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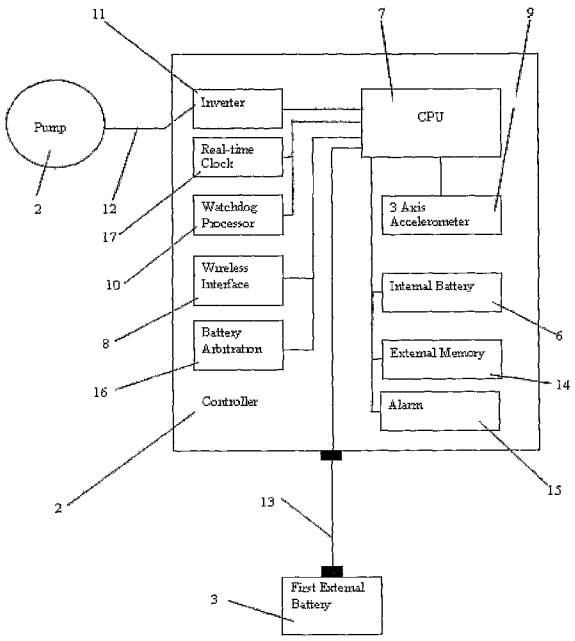
(54) Title: IMPROVEMENTS TO CONTROL SYSTEMS AND POWER SYSTEMS FOR ROTARY BLOOD PUMPS



(57) Abstract: A control and power system for a high drain implantable medical device. The system includes a controller and at least one external power source adapted to be able to be connected to the controller. An internal power source is encapsulated within and integrally connected to the controller, and the internal power source or external power source is capable of powering said high drain implantable medical device.

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IMPROVEMENTS TO CONTROL SYSTEMS AND POWER SYSTEMS FOR ROTARY BLOOD PUMPS

Field of the Invention

The present invention relates to improvements to control and power systems for high drain implantable medical devices.

Background of the Invention

There has been a long felt need to improve control and power systems for high drain medical devices.

In the past, low drain implantable medical devices have utilised internal batteries to overcome the disadvantages of multiple external batteries and external power source. However these low drain implantable medical devices, which generally include pacemakers and other such devices generally only require microwatts of power. Therefore power requirements are very low and batteries are generally small and compact. Also the batteries used in these low drain medical devices are not usually rechargeable because of the long life and low power demands. Such low drain devices include neural simulators, pacemakers and defibrillators such as those described in EP1598092 (Medtronic Inc), US2005131486 (Boveja et al), US2005165456 (Mann et al), US2005131487 (Boveja et al) and WO1998/008567 (Pacesetter).

High drain implantable medical devices generally require a power source in the vicinity of watts rather than microwatts. As the power demands are considerably larger (i.e. million fold larger) the power sources are generally much larger, heavier, bulkier and generally require recharging. An example of a high drain implantable medical

device is a rotary blood pump such as the Ventrassist™ Left Ventricle Assist Device that is implanted within a patient. The Ventrassist™ Left Ventricle Assist Device is described in detail in US Patent 6,227,797 - Watterson et al. To correctly manage such a device, a series of batteries is used, and this battery management is usually critical to health and safety of the implanted patient.

High drain medical devices have used control systems similar to the embodiment depicted in Fig. 1. However, these control systems generally include multiple external batteries and multiple power cords. Multiple power cords may generally confuse patients implanted with such a medical device. If the batteries are incorrectly managed, used or handled the result may lead to: severe adverse events, accidental medical device failure, electrocution, or compromise the health and safety of the implanted patient.

Multiple external batteries results in a disadvantage with battery management for the patient, and typically increases the bulk of the peripherals that patients need to carry with them.

A further disadvantage of prior art power and control systems for high drain implantable medical devices, is that they have poor patient usability. Firstly, many such devices have used bulky batteries such as Nickel Metal Hydride or Lead Acid Batteries, which often requires a patient to carry with them more than 10 kilograms, if they traveled with two battery packs and a mains power transformer. Secondly these prior art power and control systems have not been designed as waterproof or water resistant, thereby requiring a patient to take significant safety precautions to bathe or shower.

This disadvantage often leads to patients avoiding or not showering for fear of interfering with the medical device.

The present invention aims to or at least address or ameliorate one or more of the disadvantages associated with the above mentioned prior art.

Summary **of the Invention**

In accordance with a first aspect the present invention consists of a control and power system for a high drain implantable medical device, wherein the system includes a controller and at least one external power source adapted to be able to be connected to the controller; and wherein an internal power source is encapsulated within and integrally connected to the controller, and said internal power source or external power source is capable of powering said high drain implantable medical device.

Preferably, the internal power source is a battery pack permanently attached to the controller.

Preferably, the controller is disposable.

Preferably, the internal power source and/or the external power source includes rechargeable Lithium Ion batteries.

Preferably, the external power source is either a mains power supply or a battery pack.

Preferably, the controller includes a battery arbitration system.

Preferably, the battery arbitration system swaps between at least the external and internal power sources and outputs a substantially constant voltage.

Preferably, the controller includes a device capable of generating a vibrating alarm.

Preferably, the controller is capable of interacting with external or additional memory.

Preferably, the controller includes a three axis accelerometer.

Preferably, the controller includes a patient entertainment module.

In accordance with a second aspect the present invention consists of a controller for a high drain implantable medical device, said controller having an internal power source capable of powering said high drain implantable medical device, and said controller adapted to be connected to at least one external power source.

Preferably, the controller includes a battery arbitration system that is adapted to swap between the internal power source and the external power source and outputs a substantially constant voltage.

In accordance with a third aspect the present invention consists of a method for controlling and powering a high drain implantable medical device, wherein the method includes a controller and at least one external power source adapted to be able to be connected to the controller; and wherein an internal power source is encapsulated within and integrally joined to the controller, and said internal battery pack or external power source is capable of powering said high drain implantable medical device.

In accordance with a fourth aspect the present invention consists of a control and power system for an implantable rotary blood pump, said system comprising a

controller operably connected to said pump and in use said controller is disposed external of a patient and able to be connected to a first external power source, and a second internal power source disposed within and integrally connected to said controller, and both the first external power source and said second internal power source are each able to individually provide power to said pump, and wherein said controller includes an arbitration system that is adapted to swap between said second internal power source and said first external power source and able to output a substantially constant voltage.

Preferably, said first external power source is either a battery pack or a mains supply.

Preferably, said controller includes a device capable of generating a vibrating alarm.

Preferably, said controller includes a patient entertainment module.

Preferably, said controller includes a three axis accelerometer.

Brief Description of the Drawings

Embodiments of the present invention will now be described with reference to the accompanying drawings wherein:

Fig. 1 depicts a schematic representation of an embodiment of a prior art control and power system; and

Fig. 2 depicts a schematic representation of a first preferred embodiment of the present invention.

Fig. 3 depicts a schematic representation of a second preferred embodiment of the present invention.

Brief Description of the Preferred Embodiments

A control and power system of the prior art is depicted schematically in Fig. 1. Fig. 1 shows an external controller 2 connected to an implanted rotary blood pump 1. The rotary blood pump 1 is functioning as a high drain implantable medical device and is controlled and powered via the controller 2.

Pump 1 is connected to the controller 2 via a percutaneous lead 12. This embodiment depicts an example of the prior art, wherein a first and a second battery pack 3 and 4 are electrically connected to the controller 2 and supply power to the controller 2 which in turn powers the rotary blood pump 1. Additionally, the controller 2 may be also connected a mains power supply or transformer 5 to provide an alternate power source to the first and second battery packs 3 and 4.

The main disadvantage with this configuration is that the patient or nurse may accidentally disconnect all of the power supplies 3, 4 and 5 simultaneously from the controller 2. This disconnection will lead to the rotary blood pump 1 being without power for a period of time. Typically, it is undesirable for the rotary blood pump 1 to stop or be without power, as this may lead to thrombogenesis within the pump or haemolysis when the pump is restarted. Additionally, there is a significant or increased risk of thromboemboli or the patient suffering a stroke.

A first preferred embodiment of the present invention is depicted in Fig. 2. In Fig. 2, a schematic of the controller 2 is shown and includes its preferred components: central processor unit (CPU) 7, an inverter 11, a watchdog processor 10, a wireless

interface 8, a 3-axis accelerometer 9, an internal power source which may be an internal battery pack 6, external memory 14, and an alarm 15.

The controller 2 is preferable connected a cable 13. This cable 13 preferably includes connectors at both ends that are preferably medical grade and water resistant. One of end of the cable 13 is connected to the controller 2 and the opposed end is preferably connected to a first external battery pack 3.

The first external battery pack 3 is preferably a rechargeable Lithium-ion battery pack sealed in a waterproof, and hermetically sealed container. Preferably, the container may include an LED level, which functions as a visual gauge, to allow patient to visually check the amount of remaining charge on the battery. The first external battery pack 3 may be swapped with a mains power transformer (not shown in Fig. 2).

The CPU 7 is a microcontroller specifically designed for DC brushless motor control and is therefore ideally suited for use with the rotary blood pump 2, as depicted in Fig. 1. The CPU 7 preferably includes a simple speed control algorithm to adjust the speed of the rotary blood pump 2 within given parameters. The output or speed signal from the CPU 7 may be sent to an inverter 11 which translates the speed signal into a commutation signal suitable to power or drive the magnetic circuits of a DC brushless motor forming part of the rotary blood pump 2. Preferably, the inverter 11 may be a standard 6-MOSFET 3 phase bridge.

Preferably, the controller 2 includes an improved battery arbitration system 16 which connects to the central processor unit 7. The battery arbitration system 16 may include a DC-DC buck-boost converter. More generally, it may be described as a regulator that may accept an input voltage lower or greater than its regulated output

voltage. Preferably, the battery arbitration logic within the central processor unit 7 is simplified or reduced to a simple diode-OR. Therefore, in situations where there is a dual power supply (i.e. an internal battery pack 6 and an external battery pack 3 as depicted in Fig. 2), power will be drawn from the supply with the higher voltage. The diode-OR in conjunction with the buck boost converter and the intended battery voltages provides the improved battery arbitration. The battery arbitration is designed to preferentially select the primary power source over the reserve power source. This may be achieved by the diode-OR circuit and the fact that the primary sources are all well above the voltage of the reserve. In the event of no primary source, the diode-OR circuit selects the reserve battery. This input is fed into the buck-boost converter. The output of the converter is regulated at 12V. The buckboost regulator isolates the pump from any glitches as a result of swapping power supplies; hence the pump only ever sees a voltage of 12V (this may be set at any different voltage which may be optimal for the pump). The battery arbitration system 16 in this way avoids voltage spikes occurring when the controller 2 decides to swap between power sources. Voltage spikes commonly occur in the prior art embodiment depicted in Fig. 1.

The first preferred embodiment may also include an internal battery charger (not shown). The internal battery charger may ensure that the internal battery pack 6 remains fully charged.

In the first preferred embodiment, the controller 2 includes a three axis accelerometer 9. This three axis accelerometer 9 may be used to assist the controller 2 to determine an appropriate rate responsive control and use the information from the accelerometer 9 to feedback to the speed signal of the rotary blood pump 2. In this way, it may be possible to anticipate patient physiological demand and adjust the medical

device accordingly. Also, the accelerometer 9 may provide important information relating the patient movement in three dimension space as the CPU 7 may also be able to determine if a patient has fallen to the floor and suffered a severe adverse event.

Preferably, the controller 2 also may include an external memory 14. This external memory 8 is preferably 8 megabytes of flash memory. This flash memory stores data logged from the CPU 7. The data generally includes: errors messages, physiological information relating to the patient, data collected by the rotary blood pump 1, data from the accelerometer 9 and time/date information. A person skilled in the art will appreciate that the flash memory may be replaced with other forms of memory including but not limited to hard drives and generic memory cards.

Preferably, the short term data and long term data are both stored in a rolling format within the external memory 14. The short term data is generally of a relatively high resolution in regard to data per time, whilst the long term data is generally of a lower resolution when compared the short term data.

The controller 2, depicted in Fig. 2, includes a watchdog processor 10. This watchdog processor 10 includes a timing circuit and constantly monitors the central processor unit 7. In the case of a failure of the CPU 7, the watchdog processor 10 may trigger the alarm 15 and may also attempt to reset the central processor 7. A real-time clock 17, included within the controller 2, monitors time, even when system is powered down, or on failure of the processor and cooperates with the watchdog processor 10 to ensure that the CPU 7 is working correctly. The watchdog processor 10 is preferably powered by the internal battery pack 6.

The controller 2 may also include an alarm 15. This alarm 15 may be preferably initiated by, any combination of the following events or factors: detection of failure of the CPU 7 by the watchdog processor 10, detection of an adverse event affecting the patient by the CPU 7, electrical or mechanical failure of the rotary blood pump 1, or low power alarm if the power inputted from the first external battery pack 3 or mains power supply (not shown) falls below a predetermined level. Alarm may also be triggered by Graphical User Interface (herein referred as to 'GUI') software running on an external computer (not shown). The alarm may be audible and/or visual (for example a flashing LED). Additionally, the controller 2 may include a vibrating alarm to allow the patient to feel the alarm irrespective of the level of background noise or light. The vibrating alarm may be achieved by attaching a small motor to the controller 2 and attaching an eccentrically weighted arm to a rotor of the motor. When in use, the spinning motion of the arm will cause the controller 2 to vibrate and immediately alert the patient to the problem.

The controller 2 may also include a wireless interface 8 for interfacing with external computers (not shown) and GUI software running on those computers. The communication to the GUI may be implemented by a wireless network protocol. The most preferred wireless network protocol for this application is one known as Zigbee™. The Zigbee™ protocol is a standard wireless networking protocol to the specifications of IEEE 802.15.4. However it may also be possible to use other standard wireless protocols including but not limited to: Bluetooth™ and low bandwidth proprietary protocols.

Preferably, the controller 2, cables 12 and 13, and the external power sources, including battery pack 3 and mains power transformer (not shown), are waterproof or substantially water resistant. This waterproofing or water resistance may allow patient's to use the device and the control system in aqueous or humid environments. These environments may include: showers, bathing, and/or swimming and may grant the patient increased mobility and freedom to undertake activities that would otherwise be impossible or impractical.

Preferably, according to the first embodiment of the present invention, the internal battery pack 6 is not removable or replaceable from the controller 2. The internal battery pack 6 is integrally permanently joined to the controller 2 to prevent or resist accidental disconnection. As a result of the internal battery pack 6 being permanently joined to the controller 2, the controller 2 is preferably disposable. This may allow the patient to replace the internal battery pack 6 only by complete replacement of the controller 2.

A second preferred embodiment of the present invention is depicted in Fig. 3. In this second preferred embodiment, the alarm 15 has integrated with the first external battery pack 3. This alarm 15 may still be remotely operated by the CPU 7. However the internal battery pack 3 may be visual and audible to the patient. This may greatly improve the effectiveness of the alarm 15.

Additionally, cable 13 has been replaced with a dual cable allowing simultaneous connection of a mains power supply 18 and first external battery pack 3. The battery arbitration system 16 may still preferably switch between all of the batteries depending which power source has the largest voltage.

Any number of external power sources may connected to the controller 2 with small modification to the first or second preferred embodiments.

A further improvement depicted in the second preferred embodiment of the present invention is the inclusion of a patient entertainment module 19. The patient entertainment module 19 may include any electronic circuit designed to entertain the patient using the controller 2 or implanted with the medical device.

The patient entertainment module 19 may include, but is not limited to: an MP3 player, a personal organiser, electronic games, a video player or a miniaturised DVD player. Preferably, the patient entertainment module 19 requires a relatively low power requirement when compared to the medical device.

The patient entertainment module 19 may be powered by any one of power supplies of controller 2 as arbitrated by the battery arbitration system 16. The patient entertainment module 19 may also interact with the external memory 14 which may allow the uploading of information, or data programming to the patient entertainment module 19.

The above descriptions detail only some of the embodiments of the present invention. Modifications may be obvious to those skilled in the art and may be made without departing from the scope and spirit of the present invention.

CLAIMS:

1. A control and power system for a high drain implantable medical device, wherein the system includes a controller and at least one external power source adapted to be able to be connected to the controller; and wherein an internal power source is encapsulated within and integrally connected to the controller, and said internal power source or external power source is capable of powering said high drain implantable medical device.

2. The control and power system as claimed in claim 1, wherein the internal power source is a battery pack permanently attached to the controller.

3. The control and power system as claimed in claim 1, wherein the controller is disposable.

4. The control and power system as claimed in claim 1, wherein the internal power source and/or the external power source includes rechargeable Lithium Ion batteries.

5. The control and power system as claimed in claim 1, wherein the external power source is either a mains power supply or a battery pack.

6. The control and power system as claimed in claim 1, wherein the controller includes a battery arbitration system.

7. The control and power system as claimed in claim 6, wherein the battery arbitration system swaps between at least the external and internal power sources and outputs a substantially constant voltage.

8. The control and power system as claimed in claim 1, wherein the controller includes a device capable of generating a vibrating alarm.

9. The control and power system as claimed in claim 1, wherein the controller is capable of interacting with external or additional memory.

10. The control and power system as claimed in claim 1, wherein the controller includes a three axis accelerometer.

11. The control and power system as claimed in claim 1, wherein the controller includes a patient entertainment module.

12. A controller for a high drain implantable medical device, said controller having an internal power source capable of powering said high drain implantable medical device, and said controller adapted to be connected to at least one external power source.

13. A controller as claimed in claim 13, wherein the controller includes a battery arbitration system that is adapted to swap between the internal power source and the external power source and outputs a substantially constant voltage.

14. A method for controlling and powering a high drain implantable medical device, wherein the method includes a controller and at least one external power source adapted to be able to be connected to the controller; and wherein an internal power source is encapsulated within and integrally joined to the controller, and said internal battery pack or external power source is capable of powering said high drain implantable medical device.

15. A control and power system for an implantable rotary blood pump, said system comprising a controller operably connected to said pump and in use said controller is disposed external of a patient and able to be connected to a first external power source,

and a second internal power source disposed within and integrally connected to said controller, and both the first external power source and said second internal power source are each able to individually provide power to said pump, and wherein said controller includes an arbitration system that is adapted to swap between said second internal power source and said first external power source and able to output a substantially constant voltage.

16. A control and power system for an implantable rotary blood pump as claimed in claim 15, wherein said first external power source is either a battery pack or a mains supply.

17. A control and power system for an implantable rotary blood pump as claimed in claim 15, wherein said controller includes a device capable of generating a vibrating alarm.

18. A control and power system for an implantable rotary blood pump as claimed in claim 15, wherein said controller includes a patient entertainment module.

19. A control and power system for an implantable rotary blood pump as claimed in claim 15, wherein said controller includes a three axis accelerometer.

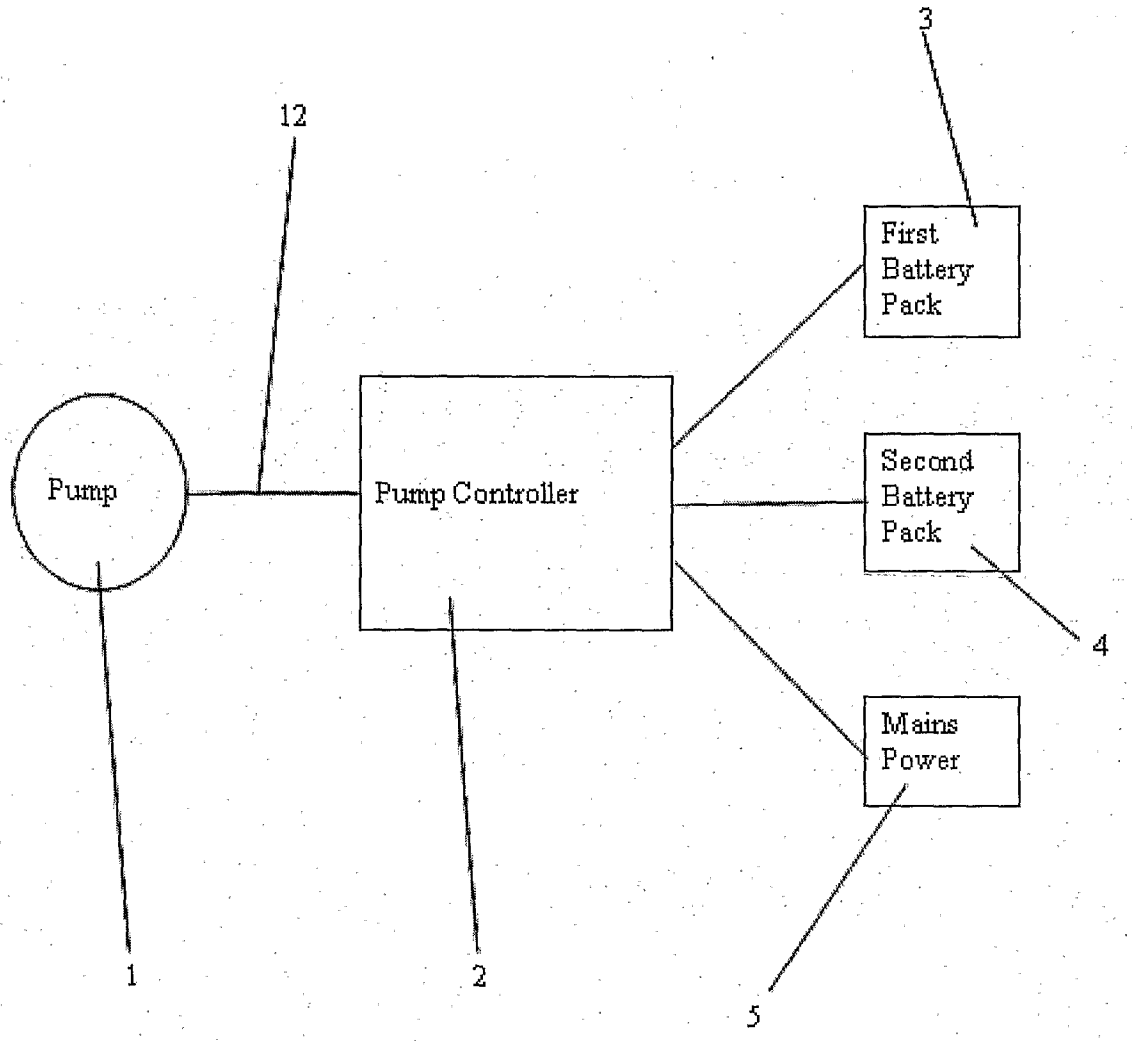

Fig. 1 (Prior Art)

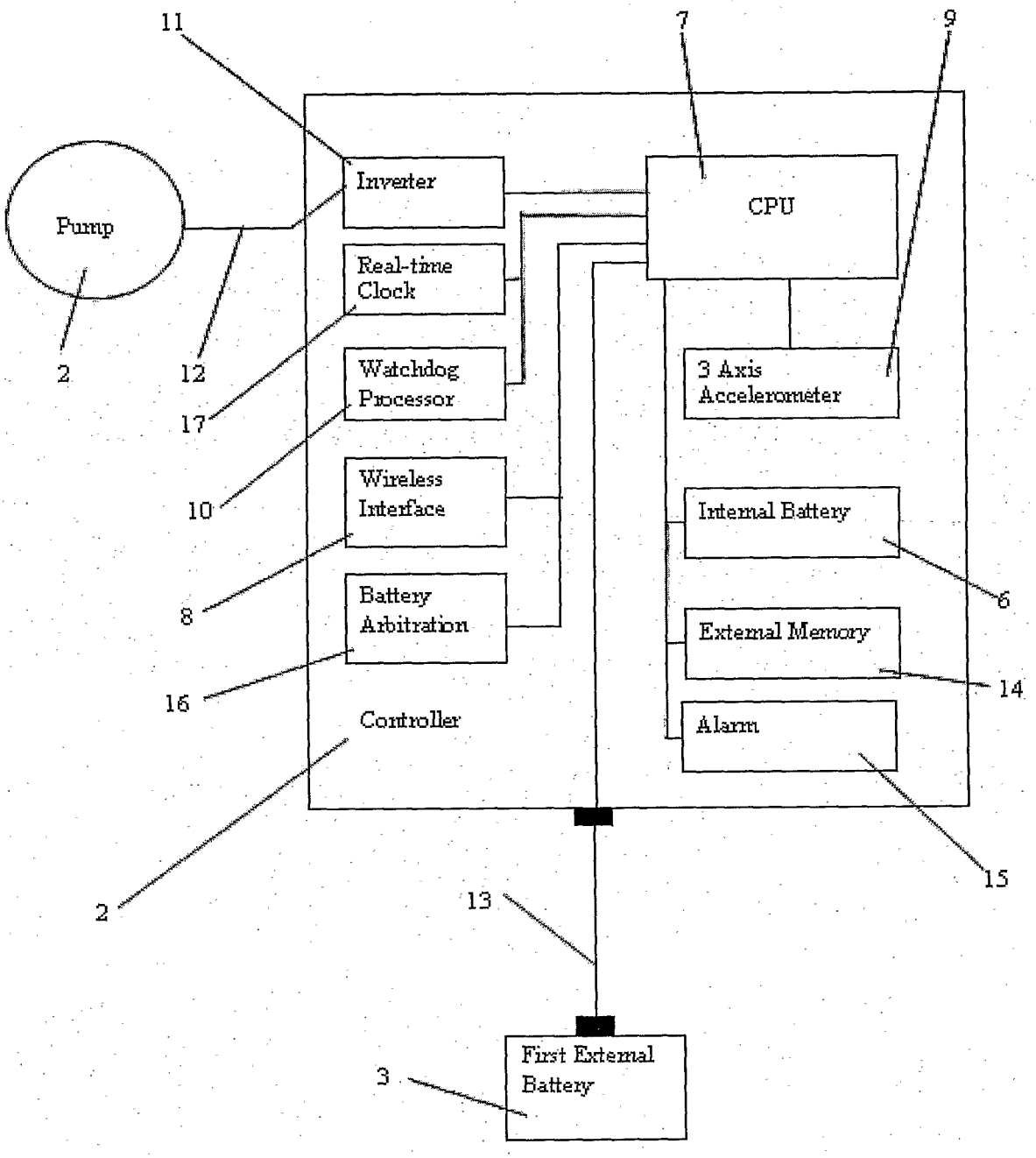
11
7
9
Inverter
CPU
Pump
Real-time Clock
2
12
Watchdog Processor
3 Axis Accelerometer
17
10
Wireless Interface
Internal Battery
6
8
Battery Arbitration
External Memory
14
16
Controller
Alarm
2
15
13
First External Battery
3

Fig. 2

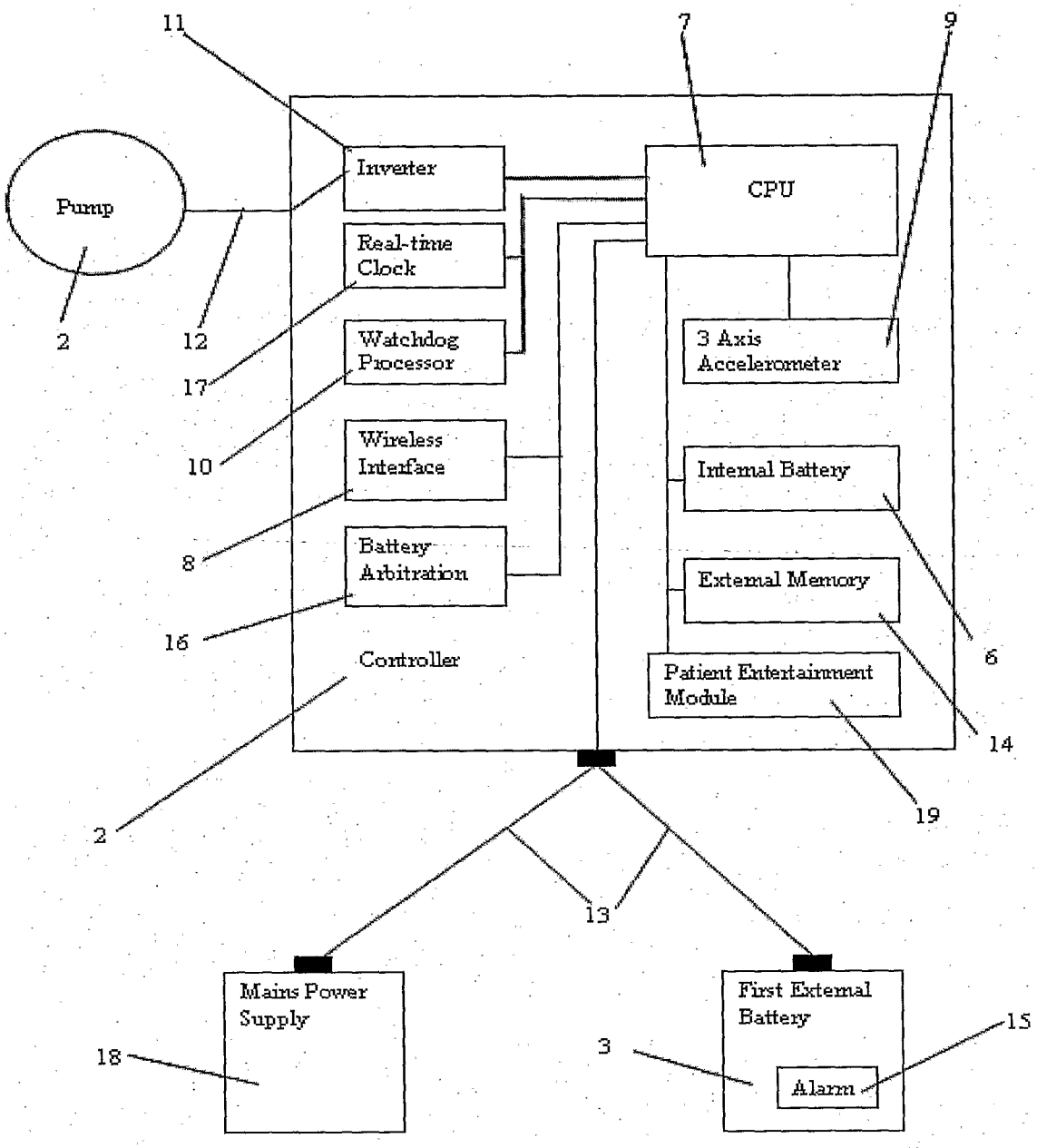
11
7
9
Pump
Inverter
CPU
Real-time Clock
Watchdog Processor
3 Axis Accelerometer
Wireless Interface
Internal Battery
Battery Arbitration
External Memory
Patient Entertainment Module
Controller
2
12
17
10
8
16
6
14
19
2
13
Mains Power Supply
First External Battery
Alarm
18
3
15

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2006/001592

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

A61N 1/378 (2006.01) *A61M1/12* (2006.01)
A61H 31/00 (2006m) *A61N 1/362* (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

DWPI: keywords: implant, battery, power, control, regulate, internal, encapsulate, inbuilt, enclosed, external and similar terms.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	EP 1598092 A2 (MEDTRONIC INC) 23 November 2005 Whole document	1-10, 12-17, 19
X	US 2004171904 A1 (FRENCH ET AL) 2 September 2004 Whole document	1-10, 12-17, 19

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
09 November 2006	28 NOV 2006

Name and mailing address of the ISA/AU	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2006/001592

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2005131486 A1 (BOVEJA ET AL) 16 June 2005 Whole document	1-10, 12-17, 19
X	US 2005165456 A1 (MANN ET AL) 28 July 2005 Whole document	1-10, 12-17, 19
X	US 2005 13 1487 A1 (BOVEJA ET AL) 16 June 2005 Whole document	1-10, 12-17, 19
X	WO 1994/002101 A1 (VASCOR INC) 3 February 1994 Whole document	1-10, 12-17, 19
X	WO 1995/007109 A1 (OTTAWA HEART INST RESEARCH CORPORATION) 16 March 1995 Whole document	1-10, 12-17, 19
X	WO 1998/008567 A1 (PACESETTER) 5 March 1998 Whole document	1-10, 12-17, 19
A	EP 1048324 A2 (MEDTRONIC INC) 2 November 2000 Whole document	
A	FR 2658084 A (CHOUARD ET AL) 16 August 1981 Whole document	
A	DE 3344642 A1 (MIROWSKI) 20 June 1984 Whole document	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2006/00 1592

Box No. **II** **Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [L] Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. [ ] Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. [ ] Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. Ill **Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

See extra sheet.

1. [ ] As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. [X] As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

[ ] The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

[ ] The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the tune limit specified in the invitation.

[ ] No protest accompanied the payment of additional search fees.

Supplemental Box
(To be used when the space in any of Boxes I to VIII is not sufficient)

Continuation of Box No: **III**

This International Application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept.

In assessing whether there is more than one invention claimed, I have given consideration to those features which can be considered to potentially distinguish the claimed combination of features from the prior art. Where different claims have different distinguishing features they define different inventions.

This International Searching Authority has found that there are different inventions as follows:

- Claims 1-11 and 14 are directed to a control and power system. It is considered that the internal power source being encapsulated within and integrally connected to the controller comprises a first distinguishing feature.

- Claims 12-13 are directed to a controller. It is considered that the controller having an internal power source capable of powering said high drain implantable medical device comprises a second distinguishing feature.

- Claims 15-19 are directed to a control and power system for an implantable rotary blood pump. It is considered that the controller including an arbitration system that is adapted to swap between said second internal power source and said first external power source and able to output a substantially constant voltage comprises a third distinguishing feature.

PCT Rule 13.2, first sentence, states that unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. PCT Rule 13.2, second sentence, defines a special technical feature as a feature which makes a contribution over the prior art.

Each of the abovementioned groups of claims has a different distinguishing feature and they do not share any feature which could satisfy the requirement for being a special technical feature. Because there is no common special technical feature it follows that there is no technical relationship between the identified inventions. Therefore the claims do not satisfy the requirement of unity of invention *a priori.*

The International Searching Authority believes that a search and examination for the second and third invention will not involve more than negligible additional search and examination effort over that for the first invention and so no additional search fees are required in order to search and examine those inventions.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU2006/001592

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
EP	1598092	EP	1283732	WO	2001/083029		
US	2004171904	US	6723039	US	7037253	US	2002161274
US	2005131486	US	6205359	US	6356788	US	6366814
		US	6505074	US	6564102	US	6611.715
		US	6615081	US	6668191	US	6879859
		US	7062330	US	7076307	US	2001002441
		US	2001003799	US	2003212440	US	2005004621
		US	2005131487	US	2005137644	US	2005143787
		US	2005149146	US	2005154426	US	2005165458
		US	2005209654	US	2005216070	US	2006004423
		US	2006009815	US	2006122660	US	2006129205
		US	2006217782				
US	2005165456	EP	1711222	US	2005136385	WO	2005/062823
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		US	6615081	US	6668191	US	6879859
		US	7062330	US	7076307	US	2001002441
		US	2001003799	US	2003212440	US	2005004621
		US	2005131486	US	2005131487	US	2005137644
		US	2005143787	US	2005149146	US	2005154426
		US	2005165458	US	2005209654	US	2005216070
		US	2006004423	US	2006009815	US	2006122660
		US	2006129205	US	2006217782		
US	2005131487	EP	1711222	US	2005136385	WO	2005/062823
		US	6205359	US	6356788	US	6366814
		US	6505074	US	6564102	US	6611715
		US	6615081	US	6668191	US	6879859
		US	7062330	US	7076307	US	2001002441
		US	2001003799	US	2003212440	US	2005004621
		US	2005131486	US	2005165456	US	2005137644
		US	2005143787	US	2005149146	US	2005154426
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Inèrna tional application No.
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WO	1995/007109	AU	76074/94	CA	2105908	CA	2105935
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EP	1048324		NONE				
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		GB	2133910	IL	70417	JP	59155269
		NL	8304252	US	4488555		

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX