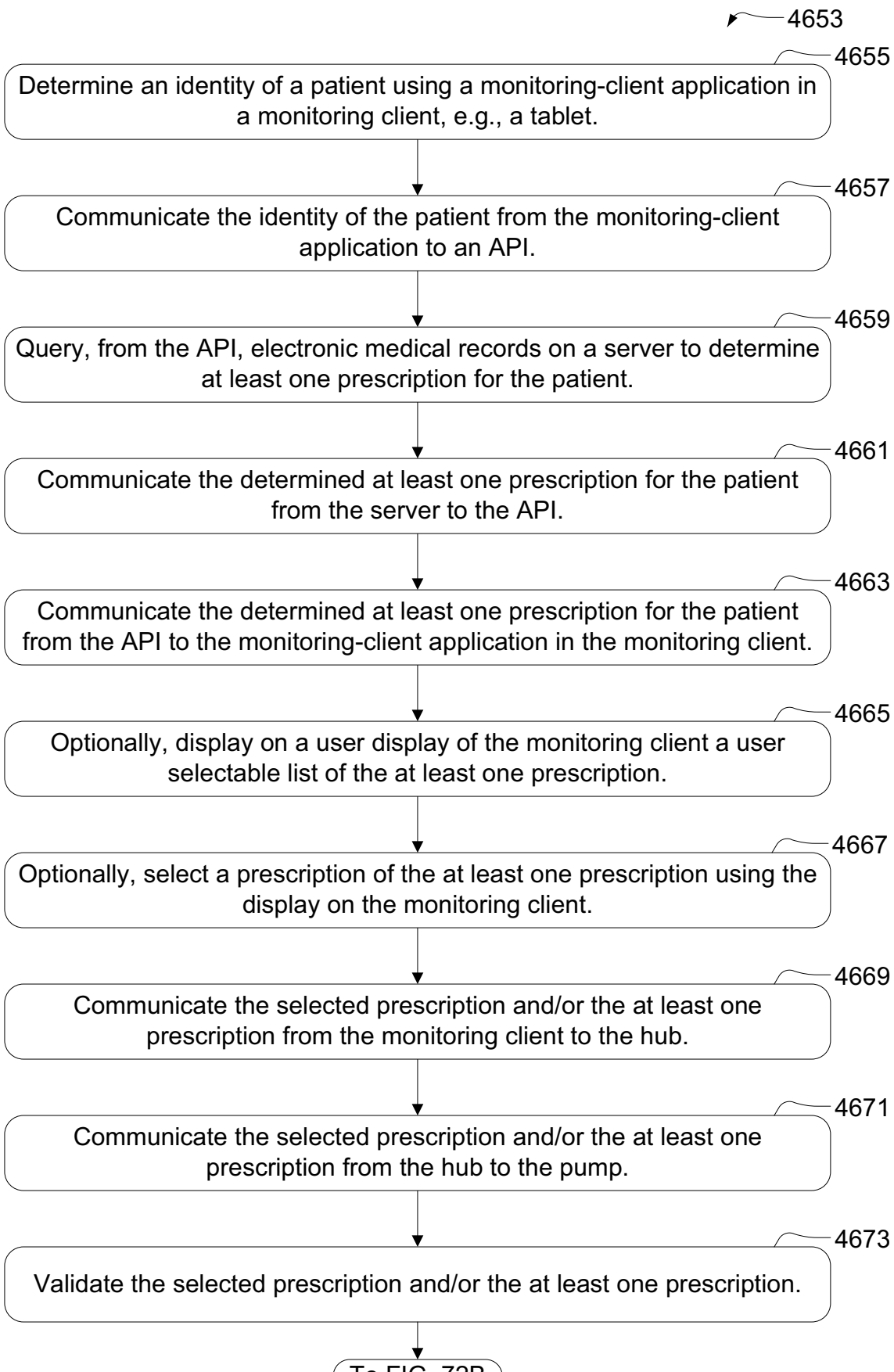

4653
4655
Determine an identity of a patient using a monitoring-client application in a monitoring client, e.g., a tablet.
4657
Communicate the identity of the patient from the monitoring-client application to an API.
4659
Query, from the API, electronic medical records on a server to determine at least one prescription for the patient.
4661
Communicate the determined at least one prescription for the patient from the server to the API.
4663
Communicate the determined at least one prescription for the patient from the API to the monitoring-client application in the monitoring client.
4665
Optionally, display on a user display of the monitoring client a user selectable list of the at least one prescription.
4667
Optionally, select a prescription of the at least one prescription using the display on the monitoring client.
4669
Communicate the selected prescription and/or the at least one prescription from the monitoring client to the hub.
4671
Communicate the selected prescription and/or the at least one prescription from the hub to the pump.
4673
Validate the selected prescription and/or the at least one prescription.
To FIG. 72B

FIG. 72A

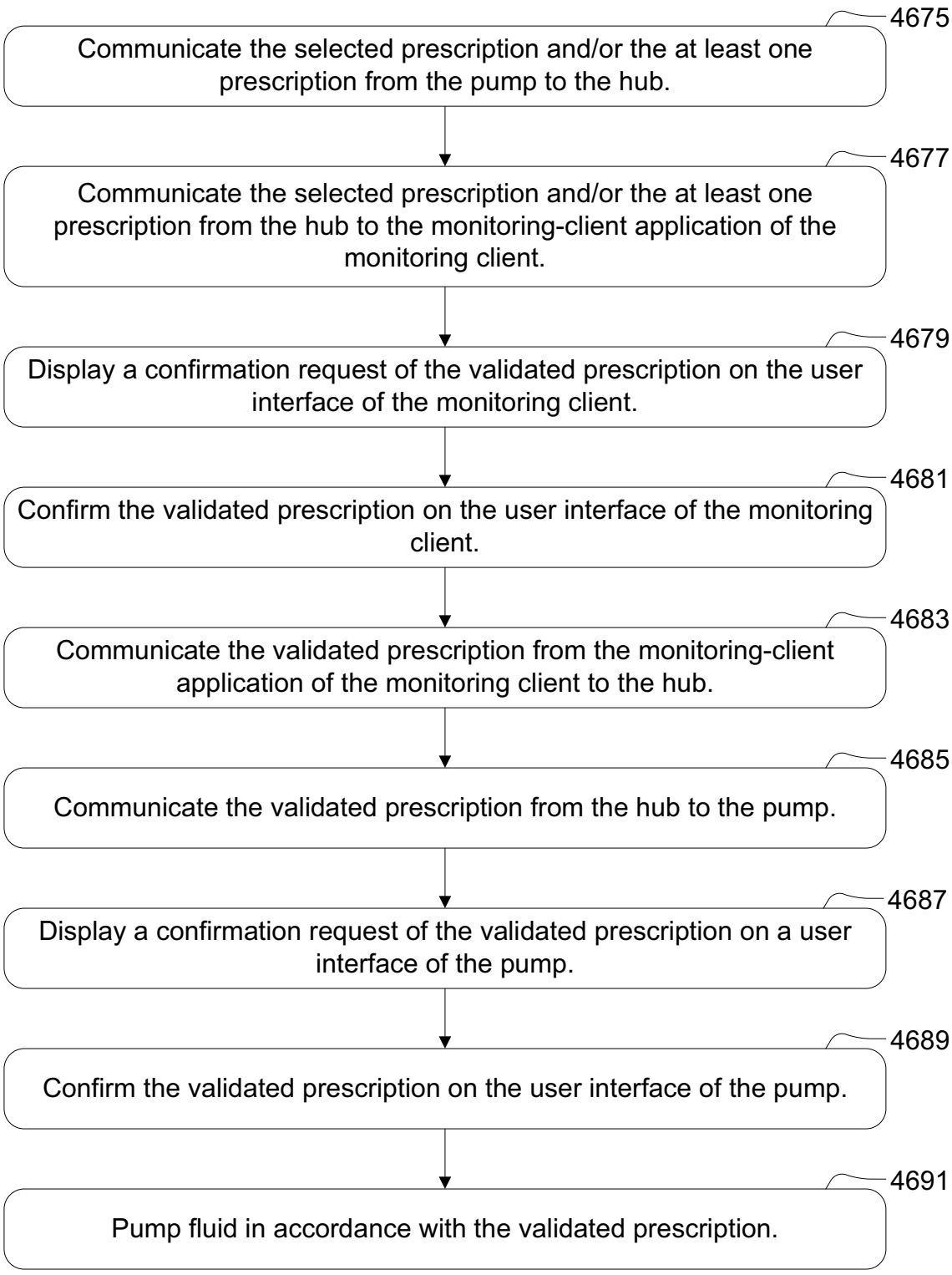

4675
Communicate the selected prescription and/or the at least one prescription from the pump to the hub.
4677
Communicate the selected prescription and/or the at least one prescription from the hub to the monitoring-client application of the monitoring client.
4679
Display a confirmation request of the validated prescription on the user interface of the monitoring client.
4681
Confirm the validated prescription on the user interface of the monitoring client.
4683
Communicate the validated prescription from the monitoring-client application of the monitoring client to the hub.
4685
Communicate the validated prescription from the hub to the pump.
4687
Display a confirmation request of the validated prescription on a user interface of the pump.
4689
Confirm the validated prescription on the user interface of the pump.
4691
Pump fluid in accordance with the validated prescription.

FIG. 72B

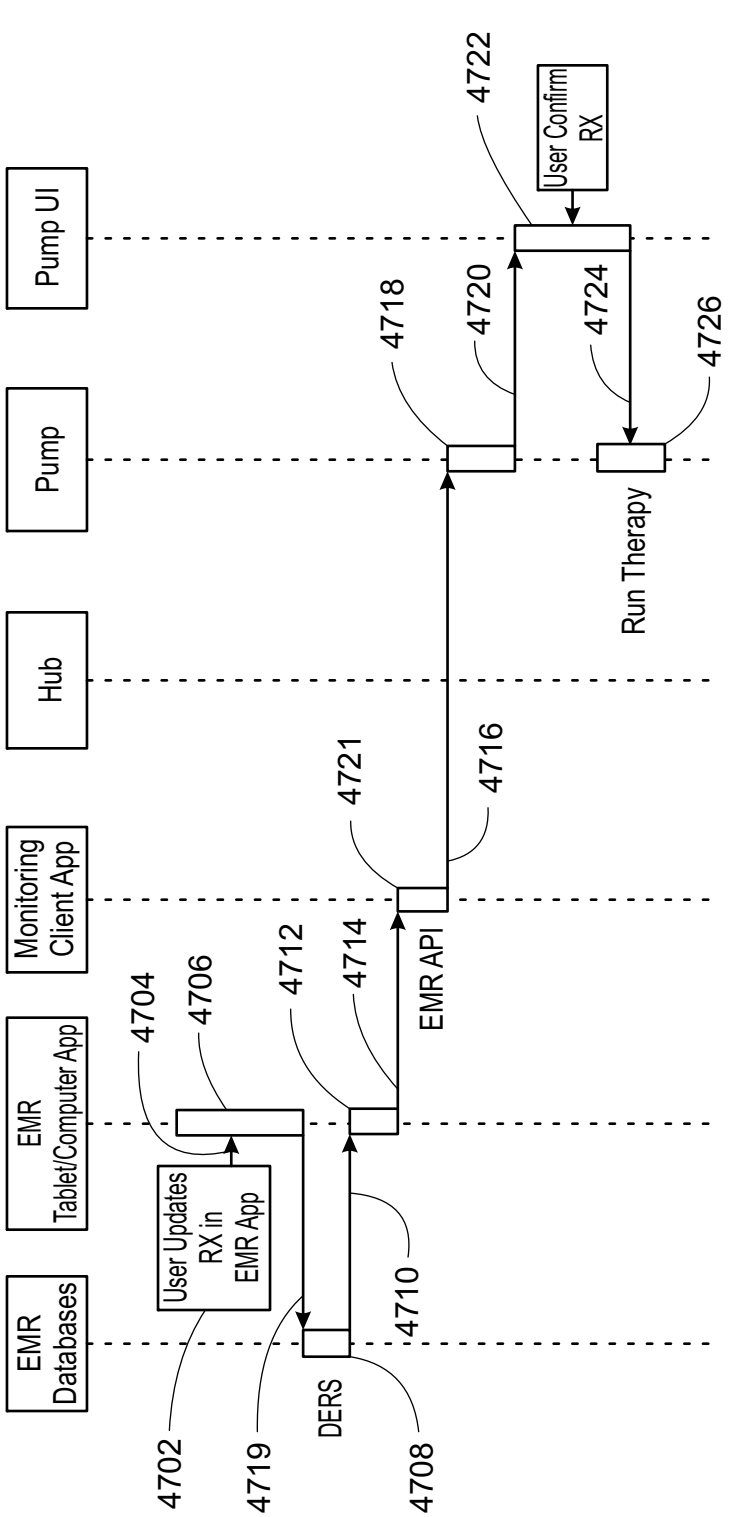

4700
EMR Databases
EMR Tablet/Computer App
Monitoring Client App
Hub
Pump
Pump UI
User Updates RX in EMR App
DERS
EMR API
Run Therapy
User Confirm RX
4702
4704
4706
4708
4710
4712
4714
4716
4718
4719
4720
4721
4722
4724
4726

FIG. 73

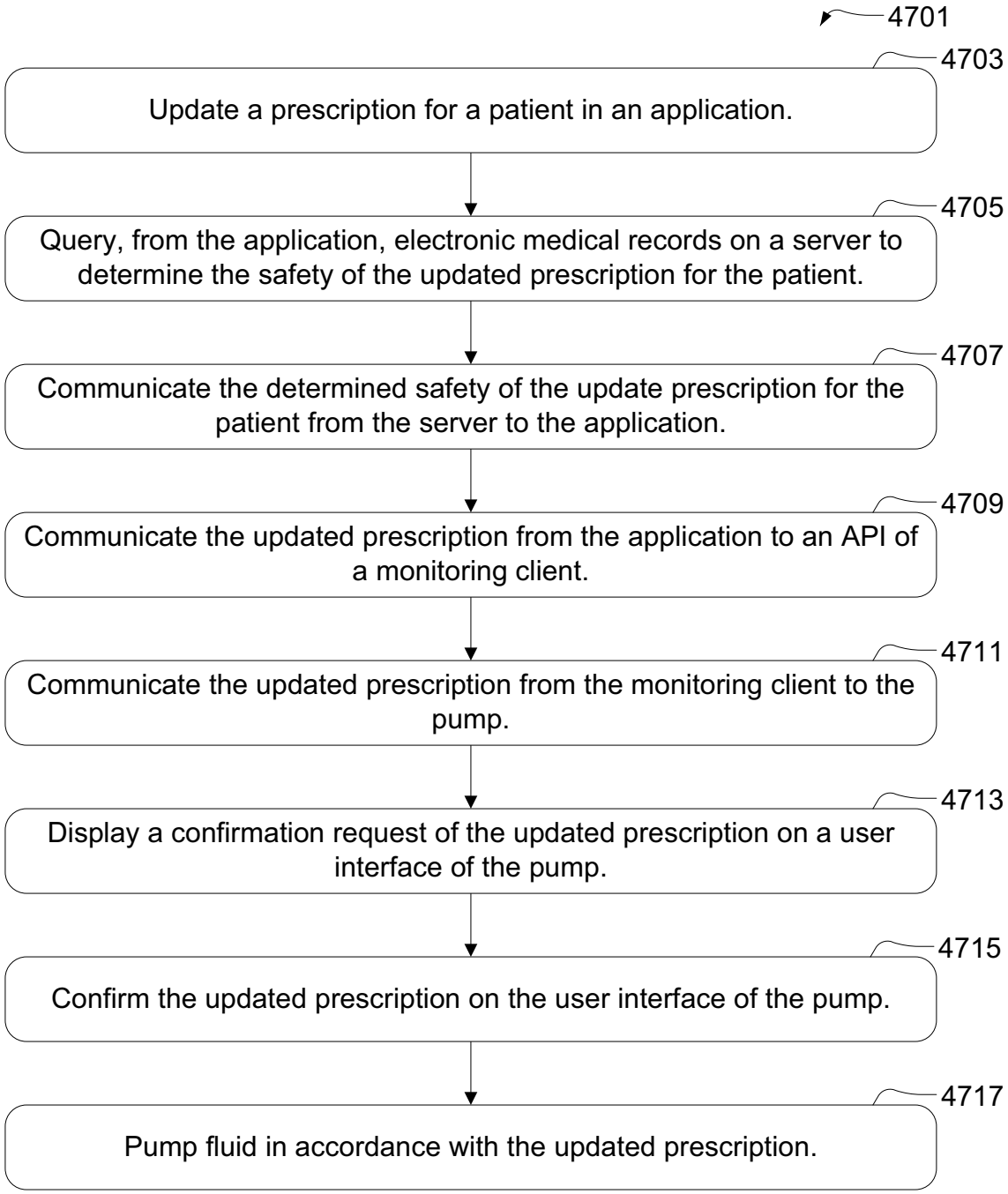

4701
4703
Update a prescription for a patient in an application.
4705
Query, from the application, electronic medical records on a server to determine the safety of the updated prescription for the patient.
4707
Communicate the determined safety of the update prescription for the patient from the server to the application.
4709
Communicate the updated prescription from the application to an API of a monitoring client.
4711
Communicate the updated prescription from the monitoring client to the pump.
4713
Display a confirmation request of the updated prescription on a user interface of the pump.
4715
Confirm the updated prescription on the user interface of the pump.
4717
Pump fluid in accordance with the updated prescription.

FIG. 74

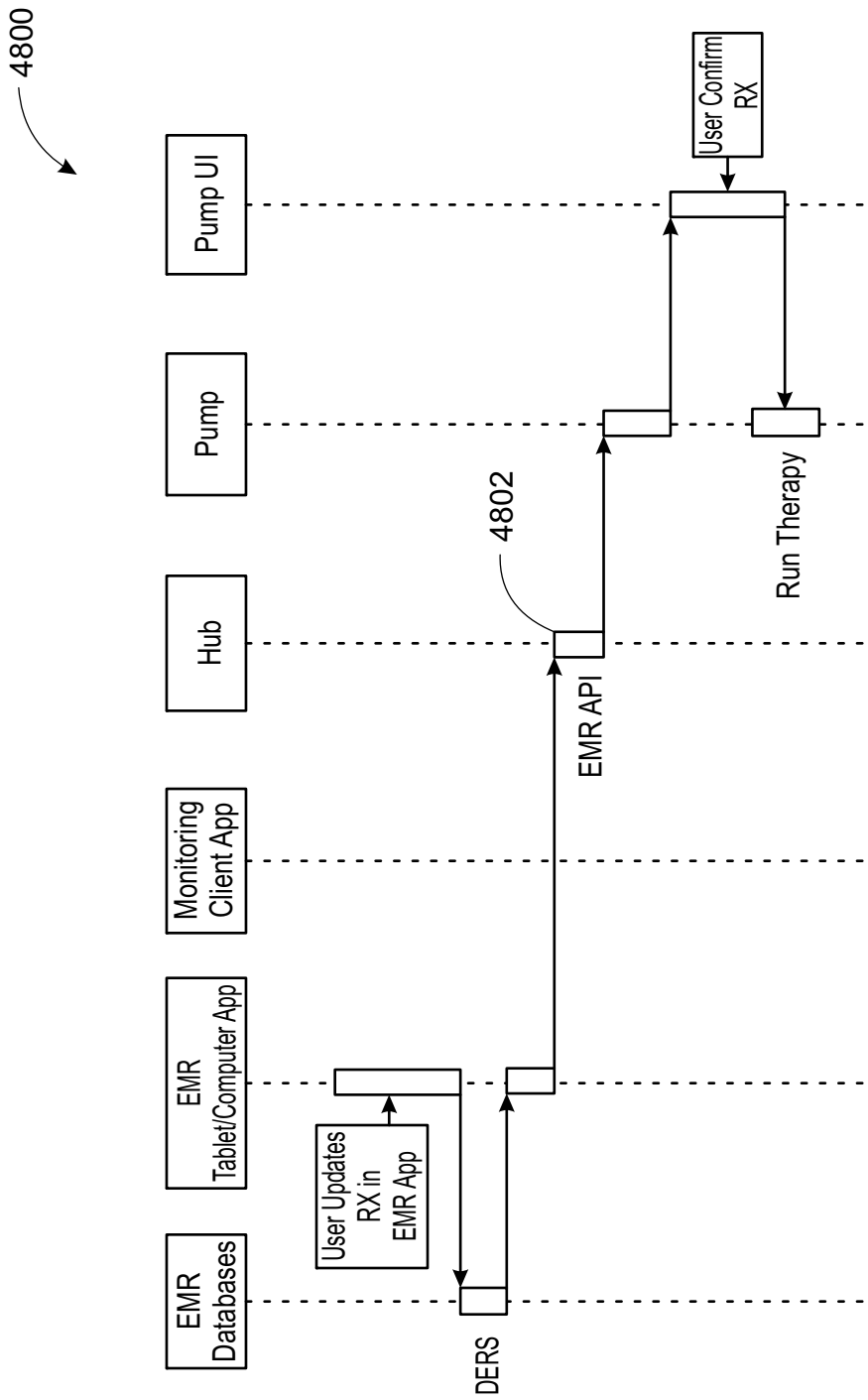

4800
Pump UI
Pump
Hub
Monitoring Client App
EMR Tablet/Computer App
EMR Databases
User Updates RX in EMR App
DERS
4802
EMR API
User Confirm RX
Run Therapy

FIG. 75

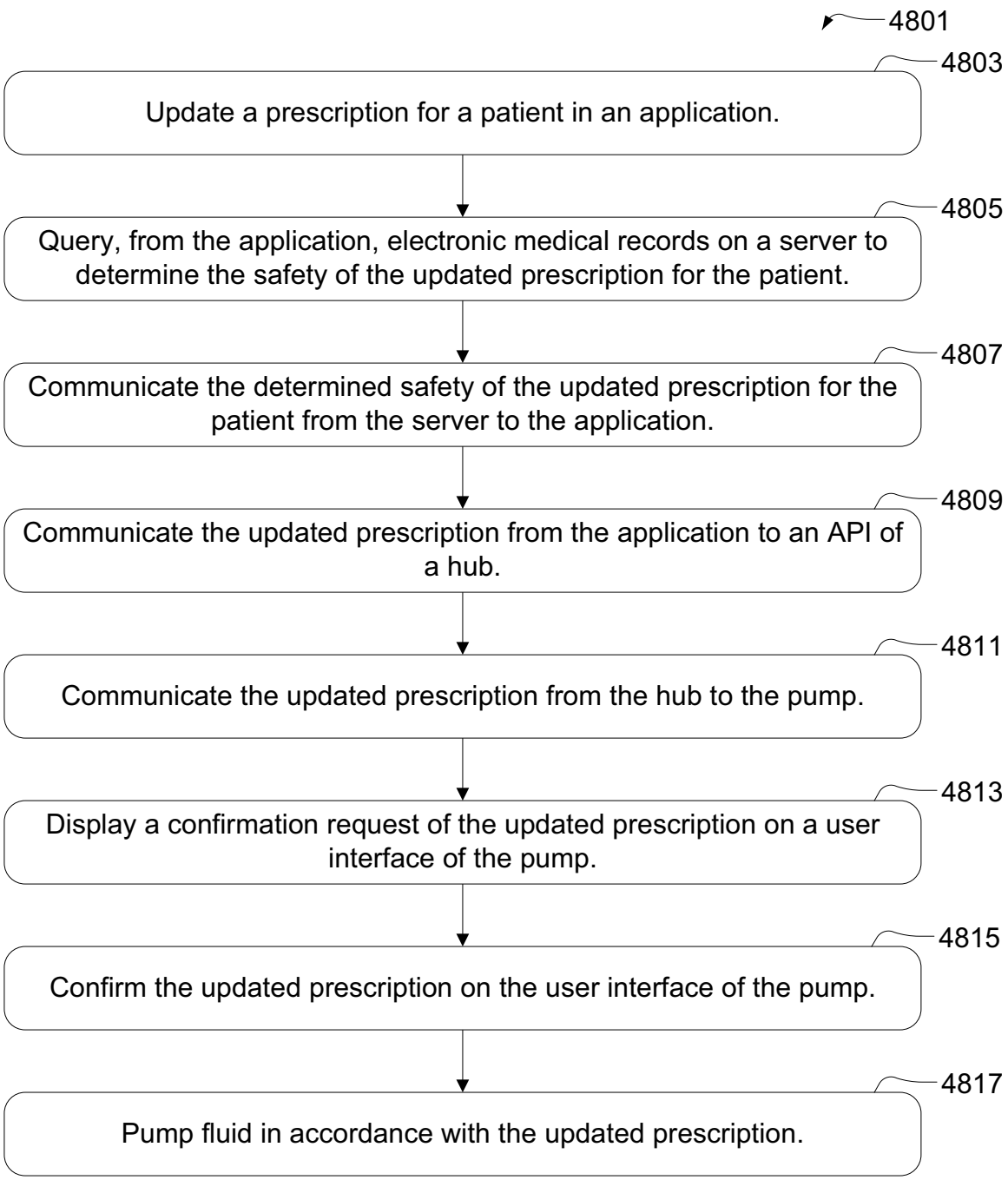

4801
4803
Update a prescription for a patient in an application.
4805
Query, from the application, electronic medical records on a server to determine the safety of the updated prescription for the patient.
4807
Communicate the determined safety of the updated prescription for the patient from the server to the application.
4809
Communicate the updated prescription from the application to an API of a hub.
4811
Communicate the updated prescription from the hub to the pump.
4813
Display a confirmation request of the updated prescription on a user interface of the pump.
4815
Confirm the updated prescription on the user interface of the pump.
4817
Pump fluid in accordance with the updated prescription.

FIG. 76

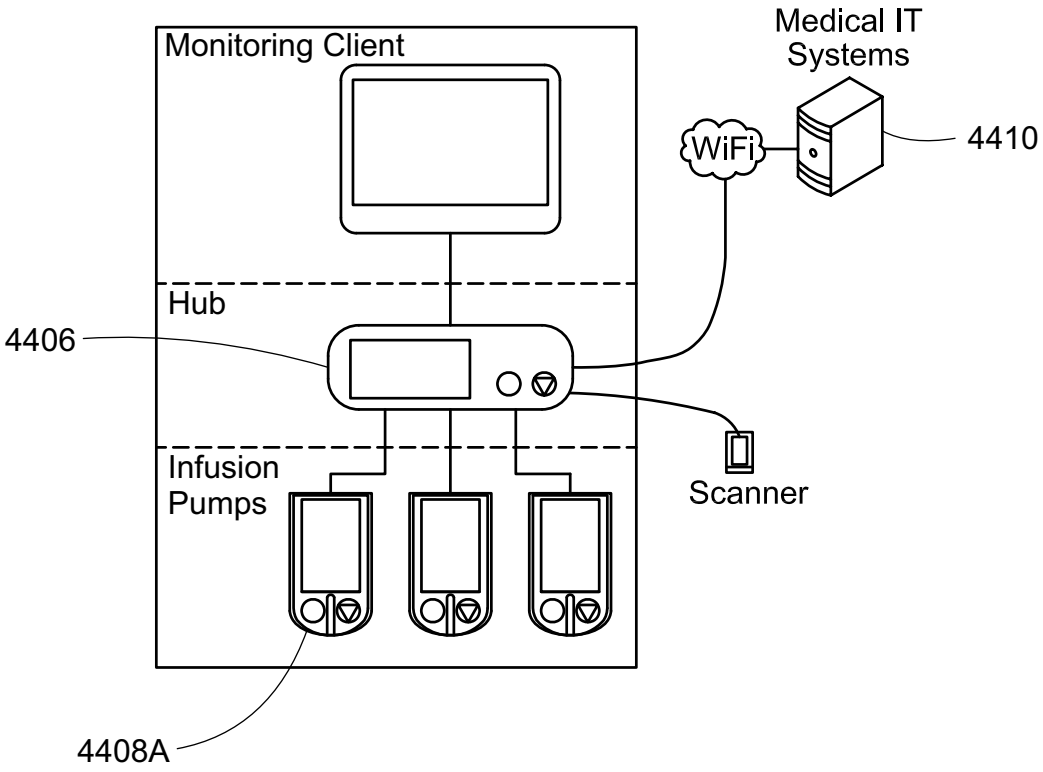

Monitoring Client
Medical IT Systems
WiFi
4410
Hub
4406
Infusion Pumps
Scanner
4408A

FIG. 77

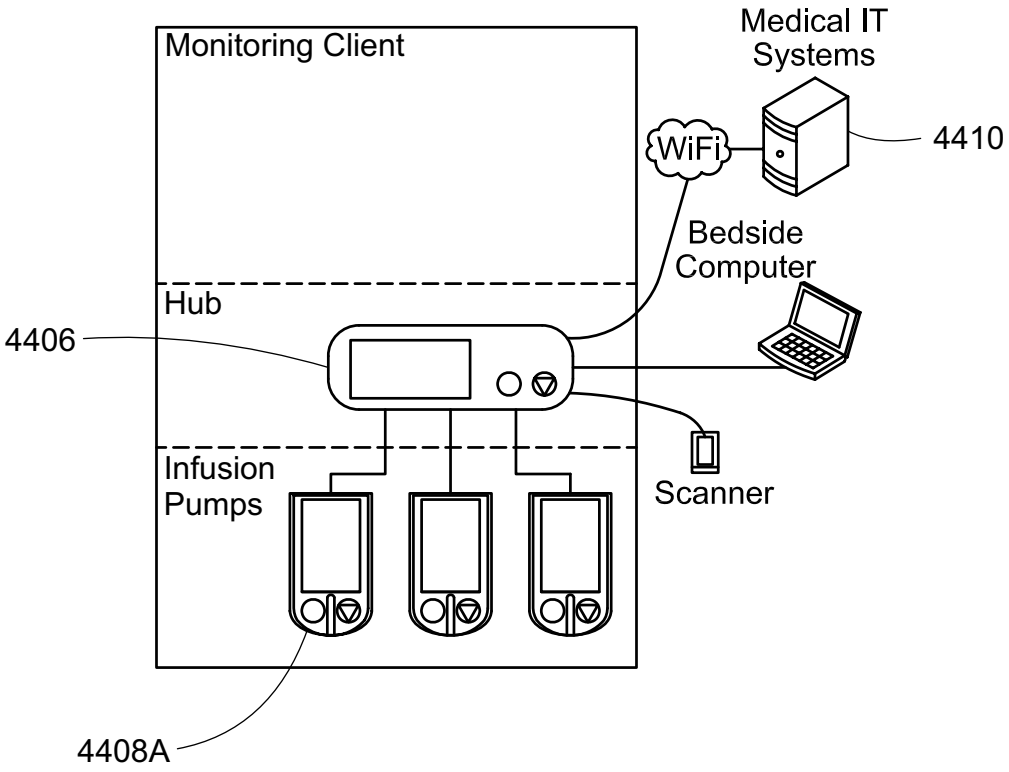

Monitoring Client
Medical IT Systems
WiFi
4410
Bedside Computer
Hub
4406
Infusion Pumps
Scanner
4408A

FIG. 78

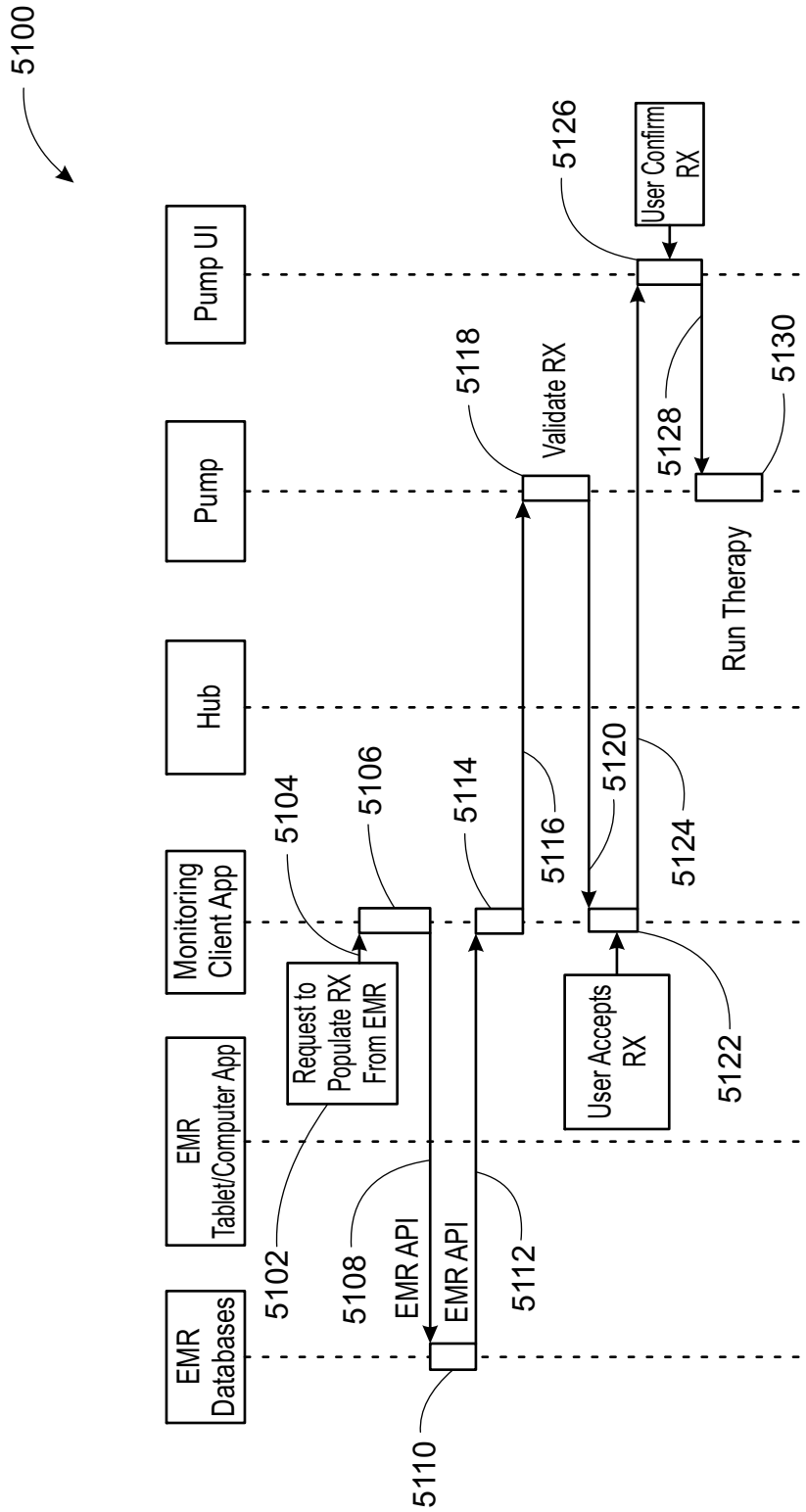

5100
EMR Databases
EMR Tablet/Computer App
Monitoring Client App
Hub
Pump
Pump UI
5102
Request to Populate RX From EMR
5104
5106
5108
EMR API
5110
EMR API
5112
5114
5116
Validate RX
5118
5120
User Accepts RX
5122
5124
5126
User Confirm RX
5128
Run Therapy
5130

FIG. 79

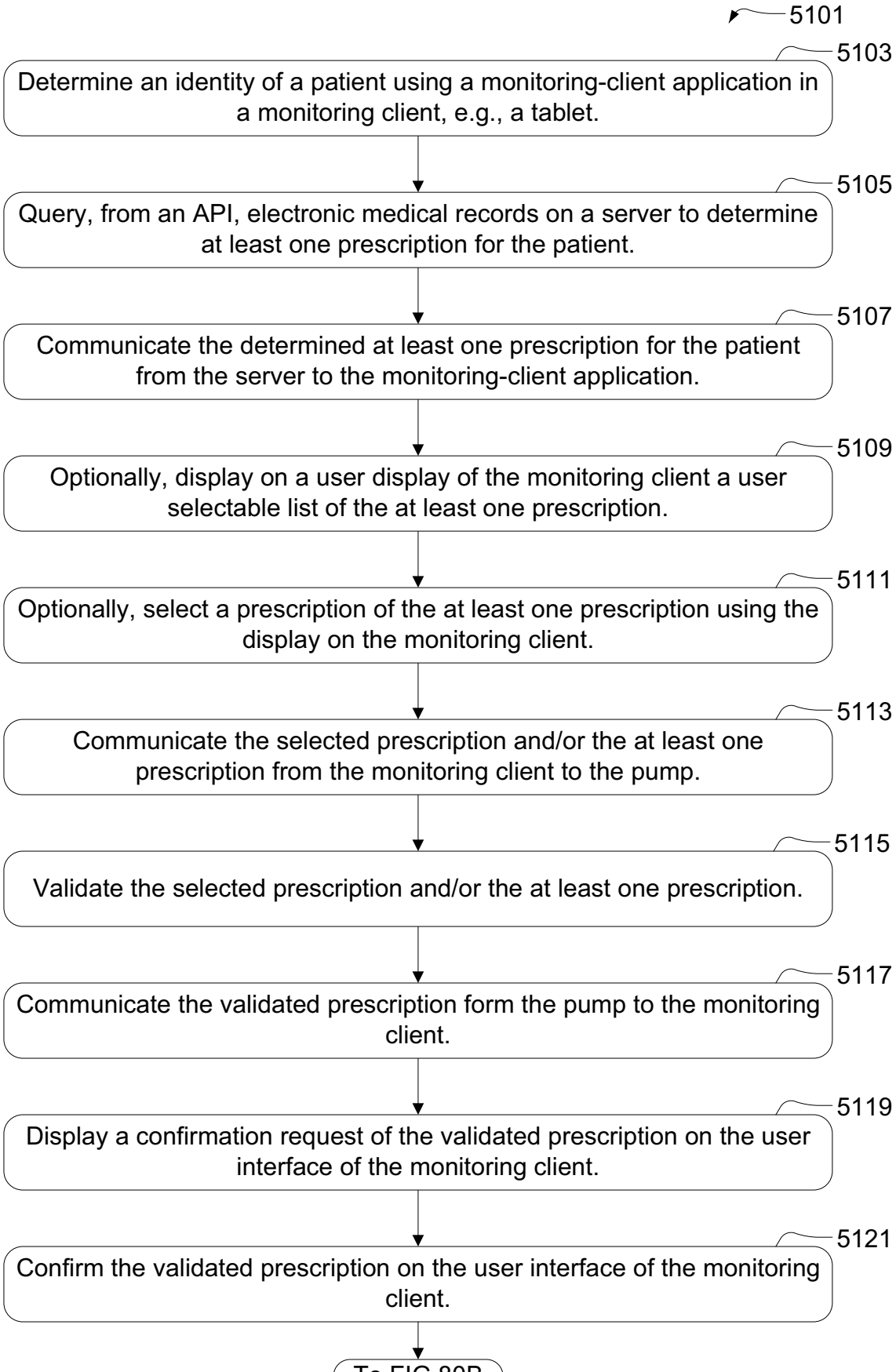

5101
5103
Determine an identity of a patient using a monitoring-client application in a monitoring client, e.g., a tablet.
5105
Query, from an API, electronic medical records on a server to determine at least one prescription for the patient.
5107
Communicate the determined at least one prescription for the patient from the server to the monitoring-client application.
5109
Optionally, display on a user display of the monitoring client a user selectable list of the at least one prescription.
5111
Optionally, select a prescription of the at least one prescription using the display on the monitoring client.
5113
Communicate the selected prescription and/or the at least one prescription from the monitoring client to the pump.
5115
Validate the selected prescription and/or the at least one prescription.
5117
Communicate the validated prescription form the pump to the monitoring client.
5119
Display a confirmation request of the validated prescription on the user interface of the monitoring client.
5121
Confirm the validated prescription on the user interface of the monitoring client.
To FIG 80B

FIG. 80A

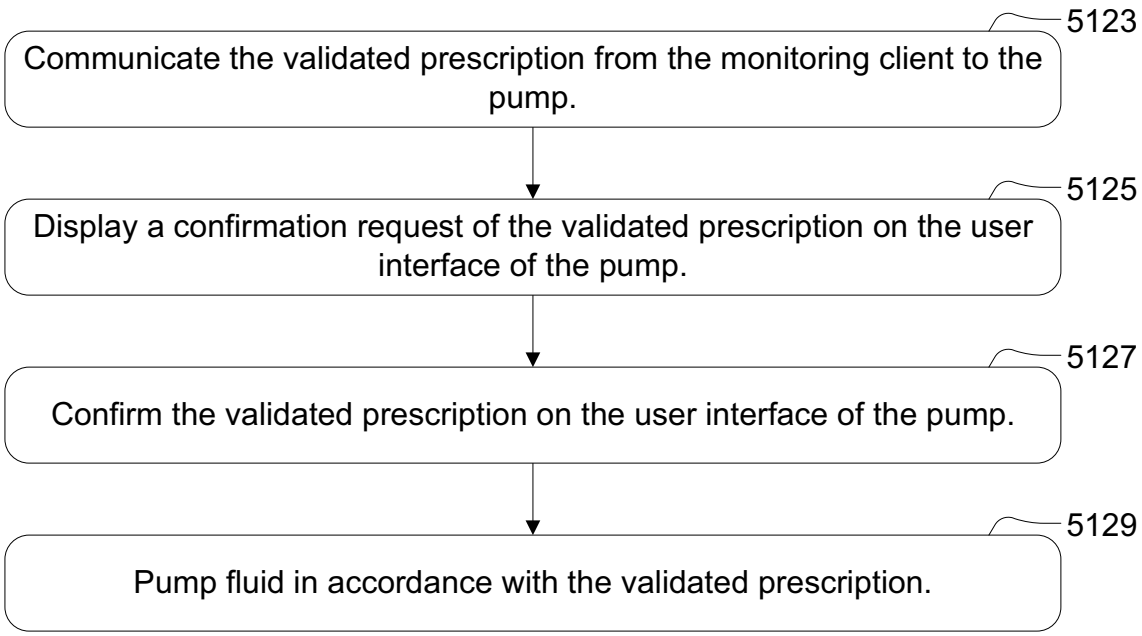

5123
Communicate the validated prescription from the monitoring client to the pump.
5125
Display a confirmation request of the validated prescription on the user interface of the pump.
5127
Confirm the validated prescription on the user interface of the pump.
5129
Pump fluid in accordance with the validated prescription.

FIG. 80B

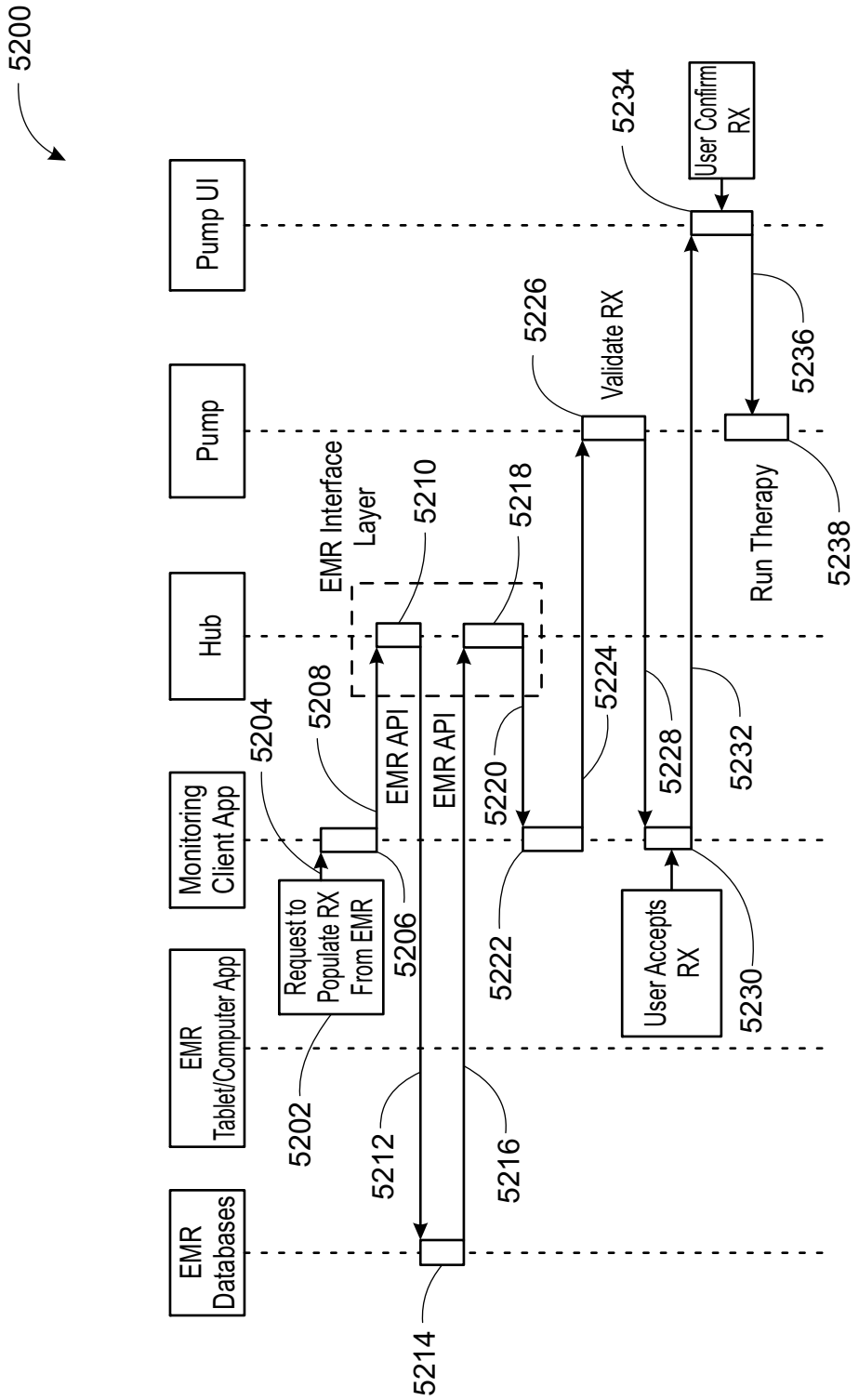

5200
EMR Databases
EMR Tablet/Computer App
Monitoring Client App
Hub
Pump
Pump UI
EMR Interface Layer
Request to Populate RX From EMR
EMR API
EMR API
Validate RX
User Accepts RX
User Confirm RX
Run Therapy
5202
5204
5206
5208
5210
5212
5214
5216
5218
5220
5222
5224
5226
5228
5230
5232
5234
5236
5238

FIG. 81

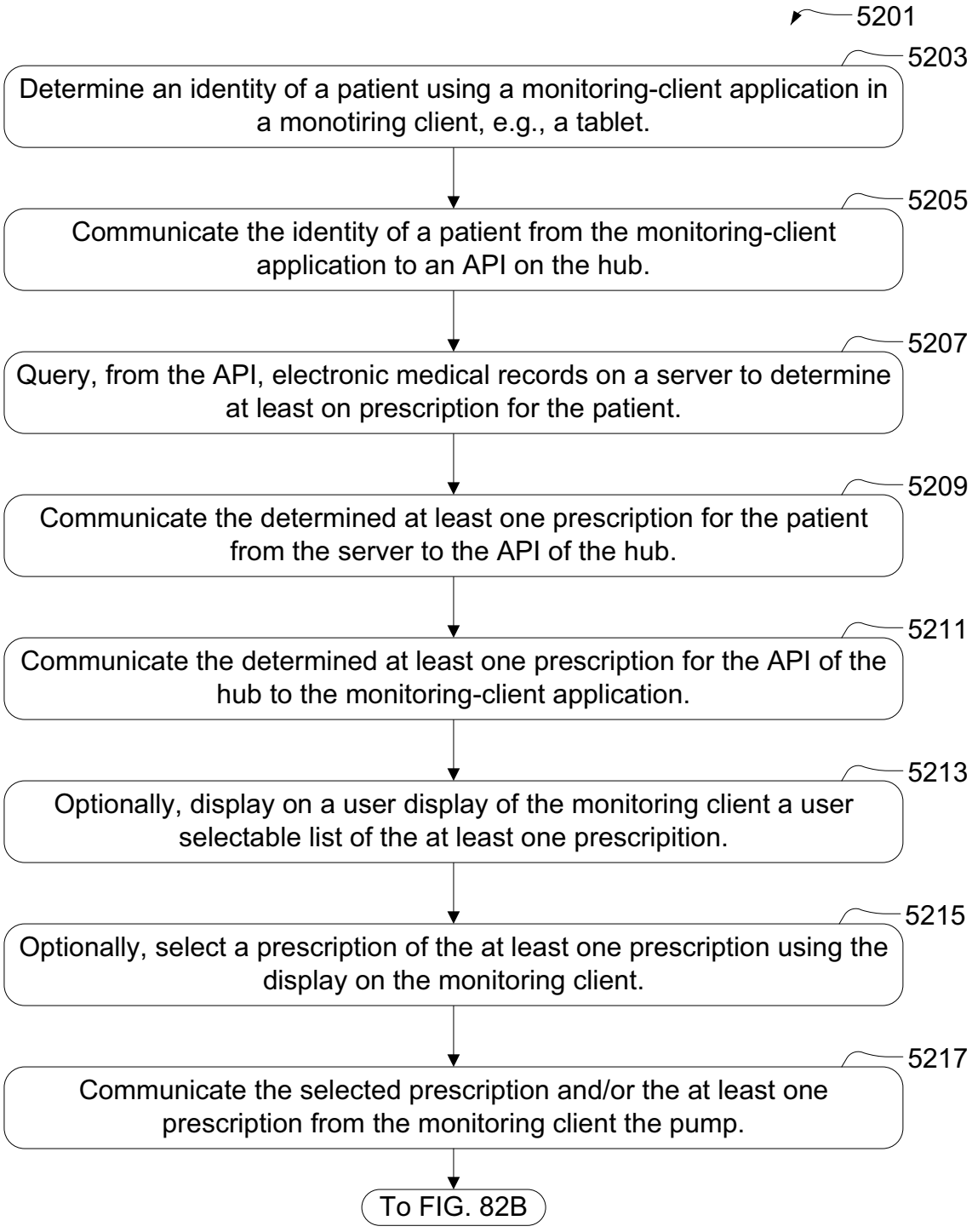

5201
5203
Determine an identity of a patient using a monitoring-client application in a monotiring client, e.g., a tablet.
5205
Communicate the identity of a patient from the monitoring-client application to an API on the hub.
5207
Query, from the API, electronic medical records on a server to determine at least on prescription for the patient.
5209
Communicate the determined at least one prescription for the patient from the server to the API of the hub.
5211
Communicate the determined at least one prescription for the API of the hub to the monitoring-client application.
5213
Optionally, display on a user display of the monitoring client a user selectable list of the at least one prescripition.
5215
Optionally, select a prescription of the at least one prescription using the display on the monitoring client.
5217
Communicate the selected prescription and/or the at least one prescription from the monitoring client the pump.
To FIG. 82B

FIG. 82A

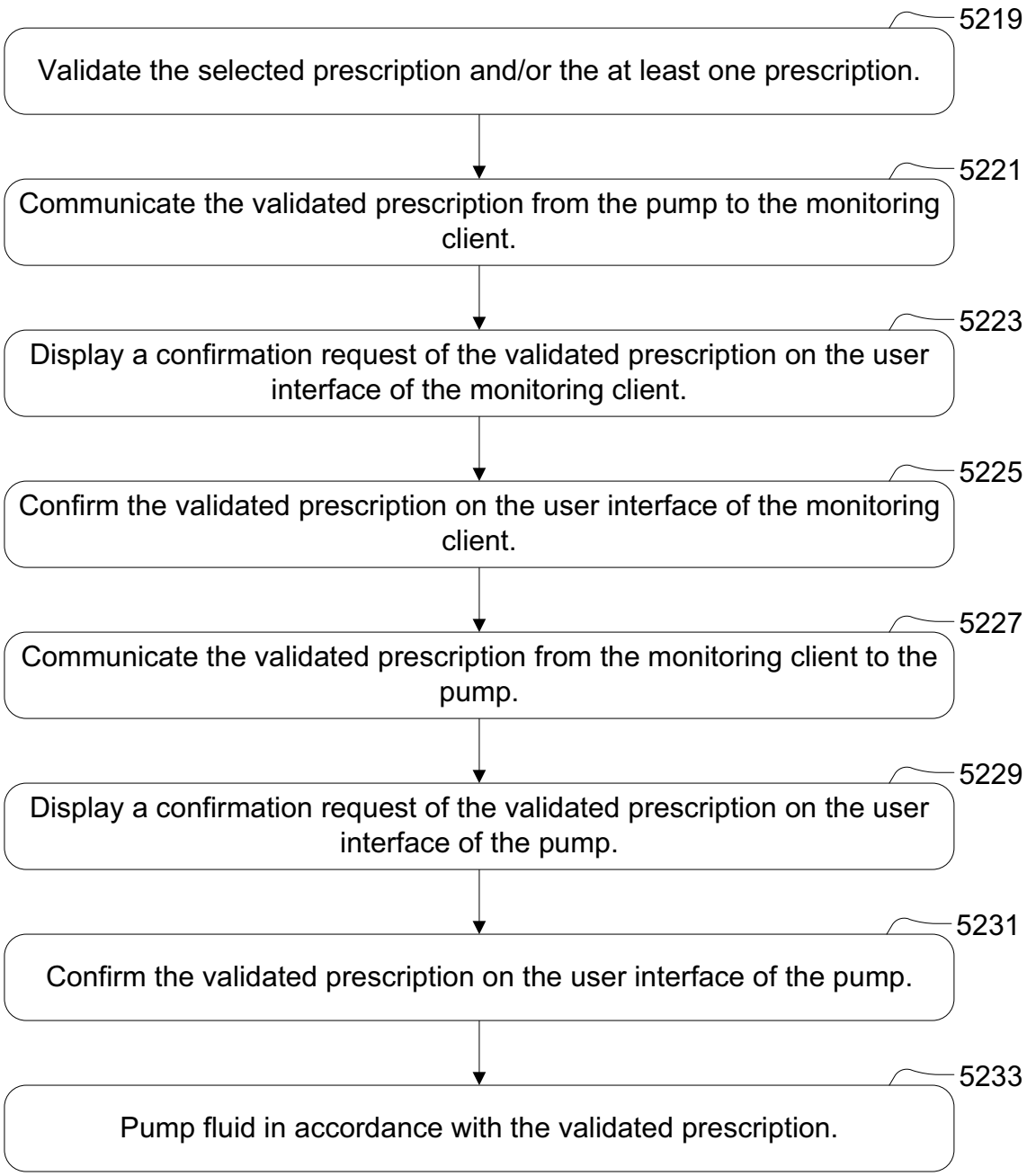

5219
Validate the selected prescription and/or the at least one prescription.
5221
Communicate the validated prescription from the pump to the monitoring client.
5223
Display a confirmation request of the validated prescription on the user interface of the monitoring client.
5225
Confirm the validated prescription on the user interface of the monitoring client.
5227
Communicate the validated prescription from the monitoring client to the pump.
5229
Display a confirmation request of the validated prescription on the user interface of the pump.
5231
Confirm the validated prescription on the user interface of the pump.
5233
Pump fluid in accordance with the validated prescription.

FIG. 82B

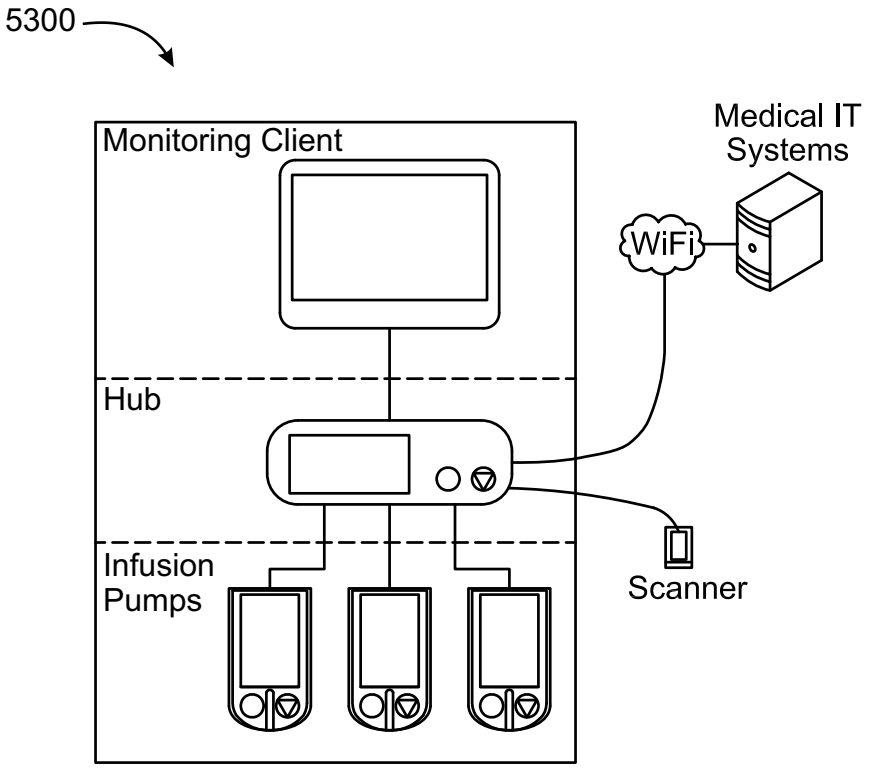

5300
Monitoring Client
Medical IT Systems
WiFi
Hub
Infusion Pumps
Scanner

FIG. 83

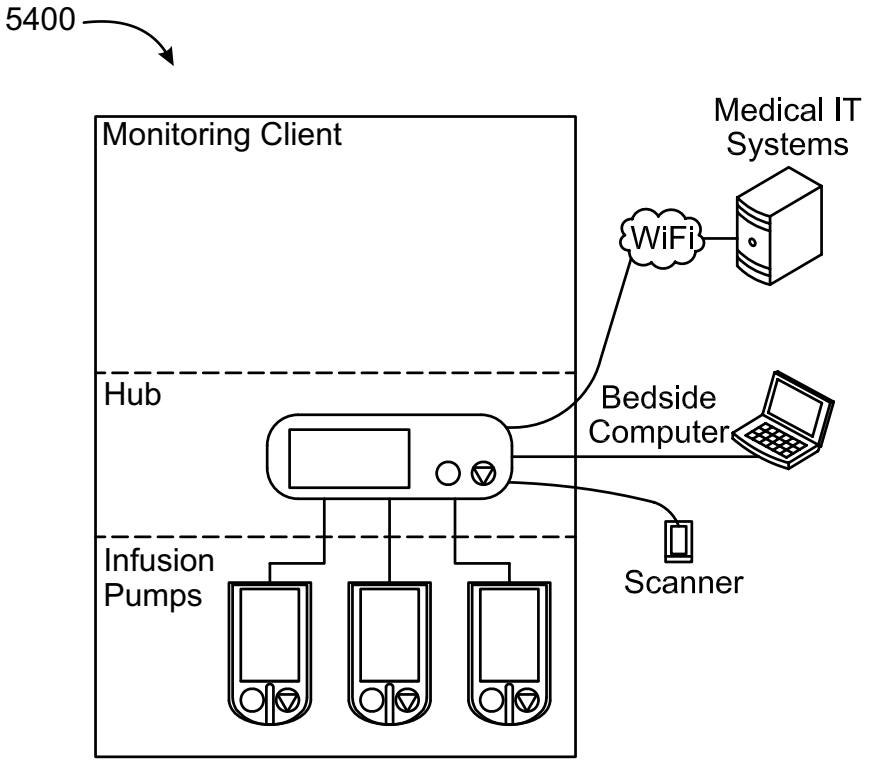

5400
Monitoring Client
Medical IT Systems
WiFi
Hub
Bedside Computer
Infusion Pumps
Scanner

FIG. 84

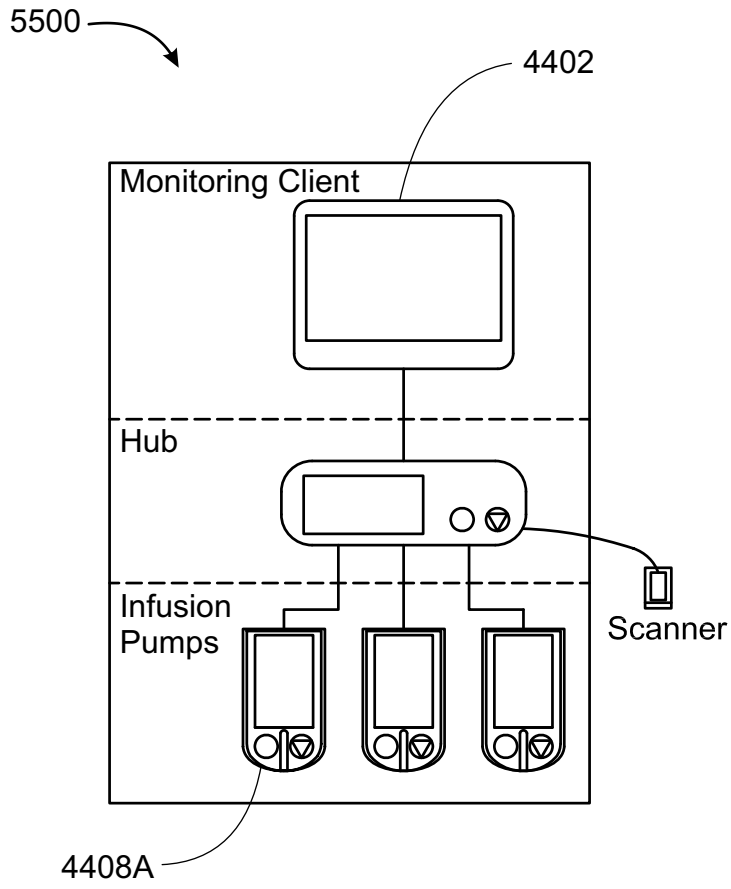

5500
4402
Monitoring Client
Hub
Infusion
Pumps
Scanner
4408A

FIG. 85

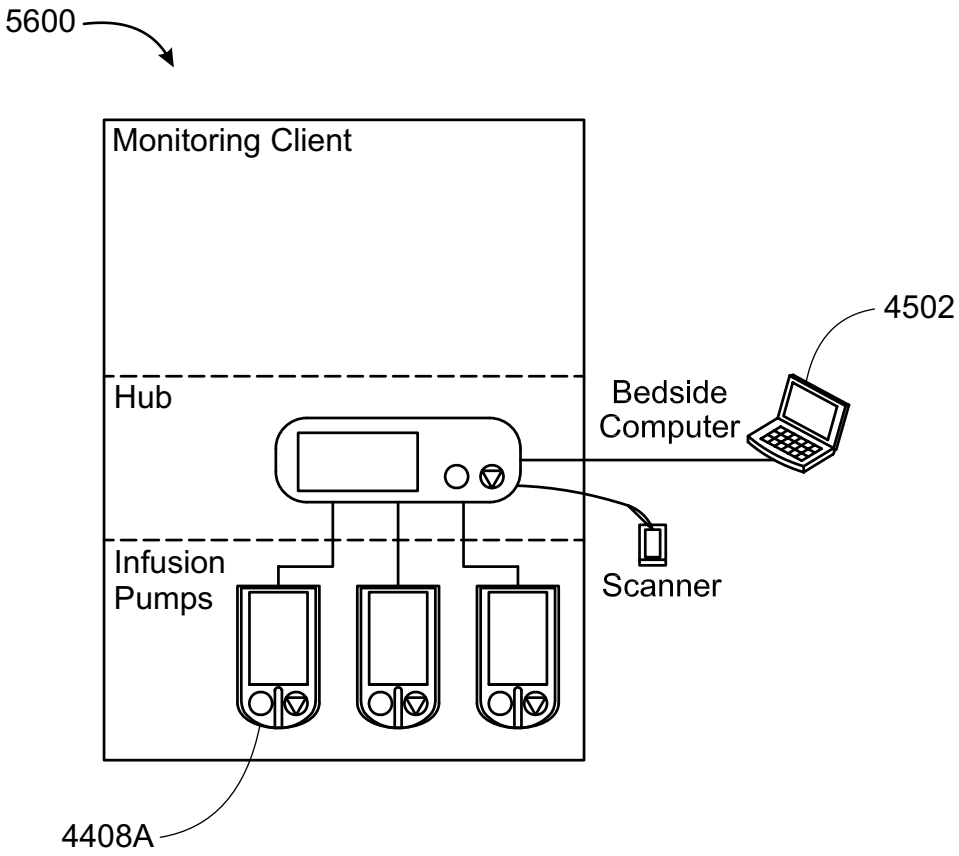

5600
Monitoring Client
4502
Hub
Bedside
Computer
Infusion
Pumps
Scanner
4408A

FIG. 86

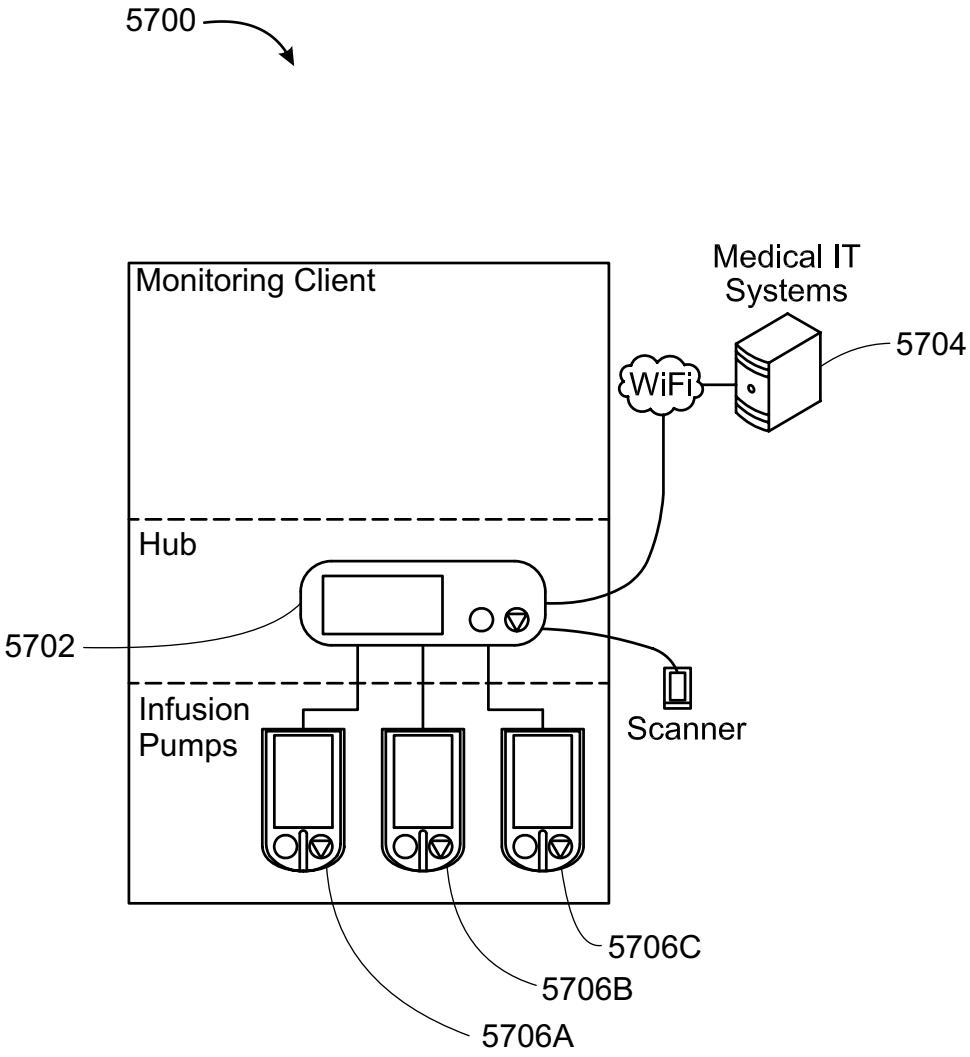

5700
Monitoring Client
Medical IT Systems
5704
WiFi
Hub
5702
Infusion Pumps
Scanner
5706C
5706B
5706A

FIG. 87

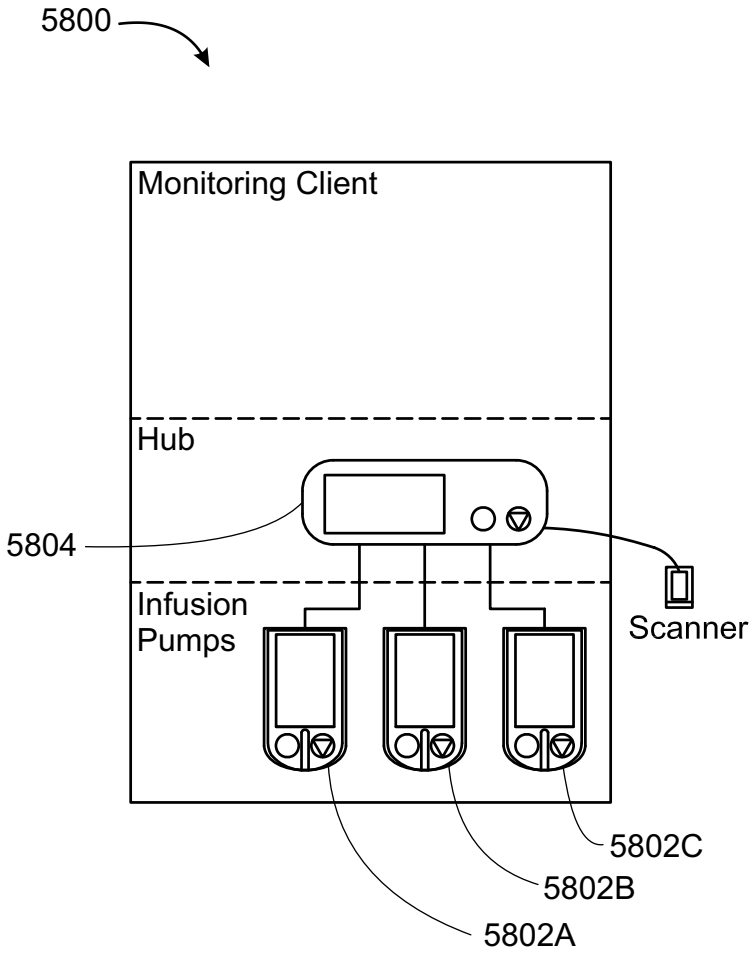

5800
Monitoring Client
Hub
5804
Infusion
Pumps
Scanner
5802C
5802B
5802A

FIG. 88

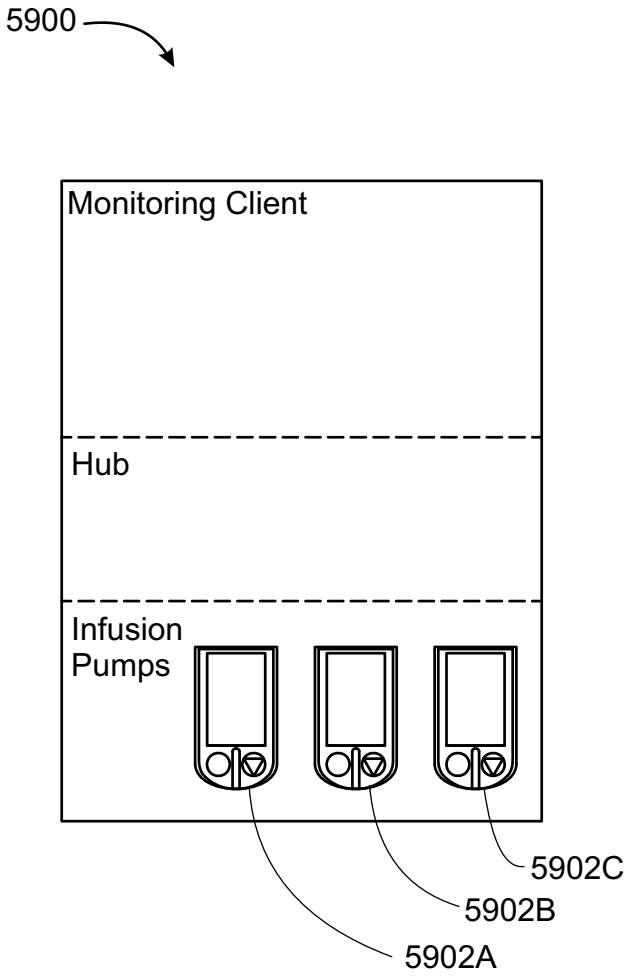
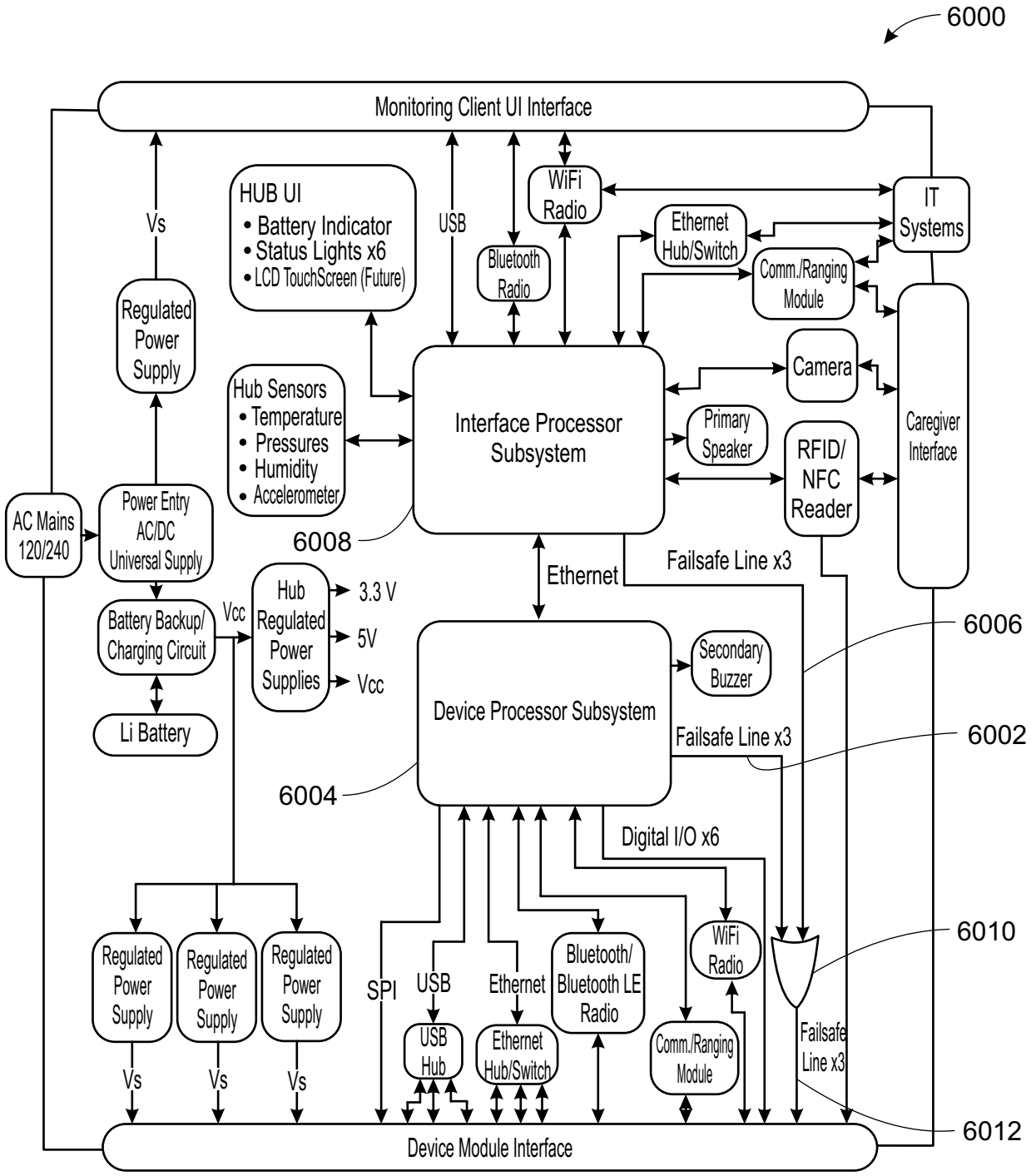

5900
Monitoring Client
Hub
Infusion
Pumps
5902C
5902B
5902A

FIG. 89



Note 1: The supply voltage (Vs) to the Devices could be programmed or a constant

FIG. 90

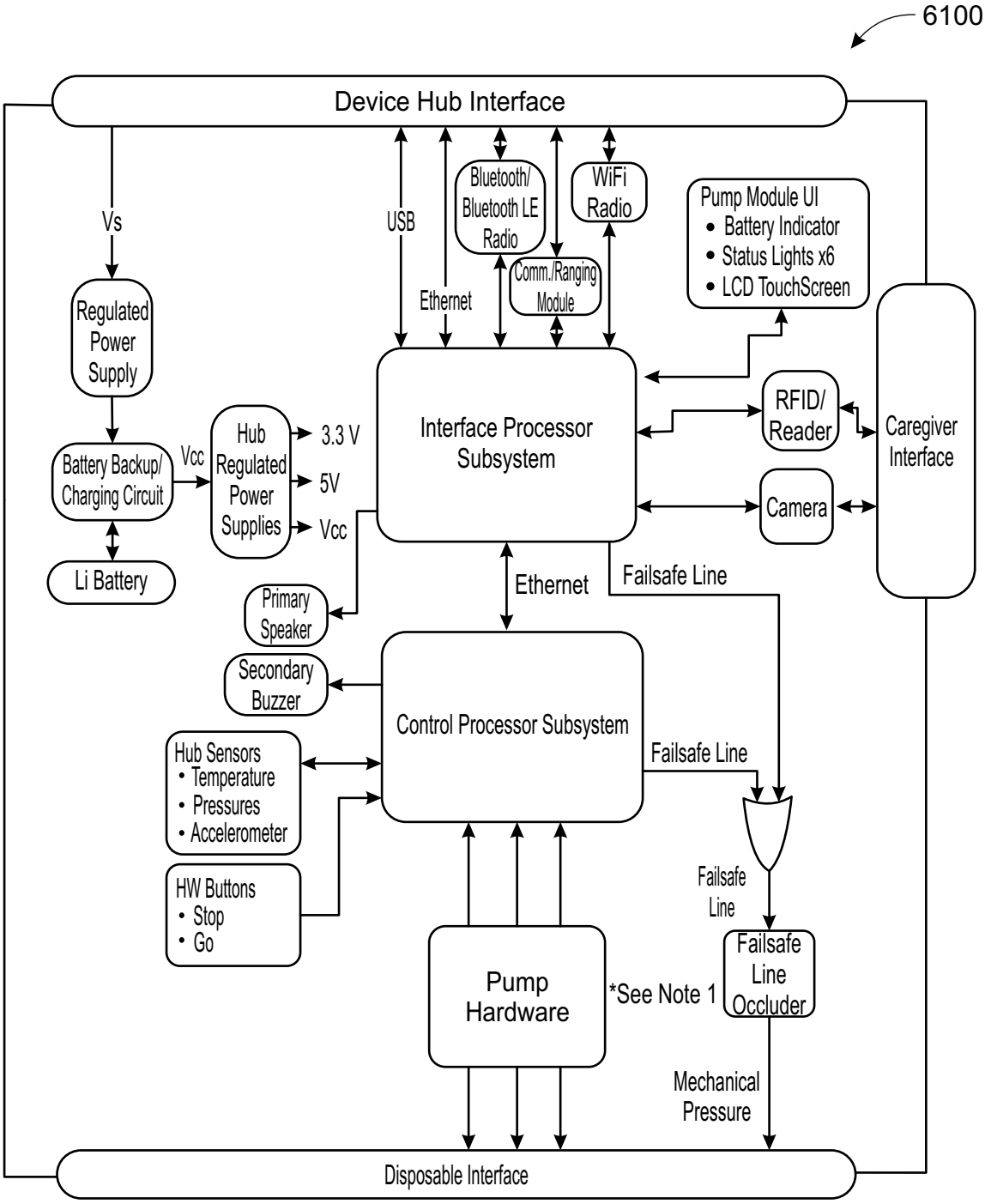

6100
Device Hub Interface
Vs
USB
Bluetooth/ Bluetooth LE Radio
WiFi Radio
Pump Module UI
• Battery Indicator
• Status Lights x6
• LCD TouchScreen
Regulated Power Supply
Ethernet
Comm./Ranging Module
Interface Processor Subsystem
RFID/ Reader
Caregiver Interface
Battery Backup/ Charging Circuit
Vcc
Hub Regulated Power Supplies
3.3 V
5V
Vcc
Camera
Li Battery
Primary Speaker
Ethernet
Failsafe Line
Secondary Buzzer
Control Processor Subsystem
Hub Sensors
• Temperature
• Pressures
• Accelerometer
Failsafe Line
HW Buttons
• Stop
• Go
Failsafe Line
Pump Hardware
*See Note 1
Failsafe Line Occluder
Mechanical Pressure
Disposable Interface

FIG. 91

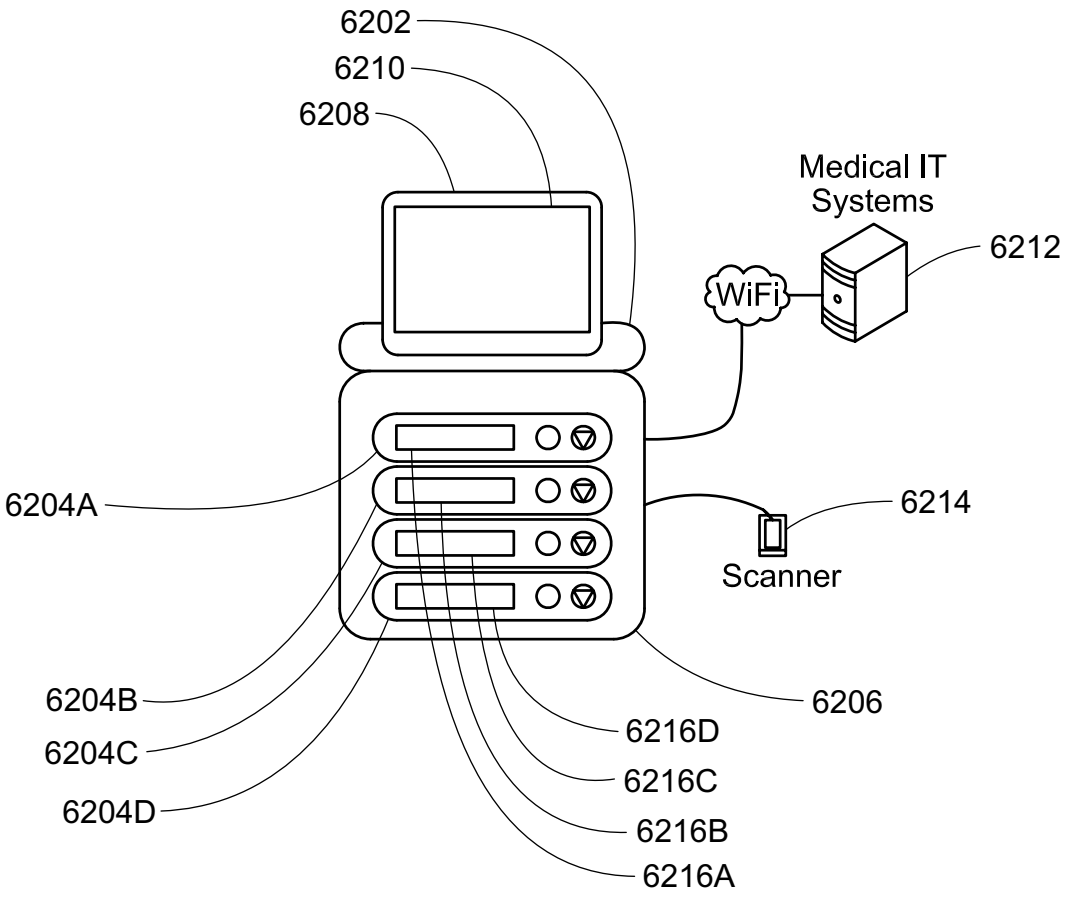

6202
6210
6208
Medical IT Systems
6212
WiFi
6204A
6214
Scanner
6204B
6204C
6204D
6206
6216D
6216C
6216B
6216A

FIG. 92

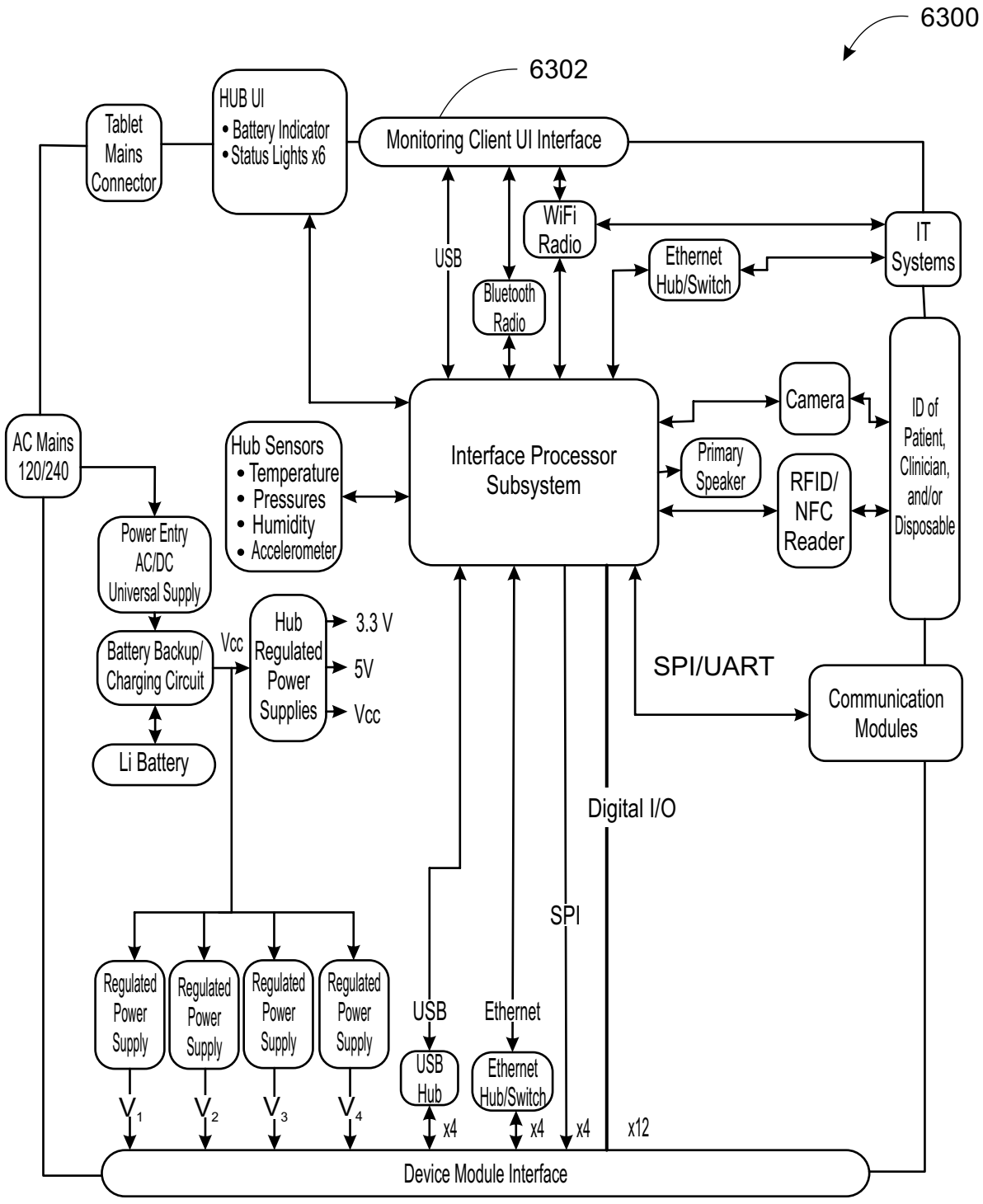

6300
6302
HUB UI
• Battery Indicator
• Status Lights x6
Tablet Mains Connector
Monitoring Client UI Interface
WiFi Radio
IT Systems
USB
Bluetooth Radio
Ethernet Hub/Switch
Camera
ID of Patient, Clinician, and/or Disposable
AC Mains 120/240
Hub Sensors
• Temperature
• Pressures
• Humidity
• Accelerometer
Interface Processor Subsystem
Primary Speaker
RFID/ NFC Reader
Power Entry AC/DC Universal Supply
Hub Regulated Power Supplies
3.3 V
5V
Vcc
Battery Backup/ Charging Circuit
Vcc
Li Battery
SPI/UART
Communication Modules
Digital I/O
SPI
Regulated Power Supply
Regulated Power Supply
Regulated Power Supply
Regulated Power Supply
USB
Ethernet
USB Hub
Ethernet Hub/Switch
V1
V2
V3
V4
x4
x4
x4
x12
Device Module Interface

FIG. 93

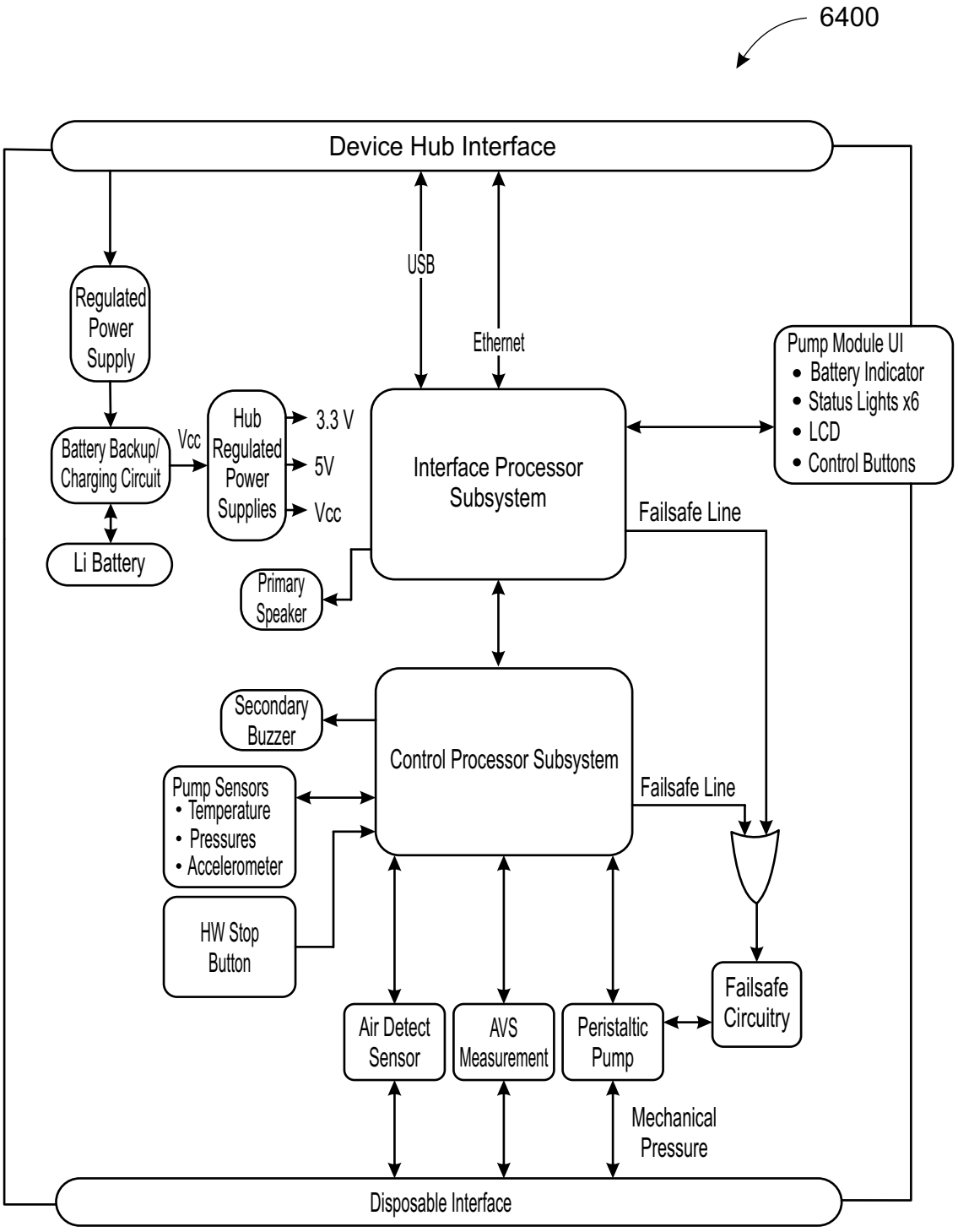

6400
Device Hub Interface
USB
Ethernet
Regulated Power Supply
Battery Backup/ Charging Circuit
Vcc
Hub Regulated Power Supplies
3.3 V
5V
Vcc
Li Battery
Interface Processor Subsystem
Pump Module UI
• Battery Indicator
• Status Lights x6
• LCD
• Control Buttons
Failsafe Line
Primary Speaker
Secondary Buzzer
Control Processor Subsystem
Pump Sensors
• Temperature
• Pressures
• Accelerometer
Failsafe Line
HW Stop Button
Failsafe Circuitry
Air Detect Sensor
AVS Measurement
Peristaltic Pump
Mechanical Pressure
Disposable Interface

FIG. 94

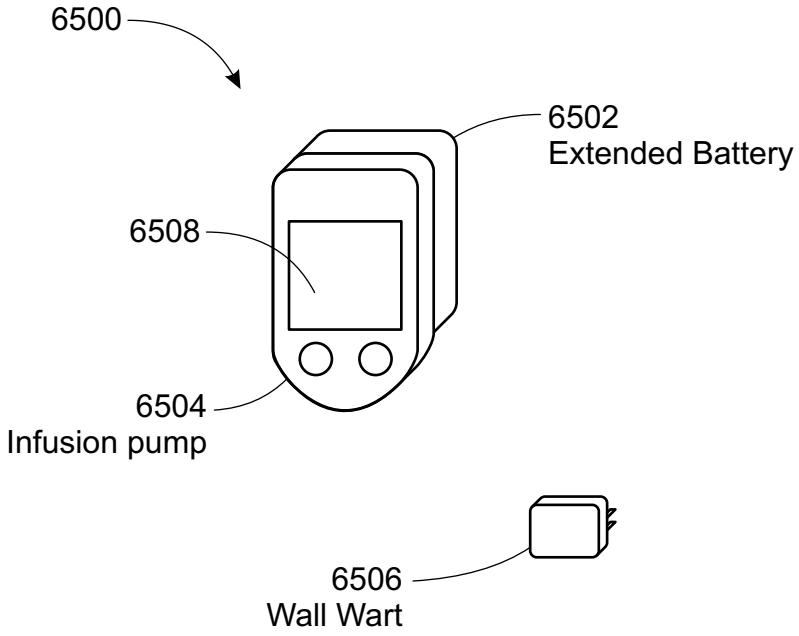

6500
6502
Extended Battery
6508
6504
Infusion pump
6506
Wall Wart

FIG. 95

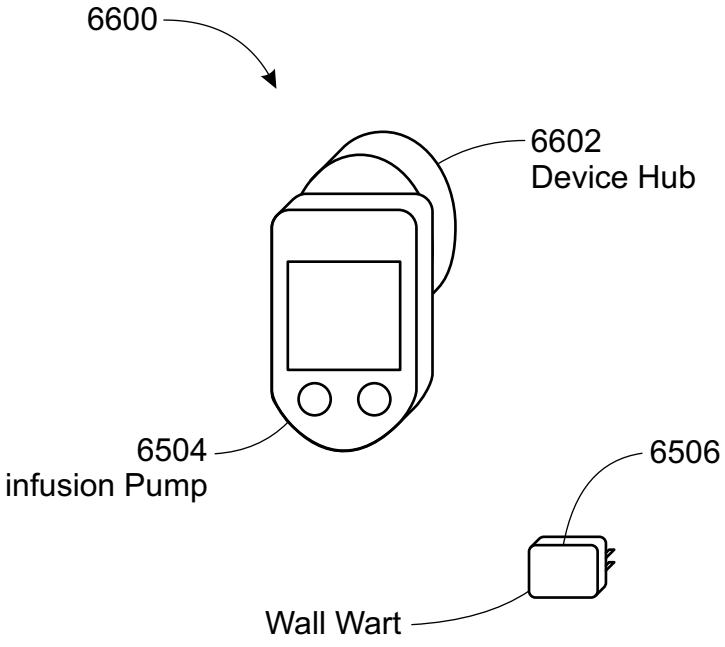

6600
6602
Device Hub
6504
infusion Pump
6506
Wall Wart

FIG. 96

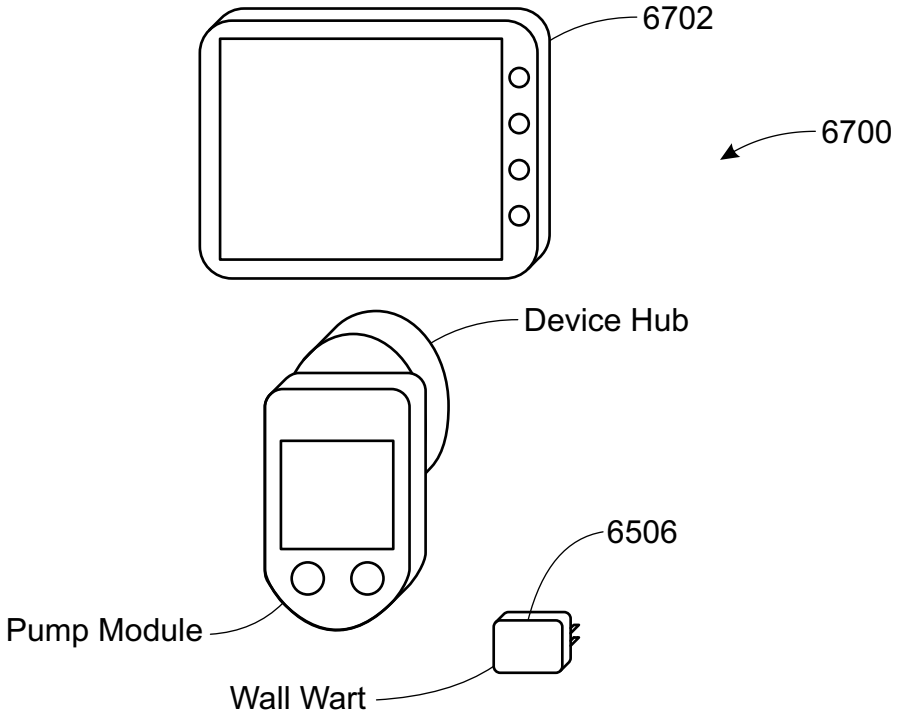

6702
6700
Device Hub
6506
Pump Module
Wall Wart

FIG. 97

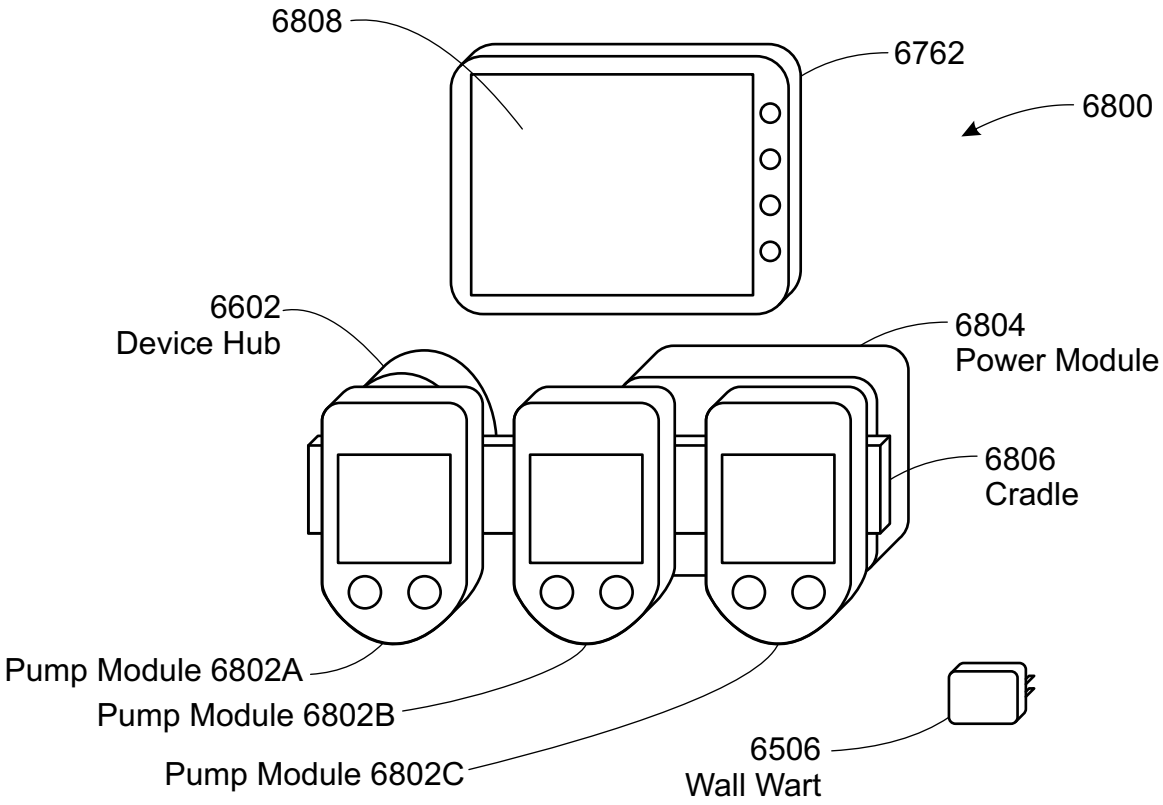

6808
6762
6800
6602
Device Hub
6804
Power Module
6806
Cradle
Pump Module 6802A
Pump Module 6802B
Pump Module 6802C
6506
Wall Wart

FIG. 98

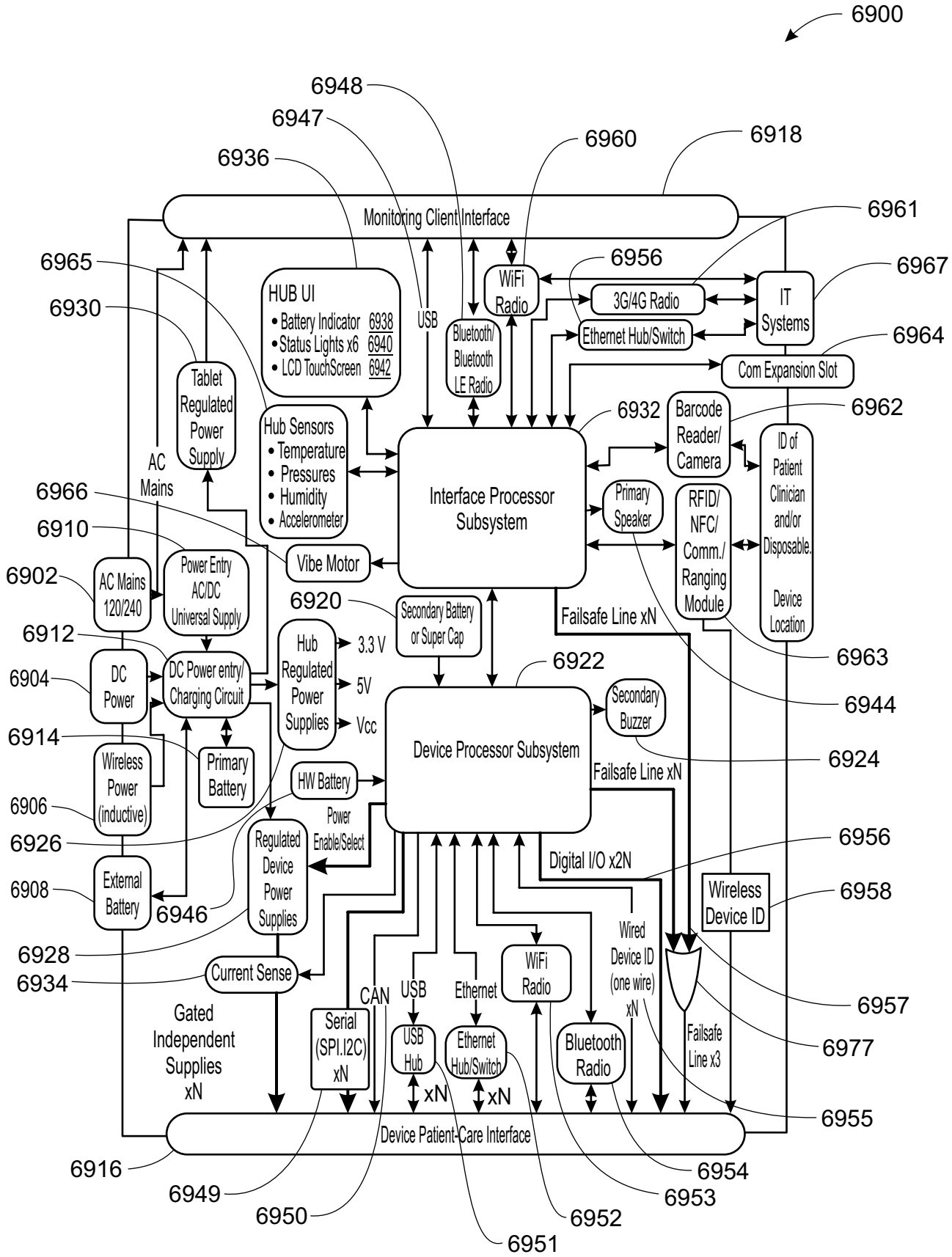

6900
6948
6947
6936
6960
6918
Monitoring Client Interface
6961
6965
6956
6967
6930
HUB UI
• Battery Indicator 6938
• Status Lights x6 6940
• LCD TouchScreen 6942
USB
WiFi Radio
3G/4G Radio
IT Systems
Bluetooth/ Bluetooth LE Radio
Ethernet Hub/Switch
6964
Com Expansion Slot
Tablet Regulated Power Supply
Hub Sensors
• Temperature
• Pressures
• Humidity
• Accelerometer
6932
Barcode Reader/ Camera
6962
ID of Patient Clinician and/or Disposable. Device Location
AC Mains
Interface Processor Subsystem
Primary Speaker
RFID/ NFC/ Comm./ Ranging Module
6966
6910
Vibe Motor
6902
AC Mains 120/240
Power Entry AC/DC Universal Supply
6920
Secondary Battery or Super Cap
Failsafe Line xN
6912
Hub Regulated Power Supplies
3.3 V
5V
Vcc
6922
6963
6904
DC Power
DC Power entry/ Charging Circuit
Secondary Buzzer
6944
6914
Wireless Power (inductive)
Primary Battery
HW Battery
Device Processor Subsystem
Failsafe Line xN
6924
6906
Power Enable/Select
6926
Regulated Device Power Supplies
Digital I/O x2N
6956
6908
External Battery
6946
Wireless Device ID
6958
6928
Wired Device ID (one wire) xN
6934
Current Sense
WiFi Radio
6957
CAN
USB
Ethernet
Gated Independent Supplies xN
Serial (SPI.I2C) xN
USB Hub
Ethernet Hub/Switch
Bluetooth Radio
Failsafe Line x3
6977
xN
xN
6955
Device Patient-Care Interface
6916
6954
6949
6953
6950
6952
6951

FIG. 99

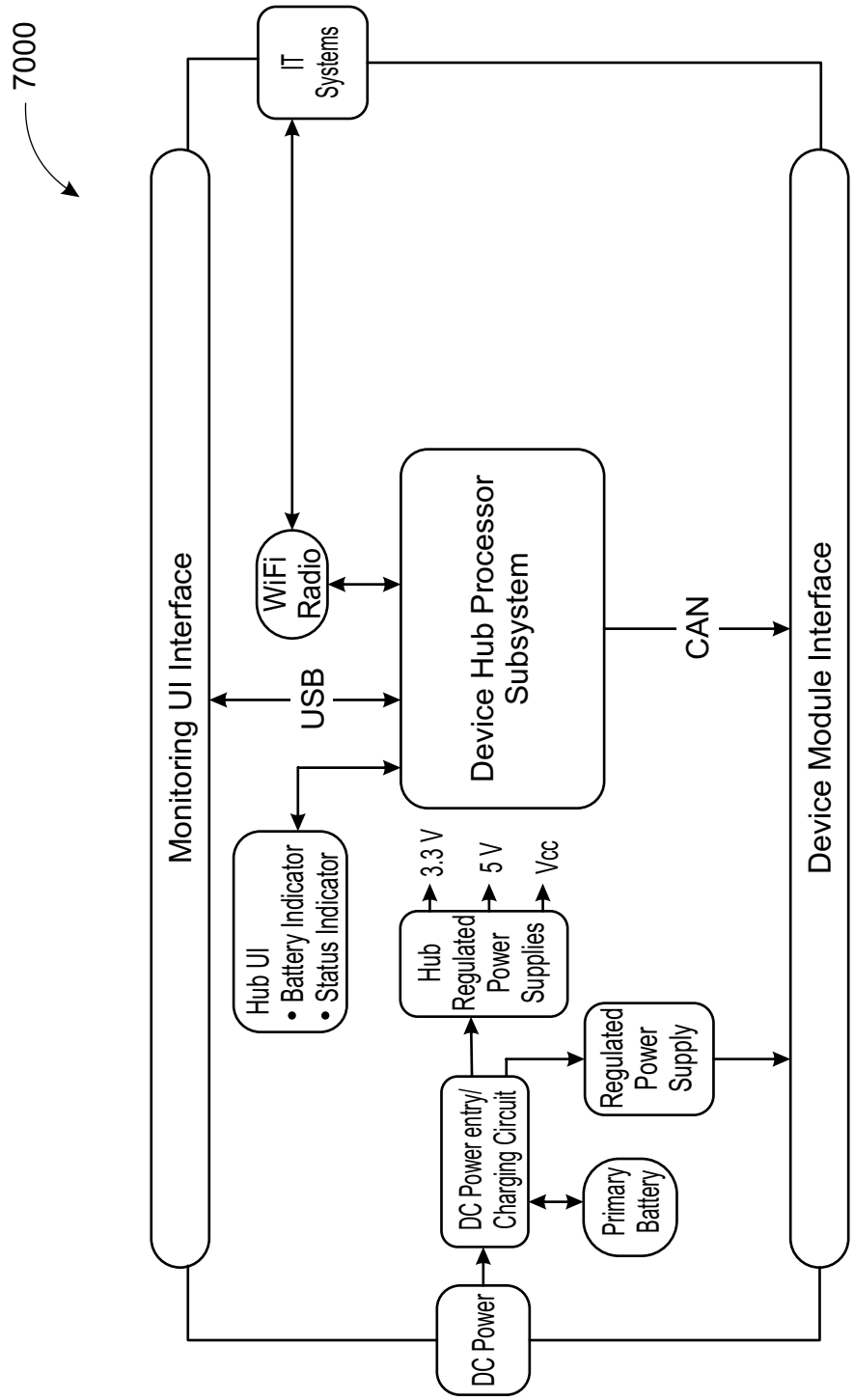

7000
IT Systems
Monitoring UI Interface
WiFi Radio
USB
Device Hub Processor Subsystem
CAN
Device Module Interface
Hub UI
• Battery Indicator
• Status Indicator
3.3 V
5 V
Vcc
Hub Regulated Power Supplies
Regulated Power Supply
DC Power entry/ Charging Circuit
Primary Battery
DC Power

FIG. 100

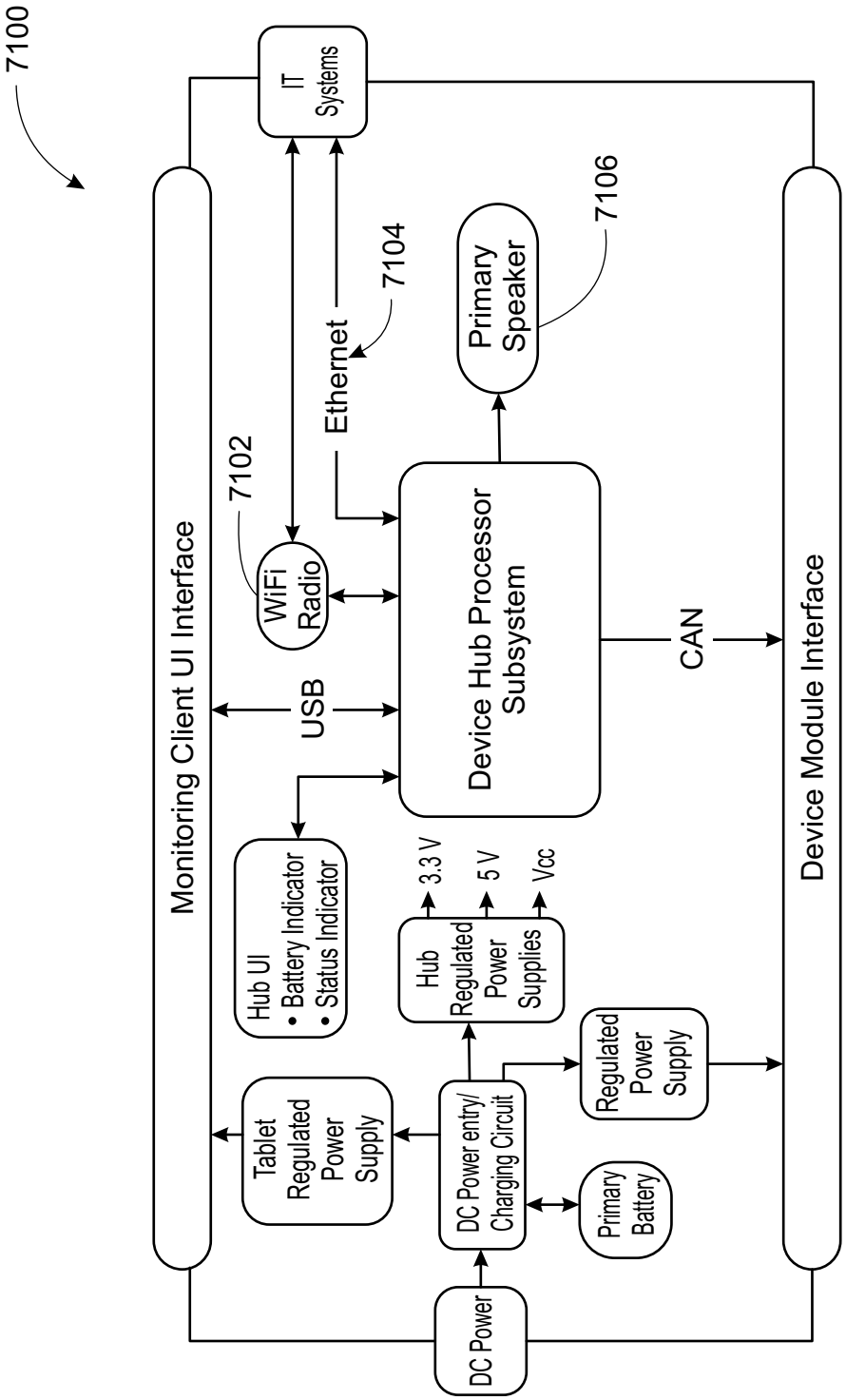

7100
IT Systems
7104
Ethernet
7106
Primary Speaker
7102
WiFi Radio
Monitoring Client UI Interface
USB
Device Hub Processor Subsystem
CAN
Device Module Interface
Hub UI
• Battery Indicator
• Status Indicator
3.3 V
5 V
Vcc
Hub Regulated Power Supplies
Tablet Regulated Power Supply
DC Power entry/ Charging Circuit
Regulated Power Supply
Primary Battery
DC Power

FIG. 101

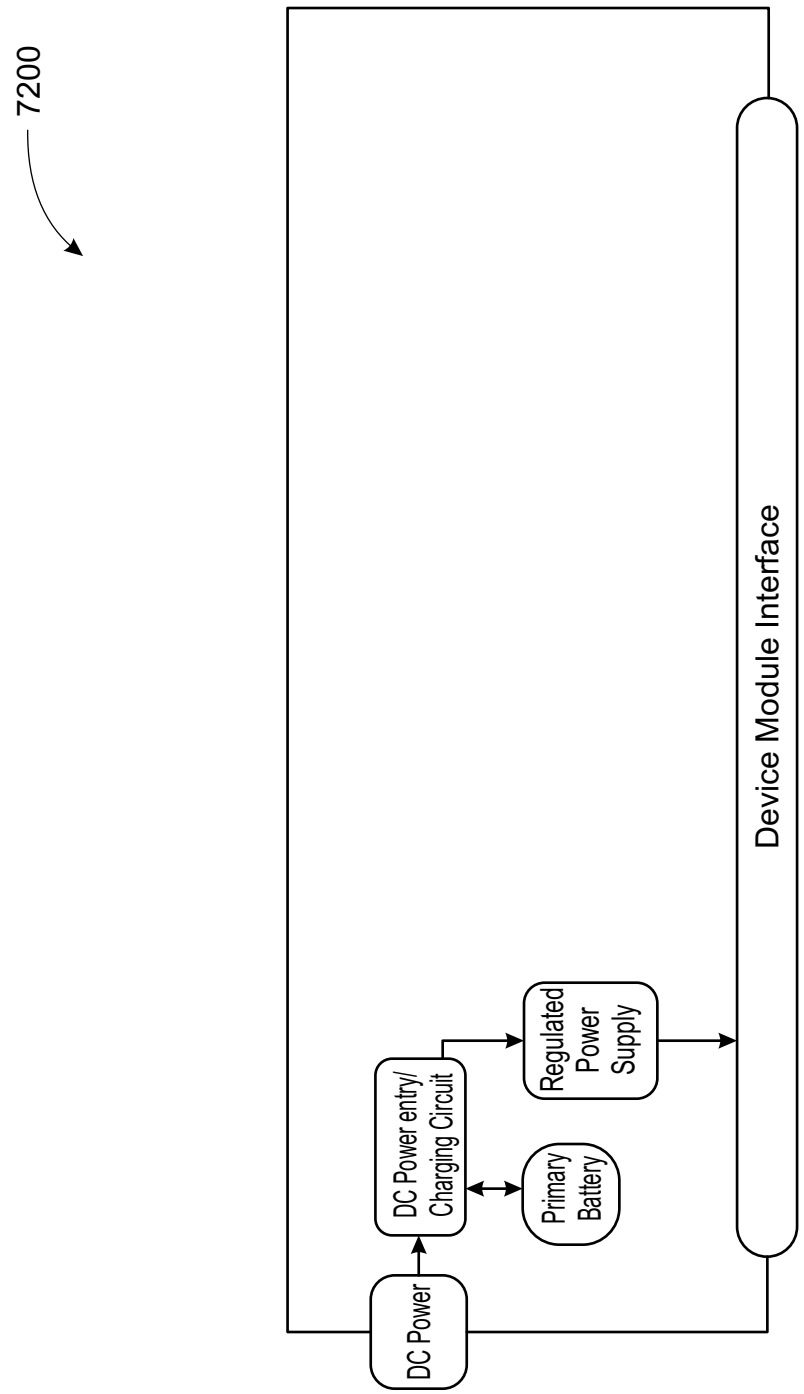

7200
DC Power
DC Power entry/ Charging Circuit
Primary Battery
Regulated Power Supply
Device Module Interface

FIG. 102

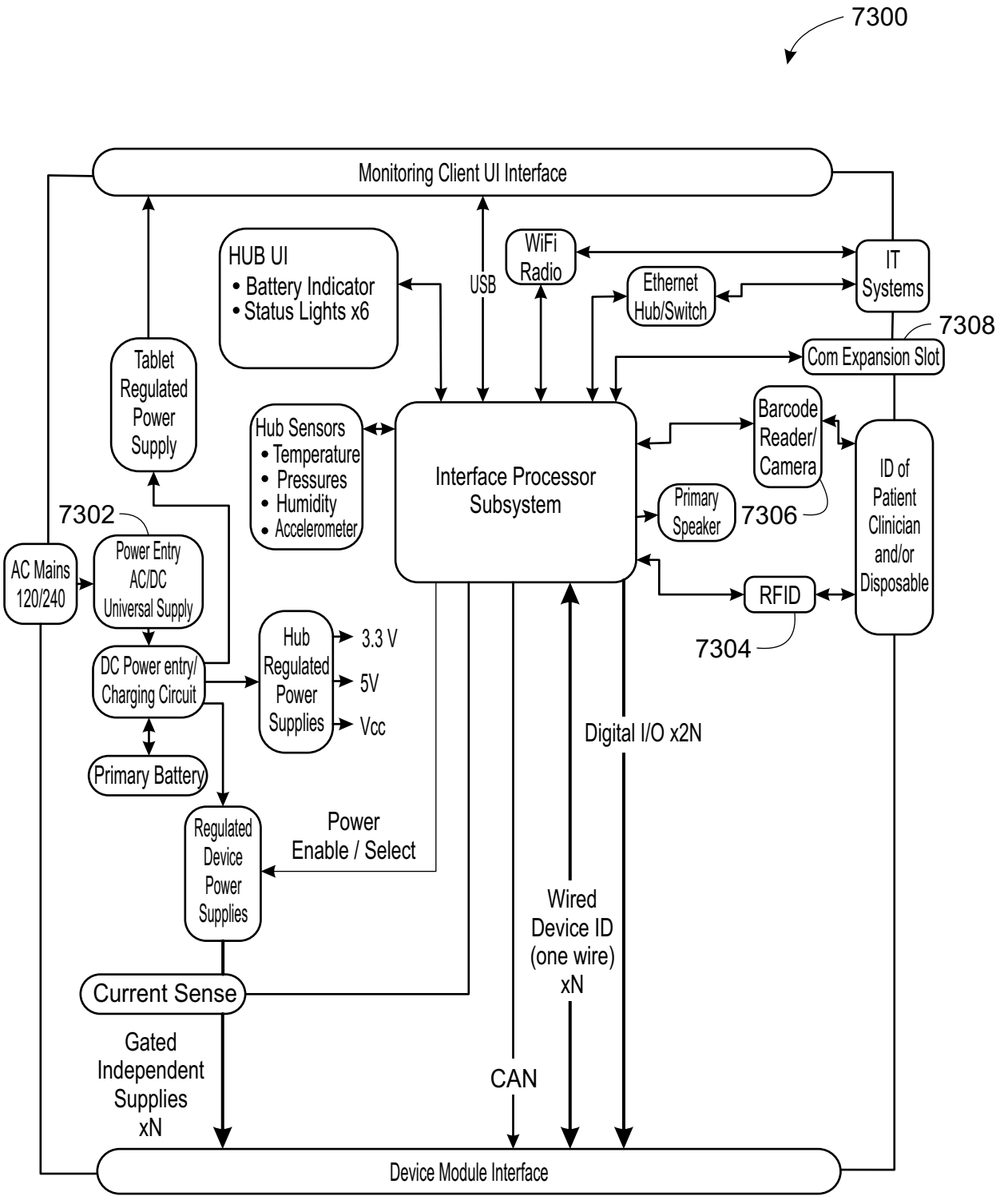

7300
Monitoring Client UI Interface
HUB UI
• Battery Indicator
• Status Lights x6
USB
WiFi Radio
Ethernet Hub/Switch
IT Systems
7308
Com Expansion Slot
Tablet Regulated Power Supply
Hub Sensors
• Temperature
• Pressures
• Humidity
• Accelerometer
Interface Processor Subsystem
Barcode Reader/ Camera
Primary Speaker
7306
ID of Patient Clinician and/or Disposable
RFID
7304
7302
AC Mains 120/240
Power Entry AC/DC Universal Supply
DC Power entry/ Charging Circuit
Hub Regulated Power Supplies
3.3 V
5V
Vcc
Primary Battery
Regulated Device Power Supplies
Power Enable / Select
Digital I/O x2N
Wired Device ID (one wire) xN
Current Sense
Gated Independent Supplies xN
CAN
Device Module Interface

FIG. 103

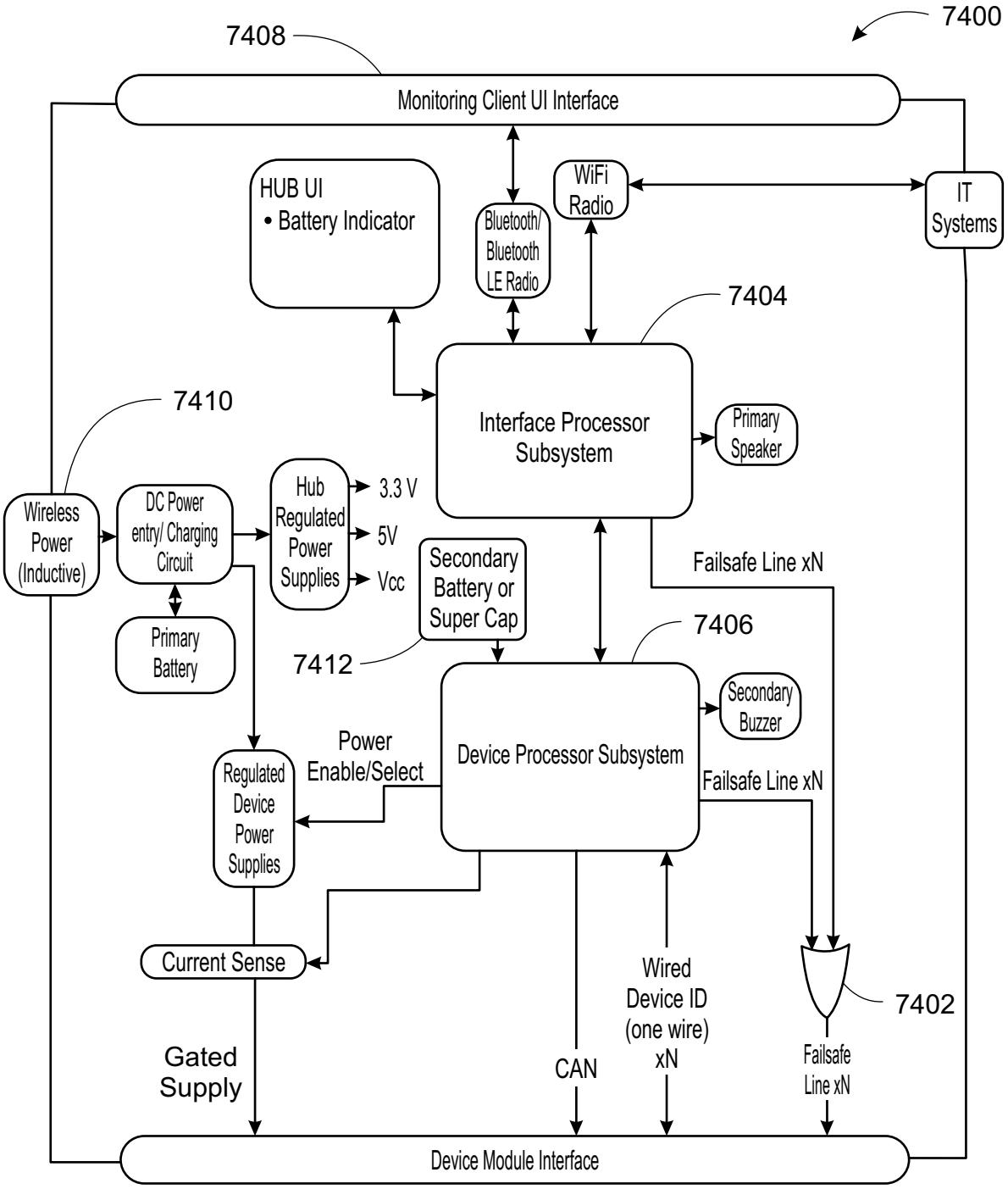

7400
7408
Monitoring Client UI Interface
HUB UI
• Battery Indicator
Bluetooth/
Bluetooth
LE Radio
WiFi
Radio
IT
Systems
7404
7410
Interface Processor
Subsystem
Primary
Speaker
Wireless
Power
(Inductive)
DC Power
entry/ Charging
Circuit
Hub
Regulated
Power
Supplies
3.3 V
5V
Vcc
Secondary
Battery or
Super Cap
Failsafe Line xN
Primary
Battery
7412
7406
Secondary
Buzzer
Power
Enable/Select
Device Processor Subsystem
Regulated
Device
Power
Supplies
Failsafe Line xN
Current Sense
Wired
Device ID
(one wire)
xN
7402
Gated
Supply
CAN
Failsafe
Line xN
Device Module Interface

FIG. 104

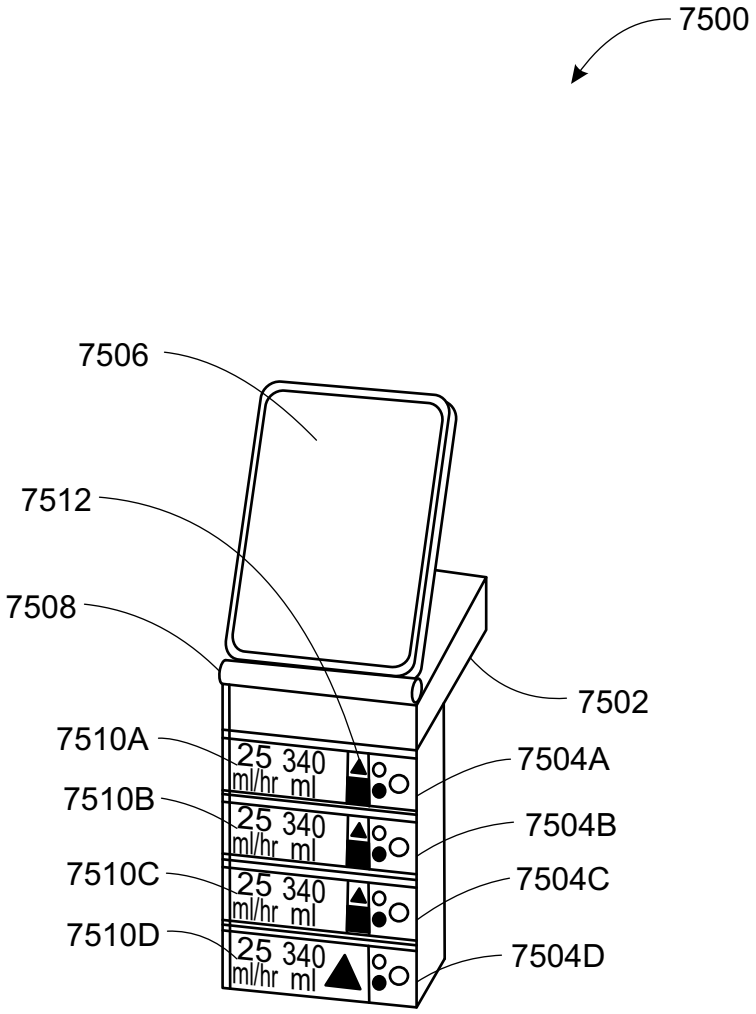

7500
7506
7512
7508
7502
7510A
7504A
7510B
7504B
7510C
7504C
7510D
7504D
25 340
ml/hr ml

FIG. 105

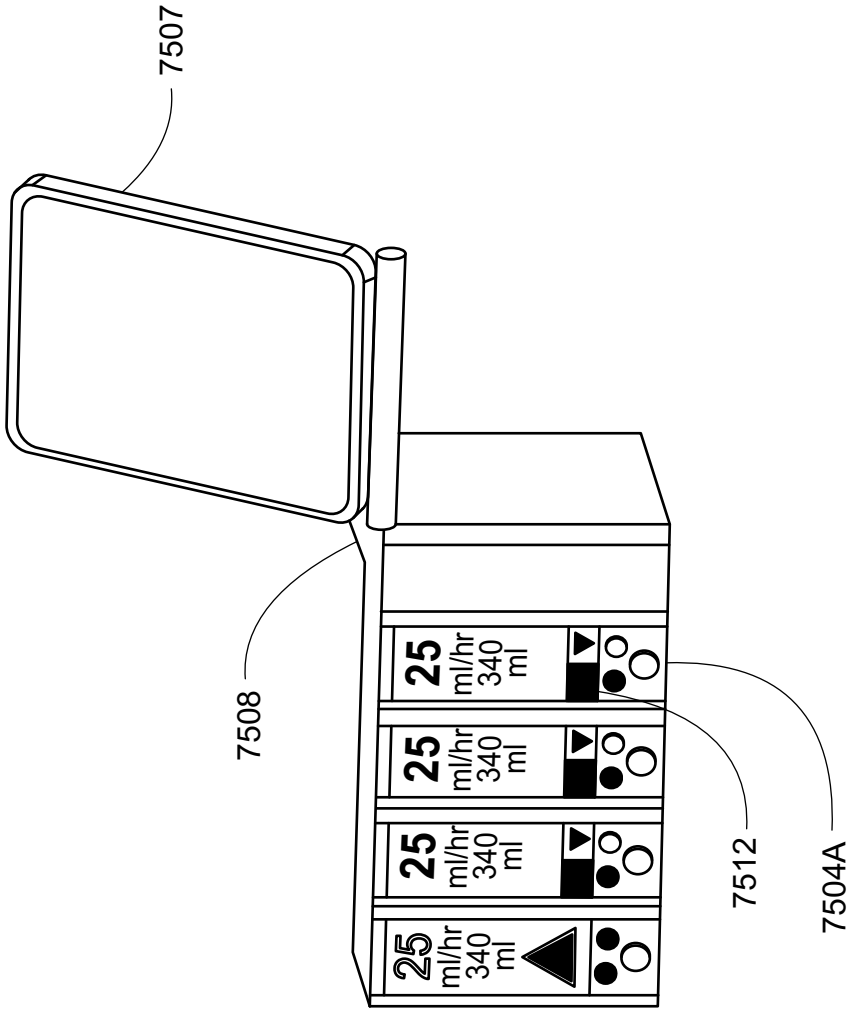

7507
7508
25 ml/hr 340 ml
25 ml/hr 340 ml
25 ml/hr 340 ml
25 ml/hr 340 ml
7512
7504A

FIG. 106

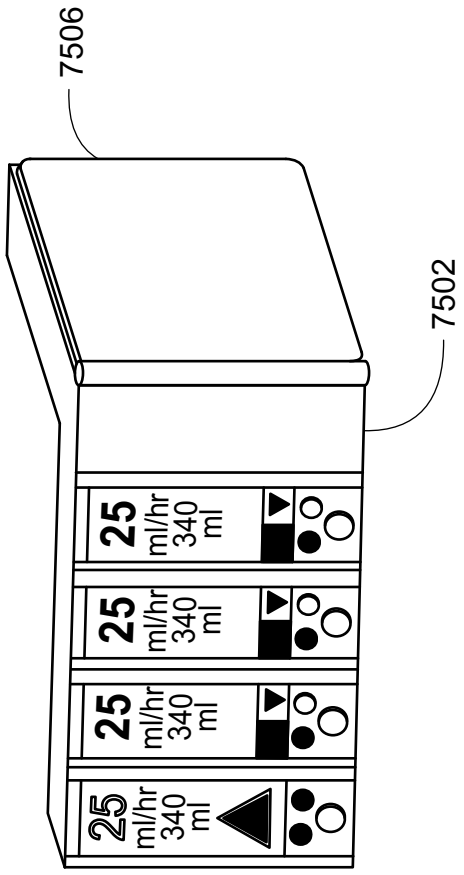

7506
7502
25 ml/hr 340 ml
25 ml/hr 340 ml
25 ml/hr 340 ml
25 ml/hr 340 ml

FIG. 107

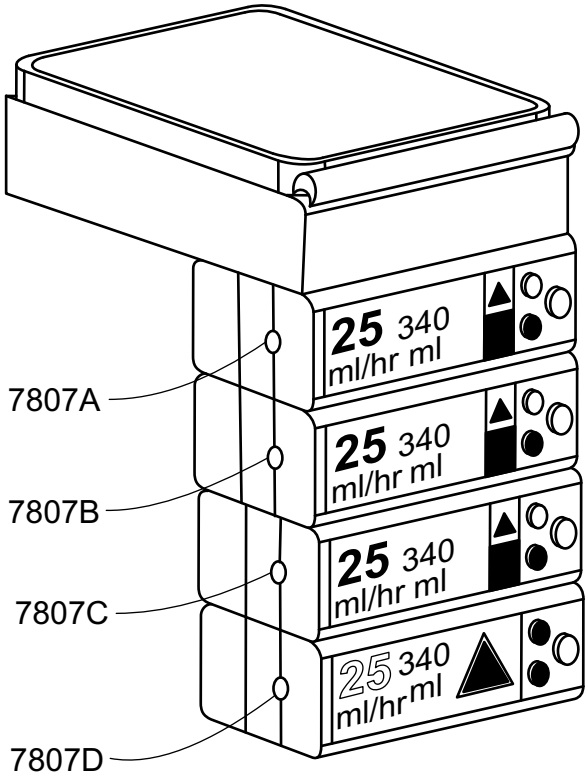

25 340
ml/hr ml
25 340
ml/hr ml
25 340
ml/hr ml
25 340
ml/hr ml
7807A
7807B
7807C
7807D

FIG. 108

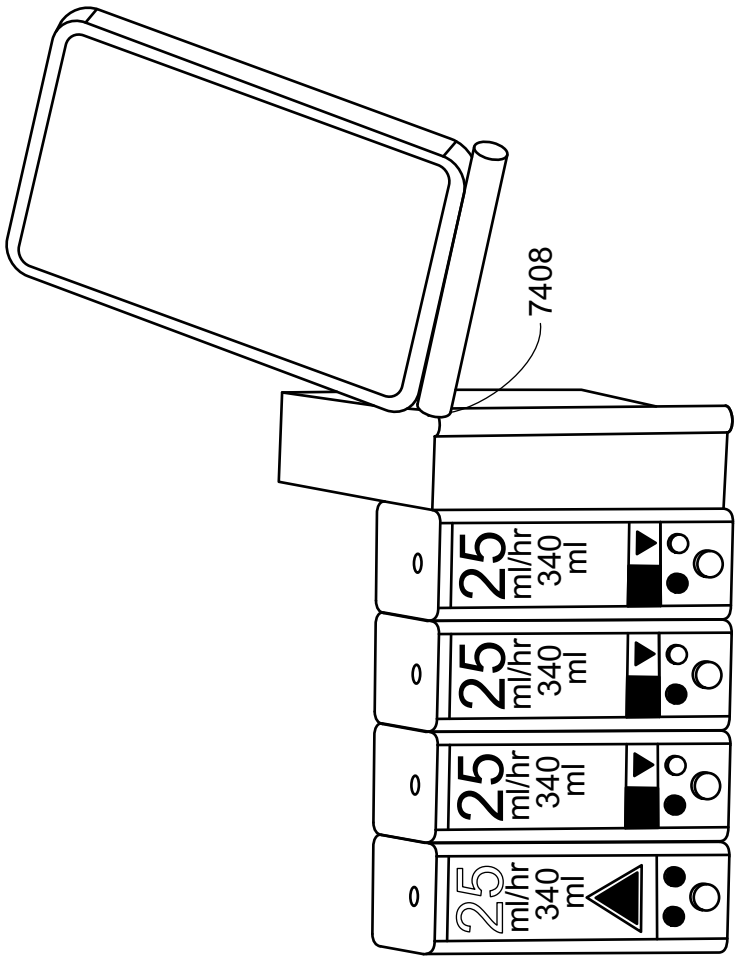


FIG. 109

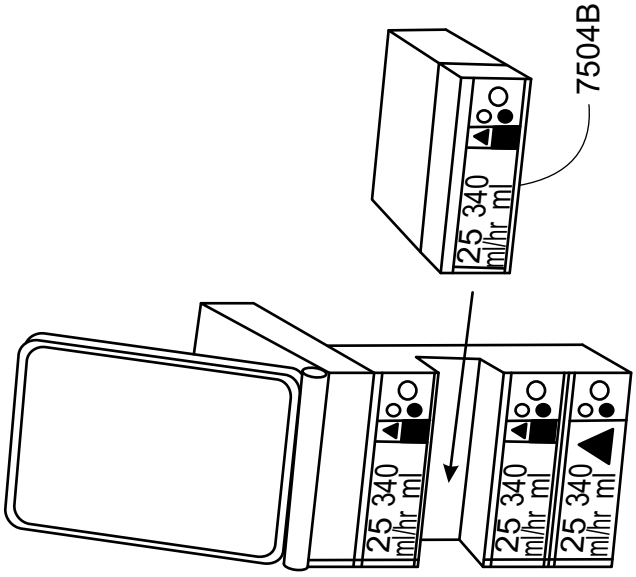


FIG. 110

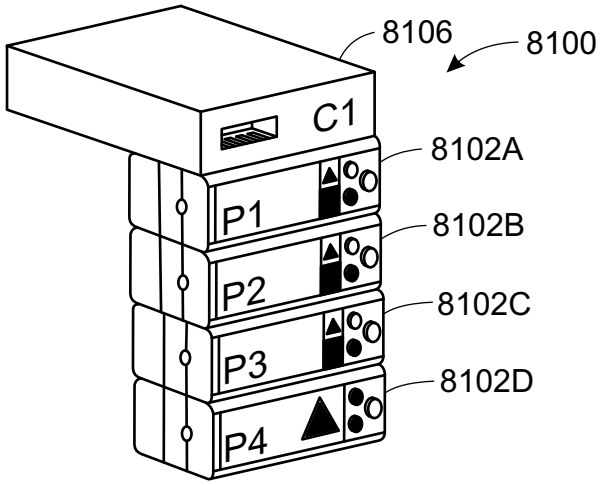


FIG. 111

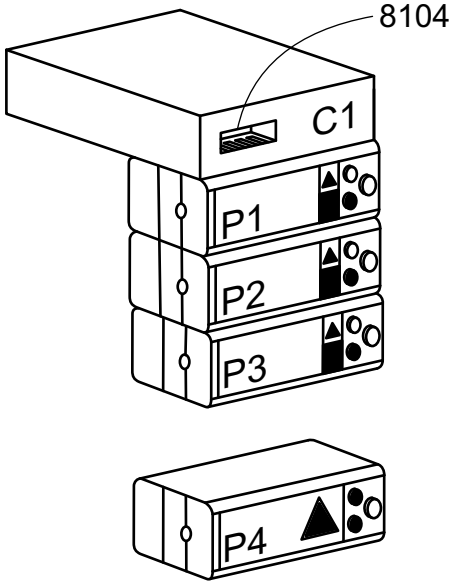


FIG. 112

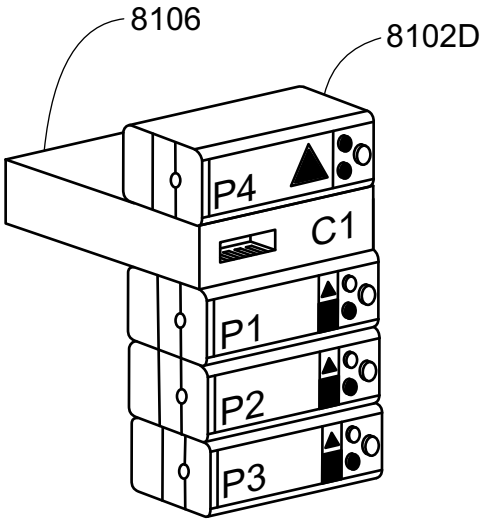


FIG. 113

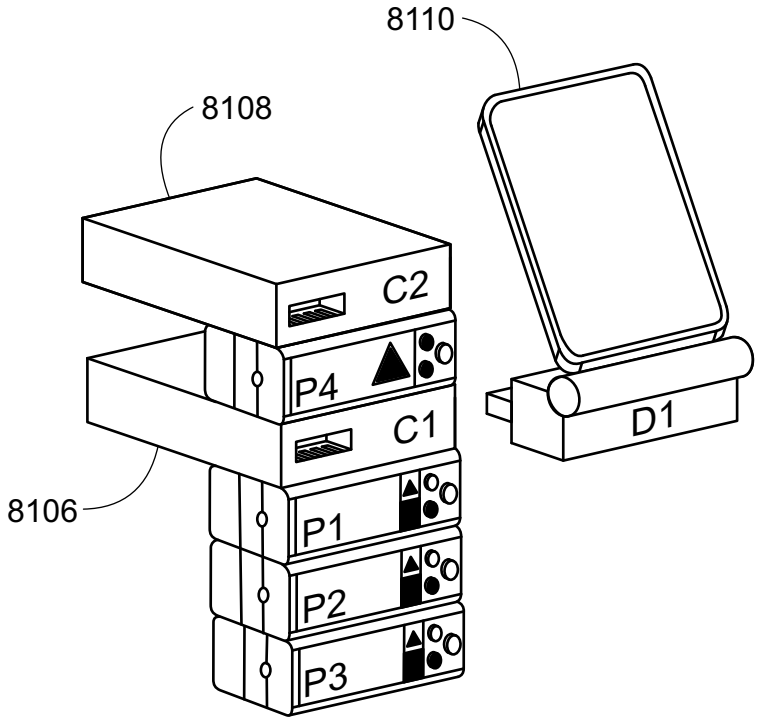


FIG. 114

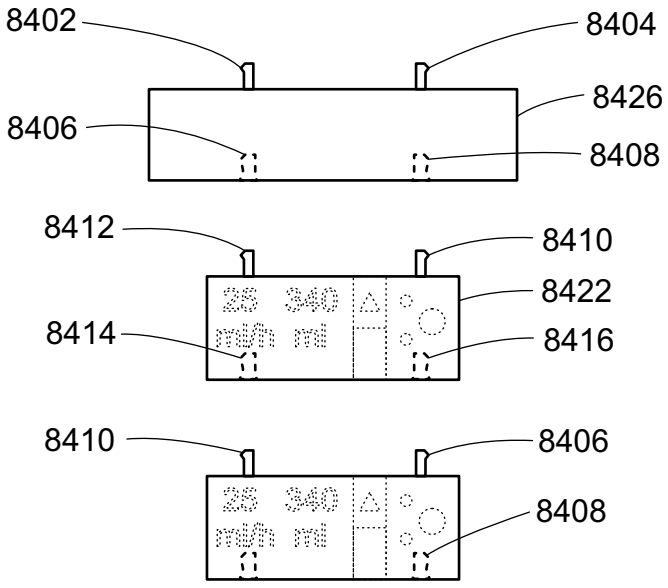


FIG. 115

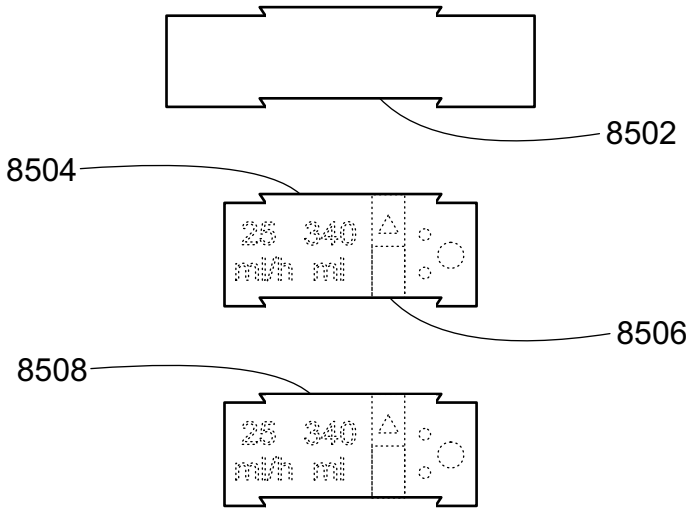


FIG. 116

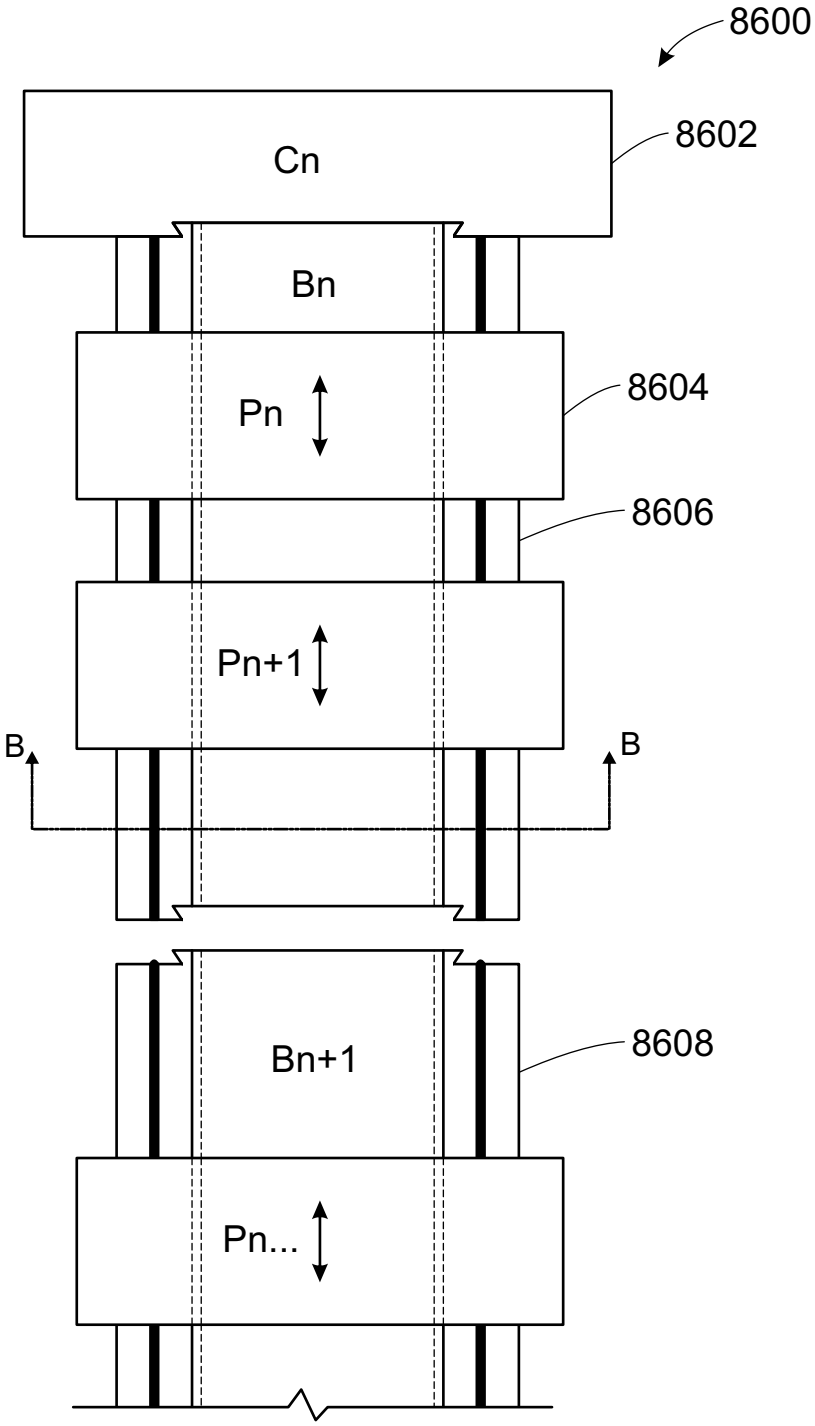


FIG. 117

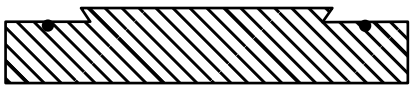


FIG. 118

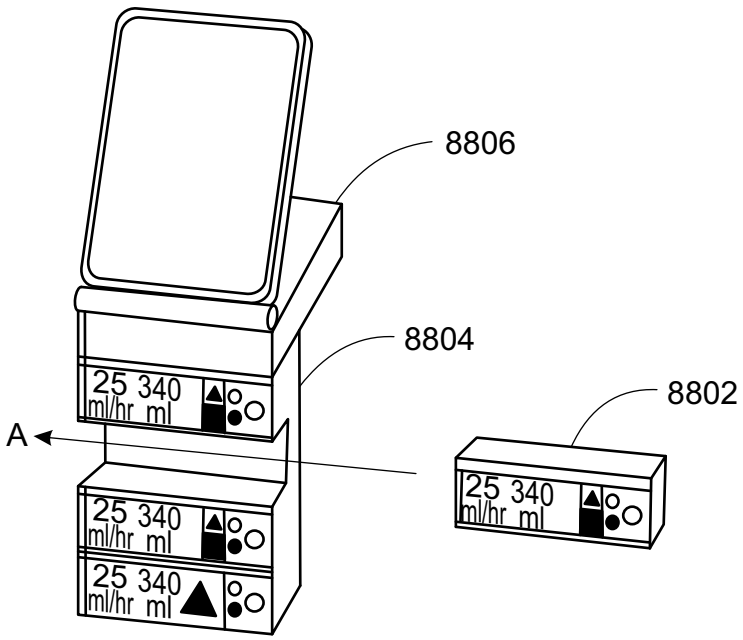

8806
8804
8802
A
25 340
ml/hr ml
25 340
ml/hr ml
25 340
ml/hr ml
25 340
ml/hr ml

FIG. 119

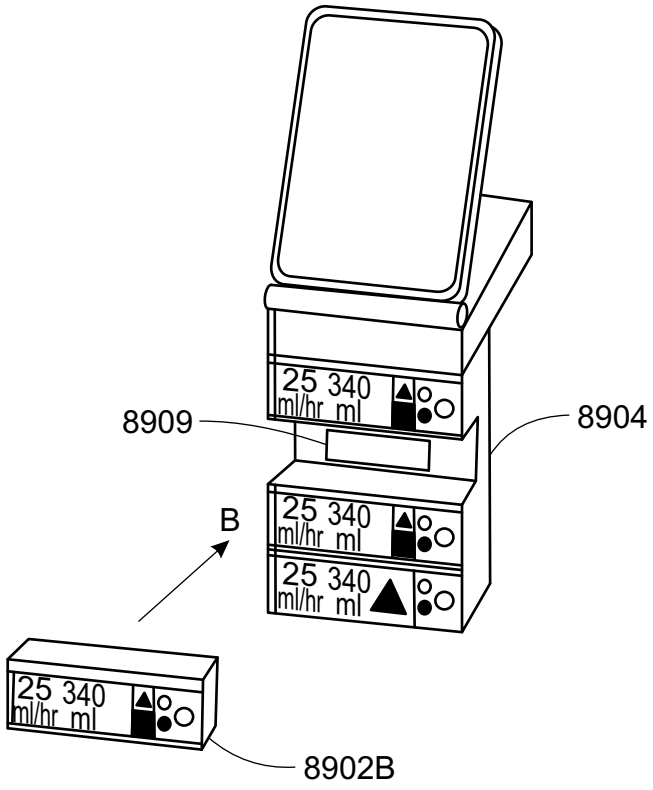

25 340
ml/hr ml
8909
8904
B
25 340
ml/hr ml
25 340
ml/hr ml
25 340
ml/hr ml
8902B

FIG. 120

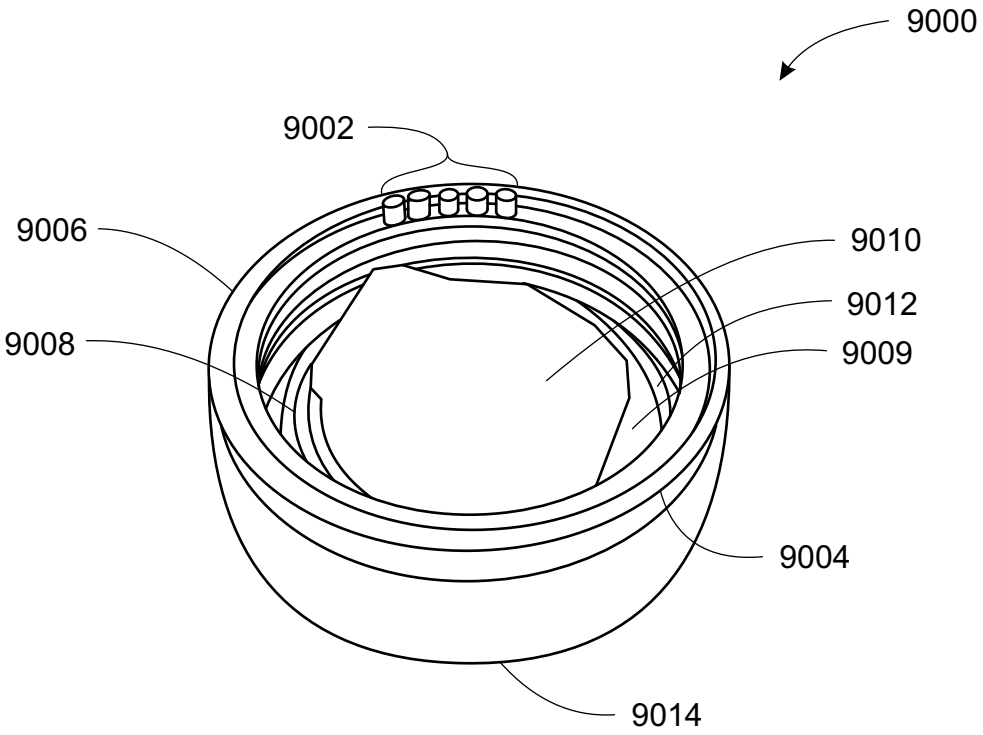


FIG. 121

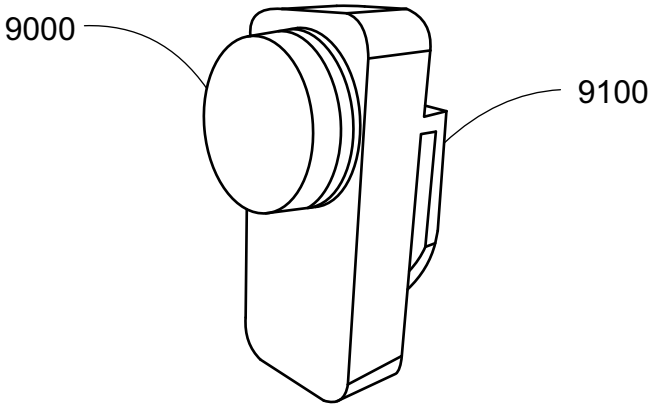


FIG. 122

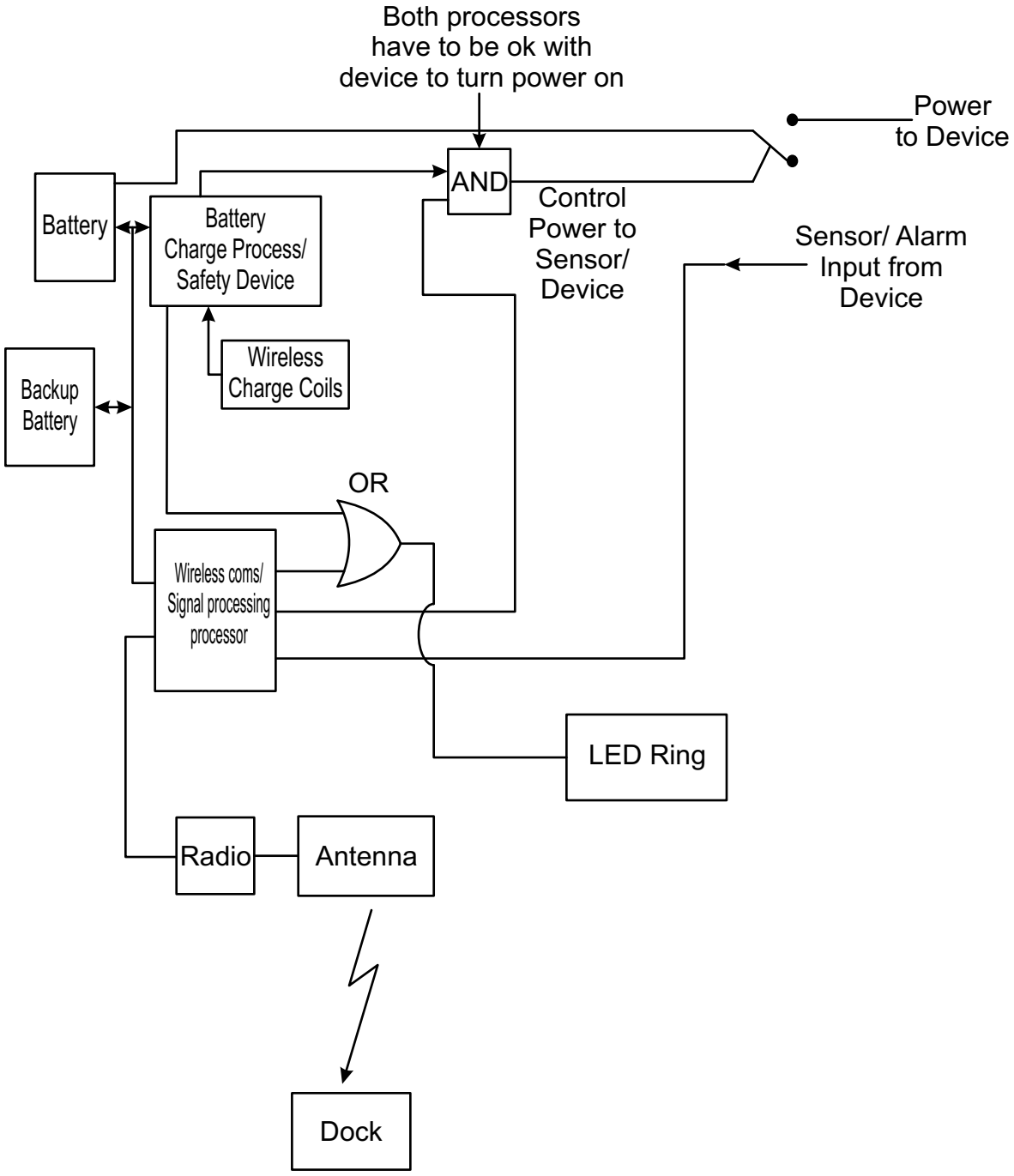

Both processors
have to be ok with
device to turn power on
Power
to Device
AND
Battery
Battery
Charge Process/
Safety Device
Control
Power to
Sensor/
Device
Sensor/ Alarm
Input from
Device
Wireless
Charge Coils
Backup
Battery
OR
Wireless coms/
Signal processing
processor
LED Ring
Radio
Antenna
Dock

FIG. 123

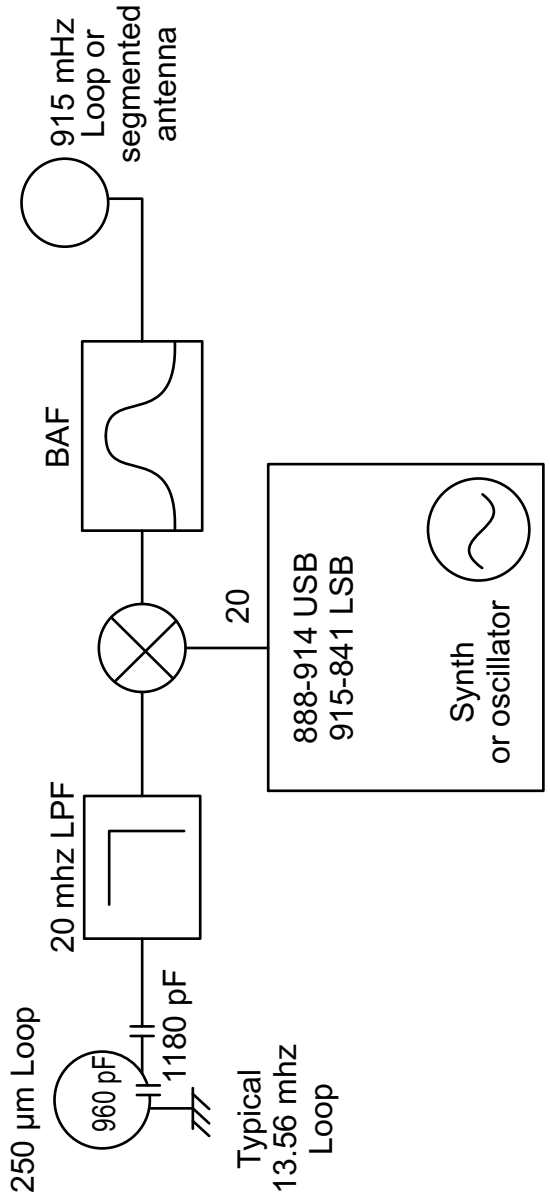

915 mHz
Loop or
segmented
antenna
BAF
20
888-914 USB
915-841 LSB
Synth
or oscillator
20 mhz LPF
250 µm Loop
960 pF
1180 pF
Typical
13.56 mhz
Loop

FIG. 124

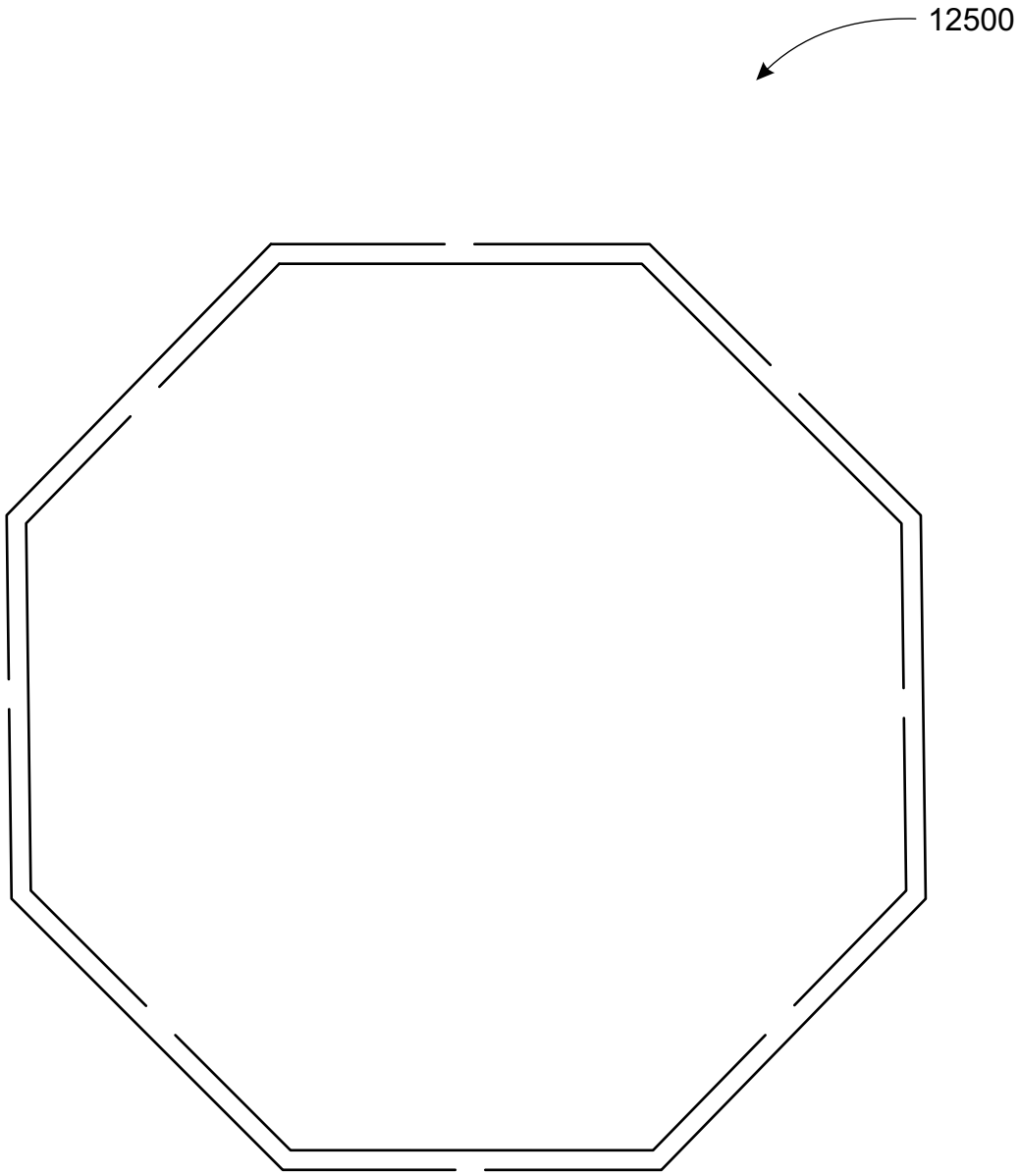


FIG. 125

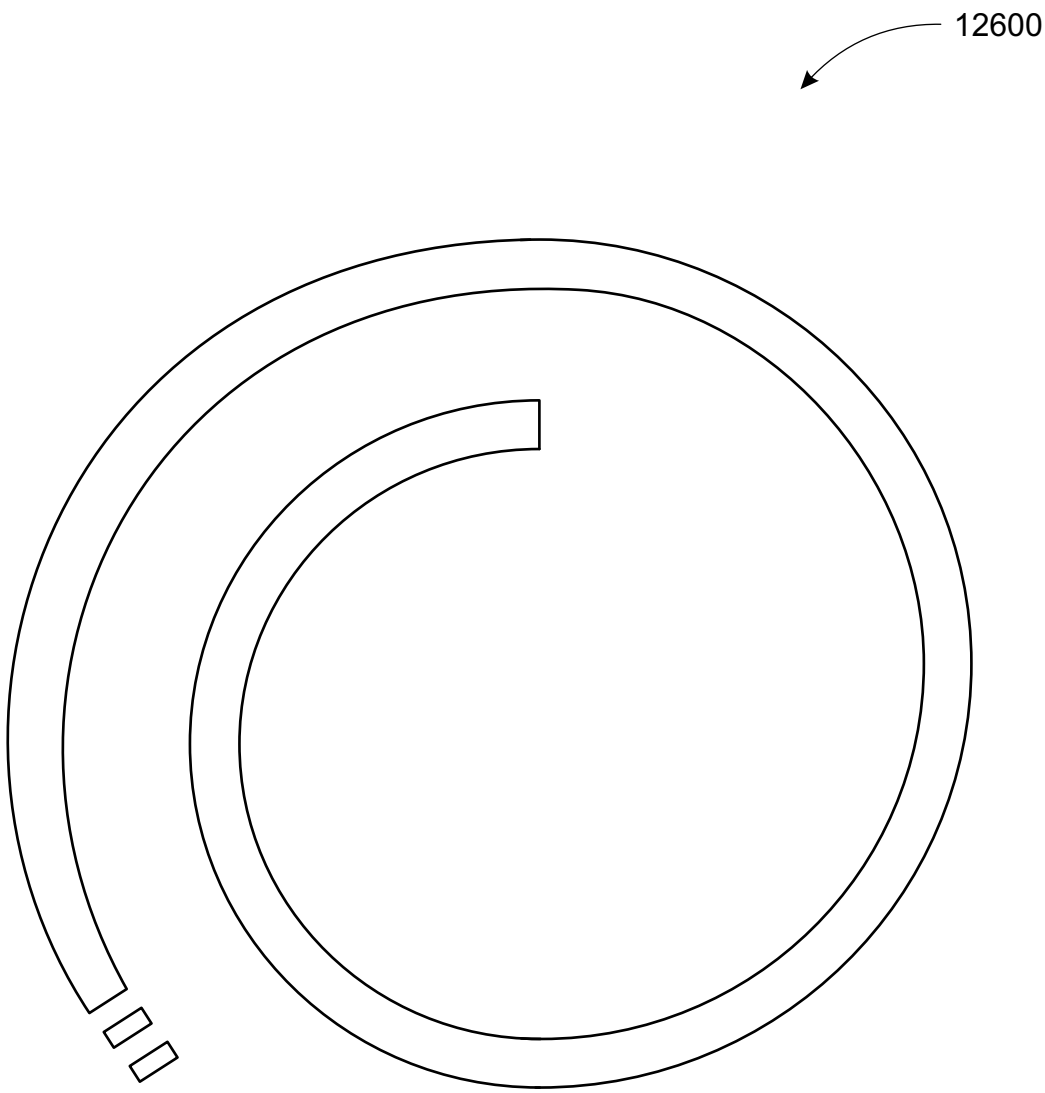


FIG. 126

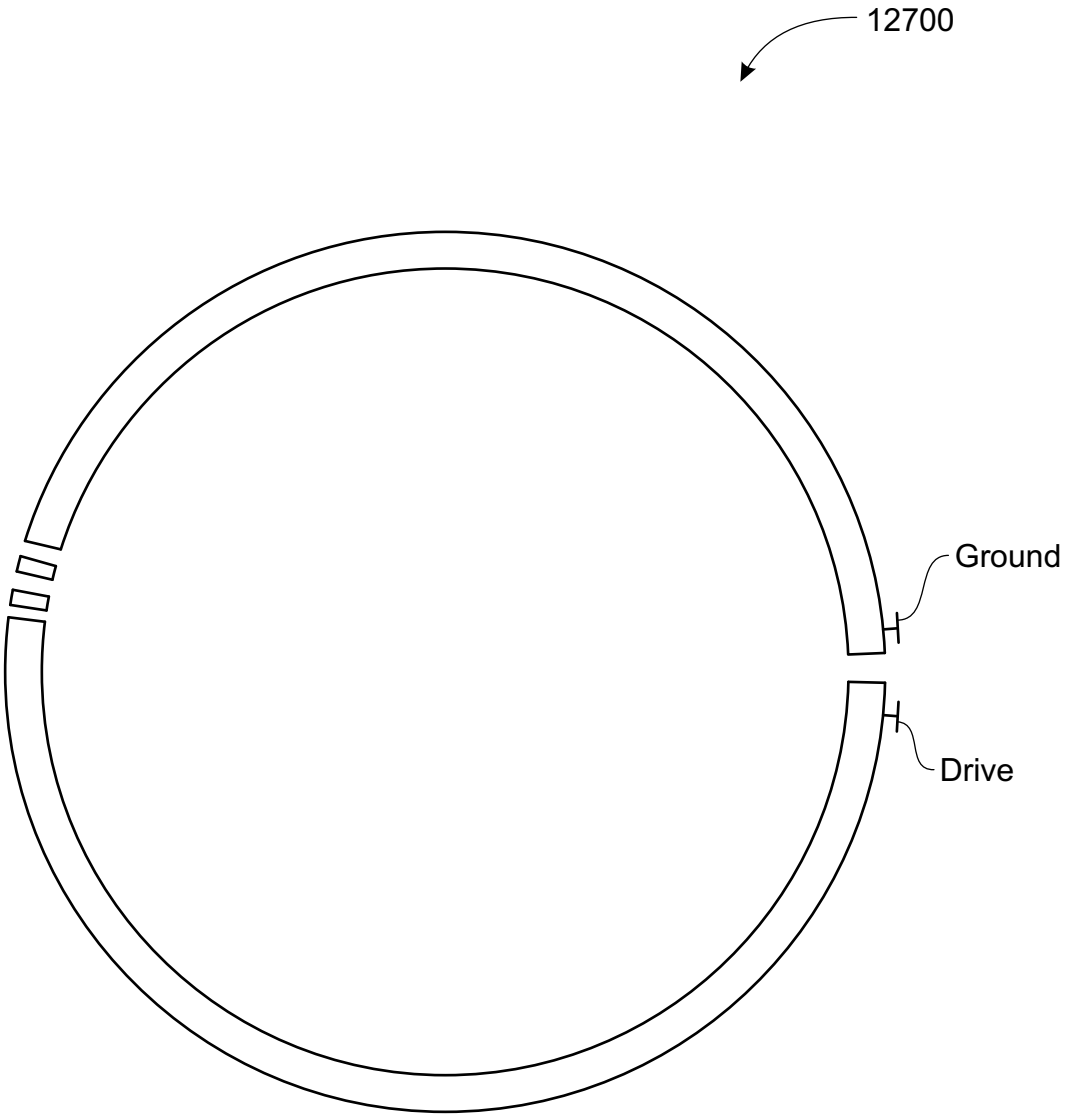


FIG. 127

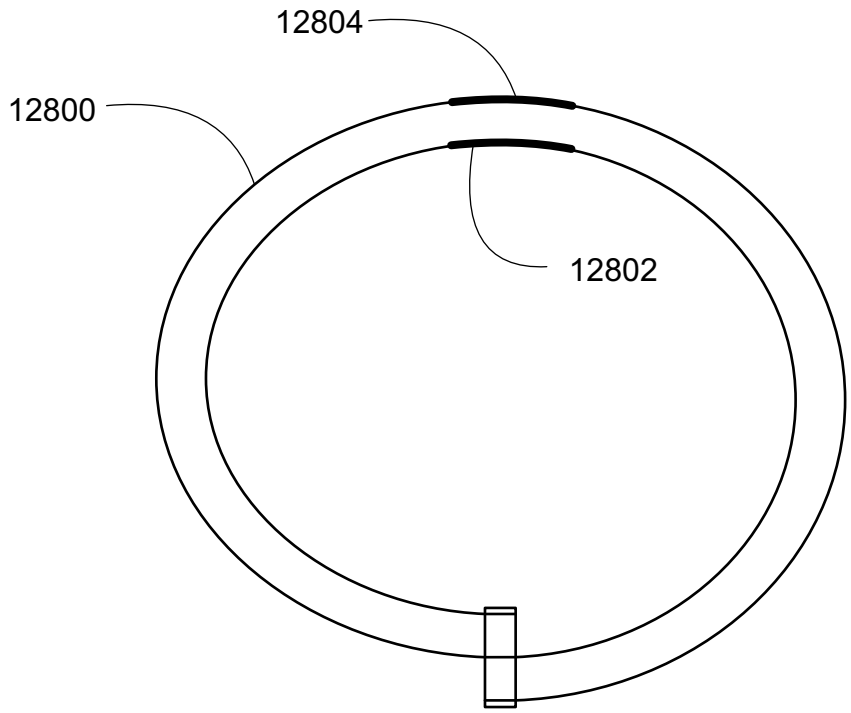


FIG. 128

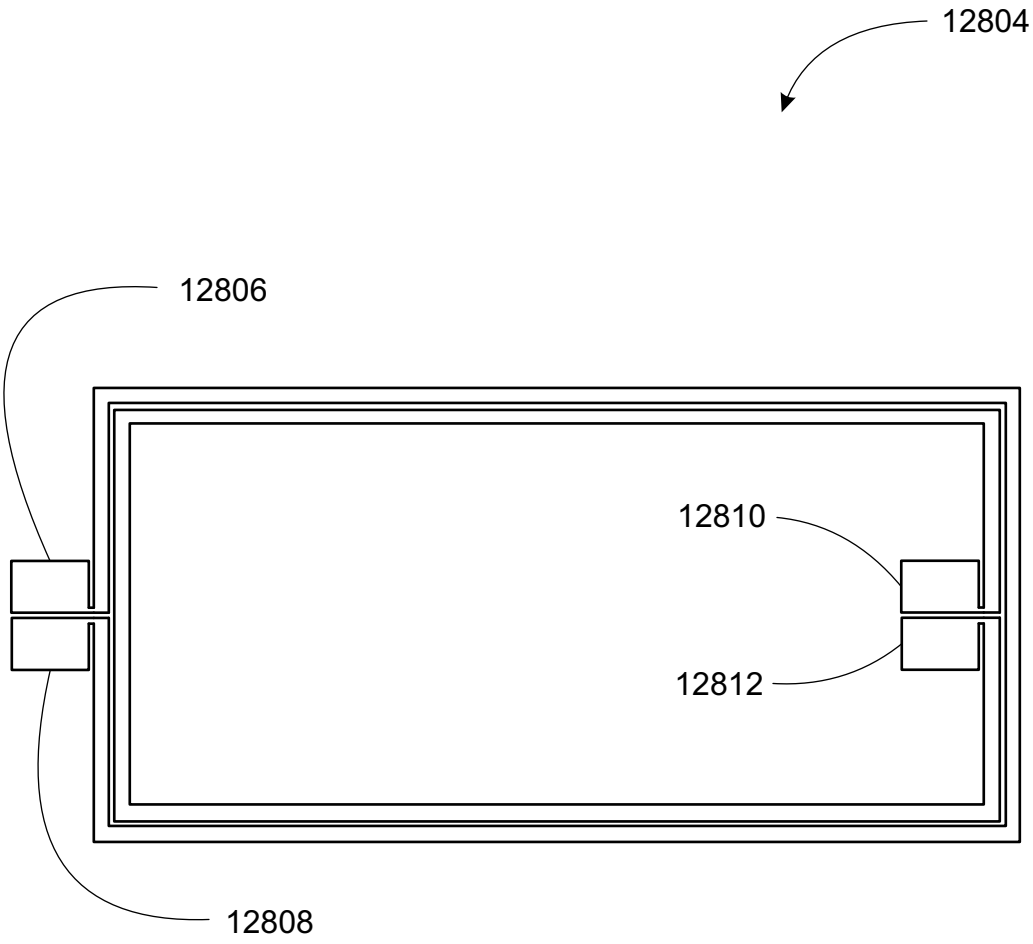


FIG. 129

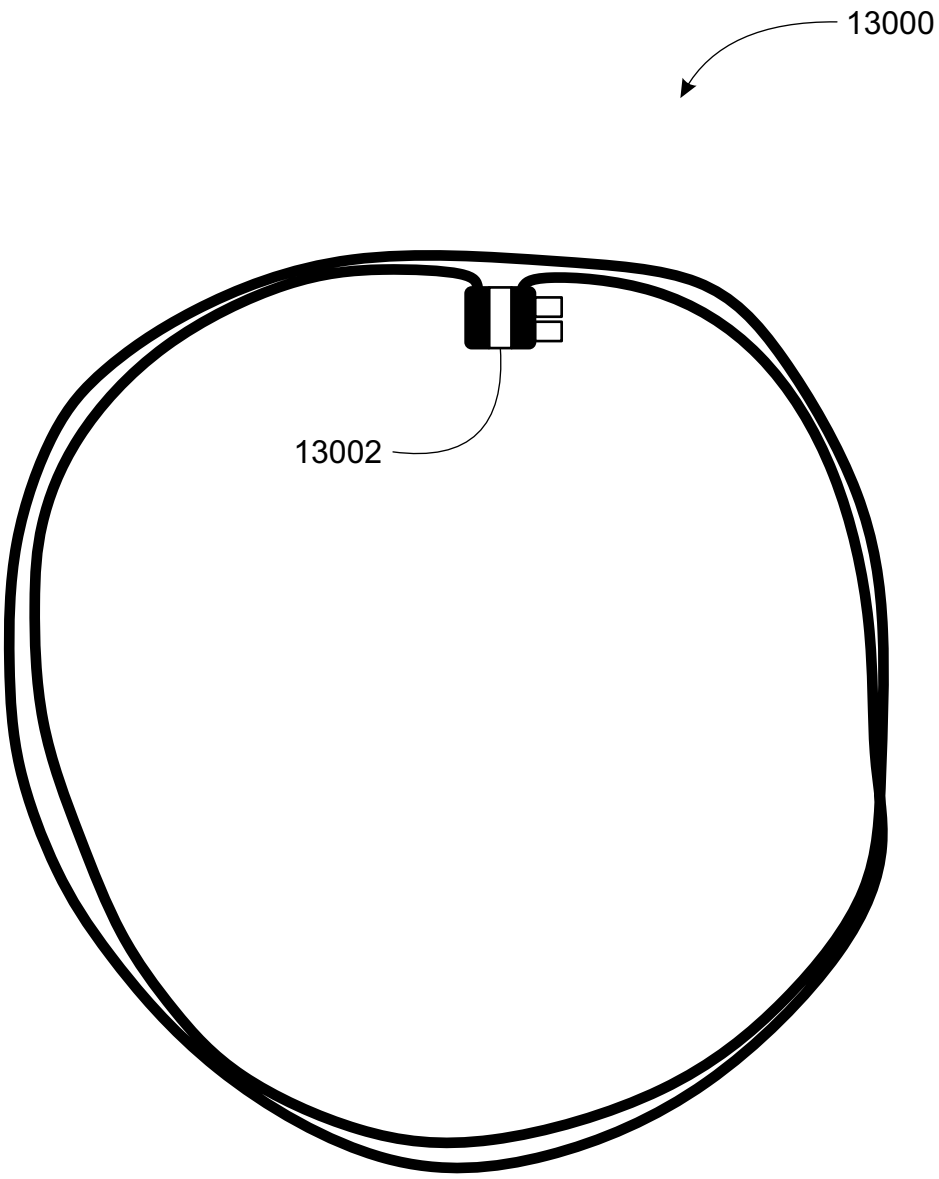


FIG. 130

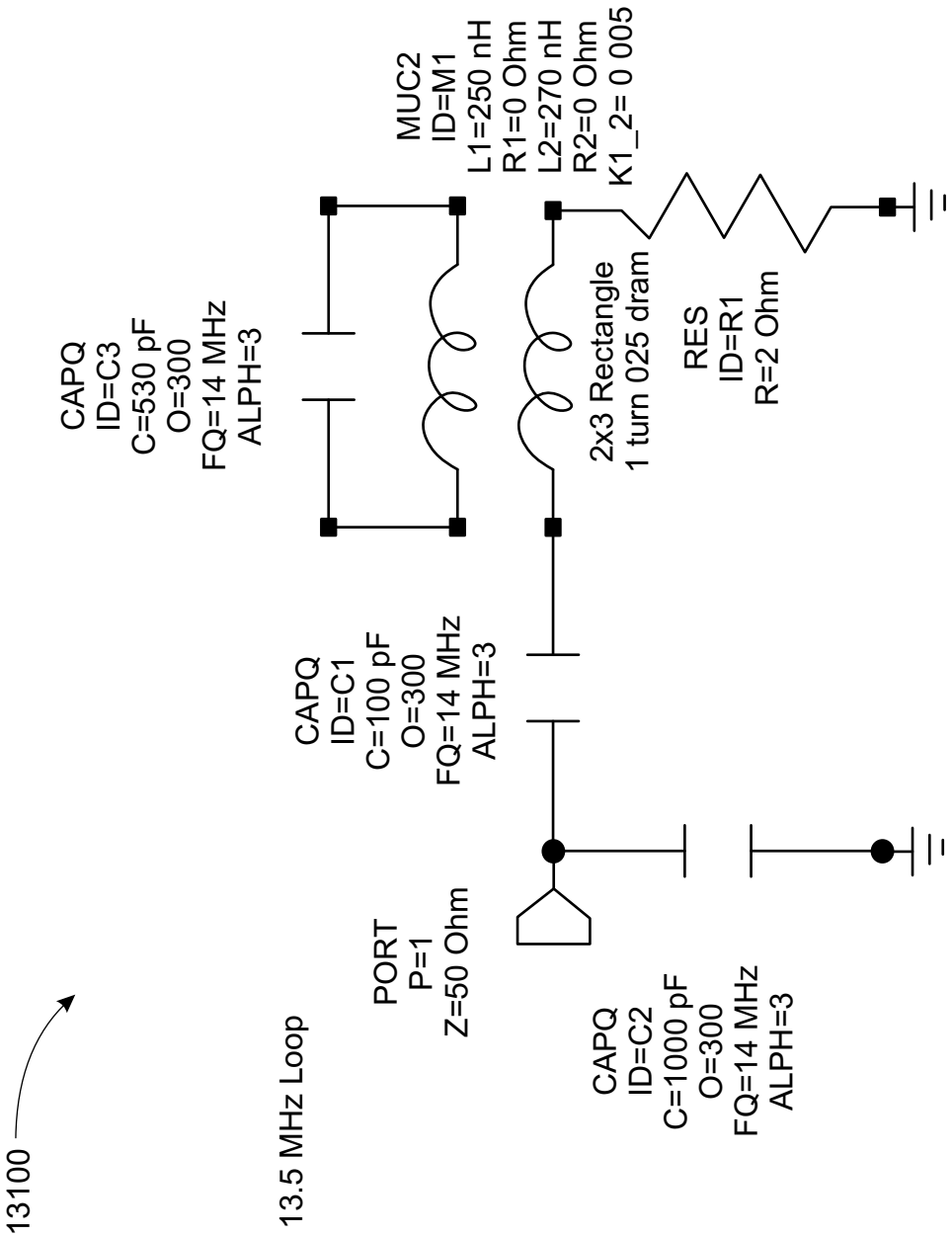

13100
13.5 MHz Loop
PORT
P=1
Z=50 Ohm
CAPQ
ID=C1
C=100 pF
O=300
FQ=14 MHz
ALPH=3
CAPQ
ID=C2
C=1000 pF
O=300
FQ=14 MHz
ALPH=3
CAPQ
ID=C3
C=530 pF
O=300
FQ=14 MHz
ALPH=3
MUC2
ID=M1
L1=250 nH
R1=0 Ohm
L2=270 nH
R2=0 Ohm
K1_2= 0 005
2x3 Rectangle
1 turn 025 dram
RES
ID=R1
R=2 Ohm

FIG. 131

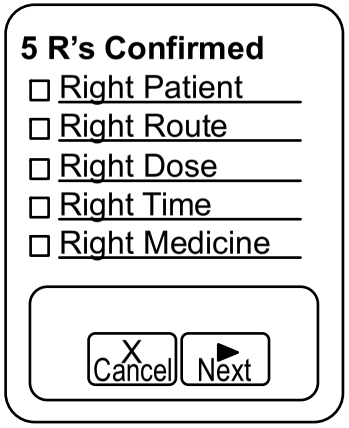


FIG. 132

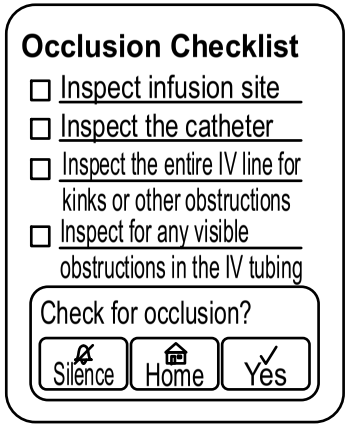


FIG. 133

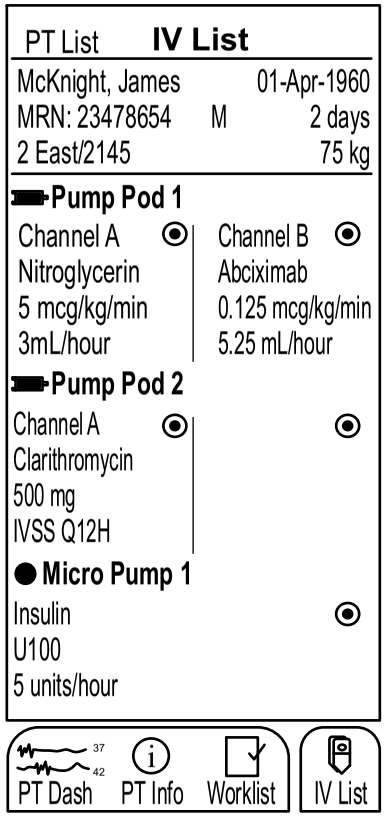


FIG. 134

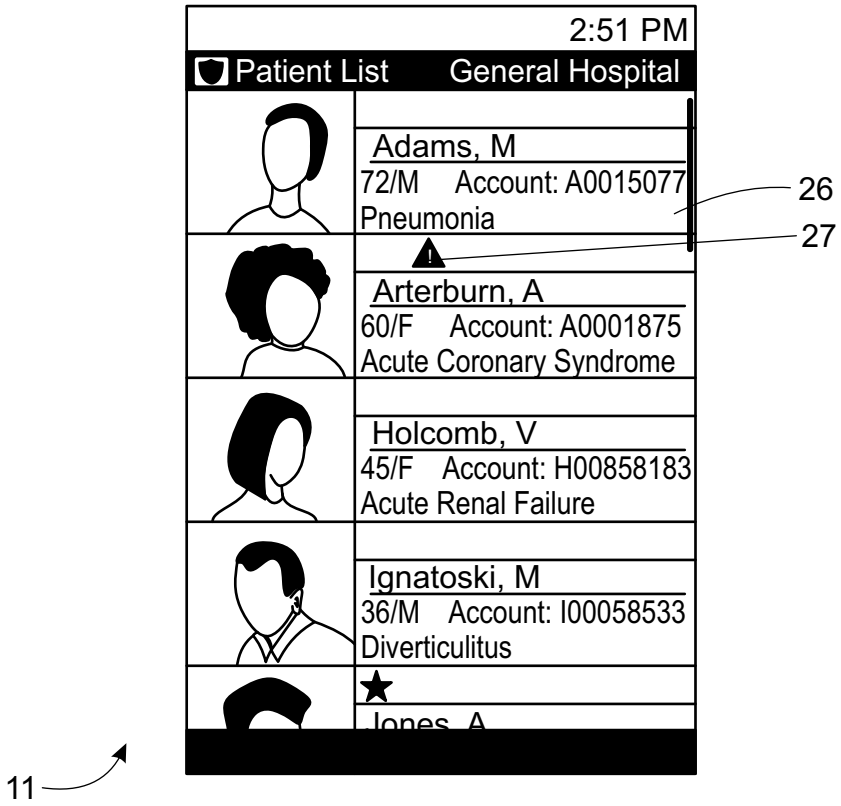

2:51 PM
Patient List
General Hospital
Adams, M
72/M Account: A0015077
Pneumonia
Arterburn, A
60/F Account: A0001875
Acute Coronary Syndrome
Holcomb, V
45/F Account: H00858183
Acute Renal Failure
Ignatoski, M
36/M Account: I00058533
Diverticulitus
Jones, A
26
27
11

FIG. 135

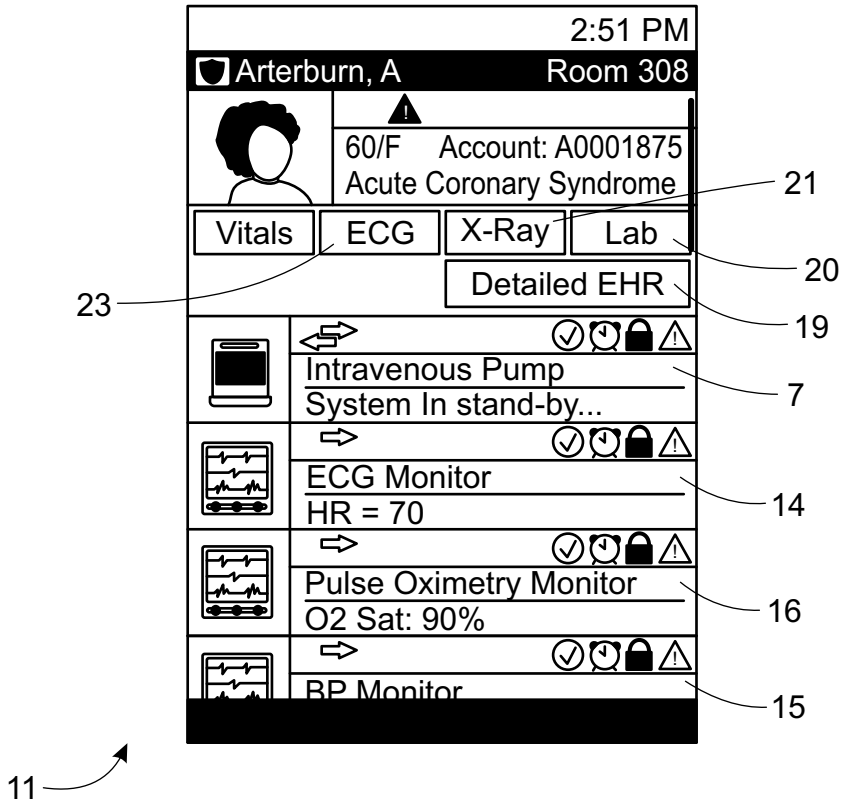

2:51 PM
Arterburn, A
Room 308
60/F Account: A0001875
Acute Coronary Syndrome
Vitals
ECG
X-Ray
Lab
Detailed EHR
Intravenous Pump
System In stand-by...
ECG Monitor
HR = 70
Pulse Oximetry Monitor
O2 Sat: 90%
BP Monitor
11
23
21
20
19
7
14
16
15

FIG. 136

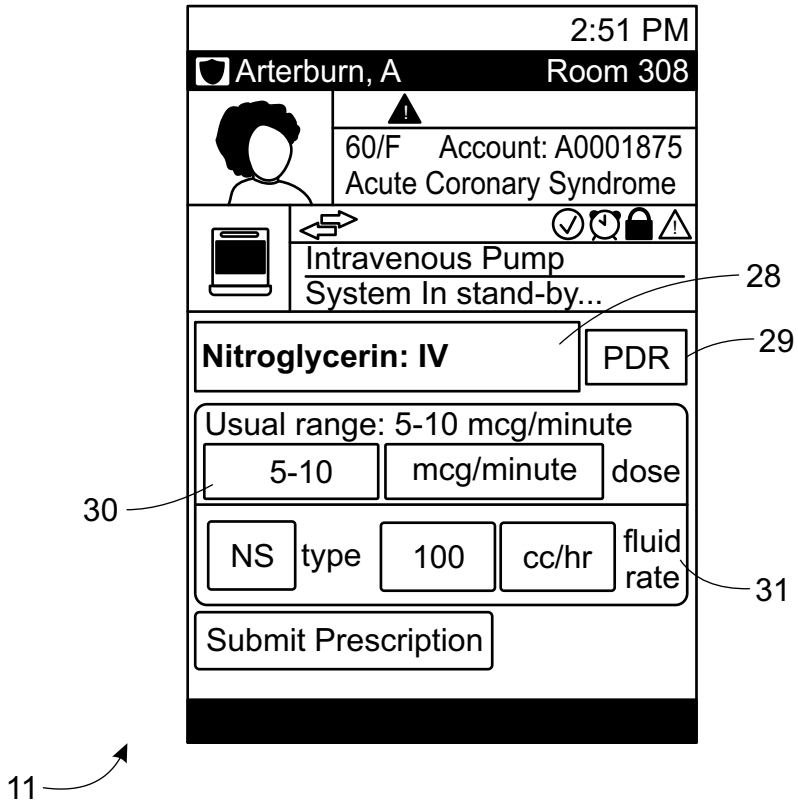

2:51 PM
Arterburn, A
Room 308
60/F Account: A0001875
Acute Coronary Syndrome
Intravenous Pump
System In stand-by...
Nitroglycerin: IV
PDR
Usual range: 5-10 mcg/minute
5-10
mcg/minute
dose
NS
type
100
cc/hr
fluid rate
Submit Prescription
11
28
29
30
31

FIG. 137

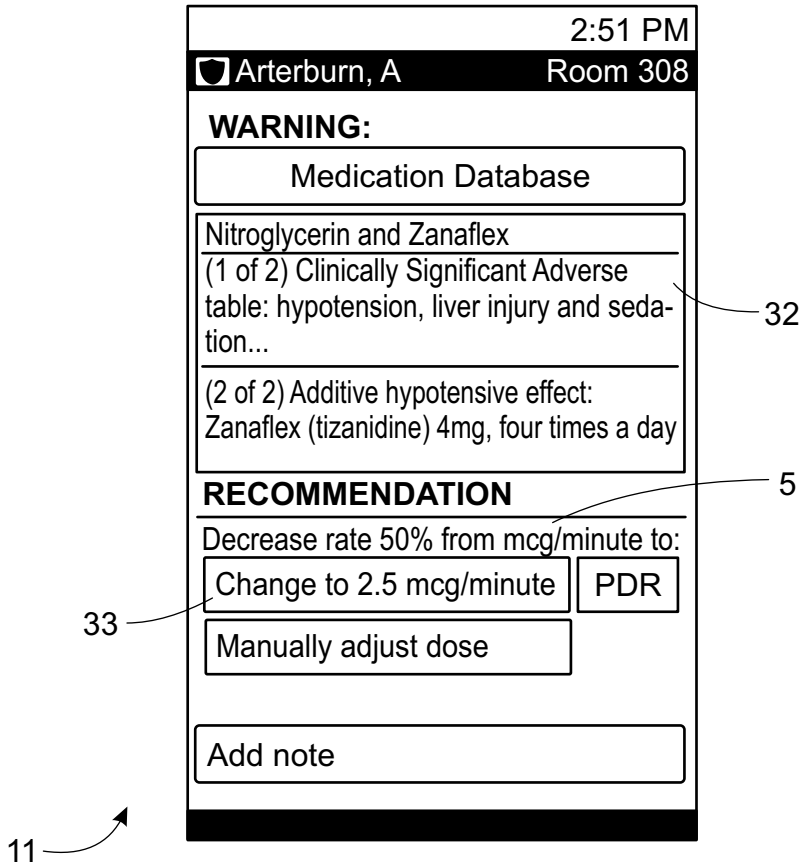

2:51 PM
Arterburn, A
Room 308
WARNING:
Medication Database
Nitroglycerin and Zanaflex
(1 of 2) Clinically Significant Adverse table: hypotension, liver injury and sedation...
(2 of 2) Additive hypotensive effect: Zanaflex (tizanidine) 4mg, four times a day
RECOMMENDATION
Decrease rate 50% from mcg/minute to:
Change to 2.5 mcg/minute
PDR
Manually adjust dose
Add note
32
5
33
11

FIG. 138

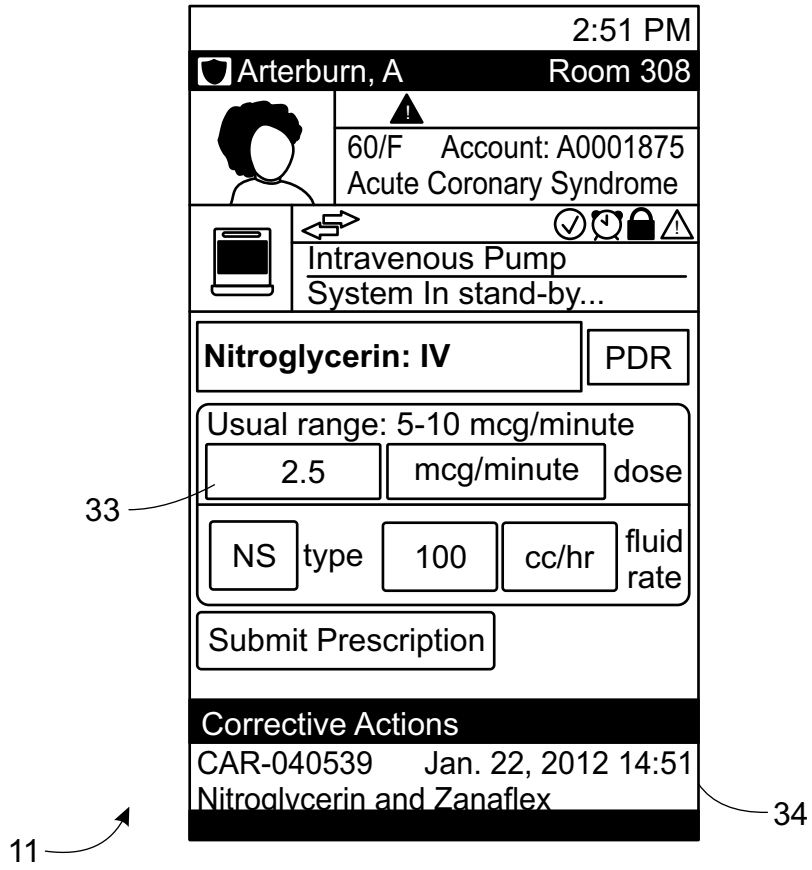

2:51 PM
Arterburn, A
Room 308
60/F Account: A0001875
Acute Coronary Syndrome
Intravenous Pump
System In stand-by...
Nitroglycerin: IV
PDR
Usual range: 5-10 mcg/minute
2.5
mcg/minute
dose
NS
type
100
cc/hr
fluid rate
Submit Prescription
Corrective Actions
CAR-040539 Jan. 22, 2012 14:51
Nitroglycerin and Zanaflex
33
34
11

FIG. 139

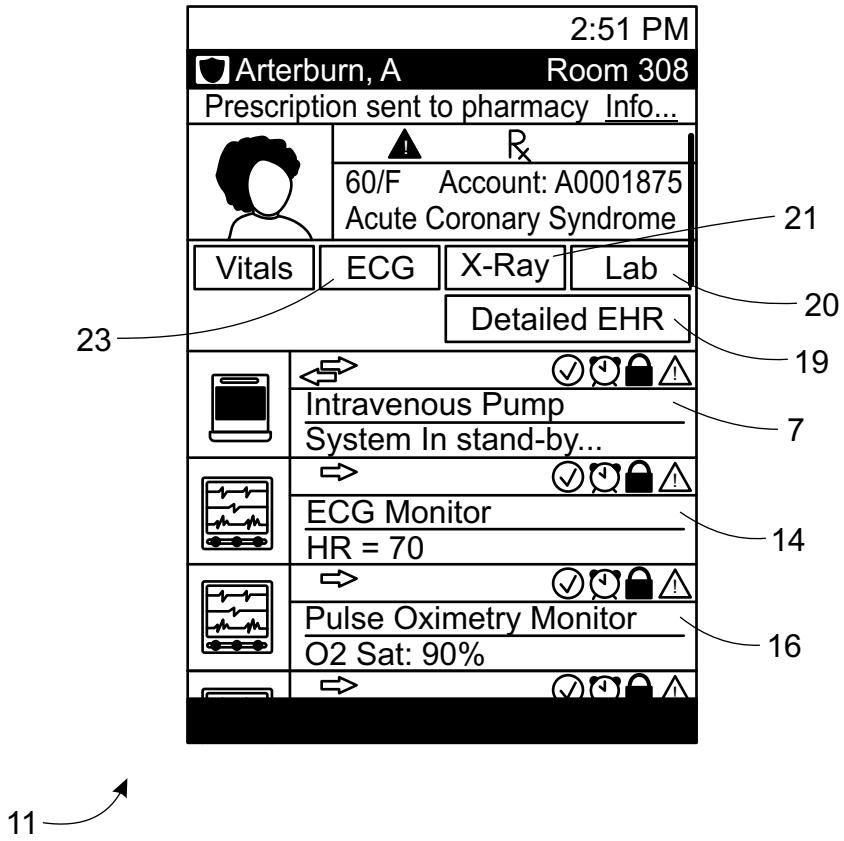

2:51 PM
Arterburn, A
Room 308
Prescription sent to pharmacy Info...
60/F Account: A0001875
Acute Coronary Syndrome
Vitals
ECG
X-Ray
Lab
Detailed EHR
Intravenous Pump
System In stand-by...
ECG Monitor
HR = 70
Pulse Oximetry Monitor
O2 Sat: 90%
11
23
21
20
19
7
14
16

FIG. 140

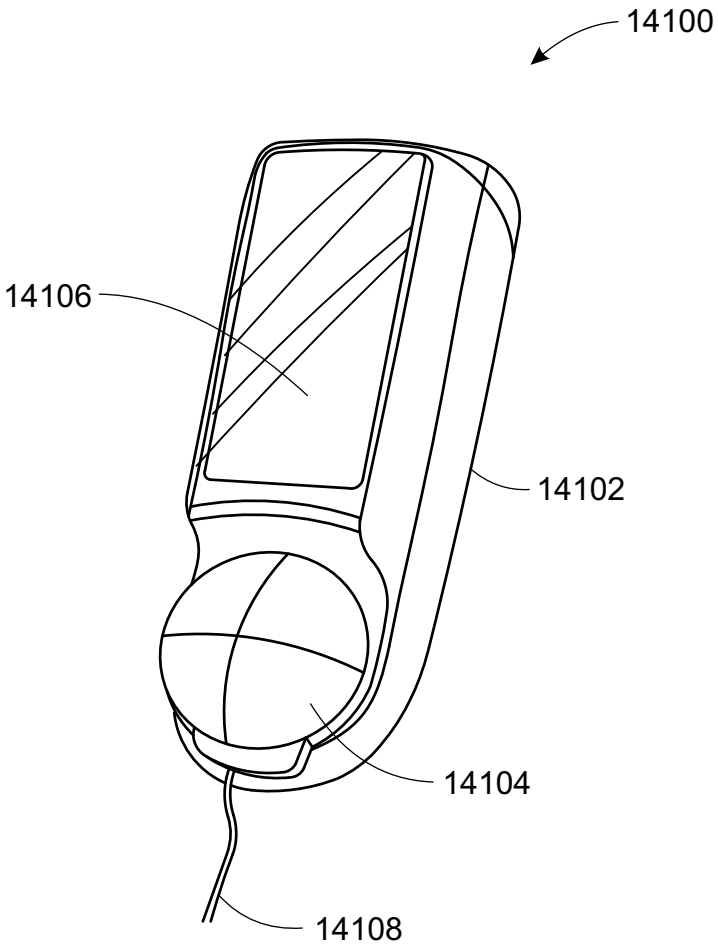


FIG. 141

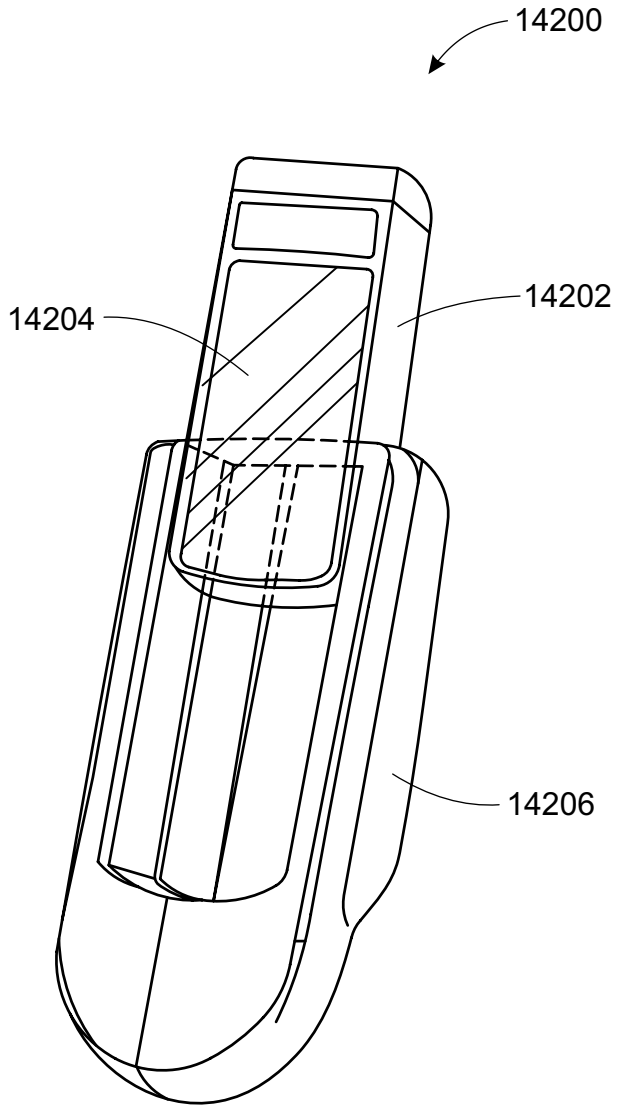


FIG. 142

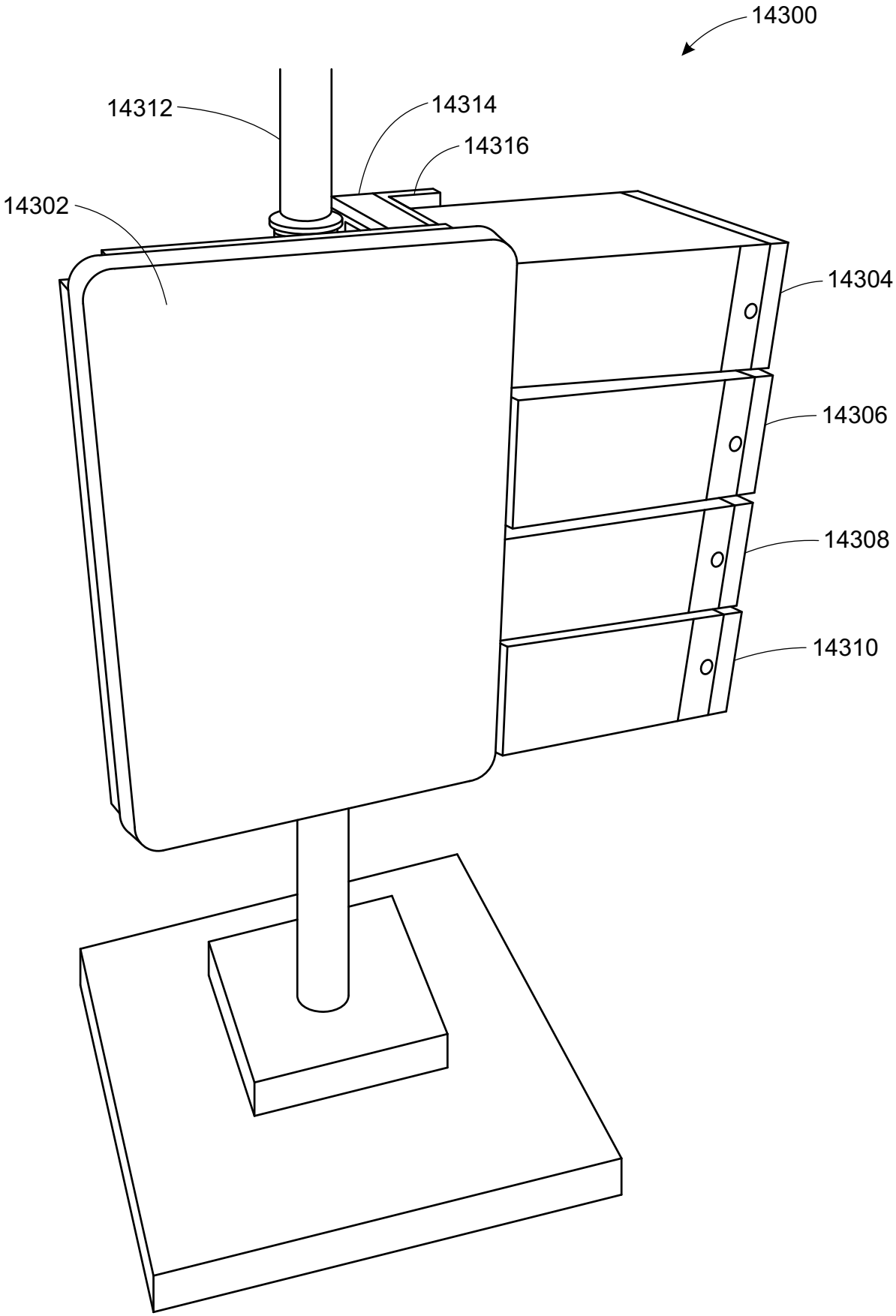


FIG. 143

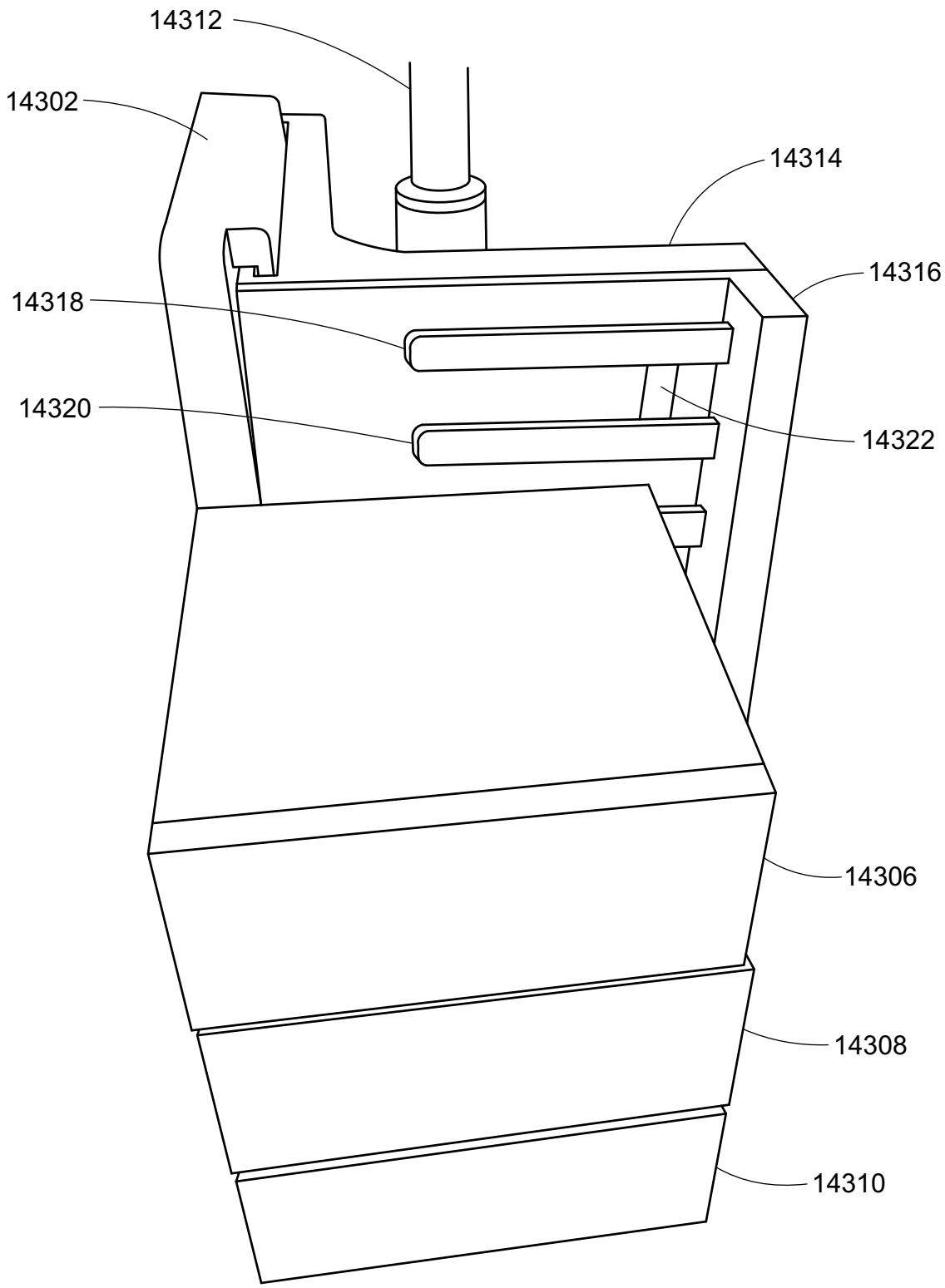

14312
14302
14314
14316
14318
14320
14322
14306
14308
14310

FIG. 144

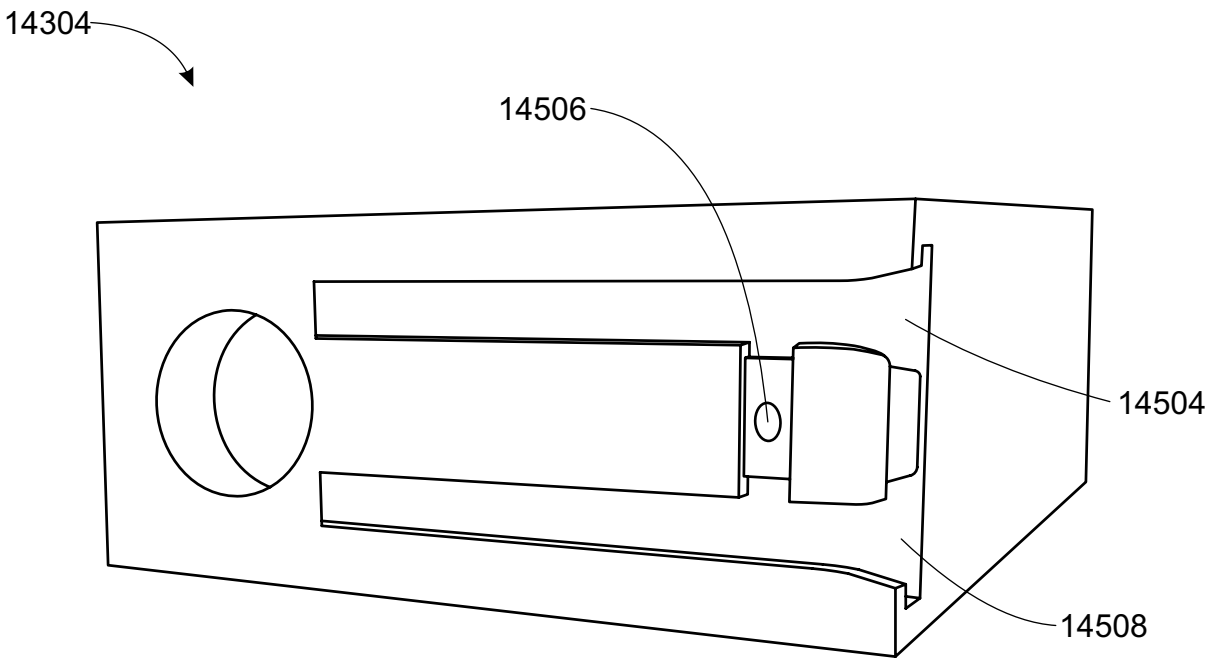


FIG. 145

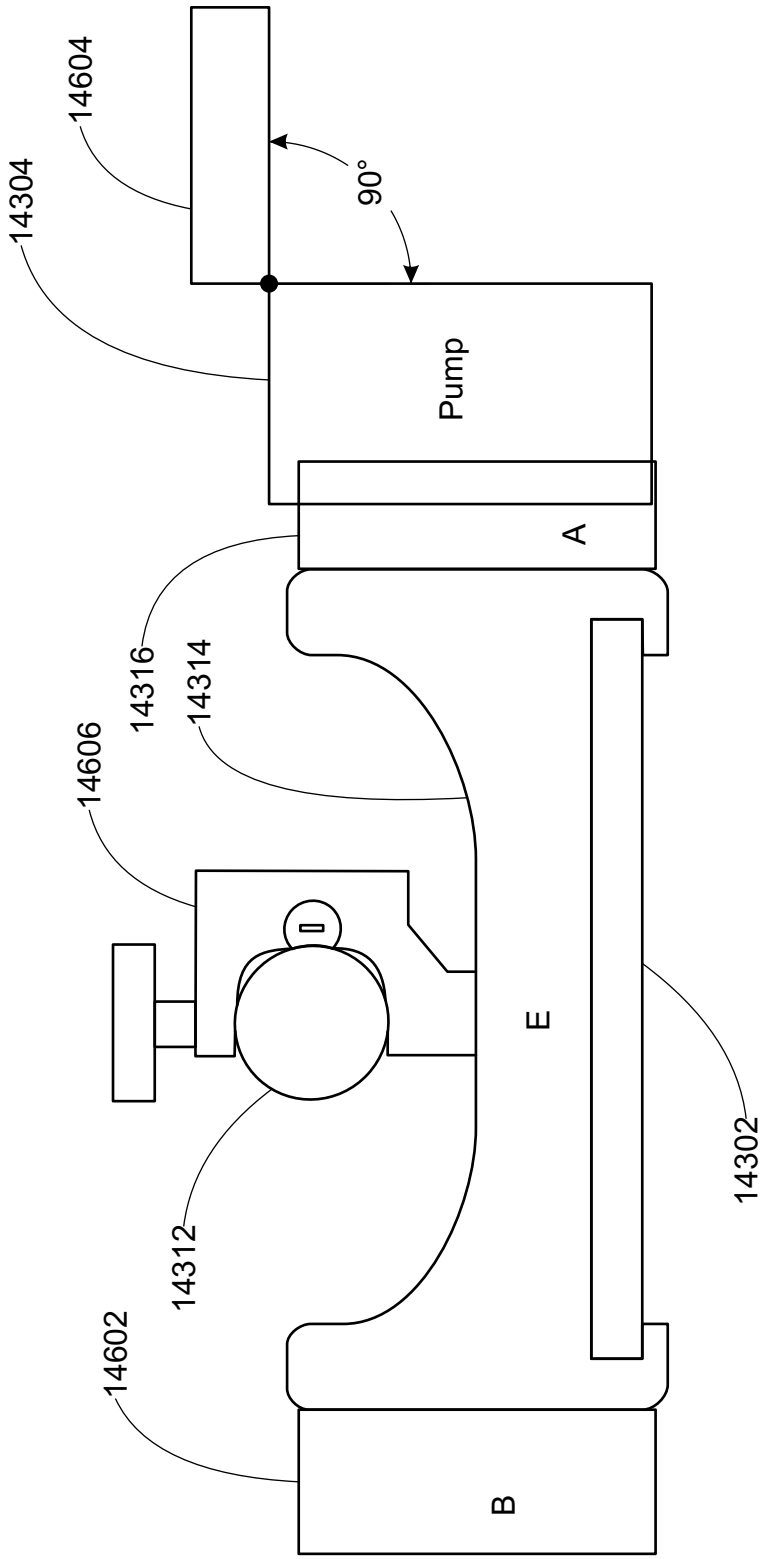

14604
90°
14304
Pump
A
14316
14314
14606
D
E
14302
14312
14602
B

FIG. 146

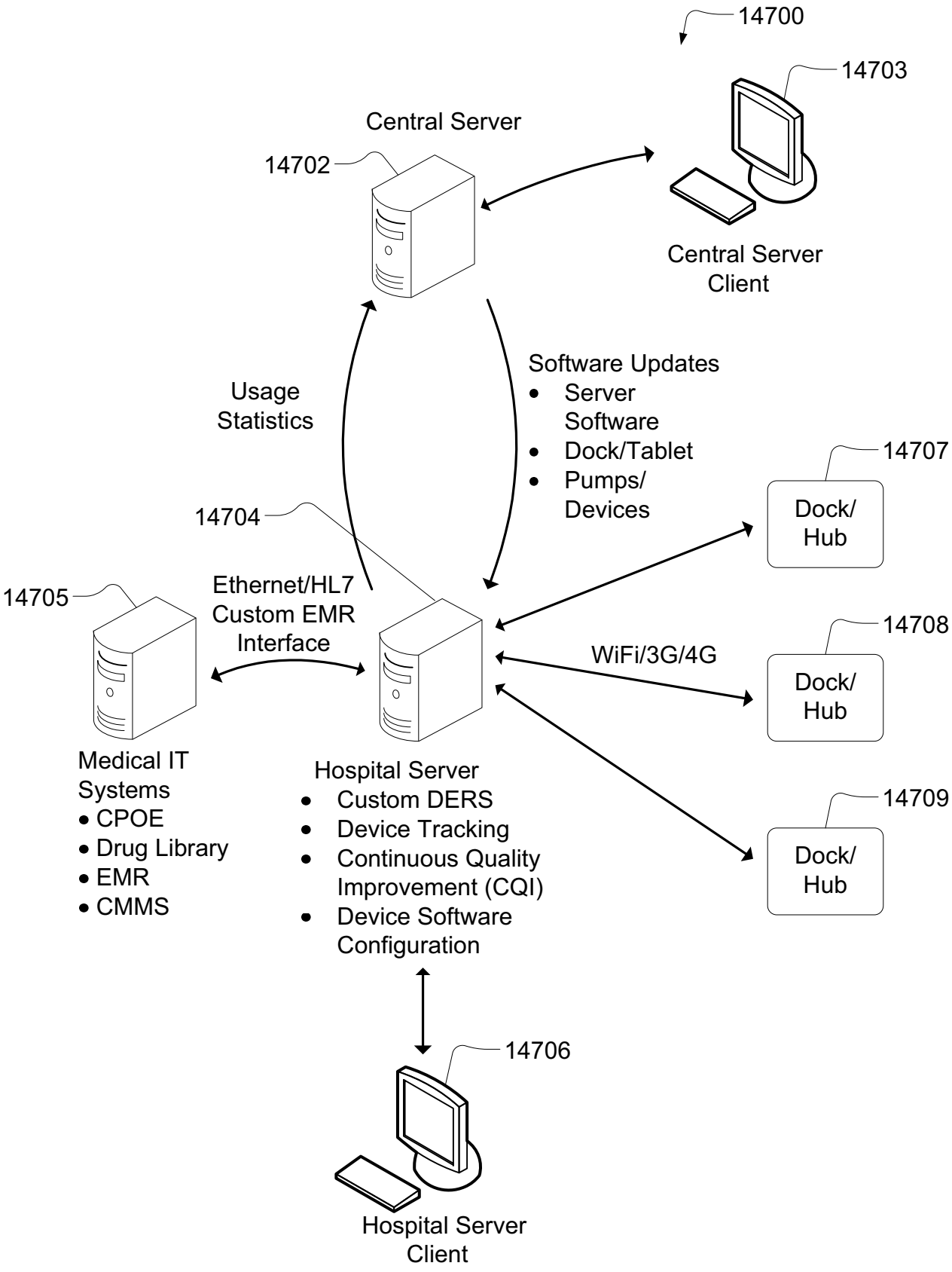

14700
14703
Central Server
14702
Central Server Client
Usage Statistics
Software Updates
• Server Software
• Dock/Tablet
• Pumps/ Devices
14707
14704
Dock/ Hub
14705
Ethernet/HL7 Custom EMR Interface
14708
WiFi/3G/4G
Dock/ Hub
Medical IT Systems
• CPOE
• Drug Library
• EMR
• CMMS
Hospital Server
• Custom DERS
• Device Tracking
• Continuous Quality Improvement (CQI)
• Device Software Configuration
14709
Dock/ Hub
14706
Hospital Server Client

FIG. 147

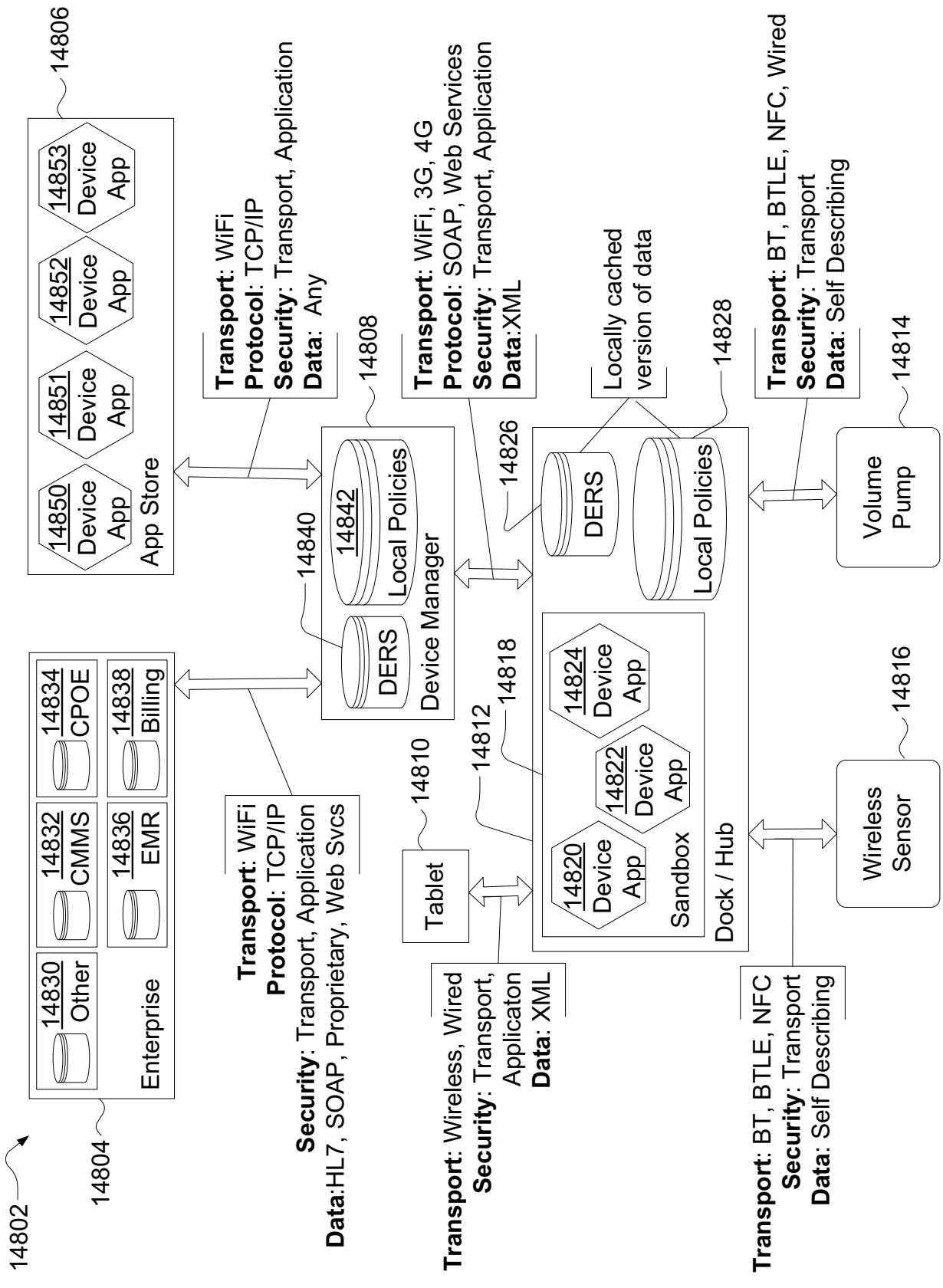

14802
14804
Enterprise
14830 Other
14832 CMMS
14834 CPOE
14836 EMR
14838 Billing
Transport: WiFi
Protocol: TCP/IP
Security: Transport, Application
Data:HL7, SOAP, Proprietary, Web Svcs
14840
DERS
14842 Local Policies
Device Manager
14808
Transport: WiFi
Protocol: TCP/IP
Security: Transport, Application
Data: Any
App Store
14806
14850 Device App
14851 Device App
14852 Device App
14853 Device App
Transport: WiFi, 3G, 4G
Protocol: SOAP, Web Services
Security: Transport, Application
Data:XML
14826
DERS
Locally cached version of data
14828
Local Policies
Transport: BT, BTLE, NFC, Wired
Security: Transport
Data: Self Describing
14814
Volume Pump
Transport: Wireless, Wired
Security: Transport, Applicaton
Data: XML
14810
Tablet
14812
14818
14820 Device App
14822 Device App
14824 Device App
Sandbox
Dock / Hub
Transport: BT, BTLE, NFC
Security: Transport
Data: Self Describing
14816
Wireless Sensor

FIG. 148

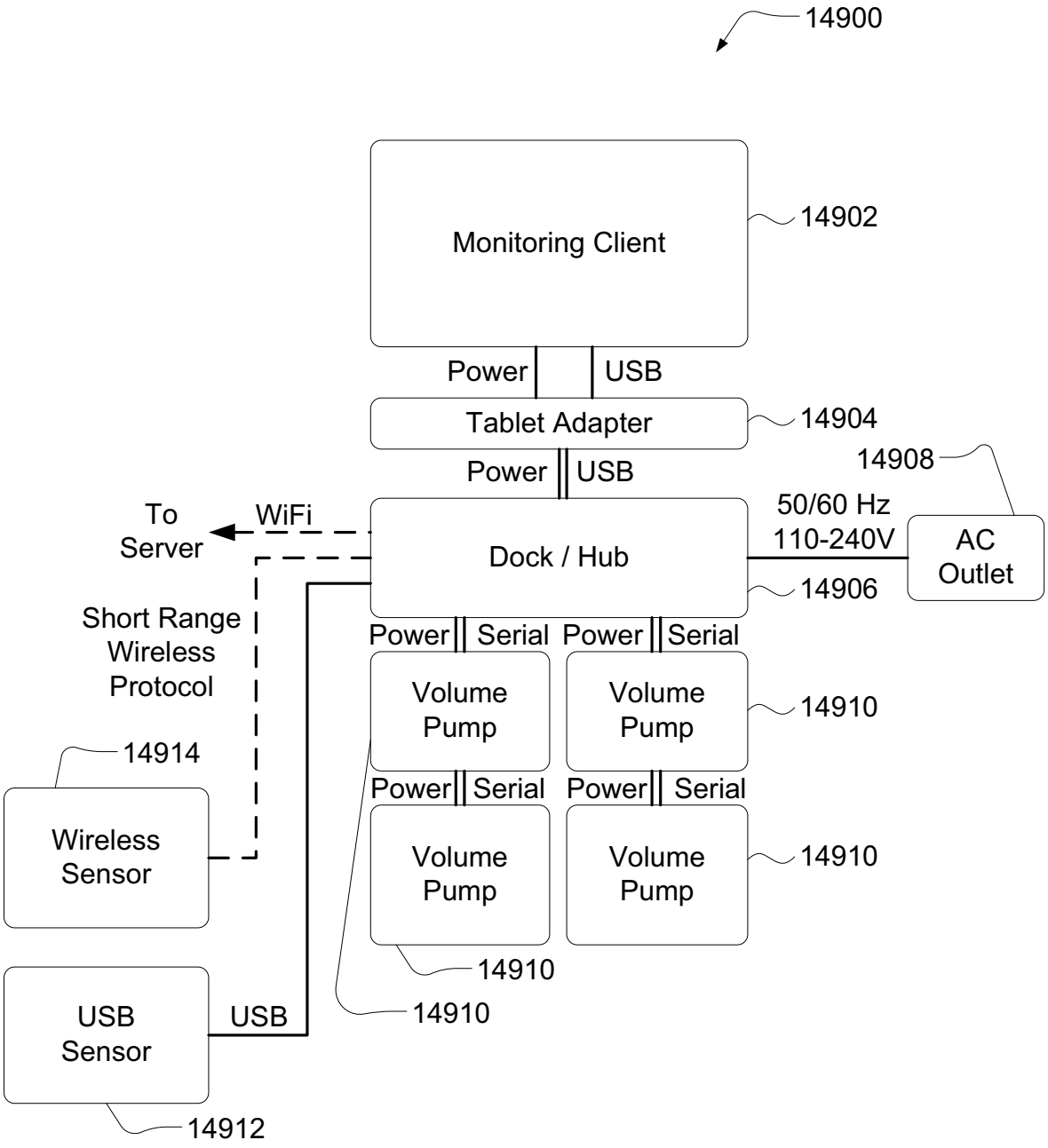

14900
Monitoring Client
14902
Power
USB
Tablet Adapter
14904
14908
Power
USB
To
Server
WiFi
Dock / Hub
50/60 Hz
110-240V
AC
Outlet
14906
Short Range
Wireless
Protocol
Power
Serial
Power
Serial
Volume
Pump
Volume
Pump
14910
14914
Power
Serial
Power
Serial
Wireless
Sensor
Volume
Pump
Volume
Pump
14910
14910
USB
Sensor
USB
14910
14912

FIG. 149

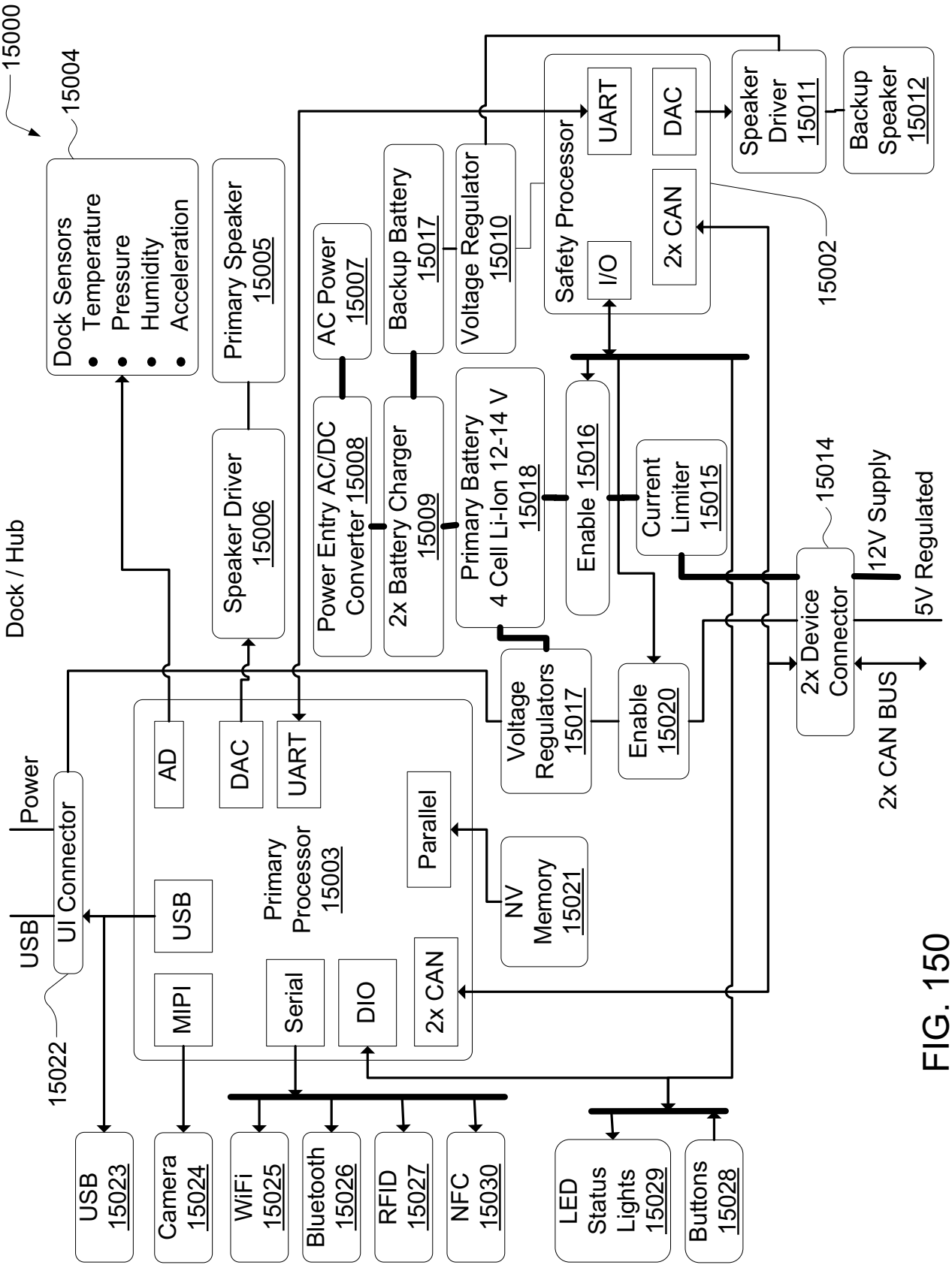

15000
15004
Dock Sensors
• Temperature
• Pressure
• Humidity
• Acceleration
Primary Speaker 15005
Speaker Driver 15006
Power Entry AC/DC Converter 15008
AC Power 15007
2x Battery Charger 15009
Backup Battery 15017
Primary Battery 4 Cell Li-Ion 12-14 V 15018
Voltage Regulator 15010
Safety Processor
UART
DAC
I/O
2x CAN
15002
Speaker Driver 15011
Backup Speaker 15012
Dock / Hub
Power
USB
UI Connector
15022
AD
DAC
UART
Primary Processor 15003
USB
MIPI
Serial
DIO
2x CAN
Parallel
NV Memory 15021
Voltage Regulators 15017
Enable 15016
Enable 15020
Current Limiter 15015
15014
2x Device Connector
12V Supply
5V Regulated
2x CAN BUS
USB 15023
Camera 15024
WiFi 15025
Bluetooth 15026
RFID 15027
NFC 15030
LED Status Lights 15029
Buttons 15028

FIG. 150

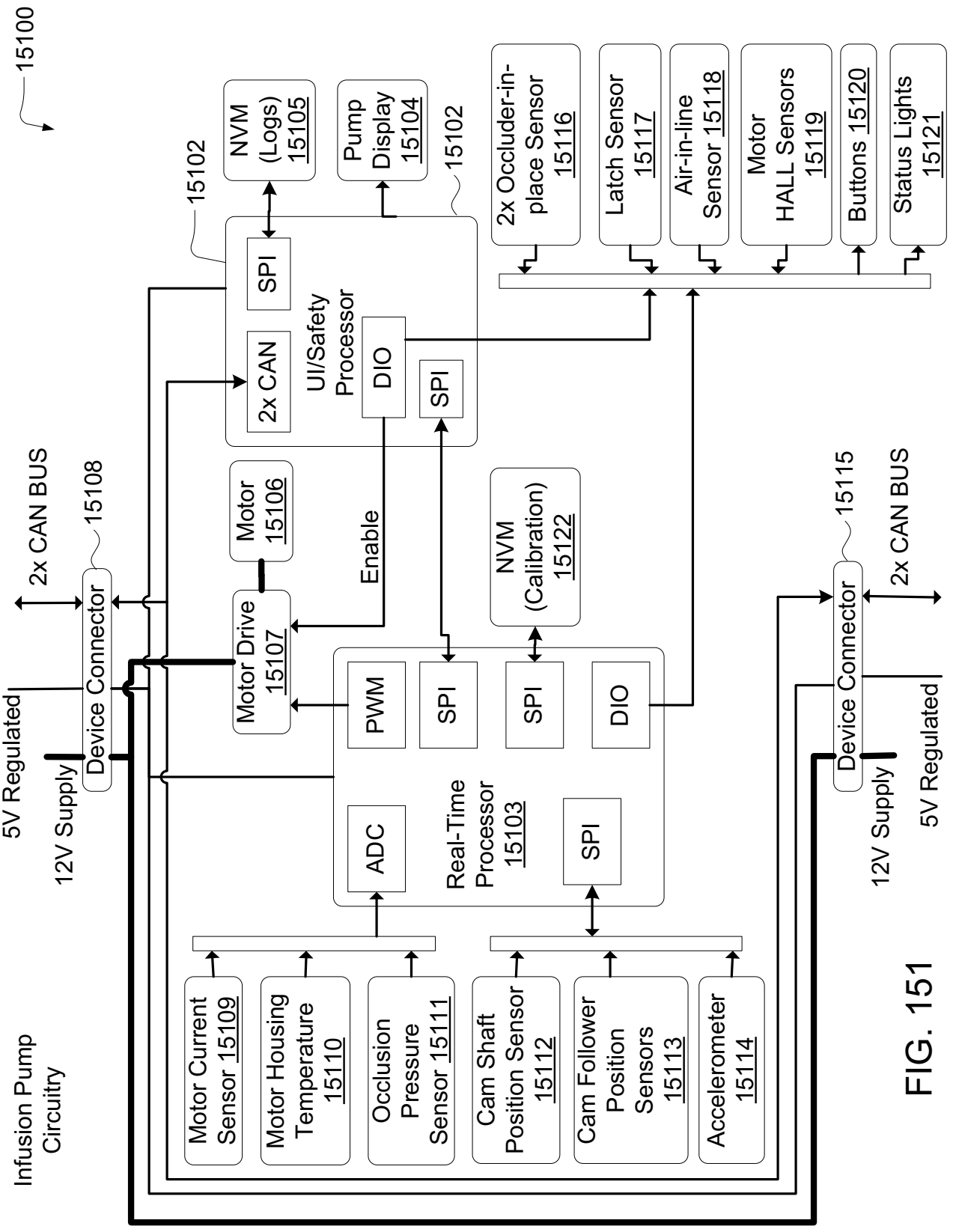

15100
Infusion Pump Circuitry
5V Regulated
12V Supply
2x CAN BUS
Device Connector
15108
Motor Current Sensor 15109
Motor Housing Temperature 15110
Occlusion Pressure Sensor 15111
Cam Shaft Position Sensor 15112
Cam Follower Position Sensors 15113
Accelerometer 15114
ADC
SPI
Real-Time Processor 15103
PWM
SPI
SPI
DIO
Motor Drive 15107
Enable
Motor 15106
NVM (Calibration) 15122
15102
2x CAN
SPI
UI/Safety Processor
DIO
SPI
15102
NVM (Logs) 15105
Pump Display 15104
2x Occluder-in-place Sensor 15116
Latch Sensor 15117
Air-in-line Sensor 15118
Motor HALL Sensors 15119
Buttons 15120
Status Lights 15121
15115
Device Connector
12V Supply
5V Regulated
2x CAN BUS

FIG. 151

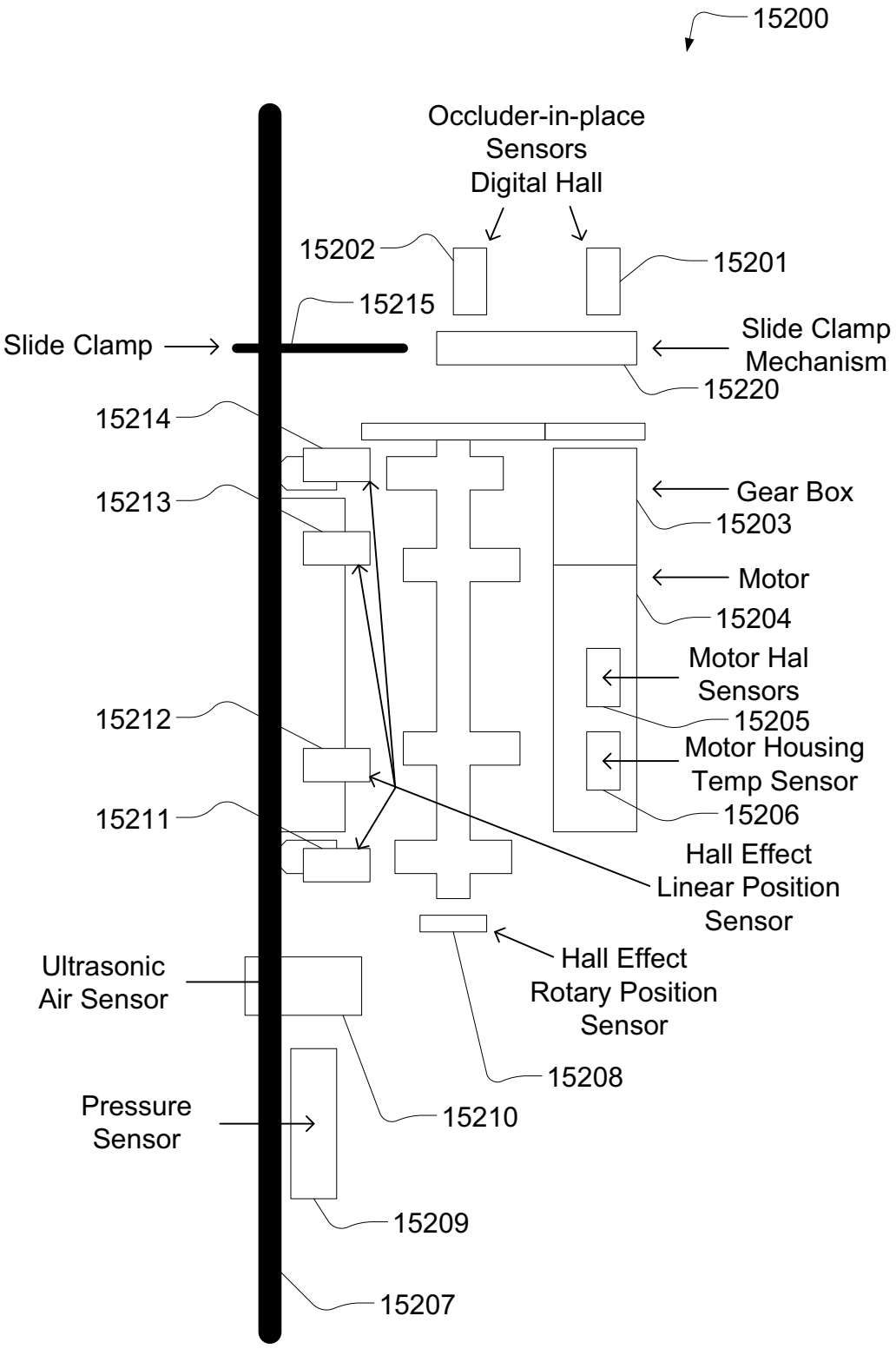

15200
Occluder-in-place Sensors Digital Hall
15202
15201
15215
Slide Clamp
Slide Clamp Mechanism
15220
15214
15213
Gear Box
15203
Motor
15204
Motor Hal Sensors
15205
15212
Motor Housing Temp Sensor
15206
15211
Hall Effect Linear Position Sensor
Hall Effect Rotary Position Sensor
Ultrasonic Air Sensor
15208
15210
Pressure Sensor
15209
15207

FIG. 152

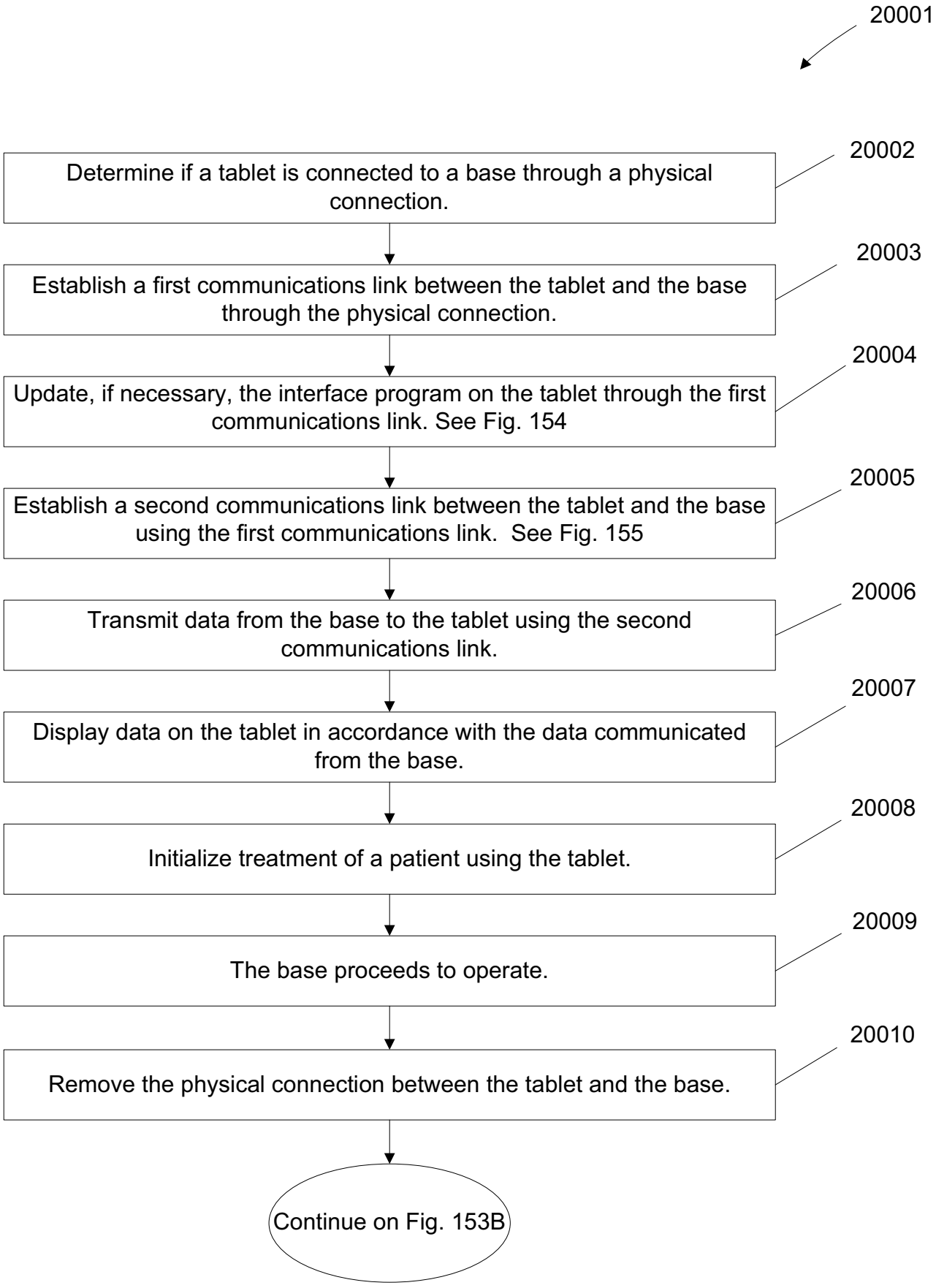

20001
Determine if a tablet is connected to a base through a physical connection.
20002
Establish a first communications link between the tablet and the base through the physical connection.
20003
Update, if necessary, the interface program on the tablet through the first communications link. See Fig. 154
20004
Establish a second communications link between the tablet and the base using the first communications link. See Fig. 155
20005
Transmit data from the base to the tablet using the second communications link.
20006
Display data on the tablet in accordance with the data communicated from the base.
20007
Initialize treatment of a patient using the tablet.
20008
The base proceeds to operate.
20009
Remove the physical connection between the tablet and the base.
20010
Continue on Fig. 153B

Fig. 153A

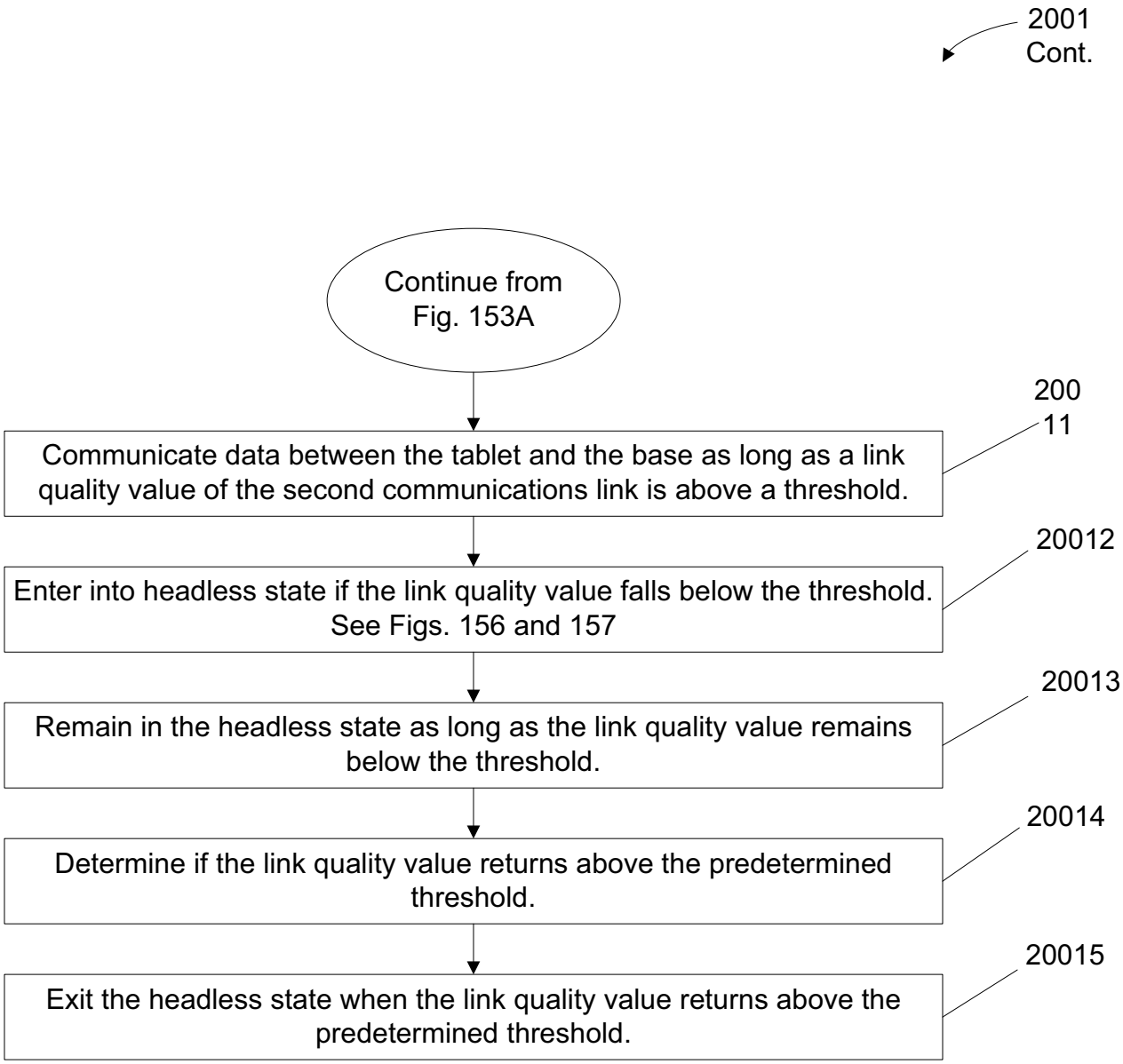

2001
Cont.
Continue from
Fig. 153A
200
11
Communicate data between the tablet and the base as long as a link quality value of the second communications link is above a threshold.
20012
Enter into headless state if the link quality value falls below the threshold.
See Figs. 156 and 157
20013
Remain in the headless state as long as the link quality value remains below the threshold.
20014
Determine if the link quality value returns above the predetermined threshold.
20015
Exit the headless state when the link quality value returns above the predetermined threshold.

Fig. 153B

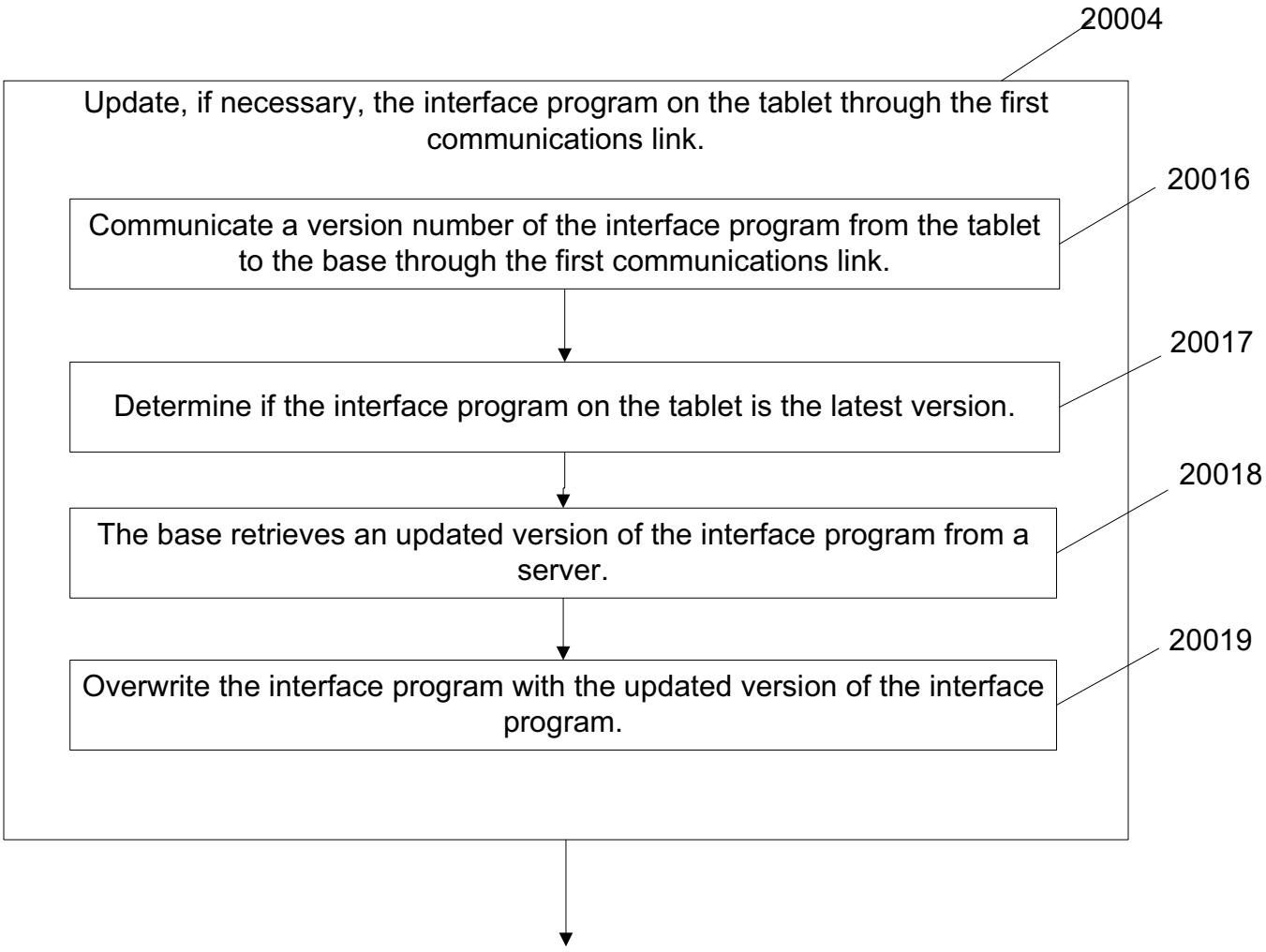

20004
Update, if necessary, the interface program on the tablet through the first communications link.
20016
Communicate a version number of the interface program from the tablet to the base through the first communications link.
20017
Determine if the interface program on the tablet is the latest version.
20018
The base retrieves an updated version of the interface program from a server.
20019
Overwrite the interface program with the updated version of the interface program.

Fig. 154

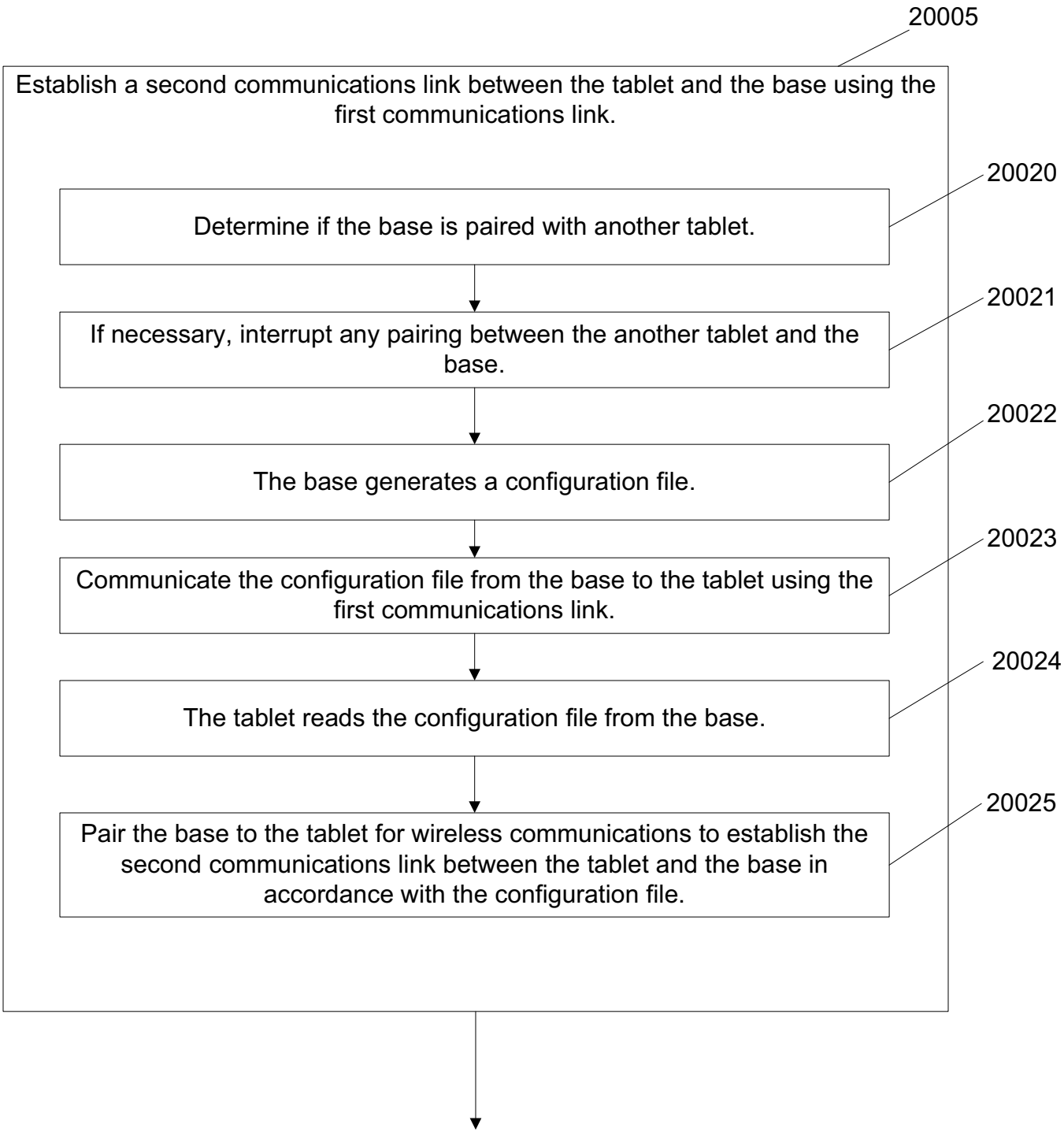

20005
Establish a second communications link between the tablet and the base using the first communications link.
20020
Determine if the base is paired with another tablet.
20021
If necessary, interrupt any pairing between the another tablet and the base.
20022
The base generates a configuration file.
20023
Communicate the configuration file from the base to the tablet using the first communications link.
20024
The tablet reads the configuration file from the base.
20025
Pair the base to the tablet for wireless communications to establish the second communications link between the tablet and the base in accordance with the configuration file.

Fig. 155

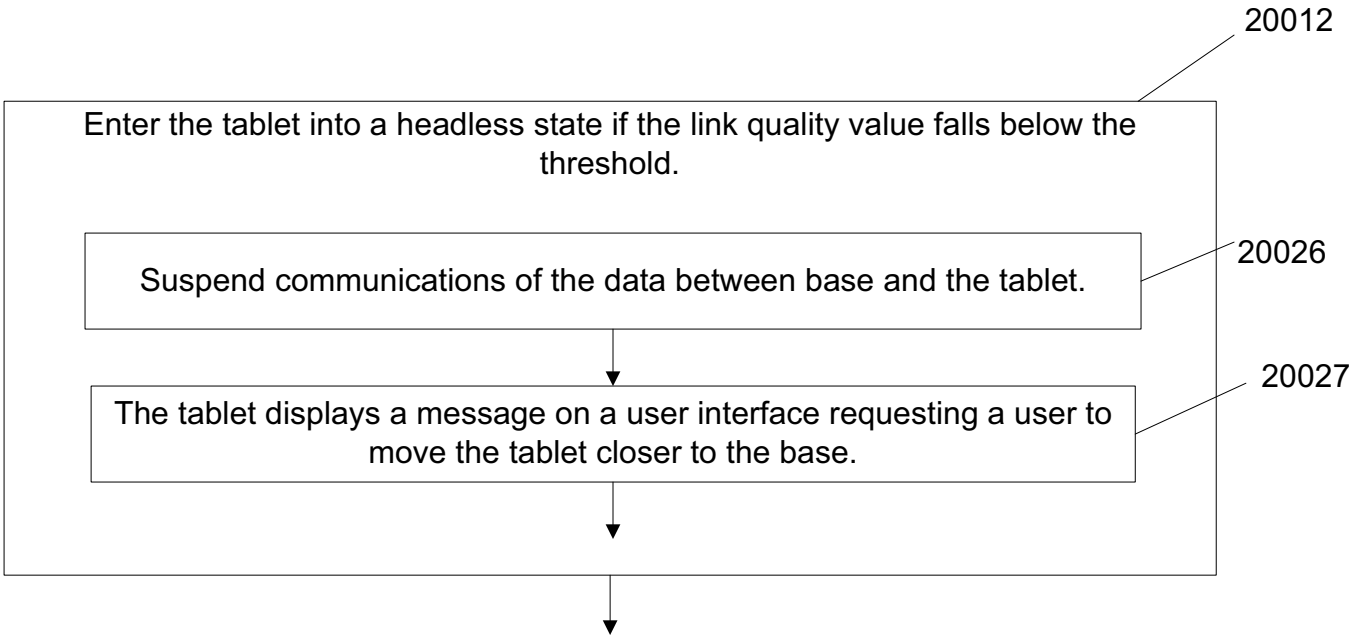

20012
Enter the tablet into a headless state if the link quality value falls below the threshold.
Suspend communications of the data between base and the tablet.
20026
The tablet displays a message on a user interface requesting a user to move the tablet closer to the base.
20027

Fig. 156

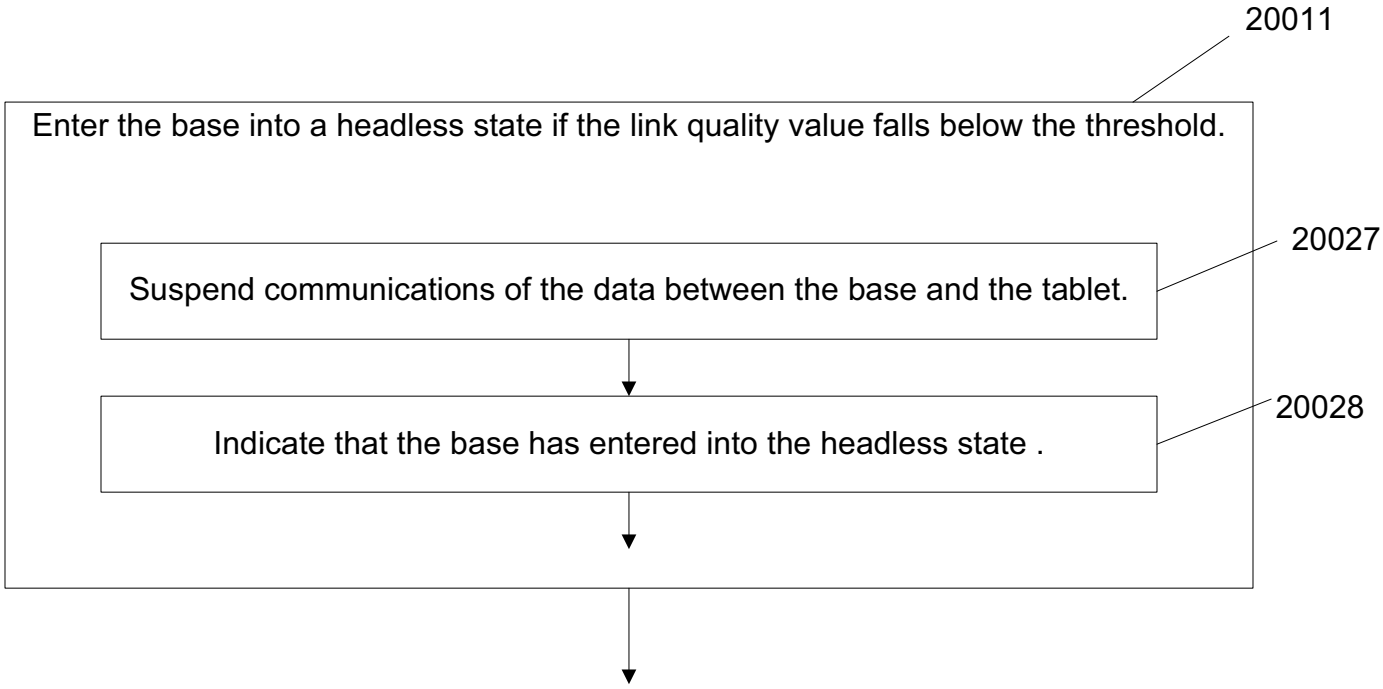

20011
Enter the base into a headless state if the link quality value falls below the threshold.
20027
Suspend communications of the data between the base and the tablet.
20028
Indicate that the base has entered into the headless state .

Fig. 157

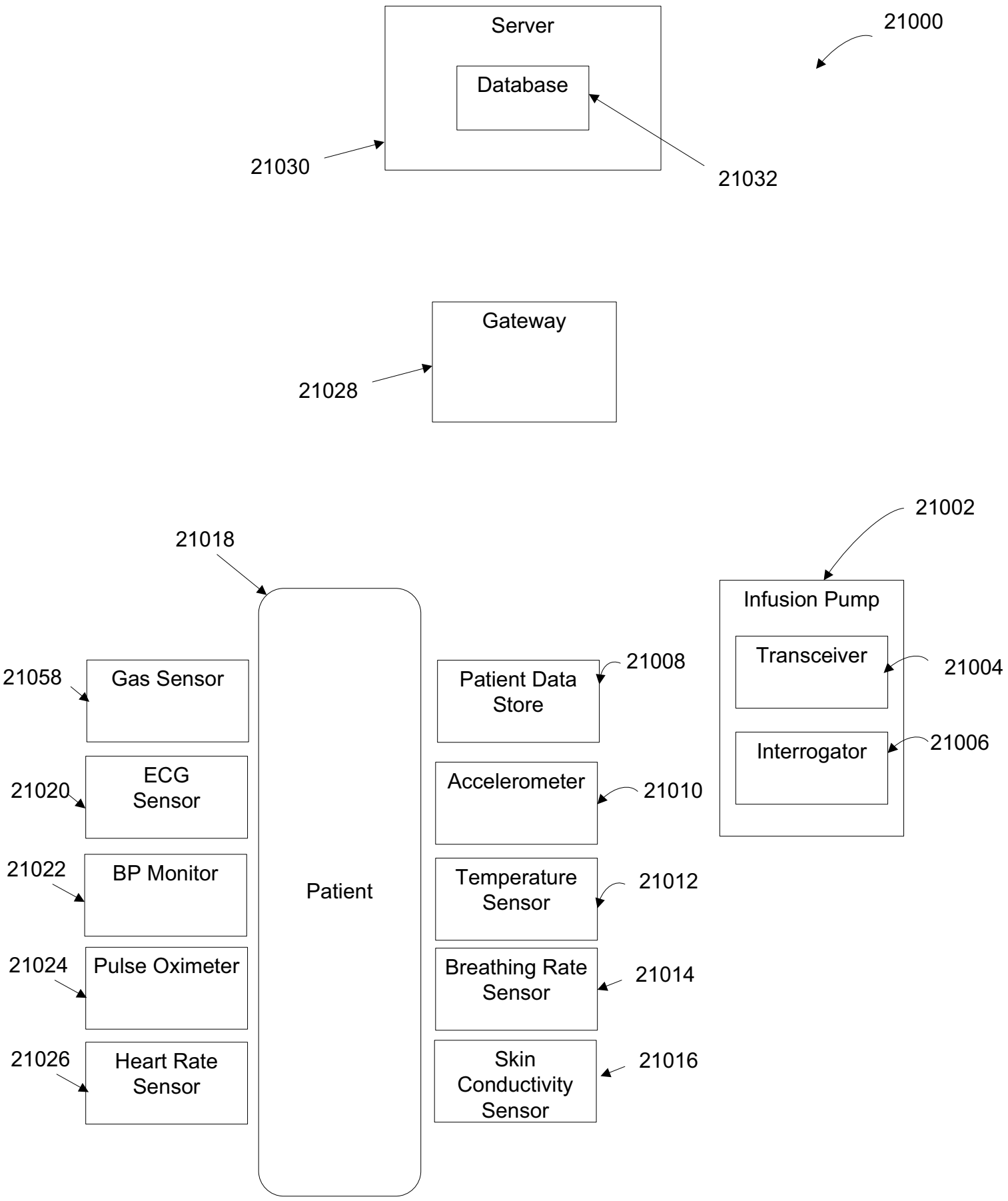

Server
Database
21000
21030
21032
Gateway
21028
21002
21018
Infusion Pump
Transceiver
21004
Interrogator
21006
21058
Gas Sensor
21008
Patient Data Store
21020
ECG Sensor
Accelerometer
21010
21022
BP Monitor
Patient
Temperature Sensor
21012
21024
Pulse Oximeter
Breathing Rate Sensor
21014
21026
Heart Rate Sensor
Skin Conductivity Sensor
21016

Fig. 158

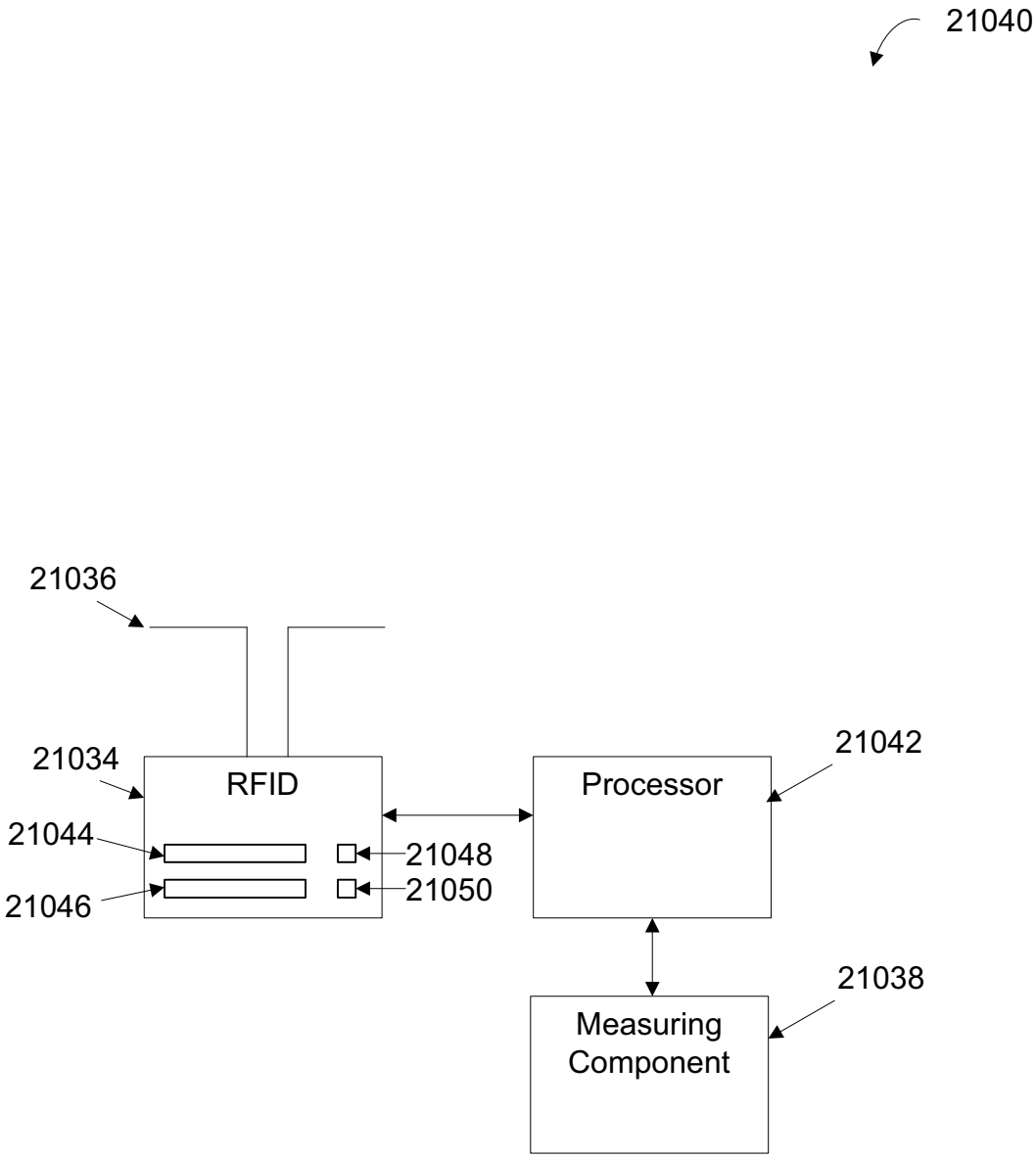

21040
21036
21034
RFID
21042
Processor
21044
21048
21046
21050
21038
Measuring
Component

Fig. 159

Physiological variable	Sensor	Example medical condition
Heart activity	Electrocardiogram (EKG)	Heart attack
Body Temperature	Thermometer	Fever
Regional temperature	Thermometer	Diabetes
Blood-O_2 saturation	Pulse oximetry	Heart attack
Pulse	Plethysmograph	Heart attack
Blood pressure	Sphygmomanometer	Hypertension
Heart rate	Heart rate monitor	Heart attack
Blood glucose	Blood glucose meter	Diabetes
Respiration rate	Costal expansion meter	Chronic obstructive pulmonary disease
Galvanic skin response	Ohmeter	Stress
Skin surface temperature	Thermometer	Fever
Ventricular pressure	Pressure transducer	Aortic stenosis
Muscle activity	Electromyography (EMG)	Seizure
Brain activity	Electroencephalogram (EEG)	Seizure
Body position	Accelerometer	Pressure ulcers
Heart image	Echocardiogram, cardiac computerized tomography, magnetic resonance imaging	Heart attack
Artery diameter	Angiogram	Atherosclerosis
Blood chemistry	Serum assay	
Creatine kinase		Heart attack
Lactate dehydrogenase		Heart attack
Cortisol levels		Stress
Troponin		Heart attack
Aspartate aminotransferase		Liver disease
myoglobin		Muscle damage
Ischemia modified albumin		Ischemia
Brain natriuretic peptide		Heart failure
Glycogen phosphorylase isoenzyme		Acute coronary syndrome
Acid-base balance	pH meter	Gastroesophageal reflux
Functional lung volume	Spirometer	Asthma

Fig. 160

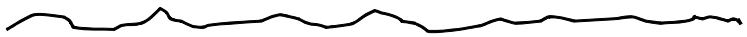
Sensor	Representative graph	Pattern
EKG		Increased heart rate
Serum assay		No troponin level change
Thermometer		No temperature change
Pulse oximetry		No blood – O_2 saturation change

Fig. 161

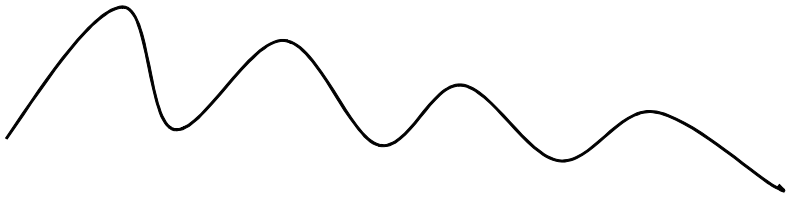
Sensor	Representative graph	Pattern
EKG		Increased heart rate
Serum assay		Increased troponin levels
Thermometer		No temperature change
Pulse oximetry		Decreased blood – O_2 saturation

Fig. 162

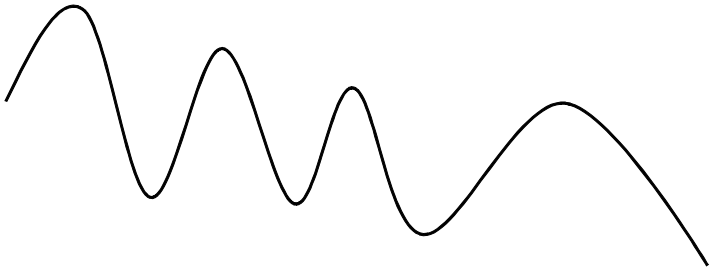
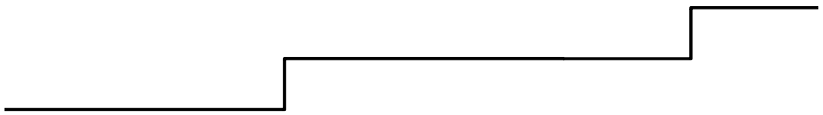
Signal	Representative graph	Pattern
EKG		Decreased heart rate
Sphygmomanometer		Decreased blood pressure
Thermometer		No temperature change
Pump infusion rate		Increased *propofol* levels

Fig. 163

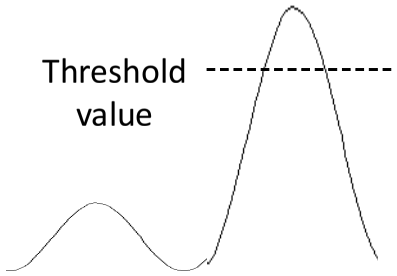
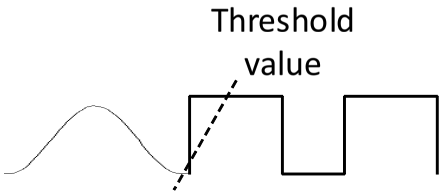
Change in Variable	Representative graph	Pattern detection response
Resting value		None
Magnitude doubles		Increased signal
Duration doubles		Increased signal
Value exceeds a threshold		Alarm triggered
Slope exceeds a threshold		Increased signal

Fig. 164

Heart rate	Blood pressure	Response
normal	normal	no alert
low increase	normal	no alert
medium increase	normal	alert
low increase	low increase	alert

Fig. 165

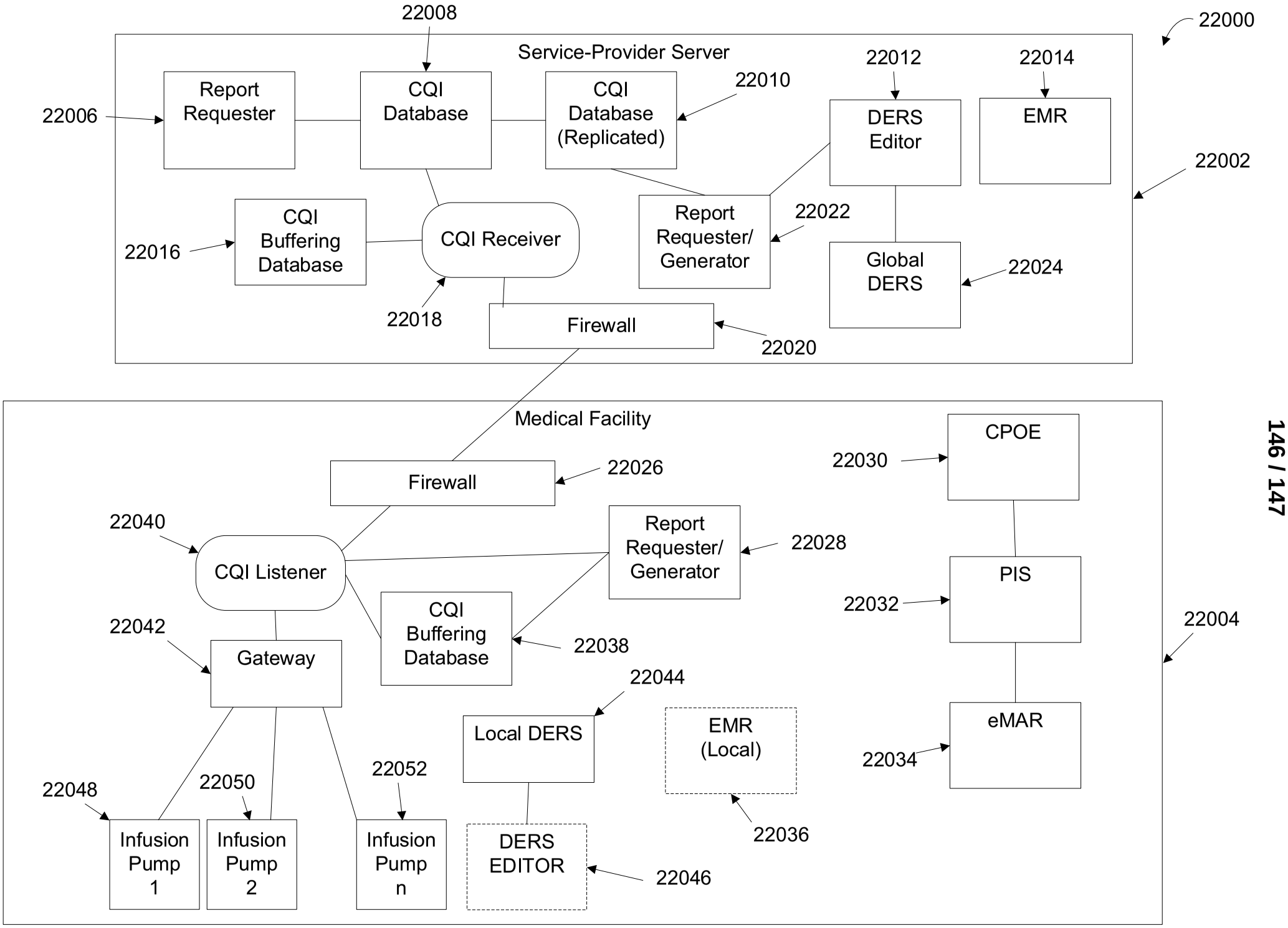

22000
22008
Service-Provider Server
22012
22014
22010
22006
Report Requester
CQI Database
CQI Database (Replicated)
DERS Editor
EMR
22002
CQI Buffering Database
CQI Receiver
Report Requester/ Generator
22022
22016
Global DERS
22024
22018
Firewall
22020
Medical Facility
CPOE
22030
Firewall
22026
22040
Report Requester/ Generator
22028
CQI Listener
PIS
22032
CQI Buffering Database
22038
22042
22004
Gateway
22044
Local DERS
EMR (Local)
eMAR
22034
22052
22048
22050
Infusion Pump 1
Infusion Pump 2
Infusion Pump n
DERS EDITOR
22046
22036

Fig. 166

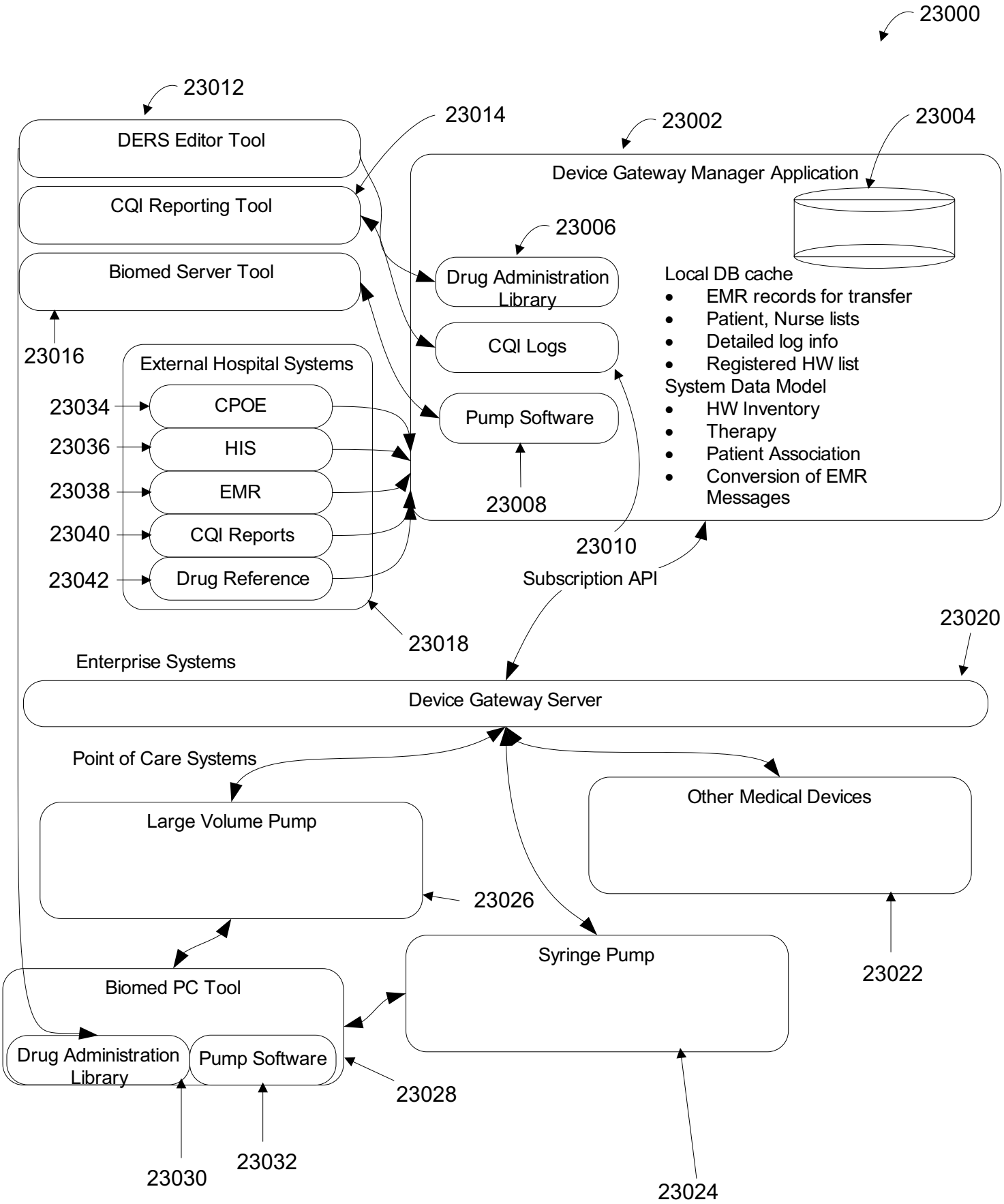

23000
23012
DERS Editor Tool
23014
23002
23004
Device Gateway Manager Application
CQI Reporting Tool
23006
Biomed Server Tool
Drug Administration Library
Local DB cache
EMR records for transfer
Patient, Nurse lists
Detailed log info
Registered HW list
System Data Model
HW Inventory
Therapy
Patient Association
Conversion of EMR Messages
23016
External Hospital Systems
CQI Logs
23034
CPOE
Pump Software
23036
HIS
23038
EMR
23008
23040
CQI Reports
23010
23042
Drug Reference
Subscription API
23018
23020
Enterprise Systems
Device Gateway Server
Point of Care Systems
Other Medical Devices
Large Volume Pump
23026
Syringe Pump
23022
Biomed PC Tool
Drug Administration Library
Pump Software
23028
23030
23032
23024

Fig. 167