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(54) **Method and apparatus for preventing excessive power consumption of an implantable device**

Verfahren und Vorrichtung zur Verhinderung von übermäßigem Stromverbrauch einer implantierbaren Vorrichtung

Procédé et appareil pour empêcher la consommation excessif d'électricité d'un dispositif implantable

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Description

5 [0001] Embodiments of the present invention pertain generally to implantable medical devices, such as cardiac pace-
makers and implantable cardioverter defibrillators, and more particularly pertain to methods and apparatus that prevent
excessive electrical power drain while exchanging information with devices outside the body.

[0002] In the United States, it is estimated that approximately five million people have congestive heart failure ("CHF").
CHF is a life threatening condition that is managed by treating patients with drugs or implantable medical devices such
as pacemakers and implantable cardioverter defibrillators ("ICD"). The information obtained through monitoring can be
used to diagnose and treat a patient's condition.

10 [0003] Current ICDs and pacemakers have the ability to non-invasively communicate a patient's physical data and
programmable parameters with a device such as an external programmer. The programmer is used to interrogate or
program the ICD or pacemaker using a wireless, radio frequency telemetry link. Typically, a physician or medical pro-
fessional utilizes the programmer, while the patient is in the medical office, to access data stored by the ICD or pacemaker,
check and adjust on programmed parameters and the like. The programmer can also be used to instruct the ICD or
pacemaker to execute desired functions, such as monitoring, stimulating, and storing diagnostic or other data. Conven-
tional programmers in the marketplace allow numerous different parameters to be programmed. The ability to exchange
data via a wireless link also permits the health care provider to reprogram or reconfigure the implantable device as
required from time to time due to changes in the patient's condition. Recently, implantable devices have been proposed
that allow a patient to operate certain types of home-based programmers to interrogate the implantable device in the
privacy of the patient's own home. Heretofore, patients have been able to use the home-based programmers at any
time to interrogate the implantable device.

[0004] However, home-based programmers present the opportunity for undue interrogation of the implantable device,
and thus excessive drain on a battery of the implantable device. A power supply, typically a specialized battery, is housed
within the implantable device to provide the electrical energy required for operation over an extended length of time.

25 One difficulty is the efficient use of electrical energy. The lifetime of the battery depends on the power demands of the
implantable device. For instance, implantable devices that require high speed and long range telemetry require greater
battery power. ICDs also require a battery to operate at low current drains for long periods of time and simultaneously
provide high current pulses. For example, the normal lifetime of a battery may be five years. To provide the longest
battery life, it is desirable to reduce the power consumption required for the various functions of the implantable device.

30 Because replacing a battery requires surgery, it is preferable that the battery last as long as possible.

[0005] Most implantable devices are configured to support interrogation by medically trained professionals in a medical
office. Most implantable devices do not have the capability of allowing the patient to perform the interrogation at home,
and therefore, there is not as great a concern with the drainage of battery power. However, as implantable devices are
manufactured to include the feature of allowing a patient to interrogate the implantable device, additional power concerns
emerge. Specifically, if a patient does not judiciously interrogate the device, for example if the patient checks the im-
plantable device every few minutes, a heavy power drain on the battery will result. This, in turn, will affect the ability of
the implantable device to communicate required patient data as well as affect the operation of the implantable device.
Depletion of battery power will potentially lead to early failure of the implantable device and require the battery to be
replaced more frequently.

40 [0006] US2003/0028184A1 teaches a system and method for controlling interrogation of an implantable device utilizing
an external device. The system comprises modules for receiving a request for interrogation and a module for recording
a history of previous interrogations used to determine the difference of internal clock drifts between the implanted and
the external devices.

[0007] A need remains for an improved implantable device including electrical circuitry and programmable features
to limit the number of interrogations performed by a patient in a home environment in order to extend battery life.

45 According to the aspect of the invention, there is provided a method for controlling interrogation of an implantable device
utilizing an external device, characterised by receiving a current request for information to be retrieved from an implantable
device; determining a temporal history of previous interrogations of the implantable device; allowing the interrogation
process to proceed based on a comparison of the temporal history of previous interrogations with the current request
for information; and transmitting information from the implantable device to the external device.

50 Preferably, the transmitting information includes reading the information from a memory location within the implantable
device. Preferably, determining a temporal history of previous interrogations is performed by the external device and/or
by the implantable device. The information may include at least one of physiological information, programmable infor-
mation, timing information, and a battery condition.

55 The method may include the step of preventing transmission of the information when a battery power level is less than
a threshold battery value. Preferably, the implantable device constitutes at least one of a pacemaker, an implantable
cardioverter defibrillator, and a defibrillator.

The invention also extends to a system for controlling interrogation of an implantable device utilizing an external device,

characterised by a module adapted to receive a current request for information to be retrieved from the implantable device a monitoring module adapted to record a temporal history of previous interrogations of the implantable device and to decide whether to allow the interrogation process to proceed based on a comparison of the temporal history of previous interrogations with the current request for information; and a telemetry unit to establish a wireless communication link with the external device.

Preferably, the information requested includes at least one of physiological information, programmable information, timing information, and a battery condition. The information may constitute physiological information that includes at least one of a heart rate, an electrical activation pattern of the heart, a strength of contraction of heart muscle, an amount of fluid in the lungs, a tachycardia rate, a bradycardia rate, a fibrillation rate, and an arrhythmia rate. The information may constitute battery condition that includes at least one of a low power battery status, a battery internal resistance, a number of charge/discharge cycles, battery age, a battery voltage and a remaining battery charge.

Preferably, the monitoring module is adapted to prevent the interrogation process from proceeding when a period of time elapsed since a last request for the information is shorter than a threshold period of time or when a battery power level is below a threshold battery value. Preferably, the monitoring module dynamically updates a threshold period of time to a new value based on a power level of a battery within the implantable device.

[0008] In accordance with one embodiment of the present invention therefore, a method is provided for controlling interrogation of an implantable device. The method includes accepting, at the external device, a request for information from an implantable device after verifying a threshold period of time has elapsed since the last request for information.

[0009] In accordance with another embodiment, an external device, such as a programmer, requests information from an implantable device, which includes a monitoring module, a memory module, and an input/output ("I/O") module having a telemetry unit. The monitoring module records the last request for information from the patient's external device to the memory module and verifies a threshold period of time has elapsed since the last request for information. The telemetry unit establishes a wireless communication link with the external device and transmits the requested information stored within the memory module based on the amount of time elapsed since the last request for information.

[0010] In the drawings, which are not necessarily drawn to scale, like numerals describe substantially similar components throughout the several views. Like numerals having different letter suffixes represent different instances of substantially similar components. The drawings illustrate generally, by way of example, but not by way of limitation, various embodiments discussed in the present document.

[0011] Figure 1 illustrates an implantable device formed in accordance with one embodiment of the present invention that remotely communicates with an external programmer.

[0012] Figure 2 illustrates a block diagram of an implantable device in communication with an external programmer utilized in accordance with an embodiment of the present invention.

[0013] Figure 3 illustrates a block diagram of an external device in communication with an implantable device, as shown in Figure 2, utilized in accordance with an embodiment of the present invention.

[0014] Figure 4 illustrates a flow chart for a process to control interrogation of an implantable device based on the time lapse since the last interrogation stored in the patient's external device in accordance with an embodiment of the present invention.

[0015] Figure 5 illustrates a flow chart for a process to control interrogation of an implantable device based on the time lapse since the last interrogation stored in the implantable device in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION

[0016] In the following detailed description, it is to be understood that the various embodiments of the invention may be combined, or that other embodiments may be utilized and that structural, logical and electrical changes may be made without departing from the scope of the present invention. For example, embodiments may be used with a pacemaker, a cardioverter, a defibrillator, and the like.

[0017] Figure 1 illustrates a programmable cardiac system 10 that includes an implantable device 12 in communication with a clinician's external device 14 and a patient's external device 15 via a communication link 16 that is controlled in accordance with an embodiment of the present invention. The implantable device 12 includes a connector 20 that is joined to a plurality of leads 22. Physiological information is detected over the leads 22 that are located with or near a heart 24 at either an atrium, a ventricle or both. The physiological information is provided through leads 22 via connector 20 to the implantable device 12. The implantable device 12 monitors the heart 24 of a patient and detects when the patient is having a post-myocardial infarct, a "silent" myocardial infarct, a myocardial infarct, an ischemia, a heart block, an arrhythmia, a fibrillation, or a congestive heart failure.

[0018] Additionally, the implantable device 12 provides an electrical stimulation through the leads 22 based on the physiological information detected. For example, stimulation may be provided when the intrinsic heartbeat is insufficient, when depolarization is not being conducted through the heart 24, when the heart rate is too slow to maintain adequate

blood from to the body and the like. In addition, implantable device 12 detects electrical characteristics of heart 24 subject to a preventative pacing scheme such as bi-ventricular, right ventricular, left ventricular, left atrial, right atrial, and bi-atrial pacing. By monitoring the excitability of cardiac tissue and its response to different pacing schemes, the implantable device 12 is able to provide a physician with information as to the patient's physiological condition, e.g., whether it has improved or is progressing towards cardiac failure.

5 [0019] A physician can utilize the external device 14 to access information stored within the implanted device 12. The external device 14 may be implemented as a programmer in accordance with an embodiment of the present invention. Information is accessed from the implantable device 12 after the communication link 16 is established between the implantable device 12 and the external device 14.

10 [0020] The external device 14 permits a physician to examine the operation of the implantable device 12. During an office visit, the physician has the ability to review physiological data and programmed parameters of the implantable device 12, as well as to adjust these parameters through the external device 14 depending on the physiological condition of the patient. Some parameters that a physician may be interested in programming include fibrillation detection rate, tachycardia detection rate, ventricular fibrillation detection rate, ventricular tachycardia detection rate, and the like. Setting a defibrillation detection rate too low may result in an unnecessary defibrillation that is both painful and potentially damaging to the heart. On the other hand, setting a detection rate too high may cause the required electrical shock not to be applied in a timely manner to a fibrillating heart and the patient may die.

15 [0021] In home-based applications, the patient is limited to certain functions that he/she can access through the external device 15 while at home. Thus, the patient should be allowed to access a restricted set of information, such as the patient's overall cardiac physiological condition, whether to consult a physician or not, and the status of the implantable device, e.g., battery power condition.

20 [0022] Figure 2 illustrates a block diagram of a portion of implantable device 12. The implantable device 12 may be a cardiac pacemaker, an implantable cardioverter defibrillator ("ICD"), a defibrillator, or an ICD coupled with a pacemaker implemented in accordance with an embodiment of the present invention. The implantable device 12 includes a processor module 30, a data/control bus module 32, a sensing module 34, a monitoring module 36, a memory module 38, an Input/Output ("I/O") module 40, and a battery 42. It is understood that data/control bus module 32, sensing module 34, monitoring module 36 and I/O module 40 are conceptual blocks, not necessarily separate hardware and may be implemented in software by the processor module 30.

25 [0023] Processor module 30 typically includes a microprocessor, a microcomputer, or equivalent control circuitry for processing physiological characteristics of the heart 24. The processor module 30 may further include RAM or ROM memory, logic and timing circuitry, state machine circuitry, and I/O circuitry. Typically, the processor module 30 includes the ability to process or monitor data as controlled by a program code stored in a designated block of memory. Data/control bus module 32 represents a hardware or software interface between the various functional modules of the implantable device 12.

30 [0024] Sensing module 34 includes a signal conversion module 44. The sensing module 34 receives physiology signals from the leads 22, such as a depolarization wave as it spreads through the cardiac tissue and measures the timing, direction of propagation, and point of initiation of successive depolarization waves. The depolarization may be a result of an inherent cardiac cycle or in response to a cardiac pacing event, such as pacing the heart utilizing bi-ventricular pacing, right ventricular pacing, left ventricular pacing, left atrial pacing, right atrial pacing or bi-atrial pacing. The signal conversion module 44 typically includes an analog-to-digital ("A/D") converter (not shown) and receives raw analog signals that are voltages that result from the change in ionic concentrations of sodium and calcium through the cardiac tissue that occur during depolarization. The signal conversion module 44 converts the raw analog signals to a plurality of digital signals. The digital signals are transferred over the data/control bus module 32 and stored in the memory module 38.

35 [0025] The monitoring module 36 analyzes the digital physiology signals from the signal conversion module 44 and identifies desired physiologic characteristics. For example, the monitoring module 36 may identify arrhythmias, trends in cardiac behavior, and the like. The monitoring module 36 determines the programmed state of the implantable device 12 and determines the remaining battery power, which is stored as battery condition 48. As previously mentioned the implantable device 12 can be programmed by a physician to operate in a specific mode, e.g., detect ventricular fibrillation and deliver an associated therapy. The monitoring module 36 verifies and records that the implantable device 12 is in the correct programmed state (e.g., not a harmful state) and the amount of time within each state. If the monitoring module 36 detects a harmful state, it will report a warning to the external device 14 or to the patient's external device 15 through the I/O module 40. The monitoring module 36 also collects timing information that includes a time the data is transmitted, a date the data is transmitted, a number of total interrogations performed, and the date and time of each interrogation request. The monitoring module 36 also monitors operation of the implantable device 12 in connection with receipt and transmission of information and parameters by and from the telemetry unit 52.

40 [0026] In addition, each time a request to interrogate the implantable device 12 is made by the external device 15, the monitoring module 36 checks on the status of the battery 42 and records the battery condition 48 in the memory

module 38. As the power of the battery decreases, the monitoring module 36 extends the time period required to accept a new interrogation. If the battery power is below a threshold level, the monitoring module 36 will prevent further responses to patient's external device 15. The battery power level depends on the type and size of battery 42 utilized by the implantable device 12. Typical batteries 42 include zinc-mercury batteries, nickel-cadmium batteries, nuclear batteries, fuel cells, lithium iodine batteries and the like. The monitoring module 36 also checks on the frequency of interrogations. If a specified threshold time period has not lapsed when an interrogation is requested, the monitoring module 36 prevents the interrogation from being answered.

[0027] The memory module 38 includes blocks of memory allocated to store programmable parameters 46, a communications log 47, a battery condition 48, and physiological characteristics 50. The blocks of memory may be ROM, PROM, EPROM, EEPROM, RAM, SRAM, DRAM, DDRAM, EDO, SDRAM, Flash, MRAM, FRAM, EEPROM, EAPROM and the like. The communications log 47 records data related to past communications to and from the implantable device 12. For example, the communications log 47 may include a time at which each incoming transmission is received, a time at which each outgoing transmission was transmitted, a length of each outgoing transmission, a nature or type associated with incoming and outgoing transmissions and an identification of the implantable device 12, as well as an identification of the type of device requesting information, e.g., the physician's external device 14 or the patient's external device 15. The nature or type of the transmission and length thereof may be of interest to estimate an amount of battery power used in connection with the transmission by the implantable device 12.

[0028] The programmable parameters 46 may include a tachycardia detection rate, a fibrillation detection rate, a ventricular tachycardia rate, a ventricular fibrillation detection rate, a bradycardia rate, stability algorithm settings, onset algorithm settings, specific therapies for each cardiac zone, a duration of therapy required for each cardiac zone and the like. The battery condition 48 may include a low power battery status, a battery internal resistance, a number of charge/discharge cycles, battery age, and a remaining battery charge. The physiological characteristics 50 may include a series of digitized data signals detected by the leads 22 over time and/or a patient's heart rate, an electrical activation pattern of the heart, a strength of contraction of heart muscle, and an amount of fluid in the lungs. Furthermore, the physiological characteristics 50 may also include a possible current condition of the patient, such as a patient's tachycardia rate, a patient's bradycardia rate, a patient's fibrillation rate, and a patient's arrhythmia rate or whether the patient is suffering from a myocardial infarction, a post-myocardial infarction, a "silent" myocardial infarction, an ischemia, an arrhythmia, a heart block, a fibrillation, or a congestive heart failure. These physiological characteristics 50 may be transmitted as physiologic information by a telemetry unit 52 to the physician's external devices 14 or to the patient's external device 15.

[0029] Input/Output ("I/O") module 40 includes a telemetry unit 52. The telemetry unit 52 enables the implantable device 12 to download data to the physician's external device 14 when a patient is at the physician's office or to the patient's external device 15 when the patient is at home via a wireless link 16. The telemetry unit 52 interfaces with processor module 30 and monitoring module 36 to determine whether to perform an interrogation. A patient that does not exercise discretion when making requests for interrogation via the external device 15 can wear down the battery 42. A low battery condition may be defined as at least 10% of the maximum battery power level, or as a power level that leads to imminent battery power failure. The lifetime of the battery 42 depends on the power demands of the implantable device 12 as well as the frequency of interrogations. For instance, the implantable device 12 may require the battery 42 to operate at low current drains for long periods of time and simultaneously provide high current pulses. To provide the longest battery life, it is desirable to reduce the power consumption required for the various functions of the implantable device 12. By limiting a patient's ability to interrogate the implantable device 12, battery power is conserved.

[0030] Figure 3 illustrates a block diagram of a patient's external device 15 in accordance with an embodiment of this invention. The patient's external device 15 includes a processor module 60, an address/data/control bus module 62, a data/memory module 64, a program memory module 66, a user interface module 68, a telemetry module 70 and a battery 72. Address/data/control bus module 62, data/memory module 64, program memory module 66, user interface module 68 and telemetry module 70 represent hardware blocks that may partially or totally implemented on the same semiconductor die.

[0031] Processor module 60 typically includes a microprocessor, a microcomputer, or equivalent control circuitry for processing a request to interrogate an implantable medical device 12. The processor module 60 may further include RAM or ROM memory, logic and timing circuitry, state machine circuitry, and I/O circuitry. Typically, the processor module 60 includes the ability to process or monitor data as controlled by a program code stored in program module 66.

[0032] Address/data/control bus module 62 represents a hardware interface between the various functional modules of the patient's external device 15.

[0033] The data memory module 64 includes blocks of memory allocated to store physiological information, timing information that includes a time the data is transmitted, a date the data is transmitted, a number of total interrogations performed, and the date and time of each interrogation request, and a battery condition.

[0034] The program memory module 66 includes blocks of memory allocated to store a program code that instructs processor 60 regarding the operation of external device 15. For instance, the program code may include instructions on

how the user may interface with the external device 15, what information the user may be allowed to access , and what format messages will be provided to the user (e.g., visual, textual, auditory).

[0035] The blocks of memory may be ROM, PROM, EPROM, EEPROM, RAM, SRAM, DRAM, DDRAM, EDO, SDRAM, Flash, MRAM, FRAM, EEPROM, EAPROM and the like.

[0036] The user interface 68 accepts commands from the user and displays the requested interrogation information, and the telemetry module 70 interfaces with the implantable device 12 over a wireless link. Further, the telemetry unit 70 is commanded by processor module 60 to communicate with the implantable device 12. Patient's external device 15 also includes a battery 72.

[0037] In one embodiment of the present invention, the processor module 60 monitors each time a request is made by the user utilizing external device 15 to interrogate the implantable medical device 12. The processing module 60 checks data memory 64 for the last time the user made a request. If a specified threshold time period has not lapsed when an interrogation is requested, the processor module 60 prevents the interrogation from being performed. If the specified threshold time period has lapsed, the processor 60 performs an interrogation of implantable device 15 via telemetry module 70. The processor module 60 monitors the receipt and transmission of information and parameters by and from the telemetry unit 70 to ensure communication is successful. The processor module 60 then logs the interrogation in data memory 64. For example, the processor 60 may, for example, log a time at which each incoming transmission is received, a time at which each outgoing transmission was transmitted, a length of each outgoing transmission, a nature or type associated with incoming and outgoing transmissions and an identification of the implantable device 12. The processor 60 utilizes user interface 68 to show/display the requested information to the user.

[0038] Figure 4 illustrates a process to control the interrogation of the implantable device 12 utilizing the patient's external device 15 in accordance with at least one embodiment of the present invention. At 100, the patient utilizes the external device 15 to make a request to interrogate the implantable medical device 12. At 102, the external device 15 compares the time elapsed from the last request for interrogation with a value for the current time threshold. The time threshold is the amount of time that must elapse before an interrogation is permitted. If the time elapsed from the last interrogation is less than the required time threshold, external device 15 denies the request and no interrogation to implantable device 12 is initiated. The patient must wait until the time threshold has elapsed before making another request for interrogation.

[0039] The time threshold is dynamically modified by the device that keeps record of the time elapsed since last interrogation (e.g., either patient's external device 15 or implantable device 12) based on the battery power level reported by implantable device 12. Table 1 shows an embodiment of how the time threshold can be modified based on implantable device 12's battery power level.

Table 1.

BATTERY POWER STATUS	TIME THRESHOLD
FULL	Thr1
MID	Thr2 > Thr1
LOW	Thr3 > Thr2
CRITICAL	Thr4 > Thr3

For instance, when the battery power level is "full" (e.g. battery is fully charged) the time threshold is initially at a value of Thr1. In one embodiment, Thr1 may allow the patient to perform an interrogation utilizing the patient's external device 15 once per hour. In another embodiment, Thr1 may allow the patient to perform an interrogation once per day. As the battery power decreases to a "mid" level (e.g. 50% power charge), processor module 30 will assign a new time threshold value, Thr2, where Thr2 will have a greater value than Thr1. Thus, Thr2 will restrict the frequency of interrogation in comparison to Thr1. In one embodiment, Thr2 may allow the patient to perform an interrogation utilizing the patient's external device 15 up to once a week. In another embodiment, Thr2 may allow an interrogation to be performed once a month. As the battery power level decreases to a "low" level (e.g. less than 50%), processor module 30 will assign Thr3 as the time threshold value. The value of Thr3 will be greater than Thr2. In one embodiment, Thr3 may allow a patient to interrogate the implantable medical device 12 once every three months. In an alternative embodiment, Thr3 may allow a patient to perform an interrogation once every six months. As the battery power level drops to a "critical" level (e.g. less than 10%), process module 30 will assign Thr4 as the time threshold value. At the "critical" level, the maximum time period allowable is assigned to a time threshold value. In one embodiment, Thr4 will not allow the patient to perform any interrogations of implantable device 12. There can be a plurality of time thresholds. For example, in one embodiment, a time threshold can be assigned for every 10% drop in battery power (e.g., 100% corresponds to Thr1, 90% corresponds to Thr2, 80% corresponds to Thr3, 70% corresponds to Thr4, etc., and at the "critical" level 10%

corresponds to Thr10).

[0040] If the time elapsed from last interrogation is longer than the required time threshold per 102, then at 104, patient's external device 15 sends a request for interrogation via a wireless connection to implantable device 12. Telemetry unit 52 receives the request for interrogation, and transfers the request via data bus 32 to monitoring module 36. The Process module 30 then retrieves the required information from the memory module 38 and has the I/O module 40 transfer the requested information to the patient's external device 15.

[0041] At 106, I/O module 40 monitors the process of interrogation and the status of the wireless connection. If the wireless connection fails or the communication between the external device 15 and the implantable medical device 12 fails for any reason during the interrogation process, monitoring module 36 will end the process. No log will be kept of the interrogation, and the patient must request another interrogation.

[0042] At 106, if the interrogation proceeds successfully, then at 108 a log of the interrogation (e.g. time and date of interrogation) will be made and stored on patient's external device 15.

[0043] Figure 5 illustrates a processing sequence where the time logs of an interrogation are stored in the implantable device 12 in accordance with an embodiment of this invention. Beginning at 200, the patient controls external device 15 and starts a request to interrogate the implantable device 12. For example, in one embodiment, the patient may push a button on external device 15 to request an interrogation.

[0044] At 202, the patient's external device 15 initiates the interrogation by sending a request via a wireless connection to the implantable device 12. In one embodiment, external device 15 may be inductively coupled with the implantable device 12. The request is received by telemetry unit 52 and the request is transferred along data bus 32 to monitoring module 36.

[0045] At 204, processor module 30 checks if the time elapsed from the last interrogation from external device 15 is longer than the current time threshold value. If the threshold has not expired, the process will be terminated at 206 and no response will be made. However, if the threshold value has expired, the process continues. At 208, implantable device 12 responds to external device 15 by having processor 30 retrieve the requested information from memory module 38 and transmit the information via I/O module 40 to external device 15. At 210, implantable device 12 logs the time and date of the interrogation in memory module 38.

Claims

1. A method for controlling interrogation of an implantable device utilizing an external device, comprising the steps of:

receiving a current request for information to be retrieved from an implantable device;
determining a temporal history of previous interrogations of the implantable device;
transmitting information from the implantable device to the external device
and **characterised by** the step of allowing the interrogation process to proceed based on a comparison of the temporal history of previous interrogations with the current request for information

2. A method as claimed in Claim 1, **characterised in that** the transmitting information includes reading the information from a memory location within the implantable device.

3. A method as claimed in Claim 1 or Claim 2, **characterised in that** determining a temporal history of previous interrogations is performed by the external device and/or by the implantable device.

4. A method as claimed in any preceding claim, **characterised in that** the information includes at least one of physiological information, programmable information, timing information, and a battery condition.

5. A method as claimed in any preceding claim, **characterised by** the step of preventing transmission of the information when a battery power level is less than a threshold battery value.

6. A method as claimed in any preceding claim, **characterised in that** the implantable device constitutes at least one of a pacemaker, an implantable cardioverter defibrillator, and a defibrillator.

7. A system for controlling interrogation of an implantable device (12) utilizing an external device (14, 15), comprising :

a module (40) adapted to receive a current request for information to be retrieved from the implantable device;
a monitoring module (36) adapted to record a temporal history of previous interrogations of the implantable device; and

a telemetry unit (70) to establish a wireless communication link (16) with the external device,

characterized in that the monitoring module (36) is adapted to decide whether to allow the interrogation process to proceed based on a comparison of the temporal history of previous interrogations with the current request for information.

8. A system as claimed in Claim 7, **characterised in that** the information requested includes at least one of physiological information, programmable information, timing information, and a battery condition.
9. A system as claimed in Claim 8, **characterised in that** the information constitutes physiological information that includes at least one of a heart rate, an electrical activation pattern of the heart, a strength of contraction of heart muscle, an amount of fluid in the lungs, a tachycardia rate, a bradycardia rate, a fibrillation rate, and an arrhythmia rate.
10. A system as claimed in Claim 7, **characterised in that** the information constitutes battery condition that includes at least one of a low power battery status, a battery internal resistance, a number of charge/discharge cycles, battery age, a battery voltage and a remaining battery charge.
11. A system as claimed in Claim 7, **characterised in that** the monitoring module is adapted to prevent the interrogation process from proceeding when a period of time elapsed since a last request for the information is shorter than a threshold period of time or when a battery power level is below a threshold battery value.
12. A system as claimed in any of Claims 7 to 11, **characterised in that** the implantable device (12) constitutes at least one of a pacemaker, an implantable cardioverter defibrillator, and a defibrillator.
13. A system as claimed in any of Claims 7 to 12, **characterised in that** the monitoring module dynamically updates a threshold period of time to a new value based on a power level of a battery (42) within the implantable device (12).

Patentansprüche

1. Verfahren zur Steuerung einer Abfrage einer implantierbaren Einrichtung unter Benutzung einer externen Einrichtung, umfassend die Schritte:
 - Empfang einer aktuellen Informationsanforderung, welche von einer implantierbaren Einrichtung abgefragt werden soll;
 - Bestimmung einer zeitlichen Vorgeschichte von vorherigen Abfragen der implantierbaren Einrichtung;
 - Übertragen von Information von der implantierbaren Einrichtung zur externen Einrichtung, und charakterisiert durch den Schritt des Erlaubens des Fortsetzens des Abfrageprozesses basierend auf einem Vergleich der zeitlichen Vorgeschichte der vorherigen Abfragen mit der aktuellen Informationsanforderung.
2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** das Übertragen von Informationen das Lesen der Information aus einem Speicherbereich innerhalb der implantierbaren Einrichtung umfasst.
3. Verfahren nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die Bestimmung einer zeitlichen Vorgeschichte von vorherigen Abfragen durch die externe Einrichtung und/oder durch die implantierbare Einrichtung durchgeführt wird.
4. Verfahren nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** die Information zumindest eine aus physiologischer Information, programmierbarer Information, zeitlicher Information und einem Batteriezustand umfasst.
5. Verfahren nach einem der Ansprüche 1 bis 4, **gekennzeichnet durch** den Schritt des Verhinderns der Übertragung der Information wenn ein Batterieenergiefüllstand geringer ist als ein Batteriegrenzwert.
6. Verfahren nach einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet, dass** die implantierbare Einrichtung zumindest eins aus einem Herzschrittmacher, einem implantierbaren Kardioverter-Defibrillator und einem Defibrillator bildet.

7. System zur Steuerung einer Abfrage einer implantierbaren Einrichtung (12) unter Benutzung einer externen Einrichtung (14, 15), umfassend:

5 ein Modul (40), welches geeignet ist, eine aktuelle Informationsanforderung zu empfangen, welche von der implantierbaren Einrichtung abgefragt werden soll;
ein Überwachungsmodul (36), welches geeignet ist, eine zeitliche Vorgeschichte von vorherigen Abfragen der implantierbaren Einrichtung aufzunehmen; und
10 eine Telemetrieinheit (70), um eine drahtlose Kommunikationsverbindung (16) mit der externen Einrichtung aufzubauen,

dadurch gekennzeichnet,

dass das Überwachungsmodul (36) geeignet ist, zu entscheiden, das Fortsetzen des Abfrageprozesses basierend auf einem Vergleich der zeitlichen Vorgeschichte der vorherigen Abfragen mit der aktuellen Informationsanforderung zu erlauben.

- 15 **8.** System nach Anspruch 7, **dadurch gekennzeichnet, dass** die angeforderte Information zumindest eine aus physiologischer Information, programmierbarer Information, zeitlicher Information und einem Batteriezustand umfasst.

- 20 **9.** System nach Anspruch 8, **dadurch gekennzeichnet, dass** die Information physiologische Information darstellt, die zumindest eins umfasst aus einer Herzfrequenz, eines elektrischen Aktivierungsmusters des Herzens, einer Stärke der Kontraktion des Herzmuskels, einer Gasmenge in der Lunge, einer Herzrasenfrequenz, einer Bradykardiefrequenz, einer Flimmerfrequenz und einer Herzrhythmusstörungsfrequenz.

- 25 **10.** System nach Anspruch 7, **dadurch gekennzeichnet, dass** die Information einen Batteriezustand darstellt, welcher zumindest eins umfasst aus einem Batterieniedrigenergiezustand, einem Batterieinnenwiderstand, einer Anzahl von Lade-/Entladezyklen, Batteriealter, einer Batteriespannung und einem verbleibenden Batterieladezustand.

- 30 **11.** System nach Anspruch 7, **dadurch gekennzeichnet, dass** das Überwachungsmodul geeignet ist, das Fortsetzen des Abfrageprozesses zu verhindern wenn eine Zeitpanne, die seit einer letzten Informationsanforderung abgelaufen ist, kürzer ist als eine Grenzwertzeitspanne oder wenn ein Batterieenergiefüllstand unter einem Batteriegrenzwert liegt.

- 35 **12.** System nach einem der Ansprüche 7 bis 11, **dadurch gekennzeichnet, dass** die implantierbare Einrichtung (12) zumindest eins darstellt aus einem Herzschrittmacher, einem implantierbaren Kardioverter-Defibrillator und einem Defibrillator.

- 40 **13.** System nach einem der Ansprüche 7 bis 12, **dadurch gekennzeichnet, dass** das Überwachungsmodul einen Zeitspannungsgrenzwert dynamisch auf einen neuen Wert basierend auf einem Energiefüllstand einer Batterie (42) innerhalb der implantierbaren Einrichtung (12) aktualisiert.

Revendications

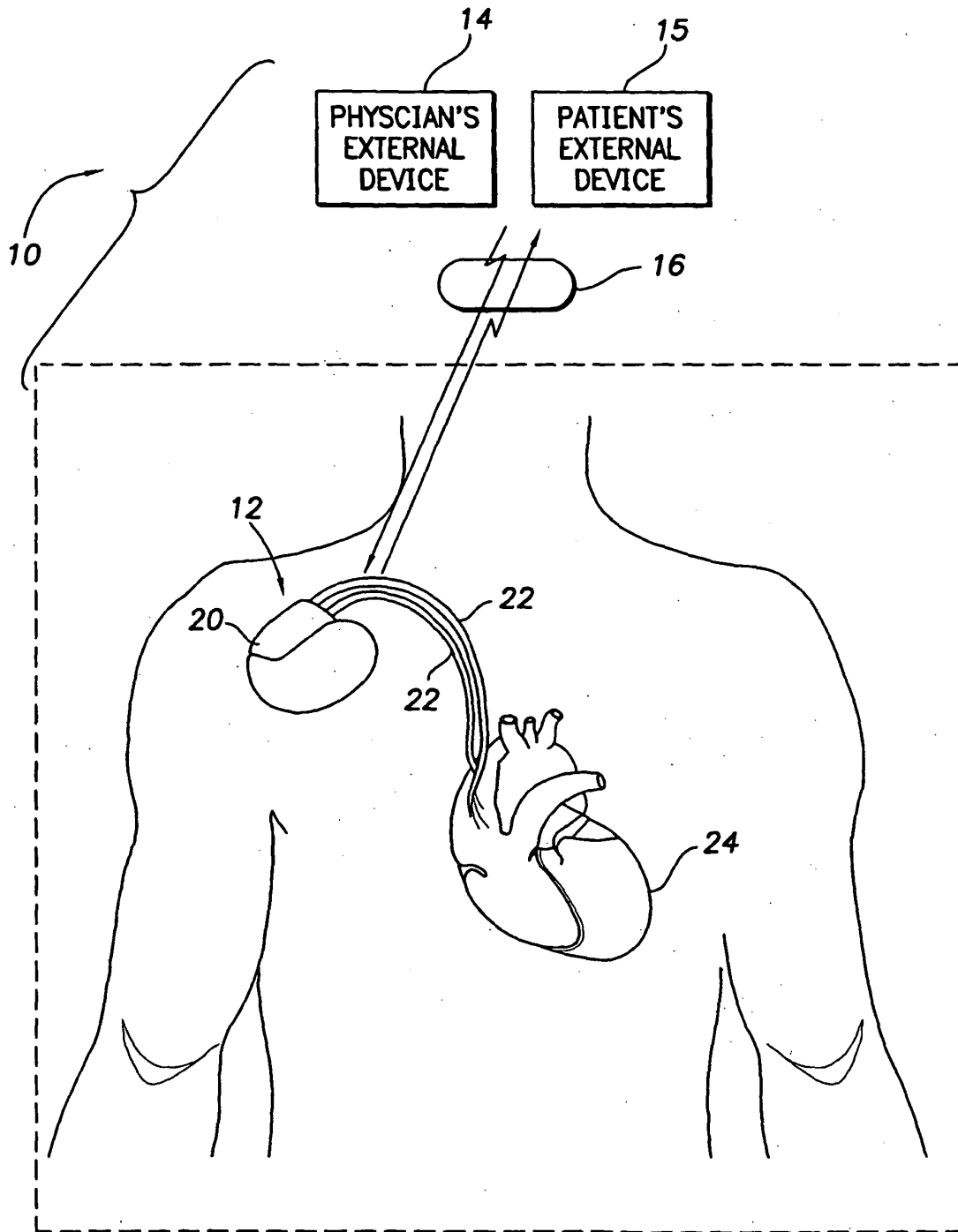
- 45 **1.** Procédé pour commander l'interrogation d'un dispositif implantable en utilisant un dispositif externe, comprenant les étapes consistant à :

recevoir une demande actuelle d'informations à récupérer auprès d'un dispositif implantable ;
déterminer un historique temporel des interrogations précédentes du dispositif implantable ;
transmettre les informations du dispositif implantable au dispositif externe,
55 et **caractérisé par** l'étape consistant à permettre que le processus d'interrogation se poursuive sur la base d'une comparaison de l'historique temporel des interrogations précédentes avec la demande actuelle d'informations.

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2. Procédé selon la revendication 1, **caractérisé en ce que** la transmission des informations comprend la lecture des informations dans un emplacement de mémoire dans le dispositif implantable.
- 5 3. Procédé selon la revendication 1 ou la revendication 2, **caractérisé en ce que** la détermination d'un historique temporel des interrogations précédentes est effectuée par le dispositif externe et / ou par le dispositif implantable.
- 10 4. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** les informations comprennent au moins l'une d'informations physiologiques, d'informations programmables, d'informations de synchronisation et d'une condition de batterie.
- 15 5. Procédé selon l'une quelconque des revendications précédentes, **caractérisé par** l'étape consistant à empêcher la transmission des informations lorsqu'un niveau de puissance de batterie est inférieur à une valeur de seuil de batterie.
- 20 6. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le dispositif implantable constitue au moins l'un d'un stimulateur cardiaque, d'un défibrillateur automatique implantable et d'un défibrillateur.
- 25 7. Système pour commander l'interrogation d'un dispositif implantable (12) en utilisant un dispositif externe (14, 15), comprenant :
- un module (40) adapté pour recevoir une demande actuelle d'informations à récupérer auprès du dispositif implantable ;
- un module de surveillance (36) adapté pour enregistrer un historique temporel des interrogations précédentes du dispositif implantable ; et
- une unité de télémétrie (70) pour établir une liaison de communication sans fil (16) avec le dispositif externe,
- caractérisé en ce que** le module de surveillance (36) est adapté pour décider s'il convient de permettre que le processus d'interrogation se poursuive sur la base d'une comparaison de l'historique temporel des interrogations précédentes avec la demande actuelle d'informations.
- 30 8. Système selon la revendication 7, **caractérisé en ce que** les informations demandées comprennent au moins l'une d'informations physiologiques, d'informations programmables, d'informations de synchronisation et d'une condition de batterie.
- 35 9. Système selon la revendication 8, **caractérisé en ce que** les informations constituent des informations physiologiques qui comprennent au moins l'un d'un rythme cardiaque, d'un modèle d'activation électrique du coeur, d'une intensité de contraction du muscle cardiaque, d'une quantité de fluide dans les poumons, d'un rythme de tachycardie, d'un rythme de bradycardie, d'un rythme de fibrillation et d'un rythme d'arythmie.
- 40 10. Système selon la revendication 7, **caractérisé en ce que** les informations constituent une condition de batterie qui comprend au moins l'un d'un état de faible puissance de batterie, d'une résistance interne de batterie, d'un nombre de cycles de charge / décharge, d'un âge de batterie, d'une tension de batterie et d'une charge restante de batterie.
- 45 11. Système selon la revendication 7, **caractérisé en ce que** le module de surveillance est adapté pour empêcher que le processus d'interrogation se poursuive lorsqu'une période de temps écoulée depuis une dernière demande des informations est plus courte qu'une période de temps de seuil ou lorsqu'un niveau de puissance de batterie est inférieur à une valeur de seuil de batterie.
- 50 12. Système selon l'une quelconque des revendications 7 à 11, **caractérisé en ce que** le dispositif implantable (12) constitue au moins l'un d'un stimulateur cardiaque, d'un défibrillateur automatique implantable et d'un défibrillateur.
- 55 13. Système selon l'une quelconque des revendications 7 à 12, **caractérisé en ce que** le module de surveillance met à jour dynamiquement une période de temps de seuil à une nouvelle valeur sur la base d'un niveau de puissance d'une batterie (42) dans le dispositif implantable (12).

FIG. 1



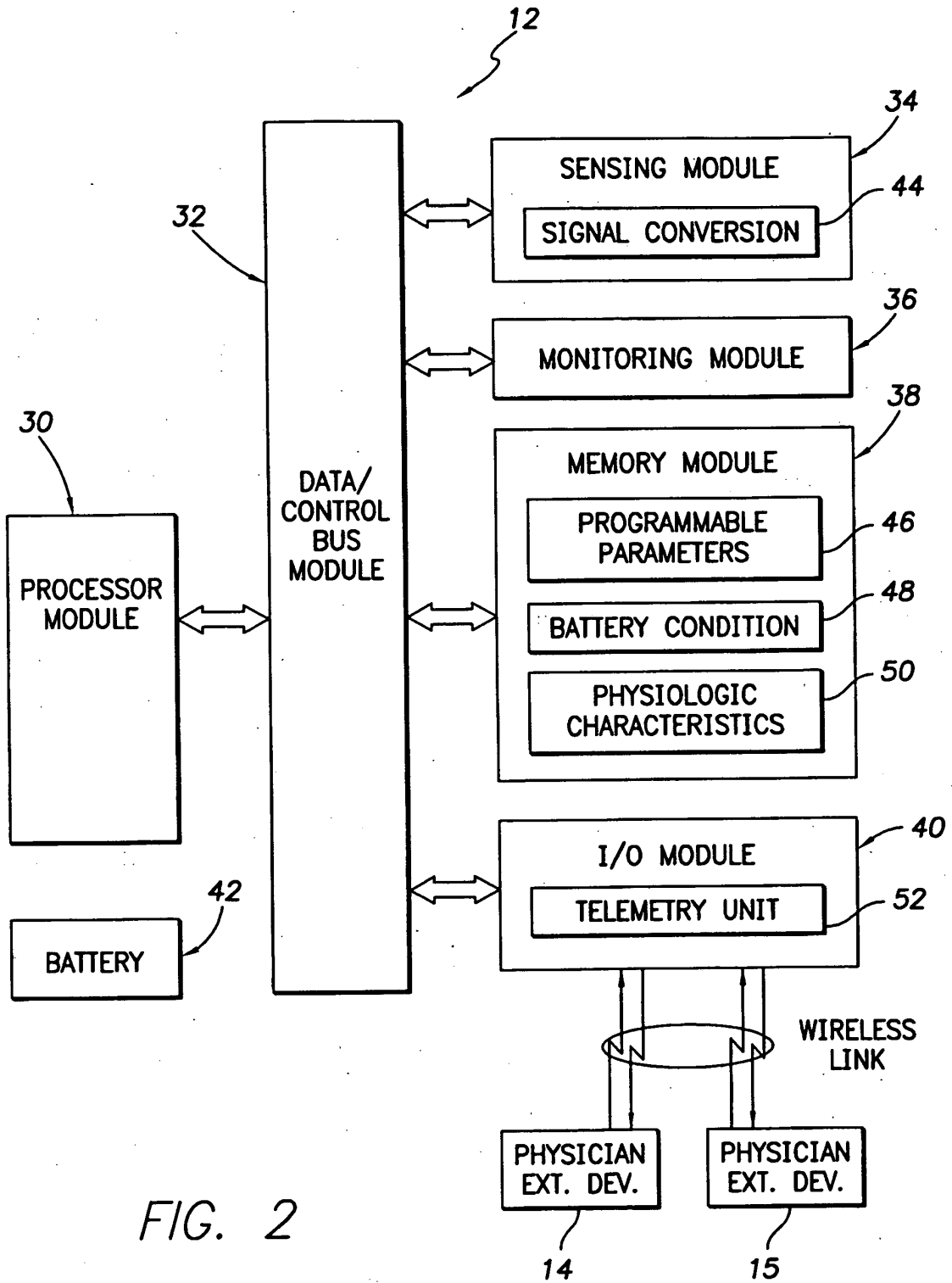


FIG. 2

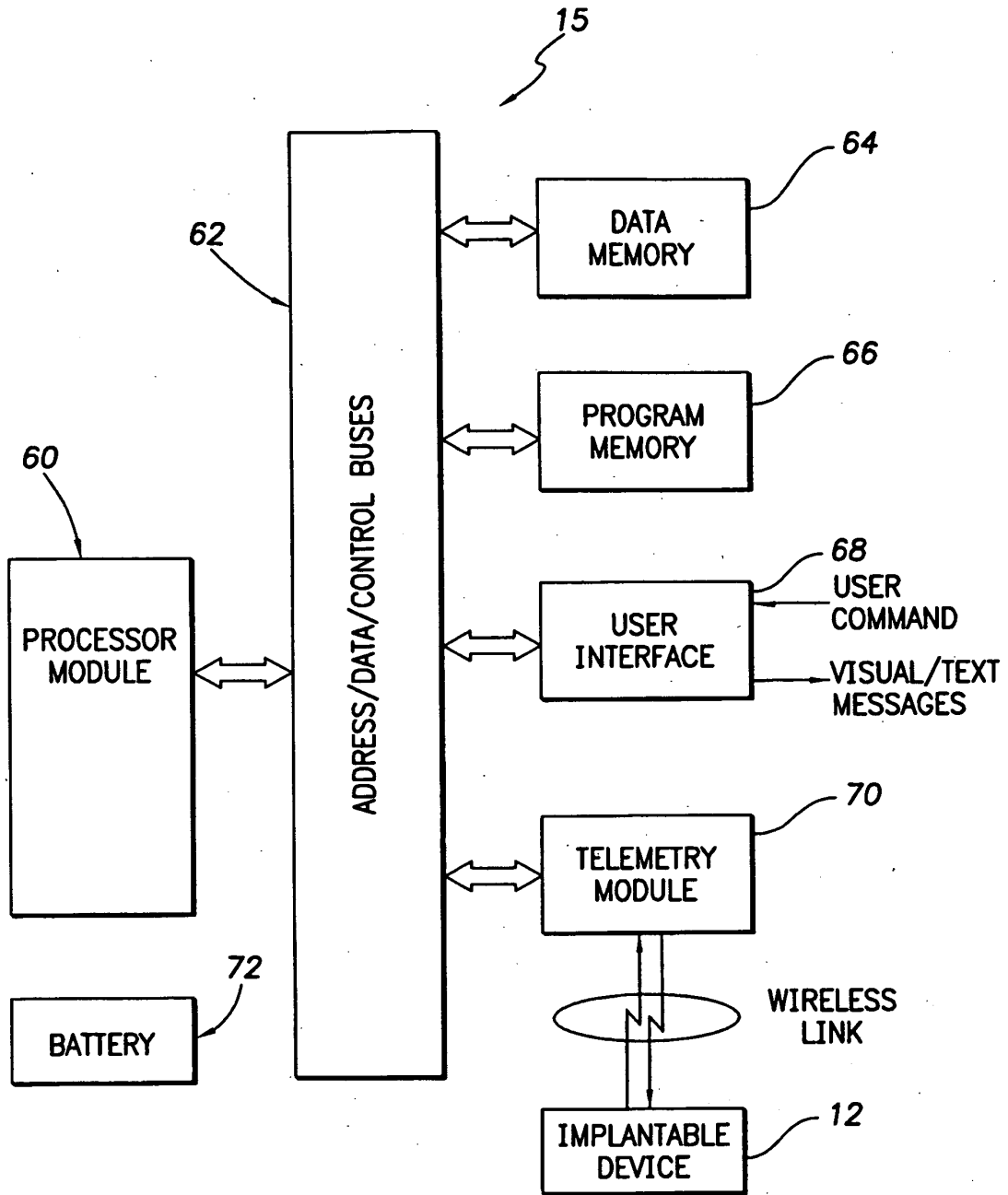
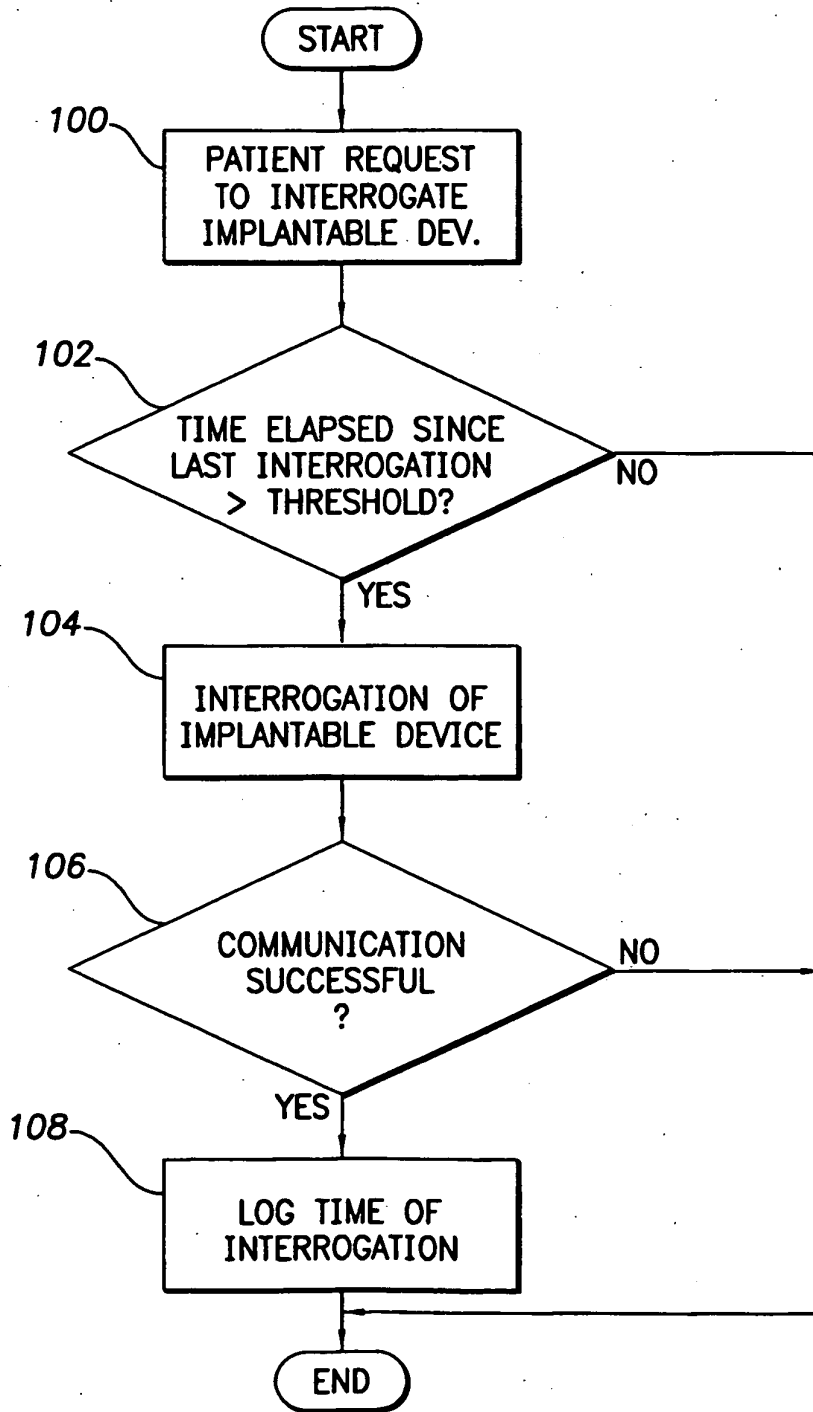


FIG. 3

FIG. 4



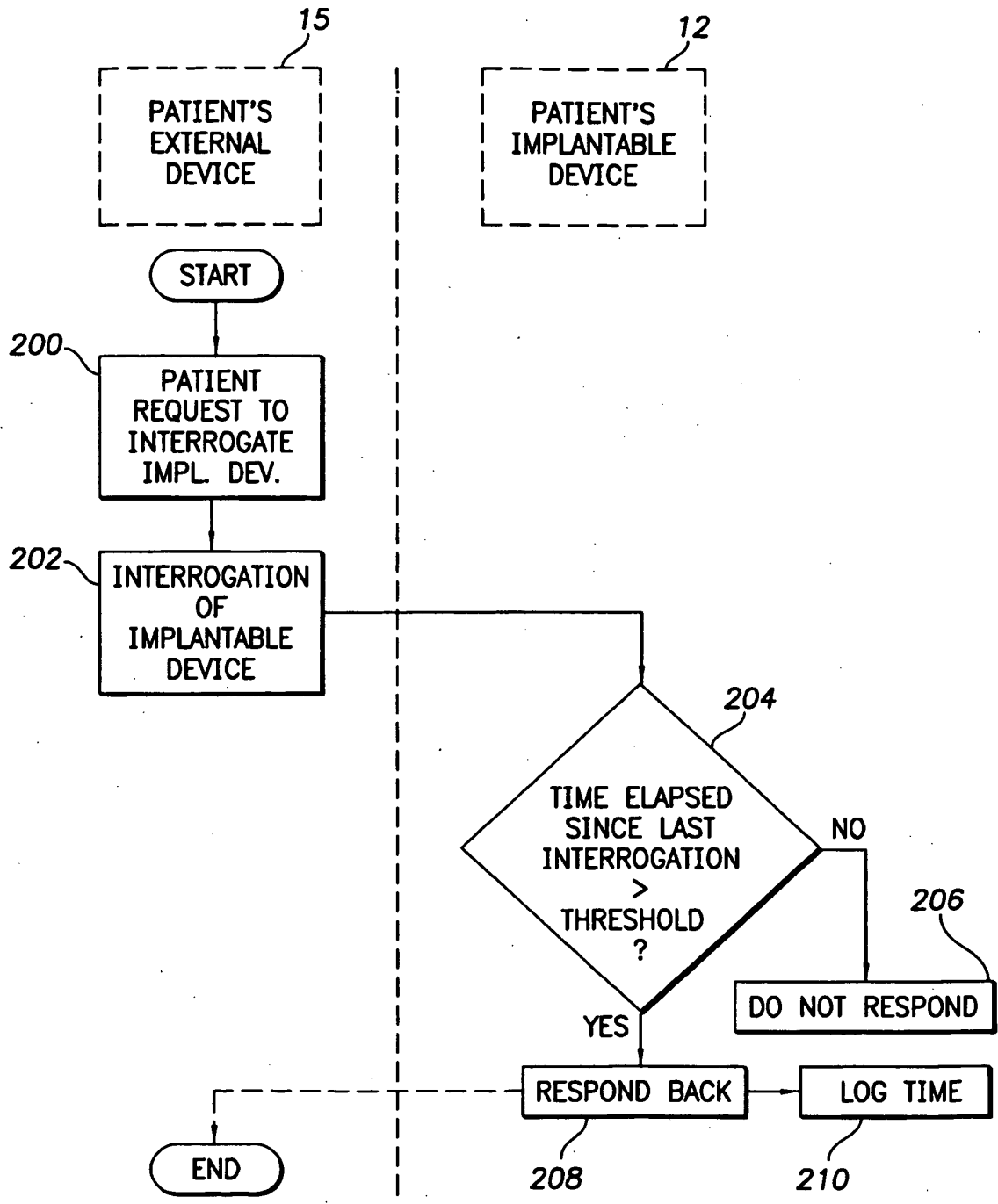


FIG. 5

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 20030028184 A1 [0006]

专利名称(译)	用于防止可植入设备的过度功耗的方法和设备		
公开(公告)号	EP1913970B1	公开(公告)日	2009-08-12
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当前申请(专利权)人(译)	PACESETTER, INC.		
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摘要(译)

提供了一种用于在家庭环境中利用外部设备 (15) 控制可植入设备 (12) (例如起搏器 , 可植入心律转变器或除颤器) 的询问的方法和设备。该方法基于自上次询问起经过的时间段和电池的功率水平来控制患者从可植入设备检索状态信息的频率 (42) 。

