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[11] **3,842,843**

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[54] **BIOGALVANIC POWER SUPPLY DEVICE AND METHOD**

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[51] **Int. Cl.**.. **A61n 1/36**

[58] **Field of Search**..................... 128/419 P, 419 B; 136/86 D, 120 FC

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[57] **ABSTRACT**

A biogalvanic power supply device for an apparatus implanted in a body comprising a cathode placed in the venous circulating stream and an anode placed in subcutaneous tissue of the body. The cathode comprises a platinum material coactable with biological substances in the body when it is placed in the venous circulating system. The anode comprises a material, such as magnesium, which is consumed when implanted in subcutaneous tissue of the body. The anode is placed in the subcutaneous tissue at a distance from the cathode which is effective to preclude inhibiting the action of the cathode as the anode is progressively consumed. An electrical connection is provided between the anode and the cathode for flowing therethrough a current flow.

22 Claims, 2 Drawing Figures

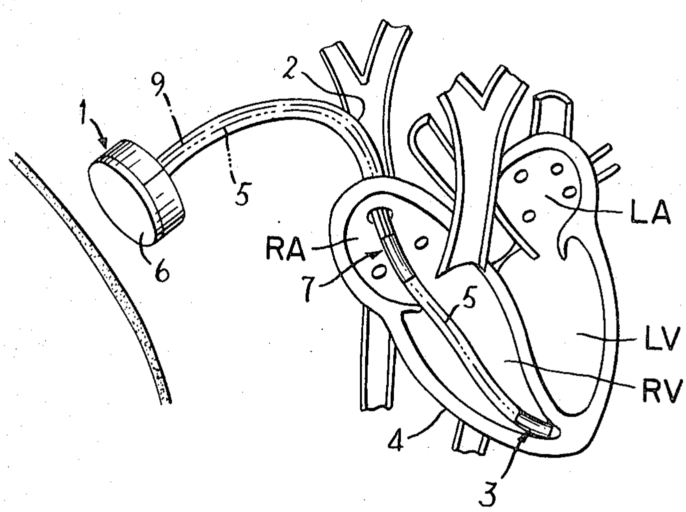


FIG. 1

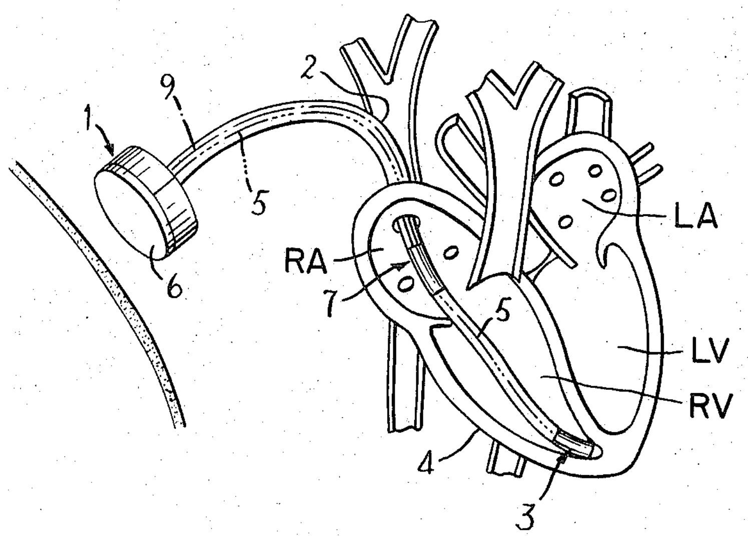
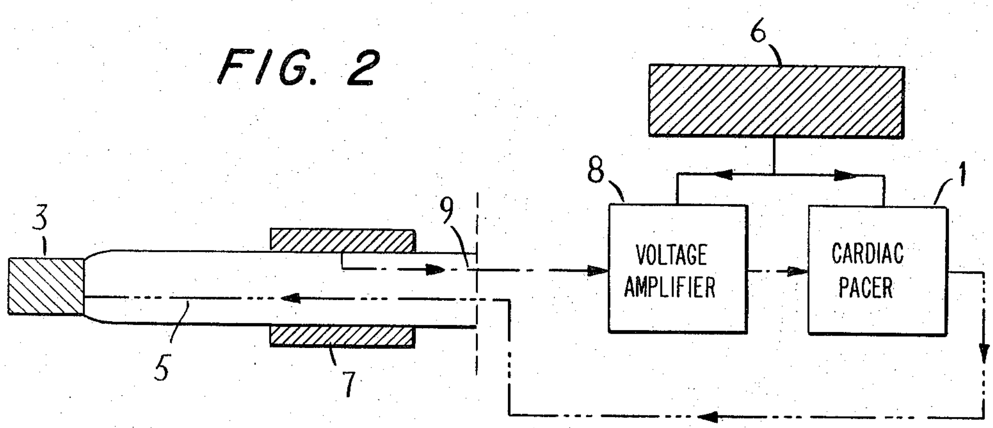

1
9
2
5
6
RA
7
5
LA
LV
RV
4
3

FIG. 2


6
8
1
3
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VOLTAGE AMPLIFIER
CARDIAC PACER
5
7

BIOGALVANIC POWER SUPPLY DEVICE AND METHOD

BACKGROUND OF THE INVENTION

The present invention relates to electrical energy supply devices for cardiac pacer or the like and more particularly to biogalvanic energy supply devices.

DESCRIPTION OF PRIOR ART

Cardiac pacers are electrical devices implanted in the body of a patient for stimulating and regulating the heart beat of the patient. The pacer generally comprises a stimulation electrode implanted in the right ventricle of the heart of the patient and an impulse generator implanted in another part of the body for generating electrical impulses to the stimulation electrode. An electrical energy supply must be provided for supplying electrical power to the impulse generator. These electrical supply devices have a short life span and must be replaced frequently. Also, because of the difficulty of replacing only the electrical supply device, the pacer must be replaced when the electrical supply device is replaced.

Cardiac pacers powered by mercury cells are well known. The mercury cell, and therefore its pacer, has a useable lifespan of from six to eight months and must be replaced during this time period. Surgery is required for removing and replacing the pacer and the mercury cell and the surgery must be preformed in a hospital, is expensive and occasions the risk of infection.

Recently, pacers have been powered by thermoelectric conversion of the heat liberated by a radioisotopic source. These pacers have a much longer life, of the order of ten years, but present a radiation hazard and are only moderately reliable.

SUMMARY OF THE INVENTION

An object of the present invention is to provide an electrical energy supply device for a cardiac pacer having a long life span.

Another object of the present invention is to provide an electrical energy supply device for cardiac pacers which is inexpensive and highly reliable.

The present invention is directed to a biogalvanic electrical supply device for pacers. The biogalvanic electrical supply device has a longer life span than the mercury cell and is less expensive and more reliable than the radioisotopic supply device.

The biogalvanic energy supply device according to the present invention comprises a biogalvanic cell having a platinum cathode and a magnesuim-based alloy anode, each implanted in the body of the patient. The cathode is placed in the returning venous circulatory stream of the heart and the anode is placed in the subcutaneous tissue. A galvanic action occurs with the anode being consumed while the cathode coacts with the biological substances in body to generate an electric potential between the anode and the cathode. An electrical connection is provided between the anode and cathode for flowing a current flow therebetween. Conductors are provided for conducting electric current from the cell electrodes to the pacers. The oxygen in the blood is consumed at the cathode, while the anode dissolves in accordance with Faraday's Law. When the anode is completely dissolved the cell must be replaced. Therefore, the life of the biogalvanic cell is limited only by the loss of mass of the anode.

Compared to the sources of energy presently used to supply pacers, the device according to the invention offers various advantages. It has a longer life span than the mercury cell and therefore need not be replaced as often. Moreover, the mercury cell has a larger volume and a heavier weight than the biogalvanic cell of the present invention.

As compared to the radioisotopic supply device, the biogalvanic cell is less expensive and more reliable. Also, the danger from radiation which is inherent in the radioisotopic supply device is not present in the biogalvanic cell.

BRIEF DESCRIPTION OF THE DRAWING

Other objects and advantages of the biogalvanic supply device in accordance with the invention will appear from the following description of an example of the invention and the novel features will be particularly pointed out in the specification, the pending claims and the drawings in which

FIG. **1** is a schematic representation illustrating a pacer and a biogalvanic supply device implanted in the body of a patient; and

FIG. **2** is a schematic diagram of the pacer and the biogalvanic supply device.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIG. **1**, a pacer **1** is implanted in any part of a patient's body. The pacer **1**, containing regulating and impulse generating circuits (not shown), is connected by a tube **2** to a stimulating electrode **3** implanted at the apex of the right ventricle RV of the heart. The tube **2** is made of a flexible plastic material and is provided therein with an electrical wire **5** for conducting electrical impulses from the pacemaker **1** to the stimulating electrode **3**.

The biogalvanic electrical supply device consists of a biogalvanic cell comprising anode **6** and cathode **7**. It is known that two dissimilar electrodes immersed in an electrolytic solution, provide an electric potential difference at their terminals.

The cathode **7** is a tubular member having, for example, a length of 40 mm., an internal diameter of 4.8 mm., and an external diameter of 5 mm., and may be made of an suitable catalytic depolorizer material. Particularly suitable are platinum iridiumplatinum alloy or iridized platinum, but depolorizing cathodes such as are used in fuel cells will also serve. The tubular cathode is threaded onto a portion of the tube **2** such that it is located in the returning venous circulatory stream when the electrode **3** is inserted into the right ventricle of the heart of a patient. This location is chosen because of the constant value of the blood parameters (ph, PO2). As shown in FIG. **1**, the preferred location for the cathode **7** is the right auricle (RA) of the heart **4**, where the flow of blood passing the cathode will be greatest.

Anode **6** of the biogalvanic cell is made of pure magnesium or a magnesium-based alloy, for example, a magnesium-zirconium alloy having up to 5 percent zirconium by weight, magnesium-manganese alloy having up to 1.5 percent maganese by weight, or a magnesium-aluminium-manganese-zinc alloy having by weight 7.5–9.2 percent aluminum, 0.2–0.8 percent zinc, and

0.12–0.3 percent manganese. The anode can be positioned in any part of the body. However, the preferred site is the deep subcutaneous tissue in proximity to the heart. Cathode **7** should be positioned about 15 cm. from the anode.

While the subcutaneous tissue can tolerate an appreciable mass of a foreign substance, it is desireable to reduce the dimensions of the biogalvanic cell. The desired service life of the cell must also be considered. In one embodiment of the invention, anode **6** is made of a magnesium-manganese alloy in the shape of a disc having a diameter of 30 mm. and a thickness of 5 mm.

By constructing the biogalvanic cell with the galvanic electrodes **6** and **7** as described above an electromotive force in the order of 0.5 volts to 1.2 volts for a current discharge of 200 to 400 microamperes is obtained. By using voltage amplifier circuits the operating voltage of the pacer can be increased to about 5 volts. The cathode **7** is connected to the amplifier **8** by an electric wire disposed within the tube **2**. As shown in FIG. **2**, the amplifier **8** has two leads connected respectively to the anode **6** and cathode **7**. A potential difference between 0.5 and 1.2 volts is obtained between the two leads. The amplifier **8** supplies at its output a voltage of about 5 volts to the pacer **1**. The pacemaker then produces electrical impulses transmitted by wire **5** to the stimulation electrode **3**.

The particular vital requirements which must be satisfied by the device in accordance with the invention are the following:

1. the galvanic electrode materials must not be toxic to the organism; platinum for the cathode and a magnesium-based alloy for the anode as used herein exhibit no toxicity to the organism;
2. the device must be tolerated locally, i.e., tolerance to the isolated metal (spontaneous corrosion in the human body) and tolerance to the biogalvanic phenomenon;
3. the volume and weight of the device must be chosen so as not to restrict the normal function of the heart.

Although the electrical supply device, in the foregoing description, has been particularly conceived as being associated with a cardiac pacer, it is evident that it could likewise supply energy to any other device implanted in the human body. For example, the device according to the present invention can also be used for micro-transmitters used for measuring tension and pressure and also for pacers for sphincters.

We claim:

1. A power supply for use implanted in use in a body for providing power to an apparatus comprising, a biogalvanic cell implantable in a body and comprising a cathode means implantable endocardially in said body and an anode means implantable in subcutaneous tissue of said body at a distance from said cathode means, said cathode means comprising platinum and having a smooth surface coacting electrochemically in use with biological substances in the body and said anode means comprising a material consumed by galvanic action when implanted in said subcutaneous tissue of said body and means electrically connecting said anode means and said cathode means for flowing a current flow therethrough in dependence upon an electric potential between said anode means and said cathode means, said distance between said anode means and said cathode means being a distance effective to preclude inhibiting the action of said cathode means as said anode means is progressively consumed.

2. A power supply device according to claim **1**, wherein said anode material comprises magnesium.

3. A power supply device according to claim **2**, wherein said anode material consists of a magnesium-based alloy.

4. A power supply device according to claim **3**: wherein said magnesium-based alloy anode consists of a magnesium-aluminum alloy comprising 7.5–9.2 percent by weight of aluminum.

5. A power supply device according to claim **3**: wherein said magnesium-based alloy anode consists of magnesium-zirconium alloy comprising 5 percent by weight of zirconium.

6. A power supply device according to claim **3**: wherein said magnesium-based alloy anode consists of magnesium-aluminum-mangese-zinc alloy comprising 7.5–9.2 percent by weight of aluminum, 0.2–0.8 percent by weight of zinc and 0.12–0.3 percent by weight of manganese.

7. A power supply device according to claim **1**, wherein said cathode material consists of iridium platinum.

8. A power supply device for an apparatus for use implanted in a human body comprising, a biogalvanic cell implantable in a body comprising a platinum cathode means having a smooth surface and implantable endocardially in said body and an anode means implantable in subcutaneous tissue of said body, at a distance in the order of at least **15** centimeters from said cathode means, said cathode means comprising a material coacting electrochemically in use with biological substances in the body, and said anode means comprising a material consumed by galvanic action when implanted in said subcutaneous tissue of said body and means electrically connecting the anode means and cathode means for flowing a current flow therethrough in dependence upon an electric potential between said anode means and cathode means.

9. A power supply device according to claim **8**: wherein said cathode material consists of iridium platinum.

10. A power supply device according to claim **8**: wherein said anode material consists of magnesium.

11. In combination: a cardiac pacer implantable in a living human body for regulating the heart beat, said cardiac pacer comprising a stimulator means implantable in the right ventricle of the heart, an impulse generator means implantable in the subcutaneous tissue of the body, a tube connecting said impulse generator means and said stimulator means, and conducting means disposed in said tube for conducting electrical impulses generated by said impulse generator means to said stimulator means; and a biogalvanic cell implantable in said body, connected to and supplying electric energy to said cardiac pacer, said biogalvanic cell comprising a cathode means having a smooth surface and implantable endocardially and an anode means implantable in subcutaneous tissue of said body at a distance in the order of 15 centimeters from said cathode means, said cathode means comprising platinum coacting electrochemically in use with biological substances in the body, and said anode means comprising material consumed by galvanic action when implanted in said subcutaneous tissue of said body and means electrically connecting said anode means and said cathode means for flowing a current flow therethrough in dependence upon an electric potential between said anode means and said cathode means.

12. A combination according to claim **11**: wherein said anode material comprises magnesium.

13. A combination according to claim **12**: wherein said anode material consists of a magnesium-based alloy.

14. A combination according to claim **13**: wherein said magnesium-based alloy anode consists of a magnesium-aluminum alloy comprising 7.5 percent to 9.2 percent by weight of aluminum.

15. A combination according to claim **13**: wherein said magnesium-based alloy anode consists of a magnesium-zirconium alloy comprising 5 percent by weight of zirconium.

16. A combination according to claim **13**: wherein said magnesium-based alloy anode consists of a magnesium-aluminum-manganese-zinc alloy comprising 7.5–9.2 percent by weight of aluminum, 0.2–0.8 percent by weight of zinc and 0.12–0.3 percent by weight of manganese.

17. A combination according to claim **12**: wherein said anode material consists of magnesium.

18. A combination according to claim **11**: wherein said cathode material consists of iridium platinum.

19. A combination according to claim **11**: wherein said anode comprises a disc connected to said impulse generator.

20. A combination according to claim **11**: wherein said cathode comprises a tube disposed circumferentially of said tube connecting said impulse generator and said stimulation and disposed in contact therewith.

21. A combination according to claim **20**: wherein said cathode is disposed in a position along said tube connecting said impulse generator and said stimulator such that said cathode may be disposed in the return venous circulatory stream when said stimulator is disposed in the right ventricle of the heart.

22. A method for supplying power to an apparatus comprising, positioning a platinum cathode having a smooth surface in the venous circulatory stream of a body, positioning an anode comprising a material consumable by galvanic action when implanted in subcutaneous tissue of the body at a distance in the order of at least **15** centimeters from said cathode, electrically connecting said anode and said cathode for flowing a current flow therethrough in dependence upon an electric potential between said anode and said cathode, and electrically connecting said anode and said cathode to an apparatus.

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