United States Patent [19]

Harris et al.

[11] **3,807,411**

[45] **Apr. 30, 1974**

[54] **EXTERNAL CARDIAC PACER WITH SEPARABLE GENERATING AND POWER-PROBE UNITS**

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[22] Filed: **Aug. 16, 1971**

[21] Appl. No.: **171,847**

[52] **U.S. Cl.** ..... **128/419 P**, 128/422

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

[58] **Field of Search** ..... 128/419 R, 419 D, 419 E, 128/419 P, 419 R, 419 S, 421, 422, 423, 404, 405, 406, 410, 420, 2.1 R, 303.13, 172.1, 24.1, 24.5

[56] **References Cited**

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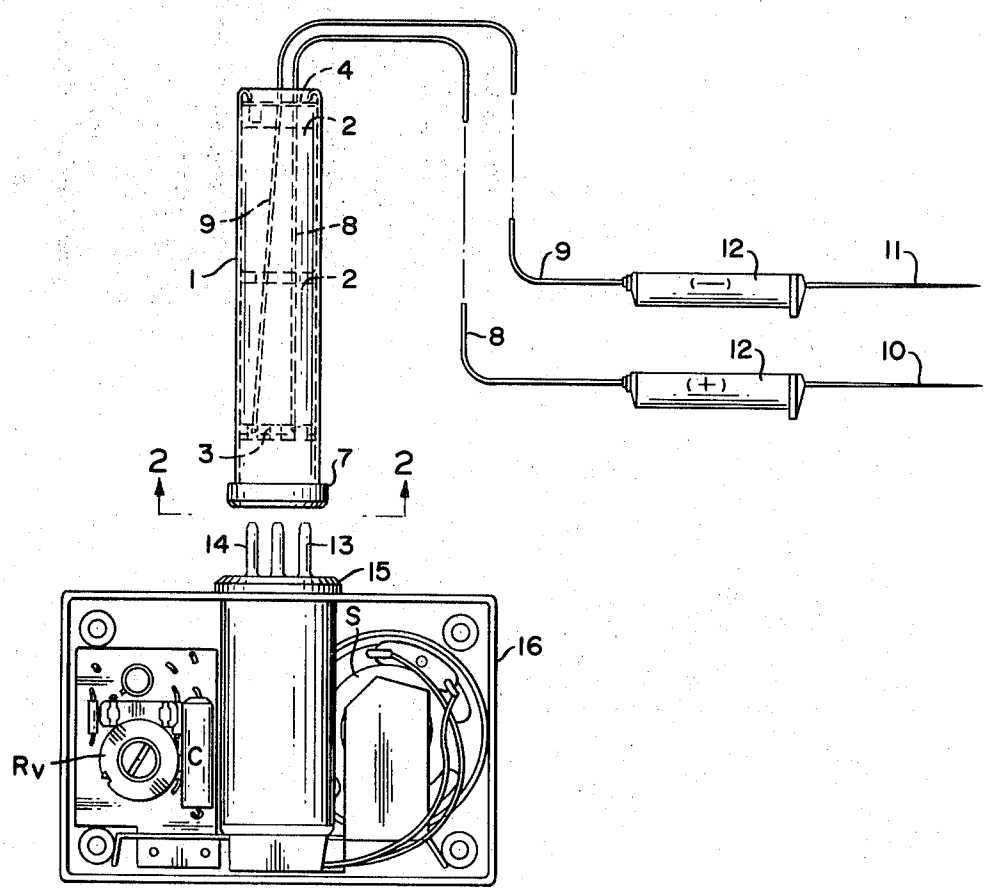
Attorney, Agent, or Firm—Arthur H. Van Horn

[57] **ABSTRACT**

A portable, self-powered, battery operated cardiac pacer comprising a removable plug-in battery and probe package and a main stimulator package, in which the stimulator, when electrically connected with the battery and probe package, will permit the cardiac surgeon to insert the negative probe lead needle into the heart muscle and to insert the positive probe lead needle into the subcutaneous tissue of the heart muscle as a ground, whereupon, in response to a predetermined timed pulse ratio selection, an abrupt short duration pulse is delivered to the heart through the positive probe. This pacer unit has a distinct advantage in that it is readily available for use in open heart procedures for instantaneous pacing either while on bypass or immediately coming off cardiopulmonary bypass when the inherent heart rate may be too slow to either sustain an adequate cardiac output of the slow rate may be associated with bradyarrhythmias. The myocardial, or heart muscle, position of the needle electrode results in a lower stimulation threshold.

4 Claims, 3 Drawing Figures



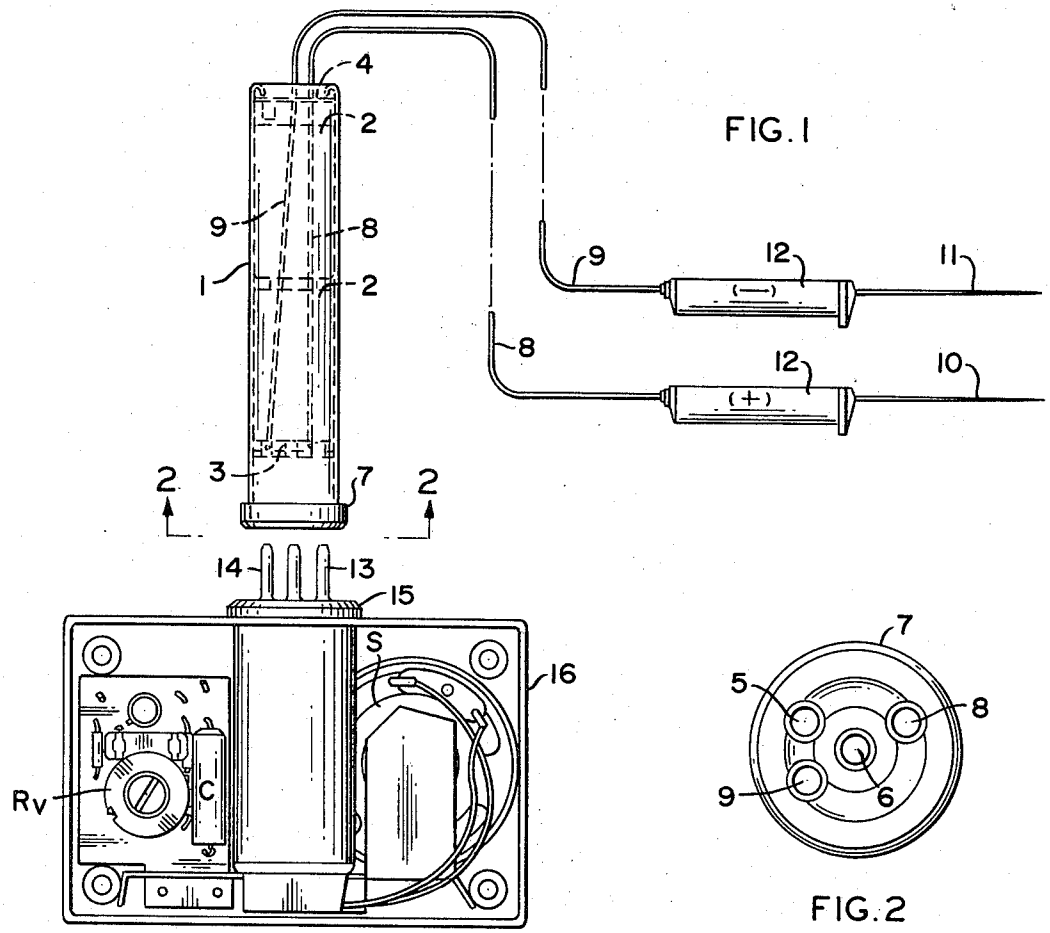


FIG. 1

FIG. 2

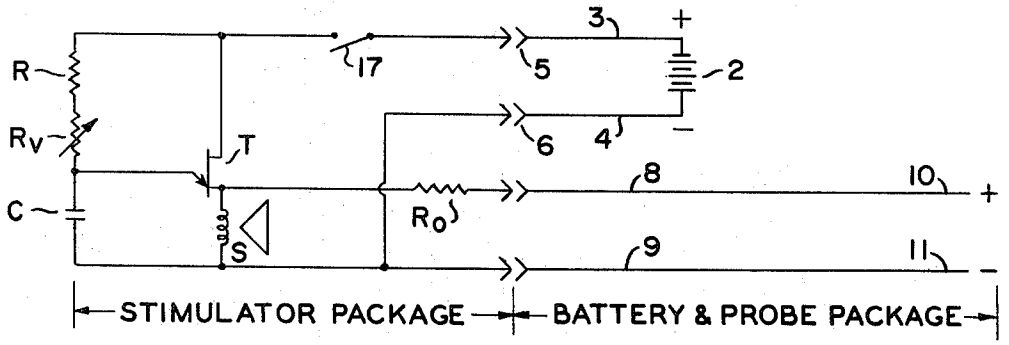


FIG. 3

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EXTERNAL CARDIAC PACER WITH SEPARABLE GENERATING AND POWER-PROBE UNITS

NATURE AND OBJECTS OF THE INVENTION

The cardiac pacer involving this invention is a portable, self-powered, battery operated cardiac pacer of simple construction and comprising two essential units, i.e., a main stimulator package and a battery and probe package, which when removably interconnected is desirable for use not only in cardiac surgery but, with appropriate probes and modifications, may be used effectively for cardiac arrhythmila treatment.

The interconnected units provide an effective and easily available cardiac pacing means which is safe in use and which assures the cardiac surgeon that the heart muscle will contract efficiently immediately after discontinuing the oxygenator during open heart surgery. At this time, the negative lead probe is inserted into the heart muscle and the positive lead probe is inserted into the subcutaneous tissue of the heart muscle as a ground, thus imposing a potential and stimulating pulse of appropriate amplitude and duration to activate the heart muscle.

THE DRAWING

FIG. 1 is an elevation of the units of the complete package, i.e., the battery and probe package and the associated stimulator unit shown electrically disconnected one from the other.

FIG. 2 is a bottom end view of the battery package as viewed in the direction of line 2—2 of FIG. 1.

FIG. 3 is a schematic view of the battery circuits embodied in the stimulator unit and shows also the plug-in power source and probe connection.

DESCRIPTION

The battery and probe package as viewed in FIG. 1 consists of a cylindrical battery casing 1 of dielectric material, closed at one end and in which one or more serially connected battery cells 2 are carried. Positive and negative insulated conductors 3 and 4, respectively, are connected at one end to the positive and negative terminals of the battery unit and to receptacle contacts 5 and 6 carried in the female coupling member 7 mounted in the opposite end of the casing 1.

Insulated probe leads 8 and 9 are electrically connected at one end to probe needles 10 and 11, respectively, through insulated respective finger grips 12, and to receptacle contacts 13 and 14 carried in the male coupling member 15.

The battery power source indicated at 1 and the pulse probe leads 8 and 9 and probe needles 10 and 11 are preferably packaged together in a sterilized disposable package (not shown) and together with the main stimulator 16 package, constitute a compact combination, readily available for use by the operating surgeon. The main stimulator package 16 is suitable for repeated use.

The main stimulator package consists of resistors R and R_p and R_o together with Capacitor C, transistor T and the audio monitor and wave shaping speaker-inductor S.

In use, the battery and probe package 1 is plugged into the stimulator package 16, as illustrated in FIG. 3, with the "on-off" switch 17 in closed position, the battery imposes a potential on transistor T and simultaneously energizes the transistor emitter through resistors R and R_p and capacitor C. As voltage on capacitor C builds up through R and Rv, the emitter of transistor T becomes sufficiently positive to cause transistor T to become conductive, thereby discharging C through T. The time required for this to occur has been determined by the values of R, R_p, and C and is a function of the desired or predetermined pulse repitition rate. In this manner, when T becomes conductive and consequently C discharges an abrupt, short duration pulse appears across the speaker-inductor S giving an audible signal or indication that the instrument is functioning.

Resistor R_o is a limiting resistor to prevent damage to transistor T in the event the instrument operator inadvertently "short circuits" the probes 10 and 11.

In use, during which the negative probe needle 10 is inserted into the heart muscle and the positive probe needle 11 is inserted into the surrounding tissue, the stimulating pulse of appropriate amplitude and duration which is evidenced across the speaker-inductor S, is conducted into resistor R_o to activate heart activity at the desired constant rate, say 85 – 90 beats per minute.

The unit has distinct advantage in that it is readily available for all open heart procedures for instantaneous pacing either while on bypass or immediately coming off cardiopulmonary bypass when the inherent heart rate may be too slow to either sustain an adequate cardiac output or the slow rate may be associated with bradyarrhythmias. The myocardial position of needle electrode results in a lower stimulation threshold. The electrodes are left in place until all coagulation is completed by use of the electrocautery. At this time, pacing wires may then be sewn to the epicardial surface for use in the immediate postoperative period as the needle electrodes are withdrawn. To our knowledge, the only available units at this time are the standard ventricular pacing wires which require suturing to the epicardium. The exposed surface of the wires may provide an electrical hazard because of possible contact with the electrocautery. The wires must be hooked to an intermediary connection before they are attached to the battery source outside of the sterile field. This procedure requires a prolonged period of time as contrasted with the use of the present invention which is of simple construction, safe, inexpensive and has reliable performance.

We claim:

1. A portable, self-powered, battery operated cardiac pacer comprising, in combination, of a pair of complementary interconnecting units comprising a disposable battery and probe package, and a stimulator package electrically and removably interconnectable one with the other, said probe package containing a battery casing, a source of battery enery in said casing, insulated positive and negative probe conductors extending from said casing, plug-in terminals in one end of said casing electrically connected with the respective probe conductors at one end thereof and with said source, a probe needle electrically connected to each of said conductors, respectively, said stimulator package comprising means for electrical interconnection with said terminals, pulse generator means connected to said interconnecting means for generating and delivering a potential through and to said conductors and said probes in the form of a heart stimulating pulse to the heart muscle when said battery and said packages are electrically interconnected, said pulse generator means

comprising a unijunction pulse generator, said probes being oppositely charged such that when said probes are applied to the heart, said probes develop an electrical potential therebetween to activate the heart muscle.

2. The invention defined in claim **1** in which is included means to select the repetitive rate of heart stimulating pulse output of said stimulator package.

3. A portable cardiac pacer comprising a casing, a source of battery power within said casing, plug-in terminals in said casing, certain of said terminals having electrical connection with the terminals of said battery power source, a pair of probe conductors having electrical connection with certain of said plug-in terminals, a pair of probe needles each having electrical connection with one of said probe conductors, a stimulation unit pulse generator means housed within said unit for generating and discharging a pulse potential, said pulse generator means comprising a unijunction pulse generator, plug-in terminals in said unit for electrical interconnection with the respective plug-in terminals carried in said battery power casing to deliver battery power to said pulse generating means and to deliver the generated pulse rate to and through said probe needles, when the respective plug-in terminals are electrically interconnected to develop and electrical potential between said probe needles to activate the heart muscle.

4. The invention defined in claim **3** including means in said stimulator unit for selecting the pulse repetitive rate delivered to and through one of said probe needles inserted into the subcutaneous tissue of the heart muscle and the other of said probe needles is inserted into the heart muscle.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,807,411 Dated April 30, 1974

Inventor(s) Paul D. Harris et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Abstract line 10, delete "ratio" and insert -- rate --.

Column 2, line 54, delete "enery" and insert -- energy --.

Column 4, line 8, delete "and" and insert -- an --.

Signed and sealed this 8th day of October 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

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